RADIO TEST REPORT

Test Report No. : 12047157H-A-R1

Applicant	:	**SUBARU CORPORATION**
Type of Equipment	:	**Keyless Access with Push-Button Start System**
Model No.	:	**FJ18-2**
FCC ID	:	**Y8PFJ18-2**
Test regulation	:	**FCC Part 15 Subpart C: 2018**
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.
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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. This report is a revised version of 12047157H-A. 12047157H-A is replaced with this report.

Date of test: December 13, 2017

Representative test engineer:
Koji Yamamoto
Engineer
Consumer Technology Division

Approved by:
Motoya Imura
Leader
Consumer Technology Division

NVLAP TESTING
NVLAP LAB CODE: 200572-0

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http://japan.ul.com/resources/emc_accredited/

REVISION HISTORY

Original Test Report No.: 12047157H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12047157H-A	January 30, 2018	-	-
1	12047157H-A-R1	April 5, 2018	P. 5	Update of FCC version
1	12047157H-A-R1	April 5, 2018	P.8	Addition of the following sentence in Clause 4.1; *By specification, “Antenna(Type 1)No.1 + (Type 1)No.2” can be only transmitted simultaneously.
1	12047157H-A-R1	April 5, 2018	P.8	Correction of notes and table in Clause 4.2.

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	SUBARU CORPORATION
Address	:	1-1, Subaru-cho, ota-shi, Gunma-ken, 373-8555, Japan
Telephone Number	:	+81-276-26-3064
Facsimile Number	:	+81-276-26-3878
Contact Person	:	Yuji Kobayashi

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

2.1 Identification of E.U.T.

Type of Equipment	:	Keyless Access with Push-Button Start System
Model No.	:	FJ18-2
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 12.0 V
Receipt Date of Sample	:	December 7, 2017
Country of Mass-production	:	United States of America
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: FJ18-2 (referred to as the EUT in this report) is the Keyless Access with Push-Button Start System.

General Specification

Clock frequencies in the system	:	8.000 MHz(CPU)

Radio Specification

[Transmitter]

Radio Type	:	Transmitter
Frequency of Operation	:	134.2 kHz
Oscillator Frequency	:	4.2944 MHz
Type of Modulation	:	OOK (A1D)
Oscillation circuit	:	Crystal
Power Supply	:	DC 12.0 V
Antenna	:	Antenna (TYPE 1) (*1) (*3) / (TYPE 2) (*2) *1) Maximum number of this antenna is 2. *2) Maximum number of this antenna is 4.
Antenna Specification	:	Ferrite antenna coil

[Receiver]

Radio Type	:	Receiver
Frequency of Operation	:	433.92 MHz
Oscillator frequency	:	30.265 MHz (Crystal)
Intermediate frequency	:	280 kHz
Type of Modulation	:	FSK
Type of receiving system	:	Super-heterodyne
Power Supply	:	DC 5.0 V
Antenna Type	:	Internal antenna (Inverted F antenna)

*3) The Antenna (TYPE 1) of this system has variations of model 1 and model 2.
The difference of these variations is only the outer shell, and the test was performed with the representative model 1.

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.

* The revisions made after testing date do not affect the test specification applied to the EUT.

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

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	0.8 dB 134.2 kHz 0 deg. PK with Duty factor Antenna(Type2)_No.4	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	6.7 dB 30.329 MHz Vertical, QP Antenna(Type2)_No.4	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 Part 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.

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 to 30 MHz
3 m	3.8 dB
10 m	3.6 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

Radiated emission test(3 m)

[Electric Field Strength of Fundamental Emission]

The data listed in this report meets the limits unless the uncertainty is taken into consideration.

[Electric Field Strength of Spurious Emission]

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

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
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 2.0 m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

SECTION 4: Operation of E.U.T. during testing

4.1 Operating Modes

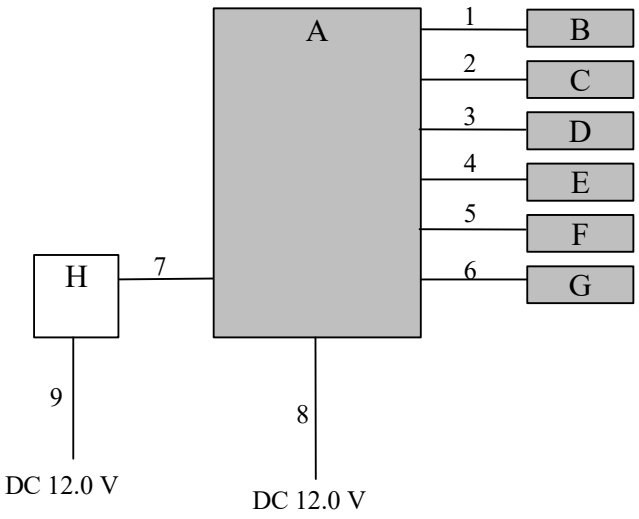
The mode is used: Transmitting mode (Tx) 134.2kHz
* LF output power is controlled by Smart ECU.

