

TEST REPORT

Report No. : ICM05008-FCC
Date : 22nd June 2005
Applicant : SEIKO EPSON CORPORATION, MATSUMO MINAMI PLANT
2070 Kotobuki Koaka, Matsumoto-shi, Nagano-Ken,
399-8702 Japan
EUT : Bluetooth Interface board for printer
FCC ID : BKMFBM224A
Model No. : M224A
Serial No. : 7.10
Receipt date of tested sample : 10th June 2005
Date of measurement : 14th, 17th June 2005 (Radiated Emission)
15th June 2005 (Conducted Emission)
16th June 2005 (AC Powerline Conducted Emission)
Test location : Taiyo Yuden Co.,Ltd. EMC Center
5607-2, Nakamuroda, Haruna-machi,
Gunma-Gun, Gunma, 370-3347, Japan.
Applied standard : FCC 47 CFR Part 15 Subpart C, Section 15.207, (10-1-04 Edition)
Procedure : ANSI C63.4-2003
Test results: PASS



Approved by : 
Manager / Kenzo Furuta

Reviewed by : 
Chief Engineer / Takeshi Matsumura

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1 Test report

- (1) This report summarizes the result of a single investigation and test result relate only to tested sample.
- (2) The report shall not be reproduced except in full without the written approval of the Taiyo Yuden Co.,Ltd.
- (3) This test report must not be used by the client to claim product endorsement by any government agency.

2 General Information

2.1 Product Description

EUT : Bluetooth Interface board for printer
 Model No. : M224A
 Serial No. : 7,10
 FCC ID : BKMFBM224A
 Description of EUT : Pre-Production
 Summary of EUT : The Epson Bluetooth Interface board for printer is frequency hopping intentional radiators that operates on the 2400 – 2483.5MHz band.
 It is designed to be install in the host printer.
 The EUT uses integral antenna.
 Modulation : GFSK
 Power supply : DC 3.3V
 Waight : 12.58g
 Dimensions of EUT : W50mm × D70mm × H6.7mm
 Antenna gain : 2.044dBi (at 2441MHz)
 The clock frequencies used in this EUT:
 1.MHz (IF-TX mode)
 1.5MHz (IF-RX mode)
 Fvco (1200.25 to 1239.25MHz[RX],1201 to 1240MHz[TX])
 X' tal (16 MHz)

2.2 Summary of Test and Inspection Result

No.	Item	Test Procedure	Specification	Remarks	Deviation	Worst Margin	Results
1	AC Powerline Conducted Emission	ANSI C63.4:2003	FCC 15.207	-	N/A	4.6dB Transmittingmode:2402MHz 0.558MHz VA (AV)	Pass
2	20dB Bandwidth	ANSI C63.4:2003 Public Notice DA00-705	FCC 15.247(a)(1) (i)	Conducted	N/A	-	Pass
3	Carrier Frequency Separation		FCC 15.247(a)(1) FCC 04-165		N/A	-	Pass
4	Number of Hoping Frequency		FCC 15.247(a)(1)(iii)		N/A	-	Pass
5	Dwell time		FCC 15.247(a)(1)(iii)		N/A	-	Pass
6	Maximum peak Output Power		FCC 15.247(b)(1)		N/A	-	Pass
7	Band Edge Compliance		FCC 15.247(c)		N/A	-	Pass
8	Spurious RF Conducted Emission		FCC 15.247(c)		N/A	-	Pass
9	Radiated Emission		FCC 15.247(c)		Radiated	N/A	9.8dB Transmitting mode:2480MHz Direction:XY Horizontal (AV)14880.0MHz

2.3 Test Methodology

Interference measurements were made in accordance with ANSI C63.4-2003 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

2.4 Test Facility

1. FCC 47CFR, Part 15, Section 15.247 regulation test were performed on the shielded room, and radiated interference field strength test was performed on the 10 meter semi-anechoic chamber located at Taiyo Yuden Co.,Ltd. EMC Center, 5607-2 Nakamuroda Haruna-Machi Gunma-Gun Gunma, 370-3347 Japan.
2. This Laboratory is accredited under the National Voluntary Laboratory Accreditation Program (NVLAP) by United States Department of Commerce, National Institute of Standard and Technology (NIST) for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations.
3. These criteria encompass the requirements of ISO/IEC 17025:1999 and the relevant requirements of ISO 9002:1994 as suppliers of calibration or test results. Accreditation awarded for specific services, listed on the Scope of Accreditation for: ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS FCC. (NVLAP LAB CODE: 200607-0).

3 System Test Configuration

3.1 Justification

1. Emission tests were performed with no deviation from the ANSI C63.4-2003 and FCC 47CFR, Part 15, Section 15.247 regulation tests were performed with no deviation from the FCC Public Notice DA00-705 released March 30, 2000.
2. The system was configured for testing a typical fashion. (as a customer would normally use it.)
3. Radiate testing in the range of 1 GHz to 25 GHz was investigated with the spectrum (peak detector function) under the FCC regulation section 15.209 (e) and 15.35 (b). The test performed at an antenna to EUT distance of 1 meter. The level of any unwanted emissions from EUT did not exceed the level of the fundamental emission (Compliance with 15.209 (c)). And test result found to be compliance with FCC regulation section 15.209 (a) Radiated emission limits (500 micro-volts/meter). Data is presented for the "worst case" measurements, that E.U.T was normal operated.
4. Radiate testing in the range of 30 MHz to 1000 MHz was performed at an antenna to EUT distance of 3 meters under the 15.209 (e) and 15.31(f)(1).
5. All tests were performed with the representative channel operation as follows.
 - a. Lowest frequency channel : CH0 2402MHz
 - b. Middle frequency channel : CH39 2442MHz
 - c. Highest frequency channel : CH78 2480MHz

3.2 Operating modes

Mode	Explanation of the mode
Transmitting mode	Signal pattern : PRBS9 Signal packet type : DH5 (Dwell time : DH1,DH3,DH5)
Receiving mode	RX continuous

DH1	Description : A 5 slot, Data High rate, ACL type packet. Supports a data payload of 0 to 27 bytes with CRC, no FEC, and fully transmits within five consecutive 625 microsecond transmission slots. Makes up the front half of a 5/1 multi-slot Frame.
DH3	Description : A 5 slot, Data High rate, ACL type packet. Supports a data payload of 0 to 183 bytes with CRC, no FEC, and fully transmits within five consecutive 625 microsecond transmission slots. Makes up the front half of a 5/1 multi-slot Frame.
DH5	Description : A 5 slot, Data High rate, ACL type packet. Supports a data payload of 0 to 339 bytes with CRC, no FEC, and fully transmits within five consecutive 625 microsecond transmission slots. Makes up the front half of a 5/1 multi-slot Frame.
PRBS9	A periodic Pseudo Random Bit Sequence. $2^9 - 1$

3.3 List of accessories

	Product name	M/N	S/N	Manufacturer	Notes
a	Board for test	-	-	TAIYO YUDEN Co.,Ltd	-
b	Conversion Board	-	-	TAIYO YUDEN Co.,Ltd	-
c	Personal Computer	PP04S	CN-0Y0119-36521-467-2020	DELL	-
d	AC Adapter for PC	PA-1650-05D	-	DELL	-
e	Regulated DC power supply	PA18-1.2	2110071	KENWOOD	-
f	Handy printer	M196B	GL6G00003	SEIKO EPSON CORP.	-
g	AC Adapter for Handy Printer	PA-42Y12	FYYZ000122	SEIKO EPSON CORP.	-

3.4 Interface cables

	Cable Type	M/N	Connection	Ferrite core	Shielded	Material of connector	Length	Treatment for the extra length
1	Flexible Flat cable	-	b↔EUT	-	Yes	Metal	0.05m	-
2	Conversion cable	UC-SGT	a↔3	Yes	Yes	Metal	0.40m	-
3	RS232C cable	-	c↔2	Yes	Yes	Metal	1.72m	Fold back and forth in the center
4	DC cable	-	c↔d	No	Yes	Metal	1.80m	-
5	AC cable	-	d↔AC	No	No	Plastic	0.90m	-
6	DC cable	-	f↔g	Yes	Yes	Metal	0.40m	Fold back and forth in the center
7	AC cable	-	g↔AC	No	No	Plastic	1.70m	Fold back and forth in the center

