EMC Technologies Pty. Ltd.
ABN 82 057 105 549

Melbourne
176 Harrick Road
Keilor Park, Vic 3042
Tel: +61 3 9365 1000

Sydney
Unit 3/87 Station Road
Seven Hills, NSW 2147
Tel: +61 2 9624 2777

Email: emc-general@emctech.com.au
Web: www.emctech.com.au

RADIO REPORT FOR CERTIFICATION

REPORT NUMBER: M180420-4

TEST STANDARD: FCC PART 15 SUBPART C SECTION 15.231

CLIENT: COOLTRAX ASIA PACIFIC PTY LTD

DEVICE: UNIVERSAL MONITORING DEVICE

MODEL: WG-V3-LTE-NA

FCC ID: WSB-UMD3-LTE1

DATE OF ISSUE: 23 NOVEMBER 2018

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TYPE OF TESTING/CALIB/INSP

CERTIFICATE OF COMPLIANCE

Device:	Universal Monitoring Device
Model Number:	WG-V3-LTE-NA
Serial Number:	UG2321
Manufacturer:	Cooltrax Asia Pacific Pty Ltd
FCC ID:	WSB-UMD3-LTE1
IC:	10944A-UMD3LTE1
Tested for:	Cooltrax Asia Pacific Pty Ltd
Address:	138b Thistlethwaite St, South Melbourne, Victoria 3205
Phone Number:	03 9686 6011
Contact:	Michael Hunter
Email:	Michael.hunter@cooltrax.com
Standard:	FCC Part 15 – Radio Frequency Devices Subpart C – Intentional Radiators Section 15.231 – Periodic operation in the band 40.66 – 40.70 MHz and above 70 MHz.
Test Date(s):	25, 26 July; 8, 28 Aug; and 4 Sep 2018
Issue Date:	23 November 2018
Test Engineer(s):	Shabbir Ahmed, PhD Wilson Xiao
Attestation:	*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*
Authorised Signatory:	Chris Zombolas Technical Director EMC Technologies Pty Ltd

Issued by: EMC Technologies Pty. Ltd.,
176 Harrick Road, Keilor Park, VIC, 3042, Australia.
Phone: +61 3 9365 1000
E-mail: emc-general@emctech.com.au **Web:** www.emctech.com.au

RADIO REPORT FOR CERTIFICATION

TO

FCC PART 15 SUBPART C (SECTION 15.231)

1 INTRODUCTION

Radio tests were performed on the 433 MHz transceiver Universal Monitoring Device (UMD) WG-V3-LTE-NA sample in accordance with the requirements of 47 CFR, Part 15 Subpart C - Section 15.231 - Periodic operation in the band 40.66 – 40.70 MHz and above 70 MHz at EMC Technologies' laboratory in Keilor Park, Victoria Australia.

1.1 Test Procedure

The measurement procedure used was in accordance with ANSI C63.10: 2013. The instrumentation conformed to the requirements of ANSI C63.2: 2009.

1.2 Test Summary

Section	Clause	Result(s)
3.1	§15.203 Antenna Requirement	Complied
3.2	§15.205 Restricted Bands of Operation	Complied
3.3	§15.207 Conducted Limits	Complied
3.4	§15.209 Radiated emission limits; general requirements	Complied
3.5	§15.231(a) Periodic operation	Complied
3.6	§15.231(b)(2) Fundamental Field Strength	Complied
3.7	§15.231(b)(3) Spurious Emissions	Complied
3.8	§15.231(c) Emission bandwidth	Complied
3.9	§2.1093 RF radiation exposure evaluation: mobile devices	Complied

1.3 Test Facility

1.3.1 General

EMC Technologies Pty Ltd is listed by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies is listed as an FCC part 47CFR2.948 test lab and may perform the testing required under Parts 15 and 18 – **FCC Registration Number 90560**

EMC Technologies Pty Ltd has also been accredited as a Conformity Assessment Body (CAB) by Australian Communications and Media Authority (ACMA) under the APECTEL MRA and is designated to perform compliance testing on equipment subject to Declaration of Conformity (DoC) and Certification under Parts 15 and 18 of the FCC Commission's rules – **Registration Number 494713 & Designation number AU0001**.

EMC Technologies indoor open are test site (iOATS) have been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS-Gen, Issue 8 - **Industry Canada iOATS number - IC 3569B**.

1.3.2 NATA Accreditation

NATA is the Australian National laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for

accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

EMC Technologies is accredited in Australia by the National Association of Testing Authorities (NATA). All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation to ISO 17025 for both testing and calibration and ISO 17020 for Inspection – **Accreditation Number 5292**.

The current full scope of accreditation can be found on the NATA website: www.nata.com.au

1.4 Test Equipment Calibration

Measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI) or in-house. All equipment calibration is traceable to Australian national standards at the National Measurements Institute.

