



RADIO TEST REPORT

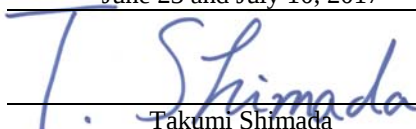
Test Report No. : 11823148H-A

Applicant : TOYOTA MOTOR CORPORATION
Type of Equipment : Smart LF Oscillator
Model No. : TMLF18D-1
FCC ID : NI4TMLF18D-1
Test regulation : FCC Part 15 Subpart C: 2017
Test Result : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with above regulation.
4. The test results in this 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 NVLAP, NIST, or any agency of the Federal Government.
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)

Date of test: June 23 and July 10, 2017

Representative test engineer:


Takumi Shimada
Engineer
Consumer Technology Division

Approved by:


Motoya Imura
Engineer
Consumer Technology Division



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.

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13-EM-F0429

REVISION HISTORY

Original Test Report No.: 11823148H-A

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SECTION 1: Customer information

Company Name : TOYOTA MOTOR CORPORATION
Address : 1, Toyota-Cho, Toyota, Aichi, 471-8572 Japan
Telephone Number : +81-565-94-0987
Facsimile Number : +81-565-94-1162
Contact Person : Tomoo Kakegawa

SECTION 2: Equipment under test (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment : Smart LF Oscillator
Model No. : TMLF18D-1
Serial No. : Refer to Section 4, Clause 4.2
Rating : DC 12.0 V (Max 0.5A)
Receipt Date of Sample : June 19, 2017
Country of Mass-production : Japan
Condition of EUT : Engineering prototype
(Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT : No Modification by the test lab

2.2 Product Description

Smart LF Oscillator, model: TMLF18D-1 is a transmitter that is installed in a motor vehicle and is used as part of Smart System.

Radio Specification

Radio Type : Transmitter
Frequency of Operation : 125 kHz
Modulation : ASK
Method of Frequency Geneneration : Crystal (for Outside Antenna, Inside Antenna, Rear Antenna)
Ceramic (for Immobilizer Antenna)
Antenna type : Ferrite Antenna Coil (for Outside Antenna, Inside Antenna, Rear Antenna)
Loop Antenna Coil (for Immobilizer Antenna)

Smart LF Oscillator (model: TMLF18D-1) consists of the following parts:

- Smart ECU
- Immobilizer Antenna
- Inside Antenna
- Outside Antenna
- Rear Antenna

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SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on June 14, 2017 and effective July 14, 2017

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted Emission
Section 15.209 Radiated emission limits, general requirements

* The revision on June 14, 2017, does not affect the test specification applied to the EUT.

3.2 Procedures and results

No.	Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
1	Conducted Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 8.8	<FCC> Section 15.207 <IC> RSS-Gen 8.8	-	N/A *1)	N/A	N/A
2	Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.4, 6.12	<FCC> Section 15.209 <IC> RSS-210 4.4 RSS-Gen 8.9	Radiated	N/A	17.7 dB 125 kHz, 0 deg. PK(PK with Duty Factor) (Inside Antenna)	Complied
3	Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.4, 6.13	<FCC> Section 15.209 <IC> RSS-210 4.4 RSS-Gen 8.9	Radiated	N/A	13.2 dB 36.249 MHz Vertical, QP	Complied
4	-26dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> -	<FCC> Reference data <IC> -	Radiated	N/A	N/A	N/A

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.

FCC 15.31 (e)

The test was performed with the New Battery (DC 12.0 V) and the EUT constantly provides the stable voltage to RF part through the regulator regardless of input voltage from New Battery. 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 vehicle. Therefore, the equipment complies with the antenna requirement of Section 15.203.

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3.3 Addition to standard

No.	Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
1	99 % Occupied Band Width	RSS-Gen 6.6	-	Radiated	N/A	N/A	N/A

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

3.4 Uncertainty

EMI

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

Test distance	Radiated emission (+/-)
	9 kHz - 30 MHz
3m	3.8 dB
10m	3.7 dB

*Measurement distance

Polarity	Radiated emission (Below 1GHz)			
	(3 m*)(+/-)		(10 m*)(+/-)	
	30 – 200 MHz	200 – 1000MHz	30 – 200 MHz	200 – 1000MHz
Horizontal	5.0 dB	5.3 dB	5.0 dB	5.0 dB
Vertical	4.7 dB	5.9 dB	5.0 dB	5.1 dB

Radiated emission test(10 m)

The data listed in this test report has enough margin, more than the site margin.

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3.5 Test Location

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	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms
No.1 semi-anechoic chamber	2973C-1	19.2 x 11.2 x 7.7m	7.0 x 6.0m	No.1 Power source room
No.2 semi-anechoic chamber	2973C-2	7.5 x 5.8 x 5.2m	4.0 x 4.0m	-
No.3 semi-anechoic chamber	2973C-3	12.0 x 8.5 x 5.9m	6.8 x 5.75m	No.3 Preparation room
No.3 shielded room	-	4.0 x 6.0 x 2.7m	N/A	-
No.4 semi-anechoic chamber	2973C-4	12.0 x 8.5 x 5.9m	6.8 x 5.75m	No.4 Preparation room
No.4 shielded room	-	4.0 x 6.0 x 2.7m	N/A	-
No.5 semi-anechoic chamber	-	6.0 x 6.0 x 3.9m	6.0 x 6.0m	-
No.6 shielded room	-	4.0 x 4.5 x 2.7m	4.0 x 4.5 m	-
No.6 measurement room	-	4.75 x 5.4 x 3.0m	4.75 x 4.15 m	-
No.7 shielded room	-	4.7 x 7.5 x 2.7m	4.7 x 7.5m	-
No.8 measurement room	-	3.1 x 5.0 x 2.7m	N/A	-
No.9 measurement room	-	8.0 x 4.6 x 2.8m	2.4 x 2.4m	-
No.11 measurement room	-	6.2 x 4.7 x 3.0m	4.8 x 4.6m	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 x 2.0m 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 E.U.T. during testing

