



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## Test Report for FCC

FCC ID:X59-HRM-3200

Report Number		ESTF151503-001	
Applicant	Company name	H3 SYSTEM Co., Ltd.	
	Address	3F, 397-27, Doryong-dong, Yuseong-gu, Daejeon, R.O.Korea	
	Telephone	82-42-862-9314	
	Contact person	Young-Hwa Kim	
Product	Product name	Heart Rate Monitor	
	Model No.	HRM-3200	Manufacturer H3 SYSTEM Co., Ltd.
	Serial No.	NONE	Country of origin KOREA
Test date	2015-02-23 ~ 2015-02-27		Date of issue 6-Mar-15
Testing location	ESTECH Co., Ltd. 97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea		
Standard	FCC PART 15 Subpart C (15.247):2010 , ANSI C 63.4(2009) , KDB 558074 D01(2014)		
Measurement facility registration number		659627	
Tested by	Engineer S.Y.Lee		(Signature)
Reviewed by	Engineering Manager J.M.Yang		(Signature)
Abbreviation	OK, Pass = Passed, Fail = Failed, N/A = not applicable		
<p>* Note</p> <ul style="list-style-type: none"><li>- This test report is not permitted to copy partly without our permission</li><li>- This test result is dependent on only equipment to be used</li><li>- This test result based on a single evaluation of one sample of the above mentioned</li></ul>			



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## Contents

1. Laboratory Information .....	3
2. Description of EUT .....	4
3. Test Standards .....	5
4. Measurement condition .....	6
5. DTS bandwidth .....	10
5.1 Test procedure .....	10
5.2 Test instruments and measurement setup .....	10
5.3 Measurement results .....	10
5.4 Trace data .....	11
6. Maximum Peak Output Power .....	13
6.1 Test procedure .....	13
6.2 Test instruments and measurement setup .....	13
6.3 Measurement results .....	13
7. Maximum conducted (average) output power .....	14
7.1 Test procedure .....	14
7.2 Test instruments and measurement setup .....	14
7.3 Measurement results .....	14
7.4 Trace data(Peak, Average).....	15
8. Maximum power spectral density level in the fundamental emission .....	18
8.1 Test procedure .....	18
8.2 Test instruments and measurement setup .....	18
8.3 Measurement results .....	18
8.4 Trace data .....	19
9. Emissions in non-restricted frequency bands .....	21
9.1 Test procedure .....	21
9.2 Test instruments and measurement setup .....	21
9.3 Measurement results .....	21
9.4 Trace data of band-edge & out of emissioin .....	22
10. Measurement of radiated emission .....	26
10.1 Measurement equipment .....	26
10.2 Environmental conditions .....	26
10.3 Measurement Instrument setting for Radiated Emission .....	27
10.4 Test Data for Bluetooth (LE).....	28
11. Measurement of conducted emission .....	36
11.1 Measurement equipment .....	36
11.2 Environmental conditions .....	36
11.3 Test Data for Bluetooth (LE).....	37
12. Photographs of test setup .....	38
12.1.Setup for Radiated Test : (30 ~ 1 000) MHz .....	38
12.2.Setup for Radiated Test : Above GHz .....	39
12.3. Setup for Conducted Test : (0.15 ~ 30) MHz.....	40
12.4. Photographs of EUT .....	41

Appendix 1. Special diagram

Appendix 2. Antenna Requirement



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 1. Laboratory Information

### 1.1 General

This EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards and is tested in accordance with the measurement procedures as indicated in this report.

ESTECH Lab attests to accuracy of test data. All measurement reported herein were performed by ESTECH Co., Ltd.

ESTECH Lab assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

### 1.2 Test Lab.

Corporation Name : ESTECH Co., Ltd.

Head Office : Rm 1015, World Venture Center II, 426-5, Gasan-dong, Geumcheon-gu, Seoul, Korea

EMC/Telecom/Safety Test Lab : 97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

### 1.3 Official Qualification(s)

MSIP : Granted Accreditation from Ministry of Information & Communication for EMC, Safety and Telecommunication

KOLAS : Accredited Lab By Korea Laboratory Accreditation Schema base on CENELEC requirements

FCC : Conformity Assessment Body(CAB) with registration number 659627 under APEC TEL MRA between the RRA and the FCC

VCCI : Granted Accreditation from Voluntary Control Council for Interference from ITE



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 2. Description of EUT

### 2.1 Summary of Equipment Under Test (Bluetooth)

Modulation Type	: Bluetooth (DSSS)
Transfer Rate	: 1 Mbps
Number of Channel	: 40 ch
PEAK Output Power	: DSSS : 0.11 mW
Rating	: INPUT : AC (100 ~ 240) V, (50 ~ 60) Hz : OUTPUT : DC 5 V, 1 000 mA
Receipt Date	: 21-Jan-15
X-tal list(s) or Frequencies generated	: The highest operating frequency is 2 480 MHz (Bluetooth) : XTAL : 16 MHz , Bluetooth : 2.4 GHz

### 2.2 General descriptions of EUT

This device is to measure heart rate and being composed of main body with sensing part, arm band, battery charger and an adaptor (Optional).

The measurement principle is based on the optics. The amount of the reflected light compared to the acting light is measured at the sensing part.

The change of the light reflectance is analyzed to calculate heart rate at the main body. Calculated pulses are displayed on the LCD screen of main body, and can be wirelessly transmitted to other devices, PC or smart phone. This device uses a rechargeable battery and can be charged through DC adapter.



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyeonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

### 3. Test Standards

#### Test Standard : FCC PART 15 Subpart C (15.247) : 2010

This Standard sets out the regulations under which an intentional, unintentional, or incidental radiator may be operated without an individual license. It also contains the technical specifications, administrative requirements and other conditions relating to the marketing of Part 15 devices.

#### Test Method : ANSI C 63.4 (2009) & KDB558074 D01(2014)

This standard sets forth uniform methods of measurement of radio-frequency (RF) signals and noise emitted from both unintentional and intentional emitters of RF energy in the frequency range 9 kHz to 40 GHz. Methods for the measurement of radiated and AC power-line conducted radio noise are covered and may be applied to any such equipment unless otherwise specified by individual equipment requirements. These methods cover measurement of certain devices that deliberately radiate energy, such as intentional emitters, but does not cover licensed transmitters. This standard is not intended for certification/approval of avionic equipment or for industrial, scientific, and medical (ISM) equipment. These methods apply to the measurement of individual units or systems comprised of multiple units.

#### Summary of Test Results

Applied Standard : 47 CFR Part 15 Subpart C				remark
Standard	Test Type	Result	Remark	Limit
15.207	AC Power Conducted Emission	Pass	Meet the requirement	
15.205 & 15.209	Restricted band / Intentional Radiated Emission	Pass	Meet the requirement	
15.247(a)(2)	6 dB Bandwidth	Pass	Meet the requirement	Min. 500 kHz
	99 % Bandwidth			
15.247(b)(3)	Maximum Peak/average output power	Pass	Meet the requirement	Max. 30 dBm
15.247(c)	Transmitter Radiated Emission	Pass	Meet the requirement	Table 15.209
15.247(e)	Power Spectral Density	Pass	Meet the requirement	Max. 8 dBm
15.247(d)	Band Edge Measurement	Pass	Meet the requirement	20 dB less



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 4. Measurement Condition

### 4.1 EUT Operation

#### a. Channel

Ch.	Frequency	Ch.	Frequency
0	2402 MHz	21	2444 MHz
1	2404 MHz	22	2446 MHz
2	2406 MHz	23	2448 MHz
3	2408 MHz	24	2450 MHz
4	2410 MHz	25	2452 MHz
5	2412 MHz	26	2454 MHz
6	2414 MHz	...	...
...	...	39	2480 MHz
20	2442 MHz		

b. Measurement Channel : Bluetooth : Low(2402 MHz), Middle(2442 MHz),High(2480 MHz)

c. Test Mode : Continuous Output, DSSS

d. Test rate : 1 Mbps



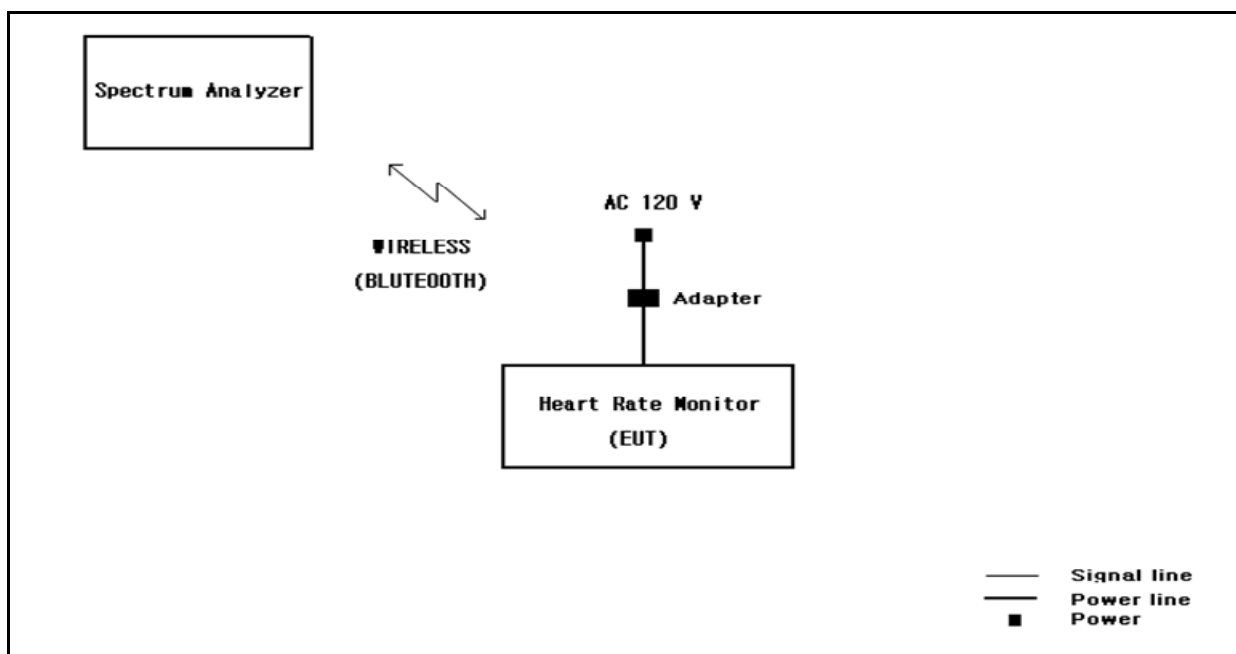
**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 4.2 EUT Operation.

- \* The EUT was in the following operation mode during all testing
- \* Execute a RF test program to enable EUT under transmission/receiving condition continuously at specific channel frequency.
- \* Transmit mode was each test.
- \* The EUT was measured up to tenth harmonic or 40 GHz of the highest operating frequencies.

## 4.3 Configuration and Peripherals





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

#### 4.4 EUT and Support equipment

Equipment Name	Model Name	S/N	Manufacturer	Remark (FCC ID)
Heart Rate Monitor	HRM-3200	NONE	H3 SYSTEM Co., Ltd.	EUT
Adapter	WL-5-1000	NONE	Shenzhenshi Wulong Dianzi chang	
Spectrum Analyzer	R3273	110600592	ADVANTEST	

#### 4.5 Cable Connecting

Start Equipment		End Equipment		Cable Standard		Remark
Name	I/O port	Name	I/O port	Length	Shielded	
Heart Rate Monitor	WIRELESS (BLUETOOTH)	Spectrum Analyzer	WIRELESS (BLUETOOTH)	-	-	
Heart Rate Monitor	POWER	ADAPTER	-	1.5	Unshielded	





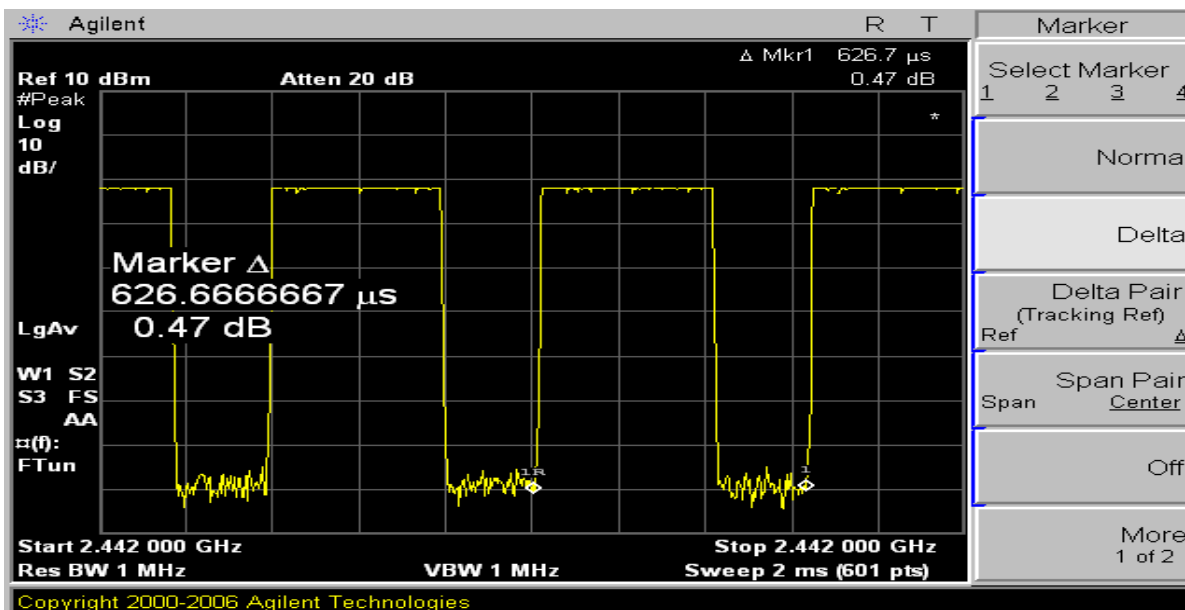
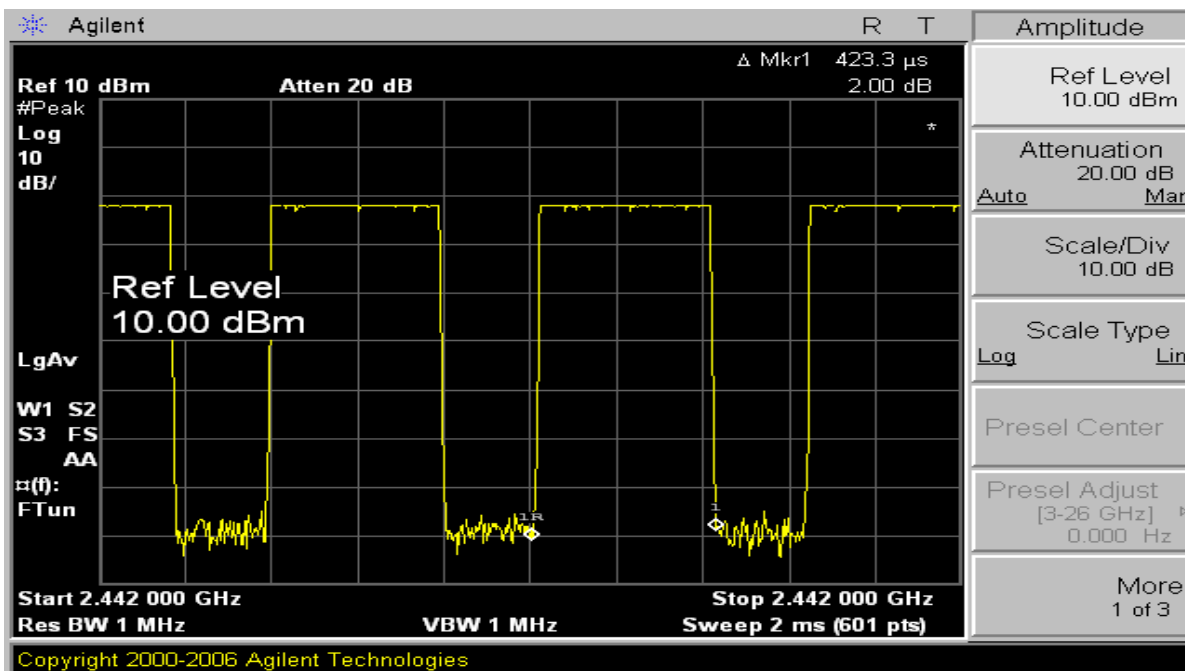
**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 4.6 DUTY CYCLE OF TEST SIGNAL

