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

Test Report No.	**: OT-182-RWD-030**
AGR No.	**: A181A-388**
Applicant	**: LG Innotek Co., Ltd.**
Address	**: 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea**
Manufacturer	**: LG Innotek Co., Ltd.**
Address	**: 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea**
Type of Equipment	**: 802.11 a/b/g/n/ac WiFi Module**
FCC ID.	**: YZP-TWFMR003D**
Model Name	**: TWFM-R003D**
Multiple Model Name	**: TWFM-R003D(A), TWFM-R003D(B)**
Serial number	**: N/A**
Total page of Report	**: 13 pages (including this page)**
Date of Incoming	**: February 02, 2018**
Date of issue	**: February 19, 2018**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART E Section 15.407***

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: Keun-Young, Choi / Vice President
ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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REVISION HISTORY

Issued Report No.	Issued Date	Revisions	Effect Section
W178R-D013	August 07, 2017	Initial Issue	All
OT-182-RWD-030	February 19, 2018	Added the multiple model.	All

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1. VERIFICATION OF COMPLIANCE

Applicant	: LG Innotek Co., Ltd.
Address	: 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Contact Person	: Jeong Inchang / Senior Research Engineer
Telephone No.	: +82-62-950-0332
FCC ID	: YZP-TWFMR003D
Model Name	: TWFM-R003D
Serial Number	: N/A
Date	: February 19, 2018

EQUIPMENT CLASS	Unlicensed National Information infrastructure(UNII)
E.U.T. DESCRIPTION	Modular Transmitter, 802.11 a/b/g/n/ac WiFi Module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART E Section 15.407 KDB 789033 D02 General UNII Test Procedures New Rules V02r01
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.

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2. GENERAL INFORMATION

2.1 Product Description

The LG Innotek Co., Ltd., Model TWFM-R003D (referred to as the EUT in this report) is a 802.11 a/b/g/n/ac WiFi 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">802.11 a/b/g/n/ac WiFi Module</td></tr>
<tr><td rowspan="8">Operating Frequency</td><td rowspan="2">WLAN
2.4 GHz Band</td><td colspan="2">2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))</td></tr>
<tr><td colspan="2">2 422 MHz ~ 2 452 MHz (802.11n(HT40))</td></tr>
<tr><td rowspan="6">WLAN
5 GHz Band</td><td rowspan="3">5 150 MHz ~
5 250 MHz Band</td><td>5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))</td></tr>
<tr><td>5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))</td></tr>
<tr><td>5 210 MHz (802.11ac(VHT80))</td></tr>
<tr><td rowspan="3">5 725 MHz ~
5 850 MHz Band</td><td>5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(VHT20))</td></tr>
<tr><td>5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))</td></tr>
<tr><td>5 775 MHz (802.11ac(VHT80))</td></tr>
<tr><td rowspan="3">RF Output Power</td><td rowspan="3">WLAN
2.4 GHz Band</td><td>Antenna 0</td><td>Wi-Fi 802.11b (12.78 dBm)
Wi-Fi 802.11g (11.73 dBm)
Wi-Fi 802.11n(HT20) (10.96 dBm)
Wi-Fi 802.11n(HT40) (10.16 dBm)</td></tr>
<tr><td>Antenna 1</td><td>Wi-Fi 802.11b (14.32 dBm)
Wi-Fi 802.11g (12.84 dBm)
Wi-Fi 802.11n(HT20) (10.83 dBm)
Wi-Fi 802.11n(HT40) (10.77 dBm)</td></tr>
<tr><td>Antenna 0
+ Antenna 1</td><td>Wi-Fi 802.11b (16.63 dBm)
Wi-Fi 802.11g (15.33 dBm)
Wi-Fi 802.11n(HT20) (13.86 dBm)
Wi-Fi 802.11n(HT40) (13.49 dBm)</td></tr>
</table>

