

**Electromagnetic Emission**

---

**F C C M E A S U R E M E N T R E P O R T**

---

**CERTIFICATION OF COMPLIANCE**

**FCC Part 15 Certification Measurement**

<b>PRODUCT</b>	: FSK MODEM
<b>MODEL/TYPE NO</b>	: TS-FSK001
<b>FCC ID</b>	: WGQ-TS-FSK001
<b>APPLICANT</b>	: TECHNOSQUARE Co., Ltd  #1110 Byucksan Digital Vally 5 <sup>th</sup> , Gasan-dong 60-73, Geumcheon-gu, Seoul, Korea  Attn.: Mr. David Lee / Senior Engineer
<b>MANUFACTURER</b>	: Same as applicant
<b>FCC CLASSIFICATION</b>	: DSC : Part 15 Security/Remote Control Transmitter
<b>FCC RULE PART(S)</b>	: FCC Title 47, Part 15 Subpart C
<b>FCC PROCEDURE</b>	: ANSI C63.4-2003
<b>TEST REPORT No.</b>	: ETLE080609.475
<b>DATES OF TEST</b>	: June 17, 2008 to June 18, 2008
<b>REPORT ISSUE DATE</b>	: July 07, 2008
<b>TEST LABORATORY</b>	: ETL Inc. (FCC Designation Number : KR0022)

This is FSK MODEM; Model TS-FSK001 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2003 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.231

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Lasswitz

Hyung Seok, Lee / Chief Engineer

**ETL Inc.**  
**#584 Sangwhal-ri, Ganam-myeon, Yoju-gun, Gyeonggi-do, 469-885, Korea**  
**Tel : 82-2-858-0786 Fax : 82-2-858-0788**

## Table of Contents

### **ATTACHMENT A: COVER LETTER(S)**

#### **FCC Measurement Report**

- 1. Introduction**
- 2. Product Information**
- 3. Description of Tests**
- 4. Test Condition**
- 5. Test Results**
  - 5.1 Summary of Test Results**
  - 5.2 Radiated Emissions Measurement**
  - 5.3 AC Power line Conducted Emissions Test**
  - 5.4 Occupied Bandwidth Measurement**
  - 5.5 Radiated Emissions for Periodic radiators**
  - 5.6 Periodic Operation Measurement Plot**
- 6. Sample Calculation**
- 7. List of test Equipment used for Measurement**

#### **Appendix A. FCC ID Label and Location**

#### **Appendix B. Test Setup Photographs**

#### **Appendix C. Photographs**

#### **Appendix D. Block Diagram**

#### **Appendix E. Circuit Diagram**

#### **Appendix F. User Manual**

#### **Appendix G. Operational Description**

#### **Appendix H. Part list**

#### **Appendix I. Component**

#### **Appendix J. Antenna specification**

## FCC MEASUREMENT REPORT

**Scope** – *Measurement and determination of electromagnetic emission(EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

### General Information

<b>Applicant Name</b>	: TECHNNOSQUARE Co., Ltd
<b>Address</b>	: #1110 Byucksan Digital Vally 5 <sup>th</sup> , Gasan-dong 60-73, Geumcheon-gu, Seoul, Korea
<b>Attention</b>	: Mr. David Lee / Senior Engineer

- EUT Type :** FSK MODEM
- Model Number :** TS-FSK001
- FCC ID :** WGQ-TS-FSK001
- S/N :** Proto-type
- Freq. Range :** 433.92 MHz
- FCC Rule Part(s) :** FCC Part 15 Subpart C section 15.231
- Test Procedure :** ANSI C63.4-2003
- FCC Classification :** DSC: Part 15 Security/Remote Control Transmitter
- Dates of Tests :** June 17, 2008 to June 18, 2008
- Place of Tests :** ETL Inc. Testing Lab. (FCC Designation Number : KR0022)

Radiated Emission test;  
#584, Sangwhal-ri, Ganam-myeon, Yoju-gun,  
Gyeonggi-do, 469-885, Korea

Conducted Emission test;  
ETL Inc. Testing Lab. (FCC Designation Number : KR0022)  
371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

- Test Report No. :** ETLE080609.475



## 1. INTRODUCTION

The measurement test for radiated and conducted emission test were conducted at the open area test site of ETL Inc. facility located at #584, Sangwhal-ri, Ganam-myeon, Yoju-gun, Gyeonggi-do, 469-885, Korea. The site is constructed in conformance with the requirements of the ANSI C63.4-2003 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with the requirements of Section 2.948 FCC Rules according to the ANSI C63.4-2003 and registered to the Federal Communications Commission (Designation Number : KR0022 ).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) was used in determining radiated and conducted emissions from the TECHNOSQUARE Co., Ltd, Model: TS-FSK001

## 2. PRODUCT INFORMATION

### 2.1 Equipment Description

The UHF FM narrow band half-duplex radio data modules to enable wireless data communication with over 1500m operation range (LOS) in combination with FSK modem for US market.

