



RADIO TEST REPORT

Test Report No. : 11377899S-A

Applicant : CASIO COMPUTER CO., LTD.
Type of Equipment : Bluetooth Watch
Model No. : EQB-501
FCC ID : BBQS03W
Test regulation : FCC Part 15 Subpart C: 2016
Test Result : Complied

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
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6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)

Date of test: August 2 to September 1, 2016

Representative test engineer:


Kazutaka Takeyama
Engineer
Consumer Technology Division

Approved by:


Akio Hayashi
Leader
Consumer Technology Division



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

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13-EM-F0429

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SECTION 1: Customer information

Company Name	:	CASIO COMPUTER CO., LTD.
Address	:	2-1, Sakaecho 3 chome, Hamura-shi, Tokyo 205-8555 Japan
Telephone Number	:	+81-42-579-7282
Facsimile Number	:	+81-42-579-7702
Contact Person	:	Hiroaki Suzuki

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

2.1 Identification of E.U.T.

Type of Equipment	:	Bluetooth Watch
Model No.	:	EQB-501
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	Typical: DC 2.5 V, Min.: DC 1.9 V, Max.: DC 2.7 V
Receipt Date of Sample	:	July 27, 2016
Country of Mass-production	:	China, Thailand, 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: EQB-501 (referred to as the EUT in this report) is a Bluetooth Watch.

General Specification

Clock frequency(ies) in the system	:	26 MHz, 32.768 kHz
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Radio Specification

Equipment type	:	Transceiver
Frequency of operation	:	2402 MHz - 2480 MHz
Bandwidth & channel spacing	:	2 MHz
Type of modulation	:	GFSK
Antenna type	:	Chip Antenna
Antenna gain	:	+2.5 dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC part 15 final revised on April 6, 2016.

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 C63.10-2013 6. Standard test methods IC: RSS-Gen 8.8	FCC: Section 15.207 IC: RSS-Gen 8.8	-	-	N/A *1)
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(1)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(4)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(2)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v03r05 IC: RSS-Gen 6.13	FCC: Section 15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	3.6 dB 12010.00 MHz, AV, Vertical Tx 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)

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

*1) The test is not applicable since the EUT has no AC mains.

*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v03r05 12.2.7.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)

The EUT provides stable voltage (DC 1.35 V) constantly to the wireless transmitter regardless of input voltage. Instead of a new battery, DC power supply was used for the test. That does not affect the test result, therefore the EUT complies with the requirement.

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.

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3.3 Addition to standard

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

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

3.4 Uncertainty

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k = 2$.
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Item	Frequency range	Uncertainty (+/-)			
		No. 1 SAC / SR	No. 2 SAC / SR	No. 3 SAC / SR	No. 4 SAC / SR
Conducted emission (AC Mains) LISN	150 kHz-30 MHz	2.1 dB	2.1 dB	2.6 dB	2.2 dB
Radiated emission (Measurement distance: 3 m)	9 kHz-30 MHz	2.7 dB	2.7 dB	3.1 dB	-
	30 MHz-300 MHz	4.4 dB	4.4 dB	4.6 dB	-
	300 MHz-1 GHz	5.6 dB	5.5 dB	5.3 dB	-
	1 GHz-13 GHz	5.2 dB	5.2 dB	5.2 dB	-
Radiated emission (Measurement distance: 1 m)	13 GHz-18 GHz	4.9 dB	4.9 dB	4.9 dB	-
	18 GHz-40 GHz	4.9 dB	4.9 dB	4.9 dB	-

SAC=Semi-Anechoic Chamber

SR= Shielded Room is applied besides radiated emission

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector)_SPM-06	0.76 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-06	0.79 dB
Power Measurement above 1 GHz (Average Detector)_SPM-07	0.74 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-07	1.08 dB
Spurious emission (Conducted) below 1GHz	1.5 dB
Spurious emission (Conducted) 1 GHz-3 GHz	1.7 dB
Spurious emission (Conducted) 3 GHz-18 GHz	2.4 dB
Spurious emission (Conducted) 18 GHz-26.5 GHz	2.5 dB
Spurious emission (Conducted) 26.5 GHz-40 GHz	2.5 dB
Bandwidth Measurement	0.66 %
Duty cycle and Time Measurement	0.012 %

Radiated emission test

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

3.5 Test Location

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JAB Accreditation No. RTL02610

Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber	2973D-1	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
No.2 Semi-anechoic chamber	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10m
No.3 Semi-anechoic chamber	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5m
No.4 Semi-anechoic chamber	-	8.1 x 5.1 x 3.55	8.1 x 5.1	-
No.1 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	-	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	-	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 shielded room	-	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	-	2.55 x 4.1 x 2.5	-	-

3.6 Test data, Test instruments, and Test set up

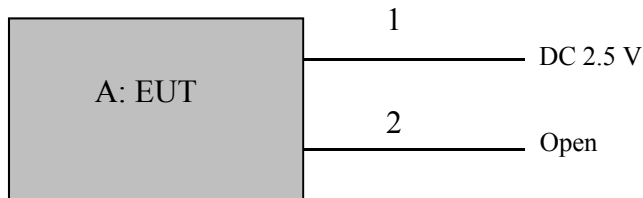
Refer to APPENDIX.

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

4.1 Operating Mode(s)

Mode	Frequency	Remarks*
Bluetooth Low Energy	2402 MHz, 2440 MHz, 2480 MHz	PN9
*Power of the EUT was set by the software as follows; Power settings: -6 dBm Software Version: Ver52 *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	Bluetooth Watch	BQB-501	51 *1) 52 *2)	Casio Computer Co., Ltd.	EUT

*1) Used for Antenna Terminal conducted test

*2) Used for Radiated Emission test

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	0.05 + 2.0	Unshielded	Unshielded	*3)
2	Signal Cable	0.05	Unshielded	Unshielded	*4)

*3) Cable for test operation

*4) Cable for system reset during the development, not used for the product

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SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "558074 D01 DTS Meas Guidance v03r05".

[For below 1 GHz]

EUT was placed on a platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane.

The table is made of Styrofoam and covered with polyvinyl chloride. That has very low permittivity.

The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]

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

The height of the measuring antenna varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength. The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.

The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear 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	30 MHz to 300 MHz	300 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

In any 100 kHz 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 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *3)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: <u>12.2.5.2</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (Linear voltage) Trace: 100 traces Duty factor was added to the results.	RBW: 100 kHz VBW: 300kHz
Test Distance	3 m	3 m *1) (1 GHz – 13 GHz), 1 m *2) (13 GHz – 26.5 GHz)		3 m *1) (1 GHz – 13 GHz)

*1) Distance Factor: $20 \times \log(3.95 \text{ m} / 3.0 \text{ m}) = 2.39 \text{ dB}$

*2) Distance Factor: $20 \times \log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

*3) Average Power Measurement was performed based on 6. 0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v03r05"

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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.

