RADIO TEST REPORT

Test Report No. : 11822931H-A

Applicant	:	**DENSO CORPORATION**
Type of Equipment	:	**Millimeter Wave Radar Sensor**
Model No.	:	**DNMWR010**
FCC ID	:	**HYQDNMWR010**
Test regulation	:	**FCC Part 15 Subpart C: 2017**
Test Result	:	**Complied**

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the 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)

Date of test: August 3 to 22, 2017

Representative test engineer:
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Engineer
Consumer Technology Division

Approved by:
Motoya Imura
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.: 11822931H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	11822931H-A	August 30, 2017	-	-

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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.	:	DNMWR010
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: DNMWR010 (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

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
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)
20 dB Bandwidth	**FCC:** ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems **IC:** -	**FCC:** Section 15.215 **IC:** Reference data	See data.	Complied	Radiated
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		Complied	Radiated
Spurious Emissions	**FCC:** ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems **IC:** RSS-Gen 6.13	**FCC:** Section 15.253 (e) **IC:** RSS-251 5.3	13.4 dB 62.118 MHz, QP, Vertical	Complied	Radiated
Frequency Stability	**FCC:** ANSI C63.10-2013 9. Procedures for testing millimeter-wave systems **IC:** RSS-Gen 8.11	**FCC:** Section 15.253 (f) **IC:** RSS-251 5.4	See data.	Complied	Radiated
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 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

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99 % Occupied Bandwidth	**IC:** RSS-Gen 6.6	**IC:** -	N/A	-	Radiated

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

*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

Radiated emission (±dB)	
40 GHz - 50 GHz	4.1 dB
50 GHz - 75 GHz	5.5 dB
75 GHz - 110 GHz	5.8 dB
110 GHz - 170 GHz	5.0 dB
170 GHz - 260 GHz	5.0 dB

Radiated emission (±dB) With Block downconverter	
75 GHz - 83 GHz	4.6 dB

Radiated 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
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

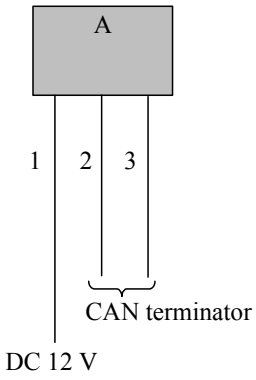
Refer to APPENDIX.

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

4.1 Operating Mode(s)

Mode	Test Item
Normal operating mode (FM-CW + FCM)	20 dB and 99 % Bandwidth Spurious Emission Frequency Stability
Test mode (FM-CW), Test mode (FCM)	Power Density
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.) The test modes (FM-CW only, FCM only) were used for the purpose of power measurement. Power of the EUT was set by the software as follows; Power settings: Same as production model Software: mwr_gen5_0041_p03.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.	

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	DNMWR010	967-008	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	-

SECTION 5: Radiated Emission (Spurious Emission, Power Density)

Test Procedure

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 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.

[For above 1 GHz, up to 40 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

The height of the measuring antenna varied between 1 m and 4 m (frequency range 9 kHz – 30 MHz: loop antenna was fixed height at 1.0 m) and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear voltage average mode).
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	Above 1 GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

Frequency	9 kHz to 150 kHz	150 kHz to 30 MHz	30 MHz to 1 GHz	1 GHz to 40 GHz	
Instrument used	Test Receiver	Test Receiver	Test Receiver	Spectrum Analyzer	
Detector	QP, Average	QP, Average	QP	Peak	Average *1)
IF Bandwidth	BW 200 Hz	BW 9 kHz	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 3 MHz
Test Distance	3 m	3 m	3 m	4.5 m *2) (1 GHz to 10 GHz) 1 m*3) (10 GHz to 40 GHz)	

*1) An RMS average mode was used.
*2) Distance Factor: 20 x log (4.5 m / 3.0 m) = 3.5 dB
*3) Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 dB

[Above 40 GHz]
The test was performed based on "Procedures for testing millimeter-wave systems" of ANSI C63.10-2013. The EUT was placed on a urethane platform, raised 1.5 m above the conducting ground plane. The measurements were performed on handheld method.

Set spectrum analyzer RBW, VBW, span, etc., to the proper values. Note these values. Enable two traces—one set to "clear write," and the other set to "max hold." Begin hand-held measurements with the test antenna (horn) at a distance of 1 m from the EUT in a horizontally polarized position. Slowly adjust its position, entirely covering the plane 1 m from the EUT. Observation of the two active traces on the spectrum analyzer will allow refined horn positioning at the point(s) of maximum field intensity. Repeat with the horn in a vertically polarized position. If the emission cannot be detected at 1 m, reduce the RBW to increase system sensitivity. Note the value. If the emission still cannot be detected, move the horn closer to the EUT, noting the distance at which a measurement is made.

Note the maximum level indicated on the spectrum analyzer. Adjust this level, if necessary, by the antenna gain, conversion loss of the external mixer and gain of LNA used, at the frequency under investigation. Calculate the field strength of the emission at the measurement distance from the Friis' transmission equation.

Frequency	40 GHz to 50 GHz	50 GHz to 76 GHz	77 GHz to 83 GHz	83 GHz to 110 GHz	110 GHz to 170 GHz	170 GHz to 231 GHz
Final measurement distance with 1 MHz Peak detector	0.5 m	1.5 m	1.5 m	0.5 m	0.03 m	0.01 m

[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 caluculation.)
Lambda is the wavelength of the emission under investigation [300/f (MHz)], in m

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

The test was made on EUT at the normal use position except for carrier measurement.
For the fundamental frequency measurement, the EUT was placed on the jig because the antenna array was mounted on angularly-tilted.

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

Measurement range : 9 kHz - 231 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: Frequency Stability

Test Procedure
The block downconverter was placed in side of the temperature chamber's drain hole.

The power supply was set to 100 % of nominal voltage, the spectrum mask was measured at 20 deg. C. After that, EUT power supply was varied between 85 % and 115 % of nominal voltage and the frequency excursion of the EUT emission mask was recorded.

The EUT operating temperature was raised to 50 deg. C., the frequency excursion of the EUT emission mask was recorded. Measurements were repeated at each 10 deg. C decrement down to –20 deg. C.

Some measurements were performed at additional temperatures according to operating temperature range of the EUT. (80 deg. C, 70 deg. C, 60 deg. C and -30 deg. C)

Both lower and upper -20 dBc frequencies on the emission mask were recorded.

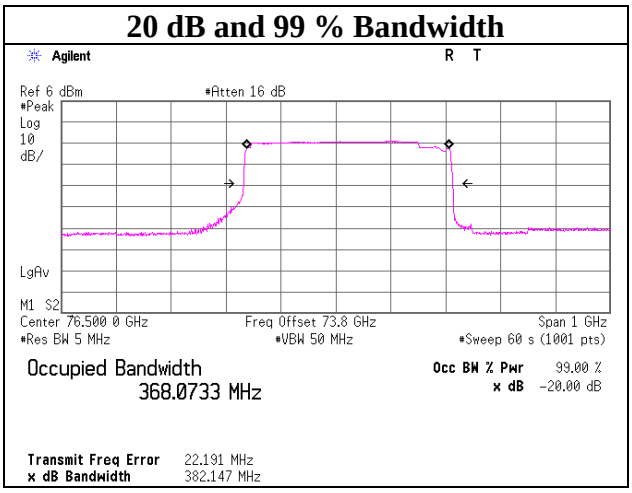
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

20 dB and 99 % Bandwidth

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11822931H
Date	August 3, 2017
Temperature / Humidity	23 deg. C / 58 % RH
Engineer	Hironobu Ohnishi
Mode	Normal operating mode

Frequency [GHz]	20 dB Bandwidth [MHz]	99 % Occupied Bandwidth [MHz]
76.5	382.147	368.0733



The measurement was performed with Peak detector and Max Hold since the duty cycle was not 100 %.

