Maximum Permissible Exposure Evaluation

FCC ID: 2A2GJ-M2808 & IC: 27498-M2808

1. Client Information

Applicant	:	Heltec Automation Technology Co., Ltd
Address	:	2-208, Block A, Yusha Building, 64 Hangtian Road, Longtan Industrial Park, Chenghua District, Chengdu, Sichuan, China
Manufacturer	:	Heltec Automation Technology Co., Ltd
Address	:	2-208, Block A, Yusha Building, 64 Hangtian Road, Longtan Industrial Park, Chenghua District, Chengdu, Sichuan, China

2. General Description of EUT

EUT Name	:	Heltec Indoor Hotspot	
HVIN/Models No.	:	HT-M2808, HT-M2802	
Model Different	:	All these models are identical in the same PCB, layout and electrical circuit, The only difference is model name.	
Sample ID	:	20210603-15-1#& 20210603-15-2#	
Product Description	:	Operation Frequency:	802.11b/g/n(HT20): 2412MHz~2462MHz 802.11n(HT40): 2422MHz~2452MHz Bluetooth 5.0(BLE): 2402MHz~2480MHz Bluetooth 5.0(BER+EDR): 2402MHz~2480MHz U-NII-1: 5180MHz~5240MHz LoRa(500KHz): 923.3MHz-927.5MHz LoRa(125KHz): 903.9MHz-905.3MHz
Power Rating	:	Adapter: Input: 90-264V~, 50/60Hz, 1.5A Output: DC 12V3.0A	
Software Version	:	N/A	
Hardware Version	:	N/A	
Remark	:	The adapter and antenna gain provided by the applicant, the verified for the RF conduction test provided by TOBY test lab.	

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Method Of Measurement for FCC

1. **Max. Antenna Gain:**
   Internal Antenna: 5dBi.
   External Antenna: 4dBi.

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

3. **Exposure Evaluation:**
   Equation from page 18 of OET Bulletin 65, Edition 97-01
   $S=(PG)/4\pi R^2$
   Where
   S: power density
   P: power input to the antenna
   G: power gain of the antenna in the direction of interest relative to an isotropic radiator.
   R: distance to the center of radiation of the antenna

Simultaneous transmission MPE Considerations

According to KDB447498 :All transmitters and antennas in the host must be either evaluated for MPE compliance, by measurement or computational modeling, or qualify for the standalone MPE test exclusion in section 7.1.Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0.
This means that:

∑ of MPE ratios ≤ 1.0

4. Test Result:

2.4G WiFi Worst Maximum MPE Result								
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]	ANT Gain (dBi) [G]	Distance (cm) [R]	Power Density (mW/cm^2) [S]
802.11b	1	2412	16.73	16±1	17	5	20	0.0315
		2437	16.62	16±1	17	5	20	0.0315
		2462	16.13	16±1	17	5	20	0.0315
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.								

5G WiFi Worst Maximum MPE Result								
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]	ANT Gain (dBi) [G]	Distance (cm) [R]	Power Density (mW/cm^2) [S]
802.11a	1	5180	10.95	10±1	11	5	20	0.0079
		5200	10.97	10±1	11	5	20	0.0079
		5240	9.87	10±1	11	5	20	0.0079
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.								

Bluetooth Worst Maximum MPE Result								
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]	ANT Gain (dBi) [G]	Distance (cm) [R]	Power Density (mW/cm^2) [S]
GFSK	1	2402	4.82	4±1	5	5	20	0.0020
		2441	4.15	4±1	5	5	20	0.0020
		2480	3.24	4±1	5	5	20	0.0020
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.								

LoRa Worst Maximum MPE Result								
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]	ANT Gain (dBi) [G]	Distance (cm) [R]	Power Density (mW/cm^2) [S]
LoRa	1	903.9	17.239	17±1	18	4	20	0.0315
		904.5	17.336	17±1	18	4	20	0.0315
		905.3	17.406	17±1	18	4	20	0.0315
Note: RF Output power specifies that Maximum Conducted Peak Output Power.								

5. Conclusion:

As specified in Table 1B of 47 CFR 1.1310- Limits for Maximum Permissible Exposure (MPE),

Limits for General Population/ Uncontrolled Exposure

Frequency Range (MHz)	Power density (mW/cm^2)
300-1,500	F/1500
1,500-100,000	1.0

For: LoRa
Worst MPE limit S: 0.6026mW/cm^2
The MPE is calculated as ***0.0315mW/cm^2 < limit 0.6026mW/cm^2***.

For:2412~2462 MHz
MPE limit S: 1mW/cm^2
The MPE is calculated as ***0.0315mW/cm^2 < limit 1mW/cm^2***.