Antenna polarization	Carrier	Spurious (Below 1 GHz)	Spurious (1 GHz -13 GHz)	Spurious (13 GHz -26.5 GHz)
Horizontal	Z	X	Z	Z
Vertical	Y	X	Y	Z

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

SECTION 6: 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	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Sample	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	10 kHz	30 kHz				
*1) Peak hold was applied as Worst-case measurement. *2) Reference data *3) Section 10.2 Method PKPSD (peak PSD) of "KDB 558074 D01 DTS Meas Guidance v03r05". *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 not detected as shown in the chart. (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz)							

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: Test data

6dB Bandwidth

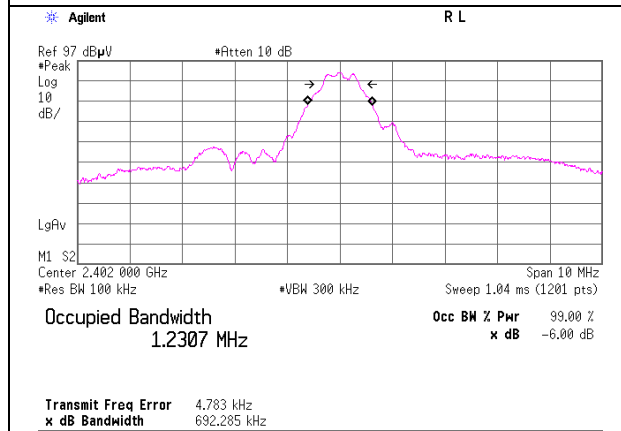
Test place	Shonan EMC Lab. No.6 Shielded Room
Report No.	11377899S-A
Date	August 23, 2016
Temperature / Humidity	26 deg. C / 46 % RH
Engineer	Kazutaka Takeyama
Mode	Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BT LE	2402	0.692	> 500
	2440	0.691	> 500
	2480	0.696	> 500

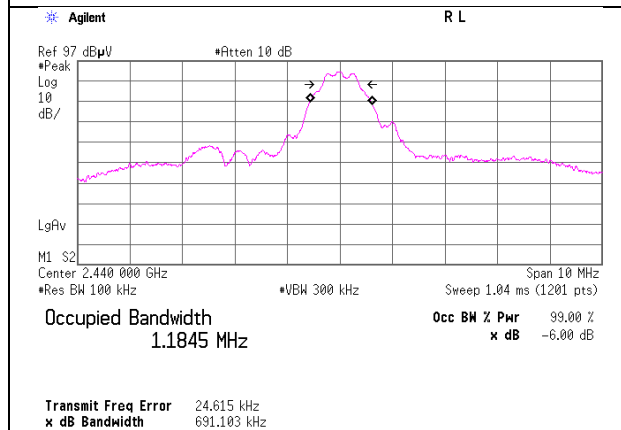
6dB Bandwidth

BT LE

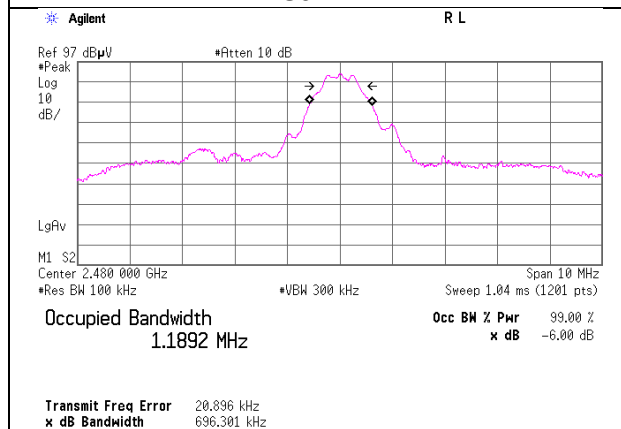
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Test place Shonan EMC Lab. No.6 Shielded Room
Report No. 11377899S-A
Date August 23, 2016
Temperature / Humidity 26 deg. C / 46 % RH
Engineer Kazutaka Takeyama
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-14.83	1.32	9.92	-3.59	0.44	30.00	1000	33.59
2440	-14.37	1.32	9.92	-3.13	0.49	30.00	1000	33.13
2480	-14.76	1.33	9.92	-3.51	0.45	30.00	1000	33.51

Sample Calculation:

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

*The equipment and cables were not used for factor 0 dB of the data sheets.

Average Output Power
(Reference data for RF Exposure)

Test place Shonan EMC Lab. No.6 Shielded Room
Report No. 11377899S-A
Date August 23, 2016
Temperature / Humidity 26 deg. C / 46 % RH
Engineer Kazutaka Takeyama
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-17.46	1.32	9.92	-6.22	0.24	0.83	-5.39	0.29
2440	-17.04	1.32	9.92	-5.80	0.26	0.83	-4.97	0.32
2480	-17.42	1.33	9.92	-6.17	0.24	0.83	-5.34	0.29

Sample Calculation:

Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

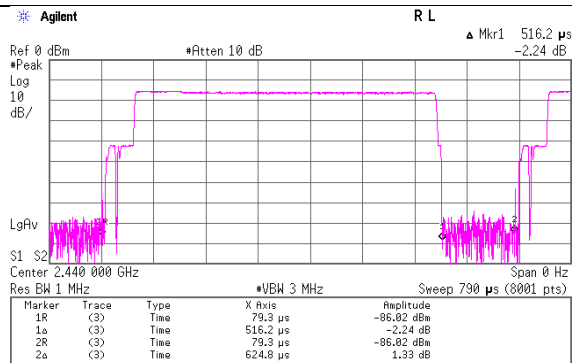
Result (Burst power average) = Time average + Duty factor

*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Test place	Shonan EMC Lab. No.6 Shielded Room
Report No.	11377899S-A
Date	August 23, 2016
Temperature / Humidity	26 deg. C / 46 % RH
Engineer	Kazutaka Takeyama
Mode	Tx BT LE

Tx on / (Tx on + Tx off) =	0.826
Tx on / (Tx on + Tx off) * 100 =	82.6 %
Duty factor = 10 * log (0.00062479125 / 0.00051616625)	0.8 dB
Duty factor = 20 * log (0.00062479125 / 0.00051616625)	1.7 dB*
*For radiated emission	



Radiated Spurious Emission

Test place : Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber
Report No. : 11377899S-A
Date : August 2, 2016 September 1, 2016
Temperature / Humidity : 22 deg. C / 55 % RH 22 deg. C / 62 % RH
Engineer : Hikaru Shirasawa Kazutaka Takeyama
(1 GHz -13 GHz) (30 MHz-1 GHz, 13 GHz -26.5 GHz)
Mode : Tx BT LE 2402 MHz

