

FCC RF EXPOSURE EVALUATION REPORT

Product Name: Promethean WIFI Module (Titanium)
Trade Mark: Promethean
Model No.: AP-WIFI-BC
Add. Model No.: N/A
Report Number: 181126027RFC-5
Test Standards: FCC 47 CFR Part 1 Subpart I
FCC ID: QAM-AP-WIFI-BC
Test Result: PASS
Date of Issue: January 18, 2019

Prepared for:

Promethean Ltd
Promethean House, Lower Philips Rd Whitebirk, Blackburn, BB1 5TH, United Kingdom

Prepared by:

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Date: January 18, 2019

Version

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1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Promethean Ltd
Address of Applicant:	Promethean House, Lower Philips Rd Whitebirk, Blackburn, BB1 5TH, United Kingdom
Manufacturer:	Guangzhou Lango Electronics Technology Co., Ltd
Address of Manufacturer:	4/f, NO.136, Gaopu Road, Tianhe District, Guangzhou, 510663, P.R. China

1.2 EUT INFORMATION

Product Name:	Promethean WIFI Module (Titanium)		
Model No.:	AP-WIFI-BC		
Add. Model No.:	N/A		
Trade Mark:	Promethean		
DUT Stage:	Identical Prototype		
EUT Supports Function:	2.4 GHz ISM Band:	IEEE 802.11b/g/n	
		Bluetooth V4.2	
	5 GHz U-NII Bands:	5 150 MHz to 5 250 MHz	IEEE 802.11a/n/ac
5 725 MHz to 5 850 MHz		IEEE 802.11a/n/ac	
Sample Received Date:	December 10, 2018		
Sample Tested Date:	December 20, 2018 to January 16, 2019		

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

For BT_LE	
Frequency Band:	2400 MHz to 2483.5 MHz
Frequency Range:	2402 MHz to 2480 MHz
Bluetooth Version:	Bluetooth LE
Type of Modulation:	GFSK
Number of Channels:	40
Channel Separation:	2 MHz
Antenna Type:	External Antenna
Antenna Gain:	4.58 dBi
Maximum Peak Power:	4.63 dBm

For BT_EDR	
Frequency Band:	2400 MHz to 2483.5 MHz
Frequency Range:	2402 MHz to 2480 MHz
Bluetooth Version:	Bluetooth BR + EDR
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Type of Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Number of Channels:	79
Channel Separation:	1 MHz
Hopping Channel Type:	Adaptive Frequency Hopping Systems
Antenna Type:	External Antenna
Antenna Gain:	4.58 dBi
Maximum Peak Power:	3.59 dBm

For 2.4 GHz ISM Band of Wi-Fi	
Frequency Band:	2400 MHz to 2483.5 MHz
Frequency Range:	2412 MHz to 2462 MHz
Support Standards:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40
Type of Modulation:	IEEE 802.11b: DSSS(CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM(64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM(64-QAM, 16-QAM, QPSK, BPSK)
Data Rate:	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS15 IEEE 802.11n-HT40: Up to MCS15
Number of Channels:	IEEE 802.11b: 11 IEEE 802.11g: 11 IEEE 802.11n-HT20: 11 IEEE 802.11n-HT40: 7
Channel Separation:	5 MHz
Antenna Type:	Chain 0 External Antenna
	Chain 1 External Antenna
Antenna Gain:	Chain 0 4.58 dBi
	Chain 1 4.58 dBi
Directional gain:	7.59 dBi
Maximum Peak Power:	SISO_ Chain 0 IEEE 802.11b: 15.8 dBm IEEE 802.11g: 19.8 dBm
	SISO_ Chain 1 IEEE 802.11b: 15.64 dBm IEEE 802.11g: 19.87 dBm
	MIMO_ Chain 0+1 IEEE 802.11n-HT20: 20.50 dBm IEEE 802.11n-HT40: 19.98 dBm

