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EMC Compliance Test Report

FCC PART 15 SUBPART C (Part: 15.225)

& RSS 210 (Annex B – B.6 Band)

Report Number: CE4013ARev1

April 2024



Tritium Pty Ltd
TRI153-28 RFID Reader
Model No: TRI153-28

The results detailed in this test report relate only to the specific sample/s tested. It is the Manufacturer's responsibility to ensure that all production units are manufactured with equivalent EMC characteristics. This report is not to be reproduced except in full, without written approval from Compliance Engineering.



COMPLIANCE CERTIFICATE

Client Details:
Company: Tritium Pty Ltd
Address: 48 Miller St,
Murarrie QLD 4172
Australia
Contact: Paul Forbes
Phone: 07 3147 8561
Email: pforbes@tritium.com.au

Product Details:
Device: TRI153-28 RFID Reader
Model: TRI153-28
Serial: 0268
FCC ID: 2AFHX-TRI15328
IC: 21662-TRI15328

Reference Standard: CFR 47 - Telecommunication
Chapter I - Federal Communications Commission
Subchapter A - General
Part 15 - Radio Frequency Devices
Subpart C intentional Radiators (Part: 15.225)

RSS-210 Issue 10 Dec 2019– License-Exempt Radio Apparatus: Category I
Equipment (Annex B – B.6 Band)

Test Method: ANSI C63.10:2020: American National Standard of Procedures for
compliance testing of unlicensed Wireless Devices.

Test Date/s: 23rd & 24th January 2024

Tests Performed by: Gabriel Mendez
Compliance Engineering
90 Indian Drive,
Keysborough, Victoria, Australia 3173.
Telephone: +61 3 9763 3079
Email: info@compeng.com.au

The **TRI153-28 RFID Reader (Model: TRI153-28)** complied with radiated emission requirements detailed in CFR 47, Chapter 1, Subpart A, Part 15, Subpart C limits for intentional Radiators Part: 15.225 & RSS-210 (Annex B – B.6 Band) License-Exempt Radio Apparatus: Category I Equipment

		30 th April 2024
Prepared By: Gabriel Mendez Test Engineer Compliance Engineering	Approved By: Matthew Grimwood EMC Laboratory Manager Compliance Engineering	Date

Revision History			
Revision	Issue Date	Remarks	Revised by
0	5-02-2024	Initial release	-
1	30-4-2024	Amended date page 2	GM

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EMC Compliance Test Report

1. INTRODUCTION

Electromagnetic compatibility (EMC) measurements were performed on the TRI153-28 RFID Reader (Model: TRI153-28) in accordance with the requirements detailed in FCC Part 15 Subpart C for intentional Radiators Part: 15.225 & RSS-210 (Annex B – B.6 Band) License-Exempt Radio Apparatus: Category I Equipment.

2. RESULTS SUMMARY

FCC Part 15 Subpart C

Standard	Measurement	Result
FCC Part 15 Subpart C Part:15.225 a, b, c)	H-Field Mask: 13.110 MHz to 14.010 MHz	Complied
FCC Part 15 Subpart C: Part:15.225 e)	Occupied bandwidth- Extreme temperature and Voltages	Complied
FCC Part 15 Subpart C: Part:15.225 d) – Referencing 15.209	Transmitter spurious emission: 9 kHz to 1 GHz	Complied

RSS-210 (Annex B - B6 Band)

Standard	Measurement	Result
RSS-210 (Annex B – B.6 Band a) i, ii, iii)	H-Field Mask: 13.110 MHz to 14.010 MHz	Complied
RSS-210 (Annex B – B.6 Band b)	Occupied bandwidth- Extreme temperature and Voltages	Complied
RSS-210 (Annex B – B.6 Band a) iv)– Referencing RSS-GEN section 8.9	Transmitter spurious emission: 9 kHz to 1 GHz	Complied

3. TEST SAMPLE

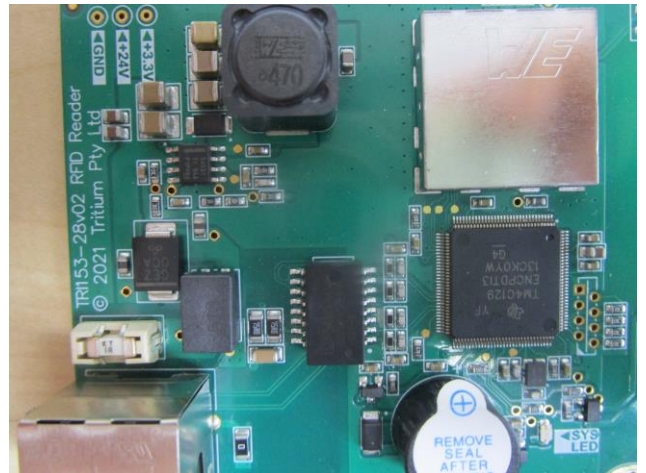
The equipment under test (EUT) is described as follows:

Equipment Under Test (<i>Information supplied by client</i>):	
Product Name:	TRI153-28 RFID Reader
Model Number:	TRI153-28
Serial Number:	0268
Product Description:	RFID sub-assembly for Tritium Electric Vehicle Charge Stations.
Equipment type:	Other Class B digital devices & peripherals
Highest Clock Frequency (CPU):	27.12 MHz
Hardware Version:	v02
Software/Firmware Version:	NA
Operating Temperature:	-20 to 50 C
Radio Type:	RFID
Radio Technology:	ISO/IEC 14443
Assigned frequency band:	13.56 MHz
Spreading:	No
Modulation:	ASK
Number of channels:	One

Channel spacing:	N/A	
Number of antennas:	1	
Radio module	FCC-ID:	2AFHX-TRI15328
	IC:	21662-TRI15328
Antenna	Type:	Loop, PCB track
	Gain:	
Power Supply	V _{NOM} :	24 VDC
	V _{MIN} :	12 VDC
	V _{MAX} :	24 VDC

The information provided on the EUT above was declared by the manufacturer. Please refer to the specifications/user manual for more details.





4. MODIFICATIONS

No modifications were performed.

5. STANDARD DEVIATIONS

No deviations from the standard were made.

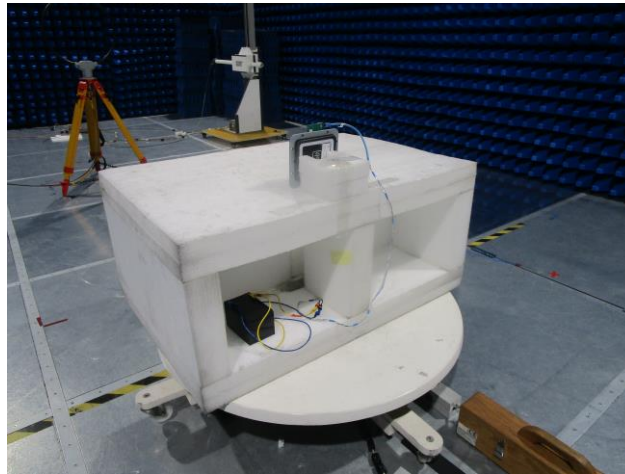
6. CONFIGURATION

The TRI153-28 RFID Reader (DUT) was connected to a 24 VDC battery via a custom RJ45 cable. The firmware of the DUT was configured to send continuous transmit signals with a duty cycle of ON= 445ms & OFF=70ms.

6.1 Supporting Equipment Used During Testing

No supporting equipment used during testing.

6.2 Test Setup



7. TEST FACILITY

All measurements were performed at Compliance Engineering, 90 Indian Drive Keysborough, Victoria, Australia.

A2LA (ISO 17025-2017) – Certificate No: 2829.01

Compliance Engineering is accredited to ISO 17025-2017 by American Association for Laboratory Accreditation (A2LA) which is an ILAC member and has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP)

All measurements within this report have been performed in accordance with Compliance Engineering's scope of A2LA accreditation.

The current full scope of accreditation can be found on the A2LA website: www.a2la.org

FCC – Registration No: 982700

Compliance Engineering has been recognized and is listed as an FCC part 47 CFR 2.948 measurement facility to perform compliance testing on equipment under Parts 15 and 18. The Designation Number is AU0006 and the Test Firm Registration Number is 982700.