Any desired frequency in 433.92MHz band be set from an external CPU By mounting all high frequency circuits in the shielding case, the module withstands external noise and provides reliable data communication.

### 2.2 General Specification

Low voltage operation from 3.6V

Ideal for battery with FSK modem

Control by SPI bus

Data sampling clock from RF module

Frequency range: 433.92 MHz

RoHS compliant

## 3. DESCRIPTION OF TESTS

### 3.1 Radiated Emission Measurement

Radiated emission measurements were in accordance with § 13 in ANSI C63.4-2003 "Measurement of Intentional radiators" and § 11 in ANSI C63.4-2003 "Measurement of Information Technology Equipment". The measurements were performed over the frequency ranges of 30 MHz to 4.5 GHz using antenna as the input transducer to a spectrum analyzer or a field intensity meter. The measurements were made with the detector set for "Quasi-peak or Peak" within a bandwidth of 120 kHz or 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the max emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double broad-band horn antennas were used. Final measurements were made open site at 3 m. The test equipment was placed on a wooden turn-table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The detector function was set to CISPR Quasi-peak mode and the bandwidth of the receiver was set to 120 kHz or 1 MHz depending on the frequency of type of signal. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the max. Emission for the frequency and were placed on top of a 0,8 m high nonmetallic 1 m x 1,5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the max emission. Each emission was maximized by: varying the mode of operation to the EUT and/or support equipment and changing the polarity of the antenna, whichever determined the worst-case emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

## 3.2 AC Power line Conducted Emissions Test

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.4-2003 "measurement of intentional radiators" The measurements were performed over the frequency range of 0,15 MHz to 30 MHz using a  $50 \Omega$  / 50  $\mu$ H LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1,5 m x 0,8 m wooden table which is placed 0,4 m away from the vertical wall and 1,5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Powers to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner  $\phi$  1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in photographs of conducted emission test setup in Appendix B.

### 3.3 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
<sup>1</sup> 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	( <sup>2</sup> )
13.36 - 13.41			

<sup>1</sup>Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

<sup>2</sup> Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

## **4. TEST CONDITION**

### **4.1 Test Configuration**

The device was configured for testing in a typical fashion (as a customer would normally use it). During the test, the EUT and the supported equipments were installed to meet FCC requirement and operated in a manner and which tends to maximize its emission level in a typical application.