Power Density

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11822931H
Date	August 3, 2017
Temperature / Humidity	23 deg. C / 58 % RH
Engineer	Hironobu Ohnishi
Mode	Test mode (FM-CW), 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]	EIRP [mW]
FM-CW	Average	76.5	-21.19	1.5	22.33	14.86	1.41	73.64	16.67	46.42
	Peak	76.5	-13.34	1.5	22.33	14.86	1.41	73.64	24.52	282.93
FCM	Average	76.5	-25.54	1.5	22.33	14.86	1.41	73.64	12.32	17.05
	Peak	76.5	-16.27	1.5	22.33	14.86	1.41	73.64	21.59	144.11

Calculating formula:
FSL (Free Space path Loss) = 10 * log10((4 * Pi * Tested Distance / Lambda) ^2)
EIRP = Measured Power - Rx Antenna Gain - Down Converter Gain + IF Cable Loss + 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)

	EIRP FM-CW [mW]	EIRP FCM [mW]	EIRP Result * [mW]	EIRP Result * [dBm]	EIRP Limit [dBm]	EIRP Margin [dB]	Power Density at 3m Result [uW/cm^2]	Power Density at 3m Limit [uW/cm^2]
Average power	46.42	17.05	63.47	18.03	50	31.97	0.056	88
Peak power	282.93	144.11	282.93	24.52	55	30.48	0.250	279

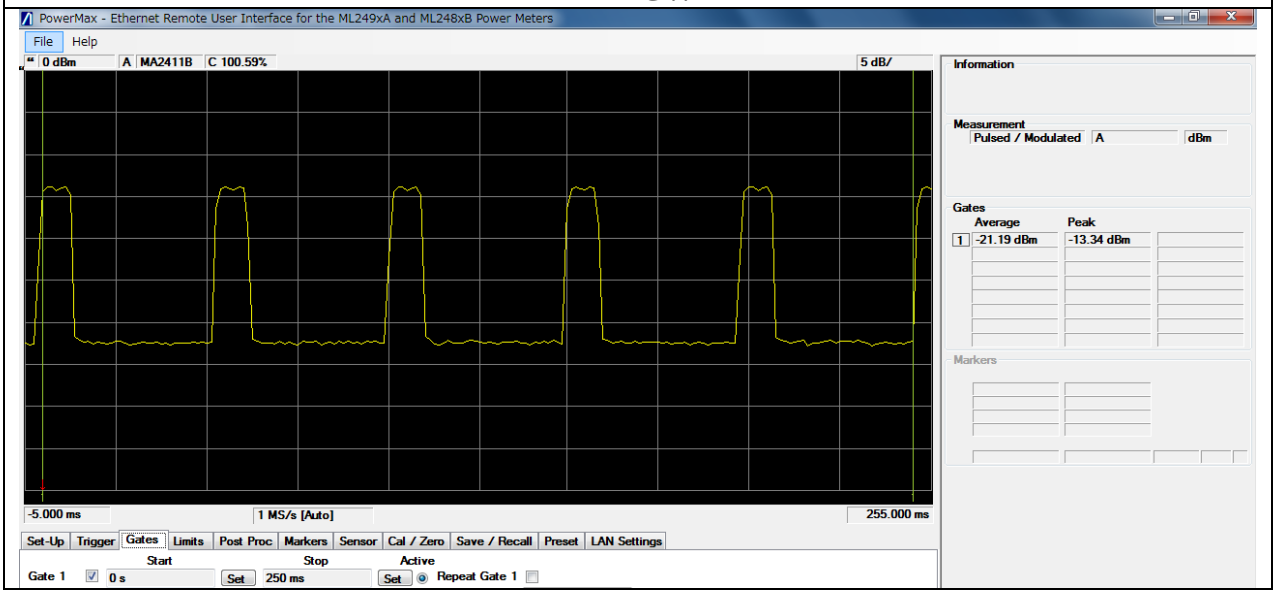
Calculating formula:
Power Density at 3 m = EIRP / (4 * Pi * 300 cm ^2)

* 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.

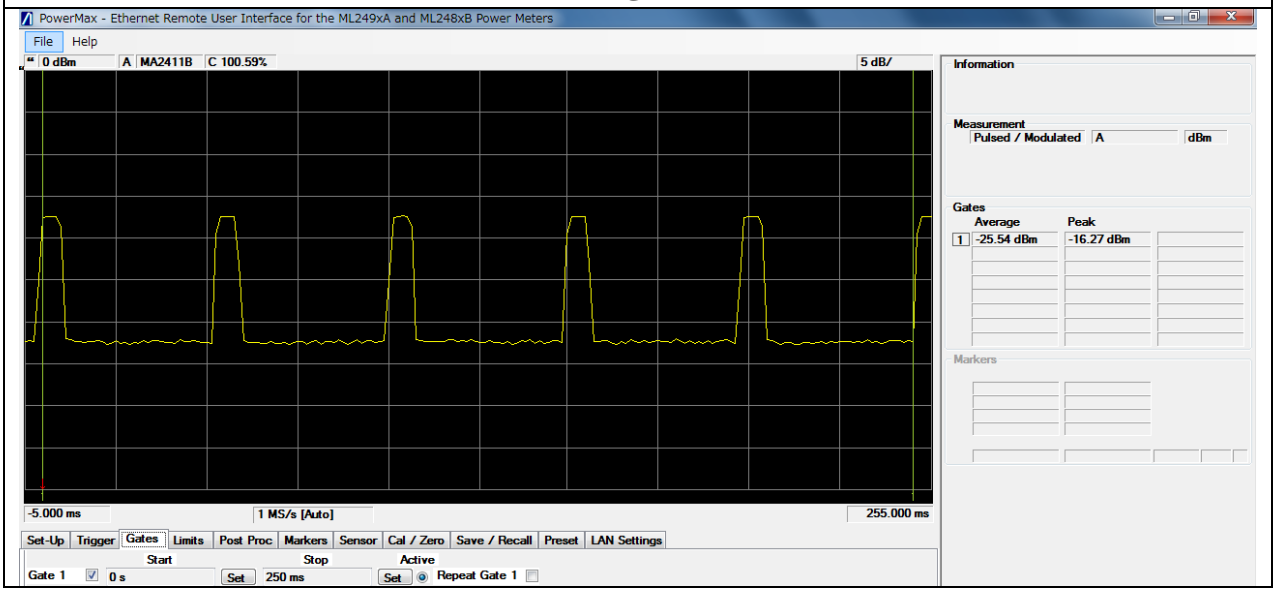
Power Density

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11822931H
Date	August 3, 2017
Temperature / Humidity	23 deg. C / 58 % RH
Engineer	Hironobu Ohnishi
Mode	Test mode (FM-CW), Test mode (FCM)

