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# RADIO REPORT FOR CERTIFICATION
# to
# FCC PART 15 Subpart C (Section 15.225)

FCC ID: 2AFHX-TRI935001US

Test Sample: Electric Vehicle (EV) Fast Charger
Model: TRI93-50-01-US

Client: Tritium Pty Ltd

Report Number: M150804-1

Issue Date: 03 May 2016

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# RADIO REPORT FOR CERTIFICATION
# to
# FCC PART 15 Subpart C (Section 15.225)

## EMC Technologies Report No.: M150804-1

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# RADIO REPORT FOR CERTIFICATION
# to
# FCC PART 15 Subpart C (Section 15.225)

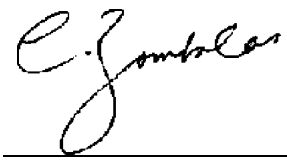
| | |
|---|---|
| **Report Number:** | M150804-1 |
| **Issue Date:** | 03 May 2016 |
| **Sample:** | Electric Vehicle (EV) Fast Charger |
| **Model:** | TRI93-50-01-US |
| **FCC ID:** | 2AFHX-TRI935001US |
| **Equipment Type:** | Intentional Radiator (Transceiver) |
| **Tested for:** | Tritium Pty Ltd |
| **Address:** | 16 Cavendish Road,<br>Coorparoo, QLD 4151 Australia |
| **Phone:** | +61 7 3129 4389 |
| **Contact:** | James Kennedy (james@tritium.com.au) |
| **Standards:** | FCC Part 15 – *Radio Frequency Devices*<br>FCC Part 15 Subpart C – *Intentional Radiators*<br>Section 15.225 – *Operation within the band 13.110-14.010 MHz* |
| **Test Dates:** | 12 to 13 August and 22 to 25 September 2015 |

**Test Engineer:**

**Larry Phuah**

**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:**



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# RADIO REPORT FOR CERTIFICATION
# to
# FCC PART 15 Subpart C (Section 15.225)

## 1.0 INTRODUCTION

Test results and procedures were performed in accordance with the following Federal Communications Commission (FCC) standards and regulations:

| | |
|---|---|
| 47 CFR, Part 15, Subpart C: | Rules for intentional radiators |
| Section 15.203: | Antenna requirements |
| Section 15.205: | Conducted Limits |
| Section 15.209: | Radiated Emission Limits (General requirements) |
| Section 15.225: | Operation within the band 13.110-14.010 MHz |

The sample **complied** with the requirements of 47 CFR, Part 15 Subpart C - Section 15.225.

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

## 1.1 Summary of Results

| FCC Part 15 Subpart C | Test Performed | Results |
|---|---|---|
| **15.203** | Antenna Requirement | **Complied** |
| **15.207** | Conducted Limits | **Complied** |
| **15.209** | Radiated Emissions Limits; General Requirements | **Complied** |
| **15.225(a)** | Fundamental Field Strength | **Complied** |
| **15.225(b and c)** | Transmission Mask 13.110-14.010 MHz | **Complied** |
| **15.225(d)** | Spurious Emissions | **Complied** |
| **15.225(e)** | Frequency Tolerance | **Complied** |

## 1.2 Modifications by EMC Technologies

No modifications were performed.

# 2.0 GENERAL INFORMATION

(Information supplied by the Client)

## 2.1 EUT (Transmitter) Details

| | |
|---|---|
| **Wireless Radio:** | 13.56 MHz |
| **Antenna type:** | PCB loop |
| **Highest Operating Freq.:** | Less than 108 MHz. |

## 2.2 EUT (Host) Details

| | |
|---|---|
| **Host:** | Electric Vehicle (EV) Fast Charger |
| **Model Number:** | TRI93-50-01-US |
| **Serial Number:** | 25252 |
| **Microprocessors:** | MSP430F149, TMS320F25335, Intel Atom |
| **Crystal frequency(s):** | 16, 50, 92, 100, 120, 600 MHz |
| **Highest Operating Freq.:** | 600 MHz |
| **Lowest Operating Freq.:** | 16 MHz |
| **Input supply:** | 277/480V 3$\phi$, 63A and 120V single phase 6A, 50/60 Hz |

## 2.3 Test Configuration

During radiated tests the 13.56 MHz circuitry was powered by an external 5 Vdc supply to isolate it from the host electronics. The device was continuously transmitting. The position of the transmitter within the host device was that of normal use. A separate circuit board removed from the host was used for the frequency stability tests.

