RADIO TEST REPORT

Test Report No. 14856180H-A

Customer	**Tokyo Communication Equipment MFG Co.,ltd.**
Description of EUT	**4ch RFID R/W Module**
Model Number of EUT	**PC-1620001 / PC-1040021**
FCC ID	**2ACJJPC1620001**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**August 22, 2023**
Remarks	**-**

Representative test engineer	Approved by
Nachi Konegawa Engineer	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".

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

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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. 14856180H-A

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14856180H-A	August 22, 2023	-

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	Tokyo Communication Equipment MFG Co.,ltd.
Address	3-8-14 Takanawa, Minato-ku, Tokyo 108-0074 Japan
Telephone Number	+81-3-3447-2421
Contact Person	Masaya Mikami

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	4ch RFID R/W Module
Model Number	PC-1620001 / PC-1040021
Serial Number	Refer to SECTION 4.2
Condition	Production model
Modification	No Modification by the test lab
Receipt Date	July 28, 2023
Test Date	July 30 to August 1, 2023

2.2 Product Description

General Specification

Rating	DC 5 V
Operating Temperature	10 deg. C to 50 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.

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	7.67 dB, 13.56000 MHz, QP, Phase L (Mode 3)	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)	66.54 dB, 13.56000 MHz, QP, 0 deg. (Mode 2)	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)	45.01 dB, 14.01000 MHz, QP, 0 deg. (Mode 1)	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)	3.96 dB 81.360 MHz, Horizontal, QP (Mode 2)	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	Conducted
	<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 110 % of the nominal rated supply voltage during frequency tolerance test according to Section 15.225(e).

FCC Part 15.203/212 Antenna requirement

The EUT has a unique coupling/antenna connector.
Therefore the equipment complies with the requirement of 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

Antenna Terminal Conducted Tests

Item	Unit	Calculated Uncertainty (+/-)
Antenna Terminated Conducted Emission / Power Density / Burst Power	dB	3.28
Adjacent Channel Power (ACP)	dB	2.27
Bandwidth (OBW)	%	0.96
Time Readout (Time span upto 100 msec)	%	0.11
Time Readout (Time span upto 1000 msec)	%	0.11
Time Readout (Time span upto 60 sec)	%	0.02
Power Measurement (Power meter)	dB	1.50
Frequency Readout (Frequency counter)	ppm	0.67
Frequency Readout (Spectrum analyzer frequency readout function)	ppm	1.61
Temperature (Constant temperature bath)	deg. C	0.78
Humidity (Constant temperature bath)	%RH	2.80
Modulation Characteristics	%	6.93
Frequency for Mobile	ppm	0.08

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 3.0 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 Terminal 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: PC-1620001 firmware Ver1.0-0 (Date: 2022.07 22, 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. The EUT has 4 Antennas but no simultaneous transmission.	
Justification: The system was configured in typical fashion (as a user would normally use it) for testing.	

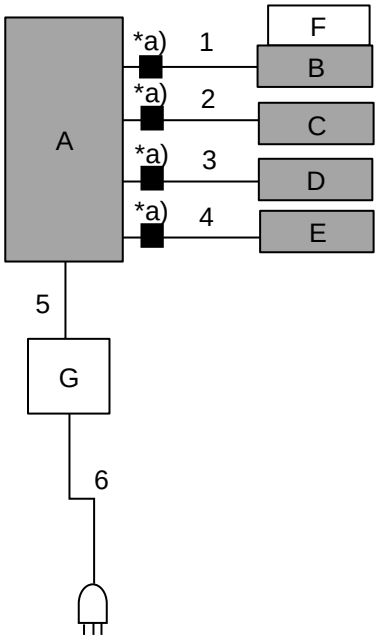
Test Item	Operating mode
Conducted Emission	1), 2), 3)
Electric Field Strength of Fundamental Emission	1), 2)
Spectrum Mask	
20 dB Bandwidth and 99 % Occupied Bandwidth	
Electric Field Strength of Spurious Emission*1)	2)
Frequency Tolerance*1)	1)

*1) 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 5 V Maximum Voltage DC 5.5 V *1) Minimum Voltage DC 4.25 V (DC 5 V -15 %)
*This EUT provides stable voltage constantly to RF Part regardless of input voltage *1) Because the EUT maximum input voltage is 5.5V.	

4.2 Configuration and peripherals

Conducted Emission



AC 120 V / 60 Hz ■ : Standard Ferrite Core

Notes for Ferrite Core
*a) Ferrite Core Model No. 3A4-TRB-16×10×10 (Manufacture Tomita) 5 cm from Item A, 4 turns