3.5 Special Test Condition

Nothing

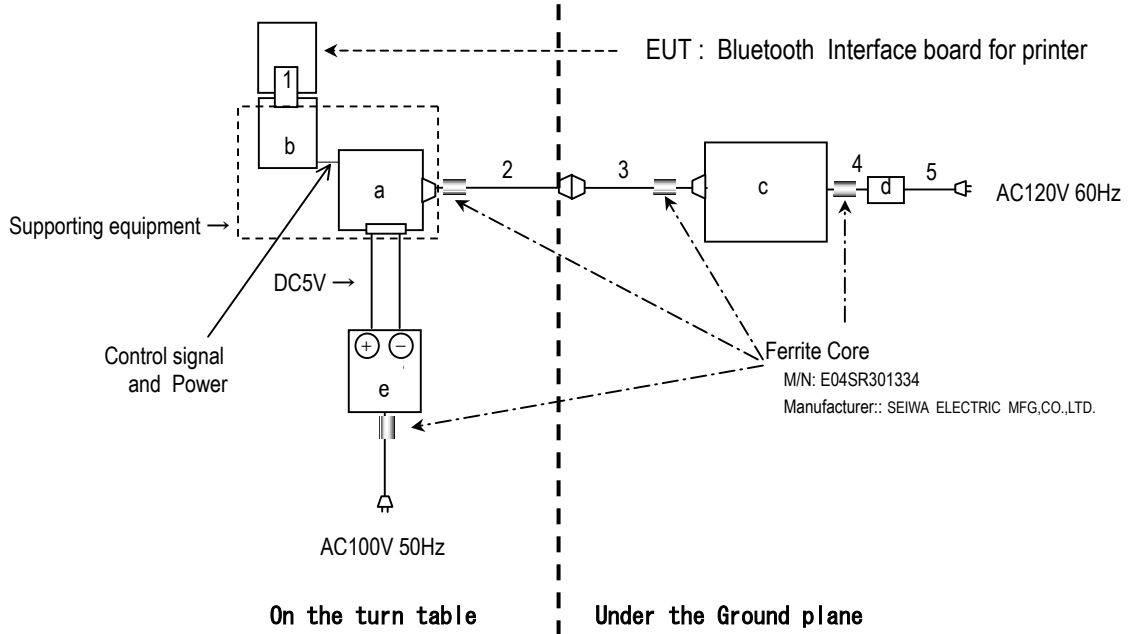
3.6 Equipment Modifications

No modification has been carried out by the test laboratory.

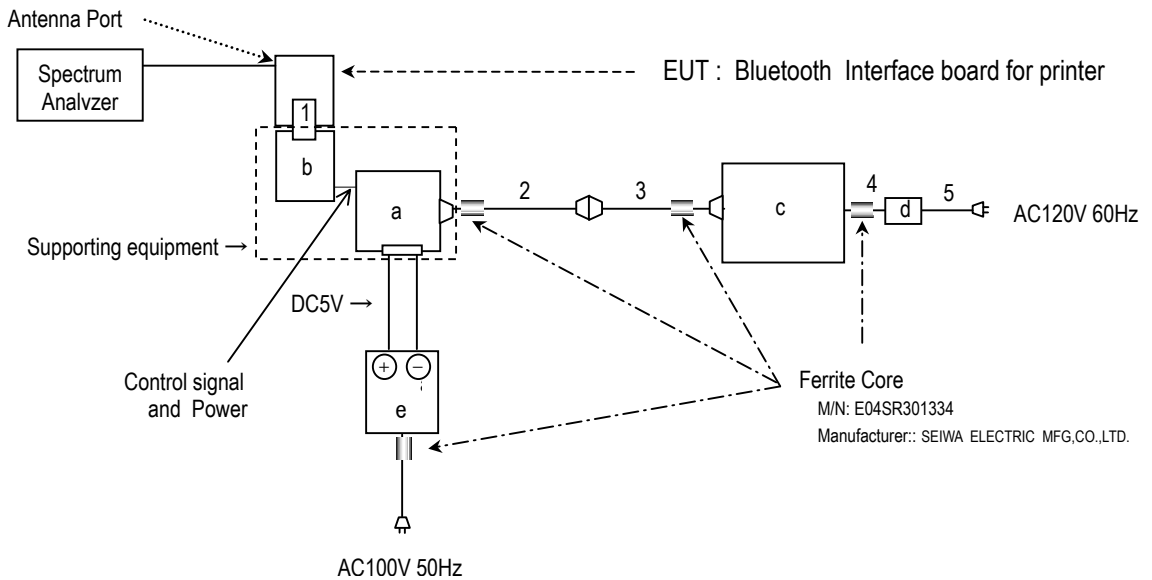
3.7 Configuration of Tested System

Operation within the bands 2400-2483.5MHz

Radiated Emission Test

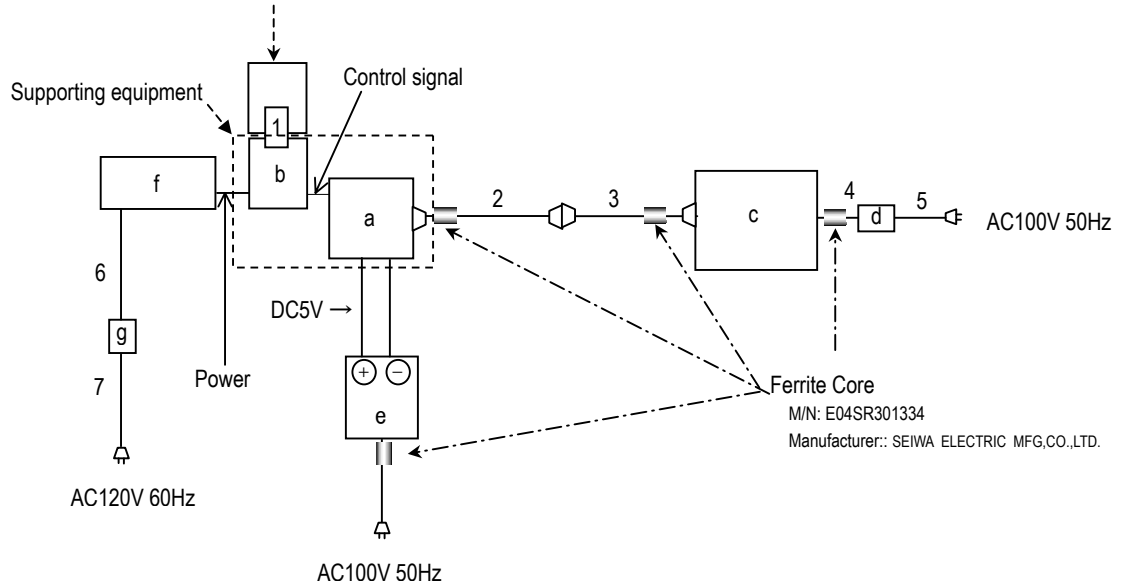


Conducted Emission Test



AC Power line Conducted Emission Test

EUT : Bluetooth Interface board for printer



These numbers and the marks in the picture above are corresponding to the numbers and the mark in Figure 3.3 and 3.4 on page 7.

4 Antenna Requirement

The EUT provide a permanently attached antenna and it found to be compliance with FCC regulation section 15.203 .

Antenna Data
 Manufacturer: Taiyo Yuden Co.,Ltd.
 Model No.: AH104F

Refer to Section 15 of this REPORT and APPENDIX1.

5 AC Powerline Conducted Emission Test

5.1 Test Setup

Conducted emission measurements were performed from 150kHz to 30 MHz.

The test setup was made according to RSS-210 and ANSI STD C63.4-2003 clause 7 in the Shielded room.

The rear of non-conductive wooden table top was placed 0.4 m from a vertical metal reference plane that one of the wall.

Rears of the peripherals were all aligned and flush with rear of non-conductive wooden tabletop.

The height of this table was 0.8 m and 1.5 m wide x 1.0 m deep size.

The spacing between the each equipment was 10 cm.

Connection of the Handy printer connected EUT to the artificial mains network (LISN) was required.

The distance between the closet surface of the EUT and the closet surface of the artificial mains network (LISN) was 0.8 m.

Connection of the all other equipment to the second artificial mains network (LISN) was required. The distance between the peripherals and the closet surface of the second artificial mains network (LISN) was minimum 0.8 m.

The second artificial mains network is terminated with 50 ohm terminator. Where a mains flexible cord is provided by the manufacture this is 2.0 m long and excess cable was folded back and forth as far as possible to 0.8 m so as to from a bundle not exceeding 0.4 m in length. Interconnecting cables of table top equipment that hang closer than 0.4 m to the floor ground plane were folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table.

The measurement has been conducted with both neutral (VA) and line (VB) power supply polarization.

The highest voltage emission has been recorded.

