



RADIO TEST REPORT

Test Report No. : 13636080H-A

Applicant : Maxell, Ltd.
Type of EUT : RFID Reader/Writer Module
Model Number of EUT : ME-MR23M4-D-SG
Test regulation : FCC Part 15 Subpart C: 2021
FCC ID : UOEME-M23D
Test Result : **Complied (Refer to SECTION 3.2)**

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by the A2LA accreditation body.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. The information provided from the customer for this report is identified in Section 1.

Date of test: January 8, 2021

Representative test engineer: T. Nakagawa
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Engineer
Consumer Technology Division

Approved by: Takayuki S.
Takayuki Shimada
Leader
Consumer Technology Division



CERTIFICATE 5107.02

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

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REVISION HISTORY

Original Test Report No.: 13636080H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13636080H-A	January 22, 2021	-	-

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Reference: Abbreviations (Including words undescribed in this report)

A2LA	The American Association for Laboratory Accreditation	LIMS	Laboratory Information Management System
AC	Alternating Current	MCS	Modulation and Coding Scheme
AFH	Adaptive Frequency Hopping	MRA	Mutual Recognition Arrangement
AM	Amplitude Modulation	N/A	Not Applicable
Amp, AMP	Amplifier	NIST	National Institute of Standards and Technology
ANSI	American National Standards Institute	NS	No signal detect.
Ant, ANT	Antenna	NSA	Normalized Site Attenuation
AP	Access Point	NVLAP	National Voluntary Laboratory Accreditation Program
ASK	Amplitude Shift Keying	OBW	Occupied Band Width
Atten., ATT	Attenuator	OFDM	Orthogonal Frequency Division Multiplexing
AV	Average	P/M	Power meter
BPSK	Binary Phase-Shift Keying	PCB	Printed Circuit Board
BR	Bluetooth Basic Rate	PER	Packet Error Rate
BT	Bluetooth	PHY	Physical Layer
BT LE	Bluetooth Low Energy	PK	Peak
BW	BandWidth	PN	Pseudo random Noise
Cal Int	Calibration Interval	PRBS	Pseudo-Random Bit Sequence
CCK	Complementary Code Keying	PSD	Power Spectral Density
Ch., CH	Channel	QAM	Quadrature Amplitude Modulation
CISPR	Comite International Special des Perturbations Radioelectriques	QP	Quasi-Peak
CW	Continuous Wave	QPSK	Quadrature Phase Shift Keying
DBPSK	Differential BPSK	RBW	Resolution Band Width
DC	Direct Current	RDS	Radio Data System
D-factor	Distance factor	RE	Radio Equipment
DFS	Dynamic Frequency Selection	RF	Radio Frequency
DQPSK	Differential QPSK	RMS	Root Mean Square
DSSS	Direct Sequence Spread Spectrum	RSS	Radio Standards Specifications
DUT	Device Under Test	Rx	Receiving
EDR	Enhanced Data Rate	SA, S/A	Spectrum Analyzer
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power	SG	Signal Generator
EMC	ElectroMagnetic Compatibility	SVSWR	Site-Voltage Standing Wave Ratio
EMI	ElectroMagnetic Interference	TR	Test Receiver
EN	European Norm	Tx	Transmitting
ERP, e.r.p.	Effective Radiated Power	VBW	Video BandWidth
ETSI	European Telecommunications Standards Institute	Vert.	Vertical
EU	European Union	WLAN	Wireless LAN
EUT	Equipment Under Test		
Fac.	Factor		
FCC	Federal Communications Commission		
FHSS	Frequency Hopping Spread Spectrum		
FM	Frequency Modulation		
Freq.	Frequency		
FSK	Frequency Shift Keying		
GFSK	Gaussian Frequency-Shift Keying		
GNSS	Global Navigation Satellite System		
GPS	Global Positioning System		
Hori.	Horizontal		
ICES	Interference-Causing Equipment Standard		
IEC	International Electrotechnical Commission		
IEEE	Institute of Electrical and Electronics Engineers		
IF	Intermediate Frequency		
ILAC	International Laboratory Accreditation Conference		
ISED	Innovation, Science and Economic Development Canada		
ISO	International Organization for Standardization		
JAB	Japan Accreditation Board		
LAN	Local Area Network		

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SECTION 1: Customer information

Company Name	:	Maxell, Ltd.
Address	:	1 Koizumi, Oyamazaki, Oyamazaki-cho, Otokuni-gun, Kyoto, 618-8525, Japan
Telephone Number	:	+81-75-951-1465
Facsimile Number	:	+81-75-952-5860
Contact Person	:	Hisao Nakajima

The information provided from the customer is as follows;

- Applicant, Type 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
 - 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

Type	:	RFID Reader/Writer Module
Model Number	:	ME-MR23M4-D-SG
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12.0 V
Receipt Date	:	January 7, 2020
Country of Mass-production	:	Japan
Condition	:	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab

2.2 Product Description

Model: ME-MR23M4-D-SG (referred to as the EUT in this report) is a RFID Reader/Writer Module.

General Specification

Clock frequency(ies) in the system	:	27.12 MHz
------------------------------------	---	-----------

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	13.56 MHz
Modulation	:	ASK
Power Supply (radio part input)	:	DC 3.3 V
Antenna type	:	Printed Loop Coil Pattern Antenna
Operating Temperature	:	0 deg. C to +45 deg. C

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on January 12, 2021 and effective February 11, 2021

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

* The revision does not affect the test result conducted before its effective date.

