RADIO TEST REPORT

Test Report No. : 10928865H-R1

Applicant	:	**OPTEX CO., LTD.**
Type of Equipment	:	**Vehicle detection sensor**
Model No.	:	**OVS-01BG**
FCC ID	:	**DC9-OVS01**
Test regulation	:	**FCC Part 15 Subpart C: 2015**
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)
7. This report is a revised version of 10928865H. 10928865H is replaced with this report.

Date of test: October 1 to December 9, 2015

Representative test engineer:

Hironobu Ohnishi
Engineer
Consumer Technology Division

Approved by:

Takayuki Shimada
Engineer
Consumer Technology Division

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

REVISION HISTORY

Original Test Report No.: 10928865H

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10928865H	December 18, 2015	-	-
1	10928865H-R1	February 23, 2016	Page 5	Correction of Test Procedure in Section 3.2. Deletion of "KDB 200443" in Section 3.2.
1	10928865H-R1	February 23, 2016	Page 10	Correction to "Procedures for testing millimeter-wave systems" from "MILLIMETER WAVE TEST PROCEDURES" in Test procedure of Above 40 GHz.

CONTENTS PAGE

SECTION 1: Customer information

Company Name	:	OPTEX CO., LTD.
Address	:	5-8-12 Ogoto, Otsu, Shiga 520-0101 Japan
Telephone Number	:	+81-77-579-8000
Facsimile Number	:	+81-77-579-7100
Contact Person	:	Atsushi Maekawa

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

2.1 Identification of E.U.T.

Type of Equipment	:	Vehicle detection sensor
Model No.	:	OVS-01BG
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 24 V (Operating range: DC 12 V – DC 24 V)
Receipt Date of Sample	:	September 19, 2015
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

This equipment is the Vehicle detection sensor, Models; OVS-01BG.

General Specification

Clock frequency(ies) in the system	:	Crystal: 16 MHz Microcomputer: 32 MHz

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	24.15 GHz
Modulation	:	Frequency modulation
Antenna Type	:	Internal Antenna
Antenna Connector	:	None
Antenna Gain	:	11 dBi
Steerable Antenna	:	None
Usage location	:	Fixed use
Power Supply (inner)	:	DC 4.0 V

Models OVS-01CC, OVS-01PK, OVS-01PKB, OVS-01BGB, OVS-01CCB are same as basic model OVS-01BG except for model designation, use application.
These differences do not affect the test results and RF specification.
Therefore, all tests were conducted on representative Model OVS-01BG.
Model OVS-01BG was used for investigation purposes and was considered representative of all models covered by this report.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C: 2015, final revised on November 23, 2015
*Some parts are effective on and after December 17, 2015 or December 23, 2015.
The revision does not affect the test specification applied to the EUT.

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.249 Operation within the bands 902 MHz - 928 MHz, 2400 MHz - 2483.5 MHz, 5725 MHz - 5875 MHz and 24.0 - 24.25 GHz

* The EUT complies with FCC Part 15 Subpart B: 2015 final revised on November 23, 2015 and FCC Part 18: 2015 final revised on September 8, 2015.

3.2 Procedures and results

Item	Test Procedure	Specification	Deviation	Worst margin	Results
Conducted Emission	ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.207	N/A	-	N/A *1)
Electric Field Strength of Fundamental Emission	ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.249(a)(c)(e)	N/A	15.4 dB 24072.80 MHz, Vertical (Peak with Duty factor)	Complied
Electric Field Strength of Spurious Emission	ANSI C63.10-2013 6. Standard test methods 9. Procedures for testing millimeter-wave systems	**FCC:** Section 15.205(a)(b)(d) Section 15.209(a) Section 15.249(a)(c)(d)(e)	N/A	1.5 dB 96266.67 MHz, Vertical (Peak with Duty factor)	Complied
20 dB Bandwidth	ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.215	N/A	See data.	Complied
Frequency Tolerance	ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.249(b)	N/A	-	N/A *2)
*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. *2) The test is not applicable since the EUT does not operate with Fixed point-to-point operation within 24.05 GHz to 24.25 GHz. Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.					

FCC Part 15.31 (e)
This EUT provides stable voltage (DC 4.0 V) constantly to the RF part regardless of input voltage. 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 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.

Test distance	Radiated emission (±dB)
	9 kHz - 30 MHz
3m	3.8 dB
10m	3.7 dB

Polarity	Radiated emission (Below 1GHz)			
	(3 m*)(±dB)		(10 m*)(±dB)	
	30 – 300 MHz	300 – 1000MHz	30 – 300 MHz	300 – 1000MHz
Horizontal	4.8 dB	5.2 dB	4.8 dB	5.0 dB
Vertical	4.5 dB	5.9 dB	4.8 dB	5.1 dB

Radiated emission				
(3 m*)(±dB)		(1 m*)(±dB)	(0.5 m*)(±dB)	(10 m*)(±dB)
1 – 6GHz	6 – 18GHz	10 – 26.5 GHz	26.5 – 40GHz	1 -18 GHz
5.1 dB	5.3 dB	5.1 dB	5.1 dB	5.3 dB

*Measurement distance

Radiated emission (±dB)	
40 GHz - 50 GHz	4.0 dB
50 GHz - 75 GHz	5.2 dB
75 GHz - 110 GHz	5.6 dB

Radiated emission test
[Electric Field Strength of Fundamental Emission]
The data listed in this test report has enough margin, more than the site margin.

[Electric Field Strength of Spurious Emission]
The data listed in this report meets the limits unless the uncertainty is taken into consideration.

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 4.5 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	-	8.0 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.

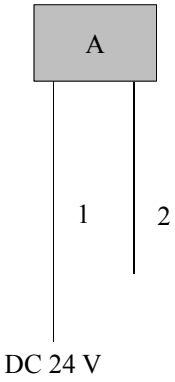
Refer to APPENDIX.

