



EMI TEST REPORT

Test Report No. : 11946975H

Applicant : **DENSO CORPORATION**
Type of Equipment : **Tire Pressure Monitoring System (Receiver)**
Model No. : **23ABG**
FCC ID : **HYQ23ABG**
Test regulation : **FCC Part 15 Subpart B: 2017**
Test Result : **Complied**

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
5. This test report 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 EMC technical requirements. It does not cover administrative issues such as Manual or non-EMC test related Requirements. (if applicable)

Date of test: September 20 and 21, 2017

Representative test engineer:



Hiroyuki Furutaka
Engineer

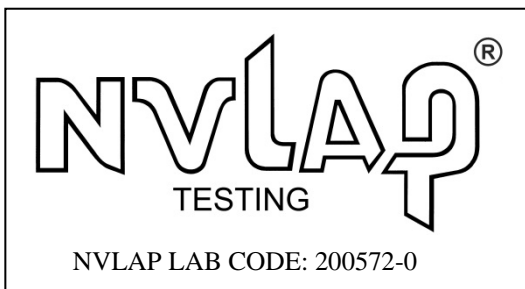
Consumer Technology Division

Approved by:



Motoya Imura
Engineer

Consumer Technology Division



This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.

*As for the range of Accreditation in NVLAP, you may refer to the WEB address,
http://japan.ul.com/resources/emc_accredited/

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CONTENTS	PAGE
SECTION 1: Customer information	4
SECTION 2: Equipment under test (E.U.T.)	4
SECTION 3: Test specification, procedures & results	5
SECTION 4: Operation of E.U.T. during testing	8
SECTION 5: Radiated Emission	10
SECTION 6: Antenna Terminal.....	11
APPENDIX 1: Test data	12
Radiated Emission	12
Antenna Terminal Conducted Emission	16
Radiated Emission (Reference data).....	18
APPENDIX 2: Test instruments	24
APPENDIX 3: Photographs of test setup.....	25
Radiated Emission	25
Worst Case Position.....	29

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SECTION 1: Customer information

Company Name : DENSO CORPORATION
Address : 1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661, Japan
Telephone Number : +81-566-61-7252
Facsimile Number : +81-566-25-4837
Contact Person : HIROMICHI HANAI

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

2.1 Identification of E.U.T.

Type of Equipment : Tire Pressure Monitoring System (Receiver)
Model No. : 23ABG
Serial No. : Refer to Section 4, Clause 4.2
Receipt Date of Sample : September 20, 2017
Country of Mass-production : Japan, China, United States of America
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

Model No: 23ABG (referred to as the EUT in this report) is the Tire Pressure Monitoring System (Receiver). 23ABG has 8 variations. For details of variations, see "Theory of Operation".

Feature of EUT:

Tire Pressure Monitoring System is used for monitoring and indicating information of air pressure in vehicle's tires. Transmitter sends receiver the data that informs air pressure in vehicle's tire to the receiver. The data also includes the information of temperature, battery voltage and identity code of transmitter. The receiver judges the data, and if the data of air pressure and others is not in a normal condition, the receiver sends signal to a warning lamp. Then, the warning lamp warns drivers.

Type of receiving system : Super-heterodyne
Frequency of Operation : 314.98 MHz
Oscillator Frequency : 21.948717 MHz Crystal
Type of Modulation : FSK (F1D)
Power Supply : DC 12.0 V
Antenna Type : ANT1: Internal antenna (Inverse F antenna)
ANT2: External antenna

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SECTION 3: Test specification, procedures & results

3.1 Test specification

Test specification : FCC Part 15 Subpart B
FCC Part 15 final revised on September 1, 2017 and effective October 2, 2017

Title : FCC 47CFR Part15 Radio Frequency Device
Subpart B Unintentional Radiators

* The revision on September 1, 2017, does not affect the test specification applied to the EUT.

3.2 Procedures and results

Item	Test Procedure	Limits	Deviation	Worst margin	Result
Conducted emission	FCC: ANSI C63.4: 2014 7. AC power - line conducted emission measurements	FCC:Part 15 Subpart B 15.107(a)	N/A *1)	N/A	N/A
	IC: RSS-Gen 8.8	IC: RSS-Gen 8.8			
Radiated emission	FCC: ANSI C63.4: 2014 8. Radiated emission measurements	FCC: Part 15 Subpart B 15.109(a)	N/A	19.5 dB 912.840 MHz Vertical, QP	Complied
	IC: RSS-Gen 7	IC: RSS-Gen 7.1.2			
Antenna Terminal	FCC: ANSI C63.4: 2014 12. Measurement of unintentional radiators other than ITE	FCC: Part 15 Subpart B 15.111(a)	N/A	38.7 dB 1217.120 MHz PK	Complied
	IC: RSS-Gen 7	IC: RSS-Gen 7.1.3 *2)			
*Note: UL Japan, Inc's EMI Work Procedure 13-EM-W0420.					
*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.					

3.3 Addition to standard

No addition, exclusion nor deviation has been made from the standard.