Innovation, Science & Economic Development Canada (ISED) - Registration No: 27266

Compliance Engineering's 3m indoor semi-anechoic chamber (iOATS) has been accepted by Innovation, Science & Economic Development Canada (ISED) for performing radiated measurements in accordance with RSS-102, RSS-GEN, RSS-210, RSS-247, RSS-248 – ISED Canada Registration No: 27266.

8. FIELD STRENGTH CALCULATION

All emission measurements are automatically calculated via the dedicated EMC software using the pre-stored calibration factors. The following equation simplifies the actual calculation performed;

$$\text{Corr.Ampl} = V_{\text{RAW}} + \text{AF} - \text{G} + \text{L}$$

Where:

Corr.Ampl = Corrected amplitude in dBμV/m (for radiated) & dBμV (for conducted)
V_{RAW} = Raw voltage receiver/analyser reading in dBμV
AF = Antenna Factor in dB (stored as a data array of factor vs frequency)
G = Preamplifier Factor in dB (stored as a data array of gain vs frequency)
L = Cable Loss Factor in dB (stored as a data array of insertion loss vs frequency)

Limit:

The FCC limits are given in units of μV/m. The following formula is used to convert the units of μV/m to dBμV/m.

$$\text{Limit (dB}\mu\text{V/m)} = 20 \cdot \log(\mu\text{V/m})$$

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example Calculation:

A peak emission is observed at 100 MHz at 21.5 dBμV. An antenna factor for that frequency is 10 dB. The preamplifier gain factor is 30 dB and the cable loss at that same frequency 1.5 dB. Hence the overall Correction Amplitude is as follows;

$$V_{\text{RAW}} + \text{AF} - \text{G} + \text{L} \quad : \quad \text{Corr.Amp} - \text{FCC Limit} = \text{Margin}$$

$$31.5 + 10 - 20 + 1.5 \quad : \quad 23 \text{ dB}\mu\text{V/m} - 57.0 \text{ dB}\mu\text{V/m} = - 34 \text{ dB}$$

9. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

Measurement	Frequency / Range	Uncertainty
Temperature	10°C to 40°C	0.5°C
Humidity	5% to 90%	2%
Magnetic Radiated Emissions	9 kHz to 30 MHz	±2.87
Radiated Emissions (Horizontal Polarisation)	30 MHz to 200 MHz	± 4.98
Radiated Emissions (Vertical Polarisation)	30 MHz to 200 MHz	± 5.23
Radiated Emissions (Horizontal Polarisation)	200 MHz to 1000 MHz	± 5.24
Radiated Emissions (Vertical Polarisation)	200 MHz to 1000 MHz	± 5.92
Radiated Emissions (STLP)	1 GHz to 6 GHz	± 5.14
Radiated Emissions (STLP)	6 GHz to 18 GHz	± 6.11
Radiated Emissions (SGH)	18 GHz to 26 GHz	± 6.11
Radiated Emissions (SGH)	26 GHz to 40 GHz	± 6.11

These uncertainties represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

The reference uncertainty standard specifies that although the measurement uncertainty shall be documented within the test report, the actual determination of compliance shall be based on measurements without taking into account the measurement uncertainty.

10. H- FIELD MASK MEASUREMENTS

10.1 REQUIREMENTS

Frequency Range:	13.110 MHz up to 14.010
Highest Operating frequency:	27.12 MHz
Measurement Distance:	3 m
Limit:	FCC Part 15 Subpart C (FCC Rule: 15.225 a, b, c) & RSS-210 (Annex B – B.6 Band a) i, ii, iii)

10.2 TEST EQUIPMENT

Asset	Equipment	Model No	Serial No	Cal Due
644	EMI Receiver 7 GHz	ESIB7	100338	Jul 24
436	Magnetic Loop Antenna	HFH2-Z2	881058/36	Jan 26
760	iOATS (11 x 7 x 6 m)	CE-iOATS	2021	Sep 25
TER-S004	Measurement Software	RadiMation	Rev:2022 1.3	-

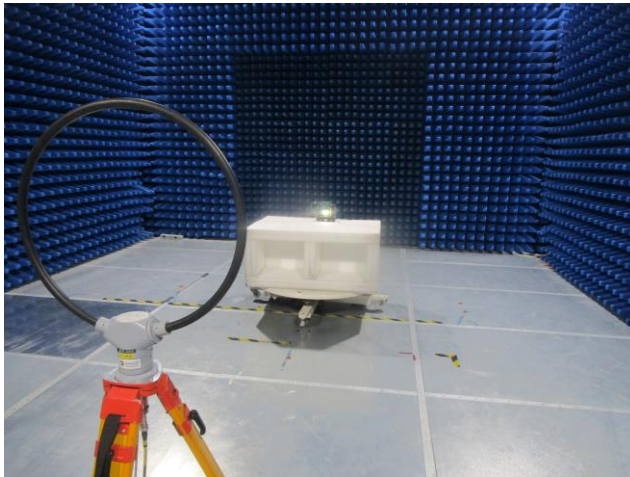
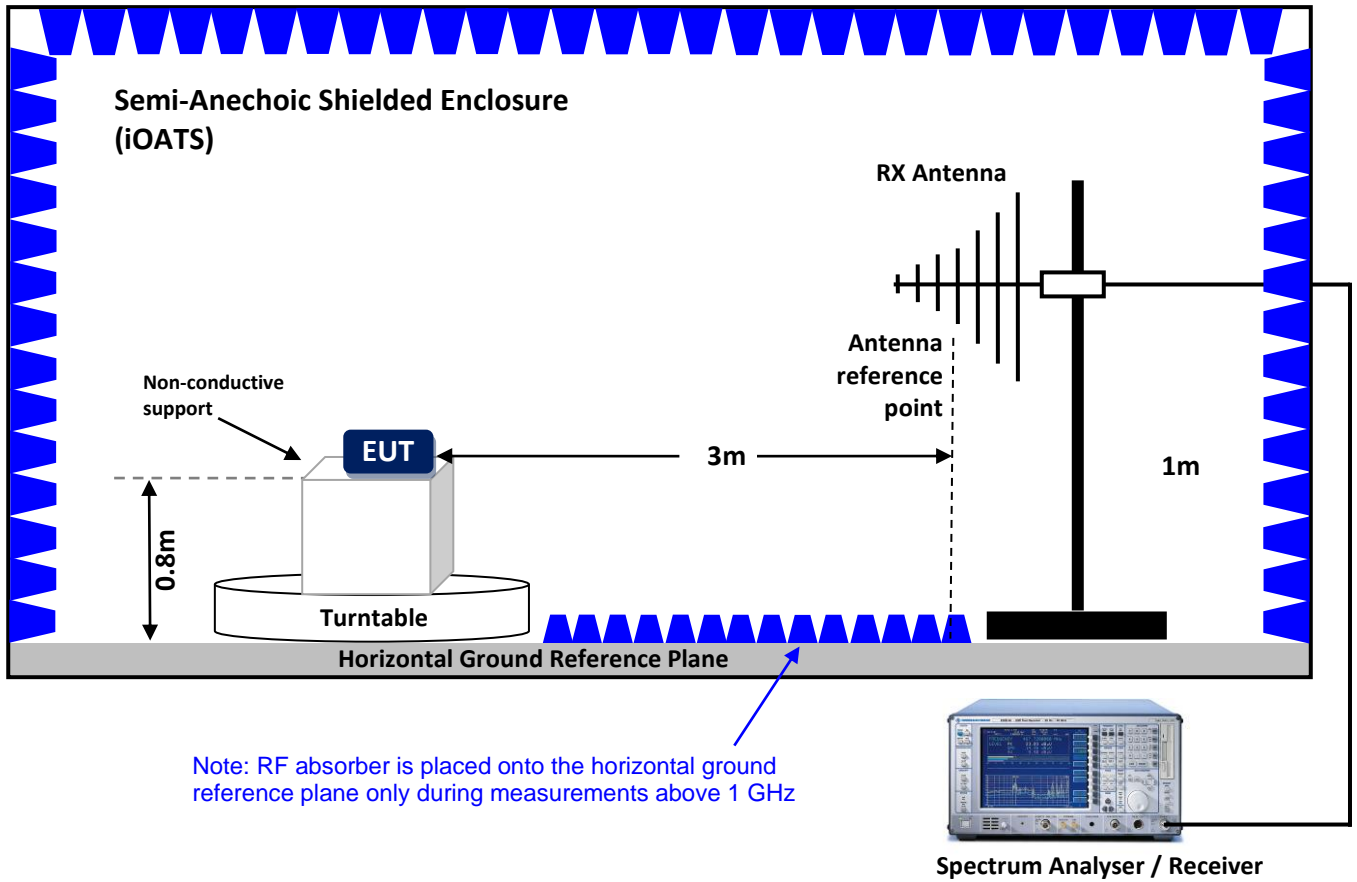
10.3 ENVIRONMENTAL CONDITIONS

