RADIO TEST REPORT

Test Report No. : 12737031H-A-R2

Applicant	:	**OMRON Automotive Electronics Co. Ltd.**
Type of Equipment	:	**Immobilizer and Alarm system**
Model No.	:	**K72R0**
FCC ID	:	**OUCK72R0**
Test regulation	:	**FCC Part 15 Subpart C: 2018**
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 above regulation.
4. The test results in this 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 Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 12737031H-A-R1. 12737031H-A-R1 is replaced with this report.

Date of test: February 20 to 28, 2019

Representative test engineer:
Akihiko Maeda
Engineer
Consumer Technology Division

Approved by:
Shinichi Miyazono
Engineer
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.
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REVISION HISTORY

Original Test Report No.: 12737031H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12737031H-A	March 19, 2019	-	-
1	12737031H-A-R1	April 4, 2019	P.8	Correction of LF Antennas and Systems table in Clause 4.1
1	12737031H-A-R1	April 4, 2019	P.8	Correction of note sentence in Clause 4.2
1	12737031H-A-R1	April 4, 2019	P.9	Correction of item name No. C to F in the list(EUT and Support equipment) of Clause 4.2
1	12737031H-A-R1	April 4, 2019	P.22 to 25	Replacement of -26dB Bandwidth and 99% Occupied Bandwidth test data
1	12737031H-A-R1	April 4, 2019	P.26	Correction of Test Instruments
2	12737031H-A-R2	April 9, 2019	P.8	Correction of note sentences in Clause 4.1 and Clause 4.2

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SECTION 1: Customer information

Company Name	:	OMRON Automotive Electronics Co. Ltd.
Address	:	6368 NENJOZAKA OKUSA KOMAKI AICHI, 485-0802 JAPAN
Telephone Number	:	+81-568-78-6159
Facsimile Number	:	+81-568-78-7659
Contact Person	:	Takashi Betsui

The information provided from the customer is as follows;
- Applicant, Type of Equipment, Model No. on the cover and other relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (E.U.T.)
- SECTION 4: Operation of E.U.T. 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 (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment	:	Immobilizer and Alarm system
Model No.	:	K72R0
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 12.0 V
Receipt Date of Sample	:	February 19, 2019
Country of Mass-production	:	Japan and India
Condition of EUT	:	Production 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

Model No: K72R0 (referred to as the EUT in this report) is the Immobilizer and Alarm system.

Radio Specification

[Transmitter part]

Radio Type	:	Transceiver
Frequency of Operation	:	125 kHz
Modulation	:	ASK
Antenna type	:	External Antenna
Clock frequency (Maximum)	:	8 MHz (CPU)

[Receiver part] *1)

Equipment Type	:	Receiver
Frequency of Operation	:	433.92 MHz
Local clock frequency	:	21.948717 MHz (Crystal)
Modulation	:	FSK
Antenna Type	:	Pattern Antenna

*1) The test of receiver part was performed separately from this test report, and the conformability is confirmed.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	:	FCC Part 15 Subpart C FCC Part 15 final revised on March 12, 2018 and effective April 11, 2018
Title	:	FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.209 Radiated emission limits; general requirements.

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

3.2 Procedures and results

Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
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	N/A *1)	N/A
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.5, 6.12	<FCC> Section 15.209 <IC> RSS-210 4.4 RSS-Gen 8.9	Radiated	N/A	3.9 dB 125 kHz 0 deg. PK with Duty factor (Ant - Type 1)	Complied a)
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods <IC> RSS-Gen 6.5, 6.6, 6.13	<FCC> Section 15.209 <IC> RSS-210 4.4 RSS-Gen 8.9	Radiated	N/A	0.8 dB 38.826 MHz, Vertical, QP (Ant - Type 1)	Complied# a)
-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.

a) Refer to APPENDIX 1 (data of Radiated emission)

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 15.31 (e)
The EUT provides stable voltage constantly to the wireless transmitter regardless of input voltage.
Instead of a new battery, DC power supply was used for the test.
That does not affect the test result, therefore the 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.

3.3 Addition to standard

Item	Test Procedure	Specification	Remarks	Deviation	Worst margin	Results
99 % Occupied Band Width	RSS-Gen 6.7	-	Radiated	N/A	N/A	-
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

EMI

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.

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

*Measurement distance

Polarity	Radiated emission (Below 1 GHz)			
	(3 m*)(+/-)		(10 m*)(+/-)	
	30 MHz to 200 MHz	200 MHz to 1000 MHz	30 MHz to 200 MHz	200 MHz to 1000 MHz
Horizontal	4.8 dB	5.2 dB	4.8 dB	5.0 dB
Vertical	5.0 dB	6.3 dB	4.9 dB	5.0 dB

* Measurement distance

Bandwidth
0.96 %

3.5 Test Location

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4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124
NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967

Test site	IC Registration Number	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	2973C-1	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	2973C-2	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	2973C-3	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	2973C-4	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.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	N/A	-	-
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 m 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

