



RADIO TEST REPORT

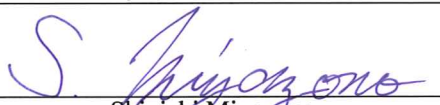
Test Report No. : 11106101H-B-R1

Applicant : Nikon Corporation
Type of Equipment : Wireless Remote Controller
Model No. : N1544
FCC ID : CGJ8152EB
Test regulation : FCC Part 15 Subpart C: 2015
Test Result : Complied


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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
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 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 11106101H-B. 11106101H-B is replaced with this report.

Date of test: February 29 and March 1, 2016

Representative test engineer:


Shinichi Miyazono
Engineer
Consumer Technology Division

Approved by:


Takayuki Shimada
Engineer
Consumer Technology Division



NVLAP LAB CODE: 200572-0

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13-EM-F0429

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SECTION 1: Customer information

Company Name : Nikon Corporation
Address : 2-15-3, Konan Minato-ku, Tokyo 108-6290 Japan
Telephone Number : +81-36-433-3873
Facsimile Number : +81-36-433-3871
Contact Person : Ryuichi Mori

***Remark**

Nikon Corporation designates Hoshiden Corporation as manufacturer of the product (Wireless Remote Controller)

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

2.1 Identification of E.U.T.

Type of Equipment : Wireless Remote Controller
Model No. : N1544
Serial No. : Refer to Section 4, Clause 4.2
Rating : DC 3.0 V(CR2032)
Receipt Date of Sample : February 28, 2016
Country of Mass-production : China
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

Model: N1544 (referred to as the EUT in this report) is a Wireless Remote Controller.

General Specification

Clock frequency(ies) in the system : CPU: 16 MHz(Max)

Radio Specification

Radio Type : Transceiver
Frequency of Operation : 2402 MHz to 2480 MHz
Modulation : GFSK
Power Supply (radio part input) : DC 1.56 V
Antenna type : Inverted-F antenna pattern
Antenna Gain : 4.05 dBi

SECTION 3: Test specification, procedures & results

3.1 Test Specification

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

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

* The EUT complies with FCC Part 15 Subpart B: 2015, final revised on November 23, 2015

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 v03r04 ----- 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 v03r04 ----- 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 v03r04 ----- 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 v03r04 ----- IC: RSS-Gen 6.13	FCC: Section15.247(d) ----- IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	3.5 dB 7320.000 MHz, AV, Vertical.	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 is not the device that is designed to be connected to the public utility (AC) power line.

*2) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v03r04 12.2.7.

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

FCC Part 15.31 (e)

voltage (DC 1.56 V) constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

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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

EMI

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k = 2$.
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Antenna terminal test Uncertainty (+/-)							
Power meter		Conducted emission and Power density			Conducted emission		Channel power
Below 1 GHz	Above 1 GHz	Below 1 GHz	1 GHz - 3 GHz	3 GHz - 18 GHz	18 GHz - 26.5 GHz	26.5 GHz - 40 GHz	
0.9 dB	1.0 dB	1.4 dB	1.7 dB	2.8 dB	2.8 dB	2.9 dB	2.6 dB

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

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

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

*Measurement distance

Radiated emission 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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Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	2973C-1	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	2973C-2	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	2973C-3	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	2973C-4	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	-	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.6 shielded room	-	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	-	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	-	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	-	3.1 x 5.0 x 2.7	N/A	-	-
No.9 measurement room	-	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.11 measurement room	-	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 m x 2.0m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

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

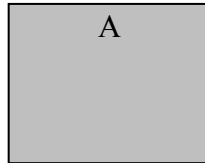
4.1 Operating Mode(s)

Bluetooth (BT) Low Energy (LE): Transmitting (Tx)

Details of Operating Mode(s)

Test Item	Operating Mode	Tested Frequency
Conducted Emission	Tx BT LE	2402MHz
Spurious Emission		2440MHz
6dB Bandwidth		2480MHz
Maximum Peak Output Power		
Power Density		
99% Occupied Bandwidth		
<p>*The power value of the EUT was set for testing as follows (setting value might be different from product specification value); Power settings: + 4 dBm Software: nRFgo Studio Version : 1.2.1.1.3 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.</p>		

4.2 Configuration and peripherals



* Setup was taken into consideration and test data was taken under worse case conditions.

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Wireless Remote Controller	N1544	G *1) H *2)	Hoshiden Corporation	EUT

*1) Used for Radiated Emission test

*2) Used for Antenna Terminal conducted test

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 v03r04".

[For below 1GHz]

EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1GHz]

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 *1)	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 (RMS) Trace: 100 traces Duty factor was added to the results. <u>15.35(c) Peak with Duty factor *4)</u>	RBW: 100 kHz VBW: 300 kHz
Test Distance	3m	4.5 m *2) (1 GHz – 10GHz), 1 m *3) (10 GHz – 26.5 GHz)		4.5 m *2) (1 GHz – 10GHz), 1 m *3) (10 GHz – 26.5 GHz)

*1) Average Power Measurement was performed based on 6.0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v03r04"

*2) Distance Factor: $20 \times \log(4.5 \text{ m} / 3.0 \text{ m}) = 3.5 \text{ dB}$

*3) Distance Factor: $20 \times \log(1.0 \text{ m} / 3.0 \text{ m}) = -9.5 \text{ dB}$

*4) The test was performed that the Spurious evaluation as Peak with Duty factor since the pulse emission which is synchronous the worst duty cycle of Bluetooth Low Energy.

- 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 : 30 M - 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	2 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	Peak	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	10 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	9.1 kHz	27 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 v03r04".

*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 = 9.1 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

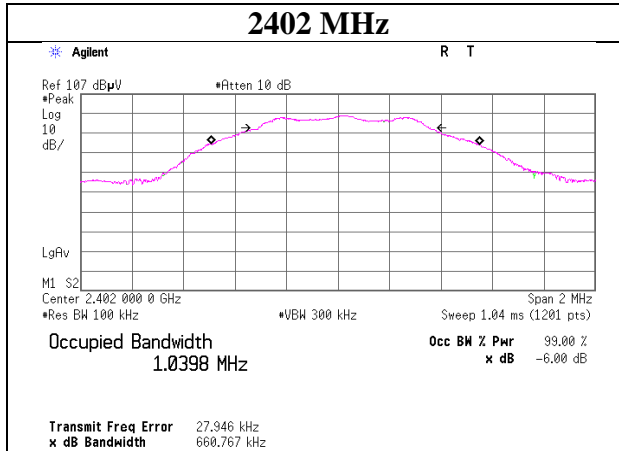
Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11106101H
Date March 1, 2016
Temperature / Humidity 22 deg. C / 32 % RH
Engineer Shinichi Miyazono
Mode Tx BT LE

