



# EMI TEST REPORT


**Test Report No. : 14006494H-R2**

**Applicant** : **DENSO WAVE INCORPORATED**  
**Type of EUT** : **High Frequency 13.56 MHz Transceiver**  
**Model Number of EUT** : **56RF-TR-8090**  
**Test regulation** : **FCC Part 15 Subpart C: 2021**  
**FCC ID** : **PZWTR-8090**  
**Test Result** : **Complied (Refer to SECTION 3)**

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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.
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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, Inc. has been accredited.
9. The information provided from the customer for this report is identified in Section 1.
10. This report is a revised version of 14006494H-R1. 14006494H-R1 is replaced with this report.

**Date of test:** September 21 to 27, 2021

**Representative test engineer:**

  
Hiroki Numata  
Engineer

**Approved by:**

  
Tsubasa Takayama  
Leader



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".

**UL Japan, Inc.**  
**Ise EMC Lab.**

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## **REVISION HISTORY**

### **Original Test Report No.: 14006494H**

Revision	Test report No.	Date	Page revised	Contents
- (Original)	14006494H	October 8, 2021	-	-
1	14006494H-R1	December 9, 2021	P.5	Deletion of the Antenna Gain and Operating Temperature from Clause 2.2.
1	14006494H-R1	December 9, 2021	P.6	Addition of the Worst margin for Conducted Emission in Clause 3.2
1	14006494H-R1	December 9, 2021	P.7	Addition of Uncertainty for Conducted Emission in Clause 3.4.
1	14006494H-R1	December 9, 2021	P.9	Addition of "Conducted Emission" in Test item of Clause 4.1.
1	14006494H-R1	December 9, 2021	P.10	Addition of Conducted Emission block diagram in Clause 4.2.
1	14006494H-R1	December 9, 2021	P.12	Addition of SECTION 5: Conducted Emission
1	14006494H-R1	December 9, 2021	P.16	Addition of Conducted Emission test data.
1	14006494H-R1	December 9, 2021	P.23	- Addition of Conducted Emission Test instruments - Deletion of the following Test instruments for Radiated Emission; Local ID: MOS-28, MMM-17, MLPA-08, MCH-05, MSA-16
1	14006494H-R1	December 9, 2021	P.24	Addition of Conducted Emission setup photo.
2	14006494H-R2	December 14, 2021	P.11	Correction of Cable list No. for Radiated Emission and Frequency Tolerance tests block diagram in Clause 4.2.

## Reference: Abbreviations (Including words undescribed in this report)

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

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## **SECTION 1: Customer information**

Company Name : DENSO WAVE INCORPORATED  
Address : 1 Yoshiike, Kusagi, Agui-cho, Chita-gun, Aichi 470-2297 Japan  
Telephone Number : +81-569-49-5423  
Facsimile Number : +81-569-49-5490  
Contact Person : JUN HAMADA

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 : High Frequency 13.56 MHz Transceiver  
Model Number : 56RF-TR-8090  
Serial Number : Refer to SECTION 4.2  
Rating : DC 24.0 V  
Receipt Date : September 16, 2021  
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: 56RF-TR-8090 (referred to as the EUT in this report) is a High Frequency 13.56 MHz Transceiver.

#### **Radio Specification**

Radio Type : Transceiver  
Frequency of Operation : 13.56 MHz  
Modulation : ASK  
Power Supply (inner) : Transmitter: DC 7.0 V, Receiver: DC 5.0 V  
Antenna type : Loop Coil  
Clock frequency (Maximum) : 13.56 MHz

## SECTION 3: Test specification, procedures & results

### 3.1 Test Specification

Test Specification : FCC Part 15 Subpart C  
FCC Part 15 final revised on May 3, 2021 and effective July 2, 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.

\* Also the EUT complies with FCC Part 15 Subpart B .

### 3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 8.8	<FCC> Section 15.207 ----- <ISED> RSS-Gen 8.8	20.36 dB 13.56000 MHz AV, Phase N	Complied a)	-
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.12	<FCC> Section 15.225(a) ----- <ISED> RSS-210 B.6	43.26 dB, 13.56000 MHz, QP, 120 deg. < without tag >	Complied b)	Radiated
Spectrum Mask	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.13	<FCC> Section 15.225(b)(c) ----- <ISED> RSS-210 B.6	24.06 dB, 13.55300 MHz, QP, 120 deg. < without tag >	Complied b)	Radiated
20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> -	<FCC> Section15.215(c) ----- <ISED> -	See data	Complied c)	Radiated
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.13	<FCC> Section 15.209, Section 15.225 (d) ----- <ISED> RSS-210 B.6 RSS-Gen 8.9	3.7 dB 406.800 MHz, Vertical, QP	Complied# d)	Radiated
Frequency Tolerance	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.11, 8.11	<FCC> Section 15.225(e) ----- <ISED> RSS-210 B.6	See data	Complied 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**

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 Band Width	<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**

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)	4.8 dB
		(Vertical)	5.0 dB
	200 MHz to 1000 MHz	(Horizontal)	5.2 dB
		(Vertical)	6.3 dB
10 m	30 MHz to 200 MHz	(Horizontal)	4.8 dB
		(Vertical)	4.8 dB
	200 MHz to 1000 MHz	(Horizontal)	5.0 dB
		(Vertical)	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

UL Japan, Inc. Ise EMC Lab.