Test mode	Remarks
Transmitting mode (Tx) 125kHz	-

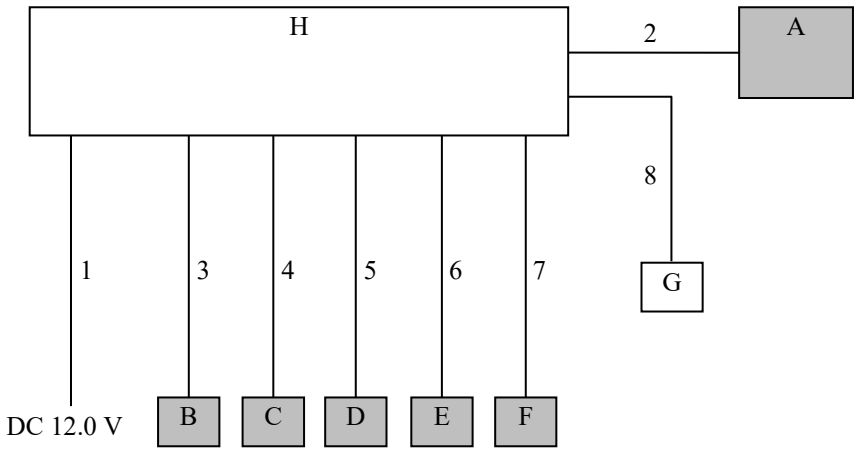
Justification : The system was configured in typical fashion (as a user would normally use it) for testing.

The EUT has 6 types of LF Antennas and 4 Systems.

Vehicle installation location	[System 1]	[System 2]	[System 3]	[System 4]
DR	- LF Antenna-1 (Type B)	- LF Antenna-4 (Type 2-2)	- LF Antenna-6 (Type 2)	- LF Antenna-1 (Type B)
AS	- LF Antenna-1 (Type B)	- LF Antenna-4 (Type 2-2)	- LF Antenna-6 (Type 2)	- LF Antenna-1 (Type B)
INF	- LF Antenna-2 (Type 1)	- LF Antenna-3 (Type 3)	- LF Antenna-2 (Type 1)	- LF Antenna-3 (Type 3)
INR	- LF Antenna-3 (Type 3)	- LF Antenna-3 (Type 3)	- LF Antenna-3 (Type 3)	- LF Antenna-5 (Type H)
TG	- LF Antenna-4 (Type 2-2)	- LF Antenna-3 (Type 3)	- LF Antenna-3 (Type 3)	- LF Antenna-3 (Type 3)

* According to the result of pre-check to five antennas(Type B, Type 1, Type 3, Type 2, Type H), it was confirmed that there was no difference in RF characteristics among antennas.
* The test was performed with System 1 as representative.

4.2 Configuration and peripherals



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

* The EUT does not transmit simultaneously from multiple antennas.
* Antenna was evaluated with the worst duty respectively.
* The EUT was set to transmit the data continuously from one antenna as a worst case, not to transmit it randomly from each antenna.
* According to the result of pre-check to two antennas(Type B), it was confirmed that there was no difference in RF characteristics among antennas. So the test was performed with Type B(DR) as a representative.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remark
A	Immobilizer and Alarm system	K72R0	001	OMRON Automotive Electronics Co. Ltd.	EUT
B	LF Antenna-1 (Type B)	CGF-S002-J0B	01	OMRON Automotive Electronics Co. Ltd.	EUT
C	LF Antenna-1 (Type B)	CGF-S002-J0B	02	OMRON Automotive Electronics Co. Ltd.	EUT
D	LF Antenna-2 (Type 1)	CGF-S002-D01	03	OMRON Automotive Electronics Co. Ltd.	EUT
E	LF Antenna-3 (Type 3)	CGF-S002-D03	04	OMRON Automotive Electronics Co. Ltd.	EUT
F	LF Antenna-4 (Type 2-2)	CGF-S002-N22	05	OMRON Automotive Electronics Co. Ltd.	EUT
G	Push Start Switch	P55R0	2919H1	OMRON Automotive Electronics Co. Ltd.	-
H	Switch BOX	RV494	001	OMRON Automotive Electronics Co. Ltd.	-

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-
2	Signal & DC Cable	2.0	Unshielded	Unshielded	-
3	Antenna Cable	2.4	Unshielded	Unshielded	-
4	Antenna Cable	2.4	Unshielded	Unshielded	-
5	Antenna Cable	2.4	Unshielded	Unshielded	-
6	Antenna Cable	2.4	Unshielded	Unshielded	-
7	Antenna Cable	2.4	Unshielded	Unshielded	-
8	Signal & DC Cable	2.0	Unshielded	Unshielded	-

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

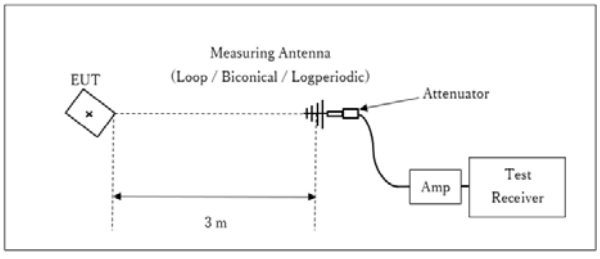
Frequency	From 9 kHz to 90 kHz and From 110 kHz to 150 kHz	From 90 kHz to 110 kHz	From 150 kHz to 490 kHz	From 490 kHz to 30 MHz	From 30 MHz to 1 GHz
Instrument used	Test Receiver				
Detector	PK / AV	QP	PK / AV	QP	QP
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz
Test Distance	3 m *1)	3 m *1)	3 m *1)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

*1) Distance Factor: 40 x log (3 m / 300 m) = -80 dB
*2) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

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.

