

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

**Test Report No.** : OT-182-RWD-029  
**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-TWFM-R003D  
**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

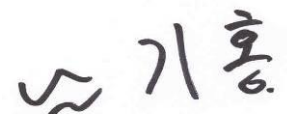
## SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART 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:

  
 Keun-Young, Choi / Vice President  
 ONETECH Corp.

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## REVISION HISTORY

Issued Report No.	Issued Date	Revisions	Effect Section
W178R-D012	August 07, 2017	Initial Issue	All
OT-182-RWD-029	February 19, 2018	Added the multiple model.	All

## 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-TWFM-R003D  
Model Name : TWFM-R003D  
Serial Number : N/A  
Date : February 19, 2018

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
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 C Section 15.247 KDB 558074 D01 DTS Meas Guidance v04
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-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.

DEVICE TYPE	802.11 a/b/g/n/ac WiFi Module		
Operating Frequency	WLAN	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
	2.4 GHz Band	2 422 MHz ~ 2 452 MHz (802.11n(HT40))	
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))
			5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))
			5 210 MHz (802.11ac(VHT80))
		5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(VHT20))
			5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))
			5 775 MHz (802.11ac(VHT80))
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)

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)

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	<input type="checkbox"/>
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.	<input type="checkbox"/>
TWFM-R003D(B)	The difference between this model and the basic model is the Antenna.	<input checked="" type="checkbox"/>

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  $1.0 \text{ mW/cm}^2$  for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a  $1 \text{ mW/cm}^2$  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  $\text{mW/cm}^2$ ,  $Z$  = Impedance of free space,  $377 \Omega$

$E$  = Electric field strength in  $\text{V/m}$ ,  $G$  = 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  $\text{mW}$  and  $\text{cm}$ , 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  $\text{cm}$ ,  $P$  = Power in  $\text{mW}$ ,  $G$  = Numeric antenna gain, and  $S$  = Power density in  $\text{mW/cm}^2$



## 4.2 EUT Description

Kind of EUT	802.11 a/b/g/n/ac WiFi Module
Operating Frequency Band	<ul style="list-style-type: none"> <li>■ WLAN: 2 412 MHz ~ 2 462 MHz</li> <li>■ WLAN: 2 422 MHz ~ 2 452 MHz</li> <li>■ WLAN: 5 180 MHz ~ 5 240 MHz</li> <li>■ WLAN: 5 190 MHz ~ 5 230 MHz</li> <li>■ WLAN: 5 210 MHz</li> <li>■ WLAN: 5 745 MHz ~ 5 825 MHz</li> <li>■ WLAN: 5 755 MHz ~ 5 795 MHz</li> <li>■ WLAN: 5 775 MHz</li> </ul>
Device Category	<ul style="list-style-type: none"> <li><input type="checkbox"/> Portable (&lt; 20 cm separation)</li> <li><input type="checkbox"/> Mobile (&gt; 20 cm separation)</li> <li>■ Others</li> </ul>
Exposure Evaluation Applied	<ul style="list-style-type: none"> <li>■ MPE</li> <li><input type="checkbox"/> SAR</li> <li><input type="checkbox"/> N/A</li> </ul>

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)

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

### 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			
2 400 ~ 2 483.5	802.11b	16.50 ± 0.5	17.00	50.12	4.75	2.99	3.45	0.029 8	1.00
	802.11g	15.50 ± 0.5	16.00	39.81			3.07	0.023 7	1.00
	802.11n_ HT20	14.00 ± 0.5	14.50	28.18			2.59	0.016 7	1.00
	802.11n_ HT40	13.50 ± 0.5	14.00	25.12			2.44	0.014 9	1.00

According to above table, for 2 400 ~ 2 483.5 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(50.12 * 2.99)/1.00} = 3.45 \text{ cm}$$

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

$$S = P * G / (4\pi * R^2) = 50.12 * 2.99 / (4 * 3.14 * 20^2) = 0.029 8$$

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

#### 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/cm <sup>2</sup> ) @ 20 cm Separation	Limit (mW/cm <sup>2</sup> )
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	16.50 ± 0.5	17.00	50.12	4.70	2.95	3.43	0.029 4	1.00
	802.11g	15.50 ± 0.5	16.00	39.81			3.06	0.023 4	1.00
	802.11n_ HT20	14.00 ± 0.5	14.50	28.18			2.57	0.016 6	1.00
	802.11n_ HT40	13.50 ± 0.5	14.00	25.12			2.43	0.014 8	1.00

According to above table, for 2 400 ~ 2 483.5 MHz Band, safe distance,

$$D = 0.282 * \sqrt{(50.12 * 2.95)/1.00} = 3.43 \text{ cm}$$

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

$$S = P * G / (4\pi * R^2) = 50.12 * 2.95 / (4 * 3.14 * 20^2) = 0.029 4$$

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



Tested by: Hyung-Kwon, Oh / Assistant Manager