\*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919

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

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.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	-	-

### 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 :

<b>Mode</b>	<b>Remarks*</b>
1) Transmitting mode (Tx) Modulated on (Mod on)	The EUT Transmits and Receives at the same time and there is no receiving mode.
<p>The EUT was operated in a manner similar to typical use during the tests.</p> <p>* EUT was set by the software as follows;  Software: 02000001.mot Version 0A.00.00.01  (Date: 2011.9.14, Storage location: Driven by EUT memory)</p> <p>*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.</p>	

<b>Test Item</b>	<b>Operating mode</b>
Conducted emission	Tx Mod on, without tag*
Electric Field Strength of Fundamental Emission	Tx Mod on, with tag / without tag
Spectrum Mask	Tx Mod on, with tag / without tag
20 dB Bandwidth and 99 % Occupied Bandwidth	Tx Mod on, with tag / without tag
Electric Field Strength of Spurious Emission	Tx Mod on, without Tag*
Frequency Tolerance	Tx Mod on, without Tag*

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

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

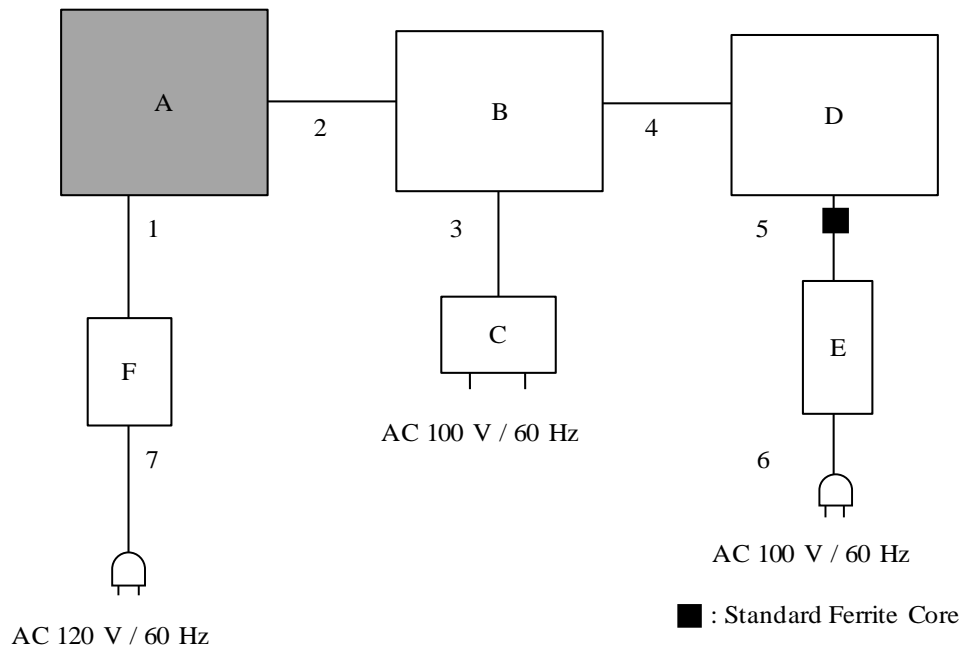
Frequency Tolerance:

Temperature : -20 deg. C to +50 deg. C Step 10 deg. C  
Voltage : Normal Voltage DC 24 V  
Maximum Voltage DC 27.6 V,  
Minimum Voltage DC 20.4 V (DC 24 V  $\pm$ 15 %)

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

## 4.2 Configuration and peripherals

[Conducted Emission test]



