



RADIO TEST REPORT

Test Report No. : 10666354M-B-R2

Applicant : **Circuit Design, Inc.**
Type of Equipment : **2.4 GHz DSSS low power radio transceiver**
Model No. : **STD-503**
FCC ID : **V9X-STD503**
Test regulation : **FCC Part 15 Subpart C: 2014**
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. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
7. This report is a revised version of 10666354M-B-R1. 10666354M-B-R1 is replaced with this report.

Date of test: February 3, 4, 6 - 10, 2015

Representative test engineer:

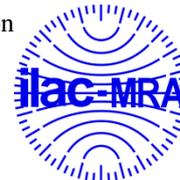
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Kazuhiro Ando
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Approved by:

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Site Manager
EMC/Wireless Group,
Consumer Technology Division



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 There is no testing item of "Non-accreditation".

TESTING
CERTIFICATE 1266.01

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13-EM-F0429

CONTENTS	PAGE
SECTION 1: Customer information.....	3
SECTION 2: Equipment under test (E.U.T.).....	3
SECTION 3: Test specification, procedures & results.....	4
SECTION 4: Operation of E.U.T. during testing.....	7
SECTION 5: Conducted emission	9
SECTION 6: 6dB bandwidth & Occupied bandwidth (99%).....	10
SECTION 7: Maximum peak conducted output power	10
SECTION 8: Maximum power spectral density	10
SECTION 9: Out of band emissions (Antenna port conducted).....	10
SECTION 10: Radiated emission	11
Contents of APPENDIXES	14
APPENDIX 1: Data of Radio test	15
APPENDIX 2: Test instruments	38
APPENDIX 3: Photographs of test setup.....	39

REVISION HISTORY

Original Test Report No. 10666354M-B

Revision	Test Report No.	Date	Page revised	Revision Description
00	10666354M-B	February 26, 2015	-	Original
01	10666354M-B-R1	March 4, 2015	P.3 P.4 P.7	Correction of description of FCC 15.31 (e) Change of description of Worst Margin in 3.2 Procedures and results Change Change of description in 4.1 Operating Modes
02	10666354M-B-R2	March 6, 2015	P.4	Correction of description of Worst Margin in 3.2 Procedures and results Change

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SECTION 1: Customer information

Company Name : Circuit Design, Inc.
Address : 7557-1, Hotaka, Azumino, Nagano 399-8303 Japan
Telephone Number : +81-263-82-1011
Facsimile Number : +81-263-82-1012
Contact Person : Yukinaga Koike

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

2.1 Identification of E.U.T.

Type of Equipment : 2.4 GHz DSSS low power radio transceiver
Model No. : STD-503
Serial No. : Refer to Section 4, Clause 4.3
Rating : DC 3.3 - 5.0 V (Absolute max voltage 5.5V)
Receipt Date of Sample : January 26, 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

Model: STD-503 (referred to as the EUT in this report) is a 2.4 GHz DSSS low power radio transceiver.

Clock frequency(ies) in the system : 16 MHz, 26MHz

<Radio part>

Equipment type : Transceiver
Frequency of operation : 2402.5-2478.5MHz
Channel spacing : 1MHz
Type of modulation : FSK
Antenna type / Antenna gain : Sleeve antenna (standard) / 2.0 dBi
Sleeve antenna (waterproof) / 2.0 dBi *1
Loop PCB antenna / 1.89dBi
Sleeve antenna with MHF / 1.5dBi
Antenna connector type : MHF
ITU code : F1D
Operation temperature range : -20 to +65 deg.C

*1) The only difference between the standard type and the waterproof type of sleeve antenna is how the resinous material covers the antenna. The tests were performed only with using the standard type as a representative of the sleeve antennas.

FCC 15.31 (e)

The RF Module has its own regulator.

The RF Module is constantly provided voltage (DC3.1V and DC3.0V) through the regulator regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC 15.203/212

The EUT has a unique coupling/antenna connector (MHF). Therefore the equipment complies with the requirement of 15.203/212.

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SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C: 2014,
final revised on August 15, 2014 and effective October 14, 2014

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.209 Radiated emission limits, general requirements
Section 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz,
and 5725-5850MHz

3.2 Procedures and results

Item	Test Procedure *1)	Specification	Remarks	Deviation	Worst Margin	Results
Conducted Emission	ANSI C63.10:2009	FCC 15.207	-	N/A	34.3 dB (0.15000 MHz, QP, N, Tx 2402.5MHz, Antenna Type: Sleeve antenna with MHF	Complied
6dB Bandwidth	ANSI C63.10:2009	FCC 15.247 (a)(2)	Conducted	N/A	* See data	Complied
Maximum Peak Conducted Output Power	ANSI C63.10:2009	FCC 15.247 (b)(3)	Conducted	N/A		Complied
Out of Band Emission & Restricted Band Edges	ANSI C63.10:2009	FCC 15.109, 15.247 (d) & 15.209	Conducted/ Radiated	N/A	1.0 dB (4957.000MHz, Hori., AV, Tx 2478.5MHz, Antenna Type: Sleeve antenna with MHF	Complied
Maximum Power Spectral Density	ANSI C63.10:2009	FCC 15.247 (e)	Conducted	N/A	* See data	Complied

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

*1) These tests were also referred to KDB 558074 v03r02 (FCC), "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

3.3 Addition to standard

Item	Test Procedure	Specification	Remarks	Worst Margin	Results
Occupied Bandwidth (99%)	ANSI C63.10:2009 RSS-Gen 6.6	-	Conducted	-	-

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

Other than above, no addition, exclusion nor deviation has been made from the standard.

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3.4 Uncertainty

The following uncertainties have been calculated to provide a confidence level of 95% using a coverage factor k=2.

Item	Frequency range	
Conducted emission (AC Mains) AMN	0.15 MHz-30 MHz	2.8 dB
Radiated emission	30 MHz-300 MHz	5.1 dB
	300 MHz-1000 MHz	6.3 dB
	1 GHz-6 GHz	4.5 dB
	6 GHz-18 GHz	4.8 dB
	18 GHz-26.5 GHz	4.9 dB

Conducted emission test

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

Radiated emission test

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

Antenna port conducted test

Power measurement uncertainty above 1GHz for this test was: (\pm) 1.5dB

Spurious emission (Conducted) measurement (below 1GHz) uncertainty for this test was: (\pm) 1.6dB

Spurious emission (Conducted) measurement (1G-3GHz) uncertainty for this test was: (\pm) 1.4dB

Spurious emission (Conducted) measurement (3G-18GHz) uncertainty for this test was: (\pm) 2.8dB

Spurious emission (Conducted) measurement (18G-26.5GHz) uncertainty for this test was: (\pm) 2.5dB

Bandwidth measurement uncertainty for this test was: (\pm) 5.4%

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3.6 Test Location

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A2LA Accreditation No. : 1266-01

	FCC Registration No.	IC Registration No.	Width x Depth x Height (m)	Size of reference ground plane/horizontal conducting plane (m)	Maximum measurement distance
No.1 Open site	90558	IC 4659A-1	6.0 x 5.5 x 2.5	20 x 40	10 m
No.2 Open site	510504	IC 4659A-2	4.4 x 4.4 x 2.15	18 x 20	10 m
No.5 Open site	99356	IC 4659A-5	8.6 x 7.1 x 2.4	18 x 23	10 m
No.1 Shielded room	90558	IC 4659A-1	5.4 x 4.5 x 2.3	-	-
No.2 Shielded room	510504	IC 4659A-2	3.6 x 2.7 x 2.3	-	-
No.3 Shielded room	-	-	5.4 x 3.6 x 2.3	-	-
No.4 Shielded Room	-	-	6.1 x 6.1 x 3.1	-	-
No.5 Shielded Room	99356	IC 4659A-5	4.2 x 3.1 x 2.5	-	-
No.3 Fully Anechoic Chamber	-	-	7.0 x 3.5 x 3.5	-	-
No.6 Semi-anechoic Chamber	372431	IC 4659A-6	8.5 x 5.5 x 5.2	-	3 m
No.10 Semi-anechoic Chamber	682397	IC 4659A-10	18.4 x 9.9 x 7.7	-	10 m
No.11 Semi-anechoic Chamber	718605	IC 4659A-7	9.0 x 6.5 x 5.2	-	3 m
No.1 Measurement room	-	-	5.0 x 3.7 x 2.6	-	-
No.2 Measurement room	-	-	4.3 x 4.4 x 2.7	-	-

3.7 Data of tests, Test instruments, and Photographs of test set up

Refer to APPENDIX.