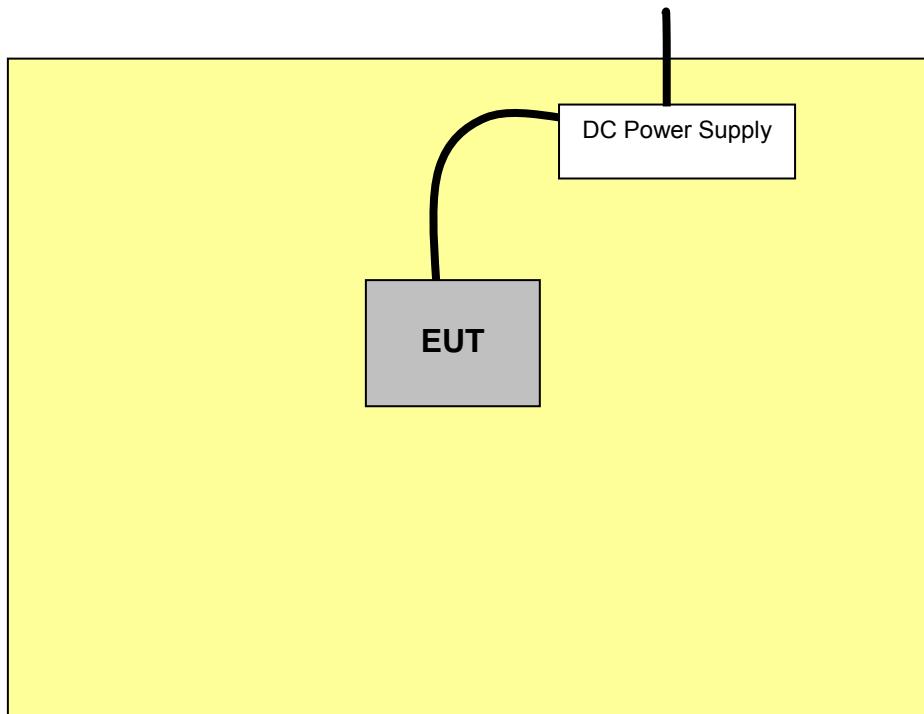
### **4.2 EUT operation**

The EUT was connected as user's guide. And during the test executed EUT is operating on the following

- Function of transmitter

The EUT (model: TS-FSK001) has been tested under operating condition.  
Fixed Channel (433.92 MHz) was chosen for testing.

### **4.3 The setup drawing(s)**



— : Data Line    — : Power Line    ..... : Outside table

## 5. TEST RESULTS

### 5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

Applied Standard : 47 CFR Part 15, Subpart C			
FCC Rule	Measurement Required	Result	Remarks
15.207(a)	Power line Conducted Emissions	Pass	
15.209(a)	Radiated Emissions	Pass	
15.231(a)(1)	Manually operated transmitter	Pass	
15.231(a)(3)	Periodic transmissions at regular predetermined intervals	Pass	
15.231(a)(4)	Radiators used in cases of emergency	Pass	
15.231(a)(5)	Set-up information for security systems	Pass	
15.231(b)	Radiated Emissions	Pass	
15.231(c)	20 dB Bandwidth	Pass	
15.231(d)	Devices operating within the frequency band 40,66-40,70 MHz	N/A	1)
15.231(e)	Radiated emissions for Periodic radiators	N/A	

Notes:

- 1) The frequency range of EUT is 433.2 MHz fixed.

The data collected shows that the **TECHNOSQUARE Co., Ltd / FSK MODEM / TS-FSK001** complied with technical requirements of above rules part 15.207, 15.209 and 15.231 limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

## 5.2 Radiated Emissions Measurement

<b>EUT</b>	FSK MODEM / TS-FSK001
<b>Limit apply to</b>	FCC Part 15.209(a)
<b>Test Date</b>	June 17, 2008
<b>Operating Condition</b>	Continues transmitter(433.92 MHz)
<b>Result</b>	Passed

### Limit

Part 15.209(a) except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequencies (MHz)	15.209 Radiated Limits (dBuV/m@3 m)
30 – 88	40
88 – 216	43.5
216 – 960	46
Above 960	54

### Test Results

- Refer to see the measured plot in next page.

## 5.2.1 Radiated Emissions Data

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

Detector mode: Quasi-Peak mode (RBW: 120 kHz) below 1 GHz

Peak mode (RBW: 1 MHz) above 1 GHz

Frequency [MHz]	Reading [dB $\mu$ V]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ V]	Emission Level [dB $\mu$ N/m]	Limit [dB $\mu$ N/m]	Margin [dB]
<b>No signal detected</b>							
Other frequencies	-	-	-	-	-	-	-

### NOTES:

1. \* H : Horizontal polarization , \*\* V : Vertical polarization
2. Result = Reading + Antenna factor + Cable loss
3. Margin value = Limit – Result
4. Results found to be 20dB or greater under the limit have not been included.
5. The measurement was performed for the frequency range 30 MHz – 4.5 GHz according to the FCC Part 15.209(a)
6. below 1 GHz = Ant factor + cable loss, above 1 GHz = Ant factor + cable loss + AMP gain



Test Engineer: Kug Kyoung, Yoon

## 5.3 AC Power line Conducted Emissions Measurement

<b>EUT</b>	FSK MODEM / TS-FSK001
<b>Limit apply to</b>	FCC Part 15.207(a)
<b>Test Date</b>	June 18, 2008
<b>Operating Condition</b>	Continues transmitter(433.92 MHz)
<b>Result</b>	Passed

### 5.3.1 AC Power line Conducted Emission Test Data

The following table shows the highest levels of conducted emissions on both polarizations of hot and neutral line.

Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

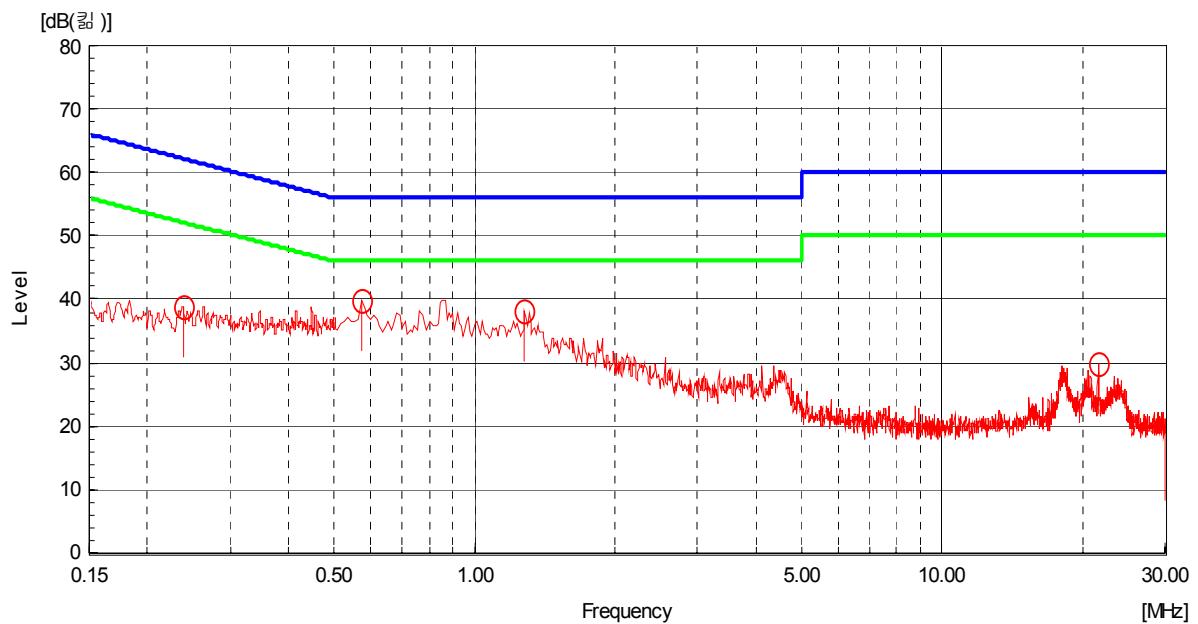
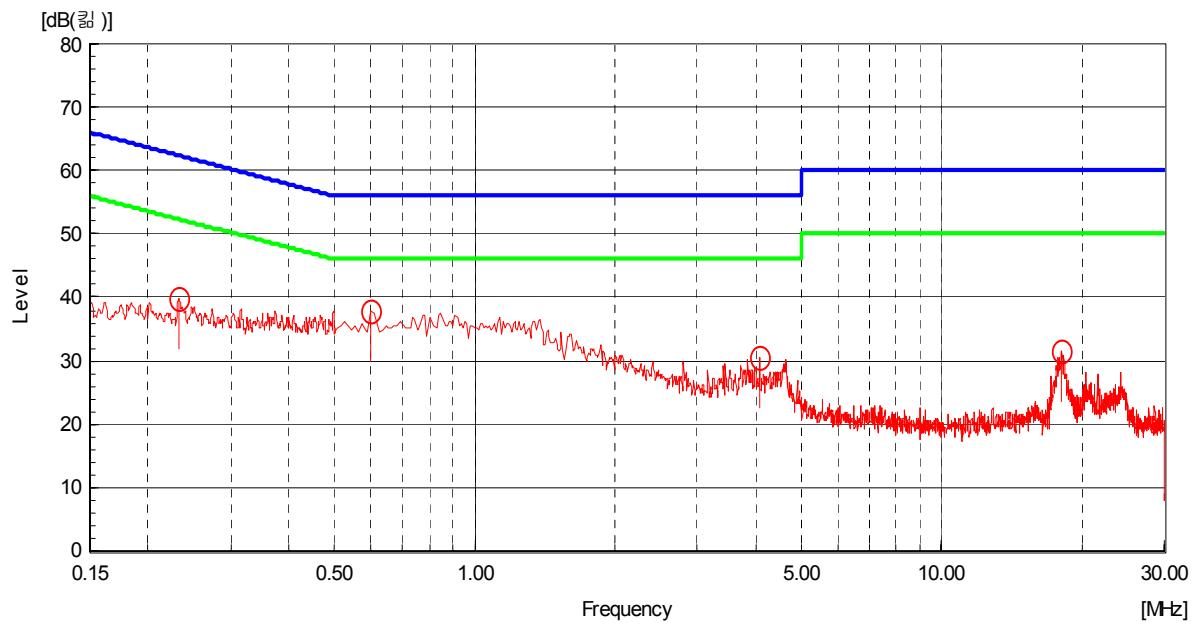
Frequency [MHz]	Result [dB $\mu$ V]		Phase (*L/**N)	Limit [dB $\mu$ V]		Margin [dB]	
	Quasi-peak	Average		Quasi-peak	Average	Quasi-peak	Average
0.232	39.90	-	N	62.40	52.40	22.50	-
0.600	37.80	-	N	56.00	46.00	18.20	-
4.072	30.70	-	N	56.00	46.00	25.30	-
18.120	31.40	-	N	60.00	50.00	28.60	-