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

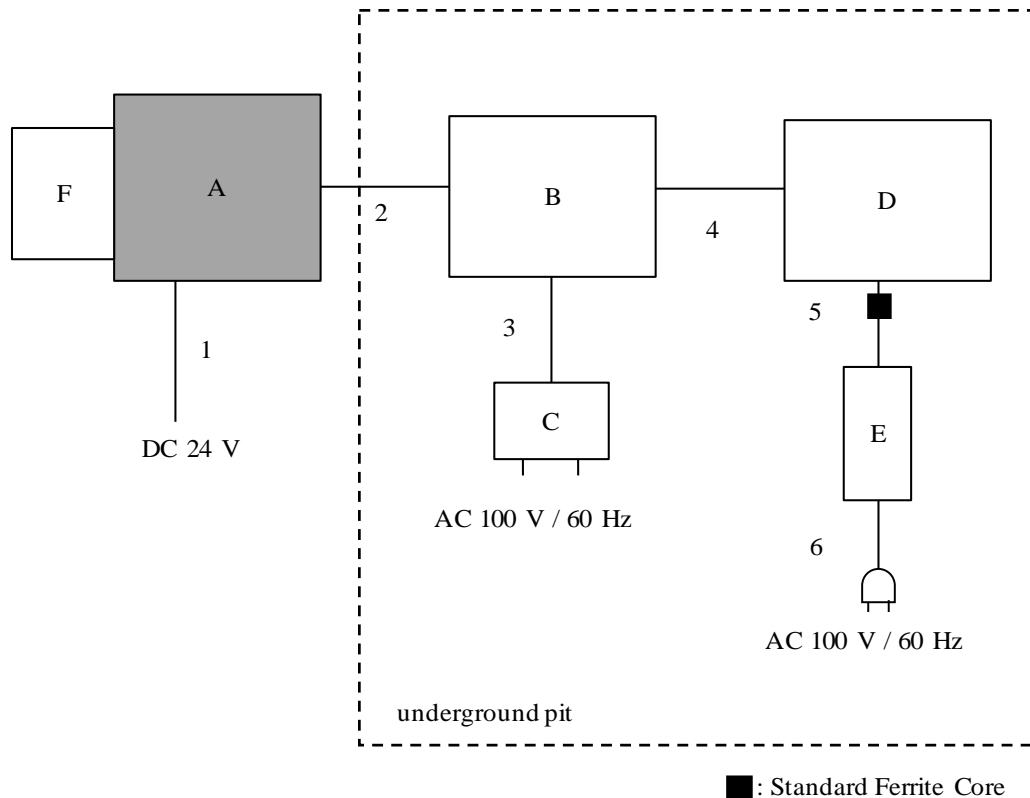
### Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	High Frequency 13.56 MHz Transceiver	56RF-TR-8090	2251127	DENSO WAVE INCORPORATED	EUT
B	Media converter	TCC-80	TBAFE1003588	MOXA Ltd.	-
C	AC Adapter	UN318-1215	MO05-0310911	UNIFIVE CO., LTD.	-
D	Laptop PC	CF-N8HWCDPS	9LKSA04645	Panasonic	-
E	AC Adapter	CF-AA6372B	6372BM610214975E	Panasonic	-
F	DC Power Supply	PMC35-2A	13090501	KIKUSUI	-

### List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Shielded	Shielded	-
2	Signal Cable	2.0	Shielded	Shielded	-
3	DC Cable	1.4	Unshielded	Unshielded	-
4	USB Cable	0.4	Shielded	Shielded	-
5	DC Cable	1.0	Unshielded	Unshielded	-
6	AC Cable	0.8	Unshielded	Unshielded	-
7	AC Cable	1.8	Unshielded	Unshielded	-

[Radiated Emission and Frequency Tolerance tests]



\* 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	Remarks
A	High Frequency 13.56 MHz Transceiver	56RF-TR-8090	2251127	DENSO WAVE INCORPORATED	EUT
B	Media converter	TCC-80	TBAFE1003588	MOXA Ltd.	-
C	AC Adapter	UN318-1215	MO05-0310911	UNIFIVE CO., LTD.	-
D	Laptop PC	CF-N8HWCDPS	9LKSA04645	Panasonic	-
E	AC Adapter	CF-AA6372B	6372BM610214975E	Panasonic	-
F	Tag	56RF-TG-50	4	DENSO WAVE INCORPORATED	-

**List of cables used**

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Shielded	Shielded	-
2	Signal Cable	2.0	Shielded	Shielded	-
3	DC Cable	1.4	Unshielded	Unshielded	-
4	USB Cable	0.4	Shielded	Shielded	-
5	DC Cable	1.0	Unshielded	Unshielded	-
6	AC Cable	0.8	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.

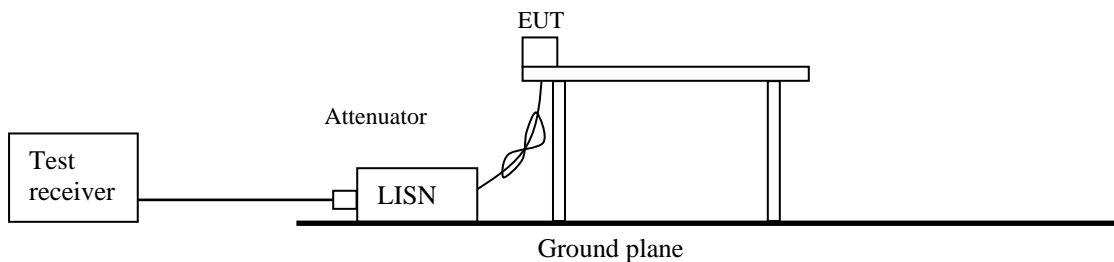
For the tests on EUT with other peripherals (as a whole system)

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.

[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.

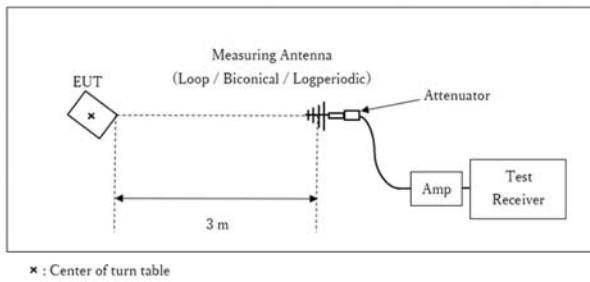
These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane.

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.