Environment	Typical Range	Actual
Temperature	15.5°C to 24°C	22°C
Humidity	15% to 60%	54%

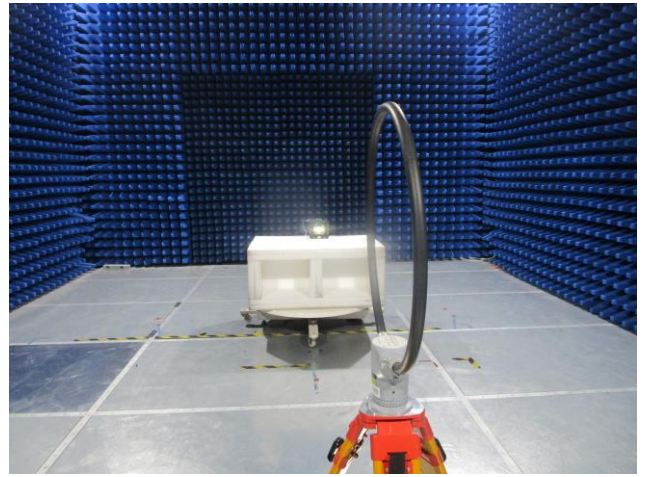
10.4 PROCEDURE

Radiated spurious RF emission measurements were performed inside a semi-anechoic chamber at a distance of 3 m. The EUT was positioned over a turntable and supported 0.8 metres above the ground reference plane. The EUT was rotated 360° whilst the antenna height was set at 1 m. Measurements were performed with the measuring antenna at parallel, perpendicular and ground-parallel positions in turn.

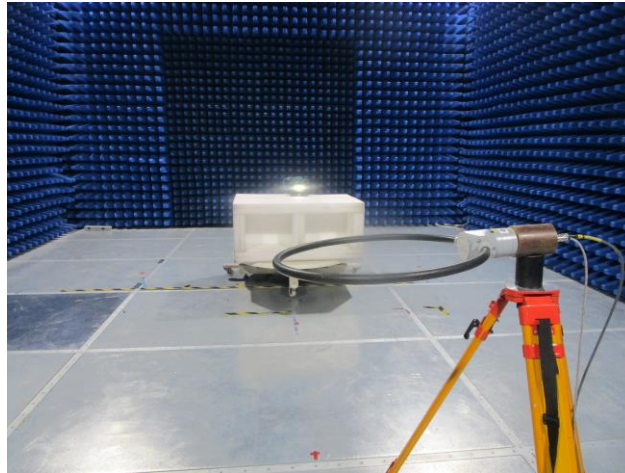
The receiver/spectrum analyser was configured to capture the highest peak emissions. Plots of the accumulated measurement data, including all transducer correction factors were produced and stored to file.