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

4.1 Operating Modes

Test Item	Mode	Tested frequency
Electric Field Strength of Fundamental Emission Electric Field Strength of Spurious Emission 20 dB Bandwidth	Transmitting mode (Tx)	24.15 GHz
The system was configured in typical fashion (as a customer would normally use it) for testing. *EUT has the power settings by the software as follows; Power Settings: Same as Production model Software: Ver.3.00/1.00 *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(s) were taken into consideration and test data was taken under worse case conditions.

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Vehicle detection sensor	OVS-01BG	4	OPTEX CO., LTD.	EUT

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-
2	Signal cable	1.0	Unshielded	Unshielded	-

SECTION 5: Radiated emission (Electric Field Strength of Fundamental and Spurious Emission)

Test Procedure and conditions

[Up to 40 GHz]
EUT was placed on an urethane platform of nominal size, 0.5 m by 1.0 m raised 0.8 m (9 kHz - 1 GHz), 0.5 m by 0.5 m raised 1.5 m (1 GHz - 40 GHz) above the conducting ground plane.
The EUT was set on the center of 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 1.

The Radiated Electric Field Strength has been measured on Semi anechoic chamber with a ground plane and at a distance of 3 m.
The measuring antenna height was varied between 1 m and 4 m (frequency 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.
The radiated emission measurements were made with the following detector function of the test receiver/spectrum analyzer.

Test Antennas are used as below;

Frequency	Below 30 MHz	30 MHz to 300 MHz	300 MHz to 1 GHz	Above 1 GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

Frequency	9 kHz – 150 kHz	150 kHz – 30 MHz	30 MHz – 1 GHz	1 GHz – 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	Pulsed emission - RBW: 1 MHz - VBW: 3 MHz - Peak with duty Other than above - RBW: 1 MHz - VBW: 10 Hz or $1/T_{ON}$ - Voltage avg.
Test Distance	3 m	3 m	3 m	3 m (below 10 GHz), 1 m*2) (10 GHz-26.5 GHz), 0.5 m*3) (26.5 GHz-40 GHz)	

*1) For Pulsed emission (Fundamental and band-edge): The Average value was calculated by reducing Duty factor from Peak (Peak value – Duty factor). For Duty factor, please refer to page Duty factor measurement. Other than pulsed emission, VBW was set to 10 Hz or $1/T_{ON}$ and linear voltage average mode was used.
*2) Distance Factor: 20 x log (3.0 m / 1.0 m) = 9.5 dB
*3) Distance Factor: 20 x log (3.0 m / 0.5 m) = 15.6 dB

[About fundamental measurement]
The carrier levels were confirmed at maximum direction of transmission. The maximum direction was searched under carefully since beam-widths are 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 [GHz]	Lambda [m]	Maximum Dimension [m]	Far Field Boundary *r* [m]
24.250	0.012	0.058	0.544

[Above 40 GHz]
The test was performed based on "Procedures for testing millimeter-wave systems". The EUT was placed on an 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 – 50 GHz	50 GHz – 75 GHz	75 GHz – 100 GHz
Final measurement distance with 1 MHz Peak detector	1.0 m	0.3 m	0.5 m

Detector	Peak	Average *1)	
IF Bandwidth	RBW: 1 MHz VBW: 3 MHz	Pulsed emission - RBW: 1 MHz - VBW: 3 MHz - Peak with duty	Other than pulsed - RBW: 1 MHz - VBW: 10 Hz - Voltage avg.

*1) For Pulsed emission (2nd harmonics): The Average value was calculated by reducing Duty factor from Peak (Peak value – Duty factor). For Duty factor, please refer to page Duty factor measurement. Other than pulsed emission, VBW was set to 10 Hz and linear voltage average mode was used.

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 : 9 kHz – 100 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: 20 dB Bandwidth and Duty Cycle

Test Procedure

The measurement was performed in the antenna height to gain the maximum of Electric field strength.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	600 MHz	2 MHz	6 MHz	200 sec	Peak	Max Hold	Spectrum Analyzer
Duty Cycle	Zero	1 MHz	3 MHz	200 msec	Peak	Single	Spectrum Analyzer

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	10928865H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No. 2	No. 4	No. 1
Date	October 1, 2015	October 13, 2015	November 2, 2015
Temperature / Humidity	23 deg. C / 51 % RH	23 deg. C / 52 % RH	21 deg. C / 43 % RH
	40 GHz - 50 GHz	1 GHz - 26.5 GHz	50 GHz - 100 GHz
Engineer	Hironobu Ohnishi		
Mode	Tx 24.15 GHz		

[Fundamental, lower band-edge, 2nd and 4th harmonics]

Peak

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result (3 m) [dBuV/m]		Limit (3 m)	Margin [dB]		Remark Inside or Outside
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m]	Hor	Ver	of Restricted Bands
24000.00	PK	45.3	45.5	39.1	-0.3	33.0	-	51.1	51.3	73.9	22.8	22.6	Inside
24072.80	PK	84.5	103.6	39.0	-0.3	33.0	-	90.2	109.3	127.9	37.7	18.6	Fundamental
48147.00	PK	46.1	46.6	40.4	-1.5	18.4	-	66.6	67.1	87.9	21.3	20.8	Inside
96266.670	PK	24.1	17.5	45.6	28.3	28.8	-	69.2	62.6	73.9	4.7	11.3	Inside

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

Peak with Duty factor

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result (3 m) [dBuV/m]		Limit (3 m)	Margin [dB]		Remark
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m]	Hor	Ver	
24000.00	PK	45.3	45.5	39.1	-0.3	33.0	-16.79	34.3	34.5	53.9	19.6	19.4	Inside
24072.80	PK	84.5	103.6	39.0	-0.3	33.0	-16.79	73.4	92.5	107.9	34.5	15.4	Fundamental
48147.00	PK	46.1	46.6	40.4	-1.5	18.4	-16.79	49.8	50.3	67.9	18.1	17.6	Inside
96266.670	PK	24.1	17.5	45.6	28.3	28.8	-16.79	52.4	45.8	53.9	1.5	8.1	Inside