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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	5.0 dB	5.3 dB	5.0 dB	5.0 dB
Vertical	5.2 dB	6.3 dB	5.0 dB	5.0 dB

Radiated emission (Above 1 GHz)				
(3 m*)(+/-)		(1 m*)(+/-)		(10 m*)(+/-)
1 GHz to 6 GHz	6 GHz to 18 GHz	10 GHz to 26.5 GHz	26.5 GHz to 40 GHz	1 GHz to 18 GHz
5.2 dB	5.5 dB	5.5 dB	5.4 dB	5.5 dB

* Measurement distance

Antenna terminated conducted emission / Power density / Burst power (+dB)
3.1 dB

Radiated emission test (3 m)

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

Antenna terminal conducted emission test

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. *NVLAP Lab. code: 200572-0
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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	-	8.8 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 2.0 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

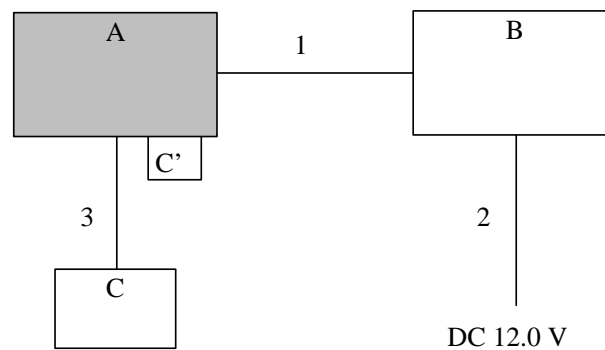
The mode used: 1) TPMS Receiving mode (314.98 MHz)

* Refer to the table in “Theory of Operation_Variation_23ABG” for test mode.

Radiated emission (External Antenna) and Antenna Terminal were tested with Variation No. 2, because there was no difference in noise level compared to the other representative variants (Variation No. 2, 4, 6, and 8) of the table in “Theory of Operation”.

Also, Radiated emission (Internal Antenna) was tested with Variation No. 1 as representative, because there was no difference with the above result.

4.2 Configuration and peripherals



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

*Tuning was confirmed to be locked on each mode by checking local oscillator frequency to be stable using a search-coil.

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Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Tire Pressure Monitoring System (Receiver)	23ABG	001 (Variation No. 1)	DENSO CORPORATION	EUT
			002 (Variation No. 2)		
			*1)		
			003 (Variation No. 4)		
			004 (Variation No. 6)		
			005 (Variation No. 8)		
B	TPMS-RKE/SMART checker bench	-	1004816-02-02	DENSO CORPORATION	-
C	Antenna	-	12J25	DENSO CORPORATION	*2)
C'	Terminal Jig	-	-	DENSO CORPORATION	*3)

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC and Signal Cable	1.8	Unshielded	Unshielded	-
2	DC Cable	1.6	Unshielded	Unshielded	-
3	Antenna Cable	2.0	Shielded	Shielded	*2)

*1) Variations owing to antenna matching (Inverse F Antenna Type) *See "Theory of Operation" for details. TYPE1 which was used for the tests has 306 "Nothing" and 307 "Nothing".

The result of Radiated emission test was mainly from characteristics of Local Oscillator.

If the range of 306, 307, 308 and 309 becomes "Capacitor 0.1 - 100pF", or "Inductor 1 - 100nH", there is no influence on the result of Radiated emission test.

*2) Used for Radiated emission test (External Antenna) only.

*3) Used for Radiated emission test (Internal Antenna) only.

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SECTION 5: Radiated Emission

5.1 Operating environment

Test place : No.4 semi anechoic chamber
Temperature : See data
Humidity : See data

5.2 Test configuration

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 EUT was set on the center the tabletop.

Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength.

Photographs of the set up are shown in Appendix 3.

5.3 Test conditions

Frequency range : 30 MHz - 200 MHz (Biconical antenna) / 200 MHz - 1000 MHz (Logperiodic antenna)
1000 MHz - 2000 MHz (Horn antenna)
Test distance : 3 m
EUT position : Table top
EUT operation mode : See Clause 4.1

5.4 Test procedure

The height of the measuring antenna 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 with the Test Receiver.

The radiated emission measurements were made with the following detector function of the Test Receiver.

Frequency	Below 1GHz	Above 1GHz *1)
Instrument used	Test Receiver	Test Receiver
IF Bandwidth	QP: BW 120 kHz	PK: BW 1 MHz, CISPR AV: BW 1 MHz

*1) The measurement data was adjusted to a 3 m distance using the following Distance Factor.

Distance Factor: $20 \times \log(4.10 \text{ m} / 3 \text{ m}) = 2.71 \text{ dB}$

- The 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.

5.5 Test result

Summary of the test results: Pass

The limit is rounded down to one decimal place.

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

Date: September 21, 2017

Test engineer: Hiroyuki Furutaka

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SECTION 6: Antenna Terminal

6.1 Operating environment

Test place : No.4 semi anechoic chamber
Temperature : See data
Humidity : See data

6.2 Test configuration

EUT was placed on a wooden table of nominal size, 1.0 m by 1.5 m, raised 0.8 m from the ground.

6.3 Test conditions

Frequency range : 30 MHz - 1000 MHz / 1000 MHz - 2000 MHz
Test distance : N / A
EUT position : Table top
EUT operation mode : See Clause 4.1

6.4 Test procedure

The Antenna Terminal was measured with a spectrum analyzer connected to the antenna port.