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

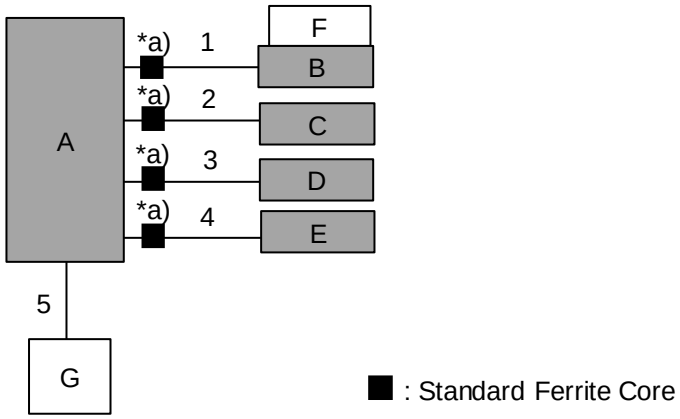
Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	4ch RFID R/W Module	PC-1620001	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
B	Antenna	PC-1040021	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
C	Antenna	PC-1040021	002	Tokyo Communication Equipment MFG Co.,ltd.	EUT
D	Antenna	PC-1040021	003	Tokyo Communication Equipment MFG Co.,ltd.	EUT
E	Antenna	PC-1040021	004	Tokyo Communication Equipment MFG Co.,ltd.	EUT
F	Tag	RI-I03-112A-03HA	001	hitachi high-tech nexus corporation	-
G	DC power supply	RPE-4323	824B168G2	RS COMPONENTS LTD	-

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	0.3	Unshielded	Unshielded	-
2	Antenna Cable	0.3	Unshielded	Unshielded	-
3	Antenna Cable	0.3	Unshielded	Unshielded	-
4	Antenna Cable	0.3	Unshielded	Unshielded	-
5	DC Cable	0.5	Unshielded	Unshielded	-
6	AC Cable	1.0	Unshielded	Unshielded	-

Radiated Emission



Notes for Ferrite Core
*a) Ferrite Core Model No. 3A4-TRB-16×10×10 (Manufacture Tomita) 5 cm from Item A, 4 turns

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

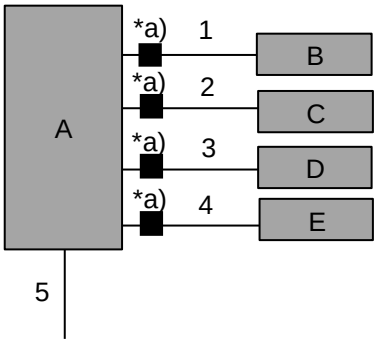
Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	4ch RFID R/W Module	PC-1620001	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
B	Antenna	PC-1040021	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
C	Antenna	PC-1040021	002	Tokyo Communication Equipment MFG Co.,ltd.	EUT
D	Antenna	PC-1040021	003	Tokyo Communication Equipment MFG Co.,ltd.	EUT
E	Antenna	PC-1040021	004	Tokyo Communication Equipment MFG Co.,ltd.	EUT
F	Tag	RI-I03-112A-03HA	001	hitachi high-tech nexus corporation	-
G	Battery Box	-	-	-	-

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	0.3	Unshielded	Unshielded	-
2	Antenna Cable	0.3	Unshielded	Unshielded	-
3	Antenna Cable	0.3	Unshielded	Unshielded	-
4	Antenna Cable	0.3	Unshielded	Unshielded	-
5	DC Cable	0.5	Unshielded	Unshielded	-

Frequency Tolerance



Notes for Ferrite Core
*a) Ferrite Core Model No. 3A4-TRB-16×10×10 (Manufacture Tomita) 5 cm from Item A, 4 turns

* 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	4ch RFID R/W Module	PC-1620001	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
B	Antenna	PC-1040021	001	Tokyo Communication Equipment MFG Co.,ltd.	EUT
C	Antenna	PC-1040021	002	Tokyo Communication Equipment MFG Co.,ltd.	EUT
D	Antenna	PC-1040021	003	Tokyo Communication Equipment MFG Co.,ltd.	EUT
E	Antenna	PC-1040021	004	Tokyo Communication Equipment MFG Co.,ltd.	EUT

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	0.3	Unshielded	Unshielded	-
2	Antenna Cable	0.3	Unshielded	Unshielded	-
3	Antenna Cable	0.3	Unshielded	Unshielded	-
4	Antenna Cable	0.3	Unshielded	Unshielded	-
5	DC Cable	2.0	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

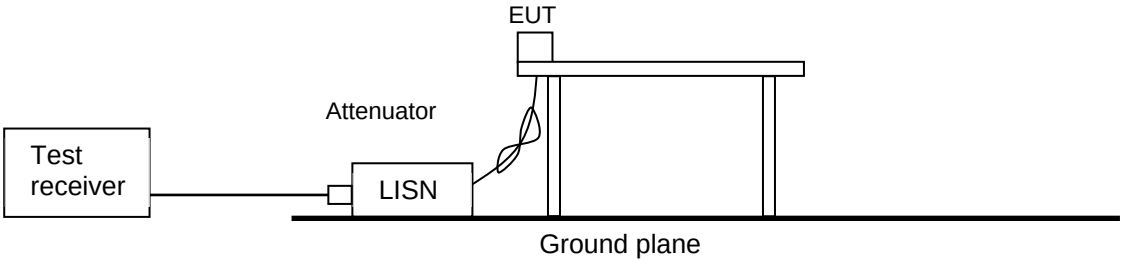
Test Procedure and conditions

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

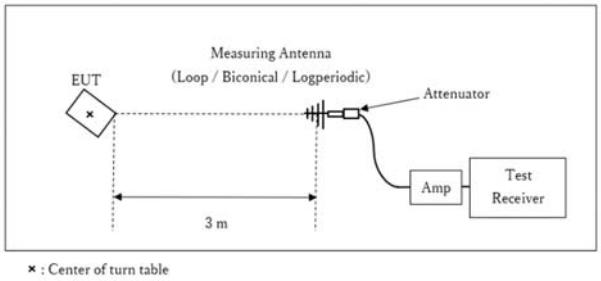
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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