Antenna Parallel



Antenna Perpendicular

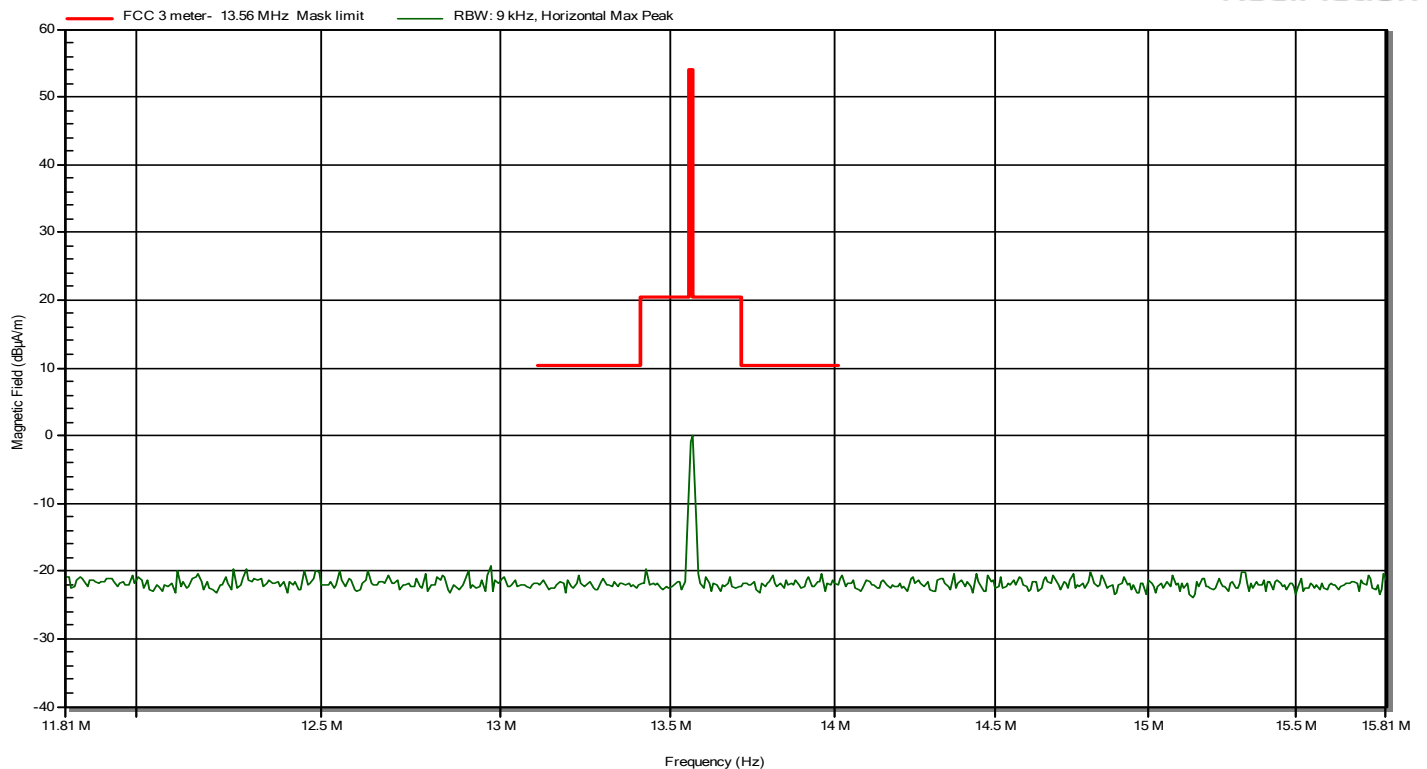


Antenna Ground-Parallel

10.5 RESULTS

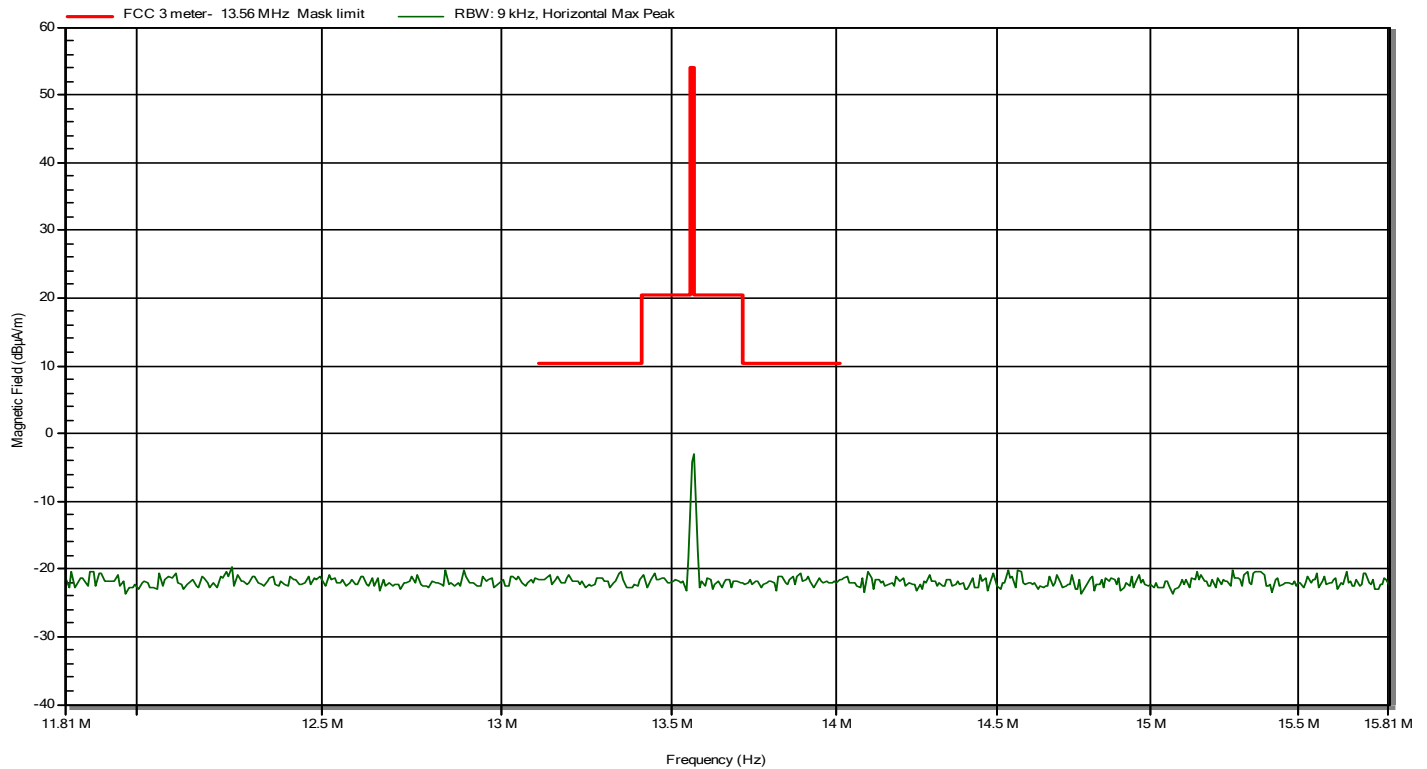
H-field Mask Emission Measurements – Antenna Parallel				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

RadiMation



H-field Mask Emission Measurements – Antenna Perpendicular				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

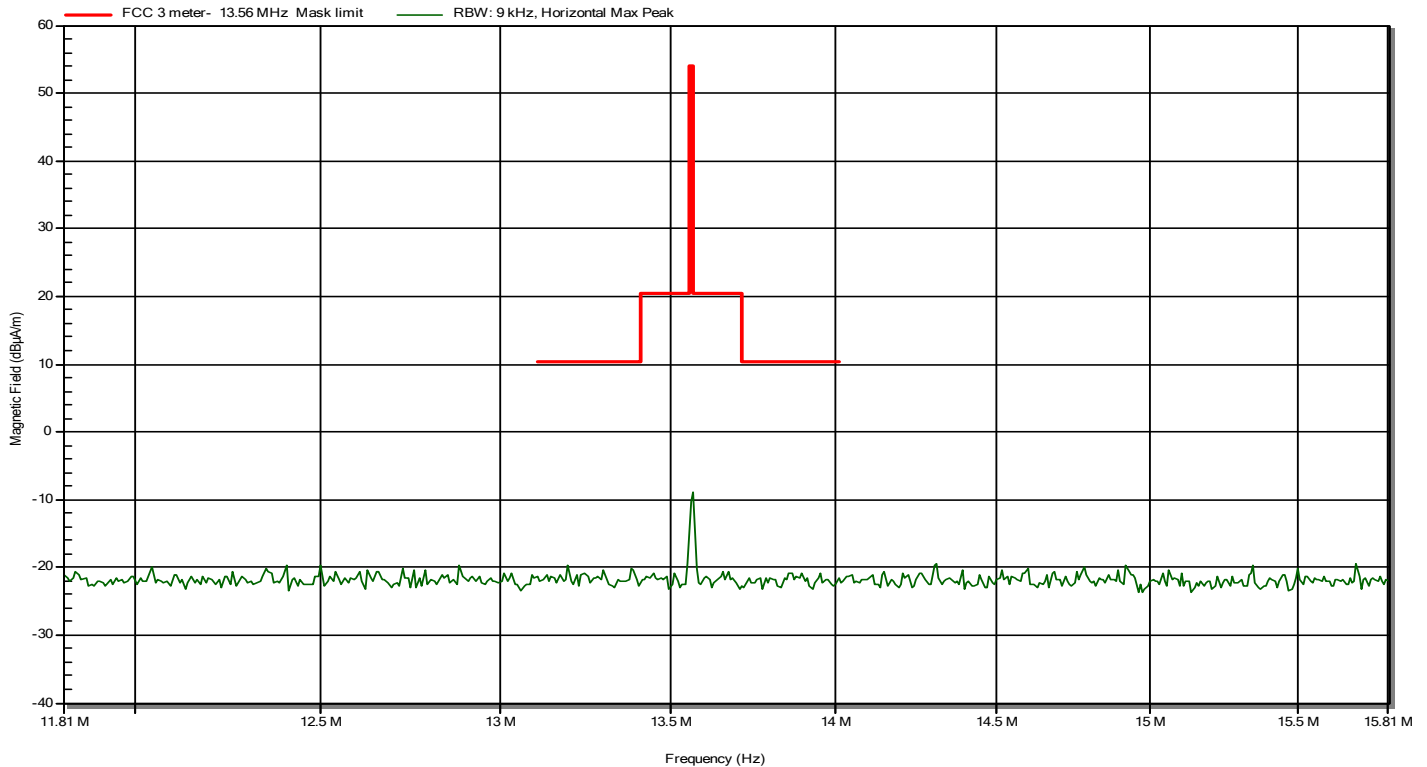
RadiMation



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H-field Mask Emission Measurements – Antenna Ground Parallel				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

RadiMation



10.6 ASSESSMENT

The TRI153-28 RFID Reader (Model: TRI153-28) complies with radiated H-Field mask emission requirements detailed in CFR 47, Chapter 1, Subpart A, Part 15, Subpart C limits (FCC Rule: 15.225) & RSS-210 (Annex B – B.6 Band (a) i, ii, iii).

11. RADIATED SPURIOUS EMISSION MEASUREMENTS

11.1 REQUIREMENTS

Frequency Range:	9 kHz to 150 kHz (RBW = 200Hz) 150 kHz to 30 MHz (RBW = 9kHz) 30 MHz to 1 GHz (RBW = 120kHz)
Highest Operating frequency:	27.12 MHz
Measurement Distance:	3 m
Limit:	FCC Part 15 Subpart C (Part: 15.225 d) – Referencing 15.209 & RSS-210 (Annex B – B.6 Band (a) iv)– Referencing RSS-GEN section 8.9

11.2 TEST EQUIPMENT

Asset	Equipment	Model No	Serial No	Cal Due
644	EMI Receiver 7 GHz	ESIB7	100338	Jul 24
436	Magnetic Loop Antenna	HFH2-Z2	881058/36	Jan 26
731	Biconical 0.03-0.2 GHz	VHBB 9124+BBA 9106	9124-1461	Aug 24
733	Log Periodic 0.2-6 GHz	UTC10-212-1	9232SN02	Aug 24
52	Preamplifier 0.03-6 GHz	ABL0600-01-3440	35401	May 24
760	iOATS (11 x 7 x 6 m)	CE-iOATS	2021	Sep 25
TER-S004	Measurement Software	RadiMation	Rev:2022 1.3	-