[Test Setup]  
Below 1 GHz

Test Distance: 3 m



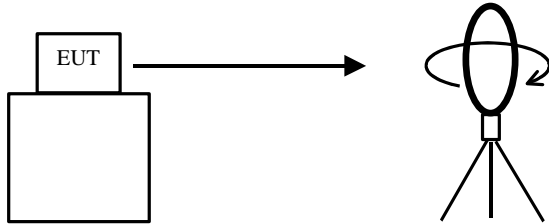
- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

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

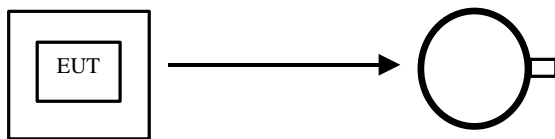
**Measurement range** : 9 kHz - 1 GHz  
**Test data** : APPENDIX 1  
**Test result** : Pass

**Figure 1: Direction of the Loop Antenna**

*Side View (Vertical)*

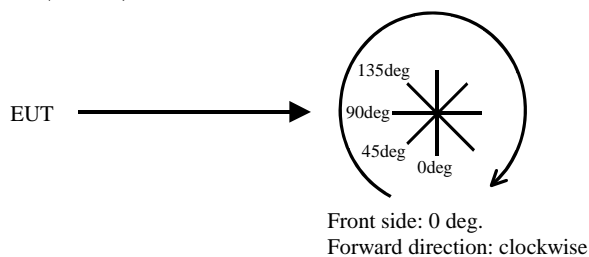


*Top View (Horizontal)*



Antenna was not rotated.

*Top View (Vertical)*



## **SECTION 7: Other test**

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	500 kHz	3 kHz *2)	9.1 kHz *2)	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 %.

\*2) 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.

Peak hold was applied as Worst-case measurement.

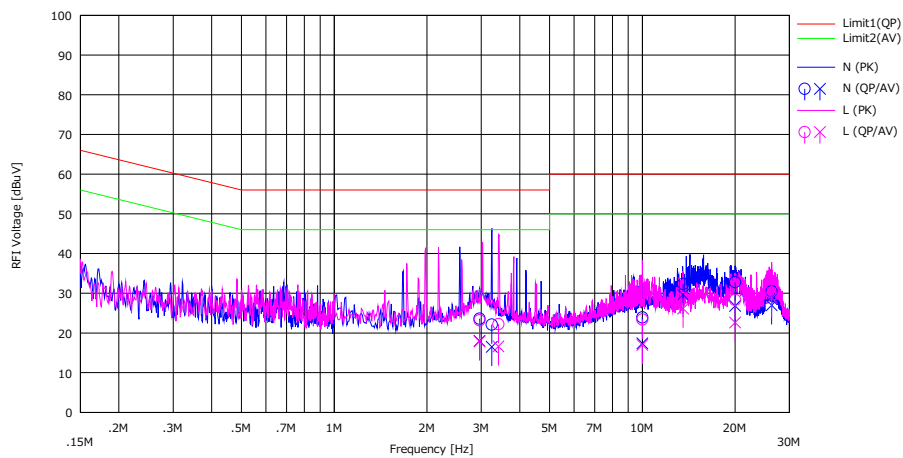
**Test data : APPENDIX**  
**Test result : Pass**

## APPENDIX 1: Test data

### Conducted Emission

Report No. 14006494H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.4  
Date September 23 2021  
Temperature / Humidity 24 deg. C / 60 % RH  
Engineer Hiroki Numata  
Mode Mode 1 without tag

Limit : FCC\_Part 15 Subpart C(15.207)



No.	Freq. [MHz]	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		(QP)	(AV)			(QP)	(AV)	(QP)	(AV)	(QP)	(AV)		
		[dBuV]	[dBuV]			[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]		
1	2.96200	10.10	4.50	0.09	13.41	23.60	18.00	56.00	46.00	32.40	28.00	N	
2	3.24600	8.60	3.00	0.09	13.42	22.11	16.51	56.00	46.00	33.89	29.49	N	
3	10.00000	10.00	3.50	0.22	13.68	23.90	17.40	60.00	50.00	36.10	32.60	N	
4	13.56000	18.30	15.60	0.27	13.77	32.34	29.64	60.00	50.00	27.66	20.36	N	
5	20.00000	18.50	12.50	0.37	13.93	32.80	26.80	60.00	50.00	27.20	23.20	N	
6	26.28000	16.00	12.50	0.45	14.05	30.50	27.00	60.00	50.00	29.50	23.00	N	
7	2.96200	9.70	4.40	0.08	13.41	23.19	17.89	56.00	46.00	32.81	28.11	L	
8	3.41200	8.70	3.10	0.09	13.43	22.22	16.62	56.00	46.00	33.78	29.38	L	
9	10.00000	9.50	3.10	0.22	13.68	23.40	17.00	60.00	50.00	36.60	33.00	L	
10	13.56000	14.70	12.10	0.29	13.77	28.76	26.16	60.00	50.00	31.24	23.84	L	
11	20.00000	14.00	8.30	0.41	13.93	28.34	22.64	60.00	50.00	31.66	27.36	L	
12	26.28000	17.60	14.20	0.52	14.05	32.17	28.77	60.00	50.00	27.83	21.23	L	