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.158	QP	23.40	11.40	7.20	31.90	0.00	10.10	40.00	29.9	150	70	
Hori.	210.895	QP	23.10	16.69	9.06	31.75	0.00	17.10	43.50	26.4	200	103	
Hori.	696.932	QP	22.80	20.25	8.85	31.55	0.00	20.35	46.00	25.6	100	121	
Hori.	958.555	QP	22.70	22.48	10.09	30.43	0.00	24.84	46.00	21.1	100	355	
Hori.	2390.000	PK	42.85	27.75	13.82	37.06	2.39	49.75	73.97	24.2	100	36	
Hori.	4804.000	PK	44.86	31.41	5.95	37.12	2.39	47.49	73.97	26.4	100	303	
Hori.	7206.000	PK	41.94	36.89	7.38	37.84	2.39	50.76	73.97	23.2	150	122	
Hori.	9608.000	PK	45.99	38.46	8.32	39.13	2.39	56.03	73.97	17.9	162	305	
Hori.	12010.000	PK	45.68	39.69	9.57	39.38	2.39	57.95	73.97	16.0	150	0	
Vert.	31.755	QP	23.80	16.78	6.83	31.91	0.00	15.50	40.00	24.5	100	300	
Vert.	100.808	QP	23.10	10.22	7.98	31.85	0.00	9.45	43.50	34.0	100	30	
Vert.	245.133	QP	23.10	17.64	9.34	31.71	0.00	18.37	46.00	27.6	100	14	
Vert.	644.419	QP	23.00	19.54	8.59	31.61	0.00	19.52	46.00	26.4	100	353	
Vert.	2390.000	PK	43.35	27.75	13.82	37.06	2.39	50.25	73.97	23.7	250	357	
Vert.	4804.000	PK	42.68	31.41	5.95	37.12	2.39	45.31	73.97	28.6	136	336	
Vert.	7206.000	PK	43.57	36.89	7.38	37.84	2.39	52.39	73.97	21.5	141	359	
Vert.	9608.000	PK	45.26	38.46	8.32	39.13	2.39	55.30	73.97	18.6	114	36	
Vert.	12010.000	PK	45.85	39.69	9.57	39.38	2.39	58.12	73.97	15.8	150	0	

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

Distance factor : 1 GHz - 13 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	33.96	27.75	13.82	37.06	1.70	2.39	42.56	53.97	11.4	*1)
Hori.	4804.000	AV	36.05	31.41	5.95	37.12	1.70	2.39	40.38	53.97	13.6	
Hori.	7206.000	AV	34.12	36.89	7.38	37.84	1.70	2.39	44.64	53.97	9.3	
Hori.	9608.000	AV	35.95	38.46	8.32	39.13	1.70	2.39	47.69	53.97	6.3	
Hori.	12010.000	AV	36.00	39.69	9.57	39.38	1.70	2.39	49.97	53.97	4.0	
Vert.	2390.000	AV	33.77	27.75	13.82	37.06	1.70	2.39	42.37	53.97	11.6	*1)
Vert.	4804.000	AV	34.56	31.41	5.95	37.12	1.70	2.39	38.89	53.97	15.1	
Vert.	7206.000	AV	34.33	36.89	7.38	37.84	1.70	2.39	44.85	53.97	9.1	
Vert.	9608.000	AV	36.22	38.46	8.32	39.13	1.70	2.39	47.96	53.97	6.0	
Vert.	12010.000	AV	36.38	39.69	9.57	39.38	1.70	2.39	50.35	53.97	3.6	

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

Distance factor : 1 GHz - 13 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	63.57	27.77	13.83	37.05	2.39	70.51	-	-	Carrier
Hori.	2400.000	PK	34.45	27.76	13.83	37.05	2.39	41.38	50.51	9.1	
Vert.	2402.000	PK	62.04	27.77	13.83	37.05	2.39	68.98	-	-	Carrier
Vert.	2400.000	PK	34.08	27.76	13.83	37.05	2.39	41.01	48.98	8.0	

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

Distance factor : 1 GHz - 13 GHz : 20log (3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

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Shonan EMC Lab.

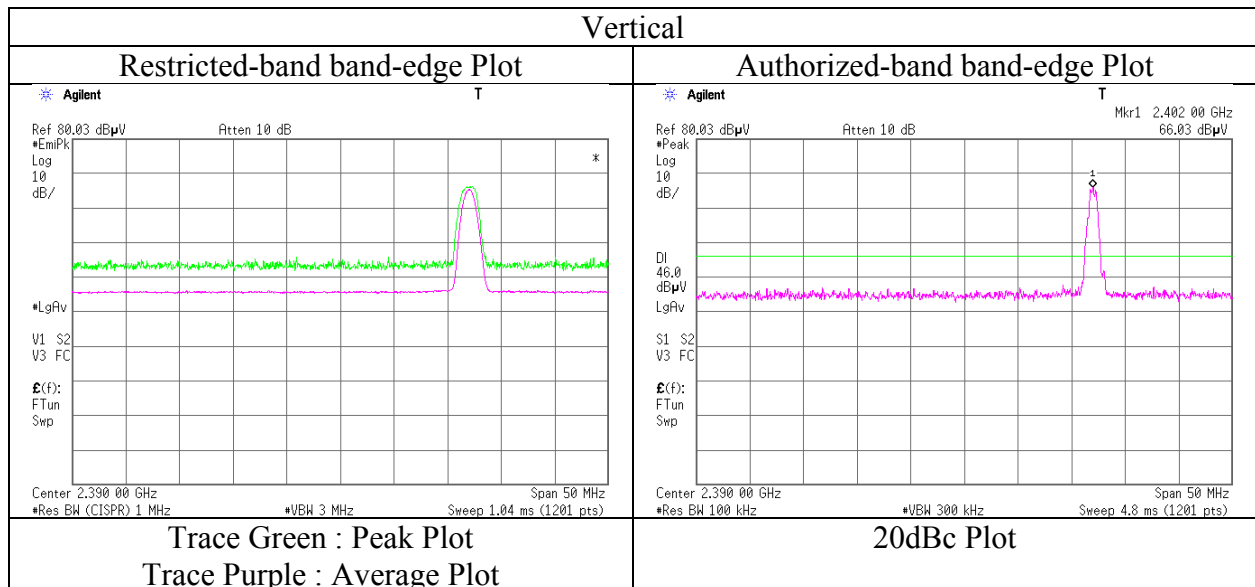
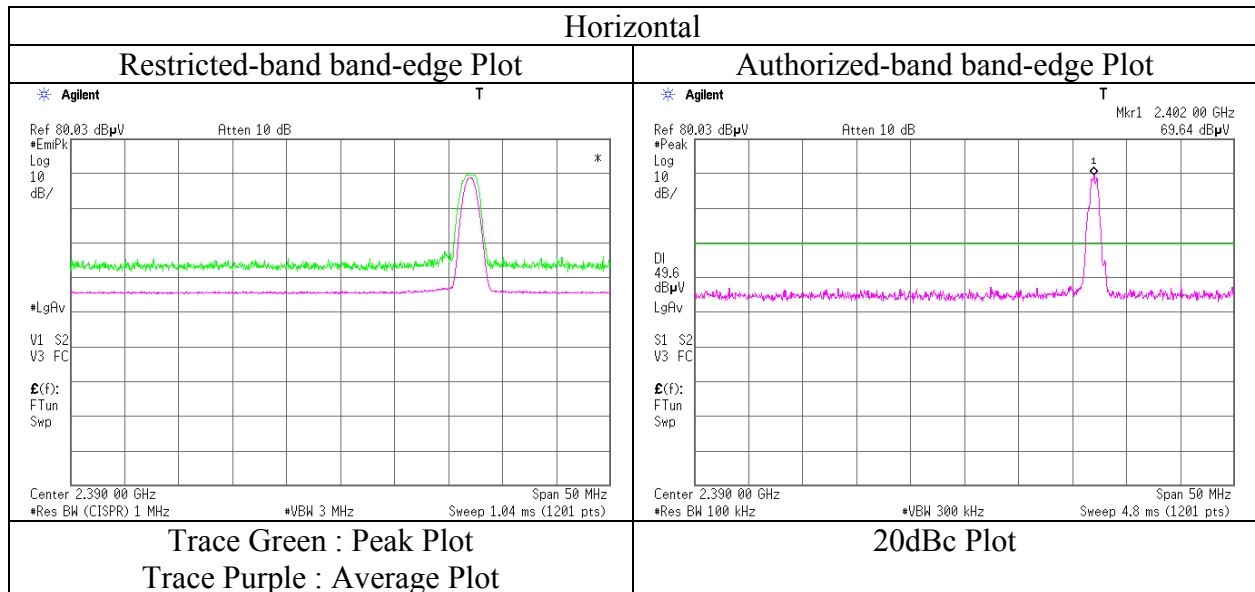
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Radiated Spurious Emission (Reference Plot for band-edge)