For further description of the configuration refer to the photographs of this report.

Detector Mode: Quasi-Peak and Average

Bandwidth: 10kHz

5.2 Test Instrumentation

Facility/ Equipment	Manufacturer	Model No.	Serial No.	Next Calibration Due	Note
Shielded room	TDK Co.,Ltd	DA-06912	-	-	-
EMI Test Receiver	R&S	ESHS 10	100005	4 th .8.2005.	-
LISN	KYORITSU ELECTRICAL WORK	KNW-407	8-680-1	18 th .3.2006.	for EUT
Cable	SUHNER	RG223	CE-1	27 th .4.2006.	-
		RG223	CE-2	27 th .4.2006.	-
		RG2214	CE-3	27 th .4.2006.	-
Attenuator	KYORITSU	KPD-602	5K325	27 th .4.2006.	-
Pulse Limiter	Agilent Technologies	11867A	1387	27 th .4.2006.	-
RF Selector	TDK Co.,Ltd	NS4900	0302-009	27 th .4.2006.	-
Software	TOYO Corporation	EP5/CE Ver.2.0	0208085	-	-

5.3 Conducted Emission Calculation

The basic equation with a sample calculation is as follows:

$$\begin{aligned} \text{c.f.} &= \text{CF} + \text{AL} \\ \text{CE} &= \text{RA} + \text{c.f.} \end{aligned}$$

Where

- c.f. = Correction Factor (dB)
- CE = Conducted Emission (Emission Level - Result) (dB μ V)
- RA = Receiver Amplitude (Reading Level) (dB μ V)
- CF = Cable Attenuation Loss (dB)
- AL = Attenuator Loss (dB)

Assume a receiver reading of 37.5 dB μ V is obtained. The Factor of 3.5dB is added, giving a terminal voltage of 41.0 dB μ V. The 41.0 dB μ V value was mathematically converted to its corresponding level in μ V.

$$\text{CE} = 37.5 + 3.5 = 41.0 \text{ dB } \mu \text{ V}$$

Level in μ V = Common Antilogarithm : $10^{(41.0/20)} = 112.2 \mu \text{ V}$

5.4 Test Results

5.4.1 Transmitting mode

AC Powerline Conducted Emission 2402MHz

Serial No. : 7
 Power : AC 120V 60Hz
 Mode : Transmitting mode
 Temperature : 23°C
 Humidity : 66%

VA

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	37.5	31.9	3.5	41.0	35.4	66.0	56.0	25.0	20.6
0.184	35.9	31.1	3.4	39.3	34.5	64.3	54.3	25.0	19.8
0.371	31.2	28.7	3.3	34.5	32.0	58.5	48.5	24.0	16.5
0.404	31.0	28.1	3.3	34.3	31.4	57.8	47.8	23.5	16.4
0.558	40.5	38.1	3.3	43.8	41.4	56.0	46.0	12.2	4.6
1.008	30.6	27.1	3.3	33.9	30.4	56.0	46.0	22.1	15.6
15.521	28.5	21.2	4.0	32.5	25.2	60.0	50.0	27.5	24.8
21.389	36.6	29.1	4.3	40.9	33.4	60.0	50.0	19.1	16.6
26.066	31.4	26.1	4.5	35.9	30.6	60.0	50.0	24.1	19.4

VB

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	40.4	35.5	3.5	43.9	39.0	66.0	56.0	22.1	17.0
0.186	38.4	34.4	3.4	41.8	37.8	64.2	54.2	22.4	16.4
0.372	32.7	29.8	3.3	36.0	33.1	58.5	48.5	22.5	15.4
0.405	32.1	28.6	3.3	35.4	31.9	57.8	47.8	22.4	15.9
0.558	40.6	38.1	3.3	43.9	41.4	56.0	46.0	12.1	4.6
1.008	30.2	26.5	3.3	33.5	29.8	56.0	46.0	22.5	16.2
20.477	35.4	27.7	3.9	39.3	31.6	60.0	50.0	20.7	18.4
25.550	33.1	27.4	4.1	37.2	31.5	60.0	50.0	22.8	18.5

Conducted Emission 2441MHz

Serial No. : 7
 Power : AC 120V 60Hz
 Mode : Transmitting mode
 Temperature : 23°C
 Humidity : 66%

VA

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	37.4	31.9	3.5	40.9	35.4	66.0	56.0	25.1	20.6
0.187	35.8	31.0	3.4	39.2	34.4	64.2	54.2	25.0	19.8
0.373	31.3	28.7	3.3	34.6	32.0	58.4	48.4	23.8	16.4
0.407	30.4	28.3	3.3	33.7	31.6	57.7	47.7	24.0	16.1
0.559	40.7	38.1	3.3	44.0	41.4	56.0	46.0	12.0	4.6
1.007	30.6	27.1	3.3	33.9	30.4	56.0	46.0	22.1	15.6
15.520	28.6	21.2	4.0	32.6	25.2	60.0	50.0	27.4	24.8
21.360	35.9	28.2	4.2	40.1	32.4	60.0	50.0	19.9	17.6
26.068	31.3	26.2	4.5	35.8	30.7	60.0	50.0	24.2	19.3

VB

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	40.3	35.4	3.5	43.8	38.9	66.0	56.0	22.2	17.1
0.184	38.3	34.4	3.4	41.7	37.8	64.3	54.3	22.6	16.5
0.372	32.7	29.8	3.3	36.0	33.1	58.5	48.5	22.5	15.4
0.405	32.1	29.1	3.3	35.4	32.4	57.8	47.8	22.4	15.4
0.559	40.6	38.1	3.3	43.9	41.4	56.0	46.0	12.1	4.6
1.008	30.2	26.5	3.3	33.5	29.8	56.0	46.0	22.5	16.2
20.350	36.6	28.7	3.9	40.5	32.6	60.0	50.0	19.5	17.4
26.065	31.4	26.2	4.1	35.5	30.3	60.0	50.0	24.5	19.7

Conducted Emission 2480MHz

Serial No. : 7
 Power : AC 120V 60Hz
 Mode : Transmitting mode
 Temperature : 23°C
 Humidity : 66%

VA

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	37.4	31.8	3.5	40.9	35.3	66.0	56.0	25.1	20.7
0.185	35.9	31.1	3.4	39.3	34.5	64.3	54.3	25.0	19.8
0.373	31.2	28.8	3.3	34.5	32.1	58.4	48.4	23.9	16.3
0.409	30.9	28.3	3.3	34.2	31.6	57.7	47.7	23.5	16.1
0.559	40.8	38.1	3.3	44.1	41.4	56.0	46.0	11.9	4.6
1.006	30.5	27.1	3.3	33.8	30.4	56.0	46.0	22.2	15.6
15.520	28.6	21.2	4.0	32.6	25.2	60.0	50.0	27.4	24.8
20.998	38.0	30.6	4.2	42.2	34.8	60.0	50.0	17.8	15.2
26.200	27.4	22.0	4.5	31.9	26.5	60.0	50.0	28.1	23.5

VB

Frequency [MHz]	Meter Reading [dB(μV)]		Factor [dB]	Conducted Emission [dB(μV)]		Limits [dB(μV)]		Margin [dB]	
	QP	AV		QP	AV	QP	AV	QP	AV
0.150	40.3	35.4	3.5	43.8	38.9	66.0	56.0	22.2	17.1
0.186	38.3	34.3	3.4	41.7	37.7	64.2	54.2	22.5	16.5
0.370	32.3	29.8	3.3	35.6	33.1	58.5	48.5	22.9	15.4
0.404	32.0	29.0	3.3	35.3	32.3	57.8	47.8	22.5	15.5
0.557	40.6	38.1	3.3	43.9	41.4	56.0	46.0	12.1	4.6
1.007	30.2	26.5	3.3	33.5	29.8	56.0	46.0	22.5	16.2
15.500	27.6	21.5	3.8	31.4	25.3	60.0	50.0	28.6	24.7
20.999	37.9	29.6	3.9	41.8	33.5	60.0	50.0	18.2	16.5
26.069	31.4	26.2	4.1	35.5	30.3	60.0	50.0	24.5	19.7