## 2.4 Operational Description

The 13.56 MHz transmitter was an RFID device for reading payment cards to be used with the host device.

## 2.5 Test Facility

### 2.5.1 General

Measurements were performed at EMC Technologies' laboratory in Keilor Park, Victoria Australia.

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 47CFR 2.948 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 and Designation number AU0001.**

EMC Technologies' indoor open area test site (iOATS) has been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS-Gen, Issue 4 - **Industry Canada iOATS number - IC 3569B.**

### 2.5.2 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 17025. NATA is an ILAC member and has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation ($A^2LA$).

All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation.

The current full scope of accreditation can be found on the NATA website: www.nata.com.au
The scope also includes a large number of emissions, immunity, SAR, EMR and Safety standards.

## 2.6 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/yy | Due Date dd/mm/yy | Cal. Interval |
|---|---|---|---|---|
| **Chamber** | Frankonia SAC-10-2<br>(R-139) | 08/01/2015 | 8/01/2016 | 1 Year, *1 |
| | | | | |
| **EMI Receiver** | R&S ESU40<br>20 Hz – 40 GHz<br>Sn: 100392 (R-140) | 09/10/2014 | 09/10/2015 | 1 Year, *2 |
| | R&S ESU40<br>20 Hz – 40 GHz<br>Sn: 100182 (R-037) | 12/02/2015 | 12/02/2016 | 1 Year, *2 |
| | | | | |
| **Antennas** | EMCO 6502 Active Loop A-231<br>9kHz – 30MHz<br>Sn. 9311-2801 | 20/07/2015 | 20/07/2018 | 3 Year, *2 |
| | SUNOL JB6 BICONILOG<br>30 – 6000 MHz<br>Sn. A012312 (A-363) | 16/05/2014 | 16/05/2016 | 2 Year, *2 |
| | | | | |
| **Cables** | Room 12 inbuilt cable Panel 1 to 10m<br>(C-422) | 24/04/2015 | 24/04/2016 | 1 Year, *1 |
| | Room 12 Antenna cable<br>(C-437) | 24/04/2015 | 24/04/2016 | 1 Year, *1 |
| | | | | |
| **LISN** | EMCO 3810/2NM<br>Sn. 9607-1505 (L-019) | 23/10/2014 | 23/10/2016 | 2 Year, *1 |

Note *1. Internal NATA calibration.
Note *2. External NATA / A2LA calibration

# 3.0 TEST RESULTS

## 3.1 §15.203 Antenna Requirement

An internal, permanently attached antenna was incorporated within the EV Charger ensuring that it could not be replaced.

## 3.2 §15.207 Conducted Limits

### 3.2.1 Test Procedure

The arrangement specified in ANSI C63.10: 2009 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2: 2009 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all short duration peaks were captured.

### 3.2.2 Peak Maximising Procedure

The various operating modes of the system were investigated. For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector and the Average detector were then invoked to measure the actual Quasi-Peak and Average level of the most significant peaks, which were detected.

