

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

Test Report No. : W17OR-D003
AGR No. : A178A-264
Applicant : HUMAX Co., Ltd.
Address : HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, 463-825, South Korea
Manufacturer : HUMAX Co., Ltd.
Address : HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, 463-825, South Korea
Type of Equipment : Wi-Fi Router
FCC ID. : O6ZT9
Model Name : QUANTUM T9
Multiple Model Name : QUANTUM T7, QUANTUM T5
Serial number : N/A
Total page of Report : 12 pages (including this page)
Date of Incoming : September 11, 2017
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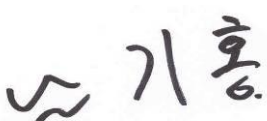
SUMMARY

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
W17OR-D003	October 10, 2017	Initial Issue	All

1. VERIFICATION OF COMPLIANCE

Applicant : HUMAX Co., Ltd.

Address : HUMAX Village, 11-4, Sunae-dong, Bundang-gu, Seongnam city, Gyeonggi-do, 463-825, South Korea

Contact Person : Inseok, Seo / Senior Engineer

Telephone No. : +82-31-776-6400

FCC ID : O6ZT9

Model Name : QUANTUM T9

Brand Name : **HUMAX**

Serial Number : N/A

Date : October 10, 2017

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Wi-Fi Router
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
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 HUMAX Co., Ltd., Model QUANTUM T9 (referred to as the EUT in this report) is a Wi-Fi Router. Product specification information described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Wi-Fi Router		
FREQUENCY RANGE	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))
MAX. RF OUTPUT POWER	WLAN 2.4 GHz Band	Antenna 0	Wi-Fi 802.11b (22.45 dBm) Wi-Fi 802.11g (22.39 dBm) Wi-Fi 802.11n(HT20) (16.46 dBm) Wi-Fi 802.11n(HT40) (16.54 dBm)
		Antenna 1	Wi-Fi 802.11b (22.49 dBm) Wi-Fi 802.11g (22.34 dBm) Wi-Fi 802.11n(HT20) (16.40 dBm) Wi-Fi 802.11n(HT40) (16.52 dBm)
		Antenna 2	Wi-Fi 802.11b (22.47 dBm) Wi-Fi 802.11g (22.45 dBm) Wi-Fi 802.11n(HT20) (16.48 dBm) Wi-Fi 802.11n(HT40) (16.55 dBm)
		Multiple transmit	Wi-Fi 802.11n(HT20) (21.22 dBm)
			Wi-Fi 802.11n(HT40) (21.31 dBm)

MAX. RF OUTPUT POWER	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (18.70 dBm) Wi-Fi 802.11n(HT20) (8.50 dBm) Wi-Fi 802.11n(HT40) (8.57 dBm) Wi-Fi 802.11ac(HT80) (11.44 dBm)
			Antenna 1	Wi-Fi 802.11a (18.56 dBm) Wi-Fi 802.11n(HT20) (8.53 dBm) Wi-Fi 802.11n(HT40) (8.62 dBm) Wi-Fi 802.11ac(HT80) (11.38 dBm)
			Antenna 2	Wi-Fi 802.11a (18.64 dBm) Wi-Fi 802.11n(HT20) (8.47 dBm) Wi-Fi 802.11n(HT40) (8.55 dBm) Wi-Fi 802.11ac(HT80) (11.40 dBm)
			Antenna 3	Wi-Fi 802.11a (18.66 dBm) Wi-Fi 802.11n(HT20) (8.55 dBm) Wi-Fi 802.11n(HT40) (8.41 dBm) Wi-Fi 802.11ac(HT80) (11.50 dBm)
			Multiple transmit	Wi-Fi 802.11n(HT20) (14.53 dBm) Wi-Fi 802.11n(HT40) (14.56 dBm) Wi-Fi 802.11ac(HT80) (17.45 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (22.39 dBm) Wi-Fi 802.11n(HT20) (13.27 dBm) Wi-Fi 802.11n(HT40) (13.01 dBm) Wi-Fi 802.11ac(HT80) (12.86 dBm)
			Antenna 1	Wi-Fi 802.11a (22.33 dBm) Wi-Fi 802.11n(HT20) (13.31 dBm) Wi-Fi 802.11n(HT40) (13.05 dBm) Wi-Fi 802.11ac(HT80) (12.92 dBm)
			Antenna 2	Wi-Fi 802.11a (22.43 dBm) Wi-Fi 802.11n(HT20) (13.25 dBm) Wi-Fi 802.11n(HT40) (13.02 dBm) Wi-Fi 802.11ac(HT80) (12.81 dBm)
			Antenna 3	Wi-Fi 802.11a (22.31 dBm) Wi-Fi 802.11n(HT20) (13.29 dBm) Wi-Fi 802.11n(HT40) (12.95 dBm) Wi-Fi 802.11ac(HT80) (12.84 dBm)
			Multiple transmit	Wi-Fi 802.11n(HT20) (19.30 dBm) Wi-Fi 802.11n(HT40) (19.03 dBm) Wi-Fi 802.11ac(HT80) (18.88 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	Ant 0 : 5.37 dBi Ant 1 : 5.23 dBi Ant 2 : 5.37 dBi Multiple Antenna : 10.10 dBi	
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz	Ant 0 : 5.42 dBi Ant 1 : 5.35 dBi Ant 2 : 5.65 dBi Ant 3 : 5.94 dBi Multiple Antenna : 11.62 dBi
		5 725 MHz ~ 5 850 MHz	Ant 0 : 6.88 dBi Ant 1 : 6.62 dBi Ant 2 : 6.85 dBi Ant 3 : 6.96 dBi Multiple Antenna : 12.85 dBi
	List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		40 MHz
POWER REQUIREMENT		DC 12.0 V	

