



RADIO TEST REPORT

Test Report No. : 11757840S-A-R2

Applicant : CASIO COMPUTER CO., LTD.
Type of Equipment : Watch
Model No. : MRG-B1000
FCC ID : BBQS09W
Test regulation : FCC Part 15 Subpart C: 2018
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.
5. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
6. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. This report is a revised version of 11757840S-A-R1. 11757840S-A-R1 is replaced with this report.

Date of test: May 9 to 10, 2017

Representative test engineer:

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Engineer

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Approved by:

A. Hayashi

Akio Hayashi

Leader

Consumer Technology Division



JAB
Testing
RTL02610

- ☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
☒ 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	:	Watch
Model No.	:	MRG-B1000
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	Typical: Nom : DC 2.5 V, Min.: DC 1.9 V, Max.: DC 2.7 V CW5526 (Module): Min.: DC 1.9 V, Max.: DC 3.3 V
Receipt Date of Sample	:	May 9, 2017
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: MRG-B1000 (referred to as the EUT in this report) is a Watch.

* MRG-B1000 has alternative name as R005.

General Specification

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

<Bluetooth part>

Equipment Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Type of Modulation	:	GFSK
Channel spacing	:	2 MHz
Antenna Type	:	Pattern Antenna (Mono Pole)
Antenna Gain	:	-2.0 dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on February 2, 2018 and effective March 5, 2018

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

* All the revisions made after testing date do not affect the test specification applied to the EUT.

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 v04 IC: -	FCC: Section 15.247(a)(2) IC: RSS-247 5.2(a)	See data.	Complied	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: RSS-Gen 6.12	FCC: Section 15.247(b)(3) IC: RSS-247 5.4(d)		Complied	Conducted
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: -	FCC: Section 15.247(e) IC: RSS-247 5.2(b)		Complied	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v04 IC: RSS-Gen 6.13	FCC: Section 15.247(d) IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	6.3 dB 9608.00 MHz, AV, Vertical Tx 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
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 v04 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	No. 5,6,8 SR
Radiated emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.1 dB	3.1 dB	3.1 dB	-	-
	30 MHz-200 MHz	4.6 dB	4.4 dB	4.6 dB	-	-
	200 MHz-1 GHz	5.8 dB	5.7 dB	5.8 dB	-	-
	1 GHz-13 GHz	4.9 dB	4.9 dB	4.9 dB	-	-
Radiated emission (Measurement distance: 1 m)	13 GHz-18 GHz	4.6 dB	4.6 dB	4.6 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	0.72 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-06	0.85 dB
Power Measurement above 1 GHz (Average Detector)_SPM-07	0.74 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-07	0.91 dB
Spurious emission (Conducted) below 1GHz	1.6 dB
Spurious emission (Conducted) 1 GHz-3 GHz	1.3 dB
Spurious emission (Conducted) 3 GHz-18 GHz	2.2 dB
Spurious emission (Conducted) 18 GHz-26.5 GHz	2.3 dB
Spurious emission (Conducted) 26.5 GHz-40 GHz	2.4 dB
Bandwidth Measurement	1.01 %
Duty cycle and Time Measurement	0.012 %

Radiated emission test

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

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	10 m
No.2 Semi-anechoic chamber	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
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

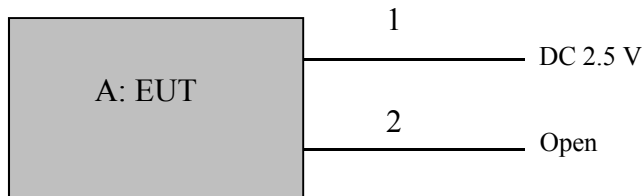
Refer to APPENDIX.

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 Setting: Fixed - Software: BLE RF Test Version 9.9 *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	Watch	MRG-B1000	14 *1) 15 *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	0.1 + 2.0	Unshielded	Unshielded	*3)
2	Signal Cable	0.1	Unshielded	Unshielded	*4)

*3) Cable for test operation

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

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 v04".

[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 200 MHz	200 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 *1)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: 12.2.5.2 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	3.97 m *2) (1 GHz – 13 GHz), 1 m *3) (13 GHz – 26.5 GHz)		3.97 m *2) (1 GHz – 13 GHz), 1 m *3) (13 GHz – 26.5 GHz)

*1) Average Power Measurement was performed based on 6.0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v04".

*2) Distance Factor: $20 \times \log(3.97 \text{ m} / 3.0 \text{ m}) = 2.44 \text{ dB}$

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

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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	X	X	X	X
Vertical	X	X	X	X

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

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) Max 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 v04". *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