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor) - Gain(Amprifier) + Duty factor (Refer to Duty factor data sheet)

Distance factor: 10 GHz - 26.5 GHz 20log (3.0 m / 1.0 m) = 9.5 dB
40 GHz - 50 GHz 20log (3.0 m / 1.0 m) = 9.5 dB
75 GHz - 100 GHz 20log (3.0 m / 0.5 m) = 15.6 dB

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

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	10928865H			
Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No. 2	No. 4	No. 4	No. 1
Date	October 1, 2015	October 13, 2015	October 14, 2015	November 2, 2015
Temperature / Humidity	23 deg. C / 51 % RH	23 deg. C / 52 % RH	22 deg. C / 47 % RH	21 deg. C / 43 % RH
	40 GHz - 50 GHz	1 GHz - 26.5 GHz	9 kHz - 1 GHz, 26.5 GHz - 40 GHz	50 GHz - 100 GHz
Engineer	Hironobu Ohnishi			
Mode	Tx 24.15 GHz			

[Spurious emissions other than previous page]

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	48.752	QP	23.2	11.0	7.4	32.1	9.5	40.0	30.5	
Hori	193.677	QP	30.1	16.4	9.0	31.8	23.7	43.5	19.8	
Hori	233.286	QP	28.8	16.9	9.4	31.8	23.3	46.0	22.7	
Hori	293.855	QP	29.2	19.4	9.8	31.8	26.6	46.0	19.4	
Hori	400.883	QP	35.6	18.2	10.6	31.9	32.5	46.0	13.5	
Hori	435.147	QP	37.7	18.6	10.8	31.9	35.2	46.0	10.8	
Hori	574.799	QP	26.4	20.0	11.6	32.1	25.9	46.0	20.1	
Hori	24250.000	PK	45.2	39.0	-0.2	33.0	51.0	73.9	22.9	NS
Hori	72200.000	PK	13.0	41.7	29.0	6.0	77.7	87.9	10.2	NS
Hori	24250.000	AV	32.2	39.0	-0.2	33.0	38.0	53.9	15.9	NS, VBW=10 Hz
Hori	72200.000	AV	0.6	41.7	29.0	6.0	65.3	67.9	2.6	NS, VBW=10 Hz
Vert	48.752	QP	39.8	11.0	7.4	32.1	26.1	40.0	13.9	
Vert	193.677	QP	36.7	16.4	9.0	31.8	30.3	43.5	13.2	
Vert	233.286	QP	35.8	16.9	9.4	31.8	30.3	46.0	15.7	
Vert	293.855	QP	37.4	19.4	9.8	31.8	34.8	46.0	11.2	
Vert	400.883	QP	45.0	18.2	10.6	31.9	41.9	46.0	4.1	
Vert	435.147	QP	43.0	18.6	10.8	31.9	40.5	46.0	5.5	
Vert	574.799	QP	34.0	20.0	11.6	32.1	33.5	46.0	12.5	
Vert	24250.000	PK	49.4	39.0	-0.2	33.0	55.2	73.9	18.7	
Vert	72200.000	PK	13.2	41.7	29.0	6.0	77.9	87.9	10.0	NS
Vert	24250.000	AV	35.0	39.0	-0.2	33.0	40.8	53.9	13.1	1/Ton VBW=6.8 kHz
Vert	72200.000	AV	0.6	41.7	29.0	6.0	65.3	67.9	2.6	NS, VBW=10 Hz

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Mixer(above 50 GHz)-Distance factor(above 10 GHz)) - Gain(Amplifier)
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*NS: No signal detected.
Distance factor: 10 GHz - 26.5 GHz 20log (3.0 m / 1.0 m) = 9.5 dB
50 GHz - 75 GHz 20log (3.0 m / 0.3 m) = 20 dB

[Below 30 MHz]

Loop Antenna direction [deg.]	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	1.315	QP	51.1	19.5	-33.7	32.1	4.8	25.2	20.4	
45	1.315	QP	49.4	19.5	-33.7	32.1	3.1	25.2	22.1	
90	1.315	QP	47.0	19.5	-33.7	32.1	0.7	25.2	24.5	
135	1.315	QP	49.3	19.5	-33.7	32.1	3.0	25.2	22.2	
180	1.315	QP	50.9	19.5	-33.7	32.1	4.6	25.2	20.6	

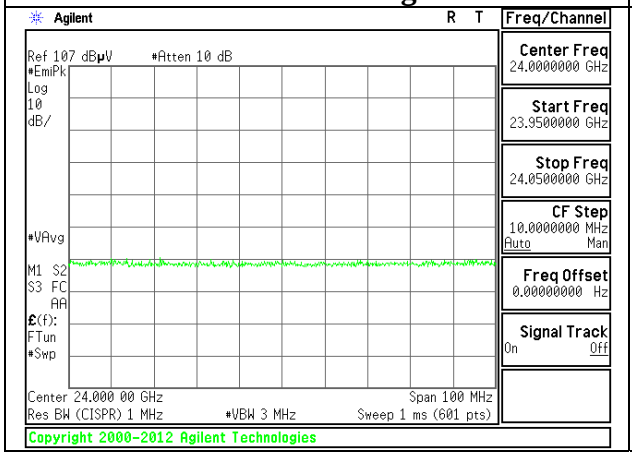
Result = Reading + Ant Factor + Loss (Cable+Attenuator-Distance factor) - Gain(Amplifier)
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
Distance factor: 40log (30 m / 3 m) = 40 dB