Test mode	Remarks
1) Tx 134.2 kHz Antenna(Type 1) No.1	-
2) Tx 134.2 kHz Antenna(Type 2) No.4	-
3) Tx 134.2 kHz Antenna(Type 1) No.1 + (Type 1) No.2	-
4) Tx 134.2 kHz Antenna(Type 2) No.3	-

*By specification, “Antenna(Type 1)No.1 + (Type 1)No.2” can be only transmitted simultaneously.

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.

*This system has two kinds (Type 1 and Type 2) of antenna ports.
- Type 1 has two ports.
  There was no difference of the output power of these antenna ports.
- Type 2 has four ports.
  The difference of output power of these antenna ports are follows;

Antenna port (Type 2)	Output power	Remarks
No.1	minimum	INSIDE 1
No.2	minimum	INSIDE 2
No.3	minimum	LUGGAGE 1
No.4	maximum	LUGGAGE 2

* No.1, No.2 and No.3 have same output power. The test was performed with the No.3 as representative.
* Antenna (Type 1) and Antenna (Type 2) were evaluated with the worst duty respectively.
  Worst duty does not change due to the difference in number of connected antenna.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Smart ECU	-	1	-	EUT
B	Antenna (Type 1) No.1	-	1-1	-	EUT
C	Antenna (Type 1) No.2	-	1-2	-	EUT
D	Antenna (Type 2) No.1	-	1-1	-	EUT
E	Antenna (Type 2) No.2	-	1-2	-	EUT
F	Antenna (Type 2) No.3	-	1-3	-	EUT
G	Antenna (Type 2) No.4	-	1-4	-	EUT
H	Jig	-	-	-	-

List of cables used

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

- 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.

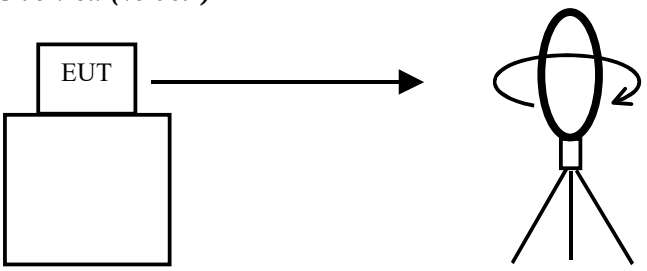
The test results and limit are rounded off to one decimal place, so some differences might be observed.

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

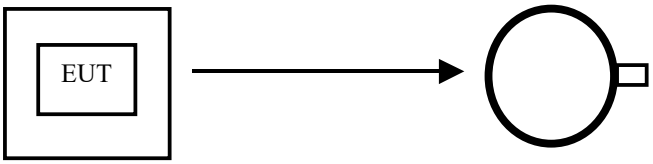
Date: December 13, 2017 Test engineer: Koji Yamamoto

Figure 1: Direction of the Loop Antenna

Side View (Vertical)

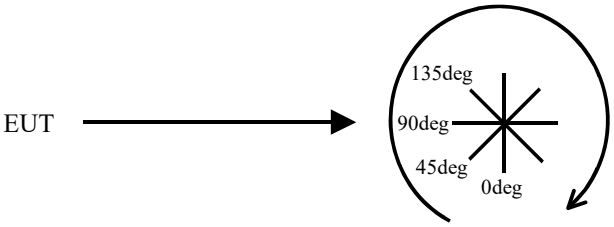


Top View (Horizontal)



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	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

APPENDIX 1: Test data

Radiated Emission below 30 MHz (Fundamental and Spurious Emission)
Antenna (Type1)No.1