6 Radiated Emission Test

6.1 Test Setup

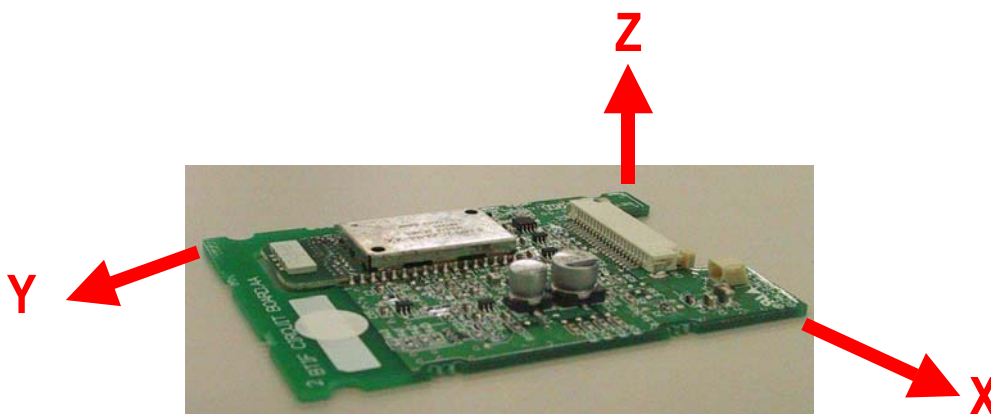
The test setup was made according to ANSI STD C63.4-2003 clause 8 on the 10 meter semi-anechoic chamber, which allows a 3 or 1 m distance measurement. EUT was placed on non-conductive table (foam polystyrene). The height of this table was 0.8 m. The measurement has been conducted with both horizontal and vertical antenna polarization. The turntable has been fully rotated. The highest radiation of the equipment has been recorded. For further description of the configuration refer to the pictures of this report.

Distance between equipment and antenna : 3m (30MHz to 18GHz)
: 1m (18GHz to 25GHz)

Spectrum Analyzer Setting

30~1000MHz	Detector : Quasi-Peak Bandwidth : 120kHz
1~25GHz	Detector : Peak and Average Bandwidth : 1MHz

Axial Direction



Test Instrumentation

Facility/ Equipment	Manufacturer	Model No.	Serial No.	Frequency Range	Next Calibration Due
10m anechoic chamber	TDK Co.,Ltd	DA-06912	-	-	13 st .3.2006.
EMI Test Receiver	R&S	ESCS 30	100148	30-1000MHz	29 nd .8.2005.
Spectrum Analyzer	Agilent Technologies	8563E	3416A02230	30-1000MHz	4 th .4.2006.
		E4446A	US42070181	1-40GHz	31 th .3.2006.
Amplifier		8449B	3008A00571	1-26.5GHz	26 th .2.2006.
		8447D	2944A06812	30-1000MHz	5 th .4.2006.
RF Selector	TDK Co.,Ltd	NS4900	0302-010	-	5 th .4.2006.
RF Cable	SUHNER	RG214	RG 1	30-1000MHz	5 th .4.2006.
		RG214	RG 3	30-1000MHz	5 th .4.2006.
		RG214	RG 8	30-1000MHz	5 th .4.2006.
		RG214	RG 5	30-1000MHz	5 th .4.2006.
		RG214	RG 6	30-1000MHz	5 th .4.2006.
		SUCOFLEX 106	SU1	1-18GHz	28 th .2.2006.
	SUCOFLEX 104	SU4	1-18GHz	28 th .2.2006.	
	HP	85381C	No.3	18-25GHz	15 th .7.2005.
85381C		No.5	18-25GHz	15 th .7.2005.	
Attenuator	KYORITSU	KPD-602	220142	30-1000MHz	5 th .4.2006.
Antenna	Schwarzbeck	BBA9106	No.4	30-300MHz	28 rd .2.2006.
		UHALP9108-A	160	300-1000MHz	28 rd .2.2006.
	EMCO	3115	9403-4232	1-18GHz	31 th .3.2006.
		3116	9311-2227	18-40GHz	31 th .3.2006.
Software	TOYO Corporation	EP5/RE Ver.2.0	0208086	-	-

6.2 Radiated Emission Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$\begin{aligned} \text{c.f.} &= \text{AF} + \text{CF} + \text{AL} - \text{AG} - \text{DF} \\ \text{RE} &= \text{RA} + \text{c.f.} \end{aligned}$$

Where

- c.f. = Correction Factor (dB/m)
- RE = Radiated Emission (Emission Level - Result) (dBuV/m)
- RA = Receiver Amplitude (Reading Level) (dBuV)
- AF = Antenna Factor (dB/m)
- CF = Cable Attenuation Loss (dB)
- AG = Amplifier Gain (dB)
- AL = Attenuator Loss (dB)
- DF = Distance Factor
 - Distance between equipment and antenna:3m = 0(dB)
 - Distance between equipment and antenna:1m = 9.5(dB)

Assume a receiver reading of 41.3 dB μ V is obtained. The Correction Factor of -1.1 dB/m is added, giving a Radiated Emission of 40.2 dB μ V/m. The 40.2 dB μ V/m value was mathematically converted to its corresponding level in μ V/m.

$$\text{RE} = 41.3 + (-1.1) = 40.2 \text{ dB } \mu \text{ V/m}$$

Level in μ V/m = Common Antilogarithm : $10^{(40.2/20)} = 102.3 \mu \text{ V/m}$

6.3 Test Results

Radiated emission was measured in all test modes; GFSK Modulation.
The results show the worst case.

6.3.1 Transmitting mode

Spurious Emission (Radiated) 2402MHz

Serial No. : 7
Power : DC 3.3V
Mode : Transmitting mode
Temperature : 23°C
Humidity : 66 %

Axial Direction : XY-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]	Factor [dB/m]	Emission Level [dB(μV/m)]	Limits [dB(μV/m)]	Margin [dB]
		QP		QP		
48.01	Vertical	33.8	-10.3	23.5	40.0	16.5
60.01	Vertical	38.7	-13.8	24.9	40.0	15.1
72.01	Vertical	41.3	-15.4	25.9	40.0	14.1
239.99	Horizontal	31.4	-2.5	28.9	46.0	17.1

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]		Factor [dB/m]	Emission Level [dB(μV/m)]		Limits [dB(μV/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
		1065.0	Vertical		-----	57.3		-13.9	-----
		41.5	-----	-13.9	27.6	-----	54.0	26.4	-----
1201.0	Vertical	-----	54.3	-12.8	-----	41.5	74.0	-----	32.5
		48.4	-----	-12.8	35.6	-----	54.0	18.4	-----
4804.0	Horizontal	-----	50.3	-1.1	-----	49.2	74.0	-----	24.8
		41.3	-----	-1.1	40.2	-----	54.0	13.8	-----

Axial Direction : YZ-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.01	Vertical	33.9		-10.3	23.6		40.0	16.4	
60.00	Vertical	38.7		-13.8	24.9		40.0	15.1	
72.01	Vertical	41.3		-15.4	25.9		40.0	14.1	
240.00	Horizontal	31.4		-2.5	28.9		46.0	17.1	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
1202.0	Vertical	----	54.2	-12.8	----	41.4	74.0	----	32.6
		48.8	----	-12.8	36.0	----	54.0	18.0	----
3000.0	Horizontal	----	47.9	-6.0	----	41.9	74.0	----	32.1
		34.2	----	-6.0	28.2	----	54.0	25.8	----

Axial Direction : ZX-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.01	Vertical	33.8		-10.3	23.6		40.0	16.5	
60.00	Vertical	38.7		-13.8	24.9		40.0	15.1	
72.00	Vertical	41.4		-15.4	26.0		40.0	14.0	
240.00	Horizontal	31.6		-2.5	29.1		46.0	16.9	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
1202.0	Vertical	----	55.9	-12.8	----	43.1	74.0	----	30.9
		50.8	----	-12.8	38.0	----	54.0	16.0	----
4804.0	Vertical	----	47.9	-1.1	----	46.8	74.0	----	27.2
		38.1	----	-1.1	37.0	----	54.0	17.0	----

Spurious Emission (Radiated) 2441MHz

Serial No. : 7
 Power : DC 3.3V
 Mode : Transmitting mode
 Temperature : 23°C
 Humidity : 66 %

Axial Direction : XY-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]	Factor [dB/m]	Emission Level [dB(μV/m)]	Limits [dB(μV/m)]	Margin [dB]
		QP		QP		
48.00	Vertical	33.8	-10.3	23.5	40.0	16.5
60.01	Vertical	38.9	-13.8	25.1	40.0	14.9
72.01	Vertical	41.3	-15.4	25.9	40.0	14.1
199.89	Vertical	30.2	-3.0	27.2	43.5	16.3

