

**RADIOCOMMUNICATIONS EQUIPMENT
COMPLIANCE ASSESSMENT
FOR
RSS-102 Issue 5
RADIO FREQUENCY RF EXPOSURE COMPLIANCE
RF EXPOSURE EVALUATION**

Client:	CNC3D Pty Ltd
Address:	3/24 Spencer Road, Nerang, QLD 4211, Australia
Report Number:	0928CNC_2.1_MPE(RSS102)
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 Description:	Nighthawk CNC Controller

Result:	COMPLIES (General Population/Uncontrolled Exposure)
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Assessed by:	Phillip Kane
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Approved by:	Colin Gan
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Date of Issue:	28 Sep 2022
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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.

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

RSS-102 RF Exposure Criteria for Intentional Radiators

RF Exposure Requirements: RSS-102 Clause 1

This Radio Standards Specification (RSS) sets out the requirements and measurement techniques used to evaluate RF exposure compliance of radiocommunication apparatus (Category I and Category II equipment) that are designed to be used within the vicinity of the human body. This standard applies to radiocommunication apparatus having an integral antenna, systems requiring licensing with detachable antennas sold with the transmitters or licence-exempt transmitters with detachable antennas, as defined in RSS-Gen.

RF Radiation Exposure Limit: RSS-102 Clauses 3 & 4

Devices that have a radiating element normally operating at or below 6 GHz, with a separation distance greater than 20 cm between the user and/or bystander and the device shall undergo an RF exposure evaluation.

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As specified in Table 4 of RSS-102 – RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment):

<i>Frequency Range (MHz)</i>	<i>Power Density (W/m²)</i>
300 – 6000	$0.02619 f^{0.6834}$

Note: f is frequency in MHz.

RF Exposure Calculation

The transmitter antenna configurations for RF Exposure Calculation 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.

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MPE Calculation for Bluetooth (2.4 GHz) Only Operation

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

RF Field Strength Limits (RSS-102)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (Minutes)
Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
0.003 to 10	83	90	-	Instantaneous*
0.1 to 10	-	$0.73 / f$	-	6**
1.1 to 10	$87 / f^{0.5}$	-	-	6**
10 to 20	27.46	0.0728	2	6
20 to 48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48 to 300	22.06	0.05852	1.291	6
300 to 6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000 to 15000	61.4	0.163	10	6
15000 to 150000	61.4	0.163	10	$616000 / f^{1.2}$
150000 to 300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000 / f^{1.2}$

f = frequency in MHz.

* = Based on nerve stimulation (NS).

** = Based on specific absorption rate (SAR)

Power Density Limits (W/m²): Tx1 = **5.34**

RF Evaluation 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) (W/m ²)	Cumulative Exposure (%)
1	2400	3.00	3.00	100	0.0079	0.15%

Total Cumulative Exposure 0.15%

Calculations are based on the following formulae:

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

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}}$$

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.

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MPE Calculation for WiFi (2.4 GHz) Only Operation

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

RF Field Strength Limits (RSS-102)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (Minutes)
Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
0.003 to 10	83	90	-	Instantaneous*
0.1 to 10	-	$0.73 / f$	-	6**
1.1 to 10	$87 / f^{0.5}$	-	-	6**
10 to 20	27.46	0.0728	2	6
20 to 48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48 to 300	22.06	0.05852	1.291	6
300 to 6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000 to 15000	61.4	0.163	10	6
15000 to 150000	61.4	0.163	10	$616000 / f^{1.2}$
150000 to 300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000 / f^{1.2}$

f = frequency in MHz.

* = Based on nerve stimulation (NS).

** = Based on specific absorption rate (SAR)

Power Density Limits (W/m²): Tx1 = **5.34**

RF Evaluation 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) (W/m ²)	Cumulative Exposure (%)
1	2400	16.00	3.00	100	0.1580	2.96%

Total Cumulative Exposure	2.96%
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Calculations are based on the following formulae:

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

$$\text{Cumulative Exposure} = \frac{\text{Power Density at Tx Frequency}}{\text{Power Density Limit at Tx Frequency}}$$

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.

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

The above minimum safety distances are not valid for transmit antennas with higher antenna gains.

Austest Summary and Recommendations

The equipment is exempted from RSS-102 Issue 5 SAR compliance for General Population / Uncontrolled Exposure based on the exclusion justification above.

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.

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