FM-CW



FCM



Duty Cycle Confirmation

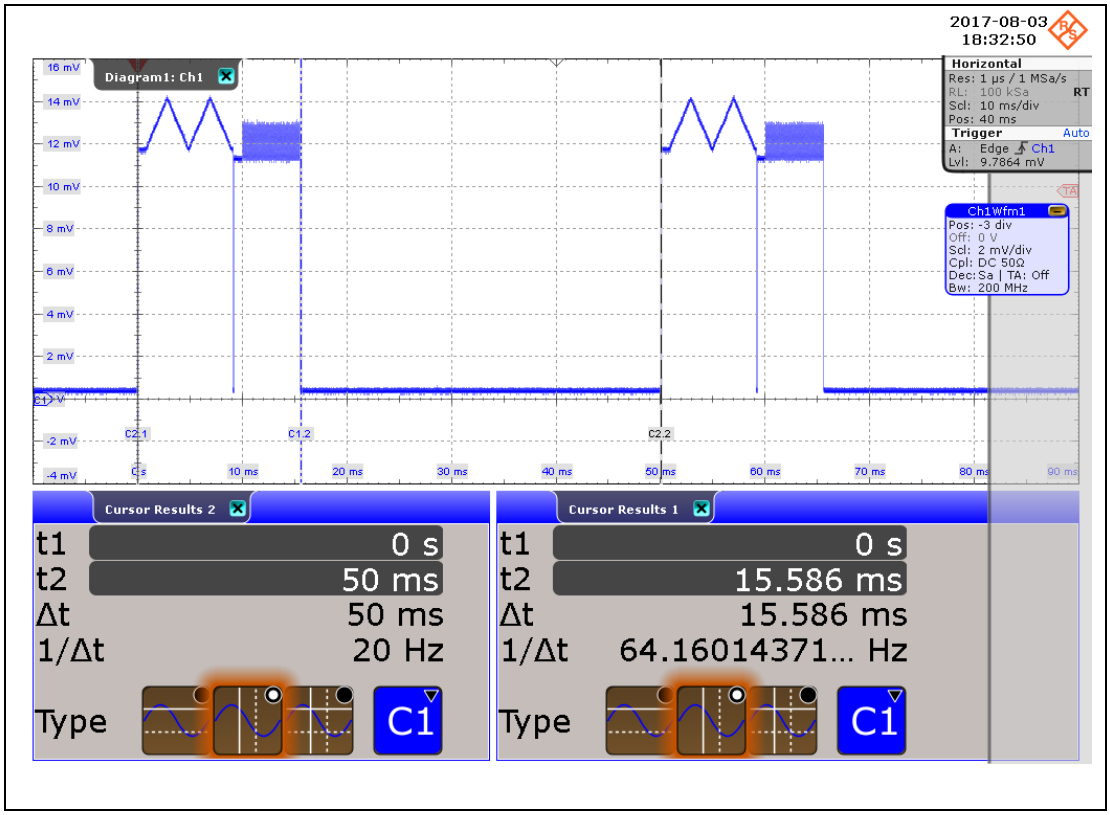
Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Report No.	11822931H
Date	August 3, 2017
Temperature / Humidity	23 deg. C / 58 % RH
Engineer	Hironobu Ohnishi
Mode	Normal operating mode

[Duty Factor]

	Tx On time [ms]	Tx On + Off time [ms]	Duty factor [dB]
Measured	15.586	50.000	-5.062
Declared *	15.580	50.000	-5.064

Duty factor = 10 * log (Tx On time / Tx On + Off time)
* See the application document.

[Data]



* This Duty Cycle is the worst case. Transmitting time does not exceed it.

Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No. 4	No. 3
Report No.	11822931H	
Date	August 8, 2017	August 21, 2017
Temperature / Humidity	24 deg. C / 76 % RH	24 deg. C / 56 % RH
Engineer	Hironobu Ohnishi	Hironobu Ohnishi
	10 GHz - 40 GHz	9 kHz - 10 GHz
Mode	Normal operating mode	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	40.000	QP	21.9	14.3	7.3	32.2	11.3	40.0	28.7	
Hori	62.118	QP	23.6	7.2	7.7	32.2	6.3	40.0	33.7	
Hori	79.998	QP	22.7	6.8	7.9	32.2	5.2	40.0	34.8	
Hori	120.000	QP	21.4	12.8	8.4	32.2	10.4	43.5	33.1	
Hori	280.000	QP	20.9	12.8	9.9	32.0	11.6	46.0	34.4	
Hori	400.000	QP	20.7	15.7	10.7	32.0	15.1	46.0	30.9	
Hori	34414.000	PK	87.6	44.5	-2.5	75.1	54.5	73.9	19.4	
Hori	38174.020	PK	81.2	44.4	-2.0	74.8	48.8	73.9	25.1	
Hori	34414.000	AV	68.3	44.5	-2.5	75.1	35.2	53.9	18.7	RMS Average
Hori	38174.020	AV	67.6	44.4	-2.0	74.8	35.2	53.9	18.7	RMS Average
Vert	40.000	QP	22.1	14.3	7.3	32.2	11.5	40.0	28.5	
Vert	62.118	QP	43.9	7.2	7.7	32.2	26.6	40.0	13.4	
Vert	79.998	QP	28.7	6.8	7.9	32.2	11.2	40.0	28.8	
Vert	120.000	QP	21.7	12.8	8.4	32.2	10.7	43.5	32.8	
Vert	280.000	QP	20.8	12.8	9.9	32.0	11.5	46.0	34.5	
Vert	400.000	QP	20.7	15.7	10.7	32.0	15.1	46.0	30.9	
Vert	34414.000	PK	87.2	44.5	-2.5	75.1	54.1	73.9	19.8	
Vert	38174.020	PK	79.5	44.4	-2.0	74.8	47.1	73.9	26.8	
Vert	34414.000	AV	68.1	44.5	-2.5	75.1	35.0	53.9	18.9	RMS Average
Vert	38174.020	AV	66.2	44.4	-2.0	74.8	33.8	53.9	20.1	RMS Average

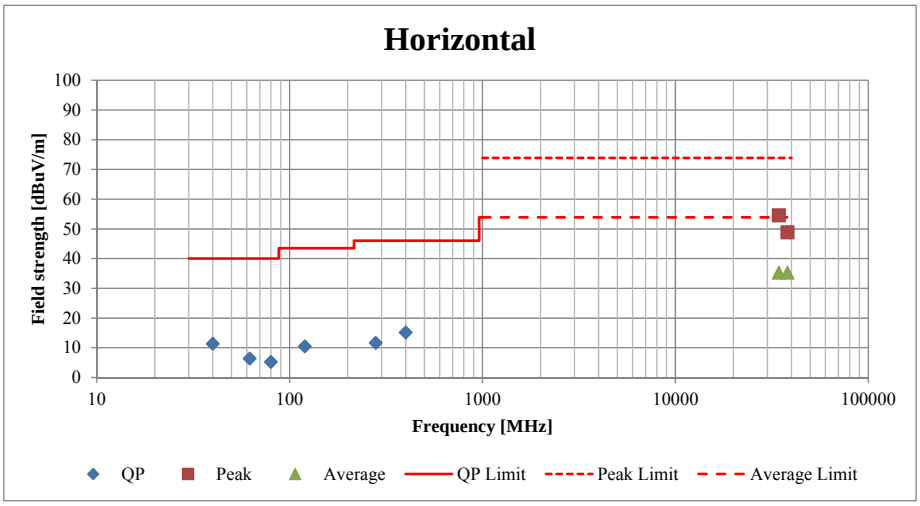
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

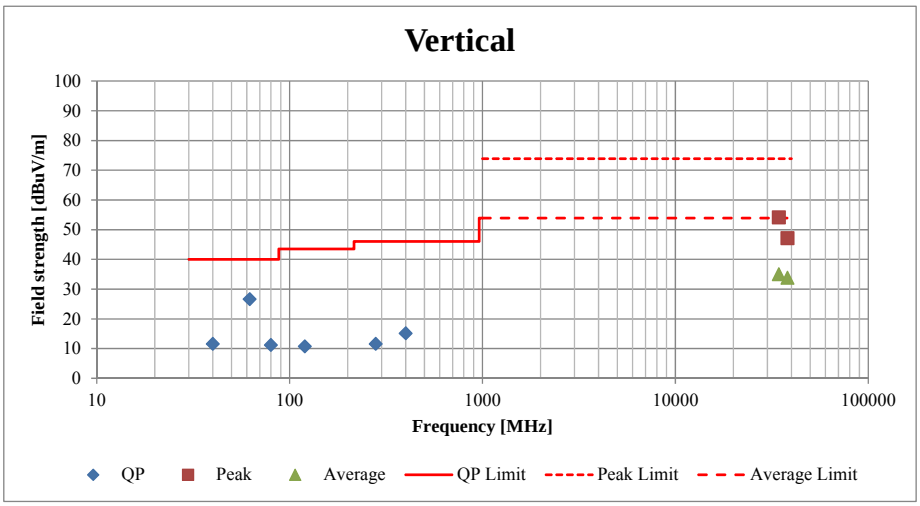
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (4.5 m / 3.0 m) = 3.5 dB
10 GHz - 40 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No. 4	No. 3
Report No.	11822931H	
Date	August 8, 2017	August 21, 2017
Temperature / Humidity	24 deg. C / 76 % RH	24 deg. C / 56 % RH
Engineer	Hironobu Ohnishi	Hironobu Ohnishi
	10 GHz - 40 GHz	9 kHz - 10 GHz
Mode	Normal operating mode	





