TEST REPORT

RADIOCOMMUNICATIONS

FCC TITLE 47 PART 15 SUBPART C

V2V Operation

Client:	Industrea Mining Technology Pty Ltd T/A: Digital Mining Technology
Address:	3 Co-wyn Close, Fountaindale, NSW, 2258, Australia
Report Number:	0122INT_PROD1177-X-Y_FCC15Ca
Date of Testing:	20th to 26th June, 18th October 2023
File Number:	INT230526
Equipment Name:	IVU Plus
Model Number	PROD1177-U-USA PROD1177-H-USA
FCC ID:	YIY-PROD1177
Description:	Rugged, multipurpose telematics computer intended for use in surface mining industry trucks/vehicles.
Result:	The sample tested **COMPLIED** with the applicable requirements of the standard. (Refer to Compliance Summary page for details).
Tested by:	Steve Garnham Test Engineer
Approved by:	Richard Turner Assessment Engineer
Date of Issue:	24th January 2024

Results appearing herein relate only to the sample(s) tested.

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.

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

TABLE OF CONTENTS

1 REPORT REVISION HISTORY 3
2 REFERENCES 3
3 COMPLIANCE SUMMARY 4
4 MODIFICATIONS 4
5 EQUIPMENT UNDER TEST INFORMATION 5
6 TEST SETUP AND EUT CONFIGURATION 6
7 TEST SPECIFICATIONS 8
8 ANTENNA REQUIREMENT, §15.203 10
9 RESTRICTED BANDS OF OPERATION, §15.205 10
10 DTS BANDWIDTH, §15.247(a)(2) 11
11 MAXIMUM PEAK CONDUCTED OUTPUT POWER, §15.247(b)(3) 12
12 POWER SPECTRAL DENSITY, §15.247(e) 13
13 OCCUPIED BANDWIDTH, 99%: §2.1049 14
14 CONDUCTED SPURIOUS EMISSIONS, OUT OF BAND, §15.247(d) 15
15 RADIATED EMISSIONS §15.209, RESTRICTED BANDS 18
16 CO-LOCATION VERIFICATION 26
APPENDIX A – PHOTOGRAPHIC RECORD OF SAMPLES (PROD1177-U-USA & PROD1177-H-USA) ... 27
APPENDIX B – PHOTOGRAPHIC RECORD OF SUPPORTING EQUIPMENT 28
APPENDIX C – TEST SETUP PHOTOGRAPHS 29
APPENDIX D– CLIENT DECLARATION 30
APPENDIX E– V2V ANTENNA SPECIFICATION 31

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

1 REPORT REVISION HISTORY

Date	Report Number	Changes
22/01/2024	0122INT_PROD1177-X-Y_FCC15C	Original Report.
24/01/2024	0122INT_PROD1177-X-Y_FCC15Ca	Corrected PSD procedure reference (page 13), Appendix D declaration revised to exclude model with no wireless functions.

2 REFERENCES

Document		Issue/ Amended
FCC Title 47	FCC Title 47 Part 15 – Radio Frequency Devices	Current as of Oct 2023
ANSI C63.10	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	2013
558074 D01	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under Section 15.247 of the FCC rules	v05r02 Apr 2, 2019
ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz	2014
Client Test Plan	IND04 153, Design Verification IVU Plus Certification Procedure	ver. 4 31 Apr 2023

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

3 COMPLIANCE SUMMARY

DISCLAIMER: Austest Laboratories makes no claim regarding the consistency of production versions of the EUT. The results in this report apply only to the sample tested, as described in Section 5 of this report.

FCC Part 15, Subpart C – Intentional Radiators		Result	Notes
15.203	Antenna Requirement	Complied	(iii)
15.205	Restricted Bands of Operation	Complied	-
15.207	Conducted Limits	N.A.	(i)
15.209	Radiated Emission Limits, General Requirements	Complied	-
15.247	Operation within the Bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz	Complied	(iv)
15.247(a)(1)	Channel Separation, Frequency Hopping Systems	N.A.	(ii)
15.247(a)(1)(iii)	Number of Hopping Channels	N.A.	(ii)
15.247(a)(1)(iii)	Time of Occupancy	N.A.	(ii)
15.247(a)(2)	Digital Modulation – 6 dB Bandwidth (≥500 kHz)	Complied	-
15.247(b)(3)	Maximum Peak Conducted Output Power: (1 Watt)	Complied	-
15.247(d)	Out of Band Emissions (non-restricted)– 100 kHz BW: (≥-20 dBc)	Complied	-
15.247(e)	Digital Modulation – Power Spectral Density: (<8 dBm/3 kHz)	Complied	
15.247(i)	Maximum Permissible Exposure (MPE)	Complied	-
2.1049	99% Bandwidth	Noted	-

Notes
(i) Not applicable as the EUT would normally be powered by a vehicle battery.
(ii) The EUT was assessed as DTS equipment.
(iii) See appendix D for antenna specs.
(iv) The EUT's V2V mode operated only in the band 902 MHz – 928 MHz.

4 MODIFICATIONS

None.

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

5 EQUIPMENT UNDER TEST INFORMATION

5.1 EUT Summary

EUT Name:	IVU Plus
EUT Model:	PROD1177-U-USA PROD1177-H -USA
EUT Serial Number(s):	1776 2305 0005 CU (-U) 1776 2204 0005 P2H (-H))
External Power Supply:	9 – 36 VDC
Operating Frequencies (V2V):	903 MHz to 927 MHz
Transmit Power (V2V):	20 dBm (as per the manufacturer's default firmware)
Modulation Technique (V2V):	4GFSK
Number of Channels (V2V):	25
Antenna Specifications (V2V):	External 3.0 dBi (as per the antenna manufacturer's specs. Refer Appendix D)

U-Unit

H-Unit

5.2 EUT Description

The EUT was a rugged, multipurpose telematics computer intended for use in surface mining industry trucks/vehicles. Applications include CAS-GPS collision avoidance, vehicle monitoring, fleet management and general remote data logging and management.

The EUT was housed in a painted metal case and contained the following radio circuits:

- V2V transceiver, operating between 903 MHz and 927 MHz.
- Doodle Labs NM-DB-2M WLAN transceiver, operating at 2.4 GHz.
- Thales PLS63-W 2G/3G/LTE modem.
- Septentrio M3PRO+ GNSS module, utilising two GPS antennas (-U model).
- uBlox ZED-F9P GPS module, utilising a single GPS antenna (-H model).

The EUT was intended to be powered by either a 12 V or 24 V vehicle battery supply. The EUT also had an internal battery, Lithiumwerks ANR26650M1B LiFePo cell with nominal voltage of 3.3 V.

Equivalent Model Nos:
Refer to Appendix D, for client declaration relating to equivalent model numbers.

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ACCREDITED
TEST LABORATORY
CERT #2765.02

6 TEST SETUP AND EUT CONFIGURATION

6.1 EUT Configurations

The EUT's V2V function was controlled by following instructions provided in the client's test plan.

The EUT was configured for continuous V2V transmission on Low (903 MHz), Mid (921 MHz) and High (927 MHz) channels using either 4GFSK modulation or CW as required. This would be 100% duty cycle as the transmission was constantly on. Conducted RF power command setting was set to ''V2Vpower 100'', producing a maximum power of 19.85 dBm (0.0966 W).

Both the CELL and WLAN outputs were turned off using software commands.
The GPS / GNSS were enabled with location information being presented on the user interface screen.

For measurement of radiated spurious emissions, the EUT's LAN port was connected to a remotely located laptop to enable control of the operating mode.

Prescan assessments were performed on both the -U and -H models to determine which model produced the highest emission levels.
Final measurements were performed on the worst model, PROD1177-U-USA.

Refer to the photographs in Appendix B for the EUT test setup and physical configuration.