Frequency	Below 1 GHz	Above 1 GHz
Instrument used	Spectrum Analyzer	Spectrum Analyzer
IF Bandwidth	PK: RBW: 100 kHz / VBW: 100 kHz	PK: RBW: 1 MHz / VBW: 3 MHz

6.5 Test result

Summary of the test results: Pass

Date: September 20, 2017

Test engineer: Hiroyuki Furutaka

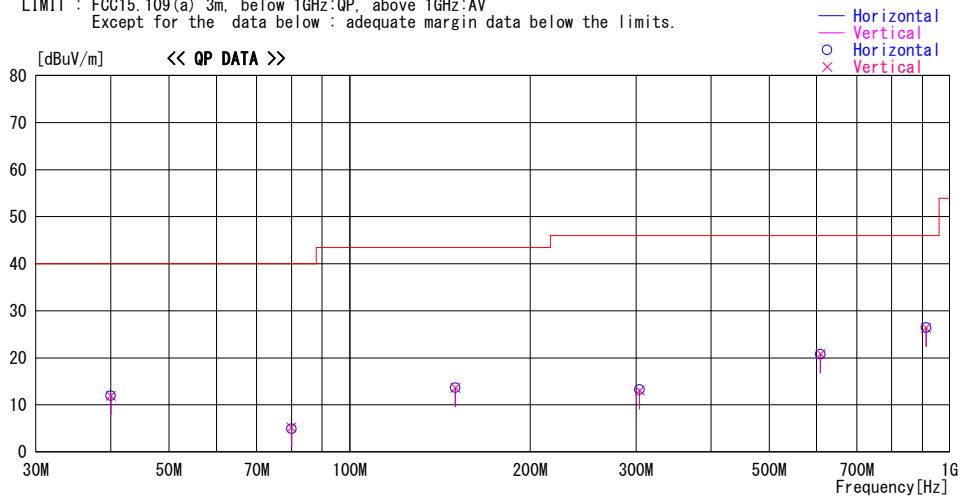
APPENDIX 1: Test data

Radiated Emission

TPMS(314.98MHz) Variation No.1 Internal Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV
Except for the data below : adequate margin data below the limits.



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss& Gain [dB]							
40.000	22.6	QP	14.3	-24.9	12.0	0	100	Hori.	40.0	28.0	
40.000	22.5	QP	14.3	-24.9	11.9	0	100	Vert.	40.0	28.1	
80.000	22.7	QP	6.8	-24.3	5.2	0	100	Vert.	40.0	34.8	
80.000	22.4	QP	6.8	-24.3	4.9	0	100	Hori.	40.0	35.1	
150.000	21.9	QP	15.1	-23.4	13.6	0	100	Vert.	43.5	29.9	
150.000	22.0	QP	15.1	-23.4	13.7	0	100	Hori.	43.5	29.8	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Vert.	46.0	32.9	
304.280	21.8	QP	13.5	-22.0	13.3	0	100	Hori.	46.0	32.7	
608.560	21.7	QP	19.1	-20.0	20.8	0	100	Hori.	46.0	25.2	
608.560	21.7	QP	19.1	-20.0	20.8	0	100	Vert.	46.0	25.2	
912.840	21.7	QP	22.1	-17.4	26.4	0	100	Hori.	46.0	19.6	
912.840	21.7	QP	22.1	-17.4	26.4	0	100	Vert.	46.0	19.6	

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))

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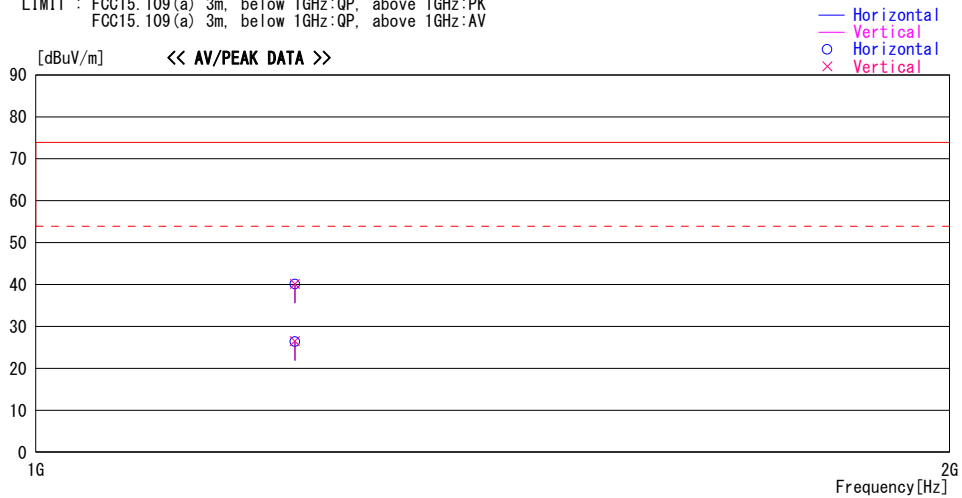
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Radiated Emission
TPMS(314.98MHz) Variation No.1 Internal Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:PK
FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV



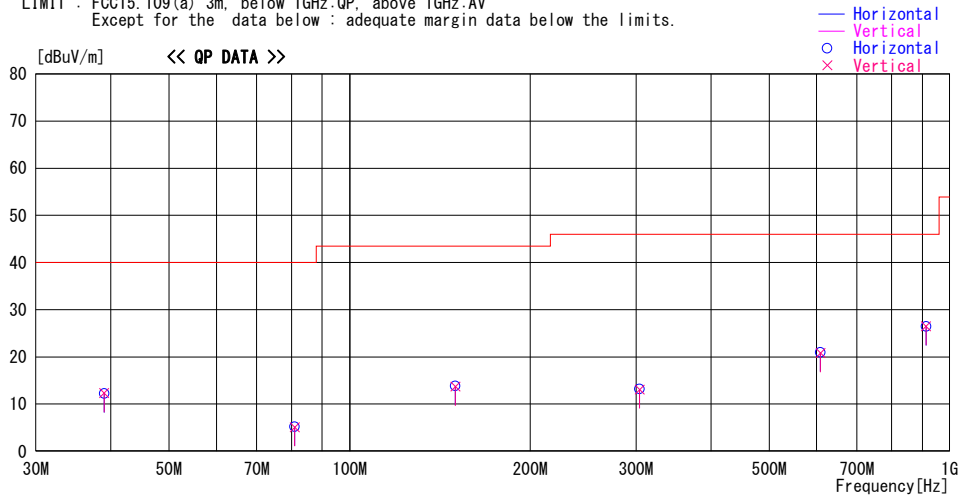
Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss&	Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit	Margin	Comment
			Factor [dB/m]	Gain [dB]					[dBuV/m]	[dB]	
1217.120	44.8	PK	25.2	-29.8	40.2	0	100	Vert.	73.9	33.7	
1217.120	44.7	PK	25.2	-29.8	40.1	0	100	Hori.	73.9	33.8	
1217.120	31.1	AV	25.2	-29.8	26.5	0	100	Vert.	53.9	27.4	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Hori.	53.9	27.5	

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 - GAIN(AMP) + D-factor)

Radiated Emission
TPMS(314.98MHz) Variation No.2 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV
Except for the data below : adequate margin data below the limits.



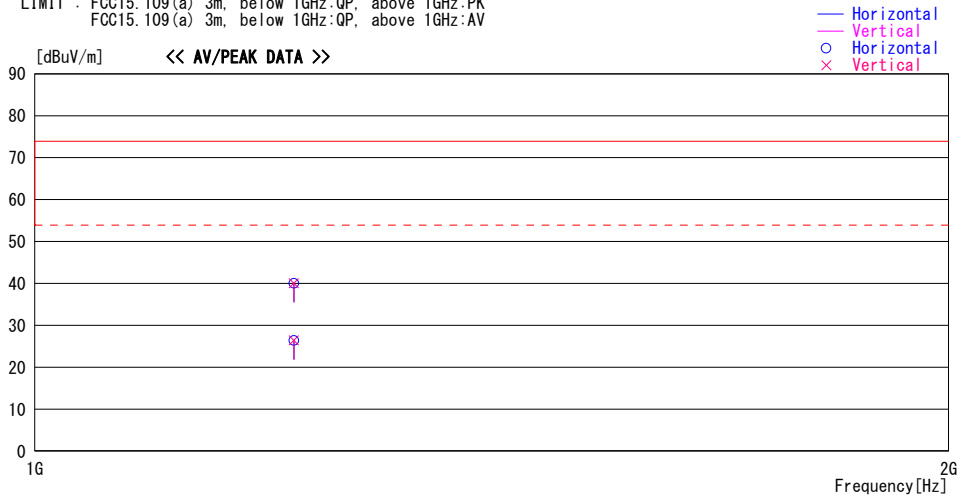
Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss & Gain [dB]							
39.000	22.5	QP	14.6	-24.9	12.2	0	100	Hori.	40.0	27.8	
39.000	22.6	QP	14.6	-24.9	12.3	0	100	Vert.	40.0	27.7	
81.000	22.5	QP	6.9	-24.3	5.1	0	100	Vert.	40.0	34.9	
81.000	22.6	QP	6.9	-24.3	5.2	0	100	Hori.	40.0	34.8	
150.000	22.0	QP	15.1	-23.4	13.7	0	100	Vert.	43.5	29.8	
150.000	22.1	QP	15.1	-23.4	13.8	0	100	Hori.	43.5	29.7	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Vert.	46.0	32.9	
304.280	21.7	QP	13.5	-22.0	13.2	0	100	Hori.	46.0	32.8	
608.560	21.8	QP	19.1	-20.0	20.9	0	100	Hori.	46.0	25.1	
608.560	21.7	QP	19.1	-20.0	20.8	0	100	Vert.	46.0	25.2	
912.840	21.7	QP	22.1	-17.4	26.4	0	100	Hori.	46.0	19.6	
912.840	21.8	QP	22.1	-17.4	26.5	0	100	Vert.	46.0	19.5	

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))

Radiated Emission
TPMS(314.98MHz) Variation No.2 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:PK
FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss& Gain [dB]							
1217.120	44.7	PK	25.2	-29.8	40.1	0	100	Vert.	73.9	33.8	
1217.120	44.6	PK	25.2	-29.8	40.0	0	100	Hori.	73.9	33.9	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Vert.	53.9	27.5	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Hori.	53.9	27.5	

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 - GAIN(AMP) + D-factor)