### 3.2.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$$V_{EMI} = V_{Rx} + L_{BPF}$$

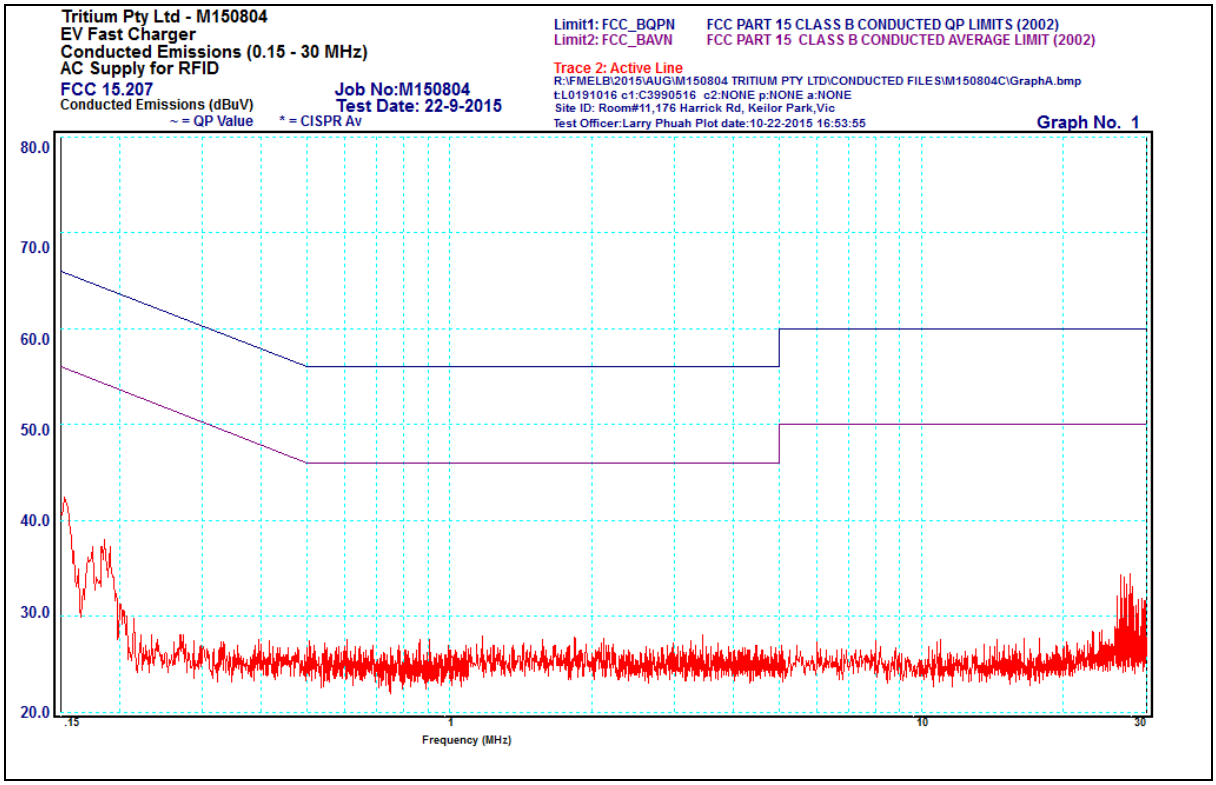
Where:
$V_{EMI}$ = the Measured EMI voltage in dBµV to be compared to the limit.
$V_{Rx}$ = the Voltage in dBµV read directly at the EMI receiver.
$L_{BPF}$ = the insertion loss in dB of the LISN, cables and limiter.

### 3.2.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graph.

### 3.2.5 Results of Conducted Emission Measurement

The conducted emissions on the active and neutral lines supplying the power to the RFID circuitry were greater than 10 dB below the average and quasi-peak limits of §15.207.




### 3.2.6 Conclusion

The conducted emissions were greater than 10 dB below the average and quasi-peak limits of §15.207.

## 3.3 §15.209 Radiated emission limits; general requirements

The general requirement limits were applied to the measurements of §15.225(d).

## 3.4 §15.225(a) Fundamental Field Strength

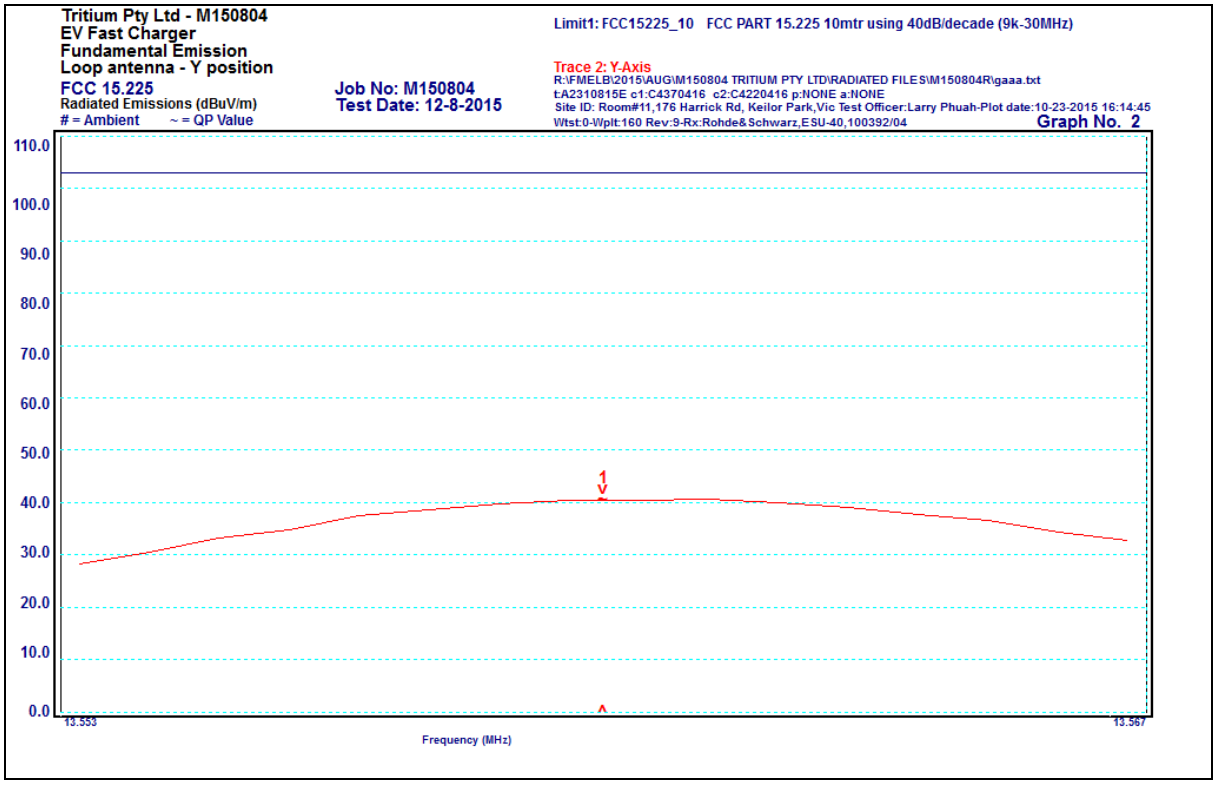
The field strength of the fundamental transmitted frequency was measured inside a compliant CISPR16-1-4 semi-anechoic chamber. The EUT was positioned on a test turn-table and rotated through 360° to determine the highest emissions. The measurement antenna was also varied between 1 and 4 metres height.