6.2 Supporting Equipment

Equipment	Brand & Model
Camera	PROD0118
Display	PROD0839A
Variable DC Power Supply	GWINSTEK GPS 3030D
Laptop	Lenovo Thinkpad T430

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

6.3 Cables

PROD1177-U

EUT Port	Source/Load	Cable Type	Length*
Deutsch Connector	Multiple Cables / Loop Back	Supplied cable harness	1.3 m
Deutsch Connector	Camera PROD0118	Supplied cable harness	1.3 m
Deutsch Connector	USB	Supplied cable harness	1.3 m
Deutsch Connector	DC Supply In	Supplied cable harness	1.3 m
LAN	Ethernet Switch	Supplied Shielded RJ45	3.0 m
Display	PROD0839A	As Supplied	15.3 m
GSM	Laird TRA6927M3PWN-001 antenna	Coax	3.0 m
V2V	Laird, TRAB923NP antenna	Coax	5.3 m
GPS	Tallysman 33-3972-01-01 antenna	Coax	3.0 m
GPS-B	Tallysman 33-3972-01-01 antenna	Coax	3.0 m
WLAN	SYSKIM OYH 02020-NF antenna	Coax	3.0 m

*Cable length was adjusted by bundling or cut to length in accordance with the standard.

PROD1177-H-

EUT Port	Source/Load	Cable Type	Length*
Deutsch Connector	Multiple Cables / Loop Back	Supplied cable harness	1.3 m
Deutsch Connector	Camera PROD0118	Supplied cable harness	1.3 m
Deutsch Connector	USB	Supplied cable harness	1.3 m
Deutsch Connector	DC Supply In	Supplied cable harness	1.3 m
LAN	Ethernet Switch	Supplied Shielded RJ45	3.0 m
Display	PROD0839A	As Supplied	15.3 m
GSM	Laird TRA6927M3PWN-001 antenna	Coax	3.0 m
V2V	Laird, TRAB923NP antenna	Coax	5.3 m
GPS	Tallysman 33-3972-01-01 antenna	Coax	3.0 m
WLAN	SYSKIM OYH 02020-NF antenna	Coax	3.0 m

*Cable length was adjusted by bundling or cut to length in accordance with the standard.

This document shall not be reproduced in any form except in full.
This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

7 TEST SPECIFICATIONS

7.1 Test Facility

Testing was performed at Austest Laboratories located at 46 Glenola Farm Lane in Yarramalong Valley, New South Wales, Australia.

Radiated emission testing was performed at an OATS, where some ambient signals may have exceeded the continuous disturbance limit. The possibility of missing an emission during testing was removed by performing pre-scans in a shielded enclosure prior to the final OATS measurements.

For testing below 30 MHz, measurements were performed over the normal OATS ground plane and over a non-conductive ground plane as per ANSI C63.10, clause 5.2.

7.2 Accreditations and Listings

Test facilities at Austest Laboratories are accredited by A2LA, Certificate Number 2765.02. The tests reported herein have been performed in accordance with its terms of accreditation.

Austest Laboratories Yarramalong and Castle Hill test facilities are accredited with the FCC under the ACMA-FCC APEC-TEL MRA. Designation Number AU0003 / Registration number 520620.

7.3 Deviations from Standards and/or Accreditations

No deviations to the standard or Austest accreditation was required.

7.4 Test Witnesses

None.

7.5 Test Equipment

All critical items are maintained on a scheduled calibration recall program or verified with equipment maintained on a scheduled calibration program. Emission measurements are traceable to Australian National standards or international equivalents.

ID	Brand/Model	Description	Calibration Due
72	HP8574B	Spectrum Analyser / EMI Rx	07/11/2023
83	OATS 1 / FSOATS 1	3m/10m Open Area Test Site NSA, Svswr compliant	Verified
225	EMCO EM6876	Loop Antenna	29/03/2024
730	Wainwright	WHKS1350-5SS HP Filter	24/08/2023
813	RE1200A	RF Preamp	16/03/2024
1101	AH Systems SAS-200/571	DRG Horn 1-18GHz	03/05/2024
1132	AH Systems SAS-200/574	DRG Horn 18-40GHz	03/05/2024
1241	Com-Power PAM-118A	RF Preamp	20/05/2024
1385	FSP38	Spectrum analyser 38GHz	11/09/2023

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

ID	Brand/Model	Description	Calibration Due
1844	Ametek CBL6141B	Bilog Antenna	09/08/2023
-	HP85869C	Test Software	Verified
-	Rohde & Schwarz	RS Commander Capture Software	Verified
-	Huber & Suhner	Coax cables	14/04/2024

7.6 Measurement Uncertainty

Measurement uncertainty U_{Lab} was calculated for a 95% level of confidence and based on a coverage factor of k=2.

Emissions Tests

Measurement	Uncertainty	
	U_{cispr}	U_{Lab}
RF Frequency	-	±5 part in 10^{10}
RF power conducted	-	±1.3 dB
Power Spectral Density	-	±1.2 dB
Bandwidth (6 dB BW, 99% OBW)	-	±2.8 %
RF Power Radiated <1 GHz	-	±4.5 dB
RF Power Radiated >1 GHz	-	±4.9 dB
Radiated Emissions – 30 MHz to 1000 MHz	6.3 dB	±4.7 dB
Radiated Emissions – 1 GHz to 6 GHz	5.2 dB	±4.9 dB
Radiated Emissions – 6 GHz to 18 GHz	5.5 dB	±5.3 dB

7.7 Emission Test Criteria

The laboratory expanded MIU (U_{lab}) was less than the CISPR 16-4-2 criterion for the expanded MIU (U_{cispr}) and therefore:

- Compliance was deemed to occur if no measured disturbance exceeded the disturbance limit.
- Non-compliance was deemed to occur if any measured disturbance exceeded the disturbance limit.

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

8 ANTENNA REQUIREMENT, §15.203

The requirement of this Section was not applicable, since the EUT must be professionally installed, typically in mining equipment and the installer shall be responsible for ensuring the proper antenna is employed.

Refer to Appendix D for antenna specifications.

9 RESTRICTED BANDS OF OPERATION, §15.205

The EUT complied with the requirements of this Section since it did not operate within the listed Restricted Bands of Operation.
Out of band emissions falling within the Restricted Bands of Operation were below limits specified in FCC section 15.209.

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

10 DTS BANDWIDTH, §15.247(a)(2)

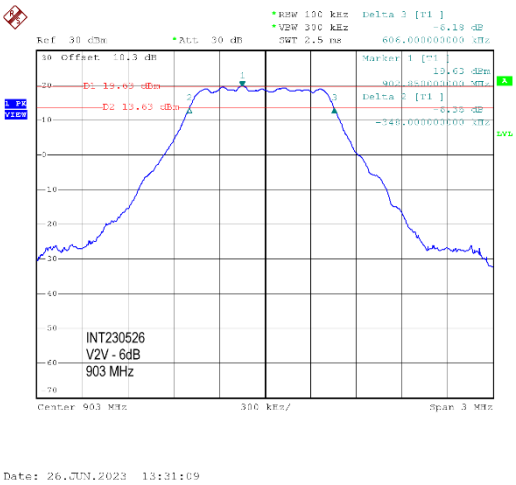
Test Date:	20th June 2023	Temperature:	19°C	Humidity:	42%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

The EUT was configured and operated as per sect 6.1 of this report.

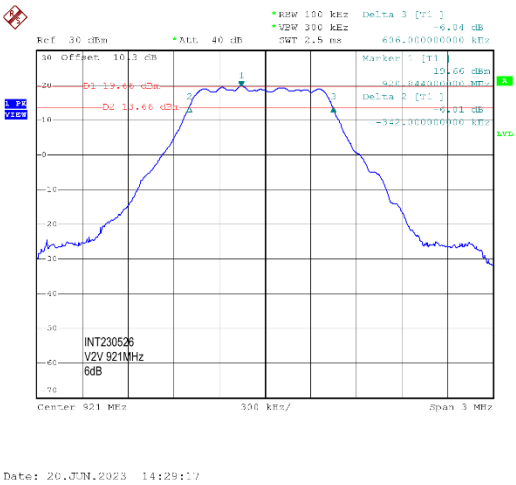
Measurements were performed on the PROD1177-U-USA sample by applying the procedure detailed in ANSI C63.10, Clause 11.8.1 DTS Bandwidth Option 1 and measured at the V2V antenna port.

