

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

Client:	Industrea Mining Technology Pty Ltd T/A: Digital Mining Technology
Address:	3 Co-wyn Close, Fountaindale, NSW 2258, Australia
Report Number:	0815IND_PROD0847-2_MPE (FCC) <i>[This report replaces report 0804IND_PROD0847-2_MPE (FCC)]</i>
File Number:	INT210709
Equipment Name:	CAS-GPS IVU
Equipment Model No:	PROD0842-2 & PROD0847-2
Equipment FCC ID:	XPYJODYW263 (WiFi module) QIPPLS62-W (Cellular module)
Equipment Description:	Collision Avoidance System IVU (In-Vehicle-Unit) with Cellular LTE, WiFi and 920MHz V2V Radio
Result:	<b>COMPLIES</b> (General Population/Uncontrolled Exposure)
Assessed by:	<b>Phillip Kane</b> 
Approved by:	<b>Colin Gan</b> 
Date of Issue:	15 Aug 2022
<small>Results appearing herein relate only to the sample(s) assessed through the submitted test report(s).</small>	
<small>This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.</small>	

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<b>EQUIPMENT DETAILS</b>	
<b>MANUFACTURER:</b>	Industrea Mining Technology Pty Ltd T/A: Digital Mining Technology
<b>MODEL:</b>	PROD0842-2 (contains V2V & WiFi functions only) PROD0847-2 (contains V2V, WiFi & Cellular functions)
<b>OPERATING FREQUENCY:</b>	<u>V2V Radio</u> : 920 MHz <sup>Note 1</sup> <u>WiFi</u> : 2400-2483.5 MHz <sup>Note 1</sup> <u>2G</u> : 850/900/1800/1900 MHz <sup>Note 1</sup> <u>WCDMA</u> : Bands 1, 2, 4, 5, 8, 9, 19 <sup>Note 1</sup> (2100/1900/1700/850/900/1700/800 MHz) <u>LTE</u> : Bands 1, 2, 3, 4, 5, 7, 8, 12, 17, 18, 19, 20, 28 <sup>Note 1</sup> (2100/1900/1800/1700/850/2600/900/700/800 MHz)
<b>TRANSMITTER POWER INTO ANTENNA:</b>	<u>V2V Radio</u> : 20 dBm (100 mW) <sup>Note 1</sup> <u>WiFi</u> : 16 dBm (39.8 mW) <sup>Note 1</sup> <u>2G</u> : 33 dBm (1.995 W) max. <sup>Note 1</sup> <u>WCDMA</u> : 24 dBm +1/-3 dB (0.316 W) max. <sup>Note 2</sup> <u>LTE</u> : 23 dBm ±2 dB (0.316 W) max. <sup>Note 2</sup>
<b>TYPE OF ANTENNA:</b>	<u>V2V Radio</u> : Laird TRAB8213NP external antenna <sup>Note 1</sup> <u>WiFi</u> : Syskim OYM02020-NF WLAN 2.4 GHz external antenna <sup>Note 1</sup> <u>Cellular</u> : Laird TRA6927M3PWN-001 4G/3G external antenna <sup>Note 1</sup>
<b>ANTENNA GAIN:</b>	<u>V2V Radio</u> : 3.0 dBi <sup>Note 1</sup> <u>WiFi</u> : 3.0 dBi <sup>Note 1</sup> <u>Cellular</u> : 3.0 dBi max. <sup>Note 1</sup>
<b>TRANSMISSION CAPABILITY:</b>	Simultaneous transmissions possible.

**Notes:**

1. *Data provided by client.*
2. *Data extracted from Cinterion PLS62-W cellular module data sheet Cinterion\_PLS62-W\_HID\_v00.140\_2-26-18.pdf.*
3. *Minimum separation distance of equipment from human body is understood to be 20 cm or greater.*

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## **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.

### **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:

- V2V (920 MHz) operation: Laird Technologies TRAB9023NP external antenna
- WiFi (2.4GHz) operation: Syskim OYM02020-NF WLAN 2.4 GHz external antenna
- Cellular operation: Laird Technologies TRA6927M3PWN-001 4G/3G external antenna

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The V2V, WiFi and cellular antennas are considered co-located as they are less than 20cm apart for the purpose of the MPE calculations.

The following radio modules will be used in the PROD0842-2 that will result in co-location of the antennas for the modules:

- V2V radio: FCC ID: YIY-PROD08422 (Tested as part of Host Equipment)
- Wi-Fi module: uBlox Jody-W2 module (FCC ID: XPYJODYW263)

Results of MPE calculations for the EUT in V2V Radio and WiFi alone plus V2V Radio co-located with the WiFi antenna configurations are included in the following pages.

