RADIO TEST REPORT

Test Report No. : 13324451H-A-R3

Applicant	:	**MinebeaMitsumi Inc.**
Type of EUT	:	**Parking Sensor**
Model Number of EUT	:	**NDPM003 US**
FCC ID	:	**2AWRLNDPM003US**
Test regulation	:	**FCC Part 15 Subpart C: 2020**
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 covers Radio technical requirements.
   It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 13324451H-A-R2. 13324451H-A-R2 is replaced with this report.

Date of test: April 16 to 19, 2020

Representative test engineer:
Yuichiro Yamazaki
Engineer
Consumer Technology Division

Approved by:
Tsubasa Takayama
Leader
Consumer Technology Division

NVLAP TESTING NVLAP LAB CODE 200572-0

This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.
*As for the range of Accreditation in NVLAP, you may refer to the WEB address,
http://japan.ul.com/resources/emc_accredited/

☐ This report contains data that are not covered by the NVLAP accreditation.
☒ There is no testing item of "Non-accreditation".

REVISION HISTORY

Original Test Report No.: 13324451H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13324451H-A	July 8, 2020	-	-
1	13324451H-A-R1	August 3, 2020	P.7	Correction of erroneous description for Clause 3.1; from May 26, 2020 to June 26, 2020
1	13324451H-A-R1	August 3, 2020	P.7	Change of the FCC Part 15.31 € in Clause 3.2; From; The RF Module has its own regulator. The RF Module is constantly provided voltage through the regulator regardless of input voltage. Therefore, this EUT complies with the requirement. To; This EUT provides stable voltage constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.
1	13324451H-A-R1	August 3, 2020	P.13	Addition of the following sentence in SECTION 6; Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.
1	13324451H-A-R1	August 3, 2020	P.13	Addition of the "*1)" to 9 kHz-30 MHz (Detector) in the table, and the following sentence.in SECTION 6; *1) 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. Also, "1)" was changed to "2)" by above addition.
2	13324451H-A-R2	September 1, 2020	P.6	Correction of Steerable Antenna for Sensor in Clause 2.2; From Electronically to None
2	13324451H-A-R2	September 1, 2020	corresponding page	Deletion of all contents related to Conducted emission test.
3	13324451H-A-R3	September 8, 2020	P.10	Addition of USB Cable in configuration diagram and Cable list of Clause 4.2
3	13324451H-A-R3	September 8, 2020	P.10	Correction of Serial number for EUT of configuration diagram in Clause 4.2; From 201 to 24

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer information

Company Name	:	MinebeaMitsumi Inc.
Address	:	3-9-6 Mita, Minato-ku, Tokyo 108-8330 Japan
Telephone Number	:	+81-3-6758-6711
Facsimile Number	:	+81-3-6758-6700
Contact Person	:	Kosuke Sumi

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	:	Parking Sensor
Model Number	:	NDPM003 US
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 3.6 V (3 AA-sized batteries)
Receipt Date	:	April 9, 2020
Country of Mass-production	:	Thailand
Condition	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab

2.2 Product Description

Model: NDPM003 US (referred to as the EUT in this report) is a Parking Sensor.

General Specificaion

Clock frequency(ies) in the system	:	50 MHz

Radio Specification

Sub-GHz Radio Interface

Radio Type	:	Transceiver
Frequency of Operation	:	902.42 MHz - 927.58 MHz
Modulation	:	GFSK
Antenna type	:	Reverse F Antenna
Antenna Gain	:	2.3 dBi (max)
TX mode	:	Frequency Hopping Spread Spectrum
Ch. Spacing	:	340 kHz
Channels	:	75

Sensor *1)

Radio Type	:	Transceiver
Frequency of Operation	:	24.15 GHz
Modulation	:	Unmodulation
Antenna type	:	PatchAntenna
Antenna connector	:	None (Internal Antenna)
Antenna Gain	:	4.0 dBi (max)
Steerable Antenna	:	None

*1) This test report applies to Sensor.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on June 26, 2020 and effective July 27, 2020 except 15.258

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.249 Operation within the bands 902-928MHz, 2400-2483.5MHz, 5725-5875MHz and 24.0-24.25GHz

* 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

No.	Item	Test Procedure	Specification	Deviation	Worst margin	Results
1	Conducted Emission	ANSI C63.10-2013 6. Standard test methods	Section 15.207(a)	N/A	N/A	N/A *1)
2	Electric Field Strength of Fundamental Emission	ANSI C63.10-2013 6. Standard test methods	Section 15.249(a)(c)(e)	N/A	5.3 dB (24135.900 MHz, Horizontal, AV)	Complied# a)
3	Electric Field Strength of Spurious Emission	ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems	Section 15.205(a)(b)(d) Section 15.209(a) Section 15.249(a)(c)(d)(e)	N/A	4.9 dB (96543.600 MHz, Horizontal, AV)	Complied# a)
4	20dB Bandwidth	ANSI C63.10-2013 6. Standard test methods	FCC 15.215	N/A	N/A	Complied b)
5	Frequency Tolerance	ANSI C63.10-2013 6. Standard test methods	Section 15.249(b)	N/A	N/A	N/A *2)

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.
*1) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.
*2) The test is not required since this EUT does not operate with 24.05 GHz to 24.25 GHz.

a) Refer to APPENDIX 1 (data of Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission))
b) Refer to APPENDIX 1 (data of 20dB Bandwidth, 99% Occupied Bandwidth)

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.