The 6 dB bandwidth was calculated using the analyser ndB down marker function.

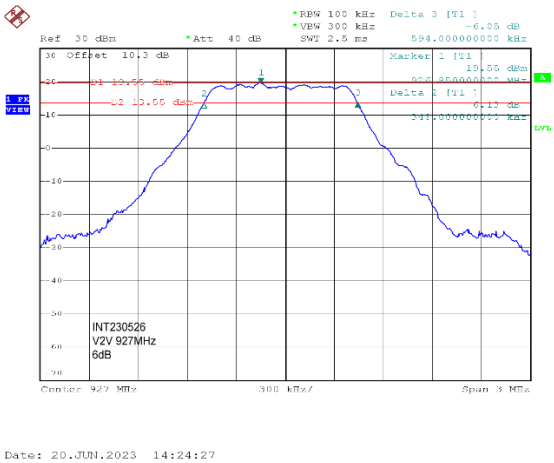
Frequency (MHz)	6 dB Bandwidth (kHz) (limit >500 kHz)
903.0	606
921.0	606
927.0	594



903 MHz



921 MHz



927 MHz

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

11 MAXIMUM PEAK CONDUCTED OUTPUT POWER, §15.247(b)(3)

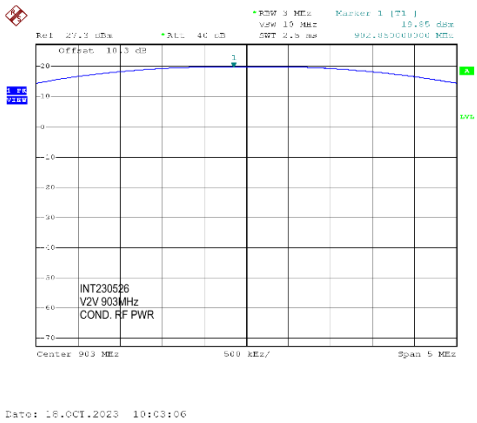
Test Date:	18th October 2023	Temperature:	23°C	Humidity:	53%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

The EUT was configured and operated as per sect 6.1 of this report.
A conducted RF measurement was performed at the V2V antenna port, refer to C63.10 clause 11.3 and applying the procedure detailed in ANSI C63.10, Clause 11.9.1.1 RBW ≥ DTS Bandwidth.

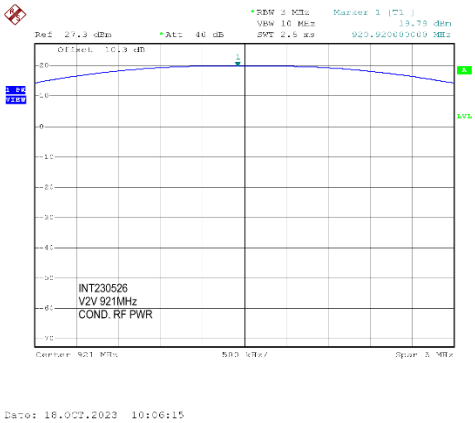
The power was measured directly from the marker results, the 10 dB pad and cable loss used for the conducted measurements were compensated for.

Frequency (MHz)	Peak Conducted Power		Limit		Margin (dB)
	(dBm)	(W)	(dBm)	(W)	
903.0	19.85	0.0966	30.0	1.00	-10.15
921.0	19.79	0.0953	30.0	1.00	-10.21
927.0	19.76	0.0946	30.0	1.00	-10.24

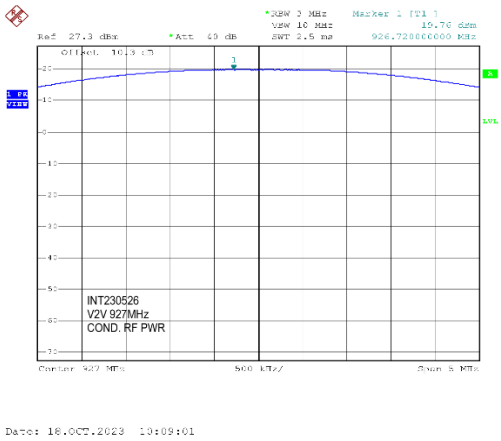
*Note that the measured Peak RF output was higher than the nominal +20 dBm setting in firmware. This would be a combination of firmware / hardware tolerance and measurement uncertainty.



903 MHz



921 MHz



927 MHz

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ACCREDITED
TEST LABORATORY
CERT #2765.02

12 POWER SPECTRAL DENSITY, §15.247(e)

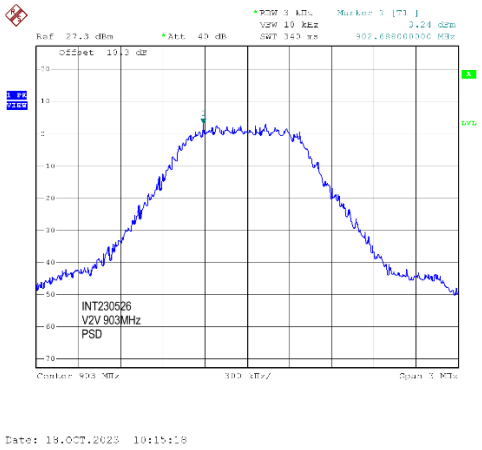
Test Date:	18th October 2023	Temperature:	23°C	Humidity:	53%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

The EUT was configured and operated as per sect 6.1 of this report.

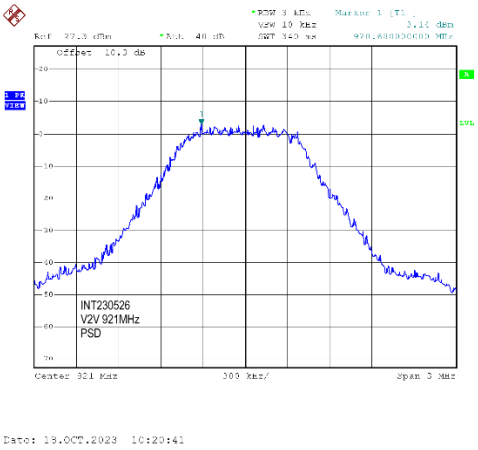
A conducted Peak PSD measurement was performed at the V2V antenna port by applying the procedure detailed in ANSI C63.10 clause 11.10.2.

The power was measured directly from the marker results, the 10 dB pad and cable loss used for the conducted measurements were compensated for.

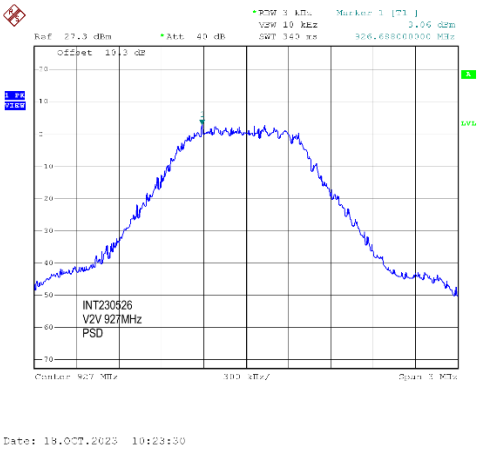
Frequency MHz	Peak Conducted PSD dBm/3 kHz	Limit dBm/3 kHz	Margin dB
903.0	3.24	8	-4.76
921.0	3.14	8	-4.86
927.0	3.06	8	-4.94



903 MHz



921 MHz



927 MHz

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

13 OCCUPIED BANDWIDTH, 99%: §2.1049

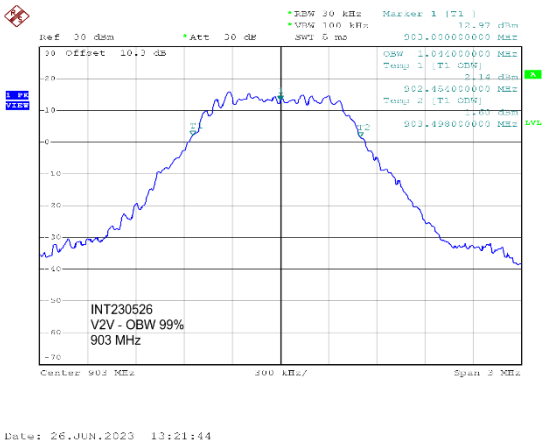
Test Date:	20th June 2023	Temperature:	19°C	Humidity:	42%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

Measurements were performed on the V2V antenna port by applying the procedure detailed in ANSI C63.10 Clause 6.9.3, Occupied bandwidth -power bandwidth (99%) measurement procedure.