For 5 GHz U-NII Bands of Wi-Fi	
Frequency Bands:	5150 MHz to 5250 MHz (U-NII-1)
	5725 MHz to 5850 MHz (U-NII-3)
Frequency Ranges:	5180 MHz to 5240 MHz
	5745 MHz to 5825 MHz
Support Standards:	IEEE 802.11a/n/ac
TPC Function:	Not Support
DFS Operational mode:	Slave without radar Interference detection function
Type of Modulation:	IEEE 802.11a: OFDM(64QAM, 16QAM, QPSK, BPSK)
	IEEE 802.11n: OFDM(64QAM, 16QAM, QPSK, BPSK)
	IEEE 802.11ac: OFDM(256QAM, 64QAM, 16QAM, QPSK, BPSK)
Channel Spacing:	IEEE 802.11a/n-HT20/ac-VHT20: 20 MHz
	IEEE 802.11n-HT40/ac-VHT40: 40 MHz
	IEEE 802.11ac-VHT80: 80 MHz
Data Rate:	IEEE 802.11a: Up to 54 Mbps
	IEEE 802.11n-HT20: Up to MCS15
	IEEE 802.11n-HT40: Up to MCS15
	IEEE 802.11ac-VHT20: Up to MCS8
	IEEE 802.11ac-VHT40: Up to MCS9
Number of Channels:	5150 MHz to 5250 MHz: 4 for IEEE 802.11a/n-HT20/ac-VHT20

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	2 for IEEE 802.11n-HT40)/ac-VHT40 1 for IEEE 802.11acVHT80		
	5725 MHz to 5850 MHz: 5 for IEEE 802.11a/n-HT20/ac-VHT20 2 for IEEE 802.11n-HT40/ac-VHT40 1 for IEEE 802.11ac-VHT80		
Antenna Type:	Chain 0	External Antenna	
	Chain 1	External Antenna	
Antenna Gain:	Chain 0	5150 MHz to 5250 MHz: 4.95 dBi	
		5725 MHz to 5850 MHz: 4.72 dBi	
	Chain 1	5150 MHz to 5250 MHz: 4.95 dBi	
		5725 MHz to 5850 MHz: 4.72 dBi	
Maximum Avg. Power (dBm):	SISO_Chain 0	U-NII-1	U-NII-3
	IEEE 802.11a:	13.49	12.74
	SISO_Chain 1	U-NII-1	U-NII-3
	IEEE 802.11a:	11.69	8.95
	MIMO_Chain 0+1	U-NII-1	U-NII-3
	IEEE 802.11n-HT20:	14.92	13.31
	IEEE 802.11n-HT40:	12.78	11.10
	IEEE 802.11ac-VHT20:	12.79	11.09
	IEEE 802.11ac-VHT40:	12.92	11.32
IEEE 802.11ac-VHT80:	12.92	11.56	

1.4 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF product, according to the specifications of the manufacturers. It must comply with the requirements of the following standards:

FCC 47 CFR Part 1 Subpart I

All test items have been performed and recorded as per the above standards

1.5 TEST LOCATION

All tests were performed at:

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China 518109
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1.6 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

IC-Registration No.: 21600-1

The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 21600-1.

A2LA-Lab Certificate No.: 4312.01

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

FCC Accredited Lab.

Designation Number: CN1194

Test Firm Registration Number: 259480

1.7 DEVIATION FROM STANDARDS

None.

1.8 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.9 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

2. EQUIPMENT LIST

Please refer to the RF test report.

3. MPE EVALUATION

3.1 REFERENCE DOCUMENTS FOR EVALUATION

No.	Identity	Document Title
1	FCC 47 CFR Part 1 Subpart I	PROCEDURES IMPLEMENTING THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969
2	KDB 447498 D01 General RF Exposure Guidance v06	RF EXPOSURE PROCEDURES AND EQUIPMENT AUTHORIZATION POLICIES FOR MOBILE AND PORTABLE DEVICES

3.2 MPE COMPLIANCE REQUIREMENT

3.2.1 Limits

According to §1.1307(b)(1), system operating under the provisions of this section shall be operating in a manner that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure.

Limits for Occupational / Controlled Exposure

Frequency range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Times E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f)*	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	F/300	6
1500-100000	/	/	5	6

Limits for General Population / Uncontrolled Exposure

Frequency range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Times E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-100000	/	/	1	30

Note: f = frequency in MHz: * = Plane-wave equivalents power density.

3.2.2 Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

3.3 MPE CALCULATION METHOD

$$S = PG/4\pi R^2 = EIRP/4\pi R^2$$

S = power density (in appropriate units, e.g., mw/cm²)

P = power input to the antenna (in appropriate units, e.g., mw)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor is normally numeric gain.

R = distance to the center of radiation of the antenna (in appropriate units, e.g., cm)

3.4 MPE CALCULATION RESULTS

Note: For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.

3.4.1 For WLAN

For Wi-Fi function, operating at 2412MHz to 2462 MHz for IEEE802.11b/g/n and operating at 5150 MHz to 5250 MHz for IEEE802.11a/n/ac and operating at 5725 MHz to 5850 MHz for IEEE802.11a/n/ac.

