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

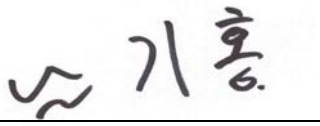
Test Report No.	**: E141R-016**
AGR No.	**: A13NA-058, A13NA-059**
Applicant	**: LG Innotek Co., Ltd.**
Address	**: 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, Korea. 506-731**
Manufacturer	**: LG Innotek Co., Ltd.**
Address	**: 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, Korea. 506-731**
Type of Equipment	**: Wi-Fi module**
FCC ID.	**: YZP-TWFML006D**
IC Certification No.	**: 7414C-TWFML006D**
Model Name	**: TWFM-L006D**
Serial number	**: N/A**
Total page of Report	**: 11 pages (including this page)**
Date of Incoming	**: December 03, 2013**
Date of issue	**: January 07, 2014**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART C Section 15.247, FCC PART 15 SUBPART E Section 15.407 and IC RSS-Gen Issue 3 and RSS 210 Issue 8.***

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.

Prepared by: 

Ki-Hong, Nam / Senior Engineer
ONETECH Corp.

Approved by: 

Gea-Won, Lee / Managing Director
ONETECH Corp.

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
E141R-016	January 07, 2014	Initial Issue	All

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1. VERIFICATION OF COMPLIANCE

Applicant	: LG Innotek Co., Ltd.
Address	: 978-1, Jangduk-dong, Gwangsan-gu, Gwangju, Korea. 506-731
Contact Person	: IC Jeong / Senior engineer
Telephone No.	: +82-62-950-0332
FCC ID	: YZP-TWFML006D
CERTIFICATION NO.	: 7414C-TWFML006D
Model Name	: TWFM-L006D
Serial Number	: N/A
Date	: January 07, 2014

EQUIPMENT CLASS	FCC: DTS – DIGITAL TRNSMISSION SYSTEM Unlicensed National Information infrastructure(UNII) IC: Low Power License-Exempt Radio-communication Device
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2009
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 FCC PART 15 SUBPART E Section 15.407 RSS 210 Issue 8, RSS-Gen Issue 3.
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m open area test site

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the IC 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.

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2. GENERAL INFORMATION

2.1 Product Description

The LG Innotek Co., Ltd., Model TWFM-L006D (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.

<table>
<tr><td>DEVICE TYPE</td><td colspan="3">Wi-Fi module</td></tr>
<tr><td rowspan="10">FREQUENCY RANGE</td><td rowspan="2">2 400 MHz ~ 2 483.5 MHz Band</td><td colspan="2">2 412 MHz ~ 2 462 MHz_20 MHz BW</td></tr>
<tr><td colspan="2">2 422 MHz ~ 2 452 MHz_40 MHz BW</td></tr>
<tr><td rowspan="2">5 150 MHz ~ 5 250 MHz Band</td><td colspan="2">5 180 MHz ~ 5 240 MHz_20 MHz BW</td></tr>
<tr><td colspan="2">5 190 MHz ~ 5 230 MHz_40 MHz BW</td></tr>
<tr><td rowspan="2">5 250 MHz ~ 5 350 MHz Band</td><td colspan="2">5 260 MHz ~ 5 320 MHz_20 MHz BW</td></tr>
<tr><td colspan="2">5 270 MHz ~ 5 310 MHz_40 MHz BW</td></tr>
<tr><td rowspan="2">5 470 MHz ~ 5 725 MHz Band</td><td colspan="2">5 500 MHz ~ 5 700 MHz_20 MHz BW</td></tr>
<tr><td colspan="2">5 510 MHz ~ 5 670 MHz_40 MHz BW</td></tr>
<tr><td rowspan="2">5 725 MHz ~ 5 850 MHz Band</td><td colspan="2">5 745 MHz ~ 5 825 MHz_20 MHz BW</td></tr>
<tr><td colspan="2">5 755 MHz ~ 5 795 MHz_40 MHz BW</td></tr>
<tr><td rowspan="5">MAX. RF OUTPUT POWER:</td><td rowspan="5">Ant.0</td><td>2 400 MHz ~ 2 483.5 MHz Band</td><td>Wi-Fi 802.11b(14.24 dBm)
Wi-Fi 802.11g (12.36 dBm)
Wi-Fi 802.11n_20 MHz (11.01 dBm)
Wi-Fi 802.11n_40 MHz (10.09 dBm)</td></tr>
<tr><td>5 150 MHz ~ 5 250 MHz Band</td><td>Wi-Fi 802.11a (8.82 dBm)
Wi-Fi 802.11n_20 MHz (6.74 dBm)
Wi-Fi 802.11n_40 MHz (5.87 dBm)</td></tr>
<tr><td>5 250 MHz ~ 5 350 MHz Band</td><td>Wi-Fi 802.11a (8.54 dBm)
Wi-Fi 802.11n_20 MHz (7.16 dBm)
Wi-Fi 802.11n_40 MHz (6.53 dBm)</td></tr>
<tr><td>5 470 MHz ~ 5 725 MHz Band</td><td>Wi-Fi 802.11a (8.27 dBm)
Wi-Fi 802.11n_20 MHz (6.82 dBm)
Wi-Fi 802.11n_40 MHz (5.96 dBm)</td></tr>
<tr><td>5 725 MHz ~ 5 850 MHz Band</td><td>Wi-Fi 802.11a (10.24 dBm)
Wi-Fi 802.11n_20 MHz (8.70 dBm)
Wi-Fi 802.11n_40 MHz (8.22 dBm)</td></tr>
</table>