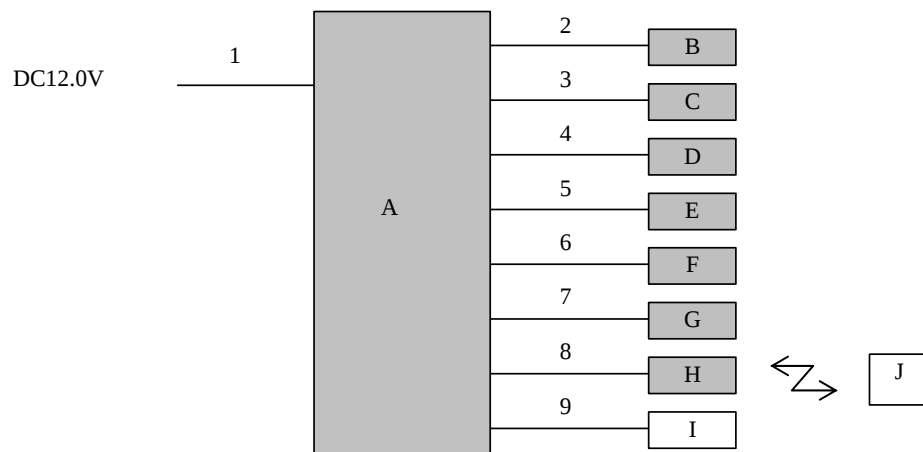
4.1 Operating Modes

The mode is used : Transmitting mode (Tx) 125 kHz
 * LF output power is controlled by Smart ECU.

Test mode	Remarks
1) Tx 125 kHz Outside Antenna	-
2) Tx 125 kHz Inside Antenna	-
3) Tx 125 kHz Rear Antenna	-
4) Tx 125 kHz Immobilizer Antenna	-
5) Tx 125 kHz, Outside Antenna 1+2	simultaneous transmission (Outside Antenna1 and Outside Antenna2)

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

4.2 Configuration and peripherals



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

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Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Smart ECU	-	1	-	EUT
B	Outside Antenna	-	1-1	-	EUT
C	Outside Antenna	-	1-2	-	EUT
D	Inside Antenna	-	1-1	-	EUT
E	Inside Antenna	-	1-2	-	EUT
F	Inside Antenna	-	1-3	-	EUT
G	Rear Antenna	-	1	-	EUT
H	Immobilizer Antenna	-	1	-	EUT
I	Switch BOX	-	1	-	-
J	Transmitter	-	1	-	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-
2	Antenna Cable	3.0	Unshielded	Unshielded	-
3	Antenna Cable	3.0	Unshielded	Unshielded	-
4	Antenna Cable	3.0	Unshielded	Unshielded	-
5	Antenna Cable	3.0	Unshielded	Unshielded	-
6	Antenna Cable	3.0	Unshielded	Unshielded	-
7	Antenna Cable	3.0	Unshielded	Unshielded	-
8	Antenna Cable	3.0	Unshielded	Unshielded	-
9	Signal Cable	3.0	Unshielded	Unshielded	-

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SECTION 5: Radiated emission (Fundamental and Spurious Emission)

Test Procedure

EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane.

The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

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	10 m *1)	10 m *1)	10 m *1)	10 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 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.

- For Immobilizer Antenna, the worst case was confirmed with and without mechanical key at pre check. As a result, the test without mechanical key was the worst case. Therefore the test without mechanical key was performed only.

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

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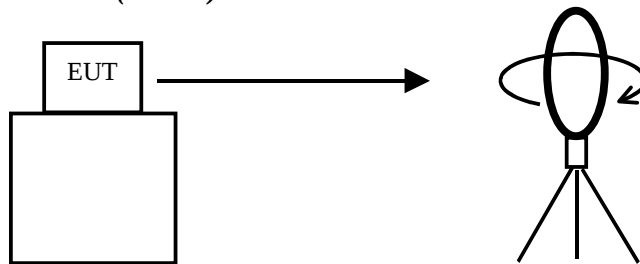
Measurement range : 9 kHz - 1 GHz
Test data : APPENDIX 1
Test result : Pass

Date: June 23, 2017
July 10, 2017

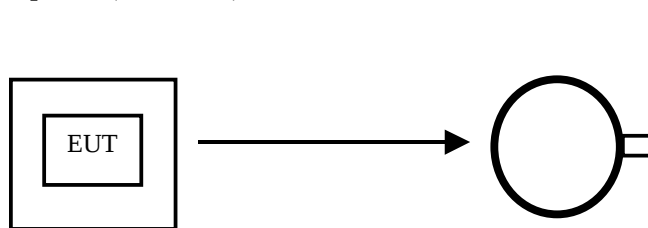
Test engineer: Takumi Shimada
Shinya Watanabe