Duty cycle is < 98%, duty factor shall be considered.

duty cycle =  $0.4233/0.627=0.675$ , duty factor =  $10 \cdot \log(1/0.675)=1.707$





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 5. DTS bandwidth

### 5.1 Test procedure

558074 D01 DTS Meas Guidance v03v02 8.2 Option 2 :The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW  $\geq$  3 RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq$  6 dB.

### 5.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- . RBW= 100 KHz
- . VBW $\geq$  3 x RBW
- . Span= 5 MHz
- . Sweep= suitable duration based on the EUT specification.

Limits : FCC § 15.247(a)(2)

#### 6dB Bandwidth Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4440A	US42041291	2016-01-15
RF Cable	Length: 6cm	–	
–Spectrum Analyzer <=> EUT	Loss: 1.0dB	–	

### 5.3 Measurement results

EUT	Heart Rate Monitor	MODEL	HRM-3200
MODE	DSSS	ENVIRONMENTAL CONDITION	24.0 °C, 44.0 % R.H.
INPUT POWER	5Vd.c.		

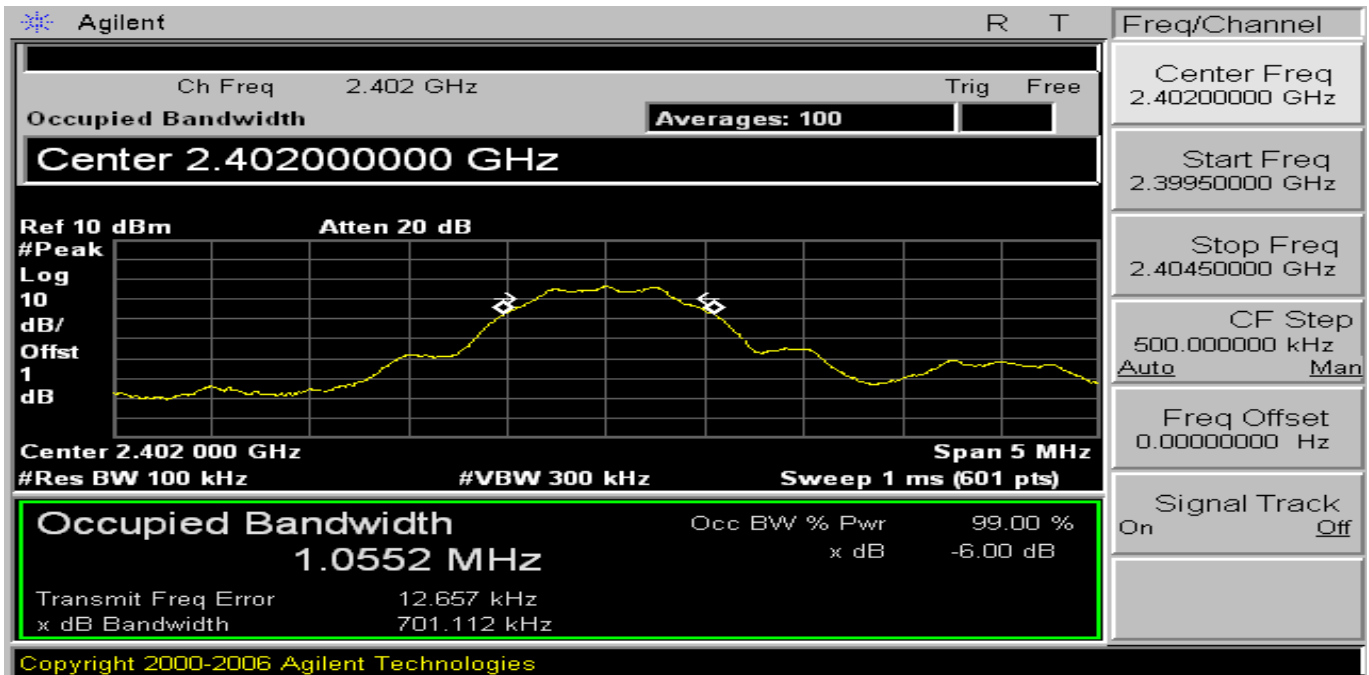
Channel Frequency (MHz)	Emission bandwidth	Bandwidth at 6dB below(MHz)	Minimum Limit (MHz)	PASS/FAIL
2402	1.05 MHz	0.70	0.5	PASS
2442	1.05 MHz	0.69	0.5	PASS
2480	1.04 MHz	0.71	0.5	PASS



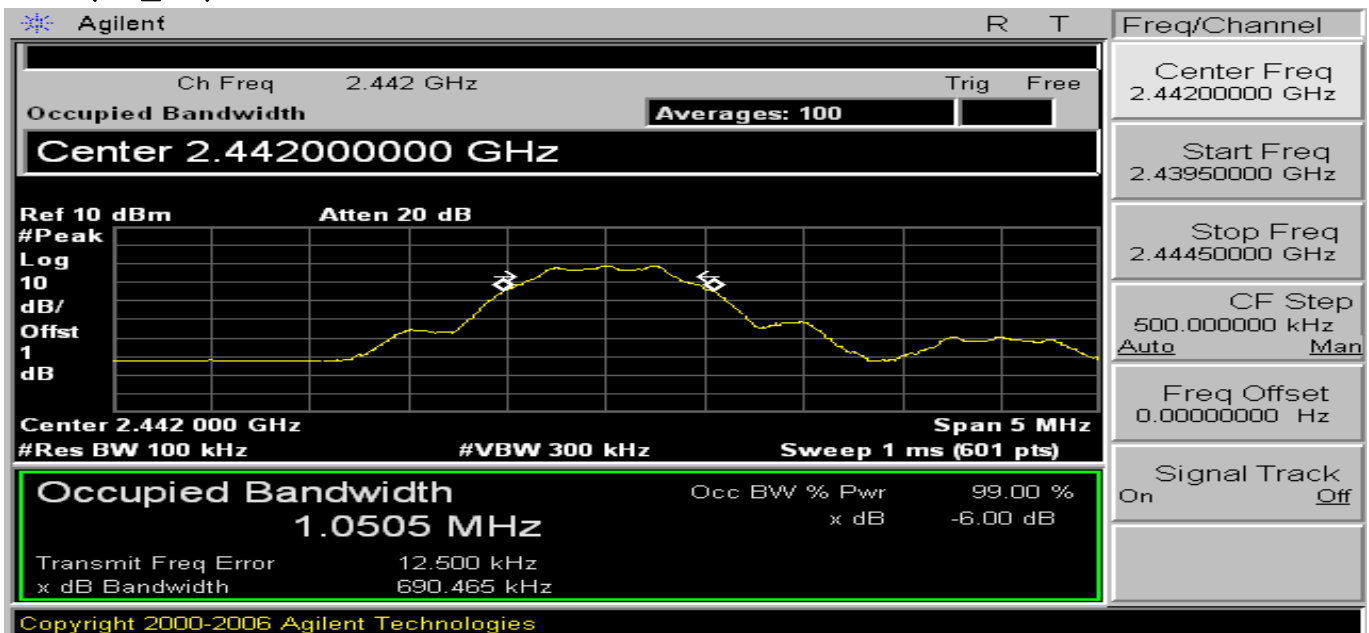
**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 5.4 Trace data (ch\_0)



## (ch\_20)

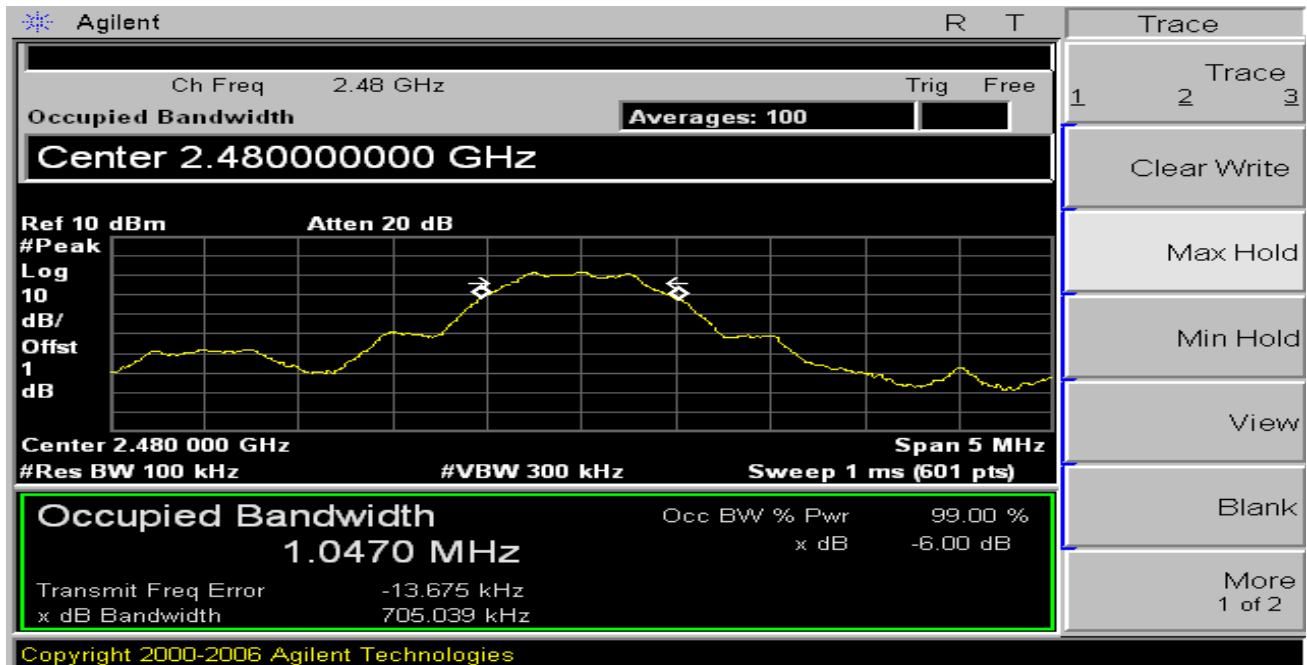




**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

(ch\_39)





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 6. Maximum peak conducted output power

### 6.1 Test procedure

KDB 558074 D01 DTS Meas Guidance V03r02 9.1.1 Integrated band power method

### 6.2 Test instruments and measurement setup

- Set the RBW = 1 MHz.
- Set VBW  $\geq 3 \times$  RBW.
- Set span  $\geq 3 \times$  RBW
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level.

Limits : FCC § 15.247

#### Maximum Peak Output Power Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4440A	US42041291	2016-01-15
RF Cable	Length: 6cm	–	
–Spectrum Analyzer <=> EUT	Loss: 1.0 dB	–	

### 6.3 Measurement results

EUT	Heart Rate Monitor	MODEL	HRM-3200
MODE	DSSS	ENVIRONMENTAL CONDITION	24.0 °C, 43.0 % R.H.
INPUT POWER	5Vd.c.		

CHANNEL	Channel frequency (MHz)	Conducted Power Output(dBm)			Limit[1W] (dBm)	PASS/FAIL
		Detector	(dBm)	(mW)		
0	2402	PEAK	-14.75	0.03	30.0	PASS
20	2442	PEAK	-12.03	0.06	30.0	PASS
39	2480	PEAK	-9.41	0.11	30.0	PASS



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 7. Maximum conducted (average) output power

### 7.1 Test procedure

KDB 558074 D01 DTS Meas Guidance V03r02 9.2.2.4 Method AVGSA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction)

### 7.2 Test instruments and measurement setup

- Measure the duty cycle,  $x$ , of the transmitter output signal as described in 6.0.
- Set span to at least 1.5 times the OBW.
- Set RBW = 1–5% of the OBW, not to exceed 1 MHz.
- Set VBW  $\geq 3 \times$  RBW.
- Number of points in sweep  $\geq 2 \times$  span / RBW. (This gives bin-to-bin spacing  $\leq$  RBW/2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
- Do not use sweep triggering. Allow the sweep to “free run”.
- Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
- Add  $10 \log (1/x)$ , where  $x$  is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add  $10 \log (1/0.25) = 6$  dB if the duty cycle is 25 %.