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
QUANTUM T9	Basic Model (2.4 GHz: 3Tx3Rx, 5 GHz: 4Tx4Rx)	☒
QUANTUM T7	These models are identical to the basic model except for the Antenna. (2.4 GHz: 3Tx3Rx, 5 GHz: 3Tx3Rx)	☐
QUANTUM T5	These models are identical to the basic model except for the Antenna. (2.4 GHz: 2Tx2Rx, 5 GHz: 3Tx3Rx)	☐

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 mW/cm^2 for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a 1 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 mW/cm^2 , Z = Impedance of free space, 377Ω

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 $P (\text{mW}) = P (\text{W}) / 1 000$, $d (\text{cm}) = 0.01 * d (\text{m})$

$$d = 0.282 * \sqrt{(P * G) / S}$$

Where

d = distance in cm , P = Power in mW , G = Numeric antenna gain, and S = Power density in mW/cm^2

4.2 EUT Description

Kind of EUT	Wi-Fi Router		
Operating Frequency Band	☐ Wireless Microphone: 494.000 MHz ~ 501.000 MHz and 498.200 MHz ~ 505.200 MHz ☒ 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 ☐ Bluetooth: 2 402 MHz ~ 2 480 MHz ☐ GFSK Modulation: 2403 MHz , 2443 MHz , 2478 MHz		
Device Category	☐ Portable (< 20 cm separation) ☐ Mobile (> 20 cm separation) ☒ Others		
Exposure Evaluation Applied	☒ MPE ☐ SAR ☐ N/A		
ANTENNA TYPE	WLAN 2.4 GHz Band	Ant 0 : 5.37 dBi Ant 1 : 5.23 dBi Ant 2 : 5.37 dBi Multiple Antenna : 10.10 dBi	
	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz	Ant 0 : 5.42 dBi Ant 1 : 5.35 dBi Ant 2 : 5.65 dBi Ant 3 : 5.94 dBi Multiple Antenna : 11.62 dBi
		5 725 MHz ~ 5 850 MHz	Ant 0 : 6.88 dBi Ant 1 : 6.62 dBi Ant 2 : 6.85 dBi Ant 3 : 6.96 dBi Multiple Antenna : 12.85 dBi