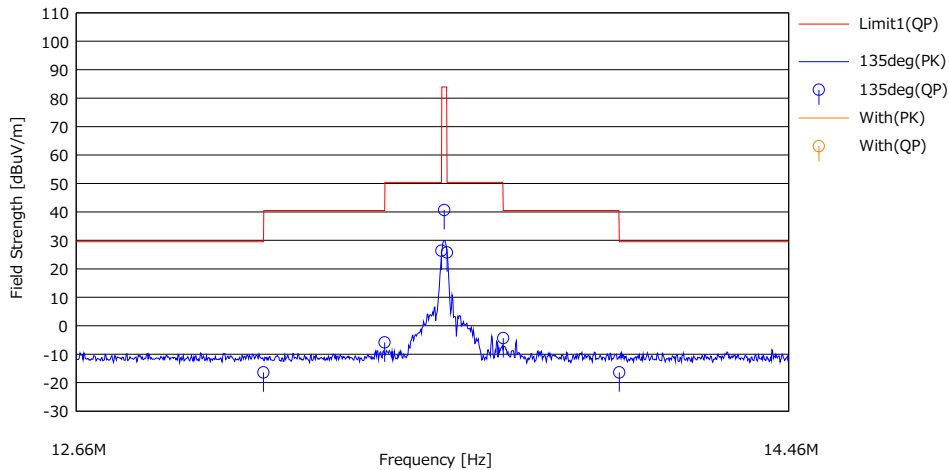
CHART: WITH FACTOR Peak hold data. CALCULATION : RESULT = READING + LISN + LOSS (CABLE + ATT)  
Except for the above table: adequate margin data below the limits.



## Fundamental emission and Spectrum Mask

Report No. 14006494H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.1  
Date September 21 2021  
Temperature / Humidity 23 deg. C / 55 % RH  
Engineer Hiroki Numata  
Mode Mode 1 without tag

Limit : FCC15\_225\_PKQP, 9-90kHz:PK, 110-490kHz:PK, other:QP



No.	Freq. [MHz]	Reading	Ant.Fac	Loss	Gain	Result	Limit	Margin	Antenna	Table	Comment
		<QP> [dBuV]				<QP> [dBuV/m]	<QP> [dB]	<QP> [dB]			
1	13.11000	29.30	19.26	-32.90	32.05	-16.39	29.50	45.89	135deg	120	
2	13.41000	39.80	19.27	-32.88	32.05	-5.86	40.50	46.36	135deg	120	
3	13.55300	72.00	19.27	-32.88	32.05	26.34	50.40	24.06	135deg	120	
4	13.56000	86.30	19.27	-32.88	32.05	40.64	83.90	43.26	135deg	120	
5	13.56700	71.40	19.27	-32.88	32.05	25.74	50.40	24.66	135deg	120	
6	13.71000	41.30	19.27	-32.87	32.05	-4.35	40.50	44.85	135deg	120	
7	14.01000	29.20	19.28	-32.85	32.05	-16.42	29.50	45.92	135deg	120	

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

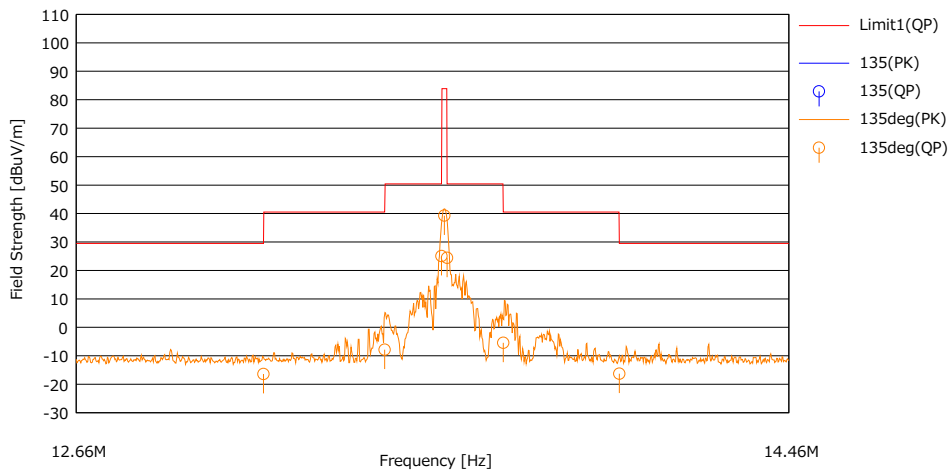
QP											
Ant Deg [deg]	Frequency	Detector	Reading	Ant Factor	Loss	Gain	Duty Factor	Result	Limit	Margin	Remark
	[MHz]		[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
0	13.56000	QP	86.30	19.27	7.12	32.05	-	80.64	-	-	Fundamental

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

## Fundamental emission and Spectrum Mask

Report No. 14006494H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.1  
Date September 21 2021  
Temperature / Humidity 23 deg. C / 55 % RH  
Engineer Hiroki Numata  
Mode Mode 1 with tag