FCC Part 15.203 Antenna requirement
It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	**ISED:** RSS-Gen 6.7	**ISED:** -	N/A	-	Conducted
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.					

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

3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the 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.

Ise EMC Lab.

Test distance	Radiated emission (+/-) 9 kHz - 30 MHz
3 m	3.3 dB
10 m	3.2 dB

Polarity	Radiated emission (Below 1 GHz)			
	(3 m*) (+/-)		(10 m*) (+/-)	
	30 MHz - 200 MHz	200 MHz - 1000 MHz	30 MHz - 200 MHz	200 MHz - 1000 MHz
Horizontal	4.8 dB	5.2 dB	4.8 dB	5.0 dB
Vertical	5.0 dB	6.3 dB	4.8 dB	5.0 dB

Radiated emission (Above 1 GHz)					
(3 m*) (+/-)		(1 m*) (+/-)		(0.5 m*) (+/-)	(10 m*) (+/-)
1 GHz - 6 GHz	6 GHz - 18 GHz	10 GHz - 26.5 GHz	26.5 GHz - 40 GHz	26.5 GHz - 40 GHz	1 GHz - 18 GHz
4.9 dB	5.2 dB	5.5 dB	5.5 dB	5.5 dB	5.2 dB

*Measurement distance

Radiated emission (+/-)		Distance
40 GHz - 50 GHz	3.9 dB	> =0.5 m
50 GHz - 75 GHz	5.3 dB	> =0.5 m
75 GHz - 110 GHz	5.6 dB	> =0.5 m

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
*NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967 / ISED Lab Company Number: 2973C
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124

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

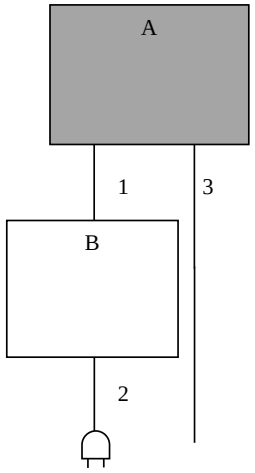
Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Modes

Test Item	Mode	Tested frequency
Electric Field Strength of Fundamental Emission Electric Field Strength of Spurious Emission 20 dB Bandwidth, 99 % Occupied Bandwidth	Transmitting mode (Tx)	24135.900 MHz
The system was configured in typical fashion (as a customer would normally use it) for testing. *EUT has the power settings by the software as follows; Power Settings: 13dBm Software: PKKGUICS.exe Version 3.13.1 (Date: April 16, 2020, 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.		

4.2 Configuration and peripherals



* 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	Parking Sensor	NDPM003 US	24	MinebeaMitsumi Inc.	EUT
B	DC Power Supply	PW16-5ADP	GJQ810118	TEXIO	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	1.8	Unshielded	Unshielded	-
2	AC Cable	2.5	Unshielded	Unshielded	-
3	USB Cable	1.8	Shielded	Shielded	-

SECTION 5: Radiated emission (Electric Field Strength of Fundamental and Spurious Emission)

Test Procedure and conditions

[For below 30 MHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane.
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.

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 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.

[For above 1 GHz, up to 40 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

The height of the measuring antenna varied between 1 m and 4 m (frequency range 9 kHz - 30 MHz: loop antenna was fixed height at 1.0 m) and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear voltage average mode).
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	Above 1 GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

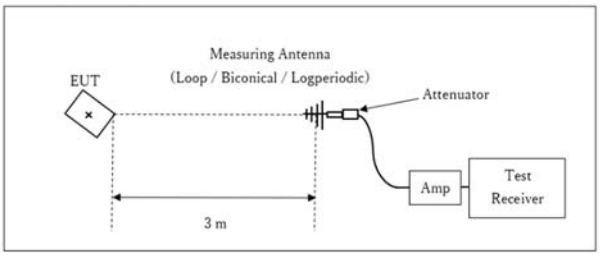
Frequency	9 kHz - 150 kHz	150 kHz - 30 MHz	30 MHz - 1 GHz	1 GHz - 40 GHz	
Instrument used	Test Receiver	Test Receiver	Test Receiver	Spectrum Analyzer	
Detector	QP, Average *1)	QP, Average *1)	QP	Peak	Average *2)
IF Bandwidth	BW 200 Hz	BW 9 kHz	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 10 Hz

*1) 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.

*2) VBW was set to 10 Hz and linear voltage average mode was used.

