RADIO TEST REPORT

Test Report No. : 10101498H-A-R1

Applicant	:	**FUJITSU COMPONENT LIMITED**
Type of Equipment	:	**Bluetooth Low Energy Module**
Model No.	:	**MBH7BLZ02**
FCC ID	:	**SQK-7BLZXX**
Test regulation	:	**FCC Part 15 Subpart C: 2013**
Test Result	:	**Complied**

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
6. This report is a revised version of 10101498H-A. 10101498H-A is replaced with this report.

Date of test: November 7 to 20, 2013

Representative test engineer:
T. Shimada
Takumi Shimada
Engineer of WiSE Japan,
UL Verification Service

Approved by:
T. Hatakeda
Takahiro Hatakeda
Leader of WiSE Japan,
UL Verification Service

NVLAP®
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://www.ul.com/japan/jpn/pages/services/emc/about/mark1/index.jsp#nvlap

REVISION HISTORY

Original Test Report No.: 10101498H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10101498H-A	November 20, 2013	-	-
1	10101498H-A-R1	November 21, 2013	P.18-20	Correction of explanatory note for test data

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	FUJITSU COMPONENT LIMITED
Address	:	Gotanda-Chuo Bldg.,3-5,Higashi-Gotanda 2-chome,Shinagawa-ku, Tokyo, 141-0022 Japan
Telephone Number	:	+81-3-5449-7802
Facsimile Number	:	+81-3-5449-7812
Contact Person	:	Takeshi Wakui

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

2.1 Identification of E.U.T.

Type of Equipment	:	Bluetooth Low Energy Module
Model No.	:	MBH7BLZ02
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC3.3V
Receipt Date of Sample	:	October 31, 2013
Country of Mass-production	:	Japan
Condition of EUT	:	Production 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

General Specification

Clock frequency(ies) in the system	:	Oscillator: 16MHz

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	2402-2480MHz
Modulation	:	GFSK
Power Supply (radio part input)	:	DC 1.8V
Antenna type	:	Mono-pole Antenna
Antenna Gain	:	-1.4dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification	:	FCC Part 15 Subpart C: 2013, final revised on September 30, 2013 and effective October 30, 2013
Title	:	FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.4:2003 7. AC powerline Conducted Emission measurements	**FCC:** Section 15.207	**QP** 18.4dB, 0.39263MHz, N **AV** 14.8dB, 0.39263MHz, N	Complied	-
	IC: RSS-Gen 7.2.4	**IC:** RSS-Gen 7.2.4			
6dB Bandwidth	**FCC:** "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247(issued on April 9, 2013)"	**FCC:** Section 15.247(a)(2)	See data.	Complied	Conducted
	IC: RSS-Gen 4.6.2	**IC:** RSS-210 A8.2(a)			
Maximum Peak Output Power	**FCC:** "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247(issued on April 9, 2013)"	**FCC:** Section 15.247(b)(3)		Complied	Conducted
	IC: RSS-Gen 4.8	**IC:** RSS-210 A8.4(4)			
Power Density	**FCC:** "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247(issued on April 9, 2013)"	**FCC:** Section 15.247 (e)		Complied	Conducted
	IC: -	**IC:** RSS-210 A8.2(b)			
Spurious Emission Restricted Band Edges	**FCC:** "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247(issued on April 9, 2013)"	**FCC:** Section15.247(d)	4.2dB 2483.500MHz, AV, Hori.	Complied	Conducted/ Radiated
	IC: RSS-Gen 4.9	**IC:** RSS-210 A8.5 RSS-Gen 7.2.3			
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.					

* In case any questions arise about test procedure, ANSI C63.4: 2003 is also referred.

FCC 15.31 (e)

This EUT provides stable voltage (DC1.8V) constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203/212 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 15.203/212.

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	**IC:** RSS-Gen 4.6.1	**IC:** RSS-Gen 4.6.1	N/A	-	Conducted

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 room (semi-anechoic chamber)	Conducted emission (±dB)
	150kHz-30MHz
No.1	3.5dB
No.2	3.5dB
No.3	3.6dB
No.4	3.5dB

Test room (semi-anechoic chamber)	Radiated emission						
	(3m*)(±dB)				(1m*)(±dB)		(0.5m*)(±dB)
	9kHz -30MHz	30MHz -300MHz	300MHz -1GHz	1GHz -10GHz	10GHz -18GHz	18GHz -26.5GHz	26.5GHz -40GHz
No.1	4.0dB	5.1dB	5.0dB	5.1dB	6.0dB	4.9dB	4.3dB
No.2	3.9dB	5.2dB	5.0dB	4.9dB	5.9dB	4.7dB	4.2dB
No.3	4.3dB	5.1dB	5.2dB	5.2dB	6.0dB	4.8dB	4.2dB
No.4	4.6dB	5.2dB	5.0dB	5.2dB	6.0dB	5.7dB	4.2dB

*3m/1m/0.5m = Measurement distance

Power meter (±dB)	
Below 1GHz	Above 1GHz
0.7dB	1.5dB

Antenna terminal conducted emission and Power density (±dB)			Antenna terminal conducted emission (±dB)		Channel power (±dB)
Below 1GHz	1GHz-3GHz	3GHz-18GHz	18GHz-26.5GHz	26.5GHz-40GHz	
1.5dB	1.7dB	2.8dB	2.8dB	2.9dB	2.6dB

Conducted Emission test

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

Radiated emission test(3m)

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

3.5 Test Location

UL Japan, Inc. Head Office 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

	FCC Registration Number	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	313583	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	655103	2973C-2	7.5 x 5.8 x 5.2m	4.0 x 4.0m	-
No.3 semi-anechoic chamber	148738	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	134570	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	2.4 x 3.4m	-

* 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 Data of EMI, Test instruments, and Test set up

Refer to APPENDIX.

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

4.1 Operating Mode(s)

Bluetooth (BT): Transmitting (Tx)

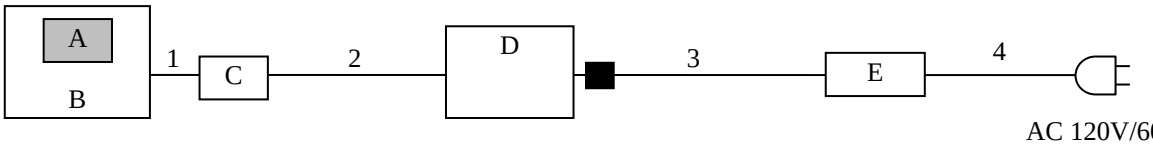
Details of Operating Mode(s)

Test Item	Operating Mode	Tested Frequency
Conducted Emission Spurious Emission 6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Tx BT LE	2402MHz 2440MHz 2480MHz

*Power of the EUT was set by the software as follows;
Power settings: 37byte (payload)
Software: nRFgo Studio Ver.1.15.1.2691

*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



■ : Standard Ferrite Core

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

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remark
A	Bluetooth Low Energy Module	MBH7BLZ02	No.2	FUJITSU COMPONENT LIMITED	EUT
B	Daughter board	-	-	FUJITSU COMPONENT LIMITED	-
C	Mother board	-	-	FUJITSU COMPONENT LIMITED	-
D	Laptop PC	Compaq 6730b	CNV0092TPJ	HP	-
E	AC Adapter	PPP014H-S	F3-07110165670C	HP	-

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Signal Cable	0.3	Unshielded	Unshielded	-
2	USB Cable	1.8	Shielded	Shielded	-
3	DC Cable	1.8	Unshielded	Unshielded	-
4	AC Cable	1.8	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a wooden table of nominal size, 1.0m by 1.5m, 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 aligned and 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 a Line Impedance Stabilization Network (LISN)/ Artificial mains Network (AMN) and excess AC cable was bundled in center.