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RF Output Power	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (9.37 dBm) Wi-Fi 802.11n(HT20) (7.49 dBm) Wi-Fi 802.11n(HT40) (7.58 dBm) Wi-Fi 802.11ac(HT80) (6.30 dBm)
			Antenna 1	Wi-Fi 802.11a (10.14 dBm) Wi-Fi 802.11n(HT20) (8.00 dBm) Wi-Fi 802.11n(HT40) (8.43 dBm) Wi-Fi 802.11ac(HT80) (6.10 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11a (12.78 dBm) Wi-Fi 802.11n(HT20) (10.76 dBm) Wi-Fi 802.11n(HT40) (11.04 dBm) Wi-Fi 802.11ac(HT80) (9.21 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (9.83 dBm) Wi-Fi 802.11n(HT20) (7.76 dBm) Wi-Fi 802.11n(HT40) (7.62 dBm) Wi-Fi 802.11ac(HT80) (5.74 dBm)
			Antenna 1	Wi-Fi 802.11a (9.80 dBm) Wi-Fi 802.11n(HT20) (7.71 dBm) Wi-Fi 802.11n(HT40) (7.72 dBm) Wi-Fi 802.11ac(HT80) (5.84 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11a (12.83 dBm) Wi-Fi 802.11n(HT20) (10.75 dBm) Wi-Fi 802.11n(HT40) (10.57 dBm) Wi-Fi 802.11ac(HT80) (8.80 dBm)

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Modulation Type	WLAN 2.4 GHz Band	DSSS Modulation(DBPSK/DQPSK/CCK) OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
	WLAN 5 GHz Band	OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
Antenna Type	WLAN 2.4 GHz Band	Antenna 0	UANZZZWHA002 : 1.30 dBi UANZZZWHA003 : 1.20 dBi
		Antenna 1	2.13 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.75 dBi UANZZZWHA003 + Antenna 1 : 4.70 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	UANZZZWHA002 : 1.00 dBi UANZZZWHA003 : 1.30 dBi
		Antenna 1	1.01 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.02 dBi UANZZZWHA003 + Antenna 1 : 4.17 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	UANZZZWHA002 : 1.30 dBi UANZZZWHA003 : 1.20 dBi
		Antenna 1	2.04 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.70 dBi UANZZZWHA003 + Antenna 1 : 4.65 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-R003D	Basic Model	☐
TWFM-R003D(A)	The difference between this model and the basic model is the PDN function added (Main IC Wake-up) and resistance component R6 added.	☐
TWFM-R003D(B)	The difference between this model and the basic model is the Antenna.	☑

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

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

3. EUT MODIFICATIONS

-. None

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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 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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4.2 EUT Description

Kind of EUT	802.11 a/b/g/n/ac WiFi Module
Operating Frequency Band	■ WLAN: 2 412 MHz ~ 2 462 MHz ■ WLAN: 2 422 MHz ~ 2 452 MHz ■ WLAN: 5 180 MHz ~ 5 240 MHz ■ WLAN: 5 190 MHz ~ 5 230 MHz ■ WLAN: 5 210 MHz ■ WLAN: 5 745 MHz ~ 5 825 MHz ■ WLAN: 5 755 MHz ~ 5 795 MHz ■ WLAN: 5 775 MHz
Device Category	☐ Portable (< 20 cm separation) ☐ Mobile (> 20 cm separation) ■ Others
Exposure Evaluation Applied	■ MPE ☐ SAR ☐ N/A

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RF Output Power	WLAN 2.4 GHz Band	Antenna 0	Wi-Fi 802.11b (12.78 dBm) Wi-Fi 802.11g (11.73 dBm) Wi-Fi 802.11n(HT20) (10.96 dBm) Wi-Fi 802.11n(HT40) (10.16 dBm)	
		Antenna 1	Wi-Fi 802.11b (14.32 dBm) Wi-Fi 802.11g (12.84 dBm) Wi-Fi 802.11n(HT20) (10.83 dBm) Wi-Fi 802.11n(HT40) (10.77 dBm)	
		Antenna 0 + Antenna 1	Wi-Fi 802.11b (16.63 dBm) Wi-Fi 802.11g (15.33 dBm) Wi-Fi 802.11n(HT20) (13.86 dBm) Wi-Fi 802.11n(HT40) (13.49 dBm)	
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (9.37 dBm) Wi-Fi 802.11n(HT20) (7.49 dBm) Wi-Fi 802.11n(HT40) (7.58 dBm) Wi-Fi 802.11ac(HT80) (6.30 dBm)
			Antenna 1	Wi-Fi 802.11a (10.14 dBm) Wi-Fi 802.11n(HT20) (8.00 dBm) Wi-Fi 802.11n(HT40) (8.43 dBm) Wi-Fi 802.11ac(HT80) (6.10 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11a (12.78 dBm) Wi-Fi 802.11n(HT20) (10.76 dBm) Wi-Fi 802.11n(HT40) (11.04 dBm) Wi-Fi 802.11ac(HT80) (9.21 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (9.83 dBm) Wi-Fi 802.11n(HT20) (7.76 dBm) Wi-Fi 802.11n(HT40) (7.62 dBm) Wi-Fi 802.11ac(HT80) (5.74 dBm)
			Antenna 1	Wi-Fi 802.11a (9.80 dBm) Wi-Fi 802.11n(HT20) (7.71 dBm) Wi-Fi 802.11n(HT40) (7.72 dBm) Wi-Fi 802.11ac(HT80) (5.84 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11a (12.83 dBm) Wi-Fi 802.11n(HT20) (10.75 dBm) Wi-Fi 802.11n(HT40) (10.57 dBm) Wi-Fi 802.11ac(HT80) (8.80 dBm)