[Test setup]

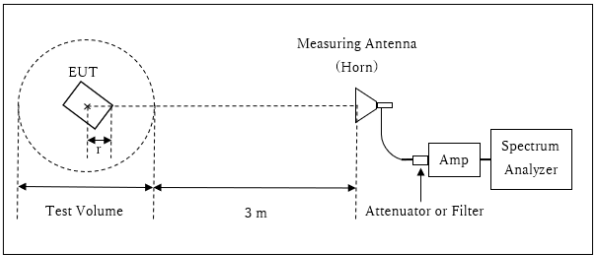
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



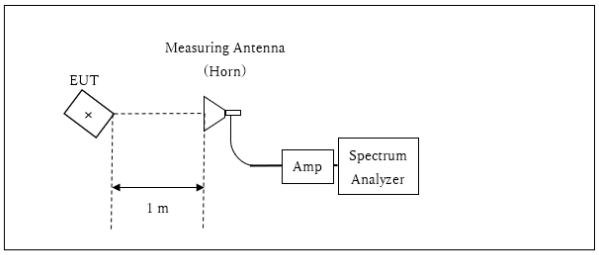
r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.75 m*/3.0 m) = 1.9 dB
* Test Distance: (3 + Test Volume /2) - r = 3.75 m

Test Volume: 1.5 m
(Test Volume has been calibrated based on CISPR 16-1-4.)
r = 0 m

* The test was performed with r = 0.0 m since EUT is small and it was the rather conservative condition.

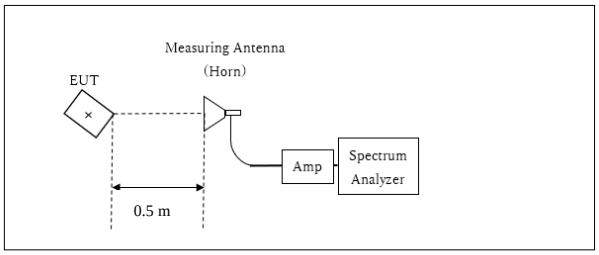
10 GHz - 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m* / 3.0 m) = -9.5 dB
*Test Distance: 1 m

26.5 GHz - 40 GHz

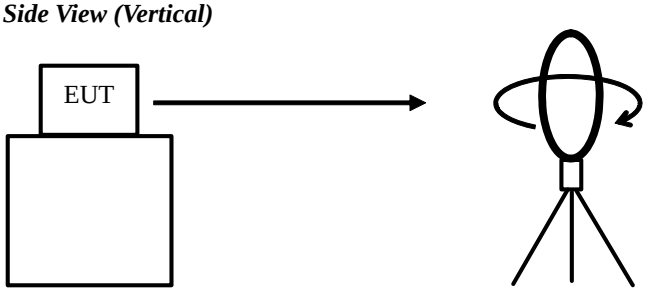


× : Center of turn table

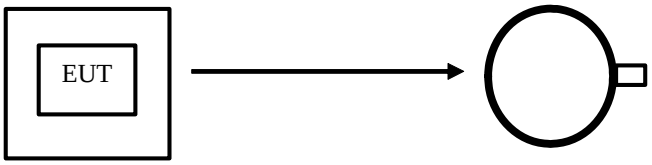
Distance Factor: 20 x log (0.5 m* / 3.0 m) = -15.6 dB
*Test Distance: 0.5 m

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

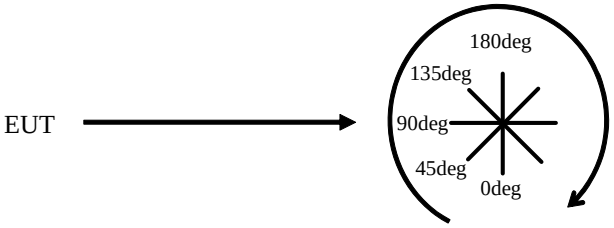


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

[About fundamental measurement]
The carrier levels were confirmed at maximum direction of transmission. The maximum direction was searched under carefully since beam-widths are narrow.

The carrier levels were measured in the far field. The distance of the far field was calculated from follow equation.

$$r = \frac{2D^2}{\lambda}$$

where

r is the distance from the radiating element of the EUT to the edge of the far field, in m
D is the largest dimension of both the radiating element and the test antenna (horn), in m
(The antenna aperture size of test antenna was used for this caluculation.)
Lambda is the wavelength of the emission under investigation [300 / *f* (MHz) * 10^3], in millimeter

Frequency	Wavelength	Maximum Dimention			Far Field
		EUT	Test Antenna	Maximum	Boundary
	Lambda		Local ID	*D*	*r*
			MHA-02		
[GHz]	[mm]	[m]	[m]	[m]	[m]
24.250	12.4	0.009	0.038	0.038	0.238

[Above 40 GHz]
The test was performed based on "Procedures for testing millimeter-wave systems" of ANSI C63.10-2013. The EUT was placed on an urethane platform, raised 1.5 m above the conducting ground plane. The measurements were performed on handheld method.

Set spectrum analyzer RBW, VBW, span, etc., to the proper values. Note these values. Enable two traces—one set to "clear write," and the other set to "max hold." Begin hand-held measurements with the test antenna (horn) at a distance of 1 m from the EUT in a horizontally polarized position. Slowly adjust its position, entirely covering the plane 1 m from the EUT. Observation of the two active traces on the spectrum analyzer will allow refined horn positioning at the point(s) of maximum field intensity. Repeat with the horn in a vertically polarized position. If the emission cannot be detected at 1 m, reduce the RBW to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.