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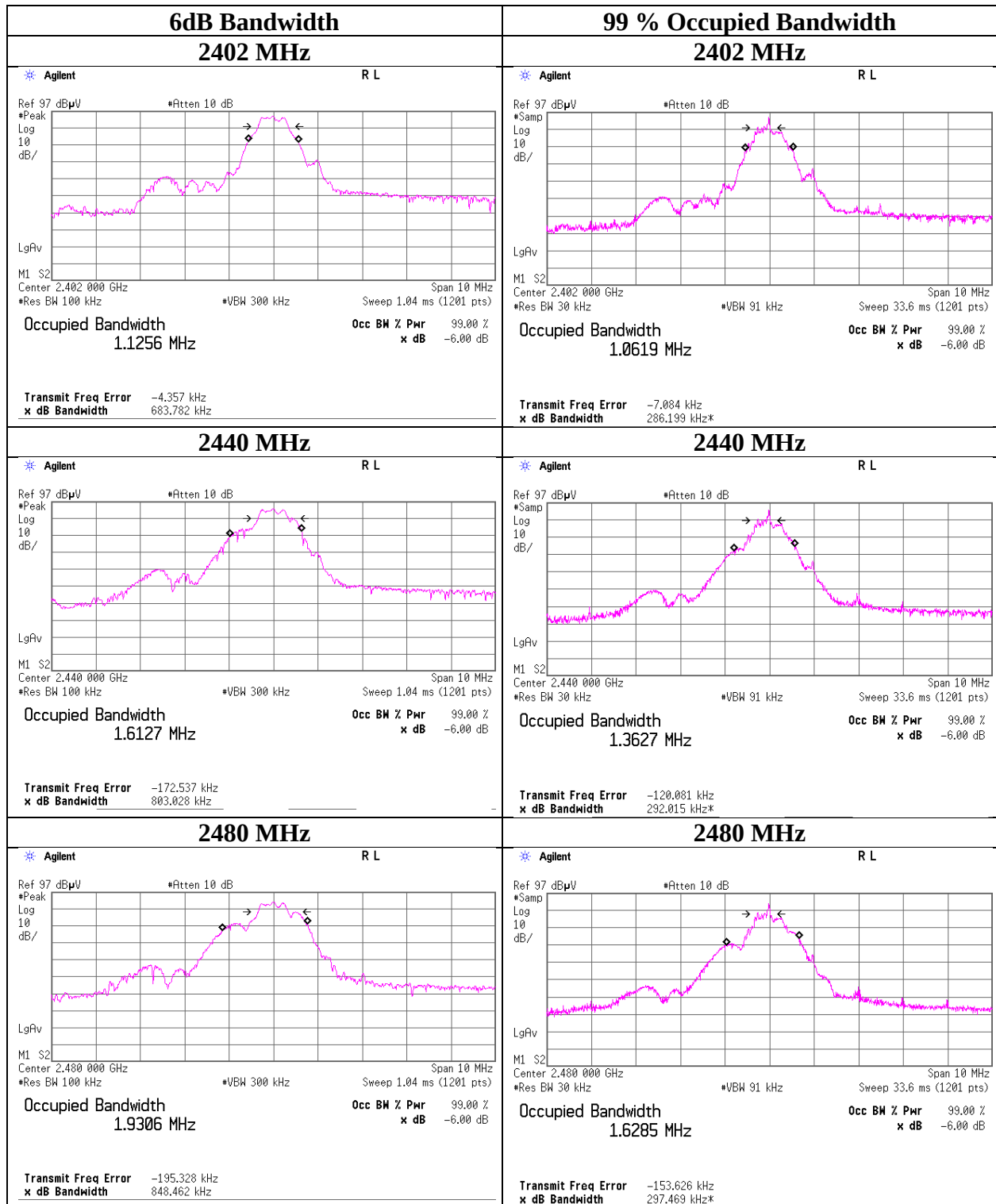
APPENDIX 1: Test data

6dB Bandwidth and 99 % Occupied Bandwidth

Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11757840S-A-R2
Date	May 9, 2017
Temperature / Humidity	24 deg. C / 41 % RH
Engineer	Makoto Hosaka
Mode	Tx

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BLE	2402	1061.9	0.684	> 0.5000
	2440	1362.7	0.803	> 0.5000
	2480	1628.5	0.848	> 0.5000

6dB Bandwidth and 99 % Occupied Bandwidth



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Maximum Peak Output Power

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11757840S-A-R2
Date May 9, 2017
Temperature / Humidity 24 deg. C / 41 % RH
Engineer Makoto Hosaka
Mode Tx

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-12.48	1.82	9.85	-0.81	0.83	30.00	1000	30.81
2440	-13.61	1.83	9.84	-1.94	0.64	30.00	1000	31.94
2480	-15.09	1.84	9.84	-3.41	0.46	30.00	1000	33.41

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.3 Shielded Room
Report No.	11757840S-A-R2
Date	May 9, 2017
Temperature / Humidity	24 deg. C / 41 % RH
Engineer	Makoto Hosaka
Mode	Tx

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	-14.22	1.82	9.85	-2.55	0.56	0.85	-1.70	0.68
2440	-15.46	1.83	9.84	-3.79	0.42	0.85	-2.94	0.51
2480	-17.18	1.84	9.84	-5.50	0.28	0.85	-4.65	0.34

Sample Calculation:

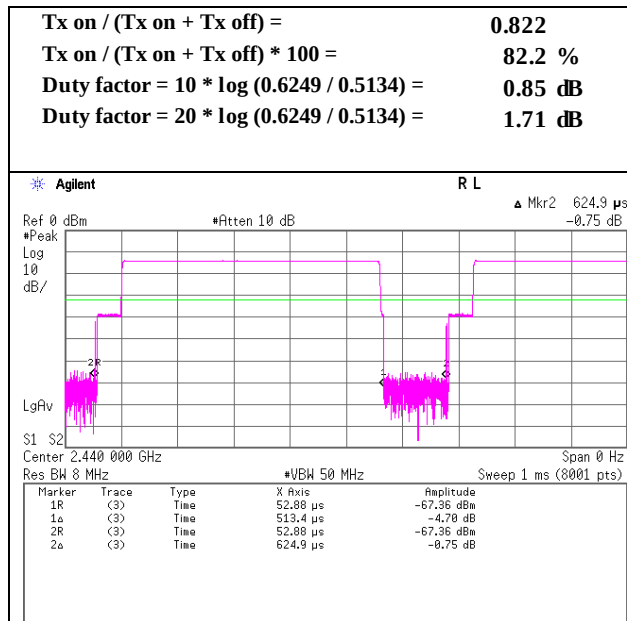
Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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.3 Shielded Room
Report No. 11757840S-A-R2
Date May 9, 2017
Temperature / Humidity 24 deg. C / 41 % RH
Engineer Makoto Hosaka
Mode Tx



* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Radiated Spurious Emission

Test place : Shonan EMC Lab. No.3 & 2 Semi Anechoic Chamber
Report No. : 11757840S-A-R2
Date : May 9, 2017
Temperature / Humidity : 22 deg. C / 44 % RH
Engineer : Kazutaka Takeyama
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.	103.959	QP	23.30	10.68	8.00	31.85	0.00	10.13	43.50	33.3	300	345	
Hori.	147.643	QP	23.10	14.73	8.61	31.80	0.00	14.64	43.50	28.8	200	7	
Hori.	601.633	QP	23.10	19.11	8.43	31.57	0.00	19.07	46.00	26.9	150	179	
Hori.	770.433	QP	22.90	20.57	9.24	31.39	0.00	21.32	46.00	24.6	150	38	
Hori.	944.873	QP	22.60	22.49	10.06	30.50	0.00	24.65	46.00	21.3	150	5	
Hori.	2390.000	PK	43.00	27.41	14.25	36.83	2.44	50.27	73.90	23.6	142	40	*1)
Hori.	4804.000	PK	43.00	31.13	6.63	36.99	2.44	46.21	73.90	27.6	100	0	
Hori.	7206.000	PK	44.00	36.44	8.12	37.81	2.44	53.19	73.90	20.7	100	0	
Hori.	9608.000	PK	45.50	38.63	9.08	38.48	2.44	57.17	73.90	16.7	100	0	
Vert.	35.270	QP	23.50	16.16	6.93	31.90	0.00	14.69	40.00	25.3	100	42	
Vert.	190.312	QP	22.90	16.24	8.84	31.77	0.00	16.21	43.50	27.2	100	10	
Vert.	743.203	QP	23.00	20.30	9.12	31.47	0.00	20.95	46.00	25.0	100	226	
Vert.	951.778	QP	22.60	22.51	10.09	30.45	0.00	24.75	46.00	21.2	100	358	
Vert.	2390.000	PK	44.40	27.41	14.25	36.83	2.44	51.67	73.90	22.2	150	44	*1)
Vert.	4804.000	PK	42.65	31.13	6.63	36.99	2.44	45.86	73.90	28.0	100	0	
Vert.	7206.000	PK	43.40	36.44	8.12	37.81	2.44	52.59	73.90	21.3	100	0	
Vert.	9608.000	PK	44.90	38.63	9.08	38.48	2.44	56.57	73.90	17.3	100	0	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97 \text{ m} / 3.0 \text{ m}) = 2.44 \text{ dB}$

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

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

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	33.47	27.41	14.25	36.83	1.71	2.44	42.45	53.90	11.5	*1)
Hori.	4804.000	AV	31.80	31.13	6.63	36.99	1.71	2.44	36.72	53.90	17.2	
Hori.	7206.000	AV	33.00	36.44	8.12	37.81	1.71	2.44	43.90	53.90	10.0	
Hori.	9608.000	AV	33.80	38.63	9.08	38.48	1.71	2.44	47.18	53.90	6.7	
Vert.	2390.000	AV	32.70	27.41	14.25	36.83	1.71	2.44	41.68	53.90	12.2	*1)
Vert.	4804.000	AV	32.10	31.13	6.63	36.99	1.71	2.44	37.02	53.90	16.9	
Vert.	7206.000	AV	33.40	36.44	8.12	37.81	1.71	2.44	44.30	53.90	9.6	
Vert.	9608.000	AV	34.20	38.63	9.08	38.48	1.71	2.44	47.58	53.90	6.3	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97 \text{ m} / 3.0 \text{ m}) = 2.44 \text{ dB}$

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.

*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	72.50	27.46	14.26	36.83	2.44	79.83	-	-	carrier
Hori.	2400.000	PK	31.70	27.45	14.26	36.83	2.44	39.02	59.83	20.8	
Vert.	2402.000	PK	69.70	27.46	14.26	36.83	2.44	77.03	-	-	carrier
Vert.	2400.000	PK	31.80	27.45	14.26	36.83	2.44	39.12	57.03	17.9	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97 \text{ m} / 3.0 \text{ m}) = 2.44 \text{ dB}$

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

UL Japan, Inc.

Shonan EMC Lab.

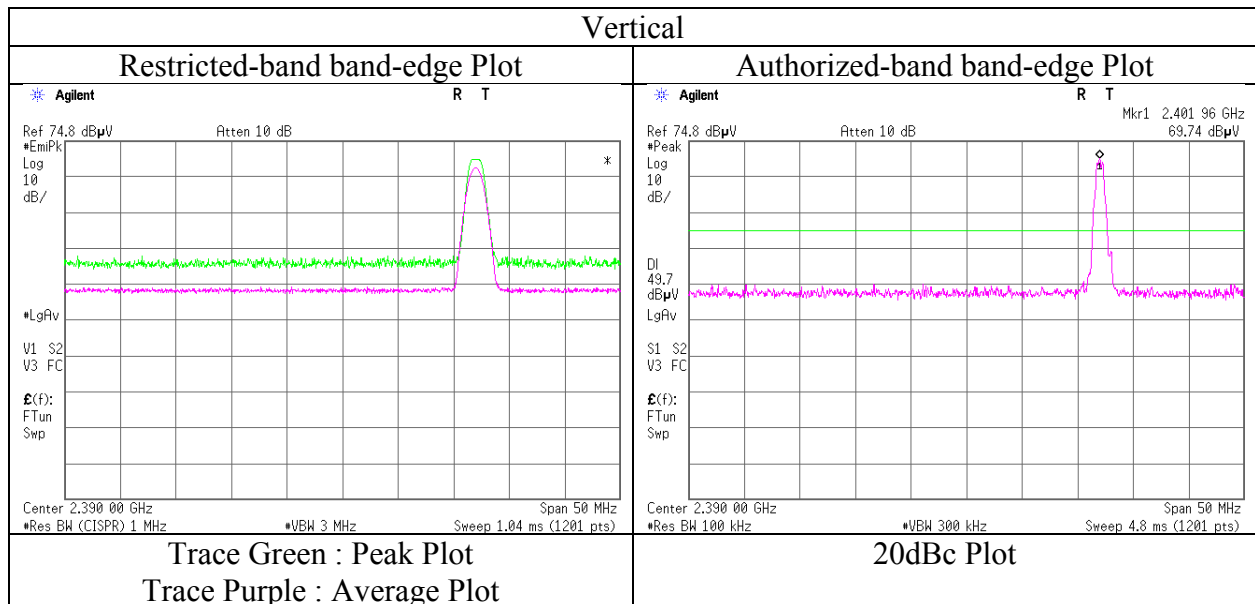
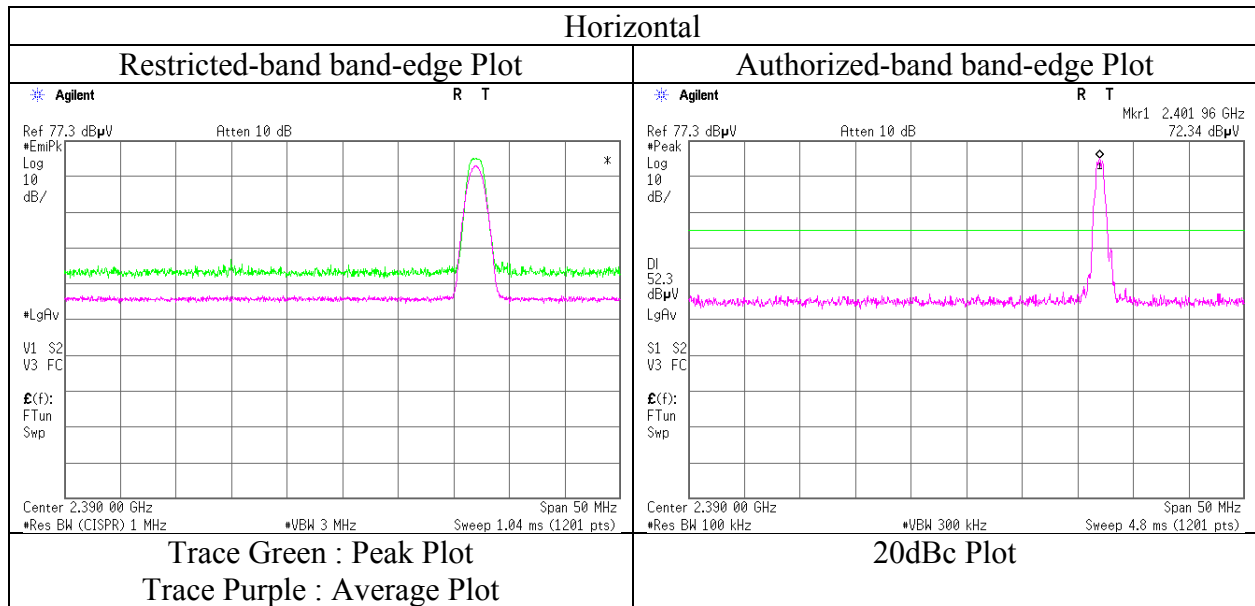
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