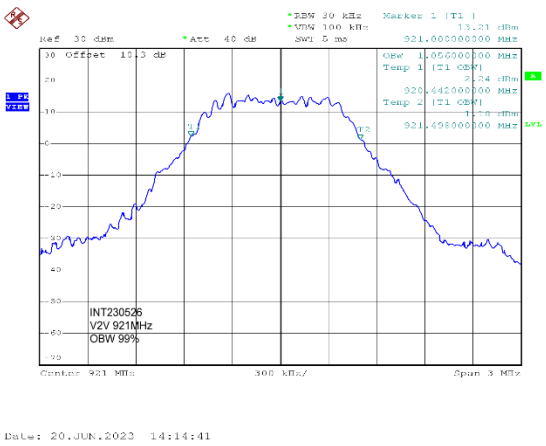
Measurements were performed on the PROD1177-U- sample.

The result was obtained directly from the markers, the 10 dB pad and cable loss used for the conducted measurements were compensated for.

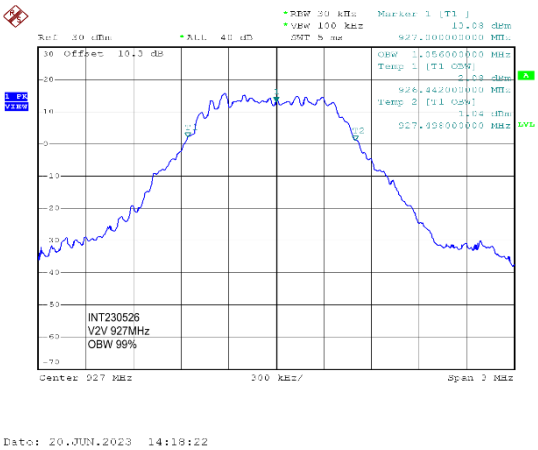
RF Channel	Centre Freq (MHz)	99% Power BW (MHz)	FLOW (MHz)	FHIGH (MHz	Band Edge (MHz)	Δ Frequency (MHz)
Low	903.0	1044.0	902.454	-	902.00	0.454
Mid	921.0	1056.0	920.442	921.498	-	-
High	927.0	1056.0	-	927.498	928.00	-0.502



903 MHz - 99% OBW



921 MHz - 99% OBW



927 MHz - 99% OBW

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ACCREDITED
TEST LABORATORY
CERT #2765.02

14 CONDUCTED SPURIOUS EMISSIONS, OUT OF BAND, §15.247(d)

Test Date:	20th June 2023	Temperature:	19°C	Humidity:	42%
Test Officer:	Steven Garnham				
Test Location:	Austest Laboratories (Yarramalong)				

14.1 EUT Operating Mode

Refer Section 6.1.
Measurements were performed on the PROD1177-U-USA sample.

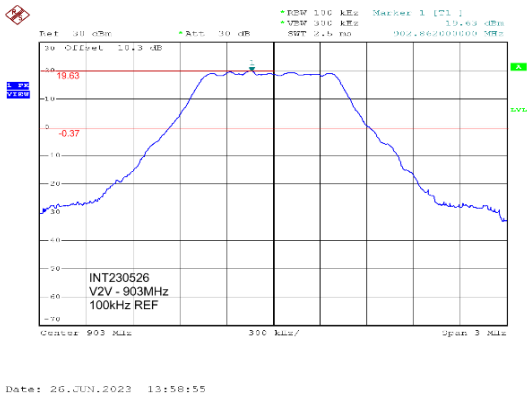
14.2 Test Method

a. Measurements were performed with reference to ANSI C63.10, Clause 11.11.1 (a).
b. The analyser RF input was connected via a 10dB pad and cable directly to the EUT RF output antenna port.
c. The 10 dB pad and cable loss used for the conducted measurements were compensated for.
d. The analyser RBW was set to 100 kHz, VBW to 300 kHz, Peak Detector max hold.

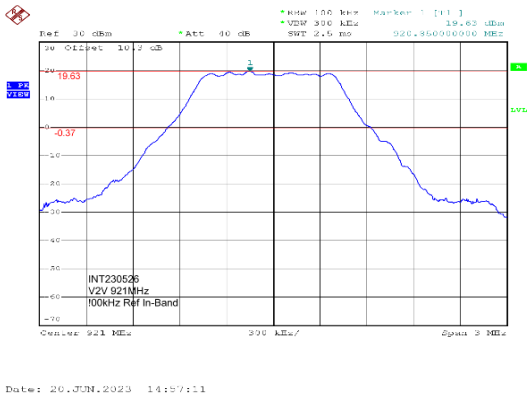
14.3 Test Results

14.3.1 Reference in-band levels

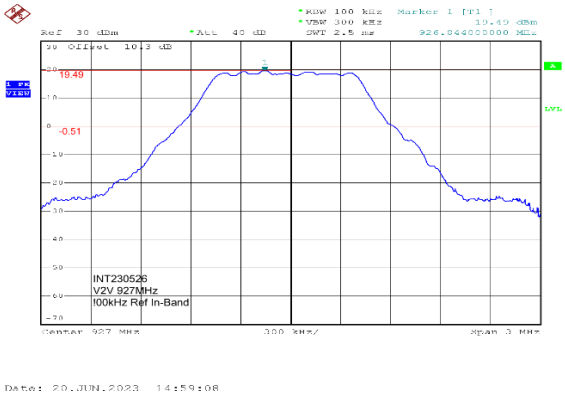
Measurements were made with a 100 kHz RBW to determine the limit for emissions in the non-restricted bands.



903 MHz Fundamental Reference



921 MHz Fundamental Reference



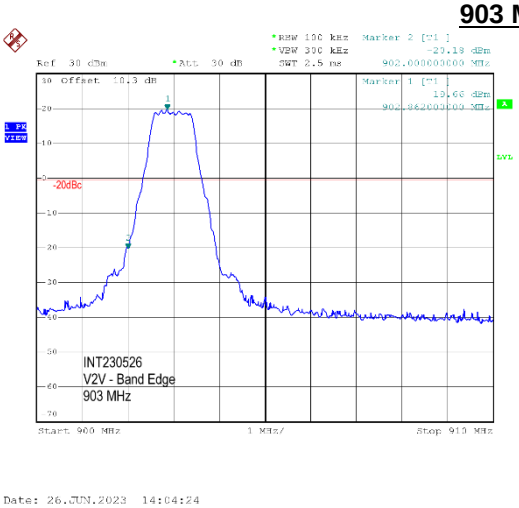
927 MHz Fundamental Reference

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

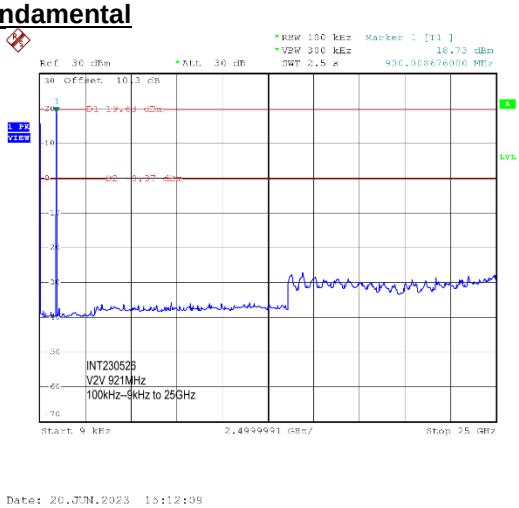
14.3.2 Measured Nonrestricted Bands: 9 kHz to 25 GHz.