Equipment Type	Make/Model/Serial Number	Last Cal. dd/mm/yyyy	Due Date dd/mm/yyyy	Cal. Interval
Chamber	Frankonia SAC-3-2 (R-144)	17/07/2017	17/07/2020	1 Year*1
EMI Receiver	R&S ESW26 Sn: 101306 (R-143)	14/05/2018	14/05/2019	1 Year*2
Antennas	EMCO 6502 Active Loop 9 kHz – 30 MHz Sn. 9311-2801 (A-231)	20/07/2015	20/08/2018	3 Year*2
	SUNOL JB1 Sn. A061917 (A-425)	21/07/2017	21/07/2019	2 Year*2
	EMCO 3115 Double Ridge Horn Sn: 9501-4398 (A-406)	15/07/2016	15/07/2019	3 Year*1
Cables*4	Huber & Suhner Sucoflex 104A Sn: 503055 (C-457)	02/01/2018	02/01/2019	1 Year*1
	Huber & Suhner Sucoflex 104A Sn: 507099 (C-479)	10/01/2018	10/01/2019	1 Year*1
	Huber & Suhner Sucoflex 104A Sn: 503061 (C-463)	03/01/2018	03/01/2019	1 Year*1

Note *1. Internal NATA calibration.
Note *2. External NATA / A2LA calibration.
Note *3. Calibration date was valid during the time of testing.
Note *4. Cables are verified before measurements are taken.

1.5 Measurement Uncertainty

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions:	9 kHz to 30 MHz	±3.2 dB
Radiated Emissions:	9 kHz to 30 MHz	±4.1 dB
	30 MHz to 300 MHz	±5.1 dB
	300 MHz to 1000 MHz	±4.7 dB
	1 GHz to 18 GHz	±4.6 dB
Peak Output Power:		±1.5 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

2 DEVICE DETAILS

(Information supplied by the Client)

The Universal Monitoring Device (UMD) is an automotive data logging unit that receives data from 433MHz wireless temperature and door tags and interfaces to the fridge in refrigerated trucks and containers and uploads this data over the cellular network. The product has a cellular module, GPS receiver and 433MHz transceiver.

2.1 EUT (Transmitter) Details

Radio:	Digital transmission system (periodic operation)
Operating Frequency Range:	433.1 MHz
Modulation:	GFSK
Antenna:	UHF Monopole - Laser Antenna model 405 (SMA connector)
Antenna gain:	2.5 dBi
Manufacturer:	Cooltrax Asia Pacific Pty Ltd
Highest frequency related to the transmitter circuit	433.1 MHz

2.2 EUT (Host) Details

Test Sample:	Universal Monitoring Device
Model Number:	WG-V3-LTE-NA
Serial Number:	UG2321
Manufacturer:	Cooltrax Asia Pacific Pty Ltd
Supply Rating:	12 V DC Battery

2.3 Test Configuration

Testing was performed with the EUT set to transmit continuously (with modulation applied).

2.4 Modifications

No modifications were required to achieve compliance.

3 RESULTS

3.1 §15.203 Antenna Requirement

The Universal Monitoring System by Cooltrax Asia Pacific Pty Ltd incorporates the following antenna only.

Antenna Type: UHF Monopole
Manufacturer: Laser Antenna
Model number: 405
Antenna gain: 2.5 dBi
Connector: SMA

The above antenna will be installed by professional installers who have been trained by Cooltrax Asia Pacific Pty Ltd. Such installation shall be accomplished using only antennas and installation materials provided by Cooltrax Asia Pacific Pty Ltd. Said installation will preclude any unauthorized switching of antennas.

3.2 §15.205 Restricted Bands of Operation

Provisions of the §15.205 restricted bands of operation and §15.209 radiated emissions limits have been met, refer to section 3.7

3.3 §15.207 Conducted Limits

The device does not connect directly or indirectly to the AC mains network.

3.4 §15.209 Radiated emission limits; general requirements

Provisions of the §15.205 restricted bands of operation and §15.209 radiated emissions limits have been met, refer to section 3.7

3.5 §15.231(a) Periodic Operation

3.5.1 Test procedure

The UMD transceiver is in continuous receive mode until it receives a known packet from a companion wireless tag/sensor. This activates the 433 MHz UMD transmitter automatically transmitting an acknowledgement packet and switching off.

