




RADIO TEST REPORT


Test Report No. : 11866078H-A

Applicant : DENSO CORPORATION
Type of Equipment : Millimeter Wave Radar Sensor
Model No. : DNMWR009
FCC ID : HYQDNMWR009
Test regulation : FCC Part 15 Subpart C: 2017
(Class II Permission Change)
* Power Density test only
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 the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)

Date of test: July 19, 2017

Representative test engineer: 
Hironobu Ohnishi
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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SECTION 1: Customer information

Company Name : DENSO CORPORATION
Address : 1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661 Japan
Telephone Number : +81-566-87-3456
Facsimile Number : +81-566-25-4683
Contact Person : Kiyohiko Sawada

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

2.1 Identification of E.U.T.

Type of Equipment : Millimeter Wave Radar Sensor
Model No. : DNMWR009
Serial No. : Refer to Section 4, Clause 4.2
Rating : DC 12 V (Car battery), DC 8 V to 16 V(Operating range)
Receipt Date of Sample : July 19, 2017
Country of Mass-production : Japan
Condition of EUT : Engineering prototype
(Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT : No Modification by the test lab

2.2 Product Description

Model No: DNMWR009 (referred to as the EUT in this report) is the 76 GHz - 77 GHz vehicle-mounted field disturbance sensor that is a millimeter wave frequency modulated (FM-CW and FCM) radar operating at 76.5 GHz.
FM-CW: Frequency Modulated Continuous Wave
FCM: Fast Chirp Modulation

General Specification

Clock frequency(ies) in the system : 40 MHz

Radio Specification

Radio Type : Transceiver
Frequency of Operation : 76.5 GHz
Modulation : Frequency modulation (FM-CW, FCM)
Antenna Type : Microstrip array antenna
Antenna Connector : None (Internal Antenna)
Antenna Gain : Tx_N (FM-CW): 16.2 dBi
Tx_W (FCM): 13.8 dBi
Steerable Antenna : Electronically (Receiving Part only)
Usage location : Vehicle-mounted
Power Supply (inner) : DC 3.3 V, DC 5 V

<Contents of the change from original model>

Test Report Number of original model is 11296853H-A-R1 (issued by UL Japan, Inc.).

Specification was changed from the original model as follows:

- Decreasing in output power setting of the FCM modulation.

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Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

SECTION 3: Test specification, procedures & results

3.1 Test Specification

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

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.253 Operation within the bands 46.7 GHz- 46.9 GHz and 76.0 GHz - 77.0 GHz.

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Power Density	ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems	FCC: Section 15.253 (d) ----- IC: RSS-251 5.2.2	See data.	Complied	Radiated

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.

FCC Part 15.31 (e)

The EUT provides stable voltage (DC 3.3 V, DC 5 V) constantly to RF Part 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. As for the Frequency Stability, the test was performed based on 15.253 (f).

FCC Part 15.203 Antenna requirement

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

3.3 Addition to standard

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 $k=2$.

Radiated emission (\pmdB) With Block downconverter	
75 GHz - 83 GHz	4.4 dB

Radiated emission test

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

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Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

3.5 Test Location

UL Japan, Inc. Ise EMC Lab. *NVLAP Lab. Code: 200572-0
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone : +81 596 24 8999 Facsimile : +81 596 24 8124

	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 4.5m	-
No.6 measurement room	-	4.75 x 5.4 x 3.0m	4.75 x 4.15m	-
No.7 shielded room	-	4.7 x 7.5 x 2.7m	4.7 x 7.5m	-
No.8 measurement room	-	3.1 x 5.0 x 2.7m	N/A	-
No.9 measurement room	-	8.0 x 4.6 x 2.8m	2.4 x 2.4m	-
No.11 measurement room	-	6.2 x 4.7 x 3.0m	4.8 x 4.6m	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 x 2.0m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

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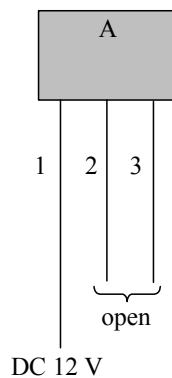
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Telephone : +81 596 24 8999
Facsimile : +81 596 24 8124