Mode	Frequency [MHz]	6dB Bandwidth [MHz]	Limit [kHz]
BTLE	2402	0.661	> 500
	2440	0.659	> 500
	2480	0.656	> 500

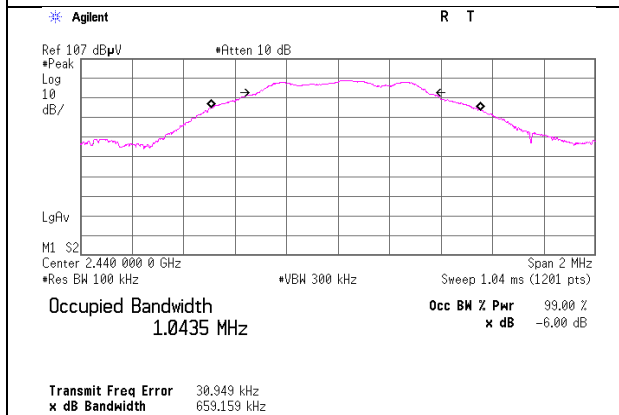
6dB Bandwidth

BTLE

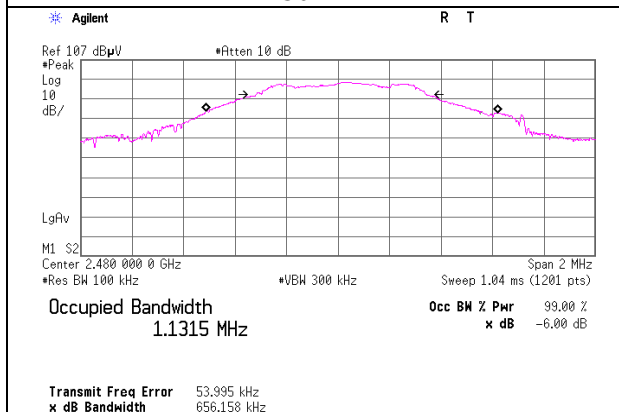
2402 MHz



2440 MHz



2480 MHz



Maximum Peak Output Power

Test place : Ise EMC Lab. No.11 Measurement Room
Report No. : 11106101H
Date : March 1, 2016
Temperature / Humidity : 22 deg. C / 32 % RH
Engineer : Shinichi Miyazono
Mode : Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]	
2402	-11.01	1.03	10.08	0.10	1.02	30.00	1000	29.90
2440	-11.08	1.03	10.08	0.03	1.01	30.00	1000	29.97
2480	-11.37	1.04	10.08	-0.25	0.94	30.00	1000	30.25

Sample Calculation:

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

Average Output Power
(Reference data for RF Exposure)

Test place : Ise EMC Lab. No.11 Measurement Room
Report No. : 11106101H
Date : March 1, 2016
Temperature / Humidity : 22 deg. C / 32 % RH
Engineer : Shinichi Miyazono
Mode : Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Frame power)		Duty factor [dB]	Result (Burst power)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-12.96	1.03	10.08	-1.85	0.65	1.13	-0.72	0.85
2440	-12.97	1.03	10.08	-1.86	0.65	1.13	-0.73	0.85
2480	-13.33	1.04	10.08	-2.21	0.60	1.13	-1.08	0.78

Sample Calculation:

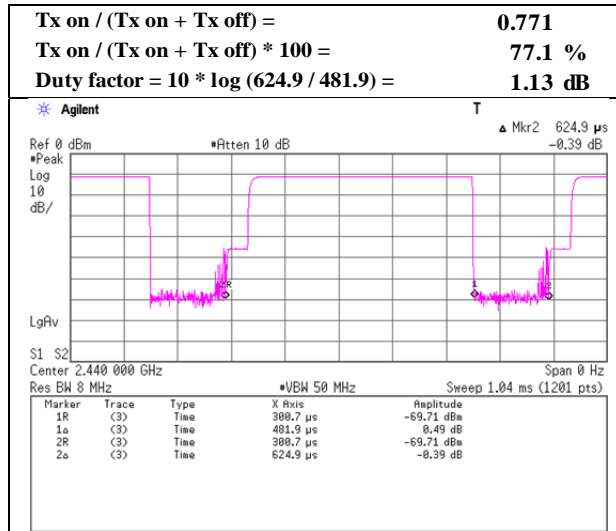
Result (Frame power) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator

Result (Burst power) = Frame power + Duty factor

Burst rate confirmation

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	March 1, 2016
Temperature / Humidity	22 deg. C / 32 % RH
Engineer	Shinichi Miyazono
Mode	Tx BT LE

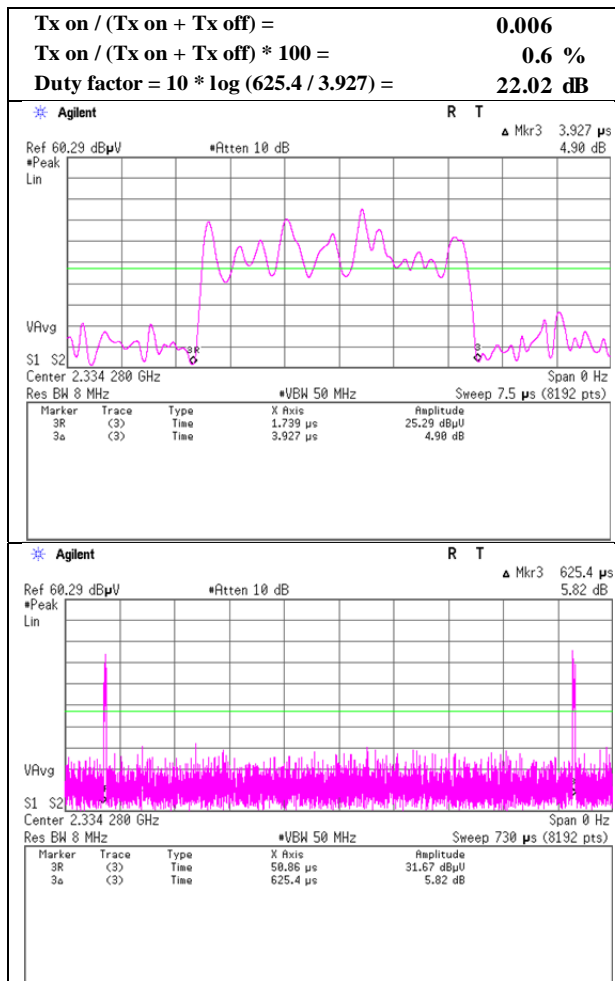
BT LE



Burst rate confirmation
(Reference data for Peak with Duty factor)

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	February 29, 2016
Temperature / Humidity	24 deg. C / 35% RH
Engineer	Takafumi Noguchi
Mode	Tx BT LE

BT LE



*The carrier was continually transmitted as the Burst that refers to Page 16.