#### NOTES:

1. \* H : HOT Line , \*\*N : Neutral Line
2. Margin value = Limit – Result
3. Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15 Class B.



Test Engineer: Kug Kyoung, Yoon

**Line: HOT Line**Limit :   
— Quasi-Peak  
— Average**Line: Neutral Line**

### 5.3 20 dB Bandwidth

<b>EUT</b>	FSK MODEM / TS-FSK001
<b>Limit apply to</b>	FCC Part 15.231(c)
<b>Test Date</b>	June 18, 2008
<b>Operating Condition</b>	Continues transmitter(433.92 MHz)
<b>Result</b>	Passed

#### Limit

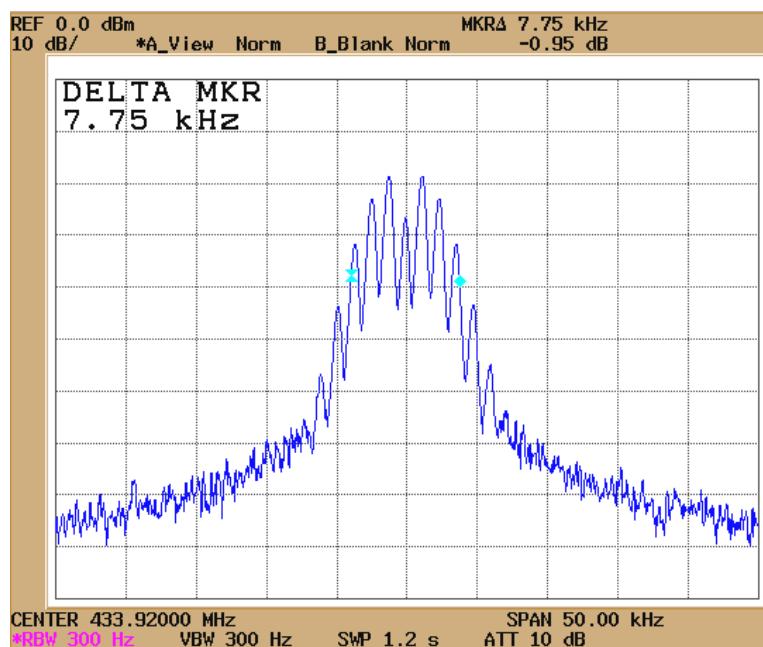
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

#### Test Data

Center Frequency [MHz]	Measured occupied bandwidth [MHz]	Limit [MHz]	Result
433.92	0.00775	1.0848 (0.25%)	Pass

#### NOTES:

1. The bandwidth is determined at the points 20 dB down from the modulated carrier.



Test Engineer: Kug Kyoung, Yoon

Report no. ETLE080609.475, Page 15 of 20

## 5.4 Radiated Emissions for Periodic radiators

<b>EUT</b>	FSK MODEM / TS-FSK001
<b>Limit apply to</b>	FCC Part 15.231(b)
<b>Test Date</b>	June 17, 2008
<b>Operating Condition</b>	Continues transmitter(433.92 MHz)
<b>Result</b>	Passed