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

4.1 Operating Mode(s)

Mode	Test Item
Test mode (FCM)	Power Density
<p>In actual operation, there are FM-CW and FCM modulation parts in one transmission burst. First, the EUT transmits FM-CW modulation. After that, FCM transmission starts immediately. These two modulations do not transmit at the same time. These modulations have individual transmit antennas. (Switching antenna Tx_N: FM-CW and Tx_W: FCM alternately.)</p> <p>The test mode (FCM only) was used for the purpose of this test report.</p> <p>Power of the EUT was set by the software as follows; Power settings: Same as production model Software: mwr_gen5_0041_t800.s This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.</p>	

4.2 Configuration and peripherals



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

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remark
A	Millimeter Wave Radar Sensor	DNMWR009	005	DENSO CORPORATION	EUT

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	1.7	Unshielded	Unshielded	-
2	CAN 1 Cable	1.7	Unshielded	Unshielded	-
3	CAN 2 Cable	1.7	Unshielded	Unshielded	-

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Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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SECTION 5: Radiated Emission (Power Density)

Test Procedure

[About fundamental measurement]

The carrier levels were confirmed at maximum direction of transmission. The maximum direction was searched under carefully since beam-widths are extremely narrow.

The carrier levels were measured in the far field. The distance of the far field was calculated from follow equation.

$$r = \frac{2D^2}{\lambda}$$

where

r is the distance from the radiating element of the EUT to the edge of the far field, in m
D is the largest dimension of both the radiating element and the test antenna (horn), in m
(The antenna aperture size of test antenna was used for this calculation.)
Lambda is the wavelength of the emission under investigation [$300/f$ (MHz)], in m

Frequency [GHz]	Wavelength <i>Lambda</i> [mm]	Maximum Dimention			Far Field Boundary <i>r</i> [m]
		EUT [m]	Test Antenna [m]	Maximum <i>D</i> [m]	
77	3.9	0.013695	0.026162	0.026162	0.352

The test was made on EUT at the normal use position.

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

Measurement range : 76 GHz - 77 GHz
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Power Density

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No.	11866078H
Date	July 19, 2017
Temperature / Humidity	23 deg. C / 57 % RH
Engineer	Hironobu Ohnishi
Mode	Test mode (FCM)

Measured data in Test modes

Mode	Power	Freq. [GHz]	Measured Power [dBm]	Tested Distance [m]	Rx Antenna Gain [dBi]	Down Converter Gain [dB]	IF Cable Loss [dB]	FSL [dB]	EIRP	
									[dBm]	[mW]
FM-CW	Average	76.5	-23.69	2.0	22.33	14.86	1.06	76.14	16.33	42.91
	Peak	76.5	-15.35	2.0	22.33	14.86	1.06	76.14	24.67	292.77
FCM	Average	76.5	-27.52	2.0	22.33	14.86	0.94	76.14	12.37	17.27
	Peak	76.5	-18.36	2.0	22.33	14.86	0.94	76.14	21.53	142.30

Calculating formula:

$$FSL (\text{Free Space path Loss}) = 10 * \log_{10}((4 * \pi * \text{Tested Distance} / \text{Lambda})^2)$$

$$EIRP = \text{Measured Power} - \text{Rx Antenna Gain} - \text{Down Converter Gain} + \text{IF Cable Loss} + \text{FSL}$$

These calculation results are same as results which were calculated with formulas described in the Section 9 of ANSI C63.10-2013

Final result in Normal operation mode (FM-CW + FCM)

	FM-CW [mW]	FCM [mW]	EIRP Result *		Limit [dBm]	Margin [dB]	Power Density at 3m	
			[mW]	[dBm]			Result [uW/cm ²]	Limit [uW/cm ²]
Average power	42.91	17.27	60.17	17.79	50	32.21	0.053	88
Peak power	292.77	142.30	292.77	24.67	55	30.33	0.259	279

Calculating formula:

$$\text{Power Density at 3 m} = EIRP / (4 * \pi * 300 \text{ cm}^2)$$

To determine the Final result, the FM-CW part was referred from the original report (11296853H-A-R1). There is no change in the FM-CW part.

* As for the average power result, FM-CW result and FCM result were added, according to Section 4.1. For the peak power result, it is a maximum power of both FM-CW and FCM.