* 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	ANSI C63.10:2013 6 Standard test methods <ISED>RSS-Gen 8.8	Section 15.207 <ISED>RSS-Gen 8.8	0.06 dB 27.12000 MHz, Phase N	Complied# a)	-
Electric Field Strength of Fundamental Emission	ANSI C63.10:2013 6 Standard test methods <ISED> RSS-Gen 6.4, 6.12	Section 15.225(a) <ISED>RSS-210 B.6	56.16 dB, 13.56000 MHz, QP, 45 deg.	Complied b)	Radiated
Spectrum Mask	ANSI C63.10:2013 6 Standard test methods <ISED>RSS-Gen 6.4, 6.13	Section 15.225(b)(c) <ISED> RSS-210 B.6	35.76 dB, 13.55300 MHz, QP, 45 deg.	Complied b)	Radiated
20 dB Bandwidth	ANSI C63.10:2013 6 Standard test methods <ISED> -	Section 15.215(c) <ISED> -	See data	Complied c)	Radiated
Electric Field Strength of Spurious Emission	ANSI C63.10:2013 6 Standard test methods <ISED>RSS-Gen 6.4, 6.13	Section 15.209, Section 15.225 (d) <ISED>RSS-210 B.6	9.90 dB 40.678 MHz, Vertical, QP	Complied d)	Radiated
Frequency Tolerance	ANSI C63.10:2013 6 Standard test methods <ISED>RSS-Gen 6.11, 8.11	Section 15.225(e) <ISED> RSS-210 B.6	See data	Complied e)	Radiated
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422 a) Refer to APPENDIX 1 (data of Conducted Emission) b) Refer to APPENDIX 1 (data of Fundamental emission and Spectrum Mask) c) Refer to APPENDIX 1 (data of 20 dB Bandwidth and 99% Occupied Bandwidth) d) Refer to APPENDIX 1 (data of Spurious emission) e) Refer to APPENDIX 1 (data of Frequency Tolerance) Symbols: Complied The data of this test item has enough margin, more than the measurement uncertainty. Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.					

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 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 % Occupied Band Width	<ISED>RSS-Gen 6.7	-	N/A	-	Radiated
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422. Symbols: Complied The data of this test item has enough margin, more than the measurement uncertainty. Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration. Other than above, no addition, exclusion nor deviation has been made from the standard.					

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3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the following results are derived depending on whether or not laboratory uncertainty is applied.

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

Conducted emission

using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.4 dB
	0.15 MHz to 30 MHz	2.9 dB

Radiated emission

Measurement distance	Frequency range	Uncertainty (+/-)
3 m	9 kHz to 30 MHz	3.3 dB
10 m		3.2 dB
3 m	30 MHz to 200 MHz (Horizontal) (Vertical)	4.8 dB
		5.0 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	5.2 dB
		6.3 dB
10 m	30 MHz to 200 MHz (Horizontal) (Vertical)	4.8 dB
		4.8 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	5.0 dB
		5.0 dB
3 m	1 GHz to 6 GHz	4.9 dB
	6 GHz to 18 GHz	5.2 dB
1 m	10 GHz to 26.5 GHz	5.5 dB
	26.5 GHz to 40 GHz	5.5 dB

Antenna Terminal test

Test Item	Uncertainty (+/-)
Frequency Tolerance	0.0154 ppm
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %

3.5 Test Location

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*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 199967 /

ISED Lab Company Number: 2973C / CAB identifier: JP0002

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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.11 measurement room	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* 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.

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SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

The mode is used :

Mode	Remarks*
1) Transmitting mode (Tx) Modulation (Mod) on	-
2) Transmitting mode (Tx CW)	-
The EUT was operated in a manner similar to typical use during the tests. The EUT Transmits and Receives at the same time and there is no receiving mode. * EUT was set by the software as follows; Software: UART_RWCheck application Version 1.3.0.10 (Date: January 8, 2021, Storage location: Driven by connected PC) *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	Tx Mod on Antenna Terminated
Electric Field Strength of Fundamental Emission Spectrum Mask Electric Field Strength of Spurious Emission	Tx Mod on without tag Tx Mod on with tag
20 dB Bandwidth and 99 % Occupied Bandwidth	Tx Mod on
Frequency Tolerance	Tx CW

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

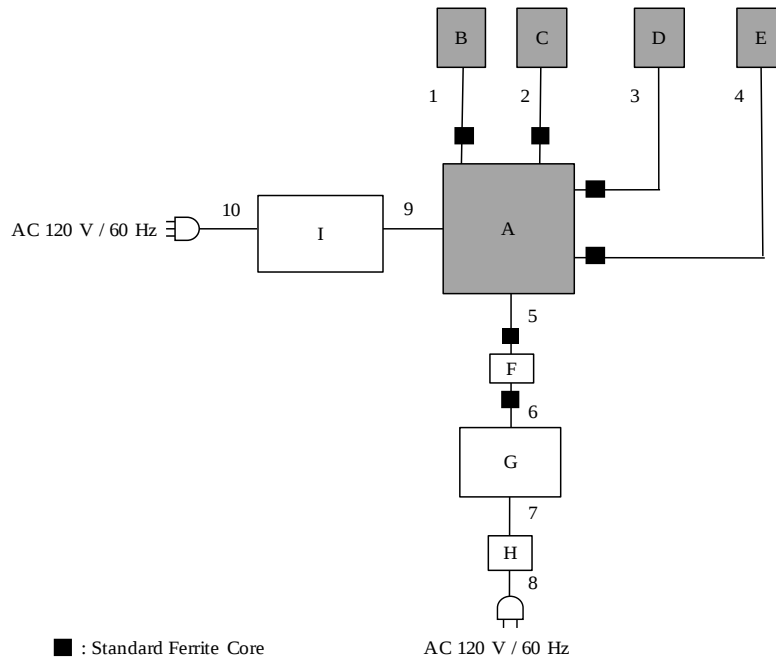
Frequency Tolerance:

Temperature : -20 deg. C to +50 deg. C Step 10 deg. C
Voltage : Normal Voltage DC 12 V
Maximum Voltage DC 13.8 V (DC 12 V +15 %),
Minimum Voltage DC 10.2 V (DC 12 V -15 %)

*This EUT provides stable voltage constantly to RF Part regardless of input voltage