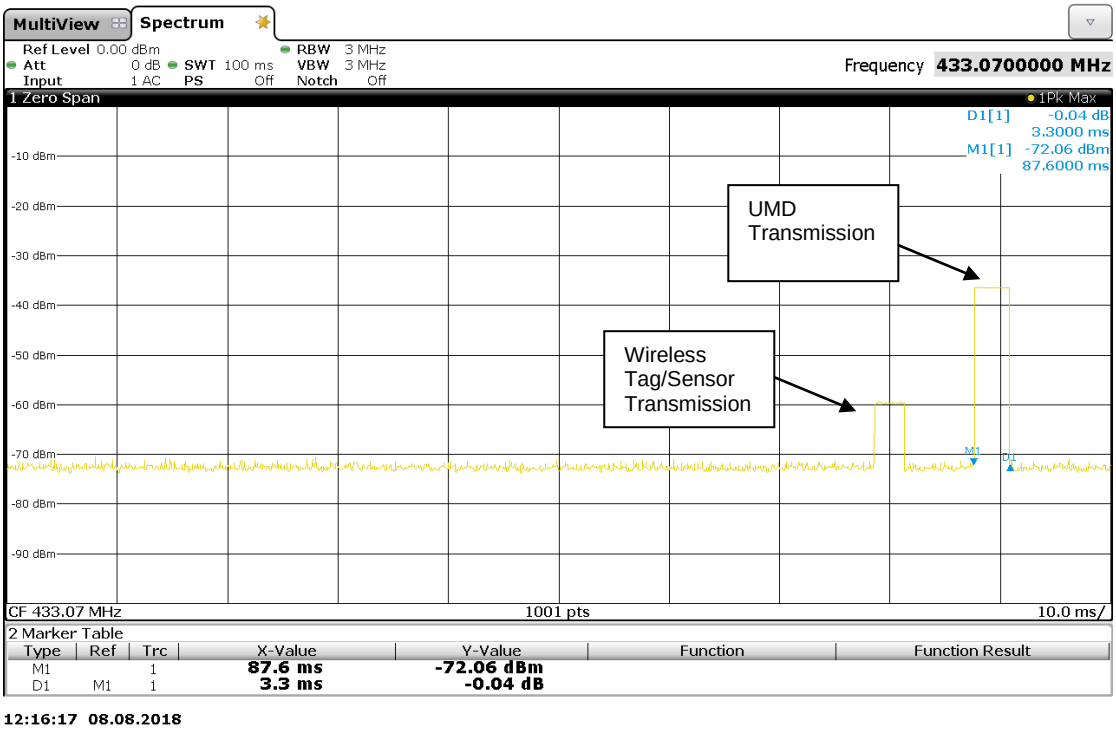
A spectrum analyser in zero span time domain mode was used to measure the transmission duration.

3.5.2 Limits

From §15.231(a) the transmission duration limit for an automatically activated transmitter is 5s.

3.5.3 Results

The 433 MHz UMD transmitter complied with the provisions of §15.231(a) periodic operation. The duration of the transmission is 3.3ms.



Graph 3-1: Time domain measurements – Duty Cycle

3.6 §15.231(b)(2) Fundamental Field Strength

3.6.1 Test procedure

The field strength of the fundamental transmitted frequency was measured inside a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The EUT was positioned on a test turn-table and rotated through 360° to determine the highest emissions. The measurement antenna was also varied between 1 and 4 metres height. A calibrated Biconilog antenna was used for measurement. Different orientations of the EUT (x, y and z-axis) and measurement antenna polarisations (vertical and horizontal) were investigated to produce the highest emission EIRP.

All measurements were made at a distance of 3 metres. The fundamental emissions were measured using a peak detector.

3.6.2 Limits

From §15.231(b) the limits for fundamental emissions at frequency 433.1 MHz at a distance of 3 metres are:

Average limit: 80.8 dBµV/m
Peak limit: 100.8 dBµV/m

3.6.3 Peak measurement

Graph 3-2: 15.231 (b)(2) Fundamental Field Strength – Peak measurement, EUT x-axis, Measurement antenna – Vertical polarisation

3.6.4 Average value calculations using duty cycle correction factor

The method of calculation was outlined in section 7.5 of ANSI C63.10:

$E_{ave} = E_{pk} - \delta$
Where:
E_{ave} = Average electric field (dBµV/m)
E_{pk} = Peak electric field (dBµV/m)
δ = duty cycle correction factor (dB)
δ = -20 $\log_{10}$ (Duty cycle)

From section 3.5, Duty cycle = 3.3/100
Therefore, Duty cycle correction factor, δ = -20 $\log_{10}$ (3.3/100) = 29.63 dB
From section 3.6.3, E_{pk}= 94.12 dBµV/m
Therefore, E_{ave}= 94.12 dBµV/m - 29.63 dB= 64.49 dBµV/m

3.6.5 Results

Compliance is demonstrated based on the peak and average values of the measured emissions.

Table 3-1: 15.231(b)(2) Fundamental Field Strength at 3 metres

Freq. MHz	E(peak) dBµV/m	Peak limit dBµV/m	Δ Peak dB *	E(average) dBµV/m	Average limit dBµV/m	Δ Average dB *	Result
433.1	94.12	100.8	- 6.68	64.49	80.8	- 16.31	Pass

*A negative Δ is below the limit

3.7 §15.231(b)(3) Spurious Emissions

3.7.1 Test procedure

Radiated spurious emission measurements were performed in a semi-anechoic chamber compliant with ANSI C63.4: 2014.

The test frequency range was sub-divided into smaller bands with the defined resolution bandwidths to permit reliable display and identification of emissions.

Frequency range [MHz]	Measurement Bandwidth [kHz]	Measurement Distance [m]	Antenna
0.009 to 0.150	0.2	3	0.6 metre loop antenna
0.150 to 30	9	3	
30 to 1000	120	3	Biconilog hybrid
1000 to 18 000	1000	3	Standard gain or broadband horns
18 000 to 40 000	1000	1	

Measurements between 9 kHz and 30 MHz were made at 3 metres using a 0.6 metre loop antenna. A Biconilog antenna was used for measurements between 30 MHz and 1000 MHz. An EMCO 3115 horn antenna was used for measurements between 1000 to 5000 MHz. EUT was set at 0.8 m for measurements below 1000 MHz and set at 1.5 m at measurements above 1000 MHz.