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Radiated Spurious Emission (Reference Plot for band-edge)

Test place	Shonan EMC Lab. No.3 & 2 Semi Anechoic Chamber		
Report No.	11757840S-A-R2		
Date	May 9, 2017	May 10, 2017	
Temperature / Humidity	22 deg. C / 44 % RH	22 deg. C / 55 % RH	
Engineer	Kazutaka Takeyama	Kazutaka Takeyama	
	(1 GHz -26.5 GHz)	(30 MHz- 1 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.3 & 2 Semi Anechoic Chamber
Report No. : 11757840S-A-R2
Date : May 9, 2017 May 10, 2017
Temperature / Humidity : 22 deg. C / 44 % RH 22 deg. C / 55 % RH
Engineer : Kazutaka Takeyama Kazutaka Takeyama
(1 GHz -26.5 GHz) (30 MHz- 1 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.	156.475	QP	23.20	15.14	8.74	31.80	0.00	15.28	43.50	28.2	200	255	
Hori.	589.393	QP	23.00	18.96	8.37	31.58	0.00	18.75	46.00	27.2	150	166	
Hori.	746.165	QP	22.90	20.33	9.13	31.46	0.00	20.90	46.00	25.1	100	7	
Hori.	824.969	QP	22.80	21.22	9.48	31.19	0.00	22.31	46.00	23.6	100	358	
Hori.	4880.000	PK	44.00	31.29	6.68	37.03	2.44	47.38	73.90	26.5	150	358	
Hori.	7320.000	PK	42.42	36.77	8.26	37.88	2.44	52.01	73.90	21.8	100	0	
Hori.	9760.000	PK	43.90	38.75	9.21	38.67	2.44	55.63	73.90	18.2	100	0	
Vert.	31.871	QP	23.60	16.92	6.84	31.90	0.00	15.46	40.00	24.5	100	131	
Vert.	166.872	QP	23.00	15.59	8.82	31.79	0.00	15.62	43.50	27.8	100	123	
Vert.	181.311	QP	23.00	16.15	8.81	31.78	0.00	16.18	43.50	27.3	100	354	
Vert.	871.137	QP	22.70	21.89	9.70	30.99	0.00	23.30	46.00	22.7	100	175	
Vert.	919.260	QP	22.50	22.39	9.94	30.70	0.00	24.13	46.00	21.8	100	24	
Vert.	4880.000	PK	43.65	31.29	6.68	37.03	2.44	47.03	73.90	26.8	150	2	
Vert.	7320.000	PK	42.70	36.77	8.26	37.88	2.44	52.29	73.90	21.6	100	0	
Vert.	9760.000	PK	43.30	38.75	9.21	38.67	2.44	55.03	73.90	18.8	100	0	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.44\text{ dB}$

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	32.59	31.29	6.68	37.03	1.71	2.44	37.68	53.90	16.2	
Hori.	7320.000	AV	32.90	36.77	8.26	37.88	1.71	2.44	44.20	53.90	9.7	
Hori.	9760.000	AV	33.90	38.75	9.21	38.67	1.71	2.44	47.34	53.90	6.6	
Vert.	4880.000	AV	32.60	31.29	6.68	37.03	1.71	2.44	37.69	53.90	16.2	
Vert.	7320.000	AV	32.70	36.77	8.26	37.88	1.71	2.44	44.00	53.90	9.9	
Vert.	9760.000	AV	33.80	38.75	9.21	38.67	1.71	2.44	47.24	53.90	6.7	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.44\text{ dB}$