4.2 Configuration and peripherals

[Conducted emission and Frequency Tolerance tests]



* 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	RFID Reader/Writer Module	ME-MR23M4-D-SG	9	Maxell, Ltd.	EUT
B	Antenna	ME-MR23M4-D-ANT(AC4)	6	Maxell, Ltd.	EUT
C	Antenna	ME-MR23M4-D-ANT(AC4)	10	Maxell, Ltd.	EUT
D	Antenna	ME-MR23M4-D-ANT(AC4)	22	Maxell, Ltd.	EUT
E	Antenna	ME-MR23M4-D-ANT(AC4)	35	Maxell, Ltd.	EUT
F	RS232C-USB Conversion board	ES-U-1w1-R100	-	-	-
G	Laptop PC	CF-N8HWCDP	0BKSA08702	Panasonic	-
H	AC Adapter	CF-AA62J2C	62J2CM21522514 38SB	Panasonic	-
I	DC Power Supply	PW16-5ADP	GJQ810118	TEXIO	-

List of cables used

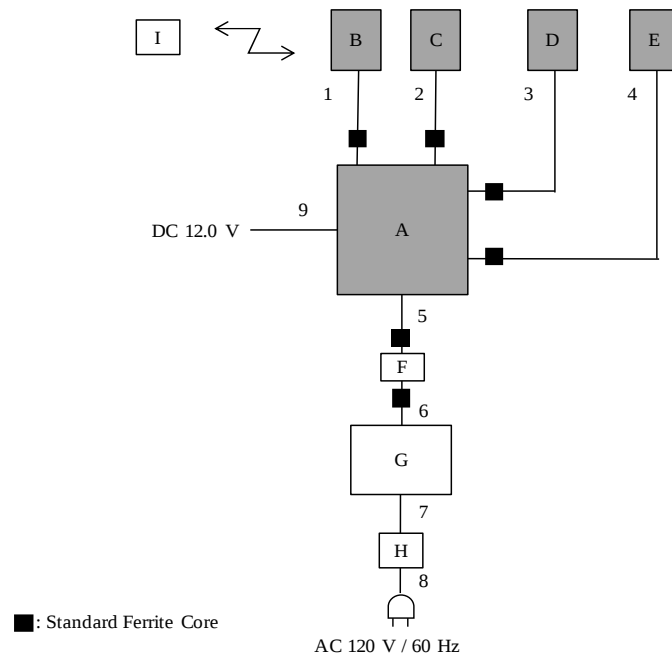
No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal Cable	0.5	Unshielded	Unshielded	-
2	Signal Cable	0.5	Unshielded	Unshielded	-
3	Signal Cable	0.5	Unshielded	Unshielded	-
4	Signal Cable	0.5	Unshielded	Unshielded	-
5	RS-232C Cable	3.0	Unshielded	Unshielded	-
6	USB Cable	1.0	Shielded	Shielded	-
7	DC Cable	1.6	Unshielded	Unshielded	-
8	AC Cable	0.8	Unshielded	Unshielded	-
9	DC Cable	1.0	Unshielded	Unshielded	-
10	AC Cable	1.5	Unshielded	Unshielded	-

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[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	RFID Reader/Writer Module	ME-MR23M4-D-SG	9	Maxell, Ltd.	EUT
B	Antenna	ME-MR23M4-D-ANT(AC4)	6	Maxell, Ltd.	EUT
C	Antenna	ME-MR23M4-D-ANT(AC4)	10	Maxell, Ltd.	EUT
D	Antenna	ME-MR23M4-D-ANT(AC4)	22	Maxell, Ltd.	EUT
E	Antenna	ME-MR23M4-D-ANT(AC4)	35	Maxell, Ltd.	EUT
F	RS232C-USB Conversion board	ES-U-1w1-R100	-	-	-
G	Laptop PC	CF-N8HWCDP	0BKSA08702	Panasonic	-
H	AC Adapter	CF-AA62J2C	62J2CM2152251 438SB	Panasonic	-
I	Tag	ME-Y1E1-BCV-SGC	-	Maxell, Ltd.	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal Cable	0.5	Unshielded	Unshielded	-
2	Signal Cable	0.5	Unshielded	Unshielded	-
3	Signal Cable	0.5	Unshielded	Unshielded	-
4	Signal Cable	0.5	Unshielded	Unshielded	-
5	RS-232C Cable	3.0	Unshielded	Unshielded	-
6	USB Cable	1.0	Shielded	Shielded	-
7	DC Cable	1.6	Unshielded	Unshielded	-
8	AC Cable	0.8	Unshielded	Unshielded	-
9	DC Cable	1.0	Unshielded	Unshielded	-

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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.

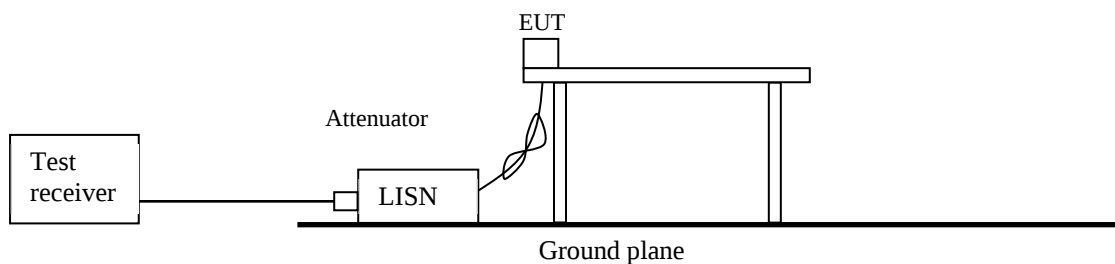
For the tests on EUT with other peripherals (as a whole system)

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.

[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 - 30 MHz
Test data	: APPENDIX
Test result	: Pass

SECTION 6: Radiated emission (Fundamental, Spurious Emission and Spectrum Mask)

Test Procedure

[For below 1GHz]

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.