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

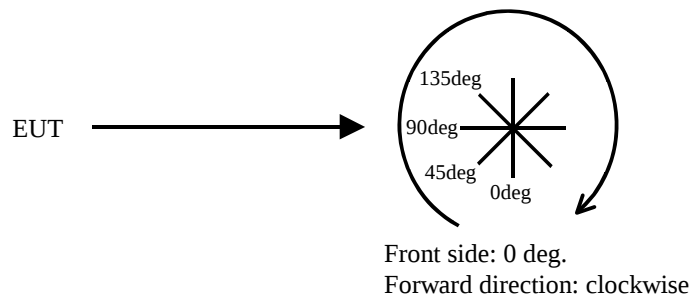


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



SECTION 6: -26dB Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
-26 dB Bandwidth	100 kHz	1 kHz	3 kHz	Auto	Peak	Max Hold	Spectrum Analyzer

Test data : APPENDIX 1

Test result : Pass

SECTION 7: 99% Occupied Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
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

*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 1

Test result : Pass

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APPENDIX 1: Test data

Radiated Emission below 30 MHz (Fundamental and Spurious Emission) Outside Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Order No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Outside Antenna

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	68.3	19.7	-53.0	32.3	-	2.7	45.6	42.9	Fundamental
0	0.25000	PK	43.4	19.6	-52.9	32.3	-	-22.2	39.6	61.8	
0	0.37500	PK	44.3	19.6	-52.9	32.3	-	-21.3	36.1	57.4	
0	0.50000	QP	33.0	19.5	-12.9	32.3	-	7.3	33.6	26.3	
0	0.62500	QP	32.8	19.5	-12.9	32.3	-	7.1	31.7	24.6	
0	0.75000	QP	31.8	19.5	-12.8	32.2	-	6.3	30.1	23.8	
0	0.87500	QP	31.7	19.5	-12.8	32.2	-	6.2	28.7	22.5	
0	1.00000	QP	31.4	19.5	-12.8	32.2	-	5.9	27.6	21.7	
0	1.12500	QP	31.3	19.5	-12.8	32.2	-	5.8	26.5	20.7	
0	1.25000	QP	31.2	19.5	-12.8	32.2	-	5.7	25.6	19.9	

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

PK with Duty 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	0.125	PK	68.3	19.7	-53.0	32.3	0.0	2.7	25.6	22.9	
0	0.250	PK	43.4	19.6	-52.9	32.3	0.0	-22.2	19.6	41.8	
0	0.375	PK	44.3	19.6	-52.9	32.3	0.0	-21.3	16.1	37.4	

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

* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 10m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	68.3	19.7	6.0	32.3	-	61.7	-	-	Fundamental

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

* All spurious emissions lower than this result.

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Inside Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Order No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Inside Antenna

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	73.5	19.7	-53.0	32.3	-	7.9	45.6	37.7	Fundamental
0	0.25000	PK	44.4	19.6	-52.9	32.3	-	-21.2	39.6	60.8	
0	0.37500	PK	43.6	19.6	-52.9	32.3	-	-22.0	36.1	58.1	
0	0.50000	QP	33.3	19.5	-12.9	32.3	-	7.6	33.6	26.0	
0	0.62500	QP	33.0	19.5	-12.9	32.3	-	7.3	31.7	24.4	
0	0.75000	QP	31.8	19.5	-12.8	32.2	-	6.3	30.1	23.8	
0	0.87500	QP	32.0	19.5	-12.8	32.2	-	6.5	28.7	22.2	
0	1.00000	QP	31.3	19.5	-12.8	32.2	-	5.8	27.6	21.8	
0	1.12500	QP	31.4	19.5	-12.8	32.2	-	5.9	26.5	20.6	
0	1.25000	QP	31.2	19.5	-12.8	32.2	-	5.7	25.6	19.9	

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

PK with Duty 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	0.125	PK	73.5	19.7	-53.0	32.3	0.0	7.9	25.6	17.7	
0	0.250	PK	44.4	19.6	-52.9	32.3	0.0	-21.2	19.6	40.8	
0	0.375	PK	43.6	19.6	-52.9	32.3	0.0	-22.0	16.1	38.1	

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

* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 10m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	73.5	19.7	6.0	32.3	-	66.9	-	-	Fundamental

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

* All spurious emissions lower than this result.

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Rear Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Order No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Rear Antenna

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	68.1	19.7	-53.0	32.3	-	2.5	45.6	43.1	Fundamental
0	0.25000	PK	42.5	19.6	-52.9	32.3	-	-23.1	39.6	62.7	
0	0.37500	PK	43.8	19.6	-52.9	32.3	-	-21.8	36.1	57.9	
0	0.50000	QP	32.9	19.5	-12.9	32.3	-	7.2	33.6	26.4	
0	0.62500	QP	33.4	19.5	-12.9	32.3	-	7.7	31.7	24.0	
0	0.75000	QP	31.8	19.5	-12.8	32.2	-	6.3	30.1	23.8	
0	0.87500	QP	31.7	19.5	-12.8	32.2	-	6.2	28.7	22.5	
0	1.00000	QP	31.3	19.5	-12.8	32.2	-	5.8	27.6	21.8	
0	1.12500	QP	31.3	19.5	-12.8	32.2	-	5.8	26.5	20.7	
0	1.25000	QP	30.9	19.5	-12.8	32.2	-	5.4	25.6	20.2	

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

PK with Duty 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	0.125	PK	68.1	19.7	-53.0	32.3	0.0	2.5	25.6	23.1	
0	0.250	PK	42.5	19.6	-52.9	32.3	0.0	-23.1	19.6	42.7	
0	0.375	PK	43.8	19.6	-52.9	32.3	0.0	-21.8	16.1	37.9	

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

* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 10m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12500	PK	68.1	19.7	6.0	32.3	-	61.5	-	-	Fundamental

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

* All spurious emissions lower than this result.