Test place	Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber		
Report No.	11377899S-A		
Date	August 2, 2016	September 1, 2016	
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 62 % RH	
Engineer	Hikaru Shirasawa (1 GHz -13 GHz)	Kazutaka Takeyama (30 MHz-1 GHz, 13 GHz -26.5 GHz)	
Mode	Tx BT LE 2402 MHz		



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

Radiated Spurious Emission

Test place : Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber
Report No. : 11377899S-A
Date : August 2, 2016 September 1, 2016
Temperature / Humidity : 22 deg. C / 55 % RH 22 deg. C / 62 % RH
Engineer : Hikaru Shirasawa Kazutaka Takeyama
(1 GHz -13 GHz) (30 MHz-1 GHz, 13 GHz -26.5 GHz)
Mode : Tx BT LE 2440 MHz

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	32.634	QP	23.50	16.60	6.85	31.91	0.00	15.04	40.00	24.9	200	88	
Hori.	180.184	QP	23.00	15.92	8.72	31.78	0.00	15.86	43.50	27.6	200	183	
Hori.	193.648	QP	22.90	16.24	8.76	31.77	0.00	16.13	43.50	27.3	150	197	
Hori.	701.441	QP	23.00	20.30	8.88	31.55	0.00	20.63	46.00	25.3	100	320	
Hori.	4880.000	PK	44.20	31.70	5.97	37.15	2.39	47.11	73.97	26.8	100	299	
Hori.	7320.000	PK	42.55	36.92	7.36	37.91	2.39	51.31	73.97	22.6	150	275	
Hori.	9760.000	PK	43.15	38.45	8.35	39.19	2.39	53.15	73.97	20.8	272	289	
Hori.	12200.000	PK	43.95	39.61	9.56	39.39	2.39	56.12	73.97	17.8	150	0	
Vert.	32.160	QP	23.70	16.70	6.85	31.91	0.00	15.34	40.00	24.6	100	254	
Vert.	190.791	QP	23.10	16.17	8.75	31.77	0.00	16.25	43.50	27.2	100	23	
Vert.	848.169	QP	22.80	21.48	9.57	31.08	0.00	22.77	46.00	23.2	100	220	
Vert.	930.608	QP	22.60	22.27	9.97	30.65	0.00	24.19	46.00	21.8	100	356	
Vert.	4880.000	PK	43.80	31.70	5.97	37.15	2.39	46.71	73.97	27.2	144	343	
Vert.	7320.000	PK	42.95	36.92	7.36	37.91	2.39	51.71	73.97	22.2	150	91	
Vert.	9760.000	PK	43.14	38.45	8.35	39.19	2.39	53.14	73.97	20.8	151	349	
Vert.	12200.000	PK	43.75	39.61	9.56	39.39	2.39	55.92	73.97	18.0	100	0	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.95\text{ m} / 3.0\text{ m}) = 2.39\text{ dB}$

13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	35.46	31.70	5.97	37.15	1.70	2.39	40.07	53.97	13.9	
Hori.	7320.000	AV	33.17	36.92	7.36	37.91	1.70	2.39	43.63	53.97	10.3	
Hori.	9760.000	AV	34.76	38.45	8.35	39.19	1.70	2.39	46.46	53.97	7.5	
Hori.	12200.000	AV	34.68	39.61	9.56	39.39	1.70	2.39	48.55	53.97	5.4	
Vert.	4880.000	AV	35.76	31.70	5.97	37.15	1.70	2.39	40.37	53.97	13.6	
Vert.	7320.000	AV	33.14	36.92	7.36	37.91	1.70	2.39	43.60	53.97	10.4	
Vert.	9760.000	AV	34.40	38.45	8.35	39.19	1.70	2.39	46.10	53.97	7.9	
Vert.	12200.000	AV	34.55	39.61	9.56	39.39	1.70	2.39	48.42	53.97	5.6	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.95\text{ m} / 3.0\text{ m}) = 2.39\text{ dB}$

13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Duty factor refer to "Duty factor Calculation chart" sheet.