Radiated Spurious Emission

Report No. 11106101H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.1 No.4
Date February 29, 2016 February 29, 2016
Temperature / Humidity 23 deg. C / 31% RH 24 deg. C / 35% RH
Engineer Takafumi Noguchi Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
Mode Tx BT LE 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	52.714	QP	28.5	9.7	7.7	38.8	-	7.1	40.0	32.9	
Hori	149.914	QP	28.5	14.8	9.1	38.8	-	13.6	43.5	29.9	
Hori	292.512	QP	28.5	19.5	10.5	38.8	-	19.7	46.0	26.3	
Hori	324.135	QP	28.6	15.1	10.7	38.7	-	15.7	46.0	30.3	
Hori	586.223	QP	27.5	19.2	12.5	38.1	-	21.1	46.0	24.9	
Hori	972.001	QP	27.8	23.1	14.6	37.5	-	28.0	53.9	25.9	
Hori	2334.280	PK	50.4	27.9	6.8	32.2	-	52.9	73.9	21.0	
Hori	2390.000	PK	55.7	27.9	6.8	32.1	-	58.3	73.9	15.6	
Hori	4804.000	PK	45.6	32.8	9.2	31.3	-	56.3	73.9	17.6	
Hori	7206.000	PK	43.2	36.8	10.4	32.6	-	57.8	73.9	16.1	
Hori	9608.000	PK	41.9	38.1	11.1	32.6	-	58.5	73.9	15.4	Floor noise
Hori	4804.000	AV	33.0	32.8	9.2	31.3	1.1	44.8	53.9	9.1	
Hori	7206.000	AV	33.1	36.8	10.4	32.6	1.1	48.8	53.9	5.1	
Hori	9608.000	AV	32.5	38.1	11.1	32.6	-	49.1	53.9	4.8	Floor noise
Vert	52.714	QP	28.8	9.7	7.7	38.8	-	7.4	40.0	32.6	
Vert	149.914	QP	28.4	14.8	9.1	38.8	-	13.5	43.5	30.0	
Vert	292.512	QP	28.5	19.5	10.5	38.8	-	19.7	46.0	26.3	
Vert	324.135	QP	28.3	15.1	10.7	38.7	-	15.4	46.0	30.6	
Vert	586.223	QP	27.8	19.2	12.5	38.1	-	21.4	46.0	24.6	
Vert	972.001	QP	27.7	23.1	14.6	37.5	-	27.9	53.9	26.0	
Vert	2334.280	PK	55.9	27.9	6.8	32.2	-	58.4	73.9	15.5	
Vert	2390.000	PK	57.6	27.9	6.8	32.1	-	60.2	73.9	13.7	
Vert	4804.000	PK	44.9	32.8	9.2	31.3	-	55.6	73.9	18.3	
Vert	7206.000	PK	42.5	36.8	10.4	32.6	-	57.1	73.9	16.8	
Vert	9608.000	PK	41.7	38.1	11.1	32.6	-	58.3	73.9	15.6	Floor noise
Vert	4804.000	AV	34.2	32.8	9.2	31.3	1.1	46.0	53.9	7.9	
Vert	7206.000	AV	33.8	36.8	10.4	32.6	1.1	49.5	53.9	4.4	
Vert	9608.000	AV	32.6	38.1	11.1	32.6	-	49.2	53.9	4.7	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty Factor

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

Distance factor: 1 GHz - 10 GHz $20\log(4.5\text{ m} / 3.0\text{ m}) = 3.5\text{ dB}$
10 GHz - 26.5 GHz $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

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	98.9	28.0	6.8	32.1	101.6	-	-	Carrier
Hori	2390.441	PK	53.8	27.9	6.8	32.1	56.4	81.6	25.2	
Hori	2400.000	PK	53.7	28.0	6.8	32.1	56.4	81.6	25.2	
Vert	2402.000	PK	97.7	28.0	6.8	32.1	100.4	-	-	Carrier
Vert	2390.421	PK	53.4	27.9	6.8	32.1	56.0	80.4	24.4	
Vert	2400.000	PK	54.6	28.0	6.8	32.1	57.3	80.4	23.1	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

PK with Duty factor

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
		Hor	Ver					Hor	Ver		Hor	Ver	
2334.280	PK	50.4	55.9	27.9	6.8	32.2	-22.0	30.9	36.4	53.9	23.0	17.5	
2390.000	PK	55.7	57.6	27.9	6.8	32.1	-22.0	36.3	38.2	53.9	17.6	15.7	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor (Refer to Burst rate confirmation sheet)