#### Maximum Peak Output Power Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4440A	US42041291	2016-01-15
RF Cable	Length: 6cm	–	
–Spectrum Analyzer <=> EUT	Loss: 1.0 dB	–	

### 7.3 Measurement results

EUT	Heart Rate Monitor	MODEL	HRM-3200
MODE	DSSS	ENVIRONMENTAL CONDITION	24 °C, 43 % R.H.
INPUT POWER	5Vdc		

CHANNEL	Channel frequency (MHz)	Conducted Power Output(dBm)			Measured + Duty Cycle(dBm)	Measured + Duty Cycle(mW)
		Detector	(dBm)	Duty Cycle		
0	2402	AVG	–17.49	0.675	–16.803	0.021
20	2442	AVG	–14.4	0.675	–13.713	0.043
39	2480	AVG	–11.77	0.675	–11.083	0.078



**Estech Co., Ltd.**

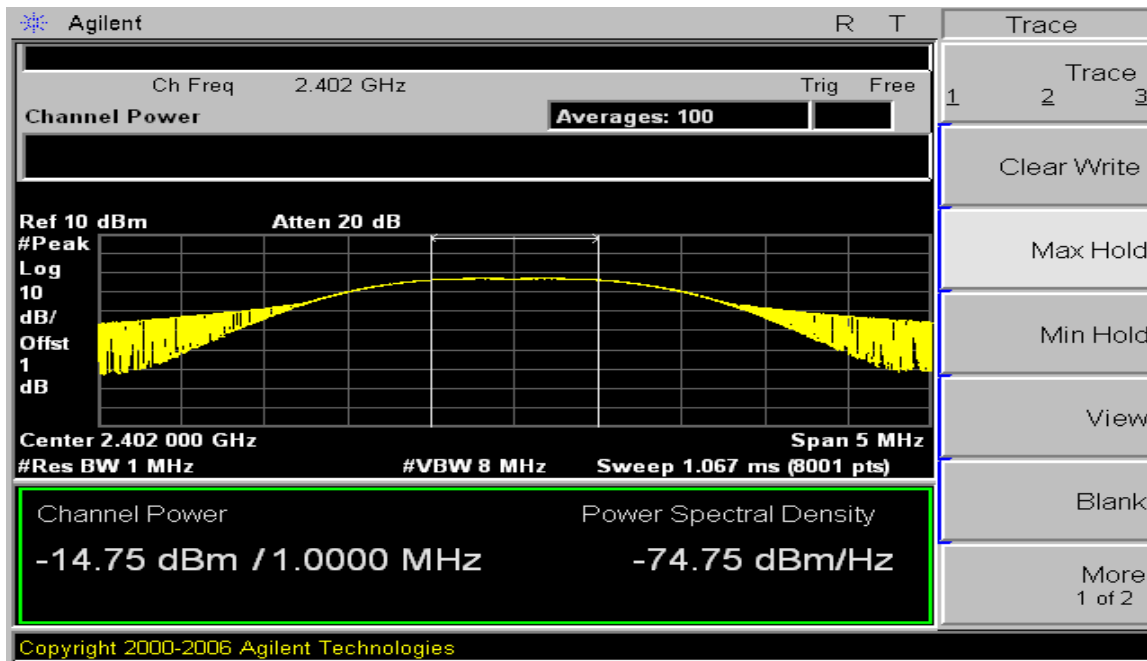
97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyeonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

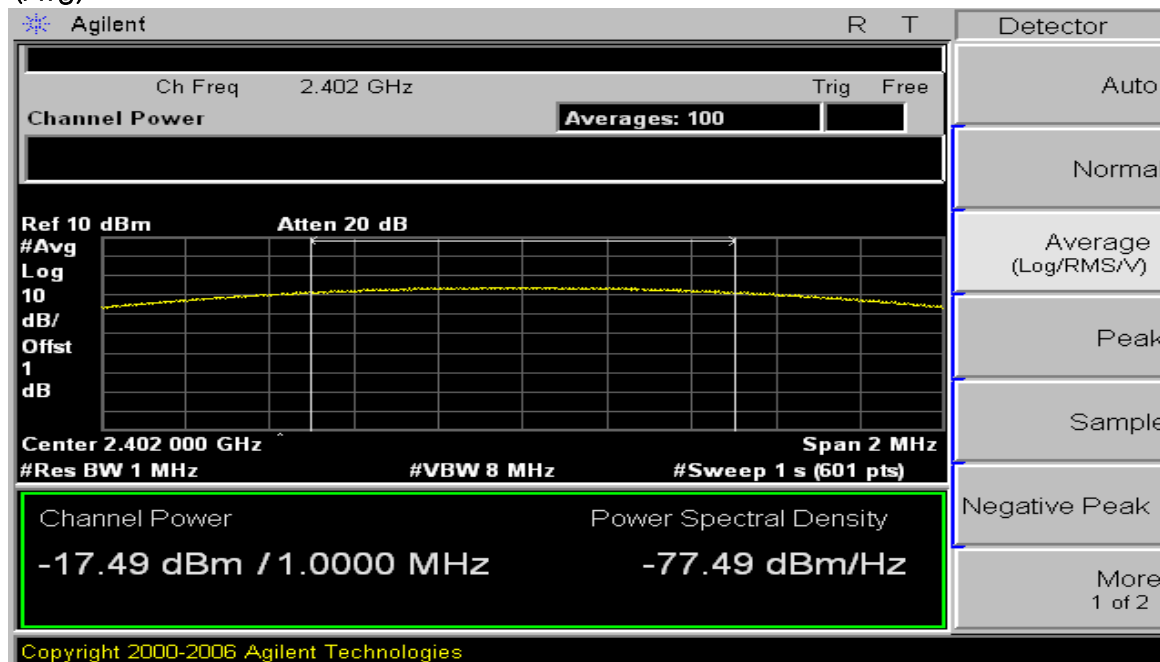
## 7.4 Trace data (Peak, Average)

(ch\_0)

(Peak)



(Avg)





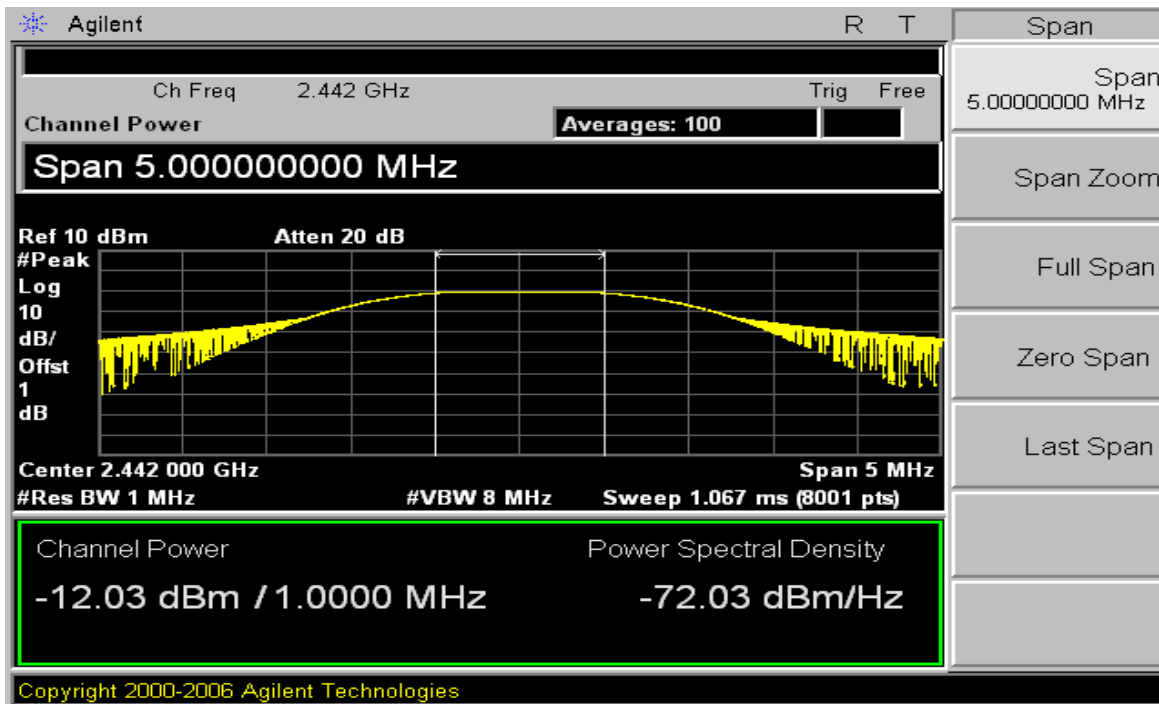
**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

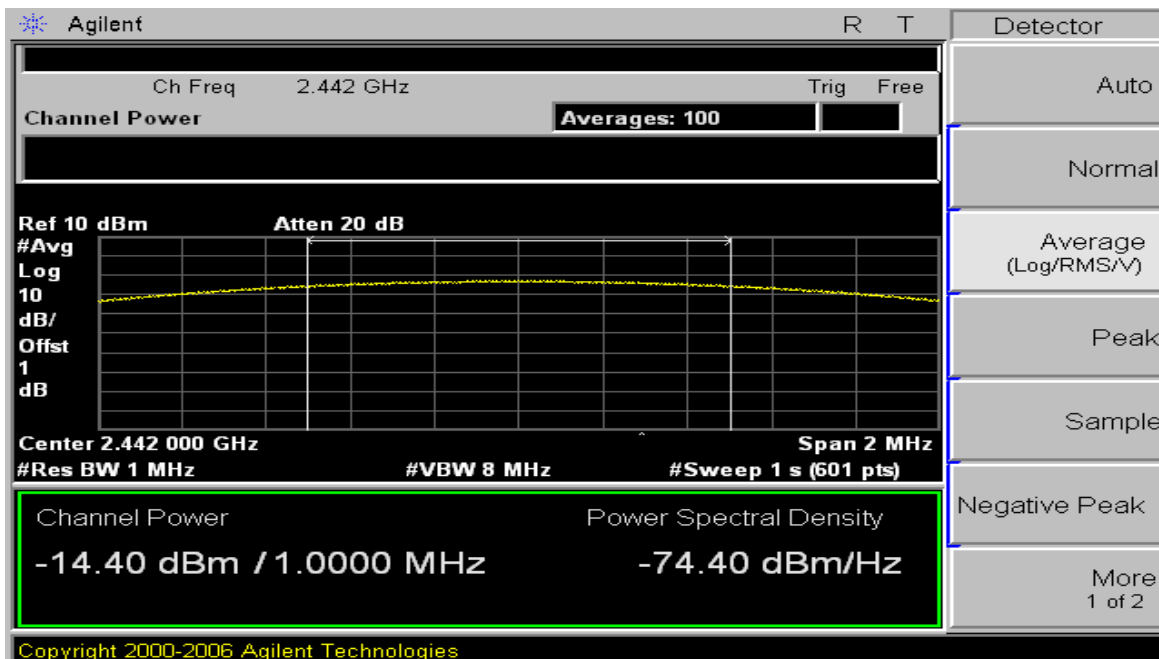
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

(ch\_20)

(Peak)



(Avg)





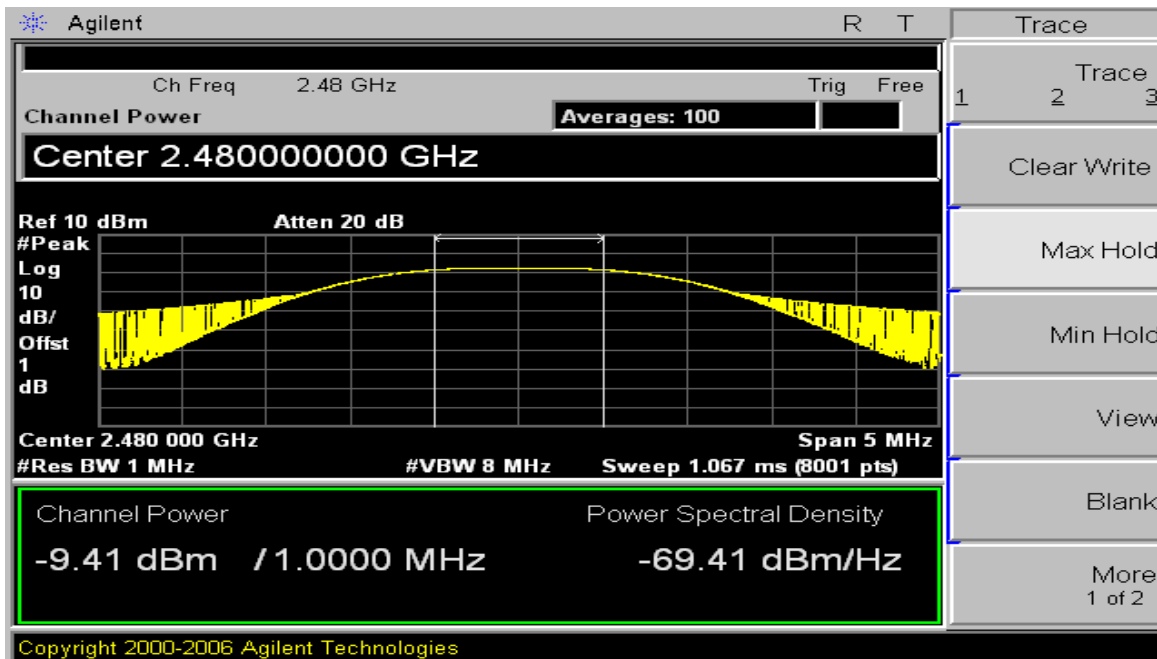


**Estech Co., Ltd.**

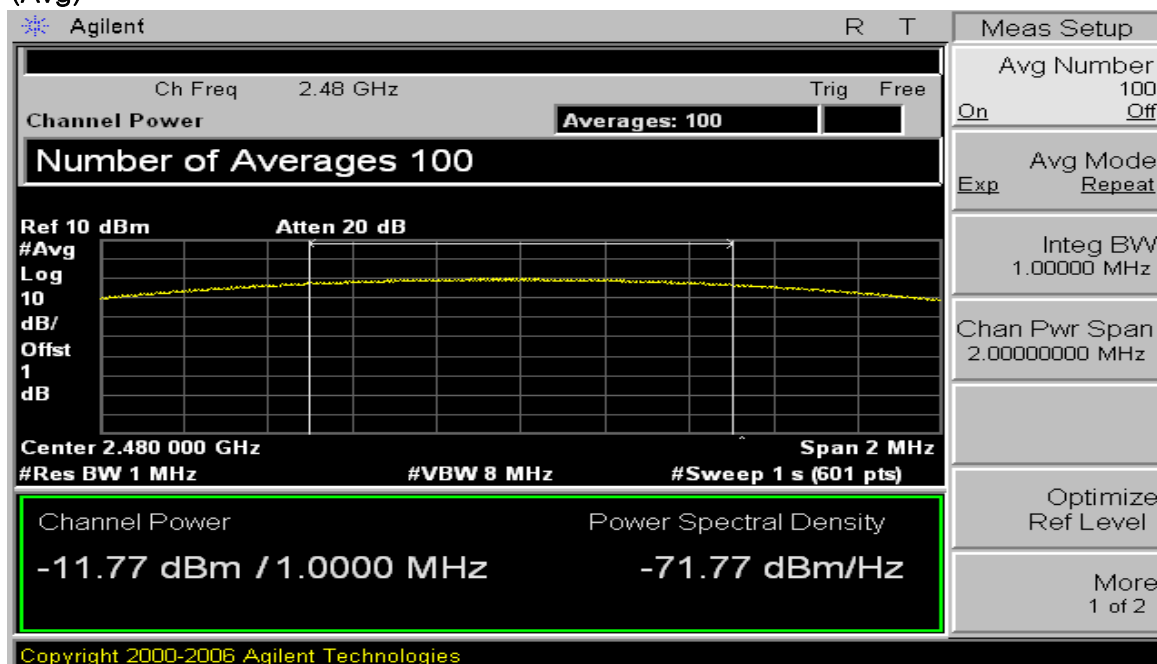
97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

(ch\_39)

(Peak)



(Avg)





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 8. Maximum power spectral density level in the fundamental emission

### 8.1 Test procedure

KDB 558074 D01 DTS Meas Guidance V03r02 10.2 Method PKPSD (peak PSD)

### 8.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- Set the VBW  $\geq 3 \times \text{RBW}$ .
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Limits FCC § 15.247

The peak power density Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E440A	US42041291	2016-01-15
RF Cable	Length: 6cm	—	
—Spectrum Analyzer <=> EUT	Loss: 1.0 dB	—	

### 8.3 Measurement results

EUT	Heart Rate Monitor	MODEL	HRM-3200
MODE	DSSS	ENVIRONMENTAL CONDITION	23.0 °C, 43.0 % R.H.
INPUT POWER	5Vd.c.		