MAX. RF OUTPUT POWER	WLAN 2.4 GHz Band	Antenna 0	Wi-Fi 802.11b (22.45 dBm) Wi-Fi 802.11g (22.39 dBm) Wi-Fi 802.11n(HT20) (16.46 dBm) Wi-Fi 802.11n(HT40) (16.54 dBm)
		Antenna 1	Wi-Fi 802.11b (22.49 dBm) Wi-Fi 802.11g (22.34 dBm) Wi-Fi 802.11n(HT20) (16.40 dBm) Wi-Fi 802.11n(HT40) (16.52 dBm)
		Antenna 2	Wi-Fi 802.11b (22.47 dBm) Wi-Fi 802.11g (22.45 dBm) Wi-Fi 802.11n(HT20) (16.48 dBm) Wi-Fi 802.11n(HT40) (16.55 dBm)
		Multiple transmit	Wi-Fi 802.11n(HT20) (21.22 dBm) Wi-Fi 802.11n(HT40) (21.31 dBm)

MAX. RF OUTPUT POWER	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (18.70 dBm) Wi-Fi 802.11n(HT20) (8.50 dBm) Wi-Fi 802.11n(HT40) (8.57 dBm) Wi-Fi 802.11ac(HT80) (11.44 dBm)
			Antenna 1	Wi-Fi 802.11a (18.56 dBm) Wi-Fi 802.11n(HT20) (8.53 dBm) Wi-Fi 802.11n(HT40) (8.62 dBm) Wi-Fi 802.11ac(HT80) (11.38 dBm)
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			Antenna 3	Wi-Fi 802.11a (18.66 dBm) Wi-Fi 802.11n(HT20) (8.55 dBm) Wi-Fi 802.11n(HT40) (8.41 dBm) Wi-Fi 802.11ac(HT80) (11.50 dBm)
			Multiple transmit	Wi-Fi 802.11n(HT20) (14.53 dBm) Wi-Fi 802.11n(HT40) (14.56 dBm) Wi-Fi 802.11ac(HT80) (17.45 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (22.39 dBm) Wi-Fi 802.11n(HT20) (13.27 dBm) Wi-Fi 802.11n(HT40) (13.01 dBm) Wi-Fi 802.11ac(HT80) (12.86 dBm)
			Antenna 1	Wi-Fi 802.11a (22.33 dBm) Wi-Fi 802.11n(HT20) (13.31 dBm) Wi-Fi 802.11n(HT40) (13.05 dBm) Wi-Fi 802.11ac(HT80) (12.92 dBm)
			Antenna 2	Wi-Fi 802.11a (22.43 dBm) Wi-Fi 802.11n(HT20) (13.25 dBm) Wi-Fi 802.11n(HT40) (13.02 dBm) Wi-Fi 802.11ac(HT80) (12.81 dBm)
			Antenna 3	Wi-Fi 802.11a (22.31 dBm) Wi-Fi 802.11n(HT20) (13.29 dBm) Wi-Fi 802.11n(HT40) (12.95 dBm) Wi-Fi 802.11ac(HT80) (12.84 dBm)
			Multiple transmit	Wi-Fi 802.11n(HT20) (19.30 dBm) Wi-Fi 802.11n(HT40) (19.03 dBm) Wi-Fi 802.11ac(HT80) (18.88 dBm)

5. Calculated MPE Safe Distance

5.1 Test data for Multiple Antenna

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 ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	21.99 ± 0.5	22.49	177.42	5.23	3.33	6.86	0.117 7	1.00

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

$$D = 0.282 * \sqrt{(177.42 * 3.33)/1.00} = 6.86 \text{ cm}$$

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

$$S = P * G / (4\pi * R^2) = 177.42 * 3.33 / (4 * 3.14 * 20^2) = 0.117 7$$

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

5.2 Calculation Result Of Maximum Conducted Power

Operating Freq. Band	Operating Mode	Target Power W/tolerance	Max tune up power		Antenna Gain		Safe Distance (cm)	Power Density (mW/cm ²) @ 20 cm Separation	Limit (mW/cm ²)
		(dBm)	(dBm)	(mW)	Log	Linear			
2 400 ~ 2 483.5	802.11b	21.99 ± 0.5	22.49	177.42	5.23	3.33	6.86	0.117 7	1.00
5 725 ~5 850	802.11a	21.93 ± 0.5	22.43	174.98	6.85	4.84	8.21	0.168 6	1.00

$$2.4 \text{ GHz band} + 5 \text{ GHz band} = (0.117 7 / 1) + (0.168 6 / 1) = 0.286 3$$

- Therefore the maximum calculations of above situations are less than the “1” limit.



Tested by: Hyung-Kwon, Oh / Assistant Manager