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 1 about Direction of the Loop Antenna.

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.

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.

Test Antennas are used as below;

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

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

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

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

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.

The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohms. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to $45.5 - 51.5 = -6.0 \text{ dBuA/m}$, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

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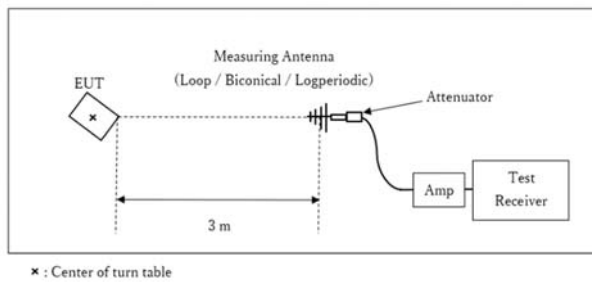
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[Test Setup]
Below 1 GHz



Test Distance: 3 m

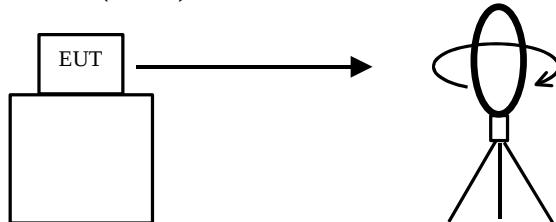
- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT and Antenna to see the position of maximum noise, and the test was made at the position that has the maximum noise.

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

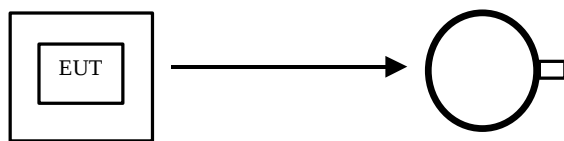
Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX 1
Test result : Pass

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

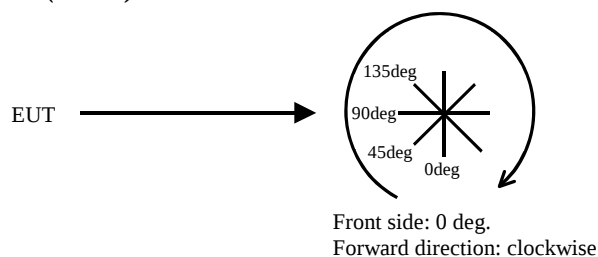


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



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Ise EMC Lab.

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SECTION 7: Other test

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	5 MHz	20 kHz	62 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth	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

*1) The measurement was performed with Peak detector, Max Hold since the duty cycle was not 100 %.
Peak hold was applied as Worst-case measurement.

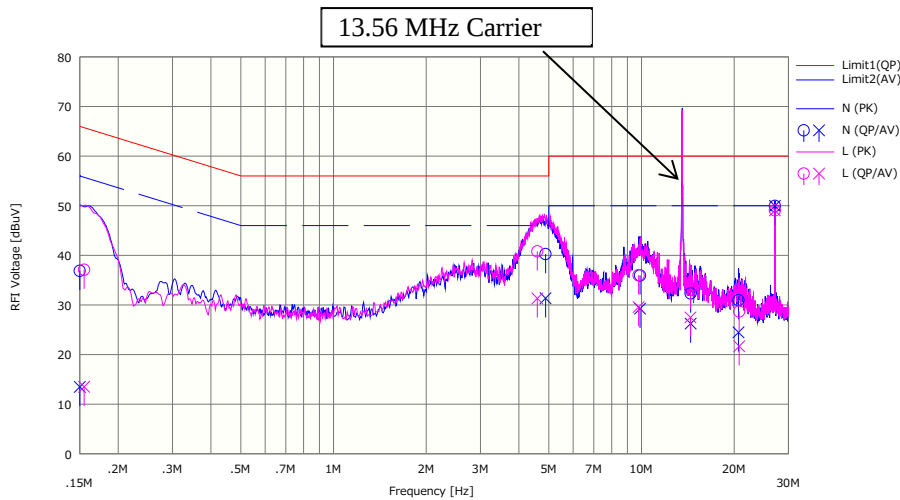
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1

Limit : FCC_Part 15 Subpart C(15.207)



No.	Freq. [MHz]	Reading		USN [dB]	LOSS [dB]	Results		Limit		Margin		Phase	Comment
		<QP> [dBuV]	<AV> [dBuV]			<QP> [dBuV]	<AV> [dBuV]	<QP> [dBuV]	<AV> [dBuV]	<QP> [dB]	<AV> [dB]		
1	0.15000	23.60	0.20	0.07	13.20	36.87	13.47	66.00	56.00	29.13	42.53	N	
2	4.87900	26.60	17.70	0.14	13.52	40.26	31.36	56.00	46.00	15.74	14.64	N	
3	9.89200	22.00	15.30	0.24	13.70	35.94	29.24	60.00	50.00	24.06	20.76	N	
4	14.44000	18.20	12.10	0.31	13.81	32.32	26.22	60.00	50.00	27.68	23.78	N	
5	20.66000	16.60	10.10	0.41	13.95	30.96	24.46	60.00	50.00	29.04	25.54	N	
6	27.12000	35.30	35.30	0.56	14.08	49.94	49.94	60.00	50.00	10.06	0.06	N	
7	0.15510	23.80	0.20	0.10	13.20	37.10	13.50	65.72	55.72	28.62	42.22	L	
8	4.58909	27.10	17.60	0.18	13.51	40.79	31.29	56.00	46.00	15.21	14.71	L	
9	9.78642	22.00	15.60	0.28	13.69	35.97	29.57	60.00	50.00	24.03	20.43	L	
10	14.41815	18.90	13.30	0.37	13.81	33.08	27.48	60.00	50.00	26.92	22.52	L	
11	20.75139	14.20	7.20	0.50	13.96	28.66	21.66	60.00	50.00	31.34	28.34	L	
12	27.12000	34.30	34.30	0.68	14.08	49.06	49.06	60.00	50.00	10.94	0.94	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.