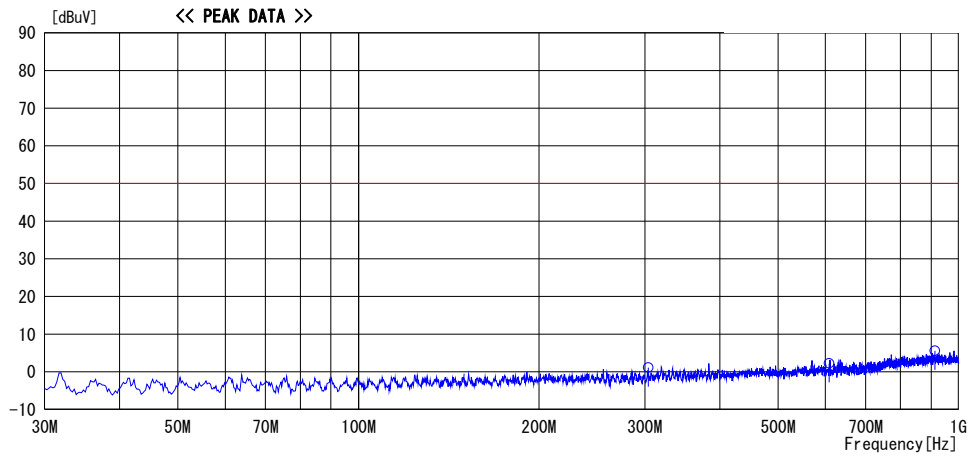
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Antenna Terminal Conducted Emission
TPMS(314.98MHz) Variation No.2 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 20, 2017
Temperature / Humidity 24 deg. C / 60 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.111 Antenna terminal measurement
Except for the data below : adequate margin data below the limits.



Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss&	Level [dBuV/m]	Polar.	Limit *1)	Margin	Comment
			Factor [dB/m]	Gain [dB]			[dBuV]	[dB]	
304.280	28.7	PK	0.0	-27.6	1.1	-	50.0	48.9	
608.560	28.3	PK	0.0	-26.1	2.2	-	50.0	47.8	
912.840	29.1	PK	0.0	-23.5	5.6	-	50.0	44.4	

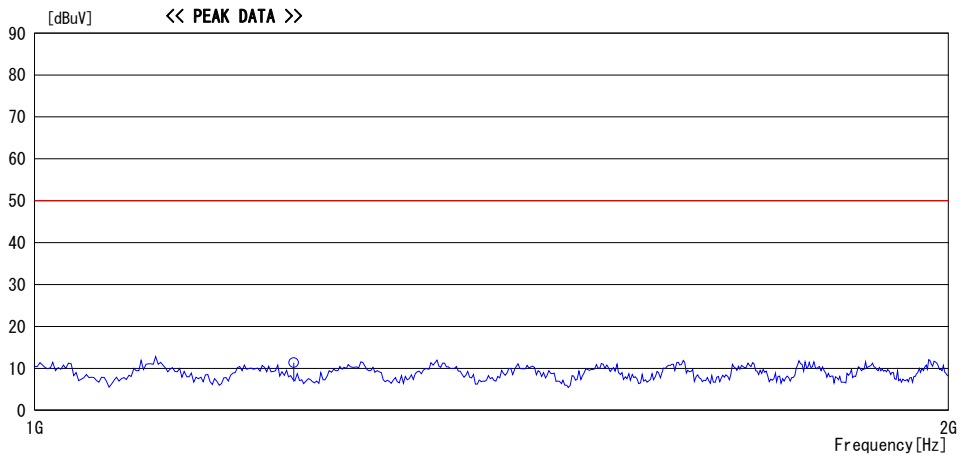
*1) 2nW = -57dBm = 50dBuV

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

Antenna Terminal Conducted Emission
TPMS(314.98MHz) Variation No.2 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 20, 2017
Temperature / Humidity 24 deg. C / 60 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.111 Antenna terminal measurement
Except for the data below : adequate margin data below the limits.



Frequency [MHz]	Reading [dBuV]	DET	Antenna	Loss &	Level [dBuV/m]	Polar.	Limit *1) [dBuV]	Margin [dB]	Comment
			Factor [dB/m]	Gain [dB]					
1217.120	46.5	PK	0.0	-35.1	11.4	-	50.0	38.7	

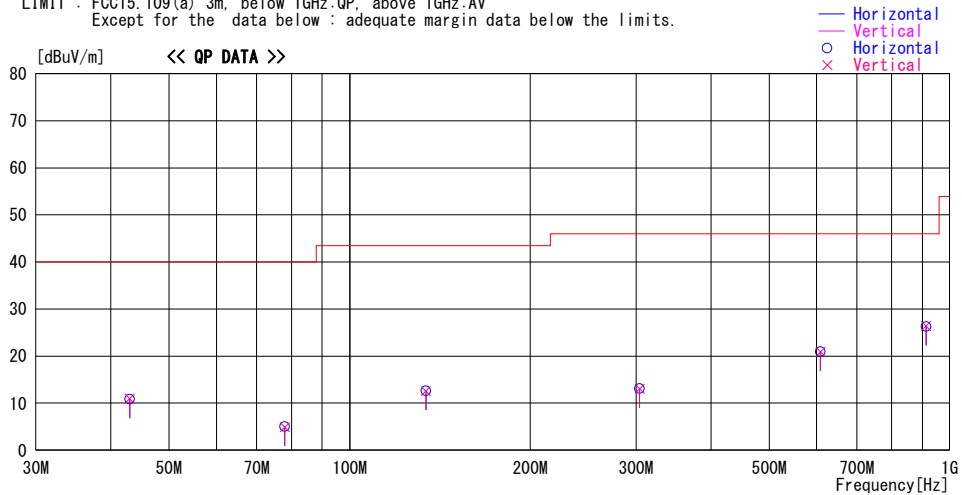
*1) 2nW = -57dBm = 50dBuV

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

Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.4 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV
Except for the data below : adequate margin data below the limits.



