A RADIO TEST REPORT

FOR

LOW POWER RADIO SOLUTIONS LTD

ON

ERA900TRS

DOCUMENT NO.TRA-012790-47-00A

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UKAS TESTING
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TRaC Wireless Test Report	**:** TRA-012790-47-00A
Applicant	**:** Low Power Radio Solutions Ltd
Apparatus	**:** ERA900TRS
Specification(s)	**:** CFR47 Part 15.249, RSS-210 Annex A2.9
Purpose of Test	**: Certification**
FCCID	**: SLW-ERA9TRS**
Certification Number	**: 11377A-ERA9TRS**
Authorised by	**:** 
	: Radio Product Manager
Issue Date	**:**15th November 2013
Authorised Copy Number	**:** *PDF*

Total number of pages: 49

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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:

Low Power Radio Solutions Ltd
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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 31st July – 9th August 2013:

ERA900TRS

The above device is a Radio Transceiver Module operating in the 902 – 928 MHz band.
The above device was tested with the following antenna variants.

Antenna Model	Antenna Type	Typical Gain
ANT-WP915SMA-Y	902-928MHz Waterproof Whip Antenna	2.5dBi
ANT-RP915SMA-Y	902-928MHz Reverse Polarity SMA Antenna	2.0dB
ANT900MS	868-915MHz flexible ¼ wave whip Antenna	3.0dBi

See Appendix D for further details.

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	Regulation		Measurement standard	Result
	Title 47 of the CFR: Part 15 Subpart (c)	RSS-210 Issue 8 RSS-Gen Issue 3		
Spurious Emissions Radiated <1000MHz	15.209 & 15.249 (a) (d)	Annex 2 A2.9(a) RSS-Gen 4.9	ANSI C63.10:2009	Pass
Spurious Emissions Radiated >1000MHz	15.209 & 15.249 (a) (d)	Annex 2 A2.9(a) RSS-Gen 4.9	ANSI C63.10:2009	Pass
AC Power conducted emissions	15.207	RSS-Gen 7.2.4	ANSI C63.10:2009	N/A
Intentional Emission Frequency	15.249 (a)	Annex 2 A2.9(a)	ANSI C63.10:2009	Pass
Intentional Emission Field Strength	15.249 (a)	RSS-Gen 4.8	ANSI C63.10:2009	Pass
Intentional Emission Band Occupancy	15.215 (c)	RSS-Gen 4.6	ANSI C63.10:2009	Pass
Intentional Emission ERP (mW)	-	RSS-Gen 4.8	ANSI C63.10:2009	N/A
Unintentional Radiated Spurious Emissions	15.109	RSS-Gen 4.10	ANSI C63.10:2009	N/A
Antenna Arrangements Integral:	15.203	RSS-Gen 7.1.2	-	Pass
Antenna Arrangements External Connector	15.204	RSS-Gen 7.1.2	-	N/A
Restricted Bands	15.205	RSS-Gen 7.2.2	-	-
Maximum Frequency of Search	15.33	RSS-Gen 4.9	-	-
Extrapolation Factor	15.31(f)	RSS-Gen 7.2.7	-	-

Abbreviations used in the above table:

ANSI C 63.10:2009 is outside the scope of the laboratories UKAS accreditation.

CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
PLCE : Power Line Conducted Emissions

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 CFR47 Part 2 & RSS-Gen.

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 in accordance with note (iii) of Section 2.1 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

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

Carrier power was verified with the EUT transmitting Test Details:	
Regulation	Part 15.249 (a) & RSS-210 Annex 2 A2.9(a)
Measurement standard	ANSI C63.10:2009
EUT sample number	S04
Modification state	0
SE in test environment	S05, S06, S07, S08
SE isolated from EUT	PSU
EUT set up	Refer to Appendix C
Temperature	22
Photographs	Appendix F

Frequency (MHz)	903.0	915.0	927.0
Antenna	Field Strength (dBµV/m)		
ANT-WP915SMA-Y	86.7	86.0	85.8
ANT-RP915SMA-Y	89.7	87.8	85.3
ANT900MS	91.4	92.7	92.5

ANT900MS						
FREQ. (MHz)	**MEASUREMENT Rx. READING (dBµV)**	**CABLE LOSS (dB)**	**ANT FACTOR (dB/m)**	**PRE AMP (dB)**	**FIELD STRENGTH (dBµV/m)**	**FIELD STRENGTH (mV/m)**
903.0	69.1	3.6	20.9	N/A	91.4	37.15
915.0	68.2	3.6	20.9	N/A	92.7	43.15
927.0	68.0	3.6	20.9	N/A	92.5	42.17
Limit value @ fc			50mV/m @ 3m			

Notes:

1 Results quoted are extrapolated as indicated
2 Receiver detector @ fc Quasi Peak 120kHz bandwidth
3 When battery powered the EUT was powered with new batteries

Test Method:

1 As per Radio – Noise Emissions, ANSI C63.10:2009
2 Measuring distances 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 orthagonal planes.
Maximum results recorded

A2 Transmitter Bandwidth

Carrier power was verified with the EUT transmitting Test Details:	
Regulation	Part 15.215 (c) & RSS-Gen Section 4.6
Measurement standard	ANSI C63.10:2009
EUT sample number	S04
Modification state	0
SE in test environment	S05, S06, S07, S08
SE isolated from EUT	PSU
EUT set up	Refer to Appendix C
Temperature	22