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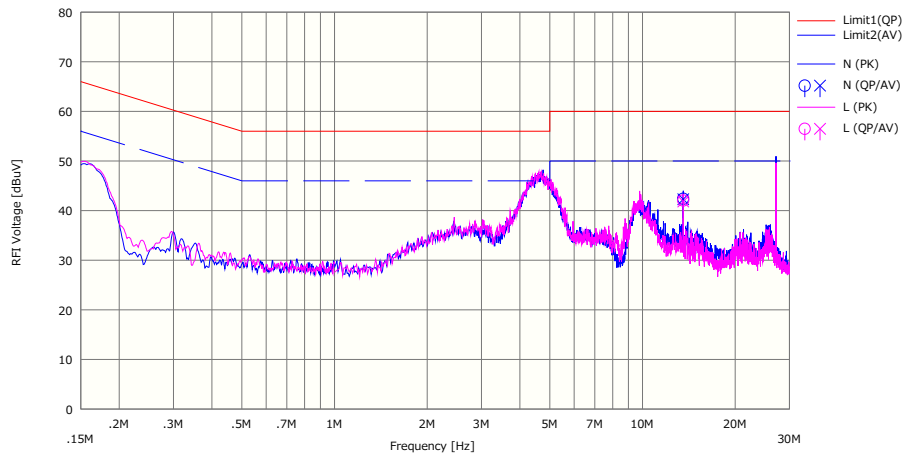
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Facsimile : +81 596 24 8124

Conducted Emission

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1 (Antenna Terminated)

Limit : FCC_Part 15 Subpart C(15.207)



No.	Freq. [MHz]	Reading		LISN [dB]	LOSS [dB]	Results		Limit		Margin		Phase	Comment
		<QP> [dBuV]	<AV> [dBuV]			<QP> [dBuV]	<AV> [dBuV]	<QP> [dBuV]	<AV> [dBuV]	<QP> [dB]	<AV> [dB]		
1	13.56000	28.30	28.20	0.30	13.79	42.39	42.29	60.00	50.00	17.61	7.71	N	
2	13.56000	27.90	27.70	0.35	13.79	42.04	41.84	60.00	50.00	17.96	8.16	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.

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Ise EMC Lab.

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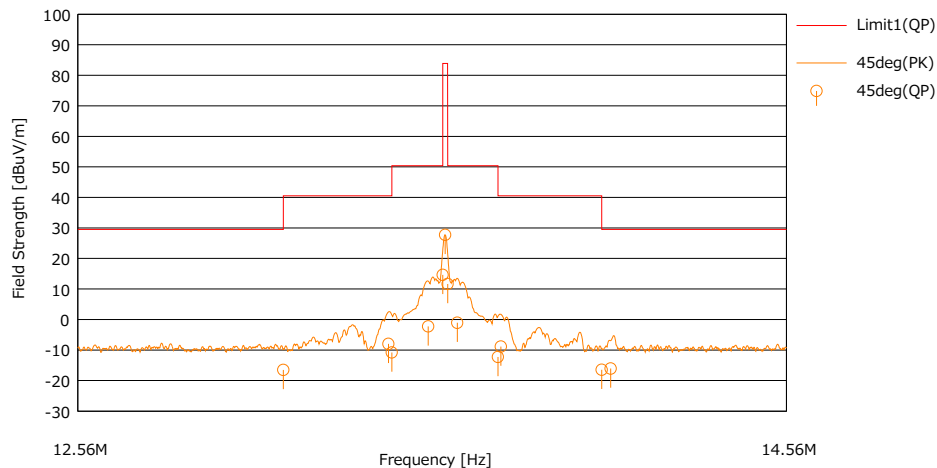
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Fundamental emission and Spectrum Mask

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1 without tag

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



No.	Freq. [MHz]	Reading <QP> [dBuV]	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result <QP> [dBuV/m]	Limit <QP> [dBuV/m]	Margin <QP> [dB]	Antenna [deg]	Table [deg]	Comment
1	13.11000	29.30	19.46	-33.23	32.01	-16.49	29.50	45.99	45deg	180	
2	13.40071	37.80	19.46	-33.22	32.01	-7.97	40.50	48.47	45deg	180	
3	13.41000	35.00	19.46	-33.22	32.01	-10.77	40.50	51.27	45deg	180	
4	13.51219	43.50	19.46	-33.22	32.01	-2.27	50.40	52.67	45deg	180	
5	13.55300	60.40	19.46	-33.21	32.01	14.64	50.40	35.76	45deg	180	
6	13.56000	73.50	19.46	-33.21	32.01	27.74	83.90	56.16	45deg	180	
7	13.56700	57.40	19.46	-33.21	32.01	11.64	50.40	38.76	45deg	180	
8	13.59437	44.70	19.46	-33.21	32.01	-1.06	50.40	51.46	45deg	180	
9	13.71000	33.50	19.46	-33.21	32.01	-12.26	40.50	52.76	45deg	180	
10	13.71853	36.90	19.46	-33.21	32.01	-8.86	40.50	49.36	45deg	180	
11	14.01000	29.30	19.46	-33.20	32.01	-16.45	29.50	45.95	45deg	180	
12	14.03620	29.70	19.46	-33.20	32.01	-16.05	29.50	45.55	45deg	180	

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

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

Result of the fundamental emission at 3 m without Distance factor

QP

Ant Deg [deg]	Frequency [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	73.50	19.46	6.79	32.01	-	67.74	-	-	Fundamental