All measured non-fundamental emission levels in the non-restricted bands were below the in-band -20 dBc reference level.

903 MHz Fundamental

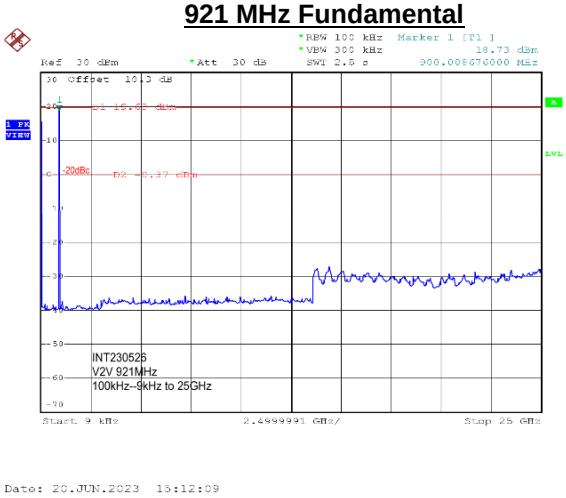


902MHz – 928MHz-Band Edge



9kHz to 25GHz

921 MHz Fundamental



9 kHz to 25 GHz

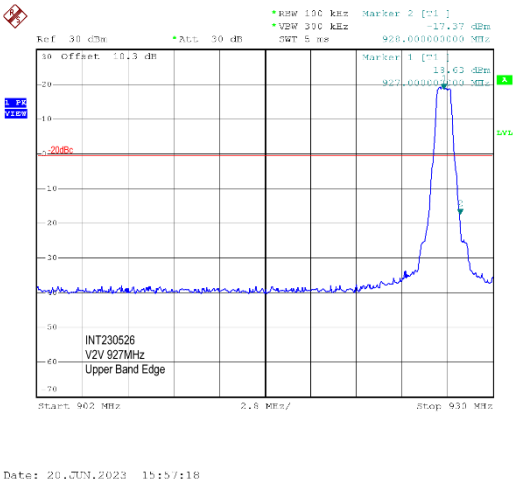
This document shall not be reproduced in any form except in full.

This report is issued within the scope of A2LA accreditation #2765.02.

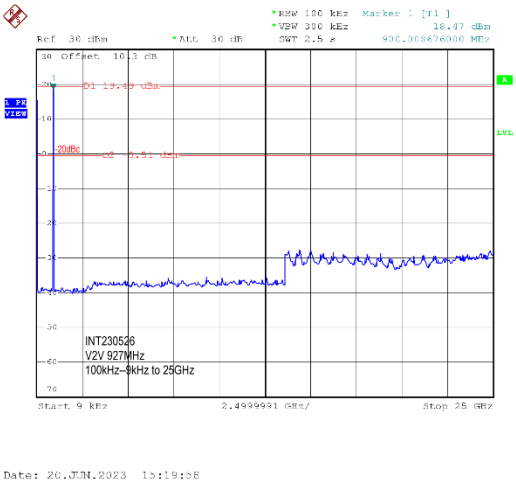
Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ACCREDITED
TEST LABORATORY
CERT #2765.02

927 MHz Fundamental



902 MHz – 928 MHz-Band Edge



9 kHz to 25 GHz

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

15 RADIATED EMISSIONS §15.209, RESTRICTED BANDS

15.1 EUT Operating Mode

- Refer to Section 6.1 of this report.
- Preliminary measurements indicated that emissions related to the V2V transmission were similar between PROD1177-U-USA and PROD1177-H-USA units.
- Final testing was performed on the PROD1177-U-USA unit.

15.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074. Peak measurements were performed using a Peak Detector; Average measurements were performed with an average detector; video averaging was not employed.

b. The measuring receiver BW settings were:

Frequency Range	Antenna	Measurement	Detector	RBW	VBW
0.15 to 30 MHz	60 cm Loop	Pre-scan	Peak	9 kHz	30 kHz
		Final Quasi-Peak	Quasi-Peak	9 kHz	-
30 to 1000 MHz	Hybrid (Bicon/log)	Pre-scan Peak	Peak	120 kHz	300 kHz
		Final Quasi-Peak	Quasi-Peak	120 kHz	-
Above 1000 MHz	Double-ridged guide horn	Pre-scan Peak	Peak	1 MHz	3 MHz
		Pre-scan Average	Average	1 MHz	3 MHz
		Final Peak	Peak	1 MHz	3 MHz
		Final Average	Average	1 MHz	3 MHz

c. The EUT was setup on a non-conductive turntable.
   i. For measurement below 1 GHz at a height of 0.8 m above the OATS conductive ground plane and at the indicated test distance away from the measuring antenna.
   ii. For measurements above 1 GHz at a height of 1.5 m above the OATS conductive ground plane with RF absorber placed between the test table and measuring antenna.

d. To maximise emissions, the EUT was rotated through 360° and the measuring antenna height adjusted between 1 m to 4 m in the following antenna orientations:
   i. Loop antenna (9 kHz to 30 MHz) over a non-metallic ground plane – Coaxial, Coplanar and also horizontal (parallel to ground) orientations.
   ii. Bilog antenna (30 MHz to 1 GHz) - Both vertical and horizontal polarizations.
   iii. Horn antenna (above 1 GHz) - Both vertical and horizontal polarizations.

e. The maximised emission level was measured and the above repeated for all measurement frequencies.

f. Average level measurements were not made where the peak level did not exceed the average limit.

g. Linearity of the measuring system was checked, reducing gain when required.

h. Test distances: Where the actual test distance used was different to that specified, then the test data results shown in any tables were extrapolated to the required distance using the formula specified within ANSI C63.10:2013. For simplicity, the test data plots have the limit lines adjusted to reflect any different test distance giving a visual indication of the relative margins.

i. **Ambient Emissions**: Measurements were performed at an Open Area Test Site (OATS), where some ambient signals may exceed the limit. The possibility of missing an emission during testing was removed by performing pre-scans in a shielded enclosure prior to the final OATS measurements. The ambient emissions are indicated as a '1' or 'A' on the scans, refer to the notes after the graphs.

15.3 Example Calculation

The final field strength levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

Calculation	Example		
$E = V + AF + L_{cbl} - G_{pre}$	V = 40.0 dBµV AF = 12.0 dB/m	L_{cbl} = 2.9 dB G_{pre} = 22.5 dB	E = 40 + 12 + 2.9 – 22.5 = 32.4 dBµV/m

Where
- E = Radiated Electric Field Strength in dBµV/m,
- V = EMI Receiver measured signal input voltage in dBµV,
- AF = Antenna Factor of the measuring antenna in dB/m,
- L_{cbl} = Total cable insertion loss in dB and
- G_{pre} = Preamplifier gain in dB.

15.4 Test Results

15.4.1 Radiated Emissions: 9 kHz to 150 kHz at 10 m distance.

Test Date:	21st June 2023	Temperature:	19°C
Test Officer:	Steven Garnham	Humidity:	38%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

Measured data extrapolated to distance defined by limits (300 m for 9-490 kHz and 30 m for 490 kHz – 30 MHz).

Measurements were performed both on an OATS ground plane and finally also over a non-conductive ground plane as specified in ANSI C63.10:2013, clause 5.2.

Prescan results were used to identify the orientation that produced the highest measured emissions in the three antenna positions, Coaxial, Coplanar and Parallel.

Frequency (MHz)	Channel	Antenna Polarity	Quasi-Peak / Linear Avg (dBµV/m)		
			Level	300 m Limit	Margin
All measured out of band emissions were greater than 40 dB below the limits specified in 15.209.					

15.4.2 Radiated Emissions: 150 kHz to 30 MHz at 3 m distance.

Measured data extrapolated to distance defined by limits (300 m for 9-490 kHz and 30 m for 490 kHz – 30 MHz).

Measurements were performed both on an OATS ground plane and finally also over a non-conductive ground plane as specified in ANSI C63.10:2013, clause 5.2.