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.3 & 2 Semi Anechoic Chamber
Report No. : 11757840S-A-R2
Date : May 9, 2017 May 10, 2017
Temperature / Humidity : 22 deg. C / 44 % RH 22 deg. C / 55 % RH
Engineer : Kazutaka Takeyama Kazutaka Takeyama
(1 GHz -26.5 GHz) (30 MHz- 1 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.	117.381	QP	23.20	12.58	7.99	31.83	0.00	11.94	43.50	31.5	150	241	
Hori.	165.668	QP	22.80	15.54	8.79	31.79	0.00	15.34	43.50	28.1	300	289	
Hori.	606.386	QP	23.10	19.15	8.45	31.58	0.00	19.12	46.00	26.8	100	249	
Hori.	950.955	QP	22.60	22.51	10.08	30.46	0.00	24.73	46.00	21.2	100	335	
Hori.	2483.500	PK	43.80	27.79	14.37	36.79	2.44	51.61	73.90	22.2	130	48	*1)
Hori.	4960.000	PK	43.00	31.45	6.73	37.07	2.44	46.55	73.90	27.3	140	1	
Hori.	7440.000	PK	42.11	37.11	8.40	37.95	2.44	52.11	73.90	21.7	100	0	
Hori.	9920.000	PK	43.20	38.87	9.34	38.87	2.44	54.98	73.90	18.9	100	0	
Vert.	32.553	QP	23.40	16.78	6.87	31.90	0.00	15.15	40.00	24.8	100	8	
Vert.	183.680	QP	22.90	16.17	8.81	31.78	0.00	16.10	43.50	27.4	100	311	
Vert.	539.230	QP	23.00	18.29	8.11	31.63	0.00	17.77	46.00	28.2	100	250	
Vert.	786.422	QP	22.90	20.73	9.31	31.33	0.00	21.61	46.00	24.3	100	101	
Vert.	889.198	QP	22.60	22.15	9.80	30.90	0.00	23.65	46.00	22.3	100	319	
Vert.	2483.500	PK	44.00	27.79	14.37	36.79	2.44	51.81	73.90	22.0	191	357	*1)
Vert.	4960.000	PK	42.45	31.45	6.73	37.07	2.44	46.00	73.90	27.9	135	1	
Vert.	7440.000	PK	43.00	37.11	8.40	37.95	2.44	53.00	73.90	20.9	100	0	
Vert.	9920.000	PK	43.40	38.87	9.34	38.87	2.44	55.18	73.90	18.7	100	0	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.44\text{ dB}$

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

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

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	32.00	27.79	14.37	36.79	1.71	2.44	41.52	53.90	12.4	*1)
Hori.	4960.000	AV	33.70	31.45	6.73	37.07	1.71	2.44	38.96	53.90	14.9	
Hori.	7440.000	AV	30.80	37.11	8.40	37.95	1.71	2.44	42.51	53.90	11.4	
Hori.	9920.000	AV	32.70	38.87	9.34	38.87	1.71	2.44	46.19	53.90	7.7	
Vert.	2483.500	AV	33.70	27.79	14.37	36.79	1.71	2.44	43.22	53.90	10.7	*1)
Vert.	4960.000	AV	34.00	31.45	6.73	37.07	1.71	2.44	39.26	53.90	14.6	
Vert.	7440.000	AV	31.00	37.11	8.40	37.95	1.71	2.44	42.71	53.90	11.2	
Vert.	9920.000	AV	32.50	38.87	9.34	38.87	1.71	2.44	45.99	53.90	7.9	

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

Distance factor : 1 GHz - 13 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.44\text{ dB}$

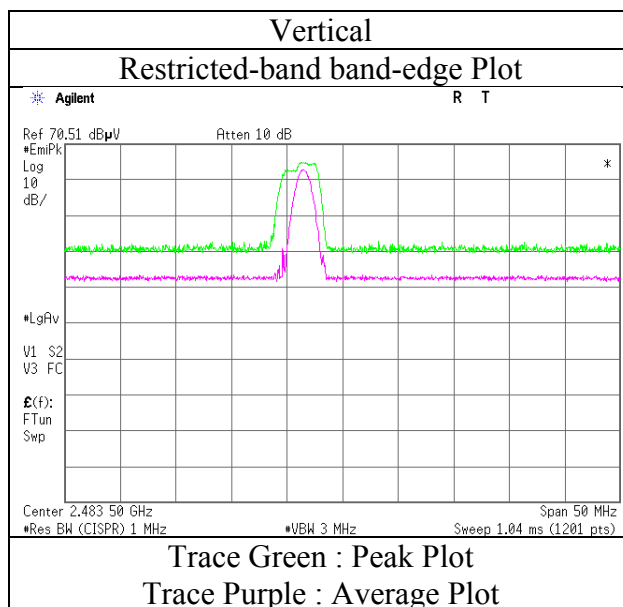
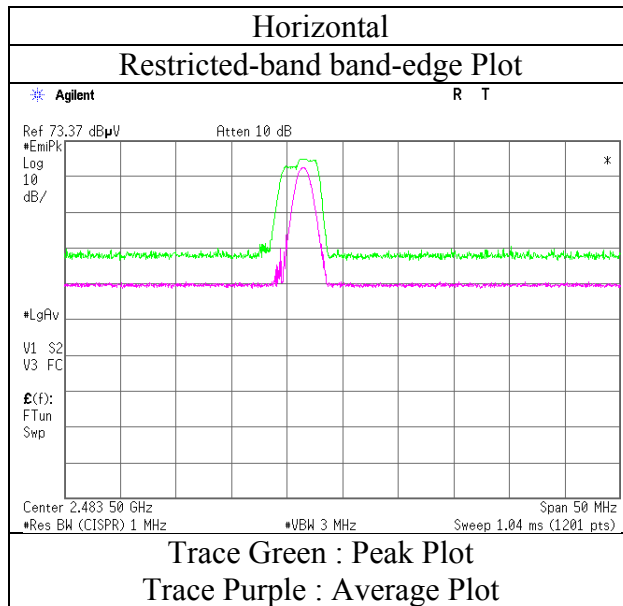
13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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

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

Radiated Spurious Emission (Reference Plot for band-edge)