[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.

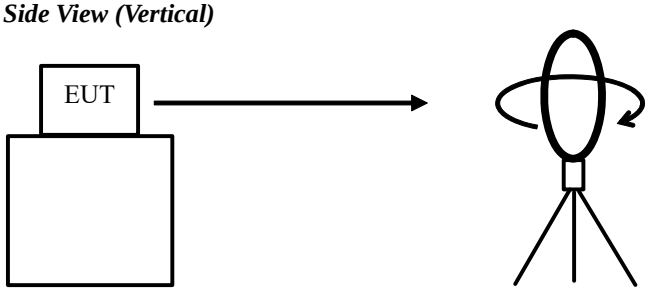
The test results and limit are rounded off to one decimal place, so some differences might be observed.

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

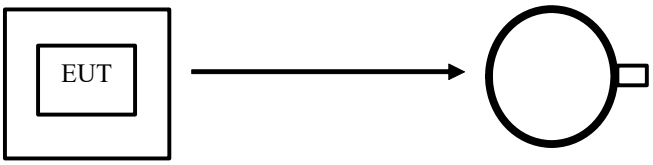
Date: February 20, 2019 Test engineer: Akihiko Maeda
February 21, 2019 Tomoki Matsui
February 27, 2019 Ken Fujita

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

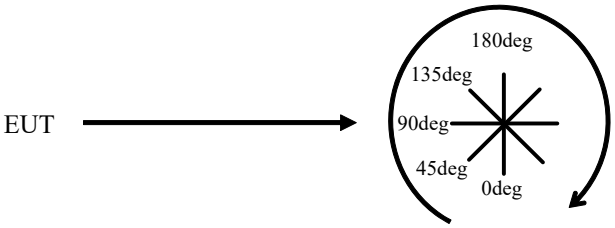


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

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	300 Hz	1 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

APPENDIX 1: Test data

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2018
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 1)

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	108.0	19.7	-73.8	32.2	-	21.7	45.6	23.9	Fundamental
0	0.25000	PK	79.4	19.7	-73.8	32.2	-	-6.9	39.6	46.5	
0	0.37500	PK	62.7	19.6	-73.8	32.2	-	-23.7	36.1	59.8	
0	0.50000	QP	37.3	19.6	-33.8	32.1	-	-9.0	33.6	42.6	
0	0.62500	QP	34.7	19.6	-33.7	32.2	-	-11.6	31.7	43.3	
0	0.75000	QP	31.9	19.6	-33.7	32.2	-	-14.4	30.1	44.5	
0	0.87500	QP	31.3	19.6	-33.7	32.2	-	-15.0	28.7	43.7	
0	1.00000	QP	31.4	19.6	-33.7	32.2	-	-14.9	27.6	42.5	
0	1.12500	QP	30.5	19.6	-33.7	32.2	-	-15.8	26.5	42.3	
0	1.25000	QP	30.8	19.6	-33.7	32.2	-	-15.5	25.6	41.1	

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

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	0.12500	PK	108.0	19.7	-73.8	32.2	0.0	21.7	25.6	3.9	
0	0.25000	PK	79.4	19.7	-73.8	32.2	0.0	-6.9	19.6	26.5	
0	0.37500	PK	62.7	19.6	-73.8	32.2	0.0	-23.7	16.1	39.8	

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

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

Result of the fundamental emission at 3m without Distance factor

PK

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	108.0	19.7	6.2	32.2	-	101.7	-	-	Fundamental

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

* 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.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2018
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 3)

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	107.9	19.7	-73.8	32.2	-	21.6	45.6	24.0	Fundamental
0	0.25000	PK	78.5	19.7	-73.8	32.2	-	-7.8	39.6	47.4	
0	0.37500	PK	62.0	19.6	-73.8	32.2	-	-24.4	36.1	60.5	
0	0.50000	QP	34.4	19.6	-33.8	32.1	-	-11.9	33.6	45.5	
0	0.62500	QP	32.5	19.6	-33.7	32.2	-	-13.8	31.7	45.5	
0	0.75000	QP	31.3	19.6	-33.7	32.2	-	-15.0	30.1	45.1	
0	0.87500	QP	32.6	19.6	-33.7	32.2	-	-13.7	28.7	42.4	
0	1.00000	QP	30.7	19.6	-33.7	32.2	-	-15.6	27.6	43.2	
0	1.12500	QP	30.6	19.6	-33.7	32.2	-	-15.7	26.5	42.2	
0	1.25000	QP	30.8	19.6	-33.7	32.2	-	-15.5	25.6	41.1	

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

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	0.12500	PK	107.9	19.7	-73.8	32.2	0.0	21.6	25.6	4.0	
0	0.25000	PK	78.5	19.7	-73.8	32.2	0.0	-7.8	19.6	27.4	
0	0.37500	PK	62.0	19.6	-73.8	32.2	0.0	-24.4	16.1	40.5	