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

4.1 Operating Mode(s)

Test item	Tx Mode	Antenna Type	Tested frequency
All items	Transmitting (Tx), Simplex mode, Data rate: 19.2 kbps	1. Sleeve antenna (standard) 2. Loop PCB antenna 3. Sleeve antenna with MHF	2402.5MHz, 2440.5MHz, 2478.5MHz

Power settings: Fixed

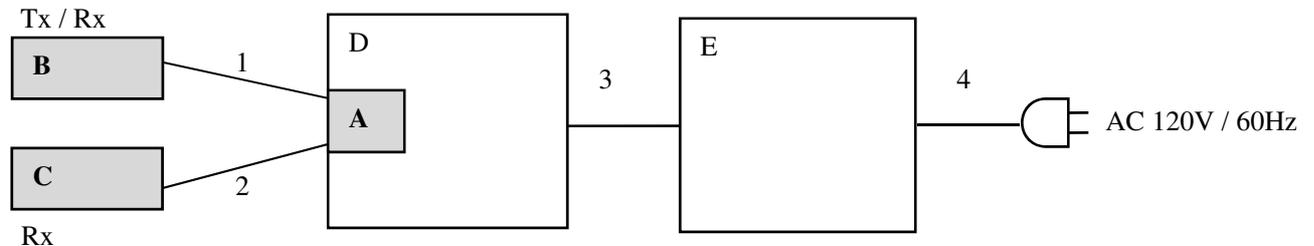
Test software: STD-503, rev1.5.

All test was conducted with the evaluation board, TB-STD-503, manufactured by Circuit Design.

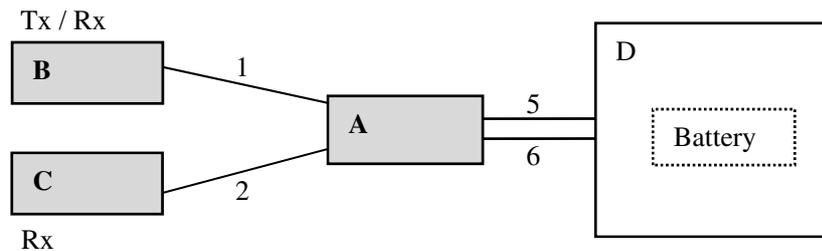
Justification: The system was configured in typical fashion (as customer would normally use it) for testing.

4.2 Configuration and peripherals

Conducted Emission Test



Radiated Emission Test



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

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4.3 EUT(s) and support equipment(s)

No.	Item	Model number	Serial number	Manufacturer	Remark
A	2.4 GHz DSSS low power radio transceiver	STD-503	S00000281	Circuit Design, Inc.	EUT
B-1	Sleeve Antenna (standard)	-	-	Circuit Design, Inc.	EUT
B-2	Loop PCB Antenna	-	-	Circuit Design, Inc.	EUT
B-3	Sleeve Antenna with MHF	-	-	Circuit Design, Inc.	EUT
C-1	Sleeve Antenna (standard)	-	-	Circuit Design, Inc.	EUT
C-2	Loop PCB Antenna	-	-	Circuit Design, Inc.	EUT
C-3	Sleeve Antenna with MHF	-	-	Circuit Design, Inc.	EUT
D	Jig	TB-STD-503	-	Circuit Design, Inc.	-
E	DC Power Supply	GSV3000	1303141419	DIAMOND ANTENNA	-

4.4 Cable(s) used

No.	Cable Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna	0.15	Shielded	Shielded	Sleeve Antenna (standard)
		0.2	Shielded	Shielded	Loop PCB Antenna
		0.1	Shielded	Shielded	Sleeve Antenna with MHF
2	Antenna	0.15	Shielded	Shielded	Sleeve Antenna (standard)
		0.2	Shielded	Shielded	Loop PCB Antenna
		0.1	Shielded	Shielded	Sleeve Antenna with MHF
3	DC	1.8	Unshielded	Unshielded	-
4	AC	1.7	Unshielded	Unshielded	-
5	Extension	0.2	Unshielded	Unshielded	-
6	Extension	0.2	Unshielded	Unshielded	-

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SECTION 5: Conducted emission

5.1 Operating environment

Test place : See test data (APPENDIX 1)
Temperature : See test data (APPENDIX 1)
Humidity : See test data (APPENDIX 1)

5.2 Test configuration

EUT was placed on a platform of nominal size, 1.0m by 2.0m, raised 0.8m above the conducting ground plane. The rear of tabletop was located 40cm to the vertical conducting plane. The rear of EUT, including peripherals was aligned and was flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80cm from LISN. Each EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the input power source. Photographs of the set up are shown in APPENDIX 3.

5.3 Test conditions

Frequency range : 0.15 - 30MHz
EUT position : Table top

5.4 Test procedure

The AC Mains Terminal Continuous disturbance Voltage had been measured with the EUT within a Shielded room. The EUT was connected to a Line Impedance Stabilization Network (LISN) via DC power supply. An overview sweep with peak detection has been performed. The measurements had been performed with a quasi-peak detector and if required, a CISPR average detector. The conducted emission measurements were made with the following detection of the test receiver.

Detection Type : Quasi-Peak/ CISPR-Average
IF Bandwidth : 9kHz

5.5 Results

Summary of the test results : Pass
Refer to APPENDIX 1.

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SECTION 6: 6dB bandwidth & Occupied bandwidth (99%)

Test procedure

The bandwidth was measured with a spectrum analyzer connected to the antenna port.
The test was measured based on Method 8.2 Option 2 of KDB 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Summary of the test results: Pass
Refer to APPENDIX 1.

SECTION 7: Maximum peak conducted output power

Test procedure

The Maximum Peak Output Power was measured with a power meter connected to the antenna port.
The test was measured based on Method 9.1.2 PKPM1 of KDB 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Detection type: Peak / Average *1)

Summary of the test results: Pass
Refer to APPENDIX 1

*1) Average detector was used only for Reference data.

SECTION 8: Maximum power spectral density

Test procedure

The peak power density was measured with a spectrum analyzer connected to the antenna port.

Instrument used : Spectrum Analyzer
RBW / VBW : 3kHz / 9.1kHz

The test was measured based on Method 10.2 PKPSD of KDB 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

Summary of the test results: Pass
Refer to APPENDIX 1.

SECTION 9: Out of band emissions (Antenna port conducted)

Test procedure

The Out of Band Emissions was measured with a spectrum analyzer connected to the antenna port.
In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.
In the frequency range below 30MHz, RBW was narrowed to separate the noise contents.
Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart. (9kHz-150kHz:RBW=200Hz, 150kHz-30MHz:RBW=10kHz)

Summary of the test results: Pass
Refer to APPENDIX 1

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SECTION 10: Radiated emission

10.1 Operating environment

Test place : See test data (APPENDIX 1)
Temperature : See test data (APPENDIX 1)
Humidity : See test data (APPENDIX 1)

10.2 Test configuration

EUT was placed on a platform of nominal size, 0.5m by 0.5m, raised 80cm above the conducting ground plane. Photographs of the set up are shown in APPENDIX 3.