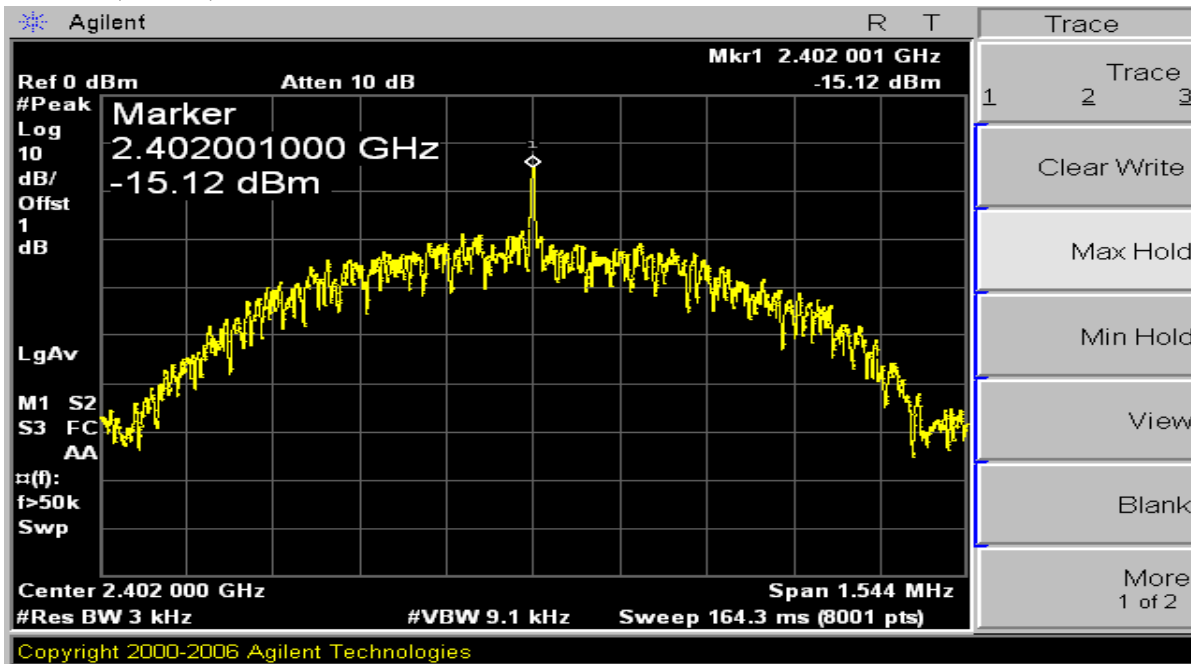
CHANNEL	Channel Frequency (MHz)	Measured Power Spectral Density (dBm)	Maximum Permissible Power Density (dBm/3kHz)	Margin
0	2402	-15.12	8.0	23.12
20	2442	-12.38	8.0	20.38
39	2480	-9.59	8.0	17.59



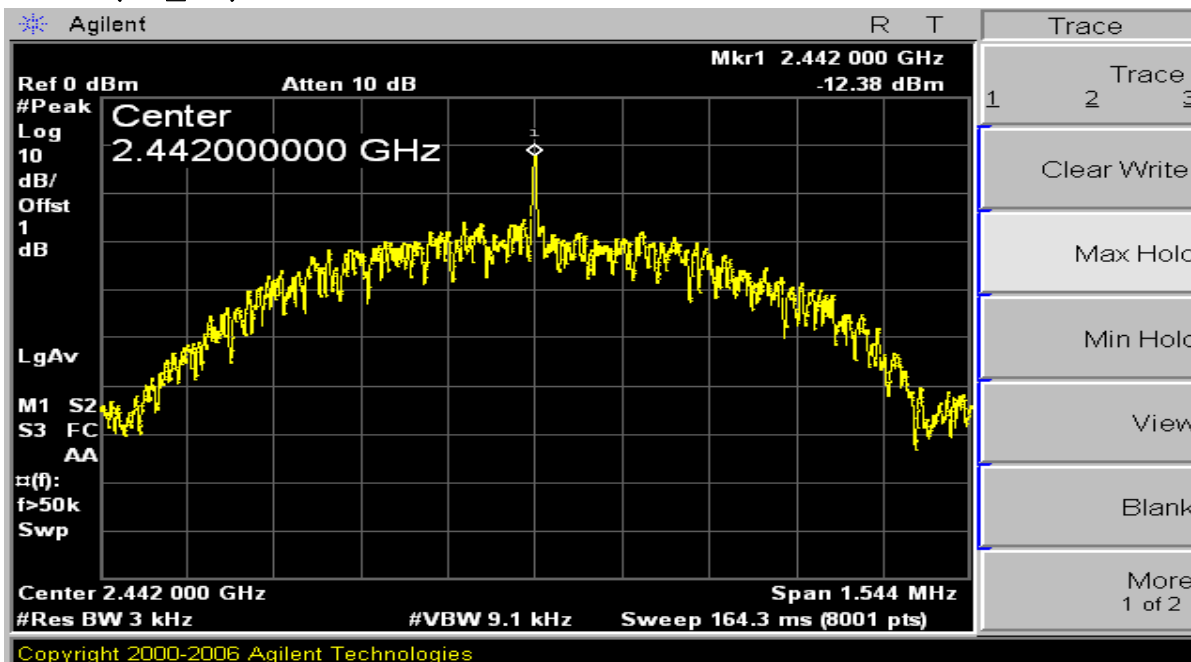
**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 8.4 Trace data (ch\_0)



## (ch\_20)



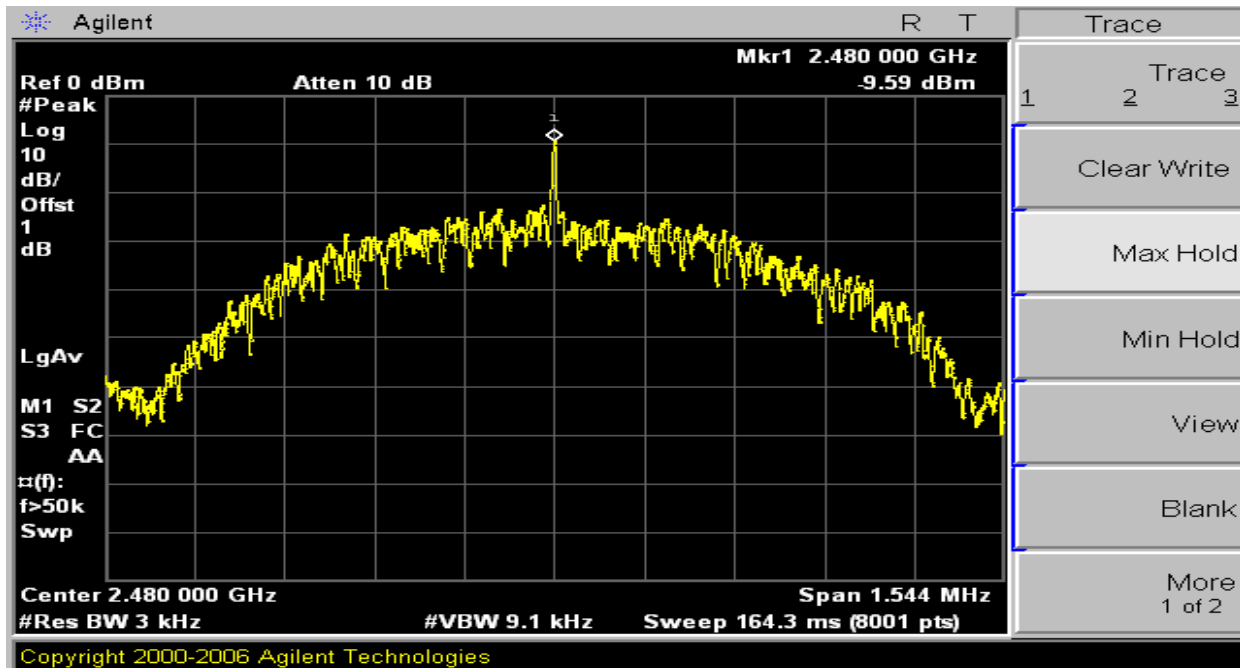


Estech Co., Ltd.

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

(ch\_39)





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 9. Emissions in non-restricted frequency bands

### 9.1 Test procedure

KDB 558074 D01 DTS Meas Guidance V03r02 11.0 Emissions in non-restricted frequency

### 9.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- Set instrument center frequency to DTS channel center frequency.
- Set the span to  $\geq 1.5$  times the DTS bandwidth.
- Set the RBW = 100 kHz.
- Set the VBW  $\geq 3 \times$  RBW.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum PSD level.

Limits FCC § 15.247

#### Band Edge&Out of Emission Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4440A	US42041291	2016-01-15
Spectrum Analyzer	FSV40	100939	2016-01-19
RF Cable	Length: 6cm		—
—Spectrum Analyzer $\Leftrightarrow$ EUT	Loss: 1.0dB		—

### 9.3 Measurement results of band-edge & out of emission

EUT	Heart Rate Monitor	MODEL	HRM-3200
MODE	DSSS	ENVIRONMENTAL CONDITION	23.0 °C, 43.0 % R.H
INPUT POWER	5Vd.c.		

CHANNEL	Channel Frequency (MHz)	limit	PASS/FAIL
0	2402	20dBc	PASS
39	2480	20dBc	PASS

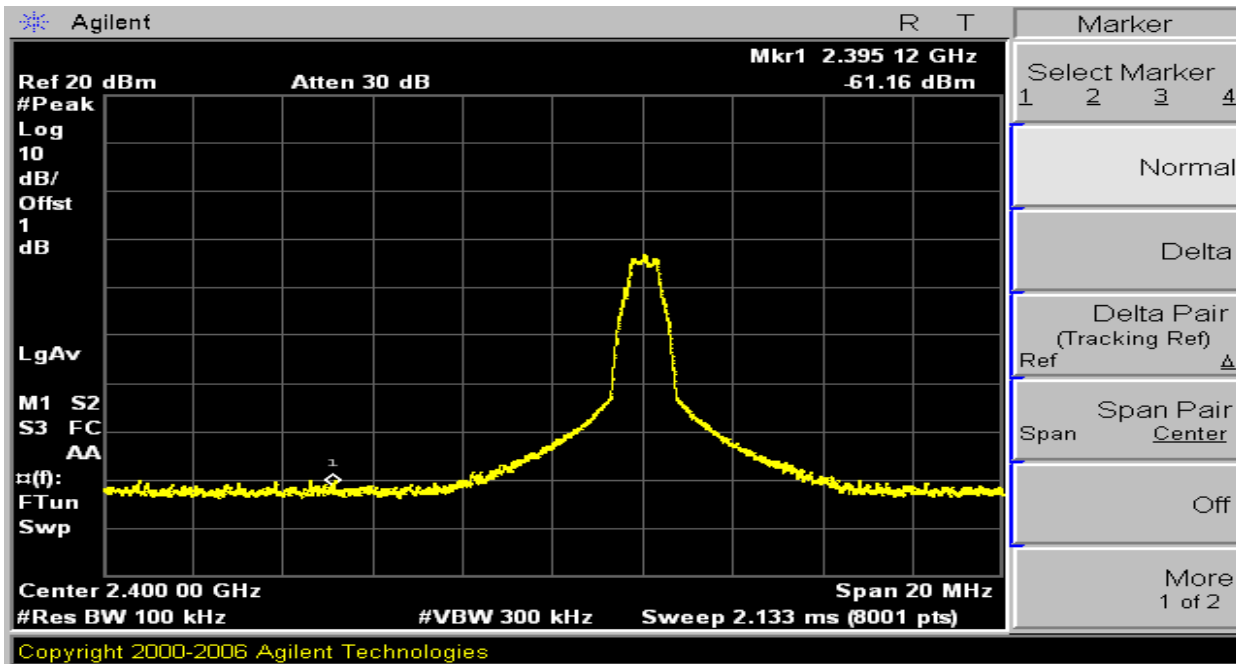


Estech Co., Ltd.