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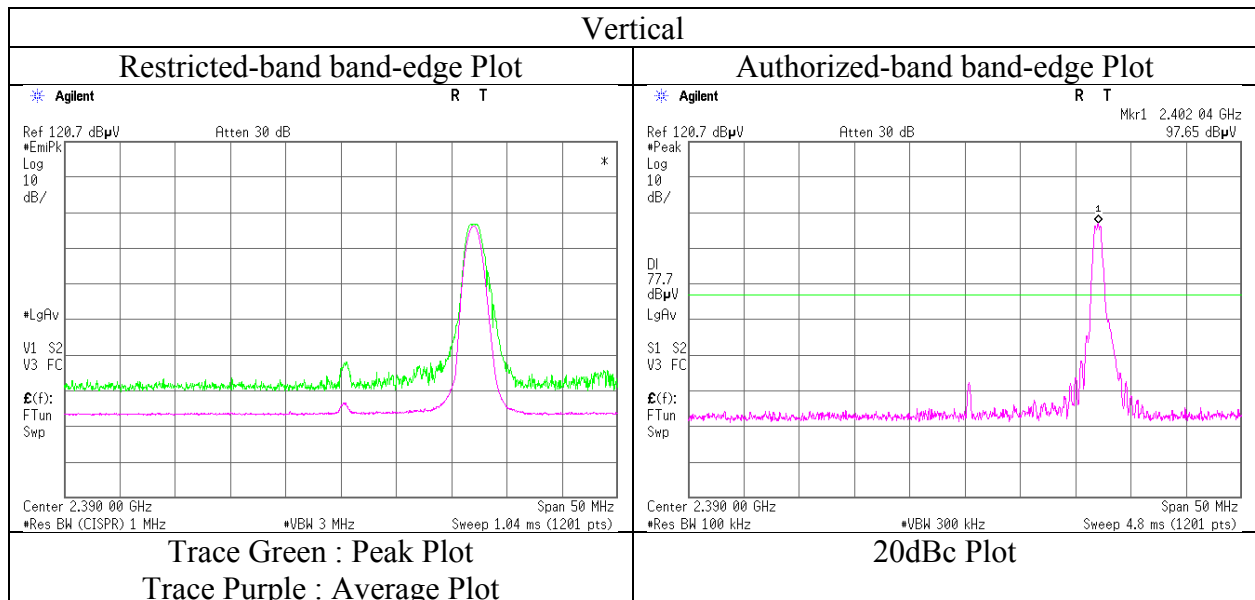
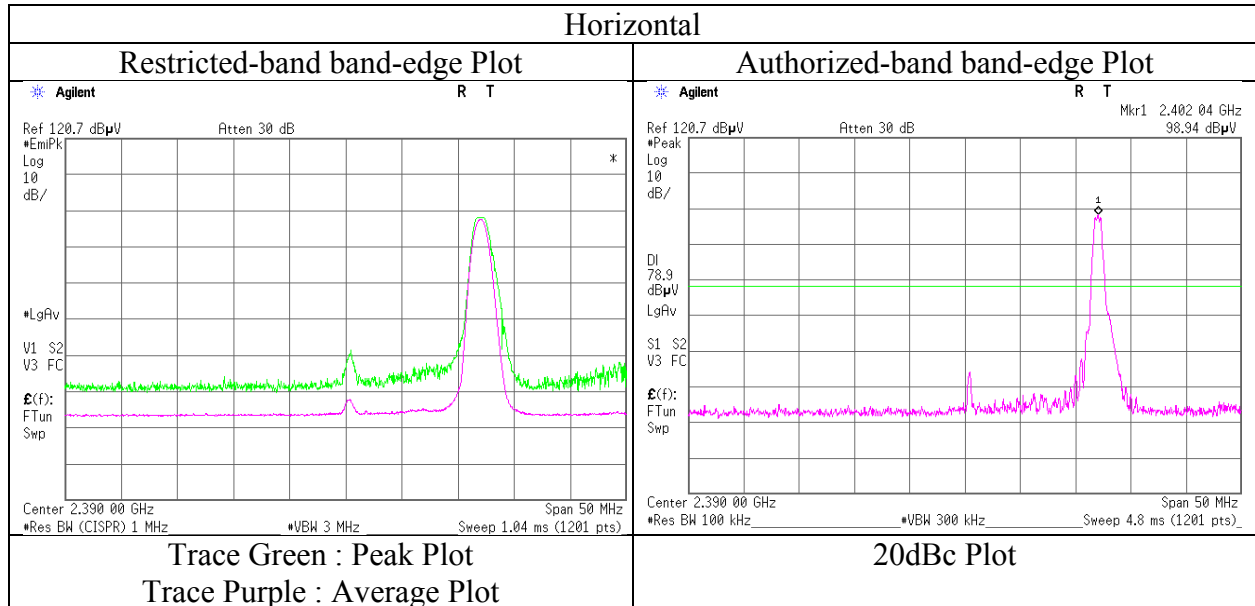
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Radiated Spurious Emission (Reference Plot for band-edge)

Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No.	11106101H
Date	February 29, 2016
Temperature / Humidity	24 deg. C / 35% RH
Engineer	Takafumi Noguchi
	(Above 1GHz)
Mode	Tx BT LE 2402 MHz



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

Radiated Spurious Emission

Report No. 11106101H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.1 No.4
Date February 29, 2016 February 29, 2016
Temperature / Humidity 23 deg. C / 31% RH 24 deg. C / 35% RH
Engineer Takafumi Noguchi Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
Mode Tx BT LE 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	52.725	QP	28.6	9.7	7.7	38.8	-	7.2	40.0	32.8	
Hori	149.943	QP	28.4	14.8	9.1	38.8	-	13.5	43.5	30.0	
Hori	292.586	QP	28.3	19.5	10.5	38.8	-	19.5	46.0	26.5	
Hori	324.191	QP	28.4	15.1	10.7	38.7	-	15.5	46.0	30.5	
Hori	586.229	QP	27.8	19.2	12.5	38.1	-	21.4	46.0	24.6	
Hori	972.035	QP	27.2	23.1	14.6	37.5	-	27.4	53.9	26.5	
Hori	2334.867	PK	52.7	27.9	6.8	32.2	-	55.2	73.9	18.7	
Hori	2390.000	PK	50.5	27.9	6.8	32.1	-	53.1	73.9	20.8	
Hori	4880.000	PK	44.5	33.1	9.3	31.3	-	55.6	73.9	18.3	
Hori	7320.000	PK	42.7	36.8	10.4	32.6	-	57.3	73.9	16.6	
Hori	9760.000	PK	41.5	38.2	11.2	32.7	-	58.2	73.9	15.7	Floor noise
Hori	4880.000	AV	36.2	33.1	9.3	31.3	1.1	48.4	53.9	5.5	
Hori	7320.000	AV	34.4	36.8	10.4	32.6	1.1	50.1	53.9	3.8	
Hori	9760.000	AV	32.8	38.2	11.2	32.7	-	49.5	53.9	4.4	Floor noise
Vert	52.725	QP	28.7	9.7	7.7	38.8	-	7.3	40.0	32.7	
Vert	149.943	QP	28.4	14.8	9.1	38.8	-	13.5	43.5	30.0	
Vert	292.586	QP	28.4	19.5	10.5	38.8	-	19.6	46.0	26.4	
Vert	324.191	QP	28.4	15.1	10.7	38.7	-	15.5	46.0	30.5	
Vert	586.229	QP	27.7	19.2	12.5	38.1	-	21.3	46.0	24.7	
Vert	972.035	QP	27.1	23.1	14.6	37.5	-	27.3	53.9	26.6	
Vert	2334.867	PK	56.1	27.9	6.8	32.2	-	58.6	73.9	15.3	
Vert	2390.000	PK	51.3	27.9	6.8	32.1	-	53.9	73.9	20.0	
Vert	4880.000	PK	43.7	33.1	9.3	31.3	-	54.8	73.9	19.1	
Vert	7320.000	PK	43.1	36.8	10.4	32.6	-	57.7	73.9	16.2	
Vert	9760.000	PK	41.4	38.2	11.2	32.7	-	58.1	73.9	15.8	Floor noise
Vert	4880.000	AV	34.9	33.1	9.3	31.3	1.1	47.1	53.9	6.8	
Vert	7320.000	AV	34.7	36.8	10.4	32.6	1.1	50.4	53.9	3.5	
Vert	9760.000	AV	32.8	38.2	11.2	32.7	-	49.5	53.9	4.4	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + duty Factor

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

Distance factor: 1 GHz - 10 GHz 20log(4.5 m / 3.0 m) = 3.5 dB
10 GHz - 26.5 GHz 20log(1.0 m / 3.0 m) = -9.5 dB

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	2440.000	PK	98.6	28.0	6.9	32.1	101.4	-	-	Carrier
Hori	2390.647	PK	51.6	27.9	6.8	32.1	54.2	81.4	27.2	
Vert	2440.000	PK	97.6	28.0	6.9	32.1	100.4	-	-	Carrier
Vert	2390.590	PK	51.6	27.9	6.8	32.1	54.2	80.4	26.2	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