10.3 Test conditions

Frequency range : 30MHz to 25GHz *)
EUT position : Table top

*) It was not measured the radiated emissions from 9kHz to 30MHz, because it had been not detected the noise from 9kHz to 30MHz with the antenna terminal.

10.4 Test procedure

The Radiated Electric Field Strength intensity has been measured on a semi-anechoic chamber with a ground plane and at a distance of 3m(below 15GHz) / 1m(above 15GHz) (Refer to Figure 1). Measurements were performed with quasi-peak, peak and average detector. The measuring antenna height was varied between 1 and 4m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity. The measurements were performed for both vertical and horizontal antenna polarization.

The radiated emission measurements were made with the following detection.

Frequency	30-1000MHz	1-25GHz		20dBc
Detection type	Quasi-Peak	Peak	Average *1)	Peak
IF Bandwidth	120kHz	RBW: 1MHz VBW: 3MHz	RBW: 1MHz VBW: 3MHz Detector: Linear Voltage Averaging	RBW: 100kHz VBW: 300kHz

*1) Average Power Measurement was measured based on 13.3.2 of KDB 558074 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247".

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The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

Combinations of the worst case

Sleeve antenna (standard)

	Hor		Ver	
	Module	Antenna	Module	Antenna
Carrier	Y	X	Y	Y
30M-1GHz	Y	X	Z	X
1-15GHz	Y	X	Y	X
15-18GHz	Y	X	Y	X
18-26GHz	Y	X	Y	X

Loop PCB antenna

	Hor		Ver	
	Module	Antenna	Module	Antenna
Carrier	Y	X	Y	Y
30M-1GHz	Y	X	Z	X
1-15GHz	Y	X	Y	X
15-18GHz	Y	X	Y	X
18-26GHz	Y	X	Y	X

Sleeve antenna with MHF

	Hor		Ver	
	Module	Antenna	Module	Antenna
Carrier	Y	X	Y	Y
30M-1GHz	Y	Y	Z	Y
1-15GHz	Y	X	Y	X
15-18GHz	Y	X	Y	X
18-26GHz	Y	X	Y	X

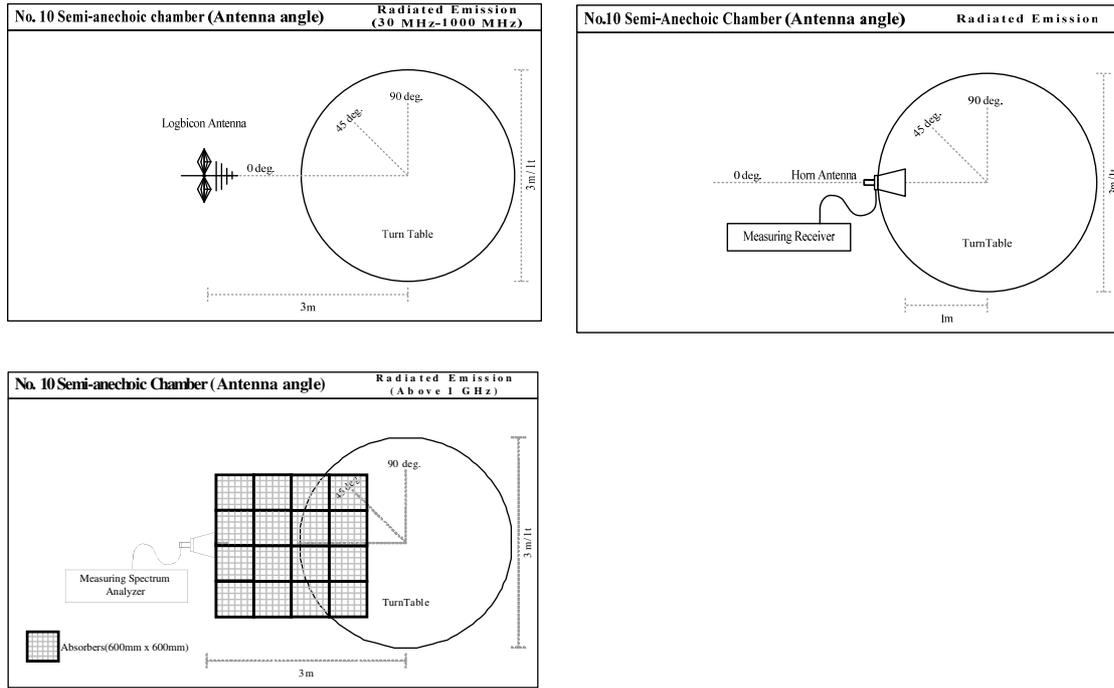


Figure 1. Antenna angle

10.5 Band edge

Band edge level at 2400MHz is less than 20dB of peak point of the carrier.
 Band edge level at 2390MHz and 2483.5MHz is below the limits of FCC 15.209.
 Refer to the data of Radiated emission.

10.6 Results

Summary of the test results : Pass *No noise was detected above the 4th order harmonics.
 Refer to APPENDIX 1

Contents of APPENDIXES

APPENDIX 1: Data of Radio tests

Conducted emission
6dB bandwidth
Maximum peak output power
Radiated emission
Spurious emission (Antenna port conducted)
Maximum power spectral density
Occupied bandwidth

APPENDIX 2: Test instruments

Test instruments

APPENDIX 3: Photographs of test setup

Conducted emission
Radiated emission
Pre-check of worst position

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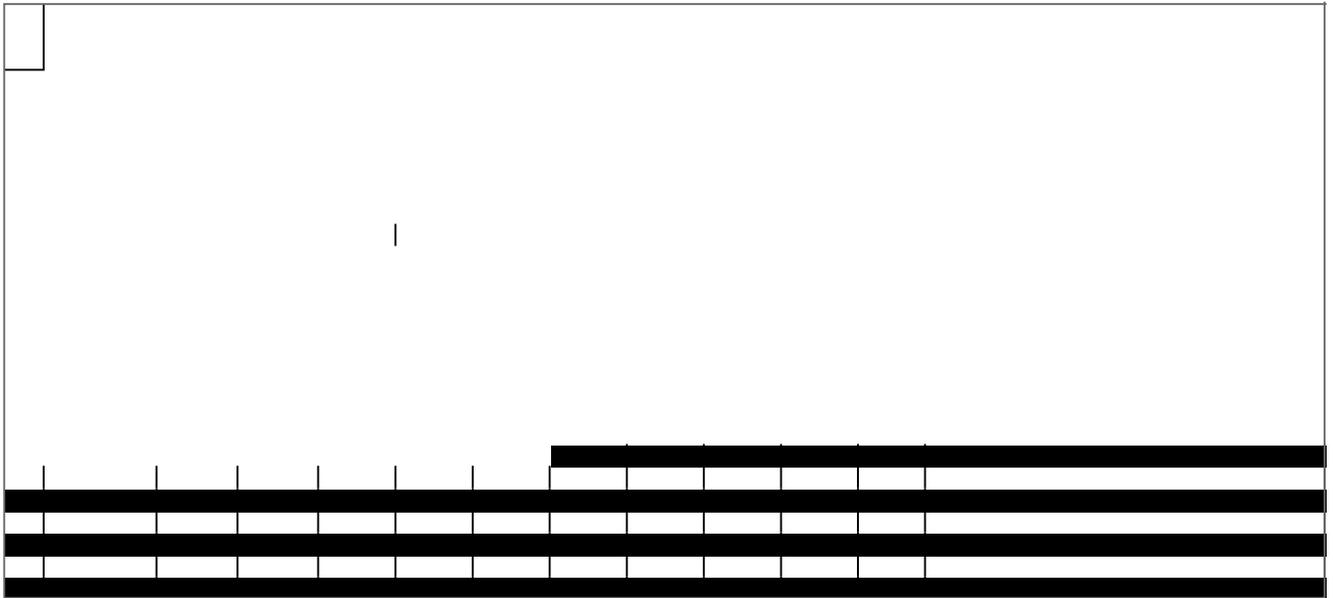
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APPENDIX 1: Data of Radio test