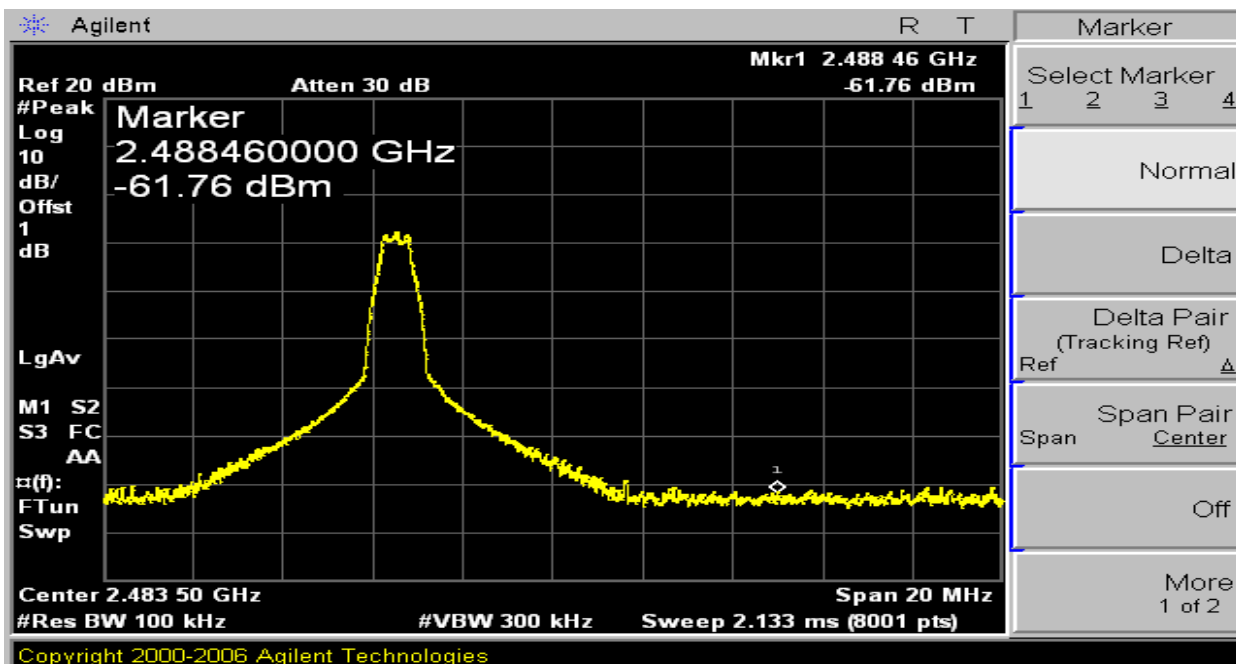
97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 9.4 Trace data of band-edge & Out of Emission (ch\_0)



(ch\_39)



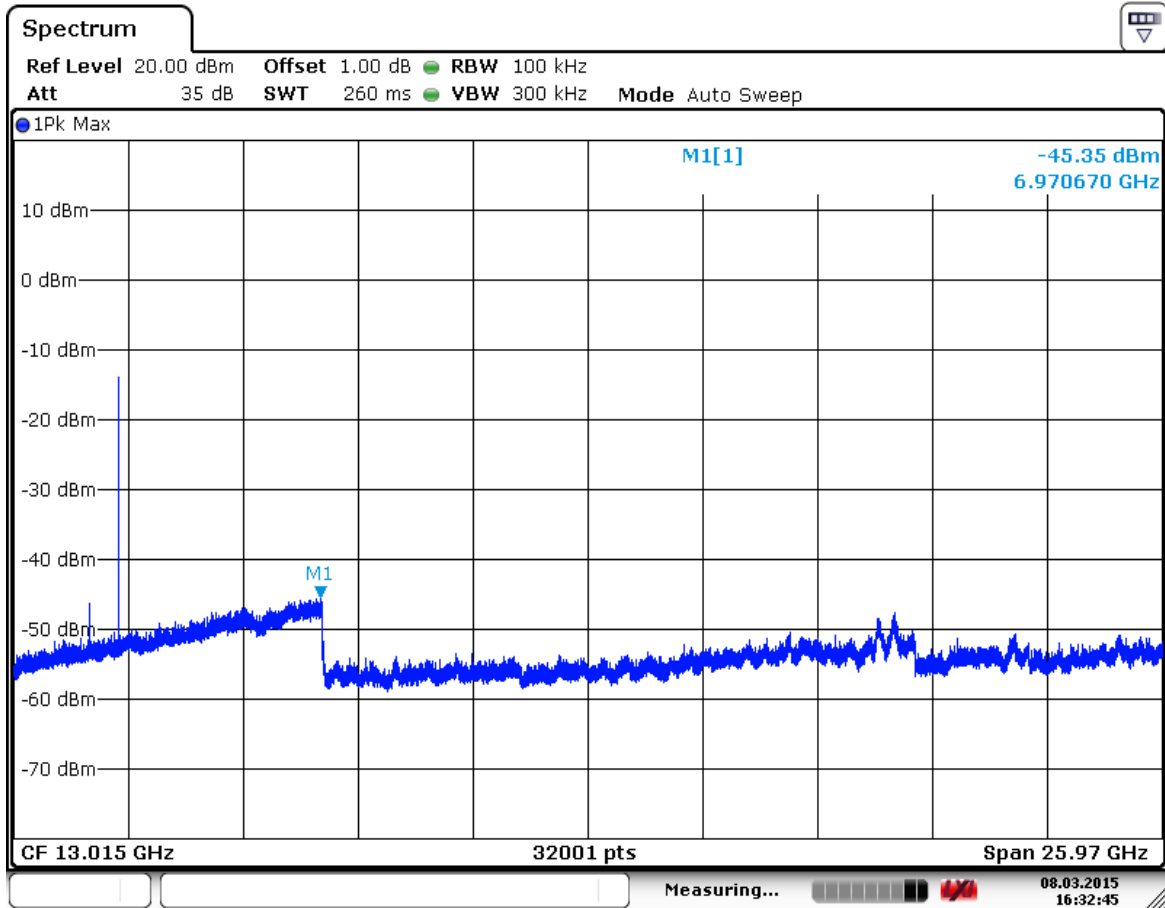


**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

(ch\_0)



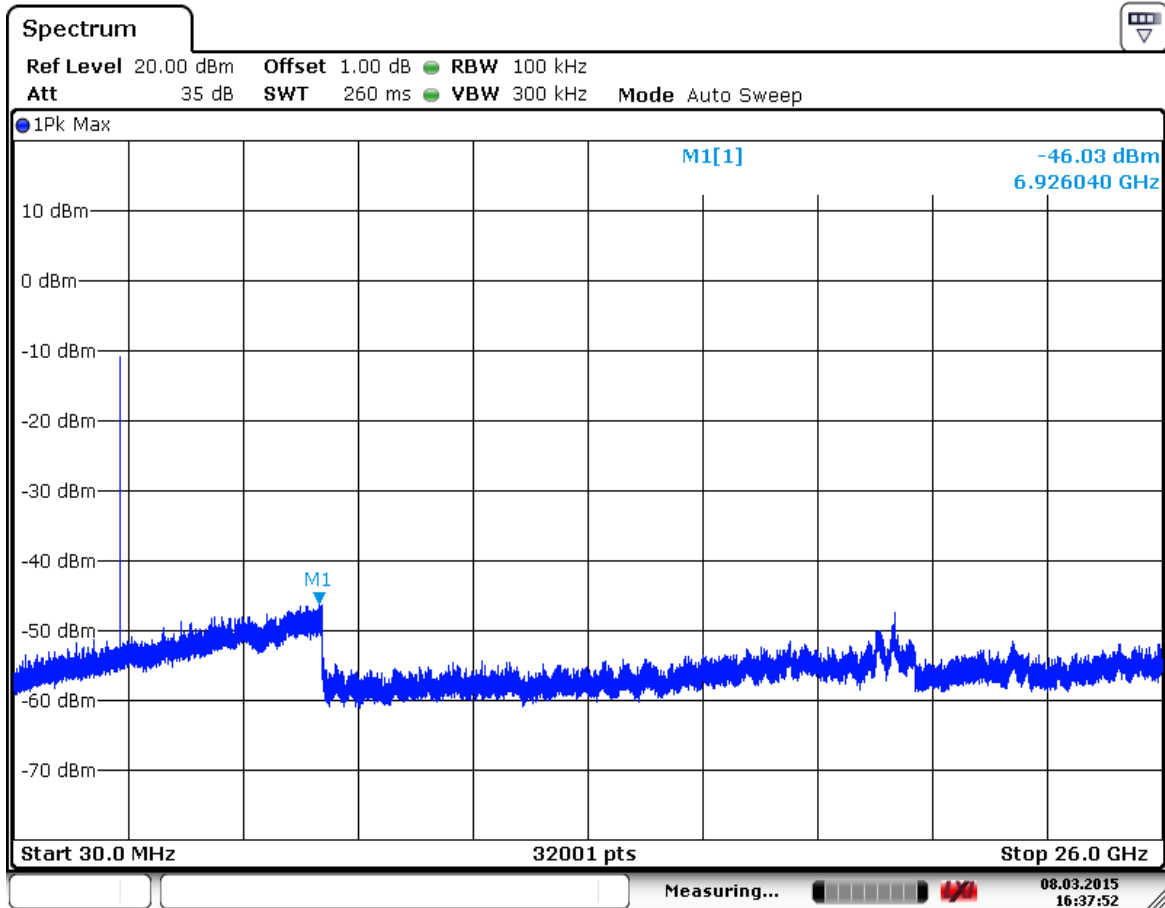


**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

(ch\_20)





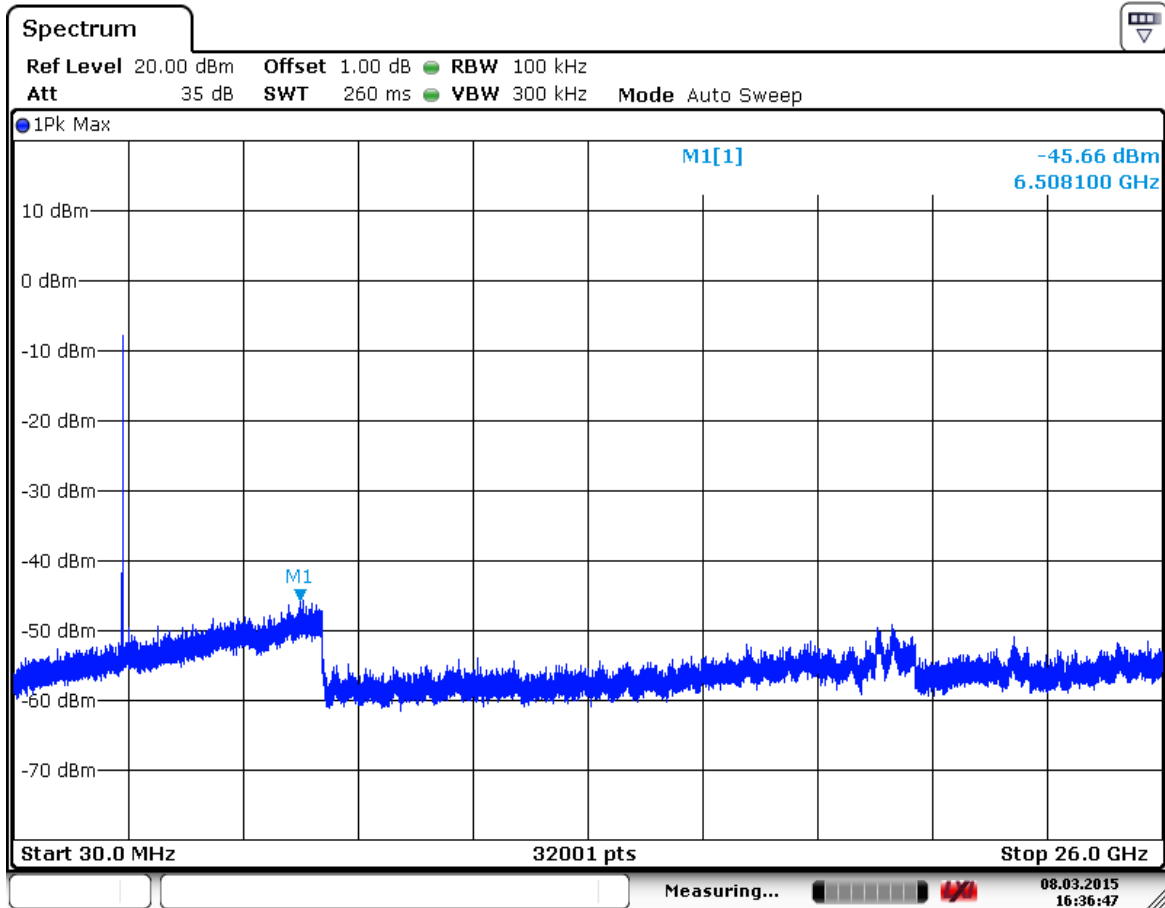


**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

(ch\_39)





## 10. Measurement of radiated disturbance

Above 30 MHz Electric Field strength was measured in accordance with FCC PART 15.205, 15.209 . The test setup was made according to ANSI C 63.4 (2009) & KDB 558074 D01 Semi-anechoic chamber, which allows a 3 m distance measurement. The EUT was placed in the center of styrofoam. turntable. The height of this table was 0.8 m. The measurement was conducted with both horizontal and vertical antenna polarization. The turntable has fully rotated. For further description of the configuration refer to the picture of the test setup.

### 10.1 Measurement equipments

Equipment Name	Type	Manufacturer	Serial No.	Next Calibration date
TEST Receiver	ESC17	ROHDE & SCHWARZ	100916	13-Jan-16
Logbicon Antenna	VULB 9168	SCHWARZBECK	193	18-Sep-15
Turn Table	DT3000-2t	Innco System GmbH	N/A	-
Antenna Mast	MA4000-EP	Innco System GmbH	N/A	-
PREAMPLIFIER	8449B	AGILENT	3008A00595	13-Jan-16
Horn Antenna	BBHA9120D	SCHWARZBECK	469	16-Oct-15
Test Receiver	ESPI7	ROHDE & SCHWARZ	100185	13-Jan-16
Spectrum Analyzer	R3273	ADVANTEST	110600592	13-Jan-16
Turn Table	DT1500-S	Innco System GmbH	N/A	-
Antenna Mast	MA4000-EP	Innco System GmbH	N/A	-
Pyramidal Horn Antenna	3160-09-01	EST-LINDGREN	102642	14-Nov-15
Antenna Master & Turn table controller	C02000-P	Innco System GmbH	CO2000/642 /28051111/L	-

### 10.2 Environmental Condition

Below 1 GHz -Test Place : 10 m Semi-anechoic chamber

#### Bluetooth LE Mode

Temperature (°C) : 21.7 °C

Humidity (% R.H.) : 44.8 % R.H.