Prescan results were used to identify the orientation that produced the highest measured emissions in the three antenna positions, Coaxial, Coplanar and Parallel.

Frequency (MHz)	Channel	Antenna Polarity	Quasi-Peak / Linear Avg (dBµV/m)		
			Level	Limit	Margin
All measured out of band emissions were greater than 20 dB below the limits specified in 15.209.					

15.4.3 Radiated Emissions: 30 MHz to 1000 MHz at 3 m distance.

Test Date:	21st June 2023	Temperature:	17°C
Test Officer:	Steven Garnham	Humidity:	46%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

The 6 highest EUT emissions, 30 MHz to 1 GHz, are tabulated below with reference to the limits of 15.209:

Channel (MHz)	Unintentional Frequency (MHz)	Antenna Pol.	QP Level (dBµV/m)	QP Limit (dBµV/m)	QP Pass Margin (dB)
921.0	227.2	Horizontal	43.0	46.0	*-3.0
903.0	189.4	Horizontal	39.3	43.5	*-4.2
927.0	880.8	Vertical	41.5	46.0	*-4.5
921.0	43.8	Vertical	35.0	40.0	-5.0
903.0	43.8	Vertical	34.9	40.0	-5.1
927.0	227.2	Horizontal	40.4	46.0	-5.6

*Results were within the Laboratory's measurement uncertainty.

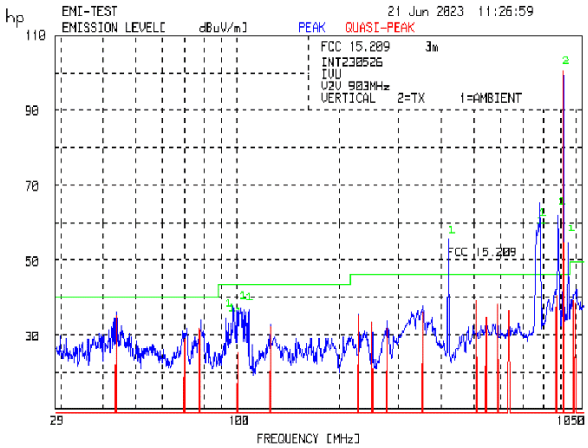
This document shall not be reproduced in any form except in full.

This report is issued within the scope of A2LA accreditation #2765.02.

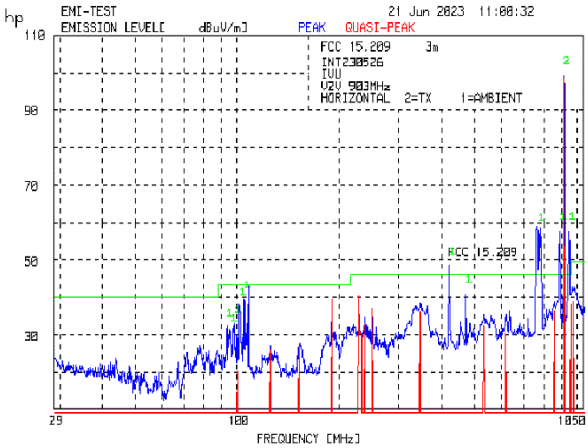
Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ilac-MRA
ACCREDITED
TEST LABORATORY
CERT #2765.02

903 MHz Transmission



Radiated Emissions (Vertical)

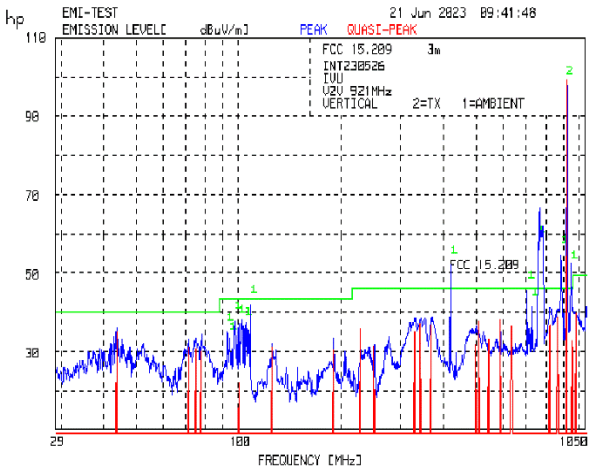


Radiated Emissions (Horizontal)

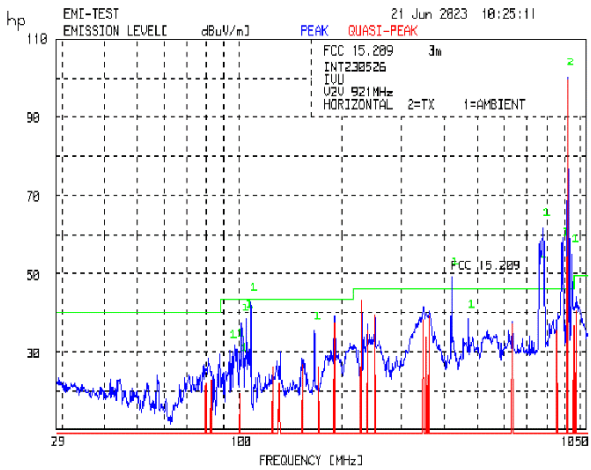
Note: A Green ''1'' indicates an ambient emission and was not from the EUT.

:A Green ''2'' label indicates an intentional transmitter emission at 903 MHz.

921 MHz Transmission



Radiated Emissions (Vertical)



Radiated Emissions (Horizontal)

Note: A Green ''1'' label indicates an ambient emission and was not from the EUT.

:A Green ''2'' label indicates an intentional transmitter emission at 921 MHz.

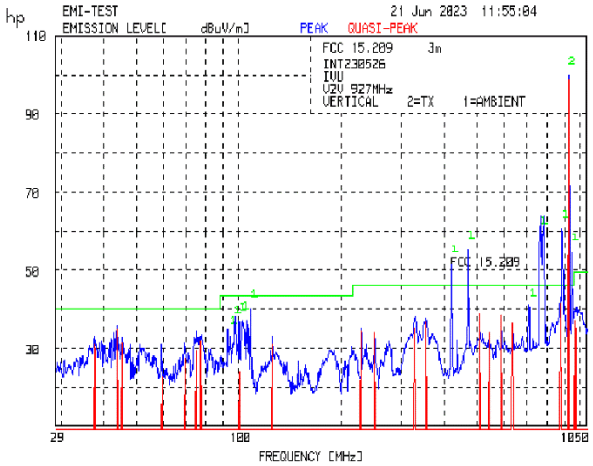
This document shall not be reproduced in any form except in full.

This report is issued within the scope of A2LA accreditation #2765.02.

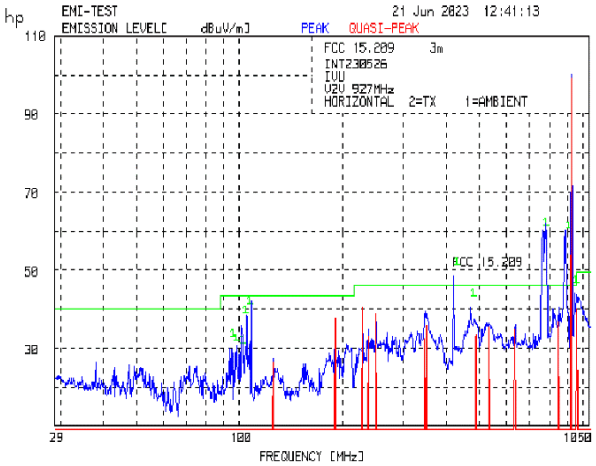
Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

927 MHz Transmission



Radiated Emissions (Vertical)



Radiated Emissions (Horizontal)

Note: A Green ''1''label indicates an ambient emission and was not from the EUT.

:A Green ''2'' label indicates an intentional transmitter emission at 927 MHz.