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

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

Result of the fundamental emission at 3m without Distance factor

PK

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	107.9	19.7	6.2	32.2	-	101.6	-	-	Fundamental

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

* 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.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2018
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type B)

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	107.0	19.7	-73.8	32.2	-	20.7	45.6	24.9	Fundamental
0	0.25000	PK	78.3	19.7	-73.8	32.2	-	-8.0	39.6	47.6	
0	0.37500	PK	61.8	19.6	-73.8	32.2	-	-24.6	36.1	60.7	
0	0.50000	QP	35.1	19.6	-33.8	32.1	-	-11.2	33.6	44.8	
0	0.62500	QP	32.1	19.6	-33.7	32.2	-	-14.2	31.7	45.9	
0	0.75000	QP	31.4	19.6	-33.7	32.2	-	-14.9	30.1	45.0	
0	0.87500	QP	31.3	19.6	-33.7	32.2	-	-15.0	28.7	43.7	
0	1.00000	QP	30.7	19.6	-33.7	32.2	-	-15.6	27.6	43.2	
0	1.12500	QP	30.6	19.6	-33.7	32.2	-	-15.7	26.5	42.2	
0	1.25000	QP	30.7	19.6	-33.7	32.2	-	-15.6	25.6	41.2	

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

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	0.12500	PK	107.0	19.7	-73.8	32.2	0.0	20.7	25.6	4.9	
0	0.25000	PK	78.3	19.7	-73.8	32.2	0.0	-8.0	19.6	27.6	
0	0.37500	PK	61.8	19.6	-73.8	32.2	0.0	-24.6	16.1	40.7	

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

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

Result of the fundamental emission at 3m without Distance factor

PK

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	107.0	19.7	6.2	32.2	-	100.7	-	-	Fundamental

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

* 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.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/27/2018
Temperature/ Humidity	22 deg. C / 42 % RH
Engineer	Ken Fujita
Mode	Tx 125 kHz (Type 2-2)

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	104.5	19.7	-73.8	32.2	-	18.2	45.6	27.4	Fundamental
0	0.25000	PK	67.2	19.7	-73.8	32.2	-	-19.1	39.6	58.7	
0	0.37500	PK	51.0	19.6	-73.8	32.2	-	-35.4	36.1	71.5	
0	0.50000	QP	34.4	19.6	-33.8	32.1	-	-11.9	33.6	45.5	
0	0.62500	QP	33.8	19.6	-33.7	32.2	-	-12.5	31.7	44.2	
0	0.75000	QP	32.0	19.6	-33.7	32.2	-	-14.3	30.1	44.4	
0	0.87500	QP	31.4	19.6	-33.7	32.2	-	-14.9	28.7	43.6	
0	1.00000	QP	31.7	19.6	-33.7	32.2	-	-14.6	27.6	42.2	
0	1.12500	QP	31.3	19.6	-33.7	32.2	-	-15.0	26.5	41.5	
0	1.25000	QP	30.9	19.6	-33.7	32.2	-	-15.4	25.6	41.0	

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

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	0.12500	PK	104.5	19.7	-73.8	32.2	0.0	18.2	25.6	7.4	
0	0.25000	PK	67.2	19.7	-73.8	32.2	0.0	-19.1	19.6	38.7	
0	0.37500	PK	51.0	19.6	-73.8	32.2	0.0	-35.4	16.1	51.5	

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

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

Result of the fundamental emission at 3m without Distance factor

PK

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	104.5	19.7	6.2	32.2	-	98.2	-	-	Fundamental

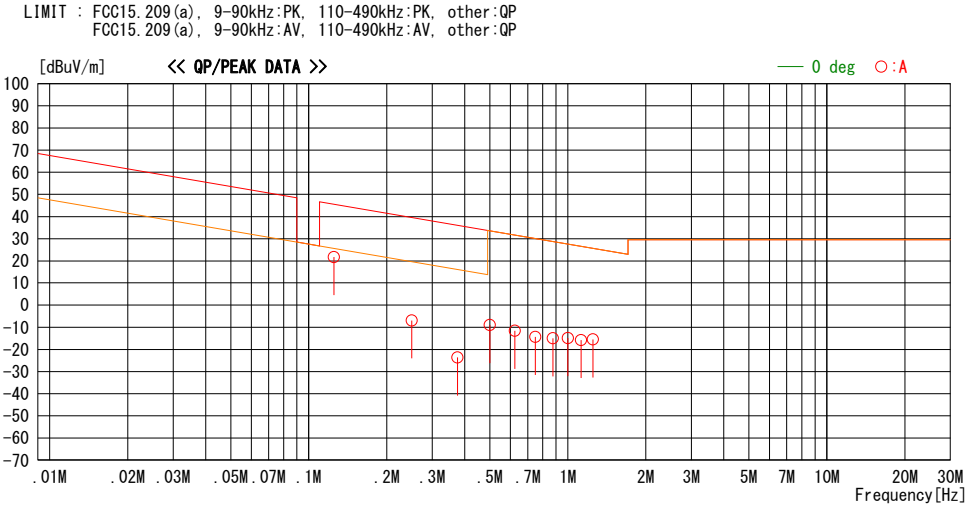
Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amprifier)

* 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.