Band occupancy @ -20 dBc			
FREQ. (MHz)	**f lower (MHz)**	**f higher (MHz)**	**Occ BW (kHz)**
903.0	902.976602564	903.016826923	40.2244
915.0	914.976442308	915.016506410	40.0641
927.0	926.975641026	927.016025641	40.3846
Band occupancy @ 99%			
FREQ. (MHz)	**f lower (MHz)**	**f higher (MHz)**	**Occ BW (kHz)**
903.0	902.976923077	903.016346154	39.4231
915.0	914.976762821	915.016185897	39.4231
927.0	926.975801282	927.015865385	40.0641

A3 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to all spurious emissions and harmonics emissions. The maximum permitted field strength is listed in Section 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:	
Regulation	Part 15.209, 15.249 (a) & (d), Annex 2 A2.9(a), RSS-Gen 4.9
Measurement standard	ANSI C63.10:2009
Frequency range	S04
EUT sample number	0
Modification state	S05
SE in test environment	PSU
SE isolated from EUT	S04
EUT set up	Refer to Appendix C
Temperature	22
Photographs	Appendix F

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Test Details: EUT Transmitting @ 903.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Qp	897.387	2.16	3.6	22.8	N/A	28.6	-	26.92	200
Qp	902.00	9.70	3.6	23.0	N/A	36.30	-	65.31	200
Pk	1807.98	60.46	2.6	27.1	36.4	53.76	-	487.53	5000
Av	1807.98	58.35	2.6	27.1	36.4	51.65	-	382.38	500
Pk	2708.99	52.10	3.3	29.1	36.0	48.50	-	266.07	5000
Av	2708.99	45.45	3.3	29.1	36.0	41.85	-	123.74	500
Pk	3611.95	53.70	3.4	31.4	35.7	52.80	-	436.52	5000
Av	3611.95	49.38	3.4	31.4	35.7	48.48	-	265.46	500
Pk	4515.00	49.76	3.8	32.2	35.6	50.16	-	322.11	5000
Av	4515.00	38.60	3.8	32.2	35.6	39.00	-	89.13	500

Test Details: EUT Transmitting @ 915.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Pk	1829.96	59.46	2.5	27.2	36.3	52.86	-	439.54	5000
Av	1829.96	56.77	2.5	27.2	36.3	50.17	-	322.48	500
Pk	2744.99	51.41	3.4	29.1	36.0	47.91	-	248.60	5000
Av	2744.99	44.65	3.4	29.1	36.0	41.15	-	114.16	500
Pk	3659.96	53.74	3.4	31.7	35.6	53.24	-	459.20	5000
Av	3659.96	48.39	3.4	31.7	35.6	47.89	-	248.03	500
Pk	4574.97	48.77	3.8	32.2	35.6	49.17	-	287.41	5000
Av	4574.97	38.03	3.8	32.2	35.6	38.43	-	83.46	500

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Test Details: EUT Transmitting @ 927.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Qp	933.379	7.64	3.6	24.2	N/A	35.4	-	58.88	200
Qp	928.00	9.90	3.7	23.8	N/A	37.40	-	74.13	200
Pk	1853.96	58.31	2.6	27.3	36.3	51.91	-	394.00	5000
Av	1853.96	55.36	2.6	27.3	36.3	48.96	-	280.54	500
Pk	2780.95	51.96	3.4	29.0	36.0	48.36	-	261.82	5000
Av	2780.95	45.60	3.4	29.0	36.0	42.00	-	125.89	500
Pk	3707.99	51.51	3.4	31.9	35.6	51.21	-	363.50	5000
Av	3707.99	45.65	3.4	31.9	35.6	45.35	-	185.14	500
Pk	4634.927	48.97	3.9	32.2	35.6	49.47	-	297.51	5000
Av	4634.927	39.44	3.9	32.2	35.6	39.94	-	99.31	500

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

A4 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 15.207, RSS-Gen 7.2.4
Measurement standard	ANSI C63.10:2009
Frequency range	150kHz to 30MHz
EUT sample number	S04
Modification state	0
SE in test environment	S05
SE isolated from EUT	PSU
EUT set up	Refer to Appendix C

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

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
No Significant Emissions Within 20 dB of limit						

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
No Significant Emissions Within 20 dB of limit						

Specification limits :

Conducted emission limits (47 CFR Part 15: Clause 15.207):

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

A5 Unintentional Radiated Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric filed emission test applies to all spurious emissions on directly related to the transmitter. The maximum permitted field strength is listed in Section 15.109. The EUT was set to operate in a transmit standby / receive mode.