11.3 ENVIRONMENTAL CONDITIONS

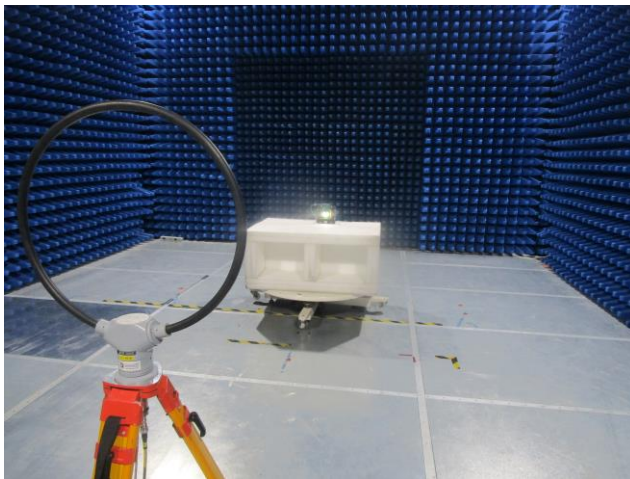
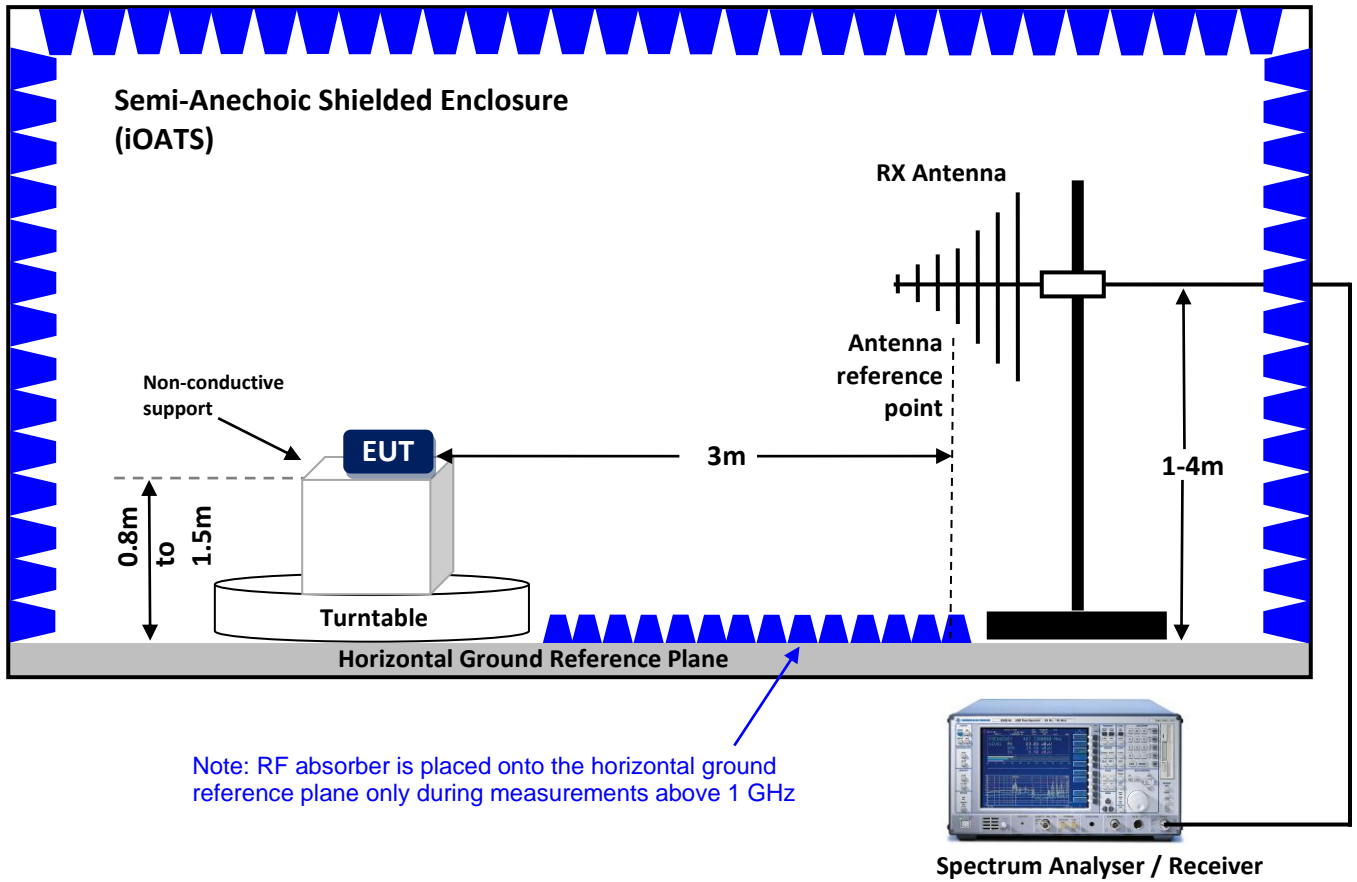
Environment	Typical Range	Actual
Temperature	15.5°C to 24°C	22°C
Humidity	15% to 60%	54%

11.4 PROCEDURE

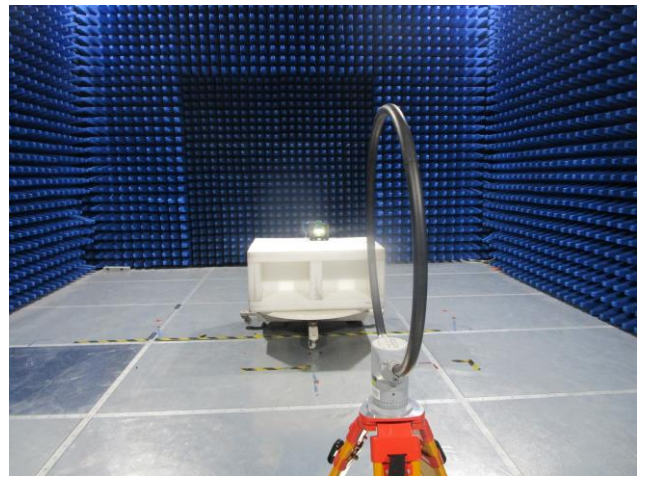
Semi-anechoic chamber test) Radiated spurious RF emission measurements were performed inside a semi-anechoic chamber at a distance of 3 m. The EUT was positioned over a turntable and supported 0.8 metres above the ground reference plane. The EUT was rotated 360° whilst the antenna height was varied between 1 m and 4 m at frequencies above 30MHz. For frequencies below 30MHz the antenna height was set at 1 m. Measurements were performed with both horizontal and vertical measuring antenna polarisations in turn.

The receiver/spectrum analyser was configured to capture the highest peak emissions. Plots of the accumulated measurement data, including all transducer correction factors were produced and stored to file.

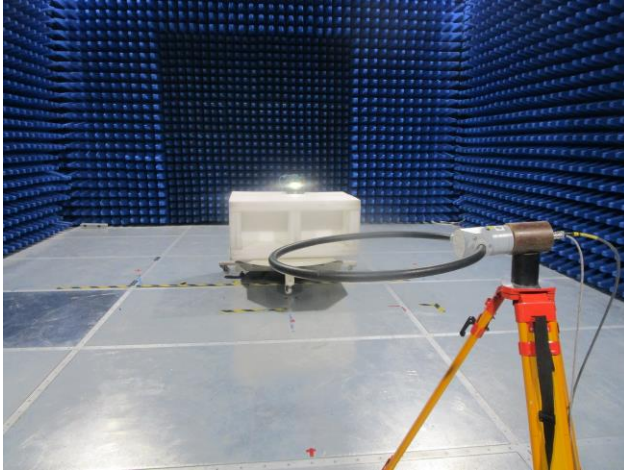
The transmitter fundamental frequency may appear as a large signal in the spectrum plots (identified with a #), is not subject to the spurious emission limit.