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Conducted Emission

Test Place	UL Japan, Inc. Kashima EMC Lab. No.5 Shielded Room
Order No.	10666354
Tempature/Humidity	2015/02/04
Engineer	21deg.C/38% RH
Mode	Tx,

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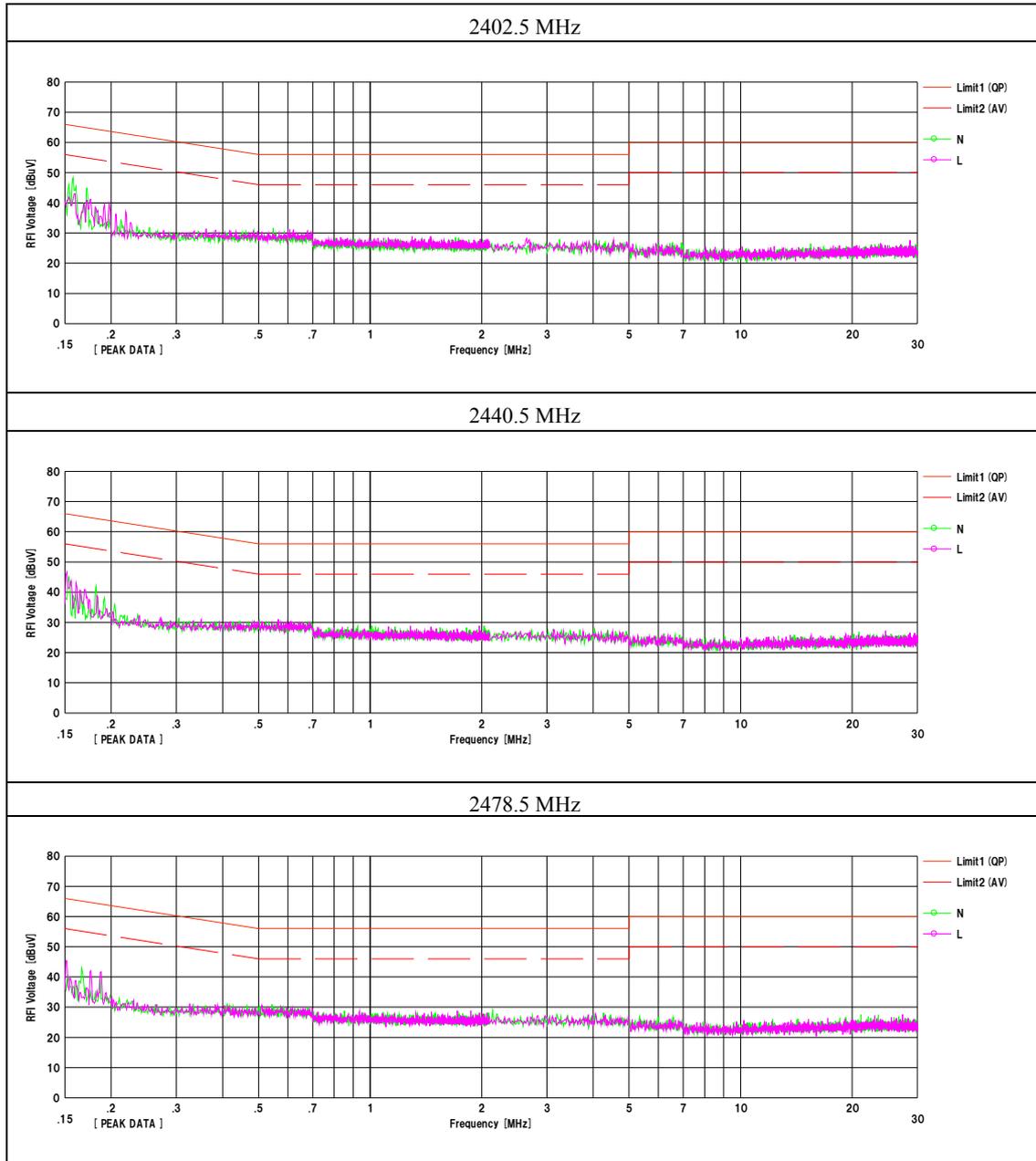
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Conducted Emission

Test Place	UL Japan, Inc. Kashima EMC Lab. No.5 Shielded Room
Order No.	10666354
Temperature/Humidity	2015/02/04
Engineer	21deg.C/38% RH
Mode	Tx, Loop PCB antenna



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Conducted Emission

Test Place	UL Japan, Inc. Kashima EMC Lab. No.5 Shielded Room
Order No.	10666354
Tempature/Humidity	2015/02/04
Engineer	21deg.C/38% RH
Mode	Tx, Sleeve antenna

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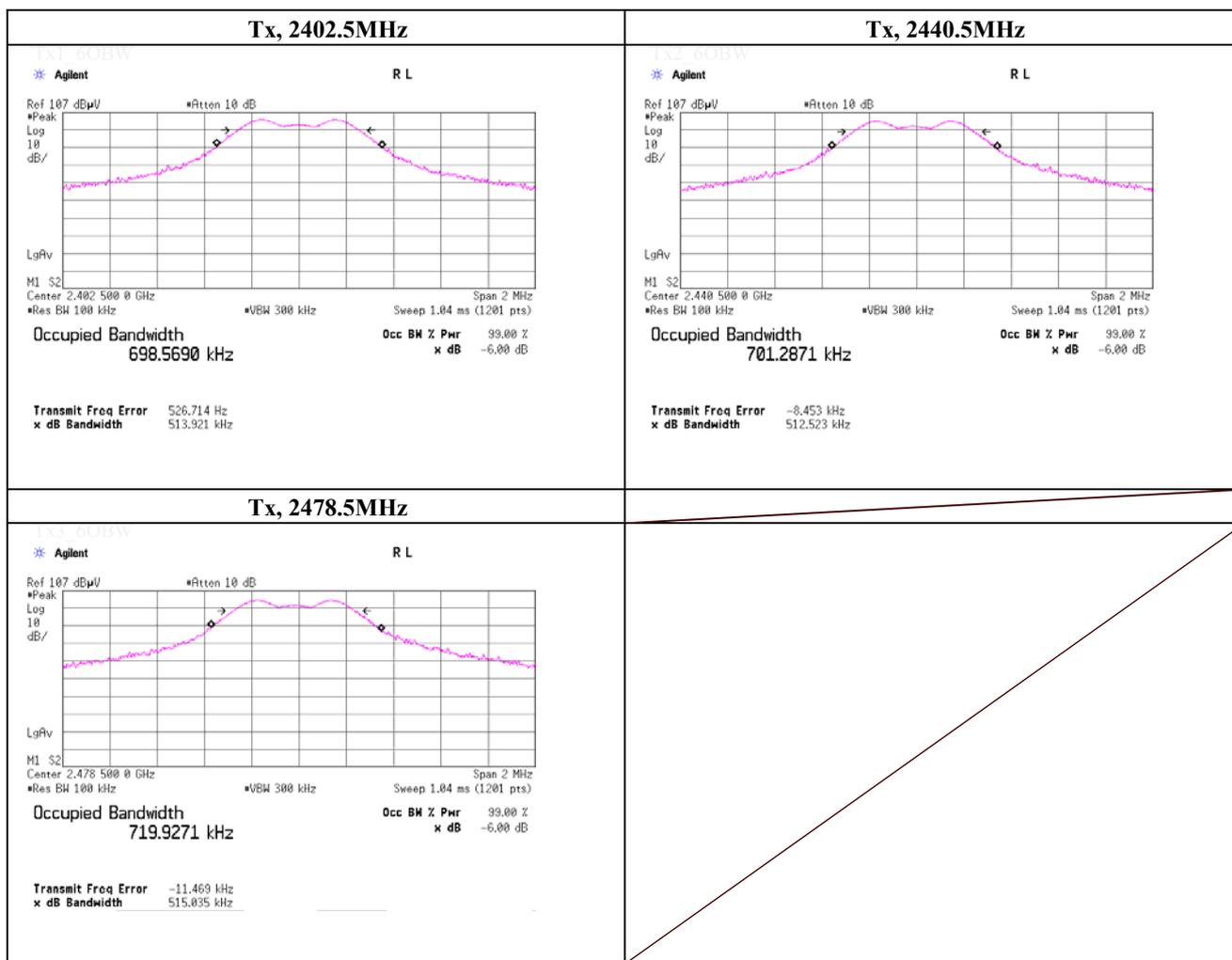
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-6dB Bandwidth

