

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : W153R-D028

AGR No. : A152A-125

Applicant : LG Innotek Co., Ltd.

Address : 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea

Manufacturer : LG Innotek Co., Ltd.

Address : 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea

Type of Equipment : Wi-Fi module

FCC ID. : YZP-TWFMK001D

Model Name : TWFM-K001D

Multiple Model Name : TWFM-K002D, TWFM-K003D

Serial number : N/A

Total page of Report : 12 pages (including this page)

Date of Incoming : February 13, 2015

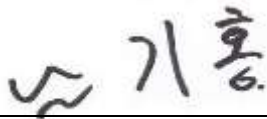
Date of issue : March 30, 2015

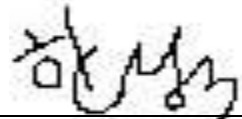
SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by: 
Ki-Hong, Nam / Asst, Chief Engineer
ONETECH Corp.

Approved by: 
Sung-Ik, Han/ Managing Director
ONETECH Corp.

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W153R-D028	March 30, 2015	Initial Issue	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Innotek Co., Ltd.
 Address : 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, 506-731 Korea
 Contact Person : IC Jeong / Senior engineer
 Telephone No. : +82-62-950-0332
 FCC ID : YZP-TWFMK001D
 Model Name : TWFM-K001D
 Serial Number : N/A
 Date : March 30, 2015

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification, Modular Approval
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. GENERAL INFORMATION

2.1 Product Description

The LG Innotek Co., Ltd., Model TWFM-K001D (referred to as the EUT in this report) is a Wi-Fi module. Product specification information described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Wi-Fi module		
FREQUENCY RANGE	2 412 MHz ~ 2 462 MHz_20 MHz BW		
	2 422 MHz ~ 2 452 MHz_40 MHz BW		
	5 180 MHz ~ 5 240 MHz_20 MHz BW		
	5 190 MHz ~ 5 230 MHz_40 MHz BW		
	5 260 MHz ~ 5 320 MHz_20 MHz BW		
	5 270 MHz ~ 5 310 MHz_40 MHz BW		
	5 500 MHz ~ 5 700 MHz_20 MHz BW		
	5 510 MHz ~ 5 670 MHz_40 MHz BW		
	5 745 MHz ~ 5 825 MHz_20 MHz BW		
	5 755 MHz ~ 5 795 MHz_40 MHz BW		
MAX. RF OUTPUT POWER	2 400 MHz ~ 2 483.5 MHz Band	Antenna 0	Wi-Fi 802.11b(12.76 dBm) Wi-Fi 802.11g (11.92 dBm) Wi-Fi 802.11n_20 MHz (10.62 dBm) Wi-Fi 802.11n_40 MHz (8.55 dBm)
		Antenna 1	Wi-Fi 802.11b(13.15 dBm) Wi-Fi 802.11g (11.85 dBm) Wi-Fi 802.11n_20 MHz (10.92 dBm) Wi-Fi 802.11n_40 MHz (8.22 dBm)
	Ant.0	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (10.31 dBm) Wi-Fi 802.11n_20 MHz (9.58 dBm) Wi-Fi 802.11n_40 MHz (7.83 dBm)
		5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (10.43 dBm) Wi-Fi 802.11n_20 MHz (9.97 dBm) Wi-Fi 802.11n_40 MHz (7.70 dBm)
		5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (10.23 dBm) Wi-Fi 802.11n_20 MHz (9.55 dBm) Wi-Fi 802.11n_40 MHz (7.97 dBm)
		5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (9.60 dBm) Wi-Fi 802.11n_20 MHz (8.94 dBm) Wi-Fi 802.11n_40 MHz (7.46 dBm)

MAX. RF OUTPUT POWER	Ant.1	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (9.64 dBm) Wi-Fi 802.11n_20 MHz (8.70 dBm) Wi-Fi 802.11n_40 MHz (6.98 dBm)
		5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (9.29 dBm) Wi-Fi 802.11n_20 MHz (8.27 dBm) Wi-Fi 802.11n_40 MHz (7.13 dBm)
		5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (11.15 dBm) Wi-Fi 802.11n_20 MHz (9.77 dBm) Wi-Fi 802.11n_40 MHz (9.43 dBm)
		5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (10.87 dBm) Wi-Fi 802.11n_20 MHz (9.68 dBm) Wi-Fi 802.11n_40 MHz (8.65 dBm)
MODULATION TYPE	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK) 802.11a/g/n(HT20)/n(HT40): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)		
Antenna Gain	2.4 GHz Band	Antenna 0 : 1.03 dBi	
		Antenna 1 : 1.01 dBi	
	5 GHz Band	Antenna 0 : 1.05 dBi	
		Antenna 1 : 1.31 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	40 MHz		

2.2 Alternative type(s)/model(s); also covered by this test report.

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
TWFM-K001D	Basic Model	☒
TWFM-K002D, TWFM-K003D	These models are identical to basic model except for the model name only.	☐

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacture is responsible for the compliance of all variants.