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]		Factor [dB/m]	Emission Level [dB(μV/m)]		Limits [dB(μV/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
		1065.0	Vertical		-----	58.5		-13.9	-----
		41.6	-----	-13.9	27.7	-----	54.0	26.3	-----
3000.0	Horizontal	-----	47.9	-6.0	-----	41.9	74.0	-----	32.1
		34.2	-----	-6.0	28.2	-----	54.0	25.8	-----

Axial Direction : YZ-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.02	Vertical	33.8		-10.3	23.5		40.0	16.5	
60.02	Vertical	38.9		-13.8	25.1		40.0	14.9	
72.01	Vertical	41.3		-15.4	25.9		40.0	14.1	
199.89	Vertical	30.1		-3.0	27.1		43.5	16.4	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
		1220.0	Vertical		----	54.7		-12.7	----
		49.3	----	-12.7	36.6	----	54.0	17.4	----
4882.0	Horizontal	----	45.7	-0.9	----	44.8	74.0	----	29.2
		33.8	----	-0.9	32.9	----	54.0	21.1	----

Axial Direction : ZX-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.00	Vertical	33.8		-10.3	23.5		40.0	16.5	
60.01	Vertical	38.7		-13.8	24.9		40.0	15.1	
72.01	Vertical	41.3		-15.4	25.9		40.0	14.1	
199.89	Vertical	30.0		-3.0	27.0		43.5	16.5	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
		1220.0	Horizontal		----	53.1		-12.7	----
		46.4	----	-12.7	33.7	----	54.0	20.3	----
4882.0	Vertical	----	46.0	-0.9	----	45.1	74.0	----	28.9
		35.3	----	-0.9	34.4	----	54.0	19.6	----

Spurious Emission (Radiated) 2480MHz

Serial No. : 7
 Power : DC 3.3V
 Mode : Transmitting mode
 Temperature : 23°C
 Humidity : 66 %

Axial Direction : XY-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]	Factor [dB/m]	Emission Level [dB(μV/m)]	Limits [dB(μV/m)]	Margin [dB]
		QP		QP		
48.01	Vertical	33.8	-10.3	23.5	40.0	16.5
60.01	Vertical	38.7	-13.8	24.9	40.0	15.1
72.01	Vertical	41.0	-15.4	25.6	40.0	14.4
240.08	Horizontal	31.6	-2.5	29.1	46.0	16.9

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μV)]		Factor [dB/m]	Emission Level [dB(μV/m)]		Limits [dB(μV/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
		1065.0	Vertical		-----	51.0		-13.9	-----
		37.9	-----	-13.9	24.0	-----	54.0	30.0	-----
4960.0	Vertical	-----	45.6	-0.7	-----	44.9	74.0	-----	29.1
		32.2	-----	-0.7	31.5	-----	54.0	22.5	-----
9920.0	Horizontal	-----	45.7	5.5	-----	51.2	74.0	-----	22.8
		33.0	-----	5.5	38.5	-----	54.0	15.5	-----
14880.0	Horizontal	-----	49.6	11.0	-----	60.6	74.0	-----	13.4
		33.2	-----	11.0	44.2	-----	54.0	9.8	-----

Axial Direction : YZ-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.01	Vertical	33.9		-10.3	23.6		40.0	16.4	
60.00	Vertical	38.7		-13.8	24.9		40.0	15.1	
72.03	Vertical	41.3		-15.4	25.9		40.0	14.1	
240.09	Horizontal	31.4		-2.5	28.9		46.0	17.1	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
1069.0	Vertical	----	51.1	-13.8	----	37.3	74.0	----	36.7
		37.9	----	-13.8	24.1	----	54.0	29.9	----
1240.0	Vertical	----	54.8	-12.7	----	42.1	74.0	----	31.9
		49.8	----	-12.7	37.1	----	54.0	16.9	----

Axial Direction : ZX-Plane

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		QP			QP				
48.01	Vertical	33.8		-10.3	23.6		40.0	16.5	
60.00	Vertical	38.7		-13.8	24.9		40.0	15.1	
72.00	Vertical	41.4		-15.4	26.0		40.0	14.0	
240.09	Horizontal	31.5		-2.5	29.0		46.0	17.0	

Frequency [MHz]	Antenna Polarization	Meter Reading [dB(μ V)]		Factor [dB/m]	Emission Level [dB(μ V/m)]		Limits [dB(μ V/m)]	Margin [dB]	
		Average	Peak		Average	Peak		Average	Peak
1240.0	Vertical	----	53.6	-12.7	----	40.9	74.0	----	33.1
		47.6	----	-12.7	34.9	----	54.0	19.1	----
4960.0	Vertical	----	45.4	-0.7	----	44.7	74.0	----	29.3
		34.3	----	-0.7	33.6	----	54.0	20.4	----

7 20dB Bandwidth

7.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

Spectrum analyzer setting :-
 DETECTOR MODE : PEAK
 RBW : 30kHz
 VBW : 30kHz
 SPAN : 2MHz
 SWEEP TIME : AUTO

7.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

7.3 Test Results

Serial No. : 10
 Power : DC 3.3V
 Mode : Transmitting mode , Non Frequency Hopping
 Temperature : 22.7 °C
 Humidity : 51.4%
 Regulation : FCC Part15 C §15.247 (a)(1)(i)

(1) Operation mode: Transmitting mode

CH	Frequency [MHz]	20dB Bandwidth [MHz]	Limit [MHz]
0ch(Lowest)	2402.0	0.942	1.0
39ch(Middle)	2441.0	0.934	1.0
78ch(Highest)	2480.0	0.934	1.0

8 Carrier Frequency Separation

8.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

Spectrum Analyzer setting : -
 DETECTOR MODE :PEAK
 RBW : 100kHz
 VBW : 300kHz
 SPAN : 3MHz
 SWEEP TIME : AUTO

8.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

8.3 Test Results

Serial No. : 10
 Power : DC 3.3V
 Mode : Transmitting mode , Frequency Hopping
 Temperature : 22.7 °C
 Humidity : 51.4%
 Regulation : FCC Part15 C §15.247 (a)(1)
 FCC 04-165

- (1) Operation mode: Transmitting mode
 Transmitting mode , Frequency Hopping (79ch)

Channel	Channel Separation [MHz]	Limit
Low frequency (0ch-1ch)	1.016	> two-thirds of the 20dB Bandwidth
Middle frequency (38ch-39ch)	1.028	> two-thirds of the 20dB Bandwidth
High frequency (77ch-78ch)	0.980	> two-thirds of the 20dB Bandwidth

Remarks: two-thirds of the 20dB Bandwidth is 0.628MHz. Refer to Clause 7.3

9 Number of Hopping Frequency

9.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

spectrum analyzer setting : -
 DETECTOR MODE : PEAK
 RBW : 300kHz
 VBW : 300kHz
 SWEEP TIME : AUTO

9.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

9.3 Test Results

Serial No. : 10
 Power : DC 3.3V
 Mode : Transmitting mode , Frequency Hopping
 Temperature : 22.7 °C
 Humidity : 50%
 Regulation : FCC Part15 C §15.247 (a)(1)(iii)

(1) Operation mode: Transmitting mode

Mode	Number of channel [time]	Limit [time]
Transmitting mode Frequency Hopping (79ch)	79	\geq 75

10 Dwell Time

10.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

Spectrum analyzer setting : -
DETECTOR MODE : PEAK
RBW : 1MHz
VBW : 1MHz
SPAN : 0Hz
SWEEP TIME : AUTO

10.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

10.3 Test Results

Serial No. : 10
Power : DC 3.3V
Mode : Transmitting mode (DH1,DH3,DH5), Frequency Hopping
Temperature : 22.7 °C
Humidity : 51.4%
Regulation : FCC Part15 C §15.247 (a)(1)(iii)

Packet	Dwell time [ms]	Limit [ms]
DH1	134.77	400
DH3	269.62	400
DH5	312.65	400

Data of Dwell Time (Frequency Hopping (79ch))

Time of occupancy (Dwell Time) for packet type DH1.

FH hop rate of Bluetooth system is 1600hops per 1 second.

A DH1 packet needs 1 time slot for transmitting and 1 time slot for receiving.

In a DH1 packet, it hops 800 times for transmitting per 1 second.

The number of hopping channel is 79.

The number of times that appears in 1 channel per 1 second is as follows.

$$800/79=10.13 \text{ (times)}$$

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed $0.4 \times 79 = 31.6$ seconds

The number of times that appears in 1 channel per 31.6 seconds is as follows.

$$10.13 \times 31.6 = 320.11 \text{ (times)}$$

Transmitting time is 420.8 μ s .

Then dwell time is $320.11 \times 421\mu\text{s} = 134.77\text{ms}$ per 31.6 seconds.