The measurements were made with the transmitter installed within the electric vehicle charger in the manner of normal use.

### 3.4.1 Result

| Antenna | Frequency MHz | E(peak) dBµV/m | E(peak) µV/m | Limit µV/m | Result |
|---|---|---|---|---|---|
| X | 13.56 | 39.4 | 93 | 15,848 | Complied |
| Y | 13.56 | 40.7 | 108 | 15,848 | Complied |
| Z | 13.56 | 32.9 | 44 | 15,848 | Complied |

All measurements were made at a distance of 10 metres. The fundamental emissions were measured using a peak detector and as the level did not exceed the limit further measurements were not made.




### 3.4.2 Conclusion

The field strength of the fundamental transmitted signal complied with the limit of §15.225(a).

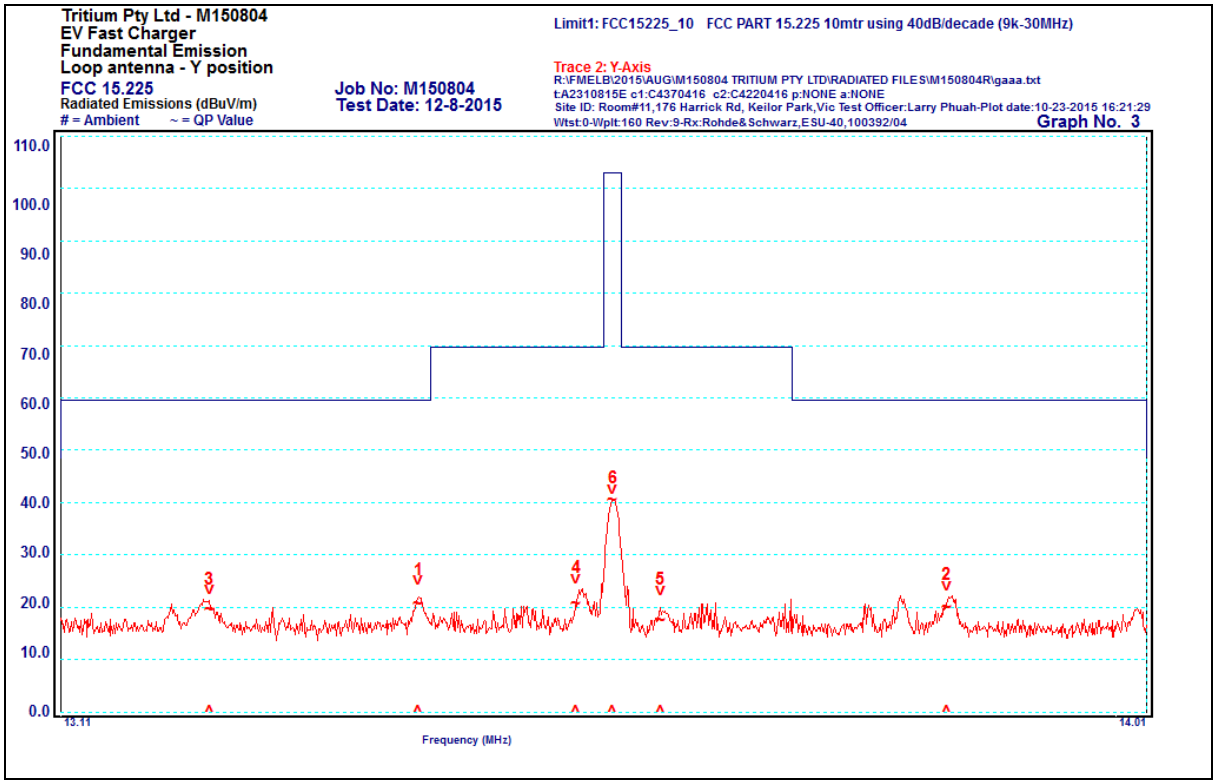
## 3.5 §15.225(b and c) Transmission Mask 13.110-14-010 MHz