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:	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.109
Measurement standard	ANSI C63.10:2009
EUT sample number	S04
Modification state	0
SE in test environment	S05
SE isolated from EUT	PSU
EUT set up	Refer to Appendix C
Temperature	22
Photographs	Appendix F

The worst case radiated emission measurements for spurious emissions are listed below: within the restricted bands are listed below:

Test Details: EUT Operating @ 903.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Pk	1805.376	51.53	2.7	27.1	36.4	44.93	-9.54	58.80	5000
Av	1805.376	49.68	2.7	27.1	36.4	43.08	-9.54	47.52	500
Pk	3610.75	51.45	3.4	31.4	35.7	50.55	-9.54	112.30	5000
Av	3610.75	49.93	3.4	31.4	35.7	49.03	-9.54	94.27	500
Pk	7221.52	44.73	4.7	36.0	36.0	49.43	-9.54	98.71	5000
Av	7221.52	42.12	4.7	36.0	36.0	46.82	-9.54	73.09	500

Test Details: EUT Operating @ 915.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Pk	1829.37	49.42	2.5	27.2	36.3	42.82	-9.54	46.12	5000
Av	1829.37	47.16	2.5	27.2	36.3	40.56	-9.54	35.55	500
Pk	3658.75	51.64	3.4	31.7	35.6	51.14	-9.54	120.19	5000
Av	3658.75	50.25	3.4	31.7	35.6	49.75	-9.54	102.42	500
Pk	7317.52	46.45	4.8	36.3	36.1	51.45	-9.54	124.56	5000
Av	7317.52	44.02	4.8	36.3	36.1	49.02	-9.54	94.16	500

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Test Details: EUT Operating @ 927.0 MHz									
DET	**FREQ. (MHz)**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (µV/m)**	**LIMIT (µV/m)**
Pk	1853.38	52.22	2.6	27.3	36.3	45.82	-9.54	65.14	5000
Av	1853.38	50.24	2.6	27.3	36.3	43.84	-9.54	51.87	500
Pk	3706.75	51.22	3.4	31.9	35.6	50.92	-9.54	117.19	5000
Av	3706.75	49.69	3.4	31.9	35.6	49.39	-9.54	98.26	500
Pk	7413.511	45.69	4.8	36.5	36.1	50.89	-9.54	116.78	5000
Av	7413.511	43.42	4.8	36.5	36.1	48.62	-9.54	89.92	500

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

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 and Appendix B.

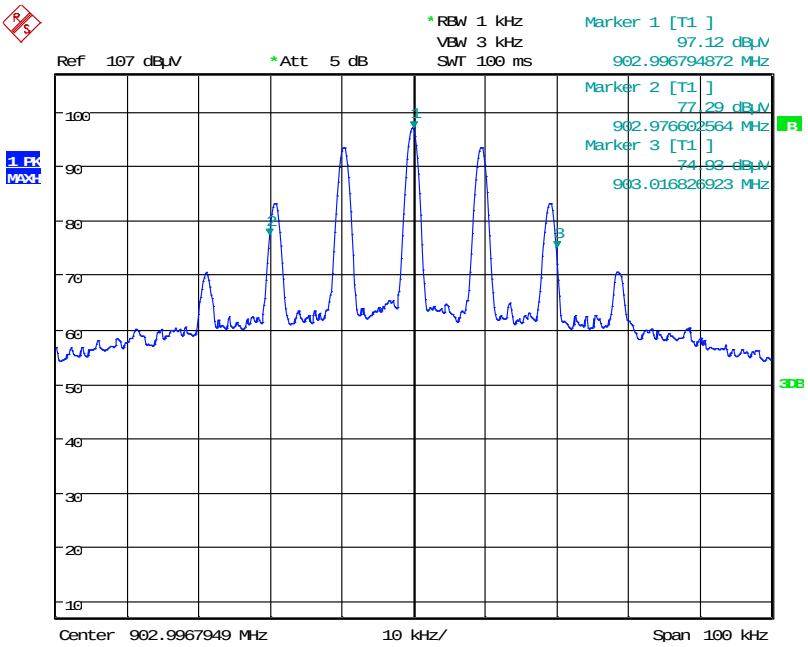
(b) The time and date on the plots do not necessarily equate to the time of the test.

(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.

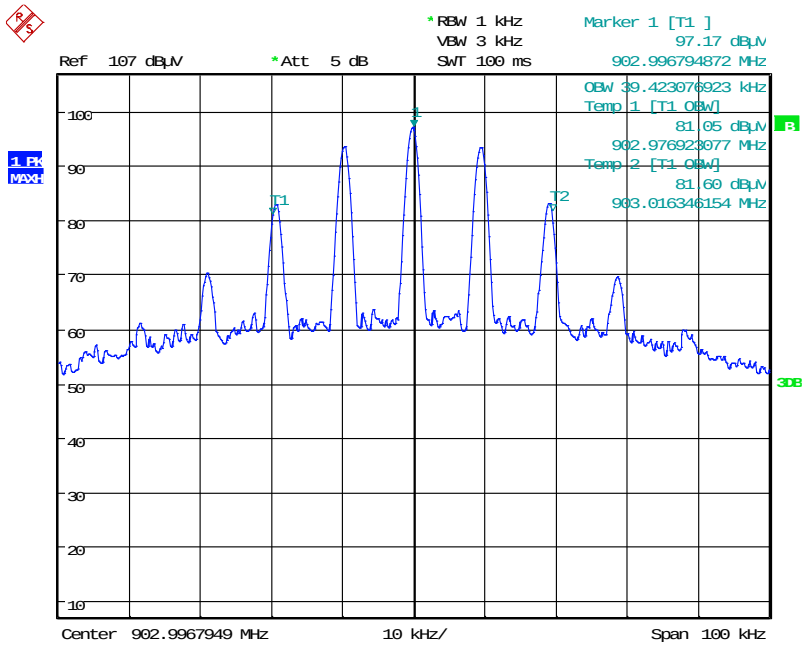
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.

