

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

Test Report No. : OT-209-RWD-082
Reception No. : 2008003013
Applicant : LG Innotek Co., Ltd.
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Manufacturer : LG Innotek Co., Ltd.
Address : 26, Hanamsandan 5beon-ro Gwangsan-gu, Gwangju, 506-731, South Korea
Type of Equipment : RF Module
FCC ID. : YZP-ATC5CPC001
Model Name : ATC5CPC001
Serial number : N/A
Total page of Report : 15 pages (including this page)
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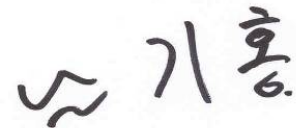
SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247 and 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.





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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-209-RWD-082	September 23, 2020	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Innotek Co., Ltd.

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FCC ID : YZP-ATC5CPC001

Model Name : ATC5CPC001

Brand Name : LG Innotek Co., Ltd.

Serial Number : N/A

Date : September 23, 2020

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM Unlicensed National Information infrastructure(UNII)
E.U.T. DESCRIPTION	Modular Transmitter, RF 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 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.

2. GENERAL INFORMATION

2.1 Product Description

The LG Innotek Co., Ltd., Model ATC5CPC001 (referred to as the EUT in this report) is a RF Module. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	RF Module	
Temperature Range	-40 °C ~ 85 °C	
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	Bluetooth	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
	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))
	5 250 MHz ~ 5 350 MHz Band	5 260 MHz ~ 5 320 MHz (802.11a/n(HT20)/ac(VHT20))
		5 270 MHz ~ 5 310 MHz (802.11n(HT40)/ac(VHT40))
		5 290 MHz (802.11ac(VHT80))
	5 470 MHz ~ 5 725 MHz Band	5 500 MHz ~ 5 700 MHz (802.11a/n(HT20)/ac(VHT20))
		5 510 MHz ~ 5 670 MHz (802.11n(HT40)/ac(VHT40))
		5 530 MHz ~ 5 690 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))
MODULATION TYPE	Bluetooth LE	GFSK for 1 Mbps
	Bluetooth	GFSK for 1Mbps, $\pi/4$ -DQPSK for 2Mbps, 8-DPSK for 3Mbps
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK)
		802.11g/n(HT20) OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
	WLAN 5 GHz	802.11a/n(HT20)/n(HT40)/ac(VHT80): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)

RF OUTPUT POWER	Bluetooth LE	1 Mbps	4.25 dBm
	Bluetooth	1 Mbps	4.85 dBm
		2 Mbps	2.67 dBm
		3 Mbps	3.07 dBm
	WLAN 2.4 GHz	Antenna 0	16.05 dBm(802.11b) 16.48 dBm(802.11g) 14.62 dBm(802.11n_HT20)
		Antenna 1	16.06 dBm(802.11b) 18.22 dBm(802.11g) 16.20 dBm(802.11n_HT20)
		Multiple Antenna	18.29 dBm(802.11n_HT20)
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	17.28 dBm(802.11a) 15.53 dBm(802.11n_HT20) 15.75 dBm(802.11n_HT40) 15.03 dBm(802.11ac_VHT80)
		Antenna 1	15.47 dBm(802.11a) 14.40 dBm(802.11n_HT20) 13.82 dBm(802.11n_HT40) 13.83 dBm(802.11ac_VHT80)
		Multiple Antenna	18.04 dBm(802.11n_HT20) 17.87 dBm(802.11n_HT40) 17.48 dBm(802.11ac_VHT80)
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	17.99 dBm(802.11a) 16.87 dBm(802.11n_HT20) 16.37 dBm(802.11n_HT40) 16.12 dBm(802.11ac_VHT80)
		Antenna 1	15.36 dBm(802.11a) 14.18 dBm(802.11n_HT20) 14.12 dBm(802.11n_HT40) 14.13 dBm(802.11ac_VHT80)
		Multiple Antenna	18.66 dBm(802.11n_HT20) 18.31 dBm(802.11n_HT40) 18.25 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 470 MHz ~ 5 725 MHz Band	Antenna 0	16.96 dBm(802.11a) 15.76 dBm(802.11n_HT20) 17.47 dBm(802.11n_HT40) 17.14 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	14.04 dBm(802.11a) 12.84 dBm(802.11n_HT20) 15.23 dBm(802.11n_HT40) 15.09 dBm(802.11ac_VHT80)
		Antenna 1	16.39 dBm(802.11a) 15.41 dBm(802.11n_HT20) 15.85 dBm(802.11n_HT40) 15.55 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	14.74 dBm(802.11a) 13.52 dBm(802.11n_HT20) 14.19 dBm(802.11n_HT40) 14.34 dBm(802.11ac_VHT80)
		Multiple Antenna	18.58 dBm(802.11n_HT20) 19.73 dBm(802.11n_HT40) 19.44 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	16.23 dBm(802.11n_HT20) 17.76 dBm(802.11n_HT40) 17.75 dBm(802.11ac_VHT80)