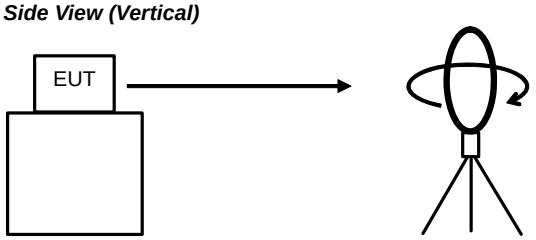
Below 1 GHz



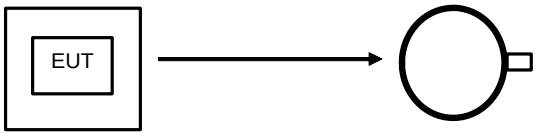
Test Distance: 3 m

Figure 3: Direction of the Loop Antenna

Side View (Vertical)

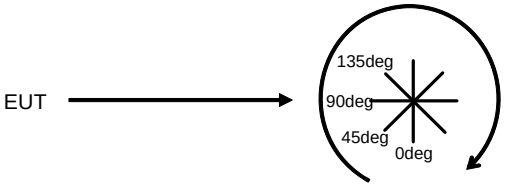


Top View (Horizontal)



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)	1 MHz	20 kHz	62 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak *2)	Max Hold *2)	Spectrum Analyzer
Frequency Tolerance	-	-	-	-	-	-	Spectrum Analyzer *3)

*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.
*2) The measurement was performed with Peak detector, Max Hold since the duty cycle was not 100 %.
Peak hold was applied as Worst-case measurement.
*3) The measurement was performed with Marker Frequency Counter Function.

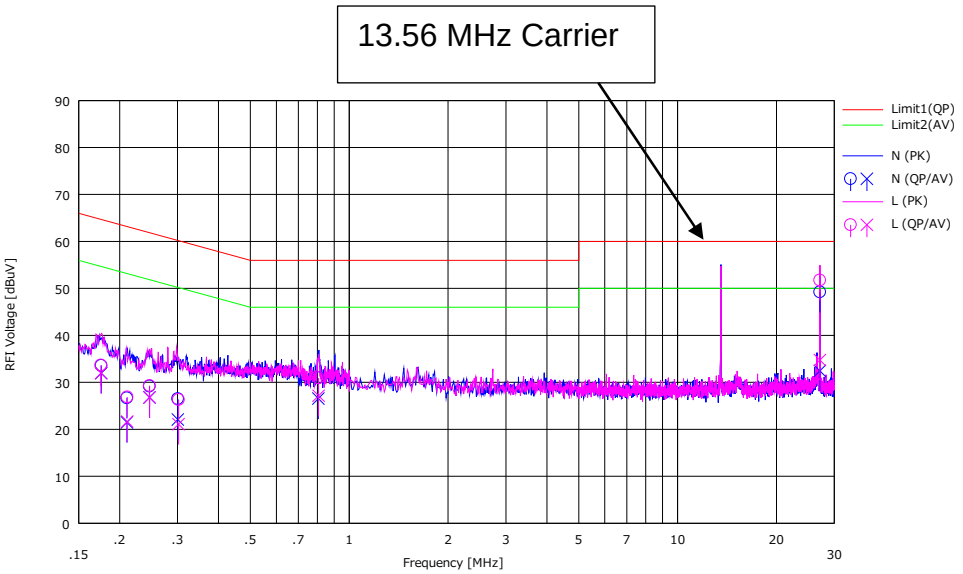
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	August 1, 2023
Temperature / Humidity	24 deg. C / 44 % RH
Engineer	Takeshi Hiyaji
Mode	Mode 1

Limit : FCC_Part 15 Subpart C(15.207)



