A RADIO TEST REPORT

FOR

CONTROLLED ELECTRONIC MANAGEMENT SYSTEMS LIMITED

ON

EMERALD MULTI CARD SMART READER

MODEL NO: TSR/300/608

DOCUMENT NO.TRA-021653-03-47-00A

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UKAS TESTING
0026

TRaC Wireless Test Report	**:** TRA-021653-03-47-00A
Applicant	**:** Controlled Electronic Management Systems Limited
Apparatus	**:** emerald multi card smart reader
Specification(s)	**:** CFR47 Part 15 (c) & RSS-210
Purpose of Test	**:** Certification
FCCID	**:** QABTSR608V93E
Authorised by	**:** John Charters Digitally signed by John Charters DN: cn=John Charters, o=TRAC Global Ltd, ou=Radio Product Manager, email=john.charters@tracglobal.com, c=GB Date: 2015.08.27 10:53:18 +01'00'
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Section 1: Introduction

1.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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1.2 Tests Requested By

This testing in this report was requested by:

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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 25th May 2015 and 5th June 2015.

emarald multi card smart reader
Model Number: TSR/300/608
Hardware Version V9.32
Firmware Revision 1.05.04T

(T is for the test version; production will be 1.05.xx with x being incremented by any bug fixes as they are found)

The above device is a door access RFID reader. It has got two variants given below.

- emarald multi card smart reader powered by POE
- emarald multi card smart reader powered by 12V Supply

Radiated spurious emissions and AC powerline conducted emissions were performed on both variants.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Title 47 of the CFR: Part 15 Subpart (c)	RSS-210	Measurement standard	Result
Spurious Emissions Radiated <1000MHz	15.209	RSS-Gen 6.11 & 8.9	ANSI C63.10:2009	Pass
Spurious Emissions Radiated >1000MHz	15.209	RSS-Gen 6.11 & 8.9	ANSI C63.10:2009	N/A
AC Power conducted emissions	15.207	RSS-Gen 8.8	ANSI C63.10:2009	Pass
Intentional Emission Frequency	15.225(a)	RSS-210 A2.6	ANSI C63.10:2009	Pass
Intentional Emission Field Strength	15.225(a)	RSS-210 A2.6	ANSI C63.10:2009	Pass
Intentional Emission Band Occupancy	15.215 (c)	RSS-Gen 6.6	ANSI C63.10:2009	Pass
Frequency Stability	15.225(e)	RSS-210 A2.6 RSS-Gen 6.11 & 8.11	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	Subpart (b) 15.109	RSS-Gen 7.1	ANSI C63.10:2009	Pass
Antenna Arrangements Integral:	15.203	RSS-Gen 8.3	-	Pass
Antenna Arrangements External Connector	15.204	RSS-Gen 8.3	-	N/A
Restricted Bands	15.205	RSS-Gen 8.10	-	Pass
Maximum Frequency of Search	15.33	RSS-Gen 6.13	-	Pass
Extrapolation Factor	15.31(f)	RSS-Gen 6.4 and 6.5	-	Pass

Abbreviations used in the above table:

CFR	: Code of Federal Regulations	ANSI	: American National Standards Institution
REFE	: Radiated Electric Field Emissions	PLCE	: Power Line Conducted Emissions
RSS-GEN	: RSS-GEN Issue 4 November 2014		

1.6 Notes Relating To the Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

For the test data recorded the following measurement uncertainty was calculated:

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98%**

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Section 4 **General Test Procedures**

4.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst case determined for function, operation, orientation etc for both vertical and horizontal polarisations

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. The EUT is rotated through 360˚in the azimuth.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360˚ in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Where regulations allow for direct measurement of field strength, power values measured on the test receiver / analyzer are converted to dBuV/m at the regulatory distance, using:

$$FS = PR + AF + CL - PA + KG + DC - CF \text{ (dBuV/m)}$$

Where:

PR is the power recorded on receiver / spectrum analyzer (dBuV),
AF is the test antenna factor in dB/m,
CL is the cable loss in dB,
PA is the pre-amplifier gain dB (when applicable),
DC is duty correction factor (when applicable) in dB, and
CF is a distance correction (employed only for measurements at alternate distance to limit) in dB.

This field strength value is then compared with the regulatory limit.

If effective radiated power (ERP) or effective isotropic radiated power (EIRP) is required, it is computed as per ANSI C63.10

$$P = \frac{(Ed)^2}{30G}$$

Where

P is the power, in W
E is the measured peak field strength, in V/m
d is the distance at which the measurement was made, in m
G is the numeric gain of the radiating element

If the gain of the radiating element is not known, then either the effective radiated power (ERP) or the effective isotropic radiated power (EIRP) may be calculated from the measured peak field strength, by using either G = 1.64 or G = 1, respectively.

4.2 AC Powerline Conducted Emissions Test Setup and Procedures

AC Powerline Conducted Emissions from the EUT are checked first by preview scans with Peak and average detectors covering both live and neutral lines. A spectrum analyser is used to determine if any periodic emissions are present. Preview scans are performed in standby or receive mode if the device is subject to these requirements. For transmit mode of operation the device is set to one of the following modes.

- Transmitting operating at full power (single mode device)
- Transmitting at freq / modulation that gives highest output power (multi mode device)
- Transmitter operating in normal TX mode (e.g. FHSS, TDMA etc)

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans.

Battery Power devices are not subject to power line conducted emissions measurements when it is powered solely by its internal battery.

4.3 Antenna Port Conducted Emissions

Antenna port conducted emissions can include, but are not limited to, Carrier power, Power Spectral Density, Occupied bandwidth and spurious emission.

Spurious Emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked to identify frequencies to perform formal measurements on.

Formal measurements are made on frequencies identified from the preview scans and fundamental emission(s). Measurements are made using the correct instrumentation (inc. power meter, receiver, spectrum analyser) that operate with the required detector(s) and bandwidth.

Care is taken to ensure the measurement instrument is not overloaded by the presence of the transmitted signal by use of external attenuation and filtering where required.

Measured levels are corrected for cables, attenuators, and filters. If applicable, for the specific measurement, antenna gain is also taken into account.

4.4 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case the EUT is designed for operation from a lead-acid battery power source, the extreme test voltages are evaluated between 90% and 130% of the nominal battery voltage declared by the manufacturer.

For float charge applications using gel-cell type batteries, extreme test voltages are evaluated between 85% and 115% of the nominal battery voltage declared.

For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

4.5 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

Tests are performed at the upper and lower extremes as required and typically at 10˚ steps between.

Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber.

4.6 Time Domain Measurements

Time domain measurements are made for (but not limited to) use in duty cycle correction, to ensure compliance with time restrictions on certain types of devices.

If measurements of a transmitter's on time are required these are performed with a spectrum analyser in the time domain or with an oscilloscope and RF detector. If time on a specific frequency is required (e.g. FHSS timing) the measurement can only be made with a spectrum analyser.

The triggering, timescale and amplitude settings are adjusted according to the signal to be measured on a case by case basis.

For devices with sharp rise/fall times measurements are made between RF reaching full power (T_{on}) and RF dropping to the measurement instrument noise floor (T_{off}). For longer rise times measurements are made for T_{on} and T_{off} at the RF level required by the occupied bandwidth measurement (e.g. 6 dB, 20 dB etc).