Test place	UL Japan, Inc. Kashima EMC Lab.	No.2 Measurement Room
Date	February 3, 2015	
Temperature / Humidity	23deg.C , 46%RH	
Engineer	Kazuhiro Ando	
Mode	Transmitting	

Freq. [MHz]	-6dB Bandwidth [MHz]	Limit [MHz]
2402.5000	0.514	> 0.500
2440.5000	0.513	> 0.500
2478.5000	0.515	> 0.500



Maximum Peak Conducted Output Power

(PKPM1)

Test place UL Japan, Inc. Kashima EMC Lab. No.2 Measurement Room
Date February 3, 2015
Temperature / Humidity 23deg.C , 46%RH
Engineer Kazuhiro Ando
Mode Transmitting

(* P/M: Power Meter with power sensor)

Ch	Freq. [MHz]	P/M (Peak) Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
					[dBm]	[mW]	[dBm]	[mW]	
Low	2402.5	-4.44	1.11	10.07	6.74	4.72	30.00	1000	23.26
Mid	2440.5	-5.12	1.12	10.07	6.07	4.05	30.00	1000	23.93
High	2478.5	-5.63	1.12	10.07	5.56	3.60	30.00	1000	24.44

Sample Calculation:

Result = Reading + Cable Loss + Atten. Loss

Maximum Average Conducted Output Power (Reference data for SAR test)

(AVGPM)

Ch	Freq. [MHz]	P/M (AV) Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result	
					[dBm]	[mW]
Low	2402.5	-4.58	1.11	10.07	6.60	4.57
Mid	2440.5	-5.29	1.12	10.07	5.90	3.89
High	2478.5	-5.83	1.12	10.07	5.36	3.44

Sample Calculation:

Result = Reading + Cable Loss + Atten. Loss

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Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 6, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	20 deg.C, 35 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Hiromitsu Tanabe	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2402.5 MHz with		

Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 6, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	20 deg.C, 35 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Hiromitsu Tanabe	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2440.5 MHz with		

Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 6, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	20 deg.C, 35 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Hiromitsu Tanabe	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2478.5 MHz with		

Radiated Emission

Test place UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber
 Date February 7, 2015 February 9, 2015 February 10, 2015
 Temperature / Humidity 20 deg.C, 39 %RH 20 deg.C, 30 %RH 20 deg.C, 39 %RH
 Engineer Tadashi Kuroda Kazutaka Takeyama Tadashi Kuroda
 Mode Tx, 2402.5 MHz
 with Loop PCB antenna

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	240.000	QP	37.3	11.4	6.8	26.1	29.4	46.0	16.6	131	0	
Hori.	352.000	QP	34.6	14.5	7.8	26.3	30.6	46.0	15.4	100	290	
Hori.	496.000	QP	32.1	17.7	8.7	27.3	31.2	46.0	14.8	209	215	
Hori.	560.000	QP	31.8	18.9	9.1	27.6	32.2	46.0	13.8	152	81	
Hori.	592.000	QP	32.9	19.5	9.3	27.6	34.1	46.0	11.9	137	91	
Hori.	624.000	QP	32.4	19.9	9.4	27.6	34.1	46.0	11.9	129	88	
Hori.	656.000	QP	30.9	20.3	9.6	27.6	33.2	46.0	12.8	123	90	
Hori.	2389.344	PK	40.3	27.6	24.2	38.5	53.6	73.9	20.3	115	223	
Hori.	2390.000	PK	40.0	27.6	24.2	38.5	53.3	73.9	20.6	115	223	
Hori.	4805.000	PK	58.1	31.3	6.0	39.6	55.8	73.9	18.1	100	205	
Hori.	7207.500	PK	48.7	36.0	7.5	38.7	53.5	73.9	20.4	100	39	
Hori.	2389.344	AV	32.7	27.6	24.2	38.5	46.0	53.9	7.9	115	223	
Hori.	2390.000	AV	31.3	27.6	24.2	38.5	44.6	53.9	9.3	115	223	
Hori.	4805.000	AV	54.4	31.3	6.0	39.6	52.1	53.9	1.8	100	205	
Hori.	7207.500	AV	41.3	36.0	7.5	38.7	46.1	53.9	7.8	100	39	
Vert.	496.000	QP	34.9	17.7	8.7	27.3	34.0	46.0	12.0	100	99	
Vert.	528.000	QP	32.8	18.3	8.9	27.5	32.5	46.0	13.5	100	284	
Vert.	2389.344	PK	40.5	27.6	24.2	38.5	53.8	73.9	20.1	110	293	
Vert.	2390.000	PK	40.3	27.6	24.2	38.5	53.6	73.9	20.3	110	293	
Vert.	4805.000	PK	55.8	31.3	6.0	39.6	53.5	73.9	20.4	100	215	
Vert.	7207.500	PK	45.0	36.0	7.5	38.7	49.8	73.9	24.1	155	290	
Vert.	2389.344	AV	32.9	27.6	24.2	38.5	46.2	53.9	7.7	110	293	
Vert.	2390.000	AV	31.6	27.6	24.2	38.5	44.9	53.9	9.0	110	293	
Vert.	4805.000	AV	51.4	31.3	6.0	39.6	49.1	53.9	4.8	100	215	
Vert.	7207.500	AV	35.2	36.0	7.5	38.7	40.0	53.9	13.9	155	290	

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 15GHz) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

20dBc Data Sheet (RBW 100kHz, VBW 300kHz)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.500	PK	88.2	27.5	24.2	38.5	101.4	-	-	Carrier
Hori.	2400.000	PK	40.5	27.5	24.2	38.5	53.7	81.4	27.7	
Vert.	2402.500	PK	89.7	27.5	24.2	38.5	102.9	-	-	Carrier
Vert.	2400.000	PK	41.6	27.5	24.2	38.5	54.8	82.9	28.1	

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 15GHz) - Gain(Amplifier)