PK with Duty factor

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
		Hor	Ver					Hor	Ver		Hor	Ver	
2334.867	PK	52.7	56.1	27.9	6.8	32.2	-22.0	33.2	36.6	53.9	20.7	17.3	
2390.000	PK	50.5	51.3	27.9	6.8	32.1	-22.0	31.1	31.9	53.9	22.8	22.0	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor (Refer to Burst rate confirmation sheet)

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Radiated Spurious Emission

Report No. 11106101H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.1 No.4
Date February 29, 2016 February 29, 2016
Temperature / Humidity 23 deg. C / 31% RH 24 deg. C / 35% RH
Engineer Takafumi Noguchi Takafumi Noguchi
(Below 1GHz) (Above 1GHz)
Mode Tx BT LE 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	52.783	QP	28.8	9.7	7.7	38.8	-	7.4	40.0	32.6	
Hori	149.993	QP	28.3	14.8	9.1	38.8	-	13.4	43.5	30.1	
Hori	292.782	QP	28.4	19.5	10.5	38.8	-	19.6	46.0	26.4	
Hori	324.258	QP	28.3	15.1	10.7	38.7	-	15.4	46.0	30.6	
Hori	586.811	QP	27.7	19.2	12.5	38.1	-	21.3	46.0	24.7	
Hori	972.221	QP	27.1	23.1	14.6	37.5	-	27.3	53.9	26.6	
Hori	2483.500	PK	64.5	28.1	6.9	32.1	-	67.4	73.9	6.5	
Hori	4960.000	PK	44.2	33.4	9.3	31.2	-	55.7	73.9	18.2	
Hori	7440.000	PK	42.4	36.8	10.4	32.7	-	56.9	73.9	17.0	
Hori	9920.000	PK	40.9	38.3	11.2	32.8	-	57.6	73.9	16.3	Floor noise
Hori	4960.000	AV	36.5	33.4	9.3	31.2	1.1	49.1	53.9	4.8	
Hori	7440.000	AV	33.8	36.8	10.4	32.7	1.1	49.4	53.9	4.5	
Hori	9920.000	AV	33.1	38.3	11.2	32.8	-	49.8	53.9	4.1	Floor noise
Vert	52.783	QP	28.9	9.7	7.7	38.8	-	7.5	40.0	32.5	
Vert	149.993	QP	28.3	14.8	9.1	38.8	-	13.4	43.5	30.1	
Vert	292.782	QP	28.3	19.5	10.5	38.8	-	19.5	46.0	26.5	
Vert	324.258	QP	28.2	15.1	10.7	38.7	-	15.3	46.0	30.7	
Vert	586.811	QP	27.7	19.2	12.5	38.1	-	21.3	46.0	24.7	
Vert	972.221	QP	27.2	23.1	14.6	37.5	-	27.4	53.9	26.5	
Vert	2483.500	PK	63.8	28.1	6.9	32.1	-	66.7	73.9	7.2	
Vert	4960.000	PK	43.0	33.4	9.3	31.2	-	54.5	73.9	19.4	
Vert	7440.000	PK	42.9	36.8	10.4	32.7	-	57.4	73.9	16.5	
Vert	9920.000	PK	41.3	38.3	11.2	32.8	-	58.0	73.9	15.9	Floor noise
Vert	4960.000	AV	35.1	33.4	9.3	31.2	1.1	47.7	53.9	6.2	
Vert	7440.000	AV	34.0	36.8	10.4	32.7	1.1	49.6	53.9	4.3	
Vert	9920.000	AV	32.9	38.3	11.2	32.8	-	49.6	53.9	4.3	Floor noise

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty Factor

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

Distance factor: 1 GHz - 10 GHz 20log(4.5 m / 3.0 m) = 3.5 dB
10 GHz - 26.5 GHz 20log(1.0 m / 3.0 m) = -9.5 dB

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	2480.000	PK	99.1	28.0	6.9	32.1	101.9	-	-	Carrier
Hori	2510.770	PK	53.2	28.1	6.9	32.1	56.1	81.9	25.8	
Hori	2579.071	PK	47.0	28.1	6.9	32.1	49.9	81.9	32.0	
Vert	2480.000	PK	98.2	28.0	6.9	32.1	101.0	-	-	Carrier
Vert	2510.686	PK	53.0	28.1	6.9	32.1	55.9	81.0	25.1	
Vert	2579.082	PK	50.0	28.1	6.9	32.1	52.9	81.0	28.1	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

PK with Duty factor

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
		Hor	Ver					Hor	Ver		Hor	Ver	
2483.500	PK	64.5	63.8	28.1	6.9	32.1	-22.0	45.4	44.7	53.9	8.5	9.2	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor (Refer to Burst rate confirmation sheet)

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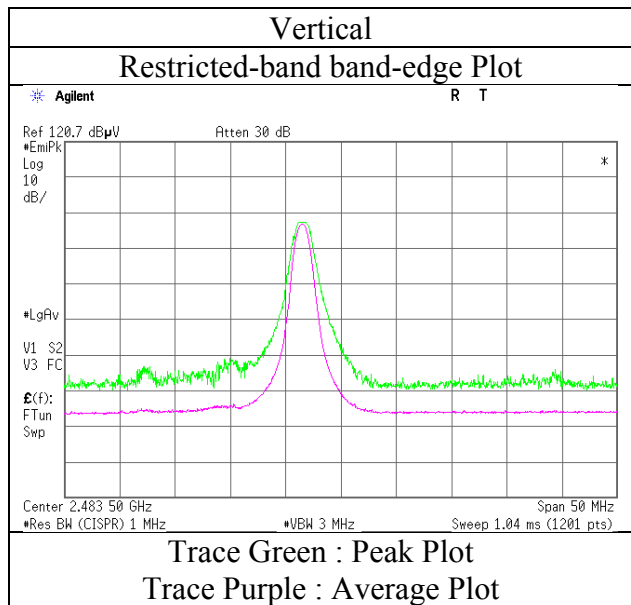
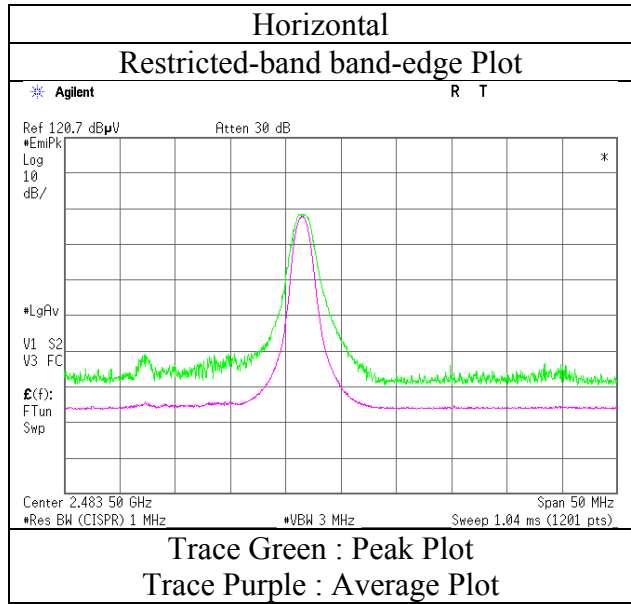
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