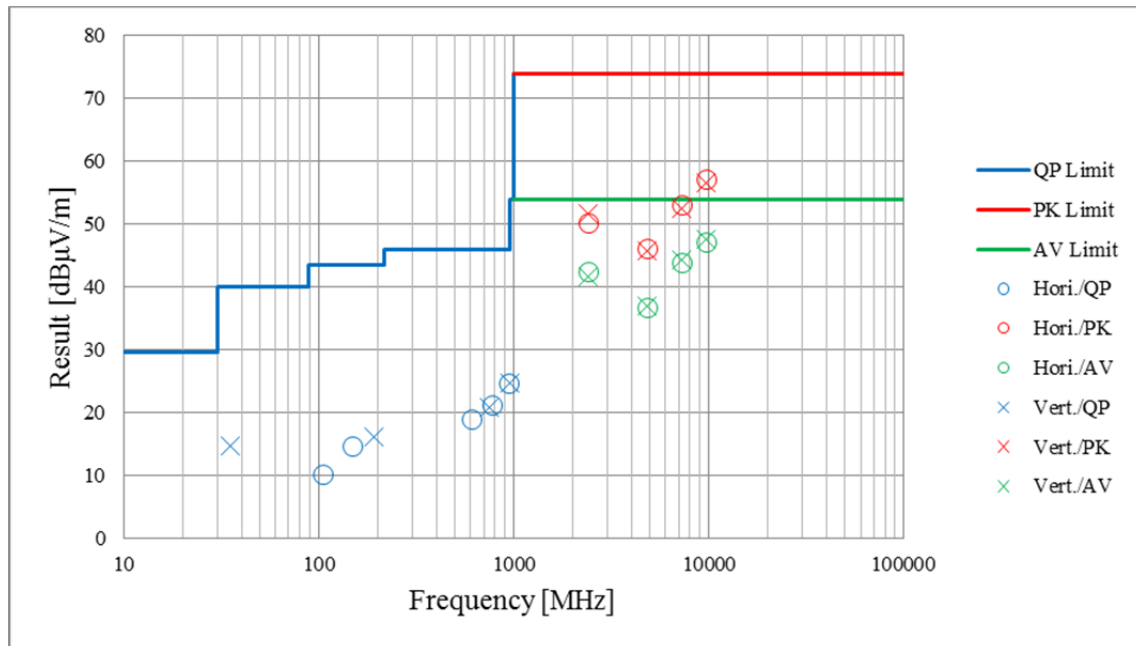
Test place	Shonan EMC Lab. No.3 & 2 Semi Anechoic Chamber		
Report No.	11757840S-A-R2		
Date	May 9, 2017	May 10, 2017	
Temperature / Humidity	22 deg. C / 44 % RH	22 deg. C / 55 % RH	
Engineer	Kazutaka Takeyama	Kazutaka Takeyama	
	(1 GHz -26.5 GHz)	(30 MHz- 1 GHz)	
Mode	Tx BT LE 2480 MHz		



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

Radiated Spurious Emission **(Plot data, Worst case)**

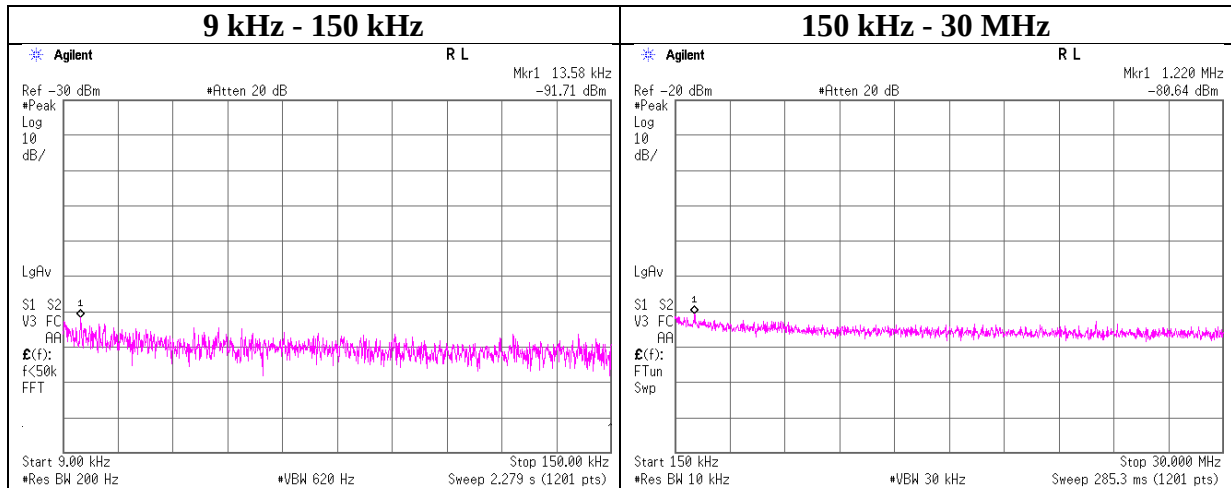
Test place	Shonan EMC Lab. No.3 & 2 Semi Anechoic Chamber	
Report No.	11757840S-A-R2	
Date	May 9, 2017	May 10, 2017
Temperature / Humidity	22 deg. C / 44 % RH	22 deg. C / 55 % RH
Engineer	Kazutaka Takeyama	Kazutaka Takeyama
	(1 GHz -26.5 GHz)	(30 MHz- 1 GHz)
Mode	Tx BT LE 2402 MHz	



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

Conducted Spurious Emission

Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11757840S-A-R2
Date	May 9, 2017
Temperature / Humidity	24 deg. C / 41 % RH
Engineer	Makoto Hosaka
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
13.58	-91.7	0.51	9.8	2.0	1	-79.4	300	6.0	-18.1	44.9	63.0	
1220.00	-80.6	0.51	9.8	2.0	1	-68.3	30	6.0	13.0	25.8	12.8	

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

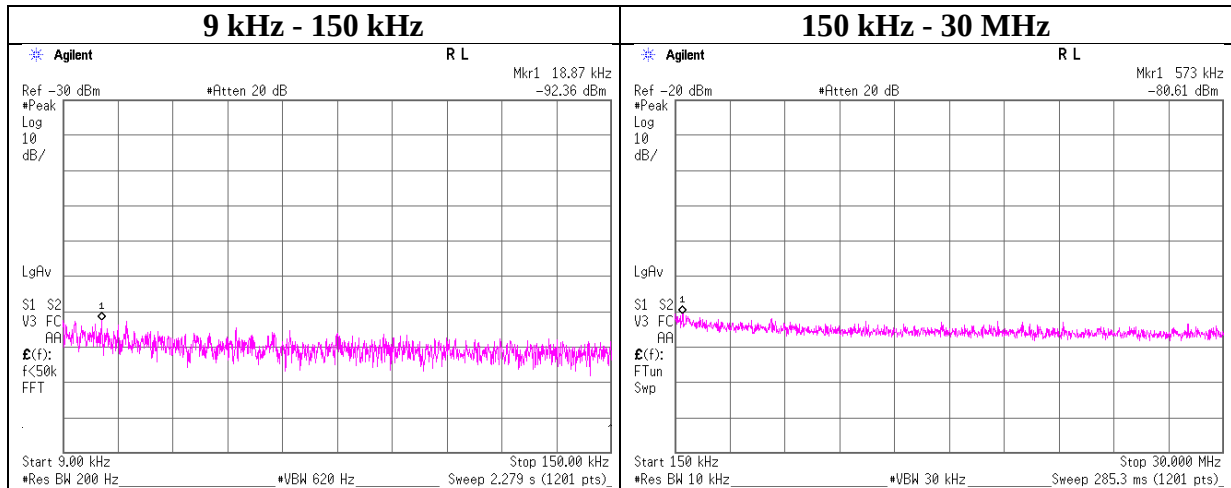
$$\text{EIRP [dBm]} = \text{Reading [dBm]} + \text{Cable loss [dB]} + \text{Attenuator Loss [dB]} + \text{Antenna gain [dBi]} + 10 * \log(N)$$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Conducted Spurious Emission