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

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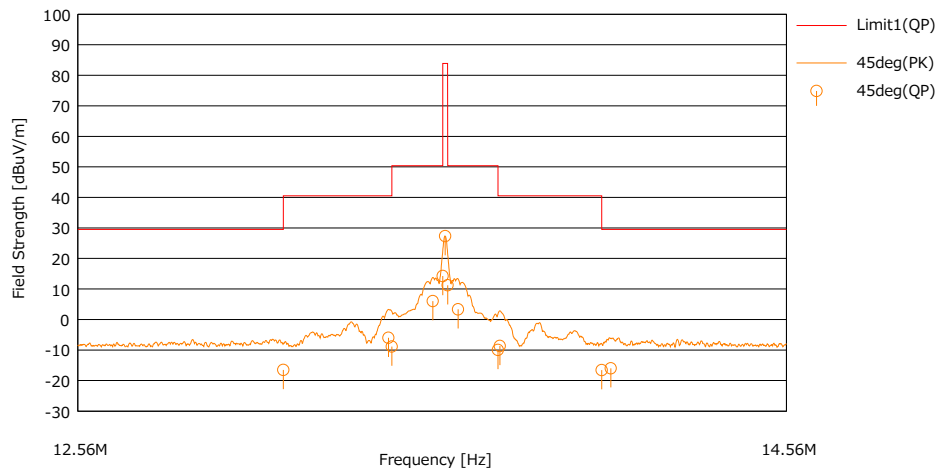
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Fundamental emission and Spectrum Mask

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1 with tag

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



No.	Freq. [MHz]	Reading <QP> [dBuV]	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result <QP> [dBuV/m]	Limit <QP> [dBuV/m]	Margin <QP> [dB]	Antenna [deg]	Table [deg]	Comment
1	13.11000	29.30	19.46	-33.23	32.01	-16.49	29.50	45.99	45deg	180	
2	13.40062	39.80	19.46	-33.22	32.01	-5.97	40.50	46.47	45deg	180	
3	13.41000	36.90	19.46	-33.22	32.01	-8.87	40.50	49.37	45deg	180	
4	13.52507	51.80	19.46	-33.22	32.01	6.03	50.40	44.37	45deg	180	
5	13.55300	60.00	19.46	-33.21	32.01	14.24	50.40	36.16	45deg	180	
6	13.56000	73.10	19.46	-33.21	32.01	27.34	83.90	56.56	45deg	180	
7	13.56700	57.00	19.46	-33.21	32.01	11.24	50.40	39.16	45deg	180	
8	13.59667	49.10	19.46	-33.21	32.01	3.34	50.40	47.06	45deg	180	
9	13.71000	35.80	19.46	-33.21	32.01	-9.96	40.50	50.46	45deg	180	
10	13.71562	37.10	19.46	-33.21	32.01	-8.66	40.50	49.16	45deg	180	
11	14.01000	29.20	19.46	-33.20	32.01	-16.55	29.50	46.05	45deg	180	
12	14.03646	29.80	19.46	-33.20	32.01	-15.95	29.50	45.45	45deg	180	

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

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

Result of the fundamental emission at 3 m without Distance factor

QP

Ant Deg [deg]	Frequency [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	73.10	19.46	6.79	32.01	-	67.34	-	-	Fundamental

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

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Spurious emission

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1 without tag

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
45deg	0.561	QP	48.20	18.78	-33.75	32.05	-	1.18	32.6	31.43	
45deg	1.125	QP	41.60	18.77	-33.70	32.02	-	-5.35	26.5	31.89	
45deg	27.120	QP	38.20	19.09	-32.93	31.99	-	-7.63	29.5	37.13	
Hori.	40.678	QP	26.20	14.49	7.29	31.98	-	16.00	40.0	24.00	*
Hori.	54.238	QP	33.00	9.56	7.47	31.97	-	18.06	40.0	21.94	*
Hori.	72.003	QP	39.40	6.27	7.69	31.96	-	21.40	40.0	18.60	*
Hori.	122.036	QP	36.40	12.95	8.17	31.89	-	25.63	43.5	17.89	*
Hori.	286.593	QP	43.90	13.45	9.49	31.76	-	35.08	46.0	10.94	*
Hori.	332.029	QP	40.40	14.61	9.77	31.77	-	33.01	46.0	13.01	*
Vert.	40.678	QP	40.30	14.49	7.29	31.98	-	30.10	40.0	9.90	*
Vert.	54.239	QP	43.70	9.56	7.47	31.97	-	28.76	40.0	11.24	*
Vert.	72.001	QP	46.70	6.27	7.69	31.96	-	28.70	40.0	11.30	*
Vert.	122.055	QP	37.50	12.95	8.17	31.89	-	26.73	43.5	16.79	*
Vert.	291.215	QP	39.30	13.50	9.52	31.76	-	30.56	46.0	15.46	*
Vert.	333.344	QP	38.10	14.67	9.78	31.77	-	30.78	46.0	15.24	*

