



**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:	0503IND_PROD1177-X-Y_MPE(FCC) <i>[Supersedes report 0420IND_PROD1177-X-Y_MPE(FCC)]</i>
File Number:	INT211029-A
Equipment Name:	IVU Plus
Equipment Model No:	PROD1177-X-Y
Equipment FCC ID:	YIY-PROD1177
Equipment Description:	IVU Plus is a Rugged, multipurpose telematics computer intended for use in surface mining industry trucks/vehicles
Result:	COMPLIES (General Population/Uncontrolled Exposure)
Assessed by:	Phillip Kane 
Approved by:	Colin Gan 
Date of Issue:	03 May 2023

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:	Industrea Mining Technology Pty Ltd T/A: Digital Mining Technology
MODEL:	PROD1177-X-Y [Where X is optional GNSS Variant code and YYY is the country code]
OPERATING FREQUENCY:	<u>V2V Radio:</u> 902 - 928 MHz ^{Note 1} <u>WiFi:</u> 2400-2483.5 MHz ^{Note 1} <u>GSM:</u> 850, 900, 1800, 1900 MHz ^{Note 2} <u>WCDMA:</u> Bands 1, 2, 3, 4, 5, 6, 8, 9, 19 ^{Note 2} (2100, 1900, 1800, 1700, 850, 800, 900 MHz) <u>LTE FDD:</u> Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 18, 19, 20, 26, 28, 66 ^{Note 2} (2100, 1900, 1800, 1700, 850, 2600, 900, 800 MHz) <u>LTE TDD:</u> Bands 38, 40, 41 ^{Note 2} (2600, 2300, 2500 MHz)
TRANSMITTER POWER INTO ANTENNA:	<u>V2V Radio:</u> 20 dBm (100 mW) ^{Note 1} <u>WiFi:</u> 30 dBm (1.0 W) ^{Note 1} <u>Cellular:</u> 33.57 dBm (2.275 W) max. ^{Note 4}
TYPE OF ANTENNA:	<u>V2V Radio:</u> TRAB9023NP external antenna (902-928 MHz) ^{Note 1} <u>WiFi:</u> Syskim OYM02020-NF WiFi 2.4 GHz external antenna ^{Note 3} <u>Cellular:</u> Laird TRA6927M3PWN-001 4G/3G external antenna ^{Note 3}
ANTENNA GAIN:	<u>V2V Radio:</u> 3.0 dBi (TRAB9023NP) ^{Note 1} <u>WiFi:</u> 3.0 dBi ^{Note 3} <u>Cellular:</u> 3.0 dBi max. ^{Note 3}
TRANSMISSION CAPABILITY:	Simultaneous transmissions possible.

Notes:

1. Data extracted from file "PROD1177_X_YYY_IVU_Plus_Product_Information_Sheet.pdf" provided by client.
2. Data extracted from Cinterion cellular module data sheets "Collateral_2_PLS63_W_R0_Web.pdf" and "Cinterion_PLS62-W_HID_v00.140_2-26-18.pdf".
3. Data provided by client.
4. Data extracted from UnionTrust FCC test report 200722016RFM-1.

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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/cm²)</i>
300 – 1500	f/1500
1,500 – 100000	1.0

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MPE Calculation

The transmitter antenna configurations for MPE considerations are as follows:

- V2V (902 - 928 MHz) operation: TRAB9023NP 3.0 dBi external antenna.
- WiFi (2.4 GHz) operation: Syskim OYM02020-NF WLAN 2.4 GHz external antenna.
- Cellular operation: Laird Technologies TRA6927M3PWN-001 4G/3G external antenna.

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 EUT that will result in co-location of the antennas for the modules:

- V2V radio module
- Wi-Fi module: Doodle Labs NM-DB-2M module (FCC ID: 2AG87NM-DB-3)
- Cellular module: PLS63-W module (FCC ID – QIPPLS63-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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MPE Calculation for V2V (902 - 928 MHz) Only Operation
(TRAB9023NP Antenna)

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	V2V Radio	NA	902	20.00	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 ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f ²)	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/cm²): Tx1 = **0.60**

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 ²)	Cumulative Exposure (%)
1	902	20.00	3.00	100	0.0397	6.60%

Total Cumulative Exposure	6.60%
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Calculations are based on the following formulae:

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

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

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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MPE Calculation for WiFi (2.4GHz) Only Operation
(OYM02020-NF WiFi 2.4GHz Antenna)

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	WiFi	FCC ID: 2AG87NM-DB-3 IC ID: 21411-NMDB3	2400	30.00	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 ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f ²)	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/cm²): 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 ²)	Cumulative Exposure (%)
1	2400	30.00	3.00	100	0.3969	39.69%

Total Cumulative Exposure	39.69%
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Calculations are based on the following formulae:

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

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

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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MPE Calculation for GSM 850 Only Operation (Worst-case)
(TRA6927M3PWN-001 4G/3G/2G Antenna)

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	GSM 850	FCC ID: QIPPLS63-W IC ID: 7830A-PLS63W	824	33.57	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 ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f ²)	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/cm²): Tx1 = 0.55

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = 26

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 26 cm) (mW/cm ²)	Cumulative Exposure (%)
1	824	33.57	3.00	100	0.5344	97.28%
Total Cumulative Exposure						97.28%

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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Worst Case MPE Calculation for Multiple Co-located Tx Sources
V2V (902 MHz) & WiFi (2.4GHz) & GSM 850 (Worst-case Configuration)

Tx Number	Description	FCC ID	Frequency (MHz)	RF Power (Max) (dBm)	Antenna Gain (Max) (dBi)
1	V2V Radio	NA	902	20.00	3.00
2	WiFi	FCC ID: 2AG87NM-DB-3 IC ID: 21411-NMDB3	2400	30.00	3.00
3	GSM 850	FCC ID: QIPPLS63-W IC ID: 7830A-PLS63W	824	33.57	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 ²)	Averaging Time (Minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3 to 1.34	614	1.63	*(100)	30
1.34 to 30	824/f	2.19/f	*(180/f ²)	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/cm²): Tx1 = **0.60** Tx2 = **1.00** Tx3 = **0.55**

MPE Calculations (based on Power Density)

Minimum Separation Distance for Co-located Tx (cm) = **29.5**

Tx Number	Frequency (MHz)	RF Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	Power Density (at 29.5 cm) (mW/cm ²)	Cumulative Exposure (%)
1	902	20.00	3.00	100	0.0182	3.03%
2	2400	30.00	3.00	100	0.1825	18.25%
3	824	33.57	3.00	100	0.4151	75.56%

Total Cumulative Exposure **96.84%**

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 EUT with co-located radios is **29.5 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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