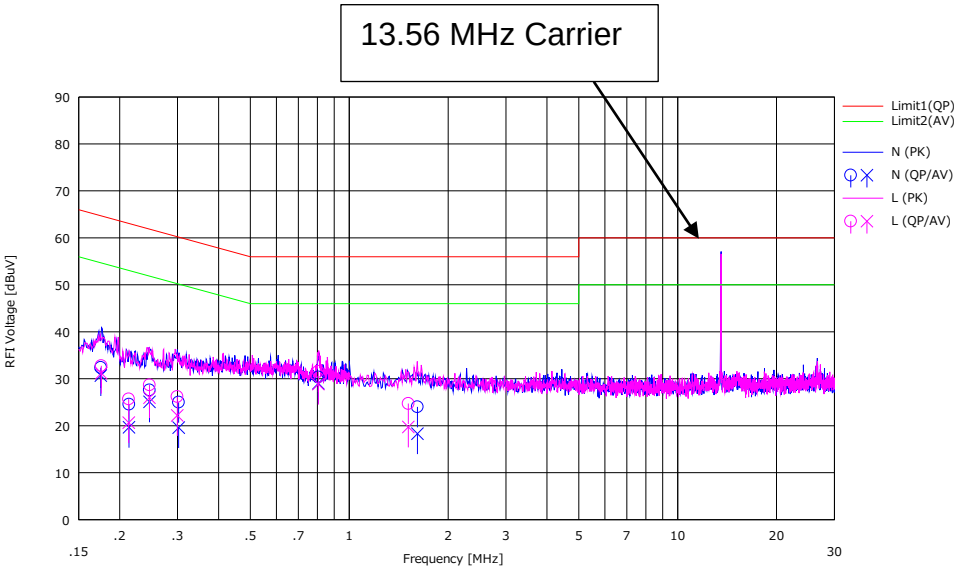
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉			〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.17576	20.40	18.80	0.04	13.13	33.57	31.97	64.68	54.68	31.11	22.71	N	
2	0.21033	13.50	8.30	0.04	13.13	26.67	21.47	63.19	53.19	36.52	31.72	N	
3	0.24651	16.00	13.60	0.04	13.14	29.18	26.78	61.87	51.87	32.69	25.09	N	
4	0.30070	13.30	8.90	0.04	13.15	26.49	22.09	60.22	50.22	33.73	28.13	N	
5	0.80575	17.70	13.30	0.06	13.19	30.95	26.55	56.00	46.00	25.05	19.45	N	
6	27.12000	34.80	18.00	0.46	13.99	49.25	32.45	60.00	50.00	10.75	17.55	N	
7	0.17541	20.50	18.80	0.04	13.13	33.67	31.97	64.70	54.70	31.03	22.73	L	
8	0.21098	13.70	8.50	0.04	13.13	26.87	21.67	63.17	53.17	36.30	31.50	L	
9	0.24688	16.10	13.60	0.04	13.14	29.28	26.78	61.86	51.86	32.58	25.08	L	
10	0.30232	13.10	7.90	0.05	13.15	26.30	21.10	60.18	50.18	33.88	29.08	L	
11	0.80703	17.70	13.90	0.06	13.19	30.95	27.15	56.00	46.00	25.05	18.85	L	
12	27.12000	37.20	20.20	0.56	13.99	51.75	34.75	60.00	50.00	8.25	15.25	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.4
Date	August 1, 2023
Temperature / Humidity	24 deg. C / 44 % RH
Engineer	Takeshi Hiyaji
Mode	Mode 2

Limit : FCC_Part 15 Subpart C(15.207)



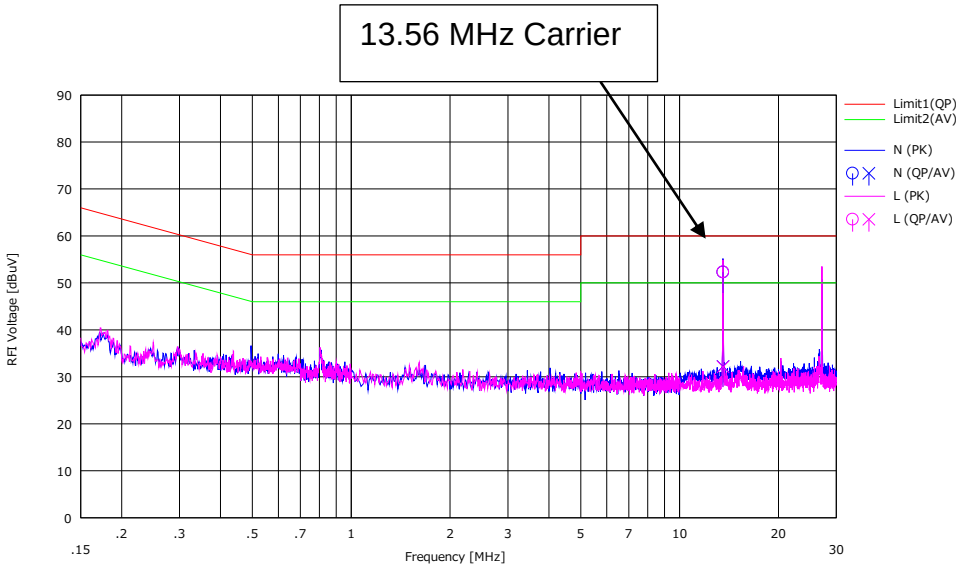
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉			〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.17513	19.20	17.50	0.04	13.13	32.37	30.67	64.71	54.71	32.34	24.04	N	
2	0.21354	11.40	6.50	0.04	13.13	24.57	19.67	63.07	53.07	38.50	33.40	N	
3	0.24641	14.40	11.90	0.04	13.14	27.58	25.08	61.88	51.88	34.30	26.80	N	
4	0.30238	11.80	6.40	0.04	13.15	24.99	19.59	60.18	50.18	35.19	30.59	N	
5	0.80525	17.10	15.80	0.06	13.19	30.35	29.05	56.00	46.00	25.65	16.95	N	
6	1.61273	10.70	5.00	0.06	13.25	24.01	18.31	56.00	46.00	31.99	27.69	N	
7	0.17582	19.60	18.00	0.04	13.13	32.77	31.17	64.68	54.68	31.91	23.51	L	
8	0.21311	12.50	7.50	0.04	13.13	25.67	20.67	63.08	53.08	37.41	32.41	L	
9	0.24648	15.50	12.80	0.04	13.14	28.68	25.98	61.88	51.88	33.20	25.90	L	
10	0.29945	13.00	9.00	0.05	13.15	26.20	22.20	60.26	50.26	34.06	28.06	L	
11	0.80500	18.30	15.60	0.06	13.19	31.55	28.85	56.00	46.00	24.45	17.15	L	
12	1.51372	11.40	6.40	0.07	13.25	24.72	19.72	56.00	46.00	31.28	26.28	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.4
Date	August 1, 2023
Temperature / Humidity	24 deg. C / 44 % RH
Engineer	Takeshi Hiyaji
Mode	Mode 3