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)
(Plot data, Worst case)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2018
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 1)

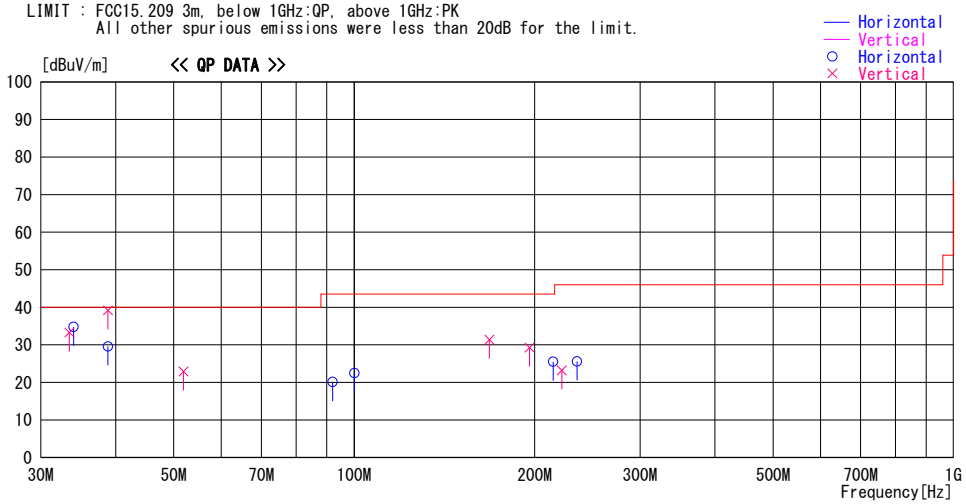


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Radiated Emission above 30MHz (Spurious Emission)

Test place	Ise EMC Lab. No.2 Semi Anechoic Chamber
Order No.	12737031H
Date	02/21/2019
Temperature/ Humidity	21 deg. C / 31 % RH
Engineer	Tomoki Matsui
Mode	Tx 125kHz (Type 1)

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 Factor [dB/m]	Loss& Gain [dB]	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
33.476	40.0	QP	17.0	-23.7	33.3	120	100	Vert.	40.0	6.7	
34.020	41.7	QP	16.8	-23.7	34.8	0	260	Hori.	40.0	5.2	
38.826	38.2	QP	15.1	-23.7	29.6	359	287	Hori.	40.0	10.4	
38.826	47.8	QP	15.1	-23.7	39.2	194	100	Vert.	40.0	0.8	
51.884	36.1	QP	10.3	-23.5	22.9	121	100	Vert.	40.0	17.1	
92.049	34.3	QP	8.7	-22.9	20.1	0	282	Hori.	43.5	23.4	
100.052	35.1	QP	10.2	-22.8	22.5	0	282	Hori.	43.5	21.0	
168.084	37.5	QP	15.7	-21.8	31.4	186	100	Vert.	43.5	12.1	
196.102	34.6	QP	16.3	-21.6	29.3	193	100	Vert.	43.5	14.2	
214.856	35.6	QP	11.1	-21.2	25.5	146	149	Hori.	43.5	18.0	
222.087	33.3	QP	11.1	-21.2	23.2	0	100	Vert.	46.0	22.8	
235.371	35.3	QP	11.3	-21.0	25.6	53	121	Hori.	46.0	20.4	

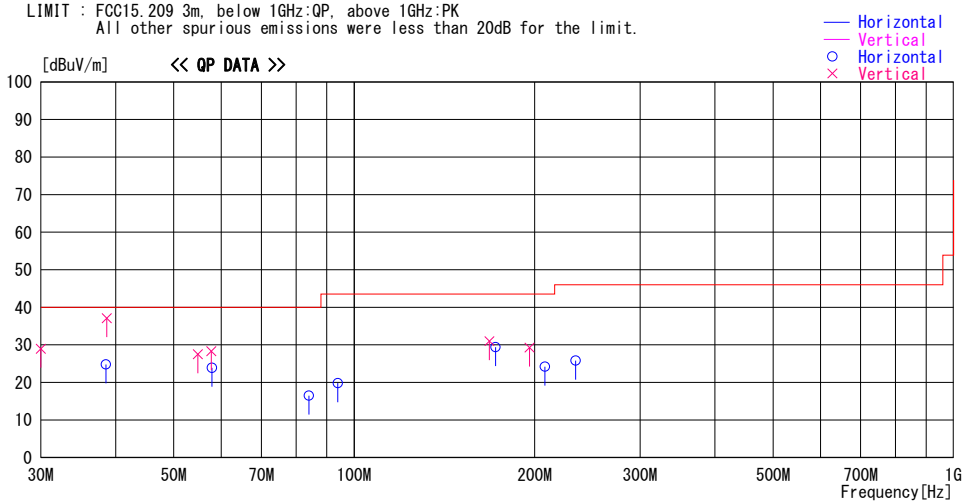
CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT – GAIN (AMP))

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

Radiated Emission above 30MHz (Spurious Emission)

