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

Test Report No.	: OT-196-RWD-042
AGR No.	: A195A-316
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 Wi-Fi Module
FCC ID.	: YZP-ETWFFTBC01
Model Name	: ETWFFTBC01
Multiple Model Name	: N/A
Serial number	: N/A
Total page of Report	: 14 pages (including this page)
Date of Incoming	: June 07, 2019
Date of issue	: June 19, 2019

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: _____
Tae-Ho, Kim / Senior Manager
ONETECH Corp.

Approved by: _____
Ki-Hong, Nam / Chief Engineer
ONETECH Corp.

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

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-196-RWD-042	June 19, 2019	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant   : LG Innotek Co., Ltd.

Address   : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea

Contact Person   : Inchang Jeong / Senior Research Engineet

Telephone No.   : +82-62-950-0332

FCC ID   : YZP-ETWFFTBC01

Model Name   : ETWFFTBC01

Serial Number   : N/A

Date   : June 19, 2019

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM Unlicensed National Information infrastructure(UNII)
E.U.T. DESCRIPTION	Modular Transmitter, 802.11 a/b/g/n/ac 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
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 558074 D01 15.247 Meas Guidance v05r02 FCC PART 15 SUBPART E Section 15.407 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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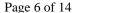
2. GENERAL INFORMATION

2.1 Product Description

The LG Innotek Co., Ltd., Model ETWFFTBC01 (referred to as the EUT in this report) is a 802.11 a/b/g/n/ac Wi-Fi 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 Wi-Fi Module		
Operating Frequency	WLAN 2.4 GHz Band	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
		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 (21.80 dBm)
			Wi-Fi 802.11g (14.46 dBm)
			Wi-Fi 802.11n(HT20) (13.81 dBm)
			Wi-Fi 802.11n(HT40) (10.32 dBm)
		Antenna 1	Wi-Fi 802.11b (21.90 dBm)
			Wi-Fi 802.11g (13.98 dBm)
			Wi-Fi 802.11n(HT20) (13.85 dBm)
			Wi-Fi 802.11n(HT40) (10.50 dBm)
		Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (16.70 dBm)
			Wi-Fi 802.11n(HT40) (13.39 dBm)

RF Output Power	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (13.02 dBm)
				Wi-Fi 802.11n(HT20) (11.92 dBm)
				Wi-Fi 802.11n(HT40) (13.22 dBm)
				Wi-Fi 802.11ac(HT80) (12.70 dBm)
			Antenna 1	Wi-Fi 802.11a (12.86 dBm)
				Wi-Fi 802.11n(HT20) (11.57 dBm)
				Wi-Fi 802.11n(HT40) (13.15 dBm)
				Wi-Fi 802.11ac(HT80) (12.60 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (14.76 dBm)
				Wi-Fi 802.11n(HT40) (16.20 dBm)
				Wi-Fi 802.11ac(HT80) (15.66 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (15.30 dBm)
				Wi-Fi 802.11n(HT20) (13.21 dBm)
				Wi-Fi 802.11n(HT40) (14.59 dBm)
				Wi-Fi 802.11ac(HT80) (12.62 dBm)
			Antenna 1	Wi-Fi 802.11a (16.05 dBm)
				Wi-Fi 802.11n(HT20) (15.50 dBm)
				Wi-Fi 802.11n(HT40) (15.85 dBm)
				Wi-Fi 802.11ac(HT80) (14.06 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (17.51 dBm)
				Wi-Fi 802.11n(HT40) (18.28 dBm)
				Wi-Fi 802.11ac(HT80) (16.41 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	1.50 dBi
		Antenna 1	1.49 dBi
		Antenna 0 + Antenna 1	4.51 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	1.46 dBi
		Antenna 1	1.01 dBi
		Antenna 0 + Antenna 1	4.25 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	1.50 dBi
		Antenna 1	1.50 dBi
		Antenna 0 + Antenna 1	4.51 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:

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

Where

S = Power density in mW/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

4.2 EUT Description

Kind of EUT	802.11 a/b/g/n/ac Wi-Fi Module
Device Category	☐ Portable (< 20 cm separation) ☐ Mobile (> 20 cm separation) ■ Others
Exposure Evaluation Applied	■ MPE ☐ SAR ☐ N/A