3. EUT MODIFICATIONS

-. None

4. MAXIMUM PERMISSIBLE EXPOSURE

4.1 RF Exposure Calculation

According to the FCC rule 1.1310 table 1B, the limit for the maximum permissible RF exposure for an uncontrolled environment are $f/1500 \text{ mW/cm}^2$ for the frequency range between 300 MHz and 1 500 MHz and 1.0 mW/cm^2 for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a 1 mW/cm^2 exposure is calculated as follows:

$$E = \sqrt{(30 * P * G) / d}, \text{ and } S = E^2 / Z = E^2 / 377, \text{ because } 1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$$

Where

S = Power density in mW/cm^2 , Z = Impedance of free space, 377Ω

E = Electric field strength in V/m , G = Numeric antenna gain, and d = distance in meter

Combining equations and rearranging the terms to express the distance as a function of the remaining variable

$$d = \sqrt{(30 * P * G) / (377 * 10 S)}$$

Changing to units of mW and cm, using $P (\text{mW}) = P (\text{W}) / 1 000$, $d (\text{cm}) = 0.01 * d (\text{m})$

$$d = 0.282 * \sqrt{(P * G) / S}$$

Where

d = distance in cm, P = Power in mW, G = Numeric antenna gain, and S = Power density in mW/cm^2

4.2 EUT Description

Kind of EUT	Wi-Fi module		
Operating Frequency Band	☐ Wireless Microphone: 494.000 MHz ~ 501.000 MHz and 498.200 MHz ~ 505.200 MHz ☒ WLAN: 2 412 MHz ~ 2 462 MHz ☒ WLAN: 5 180 MHz ~ 5 320 MHz / 5 500 MHz ~ 5 700 MHz ☒ WLAN: 5 745 MHz ~ 5 825 MHz ☐ Bluetooth: 2 402 MHz ~ 2 480 MHz ☐ GFSK Modulation: 2403 MHz , 2443 MHz , 2478 MHz		
Device Category	☐ Portable (< 20 cm separation) ☐ Mobile (> 20 cm separation) ☒ Others		
Max. Output Power	2.4 GHz Band	Ant.0	Wi-Fi 802.11b(12.76 dBm) Wi-Fi 802.11g (11.92 dBm) Wi-Fi 802.11n_20 MHz (10.62 dBm) Wi-Fi 802.11n_40 MHz (8.55 dBm)
		Ant.1	Wi-Fi 802.11b(13.15 dBm) Wi-Fi 802.11g (11.85 dBm) Wi-Fi 802.11n_20 MHz (10.92 dBm) Wi-Fi 802.11n_40 MHz (8.22 dBm)

Max. Output Power	5 GHz Band	Ant.0	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (10.31 dBm) Wi-Fi 802.11n_20 MHz (9.58 dBm) Wi-Fi 802.11n_40 MHz (7.83 dBm)
			5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (10.43 dBm) Wi-Fi 802.11n_20 MHz (9.97 dBm) Wi-Fi 802.11n_40 MHz (7.70 dBm)
			5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (10.23 dBm) Wi-Fi 802.11n_20 MHz (9.55 dBm) Wi-Fi 802.11n_40 MHz (7.97 dBm)
			5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (9.60 dBm) Wi-Fi 802.11n_20 MHz (8.94 dBm) Wi-Fi 802.11n_40 MHz (7.46 dBm)
		Ant.1	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (9.64 dBm) Wi-Fi 802.11n_20 MHz (8.70 dBm) Wi-Fi 802.11n_40 MHz (6.98 dBm)
			5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (9.29 dBm) Wi-Fi 802.11n_20 MHz (8.27 dBm) Wi-Fi 802.11n_40 MHz (7.13 dBm)
			5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (11.15 dBm) Wi-Fi 802.11n_20 MHz (9.77 dBm) Wi-Fi 802.11n_40 MHz (9.43 dBm)
			5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (10.87 dBm) Wi-Fi 802.11n_20 MHz (9.68 dBm) Wi-Fi 802.11n_40 MHz (8.65 dBm)
Used Antenna Gain	2.4 GHz Band	Antenna 0 : 1.03 dBi		
		Antenna 1 : 1.01 dBi		
	5 GHz Band	Antenna 0 : 1.05 dBi		
		Antenna 1 : 1.31 dBi		
Exposure Evaluation Applied	■ MPE □ SAR □ N/A			

2.4GHz & 5GHz can not transmit at the same time.