Radiated Spurious Emission

Test place : Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber
Report No. : 11377899S-A
Date : August 2, 2016 September 1, 2016
Temperature / Humidity : 22 deg. C / 55 % RH 22 deg. C / 62 % RH
Engineer : Hikaru Shirasawa Kazutaka Takeyama
(1 GHz -13 GHz) (30 MHz-1 GHz, 13 GHz -26.5 GHz)
Mode : Tx BT LE 2480 MHz

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	189.702	QP	22.70	16.15	8.74	31.77	0.00	15.82	43.50	27.6	150	359	
Hori.	266.667	QP	23.00	18.30	9.51	31.69	0.00	19.12	46.00	26.8	200	170	
Hori.	296.958	QP	22.90	19.25	9.74	31.67	0.00	20.22	46.00	25.7	200	0	
Hori.	880.822	QP	22.80	21.84	9.74	30.94	0.00	23.44	46.00	22.5	150	116	
Hori.	2483.500	PK	43.31	27.91	13.91	37.01	2.39	50.51	73.97	23.4	109	353	
Hori.	4960.000	PK	42.88	32.00	5.98	37.19	2.39	46.06	73.97	27.9	123	340	
Hori.	7440.000	PK	42.60	36.95	7.33	37.99	2.39	51.28	73.97	22.6	150	29	
Hori.	9920.000	PK	42.50	38.44	8.38	39.26	2.39	52.45	73.97	21.5	150	162	
Hori.	12400.000	PK	40.48	39.53	9.57	39.40	2.39	52.57	73.97	21.4	150	0	
Vert.	31.214	QP	23.60	16.90	6.82	31.91	0.00	15.41	40.00	24.5	100	7	
Vert.	125.247	QP	22.90	13.44	8.04	31.83	0.00	12.55	43.50	30.9	100	1	
Vert.	739.580	QP	22.90	20.55	9.07	31.46	0.00	21.06	46.00	24.9	100	1	
Vert.	919.378	QP	22.60	22.19	9.92	30.72	0.00	23.99	46.00	22.0	100	232	
Vert.	2483.500	PK	43.35	27.91	13.91	37.01	2.39	50.55	73.97	23.4	132	337	
Vert.	4960.000	PK	43.02	32.00	5.98	37.19	2.39	46.20	73.97	27.7	114	351	
Vert.	7440.000	PK	41.45	36.95	7.33	37.99	2.39	50.13	73.97	23.8	150	269	
Vert.	9920.000	PK	42.66	38.44	8.38	39.26	2.39	52.61	73.97	21.3	140	264	
Vert.	12400.000	PK	41.80	39.53	9.57	39.40	2.39	53.89	73.97	20.0	150	359	

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

Distance factor : 1 GHz - 13 GHz : 20log(3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	33.62	27.91	13.91	37.01	1.70	2.39	42.52	53.97	11.4	*1)
Hori.	4960.000	AV	33.73	32.00	5.98	37.19	1.70	2.39	38.61	53.97	15.4	
Hori.	7440.000	AV	32.68	36.95	7.33	37.99	1.70	2.39	43.06	53.97	10.9	
Hori.	9920.000	AV	33.82	38.44	8.38	39.26	1.70	2.39	45.47	53.97	8.5	
Hori.	12400.000	AV	31.51	39.53	9.57	39.40	1.70	2.39	45.30	53.97	8.7	
Vert.	2483.500	AV	33.54	27.91	13.91	37.01	1.70	2.39	42.44	53.97	11.5	*1)
Vert.	4960.000	AV	33.85	32.00	5.98	37.19	1.70	2.39	38.73	53.97	15.2	
Vert.	7440.000	AV	32.88	36.95	7.33	37.99	1.70	2.39	43.26	53.97	10.7	
Vert.	9920.000	AV	34.43	38.44	8.38	39.26	1.70	2.39	46.08	53.97	7.9	
Vert.	12400.000	AV	31.71	39.53	9.57	39.40	1.70	2.39	45.50	53.97	8.5	

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

Distance factor : 1 GHz - 13 GHz : 20log(3.95 m / 3.0 m) = 2.39 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

UL Japan, Inc.

Shonan EMC Lab.

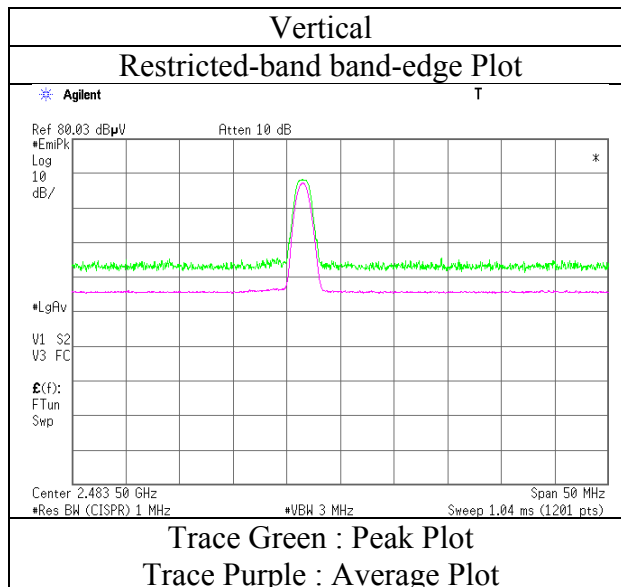
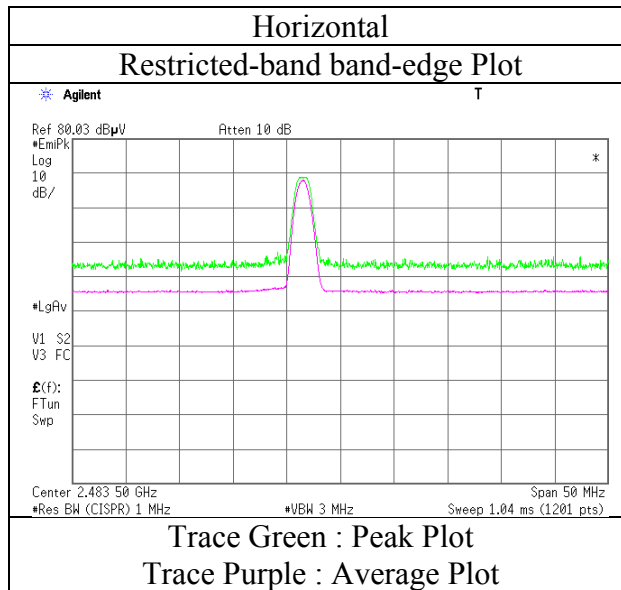
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Radiated Spurious Emission (Reference Plot for band-edge)