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type1)_No.1

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	0.13420	PK	100.2	19.7	-74.0	32.3	-	13.6	45.0	31.4	Fundamental
0	0.26840	PK	58.3	19.7	-74.0	32.3	-	-28.3	39.0	67.3	
0	0.40260	PK	74.2	19.7	-73.9	32.3	-	-12.3	35.5	47.8	
0	0.53680	QP	38.0	19.7	-33.9	32.3	-	-8.5	33.0	41.5	
0	0.67100	QP	62.0	19.7	-33.9	32.2	-	15.6	31.1	15.5	
0	0.80520	QP	32.9	19.7	-33.9	32.2	-	-13.5	29.5	43.0	
0	0.93940	QP	51.5	19.7	-33.9	32.2	-	5.1	28.1	23.0	
0	1.07360	QP	30.9	19.7	-33.9	32.2	-	-15.5	26.9	42.4	
0	1.20780	QP	43.6	19.7	-33.9	32.2	-	-2.8	25.9	28.7	
0	1.34200	QP	30.5	19.7	-33.9	32.2	-	-15.9	25.0	40.9	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.13420	PK	100.2	19.7	-74.0	32.3	0.0	13.6	25.0	11.4	
0	0.26840	PK	58.3	19.7	-74.0	32.3	0.0	-28.3	19.0	47.3	
0	0.40260	PK	74.2	19.7	-73.9	32.3	0.0	-12.3	15.5	27.8	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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 3 m 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	0.13420	PK	100.2	19.7	6.0	32.3	-	93.6	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - 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)
Antenna (Type2)No.4

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type2)_No.4

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	0.13420	PK	110.8	19.7	-74.0	32.3	-	24.2	45.0	20.8	Fundamental
0	0.26840	PK	74.3	19.7	-74.0	32.3	-	-12.3	39.0	51.3	
0	0.40260	PK	62.2	19.7	-73.9	32.3	-	-24.3	35.5	59.8	
0	0.53680	QP	37.5	19.7	-33.9	32.3	-	-9.0	33.0	42.0	
0	0.67100	QP	50.9	19.7	-33.9	32.2	-	4.5	31.1	26.6	
0	0.80520	QP	31.3	19.7	-33.9	32.2	-	-15.1	29.5	44.6	
0	0.93940	QP	50.4	19.7	-33.9	32.2	-	4.0	28.1	24.1	
0	1.07360	QP	34.2	19.7	-33.9	32.2	-	-12.2	26.9	39.1	
0	1.20780	QP	47.0	19.7	-33.9	32.2	-	0.6	25.9	25.3	
0	1.34200	QP	30.6	19.7	-33.9	32.2	-	-15.8	25.0	40.8	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.13420	PK	110.8	19.7	-74.0	32.3	0.0	24.2	25.0	0.8	
0	0.26840	PK	74.3	19.7	-74.0	32.3	0.0	-12.3	19.0	31.3	
0	0.40260	PK	62.2	19.7	-73.9	32.3	0.0	-24.3	15.5	39.8	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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 3 m 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	0.13420	PK	110.8	19.7	6.0	32.3	-	104.2	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - 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)
Antenna (Type1)No.1 + (Type1)No.2

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type1)_No.1 + No.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	0.13420	PK	100.4	19.7	-74.0	32.3	-	13.8	45.0	31.2	Fundamental
0	0.26840	PK	66.6	19.7	-74.0	32.3	-	-20.0	39.0	59.0	
0	0.40260	PK	80.3	19.7	-73.9	32.3	-	-6.2	35.5	41.7	
0	0.53680	QP	43.3	19.7	-33.9	32.3	-	-3.2	33.0	36.2	
0	0.67100	QP	64.3	19.7	-33.9	32.2	-	17.9	31.1	13.2	
0	0.80520	QP	35.9	19.7	-33.9	32.2	-	-10.5	29.5	40.0	
0	0.93940	QP	53.8	19.7	-33.9	32.2	-	7.4	28.1	20.7	
0	1.07360	QP	31.0	19.7	-33.9	32.2	-	-15.4	26.9	42.3	
0	1.20780	QP	45.4	19.7	-33.9	32.2	-	-1.0	25.9	26.9	
0	1.34200	QP	31.0	19.7	-33.9	32.2	-	-15.4	25.0	40.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.13420	PK	100.4	19.7	-74.0	32.3	0.0	13.8	25.0	11.2	
0	0.26840	PK	66.6	19.7	-74.0	32.3	0.0	-20.0	19.0	39.0	
0	0.40260	PK	80.3	19.7	-73.9	32.3	0.0	-6.2	15.5	21.7	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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 3 m 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	0.13420	PK	100.4	19.7	6.0	32.3	-	93.8	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - 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)
Antenna (Type2)No.3