Fc = 903.0



Date: 5.AUG.2013 11:32:14

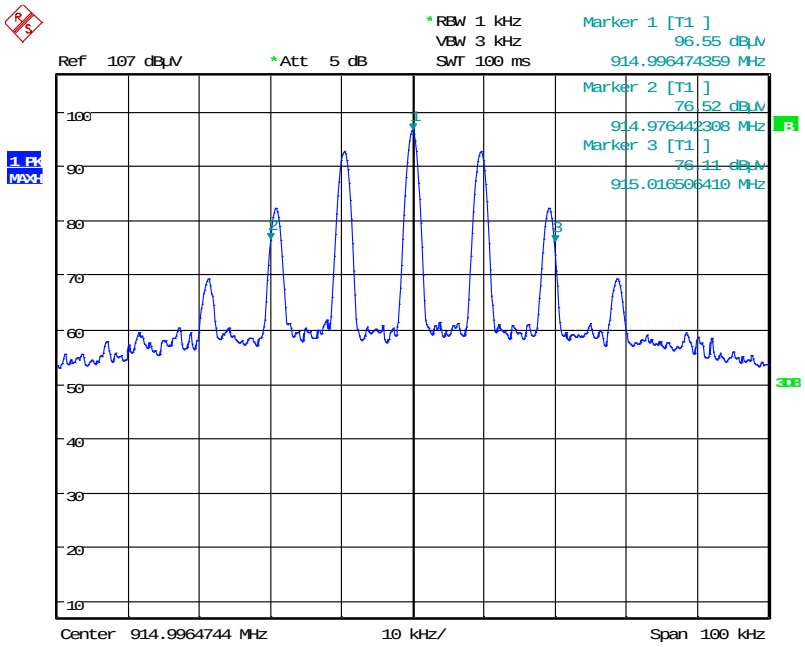
20dB Bandwidth



Date: 5.AUG.2013 11:32:28

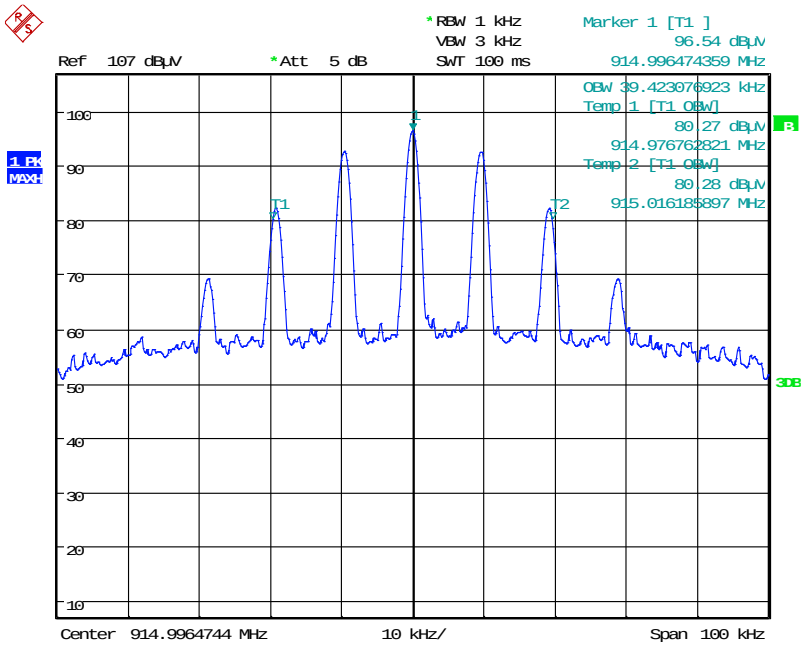
99% Bandwidth

Fc = 915.0



Date: 5.AUG.2013 11:34:03

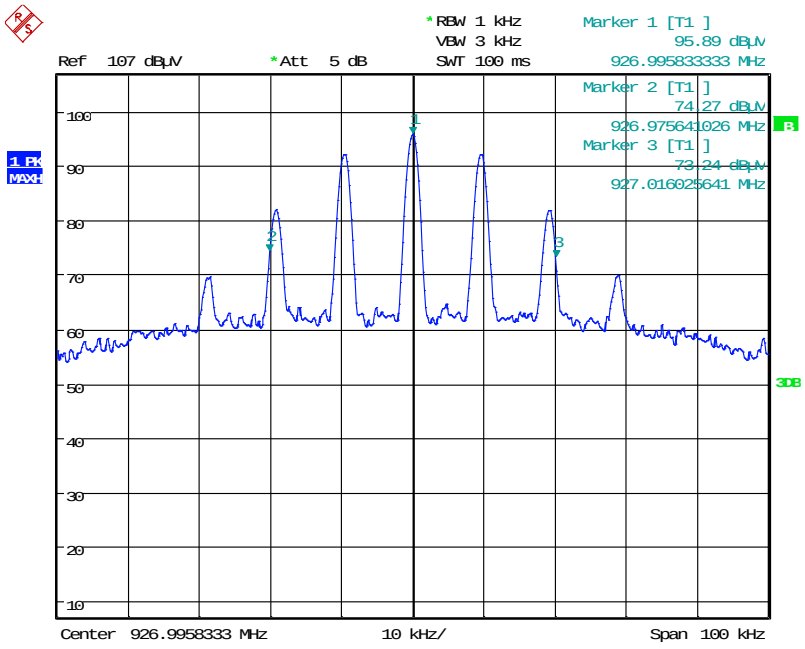
20dB Bandwidth



Date: 5.AUG.2013 11:33:36

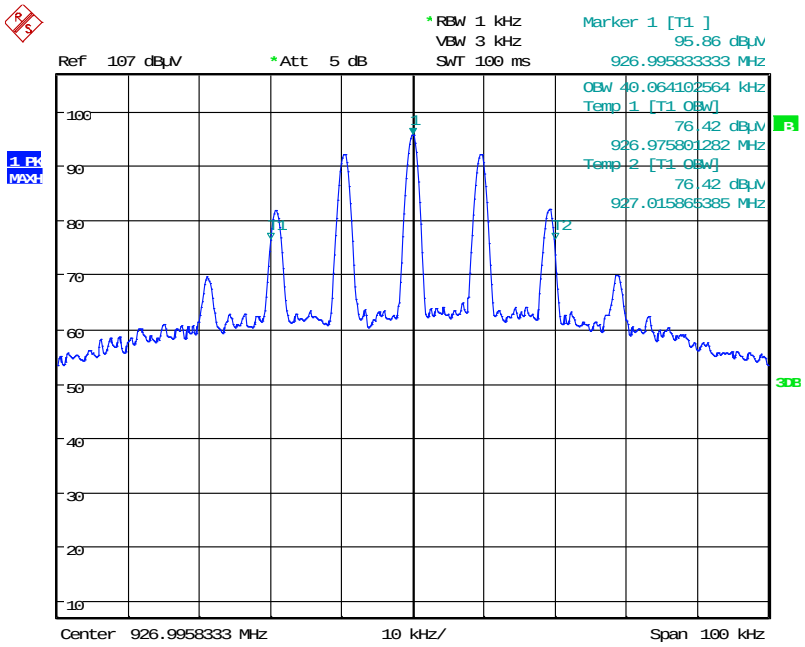