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss & Gain [dB]							
43.000	22.4	QP	13.2	-24.8	10.8	0	100	Hori.	40.0	29.2	
43.000	22.6	QP	13.2	-24.8	11.0	0	100	Vert.	40.0	29.0	
78.000	22.6	QP	6.6	-24.3	4.9	0	100	Vert.	40.0	35.1	
78.000	22.7	QP	6.6	-24.3	5.0	0	100	Hori.	40.0	35.0	
134.000	22.1	QP	14.0	-23.5	12.6	0	100	Vert.	43.5	30.9	
134.000	22.1	QP	14.0	-23.5	12.6	0	100	Hori.	43.5	30.9	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Vert.	46.0	32.9	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Hori.	46.0	32.9	
608.560	21.8	QP	19.1	-20.0	20.9	0	100	Hori.	46.0	25.1	
608.560	21.8	QP	19.1	-20.0	20.9	0	100	Vert.	46.0	25.1	
912.840	21.6	QP	22.1	-17.4	26.3	0	100	Hori.	46.0	19.7	
912.840	21.7	QP	22.1	-17.4	26.4	0	100	Vert.	46.0	19.6	

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))

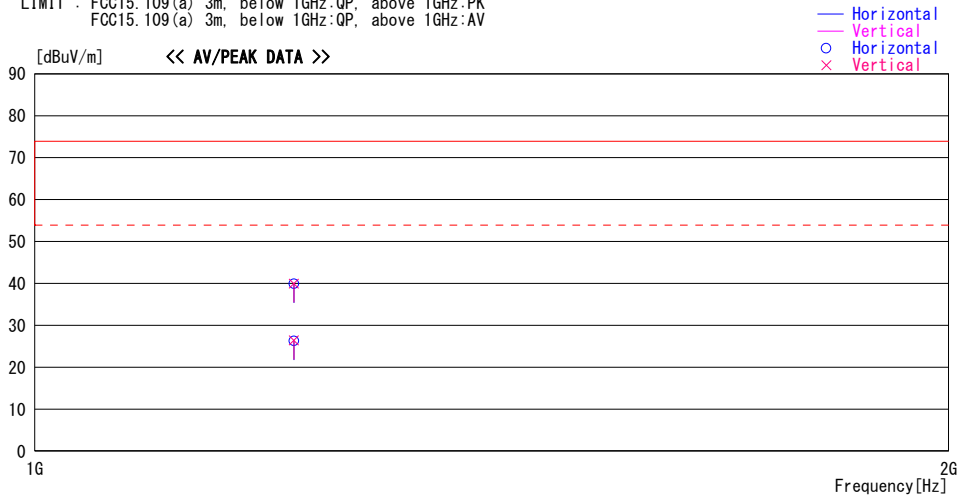
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Ise EMC Lab.

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Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.4 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:PK
FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss& Gain [dB]							
1217.120	44.6	PK	25.2	-29.8	40.0	0	100	Vert.	73.9	33.9	
1217.120	44.5	PK	25.2	-29.8	39.9	0	100	Hori.	73.9	34.0	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Vert.	53.9	27.5	
1217.120	30.9	AV	25.2	-29.8	26.3	0	100	Hori.	53.9	27.6	

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 - GAIN(AMP) + D-factor)

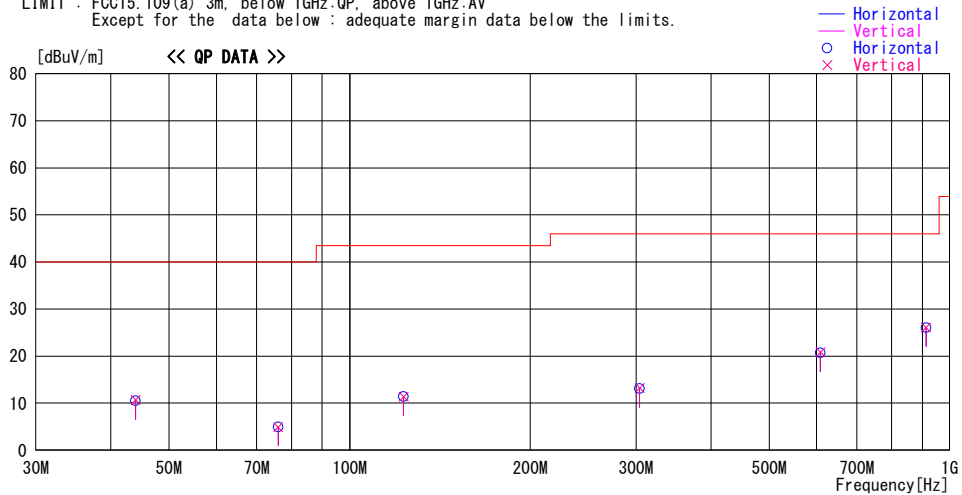
UL Japan, Inc.
Ise EMC Lab.

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Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.6 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV
Except for the data below : adequate margin data below the limits.