RF OUTPUT POWER	5 725 MHz ~ 5 850 MHz Band	Antenna 0	15.67 dBm(802.11a) 14.59 dBm(802.11n_HT20) 15.34 dBm(802.11n_HT40) 14.72 dBm(802.11ac_VHT80)
		Antenna 0_Straddle	6.57 dBm(802.11a) 5.97 dBm(802.11n_HT20) 2.88 dBm(802.11n_HT40) -0.70 dBm(802.11ac_VHT80)
		Antenna 1	15.88 dBm(802.11a) 14.57 dBm(802.11n_HT20) 14.40 dBm(802.11n_HT40) 13.83 dBm(802.11ac_VHT80)
		Antenna 1_Straddle	7.26 dBm(802.11a) 6.69 dBm(802.11n_HT20) 2.22 dBm(802.11n_HT40) -1.34 dBm(802.11ac_VHT80)
		Multiple Antenna	17.57 dBm(802.11n_HT20) 17.92 dBm(802.11n_HT40) 17.31 dBm(802.11ac_VHT80)
		Multiple Antenna _Straddle	9.33 dBm(802.11n_HT20) 5.59 dBm(802.11n_HT40) 2.01 dBm(802.11ac_VHT80)

ANTENNA TYPE	PCB Antenna		
ANTENNA GAIN	Bluetooth LE	1.49 dBi	
	Bluetooth	1.49 dBi	
	WLAN 2.4 GHz	Antenna 0	1.49 dBi
		Antenna 1	0.14 dBi
		Multiple Antenna	3.88 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	-2.10 dBi
		Antenna 1	-6.66 dBi
		Multiple Antenna	-0.80 dBi
	5 250 MHz ~ 5 350 MHz Band	Antenna 0	-2.10 dBi
		Antenna 1	-6.66 dBi
		Multiple Antenna	-0.80 dBi
	5 470 MHz ~ 5 725 MHz Band	Antenna 0	-2.82 dBi
		Antenna 1	-6.82 dBi
		Multiple Antenna	-1.36 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	-2.61 dBi
		Antenna 1	-7.60 dBi
		Multiple Antenna	-1.41 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		37.4 MHz	

2.2 Alternative type(s)/model(s); also covered by this test report.

-. None

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 $f/1500$ 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 field strength in 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 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	RF Module
Device Category	☐ Portable (< 20 cm separation) ☐ Mobile (> 20 cm separation) ☒ Others
Exposure Evaluation Applied	☒ MPE ☐ SAR ☐ N/A

4.3 Calculated MPE Safe Distance for WLAN

4.3.1 DATA 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/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	15.5 ± 1.0	16.5	44.67	1.49	1.41	2.24	0.012 5	1.00
	802.11g	16.0 ± 1.0	17.0	50.12			2.37	0.014 1	1.00
	802.11n_HT20	14.0 ± 1.0	15.0	31.62			1.88	0.008 9	1.00
5 150 ~ 5 250	802.11a	16.5 ± 1.0	17.5	56.23	-2.10	0.62	1.66	0.006 9	1.00
	802.11n_HT20	15.0 ± 1.0	16.0	39.81			1.40	0.004 9	1.00
	802.11n_HT40	15.0 ± 1.0	16.0	39.81			1.40	0.004 9	1.00
	802.11ac80	15.0 ± 1.0	16.0	39.81			1.40	0.004 9	1.00
5 250 ~ 5 350	802.11a	17.5 ± 1.0	18.5	70.79	-2.10	0.62	1.86	0.008 7	1.00
	802.11n_HT20	16.5 ± 1.0	17.5	56.23			1.66	0.006 9	1.00
	802.11n_HT40	16.0 ± 1.0	17.0	50.12			1.57	0.006 2	1.00
	802.11ac80	16.0 ± 1.0	17.0	50.12			1.57	0.006 2	1.00
5 470 ~ 5 725	802.11a	16.5 ± 1.0	17.5	56.23	-2.82	0.52	1.53	0.005 8	1.00
	802.11n_HT20	15.5 ± 1.0	16.5	44.67			1.36	0.004 6	1.00
	802.11n_HT40	17.0 ± 1.0	18.0	63.10			1.62	0.006 6	1.00
	802.11ac80	16.5 ± 1.0	17.5	56.23			1.53	0.005 8	1.00
5 725 ~ 5 850	802.11a	15.0 ± 1.0	16.0	39.81	-2.61	0.55	1.32	0.004 3	1.00
	802.11n_HT20	14.5 ± 1.0	15.5	35.48			1.24	0.003 9	1.00
	802.11n_HT40	15.0 ± 1.0	16.0	39.81			1.32	0.004 3	1.00
	802.11ac80	14.5 ± 1.0	15.5	35.48			1.24	0.003 9	1.00