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type2)_No.3

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	0.13420	PK	86.6	19.7	-74.0	32.3	-	0.0	45.0	45.0	Fundamental
0	0.26840	PK	64.9	19.7	-74.0	32.3	-	-21.7	39.0	60.7	
0	0.40260	PK	53.8	19.7	-73.9	32.3	-	-32.7	35.5	68.2	
0	0.53680	QP	41.0	19.7	-33.9	32.3	-	-5.5	33.0	38.5	
0	0.67100	QP	37.0	19.7	-33.9	32.2	-	-9.4	31.1	40.5	
0	0.80520	QP	37.2	19.7	-33.9	32.2	-	-9.2	29.5	38.7	
0	0.93940	QP	32.0	19.7	-33.9	32.2	-	-14.4	28.1	42.5	
0	1.07360	QP	33.2	19.7	-33.9	32.2	-	-13.2	26.9	40.1	
0	1.20780	QP	31.2	19.7	-33.9	32.2	-	-15.2	25.9	41.1	
0	1.34200	QP	31.0	19.7	-33.9	32.2	-	-15.4	25.0	40.4	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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	0.13420	PK	86.6	19.7	-74.0	32.3	0.0	0.0	25.0	25.0	
0	0.26840	PK	64.9	19.7	-74.0	32.3	0.0	-21.7	19.0	40.7	
0	0.40260	PK	53.8	19.7	-73.9	32.3	0.0	-32.7	15.5	48.2	

Result = Reading + Ant Factor + Loss (Cable + Attenuator + Filter + 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 3 m 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	0.13420	PK	86.6	19.7	6.0	32.3	-	80.0	-	-	Fundamental

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

DATA OF RADIATED EMISSION TEST

UL Japan, Inc. Ise EMC Lab. No.3 Semi Anechoic Chamber
Date : 2017/12/13

Report No. : 12047157H

Temp./ Humi. : 23 deg. C / 31 % RH
Engineer : Koji Yamamoto

Mode / Remarks : Tx 134.2kHz Inside Antenna No.4

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

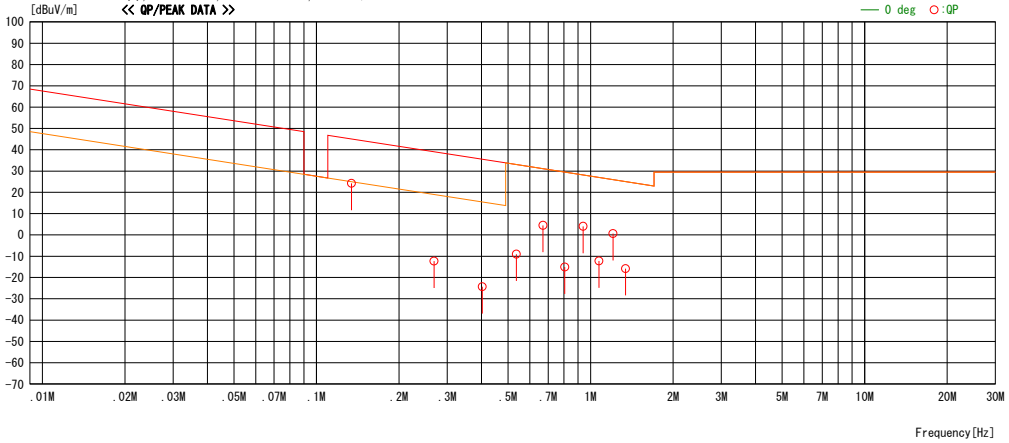
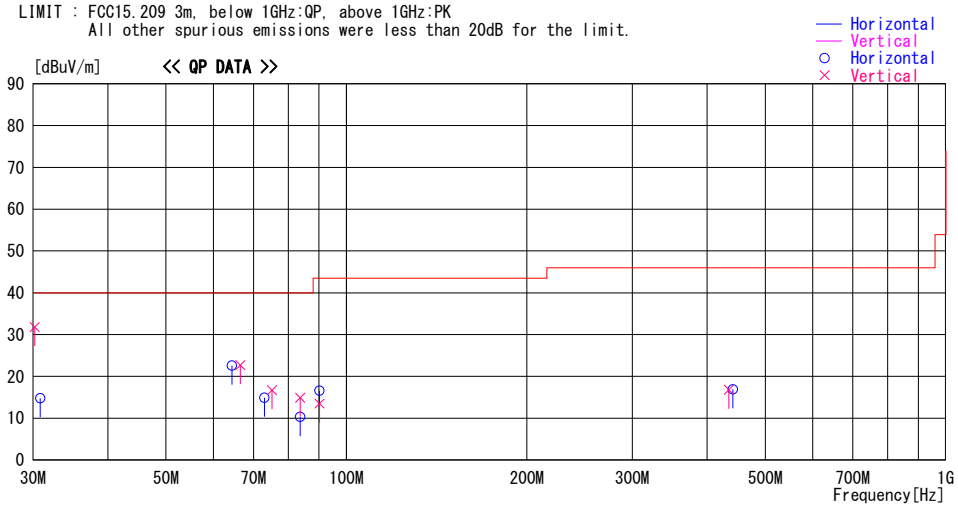