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 Transmitter Intentional Emission Radiated

Test Details:	
Regulation	Part15.225(a), RSS-210 A2.6
Measurement standard	ANSI C63.10:2009
EUT sample number	S18
Modification state	0
SE in test environment	S07, S09
SE isolated from EUT	S03, S04, S12
EUT set up	Refer to Appendix C
Temperature	25 ˚C
Photographs (Appendix F)	1

FREQ. (MHz)	MEASUREMENT DISTANCE (Metres)	MEASUREMENT Rx. READING (dBµV/m)	EXTRAP. FACTOR (dB)	FIELD STRENGTH (µV/m)
13.56	3	81.30	39.85	118.10
13.56	10	60.53	19.08	118.10
Limit value @ fc		15848 µV/m @ 30metres		

Notes:
1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc = Quasi Peak with 120kHz bandwidth
3 Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2) & RSS-Gen 6.4 and 6.5
4 10 – 30 metre extrapolation 19.08 dB (40dB/decade)
5 3 – 10 metre extrapolation as measured (20.77 dB)
6 3 – 30 metre extrapolation 39.85 dB
7 All measurement below 30MHz made with loop antenna

Test Method:
1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 1m & 3m
3 EUT 0.8 metre above ground plane
4 Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m.
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes.
Maximum results recorded

A2 Frequency Tolerance

Test Details	
Regulation	Part 15.225(e) / RSS – 210 Issue 8 (A2.6)
Measurement standard	ANSI C63.10:2009
EUT sample number	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23˚C
Humidity	28%

Test Conditions		Measured Frequency (MHz)	Drift (kHz)
$T_{nom\ (+20^{\circ}C)}$	V_{nom}	13.561987	N/A
$T_{nom\ (+20^{\circ}C)}$	V_{min}	13.561987	0.0000
$T_{nom\ (+20^{\circ}C)}$	V_{max}	13.561987	0.0000
$T_{max\ (+50^{\circ}C)}$	V_{nom}	13.561993	0.0060
$T_{min\ (-20^{\circ}C)}$	V_{nom}	13.562070	0.0830
Limit		± 1.356 kHz (± 0.01% of the operating frequency)	
Verdict		Pass	

A3 Occupied Bandwidth

Test Details	
Regulation	Part15.215(c) / RSS – Gen 6.6
Measurement standard	ANSI C63.10:2009
EUT sample number	S18
Modification state	0
SE in test environment	S07, S09
SE isolated from EUT	S03, S04, S12
EUT set up	Refer to Appendix C
Temperature	20˚C
Humidity	32%

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Band occupancy at -20 dBc	f_L	f_H
	13.5087181 MHz	13.61785272 MHz
	BW = 109.135 kHz	
99% Band occupancy	f_L	f_H
	13.402949 MHz	14.018333 MHz
	BW = 615.384 kHz	

A4 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric field emission test applies to all spurious emissions and harmonics emissions. The maximum permitted field strength is listed in Section 15.225 and 15.209. The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : [ ] 3m alternative test site : [X]

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details: Powered by 12v Battery	
Regulation	Part 15 Subpart (c) Clause 15.209, RSS-Gen 8.9
Measurement standard	ANSI C63.10:2009
Frequency range	9kHz – 1GHz
EUT sample number	S18
Modification state	0
SE in test environment	S07, S09
SE isolated from EUT	S03. S05, S12
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1,2

The worst case radiated emission measurements for spurious emissions and harmonics are listed overleaf:

Powered by 12v Supply								
Ref No.	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
1.	30.6	14.2	0.8	18.6	N/A	33.6	47.9	100.0
2.	31.4	12.4	0.8	18.2	N/A	31.4	37.2	100.0
3.	32.6	13.5	0.8	17.6	N/A	31.9	39.4	100.0
4.	36.2	14.8	0.9	15.8	N/A	31.5	37.4	100.0
5.	39.0	20.5	0.9	14.2	N/A	35.6	60.5	100.0
6.	39.5	20.0	0.9	13.9	N/A	34.8	55.1	100.0
7.	40.4	19.2	1.0	13.4	N/A	33.6	47.9	100.0
8.	43.8	19.3	1.0	11.5	N/A	31.8	39.0	100.0
9.	47.8	22.9	1.0	9.4	N/A	33.3	46.3	100.0
10.	58.7	22.8	1.1	6.1	N/A	29.9	31.3	100.0
11.	77.2	19.8	1.3	7.3	N/A	28.4	26.3	100.0
12.	85.6	20.7	1.3	8.6	N/A	30.6	34.0	100.0
13.	86.1	20.6	1.3	8.7	N/A	30.6	34.0	100.0
14.	94.4	21.4	1.4	9.7	N/A	32.6	42.5	150.0
15.	98.5	20.5	1.5	10.1	N/A	32.1	40.0	150.0
16.	101.9	25.3	1.5	10.6	N/A	37.4	74.0	150.0
17.	104.8	25.3	1.5	10.8	N/A	37.6	75.7	150.0
18.	106.7	20.4	1.5	10.9	N/A	32.8	43.5	150.0
19.	138.4	14.8	1.6	12.1	N/A	28.5	26.6	150.0
20.	141.2	12.9	1.6	12.0	N/A	26.5	21.2	150.0
21.	162.8	15.5	1.9	10.5	N/A	27.9	24.8	150.0
22.	176.3	15.8	2.0	9.5	N/A	27.3	23.1	150.0
23.	189.0	23.9	1.9	8.7	N/A	34.5	53.3	150.0
24.	189.9	30.0	2.0	8.6	N/A	40.6	106.8	150.0
25.	203.5	16.3	1.9	8.4	N/A	26.7	21.5	150.0
26.	217.0	18.7	2.0	9.3	N/A	30.0	31.7	200.0
27.	230.6	29.4	2.2	9.7	N/A	41.3	115.5	200.0
28.	244.1	19.2	2.3	11.1	N/A	32.7	42.9	200.0
29.	261.0	12.4	2.3	13.2	N/A	27.9	24.8	200.0
30.	325.5	13.2	2.5	13.6	N/A	29.3	29.2	200.0
31.	333.0	11.8	2.5	14.0	N/A	28.3	25.9	200.0
32.	352.6	14.3	2.5	14.2	N/A	31.0	35.5	200.0
33.	369.0	12.2	2.7	14.3	N/A	29.2	28.9	200.0
34.	379.8	10.5	2.9	14.7	N/A	28.0	25.2	200.0
35.	387.0	9.3	2.9	15.1	N/A	27.2	23.0	200.0
36.	405.0	9.8	2.7	16.0	N/A	28.5	26.5	200.0
37.	423.0	11.1	2.8	16.2	N/A	30.0	31.8	200.0
38.	441.0	11.9	3.0	16.1	N/A	30.9	35.1	200.0
39.	450.0	8.6	3.0	16.5	N/A	28.1	25.5	200.0
40.	459.0	10.4	3.1	16.5	N/A	30.0	31.5	200.0
41.	477.0	7.4	3.1	17.0	N/A	27.5	23.7	200.0
42.	501.8	9.2	3.1	17.4	N/A	29.7	30.5	200.0