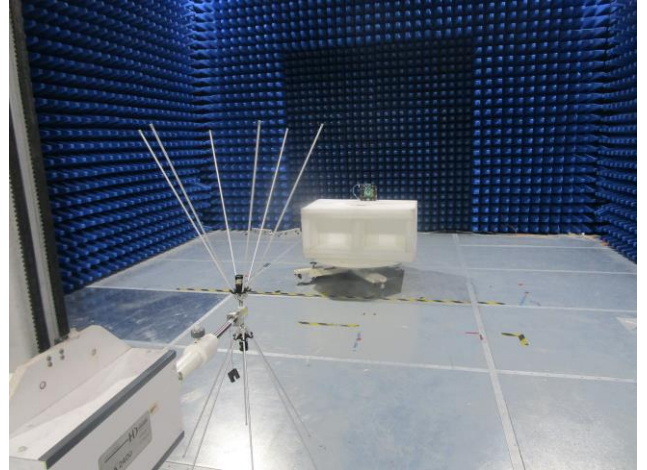
Antenna Parallel (9 kHz to 30 MHz)



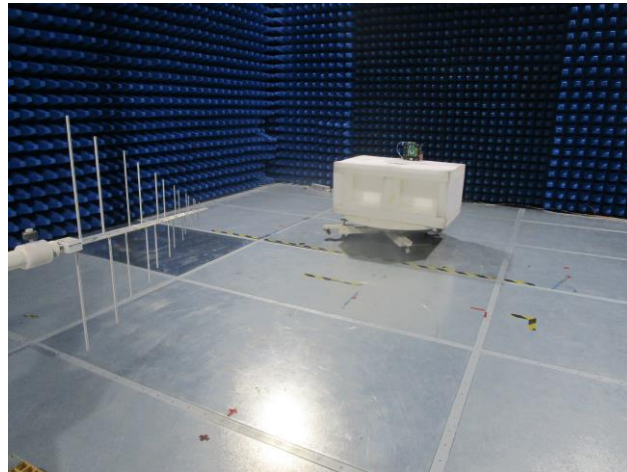
Antenna Perpendicular



Antenna Ground-Parallel



Biconical Antenna (30 – 300 MHz)

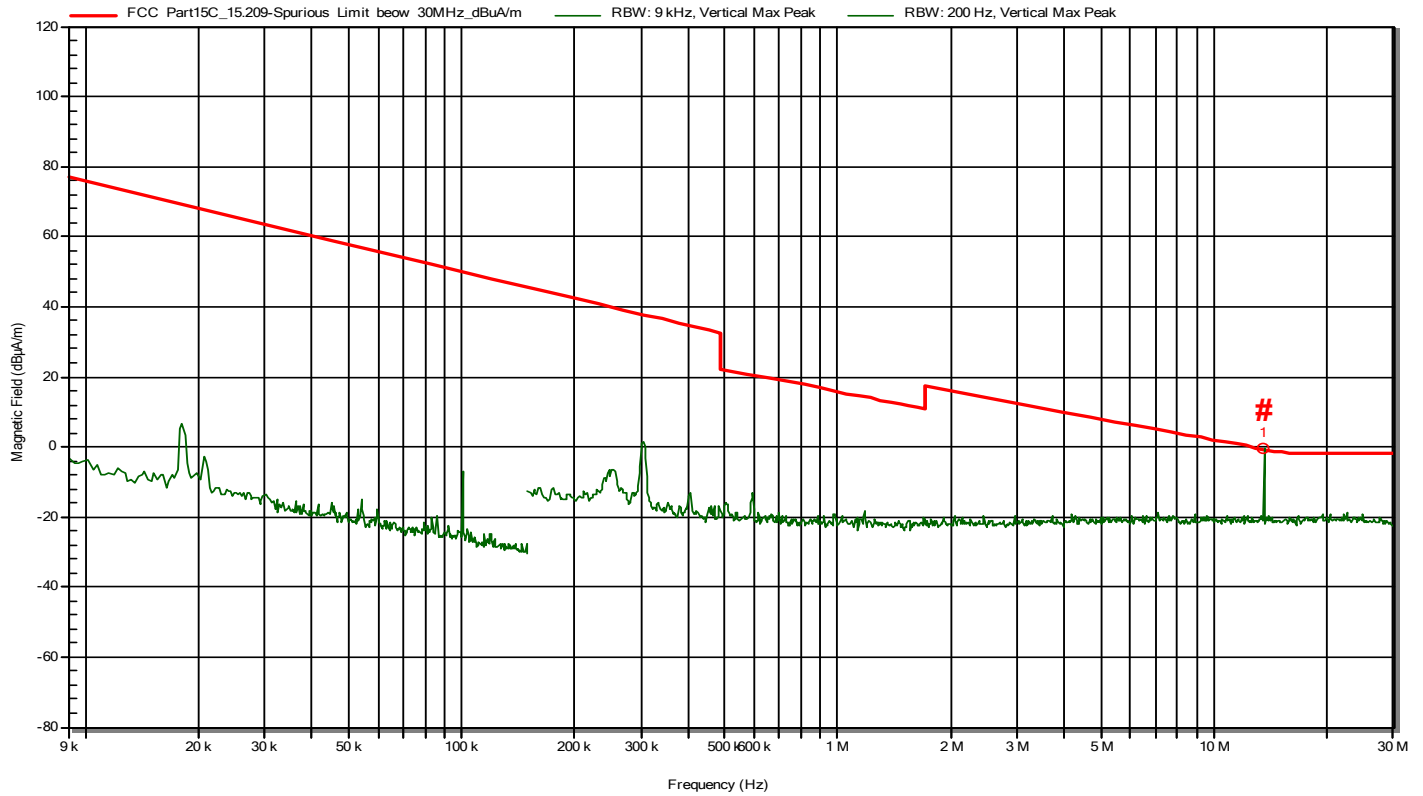


Log Periodic Antenna (300 MHz – 1 GHz)

11.5 RESULTS

Radiated Spurious Emission Measurements – Antenna Parallel – 9 kHz to 30MHz				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

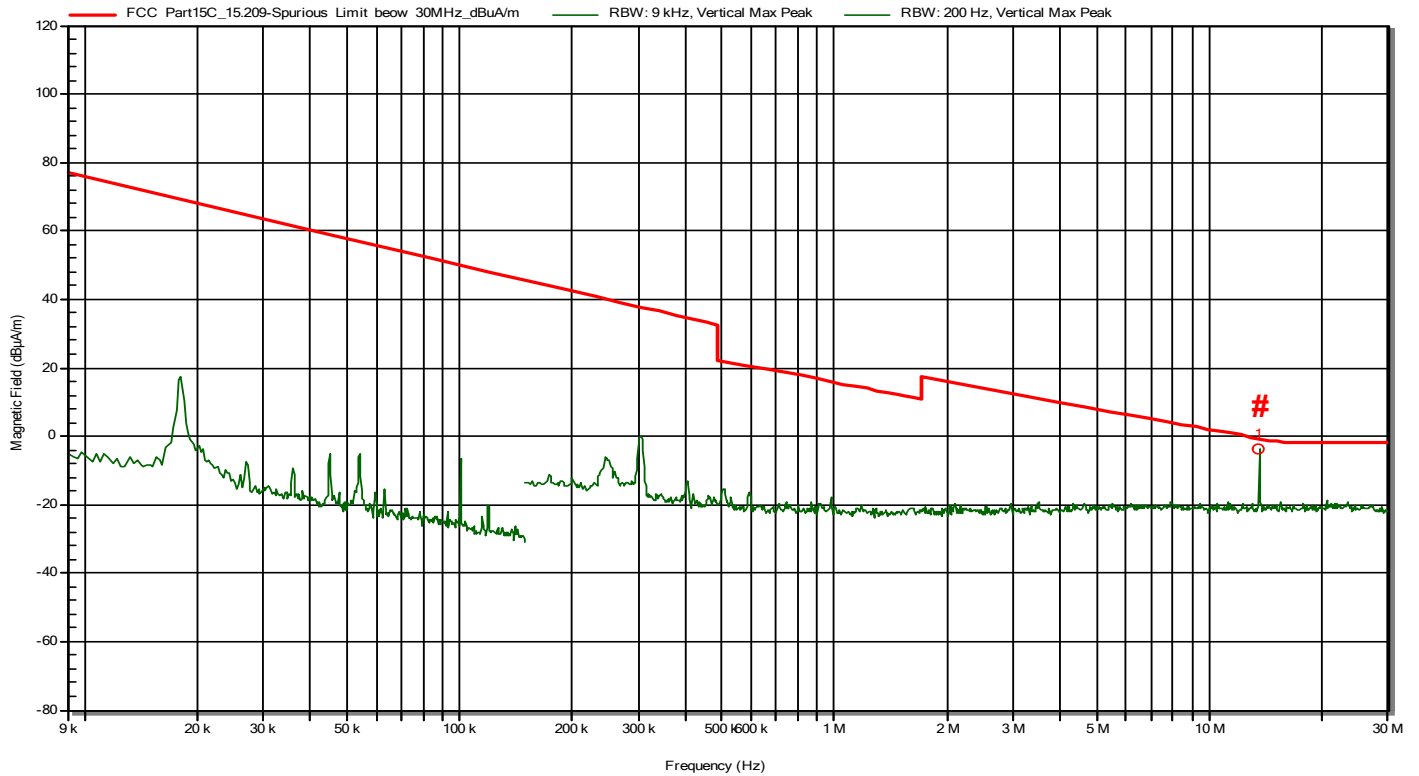
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Radiated Spurious Emission Measurements – Antenna Perpendicular – 9 kHz to 30MHz				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