The sample was slowly rotated with the spectrum analyser set to Max-Hold. This was performed for at least two antenna heights. When an emission was located, it was positively identified and its maximum level found by rotating the automated turntable and by varying the antenna height. For below 1000 MHz the emissions were measured with a Quasi-Peak detector, and for above 1000 MHz the emissions were measured with Peak and Average detectors.

EUT's designed for a fixed position/ orientation were tested in that orientation, others were investigated on all three axes (x, y, and z).

The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical polarisations of the measurement antenna.

3.7.2 Evaluation of field strength

Field strengths were calculated automatically by the software using pre-stored calibration data. The method of calculation is shown below:

$$\boldsymbol{E = V + AF - G + L}$$

Where: *E* = Radiated Field Strength in dBµV/m.
V = EMI Receiver Voltage in dBµV/m.
AF = Antenna Factor in dB. (stored as a data array)
G = Preamplifier Gain in dB. (stored as a data array)
L = Cable loss in dB. (stored as a data array of Insertion Loss versus frequency)

3.7.3 Limits

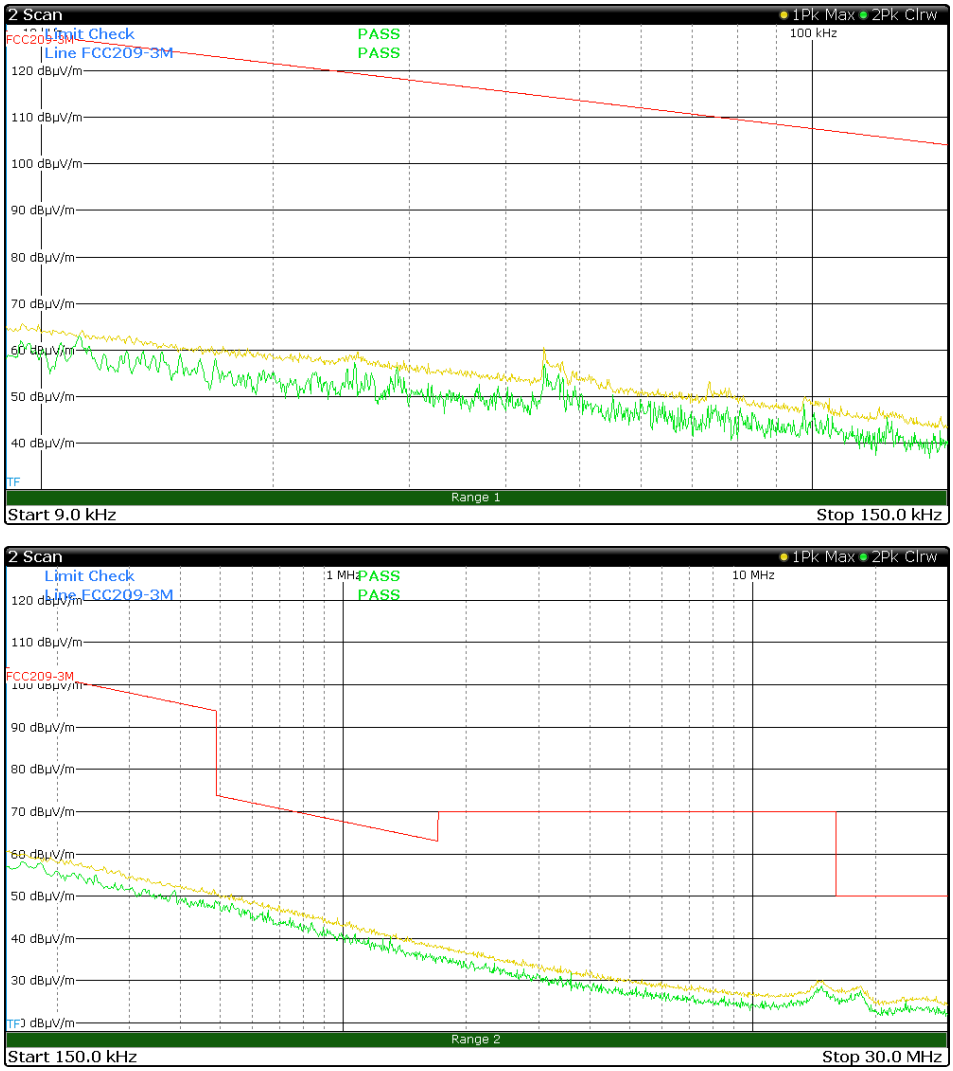
The limit applied is in accordance to the spurious emissions limit defined in §15.231(b):

Average or Quasi-peak limit: 60.8 dBµV/m
Peak limit: 80.8 dBµV/m
where the fundamental frequency is 433.1 MHz at a measurement distance of 3 metres.