Limit : FCC_Part 15 Subpart C(15.207)



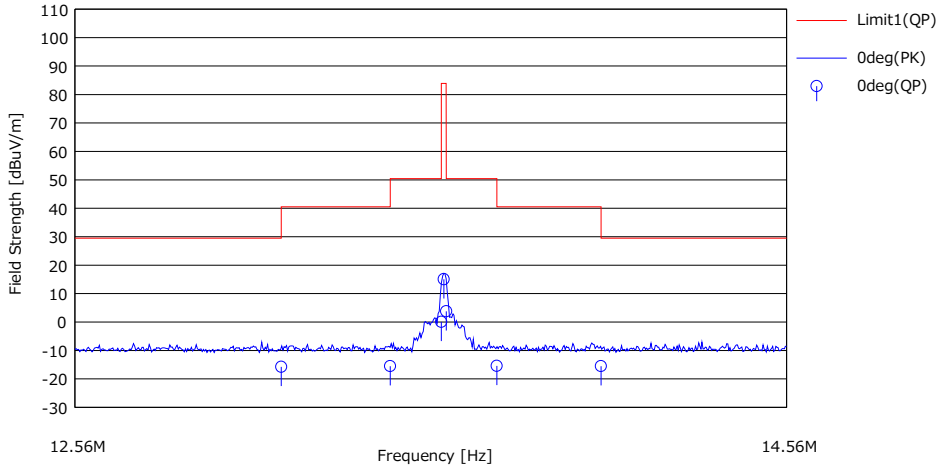
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉			〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	13.56000	38.30	18.20	0.31	13.69	52.30	32.20	60.00	50.00	7.70	17.80	N	
2	13.56000	38.30	18.10	0.34	13.69	52.33	32.13	60.00	50.00	7.67	17.87	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.1
Date	July 30, 2023
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Keiya Ido
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	28.80	20.55	-32.91	32.20	-15.76	29.50	45.26	0deg	169	
2	13.41000	29.00	20.55	-32.89	32.19	-15.53	40.50	56.03	0deg	169	
3	13.55300	44.60	20.54	-32.89	32.19	0.06	50.40	50.34	0deg	169	
4	13.56000	59.60	20.54	-32.89	32.19	15.06	83.90	68.84	0deg	169	
5	13.56700	48.30	20.54	-32.89	32.19	3.76	50.40	46.64	0deg	169	
6	13.71000	29.10	20.54	-32.88	32.19	-15.43	40.50	55.93	0deg	169	
7	14.01000	29.00	20.54	-32.86	32.19	-15.51	29.50	45.01	0deg	169	

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

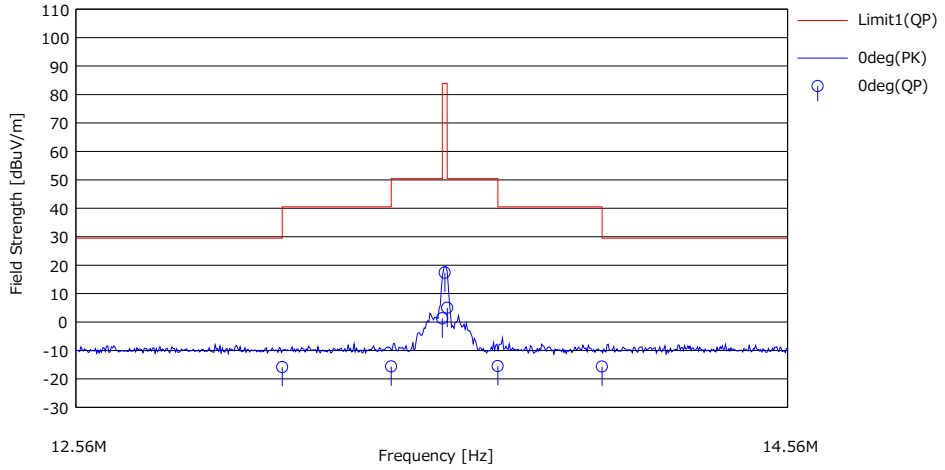
Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	13.56000	QP	59.60	20.54	7.11	32.19	-	55.06	-	-	Fundamental

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

Fundamental Emission and Spectrum Mask

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	July 30, 2023
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Keiya Ido
Mode	Mode 2

