1. RF Exposure Requirements

1.1 General Information

Client Information

Applicant:	Lumi United Technology Co., Ltd.
Address of applicant:	B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen, China
Manufacturer:	Lumi United Technology Co., Ltd.
Address of manufacturer:	B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen, China

General Description of EUT:

Product Name:	Presence Dimmer H2 US
Trade Name	Aqara
Model No.:	WS-K05D
Adding Model(s):	/
Rated Voltage:	AC120V
FCC ID:	2AKIT-WSK05D
Equipment Type:	Fixed device

Technical Characteristics of EUT:

Thread

Frequency Range:	2405-2480MHz
RF Output Power:	8.68dBm (Conducted)
Type of Modulation:	QPSK
Quantity of Channels:	16
Channel Separation:	5MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi

ZigBee

Support Standards:	IEEE802.15.4
Frequency Range:	2405-2480MHz
RF Output Power:	8.71dBm (Conducted)
Type of Modulation:	OQPSK
Quantity of Channels:	16
Channel Separation:	5MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi

Bluetooth

Bluetooth Version:	V5.0 (BLE mode)
Frequency Range:	2402-2480MHz
RF Output Power:	1Mbps: 8.66dBm (Conducted)

	2Mbps: 8.68dBm (Conducted)
Data Rate:	1Mbps, 2Mbps
Modulation:	GFSK
Quantity of Channels:	40
Channel Separation:	2MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi
RADAR	
Frequency Range:	24-24.25GHz
RF Output Power:	102.64dBuV/m
Type of Modulation:	FMCW
Type of Antenna:	Patch Antenna
Antenna Gain:	3.9dBi

1.2 RF Exposure Exemption

According to §1.1307(b)(3) and KDB 447498 D04 Interim General RF Exposure Guidance v01, 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.

Option A: FCC Rule Part 1.1307 (b)(3)(i)(A):The available maximum time-averaged power is no more than 1mW, regardless of separation distance.

Option B: FCC Rule Part 1.1307 (b)(3)(i)(B): The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20\,cm}(d/20\,cm)^x & d \leq 20\,cm \\ ERP_{20\,cm} & 20\,cm < d \leq 40\,cm \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\,cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\,cm} \text{ (mW)} = \begin{cases} 2040f & 0.3\,GHz \leq f < 1.5\,GHz \\ 3060 & 1.5\,GHz \leq f \leq 6\,GHz \end{cases}$$

d = the separation distance (cm);

Option C: FCC Rule Part 1.1307 (b)(3)(i)(C): The minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters.

Single RF Sources Subject to Routine Environmental Evaluation	
RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2
1.34-30	3,450 R^2/f^2
30-300	3.83 R^2
300-1,500	0.0128 $R^2 f$
1,500-100,000	19.2R^2

For Multiple RF sources: FCC Rule Part 1.1307(b)(3)(ii):

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required).

(B) In the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

1.3 Calculated Result

Radio Access Technology	Prediction Frequency (MHz)	Output Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Tune-Up Time-Averaged Power (dBm)	ERP (dBm)
Thread	2405	8.68	1.0	100	9.00	7.85
ZigBee	2405	8.71	1.0	100	9.00	7.85
Bluetooth	2402	8.68	1.0	100	9.00	7.85
RADAR	24000	3.48	3.9	/	4.00	5.75

Frequency (MHz)	Option	Min. Distance (cm)	Max. Power (dBm)	Max. Power (mW)	Exposure Limit (mW)	Ratio	Result Pass/Fail
2405	C	20.00	7.85	6.10	768.00	0.01	Pass
2405	C	20.00	7.85	6.10	768.00	0.01	Pass
2402	C	20.00	7.85	6.10	768.00	0.01	Pass

24000	C	20.00	5.75	3.76	768.00	0.01	Pass

*Note: 1. a. Time-Averaged Power=Output Power * Duty Cycle;*

ERP= Time-Averaged Power+ Antenna gain-2.15dB;

b. EIRP= E-104.8+20logD; Output Power=EIRP- Antenna Gain;

ERP=EIRP-2.15dB

2. Option A, B and C refers as clause 1.2.

3. For option B, Max (time-averaged power, effective radiated power (ERP)) converts to Max. Power. For option C, ERP converts to Max. Power;

4. For option B, P_{th} (mW) converts to Exposure Limit (mW); For option C, ERP (W) converts to Exposure Limit (mW).

5. Ratio= Tune-Up ERP (mW)/ Exposure Limit (mW)

Mode for Simultaneous Multi-band Transmission:

Radio Access Technology	Ratio 1	Ratio 2	Simultaneous Ratio	Limit	Result Pass/Fail
Thread+RADAR	0.01	0.01	0.02	1	Pass
ZigBee+RADAR	0.01	0.01	0.02	1	Pass
Bluetooth+RADAR	0.01	0.01	0.02	1	Pass

Note: Thread, ZigBee and Bluetooth is the use the same antenna cannot simultaneous transmission.

Result: Pass