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Radiated Emission

Test place UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber
 Date February 7, 2015 February 9, 2015 February 10, 2015
 Temperature / Humidity 20 deg.C, 39 %RH 20 deg.C, 30 %RH 20 deg.C, 39 %RH
 Engineer Tadashi Kuroda Kazutaka Takeyama Tadashi Kuroda
 Mode Tx, 2440.5 MHz
 with Loop PCB antenna

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	240.000	QP	37.1	11.4	6.8	26.1	29.2	46.0	16.8	131	0	
Hori.	352.000	QP	34.7	14.5	7.8	26.3	30.7	46.0	15.3	100	289	
Hori.	496.000	QP	33.4	17.7	8.7	27.3	32.5	46.0	13.5	211	226	
Hori.	560.000	QP	32.4	18.9	9.1	27.6	32.8	46.0	13.2	148	81	
Hori.	592.000	QP	32.9	19.5	9.3	27.6	34.1	46.0	11.9	138	85	
Hori.	624.000	QP	32.5	19.9	9.4	27.6	34.2	46.0	11.8	132	90	
Hori.	656.000	QP	30.9	20.3	9.6	27.6	33.2	46.0	12.8	123	90	
Hori.	4881.000	PK	57.5	31.2	6.0	39.6	55.1	73.9	18.8	100	205	
Hori.	7321.500	PK	48.6	36.2	7.6	38.7	53.7	73.9	20.2	100	24	
Hori.	4881.000	AV	54.0	31.2	6.0	39.6	51.6	53.9	2.3	100	205	
Hori.	7321.500	AV	41.1	36.2	7.6	38.7	46.2	53.9	7.7	100	24	
Vert.	496.000	QP	34.6	17.7	8.7	27.3	33.7	46.0	12.3	100	124	
Vert.	528.000	QP	32.7	18.3	8.9	27.5	32.4	46.0	13.6	100	272	
Vert.	4881.000	PK	54.1	31.2	6.0	39.6	51.7	73.9	22.2	110	210	
Vert.	7321.500	PK	44.8	36.2	7.6	38.7	49.9	73.9	24.0	180	270	
Vert.	4881.000	AV	50.0	31.2	6.0	39.6	47.6	53.9	6.3	110	210	
Vert.	7321.500	AV	34.0	36.2	7.6	38.7	39.1	53.9	14.8	180	270	

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 15GHz) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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Radiated Emission

Test place UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber
 Date February 7, 2015 February 9, 2015 February 10, 2015
 Temperature / Humidity 20 deg.C, 39 %RH 20 deg.C, 30 %RH 20 deg.C, 39 %RH
 Engineer Tadashi Kuroda Kazutaka Takeyama Tadashi Kuroda
 Mode Tx, 2478.5 MHz
 with Loop PCB antenna

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	240.000	QP	37.3	11.4	6.8	26.1	29.4	46.0	16.6	126	2	
Hori.	352.000	QP	35.0	14.5	7.8	26.3	31.0	46.0	15.0	100	288	
Hori.	496.000	QP	34.1	17.7	8.7	27.3	33.2	46.0	12.8	100	217	
Hori.	560.000	QP	32.2	18.9	9.1	27.6	32.6	46.0	13.4	148	85	
Hori.	592.000	QP	32.4	19.5	9.3	27.6	33.6	46.0	12.4	139	87	
Hori.	624.000	QP	32.1	19.9	9.4	27.6	33.8	46.0	12.2	130	90	
Hori.	656.000	QP	30.6	20.3	9.6	27.6	32.9	46.0	13.1	122	87	
Hori.	2483.500	PK	45.0	27.5	24.3	38.5	58.3	73.9	15.6	113	56	
Hori.	4957.000	PK	58.8	31.4	6.1	39.6	56.7	73.9	17.2	100	205	
Hori.	7435.500	PK	52.3	36.3	7.6	38.6	57.6	73.9	16.3	100	34	
Hori.	2483.500	AV	35.4	27.5	24.3	38.5	48.7	53.9	5.2	113	56	
Hori.	4957.000	AV	54.9	31.4	6.1	39.6	52.8	53.9	1.1	100	205	
Hori.	7435.500	AV	46.3	36.3	7.6	38.6	51.6	53.9	2.3	100	34	
Vert.	496.000	QP	33.9	17.7	8.7	27.3	33.0	46.0	13.0	100	118	
Vert.	528.000	QP	32.6	18.3	8.9	27.5	32.3	46.0	13.7	100	264	
Vert.	2483.500	PK	46.0	27.5	24.3	38.5	59.3	73.9	14.6	107	286	
Vert.	4957.000	PK	56.7	31.4	6.1	39.6	54.6	73.9	19.3	106	210	
Vert.	7435.500	PK	47.4	36.3	7.6	38.6	52.7	73.9	21.2	166	270	
Vert.	2483.500	AV	36.8	27.5	24.3	38.5	50.1	53.9	3.8	107	286	
Vert.	4957.000	AV	54.0	31.4	6.1	39.6	51.9	53.9	2.0	106	210	
Vert.	7435.500	AV	38.3	36.3	7.6	38.6	43.6	53.9	10.3	166	270	

Result = Reading + Ant.Fac. + Loss (Cable+Attenuator+Filter)(below 18GHz)-Distance factor(above 15GHz) - Gain(Amplifier)

Distance factor : 15GHz -40GHz : 20log(3.0m/1.0m)= 9.5dB

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Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 8, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	22 deg.C, 42 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Kazuhiro Ando	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2402.5 MHz with Sleeve antenna		

Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 8, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	22 deg.C, 42 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Kazuhiro Ando	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2440.5 MHz with		

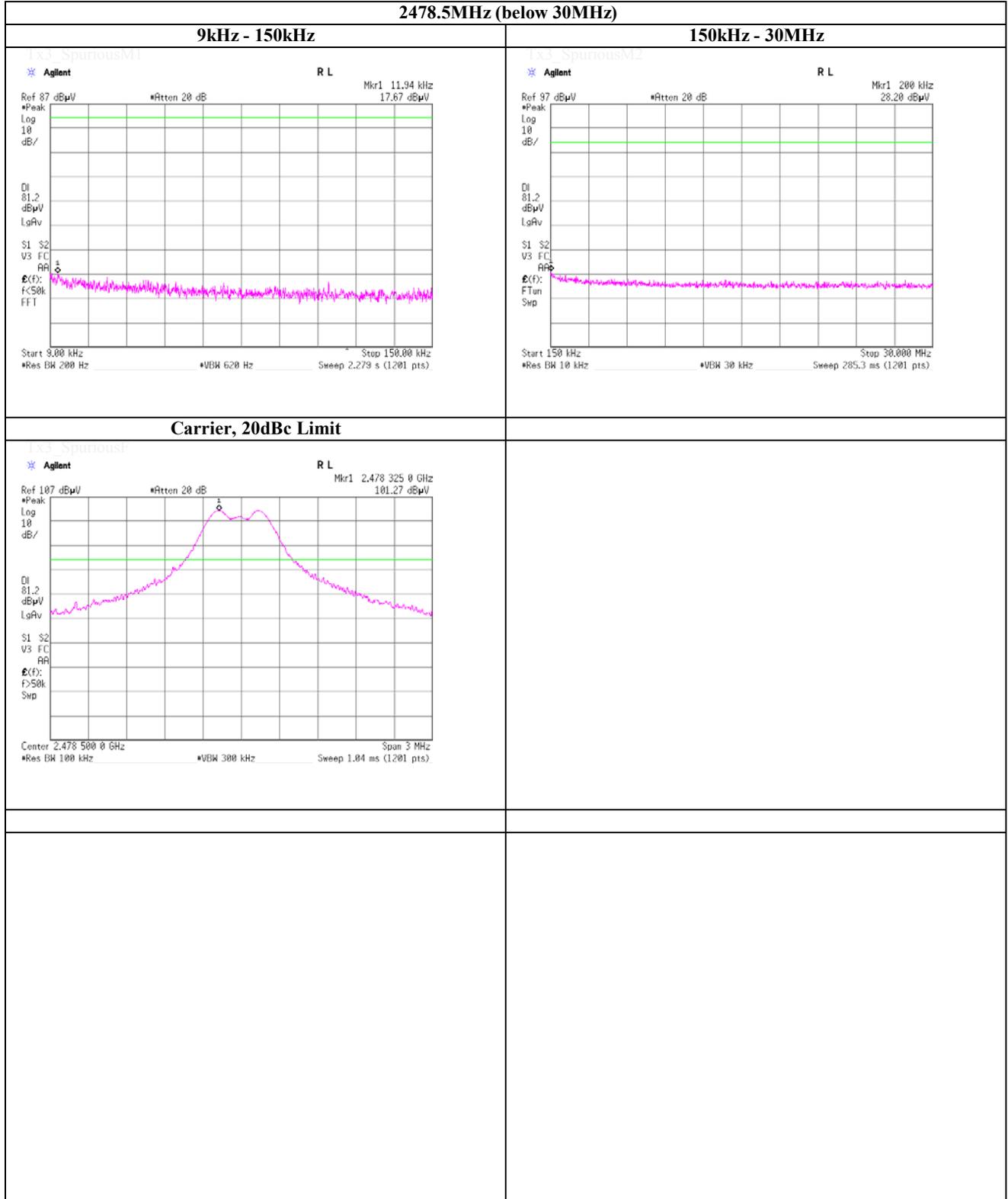
Test place	UL Japan, Inc. Kashima EMC Lab. No.10 Semi Anechoic Chamber		
Date	February 8, 2015	February 9, 2015	February 10, 2015
Temperature / Humidity	22 deg.C, 42 %RH	20 deg.C, 30 %RH	20 deg.C, 39 %RH
Engineer	Kazuhiro Ando	Kazutaka Takeyama	Tadashi Kuroda
Mode	Tx, 2478.5 MHz with		