5.2 Calculated MPE Safe Distance

5.2.1 Test data for Antenna 0

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	12.5 ± 0.5	13.0	19.95	1.03	1.268	1.42	0.0050	1.00
	802.11g	11.5 ± 0.5	12.0	15.85			1.26	0.0040	1.00
	802.11n_HT20	10.5 ± 0.5	11.0	12.59			1.13	0.0032	1.00
	802.11n_HT40	8.5 ± 0.5	12.91	19.54			1.40	0.0049	1.00
5 150 ~ 5 250	802.11a	10.0 ± 0.5	10.5	11.22	1.05	1.274	1.07	0.0028	1.00
	802.11n_HT20	9.5 ± 0.5	10.0	10.00			1.01	0.0025	1.00
	802.11n_HT40	7.5 ± 0.5	8.0	6.31			0.80	0.0016	1.00
5 250 ~ 5 350	802.11a	9.0 ± 1.0	10.0	10.00			1.01	0.0025	1.00
	802.11n_HT20	9.5 ± 0.5	10.0	10.00			1.01	0.0025	1.00
	802.11n_HT40	7.5 ± 0.5	8.0	6.31			0.80	0.0016	1.00
5 470 ~ 5 725	802.11a	10.0 ± 0.5	10.5	11.22			1.07	0.0028	1.00
	802.11n_HT20	9.0 ± 1.0	10.0	10.00			1.01	0.0025	1.00
	802.11n_HT40	8.0 ± 1.0	9.0	7.94			0.90	0.0020	1.00
5 725 ~ 5 825	802.11a	9.0 ± 1.0	10.0	10.00			1.01	0.0025	1.00
	802.11n_HT20	8.5 ± 0.5	9.0	7.94			0.90	0.0020	1.00
	802.11n_HT40	7.0 ± 0.5	7.5	5.62			0.75	0.0014	1.00

5.2.2 Test data for Antenna 1

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	13.0 ± 0.5	13.5	22.39	1.01	1.262	1.50	0.0056	1.00
	802.11g	11.5 ± 0.5	12.0	15.85			1.26	0.0040	1.00
	802.11n_HT20	10.5 ± 0.5	11.0	12.59			1.12	0.0032	1.00
	802.11n_HT40	8.0 ± 0.5	8.5	7.08			0.84	0.0018	1.00
5 150 ~ 5 250	802.11a	9.0 ± 1.0	10.0	10.00	1.31	1.352	1.04	0.0027	1.00
	802.11n_HT20	8.0 ± 1.0	9.0	7.94			0.92	0.0021	1.00
	802.11n_HT40	6.5 ± 0.5	7.0	5.01			0.73	0.0013	1.00
5 250 ~ 5 350	802.11a	9.0 ± 1.0	10.0	10.00			1.04	0.0027	1.00
	802.11n_HT20	8.0 ± 0.5	8.5	7.08			0.87	0.0019	1.00
	802.11n_HT40	7.0 ± 0.5	7.5	5.62			0.78	0.0015	1.00
5 470 ~ 5 725	802.11a	10.5 ± 1.0	11.5	14.13			1.23	0.0038	1.00
	802.11n_HT20	9.0 ± 1.0	10.0	10.00			1.04	0.0027	1.00
	802.11n_HT40	8.0 ± 1.0	9.0	7.94			0.92	0.0021	1.00
5 725 ~ 5 825	802.11a	10.5 ± 0.5	11.0	12.59			1.16	0.0034	1.00
	802.11n_HT20	9.5 ± 0.5	10.0	10.00			1.04	0.0027	1.00
	802.11n_HT40	8.5 ± 0.5	9.0	7.94			0.92	0.0021	1.00

5.2.3 Test data for Multiple transmit

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	15.5 ± 0.5	16.0	39.81	4.03	2.529	2.83	0.0200	1.00
	802.11g	14.5 ± 0.5	15.0	31.62			2.52	0.0159	1.00
	802.11n_HT20	13.5 ± 0.5	14.0	25.12			2.25	0.0126	1.00
	802.11n_HT40	11.0 ± 0.5	11.5	14.13			1.69	0.0071	1.00
5 150 ~ 5 250	802.11a	12.5 ± 0.5	13.0	19.95	4.19	2.624	2.04	0.0104	1.00
	802.11n_HT20	12.0 ± 1.0	13.0	19.95			2.04	0.0104	1.00
	802.11n_HT40	10.0 ± 0.5	10.5	11.22			1.53	0.0059	1.00
5 250 ~ 5 350	802.11a	12.5 ± 0.5	13.0	19.95			2.04	0.0104	1.00
	802.11n_HT20	11.5 ± 0.5	12.0	15.85			1.82	0.0083	1.00
	802.11n_HT40	10.0 ± 0.5	10.5	11.22			1.53	0.0059	1.00
5 470 ~ 5 725	802.11a	13.0 ± 0.5	13.5	22.39			2.16	0.0117	1.00
	802.11n_HT20	12.0 ± 1.0	13.0	19.95			2.04	0.0104	1.00
	802.11n_HT40	11.0 ± 1.0	12.0	15.85			1.82	0.0083	1.00
5 725 ~ 5 825	802.11a	13.0 ± 0.5	13.5	22.39			2.16	0.0117	1.00
	802.11n_HT20	12.0 ± 0.5	12.5	17.78			1.93	0.0093	1.00
	802.11n_HT40	10.5 ± 0.5	11.0	12.59			1.62	0.0066	1.00