Time of occupancy (Dwell Time) for packet type DH3.

FH hop rate of Bluetooth system is 1600hops per 1 second.

A DH3 packet needs 3 times slot for transmitting and 1 time slot for receiving.

In a DH3 packet, it hops 400 times for transmitting per 1 second.

The number of hopping channel is 79.

The number of times that appears in 1 channel per 1 second is as follows.

$$400/79=5.1 \text{ (times)}$$

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed $0.4 \times 79 = 31.6$ seconds

The number of times that appears in 1 channel per 31.6 seconds is as follows.

$$5.1 \times 31.6 = 161.16 \text{ (times)}$$

Transmitting time is 1.673ms .

Then dwell time is $161.16 \times 1.673\text{ms} = 269.62\text{ms}$ per 31.6 seconds.

Time of occupancy (Dwell Time) for packet type DH5.

FH hop rate of Bluetooth system is 1600hops per 1 second.

A DH5 packet needs 5 times slot for transmitting and 1 time slot for receiving.

In a DH5 packet, it hops 266.67 times for transmitting per 1 second.

The number of hopping channel is 79.

The number of times that appears in 1 channel per 1 second is as follows.

$$266.67/79=3.37 \text{ (times)}$$

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed $0.4 \times 79 = 31.6$ seconds

The number of times that appears in 1 channel per 31.6 seconds is as follows.

$$3.37 \times 31.6 = 106.49 \text{ (times)}$$

Transmitting time is 2.936ms .

Then dwell time is $106.49 \times 2.936\text{ms} = 312.65\text{ms}$ per 31.6 seconds.

11 Maximum Peak Output Power

11.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

spectrum analyzer setting : -
 DETECTOR MODE : PEAK
 RBW : 1MHz
 VBW : 1MHz
 SWEEP TIME : AUTO

11.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

11.3 Test Results

Serial No. : 10
 Power : DC 3.3V
 Mode : Transmitting mode , Non Frequency Hopping
 Temperature : 22.7 °C
 Humidity : 51.4%
 Regulation : FCC Part15 C §15.247 (b)(1)

(1) Operation mode: Transmitting mode

CH	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Result [dBm]	Limit [dBm]
0ch(Lowest)	2402.0	-1.65	0.67	-0.98	30.0
39ch(Middle)	2441.0	-1.52	0.67	-0.85	30.0
78ch(Highest)	2480.0	-1.17	0.67	-0.50	30.0

Result = Reading + Cable Loss

12 Band Edge Compliance

12.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

Spectrum analyzer setting : -
DETECTOR MODE : PEAK
RBW : 100kHz
VBW : 100kHz
SWEEP TIME : AUTO

12.2 Test Instrument

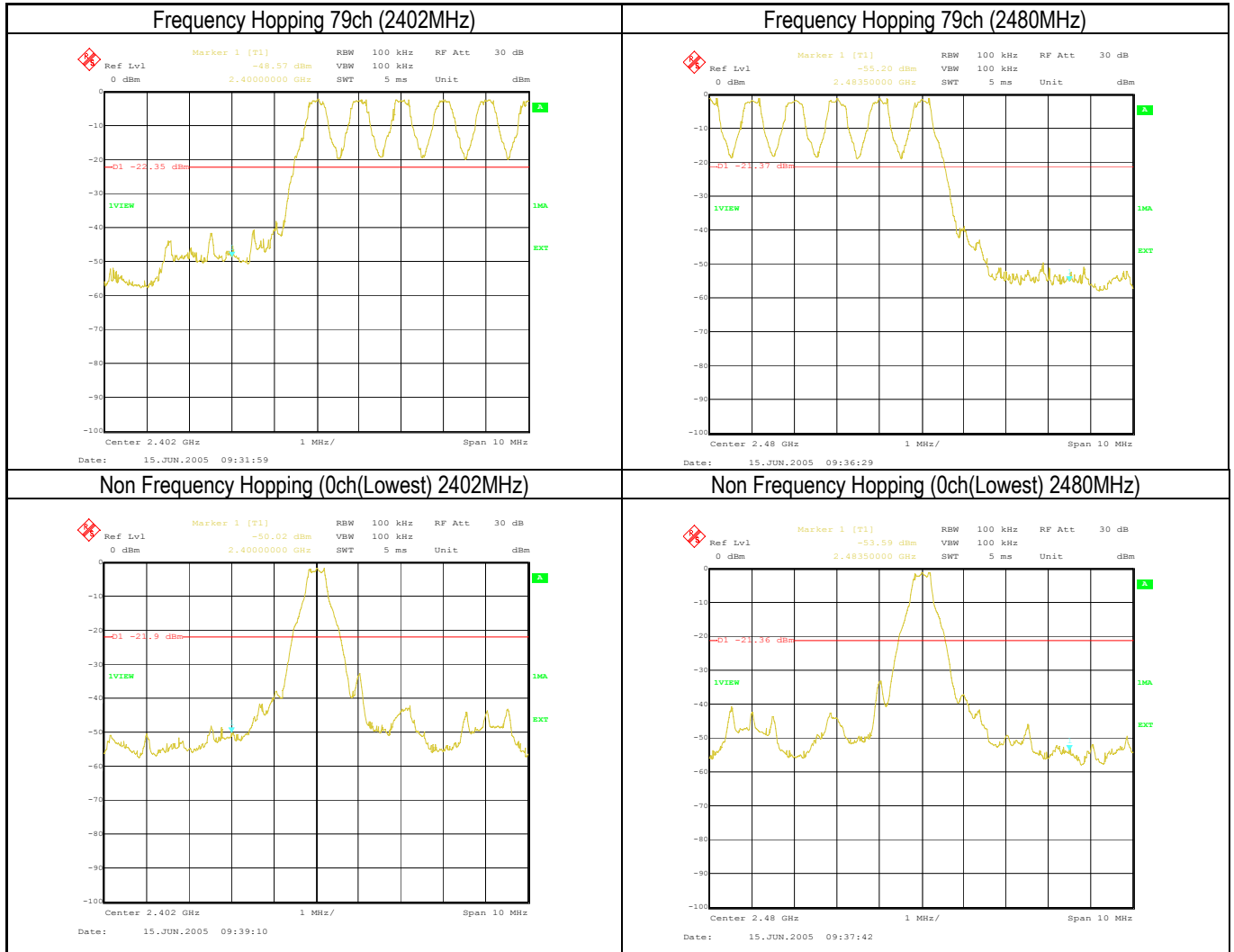
Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

12.3 Test Results

Serial No. : 10
Power : DC 3.3V
Mode : Transmitting mode , Frequency Hopping
Temperature : 22.7 °C
Humidity : 51.4%
Regulation : FCC Part15 C §15.247 (c)

The spectrum data are attached below. Display line indicates the 20dB offset below highest level. It shows compliance with the requirement in part 15.247(c)

(1) Operation mode: Transmitting mode



13 Spurious RF Conducted Emission

13.1 Test Setup

The spectrum analyzer was connected directly to the transmitter output.

spectrum analyzer setting :-
DETECTOR : PEAK
RBW : 100kHz
VBW : 100kHz
SWEEP TIME : AUTO

13.2 Test Instrument

Equipment	Manufacture	Model No.	Serial No.	Next Calibration Due
Spectrum Analyzer	Rohode&Schwarz	FSIQ26	840061/0004	7 th .2.2006.