Measurements were made at 10 metres using a 0.6 metre loop antenna. Initial investigations were made to find the EUT and measuring antenna orientations that produce the highest reading on the EMI receiver/spectrum analyser. These measurements were made at the transmit frequency, 13.56 MHz.

With the EUT and measuring antenna orientated in the position giving maximum emission, measurements with a bandwidth of 9 kHz were made between 13.110 MHz and 14.010 MHz. The following limit mask applied:

| Frequency band (MHz) | Field strength at 30m (µV/m) | Field strength at 10m (dBµV/m) |
|---|---|---|
| 13.110 to 13.410 | 106 | 59.6 |
| 13.410 to 13.553 | 334 | 69.6 |
| 13.553 to 13.567 | 15,848 | 103.1 |
| 13.567 to 13.710 | 334 | 69.6 |
| 13.710 to 14.010 | 106 | 59.6 |

### 3.5.1 Result




| Point | Frequency (MHz) | Peak (dBµV/m) | Peak (µV/m) | Limit (dBµV/m) | Limit (µV/m) | Result |
|---|---|---|---|---|---|---|
| 3 | 13.229 | 21.4 | 11.7 | 59.6 | 106 | Complied |
| 1 | 13.400 | 23.2 | 14.5 | 59.6 | 106 | Complied |
| 4 | 13.535 | 23.6 | 13.1 | 69.6 | 334 | Complied |
| 6 | 13.560 | 40.7 | 108.4 | 103.1 | 15,848 | Complied |
| 5 | 13.576 | 19.8 | 9.8 | 69.6 | 334 | Complied |
| 2 | 13.844 | 22.2 | 12.9 | 59.6 | 106 | Complied |

### 3.5.2 Conclusion

The transmitted signal complied with the limit mask of §15.225(b and c).

## 3.6 §15.225(d) Spurious Emissions

Radiated EMI tests were performed in a semi-anechoic chamber compliant with CISPR16-1-4 for a 2m x 2m x 2m test volume up to 6 GHz, at a test distance of 3 metres and 10 metres.

The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. Measurements were made at 10 metres using a 0.6 metre loop antenna and z calibrated Biconilog antenna was used for measurements between 30 MHz and 1000 MHz.

The EUT was slowly rotated with the spectrum analyser was set to Max-Hold. This was performed for 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.

Each significant peak was investigated with the Peak/Average Detectors. 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 antenna polarisations.

