

**RADIOCOMMUNICATIONS EQUIPMENT  
COMPLIANCE ASSESSMENT  
FOR  
FCC CFR 47 Part 2.1091  
RADIOFREQUENCY RADIATION EXPOSURE  
EVALUATION: MOBILE DEVICES  
MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

Client:	CNC3D Pty Ltd
Address:	3/24 Spencer Road, Nerang, QLD 4211, Australia
Report Number:	0928CNC_2.1_MPE(FCC)
Date of Assessment	23 Sep 2022
File Number:	CNC220405

Equipment Name:	Nighthawk CNC Controller
Equipment Model No:	2.1
Equipment Trade/Brand Name:	CNC3D
Equipment FCC ID:	2AC7Z-ESP32WROOM32U (BT/WiFi module)
Equipment Description:	Nighthawk CNC Controller

Result:	<b>COMPLIES</b> (General Population/Uncontrolled Exposure)
---------	---

Assessed by:	<b>Phillip Kane</b>
--------------	---------------------



Approved by:	<b>Colin Gan</b>
--------------	------------------



Date of Issue:	28 Sep 2022
----------------	-------------

Results appearing herein relate only to the sample(s) assessed through the submitted test report(s).  
This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

This document shall not be reproduced in any form except in full.

EQUIPMENT DETAILS	
<b>MANUFACTURER:</b>	CNC3D Pty Ltd
<b>MODEL:</b>	2.1
<b>OPERATING FREQUENCY:</b>	<u>Bluetooth:</u> 2400-2483.5 MHz <sup>Note 1</sup> <u>WiFi:</u> 2400-2483.5 MHz <sup>Note 2</sup>
<b>TRANSMITTER POWER INTO ANTENNA:</b>	<u>Bluetooth:</u> 3.0 dBm (2 mW) <sup>Note 1</sup> <u>WiFi:</u> 16.02 dBm (40 mW) <sup>Note 2</sup>
<b>TYPE OF ANTENNA:</b>	Single integral monopole antenna <sup>Note 3</sup>
<b>ANTENNA GAIN:</b>	3.0 dBi <sup>Note 3</sup>
<b>TRANSMISSION CAPABILITY:</b>	Single transmission only possible.

**Notes:**

1. BT data extracted from FCC TCB Grant “esp32-wroom-32u\_fcc\_bt\_certificate.pdf”, dated 22 Jan 2018 for the ESP32-WROOM\_32U BT/WiFi module [FCC ID: 2AC7Z-ESP32WROOM32U] provided by client.
2. WiFi data extracted from FCC TCB Grant “esp32-wroom-32u\_fcc\_wi-fi\_bt4.0\_certificate.pdf”, dated 17 Jan 2018 for the ESP32-WROOM\_32U BT/WiFi module [FCC ID: 2AC7Z-ESP32WROOM32U] provided by client.
3. Data extracted from product manual “nighthawk-controller-manual.pdf” provided by client.
4. Minimum separation distance of equipment from human body is understood to be 20 cm or greater.

## **FCC § 2.1091 Radiofrequency Radiation Exposure for Mobile devices**

### **§ 2.1091 (b)**

For purposes of this section, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.

### **RF Exposure Requirements: FCC §1.1307(b)(1), §1.1307(b)(2) and §1.1307(b)(3)**

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

This document shall not be reproduced in any form except in full.

**RF Radiation Exposure Limit: FCC §1.1310**

As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

**Maximum Permissible Exposure**

(As specified in Table 1B of 47 CFR 1.1310 – Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure)

<i>Frequency range (MHz)</i>	<i>Power density (mW/cm<sup>2</sup>)</i>
300 – 1500	f/1500
1,500 – 100000	1.0

**MPE Calculation**

The transmitter antenna configurations for MPE considerations are as follows:

- Bluetooth (2.4 GHz) operation: Integral antenna
- WiFi (2.4 GHz) operation: Integral antenna

Results of RF Exposure Calculations for the EUT in the stated configurations are included on the following pages.

This document shall not be reproduced in any form except in full.

### MPE Calculation for Bluetooth (2.4 GHz) Only Operation

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	B T	2AC7Z-ESP32WROOM32U	2400	3.00	3.00

#### Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (Minutes)
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30 to 300	27.5	0.073	0.2	30
300 to 1500	NA	NA	f/1500	30
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

\* = Plane-wave equivalent power density.

Power Density Limits (mW/cm<sup>2</sup>): Tx1 = **1**

#### MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm <sup>2</sup> )	Cumulative Exposure (%)
1	2400	3.00	3.00	100	0.0008	0.08%

<b>Total Cumulative Exposure</b>	<b>0.08%</b>
----------------------------------	--------------

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

This document shall not be reproduced in any form except in full.

### MPE Calculation for WiFi (2.4 GHz) Only Operation

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	WiFi	2AC7Z-ESP32WROOM32U	2400	16.00	3.00

#### Limits for Maximum Permissible Exposure (MPE) (FCC 1.1310 Table 1)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (Minutes)
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30 to 300	27.5	0.073	0.2	30
300 to 1500	NA	NA	f/1500	30
1500 to 100,000	NA	NA	1	30

f = frequency in MHz.

\* = Plane-wave equivalent power density.

Power Density Limits (mW/cm<sup>2</sup>): Tx1 = **1**

#### MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **20**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 20 cm) (mW/cm <sup>2</sup> )	Cumulative Exposure (%)
1	2400	16.00	3.00	100	0.0158	1.58%

<b>Total Cumulative Exposure</b>	<b>1.58%</b>
----------------------------------	--------------

Calculations are based on the following formulae:

$$\text{Power Density} = \frac{(\text{Gain} \times \text{Power} \times \text{Duty Cycle})}{(4 \times \pi \times \text{Distance}^2)}$$

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}} \quad (\text{per OET 65})$$

Note 1: Co-located transmitters are transmitters with antennas within 20cm of each other, which could be transmitting simultaneously.

Note 2: Where there is only one transmitting antenna, any reference to co-location is invalid.

This document shall not be reproduced in any form except in full.

Based on worst-case MPE calculations, **the minimum separation distances** between the transmission point (generally referring to the transmit antennas or structure) and the human body for the Nighthawk CNC Controller, Model 2.1 with single transmit antenna is **20 cm**, which is to be clearly and prominently stated in the product manual for the above listed combination of radios and maximum antenna gains.

The above minimum safety distance is not valid for transmit antennas with higher antenna gains.

### **Austest Summary and Recommendations**

The equipment complies with FCC 47 CFR 1.1310: Limits for Maximum Permissible Exposure (MPE), Limits for General Population / Uncontrolled Exposure, when the indicated minimum separation distances are adhered to.

If compliance is sought for model numbers other than those listed in the test report, then the compliance folder must hold additional documentation, demonstrating the equivalence of the products between the different model numbers.

This document shall not be reproduced in any form except in full.