Test place UL Japan, Inc. Kashima EMC Lab. No.2 Measurement Room
 Date February 3, 2015
 Temperature / Humidity 23deg.C , 46%RH
 Engineer Kazuhiro Ando

Spurious emission (Conducted)

Transmitting

2478.5MHz (below 30MHz)



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Maximum Power Spectral Density

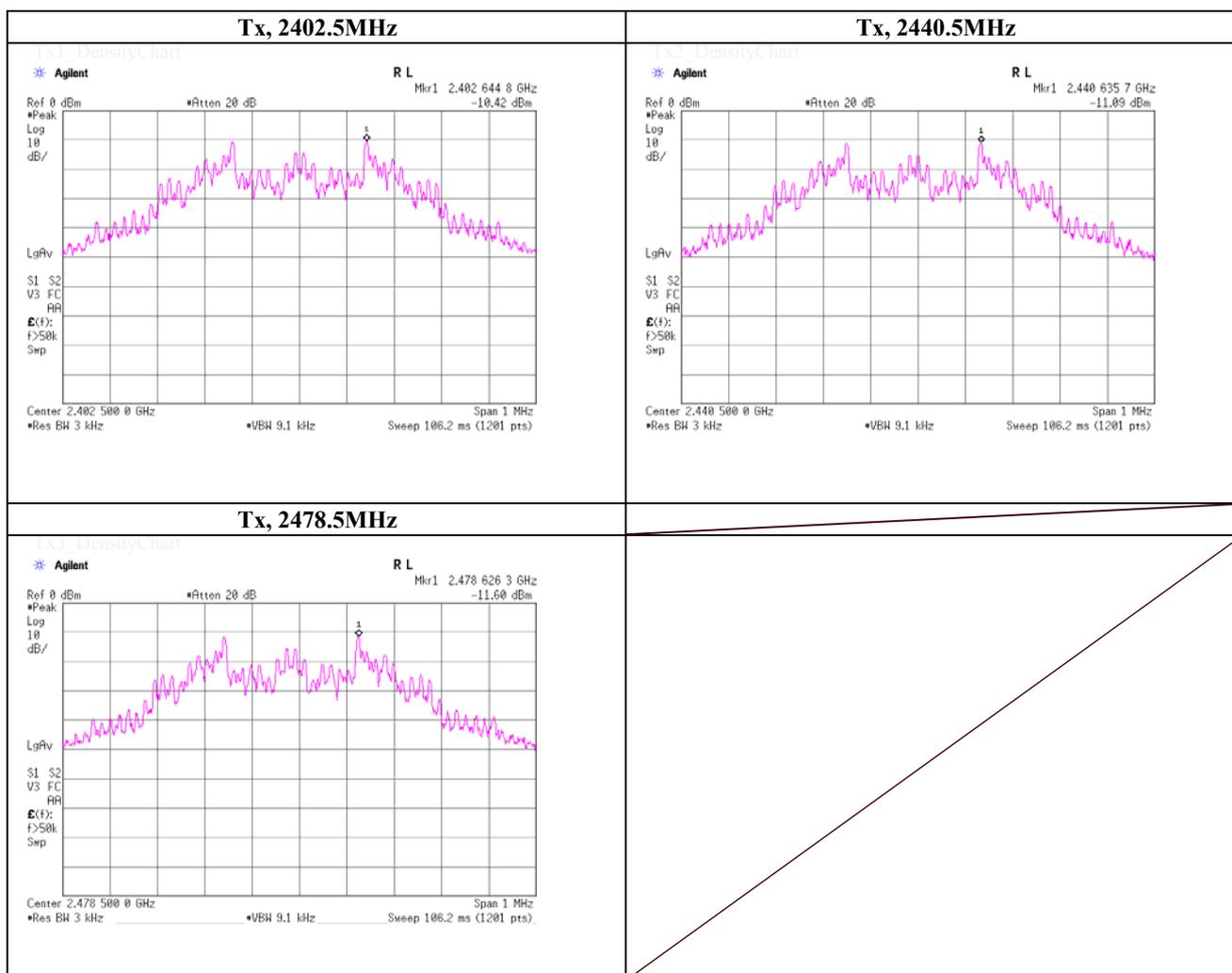
(PKPSD)

Test place	UL Japan, Inc. Kashima EMC Lab.	No.2 Measurement Room
Date	February 3, 2015	
Temperature / Humidity	23deg.C , 46%RH	
Engineer	Kazuhiro Ando	
Mode	Transmitting	

Ch. Freq. [MHz]	Freq. Reading [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.5000	2402.64	-10.42	1.11	10.07	0.76	8.00	7.24
2440.5000	2440.64	-11.09	1.12	10.07	0.10	8.00	7.90
2478.5000	2478.63	-11.60	1.12	10.07	-0.41	8.00	8.41

Sample Calculation:

Result = Reading + Cable Loss + Atten. Loss



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Kashima EMC Lab.