Powered by 12v Supply								
Ref No.	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
43.	515.4	10.9	3.1	17.8	N/A	31.8	38.9	200.0
44.	528.9	8.9	3.2	18.2	N/A	30.3	32.7	200.0
45.	531.0	8.3	3.2	18.4	N/A	29.9	31.2	200.0
46.	549.0	9.0	3.3	19.9	N/A	32.2	40.6	200.0
47.	567.0	8.1	3.4	19.2	N/A	30.7	34.3	200.0
48.	621.0	7.8	3.7	19.6	N/A	31.1	35.7	200.0
49.	639.0	7.9	3.6	19.6	N/A	31.0	35.6	200.0
50.	657.0	9.6	3.4	19.7	N/A	32.7	43.2	200.0
51.	675.0	7.6	3.6	20.1	N/A	31.2	36.3	200.0
52.	693.0	8.5	3.7	20.1	N/A	32.3	41.0	200.0
53.	711.0	10.1	3.8	20.7	N/A	34.5	53.1	200.0
54.	729.0	9.4	3.8	21.7	N/A	34.9	55.3	200.0
55.	747.0	9.0	3.9	21.9	N/A	34.8	54.7	200.0
56.	759.5	8.0	3.9	21.6	N/A	33.5	47.4	200.0
57.	765.1	7.7	3.9	21.7	N/A	33.3	46.3	200.0
58.	783.0	8.6	4.0	21.7	N/A	34.3	51.6	200.0
59.	786.6	11.7	4.0	21.8	N/A	37.5	74.7	200.0
60.	813.7	10.9	4.0	22.3	N/A	37.2	72.4	200.0
61.	840.9	9.0	4.0	22.5	N/A	35.5	59.6	200.0
62.	895.1	9.5	4.3	22.7	N/A	36.4	66.2	200.0
63.	949.4	9.8	4.4	24.0	N/A	38.2	81.1	200.0
64.	963.0	9.1	4.3	24.0	N/A	37.4	74.3	500.0
65.	976.5	11.1	4.3	24.2	N/A	39.6	95.5	500.0

Powered by PoE								
Ref No.	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
1.	30.7	11.5	0.8	18.6	N/A	30.9	35.0	100.0
2.	34.7	11.7	0.8	16.6	N/A	29.1	28.5	100.0
3.	36.2	13.0	0.9	15.8	N/A	29.7	30.4	100.0
4.	39.0	16.1	0.9	14.2	N/A	31.2	36.5	100.0
5.	42.1	16.3	1.0	12.5	N/A	29.8	30.7	100.0
6.	43.8	20.0	1.0	11.5	N/A	32.5	42.3	100.0
7.	45.8	19.1	1.0	10.5	N/A	30.6	33.7	100.0
8.	47.8	22.4	1.0	9.4	N/A	32.8	43.8	100.0
9.	55.3	17.2	1.0	6.6	N/A	24.8	17.4	100.0
10.	62.1	19.4	1.1	6.0	N/A	26.5	21.1	100.0
11.	77.2	18.8	1.3	7.3	N/A	27.4	23.4	100.0
12.	81.2	15.3	1.3	7.8	N/A	24.4	16.7	100.0
13.	90.4	18.6	1.4	9.2	N/A	29.2	28.7	150.0
14.	98.5	24.1	1.5	10.1	N/A	35.7	60.6	150.0
15.	101.9	26.4	1.5	10.6	N/A	38.5	84.0	150.0
16.	104.8	24.0	1.5	10.8	N/A	36.3	65.2	150.0
17.	106.7	19.3	1.5	10.9	N/A	31.7	38.3	150.0
18.	115.7	10.7	1.6	11.9	N/A	24.2	16.2	150.0
19.	125.0	17.9	1.6	12.6	N/A	32.1	40.3	150.0
20.	138.4	18.3	1.6	12.1	N/A	32.0	39.8	150.0
21.	145.3	19.3	1.6	11.7	N/A	32.6	42.6	150.0
22.	153.0	17.8	1.8	11.2	N/A	30.8	34.7	150.0
23.	162.0	19.3	1.9	10.6	N/A	31.8	38.7	150.0
24.	176.3	17.7	2.0	9.5	N/A	29.2	28.7	150.0
25.	189.0	28.5	1.9	8.7	N/A	39.1	90.6	150.0
26.	189.9	30.5	2.0	8.6	N/A	41.1	113.1	150.0
27.	207.0	19.0	1.9	8.9	N/A	29.8	31.0	150.0
28.	217.0	20.1	2.0	9.3	N/A	31.4	37.3	200.0
29.	230.6	26.0	2.2	9.7	N/A	37.9	78.1	200.0
30.	235.8	16.1	2.2	10.0	N/A	28.3	25.9	200.0
31.	244.1	20.3	2.3	11.1	N/A	33.8	48.7	200.0
32.	271.3	12.3	2.2	12.7	N/A	27.2	23.0	200.0
33.	325.5	11.2	2.5	13.6	N/A	27.3	23.2	200.0
34.	333.0	11.7	2.5	14.0	N/A	28.2	25.6	200.0
35.	352.6	14.1	2.5	14.2	N/A	30.8	34.7	200.0
36.	369.0	10.6	2.7	14.3	N/A	27.6	24.1	200.0
37.	387.0	11.1	2.9	15.1	N/A	29.0	28.3	200.0
38.	396.0	10.0	2.8	15.5	N/A	28.3	25.9	200.0
39.	405.0	13.5	2.7	16.0	N/A	32.2	40.6	200.0
40.	414.0	9.8	2.8	16.2	N/A	28.8	27.4	200.0
41.	423.0	13.1	2.8	16.2	N/A	32.0	40.0	200.0
42.	441.0	14.8	3.0	16.1	N/A	33.8	49.0	200.0

Powered by PoE								
Ref No.	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
43.	450.0	12.7	3.0	16.5	N/A	32.2	40.8	200.0
44.	459.0	12.2	3.1	16.5	N/A	31.8	38.7	200.0
45.	477.0	9.0	3.1	17.0	N/A	29.1	28.5	200.0
46.	501.8	9.2	3.1	17.4	N/A	29.7	30.5	200.0
47.	515.4	10.2	3.1	17.8	N/A	31.1	35.9	200.0
48.	531.0	9.7	3.2	18.4	N/A	31.3	36.6	200.0
49.	549.0	9.4	3.3	19.9	N/A	32.6	42.6	200.0
50.	567.0	8.0	3.4	19.2	N/A	30.6	33.9	200.0
51.	585.0	9.2	3.5	18.8	N/A	31.5	37.4	200.0
52.	594.8	5.4	3.5	19.0	N/A	27.9	24.9	200.0
53.	639.0	9.1	3.6	19.6	N/A	32.2	40.9	200.0
54.	651.0	8.9	3.5	19.7	N/A	32.0	39.9	200.0
55.	657.1	9.0	3.4	19.7	N/A	32.1	40.3	200.0
56.	675.0	9.7	3.6	20.1	N/A	33.3	46.3	200.0
57.	693.0	9.4	3.7	20.1	N/A	33.2	45.5	200.0
58.	711.0	9.2	3.8	20.7	N/A	33.6	47.9	200.0
59.	747.0	7.9	3.9	21.9	N/A	33.7	48.2	200.0
60.	783.0	9.2	4.0	21.7	N/A	34.9	55.3	200.0
61.	786.6	11.4	4.0	21.8	N/A	37.2	72.2	200.0
62.	801.0	9.2	4.0	21.8	N/A	35.0	56.2	200.0
63.	813.7	10.7	4.0	22.3	N/A	37.0	70.8	200.0
64.	840.9	8.8	4.0	22.5	N/A	35.3	58.3	200.0
65.	868.0	8.7	4.1	22.5	N/A	35.3	58.4	200.0
66.	895.1	9.3	4.3	22.7	N/A	36.2	64.7	200.0
67.	922.2	9.2	4.4	23.7	N/A	37.3	73.2	200.0
68.	949.4	10.9	4.4	24.0	N/A	39.3	92.0	200.0
69.	976.5	12.3	4.3	24.2	N/A	40.8	109.6	500.0

