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

Test Report No. : **W161R-D018**

AGR No. : **A15DA-264**

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/BT Combo module**

FCC ID. : **YZP-TWCMK007D**

Model Name : **TWCM-K007D**

Serial number : **N/A**

Total page of Report : **13 pages (including this page)**

Date of Incoming : **December 28, 2015**

Date of issue : **January 25, 2016**

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

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EMC Testing Div. : 307-51 Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do 464-862 Korea (TEL: 82-31-765-8289, FAX: 82-31-766-2904)

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W161R-D018	January 25, 2016	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-TWCMK007D
Model Name	: TWCM-K007D
Serial Number	: N/A
Date	: January 25, 2016

EQUIPMENT CLASS	Unlicensed National Information infrastructure(UNII)
E.U.T. DESCRIPTION	Modular Transmitter, Wi-Fi/BT Combo 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
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 TWCM-K007D (referred to as the EUT in this report) is a Wi-Fi/BT Combo 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/BT Combo module</td></tr>
<tr><td rowspan="8">FREQUENCY RANGE</td><td>Bluetooth</td><td colspan="2">2 402 MHz ~ 2 480 MHz</td></tr>
<tr><td>Bluetooth LE</td><td colspan="2">2 402 MHz ~ 2 480 MHz</td></tr>
<tr><td>WLAN 2.4 GHz Band</td><td colspan="2">2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
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
(802.11n(HT20)/ac20)</td></tr>
<tr><td>5 190 MHz ~ 5 230 MHz
(802.11n(HT40)/ac40)</td></tr>
<tr><td>5 210 MHz (802.11ac80)</td></tr>
<tr><td rowspan="3">5 725 MHz ~
5 850 MHz Band</td><td>5 745 MHz ~ 5 825 MHz
(802.11n(HT20)/ac20)</td></tr>
<tr><td>5 755 MHz ~ 5 795 MHz
(802.11n(HT40)/ac40)</td></tr>
<tr><td>5 775 MHz (802.11ac80)</td></tr>
</table>

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MAX. RF OUTPUT POWER	Bluetooth		1 Mbps	5.94 dBm
			2 Mbps	6.77 dBm
			3 Mbps	7.07 dBm
	Bluetooth LE		1.43 dBm	
	WLAN 2.4 GHz Band	Ant.0	Wi-Fi 802.11b (12.72 dBm) Wi-Fi 802.11g (11.75 dBm) Wi-Fi 802.11n_20 MHz (10.54 dBm) Wi-Fi 802.11n_40 MHz (8.69 dBm)	
		Ant.1	Wi-Fi 802.11b (12.92 dBm) Wi-Fi 802.11g (11.75 dBm) Wi-Fi 802.11n_20 MHz (10.82 dBm) Wi-Fi 802.11n_40 MHz (8.50 dBm)	
	WLAN 5 GHz Band	Ant.0	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (10.00 dBm) Wi-Fi 802.11n_20 MHz (9.87 dBm) Wi-Fi 802.11n_40 MHz (8.56 dBm) Wi-Fi 802.11ac20 MHz (9.77 dBm) Wi-Fi 802.11ac40 MHz (9.49 dBm) Wi-Fi 802.11ac80 MHz (8.04 dBm)
			5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (9.22 dBm) Wi-Fi 802.11n_20 MHz (9.09 dBm) Wi-Fi 802.11n_40 MHz (7.00 dBm) Wi-Fi 802.11ac20 MHz (9.31 dBm) Wi-Fi 802.11ac40 MHz (8.12 dBm) Wi-Fi 802.11ac80 MHz (7.40 dBm)
		Ant.1	5 150 MHz ~ 5 250 MHz Band	Wi-Fi 802.11a (9.32 dBm) Wi-Fi 802.11n_20 MHz (9.01 dBm) Wi-Fi 802.11n_40 MHz (7.57 dBm) Wi-Fi 802.11ac20 MHz (9.18 dBm) Wi-Fi 802.11ac40 MHz (8.83 dBm) Wi-Fi 802.11ac80 MHz (7.16 dBm)
			5 725 MHz ~ 5 850 MHz Band	Wi-Fi 802.11a (8.49 dBm) Wi-Fi 802.11n_20 MHz (8.45 dBm) Wi-Fi 802.11n_40 MHz (7.12 dBm) Wi-Fi 802.11ac20 MHz (8.49 dBm) Wi-Fi 802.11ac40 MHz (7.39 dBm) Wi-Fi 802.11ac80 MHz (6.54 dBm)