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Immobilizer Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Order No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Immobilizer Antenna

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12523	PK	62.5	19.7	-53.0	32.3	-	-3.1	45.6	48.7	Fundamental
0	0.25046	PK	41.4	19.6	-52.9	32.3	-	-24.2	39.6	63.8	
0	0.37569	PK	40.4	19.6	-52.9	32.3	-	-25.2	36.1	61.3	
0	0.50092	QP	32.9	19.5	-12.9	32.3	-	7.2	33.6	26.4	
0	0.62615	QP	32.5	19.5	-12.9	32.3	-	6.8	31.7	24.9	
0	0.75138	QP	31.8	19.5	-12.8	32.2	-	6.3	30.1	23.8	
0	0.87661	QP	31.7	19.5	-12.8	32.2	-	6.2	28.7	22.5	
0	1.00184	QP	31.3	19.5	-12.8	32.2	-	5.8	27.5	21.7	
0	1.12707	QP	31.3	19.5	-12.8	32.2	-	5.8	26.5	20.7	
0	1.25230	QP	31.1	19.5	-12.8	32.2	-	5.6	25.6	20.0	

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

PK with Duty 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	0.125	PK	62.5	19.7	-53.0	32.3	0.0	-3.1	25.6	28.7	
0	0.250	PK	41.4	19.6	-52.9	32.3	0.0	-24.2	19.6	43.8	
0	0.376	PK	40.4	19.6	-52.9	32.3	0.0	-25.2	16.1	41.3	

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

* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 10m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	0.12523	PK	62.5	19.7	6.0	32.3	-	55.9	-	-	Fundamental

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

* All spurious emissions lower than this result.

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Outside Antenna 1+2

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Order No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Outside Antenna 1+2

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit dBuV/m	Margin [dB]	Remark
0	0.12500	PK	69.2	19.7	-53.0	32.3	-	3.6	45.6	42.0	Fundamental
0	0.25000	PK	42.7	19.6	-52.9	32.3	-	-22.9	39.6	62.5	
0	0.37500	PK	45.3	19.6	-52.9	32.3	-	-20.3	36.1	56.4	
0	0.50000	QP	32.9	19.5	-12.9	32.3	-	7.2	33.6	26.4	
0	0.62500	QP	32.5	19.5	-12.9	32.3	-	6.8	31.7	24.9	
0	0.75000	QP	31.8	19.5	-12.8	32.2	-	6.3	30.1	23.8	
0	0.87500	QP	31.6	19.5	-12.8	32.2	-	6.1	28.7	22.6	
0	1.00000	QP	31.4	19.5	-12.8	32.2	-	5.9	27.6	21.7	
0	1.12500	QP	31.2	19.5	-12.8	32.2	-	5.7	26.5	20.8	
0	1.25000	QP	31.2	19.5	-12.8	32.2	-	5.7	25.6	19.9	

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

PK with Duty 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	0.125	PK	69.2	19.7	-53.0	32.3	0.0	3.6	25.6	22.0	
0	0.250	PK	42.7	19.6	-52.9	32.3	0.0	-22.9	19.6	42.5	
0	0.375	PK	45.3	19.6	-52.9	32.3	0.0	-20.3	16.1	36.4	

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

* Since the peak emission result satisfied the average limit, duty factor was omitted.

Result of the fundamental emission at 10m without Distance factor

PK or QP

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit dBuV/m	Margin [dB]	Remark
0	0.12500	PK	69.2	19.7	6.0	32.3	-	62.6	-	-	Fundamental

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

* All spurious emissions lower than this result.

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission above 30 MHz (Spurious Emission) Outside Antenna

DATA OF RADIATED EMISSION TEST

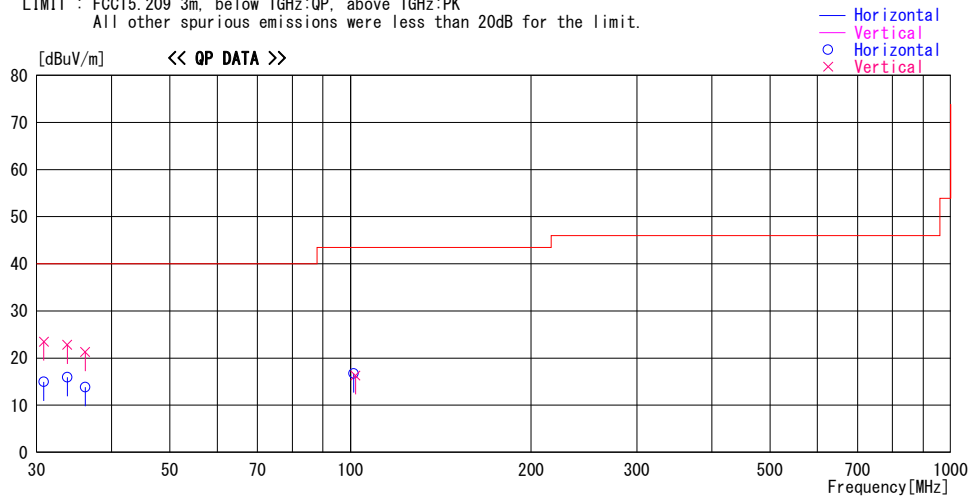
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/07/10