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MAX. RF OUTPUT POWER:	Ant.1	2 400 MHz ~ 2 483.5 MHz Band	Wi-Fi 802.11b(14.85 dBm) Wi-Fi 802.11g (11.97 dBm) Wi-Fi 802.11n_20 MHz (10.58 dBm) Wi-Fi 802.11n_40 MHz (9.72 dBm)
		5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (8.37 dBm) Wi-Fi 802.11n_20 MHz (6.63 dBm) Wi-Fi 802.11n_40 MHz (5.62 dBm)
		5 250 MHz ~ 5 350 MHz Band	Wi-Fi 802.11a (8.92 dBm) Wi-Fi 802.11n_20 MHz (7.90 dBm) Wi-Fi 802.11n_40 MHz (6.87 dBm)
		5 470 MHz ~ 5 725 MHz Band	Wi-Fi 802.11a (8.88 dBm) Wi-Fi 802.11n_20 MHz (7.78 dBm) Wi-Fi 802.11n_40 MHz (6.26 dBm)
		5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (10.59 dBm) Wi-Fi 802.11n_20 MHz (9.12 dBm) Wi-Fi 802.11n_40 MHz (7.48 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	1.5 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.

-. None

3. EUT MODIFICATIONS

-. None

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4. SYSTEM TEST CONFIGURATION

4.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	LG Innotek Co., Ltd.	TWFM-L006D	N/A

4.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
TWFM-L006D	LG Innotek Co., Ltd.	Wi-Fi module (EUT)	Note PC
LGR51	LG Electronics	Notebook PC	EUT

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5. MAXIMUM PERMISSIBLE EXPOSURE

5.1 RF Exposure Calculation

According to the FCC rule 1.1310 table 1B, and IC rule RSS-102 Section 2.4.1, the limit for the maximum permissible RF exposure for an uncontrolled environment are f/1500 mW/cm² for the frequency range between 300 MHz and 1 500 MHz and 1.0 mW/cm² for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a 1 mW/cm² exposure is calculated as follows:

$E = \sqrt{(30 * P * G)} / d$, and $S = E^2 / Z = E^2 / 377$, because 1 mW/cm² = 10 W/m²

Where

S = Power density in mW/cm², Z = Impedance of free space, 377 Ω

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

Combing 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 (mW) = P (W) / 1 000, d (cm) = 0.01 * d (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/cm²

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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	Peak Output Power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	14.22	26.42	1.50	1.41	1.72	0.007 4	1.00
	802.11g	12.40	17.38			1.40	0.004 9	1.00
	802.11n_ HT20	10.84	12.13			1.17	0.003 4	1.00
	802.11n_HT40	10.22	10.52			1.09	0.003 0	1.00
5 150 ~ 5 250	802.11a	8.82	7.62			0.93	0.002 1	1.00
	802.11n_ HT20	6.74	4.72			0.73	0.001 3	1.00
	802.11n_HT40	5.87	3.86			0.66	0.001 1	1.00
5 250 ~ 5 350	802.11a	8.54	7.14			0.90	0.002 0	1.00
	802.11n_ HT20	7.16	5.20			0.76	0.001 5	1.00
	802.11n_HT40	6.53	4.50			0.71	0.001 3	1.00
5 470 ~ 5 725	802.11a	8.27	6.71			0.87	0.001 9	1.00
	802.11n_ HT20	6.82	4.81			0.73	0.001 4	1.00
	802.11n_HT40	5.96	3.94			0.67	0.001 1	1.00
5 725 ~ 5 825	802.11a	10.25	10.59			1.09	0.003 0	1.00
	802.11n_ HT20	8.53	7.13			0.89	0.002 0	1.00
	802.11n_HT40	8.21	6.62			0.86	0.001 9	1.00