Radiated Spurious Emission

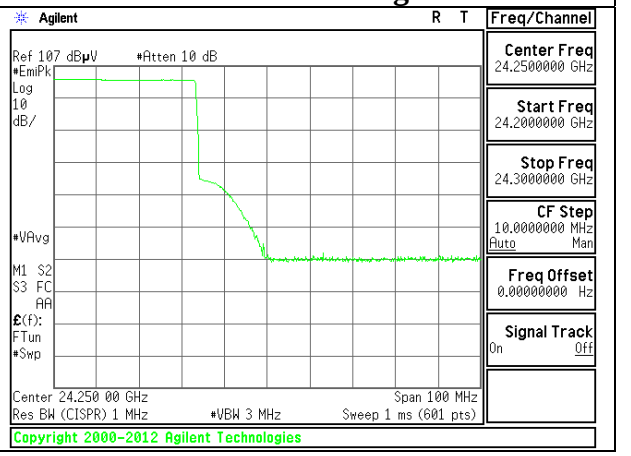
Test place	Ise EMC Lab. No. 4 Semi Anechoic Chamber
Report No.	10928865H
Date	October 13, 2015
Temperature / Humidity	23 deg. C / 52 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

Reference Plot for band-edge

Restricted band-edge Plot



Authorized band-edge Plot

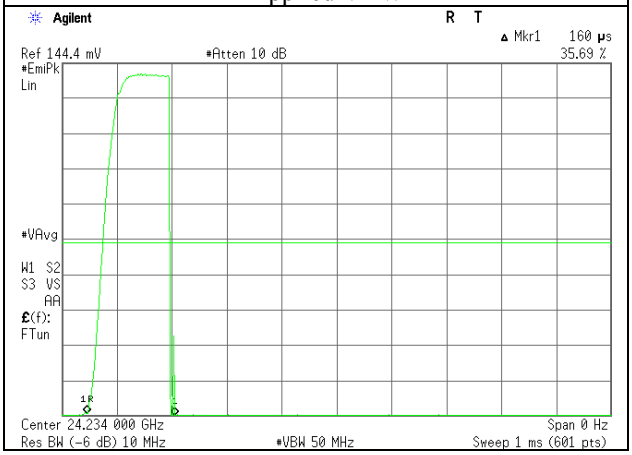


* Final result of restricted band edge was shown in tabular data.

VBW Calculation for upper band-edge

$1/T_{ON} = 1/160\ us = 6250\ Hz < 6.8\ kHz^{*)}$

*) Applied VBW

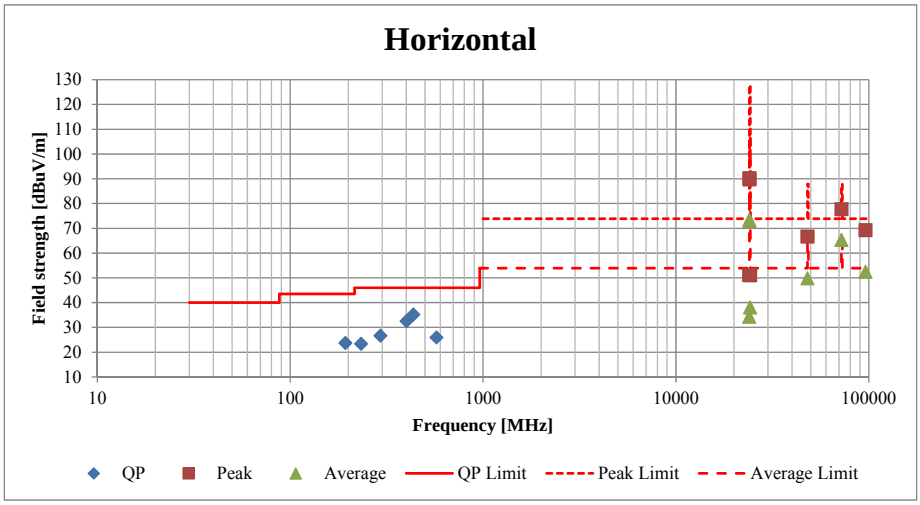


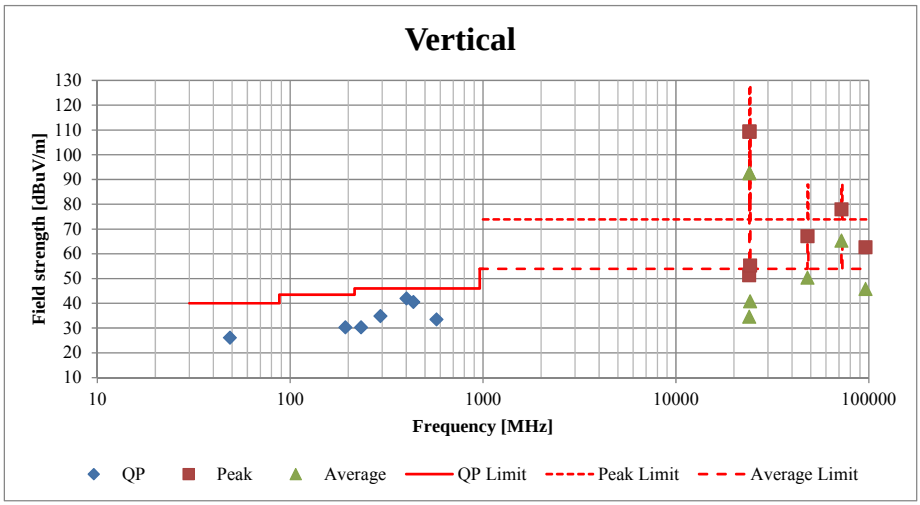
* The transmitting time which occupied upper chirp frequency was applied for the VBW calculation.