Note the maximum level indicated on the spectrum analyzer. Adjust this level, if necessary, by the antenna gain, conversion loss of the external mixer and gain of LNA used, at the frequency under investigation. Calculate the field strength of the emission at the measurement distance from the Friis' transmission equation.

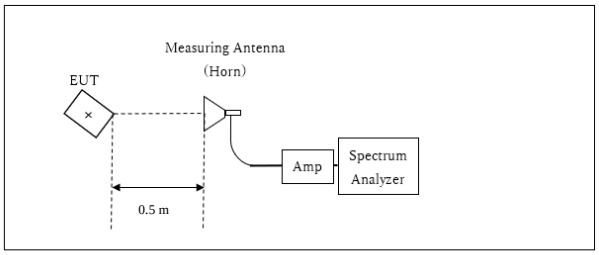
Frequency	40 GHz - 50 GHz	50 GHz - 75 GHz	75 GHz - 100 GHz
Final measurement distance with 1 MHz Peak detector	0.5 m	0.75 m	0.5 m

Detector	Peak	Average *1)
IF Bandwidth	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 10 Hz

*1) VBW was set to 10 Hz and linear voltage average mode was used.

[Test setup]

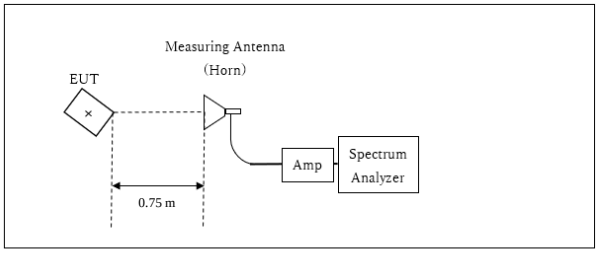
40 GHz - 50 GHz



× : Center of turn table

Distance Factor: 20 x log (0.5 m* / 3.0 m) = -15.6 dB
*Test Distance: 0.5 m

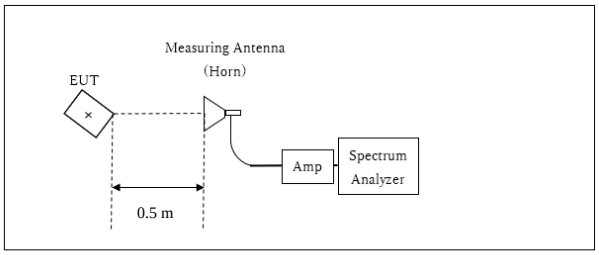
50 GHz - 75 GHz



× : Center of turn table

Distance Factor: 20 x log (0.75 m* / 3.0 m) = -12.0 dB
*Test Distance: 0.75 m

75 GHz - 100 GHz



× : Center of turn table

Distance Factor: 20 x log (0.5 m* / 3.0 m) = -15.6 dB
*Test Distance: 0.5 m

- The carrier level and noise levels were confirmed at each position of X, Y and Z axies 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 - 100 GHz**
Test data : **APPENDIX**
Test result : **Pass**

SECTION 6: 20 dB Bandwidth, 99 % Occupied Bandwidth and Duty Cycle

Test Procedure

The measurement was performed in the antenna height to gain the maximum of Electric field strength.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	20 MHz	100 kHz 1 % to 5 % of OBW	300 kHz Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth	20 MHz, Enough width to display emission skirts	100 kHz 1 % to 5 % of OBW	300 kHz Three times of RBW	Auto	Peak *1)	Max Hold	Spectrum Analyzer
Duty Cycle	-	-	-	100 msec	-	Single	Spectrum Analyzer
*1) Peak detector was applied as Worst-case measurement.							

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	13324451H
Test place	Ise EMC Lab. No. 2 Semi Anechoic Chamber
Date	April 16, 2020
Temperature / Humidity	21 deg. C / 32 % RH
Engineer	Yuichiro Yamazaki
Mode	Transmitting mode (Tx)

[Fundamental]

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	24135.900	PK	97.3	40.3	-1.2	32.6	103.7	127.9	24.2	
Hori	24135.900	AV	96.0	40.3	-1.2	32.6	102.5	107.9	5.5	VBW:10Hz Voltage Avg
Vert	24135.900	PK	97.5	40.3	-1.2	32.6	103.9	127.9	24.0	
Vert	24135.900	AV	96.2	40.3	-1.2	32.6	102.6	107.9	5.3	VBW:10Hz Voltage Avg

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Mixer(above 50 GHz)+Distance factor(above 1 GHz)) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*NS: No signal detected.

Distance factor: 18 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

[Band-edge]

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	24000.000	PK	46.6	40.3	-1.2	32.4	53.2	73.9	20.7	NS
Hori	24250.000	PK	48.2	40.3	-1.1	32.8	54.4	73.9	19.5	NS
Hori	24000.000	AV	33.2	40.3	-1.2	32.4	39.8	53.9	14.1	NS VBW:10Hz Voltage Avg
Hori	24250.000	AV	34.4	40.3	-1.1	32.8	40.7	53.9	13.3	NS VBW:10Hz Voltage Avg
Vert	24000.000	PK	46.5	40.3	-1.2	32.4	53.1	73.9	20.8	NS
Vert	24250.000	PK	48.0	40.3	-1.1	32.8	54.3	73.9	19.6	NS
Vert	24000.000	AV	32.9	40.3	-1.2	32.4	39.5	53.9	14.4	NS VBW:10Hz Voltage Avg
Vert	24250.000	AV	36.9	40.3	-1.1	32.8	43.2	53.9	10.7	NS VBW:10Hz Voltage Avg

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Mixer(above 50 GHz)+Distance factor(above 1 GHz)) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*NS: No signal detected.