Above 1 GHz-Test Place : 3 m Semi-anechoic chamber

#### Bluetooth LE Mode

Temperature (°C) : 23.4 °C

Humidity (% R.H.) : 48.6 % R.H.



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 10.3 Measurement Instrument setting for Radiated Emission

### 10.3.1 Frequency range below 1 GHz

Detector : Quasi-Peak

### 10.3.2 Frequency range above 1 GHz

#### Peak Power Measurement Procedure (KDB 558074 section 12.2.4)

- a. RBW : 1 MHz , VBW : 3 MHz
- b. Trace mode = max hold
- c. Detector : Peak
- d. Sweep time = auto

#### Average Power Measurement Procedures (KDB 558074 section 12.2.5.3)

- a. Set analyzer center frequency to the frequency associated with the emission
- b. RBW : 1 MHz , VBW : 1 kHz
- c. Detector : Peak
- d. Sweep time = auto

Note

Band	Duty cycle(%)	Ton (ms)	Ton + Toff (ms)	DCF=10*log(1/Duty) (dB)
Bluetooth	67.5	0.423	0.627	1.71

\*This was applied of duty cycle factor for average value because of measured with the EUT transmitting continuously less than 98% duty cycle at its maximum power control level.

**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 10.4 Test Data for Bluetooth (LE)

Test Date : 23-Feb-15

Measurement Distance : 3 m

Frequency (MHz)	Reading (dBμV)	Position (V/H)	Height (m)	Correction Factor		Result Value		
				Ant Factor (dB)	Cable (dB)	Limit (dBμV/m)	Result (dBμV/m)	Margin (dB)
38.70	12.48	V	1.0	12.97	1.09	40.00	26.54	13.46
71.20	12.91	V	1.0	11.50	1.46	40.00	25.87	14.13
94.70	13.02	V	1.0	8.27	1.68	43.50	22.97	20.53
154.00	10.34	V	1.0	13.12	2.13	43.50	25.59	17.91
268.00	7.14	H	4.0	12.42	2.79	46.00	22.35	23.65
292.00	11.73	V	1.0	13.24	2.91	46.00	27.88	18.12
350.00	8.25	H	2.0	14.78	3.22	46.00	26.25	19.75
358.00	10.48	H	2.5	14.90	3.24	46.00	28.62	17.38
389.90	14.22	H	2.0	15.42	3.35	46.00	32.99	13.01
416.00	12.72	H	2.0	15.98	3.47	46.00	32.17	13.83
944.20	3.30	H	1.0	23.95	5.34	46.00	32.59	13.41
Remark	H : Horizontal, V : Vertical TEST MODE : Bluetooth - LE (CH : 20 - 2 442 MHz) *Checked in all 3 axis and the maximum measured data were reported.( Worst data is Z axis of position) *CL = Cable Loss(In case of below 1 000 MHz) *Result Value = Reading + Ant Factor + Cable loss *The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection at frequency below 1 GHz.							



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyeonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 10.4-1 Test Data for Bluetooth (LE)

Test Date : 23-Feb-15

Measurement Distance : 3 m

Frequency (MHz)	Reading (dB $\mu$ V)	Position (V/H)	Height (m)	Correction Factor		Duty Cycle Correction(dB)	Result Value		
				Ant Factor (dB)	Cable (dB)		Limit (dB $\mu$ V/m)	Result (dB $\mu$ V/m)	Margin (dB)
PEAK(RBW: 1 MHz    VBW: 3 MHz)									
2359.60	26.26	H	1.0	26.54	5.62	0.00	74.00	58.42	15.58
2366.00	26.53	V	1.0	26.55	5.62	0.00	74.00	58.70	15.30
2390.00	24.39	H	1.0	26.59	5.62	0.00	74.00	56.60	17.40
2390.00	25.64	V	1.0	26.59	5.62	0.00	74.00	57.85	16.15
4804.00	45.69	H	1.0	30.72	-24.20	0.00	74.00	52.21	21.79
4804.00	44.61	V	1.0	30.72	-24.20	0.00	74.00	51.13	22.87
AV(RBW: 1 MHz    VBW: 1 kHz)									
2359.60	13.28	H	1.0	26.54	5.62	1.71	54.00	47.15	6.85
2366.00	13.17	V	1.0	26.55	5.62	1.71	54.00	47.05	6.95
2390.00	13.13	H	1.0	26.59	5.62	1.71	54.00	47.05	6.95
2390.00	13.41	V	1.0	26.59	5.62	1.71	54.00	47.33	6.67
4804.00	32.88	H	1.0	30.72	-24.20	1.71	54.00	41.11	12.89
4804.00	32.93	V	1.0	30.72	-24.20	1.71	54.00	41.16	12.84
Remark	H : Horizontal,    V : Vertical    TEST MODE : Bluetooth – LE (CH : 0 – 2 402 MHz)								
	*The TX signal wasn't detected from 3th harmonics. *Checked in all 3 axis and the maximum measured data were reported.( Worst data is Z axis of position) *Total = Reading Value + Antenna Factor + Cable Loss – Amp Gain + Duty Cycle Correction  FYI a. Ton Time : 0.423 ms b. duty cycle : 67.5 % c. DCF : 1.707 dB								



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyeonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 10.4-2 Test Data for Bluetooth (LE)

Test Date : 23-Feb-15

Measurement Distance : 3 m

Frequency (MHz)	Reading (dBμV)	Position (V/H)	Height (m)	Correction Factor		Duty Cycle Correction(dB)	Result Value		
				Ant Factor (dB)	Cable (dB)		Limit (dBμV/m)	Result (dBμV/m)	Margin (dB)
PEAK(RBW: 1 MHz    VBW: 3 MHz)									
4884.00	44.67	H	1.0	30.86	-23.96	0.00	74.00	51.56	22.44
4884.00	44.23	V	1.0	30.86	-23.96	0.00	74.00	51.12	22.88
AV(RBW: 1 MHz    VBW: 1 kHz)									
4884.00	32.15	H	1.0	30.86	-23.96	1.71	54.00	40.75	13.25
4884.00	32.84	V	1.0	30.86	-23.96	1.71	54.00	41.44	12.56
Remark	H : Horizontal,    V : Vertical    TEST MODE : Bluetooth – LE (CH : 20 – 2 442 MHz)								
	*The TX signal wasn't detected from 3th harmonics.								
	*Checked in all 3 axis and the maximum measured data were reported.( Worst data is Z axis of position)								
	*Total = Reading Value + Antenna Factor + Cable Loss – Amp Gain + Duty Cycle Correction								
	FYI a. Ton Time : 0.423 ms b. duty cycle : 67.5 % c. DCF : 1.707 dB								



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

### 10.4-3 Test Data for Bluetooth (LE)

Test Date : 23-Feb-15

Measurement Distance : 3 m

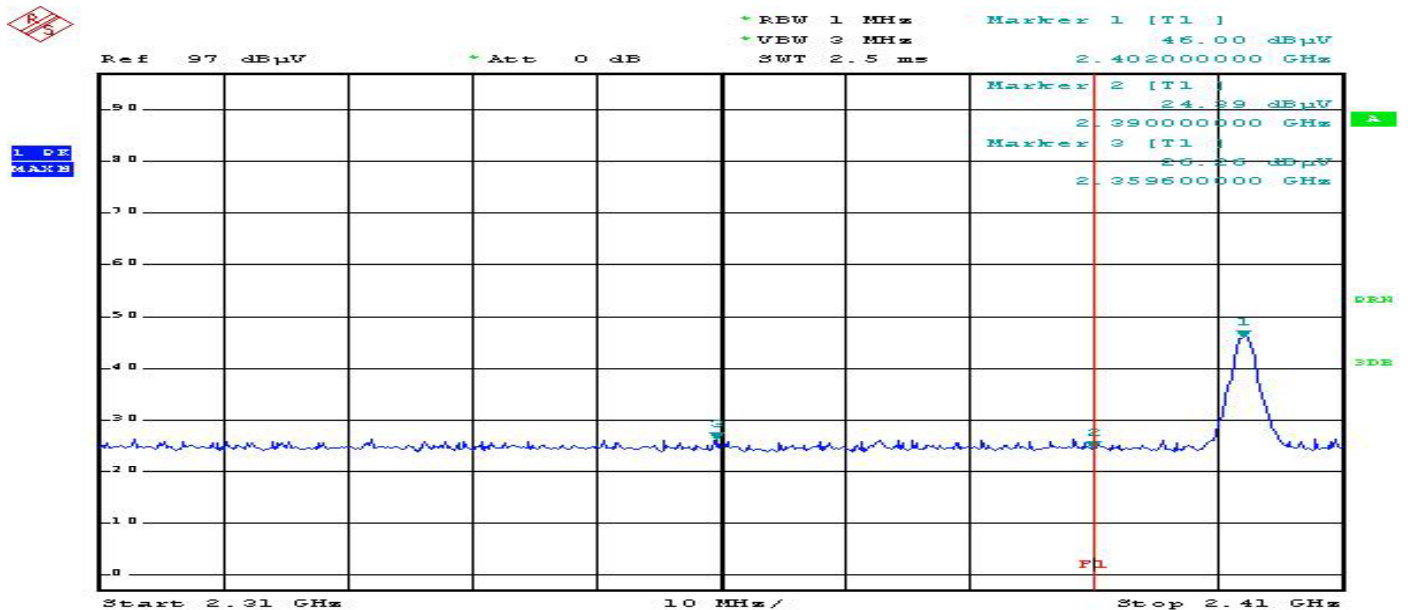
Frequency (MHz)	Reading (dBμV)	Position (V/H)	Height (m)	Correction Factor		Duty Cycle Correction(dB)	Result Value		
				Ant Factor (dB)	Cable (dB)		Limit (dBμV/m)	Result (dBμV/m)	Margin (dB)
PEAK(RBW: 1 MHz    VBW: 3 MHz)									
2483.50	26.68	H	1.0	26.74	5.80	0.00	74.00	59.22	14.78
2483.50	24.86	V	1.0	26.74	5.80	0.00	74.00	57.40	16.60
2489.35	25.85	H	1.0	26.75	5.80	0.00	74.00	58.40	15.60
2490.50	26.28	V	1.0	26.75	5.80	0.00	74.00	58.83	15.17
4960.00	45.35	H	1.0	30.98	-23.87	0.00	74.00	52.46	21.54
4960.00	45.52	V	1.0	30.98	-23.87	0.00	74.00	52.63	21.37
AV(RBW: 1 MHz    VBW: 1 kHz)									
2483.50	14.02	H	1.0	26.74	5.80	1.71	54.00	48.27	5.73
2483.50	13.18	V	1.0	26.74	5.80	1.71	54.00	47.43	6.57
2489.35	12.96	H	1.0	26.75	5.80	1.71	54.00	47.22	6.78
2490.50	12.93	V	1.0	26.75	5.80	1.71	54.00	47.19	6.81
4960.00	33.42	H	1.0	30.98	-23.87	1.71	54.00	42.24	11.76
4960.00	33.02	V	1.0	30.98	-23.87	1.71	54.00	41.84	12.16
Remark	H : Horizontal,    V : Vertical    TEST MODE : Bluetooth – LE (CH : 39 – 2 480 MHz)								
	*The TX signal wasn't detected from 3th harmonics.								
	*Checked in all 3 axis and the maximum measured data were reported.( Worst data is Z axis of position)								
	*Total = Reading Value + Antenna Factor + Cable Loss – Amp Gain + Duty Cycle Correction								
	FYI a. Ton Time : 0.423 ms b. duty cycle : 67.5 % c. DCF : 1.707 dB								

#### 10.4-4 Restricted Band Edges for Bluetooth (LE)

Band Edges(CH Low)