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4.3 Test data for WLAN 2.4 GHz Band

4.3.1 Calculated MPE Safe Distance for Antenna 0

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance (dBm)	Max tune up 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	22.0 ± 0.5	22.50	177.83	1.50	1.41	4.47	0.050 0	1.00
	802.11g	14.5 ± 0.5	15.00	31.62			1.88	0.008 9	1.00
	802.11n_ HT20	14.0 ± 0.5	14.50	28.18			1.78	0.007 9	1.00
	802.11n_ HT40	10.5 ± 0.5	11.00	12.59			1.19	0.003 5	1.00

According to above table, for 2 400 ~ 2 483.5 MHz Band(802.11b), safe distance,

$D = 0.282 * \sqrt{(177.83 * 1.41)/1.00} = 4.47$ cm

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

$S = P * G / (4\pi * R^2) = 177.83 * 1.41 / (4 * 3.14 * 20^2) = 0.050\ 0$

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

4.3.2 Calculated MPE Safe Distance for Antenna 1

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance (dBm)	Max tune up 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	22.0 ± 0.5	22.50	177.83	1.49	1.41	4.46	0.049 9	1.00
	802.11g	14.0 ± 0.5	14.50	28.18			1.78	0.007 9	1.00
	802.11n_ HT20	14.0 ± 0.5	14.50	28.18			1.78	0.007 9	1.00
	802.11n_ HT40	10.5 ± 0.5	11.00	12.59			1.19	0.003 5	1.00

According to above table, for 2 400 ~ 2 483.5 MHz Band(802.11b), safe distance,

$$D = 0.282 * \sqrt{(177.83 * 1.41)/1.00} = 4.46 \text{ cm}$$

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

$$S = P * G / (4\pi * R^2) = 177.83 * 1.41 / (4 * 3.14 * 20^2) = 0.049\ 9$$

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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4.3.3 Calculated MPE Safe Distance for Multiple Trasnmit

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	Power Density (mW/cm²)	Combined Power Density (mW/cm²)	Limit (mW/cm²)
		(dBm)	(dBm)	(mW)	Log	Linear	(cm)	@ 20 cm Separation	@ 20 cm Separation	
2 400 ~ 2 483.5	802.11n_ HT20 Antenna 0	14.0 ± 0.5	14.50	28.18	1.50	1.41	1.78	0.007 9	0.015 8	1.00
	802.11n_ HT20 Antenna 1	14.0 ± 0.5	14.50	28.18	1.49	1.41	1.78	0.007 9		1.00
	802.11n_ HT40 Antenna 0	10.5 ± 0.5	11.00	12.59	1.50	1.41	1.19	0.003 5	0.007 0	1.00
	802.11n_ HT40 Antenna 1	10.5 ± 0.5	11.00	12.59	1.49	1.41	1.19	0.003 5		1.00

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4.4 Test data for WLAN 5 GHz Band

4.4.1 Calculated MPE Safe Distance for Antenna 0

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance (dBm)	Max tune up power (dBm)	Max tune up power (mW)	Antenna Gain Log	Antenna Gain Linear	Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/ cm²)
5 150 ~ 5 250	802.11a	13.0 ± 0.5	13.50	22.39	1.46	1.40	1.58	0.006 2	1.00
	802.11n_ HT20	12.0 ± 0.5	12.50	17.78			1.41	0.005 0	1.00
	802.11n_HT40	13.0 ± 0.5	13.50	22.39			1.58	0.006 2	1.00
	802.11ac80	12.5 ± 0.5	13.00	19.95			1.49	0.005 6	1.00
5 725 ~ 5 850	802.11a	15.5 ± 0.5	16.00	39.81	1.50	1.41	2.11	0.011 2	1.00
	802.11n_ HT20	13.0 ± 0.5	13.50	22.39			1.59	0.006 3	1.00
	802.11n_HT40	14.5 ± 0.5	15.00	31.62			1.88	0.008 9	1.00
	802.11ac80	12.5 ± 0.5	13.00	19.95			1.50	0.005 6	1.00

According to above table, for 5 725 ~ 5 850 MHz Band(802.11a), safe distance,

$D = 0.282 * \sqrt{(39.81 * 1.41)/1.00} = 2.11$ cm.