Test place	Ise EMC Lab. No.2 Semi Anechoic Chamber
Order No.	12737031H
Date	02/21/2019
Temperature/ Humidity	21 deg. C / 31 % RH
Engineer	Tomoki Matsui
Mode	Tx 125kHz (Type 3)

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



Frequency	Reading	DET	Antenna Factor	Loss& Gain	Level	Angle	Height	Polar.	Limit	Margin	Comment
[MHz]	[dBuV]		[dB/m]	[dB]	[dBuV/m]	[Deg]	[cm]		[dBuV/m]	[dB]	
30.000	34.4	QP	18.4	-23.8	29.0	72	100	Vert.	40.0	11.0	
38.512	33.3	QP	15.2	-23.7	24.8	359	243	Hori.	40.0	15.2	
38.661	45.7	QP	15.1	-23.7	37.1	359	100	Vert.	40.0	2.9	
54.851	41.6	QP	9.3	-23.4	27.5	250	100	Vert.	40.0	12.5	
57.761	43.1	QP	8.5	-23.3	28.3	270	100	Vert.	40.0	11.7	
57.908	38.8	QP	8.4	-23.3	23.9	196	400	Hori.	40.0	16.1	
84.040	32.3	QP	7.2	-23.0	16.5	0	229	Hori.	40.0	23.5	
93.960	33.7	QP	9.0	-22.9	19.8	0	313	Hori.	43.5	23.7	
168.084	37.1	QP	15.7	-21.8	31.0	166	100	Vert.	43.5	12.5	
172.088	35.4	QP	15.8	-21.8	29.4	227	187	Hori.	43.5	14.1	
196.102	34.6	QP	16.3	-21.6	29.3	174	100	Vert.	43.5	14.2	
208.105	34.4	QP	11.2	-21.4	24.2	185	155	Hori.	43.5	19.3	
234.120	35.5	QP	11.3	-21.0	25.8	38	155	Hori.	46.0	20.2	

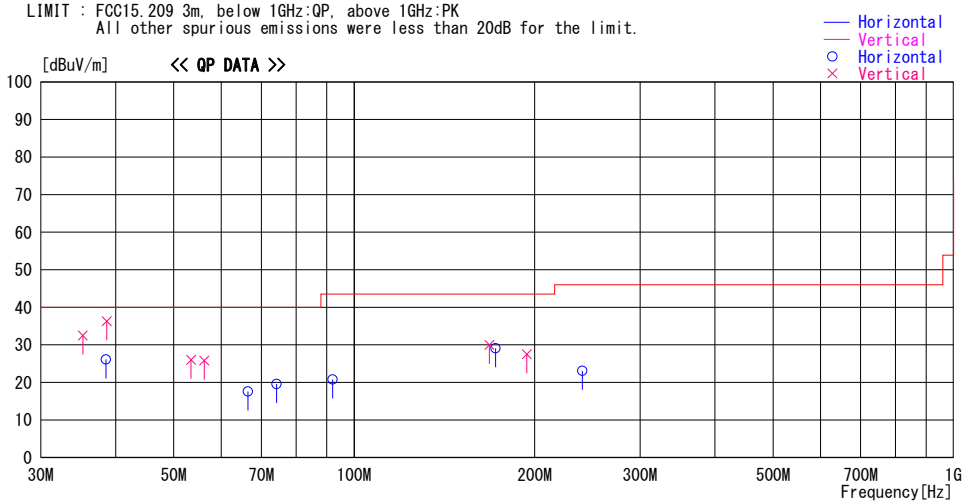
CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT – GAIN (AMP))

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

Radiated Emission above 30MHz (Spurious Emission)

Test place	Ise EMC Lab. No.2 Semi Anechoic Chamber
Order No.	12737031H
Date	02/21/2019
Temperature/ Humidity	21 deg. C / 31 % RH
Engineer	Tomoki Matsui
Mode	Tx 125kHz (Type B)

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 Factor [dB/m]	Loss& Gain [dB]	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
35.260	39.8	QP	16.4	-23.7	32.5	180	100	Vert.	40.0	7.5	
38.512	34.6	QP	15.2	-23.7	26.1	0	249	Hori.	40.0	13.9	
38.661	44.9	QP	15.1	-23.7	36.3	359	100	Vert.	40.0	3.7	
53.440	39.6	QP	9.8	-23.4	26.0	250	100	Vert.	40.0	14.0	
56.201	40.3	QP	8.9	-23.4	25.8	273	100	Vert.	40.0	14.2	
66.510	34.4	QP	6.5	-23.3	17.6	0	400	Hori.	40.0	22.4	
74.206	36.6	QP	6.2	-23.2	19.6	0	212	Hori.	40.0	20.4	
92.049	35.0	QP	8.7	-22.9	20.8	0	317	Hori.	43.5	22.7	
168.086	36.1	QP	15.7	-21.8	30.0	187	100	Vert.	43.5	13.5	
172.090	35.1	QP	15.8	-21.8	29.1	229	190	Hori.	43.5	14.4	
194.099	32.9	QP	16.2	-21.6	27.5	174	100	Vert.	43.5	16.0	
240.130	32.7	QP	11.4	-21.0	23.1	129	154	Hori.	46.0	22.9	