Distance factor: 18 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	13324451H			
Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.2	No.2	No.2	No.4
Date	April 16, 2020	April 17, 2020	April 19, 2020	April 19, 2020
Temperature /Humidity	21 deg. C / 32 % RH	22 deg. C / 44 % RH	20 deg. C / 46 % RH	22 deg. C / 42 % RH
Engineer	Yuichiro Yamazaki (10 GHz - 50 GHz)	Yuichiro Yamazaki (Above 50 GHz)	Yuichiro Yamazaki (9 kHz - 30 MHz) (1 GHz - 10 GHz)	Yuichiro Yamazaki (30 MHz - 1 GHz)
Mode	Transmitting mode (Tx)			

[Spurious emissions other than above]

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	79.999	QP	34.8	6.9	7.9	32.0	17.6	40.0	22.4	
Hori.	103.117	QP	26.6	10.7	8.1	31.9	13.5	43.5	30.0	
Hori.	117.849	QP	27.0	12.6	8.3	31.9	16.0	43.5	27.5	
Hori.	309.357	QP	30.2	13.7	9.8	31.8	22.0	46.0	24.0	
Hori.	356.495	QP	36.3	15.1	10.1	31.8	29.7	46.0	16.3	
Hori.	450.774	QP	26.8	16.7	10.7	31.8	22.3	46.0	23.7	
Hori.	48271.800	PK	64.6	41.7	-6.7	33.0	66.7	87.9	21.2	
Hori.	72407.700	PK	40.4	43.1	6.1	21.0	68.5	87.9	19.4	
Hori.	96543.600	PK	47.1	45.6	-3.3	28.8	60.7	73.9	13.2	
Hori.	48271.800	AV	57.7	41.7	-6.7	33.0	59.7	67.9	8.2	VBW:10Hz Voltage Avg
Hori.	72407.700	AV	28.4	43.1	6.1	21.0	56.6	67.9	11.3	VBW:10Hz Voltage Avg
Hori.	96543.600	AV	35.4	45.6	-3.3	28.8	49.0	53.9	4.9	VBW:10Hz Voltage Avg
Vert.	79.999	QP	36.4	6.9	7.9	32.0	19.2	40.0	20.8	
Vert.	103.117	QP	38.0	10.7	8.1	31.9	24.9	43.5	18.6	
Vert.	117.849	QP	33.5	12.6	8.3	31.9	22.5	43.5	21.0	
Vert.	309.357	QP	31.5	13.7	9.8	31.8	23.3	46.0	22.7	
Vert.	356.495	QP	31.6	15.1	10.1	31.8	25.0	46.0	21.0	
Vert.	450.774	QP	26.6	16.7	10.7	31.8	22.1	46.0	23.9	
Vert.	48271.800	PK	64.4	41.7	-6.7	33.0	66.5	87.9	21.4	
Vert.	72407.700	PK	39.6	43.1	6.1	21.0	67.8	87.9	20.1	
Vert.	96543.600	PK	46.9	45.6	-3.3	28.8	60.5	73.9	13.4	
Vert.	48271.800	AV	57.2	41.7	-6.7	33.0	59.2	67.9	8.7	VBW:10Hz Voltage Avg
Vert.	72407.700	AV	27.5	43.1	6.1	21.0	55.6	67.9	12.3	VBW:10Hz Voltage Avg
Vert.	96543.600	AV	34.6	45.6	-3.3	28.8	48.2	53.9	5.7	VBW:10Hz Voltage Avg

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Mixer(above 50 GHz)+Distance factor(above 1 GHz)) - Gain(Amplifier)

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

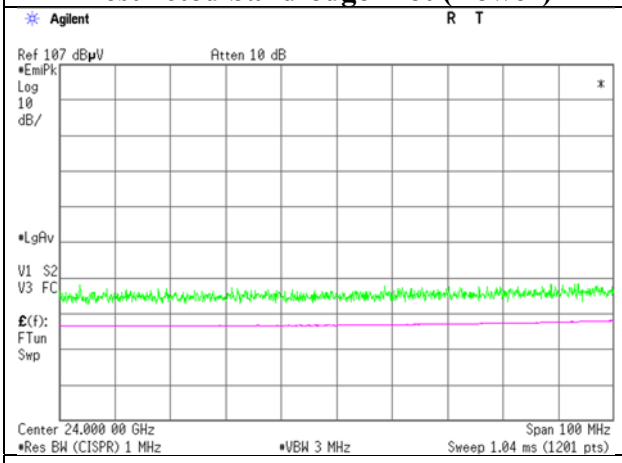
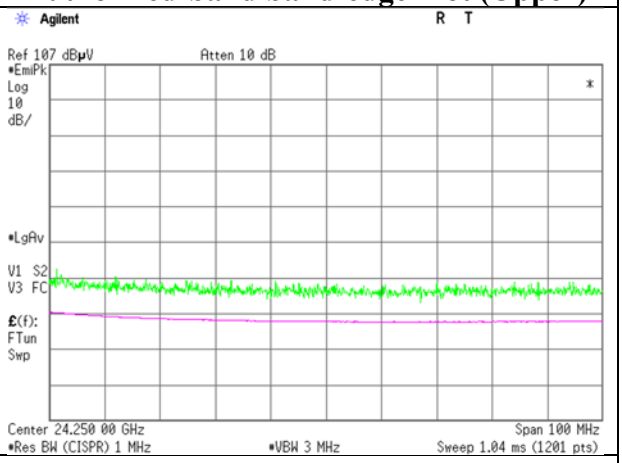
Distance factor:

1 GHz - 10 GHz	20log (3.75 m / 3.0 m) = 1.9 dB
10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB
26.5 GHz - 50 GHz	20log (0.5 m / 3.0 m) = -15.6 dB
50 GHz - 75 GHz	20log (0.75 m / 3.0 m) = -12.0 dB
75 GHz - 100 GHz	20log (0.5 m / 3.0 m) = -15.6 dB

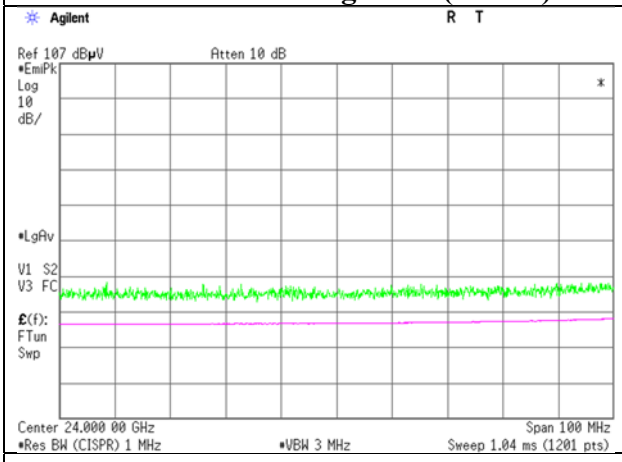
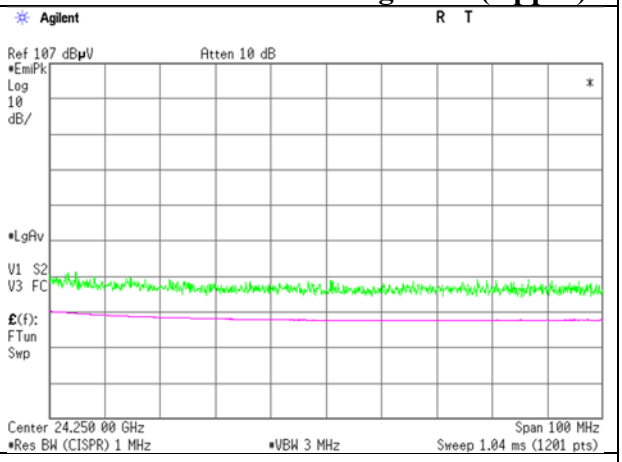
Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	13324451H
Test place	Ise EMC Lab. No. 2 Semi Anechoic Chamber
Date	April 16, 2020
Temperature / Humidity	21 deg. C / 32 % RH
Engineer	Yuichiro Yamazaki
Mode	Transmitting mode (Tx)

Horizontal polarization

Restricted band-edge Plot (Lower)	Authorized-band band-edge Plot (Upper)
	
Trace Green : Peak Plot Trace Purple : Average Plot	Trace Green : Peak Plot Trace Purple : Average Plot