### 3.6.1 Calculation of field strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

**E = V + AF - G + L**

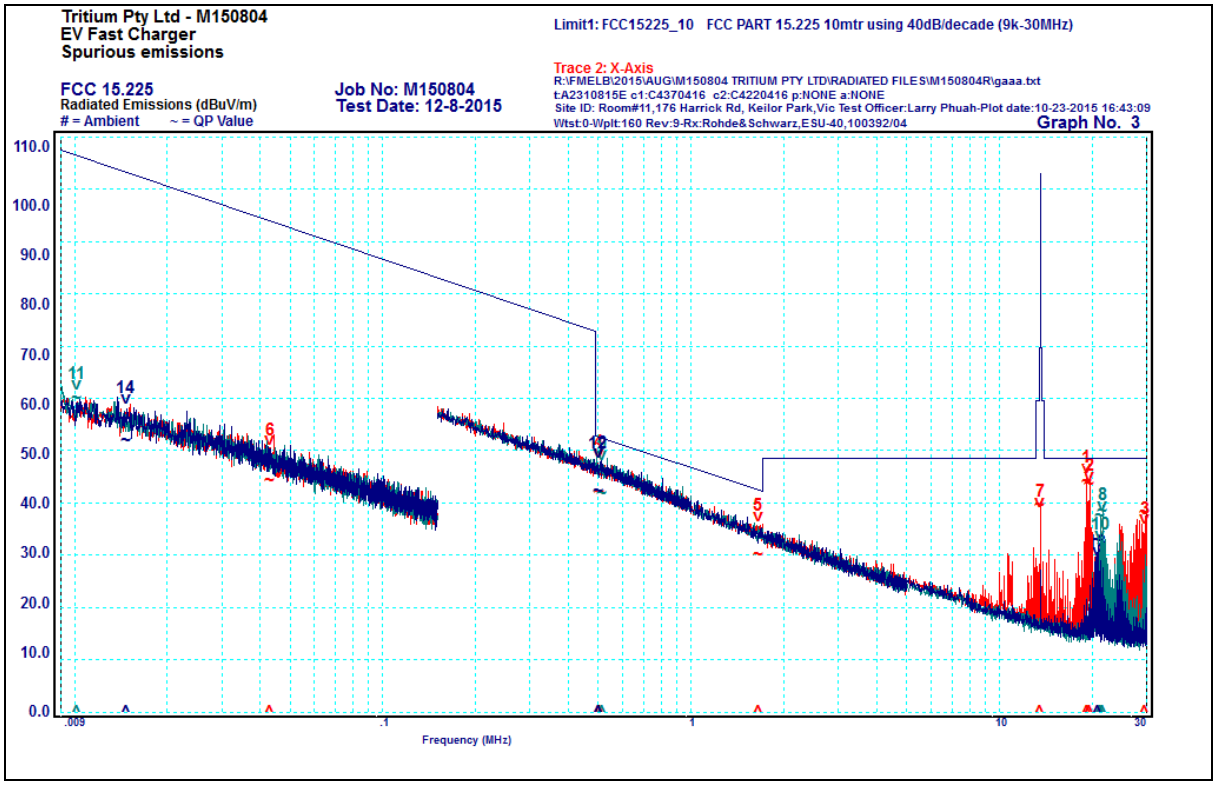
Where:

| | | |
|---|---|---|
| **E** | = | Radiated Field Strength in dBµV/m. |
| **V** | = | EMI Receiver Voltage in dBµV. (measured value) |
| **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) |

### 3.6.2 Frequency Band: 9 kHz - 30 MHz

Testing was performed at a distance of 10 metres. The measurement of emissions between 9 kHz – 150 kHz were made with a resolution bandwidth (RBW) of 200 Hz and the video bandwidth (VBW) of 3 kHz, 150 kHz – 30 MHz were measured with the resolution bandwidth (RBW) of 9 kHz and the video bandwidth (VBW) of 30 kHz.