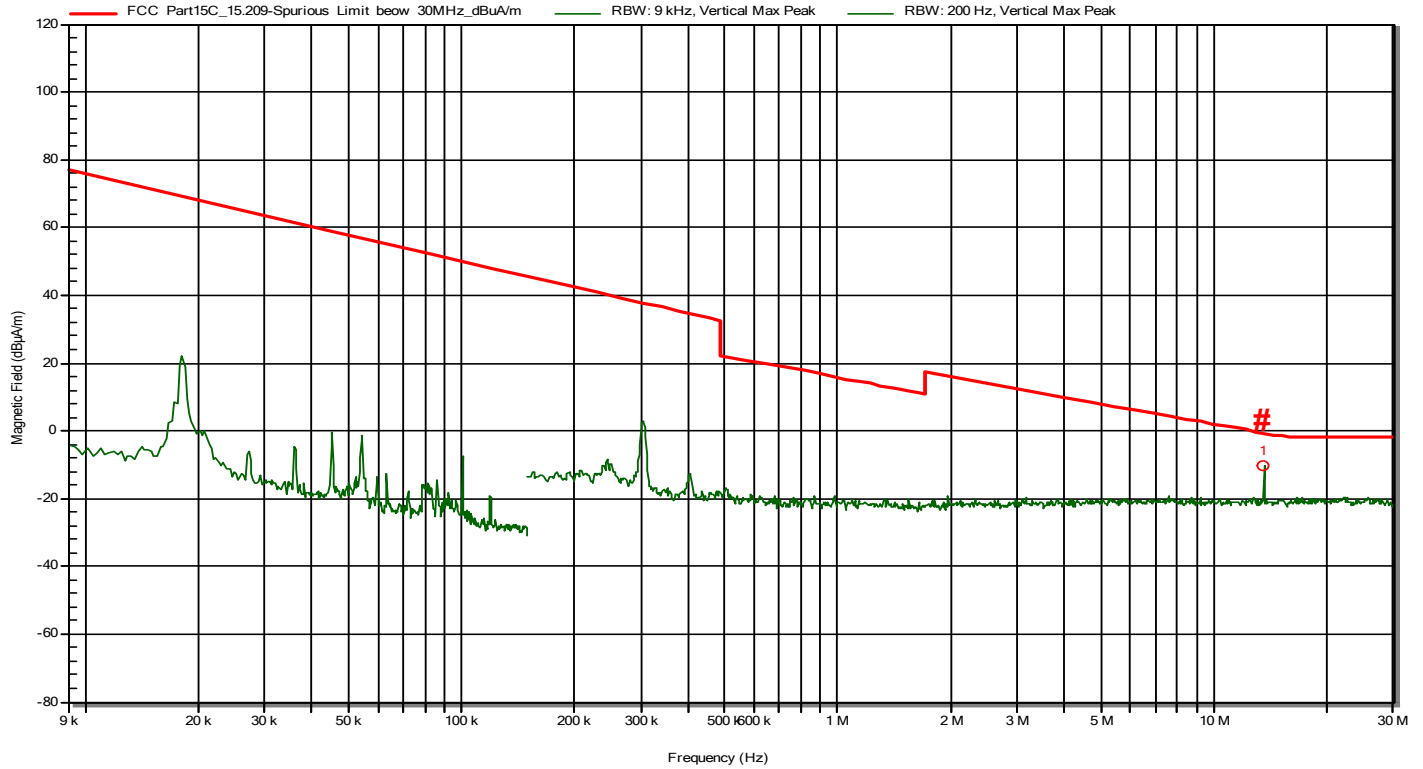
RadiMation



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Radiated Spurious Emission Measurements – Antenna Ground Parallel – 9 kHz to 30MHz				
Frequency (MHz)	Quasi-Peak (dB μ A/m)	Quasi-Peak Limit (dB μ A/m)	Delta Limit (dB)	Result
Peak emissions > 10db below the limits				Pass

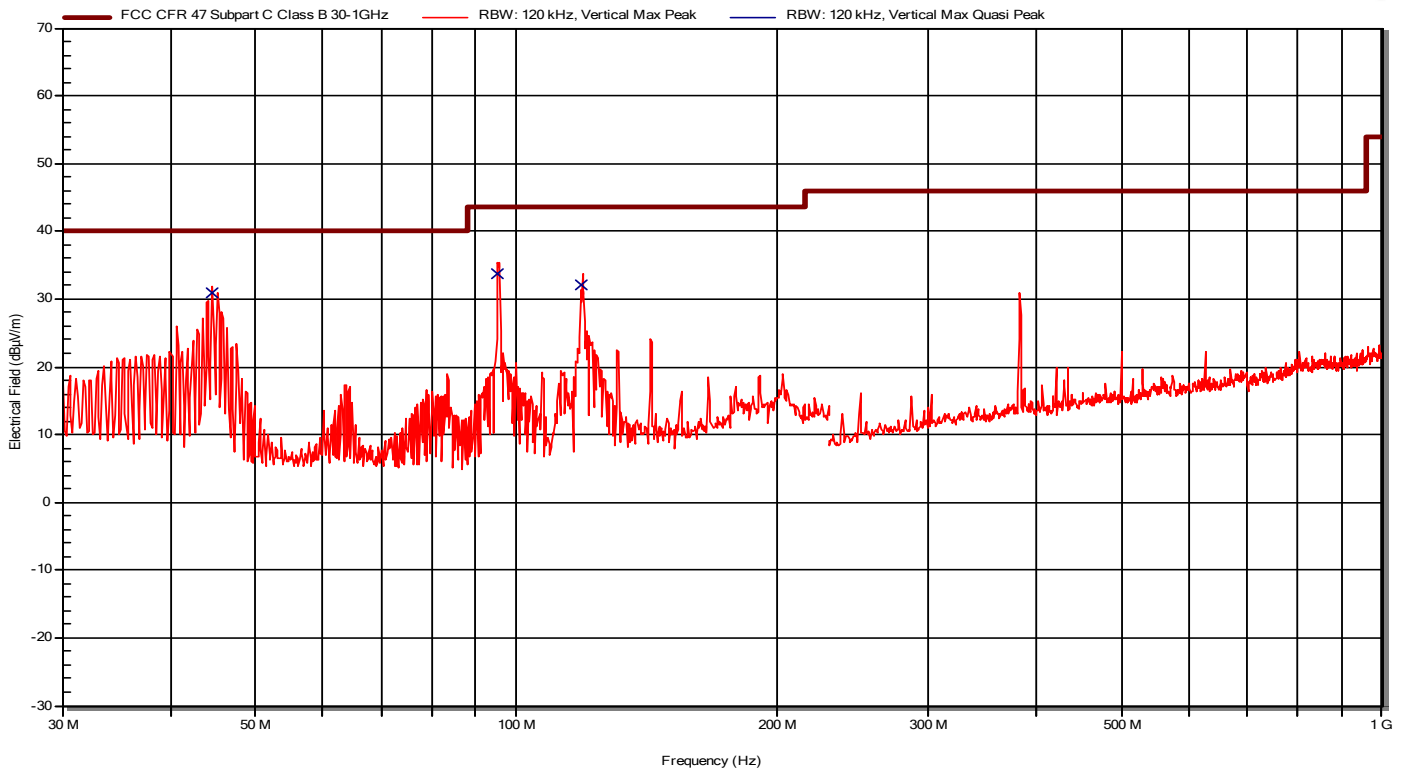
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Radiated Spurious Emission Measurements – Vertical Polarisation – 30 MHz to 1GHz				
Frequency (MHz)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Delta Limit (dB)	Result
44.713	31	40	-9.0	Pass
95.306	33.8	43.5	-9.7	Pass
119.354	32	43.5	-11.5	Pass