13.3 Test Results

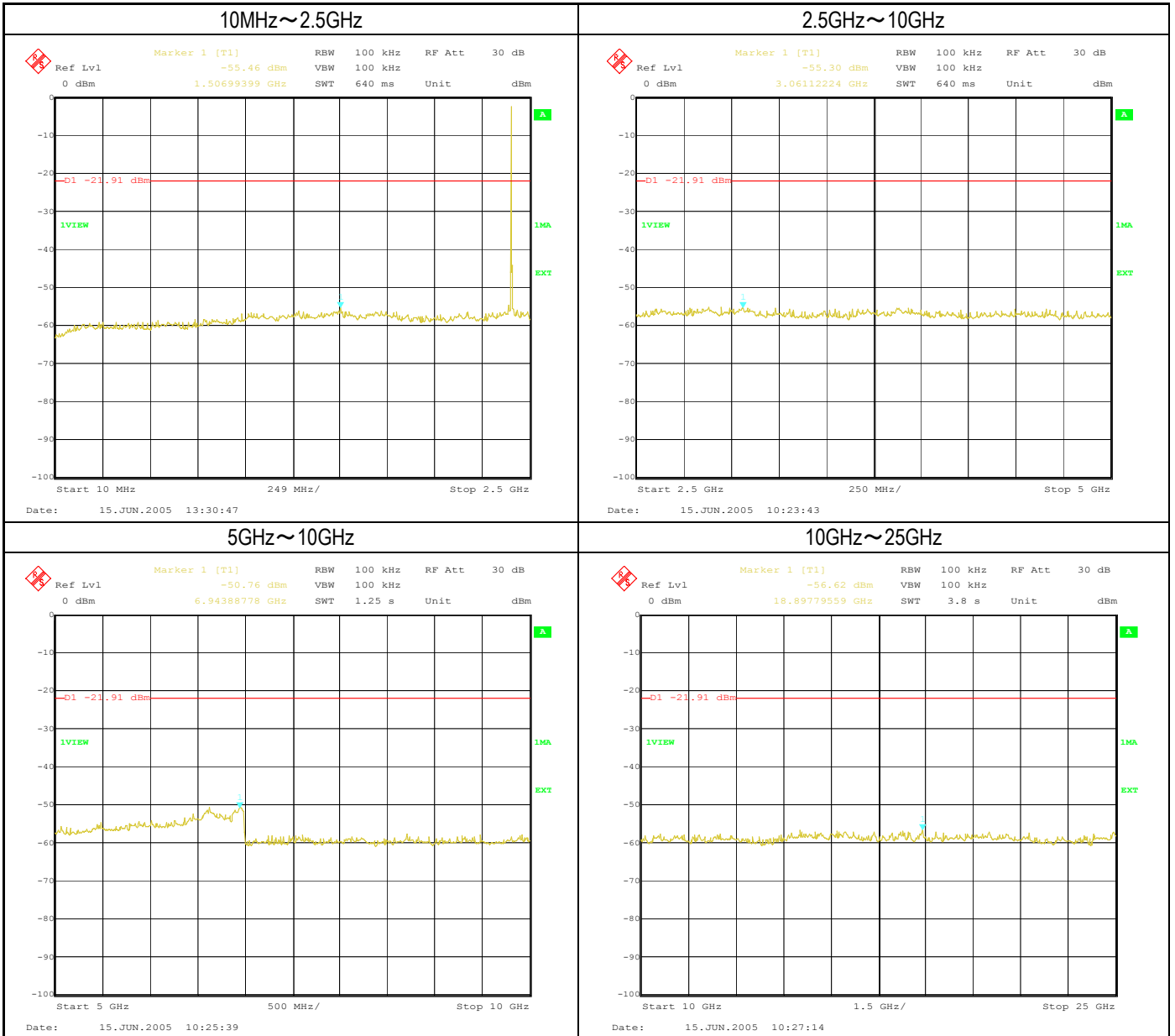
Serial No. : 10
Power : DC 3.3V
Mode : Transmitting mode , Non Frequency Hopping
Temperature : 22.7 °C
Humidity : 51.4%
Regulation : FCC Part15 C §15.247 (c)

The spectrum data are attached below. Display line indicates the 20dB offset below highest level.
It shows compliance with the requirement in part 15.247(c)