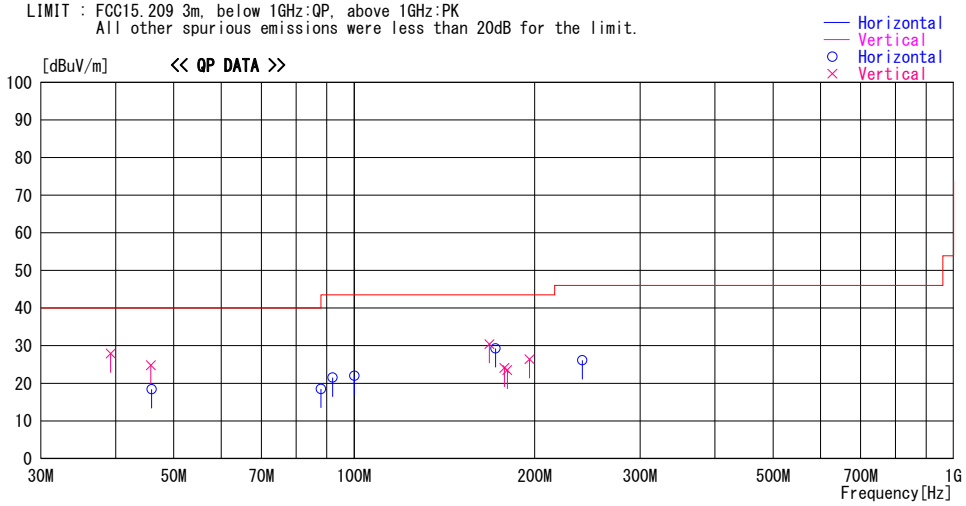
CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT – GAIN (AMP))

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

Radiated Emission above 30MHz (Spurious Emission)

Test place	Ise EMC Lab. No.2 Semi Anechoic Chamber
Order No.	12737031H
Date	02/21/2019
Temperature/ Humidity	21 deg. C / 31 % RH
Engineer	Tomoki Matsui
Mode	Tx 125kHz (Type 2-2)

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



Frequency	Reading	DET	Antenna Factor	Loss& Gain	Level	Angle	Height	Polar.	Limit	Margin	Comment
[MHz]	[dBuV]		[dB/m]	[dB]	[dBuV/m]	[Deg]	[cm]		[dBuV/m]	[dB]	
39.221	36.6	QP	14.9	-23.6	27.9	276	100	Vert.	40.0	12.1	
45.772	35.7	QP	12.7	-23.6	24.8	55	100	Vert.	40.0	15.2	
45.936	29.4	QP	12.6	-23.6	18.4	0	275	Hori.	40.0	21.6	
88.048	33.4	QP	8.0	-22.9	18.5	0	385	Hori.	43.5	25.0	
92.044	35.7	QP	8.7	-22.9	21.5	0	309	Hori.	43.5	22.0	
100.051	34.6	QP	10.2	-22.8	22.0	359	284	Hori.	43.5	21.5	
168.086	36.5	QP	15.7	-21.8	30.4	187	100	Vert.	43.5	13.1	
172.090	35.3	QP	15.8	-21.8	29.3	230	190	Hori.	43.5	14.2	
178.081	29.9	QP	16.0	-21.8	24.1	176	100	Vert.	43.5	19.4	
180.091	29.3	QP	16.0	-21.8	23.5	350	100	Vert.	43.5	20.0	
196.098	31.7	QP	16.3	-21.6	26.4	181	100	Vert.	43.5	17.1	
240.130	35.7	QP	11.4	-21.0	26.1	301	154	Hori.	46.0	19.9	

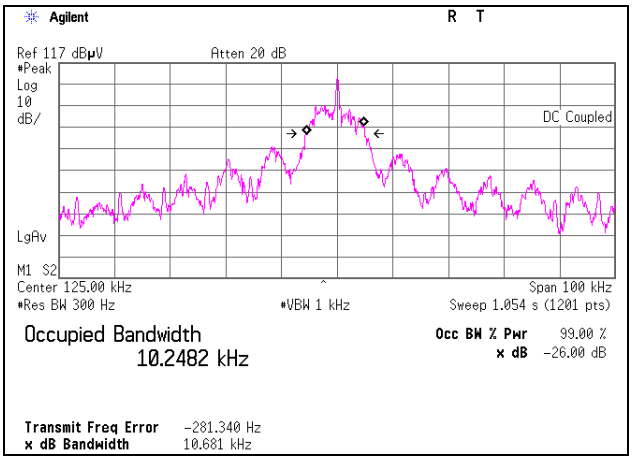
CHART: WITH FACTOR
ANT TYPE: - 30 MHz: LOOP, 30 MHz - 200 MHz: BICONICAL, 200 MHz - 1000 MHz: LOGPERIODIC, 1000 MHz -: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT – GAIN (AMP))

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

-26dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2019
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 1)