Part 15.231(b) In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emission (microvolts/meter)
40.66-40.70	2 250	225
70-130	1 250	125
130-174	1 250 to 3 750**	125 to 375**
174-260	3 750	375
260-470	3 750 to 12 500**	375 to 1 250**
Above 470	12 500	1 250

\*\* linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, uV/m at 3 meters =  $56.81818(F) - 6136.3636$ ; for the band 260-470 MHz, uV/m at 3 meters =  $41.6667(F) - 7083.3333$ . The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]

$$\begin{aligned}\text{Fundamental: uV/m at 3 meters} &= 41.6667(433.92) - 7083.3333 = 10996.6812 = 20\log*10996.6812 \\ &= 80.82 \text{ dB}_{\mu\text{V/m}}\end{aligned}$$

$$\begin{aligned}\text{Spurious emissions: uV/m at 3 meters} &= 20 \text{ dB below of fundamental level} \\ &= 60.82 \text{ dB}_{\mu\text{V/m}}\end{aligned}$$

### Test Results

- Refer to see the measured plot in next page.

## 5.4.1 Field Strength of Fundamental and Spurious Emissions Data

### Peak Mode Test Data

Frequency [MHz]	Reading [dB $\mu$ V]	Polarization (*H/**V)	AMP gain [dB/m]	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ V]	Result [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]
433.92	53.88	H	0	15.31	7.01	76.20	100.82	24.62
Other frequencies	-	-		-	-	-	-	-

### Average Mode Test Data

Frequency [MHz]	Reading [dB $\mu$ V]	Polarization (*H/**V)	AMP gain [dB/m]	Ant. Factor [dB/m]	Cable Loss [dB $\mu$ V]	Result [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]
433.92	53.38	H	0	15.31	7.01	75.70	80.82	5.12
Other frequencies	-	-		-	-	-	-	-

#### NOTES:

1. The test was searched from 30 MHz to the 10<sup>th</sup> Harmonic.(30MHz – 4.5GHz)
2. Results found to be 40dB or greater under the limit have not been included.
3. Below 1 GHz = Ant factor + cable loss, above 1 GHz = Ant factor + cable loss + AMP gain