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	10928865H			
Test place	Ise EMC Lab.			
Semi Anechoic Chamber	No. 2	No. 4	No. 4	No. 1
Date	October 1, 2015	October 13, 2015	October 14, 2015	November 2, 2015
Temperature / Humidity	23 deg. C / 51 % RH	23 deg. C / 52 % RH	22 deg. C / 47 % RH	21 deg. C / 43 % RH
	40 GHz - 50 GHz	1 GHz - 26.5 GHz	9 kHz - 1 GHz, 26.5 GHz - 40 GHz	50 GHz - 75 GHz, 75 GHz - 100 GHz
Engineer	Hironobu Ohnishi			
Mode	Tx 24.15 GHz			

[30 MHz – 100 GHz]

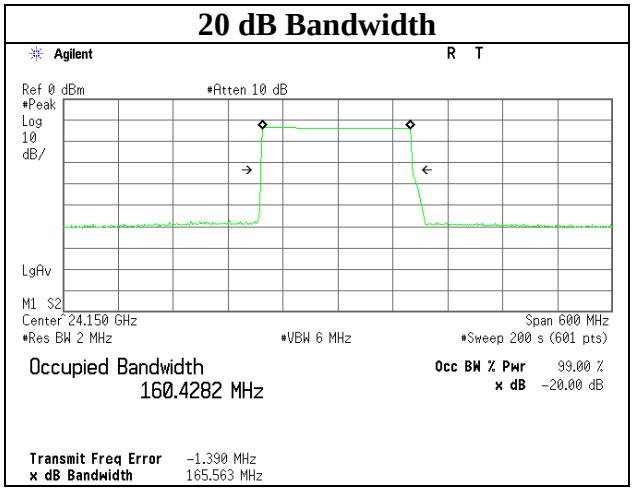




20 dB Bandwidth

Test place	Ise EMC Lab. No. 6 Shielded room
Report No.	10928865H
Date	October 22, 2015
Temperature/ Humidity	25 deg. C / 50 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

Frequency [GHz]	20 dB Bandwidth [MHz]
24.15	165.563



Duty factor (Dwell time factor)

Test place	Ise EMC Lab. No. 6 Shielded room
Report No.	10928865H
Date	December 9, 2015
Temperature/ Humidity	23 deg. C / 34 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

[Declared data]

Frequency	On time [ms]	Period time [ms]	Duty factor [dB]
f1 - f7	12	84.5	-16.95

Calculation:
Duty factor = 20 * log(On time / Period time)

[Measured data]

Frequency	On time				Period time [ms]	Duty factor [dB]	Remarks
	1 [ms]	2 [ms]	3 [ms]	Total [ms]			
f1	0.075	11.00	-	11.075	83.55	-17.55	
f2	0.115	0.030	11.94	12.085	83.55	-16.79	Worst case
f3	0.020	0.020	11.95	11.990	83.55	-16.86	
f4	0.020	0.025	11.94	11.985	83.55	-16.87	
f5	0.025	0.025	11.94	11.990	83.55	-16.86	
f6	0.020	0.030	11.94	11.990	83.55	-16.86	
f7	0.030	0.010	11.94	11.980	83.55	-16.87	

Calculation:
Duty factor = 20 * log(Total On time / Period time)

[Result]