Spurious Emission (above 40 GHz)

Report No.	11822931H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.4
Date	August 3, 2017	August 4, 2017	August 8, 2017
Temperature / Humidity	23 deg. C / 58 % RH	23 deg. C / 57 % RH	24 deg. C / 76 % RH
Engineer	Hironobu Ohnishi	Hironobu Ohnishi	Hironobu Ohnishi
	75 GHz - 83 GHz	50 GHz - 75 GHz, 83 GHz - 231 GHz	40 GHz - 50 GHz
Mode	Normal operating mode		

Freq.	Reading	Rx ant. gain	Filter loss	LNA gain	Mixer loss	IF amp. gain	IF cable loss	Meas. range D	FSL	EIRP		Power density at 3 m			Remarks
												Result	Limit	Margin	
[GHz]	[dBm]	[dBi]	[dB]	[dB]	[dB]	[dB]	[dB]	[m]	[dB]	[dBm]	[mW]	[pW/cm^2]	[pW/cm^2]	[dB]	
49.475	-51.58	22.39	0.00	31.82	0.00	0.00	8.52	0.5	60.31	-36.96	0.000201	0.18	600	35.27	No signal detected.
60.002	-65.10	24.20	0.00	25.48	46.43	31.97	0.10	1.5	71.53	-28.69	0.001351	1.19	600	27.01	No signal detected.
75.074	-66.45	22.16	0.00	0.00	-15.34	0.00	0.97	1.5	73.47	-29.50	0.001122	0.99	600	27.82	No signal detected.
81.522	-64.68	22.83	0.00	0.00	-12.62	0.00	2.40	1.5	74.19	-23.54	0.004428	3.92	600	21.85	No signal detected.
86.753	-65.67	23.38	0.69	0.00	42.91	31.97	0.10	0.5	65.19	-12.13	0.061205	54.12	600	10.45	No signal detected.
100.028	-65.29	24.67	0.39	0.00	43.42	31.97	0.10	0.5	66.42	-11.59	0.069289	61.26	600	9.91	No signal detected.
120.636	-81.60	22.66	0.00	0.00	51.20	0.00	0.00	0.03	43.61	-9.44	0.113677	100.51	600	7.76	No signal detected.
131.743	-82.93	22.99	0.00	0.00	52.78	0.00	0.00	0.03	44.38	-8.76	0.132915	117.52	600	7.08	No signal detected.
153.005	-83.89	23.35	0.00	0.00	57.44	0.00	0.00	0.03	45.68	-4.12	0.386926	342.1	600	2.44	No signal detected.
154.471	-85.10	23.36	0.00	0.00	57.54	0.00	0.00	0.03	45.76	-5.16	0.304868	269.6	600	3.47	No signal detected.
189.121	-82.11	22.83	0.00	0.00	56.71	0.00	0.00	0.01	37.98	-10.25	0.094418	83.5	600	8.57	No signal detected.
192.893	-82.83	22.90	0.00	0.00	60.18	0.00	0.00	0.01	38.15	-7.40	0.181891	160.8	600	5.72	No signal detected.
211.242	-83.68	23.18	0.00	0.00	62.32	0.00	0.00	0.01	38.94	-5.61	0.275002	243.2	1000	6.14	No signal detected.
230.466	-84.57	23.35	0.00	0.00	64.04	0.00	0.00	0.01	39.69	-4.19	0.381233	337.1	1000	4.72	No signal detected.

Calculation:

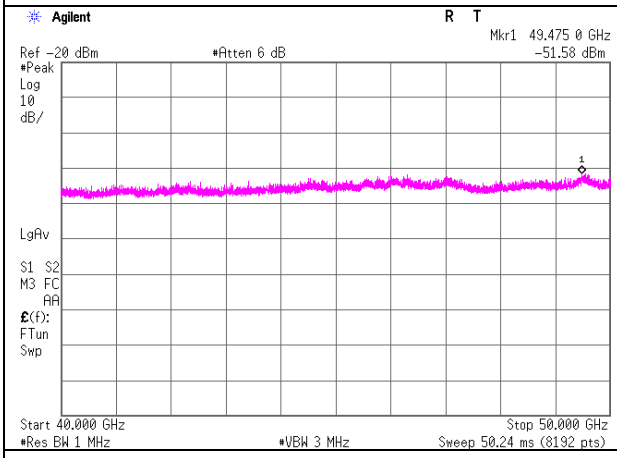
FSL (Free Space path Loss) = 10 * log ((4 * Pi * D / λ) ^{2})
EIRP = Reading - Rx ant. gain + Filter loss - LNA gain + Mixer loss - IF amp. gain + IF cable loss + FSL
Power density Result at 3 m = EIRP / (4 * Pi * 300 ^{2})

These calculation results are same as results which were calculated with formulas described in the Section 9 of ANSI C63.10-2013.
The equipment were not used for factor 0 dB of the data sheets.

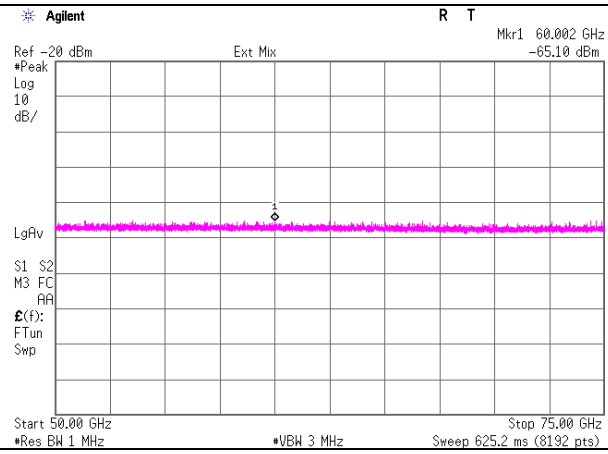
* The peak density is less than the average limit.
There is no spurious emission from 40 GHz to 231 GHz except for operating band.