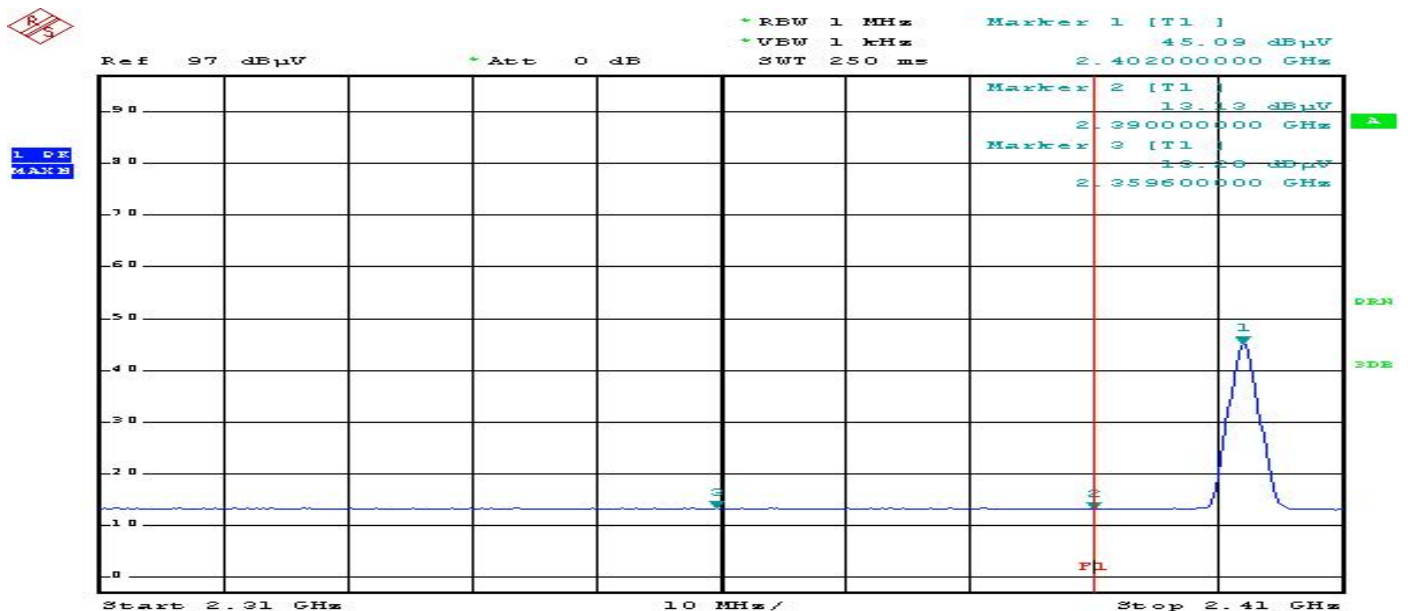
Detector mode:Peak

Polarity:Horizontal



Detector mode:Average

Polarity:Horizontal







**Estech Co., Ltd.**

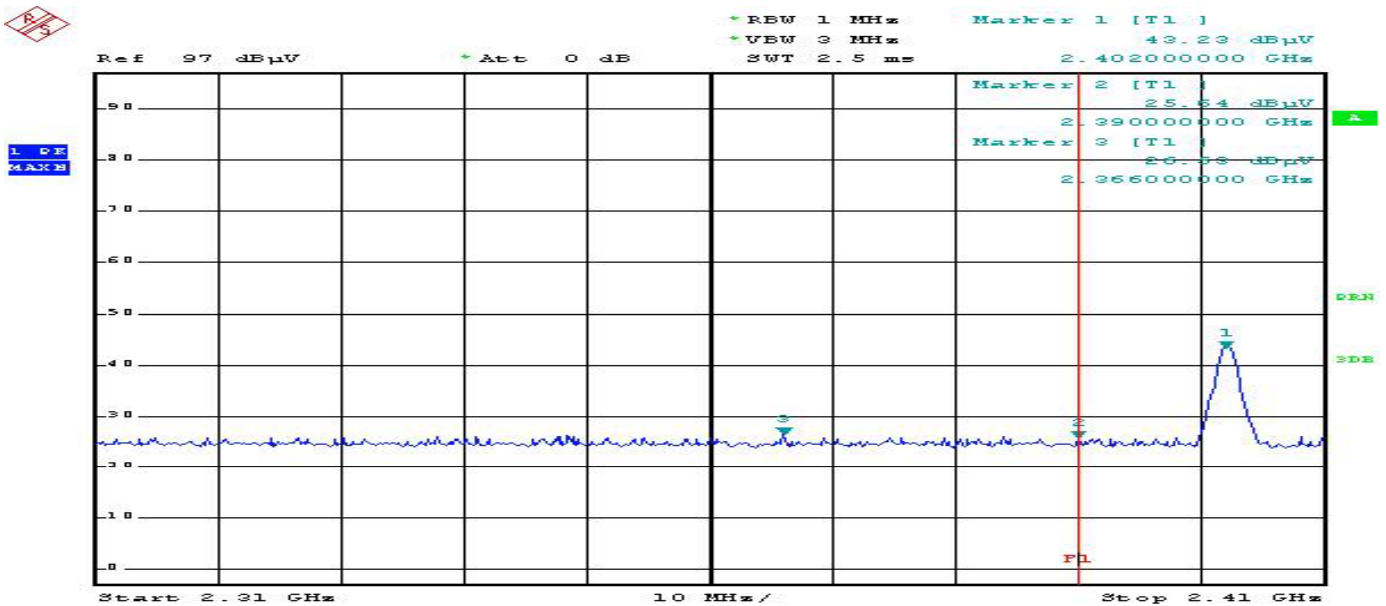
97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

Band Edges(CH Low)

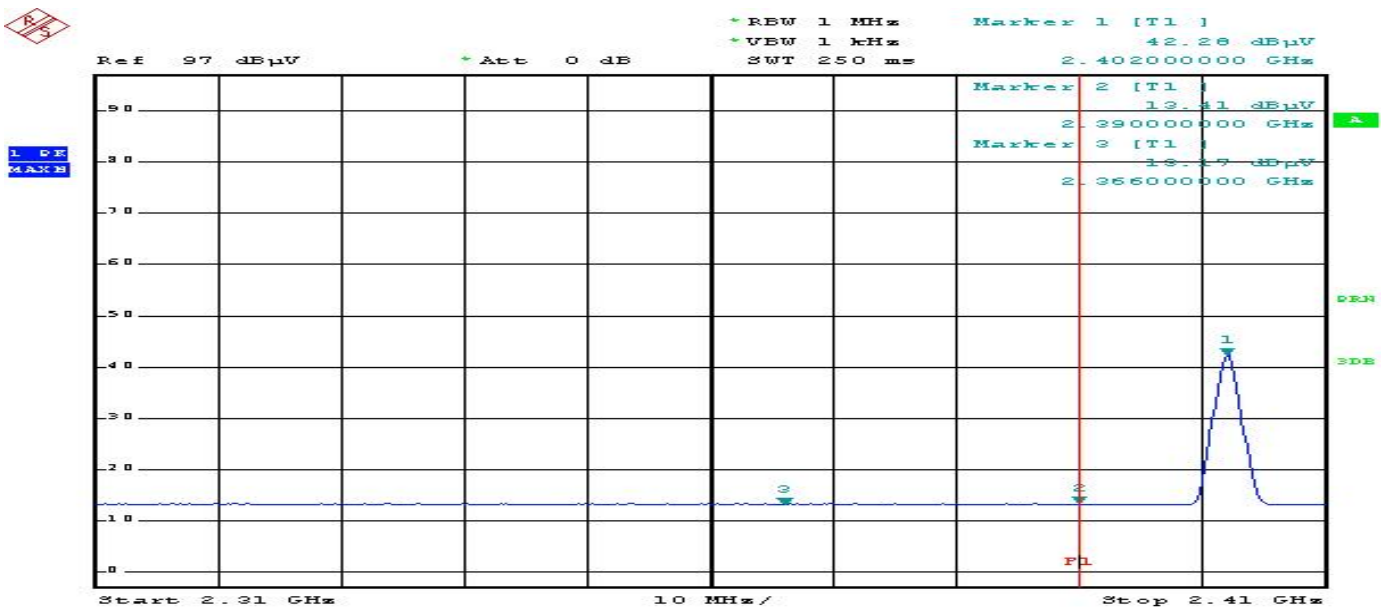
Detector mode:Peak

Polarity:Vertical



Detector mode:Average

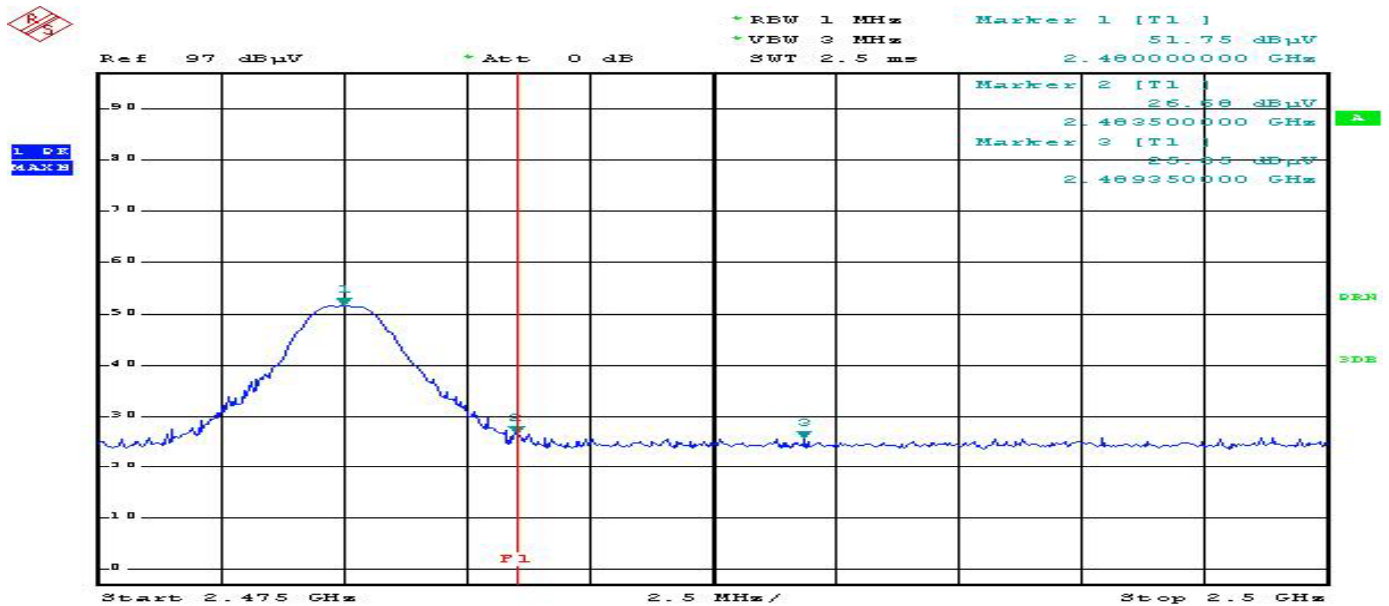
Polarity:Vertical



Band Edges(CH High)

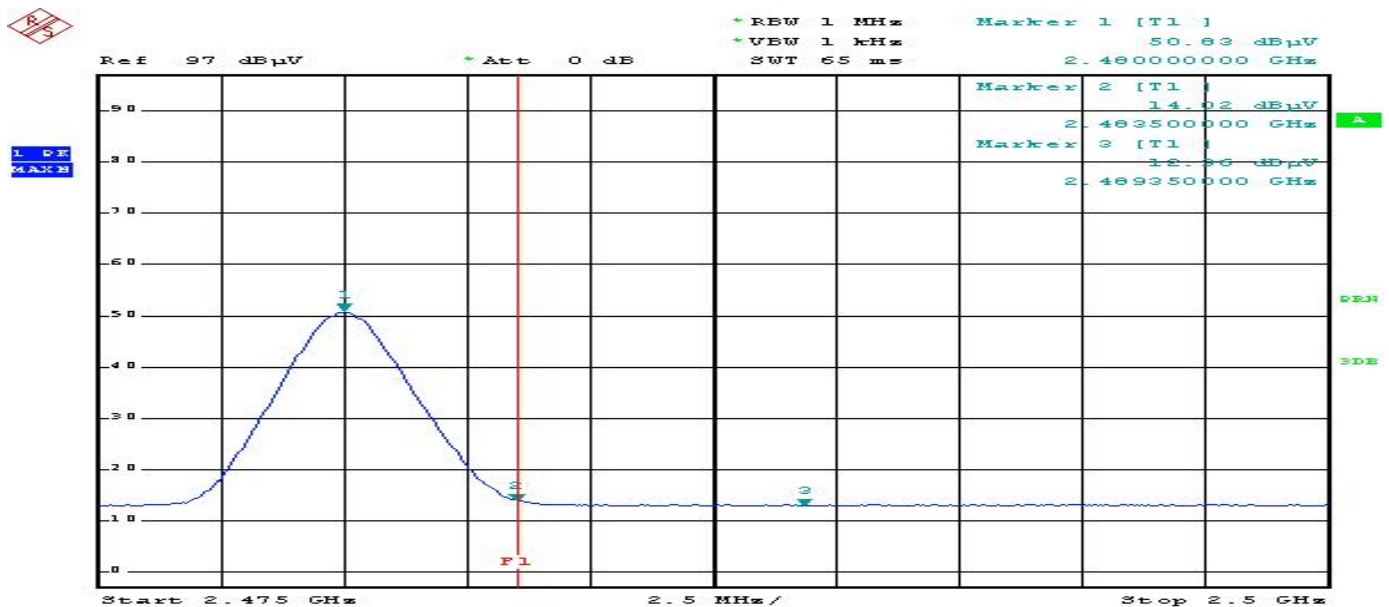
Detector mode:Peak

Polarity:Horizontal



Detector mode:Average

Polarity:Horizontal





**Estech Co., Ltd.**

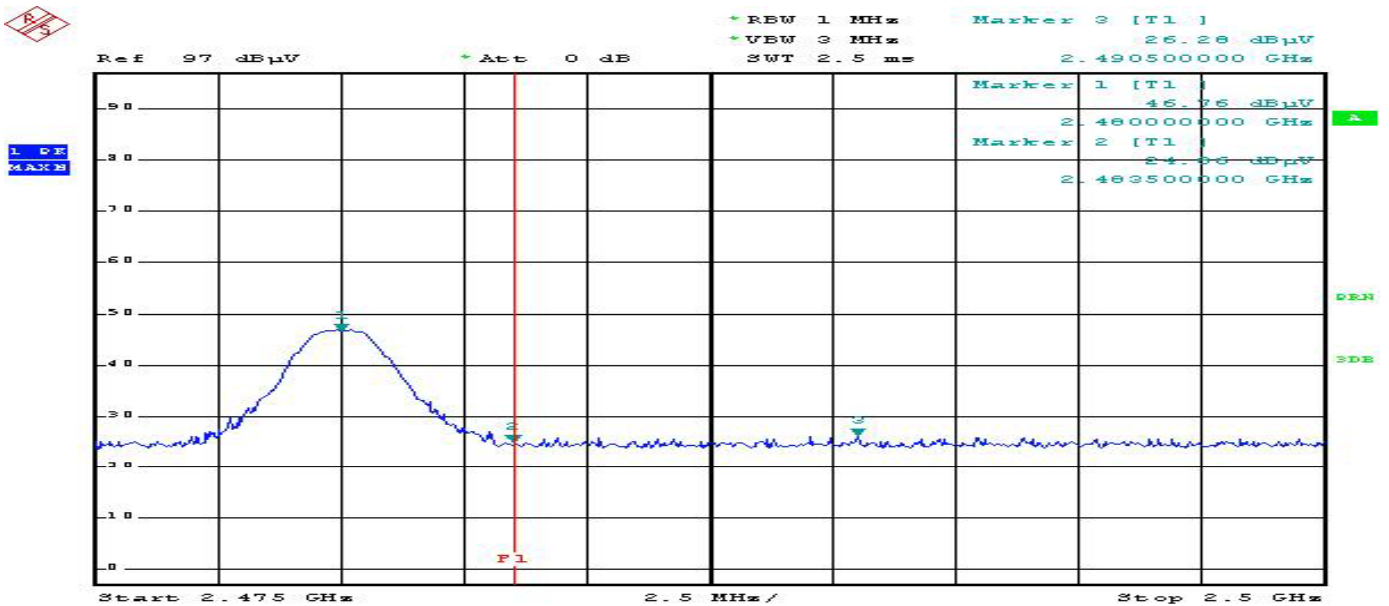
97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

Band Edges(CH High)