According to above table, for 2 400 ~ 2483.5 MHz Band(802.11 g), safe distance,

$$D = 0.282 * \sqrt{(50.12 * 1.41)/1.00} = 2.37 \text{ cm.}$$

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

$$S = P * G / (4\pi * R^2) = 50.12 * 1.41 / (4 * \pi * 20^2) = 0.014 1$$

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

4.3.2 DATA 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/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	15.5 ± 1.0	16.5	44.67	0.14	1.03	1.92	0.009 2	1.00
	802.11g	17.5 ± 1.0	18.5	70.79			2.41	0.014 6	1.00
	802.11n_HT20	15.5 ± 1.0	16.5	44.67			1.92	0.009 2	1.00
5 150 ~ 5 250	802.11a	15.0 ± 1.0	16.0	39.81	-6.66	0.22	0.83	0.001 7	1.00
	802.11n_HT20	14.0 ± 1.0	15.0	31.62			0.74	0.001 4	1.00
	802.11n_HT40	13.5 ± 1.0	14.5	28.18			0.70	0.001 2	1.00
	802.11ac80	13.5 ± 1.0	14.5	28.18			0.70	0.001 2	1.00
5 250 ~ 5 350	802.11a	15.0 ± 1.0	16.0	39.81	-6.66	0.22	0.83	0.001 7	1.00
	802.11n_HT20	14.0 ± 1.0	15.0	31.62			0.74	0.001 4	1.00
	802.11n_HT40	13.5 ± 1.0	14.5	28.18			0.70	0.001 2	1.00
	802.11ac80	13.5 ± 1.0	14.5	28.18			0.70	0.001 2	1.00
5 470 ~ 5 725	802.11a	16.0 ± 1.0	17.0	50.12	-6.82	0.21	0.91	0.002 1	1.00
	802.11n_HT20	15.0 ± 1.0	16.0	39.81			0.81	0.001 6	1.00
	802.11n_HT40	15.0 ± 1.0	16.0	39.81			0.81	0.001 6	1.00
	802.11ac80	15.0 ± 1.0	16.0	39.81			0.81	0.001 6	1.00
5 725 ~ 5 850	802.11a	15.5 ± 1.0	16.5	44.67	-7.60	0.17	0.79	0.001 5	1.00
	802.11n_HT20	14.0 ± 1.0	15.0	31.62			0.66	0.001 1	1.00
	802.11n_HT40	14.0 ± 1.0	15.0	31.62			0.66	0.001 1	1.00
	802.11ac80	13.5 ± 1.0	14.5	28.18			0.62	0.001 0	1.00