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

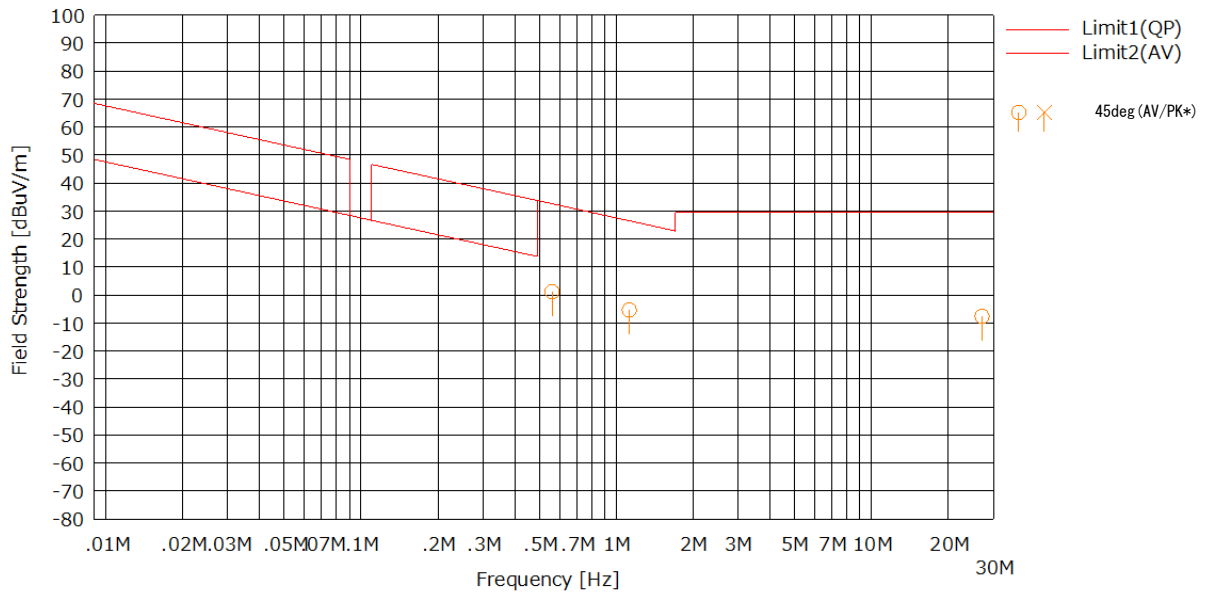
*Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amplifier)

Radiated Emission Plot data, Worst case

Report No.	13636080H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	January 8, 2021
Temperature / Humidity	24 deg. C / 30 % RH
Engineer	Tomohisa Nakagawa
Mode	Mode 1

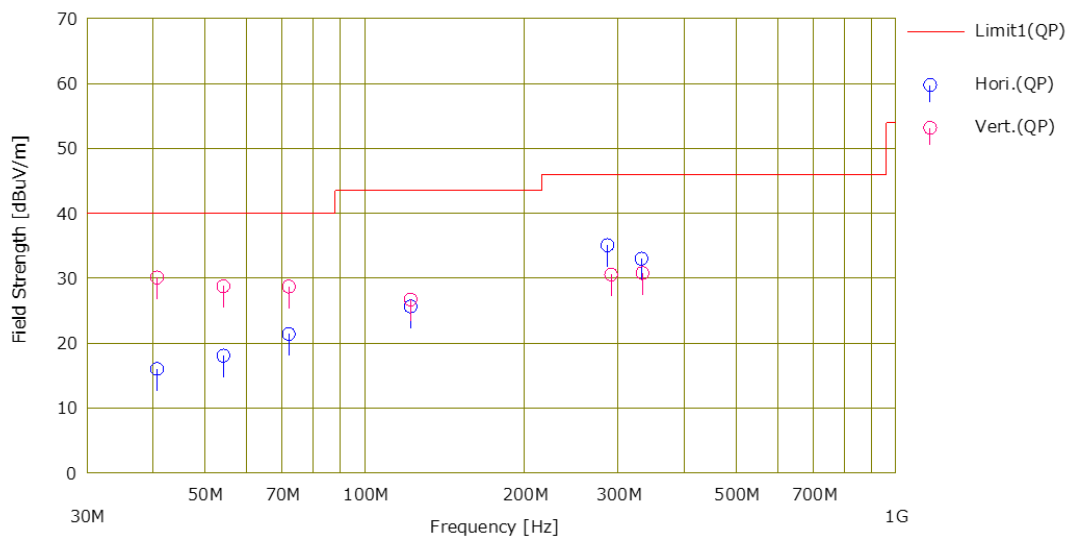
(below 30MHz)

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



* 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.

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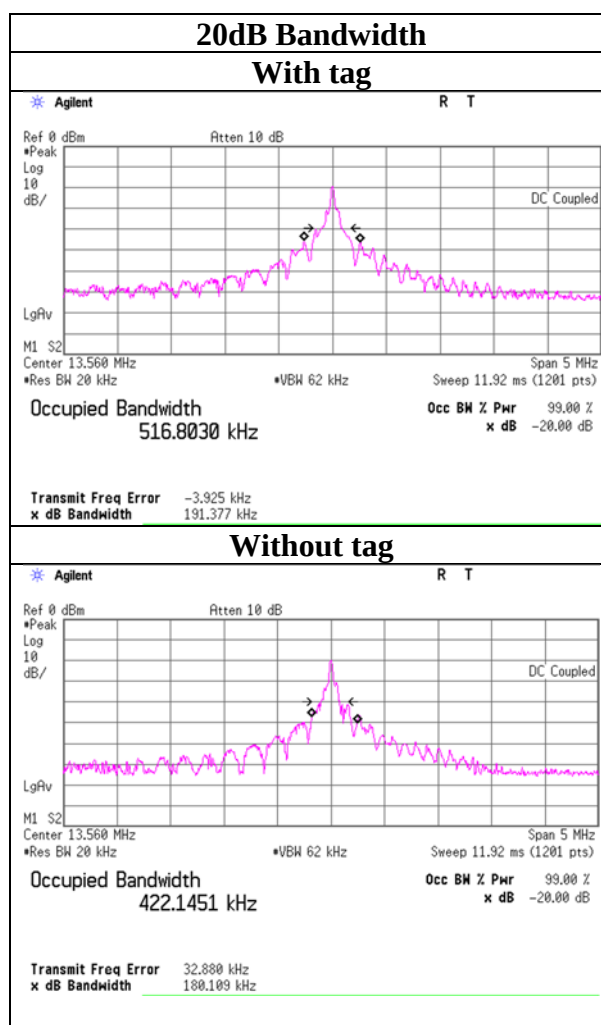
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20 dB Bandwidth and 99% Occupied Bandwidth

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date January 8, 2021
Temperature / Humidity 24 deg. C / 30 % RH
Engineer Tomohisa Nakagawa
Mode Mode 1

FREQ [MHz]	Mode	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	With Tag	191.377	516.8030
	Without Tag	180.109	422.1451



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.