3.4.1.1 Antenna Type:

Chain 0: External Antenna

Chain 1: External Antenna

3.4.1.2 Antenna Gain:

Chain 0: 2412MHz to 2462 MHz: 4.58 dBi
 5150 MHz to 5250 MHz: 4.95 dBi
 5725 MHz to 5850 MHz: 4.72 dBi

Chain 1: Same as chain 0

For MIMO mode (2Tx/2Rx), there are two transmission antennas. Both Chain 0 and Chain 1 used at the same time and antenna ports have uniform output powers. The Chain 0 and Chain 1 antenna ports can be used alone. The transmit signals are correlated with each other.

$$\text{The directional gain} = G_{\text{ANT}} + 10 \log(N_{\text{ANT}}) \text{ dBi}$$

For SISO mode (1Tx/1Rx), there are two transmission antennas. Both Chain 0 and Chain 1 used at the same time and antenna ports have uniform output powers. The Chain 0 and Chain 1 antenna ports cannot be used alone

$$\text{The antenna gain} = \text{Chain 0 or Chain 1}$$

3.4.1.3 Results for WLAN

Operating Mode	Freq.	Declared maximum conducted average output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP	Declared maximum EIRP	MPE Limit	MPE Value	
	(MHz)								(dBm)
SISO	IEEE 802.11b	2412-2462	13	1.5	4.58	19.08	80.9096	1	0.0161
	IEEE 802.11g	2412-2462	10	1.5	4.58	16.08	40.5509	1	0.0081
	IEEE 802.11a	5180-5240	14	1.5	4.95	20.45	110.9175	1	0.0221
		5745-5825	13	1.5	4.72	19.22	83.5603	1	0.0166

Operating Mode	Freq.	Declared maximum conducted average output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP	Declared maximum EIRP	MPE Limit	MPE Value	
	(MHz)								(dBm)
MIMO	IEEE 802.11n-HT20	2412-2462	11	1.5	4.58	17.08	51.0505	1	0.0102
	IEEE 802.11n-HT40	2422-2452	11	1.5	4.58	17.08	51.0505	1	0.0102
	IEEE 802.11n-HT20	5180-5240	15	1.5	4.95	21.45	139.6368	1	0.0278
		5745-5825	14	1.5	4.72	20.22	105.1962	1	0.0209
	IEEE 802.11n-HT40	5190-5230	13	1.5	4.95	19.45	88.1049	1	0.0175
		5755-5795	12	1.5	4.72	18.22	66.3743	1	0.0132
	IEEE 802.11ac-VHT20	5180-5240	13	1.5	4.95	19.45	88.1049	1	0.0175
		5745-5825	12	1.5	4.72	18.22	66.3743	1	0.0132
	IEEE 802.11ac-VHT40	5190-5230	13	1.5	4.95	19.45	88.1049	1	0.0175
		5755-5795	12	1.5	4.72	18.22	66.3743	1	0.0132
	IEEE 802.11ac-VHT80	5230	13	1.5	4.95	19.45	88.1049	1	0.0175
		5775	12	1.5	4.72	18.22	66.3743	1	0.0132

3.4.2 For BT

For BT_LE function, operating at 2402MHz to 2480 MHz for GFSK and

For BT_EDR function, operating at 2402MHz to 2480 MHz for GFSK, $\pi/4$ DQPSK, 8DPSK

3.4.2.1 Antenna Type:

Chain 0: External Antenna

3.4.2.2 Antenna Gain:

Chain 0: 2402MHz to 2480 MHz: 4.58 dBi

3.4.2.3 Results for BT

Operating Mode	Freq.	Declared maximum conducted average output power	Max. positive tolerance according manufacturer	Antenna Gain	Calculated maximum EIRP	Declared maximum EIRP	MPE Limit	MPE Value
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(mW)	(mw/cm ²)	
LE	2402-2480	2	1	4.58	7.58	5.7280	1	0.0011
EDR	2402-2480	5	1	4.58	10.58	11.4288	1	0.0023

3.4.3 Simultaneous Multi-band Transmission MPE Analysis

3.4.4.1 List of Mode for Simultaneous Multi-band Transmission

No.	Configurations	Support/Not Support
1	2.4G_SISO_WLAN + BT	Not support
2	2.4G_MIMO_WLAN + BT	Not support
3	5G_SISO_WLAN + BT	Not support
4	5G_MIMO_WLAN + BT	Not support

APPENDIX 1 PHOTOS OF TEST SETUP

N/A

APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photos.

*** End of Report ***

The test report is effective only with both signature and specialized stamp. The result(s) shown in this report refer only to the sample(s) tested. Without written approval of UnionTrust, this report can't be reproduced except in full.