According to above table, for example 802.11b mode of 2 400 ~ 2 483.5 MHz Band, safe distance,

$D = 0.282 * \sqrt{(26.42 * 1.41)/1.00} = 1.72$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P * G / (4\pi * R^2) = 26.42 * 1.41 / (4 * 3.14 * 20^2) = 0.007\ 4$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

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5.2.2 Test data for Antenna 1

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Peak Output Power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	14.63	29.04	1.50	1.41	1.81	0.008 2	1.00
	802.11g	11.94	15.63			1.33	0.004 4	1.00
	802.11n_HT20	10.43	11.04			1.11	0.003 1	1.00
	802.11n_HT40	12.91	19.54			1.48	0.005 5	1.00
5 150 ~ 5 250	802.11a	8.37	6.87			0.88	0.001 9	1.00
	802.11n_HT20	6.63	4.60			0.72	0.001 3	1.00
	802.11n_HT40	5.62	3.65			0.64	0.001 0	1.00
5 250 ~ 5 350	802.11a	8.92	7.80			0.94	0.002 2	1.00
	802.11n_HT20	7.90	6.17			0.83	0.001 7	1.00
	802.11n_HT40	6.87	4.86			0.74	0.001 4	1.00
5 470 ~ 5 725	802.11a	8.88	7.73			0.93	0.002 2	1.00
	802.11n_HT20	7.78	6.00			0.82	0.001 7	1.00
	802.11n_HT40	6.26	4.23			0.69	0.001 2	1.00
5 725 ~ 5 825	802.11a	10.33	10.79			1.10	0.003 0	1.00
	802.11n_HT20	9.03	8.00			0.95	0.002 2	1.00
	802.11n_HT40	7.48	5.60			0.79	0.001 6	1.00

According to above table, for example 802.11b mode of 2 400 ~ 2 483.5 MHz Band, safe distance,

$D = 0.282 * \sqrt{(29.04 * 1.41)/1.00} = 1.81$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P * G / (4\pi * R^2) = 29.04 * 1.41 / (4 * 3.14 * 20^2) = 0.008\ 2$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

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5.2.3 Test data for Multiple transmit

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Peak Output Power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	17.42	55.21	1.50	1.41	2.49	0.015 5	1.00
	802.11g	15.19	33.04			1.93	0.009 3	1.00
	802.11n_HT20	13.65	23.17			1.61	0.006 5	1.00
	802.11n_HT40	12.91	19.54			1.48	0.005 5	1.00
5 150 ~ 5 250	802.11a	11.37	13.71			1.24	0.003 9	1.00
	802.11n_HT20	9.70	9.33			1.02	0.002 6	1.00
	802.11n_HT40	8.76	7.52			0.92	0.002 1	1.00
5 250 ~ 5 350	802.11a	11.58	14.39			1.27	0.004 0	1.00
	802.11n_HT20	10.52	11.27			1.13	0.003 2	1.00
	802.11n_HT40	9.44	8.79			0.99	0.002 5	1.00
5 470 ~ 5 725	802.11a	11.60	14.45			1.27	0.004 1	1.00
	802.11n_HT20	10.34	10.81			1.10	0.003 0	1.00
	802.11n_HT40	9.12	8.17			0.96	0.002 3	1.00
5 725 ~ 5 825	802.11a	13.30	21.38			1.55	0.006 0	1.00
	802.11n_HT20	11.80	15.14			1.30	0.004 3	1.00
	802.11n_HT40	10.87	12.22			1.17	0.003 4	1.00

According to above table, for example 802.11b mode of 2 400 ~ 2 483.5 MHz Band, safe distance,

$D = 0.282 * \sqrt{(55.21 * 1.41)/1.00} = 2.49$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P * G / (4\pi * R^2) = 55.21 * 1.41 / (4 * 3.14 * 20^2) = 0.015\ 5$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

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