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

15.4.4 Radiated Emissions: 1 GHz to 18 GHz at 3m distance.

Test Date:	26th June 2023	Temperature:	19°C
Test Officer:	Steven Garnham	Humidity:	36%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

The highest measured EUT intentionally radiated emissions above 1 GHz are tabulated below with reference to the limits of 15.209.
All other measured Pk emission levels were greater than 20 dB below the Pk limits.
All other measured Average emission levels were greater than 15 dB below the Average limits.
The plot max hold traces are indicative of the response with the below table presenting the zoomed-in maximised levels.

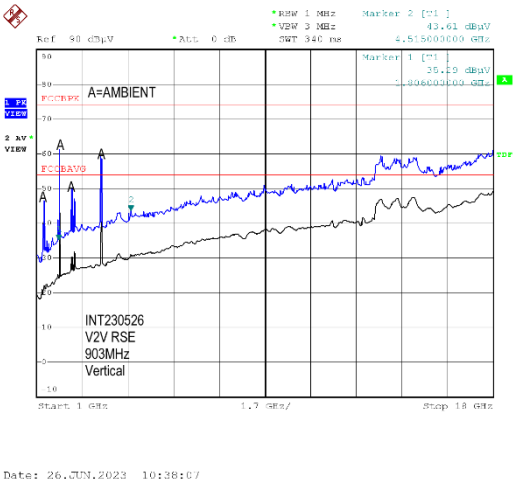
Channel (MHz)	Unwanted Frequency (MHz)	Antenna Pol.	Pk Level (dBµV/m)	Pk Limit (dBµV/m)	Margin (dB)	Avg Level (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
903.0	1806.0 *	Horiz.	46.8	74.0	>-20	45.5	54.0	-8.5
903.0	1806.0 *	Vert.	43.0	74.0	>-20	40.9	54.0	-13.1
903.0	4515.0	Vert.	46.7	74.0	>-20	37.5	54.0	-16.5
903.0	4515.0	Horiz.	45.0	74.0	>-20	36.4	54.0	-17.6
921.0	1842.0 *	Vert.	47.2	74.0	>-20	45.7	54.0	-8.3
921.0	1842.0 *	Horiz.	46.2	74.0	>-20	44.5	54.0	-9.5
921.0	4605.0	Vert.	48.0	74.0	>-20	40.8	54.0	-13.2
921.0	4605.0	Horiz.	45.9	74.0	>-20	38.3	54.0	-15.7
927.0	1854.0	Vert.	40.3	74.0	>-20	37.7	54.0	-16.3
927.0	1854.0 *	Horiz.	42.9	74.0	>-20	40.2	54.0	-13.8
927.0	4635.0	Vert.	47.3	74.0	>-20	40.8	54.0	-13.2
927.0	4635.0	Horiz.	46.7	74.0	>-20	39.3	54.0	-14.7

* Emission was not within a Restricted Band but included for reference.

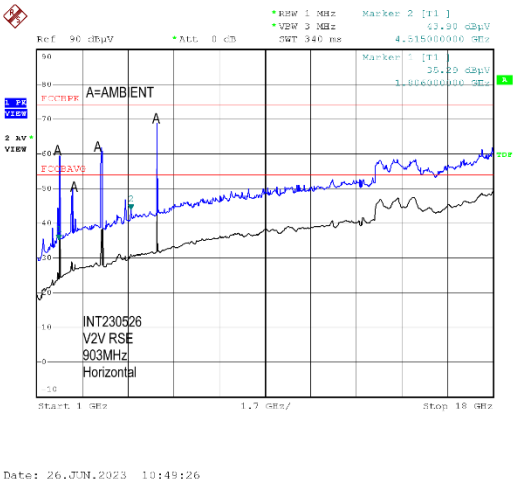
Note: An 'A' label on the plot indicates an ambient emission and was not from the EUT.

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

903 MHz Transmission

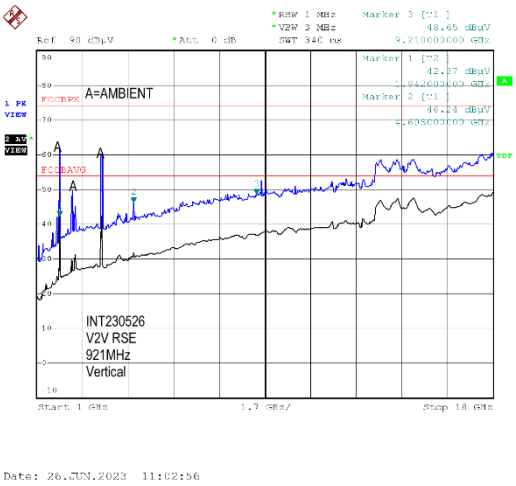


Radiated Emissions (Vertical)

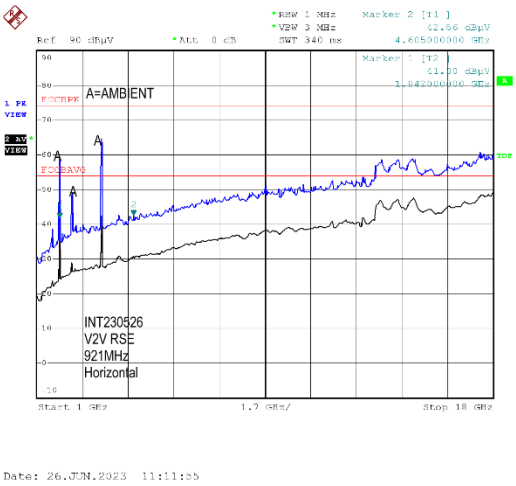


Radiated Emissions (Horizontal)

921 MHz Transmission



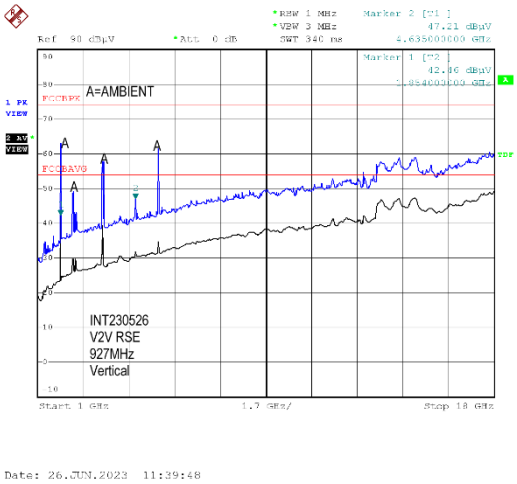
Radiated Emissions (Vertical)



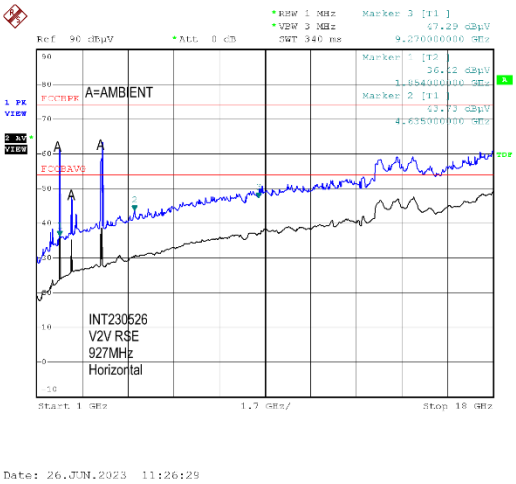
Radiated Emissions (Horizontal)

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

927 MHz Transmission



Radiated Emissions (Vertical)



Radiated Emissions (Horizontal)

15.4.5 Radiated Disturbances: 18 GHz to 25 GHz at 1 m distance.

Test Date:	26th June 2023	Temperature:	18°C
Test Officer:	Steven Garnham	Humidity:	42%
Test Location:	Austest Laboratories (Yarramalong, NSW)		

Measured field strength levels performed at a 1 metre distance were extrapolated to a 3 metre distance using the extrapolation factor of 20 dB/decade.

There were no measured radiated spurious emissions above the system noise floor.