Spurious Emission (above 40 GHz)

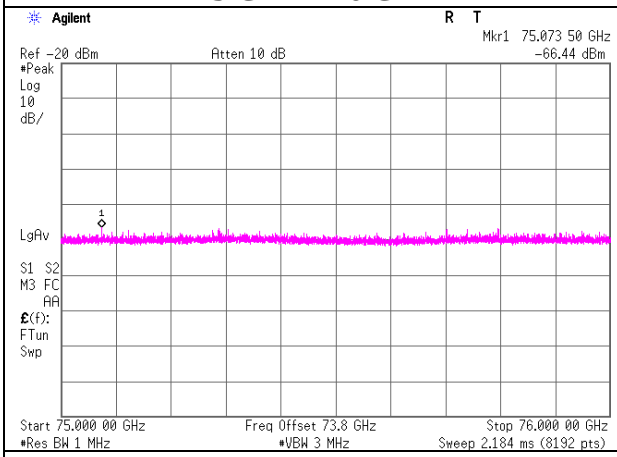
40 GHz – 50 GHz



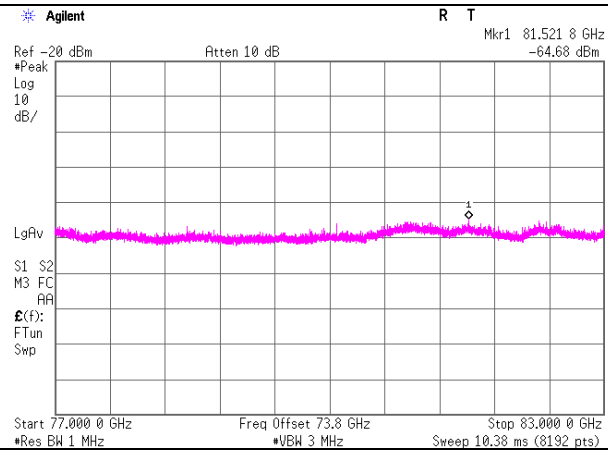
50 GHz – 75 GHz



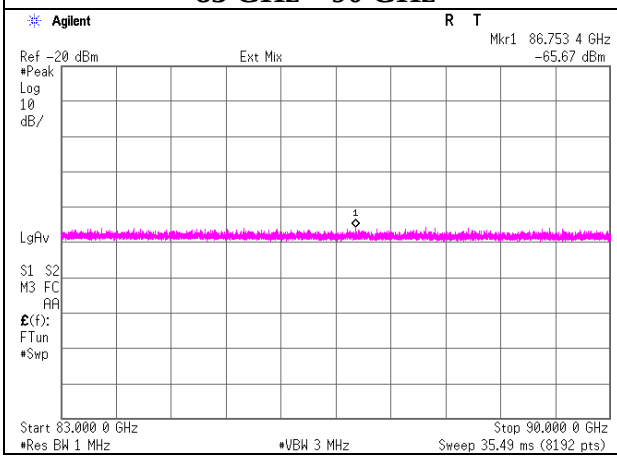
75 GHz – 76 GHz



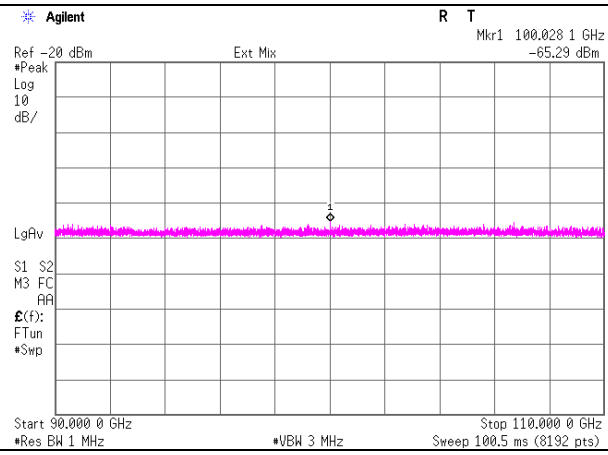
77 GHz – 83 GHz



83 GHz – 90 GHz

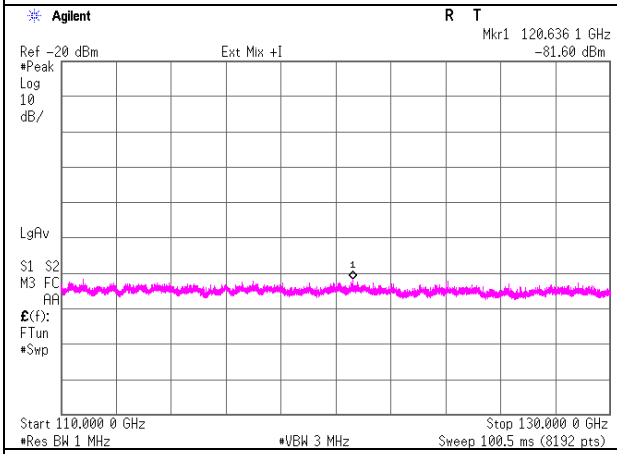


90 GHz – 110 GHz

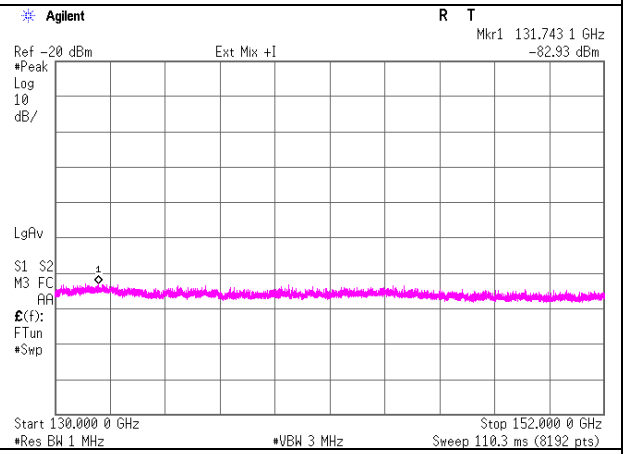


Spurious Emission (above 40 GHz)