Report No. : 11823148H

Temp./Humi. : 24 deg. C / 56 % RH
Engineer : Shinya Watanabe

Mode / Remarks : Tx 125kHz Outside Antenna

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss&	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Gain [dB]							
30.840	23.2	QP	16.9	-25.1	15.0	0	300	Hori.	40.0	25.0	
30.840	31.7	QP	16.9	-25.1	23.5	66	100	Vert.	40.0	16.5	
33.746	24.6	QP	16.3	-25.0	15.9	0	300	Hori.	40.0	24.1	
33.746	31.5	QP	16.3	-25.0	22.8	266	100	Vert.	40.0	17.2	
36.155	23.1	QP	15.7	-25.0	13.8	0	300	Hori.	40.0	26.2	
36.155	30.6	QP	15.7	-25.0	21.3	0	100	Vert.	40.0	18.7	
101.240	30.6	QP	10.1	-24.0	16.7	0	300	Hori.	43.5	26.8	
101.967	30.0	QP	10.3	-24.0	16.3	271	100	Vert.	43.5	27.2	

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission above 30 MHz (Spurious Emission) Inside Antenna

DATA OF RADIATED EMISSION TEST

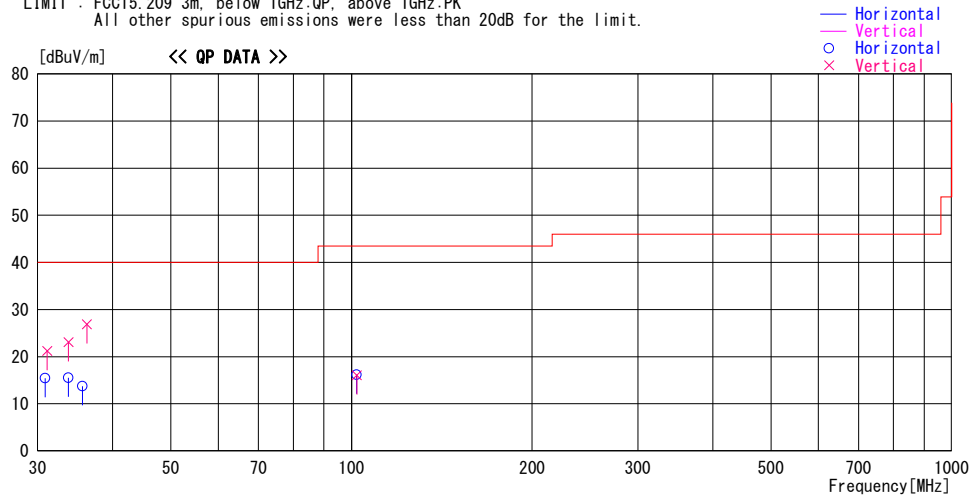
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/07/10

Report No. : 11823148H

Temp./Humi. : 24 deg. C / 56 % RH
Engineer : Shinya Watanabe

Mode / Remarks : Tx 125kHz Inside Antenna

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Gain [dB]							
30.867	23.6	QP	16.9	-25.1	15.4	0	300	Hori.	40.0	24.6	
31.124	29.5	QP	16.8	-25.1	21.2	86	100	Vert.	40.0	18.8	
33.764	24.3	QP	16.3	-25.0	15.6	0	300	Hori.	40.0	24.4	
33.765	31.8	QP	16.3	-25.0	23.1	256	100	Vert.	40.0	16.9	
35.618	22.9	QP	15.9	-25.0	13.8	0	300	Hori.	40.0	26.2	
36.249	36.2	QP	15.6	-25.0	26.8	280	100	Vert.	40.0	13.2	
101.967	29.9	QP	10.3	-24.0	16.2	0	300	Hori.	43.5	27.3	
102.103	29.7	QP	10.3	-24.0	16.0	248	100	Vert.	43.5	27.5	

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission above 30 MHz (Spurious Emission)
Rear Antenna

DATA OF RADIATED EMISSION TEST

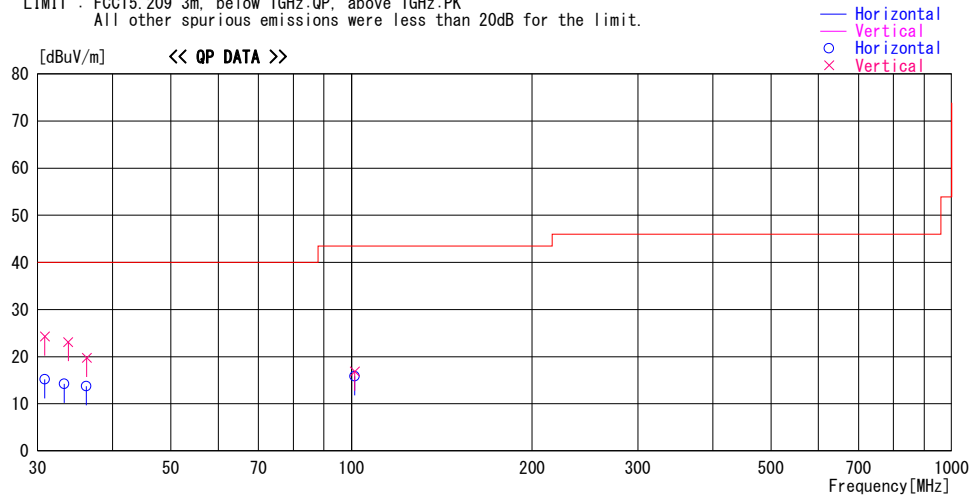
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/07/10