99% Bandwidth

Fc = 927.0



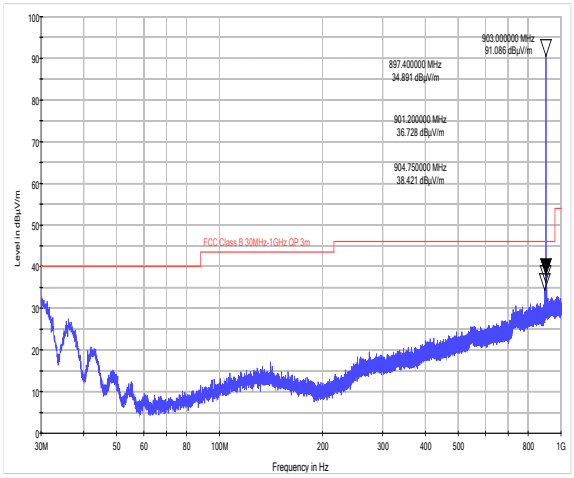
Date: 5.AUG.2013 11:35:14

20dB Bandwidth

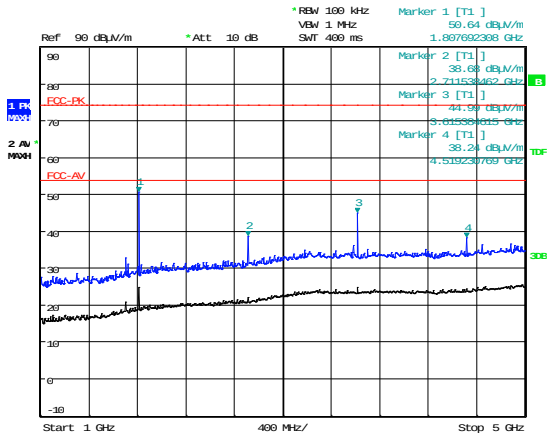


Date: 5.AUG.2013 11:35:49

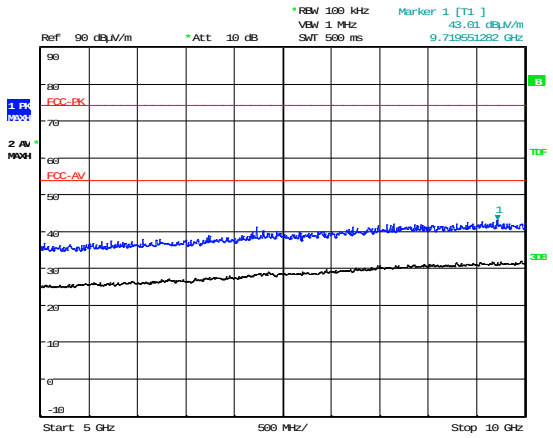
99% Bandwidth



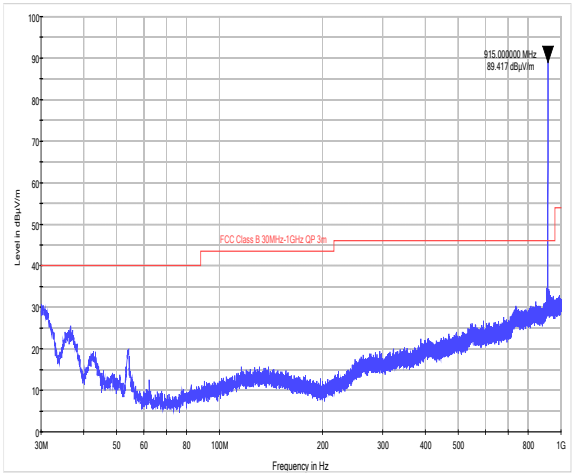
Fc = 903.0 Radiated spurious emissions 30 MHz to 1 GHz