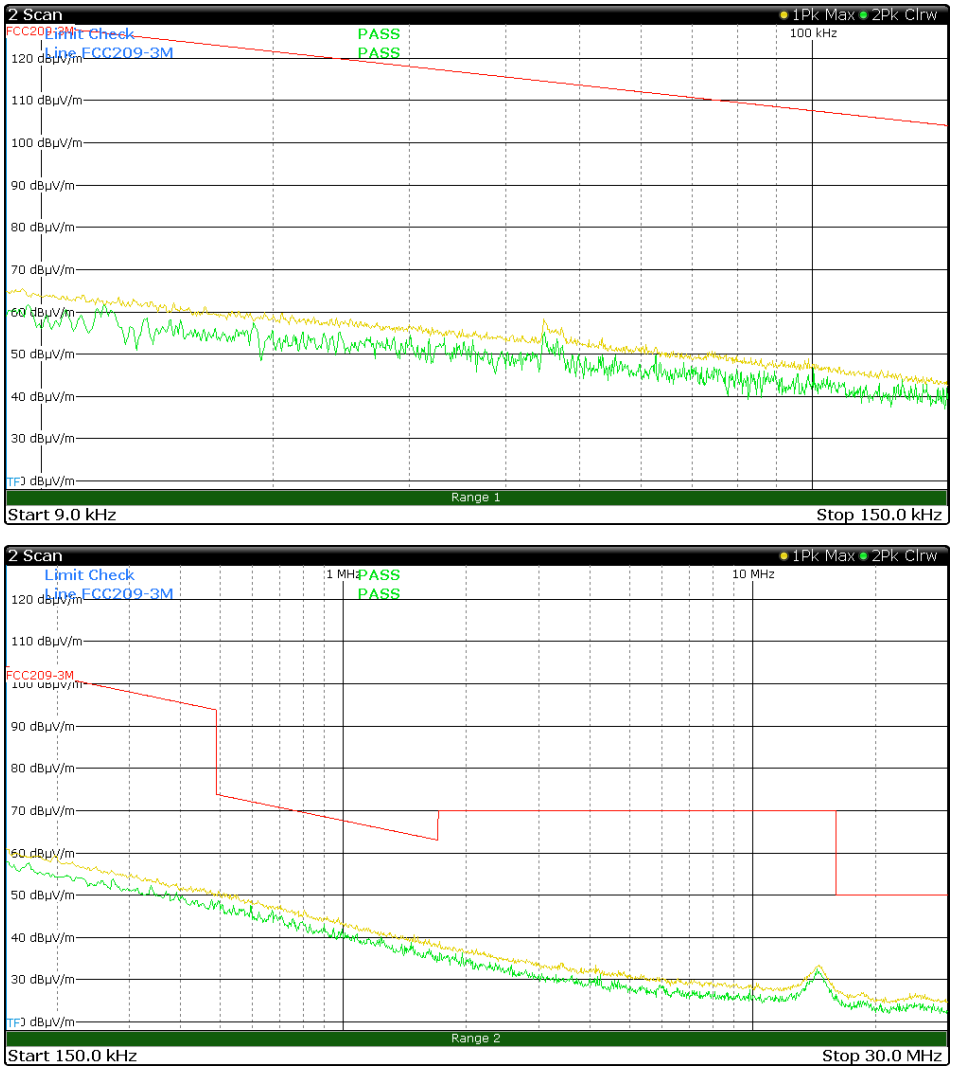
However, the general limits of §15.209 apply for the restricted bands of operation defined in §15.205 and the frequency bands where §15.209 permits a higher field strength than that defined in §15.231(b).

3.7.4 Results Frequency Band: 9 kHz - 30 MHz

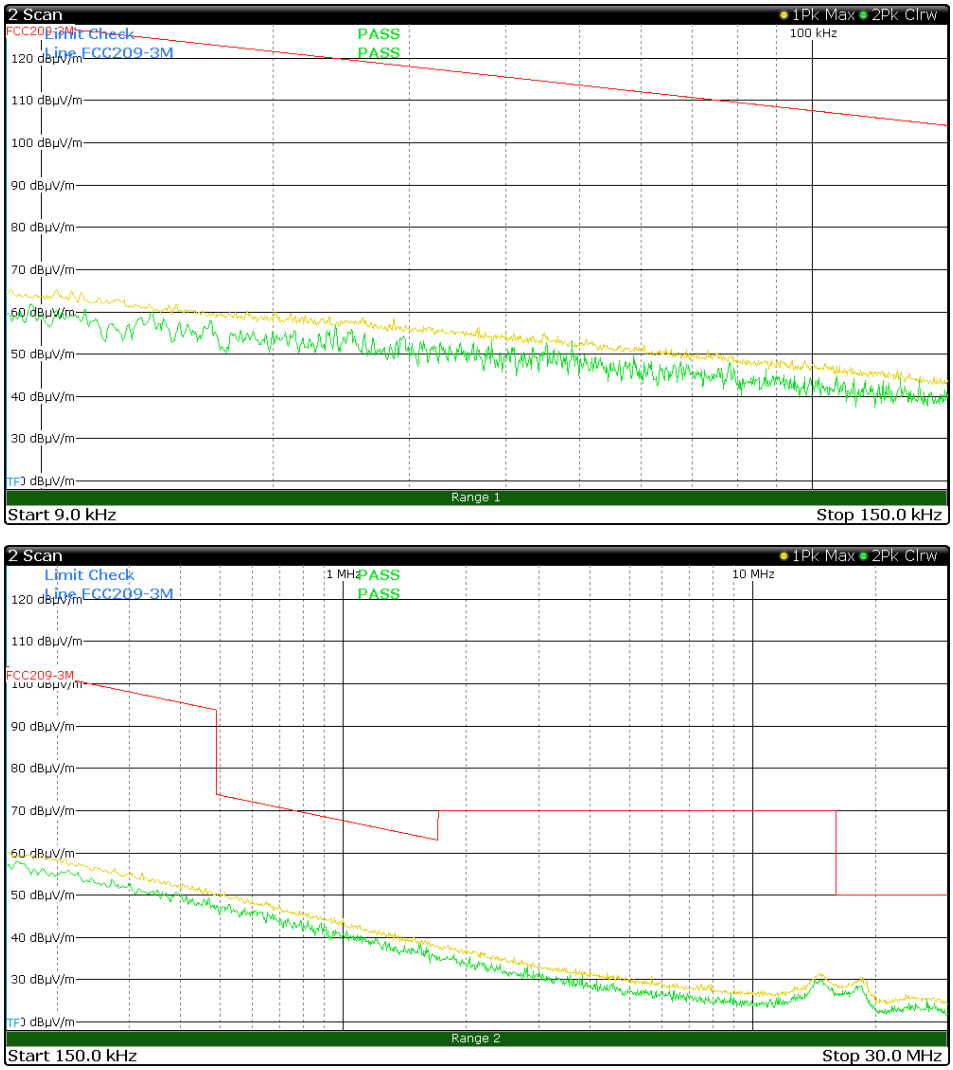
All emissions measured in the frequency band 9 kHz to 30 MHz complied with the requirements of §15.231(b). The emissions were more than 20 dB below the limit.