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
4 For Frequencies below 1 GHz, RBW= 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW= 1MHz, VBW ≥ RBW
Average	RBW= 1MHz, VBW ≥ RBW

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR Part 15: Clause 15.209 for all emissions:

Frequency of emission (MHz)	Field strength µV/m	Measurement Distance m	Field strength dBµV/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation}\,(\text{dB}) = 20\log_{10}\left(\frac{\text{measurement distance}}{\text{specification distance}}\right)$$

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels	✓			

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A5 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room. The effect of the EUT set-up on the measurements is summarised in note (b). Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector.

Test Details:	
Regulation	Part 15 Subpart (c) Clause 15.207, RSS-Gen 8.8
Measurement standard	ANSI C63.10:2009
Frequency range	150kHz to 30MHz
EUT sample number	S18
Modification state	0
SE in test environment	S03, S04, S07, S09, S14
SE isolated from EUT	None
EUT set up	Refer to Appendix C

The worst-case power line conducted emission measurements are listed below:

Powered by +12Vdc						
Results measured using the average detector compared to the average limit						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1.	0.175	N	16.7	64.7	16.7	Pass
2.	0.245	N	16.5	61.9	16.5	Pass
3.	0.255	N	16.6	61.6	16.6	Pass
4.	0.355	L1	17.6	58.8	17.6	Pass
5.	0.435	L1	19.7	57.2	19.7	Pass
6.	17.695	L1	19.7	60.0	19.7	Pass
7.	18.245	L1	18.7	60.0	18.7	Pass
8.	18.305	L1	19.6	60.0	19.6	Pass
9.	19.710	L1	18.9	60.0	18.9	Pass
10.	20.260	L1	19.8	60.0	19.8	Pass
11.	21.665	L1	19.7	60.0	19.7	Pass
12.	23.130	L1	17.6	60.0	17.6	Pass
13.	27.125	L1	10.1	60.0	10.1	Pass

Powered by +12Vdc						
Results measured using the quasi-peak detector compared to the quasi–peak limit						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1.	16.230	L1	17.3	50.0	17.3	Pass
2.	17.695	L1	13.4	50.0	13.4	Pass
3.	18.245	L1	12.2	50.0	12.2	Pass
4.	18.305	L1	13.0	50.0	13.0	Pass
5.	18.365	L1	13.7	50.0	13.7	Pass
6.	18.915	L1	14.7	50.0	14.7	Pass
7.	19.710	L1	12.8	50.0	12.8	Pass
8.	20.260	L1	13.6	50.0	13.6	Pass
9.	20.320	L1	14.9	50.0	14.9	Pass
10.	20.380	L1	15.0	50.0	15.0	Pass
11.	21.665	L1	13.3	50.0	13.3	Pass
12.	23.130	L1	11.1	50.0	11.1	Pass
13.	24.350	L1	14.9	50.0	14.9	Pass
14.	26.610	L1	14.7	50.0	14.7	Pass
15.	27.125	N	13.1	50.0	13.1	Pass
16.	16.230	L1	17.3	50.0	17.3	Pass
17.	17.695	L1	13.4	50.0	13.4	Pass
18.	18.245	L1	12.2	50.0	12.2	Pass
19.	18.305	L1	13.0	50.0	13.0	Pass
20.	18.365	L1	13.7	50.0	13.7	Pass
21.	18.915	L1	14.7	50.0	14.7	Pass
22.	19.710	L1	12.8	50.0	12.8	Pass
23.	20.260	L1	13.6	50.0	13.6	Pass
24.	20.320	L1	14.9	50.0	14.9	Pass
25.	20.380	L1	15.0	50.0	15.0	Pass

Powered by POE						
Results measured using the average detector compared to the average limit						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1.	0.395	L1	38.7	58.0	19.3	Pass
2.	28.420	N	41.5	60.0	18.5	Pass
3.	28.920	N	40.4	60.0	19.6	Pass

Powered by POE						
Results measured using the quasi-peak detector compared to the quasi–peak limit						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1.	0.200	L1	35.0	53.6	18.6	Pass
2.	0.395	L1	35.1	48.0	12.9	Pass
3.	0.460	L1	30.4	46.7	16.3	Pass
4.	0.530	L1	32.5	46.0	13.5	Pass
5.	0.725	N	29.3	46.0	16.7	Pass
6.	0.990	N	27.3	46.0	18.7	Pass
7.	1.515	N	28.2	46.0	17.8	Pass
8.	2.310	N	26.2	46.0	19.8	Pass
9.	3.430	N	27.7	46.0	18.3	Pass
10.	15.710	N	33.8	50.0	16.2	Pass
11.	16.455	N	40.5	50.0	9.5	Pass
12.	18.450	N	35.5	50.0	14.5	Pass
13.	28.420	N	37.6	50.0	12.4	Pass
14.	28.920	N	33.0	50.0	17.0	Pass
15.	29.670	N	31.1	50.0	18.9	Pass
16.	29.915	N	35.8	50.0	14.2	Pass

Specification limits :

Conducted emission limits (47 CFR Part 15: Clause 15.207 & RSS-Gen 7.2.4):

Conducted disturbance at the mains ports.

Frequency range MHz	Limits dBμV	
	Quasi-peak	Average
0.15 to 0.5	66 to 56[2]	56 to 46[2]
0.5 to 5	56	46
5 to 30	60	50
Notes: 1. The lower limit shall apply at the transition frequency. 2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.		

Notes:

(a) The levels may have been rounded for display purposes.

(b) The following table summarises the effect of the EUT operating mode and internal configuration on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		
(i) Parameter defined by standard and / or single possible, refer to Appendix C (ii) Parameter defined by client and / or single possible, refer to Appendix C (iii) Parameter had a negligible effect on emission levels, refer to Appendix C (iv) Worst case determined by initial measurement, refer to Appendix C				

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A.

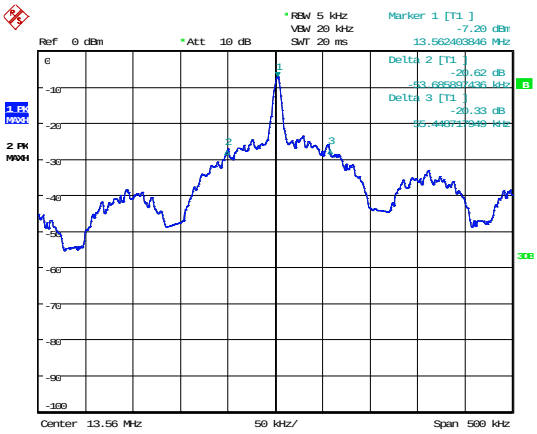
(b) The time and date on the plots do not necessarily equate to the time of the test.