#### 3.6.2.1 Results

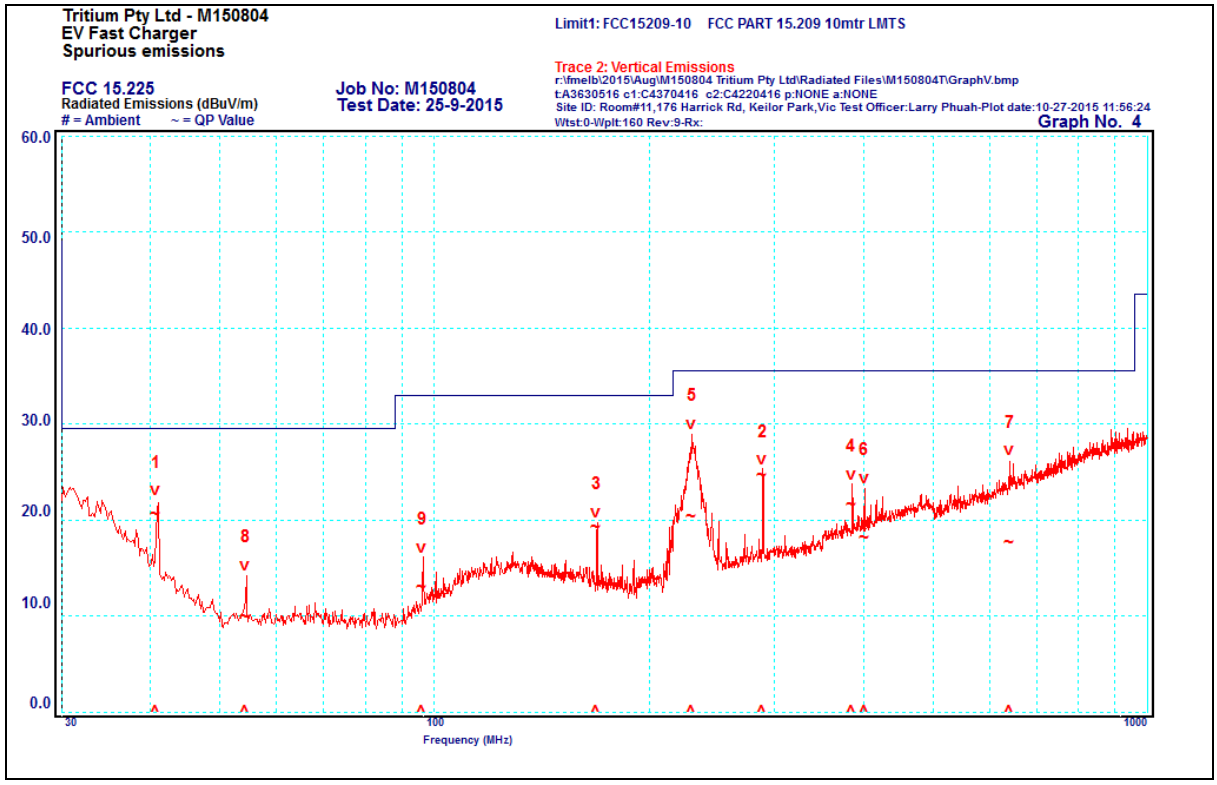



| Point | Frequency (MHz) | Loop Orientation | Quasi-Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 1 | 19.20 | X | 43.90 | 48.6 | -4.7 |
| 2 | 19.60 | X | 43.50 | 48.6 | -5.1 |
| 3 | 29.60 | X | 38.10 | 48.6 | -10.5 |
| 4 | 0.504 | X | 42.00 | 52.7 | -10.7 |
| 5 | 1.649 | X | 30.00 | 42.4 | -12.4 |
| 6 | 0.043 | X | 44.20 | 94.0 | -49.8 |
| 7 | 13.56 | X | 39.40 | 103.1 | -63.7 |
| 8 | 21.60 | Y | 38.30 | 48.6 | -10.3 |
| 9 | 0.515 | Y | 41.90 | 42.5 | -10.6 |
| 10 | 21.20 | Y | 37.50 | 48.6 | -11.1 |
| 11 | 0.010 | Y | 60.00 | 106.5 | -46.5 |
| 12 | 0.499 | Z | 42.10 | 52.7 | -10.6 |
| 13 | 20.80 | Z | 32.70 | 48.6 | -15.9 |
| 14 | 0.015 | Z | 51.80 | 103.3 | -51.5 |