For the tests on EUT with other peripherals (as a whole system)
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30cm to 40cm long and were hanged at a 40cm height to the ground plane. All unused 50ohm connectors of the LISN(AMN) were resistivity terminated in 50ohm when not connected to the measuring equipment.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber.
The EUT was connected to a LISN (AMN).
An overview sweep with peak detection has been performed.

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

Detector	**: QP and CISPR AV**
Measurement range	**: 0.15-30MHz**
Test data	**: APPENDIX**
Test result	**: Pass**

SECTION 6: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (Issued on April 9, 2013)".
EUT was placed on a urethane platform of nominal size, 0.5m by 1.0m, raised 0.8m above the conducting ground plane.
The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.
The height of the measuring antenna varied between 1 and 4m 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 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 30MHz	30MHz to 300MHz	300MHz to 1GHz	Above 1GHz
Antenna Type	Loop	Biconical	Logperiodic	Horn

In any 100kHz bandwidth outside the restricted 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.

20dBc was applied to the frequency over the limit of FCC 15.209 / Table 5 of RSS-Gen 7.2.5(IC) and outside the restricted band of FCC15.205 / Table 3 of RSS-Gen 7.2.2 (IC).

Frequency	Below 1GHz	Above 1GHz		20dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1)	PK
IF Bandwidth	BW 120kHz(T/R)	RBW: 1MHz VBW: 3MHz	Alternative Method1 RBW: 1MHz VBW: 3MHz Trace: Free Run Detector: Power Averaging (RMS) Duty factor was added to the results.	RBW: 100kHz VBW: 300kHz (S/A)
			PK with Duty factor	
Test Distance	3m	3m (below 10GHz), 1m *2) (above 10GHz)		3m (below 10GHz), 1m *2) (above 10GHz)

*1) Average Power Measurement was performed based on 6.0 & 12.2.5 of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (Issued on April 9, 2013)"
*2) Distance Factor: 20 x log (3.0m/1.0m) = 9.5dB

- 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.

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

Measurement range : 30M-26.5GHz
Test data : APPENDIX
Test result : Pass

SECTION 7: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
6dB Bandwidth	3MHz	100kHz	300kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth	Enough width to display 20dB Bandwidth	1 to 3% of Span	Three times of RBW	Auto	Peak	Max Hold*1)	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 50MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3kHz	10kHz	116msec	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4)	9kHz to 150kHz	200Hz	620Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	9.1kHz	27kHz				

*1) The measurement was performed with Max Hold since the duty cycle was not 100%.
*2) Reference data
*3) Section 10.2 Method PKPSD (peak PSD) of "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (Issued on April 9, 2013)".
*4) 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 low enough as shown in the chart.(9kHz-150kHz:RBW=200Hz, 150kHz-30MHz:RBW=9.1kHz).

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

Test data : APPENDIX
Test result : Pass

APPENDIX 1: Data of EMI test

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

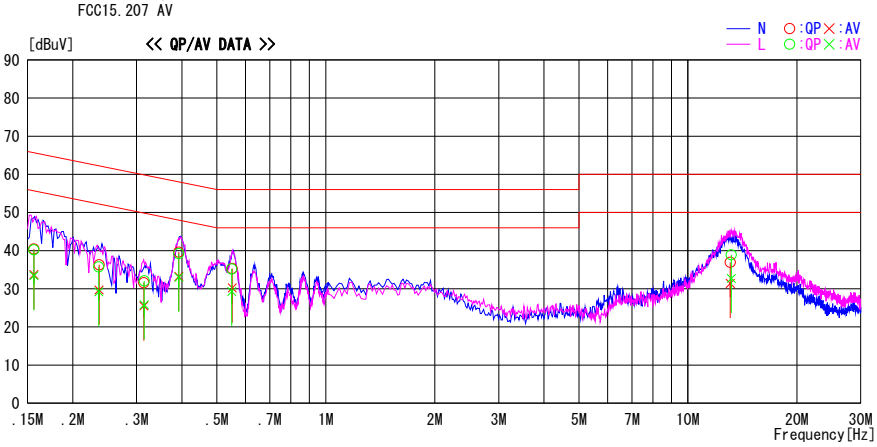
UL Japan, Inc. Head Office EMC Lab. No.4 Semi Anechoic Chamber
Date : 2013/11/20

Report No. : 10101498H

Temp./Humi. : 24deg. C / 48% RH
Engineer : Takayuki Shimada

Mode / Remarks : LE Tx 2440MHz

LIMIT : FCC15.207 QP
FCC15.207 AV



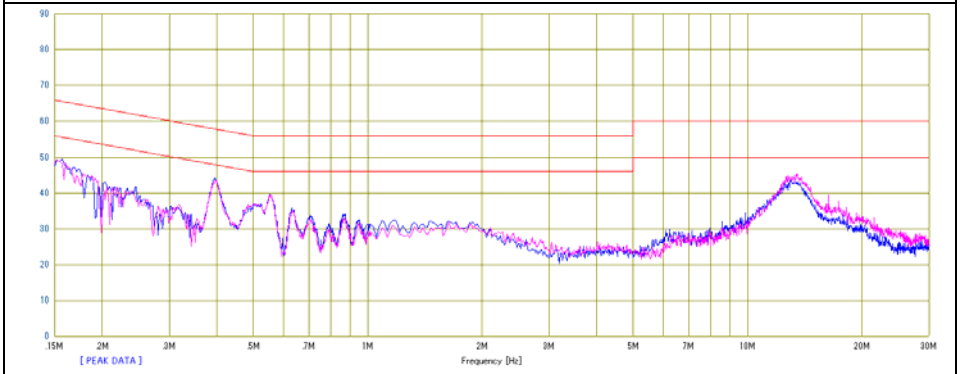
Frequency	Reading Level		Corr.	Results		Limit		Margin		Phase	Comment
	QP	AV	Factor	QP	AV	QP	AV	QP	AV		
[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
0.15621	27.1	20.4	13.3	40.4	33.7	65.7	55.7	25.3	22.0	N	
0.23648	23.0	16.4	13.3	36.3	29.7	62.2	52.2	25.9	22.5	N	
0.31435	18.3	12.2	13.3	31.6	25.5	59.9	49.9	28.3	24.4	N	
0.39263	26.3	19.9	13.3	39.6	33.2	58.0	48.0	18.4	14.8	N	
0.55161	21.9	16.8	13.4	35.3	30.2	56.0	46.0	20.7	15.8	N	
13.08406	22.5	17.0	14.4	36.9	31.4	60.0	50.0	23.1	18.6	N	
0.15621	26.9	20.1	13.3	40.2	33.4	65.7	55.7	25.5	22.3	L	
0.23615	22.4	15.9	13.3	35.7	29.2	62.2	52.2	26.5	23.0	L	
0.31515	18.8	12.5	13.3	32.1	25.8	59.8	49.8	27.7	24.0	L	
0.39275	25.9	19.7	13.3	39.2	33.0	58.0	48.0	18.8	15.0	L	
0.55000	21.8	15.9	13.4	35.2	29.3	56.0	46.0	20.8	16.7	L	
13.16442	24.5	18.3	14.4	38.9	32.7	60.0	50.0	21.1	17.3	L	

CHART:WITH FACTOR,Peak hold data. CALCULATION:RESULT=READING+C.F(LISN LOSS+ATT LOSS +CABLE LOSS)
Except for the above table : adequate margin data below the limits.