(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

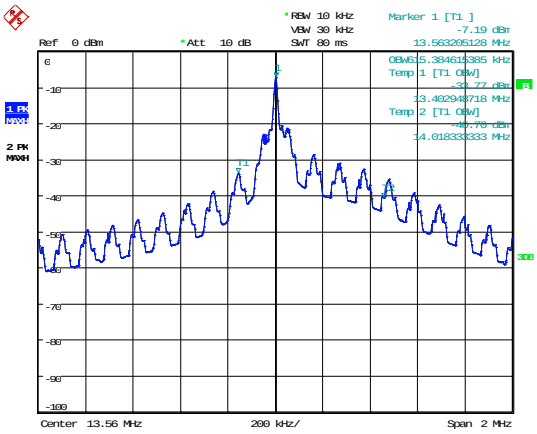
(d) Appendix C details the numbering system used to identify the sample and its modification state.

(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

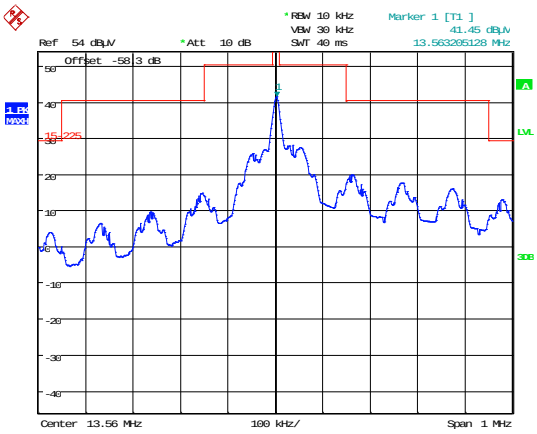
Occupied Bandwidth and Emission Mask



20dB Bandwidth

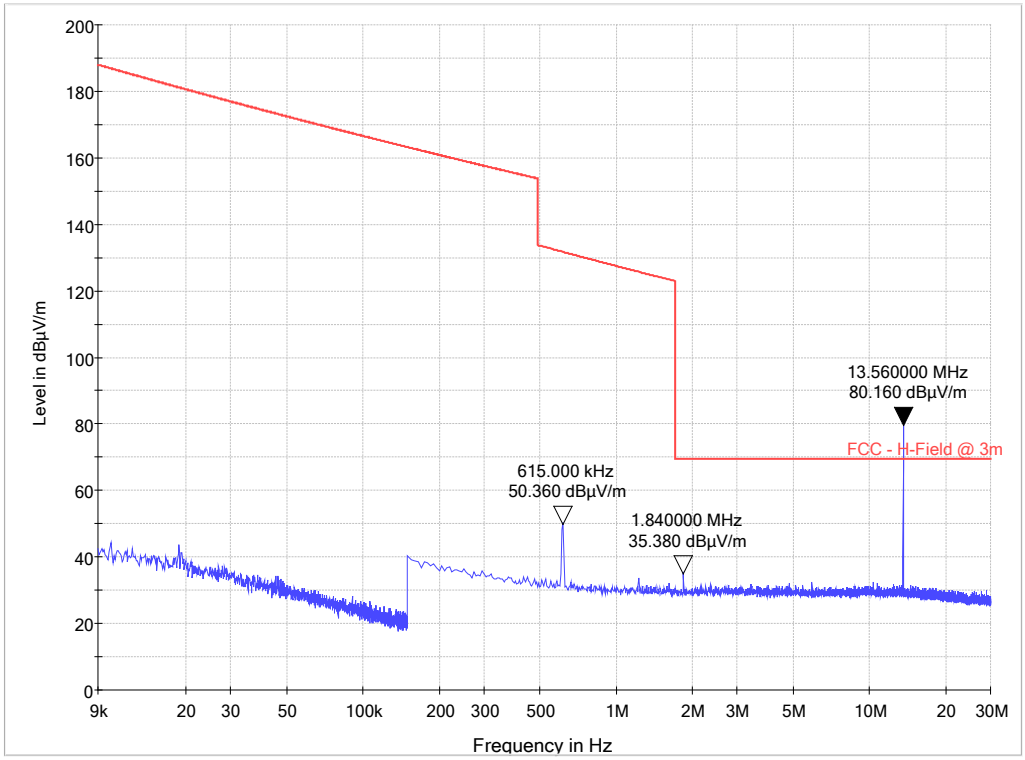


99% Bandwidth

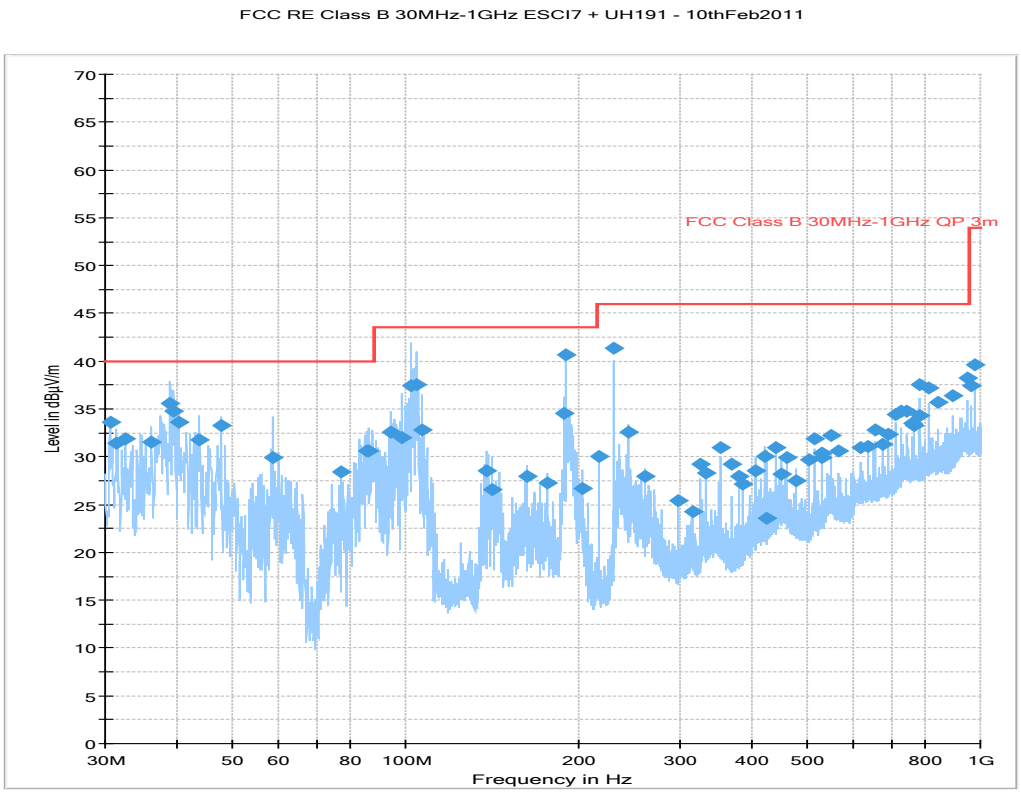


Emission Mask

Radiated spurious emissions – powered by 12v battery

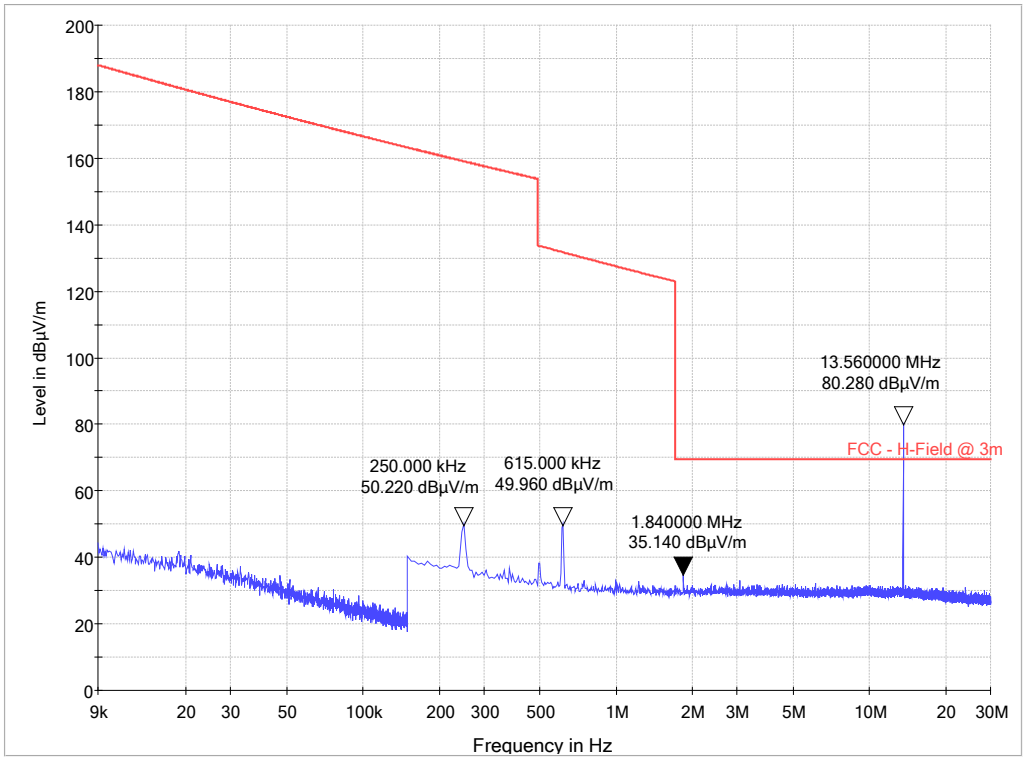


9 kHz to 30 MHz

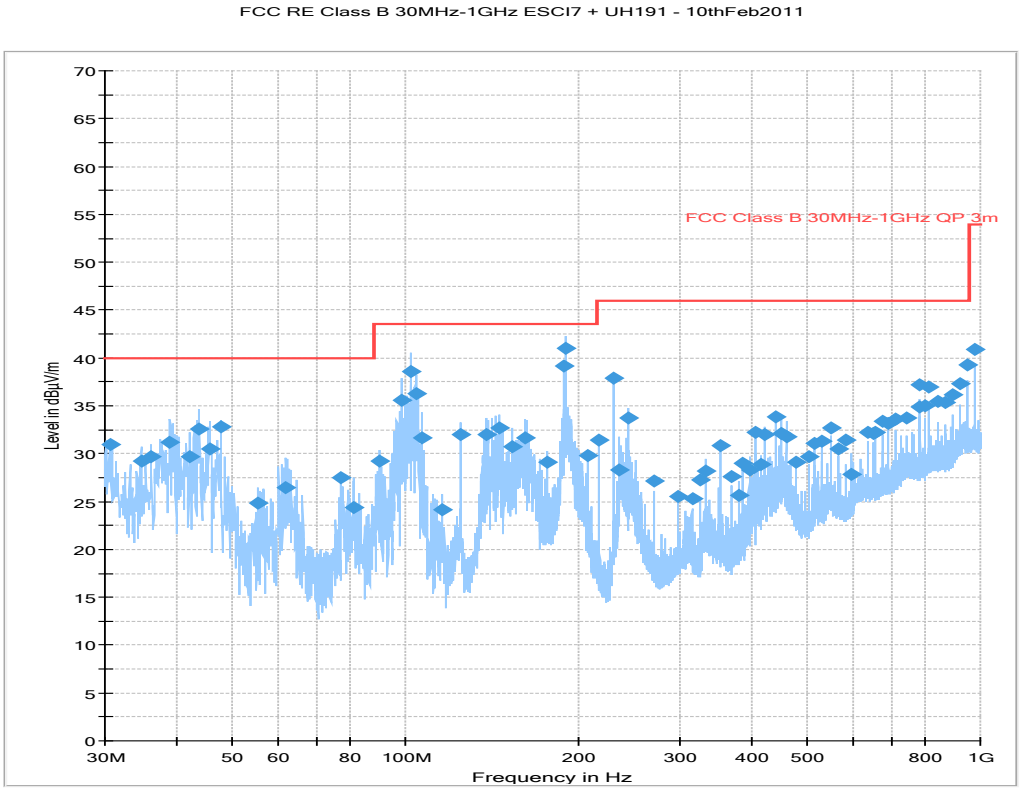


30 MHz to 1 GHz

Radiated spurious emissions – powered by PoE

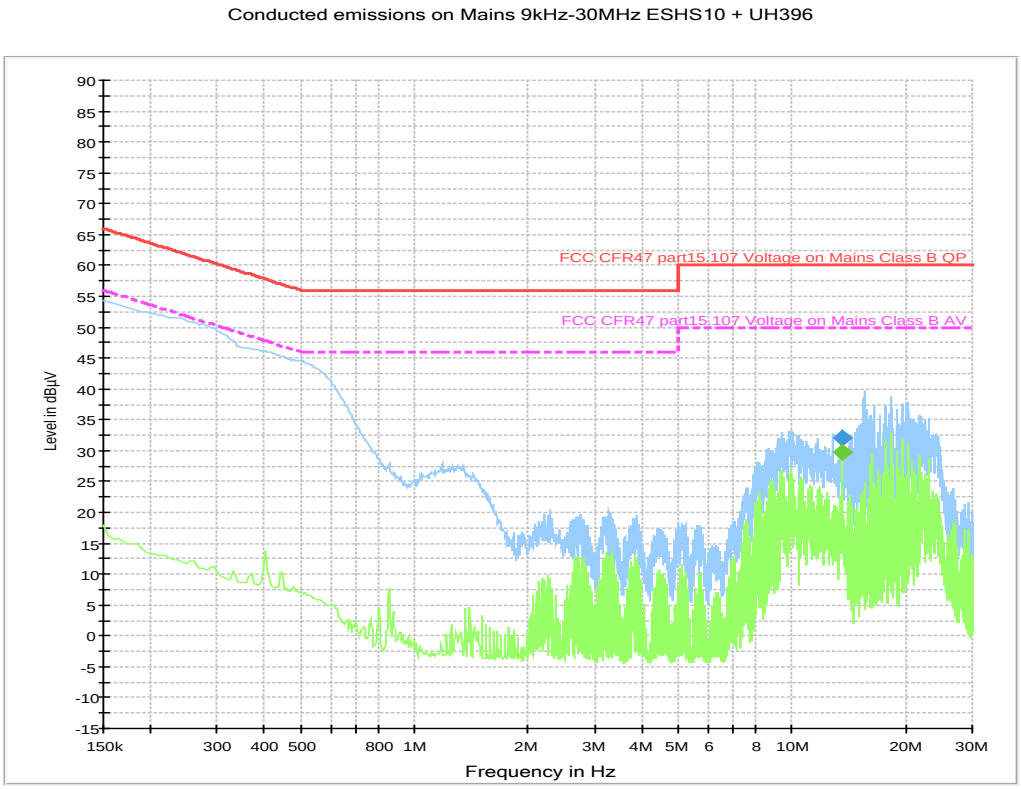


9 kHz to 30 MHz

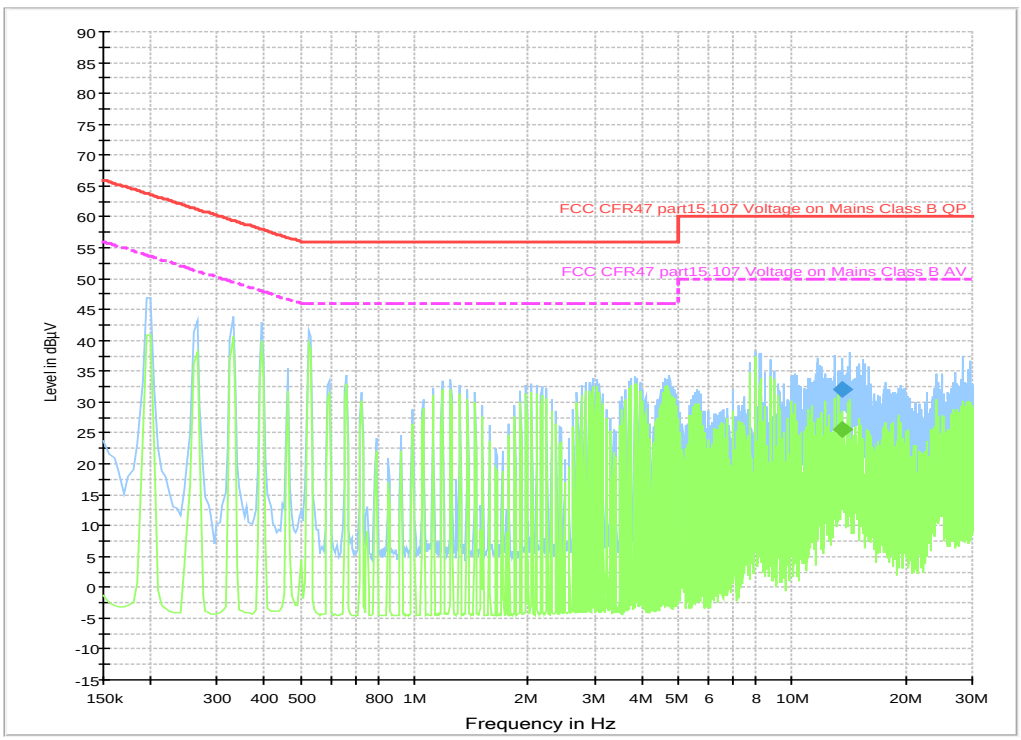


30 MHz to 1 GHz

AC Powerline Conducted Emissions



AC Powerline Conducted Emissions– powered by +12Vdc



AC Powerline Conducted Emissions– powered by PoE

Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

Sample No: Sxx Mod w

where:

xx = sample number eg. S15
w = modification number eg. Mod 2

The following terminology is used throughout the test report:

Support Equipment (SE) is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

EUT configuration refers to the internal set-up of the EUT. It may include for example:

Positioning of cards in a chassis.
Setting of any internal switches.
Circuit board jumper settings.
Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

EUT arrangement refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

C1) Test samples

The following samples of the apparatus were submitted by the client for testing:

Sample No.	Description	Identification
S18	emarald multi smart card reader	None

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
S03	Laptop	None
S04	PoE	None
S05	PoE	None
S07	Magnetic Lock	None
S09	Door Simulator	None
S12	12V Power Supply	None
S14	WURTH ELEKTRONIK Ferrite	742 727 22

The following samples of apparatus were supplied by TRaC Global as support or drive equipment (auxiliary equipment):

Identification	Description
None	None

C2) EUT Operating Mode during Testing

During testing, the EUT was exercised as described in the following tables:

Test	Description of Operating Mode:
All tests detailed in this report	EUT is actively transmitting either waiting for a tag to be presented or reading a tag as required.

C3) EUT Configuration Information

The EUT was submitted for testing in one single possible configuration.

C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S18
Tests : Radiated emissions / Powerline conducted emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Maglock	Multiple wires Cable	20cm	S07
Door simulator	Multiple wires Cable	20cm	S09
Power	2 wires	1m	S12
Ethernet	Ethernet cable with 2 turns on ferrite S14	1m	S04/S05

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH003	ESHS10	Receiver	R&S	03/07/2014	12	03/07/2015
UH093	CBL6112B	Bilog	Chase	17/06/2015	24	17/06/2017
UH100	-	PSU	Thandar	Calibrated with REF976		
UH191	CBL611/A	Bilog	Chase	26/02/2015	24	26/02/2017
UH195	ESH3-Z5.831.5	Lisn	R&S	21/07/2014	12	21/07/2015
UH387	ATS	Chamber 1	Rainford EMC	06/09/2014	12	06/09/2015
UH387	ATS	IC Reg - Chamber 1	Rainford EMC	19/11/2014	36	19/11/2017