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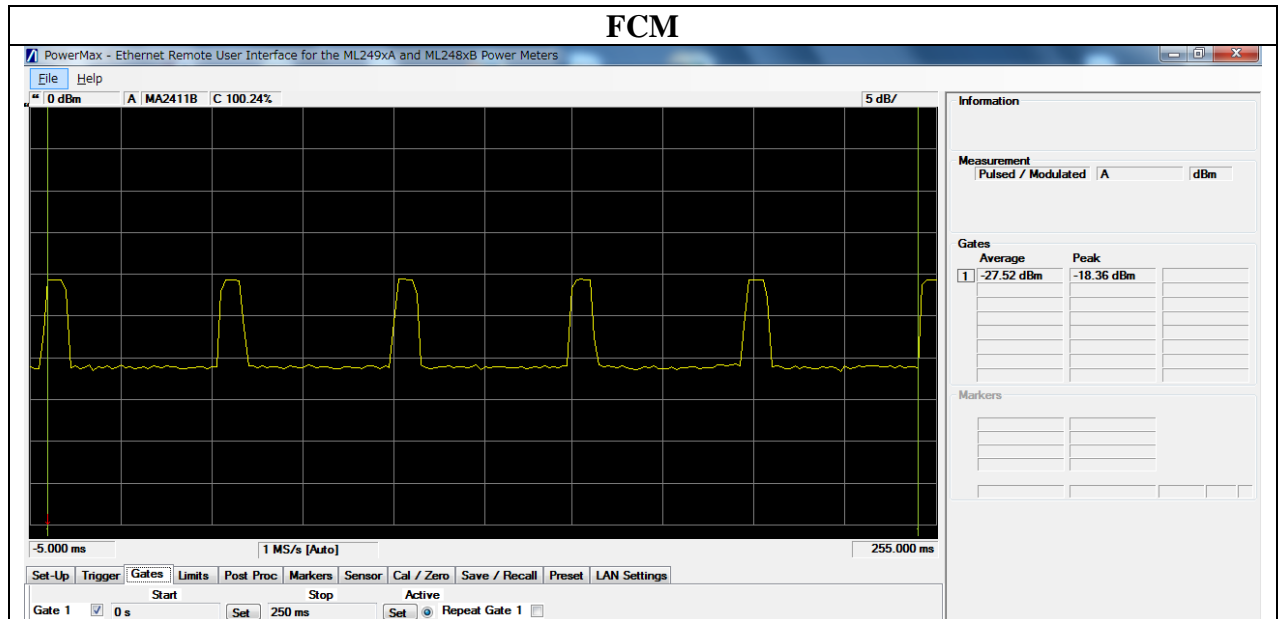
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Power Density

Test place : Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No. : 11866078H
Date : July 19, 2017
Temperature / Humidity : 23 deg. C / 57 % RH
Engineer : Hironobu Ohnishi
Mode : Test mode (FCM)



UL Japan, Inc.

Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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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-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2016/10/19 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	RE	2017/01/20 * 12
MJM-26	Measure	KOMELON	KMC-36	-	RE	-
MLDM-04	Digital laser distance meter	BOSCH	DLE 50	781422774	RE	2016/08/19 * 36
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2017/01/19 * 12
MHA-11	Horn Antenna	WiseWave	ARH1023-02	10766-01	RE	2016/10/18 * 12
MMX-05	Block Downconverter	KEYSIGHT	PS-X30-W10117A	13715	RE	2017/02/01 * 12
MCC-171	Microwave Cable	Junkosha	MWX221	1409S494	RE	2017/03/13 * 12
MPM-13	Power Meter	Anritsu	ML2495A	0824014	RE	2016/11/02 * 12
MPSE-18	Power sensor	Anritsu	MA2411B	0738174	RE	2016/11/02 * 12
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2016/08/17 * 12

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

[Below 40 GHz]

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

[Above 40 GHz]

Acceptance criteria for untraceable equipment was formulated according to ISO/IEC 17025 5.6.2.2.2, and the regular inspection was performed based on it annually.

For 40 GHz - 110 GHz, power sensor is calibrated by manufacturer, and the measured calibration data is used as in-house reference. The calibration data by manufacturer is checked for acceptance by a calorie meter except for some frequency bands.

For above 110 GHz, output level of millimeter wave source module is used as the reference, and inspection by the calorie meter is performed.

Electric power is checked with the calorie meter by measuring resistance and voltage of reference resistor.

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

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Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124