Limit : FCC15\_225\_PKQP, 9-90kHz:PK, 110-490kHz:PK, other:QP



No.	Freq. [MHz]	Reading <QP> [dBuV]	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result	Limit	Margin	Antenna	Table	Comment
						<QP> [dBuV/m]	<QP> [dBuV/m]	<QP> [dB]			
1	13.11000	29.30	19.26	-32.90	32.05	-1.639	29.50	45.89	135deg	110	
2	13.41000	37.80	19.27	-32.88	32.05	-7.86	40.50	48.36	135deg	110	
3	13.55300	70.70	19.27	-32.88	32.05	25.04	50.40	25.36	135deg	110	
4	13.56000	84.90	19.27	-32.88	32.05	39.24	83.90	44.66	135deg	110	
5	13.56700	70.10	19.27	-32.88	32.05	24.44	50.40	25.96	135deg	110	
6	13.71000	40.20	19.27	-32.87	32.05	-5.45	40.50	45.95	135deg	110	
7	14.01000	29.30	19.28	-32.85	32.05	-1.632	29.50	45.82	135deg	110	

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

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	84.90	19.27	7.12	32.05	-	79.24	-	-	Fundamental

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

## Spurious emission

Report No.	14006494H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	September 21 2021	September 22 2021
Temperature / Humidity	23 deg. C / 55 % RH	23 deg. C / 60 % RH
Engineer	Hiroki Numata (Below 30 MHz)	Hiroki Numata (Above 30 MHz)
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
0deg	0.049	QP	65.40	19.00	-34.04	32.16	-	18.20	53.7	35.51	
0deg	0.925	QP	42.80	18.77	-33.84	32.13	-	-4.40	28.2	32.64	
0deg	27.120	QP	34.50	19.43	-32.30	32.04	-	-10.41	29.5	39.91	
Hori.	38.050	QP	32.00	15.52	7.47	38.73	-	16.26	40.0	23.74	
Hori.	67.800	QP	38.60	6.55	8.04	38.77	-	14.42	40.0	25.58	
Hori.	70.936	QP	29.70	6.41	8.09	38.78	-	5.42	40.0	34.58	
Hori.	244.080	QP	51.30	12.61	10.17	38.77	-	35.31	46.0	10.71	
Hori.	271.200	QP	53.30	13.99	10.43	38.71	-	39.01	46.0	7.01	
Hori.	406.800	QP	47.60	16.58	11.55	38.38	-	37.35	46.0	8.67	
Vert.	38.050	QP	42.50	15.52	7.47	38.73	-	26.76	40.0	13.24	
Vert.	67.800	QP	57.00	6.55	8.04	38.77	-	32.82	40.0	7.18	
Vert.	70.936	QP	45.80	6.41	8.09	38.78	-	21.52	40.0	18.48	
Vert.	244.080	QP	54.60	12.61	10.17	38.77	-	38.61	46.0	7.41	
Vert.	271.200	QP	52.30	13.99	10.43	38.71	-	38.0	46.0	8.0	
Vert.	406.800	QP	52.60	16.58	11.55	38.38	-	42.4	46.0	3.7	

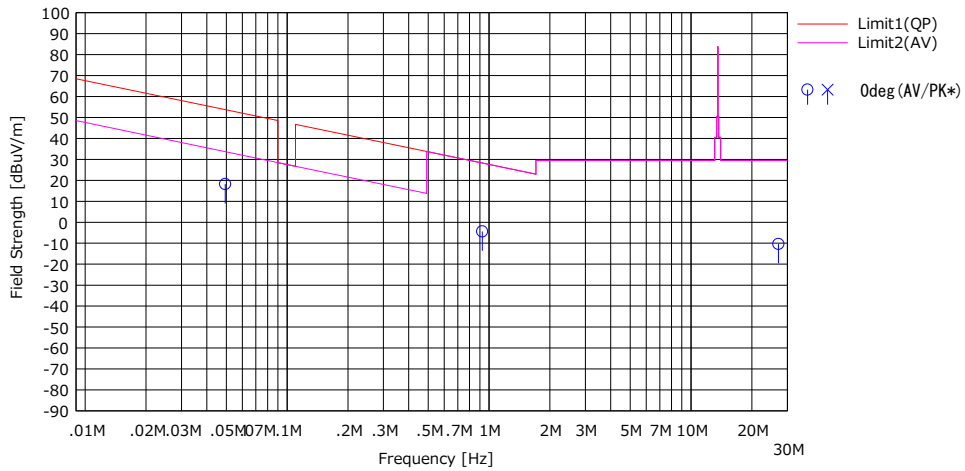
Result = Reading + Ant Factor + Loss (Cable + Attenuator + D.Factor) - Gain(Amplifier)

### Radiated Emission Plot data, Worst case

Report No.	14006494H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	September 22 2021	September 21 2021
Temperature / Humidity	23 deg. C / 60 % RH	23 deg. C / 55 % RH
Engineer	Hiroki Numata	Hiroki Numata
	(Above 30 MHz)	(Below 30 MHz)
Mode	Mode 1	