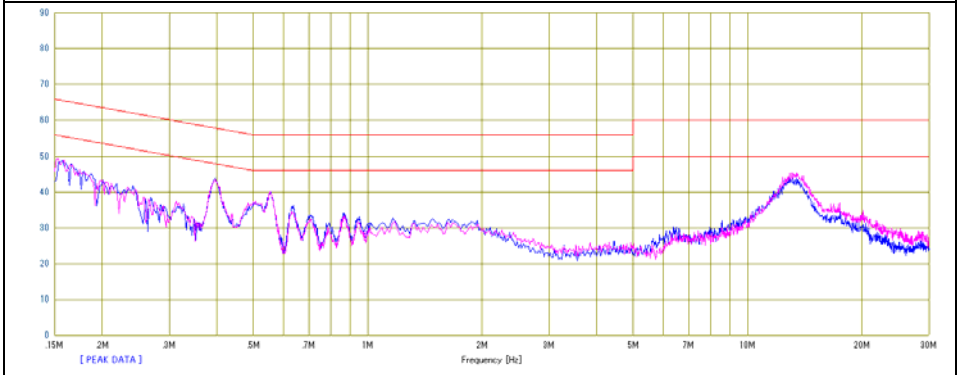
Conducted Emission

Test place	Head Office EMC Lab. No.4 Semi Anechoic Chamber
Report No.	10101498H
Date	11/20/2013
Temperature/ Humidity	24 deg. C / 48% RH
Engineer	Takayuki Shimada
Mode	LE Tx

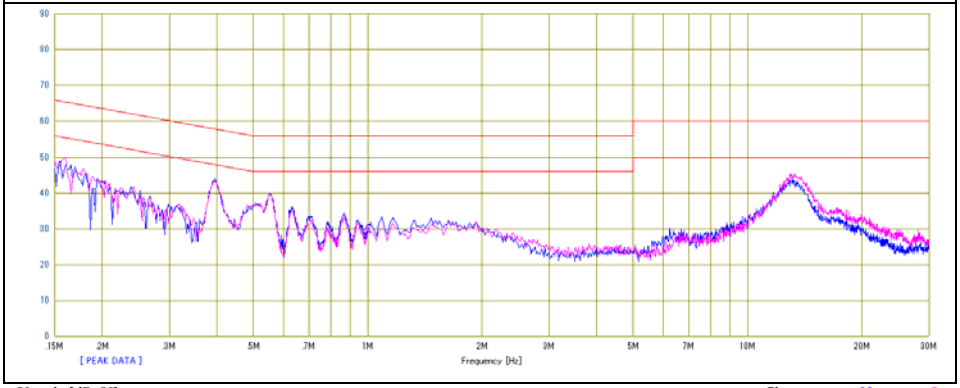
2402MHz



2440MHz



2480MHz



Y scale [dBuV] Chart — N — L

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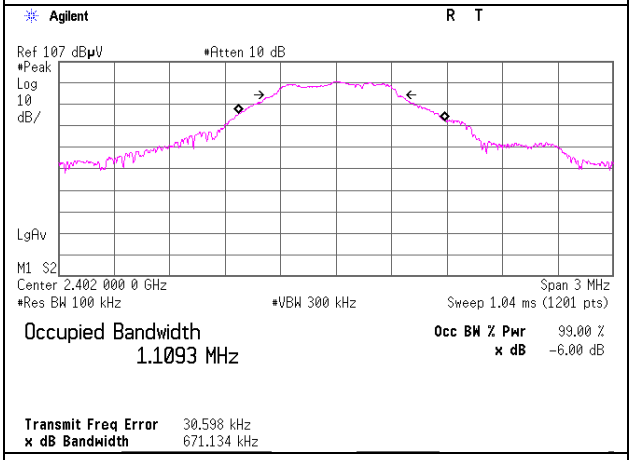
6dB Bandwidth

Test place	Head Office EMC Lab. No.11 Measurement Room
Report No.	10101498H
Date	11/07/2013
Temperature/ Humidity	22 deg. C / 48 % RH
Engineer	Takumi Shimada
Mode	LE Tx

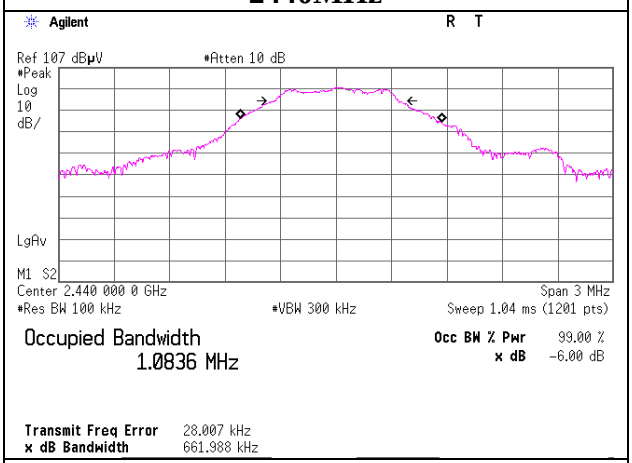
Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
2402	0.671	>500
2440	0.662	>500
2480	0.658	>500

6dB Bandwidth

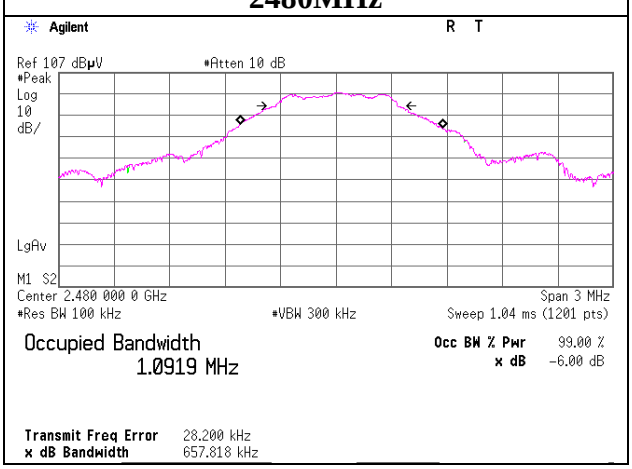
2402MHz



2440MHz



2480MHz



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

Maximum Peak Output Power

Test place	Head Office EMC Lab. No.11 Measurement Room
Report No.	10101498H
Date	11/07/2013
Temperature/ Humidity	22 deg. C / 48 % RH
Engineer	Takumi Shimada
Mode	LE Tx