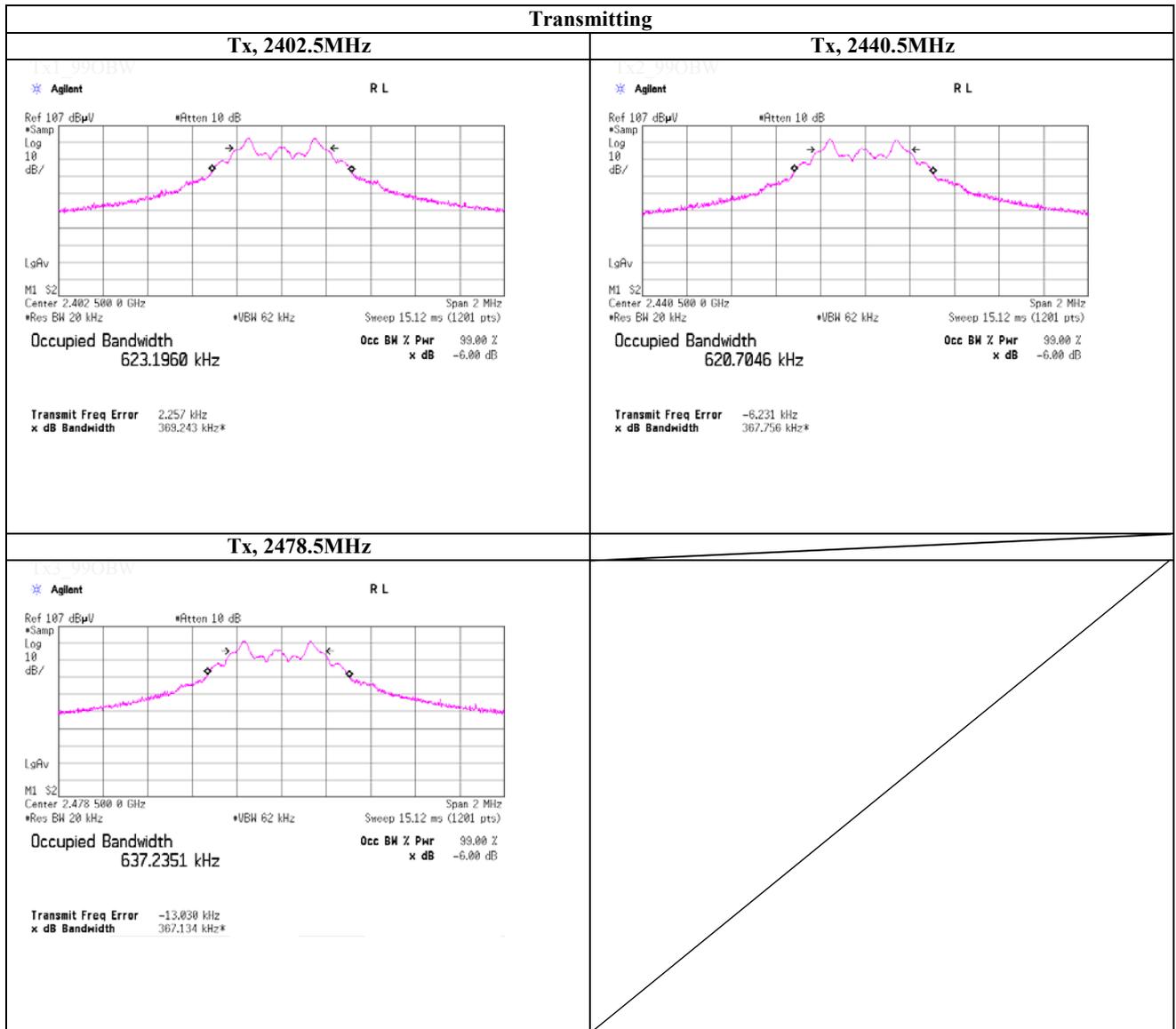
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Test place UL Japan, Inc. Kashima EMC Lab. No.2 Measurement Room
 Date February 3, 2015
 Temperature / Humidity 23deg.C , 46%RH
 Engineer Kazuhiro Ando

99% Occupied Bandwidth



UL Japan, Inc.
Kashima EMC Lab.
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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)
CSA-07	Spectrum Analyzer	Agilent	E4448A	MY52490024	AT	2014/05/19 * 12
CAT10-17	10dB Fixed Atten.	Weinschel	54A-10	56251	AT	2014/05/23 * 12
CCC-W06	Micro Wave Cable	Junkosha	MWX241	MRA-12-14-14 6	AT	2014/05/23 * 12
CPM-16	Peak Power Analyzer	Agilent	8990B	MY51000276	AT	2014/06/26 * 12
CP50-24	Power Sensor	Agilent	N1923A	MY54070024	AT	2014/06/26 * 12
COS-12	Temperature & Humidity Indicator	A&D	AD-5681	6876017	AT	2014/07/01 * 12
CLS-11	A.M.N.	Rohde & Schwarz	ESH3-Z5	835239/022	CE	2014/07/09 * 12
CCC-S5-C(2/9/10/11)	Coaxial Cable	Fujikura,Fujikura,Fujikura .Fujikura	5D-2W,5D-2W,5D-2W, 5D-2W	-	CE	2014/07/09 * 12
CTR-01	Test Receiver	Rohde & Schwarz	ESU40	100426	CE	2014/04/01 * 12
CSCL-06	Ruler	Tajima	L19-55S	none	CE	2014/02/03 * 12
COS-05	Temperature & Humidity Indicator	A&D	AD-5681	6975761	CE	2014/07/01 * 12
COTS-CEMI-02	EMI Software	T SJ	TEPTO-DV(RE,CE, MF,PE)	Ver.2.5.0130	CE/RE	-
CTR-09	Test Receiver	Agilent	N9038A	MY53290016	RE	2014/06/06 * 12
CBL-08	LOGBICON	Schwarzbeck	VULB 9168	343	RE	2014/11/15 * 12
CCC-S10-R(2/4/CATS-11/5/6/7/8/11/12)	Coaxial Cable	Fujikura,Fujikura,Agilent, Fujikura,Fujikura,Fujikura .Fujikura,Fujikura,Fujiku ra	5D-2W,5D-2W,8494 A,5D-2W,5D-2W,5D-2W, 5D-2W,5D-2W,5D-2W, 5D-2W	MY41110200(St ep Att)	RE	2014/08/29 * 12
CAF-08	Pre-Amplifier	Hewlett Packard	8447D	2944A09041	RE	2014/08/29 * 12
CSCL-13	Ruler	Tajima	L19-55	none	RE	2014/02/03 * 12
COS-10	Temperature & Humidity Indicator	HIOKI	3641/9680-50	090999895/090 905406	RE	2014/05/07 * 12
CAT3-04	3dB Fixed Atten.	TAMAGAWA	UFA-01	none	RE	2014/09/18 * 12
CSA-06	Spectrum Analyzer	Agilent	N9030A	MY53310670	RE	2014/05/20 * 12
CCC-W05	Micro Wave Cable	Junkosha	MWX241	MRA-12-14-14 5	RE	2014/05/23 * 12
CAF-18	Pre-Amplifier	TOYO	TPA0118-36	A-1001	RE	2014/07/14 * 12
CCC-W07	Micro Wave Cable	Junkosha	MWX221	MRA-12-14-14 8	RE	2014/05/23 * 12
CHF-03	HPF	Micro-Tronics	HPM50111-02	008	RE	2014/05/23 * 12
CAT20-04	20dB Fixed Atten.	Weinschel	54A-20	41994	RE	2014/05/23 * 12
CHA-20	Broad Band Horn	Schwarzbeck	BBHA 9120D	9120D-1270	RE	2014/07/12 * 12
CCC-W09	Micro Wave Cable	SUHNER	SUCOFLEX104	MY588/4	RE	2014/07/17 * 12
CHA-07	Double Ridged Horn	ETS-Lindgren	3160-09	00166043	RE	2014/06/26 * 12

The expiration date of the calibration is the end of the expired month .
As for some calibrations performed after the tested dates , those test equipment have been controlled by means of an unbroken chains of calibrations .

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

Test Item :

- CE: Conducted emission ,
- RE: Radiated emission ,
- AT: Antenna terminal disturbance voltage