The following radio modules will be used in the PROD0847-2 that will result in co-location of the antennas for the modules:

- V2V radio: FCC ID: YIY-PROD08472 (Tested as part of Host Equipment)
- Wi-Fi module: uBlox Jody-W2 module (FCC ID: XPYJODYW263)
- Cellular module: PLS62-W module (FCC ID – QIPPLS62-W)

Results of MPE calculations for the EUT in V2V Radio, WiFi and Cellular alone plus V2V Radio co-located with the WiFi and cellular antenna configurations are included in the following pages.

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**Models PROD0842-2 & PROD0847-2**  
**MPE Calculation for V2V (920 MHz) Only Operation**  
**(TRAB9023NP Antenna)**

**Product Details**

Tx Number	Description	FCC / IC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	V2V	PROD0842-2 FCC ID: YIY-PROD08422 IC ID: 8903A-PROD08422 PROD0847-2 FCC ID: YIY-PROD08472 IC ID: 8903A-PROD08472	920	20.00	3.00

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

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

f = frequency in MHz.

\* = Plane-wave equivalent power density.

**Power Density Limits (mW/cm<sup>2</sup>):** Tx1 = 0.613

**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	920	20.00	3.00	100	0.0397	6.47%
<b>Total Cumulative Exposure</b>						<b>6.47%</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.

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**Models PROD0842-2 & PROD0847-2**  
**MPE Calculation for WiFi (2.4GHz) Only Operation**  
**(OYM02020-NF WLAN 2.4GHz Antenna)**

**Product Details**

Tx Number	Description	FCC / IC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	WiFi	FCC ID: XPYJODYW263 IC ID: 8595A-JODYW263	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 = 1.000

**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.

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**Model PROD0847-2**  
**MPE Calculation for 2G (850 MHz) Only Operation**  
**(TRA6927M3PWN-001 4G/3G/2G Antenna)**

**Product Details**

Tx Number	Description	FCC / IC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	2G 850 Band	FCC ID: QIPPLS62-W IC ID: 7830A-PLS62W	824	33.00	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 = 0.549

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

Minimum Separation Distance for Co-located Tx (cm) = 25

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 25 cm) (mW/cm <sup>2</sup> )	Cumulative Exposure (%)
1	824	33.00	3.00	100	0.5069	92.27%
<b>Total Cumulative Exposure</b>						<b>92.27%</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.

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**Models PROD0842-2 & PROD0847-2**  
**Worst Case MPE Calculation for Multiple Co-located Tx Sources**  
**V2V (920 MHz) & WiFi (2.4GHz)**

**Product Details**

Tx Number	Description	FCC / IC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	V2V	PROD0842-2 FCC ID: YIY-PROD08422 IC ID: 8903A-PROD08422 PROD0847-2 FCC ID: YIY-PROD08472 IC ID: 8903A-PROD08472	920	20.00	3.00
2	WiFi	FCC ID: XPYJODYW263 IC ID: 8595A-JODYW263	2400	16.00	3.00

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

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

f = frequency in MHz.

\* = Plane-wave equivalent power density.

Power Density Limits (mW/cm<sup>2</sup>): Tx1 = 0.613 Tx2 = 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	920	20.00	3.00	100	0.0397	6.47%
2	2400	16.00	3.00	100	0.0158	1.58%
<b>Total Cumulative Exposure</b>						<b>8.05%</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.

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**Model PROD0847-2**  
**Worst Case MPE Calculation for Multiple Co-located Tx Sources**  
**V2V (920 MHz) & WiFi (2.4GHz) & 2G (850MHz)**

**Product Details**

Tx Number	Description	FCC / IC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	V2V	FCC ID: YIY-PROD08472 IC ID: 8903A-PROD08472	920	20.00	3.00
2	WiFi	FCC ID: XPYJODYW263 IC ID: 8595A-JODYW263	2400	16.00	3.00
3	2G	FCC ID: QIPPLS62-W IC ID: 7830A-PLS62W	824	33.00	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 = 0.613 Tx2 = 1 Tx3 = 0.549

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

**Minimum Separation Distance for Co-located Tx (cm) =** 25

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 25 cm) (mW/cm <sup>2</sup> )	Cumulative Exposure (%)
1	920	20.00	3.00	100	0.0254	4.14%
2	2400	16.00	3.00	100	0.0101	1.01%
3	824	33.00	3.00	100	0.5069	92.27%
<b>Total Cumulative Exposure</b>						<b>97.43%</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.

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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 CAS-GPS IVU, Model PROD0842-2 with co-located radios 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.

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 CAS-GPS IVU, Model PROD0847-2 with co-located radios is **25 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.

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