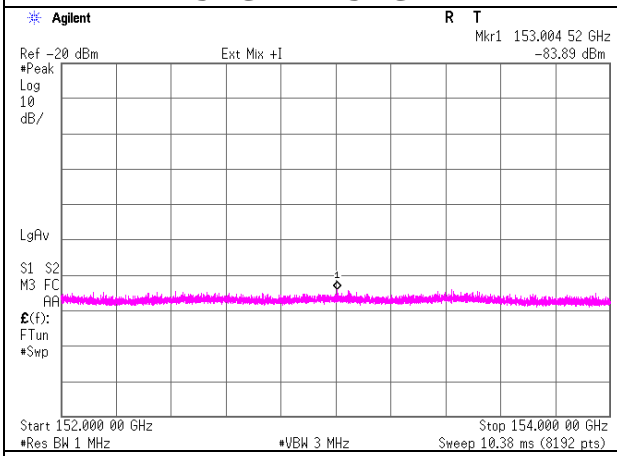
110 GHz – 130 GHz



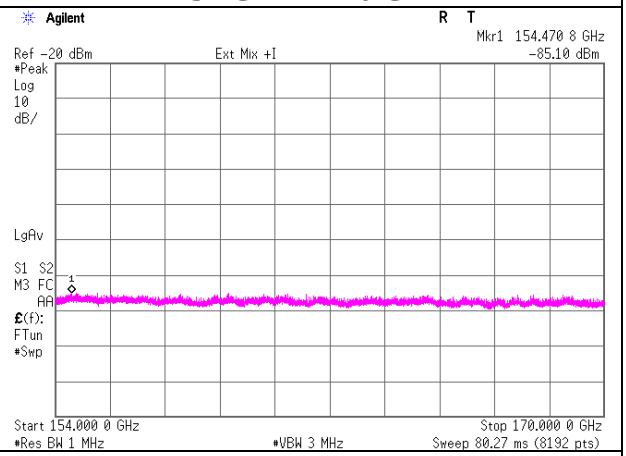
130 GHz – 152 GHz



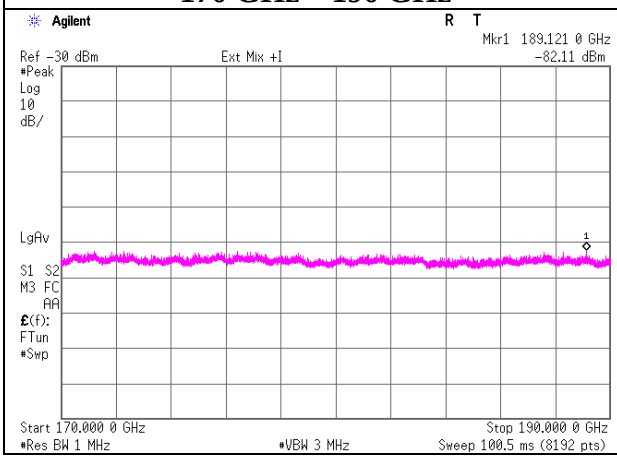
152 GHz – 154 GHz



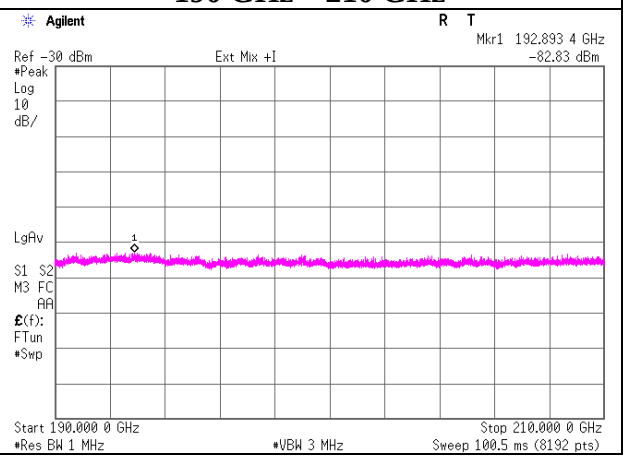
154 GHz – 170 GHz



170 GHz – 190 GHz

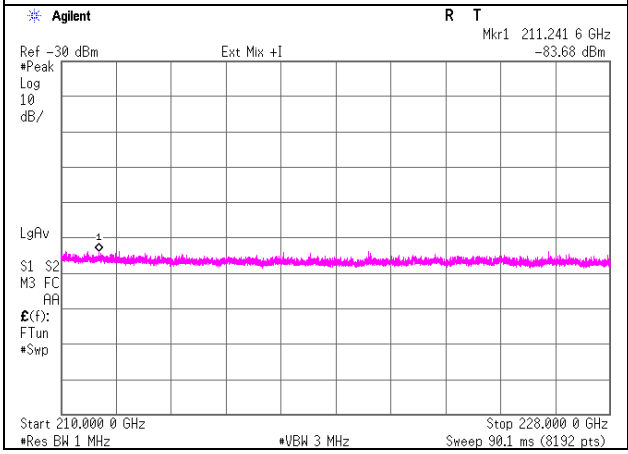


190 GHz – 210 GHz

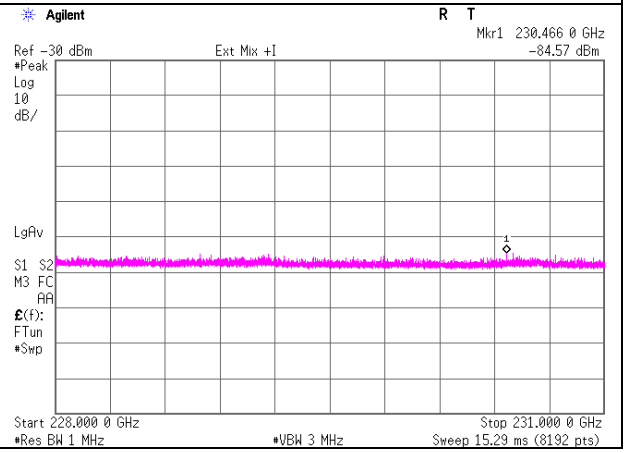


Spurious Emission (above 40 GHz)

210 GHz – 228 GHz



228 GHz – 231 GHz



Frequency Stability

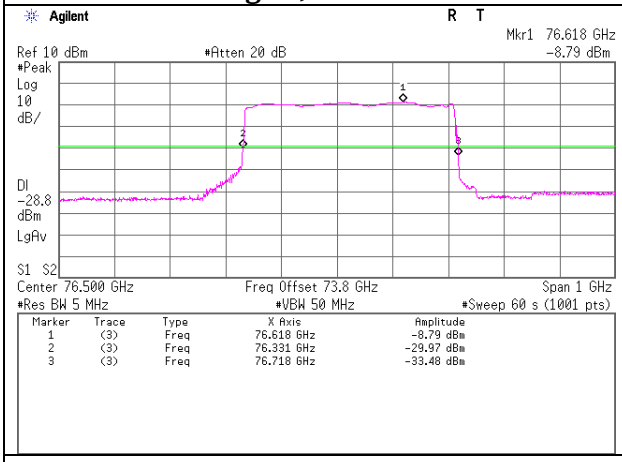
Test place	Ise EMC Lab. No.11 Measurement room
Report No.	11822931H
Date	August 22, 2017
Temperature	See data.
Engineer	Hironobu Ohnishi
Mode	Normal operating mode

Test Condition		Measured -20 dBc Frequency		Remarks
Temperature [deg. C]	Power Supply [V]	Lower Result [GHz]	Upper Result [GHz]	
80	12.0	76.331	76.718	Customer requested temperature
70	12.0	76.330	76.715	Maximum operating temperature
60	12.0	76.331	76.715	
50	12.0	76.330	76.713	
40	12.0	76.331	76.714	
30	12.0	76.331	76.714	
20	12.0	76.332	76.714	
20	6.8	76.332	76.714	85 % of the minimum operating voltage, DC 8 V * 0.85
20	18.4	76.332	76.716	115 % of the maximum operating voltage, DC 16 V * 1.15
10	12.0	76.333	76.715	
0	12.0	76.333	76.715	
-10	12.0	76.333	76.715	
-20	12.0	76.334	76.715	
-30	12.0	76.334	76.716	Minimum operating temperature

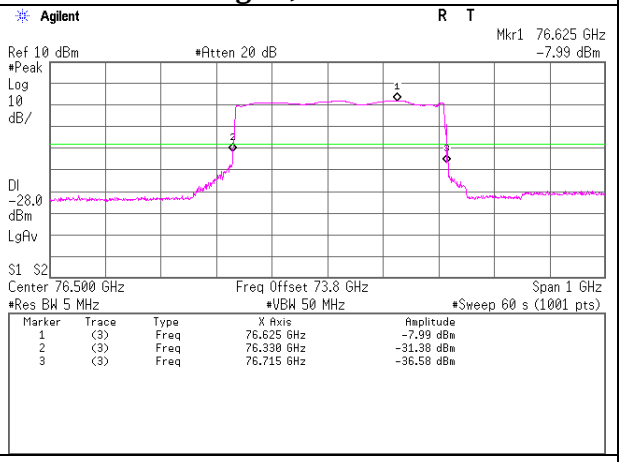
Fundamental emissions were contained within the frequency band 76 GHz – 77 GHz during all conditions of operation.