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	28.70	20.55	-32.91	32.20	-15.86	29.50	45.36	0deg	166	
2	13.41000	28.90	20.55	-32.89	32.19	-15.63	40.50	56.13	0deg	166	
3	13.55300	45.80	20.54	-32.89	32.19	1.26	50.40	49.14	0deg	166	
4	13.56000	61.90	20.54	-32.89	32.19	17.36	83.90	66.54	0deg	166	
5	13.56700	49.50	20.54	-32.89	32.19	4.96	50.40	45.44	0deg	166	
6	13.71000	29.00	20.54	-32.88	32.19	-15.53	40.50	56.03	0deg	166	
7	14.01000	28.80	20.54	-32.86	32.19	-15.71	29.50	45.21	0deg	166	

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	13.56000	QP	61.90	20.54	7.11	32.19	-	57.36	-	-	Fundamental

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

Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	July 30, 2023	July 30, 2023
Temperature / Humidity	23 deg. C / 45 % RH	23 deg. C / 45 % RH
Engineer	Keiya Ido	Takeshi Hiyaji
	(Below 30 MHz)	(Above 30 MHz)
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
0 deg	27.120	QP	29.40	19.90	-32.31	32.17	-	-15.18	29.5	44.68	
Hori.	54.240	QP	52.70	9.51	7.70	38.75	-	31.16	40.0	8.84	
Hori.	67.800	QP	57.60	6.55	7.94	38.79	-	33.30	40.0	6.70	
Hori.	81.360	QP	59.50	7.23	8.14	38.83	-	36.04	40.0	3.96	
Hori.	94.920	QP	56.60	9.28	8.33	38.84	-	35.37	43.5	8.15	
Hori.	162.720	QP	50.50	15.51	9.14	38.86	-	36.29	43.5	7.23	
Hori.	270.200	QP	27.70	12.75	10.16	38.73	-	11.88	46.0	34.14	
Vert.	54.240	QP	46.10	9.51	7.70	38.75	-	24.56	40.0	15.44	
Vert.	67.800	QP	49.60	6.55	7.94	38.79	-	25.30	40.0	14.70	
Vert.	81.360	QP	51.60	7.23	8.14	38.83	-	28.14	40.0	11.86	
Vert.	94.920	QP	48.40	9.28	8.33	38.84	-	27.17	43.5	16.35	
Vert.	162.720	QP	42.70	15.51	9.14	38.86	-	28.49	43.5	15.03	
Vert.	271.200	QP	31.80	12.82	10.17	38.73	-	16.06	46.0	29.96	

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.1	No.1
Date	July 30, 2023	July 30, 2023
Temperature / Humidity	23 deg. C / 45 % RH	23 deg. C / 45 % RH
Engineer	Keiya Ido	Takeshi Hiyaji
	(Below 30 MHz)	(Above 30 MHz)
Mode	Mode 2	

(below 30MHz)

Limit : FCC15.209(a), 9-90kHz:PK, 110-490kHz:PK, other:QP

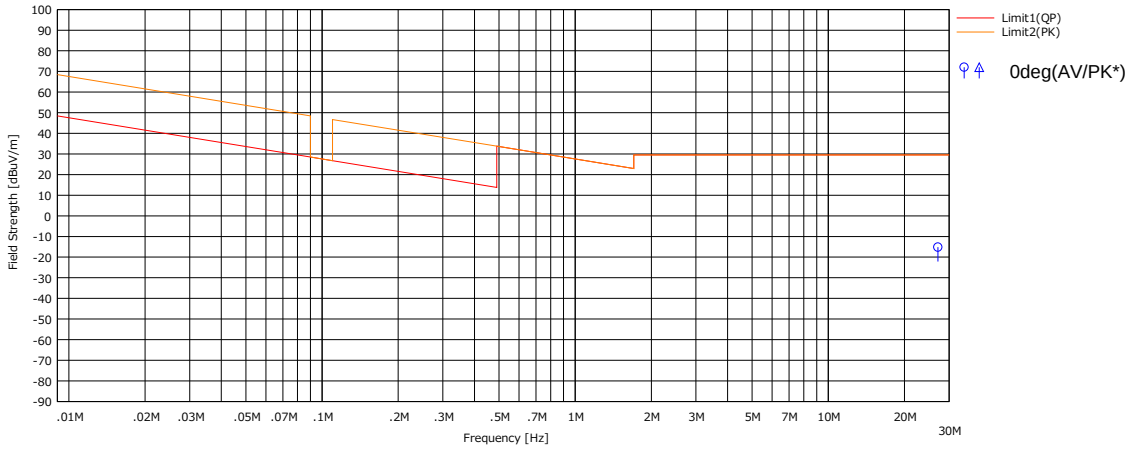
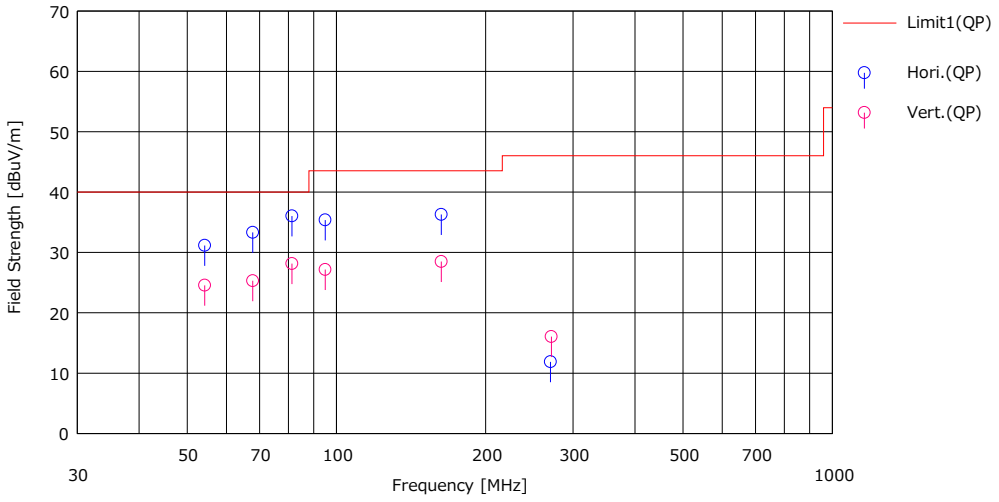


CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200-1000MHz: LOGPERIODIC, 1000MHz-: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS(CABLE + ATT.) - GAIN(AMP)

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

(above 30MHz)

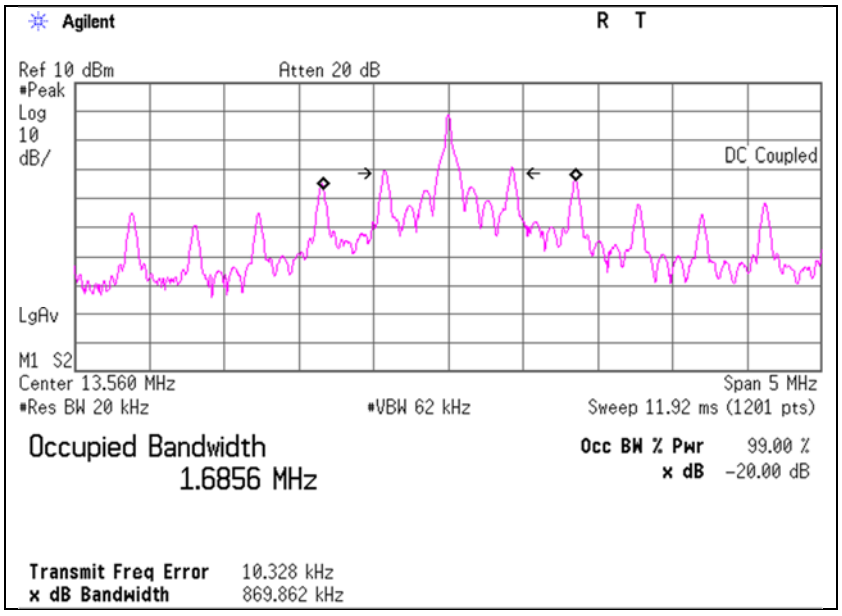


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

20 dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.8
Date	July 31, 2023
Temperature / Humidity	22 deg. C / 72 % RH
Engineer	Nachi Konegawa
Mode	Mode 1

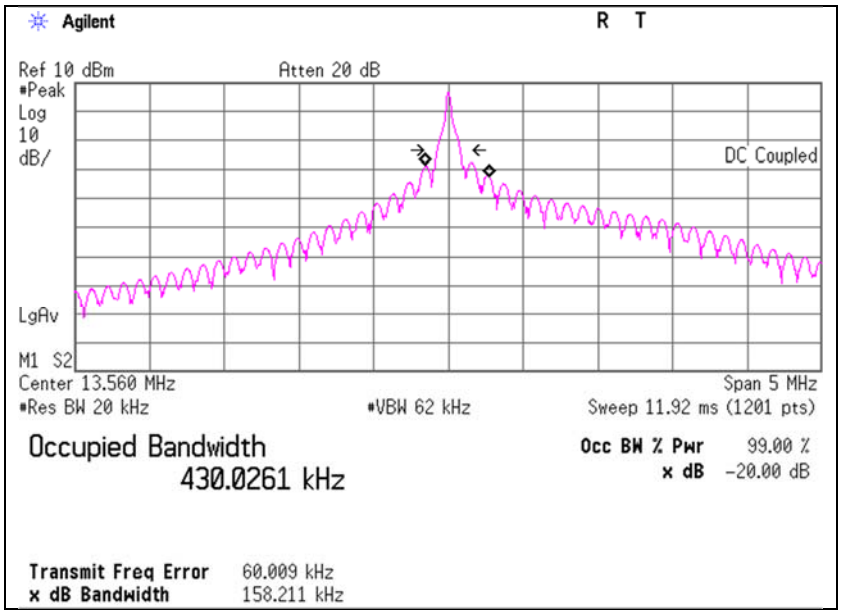
FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	869.8620	1685.6000



20 dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab.
Measurement Room	No.8
Date	July 31, 2023
Temperature / Humidity	22 deg. C / 72 % RH
Engineer	Nachi Konegawa
Mode	Mode 2

FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	158.2110	430.0261



Frequency Tolerance

Test place	Ise EMC Lab.
Measurement Room	No.8
Date	August 1, 2023
Temperature / Humidity	23 deg. C / 68 % RH
Engineer	Nachi Konegawa
Mode	Mode 1