### 3.6.3 Frequency Band: 30 - 1000 MHz

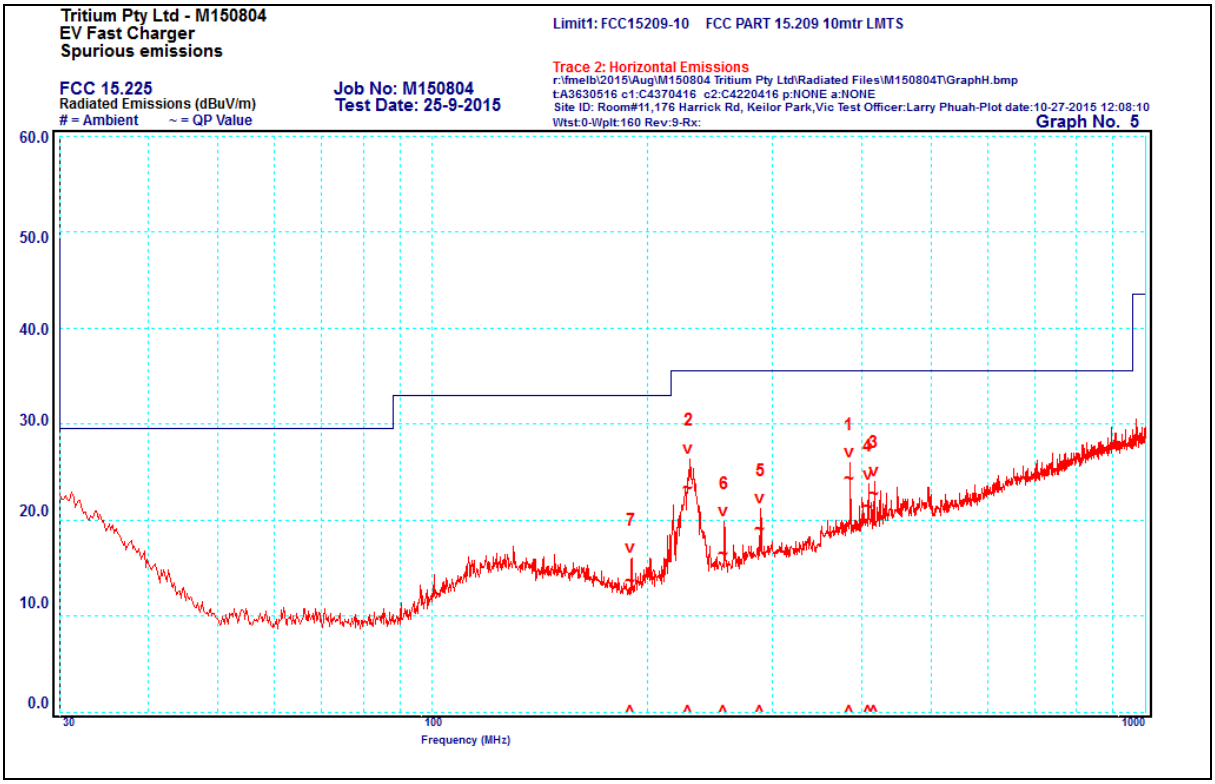
Testing was performed at a distance of 10 metres. The measurement of emissions between 30 - 1000 MHz were made with a resolution bandwidth (RBW) of 120 kHz and the video bandwidth (VBW) of 300 kHz.

#### 3.6.3.1 Vertical Polarisation




| Point | Frequency (MHz) | Quasi-Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| 1 | 40.70 | 20.5 | 29.5 | -9.0 |
| 2 | 288.05 | 24.6 | 35.5 | -10.9 |
| 3 | 168.74 | 19.2 | 33.0 | -13.8 |
| 4 | 384.03 | 21.6 | 35.5 | -13.9 |
| 5 | 229.60 | 20.3 | 35.5 | -15.2 |
| 6 | 400.00 | 18.2 | 35.5 | -17.3 |
| 7 | 640.57 | 17.7 | 35.5 | -17.8 |
| 8 | 54.28 | 9.9 | 29.5 | -19.6 |
| 9 | 96.02 | 13.0 | 33.0 | -20.0 |

### 3.6.3.2 Horizontal Polarisation




| Point | Frequency (MHz) | Quasi-Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| 1 | 384.00 | 24.2 | 35.5 | -11.3 |
| 2 | 228.56 | 23.3 | 35.5 | -12.2 |
| 3 | 416.01 | 22.6 | 35.5 | -12.9 |
| 4 | 407.99 | 21.4 | 35.5 | -14.1 |
| 5 | 288.05 | 19.0 | 35.5 | -16.5 |
| 6 | 256.00 | 16.4 | 35.5 | -19.1 |
| 7 | 189.83 | 13.6 | 33.0 | -19.4 |

### 3.6.4 Conclusion

The spurious emissions complied with the general limits of §15.209 by a margin of 4.7 dB.

## 3.7 §15.225(e) Frequency Tolerance

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 °C to + 50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 °C. For battery operated equipment, the equipment tests shall be performed using a new battery.

| Limit (MHz) | Temperature (°C) | Frequency (MHz) | Result |
|---|---|---|---|
| 13.558644 < f < 13.561356 | -20 | 13.560415 | Complied |
| | 20 | 13.560334 | Complied |
| | 50 | 13.560313 | Complied |

## 4.0 COMPLIANCE STATEMENT

The 13.56 MHz RFID component of the EV Charger tested on behalf of Tritium Pty Ltd **complied** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.225 - Operation within the band 13.110-14.010 MHz.

**Results were as follows:**

| FCC Part 15 Subpart C | Test Performed | Results |
|---|---|---|
| **15.203** | Antenna Requirement | **Complied** |
| **15.207** | Conducted Limits | **Complied** |
| **15.209** | Radiated Emissions Limits; General Requirements | **Complied** |
| **15.225(a)** | Fundamental Field Strength | **Complied** |
| **15.225(b and c)** | Transmission Mask 13.110-14.010 MHz | **Complied** |
| **15.225(d)** | Spurious Emissions | **Complied** |
| **15.225(e)** | Frequency Tolerance | **Complied** |

## 5.0 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%.