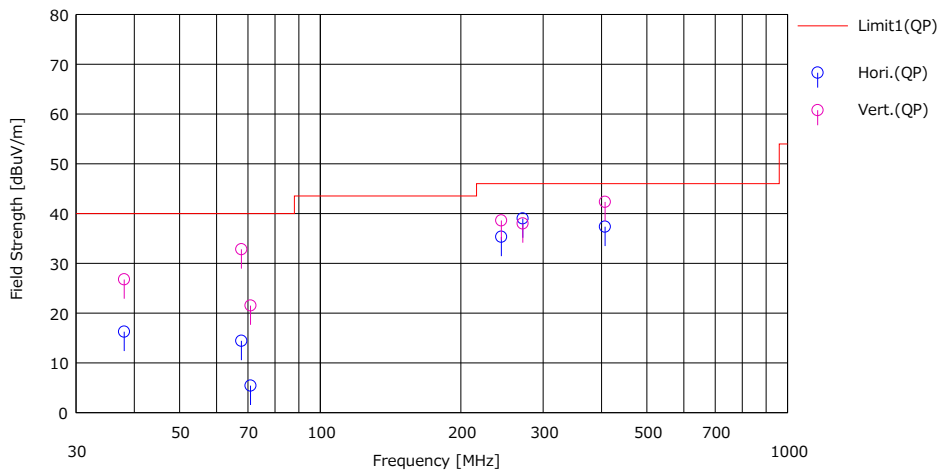
#### (below 30MHz)

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



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

#### (above 30MHz)

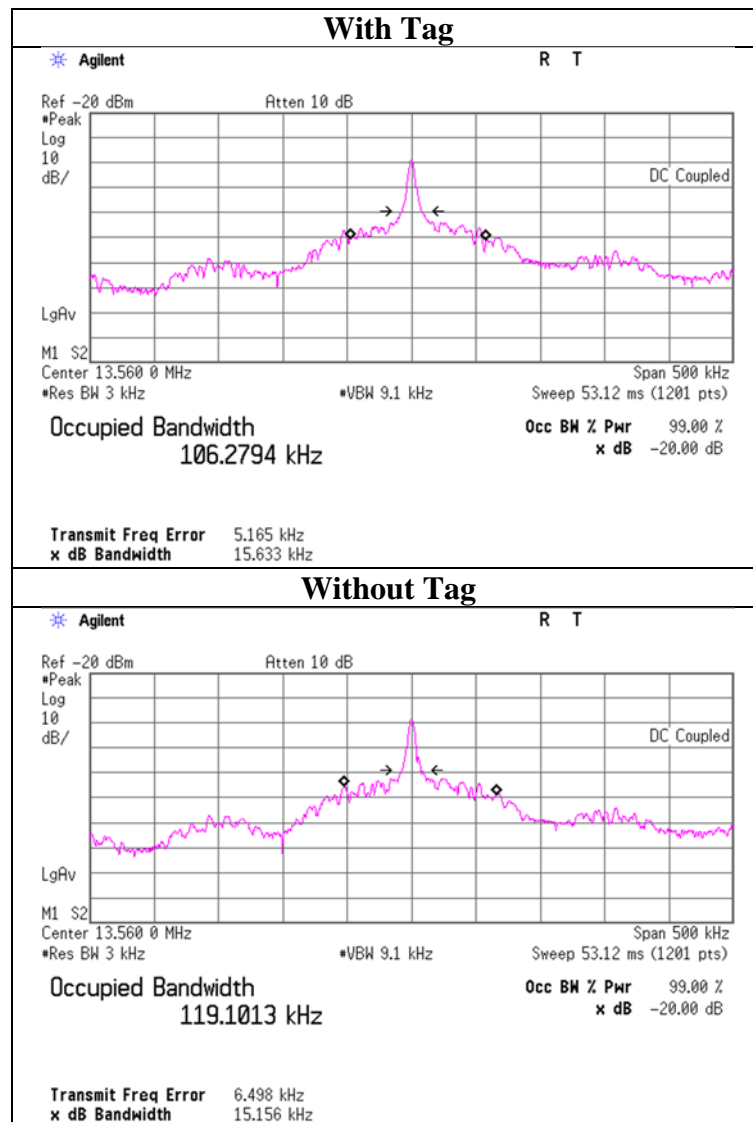


\*These plots data contains sufficient number to show the trend of characteristic features for EUT.

**20 dB Bandwidth and 99% Occupied Bandwidth**

Report No. 14006494H  
Test place Ise EMC Lab.  
Semi Anechoic Chamber No.8  
Date September 27, 2021  
Temperature / Humidity 23 deg. C / 42 % RH  
Engineer Junki Nagatomi  
Mode Mode 1

FREQ [MHz]	Mode	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	With Tag	15.633	106.2794
	Without Tag	15.156	119.1013



## Frequency Tolerance

Report No. 14006494H  
Test place Ise EMC Lab.  
Measurement room No.8  
Date September 27, 2021  
Temperature / Humidity 23 deg. C / 42 % RH  
Engineer Junki Nagatomi  
Mode Mode 1