Frequency (MHz)	Channel Number	Antenna Pol.	Pk Level (dBµV/m)	Pk Limit (dBµV/m)	Margin (dB)	Avg Level (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
-	-	-	-	74.0	-	-	54.0	-
All measured out of band emissions were greater than 20 dB below the limits specified in 15.209.								
-	-	-	-	74.0	-	-	54.0	-

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ACCREDITED
TEST LABORATORY
CERT #2765.02

16 CO-LOCATION VERIFICATION

Co-location transmissions were evaluated in all co-location configurations of V2V transmitter, WLAN transmitter and 2G/3G/LTE modem transmitting simultaneously.

It was verified that there were no significant emissions related to co-location transmissions observed.

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

TEST LABORATORY
CERT #2765.02

APPENDIX A – PHOTOGRAPHIC RECORD OF SAMPLES (PROD1177-U-USA & PROD1177-H-USA)

Please refer to the following documents for external and internal photos of the samples:

- External Photos - YIY-PROD1177 (External Photos).pdf
- Internal Photos - YIY-PROD1177 (Internal Photos).pdf

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

APPENDIX B – PHOTOGRAPHIC RECORD OF SUPPORTING EQUIPMENT

Display Unit

Camera Unit

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ilac-MRA
ACCREDITED
TEST LABORATORY
CERT #2765.02

APPENDIX D– CLIENT DECLARATION

Wabtec CORPORATION

Industrea Mining Technology Pty Ltd
T/A Digital Mining Technology
3 Co-Wyn Close, Fountaindale
NSW 2258, Australia
T: +61 2 8863 4730 www.wabteccorp.com

Ref. No.: DMT/PVS/2022-032
September 22, 2022

Subject: IVU Plus - Product Equivalence Declaration

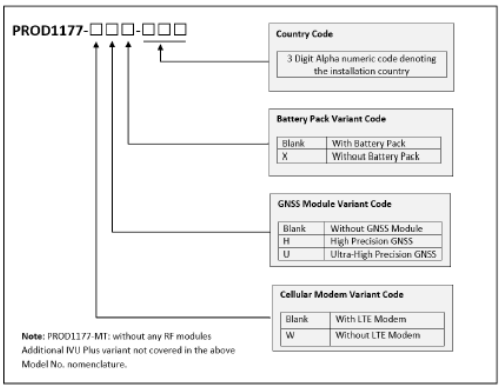
Industrea Mining Technology Pty Ltd, declares IVU Plus PROD1177-yyy-xxx variant models listed in the below table have the same hardware, RF modules, external antennae, power supply and construction characteristics. Only difference being the permutation and combination of plugging in the optional RF modules, viz. WiFi Module (NM-DB-2M), Cellular Modem (PLS63-W), High Precision GNSS Module (ZED-F9P), Ultra High precision (AsteRx-m3 Pro+ or AsteRx-m2a) and battery pack as detailed below.

IVU Plus Model No. & Variants:

Model No.	RF Modules (yyy)					Internal Battery
	V2V SRD	WiFi Module	Cellular Modem	Ultra-high Precision GNSS Receiver Module	High Precision GNSS Receiver Module	
PROD1177-WH-xxx	✓	✓	-	-	✓	✓
PROD1177-WU-xxx	✓	✓	-	✓	-	✓
PROD1177-W-xxx	✓	✓	-	-	-	✓
PROD1177-WHX-xxx	✓	✓	-	-	✓	-
PROD1177-WUX-xxx	✓	✓	-	✓	-	-
PROD1177-WX-xxx	✓	✓	-	-	-	-
PROD1177-H-xxx	✓	✓	✓	-	✓	✓
PROD1177-U-xxx	✓	✓	✓	✓	-	✓
PROD1177-xxx	✓	✓	✓	-	-	✓
PROD1177-HX-xxx	✓	✓	✓	-	✓	-
PROD1177-UX-xxx	✓	✓	✓	✓	-	-
PROD1177-X-xxx	✓	✓	✓	-	-	-

Where xxx denotes the installation country code

IVU Plus Model No. Nomenclature:



Country Code:

Markets (Pending Regulatory Approval)				
Country	Australia	USA	SUAfrica	Canada
Regulatory Authority	ACMA	FCC	ICASA	ISED
Order Code	**AUS**	**USA**	**ZAF**	**CAN**
Country	Chile	Europe	Brazil	Russia
Regulatory Authority	SUBTEL	CE	ANATEL	ROSSVYAZ
Order Code	**CHL**	**EUR**	**BRA**	**RUS**
Country	PNG	India	Mexico	Indonesia
Regulatory Authority	NCTA	WPC	IFETEL	POSTEL
Order Code	**PNG**	**IND**	**MEX**	**IDN**
Country	Peru	Colombia	Ghana	Mozambique
Regulatory Authority	MTC	CRC	NCA	INCM
Order Code	**PER**	**COL**	**GHA**	**MOZ**
Country	Mongolia			
Regulatory Authority	CRC			
Order Code	**MNG**			

Kind Regards,

Steve Clifton
Senior Engineering Director
Industrea Mining Technology Pty Ltd
T/A Digital Mining Technology
3 Co-Wyn Close, Fountaindale, NSW 2258, Australia
Ph: 61 2 8863 4730
steve.clifton@wabtec.com
www.wabteccorp.com

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

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
Approval Specialists Pty Ltd (ACN: 094 656 354) Trading as Austest Laboratories
2/9 Packard Avenue, Castle Hill NSW 2154 Australia Ph: +612 9680 9990

ilac-MRA
ACCREDITED
TEST LABORATORY
CERT #2765.02

APPENDIX E– V2V ANTENNA SPECIFICATION

Laird
Smart Technology. Delivered.

Phantom®
800 MHz-5.8GHz Antennas

SPECIFICATIONS

ELECTRICAL	
VSWR	< 2.1
Nominal Gain	3 dB-M.E.G.
Maximum Power	100 W
Nominal Impedance	50 Ω
Polarization	Vertical
Pattern	Omnidirectional
Half-Power Beamwidth (Elevation° x Azimuth°)	130° x 360°
Coaxial Cable Length & Type	None
Terminations	NMO Socket or, type N-female

MECHANICAL	
Color	Black or White
Height (initially)	2¾"
Diameter	1.438"
Weight	0.173 lb
Material	ABS
Mounting Information	NMO (PN: MB8, MAB8) Sold Separately
Noise Suppressor	BlackHawk NS1535 1-35 VOLT, 15 Amp Noise Suppessor (Sold Separately)

Permanent Mounting Option:
Please order by antenna model and insert letter "P" to indicate permanent mounting option (TRA8063P).

MODEL AND ORDERING INFORMATION

MODEL	DESCRIPTION
TRA8063	806-870 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA8213	821-896 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA8903	890-960 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA9023	902-928 MHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA18503	1.85 - 1.99 GHz 3dB-MEG Phantom® ¾ NMO, White Radome
TRA24003	2.4 – 2.5 GHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRA58003	4.9 – 6.0 GHz 3 dB-MEG Phantom® ¾ NMO, White Radome
TRADCAGP	G - Drop ceiling antenna adaptor for P-mount Phantom w/ 6"x6"x0.016" ground plane
Sealtube3	Heat shrink tubing 3"x1"DIA install (use for jaw protector on installation wrench)

Add "B" to model number for black radome. Example: TRAB8063
Add "P" to model number for Permanent Mount. Example: TRA8063P

ANT-DS-PHANTOM 800-5800 MHz 1214

Any information furnished by Laird Inc. and its agents is believed to be accurate and reliable. All specifications are subject to change without notice. Responsibility for the use and application of Laird materials rests with the end user, since Laird and its agents cannot be aware of all potential uses. Laird makes no warranties as to the fitness, merchantability or suitability of any Laird materials or products for any specific or general uses. Laird shall not be liable for incidental or consequential damages of any kind. All Laird products are sold pursuant to the Laird Terms and Conditions of sale in effect from time to time, a copy of which will be furnished upon request. © Copyright 2014 Laird Inc. All Rights Reserved. Laird, Laird Technologies, the Laird Logo, and other marks are trade marks or registered trade marks of Laird Inc. or an affiliate company thereof. Other product or service names may be the property of third parties. Nothing herein provides a license under any Laird or any third party intellectual property rights.