Graph 3-3: Radiated spurious emissions 9 kHz – 30 MHz, loop antenna – parallel



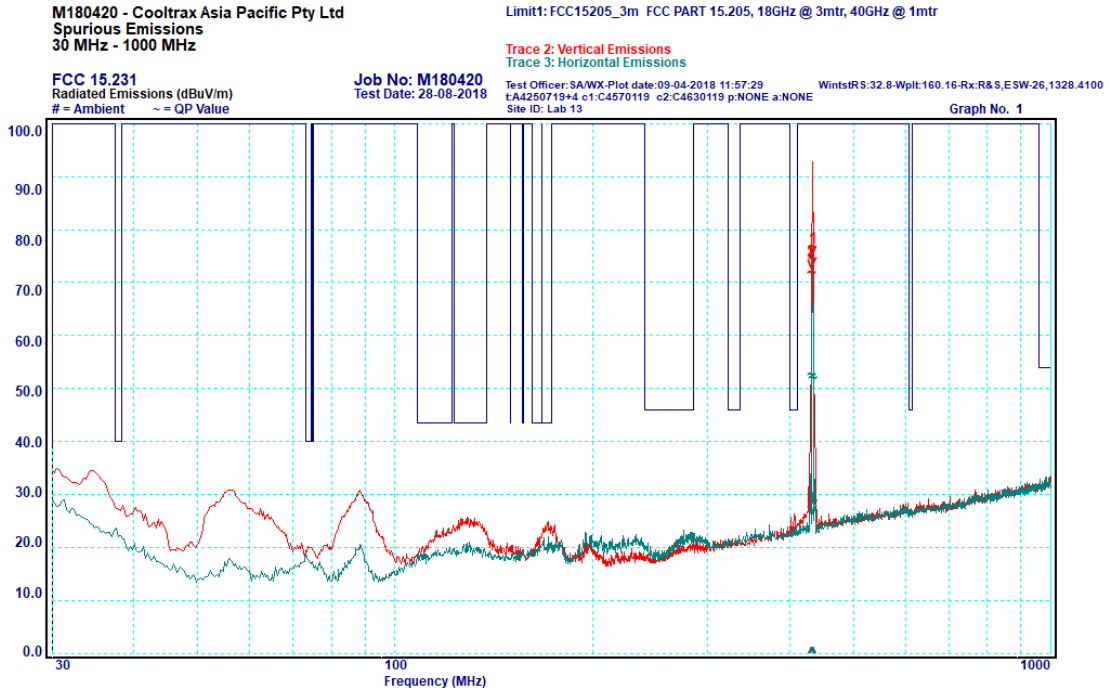
Graph 3-4: Radiated spurious emissions 9 kHz – 30 MHz, loop antenna – perpendicular



Graph 3-5: Radiated spurious emissions 9 kHz – 30 MHz, loop antenna – ground parallel

3.7.5 Results Frequency Band: 30 - 1000 MHz

All spurious emissions measured in the frequency band 30 MHz to 1000 MHz complied with the requirements of §15.231(b).