Report No. : 11823148H

Temp./Humi. : 24 deg. C / 56 % RH
Engineer : Shinya Watanabe

Mode / Remarks : Tx 125kHz Rear Antenna

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Gain [dB]							
30.857	23.4	QP	16.9	-25.1	15.2	0	300	Hori.	40.0	24.8	
30.857	32.5	QP	16.9	-25.1	24.3	99	100	Vert.	40.0	15.7	
33.233	22.8	QP	16.4	-25.0	14.2	0	300	Hori.	40.0	25.8	
33.758	31.8	QP	16.3	-25.0	23.1	267	100	Vert.	40.0	16.9	
36.171	23.0	QP	15.7	-25.0	13.7	0	300	Hori.	40.0	26.3	
36.233	29.1	QP	15.6	-25.0	19.7	236	100	Vert.	40.0	20.3	
101.279	29.8	QP	10.1	-24.0	15.9	0	300	Hori.	43.5	27.6	
101.278	30.8	QP	10.1	-24.0	16.9	275	100	Vert.	43.5	26.7	

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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Radiated Emission above 30 MHz (Spurious Emission)
Immobilizer Antenna

DATA OF RADIATED EMISSION TEST

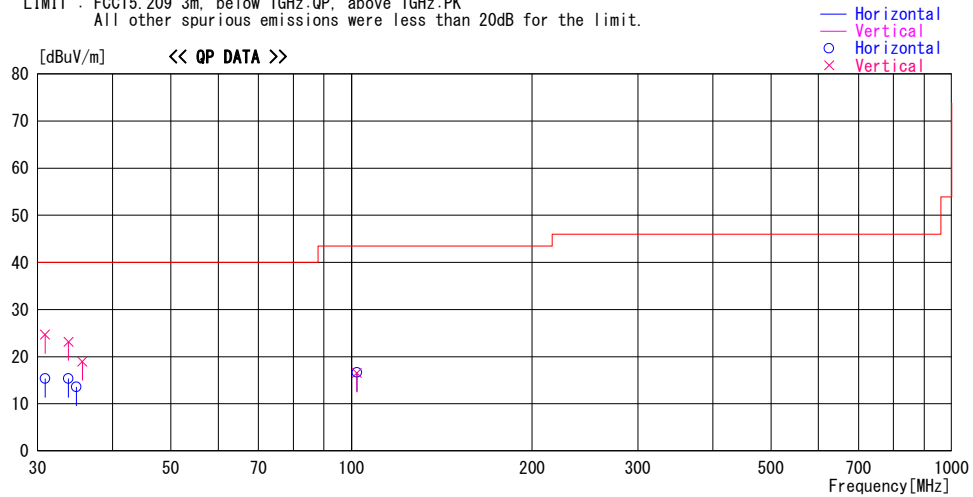
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/07/10

Report No. : 11823148H

Temp./Humi. : 24 deg. C / 56 % RH
Engineer : Shinya Watanabe

Mode / Remarks : Tx 125kHz Immobilizer Antenna

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]
			Factor [dB/m]	Loss & Gain [dB]						
30.870	23.6	QP	16.9	-25.1	15.4	0	300	Hori.	40.0	24.6
30.870	32.9	QP	16.9	-25.1	24.7	87	100	Vert.	40.0	15.3
33.766	24.1	QP	16.3	-25.0	15.4	0	300	Hori.	40.0	24.6
33.766	31.9	QP	16.3	-25.0	23.2	247	100	Vert.	40.0	16.8
34.817	22.4	QP	16.2	-25.0	13.6	0	300	Hori.	40.0	26.4
35.621	28.1	QP	15.9	-25.0	19.0	175	100	Vert.	40.0	21.0
102.117	30.3	QP	10.3	-24.0	16.6	0	300	Hori.	43.5	26.9
102.117	30.2	QP	10.3	-24.0	16.5	269	100	Vert.	43.5	27.0

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

Radiated Emission above 30 MHz (Spurious Emission) Outside Antenna 1+2

DATA OF RADIATED EMISSION TEST

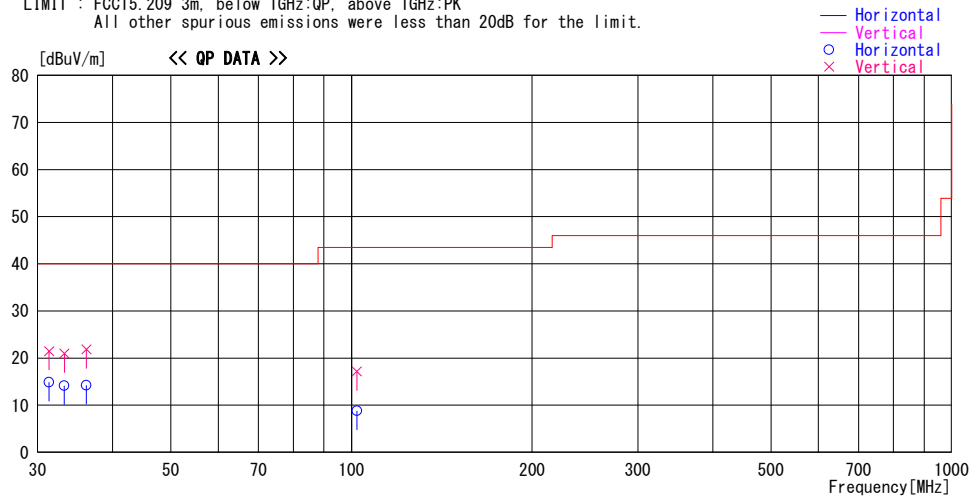
UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/07/10

Report No. : 11823148H

Temp./Humi. : 24 deg. C / 56 % RH
Engineer : Shinya Watanabe

Mode / Remarks : Tx 125kHz Outside Antenna 1+2

LIMIT : FCC15.209 3m, below 1GHz:QP, above 1GHz:PK
All other spurious emissions were less than 20dB for the limit.



Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss&	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]
			Factor [dB/m]	Gain [dB]						
31.358	23.2	QP	16.8	-25.1	14.9	0	300	Hori.	40.0	25.1
31.358	29.8	QP	16.8	-25.1	21.5	83	100	Vert.	40.0	18.5
33.247	22.7	QP	16.4	-25.0	14.1	0	300	Hori.	40.0	25.9
33.249	29.5	QP	16.4	-25.0	20.9	84	100	Vert.	40.0	19.1
36.183	23.6	QP	15.7	-25.0	14.3	0	300	Hori.	40.0	25.7
36.184	31.1	QP	15.7	-25.0	21.8	215	100	Vert.	40.0	18.2
102.122	22.5	QP	10.3	-24.0	8.8	0	300	Hori.	43.5	34.7
102.119	30.9	QP	10.3	-24.0	17.2	270	100	Vert.	43.5	26.3

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

*The test result is rounded off to one or two decimal places, so some differences might be observed.

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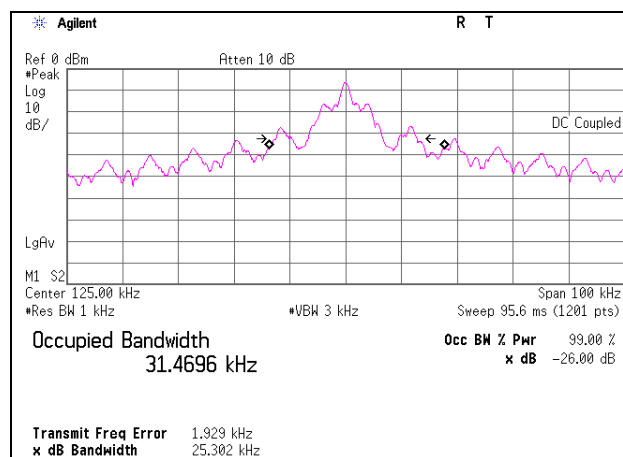
Facsimile : +81 596 24 8124

-26dB Bandwidth and 99% Occupied Bandwidth
Outside Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Report No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Outside Antenna

-26 dB Bandwidth
[kHz]
25.302

99% Occupied Bandwidth
[kHz]
31.4696

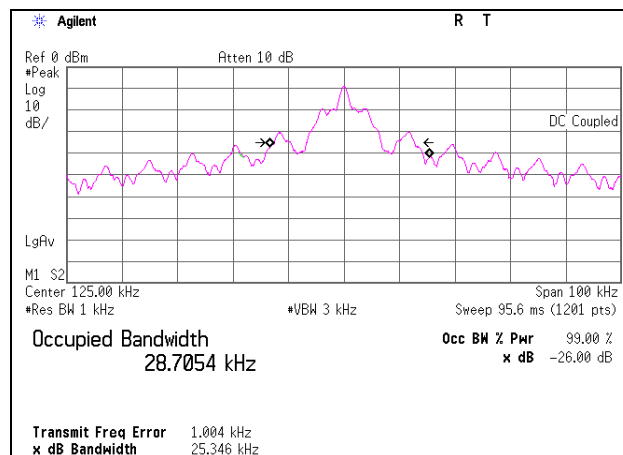


-26dB Bandwidth and 99% Occupied Bandwidth
Inside Antenna

Test place Ise EMC Lab. No.1 Semi Anechoic Chamber
Report No. 11823148H
Date 06/23/2017
Temperature/ Humidity 23 deg. C / 54 % RH
Engineer Takumi Shimada
Mode Tx 125 kHz, Inside Antenna

-26 dB Bandwidth
[kHz]
25.346

99% Occupied Bandwidth
[kHz]
28.7054



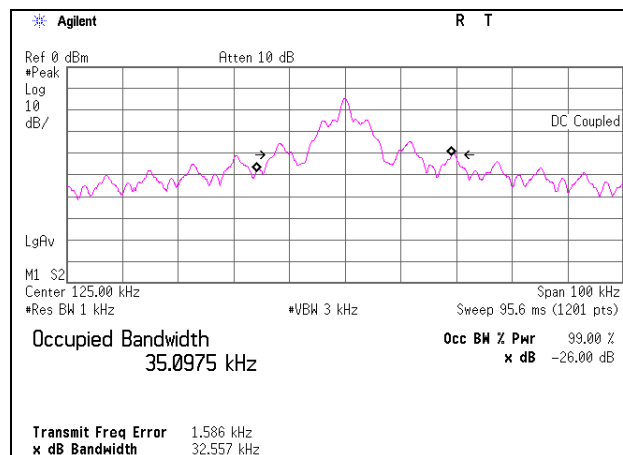
-26dB Bandwidth and 99% Occupied Bandwidth