For:5180~5240MHz
MPE limit S: 1mW/cm^2
The MPE is calculated as ***0.0079mW/cm^2 < limit 1mW/cm^2***.

For:2402~2480MHz
MPE limit S: 1mW/cm^2
The MPE is calculated as ***0.0020mW/cm^2 < limit 1mW/cm^2***.

LoRa and WiFi support Synchronization transmit the

$$\sum MPE_{ratios}=0.0315+0.0315=0.0630<1$$

So, RF exposure limit warning or SAR test are not required.

The EUT will only be used with a separation of 20cm or greater between the antenna and nearby persons and can therefore be considered a mobile transmitter per 47 CFR2.1091 (b). The RF Exposure Information page from the manual is included here for reference.

Method Of Measurement for IC

1. Applicable Standard

Radio Standards Specification 102, Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands), sets out the requirements and measurement techniques used to evaluate radio frequency (RF) exposure compliance of radio communication apparatus designed to be used within the vicinity of the human body.

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

FCC KDB publication 447498 D01 General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

2. Evaluation Method and Limit

According to RSS-102 §4 Table 4, RF Filed Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10^{21}	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Frequency Band	f (MHz)	Limit of Power Density (W/m^2)
2.4G WLAN	2412	5.37
U-NII-1	5180	9.05
Bluetooth	2402	5.35
LoRa	903.9	2.74

Note: Limit=$0.02619f^{0.6834}$ (where f is in MHz).
The f in the limit is the frequency of the lowest Channel.

4.1 Calculation Formula

Prediction of power density at the distance of the applicable MPE limit:
S=PG/4πR²=Power density(in appropriate units, e.g W/m²）

P=power input to antenna (in appropriate units, e.g W）
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 m）

Simultaneous transmission MPE Considerations

According to KDB447498: All transmitters and antennas in the host must be either evaluated for MPE compliance, by measurement or computational modeling, or qualify for the standalone MPE test exclusion in section 7.1.Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0.
This means that:

∑ of MPE ratios ≤ 1.0

5. Evaluation Results

Standalone MPE Evaluation:

2.4G WiFi Worst Data					
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]
802.11b	1	2412	16.73	16±1	17
		2437	16.62	16±1	17
		2462	16.13	16±1	17
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.					

5G WiFi Worst Data					
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]
802.11a	1	5180	10.95	10±1	11
		5200	10.97	10±1	11
		5240	9.87	10±1	11
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.					

Bluetooth Worst Data					
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]
GFSK	1	2402	4.82	4±1	5
		2441	4.15	4±1	5
		2480	3.24	4±1	5
Note: N_{TX}= Number of Transmit Antennas RF Output power specifies that Maximum Conducted Peak Output Power.					

LoRa Worst Data					
Mode	N_{TX}	Freq. (MHz)	Conducted Power(max) (dBm)	Turn-up Power (dB)	Max tune up power (dBm) [P]
LoRa	1	903.9	17.239	17±1	18
		904.5	17.336	17±1	18
		905.3	17.406	17±1	18
Note: RF Output power specifies that Maximum Conducted Peak Output Power.					

Worst MPE Result

Modulation Type	Output power (Turn-up Procedure)	Antenna Gain (dBi)	E.I.R.P. (dBm)	E.I.R.P. (W)	E.I.R.P. Limit (W)
	dBm				
2.4G WiFi	17	5	22.00	0.158	2.684
5G WiFi	11	5	16.00	0.040	9.050
Bluetooth	5	5	10.00	0.010	2.676
LoRa	18	4	22.00	0.158	1.372

LoRa and WiFi support Synchronization transmit

Modulation Type	Output power (Turn-up Procedure)		Antenna Gain (dBi)	Antenna Gain (Numeric)	Distance (m) [R]	Power Density At 20 cm (W/m^2)	Power Density Limit (W/m^2)
	dBm	W					
2.4G WiFi	17	0.158	5	3.1623	0.20	0.315	5.37
5G WiFi	11	0.040	5	3.1623	0.20	0.079	9.05
Bluetooth	5	0.010	5	3.1623	0.20	0.020	5.35
LoRa	18	0.158	4	2.5119	0.20	0.315	2.74

Maximum Simultaneous transmission MPE Ratios for LoRa and WiFi support

Maximum MPE ratio $_{WiFi}$	Maximum MPE ratio $_{LoRa}$	∑MPE ratios	Limit	Results
0.315	0.315	0.630	1	PASS

Remark:
1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

Note

For a more detailed features description, please refer to the RF Test Report.

-----END OF REPORT-----