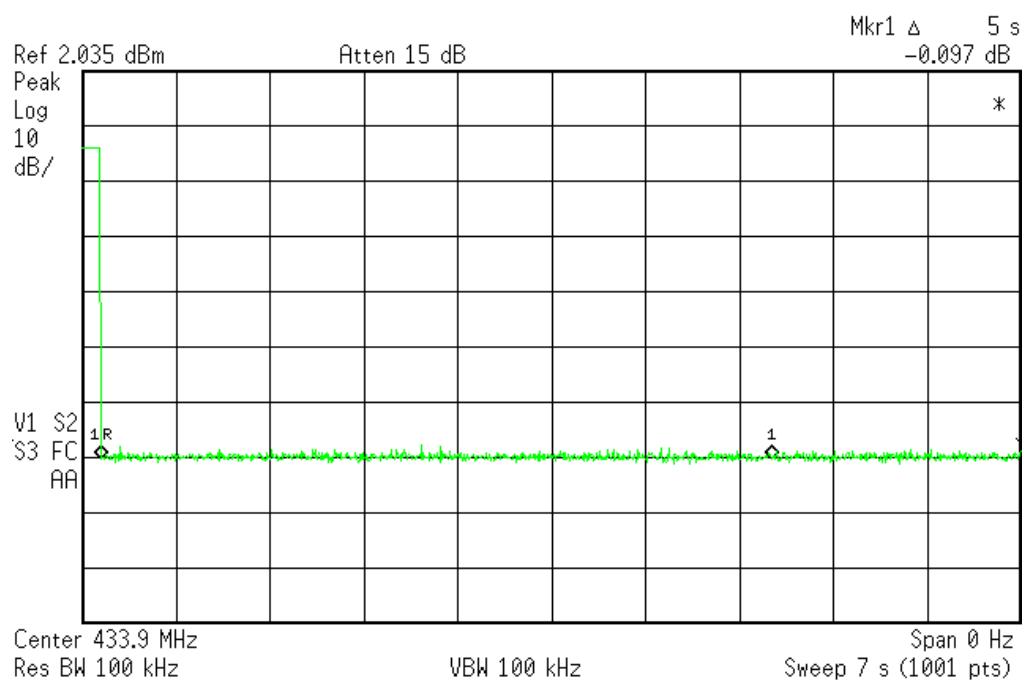
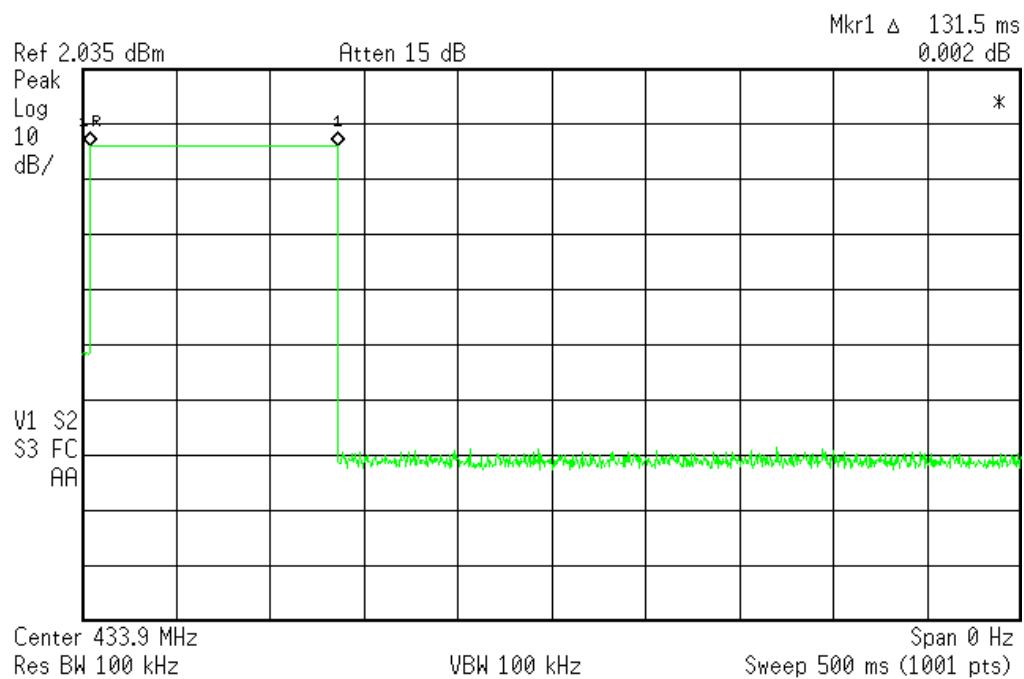
Test Engineer : Kug Kyoung, Yoon

## 5.5 Periodic Operation Measurement Plot

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

This device does meet the FCC 15.231(a)(1) requirement.

Manual activation time



Report no. ETLE080609.475, Page 18 of 20

## 6. SAMPLE CALCULATION

### Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.  
The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF$$

Where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

$$dB(\mu V) = 20 \log_{10} (\mu V)$$

$$dB\mu V = dBm + 107$$

Example : @ 433.92 MHz

Limit	=	80.82 dB $\mu V/m$
Reading	=	53.38 dB $\mu V$
Antenna Factor + Cable Loss	=	15.31 + 7.01 = 22.32 dB/m
Total	=	75.70 dB $\mu V/m$
Margin	=	80.82 - 75.70 = 5.12 dB
	=	5.12 dB below Limit

## 7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Due Date
<input checked="" type="checkbox"/>	SPECTRUM ANALYZER	E7405A	H.P	US41160290	08.10.04
<input checked="" type="checkbox"/>	EMI TEST RECEIVER	ESVS10	R&S	835165/001	09.04.04
<input checked="" type="checkbox"/>	EMI TEST RECEIVER	ESPI3	R&S	100478	08.10.04
<input checked="" type="checkbox"/>	Broad band Horn antenna	BBHA 9120D	Schwarzbeck	227	09.03.15
<input checked="" type="checkbox"/>	LISN	3816-2	EMCO	1002	08.10.05
<input checked="" type="checkbox"/>	Turn-Table	DETT-03	Daeil EMC	-	N/A
<input checked="" type="checkbox"/>	Antenna Master	DEAM-03	Daeil EMC	-	N/A
<input checked="" type="checkbox"/>	LogBicon Antenna	VULB9165	Schwarz Beck	2023	09.08.28
<input checked="" type="checkbox"/>	Preamplifier	8447D	H.P	3307A02865	08.10.05

End of Test Report