Test place	Shonan EMC Lab. No.3 Shielded Room
Report No.	11757840S-A-R2
Date	May 9, 2017
Temperature / Humidity	24 deg. C / 41 % RH
Engineer	Makoto Hosaka
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
18.87	-92.4	0.51	9.8	2.0	1	-80.0	300	6.0	-18.8	42.0	60.8	
573.00	-80.6	0.51	9.8	2.0	1	-68.3	30	6.0	13.0	32.4	19.4	

$E [dBuV/m] = EIRP [dBm] - 20 \log (Distance [m]) + Ground\ bounce [dB] + 104.8 [dBuV/m]$

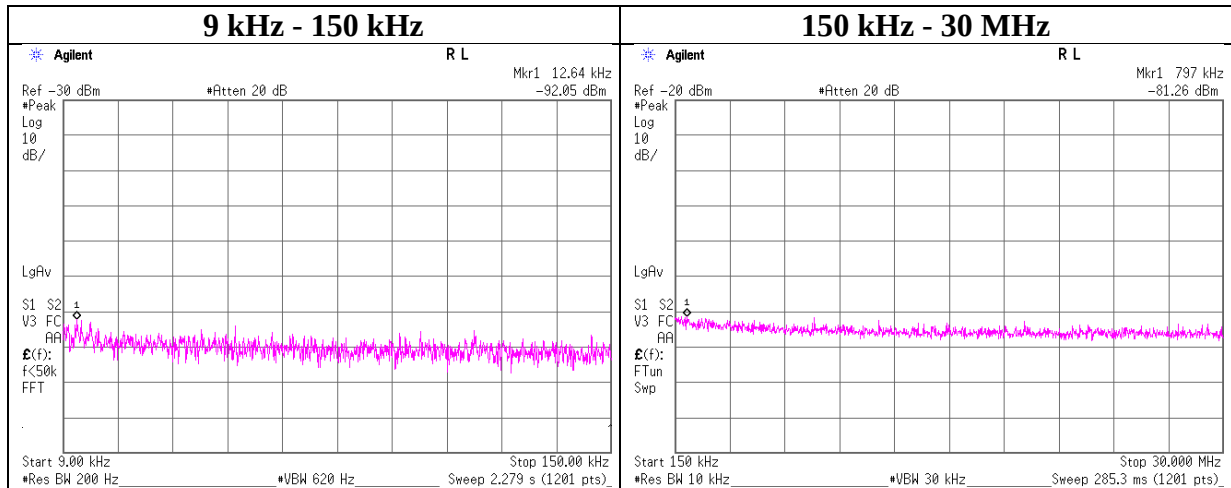
$EIRP [dBm] = Reading [dBm] + Cable\ loss [dB] + Attenuator\ Loss [dB] + Antenna\ gain [dBi] + 10 * \log (N)$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Conducted Spurious Emission

Test place : Shonan EMC Lab. No.3 Shielded Room
Report No. : 11757840S-A-R2
Date : May 9, 2017
Temperature / Humidity : 24 deg. C / 41 % RH
Engineer : Makoto Hosaka
Mode : Tx BT LE 2480 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
12.64	-92.1	0.51	9.8	2.0	1	-79.7	300	6.0	-18.4	45.5	63.9	
797.00	-81.3	0.51	9.8	2.0	1	-68.9	30	6.0	12.3	29.5	17.2	

$E [dBuV/m] = EIRP [dBm] - 20 \log (Distance [m]) + Ground\ bounce [dB] + 104.8 [dBuV/m]$

$EIRP[dBm] = Reading [dBm] + Cable\ loss [dB] + Attenuator\ Loss [dB] + Antenna\ gain [dBi] + 10 * \log (N)$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Power Density

Test place Shonan EMC Lab. No.3 Shielded Room
Report No. 11757840S-A-R2
Date May 9, 2017
Temperature / Humidity 24 deg. C / 41 % RH
Engineer Makoto Hosaka
Mode Tx

Freq.	Reading	Cable Loss	Atten. Loss	Result	Limit	Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[dBm]	[dB]
2402	-22.19	1.82	9.85	-10.52	8.00	18.52
2440	-23.07	1.83	9.84	-11.40	8.00	19.40
2480	-24.66	1.84	9.84	-12.98	8.00	20.98