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

$S = P * G / (4\pi * R^2) = 39.81 * 1.41 / (4 * 3.14 * 20^2) = 0.011\ 2$

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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4.4.2 Calculated MPE Safe Distance for Antenna 1

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance (dBm)	Max tune up power (dBm)	Max tune up power (mW)	Antenna Gain Log	Antenna Gain Linear	Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/cm²)
5 150 ~ 5 250	802.11a	13.0 ± 0.5	13.50	22.39	1.01	1.26	1.50	0.005 6	1.00
	802.11n_ HT20	11.5 ± 0.5	12.00	15.85			1.26	0.004 0	1.00
	802.11n_HT40	13.0 ± 0.5	13.50	22.39			1.50	0.005 6	1.00
	802.11ac80	12.5 ± 0.5	13.00	19.95			1.41	0.005 0	1.00
5 725 ~ 5 850	802.11a	16.0 ± 0.5	16.50	44.67	1.50	1.41	2.24	0.012 6	1.00
	802.11n_ HT20	15.5 ± 0.5	16.00	39.81			2.11	0.011 2	1.00
	802.11n_HT40	16.0 ± 0.5	16.50	44.67			2.24	0.012 6	1.00
	802.11ac80	14.0 ± 0.5	14.50	28.18			1.78	0.007 9	1.00

According to above table, for 5 725 ~ 5 850 MHz Band(802.11a), safe distance,

$D = 0.282 * \sqrt{(44.67 * 1.41)/1.00} = 2.24$ cm.

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

$S = P * G / (4\pi * R^2) = 44.67 * 1.41 / (4 * 3.14 * 20^2) = 0.012\ 6$

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

4.4.3 Calculated MPE Safe Distance for Multiple Transmit

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Operating Mode	Target Power W/tolerance (dBm)	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm²) @ 20 cm Separation	Combined Power Density (mW/cm²) @ 20 cm Separation	Limit (mW/cm²)
			(dBm)	(mW)	Log	Linear				
5 150 ~ 5 250	802.11n_ HT20 Antenna 0	12.0 ± 0.5	12.50	17.78	1.46	1.40	1.41	0.005 0	0.009 0	1.00
	802.11n_ HT20 Antenna 1	11.5 ± 0.5	12.00	15.85	1.01	1.26	1.26	0.004 0		1.00
	802.11n_HT40 Antenna 0	13.0 ± 0.5	13.50	22.39	1.46	1.40	1.58	0.006 2	0.011 8	1.00
	802.11n_HT40 Antenna 1	13.0 ± 0.5	13.50	22.39	1.01	1.26	1.50	0.005 6		1.00
	802.11ac80 Antenna 0	12.5 ± 0.5	13.00	19.95	1.46	1.40	1.49	0.005 6	0.010 6	1.00
	802.11ac80 Antenna 1	12.5 ± 0.5	13.00	19.95	1.01	1.26	1.41	0.005 0		1.00
5 725 ~ 5 850	802.11n_ HT20 Antenna 0	13.0 ± 0.5	13.50	22.39	1.50	1.41	1.59	0.006 3	0.017 5	1.00
	802.11n_ HT20 Antenna 1	15.5 ± 0.5	16.00	39.81	1.50	1.41	2.11	0.011 2		1.00
	802.11n_HT40 Antenna 0	14.5 ± 0.5	15.00	31.62	1.50	1.41	1.88	0.008 9	0.021 5	1.00
	802.11n_HT40 Antenna 1	16.0 ± 0.5	16.50	44.67	1.50	1.41	2.24	0.012 6		1.00
	802.11ac80 Antenna 0	12.5 ± 0.5	13.00	19.95	1.50	1.41	1.50	0.005 6	0.013 5	1.00
	802.11ac80 Antenna 1	14.0 ± 0.5	14.50	28.18	1.50	1.41	1.78	0.007 9		1.00

Tested by: Hyung-Kwon, Oh / Assistant Manager