Graph 3-6: Spurious Emissions, 30 – 1000 MHz, Peak measurement

Pt.	Freq. (MHz)	Pol.	Peak (dBµV/m)	Pk. Limit (dBµV/m)	Δ Pk. Limit (dB)	Average* (dBµV/m)	Avg. Limit (dBµV/m)	Δ Avg. Limit (dB)
1	434.30	Vertical	74.3	80.8	-6.5	44.7	60.8	-16.1
2	431.98	Vertical	71.8	80.8	-9.0	42.2	60.8	-18.6
3	431.98	Horizontal	52.5	80.8	-28.3	22.9	60.8	-37.9
4	434.31	Horizontal	52.0	80.8	-28.8	22.4	60.8	-38.4

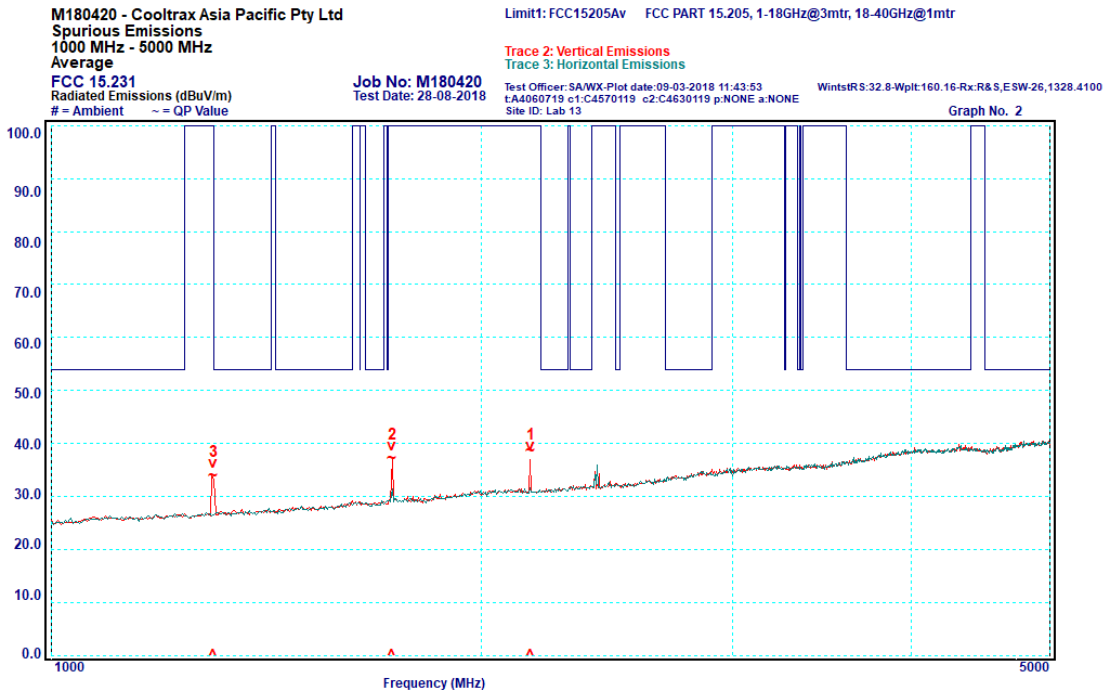
*Average values are evaluated from the peak values using the duty cycle correction factor.

Note all emissions in the above table are related to the 433.1 MHz transmitter. Transmission at the fundamental frequency was not subjected to the spurious emission limit.

3.7.6 Results Frequency Band: 1000 – 5000 MHz

All spurious emissions measured in the frequency band 1000 MHz to 5000 MHz complied with the requirements of §15.231(b).

3.7.6.1 Average Detector



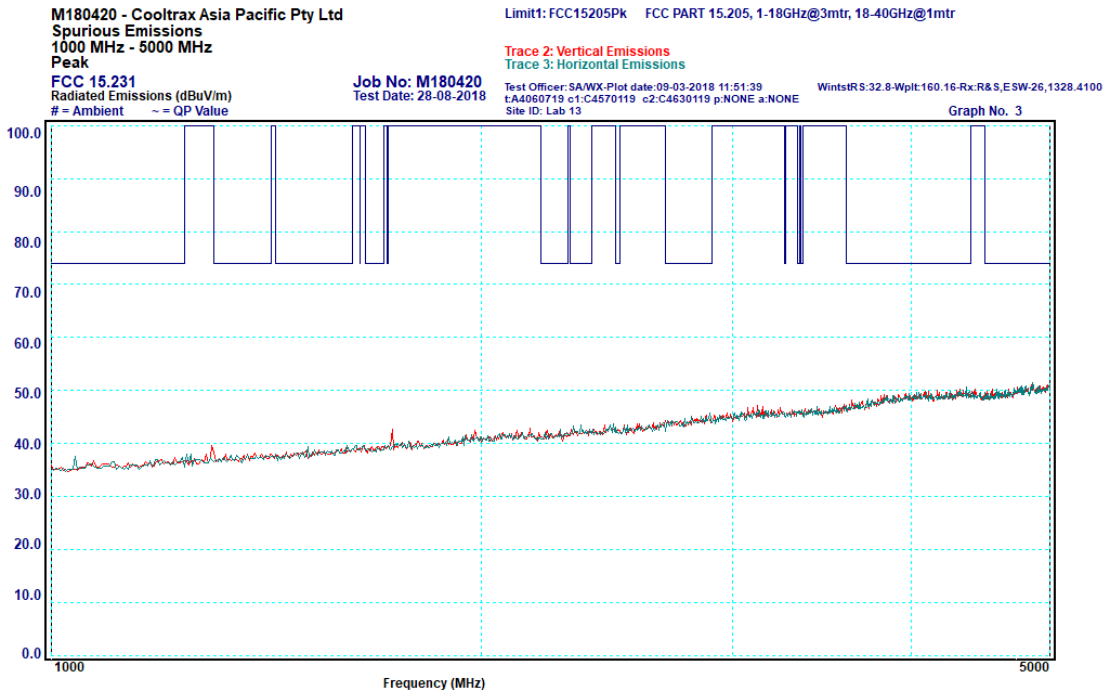
Graph 3-7: Spurious Emissions, 1000 - 5000 MHz, Average Detector