Test condition		Tested	Measured	Frequency	Result		Limit
Temp.	Voltage	timing	frequency	error			
[deg. C]	[V]		[MHz]	[MHz]	[%]	[ppm]	[+/- %]
50	5	Power on	13.560401	0.000401	0.00296	29.6	0.01
		+ 2 min.	13.560449	0.000449	0.00331	33.1	0.01
		+ 5 min.	13.560334	0.000334	0.00246	24.6	0.01
		+ 10 min.	13.560256	0.000256	0.00189	18.9	0.01
40	5	Power on	13.560346	0.000346	0.00255	25.5	0.01
		+ 2 min.	13.560371	0.000371	0.00273	27.3	0.01
		+ 5 min.	13.560396	0.000396	0.00292	29.2	0.01
		+ 10 min.	13.560392	0.000392	0.00289	28.9	0.01
30	5	Power on	13.560384	0.000384	0.00283	28.3	0.01
		+ 2 min.	13.560432	0.000432	0.00318	31.8	0.01
		+ 5 min.	13.560421	0.000421	0.00311	31.1	0.01
		+ 10 min.	13.560404	0.000404	0.00298	29.8	0.01
20	5	Power on	13.560482	0.000482	0.00356	35.6	0.01
		+ 2 min.	13.560470	0.000470	0.00347	34.7	0.01
		+ 5 min.	13.560472	0.000472	0.00348	34.8	0.01
		+ 10 min.	13.560378	0.000378	0.00279	27.9	0.01
20	4.25	Power on	13.560453	0.000453	0.00334	33.4	0.01
	(5V -15%)	+ 2 min.	13.560481	0.000481	0.00354	35.4	0.01
		+ 5 min.	13.560438	0.000438	0.00323	32.3	0.01
		+ 10 min.	13.560396	0.000396	0.00292	29.2	0.01
20	5.5	Power on	13.560463	0.000463	0.00341	34.1	0.01
	*1)	+ 2 min.	13.560512	0.000512	0.00378	37.8	0.01
		+ 5 min.	13.560460	0.000460	0.00339	33.9	0.01
		+ 10 min.	13.560488	0.000488	0.00360	36.0	0.01
10	5	Power on	13.560509	0.000509	0.00375	37.5	0.01
		+ 2 min.	13.560432	0.000432	0.00318	31.8	0.01
		+ 5 min.	13.560529	0.000529	0.00390	39.0	0.01
		+ 10 min.	13.560502	0.000502	0.00370	37.0	0.01
0	5	Power on	13.560489	0.000489	0.00361	36.1	0.01
		+ 2 min.	13.560536	0.000536	0.00395	39.5	0.01
		+ 5 min.	13.560452	0.000452	0.00333	33.3	0.01
		+ 10 min.	13.560459	0.000459	0.00339	33.9	0.01
-10	5	Power on	13.560455	0.000455	0.00336	33.6	0.01
		+ 2 min.	13.560510	0.000510	0.00376	37.6	0.01
		+ 5 min.	13.560442	0.000442	0.00326	32.6	0.01
		+ 10 min.	13.560434	0.000434	0.00320	32.0	0.01
-20	5	Power on	13.560458	0.000458	0.00338	33.8	0.01
		+ 2 min.	13.560419	0.000419	0.00309	30.9	0.01
		+ 5 min.	13.560432	0.000432	0.00319	31.9	0.01
		+ 10 min.	13.560404	0.000404	0.00298	29.8	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.
*1) Because the EUT maximum input voltage is 5.5V.

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-04	142011	AC4_Semi Anechoic Chamber (NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2022	24
CE	MAT-64	141290	Attenuator(13dB)	JFW Industries, Inc.	50FP-013H2 N	-	12/22/2022	12
CE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/421-010/ sucoform141-PE/ RFM-E121(SW)	-/04178	06/27/2023	12
CE	MJM-29	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/05/2023	12
CE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/18/2023	12
CE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/13/2023	12
CE	MTR-09	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	10/11/2022	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	KBA-05	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	2513	06/06/2023	12
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber (NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/28/2022	24
RE	MAT-08	141213	Attenuator(6dB)	Weinschel Corp	2	BK7971	11/19/2022	12
RE	MCC-02	141350	Coaxial Cable	Suhner/storm/Agilent /TSJ	-	-	03/03/2023	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-219	159670	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MJM-25	142226	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	LA-17	160924	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	225	11/12/2022	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/11/2022	12
RE	MMM-03	141530	Digital Tester	Fluke Corporation	FLUKE 26-3	78030621	01/18/2023	12
RE	MMM-17	141557	DIGIITAL HiTESTER	HIOKI E.E. CORPORATION	3805	70900530	01/18/2023	12
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/13/2023	12
RE	MOS-28	141567	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0008	01/13/2023	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/07/2023	12
RE	MPA-19	141585	Pre Amplifier	L3 Narda-MITEQ	MLA-10K01-B01-35	1237616	02/02/2023	12
RE	MSA-14	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/16/2023	12
RE	MTR-09	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	10/11/2022	12

Test Equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
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	DIGIITAL HiTESTER	HIOKI E.E. CORPORATION	3805	70900530	01/18/2023	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:

CE: Conducted Emission
RE: Radiated Emission
FT: Frequency Tolerance