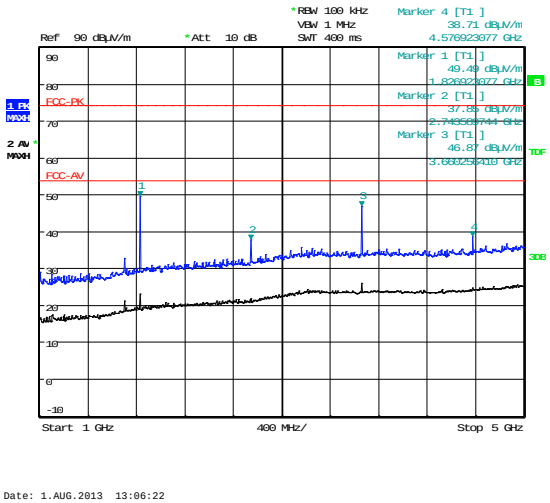
Fc = 903.0 Radiated spurious emissions 1 GHz to 5 GHz



Fc = 903.0 Radiated spurious emissions 5 GHz to 10 GHz

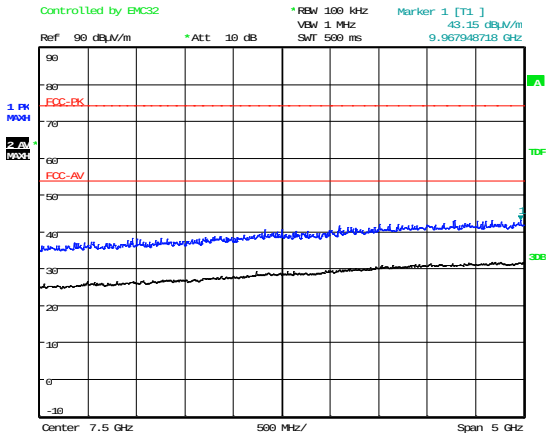


Fc = 915.0 Radiated spurious emissions 30 MHz to 1 GHz



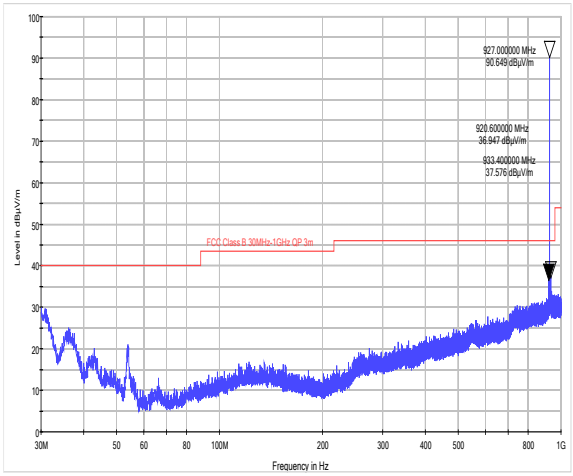
Date: 1.AUG.2013 13:06:22

Fc = 915.0 Radiated spurious emissions 1 GHz to 5 GHz

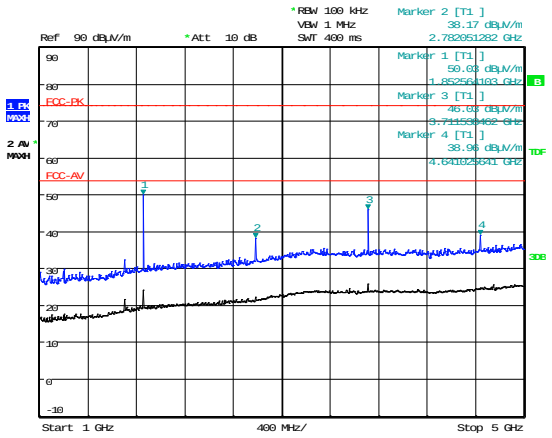


Date: 1.AUG.2013 13:08:20