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Radiated Spurious Emission
(Reference Plot for band-edge)

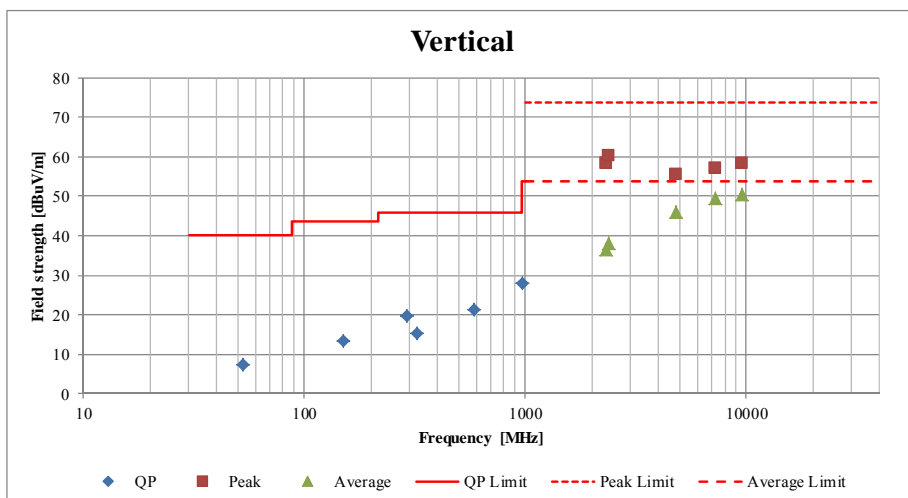
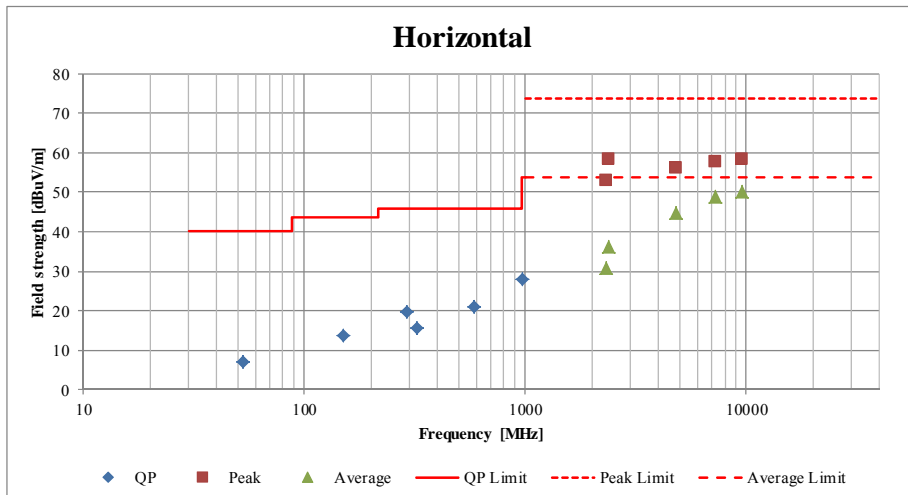
Test place	Ise EMC Lab. No.4 Semi Anechoic Chamber
Report No.	11106101H
Date	February 29, 2016
Temperature / Humidity	24 deg. C / 35% RH
Engineer	Takafumi Noguchi (Above 1GHz)
Mode	Tx BT LE 2480 MHz



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

Radiated Spurious Emission (Plot data, Worst case)

Report No.	11106101H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.4
Date	February 29, 2016	February 29, 2016
Temperature / Humidity	23 deg. C / 31% RH	24 deg. C / 35% RH
Engineer	Takafumi Noguchi (Below 1GHz)	Takafumi Noguchi (Above 1GHz)
Mode	Tx BT LE 2402MHz	



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

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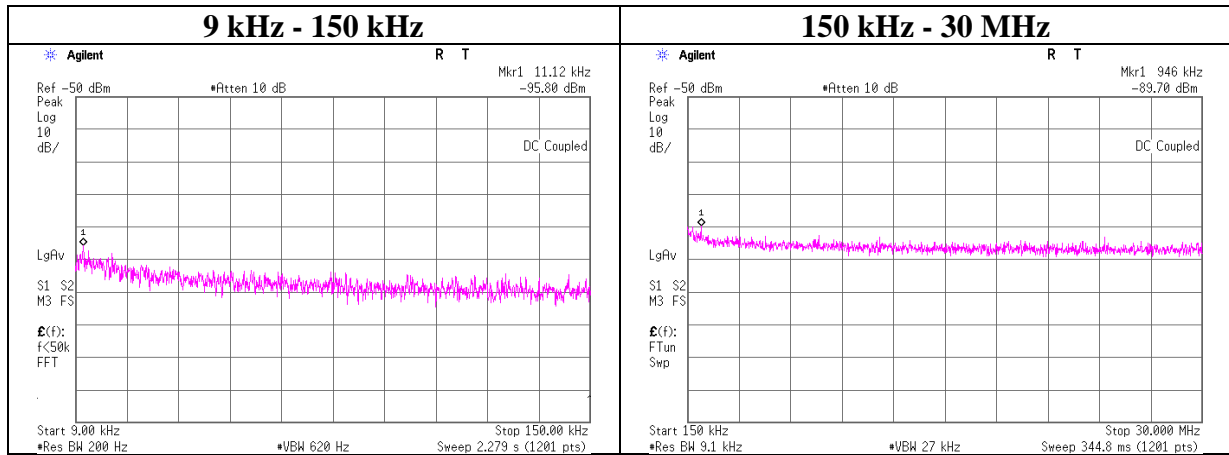
Telephone : +81 596 24 8999

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Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	March 1, 2016
Temperature / Humidity	22 deg. C / 32 % RH
Engineer	Shinichi Miyazono
Mode	Tx BT LE

2402MHz



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
11.12	-95.8	1.21	10.1	4.05	1	-80.5	300	6.0	-19.2	46.6	65.8	
946.00	-89.7	1.21	10.1	4.05	1	-74.4	30	6.0	6.9	28.0	21.1	