CHART: WITH FACTOR, ANT TYPE: LOOP, Except for the data below: adequate margin data below the limits.
CALCULATION : RESULT = READING + ANT FACTOR + LOSS(CABLE + ATTEN) - GAIN(AMP)

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

Radiated Emission above 30 MHz (Spurious Emission)
Antenna (Type1)No.1

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type1)_No.1



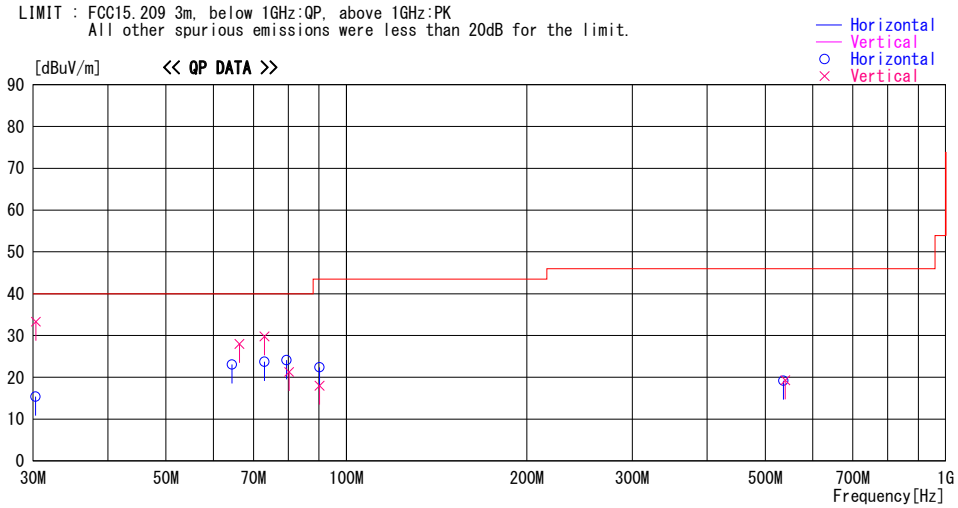
Frequency [MHz]	Reading [dBuV]	DET	Antenna Factor [dB/m]	Loss& Gain [dB]	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
30.195	39.6	QP	17.3	-25.1	31.8	86	100	Vert.	40.0	8.2	
30.850	22.9	QP	17.0	-25.1	14.8	0	400	Hori.	40.0	25.2	
64.416	40.3	QP	6.8	-24.5	22.6	181	299	Hori.	40.0	17.4	
66.564	40.7	QP	6.5	-24.5	22.7	323	100	Vert.	40.0	17.3	
73.004	33.1	QP	6.2	-24.4	14.9	346	400	Hori.	40.0	25.1	
75.152	34.6	QP	6.4	-24.3	16.7	220	100	Vert.	40.0	23.3	
83.740	31.7	QP	7.4	-24.2	14.9	266	100	Vert.	40.0	25.1	
83.740	27.1	QP	7.4	-24.2	10.3	175	222	Hori.	40.0	29.7	
90.182	29.1	QP	8.5	-24.1	13.5	254	100	Vert.	43.5	30.0	
90.182	32.2	QP	8.5	-24.1	16.6	170	236	Hori.	43.5	26.9	
434.668	21.5	QP	16.4	-21.1	16.8	0	100	Vert.	46.0	29.2	
441.335	21.4	QP	16.5	-21.0	16.9	0	100	Hori.	46.0	29.1	

CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200-1000MHz: LOGPERIODIC, 1000MHz-: 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 30 MHz (Spurious Emission)
Antenna (Type2)No.4