According to above table, for 2 400 ~ 2483.5 MHz Band(802.11 g), safe distance,

$$D = 0.282 * \sqrt{(70.79 * 1.03)/1.00} = 2.41 \text{ cm.}$$

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

$$S = P * G / (4\pi * R^2) = 70.79 * 1.03 / (4 * \pi * 20^2) = 0.014 6$$

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

4.3.3 DATA 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		Power Density (mW/cm ²) @ 20 cm Separation	Sum Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)			
2 400 ~ 2 483.5	802.11n_HT20	14.0 ± 1.0	15.0	31.62	0.008 9	0.018 1	1.00
		15.5 ± 1.0	16.5	44.67	0.009 2		
5 150 ~ 5 250	802.11n_HT20	15.0 ± 1.0	16.0	39.81	0.004 9	0.006 3	1.00
		14.0 ± 1.0	15.0	31.62	0.001 4		
	802.11n_HT40	15.0 ± 1.0	16.0	39.81	0.004 9	0.006 1	1.00
		13.5 ± 1.0	14.5	28.18	0.001 2		
	802.11ac80	15.0 ± 1.0	16.0	39.81	0.004 9	0.006 1	1.00
		13.5 ± 1.0	14.5	28.18	0.001 2		
5 250 ~ 5 350	802.11n_HT20	16.5 ± 1.0	17.5	56.23	0.006 9	0.008 3	1.00
		14.0 ± 1.0	15.0	31.62	0.001 4		
	802.11n_HT40	16.0 ± 1.0	17.0	50.12	0.006 2	0.007 4	1.00
		13.5 ± 1.0	14.5	28.18	0.001 2		
	802.11ac80	16.0 ± 1.0	17.0	50.12	0.006 2	0.007 4	1.00
		13.5 ± 1.0	14.5	28.18	0.001 2		
5 470 ~ 5 725	802.11n_HT20	15.5 ± 1.0	16.5	44.67	0.004 6	0.006 2	1.00
		15.0 ± 1.0	16.0	39.81	0.001 6		
	802.11n_HT40	17.0 ± 1.0	18.0	63.10	0.006 6	0.008 2	1.00
		15.0 ± 1.0	16.0	39.81	0.001 6		
	802.11ac80	16.5 ± 1.0	17.5	56.23	0.005 8	0.007 4	1.00
		15.0 ± 1.0	16.0	39.81	0.001 6		
5 725 ~ 5 850	802.11n_HT20	14.5 ± 1.0	15.5	35.48	0.003 9	0.005 0	1.00
		14.0 ± 1.0	15.0	31.62	0.001 1		
	802.11n_HT40	15.0 ± 1.0	16.0	39.81	0.004 3	0.005 4	1.00
		14.0 ± 1.0	15.0	31.62	0.001 1		
	802.11ac80	14.5 ± 1.0	15.5	35.48	0.003 9	0.004 9	1.00
		13.5 ± 1.0	14.5	28.18	0.001 0		

$$\text{WLAN 2 GHz}(802.11 \text{ n_HT20}) = (0.008 \text{ 9/1}) + (0.009 \text{ 2/1}) = 0.018 \text{ 1}$$

4.4 Calculated MPE Safe Distance for Bluetooth LE

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/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	1 Mbps	4.0 ± 1.0	5.00	3.16	1.49	1.41	0.60	0.000 9	1.00

According to above table, for 2 402 ~ 2480 MHz Band(1 Mbps), safe distance,

$$D = 0.282 * \sqrt{(3.16 * 1.41)/1.00} = 0.60 \text{ cm.}$$

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

$$S = P * G / (4\pi * R^2) = 3.16 * 1.41 / (4 * \pi * 20^2) = 0.000 9$$

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

4.5 Calculated MPE Safe Distance for Bluetooth

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/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)	Log	Linear			
2 402 ~ 2 480	1 Mbps	4.5 ± 1.0	5.50	3.55	1.49	1.41	0.63	0.001 0	1.00
	2 Mbps	2.5 ± 1.0	3.50	2.24			0.50	0.000 6	1.00
	3 Mbps	2.5 ± 1.0	3.50	2.24			0.50	0.000 6	1.00

According to above table, for 2 402 ~ 2480 MHz Band(1 Mbps), safe distance,

$$D = 0.282 * \sqrt{(3.55 * 1.41)/1.00} = 0.63 \text{ cm.}$$

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

$$S = P * G / (4\pi * R^2) = 3.55 * 1.41 / (4 * \pi * 20^2) = 0.001 0$$

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

4.6 DATA for Intermodulation 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		Power Density (mW/cm ²) @ 20 cm Separation	Sum Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
			(dBm)	(mW)			
Bluetooth + WLAN 2 G	Bluetooth (1 Mbps)	4.5 ± 1.0	5.50	3.55	0.0010	0.015 6	1.00
	WLAN 2 G (802.11 g_Ant 1)	17.5 ± 1.0	18.5	70.79	0.0146		
Bluetooth LE + WLAN 5 G (5 470 MHz ~ 5 725 MHz)	Bluetooth (1 Mbps)	4.5 ± 1.0	5.50	3.55	0.0010	0.003 1	1.00
	WLAN 5 G (802.11 a_Ant 1)	16.0 ± 1.0	17.0	50.12	0.0021		