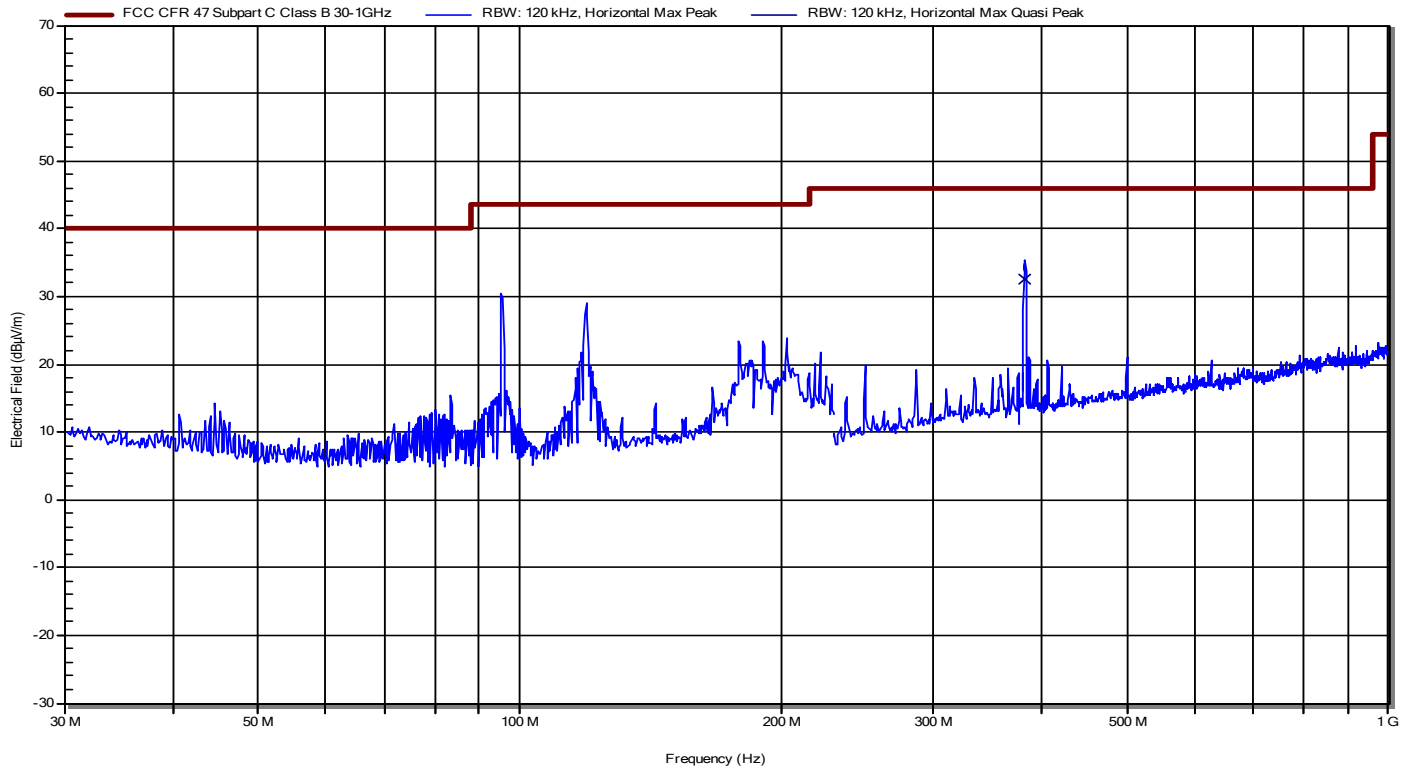
RadiMation



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Radiated Spurious Emission Measurements – Horizontal Polarisation – 30 MHz to 1GHz				
Frequency (MHz)	Quasi-Peak (dB μ V/m)	Quasi-Peak Limit (dB μ V/m)	Delta Limit (dB)	Result
381.891	32.6	46	-13.4	Pass

RadiMation



11.6 ASSESSMENT

The TRI153-28 RFID Reader (Model: TRI153-28) complies with radiated Spurious emission requirements detailed in CFR 47, Chapter 1, Subpart A, Part 15, Subpart C limits (Part: 15.225 d) – Referencing 15.209 & RSS-210 (Annex B – B.6 Band (a) iv) – Referencing RSS-GEN section 8.9.

12. FREQUENCY STABILITY UNDER EXTREME CONDITIONS

12.1 REQUIREMENTS

FCC Part 15 Subpart C: Part:15.225 e)

The operating frequency shall be assessed while the transmitter is subjected to the following extreme conditions. The emission bandwidth shall remain within $\pm 0.01\%$ the specified band under these conditions. Procedure in accordance with ANSI C63.10 Clause 6.8

RSS-210 (Annex B – B.6 Band (b.))

The carrier frequency stability shall not exceed ± 100 ppm

Temperature requirements:

-20 °C to +50 °C

Voltage requirements:

Voltage min @ 20 °C $12 \times 0.85 = 10.2$ VDC

Voltage max @ 20 °C $24 \times 1.15 = 27.6$ VDC

12.2 TEST EQUIPMENT

Asset	Equipment	Model No	Serial No	Cal Due
91	Spectrum Analyser	HP8593EM	3710A00205	Jul 24
362	Environmental Oven	C340/40	54626007070010	Aug 25
775	DC Power Supply	3010D	1YHFM37734	NA

12.3 PROCEDURE

The EUT was powered via a variable power supply and set to the transmitter's nominal operating voltage.

The transmitter was placed inside a temperature chamber connected to a spectrum analyser located outside the temperature chamber.

The temperature was adjusted to the required extremes of +50 °C Through to -20 °C in 10 °C increments and allowed to stabilise.



12.4 RESULTS

Frequency Stability Temperature Variation Measurements						
Supply (VDC)	Temp (°C)	0 Min	2 Min	5 Min	10 Min	Limit $\pm 0.01\% f_c$ 13.558994 < 13.56035 < 13.561706 Results
		Measured Frequency (MHz)	Measured Frequency (MHz)	Measured Frequency (MHz)	Measured Frequency (MHz)	
24	+50	13.560256	13.560256	13.560256	13.560256	Complied
	+40	13.560303	13.560303	13.560303	13.560303	Complied
	+30	13.560350	13.560350	13.560326	13.560326	Complied
	+20	13.560373	13.560373	13.560373	13.560373	Complied
	+10	13.560396	13.560350	13.560350	13.560350	Complied
	0	13.560420	13.560420	13.560420	13.560420	Complied
	-10	13.560420	13.560420	13.560420	13.560420	Complied
	-20	13.560396	13.560396	13.560396	13.560396	Complied

Frequency Stability Voltage Variation Measurements						
Supply (VDC)	Temp (°C)	0 Min	2 Min	5 Min	10 Min	Limit $\pm 0.01\% f_c$ 13.558994 < 13.56035 < 13.561706 Results
		Measured Frequency (MHz)	Measured Frequency (MHz)	Measured Frequency (MHz)	Measured Frequency (MHz)	
24	20	13.560373	13.560373	13.560373	13.560373	Complied
27.6		13.560401	13.560373	13.560401	13.560401	Complied
10.2		13.560401	13.560401	13.560373	13.560373	Complied

12.5 ASSESSMENT

The TRI153-28 RFID Reader (Model: TRI153-28) complies with frequency stability requirements detailed in CFR 47, Chapter 1, Subpart A, Part 15, Subpart C limits (Part: 15.225e) & RSS-210 (Annex B – B.6 Band (b.))

13. CONCLUSION

The **TRI153-28 RFID Reader (Model: TRI153-28)** complied with radiated emission requirements detailed in CFR 47, Chapter 1, Subpart A, Part 15, Subpart C limits for intentional Radiators Part: 15.225 & RSS-210 (Annex B – B.6 Band) License-Exempt Radio Apparatus: Category I Equipment.