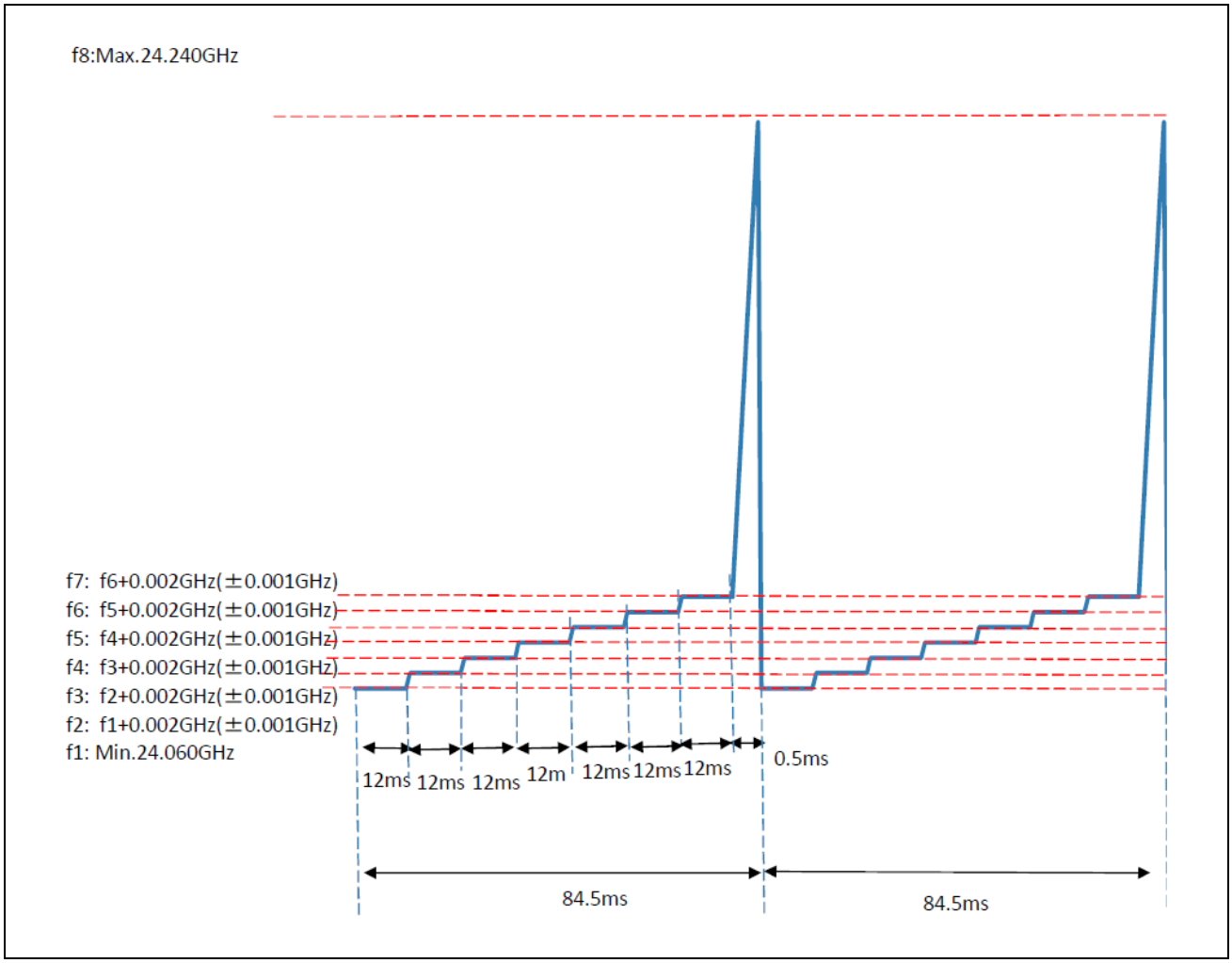
Applied Duty factor	-16.79 dB

There are seven doppler frequencies and chirp part in one transmission period. These doppler parts and chirp part were compared to calculate the duty factor. The duty factor was calculated within doppler part, because doppler's dwell time is longer than the chirp part.

The declared duty factor and measured one were compared. The maximum duty factor of these results was applied to the average field strength measurement. (Worst case)

Duty Cycle (Dwell time)

[Declared data]



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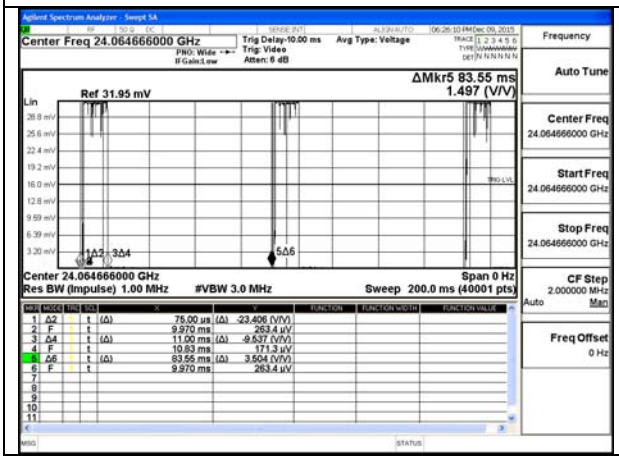
Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone : +81 596 24 8999
Facsimile : +81 596 24 8124

Duty Cycle (Dwell time)

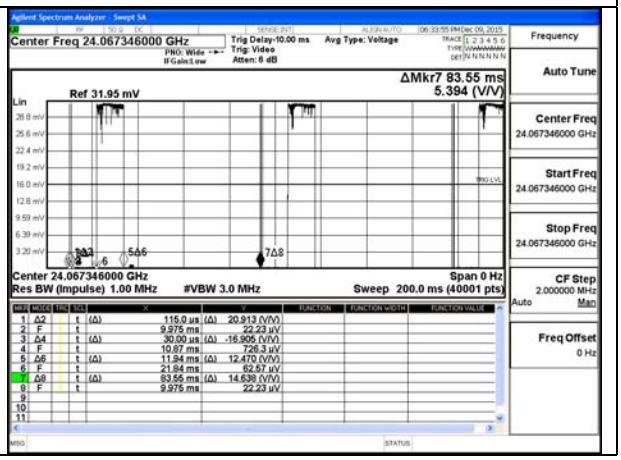
Test place	Ise EMC Lab. No. 6 Shielded room
Report No.	10928865H
Date	December 9, 2015
Temperature/ Humidity	23 deg. C / 34 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

[Measured data]