Fc = 915.0 Radiated spurious emissions 5 GHz to 10 GHz

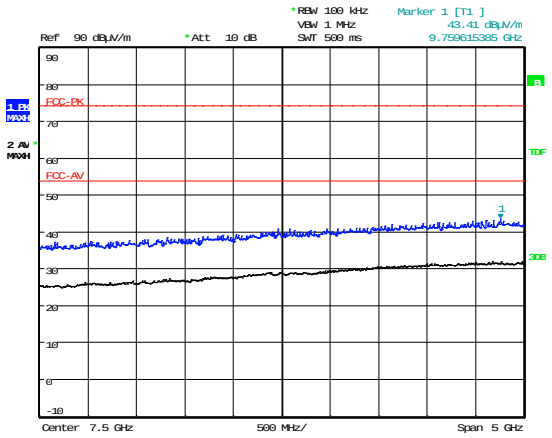


Fc = 927.0 Radiated spurious emissions 30 MHz to 1 GHz



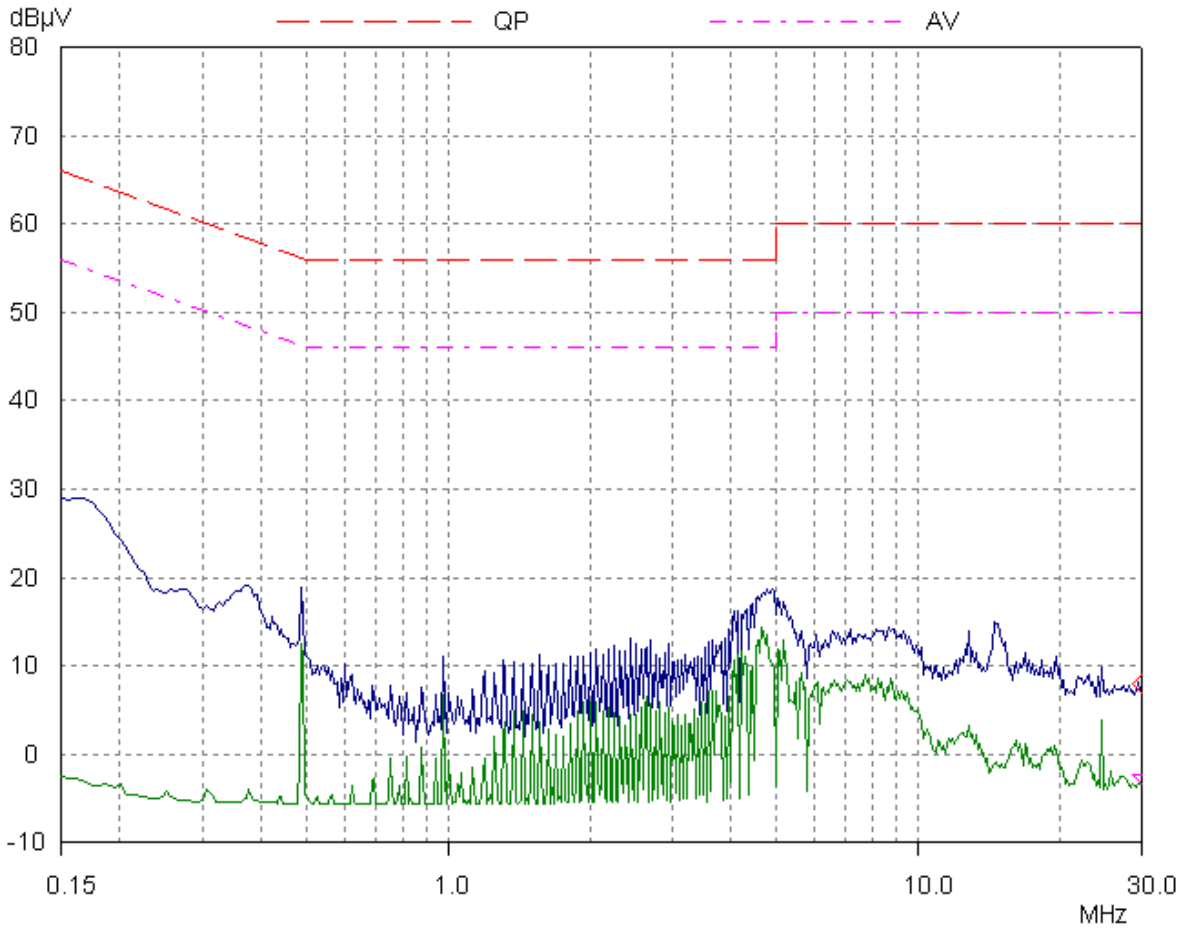
Date: 1.AUG.2013 13:22:53

Fc = 927.0 Radiated spurious emissions 1 GHz to 5 GHz

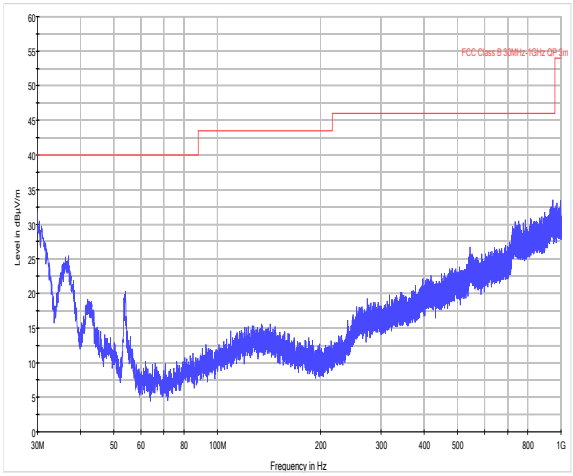


Date: 1.AUG.2013 13:18:41

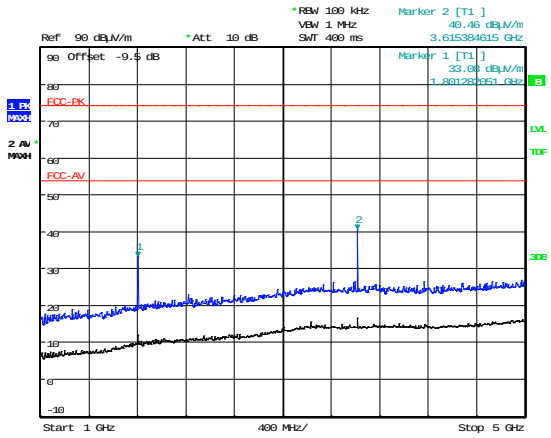
Fc = 927.0 Radiated spurious emissions 5 GHz to 10 GHz