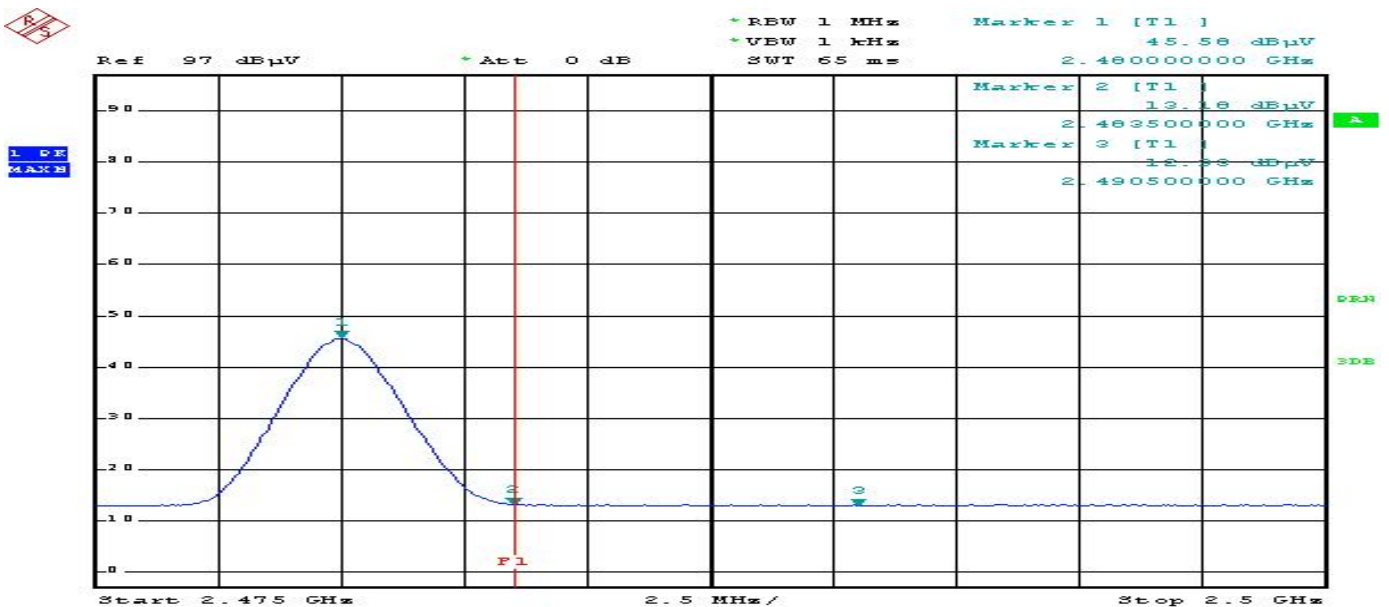
Detector mode:Peak

Polarity:Vertical



Detector mode:Average

Polarity:Vertical



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

## 11. Measurement of conducted disturbance

The continuous disturbance voltage of AC Mains in the frequency from 0.15 MHz to 30 MHz was measured in accordance to FCC PART 15.207. The test setup was made according to ANSI C 63.4 (2009) in a shielded room. The EUT was placed on a non-conductive table at least 0.8 m above the ground plan. A grounded vertical reference plane was positioned in a distance of 0.4 m from the EUT. The distance from the EUT to other metal surfaces was at least 0.8 m. The EUT was only earthen by its power cord through the line impedance stabilizing network. The power cord has been bundled to a length of 1.0 m. The test receiver with Quasi Peak detector complies with CISPR 16.

### 11.1 Measurement equipments

Equipment Name	Type	Manufacturer	Serial No.	Next Calibration date
TEST RECEIVER	ESPI	Rohde & Schwarz	100005	13-Jan-16
LISN	ENV216	Rohde & Schwarz	101231	18-Aug-15
LISN	ESH3-Z5	Rohde & Schwarz	836679/025	13-Jan-16
Pulse Limiter	ESH3Z2	Rohde & Schwarz	NONE	13-Jan-16

### 11.2 Environmental Condition

Test Place : Shielded Room

Temperature (°C) : 21.5 °C

Humidity (% R.H.) : 44.7 % R.H.



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 www.estech.co.kr

### 11.3 Test Data for Bluetooth (LE)

Test Date : 23-Feb-15

Frequency (MHz)	Correction Factor		Line (H/N)	Quasi-peak Value			Average Value		
	Lisn (dB)	Cable (dB)		Limit (dBμV)	Reading (dBμV)	Result (dBμV)	Limit (dBμV)	Reading (dBμV)	Result (dB)
0.15	0.12	0.12	H	66.00	31.39	31.63	56.00	17.97	18.21
0.39	0.12	0.14	H	58.06	29.92	30.18	48.06	15.56	15.82
0.42	0.12	0.14	H	57.45	30.25	30.51	47.45	15.46	15.72
0.54	0.12	0.14	H	56.00	28.21	28.47	46.00	14.76	15.02
1.29	0.14	0.16	H	56.00	27.19	27.49	46.00	13.99	14.29
2.30	0.16	0.21	H	56.00	25.07	25.44	46.00	10.22	10.59
0.15	0.10	0.12	N	66.00	31.82	32.04	56.00	17.70	17.92
0.34	0.10	0.14	N	59.20	20.82	21.06	49.20	15.07	15.31
0.38	0.11	0.14	N	58.28	21.69	21.94	48.28	14.55	14.80
0.41	0.11	0.14	N	57.65	20.48	20.73	47.65	14.35	14.60
0.46	0.11	0.15	N	56.69	20.91	21.17	46.69	14.11	14.37
0.57	0.11	0.14	N	56.00	18.94	19.19	46.00	13.69	13.94
Remark	H : Hot Line, N : Neutral Line *Correction Factor = Lisn + Cable *Result = Correction Factor + Reading								



**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyeonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 12. Photographs of test setup

### 12.1. Setup for Radiated Test : (30 ~ 1 000) MHz

[ Front ]



[ Rear ]







**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

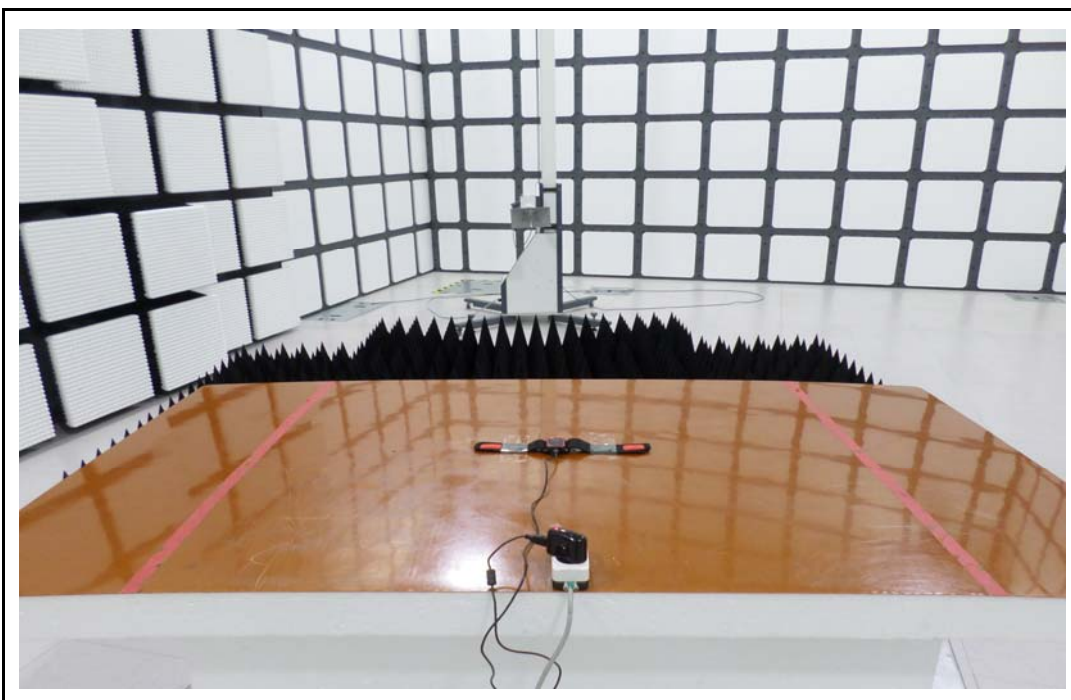
TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 12.2.Setup for Radiated Test : Above 1 GHz

[ Front ]



[ Rear ]





**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea  
TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

### 12.3. Setup for Conducted Test : (0.15 ~ 30) MHz

[ Front ]



[ Rear ]







**Estech Co., Ltd.**

97-1, Hooeok-ri, Majang-myun, Ichion-city, Gyonggi-do, South Korea

TEL : +82 31 6318037 FAX : +82 31 6318039 [www.estech.co.kr](http://www.estech.co.kr)

## 12.4. Photographs of EUT

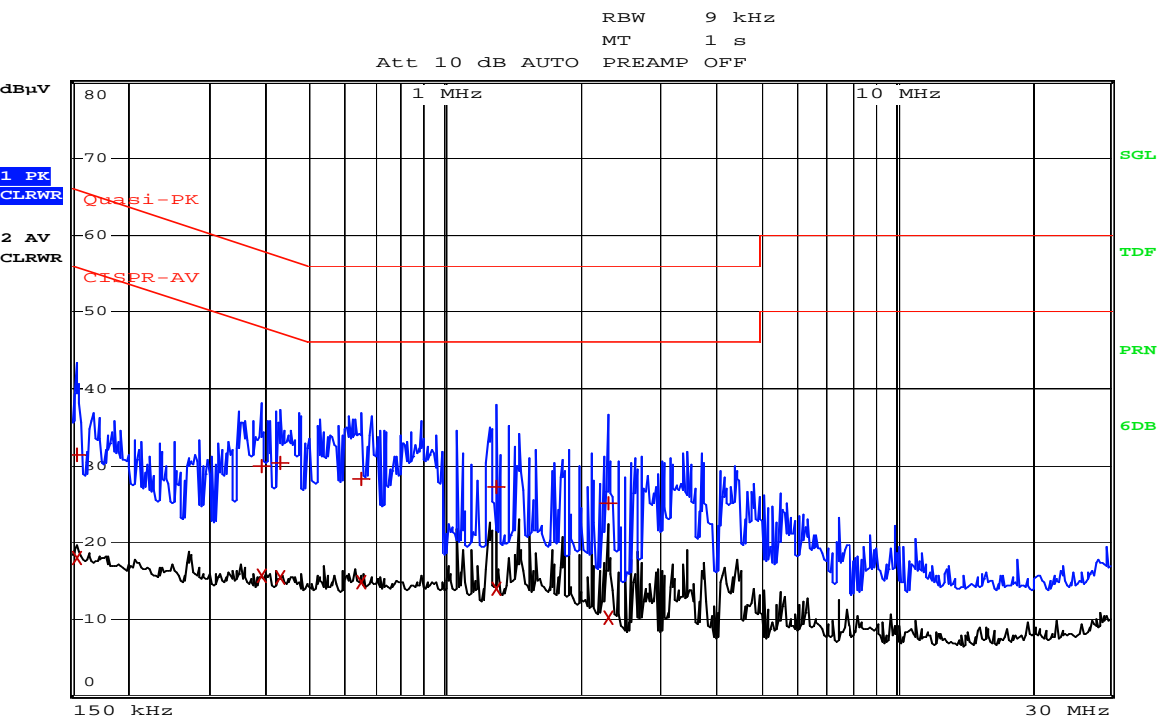
[ Front ]



[ Rear ]

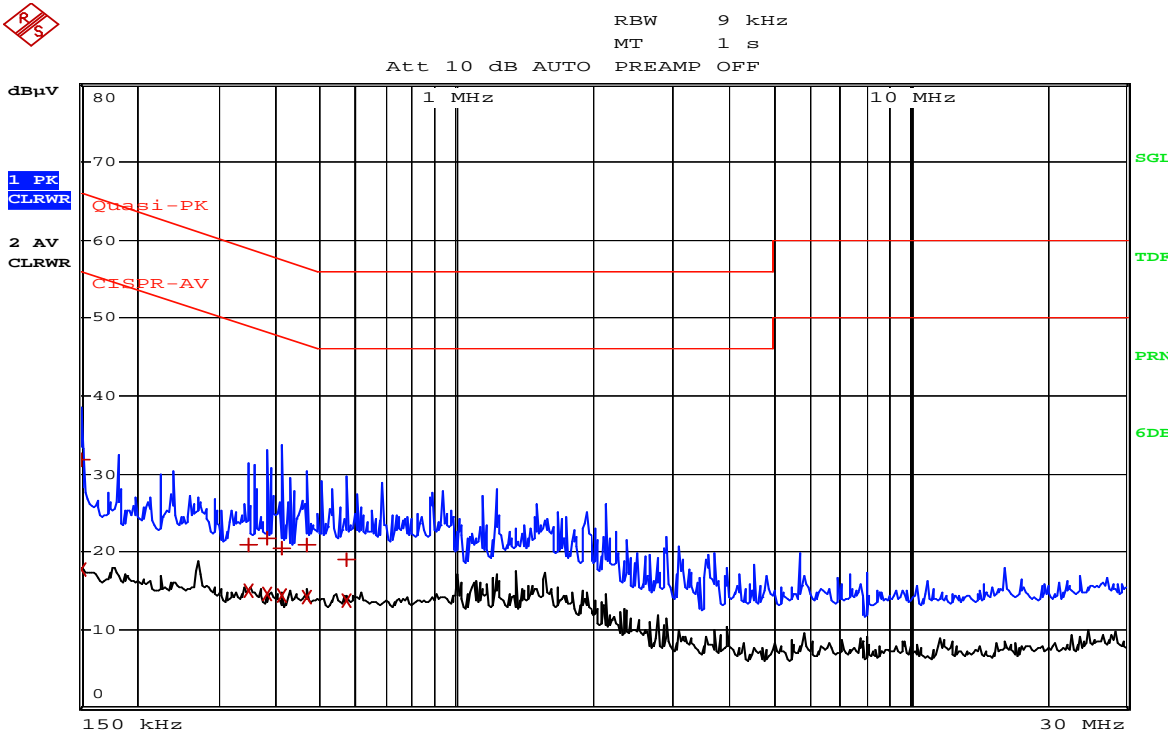


Appendix 1. Special diagram for Bluetooth (LE)  
\* HOT LINE



Comment: ESTC-15-00189\_HOT  
Date: 23.FEB.2015 06:48:33

\* NEUTRAL LINE



Comment: ESTC-15-00189\_NEUTRAL  
Date: 23.FEB.2015 06:52:17

## Appendix 2. Antenna Requirement

### 1. Antenna Requirement

#### 1.1 Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

And according to FCC 47 CFR Section 15.204

#### 1.2 Antenna Connected Construction

The antenna types used in this product are Intergrated SMD antenna . The maximum Gain of this antenna is 2.88 dBi.