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Antenna Type	WLAN 2.4 GHz Band	Antenna 0	UANZZZWHA002 : 1.30 dBi UANZZZWHA003 : 1.20 dBi
		Antenna 1	2.13 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.75 dBi UANZZZWHA003 + Antenna 1 : 4.70 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	UANZZZWHA002 : 1.00 dBi UANZZZWHA003 : 1.30 dBi
		Antenna 1	1.01 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.02 dBi UANZZZWHA003 + Antenna 1 : 4.17 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	UANZZZWHA002 : 1.30 dBi UANZZZWHA003 : 1.20 dBi
		Antenna 1	2.04 dBi
		Antenna 0 + Antenna 1	UANZZZWHA002 + Antenna 1 : 4.70 dBi UANZZZWHA003 + Antenna 1 : 4.65 dBi

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4.3 Calculated MPE Safe Distance for Antenna 0 (UANZZZWHA002)

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/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	13.0 ± 0.5	13.50	22.39	4.02	2.52	2.12	0.011 2	1.00
	802.11n_ HT20	11.0 ± 0.5	11.50	14.13			1.68	0.007 1	1.00
	802.11n_HT40	11.5 ± 0.5	12.00	15.85			1.78	0.008 0	1.00
	802.11ac80	9.5 ± 0.5	10.00	10.00			1.42	0.005 0	1.00
5 725 ~ 5 850	802.11a	13.0 ± 0.5	13.50	22.39	4.70	2.95	2.29	0.013 2	1.00
	802.11n_ HT20	11.0 ± 0.5	11.50	14.13			1.82	0.008 3	1.00
	802.11n_HT40	10.5 ± 0.5	11.00	12.59			1.72	0.007 4	1.00
	802.11ac80	9.0 ± 0.5	9.50	8.91			1.45	0.005 2	1.00

According to above table, for 5 725 ~ 5 850 MHz Band, safe distance,

D = 0.282 * √ (22.39 * 2.95)/1.00 = 2.29 cm.

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

$S = P * G / (4\pi * R^2) = 22.39 * 2.95 / (4 * 3.14 * 20^2) = 0.013\ 2$

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

Tested by: Hyung-Kwon, Oh / Assistant Manager

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4.4 Calculated MPE Safe Distance for Antenna 0 (UANZZZWHA003)

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/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	13.0 ± 0.5	13.50	22.39	4.17	2.61	2.16	0.011 6	1.00
	802.11n_ HT20	11.0 ± 0.5	11.50	14.13			1.71	0.007 3	1.00
	802.11n_HT40	11.5 ± 0.5	12.00	15.85			1.81	0.008 2	1.00
	802.11ac80	9.5 ± 0.5	10.00	10.00			1.44	0.005 2	1.00
5 725 ~ 5 850	802.11a	13.0 ± 0.5	13.50	22.39	4.65	2.92	2.28	0.013 0	1.00
	802.11n_ HT20	11.0 ± 0.5	11.50	14.13			1.81	0.008 2	1.00
	802.11n_HT40	10.5 ± 0.5	11.00	12.59			1.71	0.007 3	1.00
	802.11ac80	9.0 ± 0.5	9.50	8.91			1.44	0.005 2	1.00

According to above table, for 5 725 ~ 5 850 MHz Band, safe distance,

D = 0.282 * √ (22.39 * 2.92)/1.00 = 2.28 cm.

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

$S = P * G / (4\pi * R^2) = 22.39 * 3.75 / (4 * 3.14 * 20^2) = 0.013\ 0$

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

Tested by: Hyung-Kwon, Oh / Assistant Manager

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