Freq.	Reading	Cable Loss	Atten.	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-9.29	1.56	9.38	1.65	1.46	30.00	1000	28.35
2440	-9.08	1.57	9.38	1.87	1.54	30.00	1000	28.13
2480	-9.18	1.58	9.38	1.78	1.51	30.00	1000	28.22

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Maximum Average Output Power (Reference data for RF EXposure)

Average Output Power

Test place	Head Office EMC Lab. No.11 Measurement Room
Report No.	10101498H
Date	11/07/2013
Temperature/ Humidity	22 deg. C / 48 % RH
Engineer	Takumi Shimada
Mode	Tx

[AV]

Freq.	Reading	Cable Loss	Atten.	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-11.24	1.56	9.38	-0.30	0.93	30.00	1000	30.30
2440	-11.01	1.57	9.38	-0.06	0.99	30.00	1000	30.06
2480	-11.08	1.58	9.38	-0.12	0.97	30.00	1000	30.12

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Radiated Spurious Emission

Test place	Head Office EMC Lab. No.2 and No.3 Semi Anechoic Chamber	
Report No.	10101498H	
Date	11/07/2013	11/08/2013
Temperature/ Humidity	24 deg. C / 53% RH	23 deg. C / 41% RH
Engineer	Tomohisa Nakagawa (Above 1GHz)	Keisuke Kawamura (Below 1GHz)
Mode	LE Tx 2402MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	43.953	QP	22.7	13.2	6.9	28.6	-	14.2	40.0	25.8	
Hori	121.574	QP	22.1	13.0	7.6	28.3	-	14.4	43.5	29.1	
Hori	153.589	QP	23.8	15.0	7.9	28.2	-	18.5	43.5	25.0	
Hori	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Hori	520.498	QP	22.3	18.4	9.9	28.8	-	21.8	46.0	24.2	
Hori	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Hori	4804.000	PK	41.8	30.5	5.3	31.4	-	46.2	73.9	27.7	
Hori	7206.000	PK	42.2	35.8	6.7	32.3	-	52.4	73.9	21.5	
Hori	9608.000	PK	42.6	39.0	7.3	33.0	-	55.9	73.9	18.0	
Hori	4804.000	AV	32.9	30.5	5.3	31.4	1.0	38.3	53.9	15.6	
Hori	7206.000	AV	34.2	35.8	6.7	32.3	1.0	45.4	53.9	8.5	
Hori	9608.000	AV	34.2	39.0	7.3	33.0	1.0	48.5	53.9	5.4	
Vert	44.423	QP	27.0	13.0	6.9	28.5	-	18.4	40.0	21.6	
Vert	118.652	QP	22.5	12.7	7.6	28.4	-	14.4	43.5	29.1	
Vert	152.851	QP	23.1	15.0	7.9	28.2	-	17.8	43.5	25.7	
Vert	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Vert	523.998	QP	22.3	18.5	9.9	28.8	-	21.9	46.0	24.1	
Vert	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Vert	4804.000	PK	41.9	30.5	5.3	31.4	-	46.3	73.9	27.6	
Vert	7206.000	PK	43.3	35.8	6.7	32.3	-	53.5	73.9	20.4	
Vert	9608.000	PK	41.8	39.0	6.8	33.0	-	54.6	73.9	19.3	
Vert	4804.000	AV	33.3	30.5	5.3	31.4	1.0	38.7	53.9	15.2	
Vert	7206.000	AV	33.5	35.8	6.7	32.3	1.0	44.7	53.9	9.2	
Vert	9608.000	AV	33.9	39.0	6.8	33.0	1.0	47.7	53.9	6.2	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 10GHz)) - Gain(Amplifier) + Duty factor(Refer to Duty factor data sheet)
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

Distance factor: 10GHz-26.5GHz 20log(3.0m/1.0m)= 9.5dB

20dBc Data Sheet

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2402.000	PK	103.6	28.2	3.1	32.4	102.5	-	-	Carrier
Hori	2400.000	PK	69.2	28.2	3.1	32.4	68.1	82.5	14.4	
Vert	2402.000	PK	100.2	28.2	3.1	32.4	99.1	-	-	Carrier
Vert	2400.000	PK	62.2	28.2	3.1	32.4	61.1	79.1	18.0	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 10GHz)) - Gain(Amprifier)

PK

Polarity [Hori/Ver]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2313.70	PK	61.0	28.0	3.1	32.4	-	59.7	73.9	14.2	
Vert	2313.70	PK	55.4	28.0	3.1	32.4	-	54.1	73.9	19.8	
Hori	2370.21	PK	64.4	28.1	3.1	32.4	-	63.2	73.9	10.7	
Vert	2370.21	PK	59.4	28.1	3.1	32.4	-	58.2	73.9	15.7	
Hori	2390.00	PK	60.1	28.2	3.1	32.4	-	59.0	73.9	14.9	
Vert	2390.00	PK	54.4	28.2	3.1	32.4	-	53.3	73.9	20.6	

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

PK with Duty factor

Polarity [Hori/Ver]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2313.700	AV	61.0	28.0	3.1	32.4	-43.9	15.8	53.9	38.1	
Vert	2313.700	AV	55.4	28.0	3.1	32.4	-43.9	10.2	53.9	43.7	
Hori	2370.211	AV	64.4	28.1	3.1	32.4	-43.9	19.3	53.9	34.6	
Vert	2370.211	AV	59.4	28.1	3.1	32.4	-43.9	14.3	53.9	39.6	
Hori	2390.000	AV	60.1	28.2	3.1	32.4	-43.9	15.1	53.9	38.8	
Vert	2390.000	AV	54.4	28.2	3.1	32.4	-43.9	9.4	53.9	44.5	