Table 3-2: Spurious Emissions, 1000 - 5000 MHz, Average Detector

Point	Frequency (MHz)	Polarisation	Average (dBµV/m)	Limit (dBµV/m)	Δ Limit (dB)
1	2165.84	Vertical	38.7	60.8	-22.1
2	1732.57	Vertical	37.2	60.8	-23.6
3	1299.39	Vertical	33.8	60.8	-27

*A negative Δ is below the limit

3.7.6.2 Peak Detector



Graph 3-8: Spurious Emissions, 1000 - 5000 MHz, Peak Detector

No emissions were measured within 20 dB of the limit.

3.8 §15.231(c) Emission Bandwidth

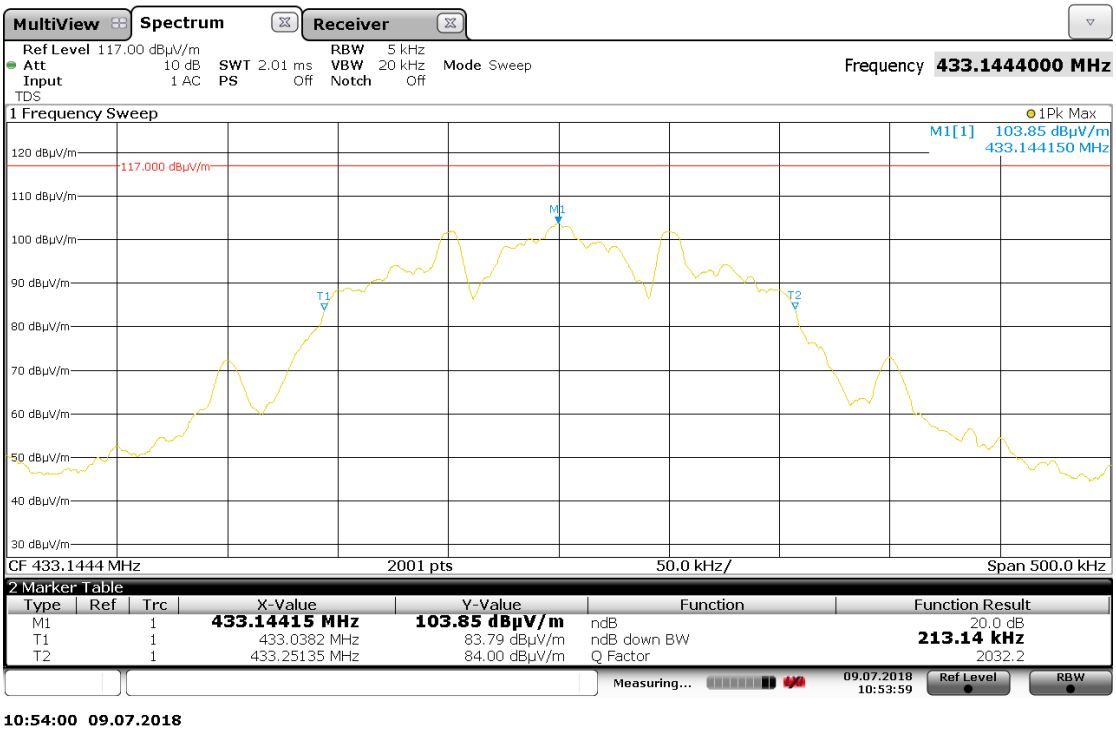
The transmitter's 20 dB bandwidth of the modulated carrier complied with the requirements of §15.231(c)

3.8.1 Limit

Bandwidth limit = 433.1 x 0.25 / 100 = 1.0828 MHz

3.8.2 Results

3.8.2.1 20-dB bandwidth



Graph 3-9: 15.231 (c) Emission Bandwidth

Table 3-3: 15.231 (c) Emission Bandwidth

Frequency (MHz)	20 dB BW (kHz)	Limit (kHz)	Results
433.1	213.14	1082.8	Complied

3.9 §2.1093 Radio frequency radiation exposure evaluation: mobile devices

The EUT complied with the applicable maximum permissible exposure levels. Refer to EMC Technologies report M180420-2.

4 COMPLIANCE STATEMENT

The Universal Monitoring Device Model WG-V3-LTE-NA was tested on behalf of Cooltrax Asia Pacific Pty Ltd. The EUT complied with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.231 – Periodic operation in the band 40.66 – 40.70 MHz and above 70 MHz.