

1. RF Exposure Requirements

1.1 General Information

Client Information

Applicant: Lumi United Technology Co., Ltd
Room 801-804, Building 1, Chongwen Park, Nanshan iPark, No. 3370,
Address of applicant: Liuxian Avenue, Fuguang Community, Taoyuan Residential District,
Nanshan District, Shenzhen, China

Manufacturer: Lumi United Technology Co., Ltd
Room 801-804, Building 1, Chongwen Park, Nanshan iPark, No. 3370,
Address of manufacturer: Liuxian Avenue, Fuguang Community, Taoyuan Residential District,
Nanshan District, Shenzhen, China

General Description of EUT:

Product Name: Presence Switch H2 US (2 Buttons, 1 Channel), Presence Switch H2
US (2 Buttons, 2 Channels), Presence Switch H2 US (4 Buttons, 3
Channels)
Trade Name: Aqara
Model No.: WS-K04D
Adding Model(s): WS-K22D, WS-K03D
Rated Voltage: AC120V
Power Adapter: /
FCC ID: 2AKIT-WSK04D
Equipment Type: Fixed device

Technical Characteristics of EUT:

Zigbee

Support Standards: IEEE802.15.4
Frequency Range: 2405-2480MHz
RF Output Power: 9.07dBm (Conducted)
Type of Modulation: QPSK
Quantity of Channels: 16
Channel Separation: 5MHz
Type of Antenna: Integral Antenna
Antenna Gain: 1dBi

Bluetooth

Bluetooth Version: V5.0 (LE mode)
Frequency Range: 2402-2480MHz
RF Output Power: 1Mbps: 2.85dBm (Conducted)
2Mbps: 2.91dBm (Conducted)
Data Rate: 1Mbps, 2Mbps
Modulation: GFSK

Quantity of Channels:	40
Channel Separation:	2MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi

Thread

Frequency Range:	2405-2480MHz
RF Output Power:	9.01dBm (Conducted)
Type of Modulation:	QPSK
Quantity of Channels:	16
Channel Separation:	5MHz
Type of Antenna:	Integral Antenna
Antenna Gain:	1dBi

RADAR

Frequency Range:	24-24.25GHz
RF Output Power:	93.82dBuV/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:

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

Where

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

and

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

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	$19.2 R^2$

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)
Zigbee	2405	9.07	1	100	10.00	8.85
Bluetooth	2402	2.91	1	100	3.00	1.85
Thread	2405	9.01	1	100	10.00	8.85
RADAR	24000	-1.44	3.9	/	-1.00	0.75

Frequency (MHz)	Option	Min. Distance (cm)	Max. Power (dBm) (mW)		Exposure Limit (mW)	Ratio	Result Pass/Fail
2405	C	20.00	8.85	7.67	768.00	0.01	Pass
2402	C	20.00	1.85	1.53	768.00	0.01	Pass
2405	C	20.00	8.85	7.67	768.00	0.01	Pass
24000	C	20.00	0.75	1.19	768.00	0.01	Pass

Note: 1. Time-Averaged Power=Output Power * Duty Cycle; ERP= Time-Averaged Power+ Antenna gain-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
MAX(Bluetooth /Zigbee/Thread) +Radar	0.01	0.01	0.02	1	Pass

Result: Pass