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

Radiated Spurious Emission

Test place	Head Office EMC Lab. No.2 and No.3 Semi Anechoic Chamber	
Report No.	10101498H	
Date	11/07/2013	11/08/2013
Temperature/ Humidity	24 deg. C / 53% RH	23 deg. C / 41% RH
Engineer	Tomohisa Nakagawa (Above 1GHz)	Keisuke Kawamura (Below 1GHz)
Mode	LE Tx 2440MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	43.953	QP	22.7	13.2	6.9	28.6	-	14.2	40.0	25.8	
Hori	121.574	QP	22.1	13.0	7.6	28.3	-	14.4	43.5	29.1	
Hori	153.589	QP	23.8	15.0	7.9	28.2	-	18.5	43.5	25.0	
Hori	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Hori	520.498	QP	22.3	18.4	9.9	28.8	-	21.8	46.0	24.2	
Hori	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Hori	4880.000	PK	41.9	30.6	5.3	31.4	-	46.4	73.9	27.5	
Hori	7320.000	PK	42.1	36.0	6.8	32.4	-	52.5	73.9	21.4	
Hori	9760.000	PK	42.6	39.4	7.3	33.0	-	56.3	73.9	17.6	
Hori	4880.000	AV	32.6	30.6	5.3	31.4	1.0	38.1	53.9	15.8	
Hori	7320.000	AV	34.4	36.0	6.8	32.4	1.0	45.8	53.9	8.1	
Hori	9760.000	AV	33.6	39.4	7.3	33.0	1.0	48.3	53.9	5.6	
Vert	44.423	QP	27.0	13.0	6.9	28.5	-	18.4	40.0	21.6	
Vert	118.652	QP	22.5	12.7	7.6	28.4	-	14.4	43.5	29.1	
Vert	152.851	QP	23.1	15.0	7.9	28.2	-	17.8	43.5	25.7	
Vert	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Vert	523.998	QP	22.3	18.5	9.9	28.8	-	21.9	46.0	24.1	
Vert	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Vert	4880.000	PK	42.0	30.6	5.3	31.4	-	46.5	73.9	27.4	
Vert	7320.000	PK	42.0	36.0	6.8	32.4	-	52.4	73.9	21.5	
Vert	9760.000	PK	42.4	39.4	7.3	33.0	-	56.1	73.9	17.8	
Vert	4880.000	AV	33.0	30.6	5.3	31.4	1.0	38.5	53.9	15.4	
Vert	7320.000	AV	33.8	36.0	6.8	32.4	1.0	45.2	53.9	8.7	
Vert	9760.000	AV	33.9	39.4	7.3	33.0	1.0	48.6	53.9	5.3	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 10GHz)) - Gain(Amplifier) + Duty factor(Refer to Duty factor data sheet)
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

Distance factor: 10GHz-26.5GHz 20log(3.0m/1.0m)= 9.5dB

PK

Polarity [Hori/Ver]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m	Margin [dB]	Remark
Vert	2492.09	PK	62.3	28.4	3.1	32.3	-	61.5	73.9	12.4	
Hori	2492.09	PK	64.3	28.4	3.1	32.3	-	63.5	73.9	10.4	
Vert	2561.96	PK	60.8	28.6	3.2	32.3	-	60.3	73.9	13.6	
Hori	2561.96	PK	61.2	28.6	3.2	32.3	-	60.7	73.9	13.2	

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

PK with Duty factor

Polarity [Hori/Ver]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m	Margin [dB]	Remark
Vert	2492.088	AV	62.3	28.4	3.1	32.3	-43.9	17.6	53.9	36.3	
Hori	2492.088	AV	64.3	28.4	3.1	32.3	-43.9	19.6	53.9	34.3	
Vert	2561.962	AV	60.8	28.6	3.2	32.3	-43.9	16.4	53.9	37.5	
Hori	2561.962	AV	61.2	28.6	3.2	32.3	-43.9	16.8	53.9	37.1	

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

Radiated Spurious Emission

Test place	Head Office EMC Lab. No.2 and No.3 Semi Anechoic Chamber	
Report No.	10101498H	
Date	11/07/2013	11/08/2013
Temperature/ Humidity	24 deg. C / 53% RH	23 deg. C / 41% RH
Engineer	Tomohisa Nakagawa (Above 1GHz)	Keisuke Kawamura (Below 1GHz)
Mode	LE Tx 2480MHz	

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	43.953	QP	22.7	13.2	6.9	28.6	-	14.2	40.0	25.8	
Hori	121.574	QP	22.1	13.0	7.6	28.3	-	14.4	43.5	29.1	
Hori	153.589	QP	23.8	15.0	7.9	28.2	-	18.5	43.5	25.0	
Hori	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Hori	520.498	QP	22.3	18.4	9.9	28.8	-	21.8	46.0	24.2	
Hori	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Hori	2483.500	PK	61.0	28.4	3.1	32.3	-	60.2	73.9	13.7	
Hori	4960.000	PK	41.3	30.7	4.7	31.4	-	45.3	73.9	28.6	
Hori	7440.000	PK	42.1	36.2	6.7	32.4	-	52.6	73.9	21.3	
Hori	9920.000	PK	43.5	39.8	7.4	33.1	-	57.6	73.9	16.3	
Hori	2483.500	AV	49.5	28.4	3.1	32.3	1.0	49.7	53.9	4.2	
Hori	4960.000	AV	32.5	30.7	5.4	31.4	1.0	38.2	53.9	15.7	
Hori	7440.000	AV	33.8	36.2	6.7	32.4	1.0	45.3	53.9	8.6	
Hori	9920.000	AV	34.5	39.8	7.4	33.1	1.0	49.6	53.9	4.3	
Vert	44.423	QP	27.0	13.0	6.9	28.5	-	18.4	40.0	21.6	
Vert	118.652	QP	22.5	12.7	7.6	28.4	-	14.4	43.5	29.1	
Vert	152.851	QP	23.1	15.0	7.9	28.2	-	17.8	43.5	25.7	
Vert	401.499	QP	21.9	17.3	9.3	28.3	-	20.2	46.0	25.8	
Vert	523.998	QP	22.3	18.5	9.9	28.8	-	21.9	46.0	24.1	
Vert	972.453	QP	21.8	23.0	11.6	27.5	-	28.9	53.9	25.0	
Vert	2483.500	PK	57.9	28.4	3.1	32.3	-	57.1	73.9	16.8	
Vert	4960.000	PK	42.8	30.7	5.4	31.4	-	47.5	73.9	26.4	
Vert	7440.000	PK	42.5	36.2	6.7	32.4	-	53.0	73.9	20.9	
Vert	9920.000	PK	42.1	39.8	7.4	33.1	-	56.2	73.9	17.7	
Vert	2483.500	AV	44.1	28.4	3.1	32.3	1.0	44.3	53.9	9.6	
Vert	4960.000	AV	32.9	30.7	5.4	31.4	1.0	38.6	53.9	15.3	
Vert	7440.000	AV	33.7	36.2	6.7	32.4	1.0	45.2	53.9	8.7	
Vert	9920.000	AV	34.3	39.8	7.4	33.1	1.0	49.4	53.9	4.5	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter-Distance factor(above 10GHz)) - Gain(Amplifier) + Duty factor(Refer to Duty factor data sheet)
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

Distance factor: 10GHz-26.5GHz 20log(3.0m/1.0m)= 9.5dB

PK

Polarity [Hori/Ver	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2492.40	PK	64.2	28.4	3.1	32.3	-	63.4	73.9	10.5	
Vert	2492.40	PK	61.1	28.4	3.1	32.3	-	60.3	73.9	13.6	
Hori	2562.00	PK	63.0	28.6	3.2	32.3	-	62.5	73.9	11.4	
Vert	2562.00	PK	60.6	28.6	3.2	32.3	-	60.1	73.9	13.8	