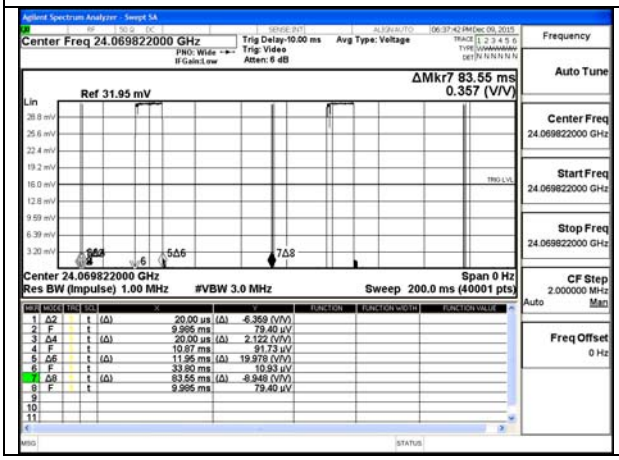
f1



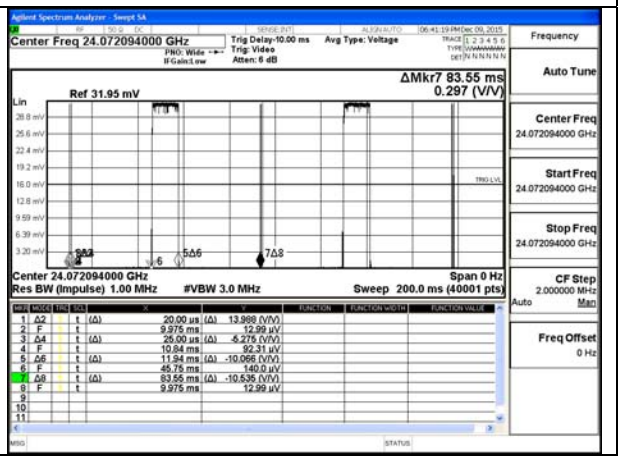
f2



f3



f4



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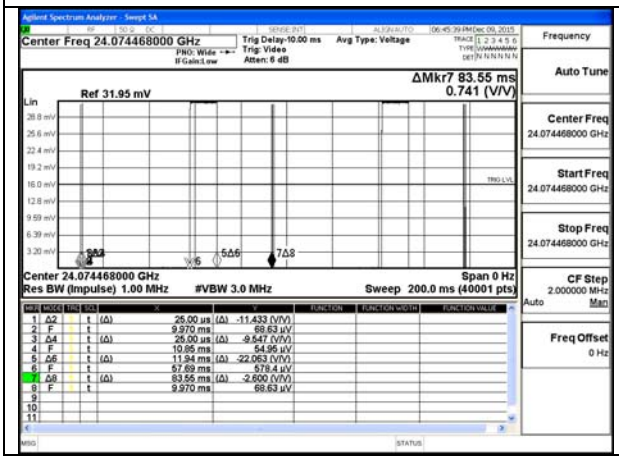
Duty Cycle (Dwell time)

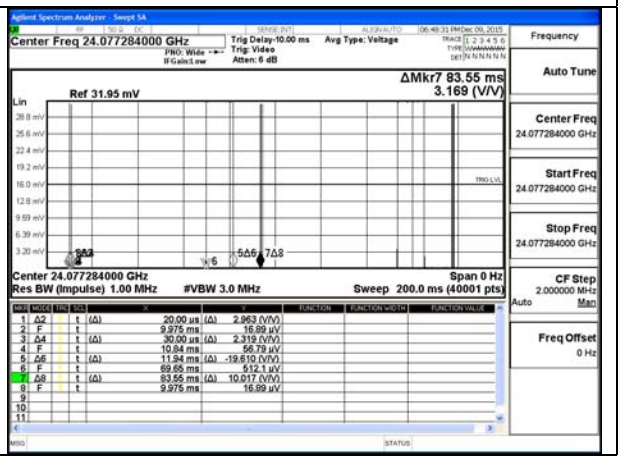
Test place	Ise EMC Lab. No. 6 Shielded room
Report No.	10928865H
Date	December 9, 2015
Temperature/ Humidity	23 deg. C / 34 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

[Measured data]

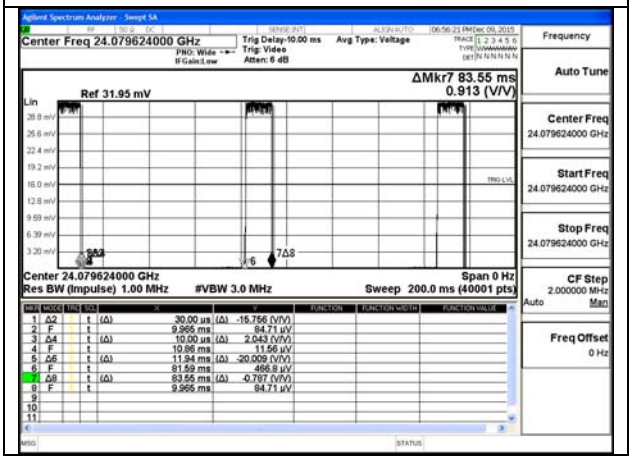
f5



f6



f7

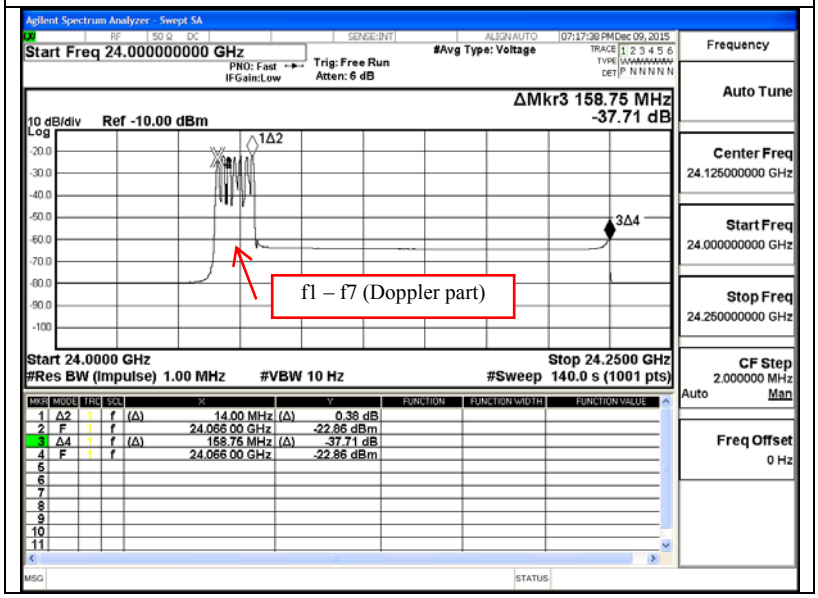


Duty Cycle (Dwell time)