Frequency Stability

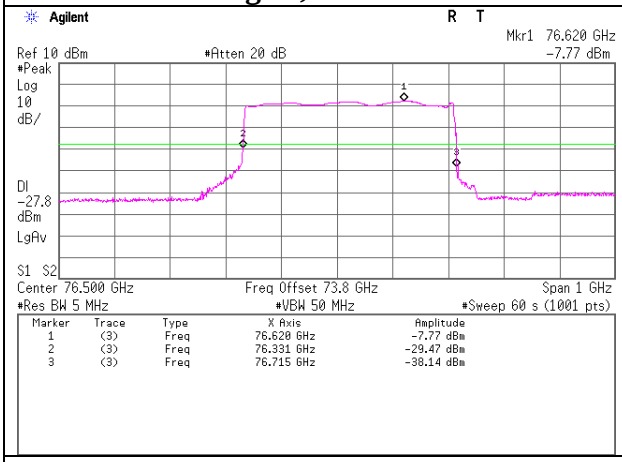
80 deg. C, DC 12.0 V



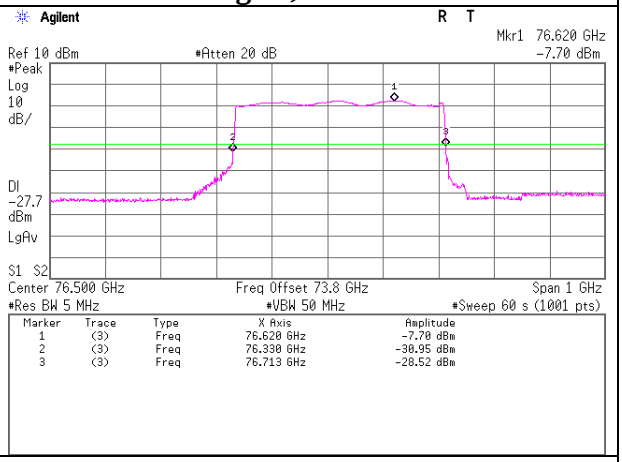
70 deg. C, DC 12.0 V



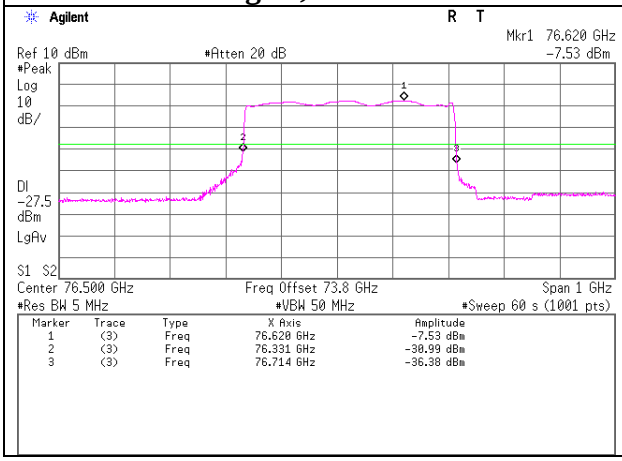
60 deg. C, DC 12.0 V



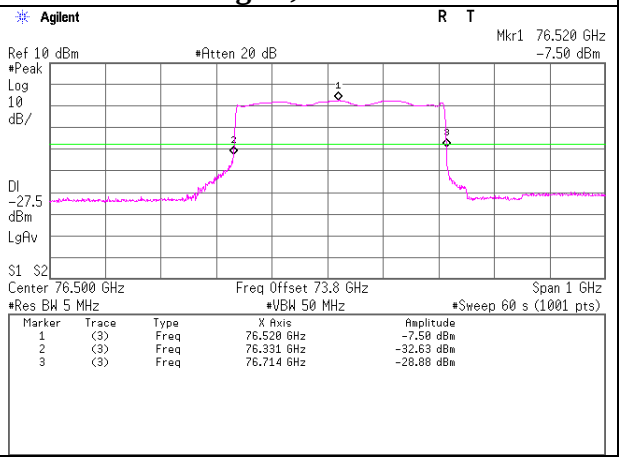
50 deg. C, DC 12.0 V



40 deg. C, DC 12.0 V

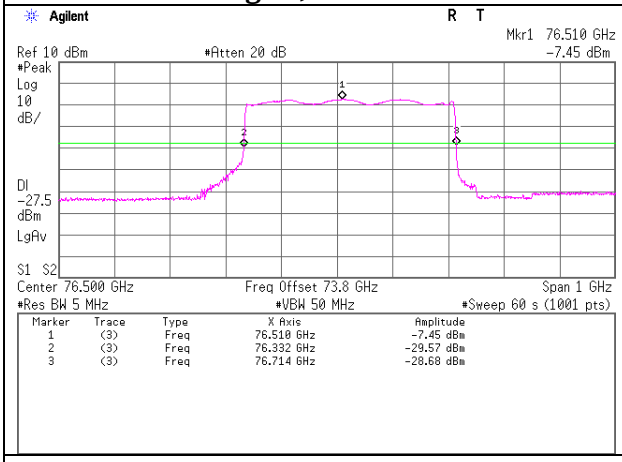


30 deg. C, DC 12.0 V

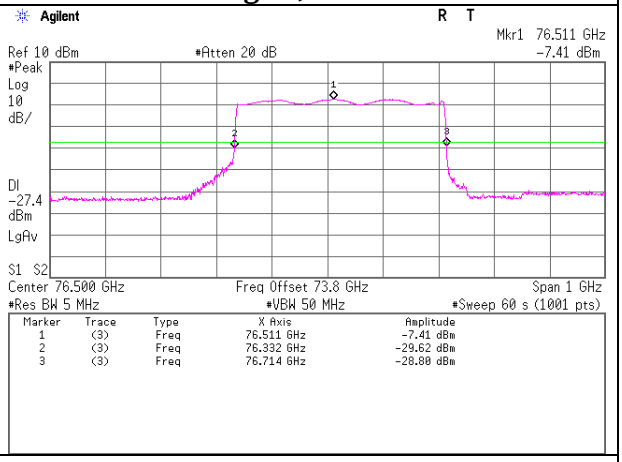


Frequency Stability

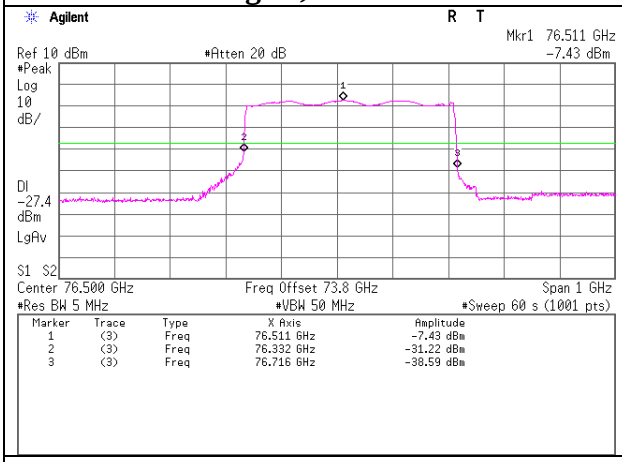
20 deg. C, DC 12.0 V



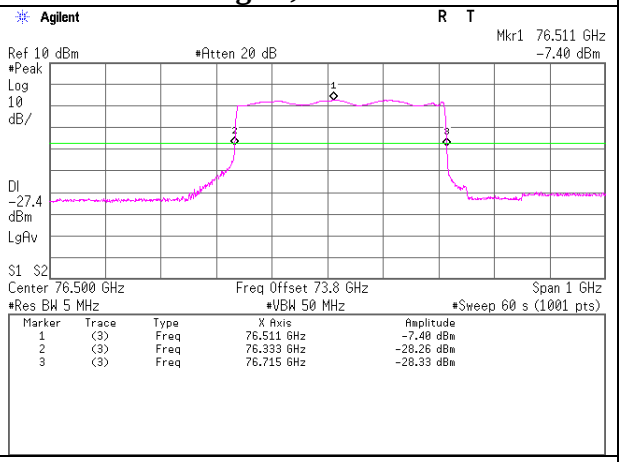
20 deg. C, DC 6.8 V



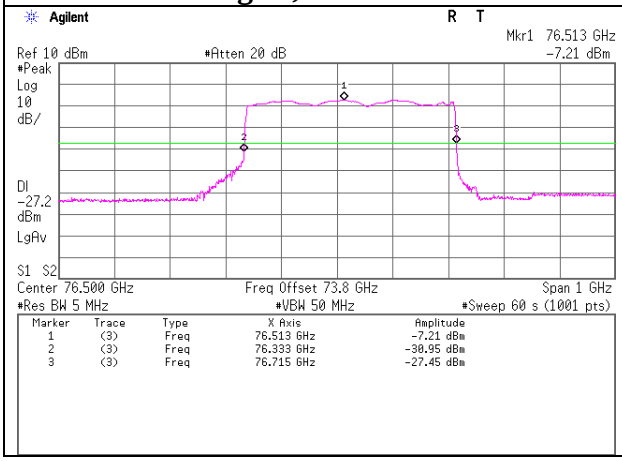
20 deg. C, DC 18.4 V



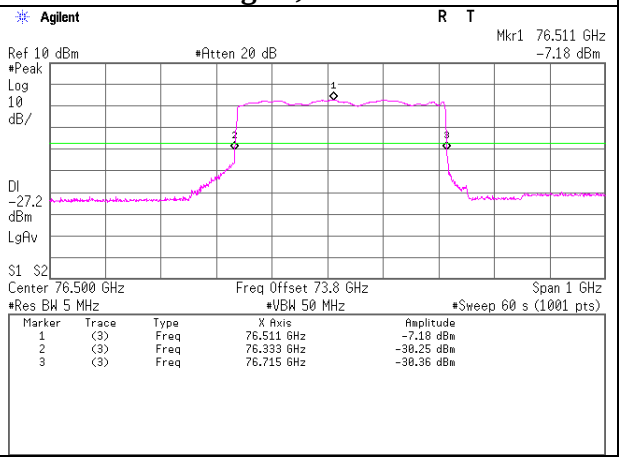
10 deg. C, DC 12.0 V



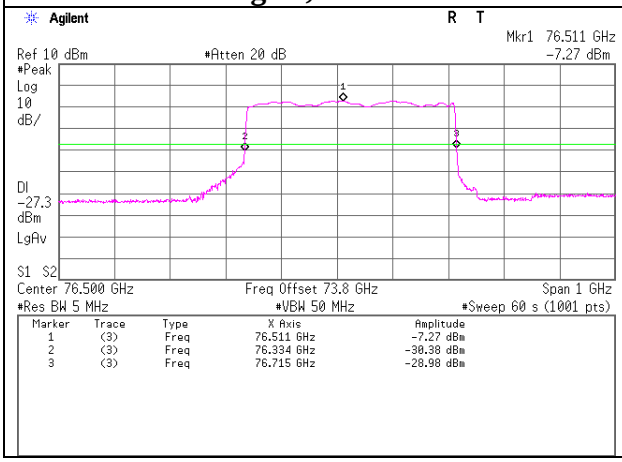
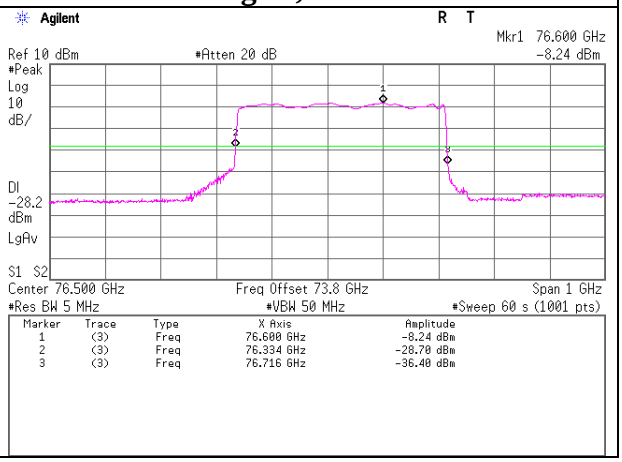
0 deg. C, DC 12.0 V



-10 deg. C, DC 12.0 V



Frequency Stability

-20 deg. C, DC 12.0 V	-30 deg. C, DC 12.0 V
	

APPENDIX 2: Test instruments

EMI test equipment (1/2)

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	-
MLDM-03	Digital laser distance meter	BOSCH	DLE 50	781414005	RE	2016/08/19 * 36
MMM-08	DIGITAL HiTESTER	Hioki	3805	051201197	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-67	Microwave Cable 1G-40GHz	Suhner	SUCOFLEX102	28635/2	RE	2017/04/04 * 12
MSA-03	Spectrum Analyzer	Agilent	E4448A	MY44020357	RE	2017/05/29 * 12
MPM-09	Power Meter	Anritsu	ML2495A	6K00003348	RE	2016/10/17 * 12
MPSE-12	Power sensor	Anritsu	MA2411B	011598	RE	2016/10/17 * 12
MDT-04	Detector	Millitech	DET-15-RPFW0	34	RE	-
OSC-01	Digital Oscilloscope	Rohde & Schwarz	RTO1004	200355	RE	2016/08/12 * 12
MHA-10	Horn Antenna	WiseWave	ARH1523-02	10766-02	RE	2016/10/18 * 12
MPA-23	Power Amplifier	SAGE Millimeter, Inc.	SBP-5037532015-1515-N1	11599-01	RE	2016/12/26 * 12
MRENT-131	Preselected Millimeter Mixer	Agilent	11974V	MY30013051	RE	2017/06/26 * 12
MCC-135	Microwave Cable	HUBER+SUHNER	SUCOFLEX102	37511/2	RE	2016/08/03 * 12
MCC-136	Microwave Cable	HUBER+SUHNER	SUCOFLEX102	37512/2	RE	2016/08/03 * 12
MPA-13	Pre Amplifier	SONOMA INSTRUMENT	310	260834	RE	2017/03/27 * 12
MCC-177	Microwave Cable	Junkosha	MMX221-00500DMSDMS	1502S304	RE	2017/03/13 * 12