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

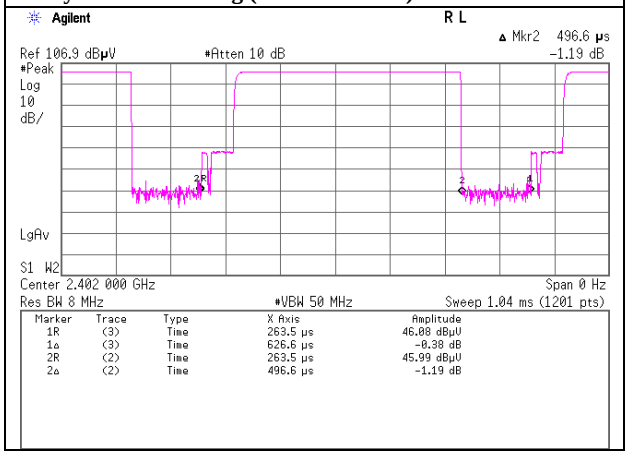
PK with Duty factor

Polarity [Hori/Ver	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori	2492.40	AV	64.2	28.4	3.1	32.3	-43.9	19.5	53.9	34.4	
Vert	2492.40	AV	61.1	28.4	3.1	32.3	-43.9	16.4	53.9	37.5	
Hori	2562.00	AV	63.0	28.6	3.2	32.3	-43.9	18.6	53.9	35.3	
Vert	2562.00	AV	60.6	28.6	3.2	32.3	-43.9	16.2	53.9	37.7	

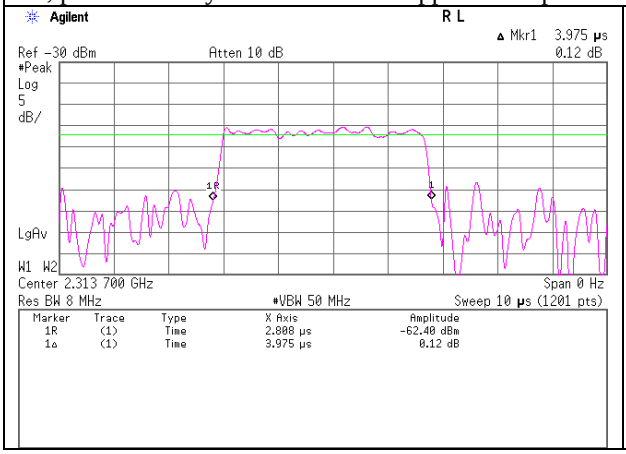
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier) + Duty factor (Refer to Duty factor data sheet)

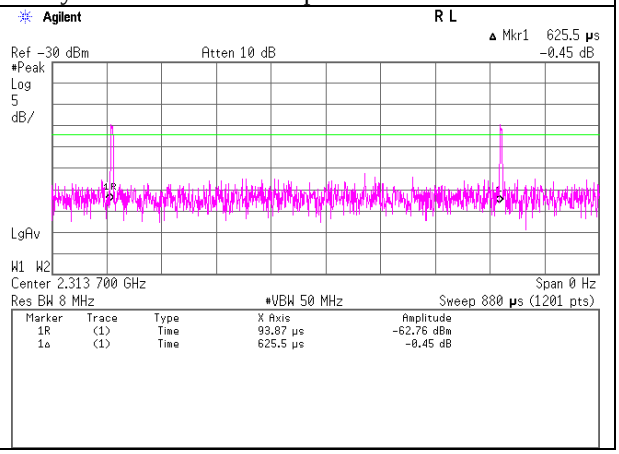
Duty factor data sheet

Tx on / (Tx on + Tx off) =	**0.793**
Tx on / (Tx on + Tx off) * 100 =	**79.3 %**
Duty factor = 10 * log (0.6266 / 0.4966) =	**1.01 dB**



Peak with duty factor = 20*log (3.975usec/625.5usec) = -43.9dB
Worst Tx Duty cycle on BLE is Advertising mode which minimum interval is 3.75msec.
However, test mode duty cycle is severer than above normal operating mode, and this spurious emission was synchronized with maximum duty cycle of carrier.
So, peak with duty factor value was applied for “peak with duty factor” at Radiated Spurious Emission test.





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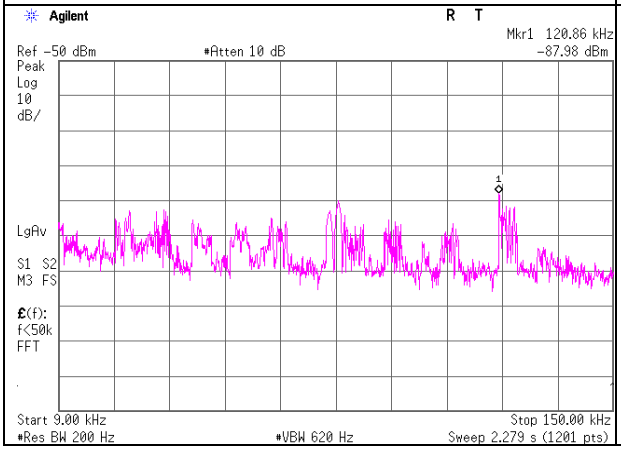
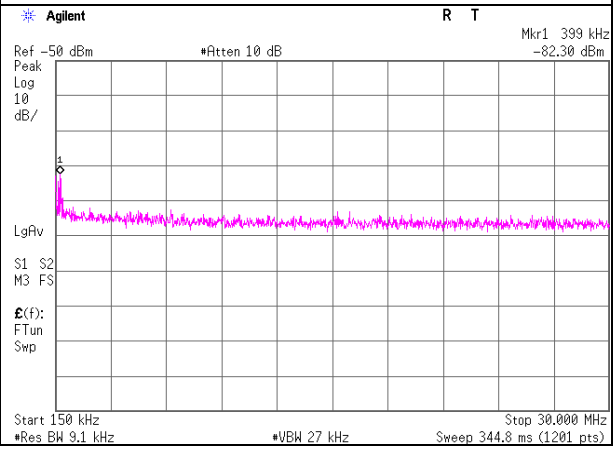
Conducted Spurious Emission

Tx 2402MHz

9kHz-150kHz



150kHz-30MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenator [dB]	Antenna Gain [dBi]	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]
120.86	-88.0	0.01	10.0	-1.4	-79.4	300.0	6.0	-18.1	26.0
399	-82.3	0.01	10.0	-1.4	-73.7	300.0	6.0	-12.4	15.6

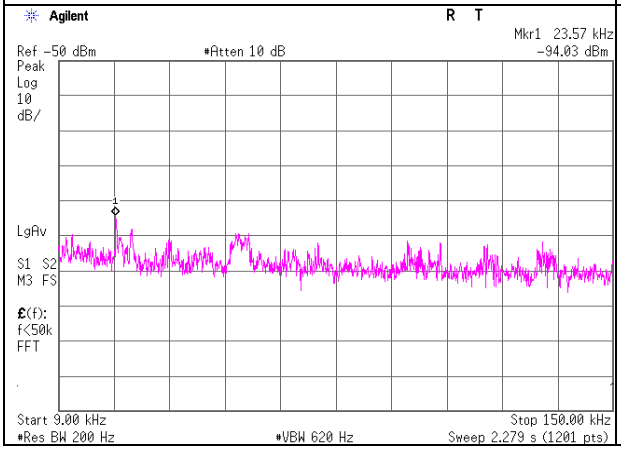
E=EIRP-20log(D)+Ground bounce +104.8[dBuV/m]