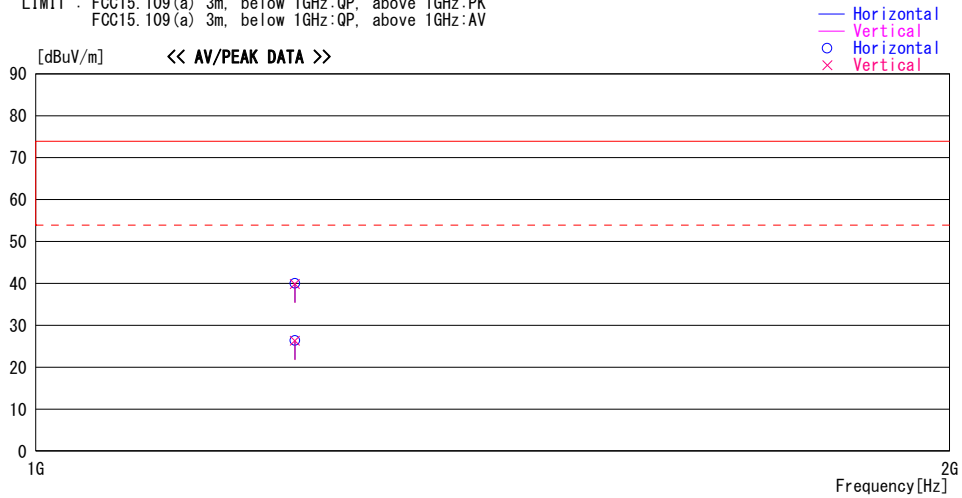
Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss & Gain [dB]							
44.000	22.4	QP	12.9	-24.8	10.5	0	100	Hori.	40.0	29.5	
44.000	22.6	QP	12.9	-24.8	10.7	0	100	Vert.	40.0	29.3	
76.000	22.7	QP	6.5	-24.3	4.9	0	100	Vert.	40.0	35.1	
76.000	22.7	QP	6.5	-24.3	4.9	0	100	Hori.	40.0	35.1	
123.000	22.1	QP	13.1	-23.8	11.4	0	100	Vert.	43.5	32.1	
123.000	22.1	QP	13.1	-23.8	11.4	0	100	Hori.	43.5	32.1	
304.280	21.7	QP	13.5	-22.0	13.2	0	100	Vert.	46.0	32.8	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Hori.	46.0	32.9	
608.560	21.6	QP	19.1	-20.0	20.7	0	100	Hori.	46.0	25.3	
608.560	21.7	QP	19.1	-20.0	20.8	0	100	Vert.	46.0	25.2	
912.840	21.3	QP	22.1	-17.4	26.0	0	100	Hori.	46.0	20.0	
912.840	21.4	QP	22.1	-17.4	26.1	0	100	Vert.	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))

Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.6 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:PK
FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss& Gain [dB]							
1217.120	44.5	PK	25.2	-29.8	39.9	0	100	Vert.	73.9	34.0	
1217.120	44.6	PK	25.2	-29.8	40.0	0	100	Hori.	73.9	33.9	
1217.120	30.9	AV	25.2	-29.8	26.3	0	100	Vert.	53.9	27.6	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Hori.	53.9	27.5	

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 - GAIN(AMP) + D-factor)

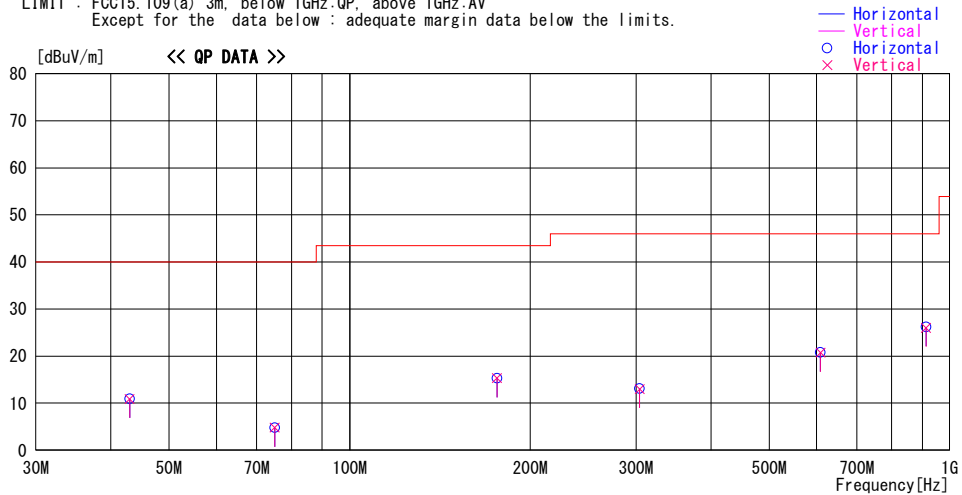
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Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.8 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Below 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV
Except for the data below : adequate margin data below the limits.