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Frequency Tolerance

Report No. 13636080H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.6
Date January 8, 2021
Temperature / Humidity 22 deg. C / 40 % RH
Engineer Hiroyuki Furutaka
Mode Mode 2

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	12	Power on	13.559568	-0.000432	-0.00319	-31.9	0.01
		+ 2 min.	13.559564	-0.000436	-0.00322	-32.2	0.01
		+ 5 min.	13.559565	-0.000436	-0.00321	-32.1	0.01
		+ 10 min.	13.559564	-0.000437	-0.00322	-32.2	0.01
40	12	Power on	13.559598	-0.000402	-0.00296	-29.6	0.01
		+ 2 min.	13.559592	-0.000408	-0.00301	-30.1	0.01
		+ 5 min.	13.559592	-0.000408	-0.00301	-30.1	0.01
		+ 10 min.	13.559593	-0.000407	-0.00300	-30.0	0.01
30	12	Power on	13.559638	-0.000363	-0.00267	-26.7	0.01
		+ 2 min.	13.559628	-0.000373	-0.00275	-27.5	0.01
		+ 5 min.	13.559627	-0.000373	-0.00275	-27.5	0.01
		+ 10 min.	13.559627	-0.000373	-0.00275	-27.5	0.01
20	12	Power on	13.559647	-0.000353	-0.00260	-26.0	0.01
		+ 2 min.	13.559650	-0.000350	-0.00258	-25.8	0.01
		+ 5 min.	13.559651	-0.000349	-0.00258	-25.8	0.01
		+ 10 min.	13.559651	-0.000349	-0.00257	-25.7	0.01
20	10.2 (12V -15%)	Power on	13.559671	-0.000329	-0.00242	-24.2	0.01
		+ 2 min.	13.559669	-0.000331	-0.00244	-24.4	0.01
		+ 5 min.	13.559664	-0.000336	-0.00248	-24.8	0.01
		+ 10 min.	13.559661	-0.000339	-0.00250	-25.0	0.01
20	13.8 (12V +15%)	Power on	13.559660	-0.000341	-0.00251	-25.1	0.01
		+ 2 min.	13.559653	-0.000348	-0.00256	-25.6	0.01
		+ 5 min.	13.559650	-0.000350	-0.00258	-25.8	0.01
		+ 10 min.	13.559648	-0.000352	-0.00259	-25.9	0.01
10	12	Power on	13.559718	-0.000282	-0.00208	-20.8	0.01
		+ 2 min.	13.559713	-0.000287	-0.00212	-21.2	0.01
		+ 5 min.	13.559712	-0.000288	-0.00212	-21.2	0.01
		+ 10 min.	13.559712	-0.000288	-0.00212	-21.2	0.01
0	12	Power on	13.559726	-0.000274	-0.00202	-20.2	0.01
		+ 2 min.	13.559726	-0.000274	-0.00202	-20.2	0.01
		+ 5 min.	13.559725	-0.000276	-0.00203	-20.3	0.01
		+ 10 min.	13.559726	-0.000274	-0.00202	-20.2	0.01
-10	12	Power on	13.559707	-0.000293	-0.00216	-21.6	0.01
		+ 2 min.	13.559715	-0.000285	-0.00210	-21.0	0.01
		+ 5 min.	13.559716	-0.000284	-0.00210	-21.0	0.01
		+ 10 min.	13.559716	-0.000284	-0.00209	-20.9	0.01
-20	12	Power on	13.559658	-0.000342	-0.00253	-25.3	0.01
		+ 2 min.	13.559672	-0.000328	-0.00242	-24.2	0.01
		+ 5 min.	13.559674	-0.000326	-0.00240	-24.0	0.01
		+ 10 min.	13.559675	-0.000325	-0.00240	-24.0	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	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/25/2020	24
CE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/07/2020	12
CE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/07/2021	12
CE	MJM-29	142230	Measure	KOMELON	KMC-36	-	-	-
CE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess - Elektronik	NSLK8127	8127-729	07/22/2020	12
CE	MLS-24	141358	LISN(AMN)	Schwarzbeck Mess - Elektronik	NSLK8127	8127-730	07/22/2020	12
CE	MTA-55	141937	Terminator	TME	CT-01BP	-	12/04/2020	12
CE	MAT-67	141248	Attenuator	JFW Industries, Inc.	50FP-013H2 N	-	12/07/2020	12
CE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/421-010/sucoform141-PE/RFM-E121(SW)	-/04178	06/18/2020	12
CE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/10/2020	12
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/25/2020	24
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/07/2020	12
RE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/06/2020	12
RE	MJM-29	142230	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/10/2020	12
RE	MSA-13	141900	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46185823	09/24/2020	12
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/05/2020	12
RE	MBA-05	141425	Biconical Antenna	Schwarzbeck Mess - Elektronik	VHA9103+BBA9106	VHA 91031302	08/31/2020	12
RE	MCC-50	141397	Coaxial Cable	UL Japan	-	-	11/06/2020	12
RE	MLA-23	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess - Elektronik	VUSLP9111B	9111B-192	09/02/2020	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	02/18/2020	12
RE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/421-010/sucoform141-PE/RFM-E121(SW)	-/04178	06/18/2020	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	12/04/2020	12
RE	MCC-219	159670	Coaxial Cable	UL Japan Inc.	-	-	11/17/2020	12
FT	MOS-14	141561	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1401	01/07/2020	12
FT	MMM-12	141547	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	60500120	02/03/2020	12
FT	MJM-24	142225	Measure	ASKUL	-	-	-	-
FT	MCH-04	141429	Temperature and Humidity Chamber	Espec	PL-2KP	14015723	08/24/2020	12
FT	MFC-01	141498	Microwave Counter	ADVANTEST	R5373	120100309	06/17/2020	12
FT	MLPA-08	202511	Loop Antenna	UL Japan	-	-	-	-

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*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