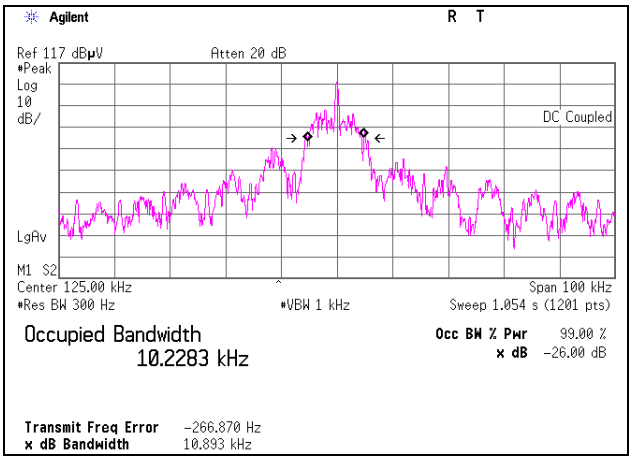
Frequency [kHz]	-26dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
125	10.681	10.2482



-26dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2019
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 3)

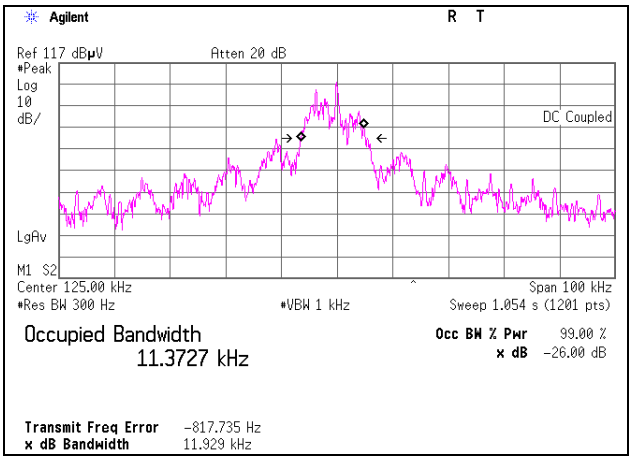
Frequency [kHz]	-26dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
125	10.893	10.2283



-26dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/20/2019
Temperature/ Humidity	20 deg. C / 45 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type B)

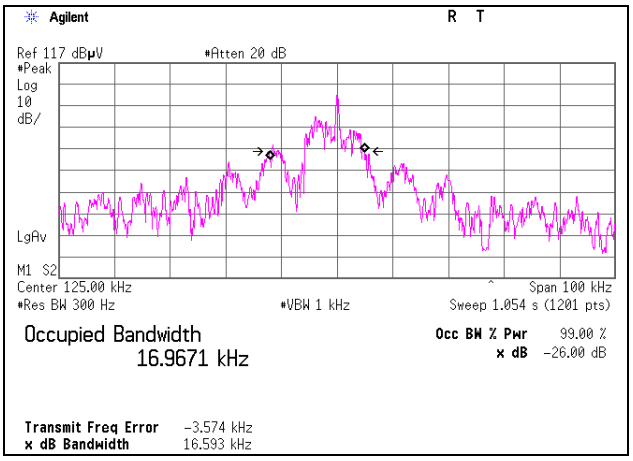
Frequency [kHz]	-26dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
125	11.929	11.3727



-26dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Order No.	12737031H
Date	02/28/2019
Temperature/ Humidity	21 deg. C / 40 % RH
Engineer	Akihiko Maeda
Mode	Tx 125 kHz (Type 2-2)

Frequency [kHz]	-26dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
125	16.593	16.9671



APPENDIX 2: Test instruments

Test Instruments

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/ 421-010/ sucoform141-P	-/04178	6/13/2018	6/30/2019	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	2/8/2019	2/29/2020	12
RE	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	6/28/2018	6/30/2020	24
RE	148898	Attenuator	KEYSIGHT	8491A	MY52462282	10/3/2018	10/31/2019	12
RE	141562	Thermo-Hygrometer	CUSTOM	CTH-201	0010	1/11/2019	1/31/2020	12
RE	141545	DIGITAL HiTESTER	HIOKI	3805	51201148	1/29/2019	1/31/2020	12
RE	142183	Measure	KOMELON	KMC-36	-	-	-	-
RE	141901	Spectrum Analyzer	AGILENT	E4440A	MY48250080	10/4/2018	10/31/2019	12
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	8/6/2018	8/31/2019	12
RE	141254	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	10/11/2018	10/31/2019	12
RE	141413	Coaxial Cable	UL Japan	-	-	6/12/2018	6/30/2019	12
RE	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	6/29/2018	6/30/2020	24
RE	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/5/2018	11/30/2019	12
RE	141427	Biconical Antenna	Schwarzbeck	VHA9103B	8031	5/31/2018	5/31/2019	12
RE	141317	Coaxial Cable	Fujikura/Agilent	-	-	2/25/2019	2/29/2020	12
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	8/21/2018	8/31/2019	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141265	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-190	5/31/2018	5/31/2019	12
RE	142228	Measure	KOMELON	KMC-36	-	-	-	-
RE	141578	Pre Amplifier	AGILENT	8447D	2944A10845	9/19/2018	9/30/2019	12
RE	141556	Thermo-Hygrometer	CUSTOM	CTH-201	0003	12/5/2018	12/31/2019	12
RE	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	8/8/2018	8/31/2019	12
RE	141902	Spectrum Analyzer	AGILENT	E4440A	MY46187105	10/4/2018	10/31/2019	12

***Hyphens for Last Calibration Date, Calibration Due 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.
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