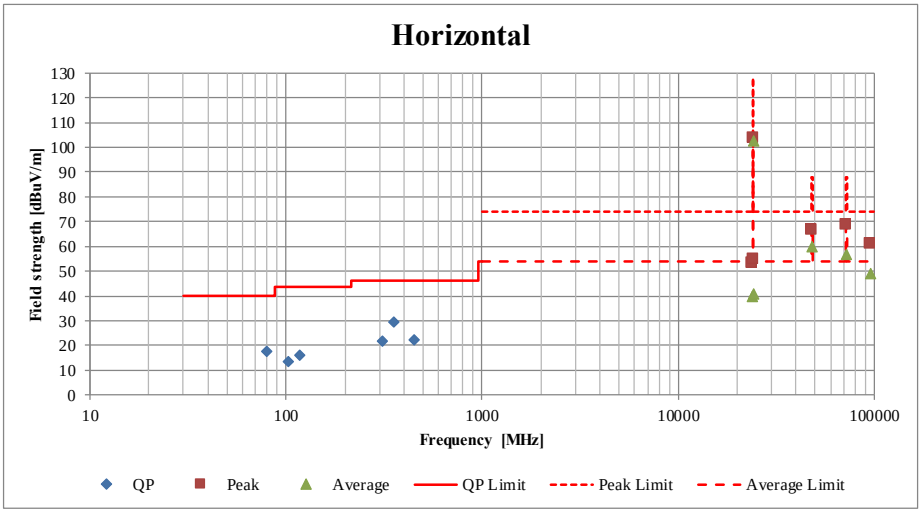
Vertical polarization

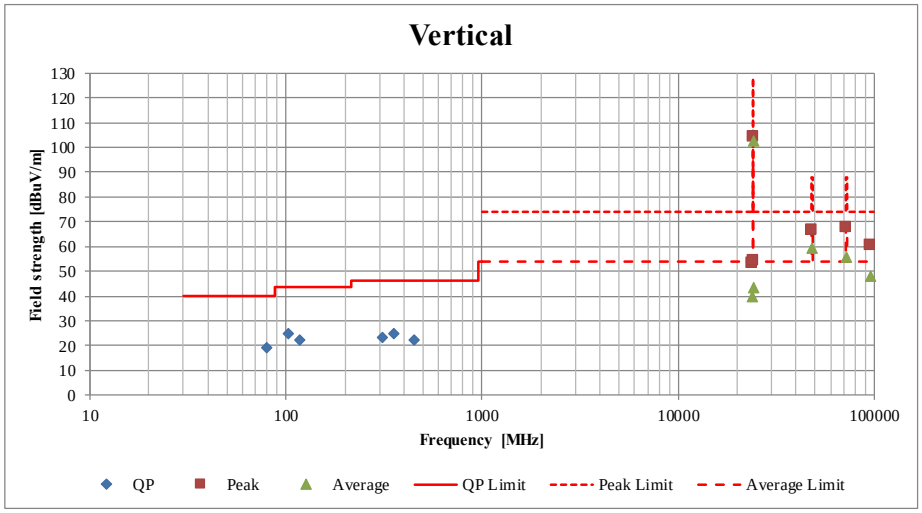
Restricted band-edge Plot (Lower)	Authorized-band band-edge Plot (Upper)
	
Trace Green : Peak Plot Trace Purple : Average Plot	Trace Green : Peak Plot Trace Purple : Average Plot

* Final result of restricted band edge was shown in tabular data.

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	13324451H			
Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No.2	No.2	No.2	No.4
Date	April 16, 2020	April 17, 2020	April 19, 2020	April 19, 2020
Temperature /Humidity	21 deg. C / 32 % RH	22 deg. C / 44 % RH	20 deg. C / 46 % RH	22 deg. C / 42 % RH
Engineer	Yuichiro Yamazaki (10 GHz - 50 GHz)	Yuichiro Yamazaki (Above 50 GHz)	Yuichiro Yamazaki (9 kHz - 30 MHz) (1 GHz - 10 GHz)	Yuichiro Yamazaki (30 MHz - 1 GHz)
Mode	Transmitting mode (Tx)			



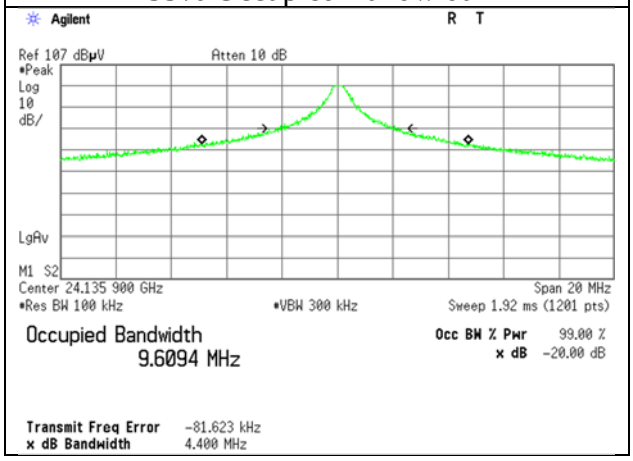


20dB Bandwidth, 99% Occupied Bandwidth

Report No.	13324451H
Test place	Ise EMC Lab. No. 2 Semi Anechoic Chamber
Date	April 16, 2020
Temperature / Humidity	21 deg. C / 32 % RH
Engineer	Yuichiro Yamazaki
Mode	Transmitting mode (Tx)

Frequency [GHz]	20 dB Bandwidth [MHz]	99% Occupied Bandwidth [MHz]
24.1359	4.400	9.609

20dB Bandwidth,
99% Occupied Bandwidth

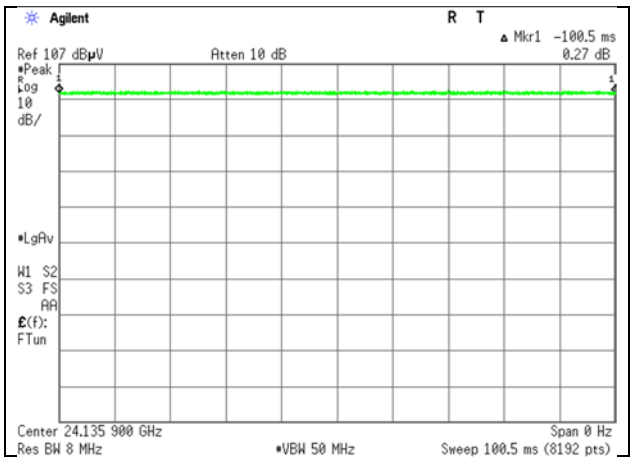


Duty Cycle

Report No.	13324451H
Test place	Ise EMC Lab. No. 2 Semi Anechoic Chamber
Date	April 16, 2020
Temperature / Humidity	21 deg. C / 32 % RH
Engineer	Yuichiro Yamazaki
Mode	Transmitting mode (Tx)