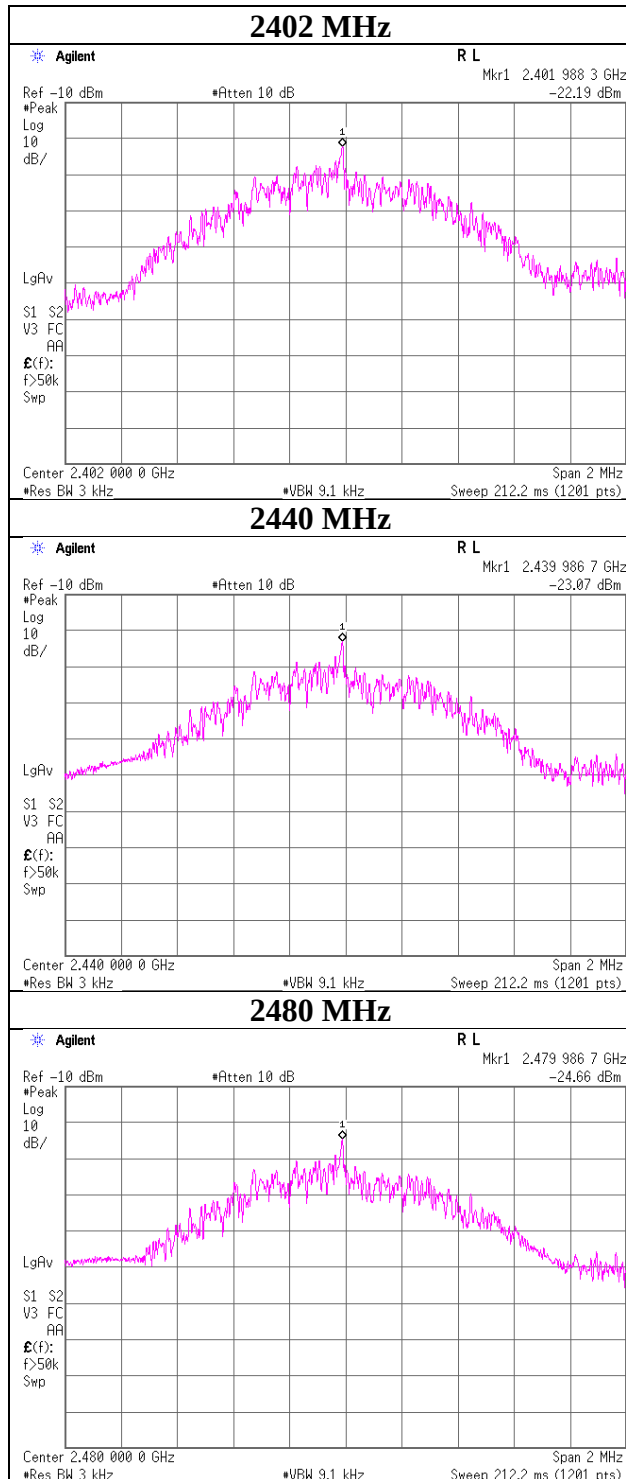
Sample Calculation:

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.

Power Density

BLE



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APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
SPM-06	Power Meter	Anritsu	ML2495A	0850009	AT	2017/04/25 * 12
SPSS-03	Power sensor	Anritsu	MA2411B	0917063	AT	2017/04/25 * 12
SAT10-12	Attenuator	Weinschel Corp.	54A-10	81601	AT	2017/03/23 * 12
SCC-G14	Coaxial Cable	Suhner	SUCOFLEX 102	31600/2	AT	2017/03/23 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	AT	2017/03/07 * 12
SOS-06	Humidity Indicator	A&D	AD-5681	4062118	AT	2016/12/13 * 12
STS-03	Digital Hitester	Hioki	3805-50	080997823	AT	2016/10/17 * 12
SAF-05	Pre Amplifier	TOYO Corporation	TPA0118-36	1440490	RE	2017/02/17 * 12
SCC-G06	Coaxial Cable	Junkosha	J121102207-00	MAY-23-16-091	RE	2016/06/14 * 12
SCC-G21	Coaxial Cable	Suhner	SUCOFLEX 104	296169/4	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	2016/10/12 * 12
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	RE	2017/03/07 * 12
SJM-02	Measure	KOMELON	KMC-36	-	RE	-
SAEC-03(SVSWR)	Semi-Anechoic Chamber	TDK	SAEC-03(SVSWR)	3	RE	2016/07/25 * 12
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE,RFI,MF)	-	RE	-
STS-03	Digital Hitester	Hioki	3805-50	080997823	RE	2016/10/17 * 12
SCC-G40	Coaxial Cable	Junkosha	MWX221-0100 ONFSNMS/B	1612S005	RE	2017/01/08 * 12
SAT10-05	Attenuator(above1GHz)	Agilent	8493C-010	74864	RE	2016/11/07 * 12
SFL-02	Highpass Filter	MICRO-TRONICS	HPM50111	051	RE	2016/11/29 * 12
SHA-05	Horn Antenna	ETS LINDGREN	3160-09	LM4210	RE	2017/03/15 * 12
SCC-G19	Coaxial Cable	Suhner	SUCOFLEX 102A	1188/2A	RE	2017/03/23 * 12
SAF-09	Pre Amplifier	TOYO Corporation	HAP18-26W	00000018	RE	2016/09/27 * 12
SCC-G33	Coaxial Cable	Junkosha	MWX241-0100 0KMSKMS	-	RE	2017/04/20 * 12
SAF-02	Pre Amplifier	SONOMA	310N	290212	RE	2017/02/09 * 12
SAT6-02	Attenuator	JFW	50HF-006N	-	RE	2017/02/09 * 12
KAT3-10	Attenuator	JFW IND. INC.	50HF-003N	-	RE	2016/07/26 * 12
SBA-02	Biconical Antenna	Schwarzbeck	BBA9106	91032665	RE	2016/11/23 * 12
SCC-B1/B3/B5/B7/B8/B13/SRSE-02	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/T OYO	8D2W/12DSFA /141PE/141PE/141PE/141PE/NS4906	-/0901-270(R F Selector)	RE	2017/04/07 * 12
SCC-B2/B4/B6/B7/B8/B13/SRSE-02	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/T OYO	8D2W/12DSFA /141PE/141PE/141PE/141PE/NS4906	-/0901-270(R F Selector)	RE	2017/04/07 * 12
SLA-06	Logperiodic Antenna	Schwarzbeck	VUSLP9111B	195	RE	2017/01/05 * 12
SOS-03	Humidity Indicator	A&D	AD-5681	4063325	RE	2016/10/12 * 12
STR-01	Test Receiver	ROHDE & Schwarz	ESU40	100093	RE	2017/04/12 * 12
SJM-09	Measure	PROMART	SEN1935	-	RE	-
SAEC-02(NSA)	Semi-Anechoic Chamber	TDK	SAEC-02(NSA)	2	RE	2016/07/13 * 12
STS-02	Digital Hitester	Hioki	3805-50	080997819	RE	2017/03/08 * 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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