EIRP=Reading+Cable Loss+Attenator+Antenna Gain

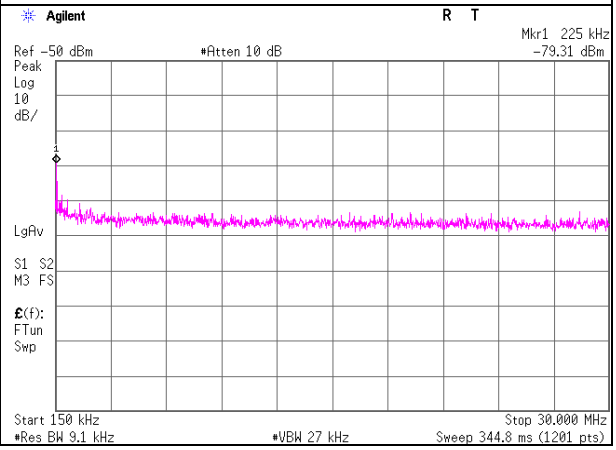
Conducted Spurious Emission

Tx 2440MHz

9kHz-150kHz



150kHz-30MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenator [dB]	Antenna Gain [dBi]	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]
23.57	-94.0	0.01	10.0	-1.4	-85.4	300.0	6.0	-24.2	40.2
225	-79.3	0.01	10.0	-1.4	-70.7	300.0	6.0	-9.4	20.6

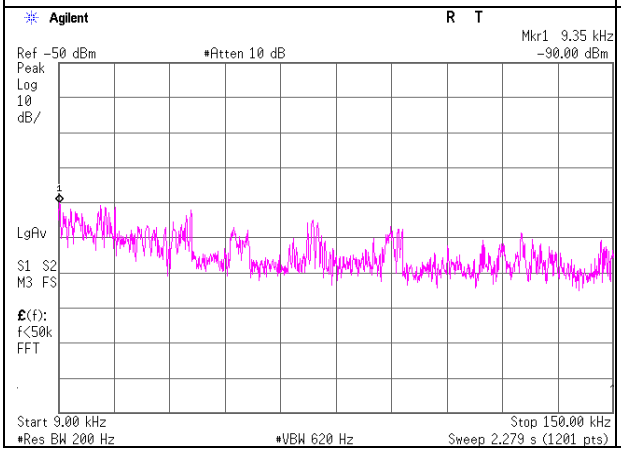
E=EIRP-20log(D)+Ground bounce +104.8[dBuV/m]

EIRP=Reading+Cable Loss+Attenator+Antenna Gain

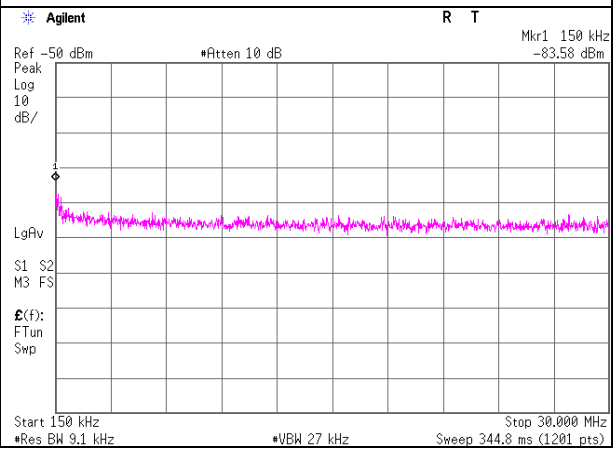
Conducted Spurious Emission

Tx 2480MHz

9kHz-150kHz



150kHz-30MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenator [dB]	Antenna Gain [dBi]	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]
9.35	-90.0	0.01	10.0	-1.4	-81.4	300.0	6.0	-20.1	48.2
150	-83.6	0.01	10.0	-1.4	-75.0	300.0	6.0	-13.7	24.1

E=EIRP-20log(D)+Ground bounce +104.8[dBuV/m]

EIRP=Reading+Cable Loss+Attenator+Antenna Gain

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

Power Density

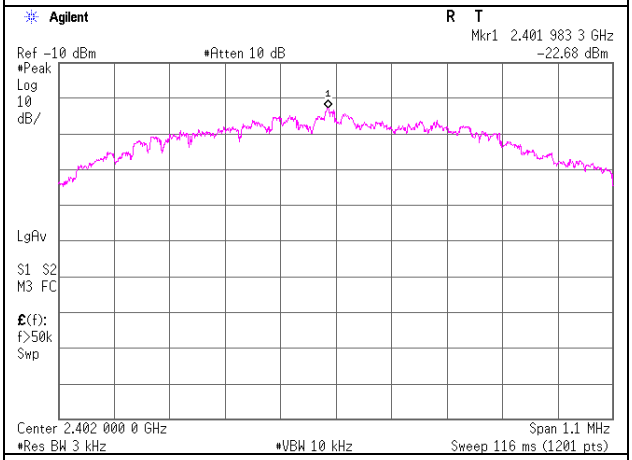
Test place	Head Office EMC Lab. No.11 Measurement Room
Report No.	10101498H
Date	11/07/2013
Temperature/ Humidity	22 deg. C / 48 % RH
Engineer	Takumi Shimada
Mode	LE Tx

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-22.68	1.56	9.38	-11.74	8.00	19.74
2440.00	-23.05	1.57	9.38	-12.10	8.00	20.10
2480.00	-22.72	1.58	9.38	-11.76	8.00	19.76

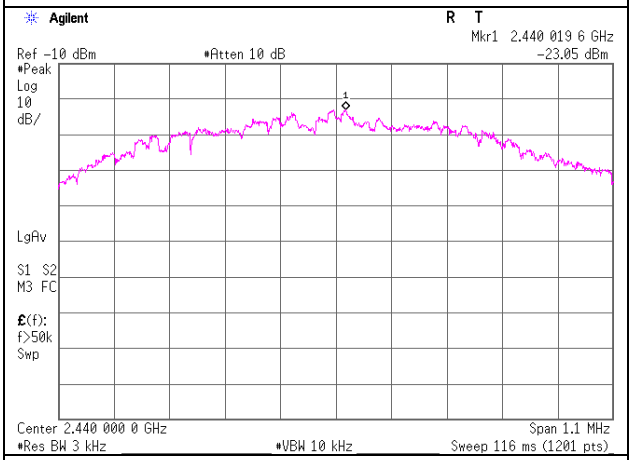
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Power Density