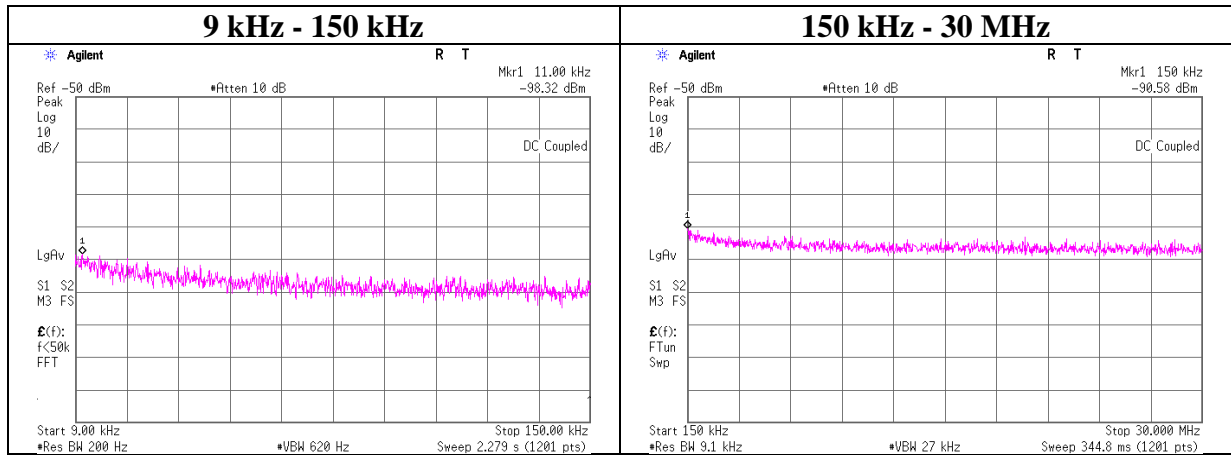
$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

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

Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	March 1, 2016
Temperature / Humidity	22 deg. C / 32 % RH
Engineer	Shinichi Miyazono
Mode	Tx BT LE

2440MHz



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
11.00	-98.3	1.21	10.1	4.05	4.05	-76.9	300	6.0	-15.7	46.7	62.4	
150.00	-90.6	1.21	10.1	4.05	4.05	-69.2	300	6.0	-7.9	24.0	31.9	

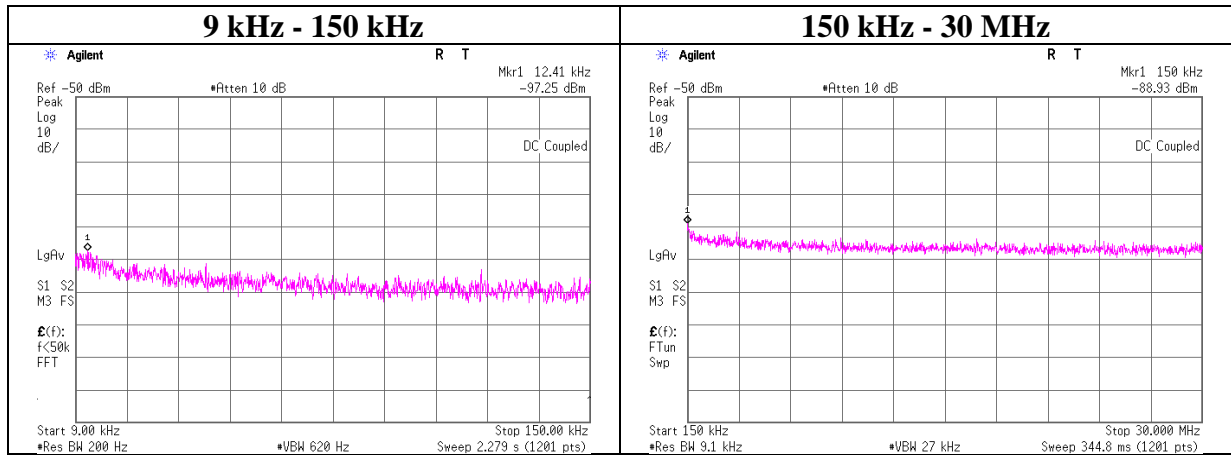
$E = \text{EIRP} - 20 \log(D) + \text{Ground bounce} + 104.8 \text{ [dBuV/m]}$

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

Conducted Spurious Emission

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	March 1, 2016
Temperature / Humidity	22 deg. C / 32 % RH
Engineer	Shinichi Miyazono
Mode	Tx BT LE

2480MHz



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
12.41	-97.3	1.21	10.1	4.05	1	-81.9	300	6.0	-20.7	45.7	66.4	
150.00	-88.9	1.21	10.1	4.05	1	-73.6	300	6.0	-12.4	24.0	36.4	

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

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

Power Density

Test place Ise EMC Lab. No.11 Measurement Room
Report No. 11106101H
Date March 1, 2016
Temperature / Humidity 22 deg. C / 32 % RH
Engineer Shinichi Miyazono
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
2402.00	-23.22	1.38	10.08	-11.76	8.00	19.76
2440.00	-25.14	1.38	10.08	-13.68	8.00	21.68
2480.00	-24.87	1.39	10.08	-13.40	8.00	21.40

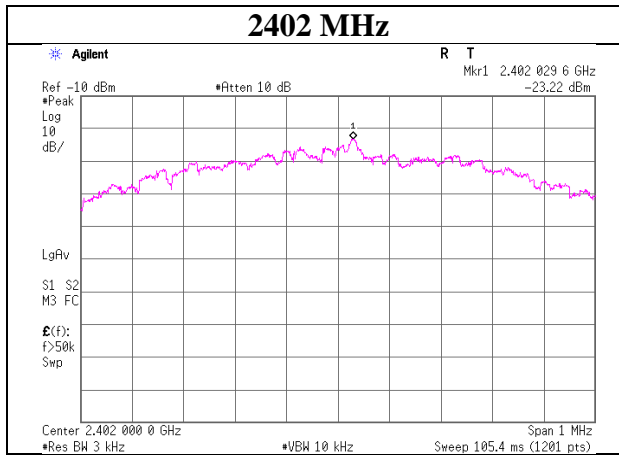
Sample Calculation:

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

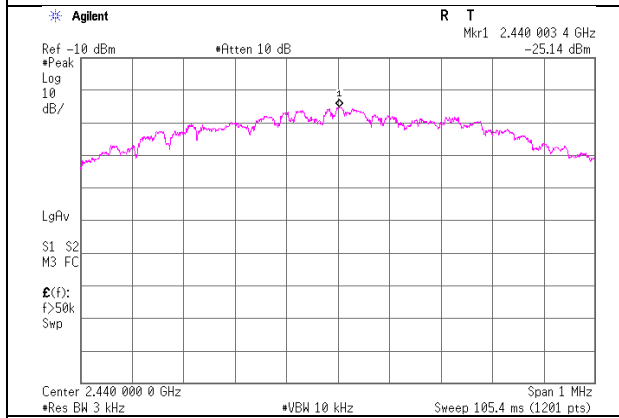
Power Density

BTLE

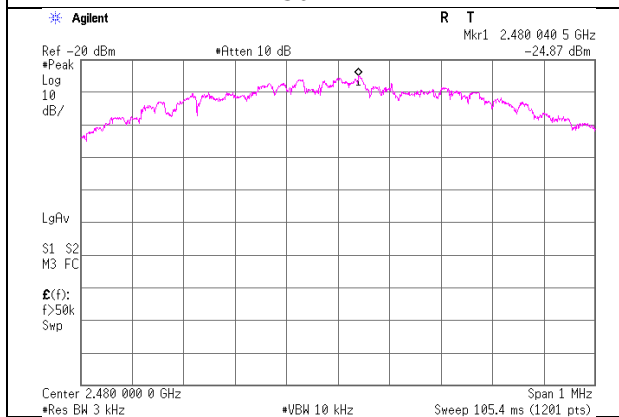
2402 MHz



2440 MHz



2480 MHz



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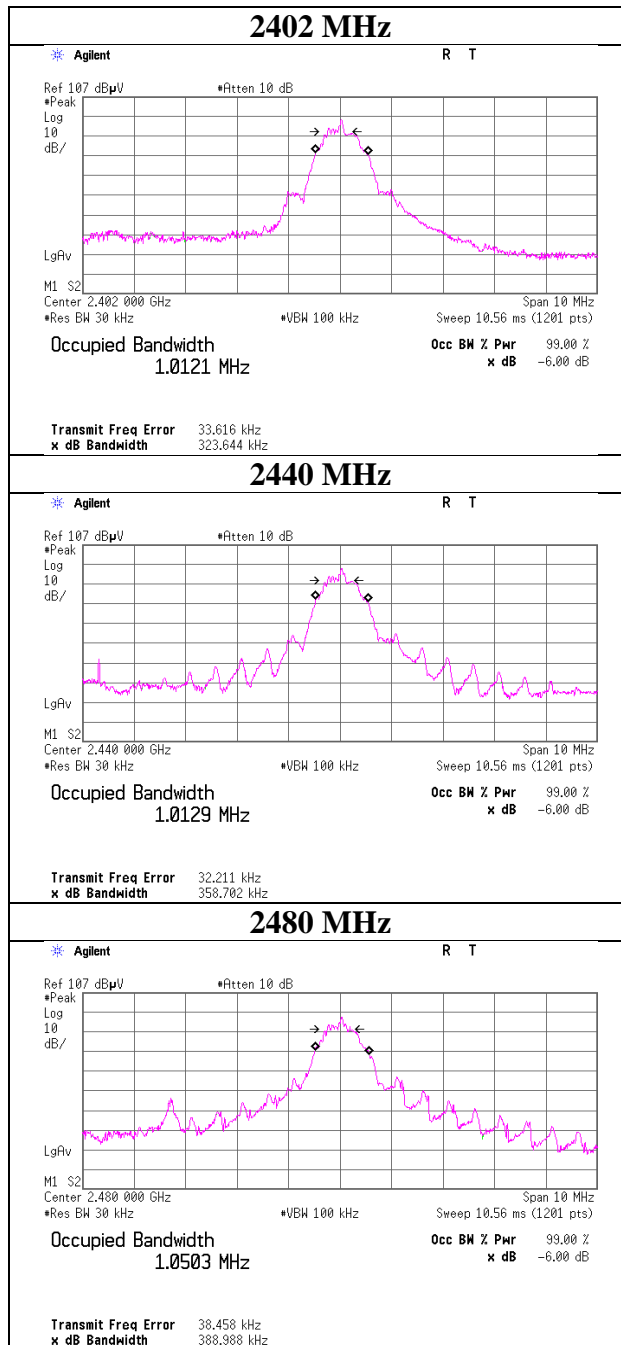
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

99% Occupied Bandwidth

Test place	Ise EMC Lab. No.11 Measurement Room
Report No.	11106101H
Date	March 1, 2016
Temperature / Humidity	22 deg. C / 32 % RH
Engineer	Shinichi Miyazono
Mode	Tx BT LE

BTLE



UL Japan, Inc.

Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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APPENDIX 2: Test instruments

Test equipment

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MSA-15	Spectrum Analyzer	Agilent	E4440A	MY46187105	AT/RE	2015/11/11 * 12
MPM-12	Power Meter	Anritsu	ML2495A	0825002	AT	2015/06/09 * 12
MPSE-17	Power sensor	Anritsu	MA2411B	0738285	AT	2015/06/09 * 12
MCC-172	Microwave Cable	Junkosha	MWX221	1409S495	AT	2015/03/04 * 12
MAT-20	Attenuator(10dB)(above 1GHz)	HIROSE ELECTRIC CO.,LTD.	AT-110	-	AT	2016/01/08 * 12
MMM-17	DIGITAL HiTESTER	Hioki	3805	070900530	AT	2016/01/13 * 12
MOS-19	Thermo-Hygrometer	Custom	CTH-201	0001	AT	2015/12/08 * 12
MAEC-01	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	RE	2015/09/19 * 12
MOS-27	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q26	RE	2016/01/21 * 12
MJM-25	Measure	KOMELON	KMC-36	-	RE	-
COTS-MEMI	EMI measurement program	TSJ	TEPTO-DV	-	RE	-
MTR-09	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	RE	2015/06/08 * 12
KBA-05	Biconical Antenna	Schwarzbeck	BBA9106	2513	RE	2015/11/02 * 12
KLA-04	Logperiodic Antenna	Schwarzbeck	USLP9143	361	RE	2015/11/03 * 12
MAT-08	Attenuator(6dB)	Weinschel Corp	2	BK7971	RE	2015/11/10 * 12
MCC-02	Coaxial Cable	Suhner/storm/Agilent/TSJ	-	-	RE	2015/09/29 * 12
MPA-19	Pre Amplifier	MITEQ	MLA-10K01-B01-35	1237616	RE	2016/02/25 * 12
MMM-03	Digital Tester	Fluke	FLUKE 26-3	78030621	RE	2015/08/19 * 12
MAEC-04	Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	RE	2015/10/02 * 12
MOS-15	Thermo-Hygrometer	Custom	CTH-180	1501	RE	2016/01/21 * 12
MJM-26	Measure	KOMELON	KMC-36	-	RE	-
MHA-21	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	RE	2015/08/10 * 12
MCC-141	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	RE	2015/06/22 * 12
MPA-12	MicroWave System Amplifier	Agilent	83017A	00650	RE	2015/10/01 * 12
MHA-17	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170307	RE	2015/06/06 * 12
MMM-10	DIGITAL HiTESTER	Hioki	3805	051201148	RE	2016/01/18 * 12
MHF-26	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	RE	2015/09/17 * 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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