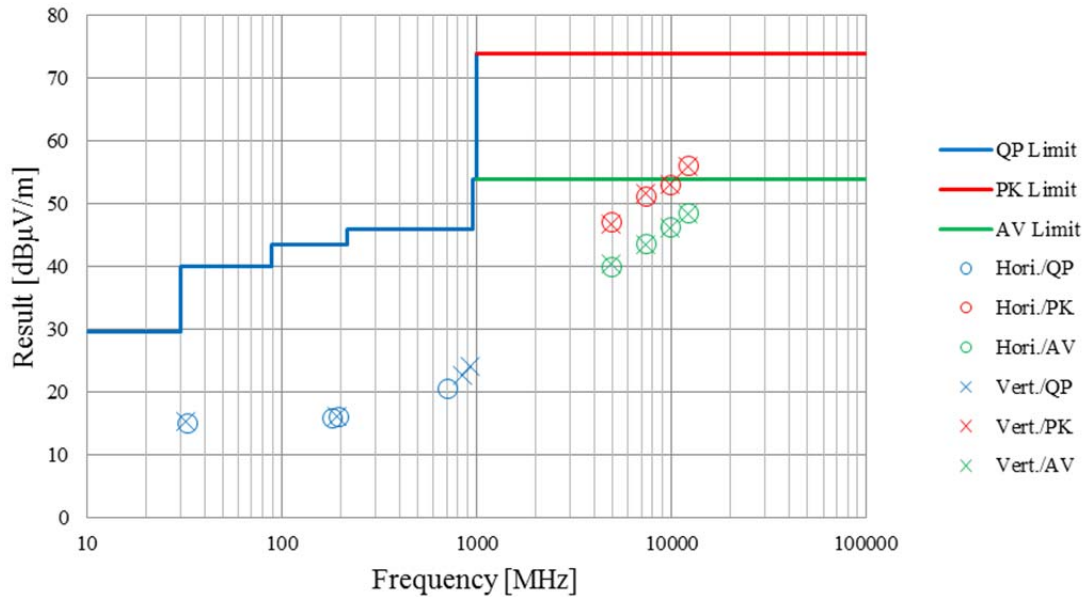
Test place	Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber		
Report No.	11377899S-A		
Date	August 2, 2016	September 1, 2016	
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 62 % RH	
Engineer	Hikaru Shirasawa	Kazutaka Takeyama	
	(1 GHz -13 GHz)	(30 MHz-1 GHz, 13 GHz -26.5 GHz)	
Mode	Tx BT LE 2480 MHz		



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

Radiated Spurious Emission
(Plot data, Worst case)

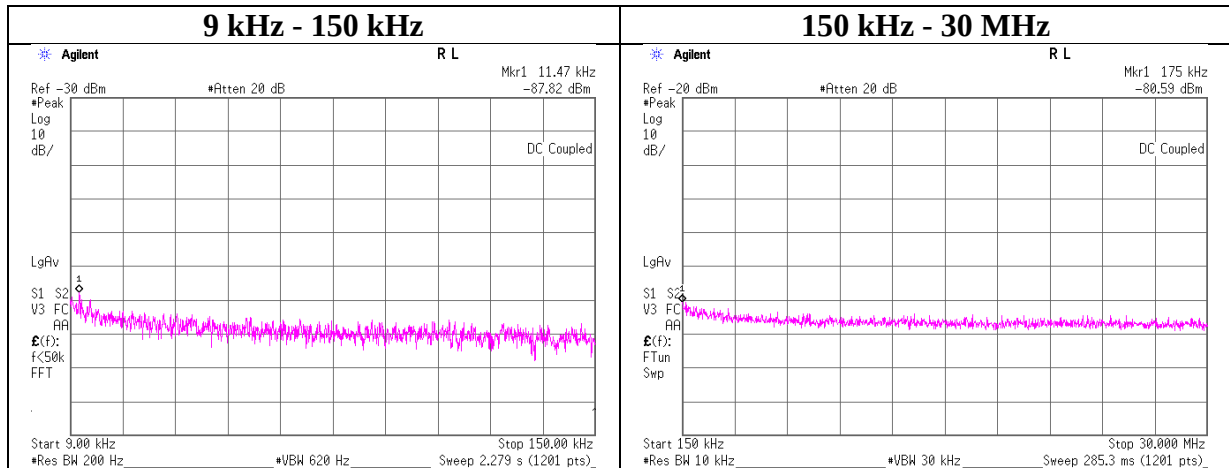
Test place	Shonan EMC Lab. No.2 and 3 Semi Anechoic Chamber		
Report No.	11377899S-A		
Date	August 2, 2016	September 1, 2016	
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 62 % RH	
Engineer	Hikaru Shirasawa	Kazutaka Takeyama	
	(1 GHz -13 GHz)	(30 MHz-1 GHz, 13 GHz -26.5 GHz)	
Mode	Tx BT LE 2440 MHz		



*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Test place	Shonan EMC Lab. No.6 Shielded Room
Report No.	11377899S-A
Date	August 23, 2016
Temperature / Humidity	26 deg. C / 46 % RH
Engineer	Kazutaka Takeyama
Mode	Tx BT LE 2402 MHz



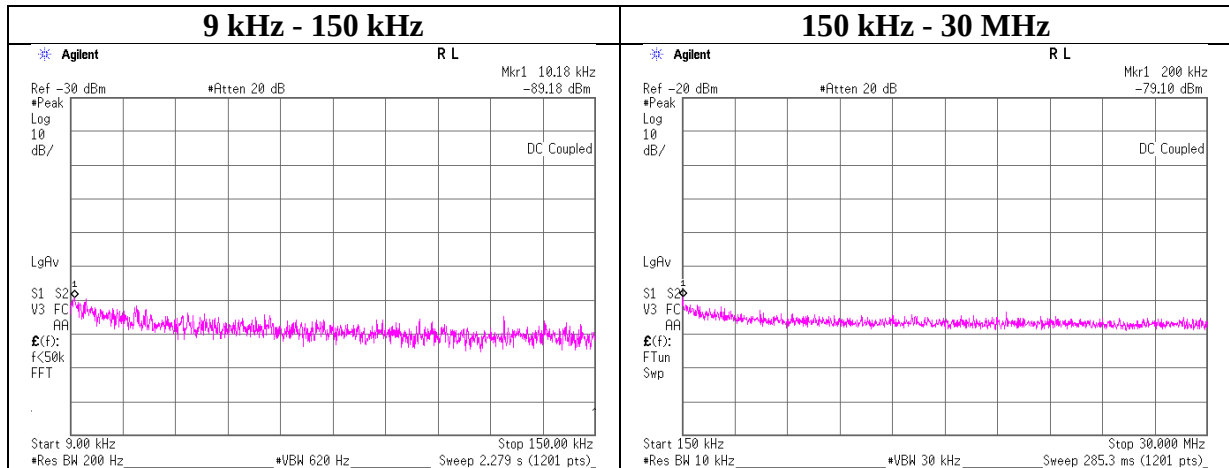
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.47	-87.8	0.02	9.8	2.5	1	-75.5	300	6.0	-14.2	46.4	60.6	
175.00	-80.6	0.02	9.8	2.5	1	-68.2	300	6.0	-7.0	22.7	29.7	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = \text{Reading} + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

Conducted Spurious Emission

Test place	Shonan EMC Lab. No.6 Shielded Room
Report No.	11377899S-A
Date	August 23, 2016
Temperature / Humidity	26 deg. C / 46 % RH
Engineer	Kazutaka Takeyama
Mode	Tx BT LE 2440 MHz