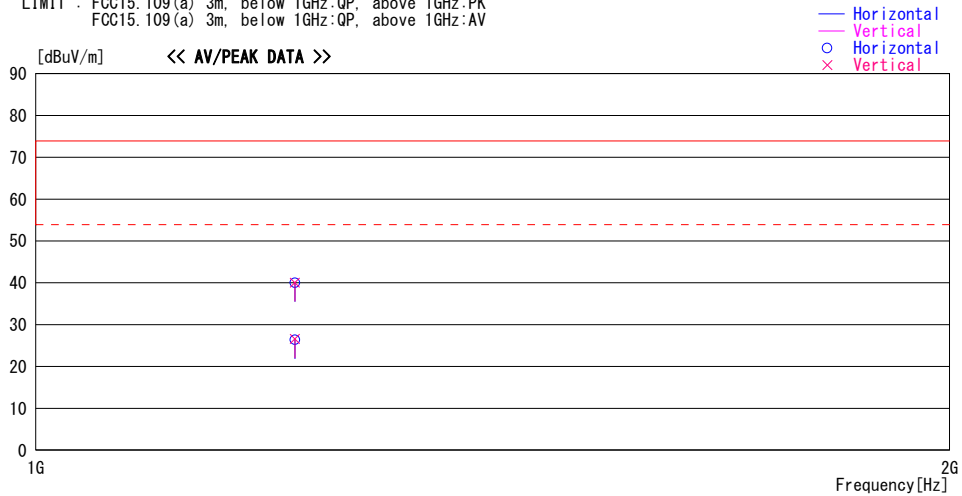
Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss & Gain [dB]							
43.000	22.5	QP	13.2	-24.8	10.9	0	100	Hori.	40.0	29.1	
43.000	22.5	QP	13.2	-24.8	10.9	0	100	Vert.	40.0	29.1	
75.000	22.6	QP	6.5	-24.3	4.8	0	100	Vert.	40.0	35.2	
75.000	22.6	QP	6.5	-24.3	4.8	0	100	Hori.	40.0	35.2	
176.000	22.2	QP	16.2	-23.1	15.3	0	100	Vert.	43.5	28.2	
176.000	22.2	QP	16.2	-23.1	15.3	0	100	Hori.	43.5	28.2	
304.280	21.5	QP	13.5	-22.0	13.0	0	100	Vert.	46.0	33.0	
304.280	21.6	QP	13.5	-22.0	13.1	0	100	Hori.	46.0	32.9	
608.560	21.7	QP	19.1	-20.0	20.8	0	100	Hori.	46.0	25.2	
608.560	21.6	QP	19.1	-20.0	20.7	0	100	Vert.	46.0	25.3	
912.840	21.5	QP	22.1	-17.4	26.2	0	100	Hori.	46.0	19.8	
912.840	21.3	QP	22.1	-17.4	26.0	0	100	Vert.	46.0	20.0	

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))

Radiated Emission (Reference data)
TPMS(314.98MHz) Variation No.8 External Antenna

Report No. 11946975H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date September 21, 2017
Temperature / Humidity 22 deg. C / 59 % RH
Engineer Hiroyuki Furutaka
(Above 1GHz)
Mode Mode 1

LIMIT : FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:PK
FCC15.109(a) 3m, below 1GHz:QP, above 1GHz:AV



Frequency [MHz]	Reading [dBuV]	DET	Antenna		Level [dBuV/m]	Angle [Deg]	Height [cm]	Polar.	Limit [dBuV/m]	Margin [dB]	Comment
			Factor [dB/m]	Loss& Gain [dB]							
1217.120	44.7	PK	25.2	-29.8	40.1	0	100	Vert.	73.9	33.8	
1217.120	31.0	AV	25.2	-29.8	26.4	0	100	Hori.	53.9	27.5	
1217.120	31.2	AV	25.2	-29.8	26.6	0	100	Vert.	53.9	27.3	
1217.120	44.6	PK	25.2	-29.8	40.0	0	100	Hori.	73.9	33.9	

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 - GAIN(AMP) + D-factor)

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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	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-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2017/08/22 * 12
MTR-08	Test Receiver	Rohde & Schwarz	ESCI	100767	RE	2017/08/22 * 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	2017/07/12 * 12
MAT-98	Attenuator	KEYSIGHT	8491A	MY52462349	RE	2016/12/05 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2017/03/27 * 12
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	RE	2017/01/19 * 12
MTR-09	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	RE	2017/06/27 * 12
MHA-20	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	RE	2017/05/22 * 12
MCC-167	Microwave Cable	Junkosha	MWX221	1404S374(1m) / 1405S074(5m)	RE	2017/05/29 * 12
MPA-11	MicroWave System Amplifier	Agilent	83017A	MY39500779	RE	2017/03/21 * 12
MAEC-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	AT	2016/10/19 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	AT	2017/01/20 * 12
MJM-26	Measure	KOMELON	KMC-36	-	AT	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	AT/RE	-
MTR-10	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	AT	2017/01/12 * 12
MCC-50	Coaxial Cable	UL Japan	-	-	AT	2017/06/26 * 12
MPA-14	Pre Amplifier	SONOMA INSTRUMENT	310	260833	AT	2017/03/27 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	AT	2017/01/19 * 12
MDCB-03	DC Block	KEYSIGHT	N9398C	MY46457600	AT	2017/07/05 * 12
MCC-217	Microwave Cable	Junkosha	MWX221	1604S254(1 m) / 1608S088(5 m)	AT	2017/08/02 * 12
MPA-01	Pre Amplifier	Agilent	8449B	3008A01671	AT	2017/02/03 * 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: Radiated emission
AT: Antenna Terminal

UL Japan, Inc.

Ise EMC Lab.

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