MMX-02	Harmonic Mixer	Agilent	11970W	2521 A01909	RE	2017/06/26 * 12
MHF-29	High Pass Filter 83 GHz - 110 GHz	Oshima Prototype Engineering Co.	A17-016	1	RE	2017/05/01 * 12
MHA-24	Horn Antenna	Custom Microwave Inc.	HO6R	-	RE	2016/09/27 * 12
MMX-03	Harmonic Mixer	OML Inc.	M06HWD	D100709-1	RE	2016/10/12 * 12
MHA-27	Horn Antenna	Custom Microwave Inc.	HO4R	-	RE	2016/09/27 * 12
MMX-04	Harmonic Mixer	OML Inc.	M04HWD	Y100709-1	RE	2016/10/12 * 12
MDPLX-01	Diplexer	OML Inc.	DPL26	-	RE	2016/10/06 * 12
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	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MHA-21	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	RE	2016/09/28 * 12
MCC-141	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	RE	2017/06/23 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	00650	RE	2016/10/21 * 12
MHA-17	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170307	RE	2017/06/30 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2017/01/19 * 12
MHA-29	Horn Antenna 26.5-40GHz	ETS LINDGREN	3160-10	00152399	RE	2016/09/28 * 12
MPA-22	Pre Amplifier	MITEQ, Inc	AMF-6F-2600400-33-8P / AMF-4F-2600400-33-8P	1871355 /1871328	RE	2016/09/06 * 12
MCC-220	Microwave Cable	HUBER+SUHNER	SF101EA/11PC24/11PC24/2.5M	SN MY1726/1EA	RE	2017/04/06 * 12

EMI test equipment (2/2)

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MHA-31	Horn Antenna	Oshima Prototype Engineering Co.	A16-186	1	RE	2016/09/01 * 12
MPA-25	Power Amplifier	SAGE Millimeter, Inc.	SBP-4035033018-2F2F-S1	12559-01	RE	2016/11/08 * 12
MSA-14	Spectrum Analyzer	Agilent	E4440A	MY48250080	RE	2016/10/14 * 12
MTR-10	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	RE	2017/01/12 * 12
MLPA-01	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	RE	2016/10/14 * 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
MAT-98	Attenuator	KEYSIGHT	8491A	MY52462349	RE	2016/12/05 * 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
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
MCH-06	Temperature and Humidity Chamber	Tabai Espec	PL-1KT	14007630	RE	2017/04/10 * 12
MMM-17	DIGIITAL HiTESTER	Hioki	3805	070900530	RE	2017/01/19 * 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