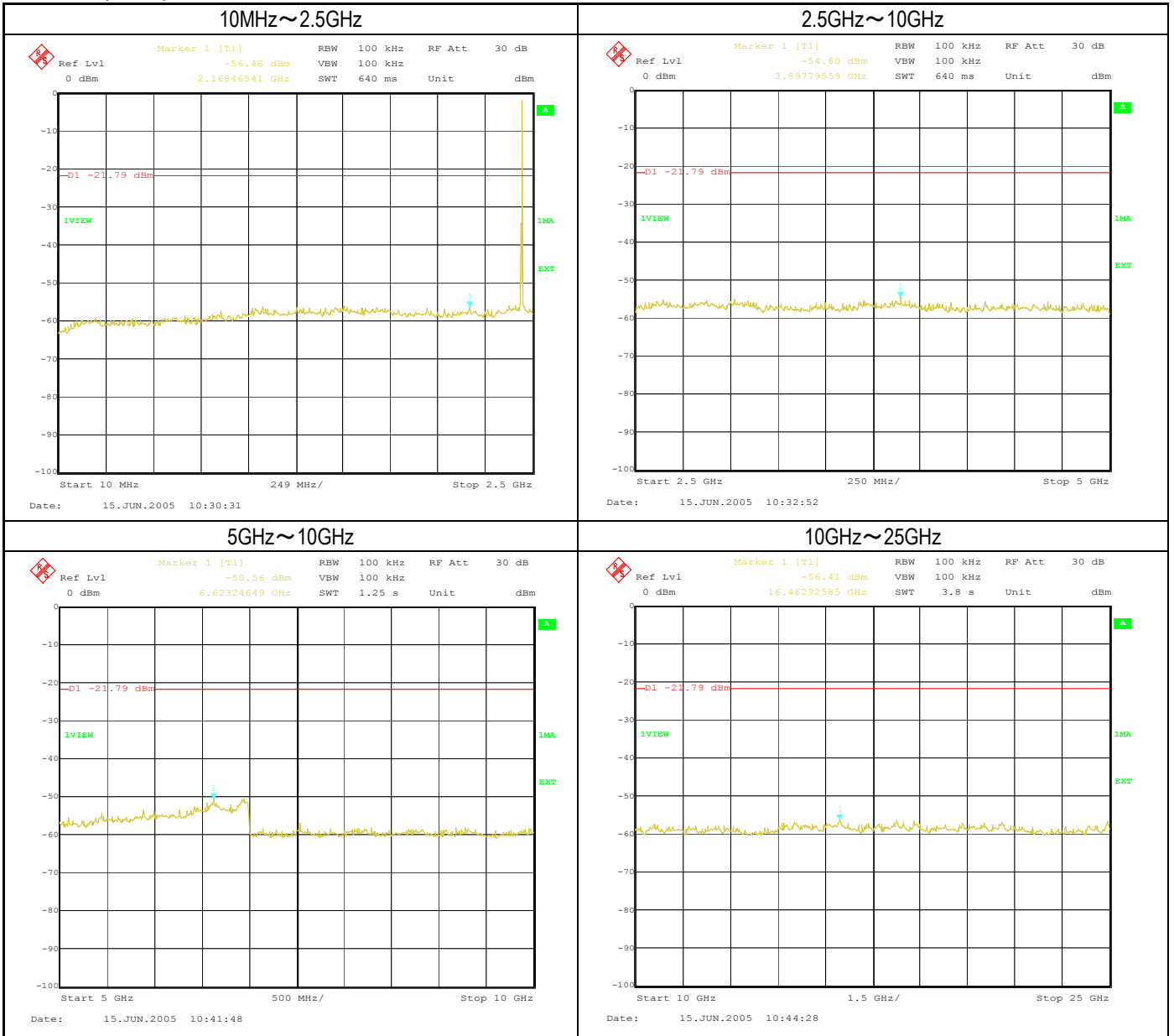
Non Frequency Hopping

(1) Operation mode: Transmitting mode

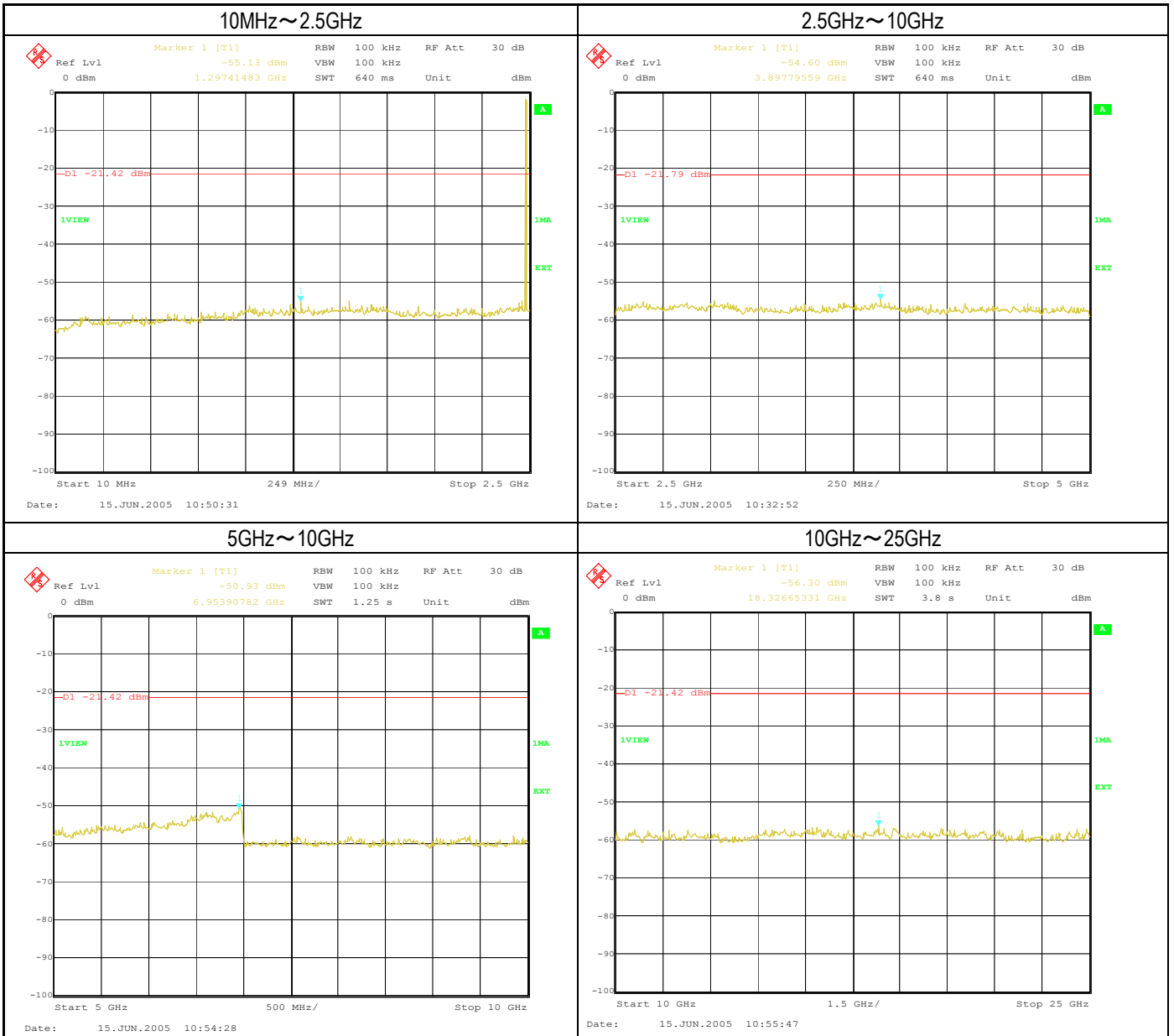
0ch(Lowest) 2402MHz



39ch(Middle) 2441MHz



78ch(Highest) 2480MHz



14 EIRP Calculation from Peak Power

15.247 (b)(5): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

EIRP Calculation :

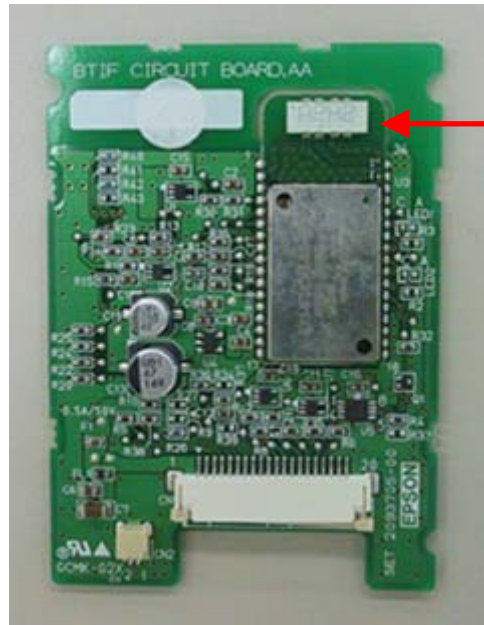
A	B	C	D	E
Specified Antenna Gain (dBi)	Minimum Cable Losses (dB)	Total Antenna Gain (dBi)	Max. RF Output Power at Antenna Terminal (dBm)	Total EIRP (dBm)
2.044	0	2.044	-0.5	1.544

Calculation : $C = A + B$, $E = C + D$

Note : Cable losses was very small and it can not measured due to the antenna and the transmitting circuit was connected by printed circuit.

EIRP = 1.544dBm = 1.427mW

15 PHOTOS OF TESTED EUT



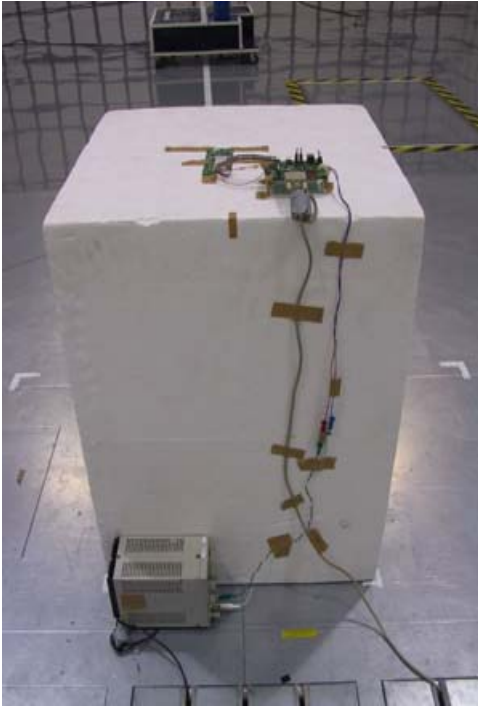
Antenna



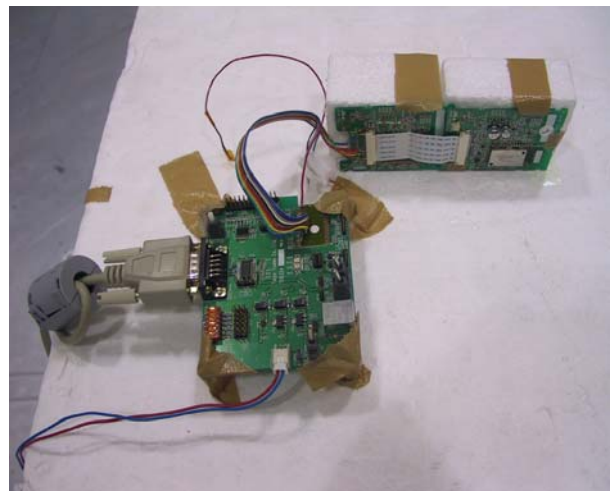
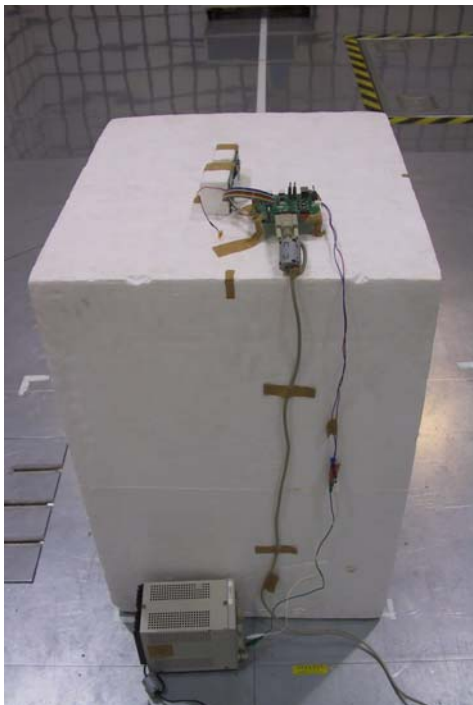
16 PHOTOS OF TEST SETUP

16.1 Photos of Radiated Measurement

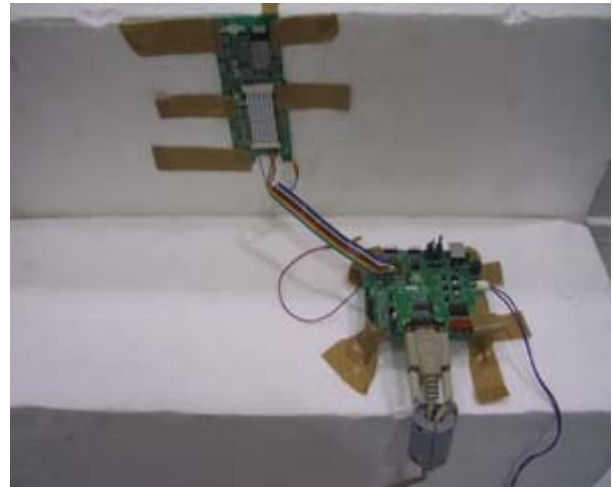
Axial Direction : XY-Plane



Axial Direction : YZ-Plane



Axial Direction : ZX-Plane



16.2 Photos of Conducted Measurement