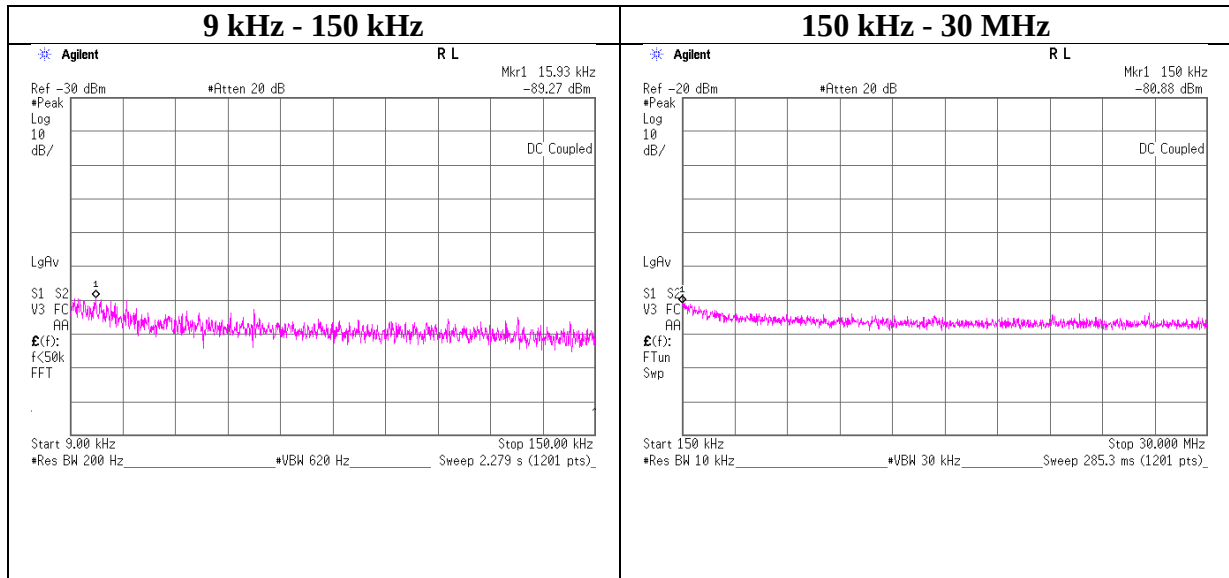
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
10.18	-89.2	0.02	9.8	2.5	1	-76.8	300	6.0	-15.6	47.4	63.0	
200.00	-79.1	0.02	9.8	2.5	1	-66.7	300	6.0	-5.5	21.5	27.0	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = \text{Reading} + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

Conducted Spurious Emission

Test place : Shonan EMC Lab. No.6 Shielded Room
Report No. : 11377899S-A
Date : August 23, 2016
Temperature / Humidity : 26 deg. C / 46 % RH
Engineer : Kazutaka Takeyama
Mode : Tx BT LE 2480 MHz



Frequency	Reading	Cable Loss	Attenuator Loss	Antenna Gain	N	EIRP	Distance	Ground bounce	E (field strength)	Limit	Margin	Remark
[kHz]	[dBm]	[dB]	[dB]	[dBi]	(Number of Output)	[dBm]	[m]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
15.93	-89.3	0.02	9.8	2.5	1	-76.9	300	6.0	-15.7	43.5	59.2	
150.00	-79.1	0.02	9.8	2.5	1	-66.7	300	6.0	-5.5	24.0	29.5	

$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

$\text{EIRP} = \text{Reading} + \text{Cable Loss} + \text{Attenuator Loss} + \text{Antenna Gain} + 10 * \log(N)$

Power Density

Test place Shonan EMC Lab. No.6 Shielded Room
Report No. 11377899S-A
Date August 23, 2016
Temperature / Humidity 26 deg. C / 46 % RH
Engineer Kazutaka Takeyama
Mode Tx BT LE

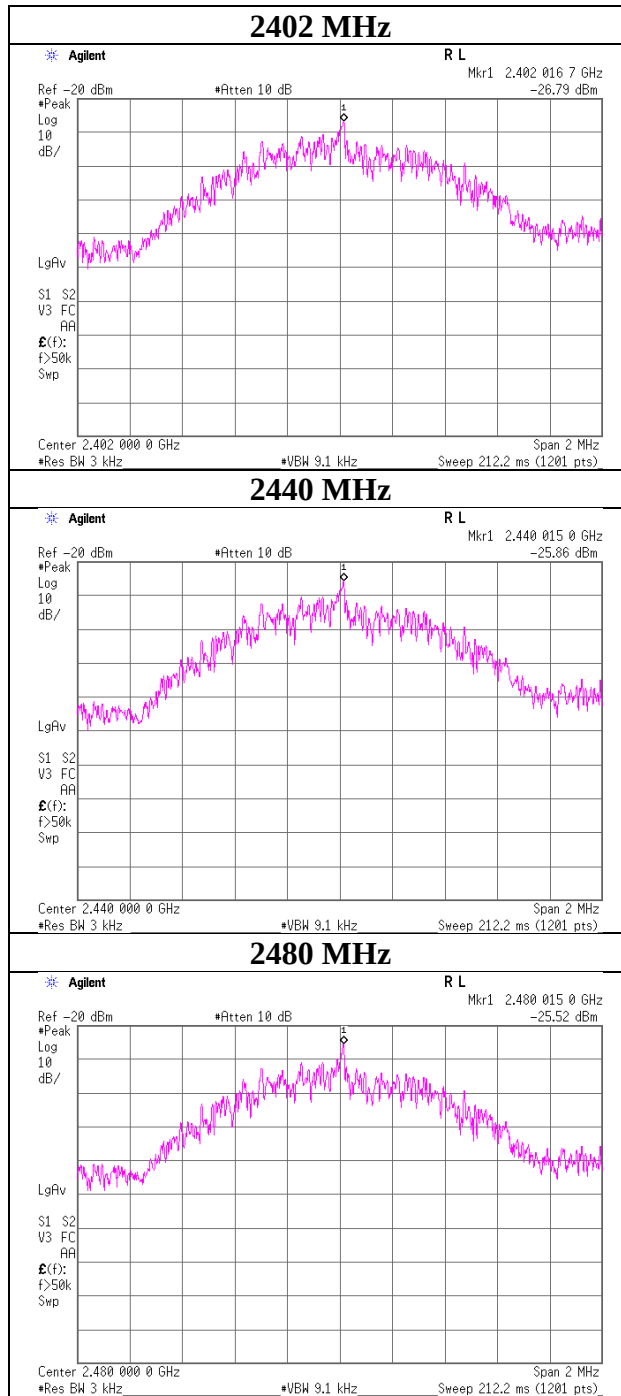
Freq.	Reading	Cable Loss	Atten. Loss	Result	Limit	Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[dBm]	[dB]
2402.00	-26.79	1.32	9.92	-15.55	8.00	23.55
2440.00	-25.86	1.32	9.92	-14.62	8.00	22.62
2480.00	-25.52	1.33	9.92	-14.27	8.00	22.27

Sample Calculation:

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

*The equipment and cables were not used for factor 0 dB of the data sheets.