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type2)_No.4



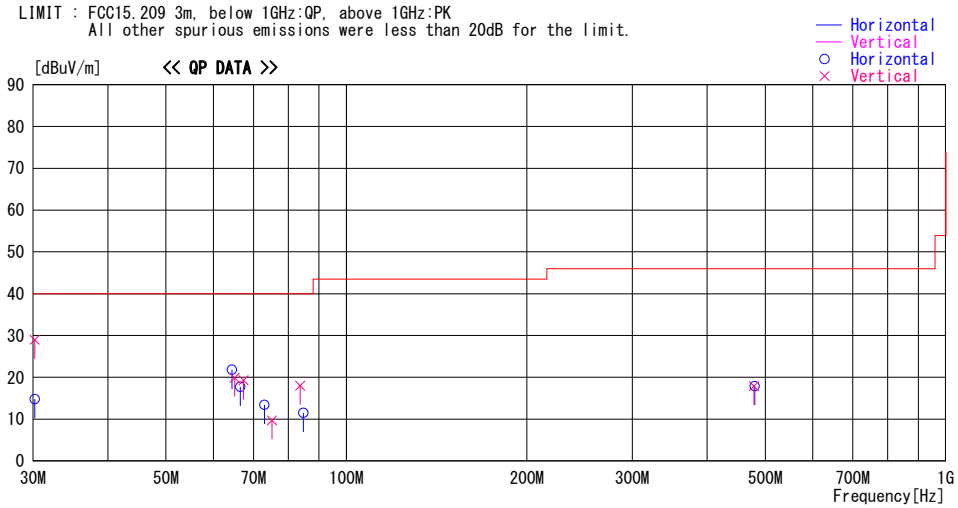
Frequency [MHz]	Reading [dBuV]	DET	Antenna Factor [dB/m]	Loss& Gain [dB]	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
30.283	23.3	QP	17.2	-25.1	15.4	155	337	Hori.	40.0	24.6	
30.329	41.2	QP	17.2	-25.1	33.3	277	100	Vert.	40.0	6.7	
64.416	40.8	QP	6.8	-24.5	23.1	175	330	Hori.	40.0	16.9	
66.294	46.0	QP	6.5	-24.5	28.0	309	100	Vert.	40.0	12.0	
73.004	41.9	QP	6.2	-24.4	23.7	342	400	Hori.	40.0	16.3	
73.004	48.0	QP	6.2	-24.4	29.8	306	100	Vert.	40.0	10.2	
79.446	41.8	QP	6.6	-24.3	24.1	0	400	Hori.	40.0	15.9	
80.251	38.9	QP	6.7	-24.3	21.3	63	100	Vert.	40.0	18.7	
90.182	38.0	QP	8.5	-24.1	22.4	173	218	Hori.	43.5	21.1	
90.182	33.6	QP	8.5	-24.1	18.0	86	100	Vert.	43.5	25.5	
536.001	21.4	QP	18.2	-20.4	19.2	0	100	Hori.	46.0	26.8	
540.001	21.5	QP	18.2	-20.4	19.3	0	100	Vert.	46.0	26.7	

CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200-1000MHz: LOGPERIODIC, 1000MHz-: 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 30 MHz (Spurious Emission)
Antenna (Type1)No.1 + (Type1)No.2

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type1)_No.1 + No.2



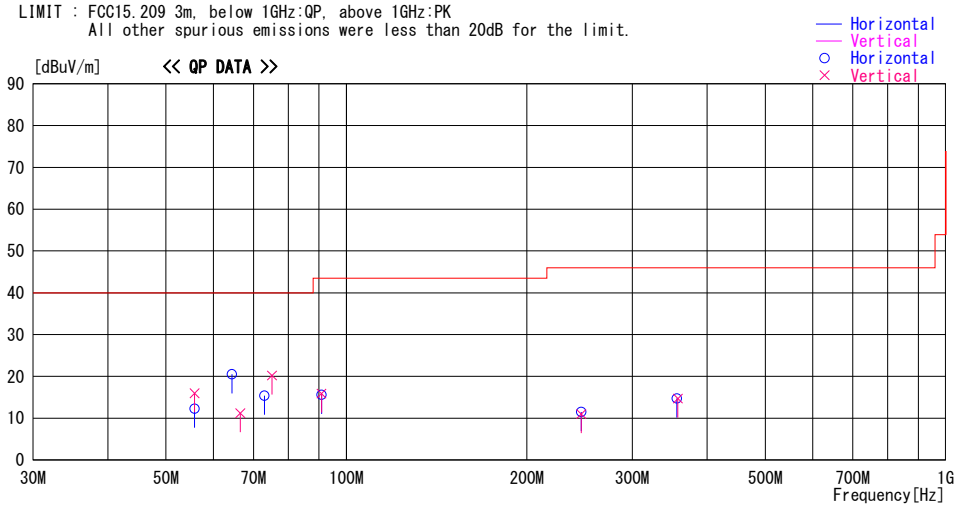
Frequency [MHz]	Reading [dBuV]	DET	Antenna Factor [dB/m]	Loss& Gain [dB]	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
30.195	36.8	QP	17.3	-25.1	29.0	82	100	Vert.	40.0	11.0	
30.195	22.6	QP	17.3	-25.1	14.8	0	400	Hori.	40.0	25.2	
64.415	39.5	QP	6.8	-24.5	21.8	182	310	Hori.	40.0	18.2	
65.086	37.7	QP	6.7	-24.5	19.9	166	100	Vert.	40.0	20.1	
66.562	35.7	QP	6.5	-24.5	17.7	355	282	Hori.	40.0	22.3	
67.367	37.4	QP	6.4	-24.5	19.3	317	100	Vert.	40.0	20.7	
73.004	31.6	QP	6.2	-24.4	13.4	183	400	Hori.	40.0	26.6	
75.151	27.6	QP	6.4	-24.3	9.7	324	100	Vert.	40.0	30.3	
83.739	34.8	QP	7.4	-24.2	18.0	251	100	Vert.	40.0	22.0	
84.813	28.2	QP	7.5	-24.2	11.5	177	206	Hori.	40.0	28.5	
478.668	21.4	QP	17.3	-20.8	17.9	0	100	Vert.	46.0	28.1	
480.002	21.4	QP	17.3	-20.8	17.9	0	100	Hori.	46.0	28.1	

CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200-1000MHz: LOGPERIODIC, 1000MHz-: 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 30 MHz (Spurious Emission)
Antenna (Type2)No.3

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Order No.	12047157H
Date	12/13/2017
Temperature/ Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type2)_No.3



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
55.823	28.2	QP	8.7	-24.6	12.3	191	369	Hori.	40.0	27.7	
55.823	31.9	QP	8.7	-24.6	16.0	256	100	Vert.	40.0	24.0	
64.415	38.2	QP	6.8	-24.5	20.5	180	320	Hori.	40.0	19.5	
66.563	29.2	QP	6.5	-24.5	11.2	299	100	Vert.	40.0	28.8	
73.005	33.6	QP	6.2	-24.4	15.4	348	400	Hori.	40.0	24.6	
75.152	38.1	QP	6.4	-24.3	20.2	247	100	Vert.	40.0	19.8	
90.898	31.1	QP	8.6	-24.1	15.6	181	220	Hori.	43.5	27.9	
90.898	31.4	QP	8.6	-24.1	15.9	258	100	Vert.	43.5	27.6	
246.667	22.1	QP	11.8	-22.4	11.5	0	100	Hori.	46.0	34.5	
246.667	21.6	QP	11.8	-22.4	11.0	359	100	Vert.	46.0	35.0	
356.001	21.6	QP	14.7	-21.6	14.7	0	100	Hori.	46.0	31.3	
357.334	21.5	QP	14.8	-21.6	14.7	359	100	Vert.	46.0	31.3	

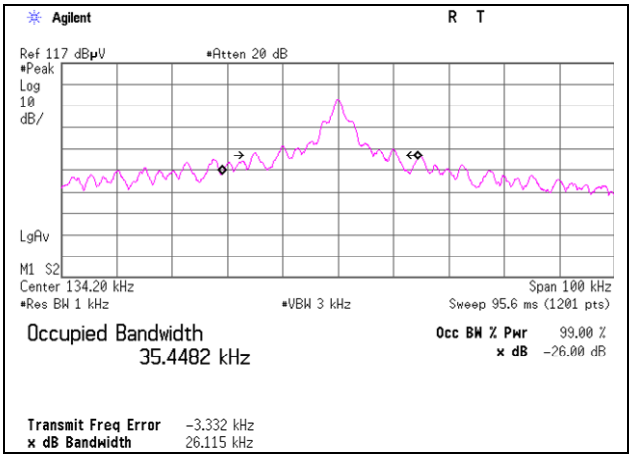
CHART: WITH FACTOR ANT TYPE: -30MHz: LOOP, 30-200MHz: BICONICAL, 200-1000MHz: LOGPERIODIC, 1000MHz-: HORN
CALCULATION: RESULT = READING + ANT FACTOR + LOSS & GAIN (CABLE + ATT - GAIN(AMP))

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

-26 dB Bandwidth and 99 % Occupied Bandwidth
Antenna (Type1)No.1

Report No.	12047157H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	12/13/2017
Temperature / Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz Antenna (Type 1)_No.1