UH396	ENV216	Lisn	R&S	01/06/2015	12	01/06/2016
UH403	ESCI 7	Receiver	R&S	20/08/2014	12	20/08/2015
L007	hfh2	Loop Antenna	R&S	10/04/2015	24	10/04/2017
L317	ESVS10	Receiver	R&S	26/02/2015	12	26/02/2016
REF909	FSU26	Spectrum Analyser	R&S	13/02/2015	12	13/02/2016
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
REF940	ATS	IC Reg Radio Chamber - PP	Rainford EMC	19/11/2014	36	19/11/2017
REF976	34405a	Multimeter	Agilent	01/06/2015	12	03/06/2016

Appendix D: Additional Information

Client declaration regarding model numbers:-

Please be advised that all following emerald models - TSR/300/608, TSR/300/105, TSR/300/106, TSR/300/107, TSR/300/108, TSR/200/608, TSR/200/105, TSR/200/106, TSR/200/107, TSR/200/108, TSR/100/608, TSR/100/105, TSR/100/106, TSR/100/107 and TSR/100/108 are electronically identical, all RF measurements and test results are the same. All 15 versions are built to one hardware and firmware build. The only difference is the SAM card which is required for compatibility with Picopass/iClass /iClass SE smart cards. The emerald models - TSR/*00/105 and TSR/*00/107 do not have the SAM card fitted. Without the SAM card fitted the emerald (TSR) is compatible with only Mifare CSN and/or CEM Desfire smart card formats.

The differences between the 100, 200 & 300 models are purely functional and are controlled by product licensing. The 300 model is fully featured; the 200 and 100 models have subsets of the features offered by the 300 model.

The TSR/*00/608 is classed as multi smart, this means that it can work with most 13.56MHz RFID card formats i.e. Picopass, iClass, iClass SE, Mifare CSN and CEM Desfire.