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	24	Power on	13.559892	-0.000108	-0.00079	-7.9	0.01
		+ 2 min.	13.559887	-0.000113	-0.00083	-8.3	0.01
		+ 5 min.	13.559889	-0.000111	-0.00082	-8.2	0.01
		+ 10 min.	13.559890	-0.000110	-0.00081	-8.1	0.01
40	24	Power on	13.559921	-0.000079	-0.00058	-5.8	0.01
		+ 2 min.	13.559915	-0.000086	-0.00063	-6.3	0.01
		+ 5 min.	13.559898	-0.000102	-0.00075	-7.5	0.01
		+ 10 min.	13.559894	-0.000106	-0.00078	-7.8	0.01
30	24	Power on	13.559967	-0.000033	-0.00025	-2.5	0.01
		+ 2 min.	13.559949	-0.000051	-0.00038	-3.8	0.01
		+ 5 min.	13.559937	-0.000064	-0.00047	-4.7	0.01
		+ 10 min.	13.559930	-0.000070	-0.00051	-5.1	0.01
20	24	Power on	13.559959	-0.000041	-0.00030	-3.0	0.01
		+ 2 min.	13.559934	-0.000066	-0.00049	-4.9	0.01
		+ 5 min.	13.559927	-0.000073	-0.00054	-5.4	0.01
		+ 10 min.	13.559923	-0.000077	-0.00057	-5.7	0.01
20	20.4 (24V -15%)	Power on	13.559926	-0.000074	-0.00054	-5.4	0.01
		+ 2 min.	13.559915	-0.000085	-0.00063	-6.3	0.01
		+ 5 min.	13.559912	-0.000088	-0.00065	-6.5	0.01
		+ 10 min.	13.559911	-0.000089	-0.00066	-6.6	0.01
20	27.6 (24V +15%)	Power on	13.559914	-0.000086	-0.00063	-6.3	0.01
		+ 2 min.	13.559918	-0.000082	-0.00061	-6.1	0.01
		+ 5 min.	13.559920	-0.000080	-0.00059	-5.9	0.01
		+ 10 min.	13.559923	-0.000077	-0.00057	-5.7	0.01
10	24	Power on	13.560015	0.000015	0.00011	1.1	0.01
		+ 2 min.	13.559915	-0.000085	-0.00063	-6.3	0.01
		+ 5 min.	13.559976	-0.000024	-0.00017	-1.7	0.01
		+ 10 min.	13.559975	-0.000025	-0.00018	-1.8	0.01
0	24	Power on	13.560051	0.000051	0.00038	3.8	0.01
		+ 2 min.	13.560040	0.000040	0.00030	3.0	0.01
		+ 5 min.	13.560011	0.000011	0.00008	0.8	0.01
		+ 10 min.	13.560014	0.000014	0.00010	1.0	0.01
-10	24	Power on	13.560059	0.000059	0.00043	4.3	0.01
		+ 2 min.	13.560055	0.000055	0.00040	4.0	0.01
		+ 5 min.	13.560050	0.000050	0.00037	3.7	0.01
		+ 10 min.	13.560049	0.000049	0.00036	3.6	0.01
-20	24	Power on	13.560059	0.000058	0.00043	4.3	0.01
		+ 2 min.	13.560065	0.000065	0.00048	4.8	0.01
		+ 5 min.	13.560070	0.000070	0.00051	5.1	0.01
		+ 10 min.	13.560069	0.000069	0.00051	5.1	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	01/15/2021	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-ME MI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
CE	MTR-08	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	08/05/2021	12
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/18/2021	12
CE	MLS-24	141358	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-730	07/18/2021	12
CE	MTA-56	141938	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	06/02/2021	12
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/08/2020	24
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/15/2021	12
RE	MMM-03	141530	Digital Tester	Fluke Corporation	FLUKE 26-3	78030621	08/10/2021	12
RE	MJM-25	142226	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-ME MI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAT-08	141213	Attenuator(6dB)	Weinschel Corp	2	BK7971	11/13/2020	12
RE	MCC-03	141215	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W/3D-2W/RG400u/RFM-E421(SW)	-/01068(Switcher)	06/02/2021	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	02/18/2021	12
RE	MCC-255	207745	Coaxial Cable	UL Japan Inc.	-	-	05/17/2021	12
RE	MLPA-01	141254	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	04/17/2021	12
RE	MTR-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	08/05/2021	12
RE	KBA-05	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	2513	04/10/2021	12
RE	MLA-20	141264	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	189	04/10/2021	12
RE	MCC-02	141350	Coaxial Cable	Suhner/storm/Agilent/TSJ	-	-	06/02/2021	12
RE	MPA-19	141585	Pre Amplifier	MITEQ	MLA-10K01-B01-35	1237616	02/18/2021	12
FT	MOS-28	141567	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0008	01/15/2021	12
FT	MMM-17	141557	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	70900530	01/07/2021	12
FT	MCH-05	141440	Temperature and Humidity Chamber	Espec	PL-1KP	14019569	04/25/2021	12
FT	MFC-01	141498	Microwave Counter	ADVANTEST	R5373	120100309	07/07/2021	12
FT	MLPA-08	202511	Loop Antenna	UL Japan	-	-	-	-

\*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

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