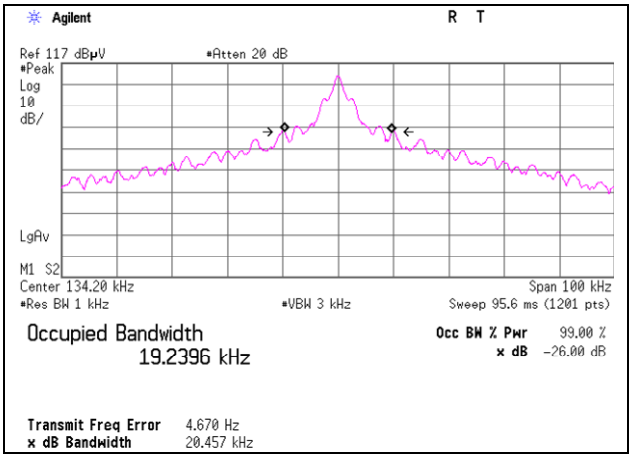
-26 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
26.1150	35.4482



-26 dB Bandwidth and 99 % Occupied Bandwidth
Antenna (Type2)No.4

Report No.	12047157H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	12/13/2017
Temperature / Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz Antenna (Type 2)_No.4

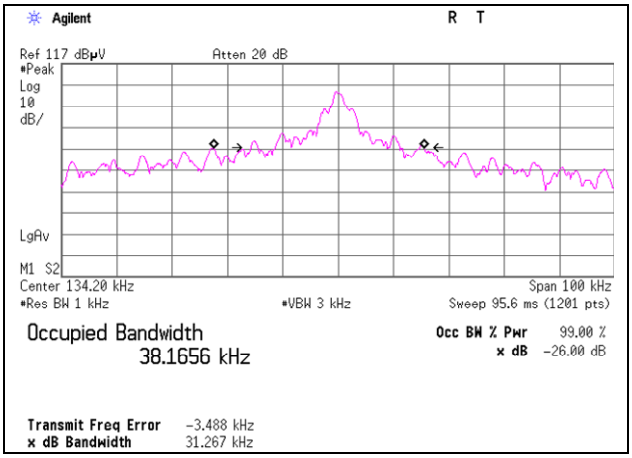
-26 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
20.4570	19.2396



-26 dB Bandwidth and 99 % Occupied Bandwidth
Antenna (Type1)No.1 + (Type1)No.2

Report No.	12047157H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	12/13/2017
Temperature / Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz Antenna (Type1)No.1 + (Type1)No.2

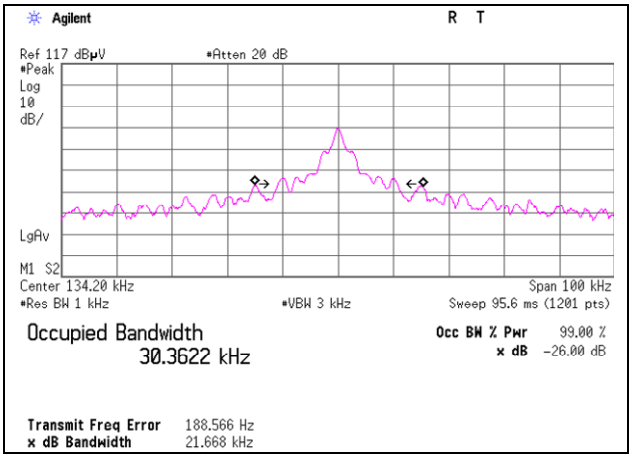
-26 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
31.2670	38.1656



-26 dB Bandwidth and 99 % Occupied Bandwidth
Antenna (Type2)No.3

Report No.	12047157H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	12/13/2017
Temperature / Humidity	23 deg. C / 31 % RH
Engineer	Koji Yamamoto
Mode	Tx 134.2 kHz, Antenna (Type2)_No.3

-26 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]
21.6680	30.3622



APPENDIX 2: Test instruments

EMI test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-03	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2017/10/31 * 12
MOS-13	Thermo-Hygrometer	Custom	CTH-180	1301	RE	2017/01/20 * 12
MJM-16	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2017/08/22 * 12
MTR-08	Test Receiver	Rohde & Schwarz	ESCI	100767	RE	2017/08/22 * 12
MLPA-01	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	RE	2017/10/11 * 12
MCC-112	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W(10m)/ SFM141(3m)/ sucoform141-PE(1m)/ 421-010(1.5m)/ RFM-E321(Switcher)	-/00640	RE	2017/07/12 * 12
MCC-143	Coaxial Cable	UL Japan	-	-	RE	2017/06/12 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2017/03/27 * 12
MAT-98	Attenuator	KEYSIGHT	8491A	MY52462349	RE	2016/12/05 * 12
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	RE	2017/01/19 * 12
MBA-03	Biconical Antenna	Schwarzbeck	BBA9106	1915	RE	2017/10/02 * 12
MLA-22	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	RE	2017/01/26 * 12
MCC-51	Coaxial cable	UL Japan	-	-	RE	2017/07/12 * 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