Rear Antenna

Test place	Ise EMC Lab. No.1 Semi Anechoic Chamber
Report No.	11823148H
Date	06/23/2017
Temperature/ Humidity	23 deg. C / 54 % RH
Engineer	Takumi Shimada
Mode	Tx 125 kHz, Rear Antenna

-26 dB Bandwidth
[kHz]
32.557

99% Occupied Bandwidth
[kHz]
35.0975

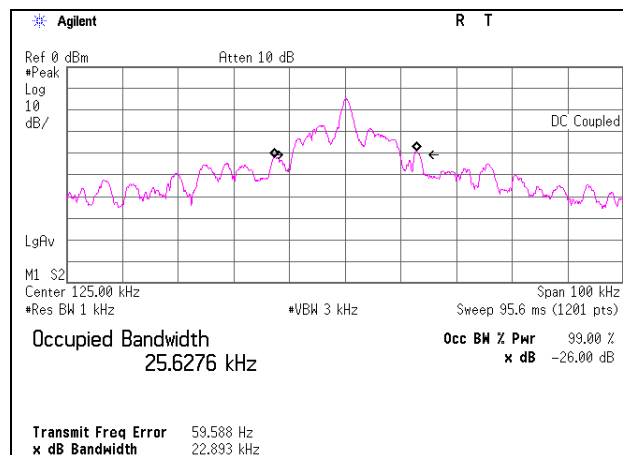


-26dB Bandwidth and 99% Occupied Bandwidth
Immobilizer Antenna

Test place : Ise EMC Lab. No.1 Semi Anechoic Chamber
Report No. : 11823148H
Date : 06/23/2017
Temperature/ Humidity : 23 deg. C / 54 % RH
Engineer : Takumi Shimada
Mode : Tx 125 kHz, Immobilizer Antenna

-26 dB Bandwidth
[kHz]
22.893

99% Occupied Bandwidth
[kHz]
25.6276



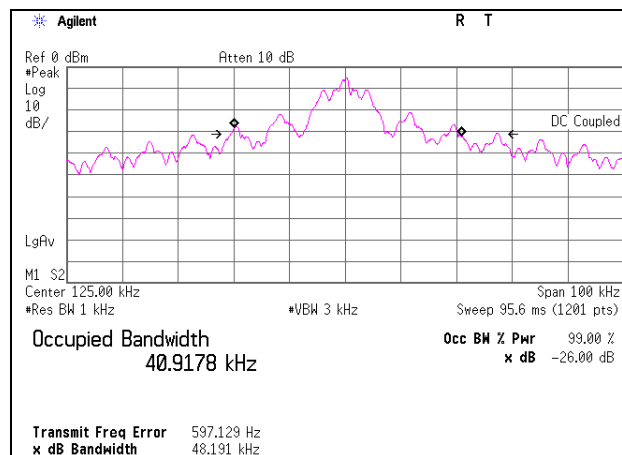
-26dB Bandwidth and 99% Occupied Bandwidth

Outside Antenna 1+2

Test place	Ise EMC Lab. No.1 Semi Anechoic Chamber
Report No.	11823148H
Date	06/23/2017
Temperature/ Humidity	23 deg. C / 54 % RH
Engineer	Takumi Shimada
Mode	Tx 125 kHz, Outside Antenna 1+2

-26 dB Bandwidth
[kHz]
48.191

99% Occupied Bandwidth
[kHz]
40.9178



APPENDIX 2: Test instruments

EMI test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-01	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	RE	2016/09/30 * 12
MOS-27	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q26	RE	2017/01/20 * 12
MJM-25	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MTR-09	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	RE	2017/06/27 * 12
MLPA-01	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	RE	2016/10/14 * 12
MCC-143	Coaxial Cable	UL Japan	-	-	RE	2017/06/12 * 12
MCC-03	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W(20m)/ 3D-2W(7.5m)/ RG400u(1.5m)/ RFM-E421(Switcher)	-/01068 (Switcher)	RE	2017/06/26 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2017/03/27 * 12
MAT-08	Attenuator(6dB)	Weinschel Corp	2	BK7971	RE	2016/11/28 * 12
MMM-03	Digital Tester	Fluke	FLUKE 26-3	78030621	RE	2016/08/23 * 12
MSA-14	Spectrum Analyzer	Agilent	E4440A	MY48250080	RE	2016/10/14 * 12
MAEC-03	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2016/10/20 * 12
MOS-13	Thermo-Hygrometer	Custom	CTH-180	1301	RE	2017/01/20 * 12
MJM-16	Measure	KOMELON	KMC-36	-	RE	-
MSA-03	Spectrum Analyzer	Agilent	E4448A	MY44020357	RE	2017/05/29 * 12
MTR-08	Test Receiver	Rohde & Schwarz	ESCI	100767	RE	2016/09/15 * 12
MBA-03	Biconical Antenna	Schwarzbeck	BBA9106	1915	RE	2016/10/15 * 12
MLA-22	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	RE	2017/01/26 * 12
MCC-51	Coaxial cable	UL Japan	-	-	RE	2016/07/26 * 12
MAT-98	Attenuator	KEYSIGHT	8491A	MY52462349	RE	2016/12/05 * 12
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	RE	2017/01/19 * 12

The expiration date of the calibration is the end of the expired month.

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

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test Item:

RE: Spurious emission

UL Japan, Inc.

Ise EMC Lab.

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