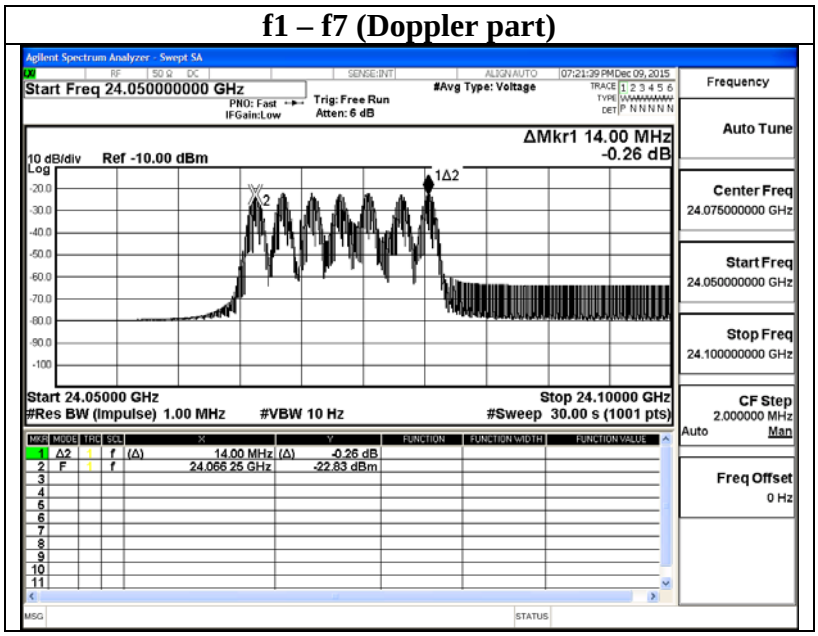
Test place	Ise EMC Lab. No. 6 Shielded room
Report No.	10928865H
Date	December 9, 2015
Temperature/ Humidity	23 deg. C / 34 % RH
Engineer	Hironobu Ohnishi
Mode	Tx 24.15 GHz

[Measured data]

f1 – f8



f1 – f7 (Doppler part)



There are seven doppler frequencies and chirp part in one transmission period. These doppler parts and chirp part were compared to calculate the duty factor. The duty factor was calculated within doppler part, because doppler's dwell time is longer than the chirp part.

APPENDIX 2: Test Instruments

EMI test equipment (1/2)

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-02	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	RE	2015/07/01 * 12
MOS-22	Thermo-Hygrometer	Custom	CTH-201	0003	RE	2015/01/13 * 12
MJM-14	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	RE	2015/02/26 * 12
MHA-07	Horn Antenna	Custom	HO22R	10766-01	RE	2015/10/22 * 12
MPA-03	Microwave System Power Amplifier	Agilent	83050A	3950M00205	RE	2015/06/02 * 12
MCC-140	Microwave Cable	Junkosha	J12J101596-00	JAN-31-12-001	RE	2015/02/23 * 12
MMM-01	Digital Tester	Fluke	FLUKE 26-3	78030611	RE	2015/08/19 * 12
MAEC-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2015/10/02 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	RE	2015/01/13 * 12
MJM-23	Measure	ASKUL	-	-	RE	-
MLDM-04	Digital laser distance meter	BOSCH	DLE 50	781422774	RE	2013/06/26 * 36
MSA-04	Spectrum Analyzer	Agilent	E4448A	US44300523	RE	2015/11/06 * 12
MHA-21	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	RE	2015/08/10 * 12
MCC-141	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	RE	2015/06/22 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	00650	RE	2015/10/01 * 12
MHA-17	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170307	RE	2015/06/06 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2015/01/16 * 12
MTR-01	Test Receiver	Rohde & Schwarz	ESI40	100084	RE	2015/11/28 * 12
MLPA-01	Loop Antenna	Rohde & Schwarz	HFH2-Z2	100017	RE	2015/10/24 * 12
MCC-113	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W(10m)/ SFM141(5m)/ 421-010(1m)/ sucoform141-PE(1m)/ RFM-E121(Switcher)	-/04178	RE	2015/07/02 * 12
MCC-143	Coaxial Cable	UL Japan	-	-	RE	2015/06/24 * 12
MPA-14	Pre Amplifier	SONOMA INSTRUMENT	310	260833	RE	2015/03/09 * 12
MAT-68	Attenuator	Anritsu	MP721B	6200961025	RE	2015/11/12 * 12
MBA-05	Biconical Antenna	Schwarzbeck	BBA9106	1302	RE	2015/11/02 * 12
MLA-08	Logperiodic Antenna	Schwarzbeck	UKLP9140-A	N/A	RE	2015/11/03 * 12
MCC-50	Coaxial Cable	UL Japan	-	-	RE	2015/06/19 * 12
MHA-04	Horn Antenna 26.5-40GHz	EMCO	3160-10	1140	RE	2015/11/13 * 12
MOS-27	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q26	RE	2015/01/13 * 12
MMM-03	Digital Tester	Fluke	FLUKE 26-3	78030621	RE	2015/08/19 * 12
MHA-09	Horn Antenna	WiseWave	ARH1523-02	10766-01	RE	2015/10/22 * 12
MPA-08	Pre Amplifier	WiseWave	ALN-61226028-51	11576-01-071	RE	2015/08/25 * 12
MMX-01	Preselected Millimeter Mixer	Agilent	11974V-E01	3001A00412	RE	2015/06/29 * 12
MCC-135	Microwave Cable	HUBER+SUHNER	SUCOFLEX102	37511/2	RE	2015/08/04 * 12
MCC-136	Microwave Cable	HUBER+SUHNER	SUCOFLEX102	37512/2	RE	2015/08/04 * 12

EMI test equipment (2/2)

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-01	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	RE	2015/09/19 * 12
MOS-27	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q26	RE	2015/01/13 * 12
MJM-25	Measure	KOMELON	KMC-36	-	RE	-
MMM-03	Digital Tester	Fluke	FLUKE 26-3	78030621	RE	2015/08/19 * 12
MHA-10	Horn Antenna	WiseWave	ARH1523-02	10766-02	RE	2015/10/22 * 12
MPA-18	Pre Amplifier	AmTechs Corporation	LNA-7511025	9601	RE	2015/08/25 * 12
MMX-02	Harmonic Mixer	Agilent	11970W	2521 A01909	RE	2015/06/29 * 12
MRENT-127	Spectrum Analyzer	KEYSIGHT	N9030A	US51350215	RE	2015/11/02 * 12
MOS-24	Thermo-Hygrometer	Custom	CTH-201	0005	RE	2015/01/13 * 12
MMM-12	DIGITAL HiTESTER	Hioki	3805	060500120	RE	2015/02/05 * 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. 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 test