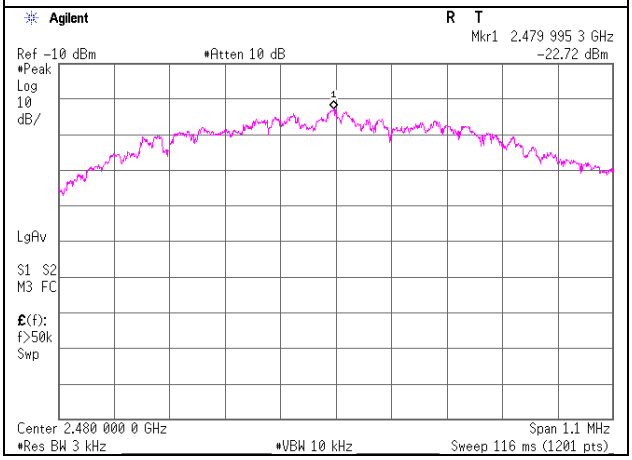
2402MHz



2440MHz

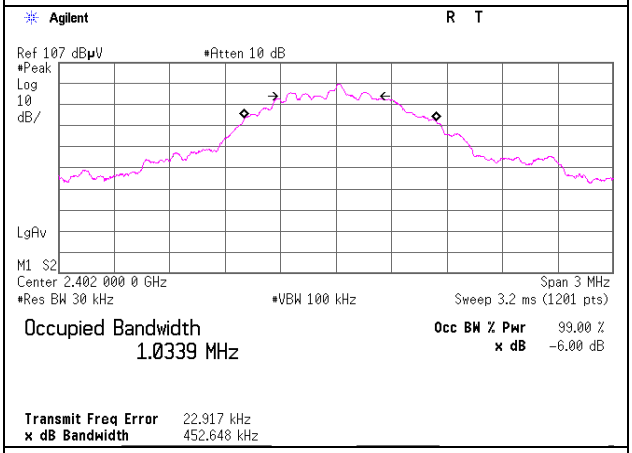


2480MHz

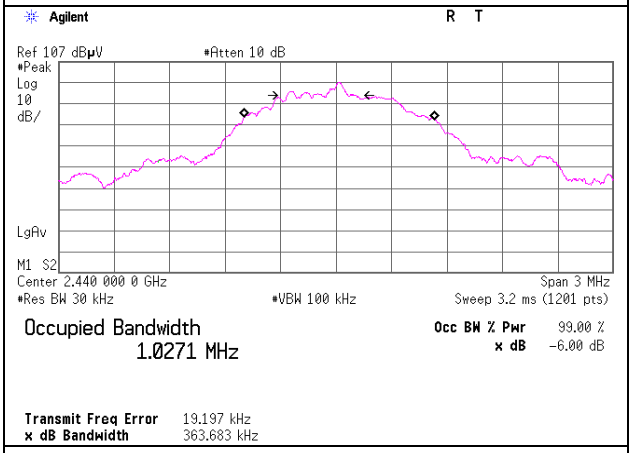


99% Occupied Bandwidth

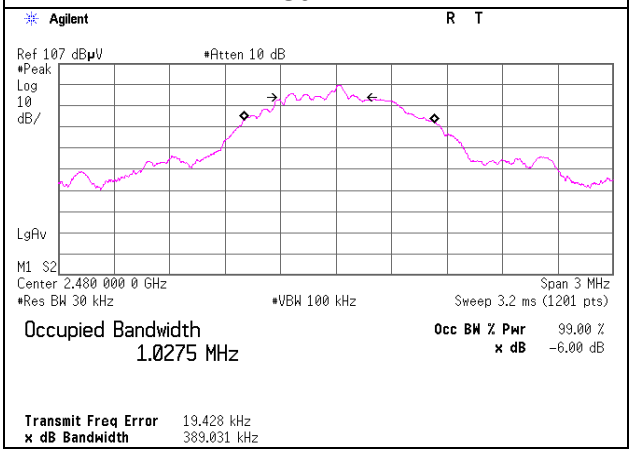
2402MHz



2440MHz



2480MHz



APPENDIX 2: Test instruments

EMI test equipment (1/2)

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MPM-13	Power Meter	Anritsu	ML2495A	0824014	AT	2013/11/15 * 12
MPSE-18	Power sensor	Anritsu	MA2411B	0738174	AT	2013/11/15 * 12
MCC-137	Microwave cable	HUBER+SUHNER	SUCOFLEX 102	37954/2	AT	2013/10/18 * 12
MAT-38	Attenuator	Weinschel	54A-10	T1373	AT	2013/10/28 * 12
MSA-10	Spectrum Analyzer	Agilent	E4448A	MY46180655	AT	2013/02/22 * 12
MOS-19	Thermo-Hygrometer	Custom	CTH-201	0001	AT	2012/12/25 * 12
MCC-64	Coaxial Cable	UL Japan	-	-	RE	2013/03/22 * 12
MAT-10	Attenuator(10dB)	Weinschel Corp	2	BL1173	RE	2012/11/06 * 12
MAEC-03	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2013/02/28 * 12
MOS-13	Thermo-Hygrometer	Custom	CTH-180	-	RE	2013/02/26 * 12
MJM-16	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE/CE	-
MSA-05	Spectrum Analyzer	Advantest	R3273	160400285	RE	2013/11/08 * 12
MHA-20	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	RE	2013/05/17 * 12
MCC-133	Microwave Cable	HUBER+SUHNER	SUCOFLEX104	336164/4(1m) / 340640(5m)	RE	2013/09/27 * 12
MPA-11	MicroWave System Amplifier	Agilent	83017A	MY39500779	RE	2013/03/12 * 12
MHA-16	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	RE	2013/05/17 * 12
MHF-25	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	RE	2013/09/01 * 12
MAEC-02	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	RE	2013/06/30 * 12
MOS-22	Thermo-Hygrometer	Custom	CTH-201	0003	RE	2013/02/26 * 12
MJM-14	Measure	KOMELON	KMC-36	-	RE	-
MSA-03	Spectrum Analyzer	Agilent	E4448A	MY44020357	RE	2013/11/15 * 12
MTR-03	Test Receiver	Rohde & Schwarz	ESCI	100300	RE	2013/06/11 * 12
MBA-02	Biconical Antenna	Schwarzbeck	BBA9106	VHA91032008	RE	2013/10/13 * 12
MLA-02	Logperiodic Antenna	Schwarzbeck	USLP9143	201	RE	2013/10/13 * 12
MCC-12	Coaxial Cable	Fujikura/Agilent	-	-	RE	2013/02/06 * 12
MAT-07	Attenuator(6dB)	Weinschel Corp	2	BK7970	RE	2012/11/06 * 12
MPA-09	Pre Amplifier	Agilent	8447D	2944A10845	RE	2013/09/12 * 12

EMI test equipment (2/2)

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MAEC-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	CE	2013/02/28 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	-	CE	2013/02/26 * 12
MJM-09	Measure	KDS	E19-55	-	CE	-
MTR-01	Test Receiver	Rohde & Schwarz	ESI40	100084	CE	2013/11/12 * 12
MLS-07	LISN(AMN)	Schwarzbeck	NSLK8127	8127364	CE(EUT)	2013/01/07 * 12
MAT-67	Attenuator	JFW Industries, Inc.	50FP-013H2 N	-	CE	2013/01/09 * 12
MCC-113	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W(10m)/SFM141(5m)/421-010(1m)/sucoform141-PE(1m)/RFM-E121(Switcher)	-/04178	CE	2013/07/23 * 12

The expiration date of the calibration is the end of the expired month.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test Item: CE: Conducted Emission
RE: Radiated Emission
AT: Antenna Terminal Conducted test