Power Density



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Shonan EMC Lab.

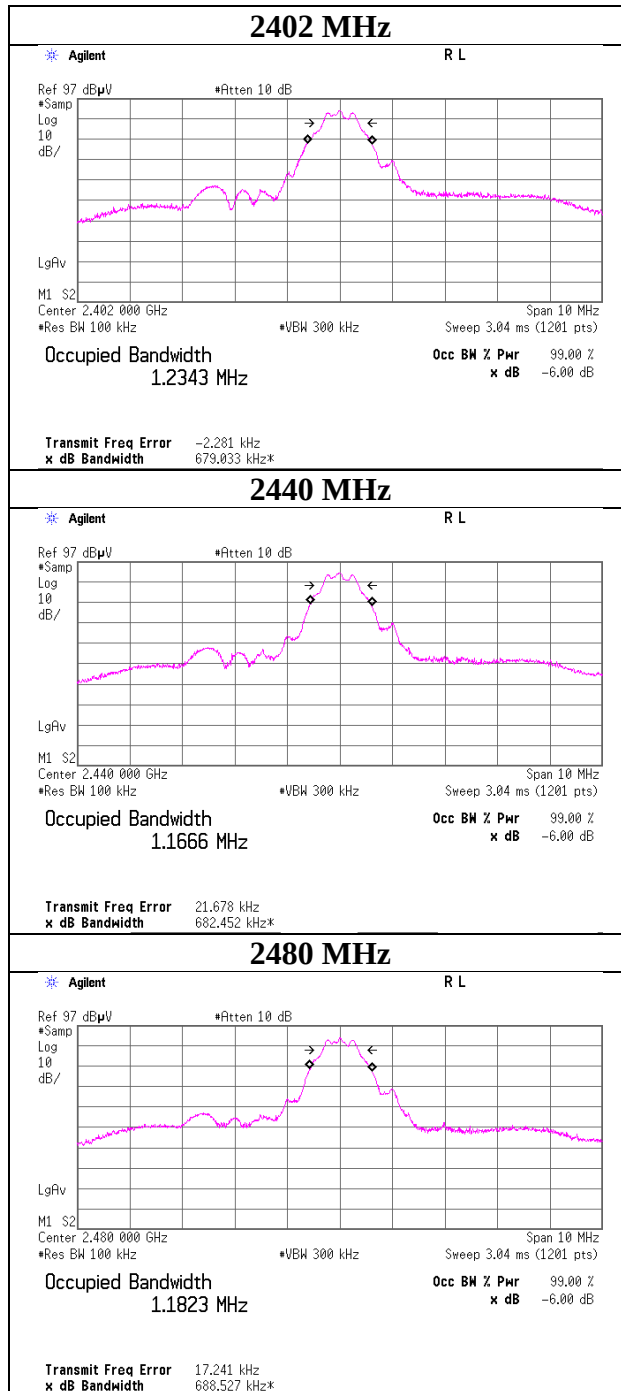
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

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99% Occupied Bandwidth

Test place : Shonan EMC Lab. No.6 Shielded Room
Report No. : 11377899S-A
Date : August 23, 2016
Temperature / Humidity : 26 deg. C / 46 % RH
Engineer : Kazutaka Takeyama
Mode : Tx BT LE



APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
SRENT-06	Spectrum Analyzer	KEYSIGHT	E4440A	MY482509 21	AT	2016/08/07 * 12
SPM-06	Power Meter	Anritsu	ML2495A	0850009	AT	2016/04/01 * 12
SPSS-03	Power sensor	Anritsu	MA2411B	0917063	AT	2016/04/01 * 12
SCC-G14	Coaxial Cable	Suhner	SUCOFLEX 102	31600/2	AT	2016/03/23 * 12
SAT10-10	Attenuator	Weinschel Corp.	54A-10	37584	AT	2016/04/18 * 12
SOS-10	Humidity Indicator	A&D	AD-5681	4064561	AT	2015/10/22 * 12
SAF-05	Pre Amplifier	TOYO Corporation	TPA0118-36	1440490	RE	2016/02/10 * 12
SCC-G04	Coaxial Cable	Junkosha	J12J102207-0 0	JUN-12-14- 018	RE	2016/06/23 * 12
SCC-G23	Coaxial Cable	Suhner	SUCOFLEX 104	297342/4	RE	2016/05/11 * 12
SHA-03	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-739	RE	2016/08/22 * 12
SOS-05	Humidity Indicator	A&D	AD-5681	4062518	RE	2015/10/22 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY482501 06	RE	2016/03/23 * 12
SJM-15	Measure	ASKUL	-	-	RE	-
SAEC-03(SVS WR)	Semi-Anechoic Chamber	TDK	SAEC-03(SV SWR)	3	RE	2016/07/25 * 12
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE,RFI,M F)	-	RE	-
STS-03	Digital Hitester	Hioki	3805-50	080997823	RE	2015/11/18 * 12
SAT10-06	Attenuator	Agilent	8493C-010	74865	RE	2015/11/04 * 12
SFL-18	Highpass Filter	MICRO-TRONICS	HPM50111	119	RE	2016/04/18 * 12
SAEC-02(NSA)	Semi-Anechoic Chamber	TDK	SAEC-02(NS A)	2	RE	2016/07/13 * 12
SCC-G05	Coaxial Cable	Junkosha	J12J102207-0 0	APR-30-15- 037	RE	2016/05/24 * 12
SCC-G22	Coaxial Cable	Suhner	SUCOFLEX 104	296199/4	RE	2016/05/11 * 12
SHA-02	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-726	RE	2016/08/09 * 12
SOS-03	Humidity Indicator	A&D	AD-5681	4063325	RE	2015/10/22 * 12
STR-07	Test Receiver	Rohde & Schwarz	ESU26	100484	RE	2015/09/04 * 12
SJM-09	Measure	PROMART	SEN1935	-	RE	-
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE,RFI,M F)	-	RE	-
STS-02	Digital Hitester	Hioki	3805-50	080997819	RE	2016/03/22 * 12
SHA-04	Horn Antenna	ETS LINDGREN	3160-09	LM3640	RE	2016/03/15 * 12
SAF-08	Pre Amplifier	TOYO Corporation	HAP18-26W	00000019	RE	2016/03/23 * 12
SCC-G33	Coaxial Cable	Junkosha	MWX241-01 000KMSKM S	-	RE	2016/04/18 * 12
SCC-G15	Coaxial Cable	Suhner	SUCOFLEX 102	32703/2	RE	2016/03/08 * 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: RE: Radiated Emission test, AT: Antenna Terminal Conducted test

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