Product code	Card technology	Functionality
TSR/100/608	MultiSmar	Intelligent access terminal
TSR/200/608	MultiSmart	Intelligent access terminal with integrated VoIP intercom
TSR/300/608	MultiSmart	Intelligent access terminal with integrated VoIP intercom & Remote
TSR/100/105	Mifare CSN	Intelligent access terminal
TSR/200/105	Mifare CSN	Intelligent access terminal with integrated VoIP intercom
TSR/300/105	Mifare CSN	Intelligent access terminal with integrated VoIP intercom & Remote
TSR/100/106	Pico pass	Intelligent access terminal
TSR/200/106	Pico pass	Intelligent access terminal with integrated VoIP intercom
TSR/300/106	Pico pass	Intelligent access terminal with integrated VoIP intercom & Remote
TSR/100/107	CEM Desfire	Intelligent access terminal
TSR/200/107	CEM Desfire	Intelligent access terminal with integrated VoIP intercom
TSR/300/107	CEM Desfire	Intelligent access terminal with integrated VoIP intercom & Remote
TSR/100/108i	Class/iClass SE	Intelligent access terminal
TSR/200/108i	Class/iClass SE	Intelligent access terminal with integrated VoIP intercom
TSR/300/108i	Class/iClass SE	Intelligent access terminal with integrated VoIP intercom & Remote

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time is set accordingly to capture the pulse train. The transmit pulse widths and period is measured. Any applicable plot will be contained in appendix B of this test report.

If the pulse train is less than 100 ms, including blanking intervals, the duty cycle is calculated by averaging the sum of the pulse widths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle is calculated by averaging the sum of the pulse widths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100 ms), divided by the length of the period (or 100 ms). The duty cycle correction factor is then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor (dB) = 20 x Log_{10} (Calculated Duty Cycle)

For the pulse train period greater than 100 ms

Duty cycle = (the sum of the highest average value pulse widths over 100ms) / 100 ms

e.g.

$$= \frac{7.459ms}{100ms} = 0.07459$$

0.07459 Or 7.459 %

So

Correction factor (dB) = 20 x Log_{10} (0.07459) = -22.54 dB

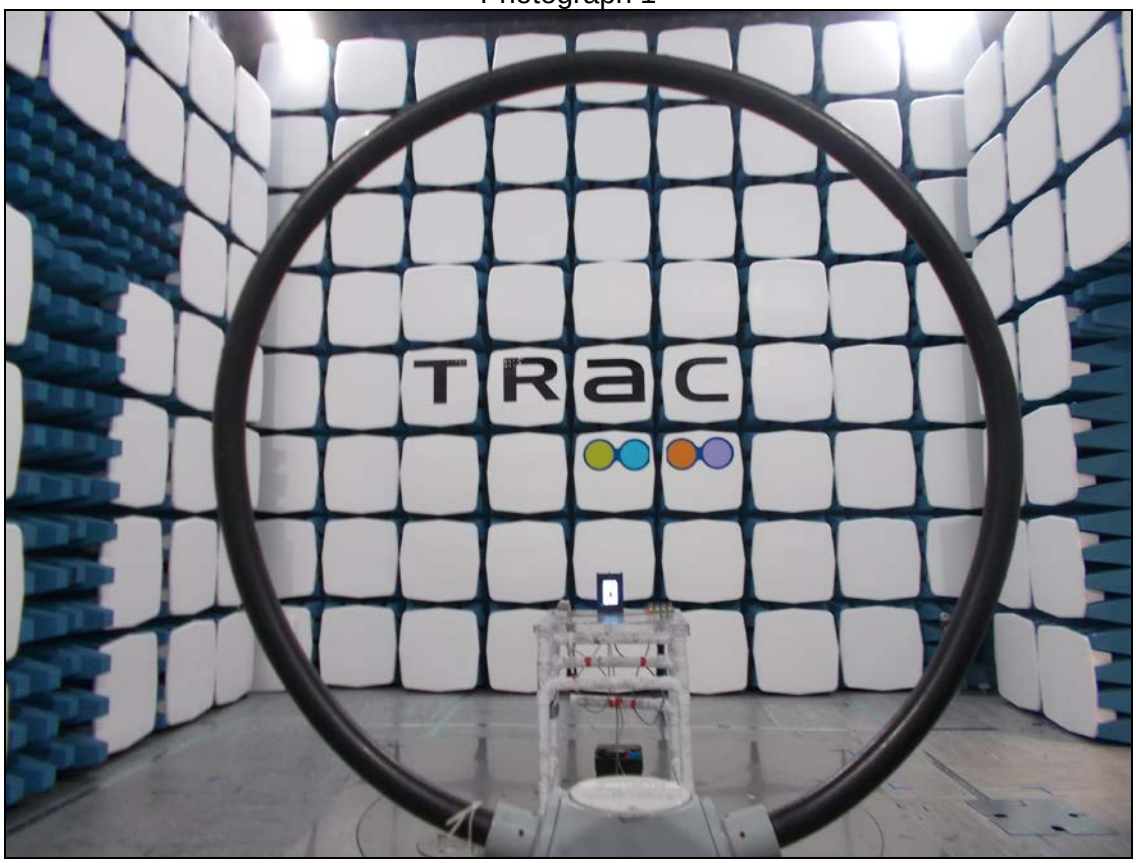
Duty cycle correction may not be applicable / required by the device covered in this report. The correction factor above is for example of how the correction is calculated. Any applicable duty cycle used will be recorded in the relevant results sections of this report.

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. H Field Radiated emissions arrangement: Overview
2. E Field Radiated emissions arrangement: Overview

Photograph 1



Photograph 2

Appendix G: General SAR test reduction and exclusion guidance

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

The SAR Test Exclusion Threshold for frequency range below 100 MHz will be determined as follows.

SAR Exclusion Threshold (SARET) = (Step 1 + Step 2) * Step 3

Step 1

$$NT = [(MP/TSD^{A}) * \sqrt{f_{GHz}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
MP = Max Power of channel (mW) (including tune-up tolerance)
TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} - 50mm) * 10$$

Where:
TSD^{B} = Min Test separation Distance (mm) = 50

Note: Step 2 doesn't apply here as the TSD^{A} is less than 50 mm

Step 3

a) the power threshold at the corresponding test separation distance at 100 MHz in step 2 is multiplied by [1 + log (100/ f_{MHz}))] for test separation distances > 50 mm and < 200 mm

b) the power threshold determined by the equation in steps 1 for 50 mm and 100 MHz is multiplied by ½ for test separation distances ≤ 50 mm

SARET = $[(NT \times TSD^{A}) / \sqrt{f_{GHz}}] * {}^{1}/_{2}$
SARET = $[(3.0 \times 50) / \sqrt{0.1}] * {}^{1}/_{2}$
SARET = 474.34 mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
13.56	2.83×10^{-5}	474.34	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

Appendix H: MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC and Industry Canada as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC and Industry Canada rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC and Industry Canada rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note: The EIRP value was calculated using the peak E Field measurement.

FCC Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.98 mW/cm^2
13.56	$2.83x10^{-5}$	0.98	0.0016

IC Result

Prediction Frequency (MHz)	Maximum EIRP (W)	Exemption limit (W)	RF Exposure calculation
13.56	$2.83x10^{-8}$	1.00	Not Required

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