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MODULATION TYPE	Bluetooth	GFSK for 1 Mbps, DQPSK for 2 Mbps, 8-DPSK for 3 Mbps
	Bluetooth LE	GFSK
	WLAN 2.4 GHz Band	DSSS Modulation(DBPSK/DQPSK/CCK)
	WLAN 5 GHz Band	OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
Antenna Gain	2.4 GHz Band [BT(BDR / EDR / LE)]	0.42 dBi
	2.4 GHz Band [WLAN]	Antenna 0 : 1.23 dBi
		Antenna 1 : 1.21 dBi
	5 GHz Band [5 150 MHz ~ 5 250 MHz Band]	Antenna 0 : 1.71 dBi
		Antenna 1 : 1.39 dBi
	5 GHz Band [5 725 MHz ~ 5 850 MHz Band]	Antenna 0 : 1.10 dBi
		Antenna 1 : 0.71 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. 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

<table>
<tr><td>Kind of EUT</td><td colspan="4">Wi-Fi/BT Combo module</td></tr>
<tr><td>Operating Frequency Band</td><td colspan="4">☐ 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 ~ 5 240 MHz
■ WLAN: 5 745 MHz ~ 5 825 MHz
■ Bluetooth: 2 402 MHz ~ 2 480 MHz
■ Bluetooth BLE: 2 402 MHz ~ 2 480 MHz</td></tr>
<tr><td>Device Category</td><td colspan="4">☐ Portable (< 20 cm separation)
☐ Mobile (> 20 cm separation)
■ Others</td></tr>
<tr><td rowspan="6">MAX. RF OUTPUT POWER</td><td rowspan="3">Bluetooth</td><td colspan="2">1 Mbps</td><td>5.94 dBm</td></tr>
<tr><td colspan="2">2 Mbps</td><td>6.77 dBm</td></tr>
<tr><td colspan="2">3 Mbps</td><td>7.07 dBm</td></tr>
<tr><td>Bluetooth LE</td><td colspan="3">1.43 dBm</td></tr>
<tr><td rowspan="2">WLAN
2.4 GHz Band</td><td>Ant.0</td><td>Wi-Fi 802.11b (12.72 dBm)
Wi-Fi 802.11g (11.75 dBm)
Wi-Fi 802.11n_20 MHz (10.54 dBm)
Wi-Fi 802.11n_40 MHz (8.69 dBm)</td></tr>
<tr><td>Ant.1</td><td>Wi-Fi 802.11b (12.92 dBm)
Wi-Fi 802.11g (11.75 dBm)
Wi-Fi 802.11n_20 MHz (10.82 dBm)
Wi-Fi 802.11n_40 MHz (8.50 dBm)</td></tr>
</table>

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<table>
<tr><td rowspan="12"></td><td rowspan="12">WLAN
5 GHz Band</td><td rowspan="6">Ant.0</td><td rowspan="6">5 150 MHz ~
5 250 MHz Band</td><td>Wi-Fi 802.11a (10.00 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_20 MHz (9.87 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_40 MHz (8.56 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac20 MHz (9.77 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac40 MHz (9.49 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac80 MHz (8.04 dBm)</td></tr>
<tr><td rowspan="6">5 725 MHz ~
5 850 MHz Band</td><td>Wi-Fi 802.11a (9.22 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_20 MHz (9.09 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_40 MHz (7.00 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac20 MHz (9.31 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac40 MHz (8.12 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac80 MHz (7.40 dBm)</td></tr>
<tr><td rowspan="6">Ant.1</td><td rowspan="6">5 150 MHz ~
5 250 MHz Band</td><td>Wi-Fi 802.11a (9.32 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_20 MHz (9.01 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_40 MHz (7.57 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac20 MHz (9.18 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac40 MHz (8.83 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac80 MHz (7.16 dBm)</td></tr>
<tr><td rowspan="6">5 725 MHz ~
5 850 MHz Band</td><td>Wi-Fi 802.11a (8.49 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_20 MHz (8.45 dBm)</td></tr>
<tr><td>Wi-Fi 802.11n_40 MHz (7.12 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac20 MHz (8.49 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac40 MHz (7.39 dBm)</td></tr>
<tr><td>Wi-Fi 802.11ac80 MHz (6.54 dBm)</td></tr>
<tr><td rowspan="6">Antenna Gain</td><td colspan="2">2.4 GHz Band
[BT(BDR / EDR / LE)]</td><td>0.42 dBi</td></tr>
<tr><td rowspan="2">2.4 GHz Band
[WLAN]</td><td colspan="2">Antenna 0 : 1.23 dBi</td></tr>
<tr><td colspan="2">Antenna 1 : 1.21 dBi</td></tr>
<tr><td rowspan="2">5 GHz Band
[5 150 MHz ~
5 250 MHz Band]</td><td colspan="2">Antenna 0 : 1.71 dBi</td></tr>
<tr><td colspan="2">Antenna 1 : 1.39 dBi</td></tr>
<tr><td rowspan="2">5 GHz Band
[5 725 MHz ~
5 850 MHz Band]</td><td colspan="2">Antenna 0 : 1.10 dBi</td></tr>
<tr><td colspan="2">Antenna 1 : 0.71 dBi</td></tr>
<tr><td>Exposure
Evaluation Applied</td><td colspan="3">■ MPE
☐ SAR
☐ N/A</td></tr>
</table>