Tx On time [ms]	Tx On + Off time [ms]	Duty factor [dB]
100.500	100.500	0.00

Duty factor = 20 * log (Tx On time / Tx On + Off time)



APPENDIX 2: Test Instruments

Test equipment (1/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	MAEC-02	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	06/29/2018	24
RE	MOS-41	192300	Thermo-Hygrometer	CUSTOM	CTH-201	0013	12/19/2019	12
RE	MMM-01	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/20/2019	12
RE	MJM-27	142228	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ	TEPTO-DV	-	-	-
RE	MAEC-02-SVSWR	142006	AC2_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-06902	04/01/2019	24
RE	MHA-06	141512	Horn Antenna 1-18GHz	Schwarzbeck Mess - Elektronik	BBHA9120D	254	09/03/2019	12
RE	MCC-216	141392	Microwave Cable	Junkosha	MWX221	1604S253(1 m) / 537073/126E(5 m)	02/18/2020	12
RE	MPA-10	141579	Pre Amplifier	Keysight Technologies Inc	8449B	3008A02142	01/07/2020	12
RE	MHA-02	141503	Horn Antenna 18-26.5GHz	EMCO	3160-09	1265	10/08/2019	12
RE	MHA-04	141505	Horn Antenna 26.5-40GHz	EMCO	3160-10	1140	09/19/2019	12
RE	MCC-220	151897	Microwave Cable	Huber+Suhner	SF101EA/11PC24/11 PC24/2.5M	SN MY1726/1EA	04/13/2020	12
RE	MPA-03	141577	Microwave System Power Amplifier	Keysight Technologies Inc	83050A	MY39500610	10/01/2019	12
RE	MPA-25	159919	Power Amplifier	SAGE Millimeter, Inc.	SBP-4035033018-2F2F-S1	12559-01	06/19/2019	12
RE	MHA-31	142041	Horn Antenna	Oshima Prototype Engineering Co.	A16-187	1	09/27/2019	12
RE	MSA-10	141899	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180655	08/07/2019	12
RE	MHA-33	180634	Horn Antenna	SAGE Millimeter, Inc.	SAZ-2410-15-S1	17343-01	06/25/2019	12
RE	MPA-23	142055	Power Amplifier	SAGE Millimeter, Inc.	SBP-5037532015-1515-N1	11599-01	12/19/2019	12
RE	MMX-01	142047	Preselected Millimeter Mixer	Keysight Technologies Inc	11974V-E01	3001A00412	06/14/2019	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	02/18/2020	12
RE	MCC-178	141227	Microwave Cable	Junkosha	MMX221-00500DMSDMS	1502S305	03/18/2020	12
RE	MCC-135	142032	Microwave Cable	Huber+Suhner	SUCOFLEX102	37511/2	09/11/2019	12
RE	MCC-136	142033	Microwave Cable	Huber+Suhner	SUCOFLEX102	37512/2	09/11/2019	12
RE	MHA-35	180544	Horn Antenna	SAGE Millimeter, Inc.	SAZ-2410-10-S1	17343-01	06/25/2019	12
RE	MPA-18	142054	Pre Amplifier	AmTechs Corporation	LNA-7511025	9601	06/17/2019	12
RE	MMX-02	142048	Harmonic Mixer	Keysight Technologies Inc	11970W	2521 A01909	06/14/2019	12
RE	MCC-13	141222	Coaxial Cable	Fujikura,HP,Mini-Circits,Fujikura	3D-2W(12m)/ 5D-2W(5m)/ 5D-2W(0.8m)/ 5D-2W(1m)	-	02/25/2020	12
RE	MLPA-01	141254	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	10/04/2019	12
RE	MCC-143	141413	Coaxial Cable	UL Japan	-	-	06/07/2019	12
RE	MAT-07	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/07/2019	12
RE	MTR-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	08/08/2019	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	1302	08/24/2019	12
RE	MCC-50	141397	Coaxial Cable	UL Japan	-	-	03/24/2020	12
RE	MLA-23	141267	Logperiodic Antenna(200-1000MHz)	Schwarzbeck Mess - Elektronik	VUSLP9111B	9111B-192	08/24/2019	12

Test equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	06/28/2018	24
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM	CTH-201	0010	01/07/2020	12
RE	MMM-10	141545	DIGITAL HiTESTER	Hioki	3805	51201148	01/06/2020	12
RE	MJM-26	142227	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ	TEPTO-DV	-	-	-
RE	MAT-07	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/07/2019	12
RE	MSA-10	141899	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180655	08/07/2019	12

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

The expiration date of the calibration is the end of the expired month.
As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

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

Test item:

RE: Radiated emission, 20 dB bandwidth, Automatically deactivate and Duty cycle tests