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

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4.3 Calculated MPE Safe Distance

4.3.1 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/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	10.0 ± 0.5	10.5	11.22	1.71	1.48	1.15	0.0033	1.00
	802.11n_ HT20	9.5 ± 0.5	10.0	10.00			1.09	0.0029	1.00
	802.11n_HT40	8.0 ± 0.5	9.0	7.94			0.97	0.0023	1.00
	802.11ac20	9.5 ± 0.5	10	10.00			1.09	0.0029	1.00
	802.11ac40	9.0 ± 0.5	9.5	8.91			1.03	0.0026	1.00
	802.11ac80	8.0 ± 0.5	8.5	7.08			0.91	0.0021	1.00
5 725 ~ 5 825	802.11a	10.0 ± 0.5	9.5	8.91	1.10	1.29	0.96	0.0023	1.00
	802.11n_ HT20	8.5 ± 0.6	9.1	8.13			0.91	0.0021	1.00
	802.11n_HT40	7.0 ± 0.5	7.5	5.62			0.76	0.0014	1.00
	802.11ac20	8.5 ± 1.0	9.5	8.91			0.96	0.0023	1.00
	802.11ac40	8.0 ± 0.5	8.5	7.08			0.85	0.0018	1.00
	802.11ac80	7.0 ± 0.5	7.5	5.62			0.76	0.0014	1.00

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4.3.2 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/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	9.0 ± 0.5	9.5	8.91	1.39	1.38	0.99	0.0024	1.00
	802.11n_ HT20	8.7 ± 0.5	9.2	8.32			0.95	0.0023	1.00
	802.11n_HT40	7.5 ± 0.5	8.0	6.31			0.83	0.0017	1.00
	802.11ac20	9.0 ± 0.5	9.5	8.91			0.99	0.0024	1.00
	802.11ac40	8.5 ± 0.5	9.0	7.94			0.93	0.0022	1.00
	802.11ac80	7.0 ± 0.5	7.5	5.62			0.78	0.0015	1.00
5 725 ~ 5 825	802.11a	8.0 ± 1.0	9.0	7.94	0.71	1.18	0.86	0.0019	1.00
	802.11n_ HT20	8.0 ± 1.0	9.0	7.94			0.86	0.0019	1.00
	802.11n_HT40	7.0 ± 0.5	7.5	5.62			0.73	0.0013	1.00
	802.11ac20	8.0 ± 0.5	8.5	7.08			0.81	0.0017	1.00
	802.11ac40	7.0 ± 0.5	7.5	5.62			0.73	0.0013	1.00
	802.11ac80	6.5 ± 0.5	7.0	5.01			0.69	0.0012	1.00

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4.3.3 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/cm²) @ 20 cm Separation	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear			
5 150 ~ 5 250	802.11a	12.5 ± 0.5	13.0	19.95	1.71	1.48	1.53	0.0059	1.00
	802.11n_ HT20	12.0 ± 0.5	12.5	17.78			1.45	0.0052	1.00
	802.11n_HT40	10.5 ± 0.5	11.0	12.59			1.22	0.0037	1.00
	802.11ac20	12.0 ± 0.5	12.5	17.78			1.45	0.0052	1.00
	802.11ac40	12.0 ± 0.5	12.5	17.78			1.45	0.0052	1.00
	802.11ac80	10.5 ± 0.5	11.0	12.59			1.22	0.0037	1.00
5 725 ~ 5 825	802.11a	11.0 ± 1.0	12.0	15.85	1.10	1.29	1.27	0.0041	1.00
	802.11n_ HT20	11.0 ± 1.0	12.0	15.85			1.27	0.0041	1.00
	802.11n_HT40	10.0 ± 0.5	10.5	11.22			1.07	0.0029	1.00
	802.11ac20	11.0 ± 1.0	12.0	15.85			1.27	0.0041	1.00
	802.11ac40	10.5 ± 0.5	11.0	12.59			1.14	0.0032	1.00
	802.11ac80	9.5 ± 0.5	10.0	10.00			1.01	0.0026	1.00

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