AC Powerline Conducted Emissions

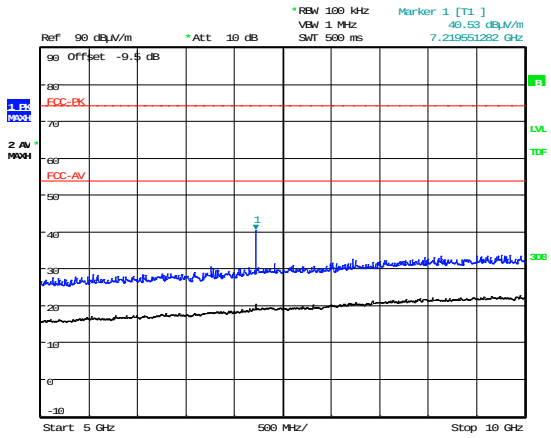


Fc = 903.0 Unintentional Radiated spurious emissions 30 MHz to 1 GHz



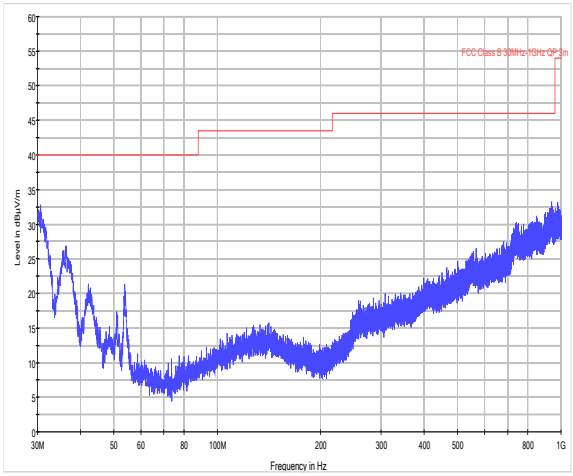
Date: 2.AUG.2013 10:16:22

Fc = 903.0 Unintentional Radiated spurious emissions 1 GHz to 5 GHz

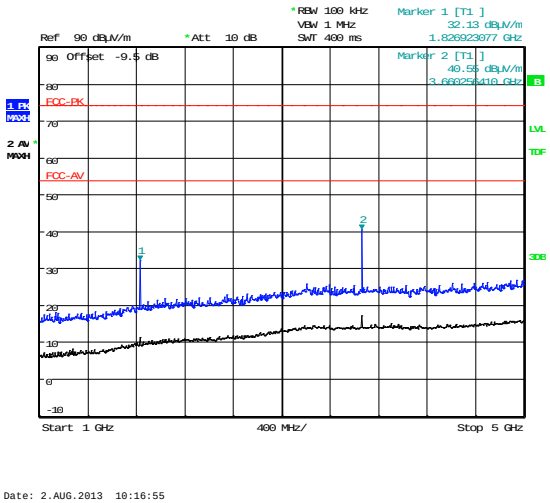


Date: 2.AUG.2013 10:15:32

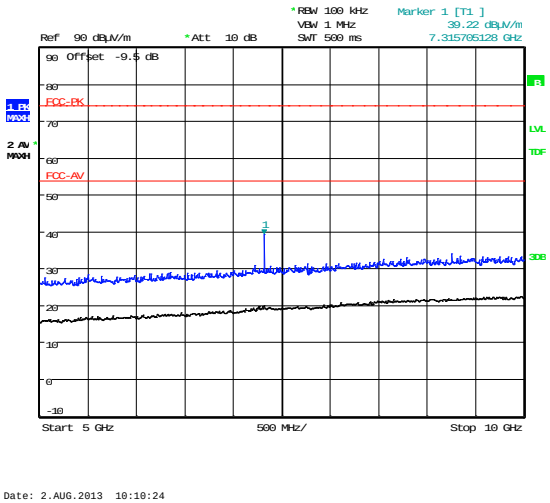
Fc = 903.0 Unintentional Radiated spurious emissions 5 GHz to 10 GHz



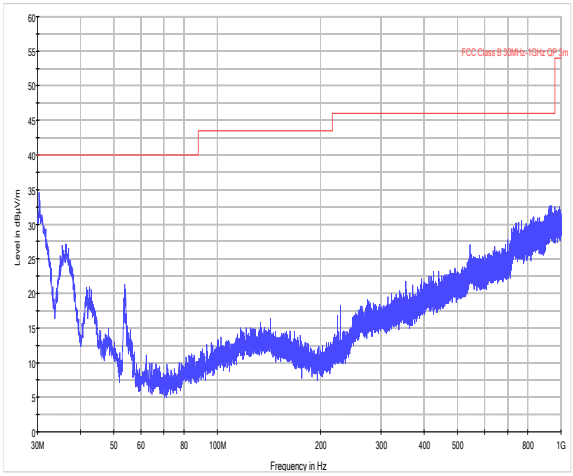
Fc = 915.0 Unintentional Radiated spurious emissions 30 MHz to 1 GHz



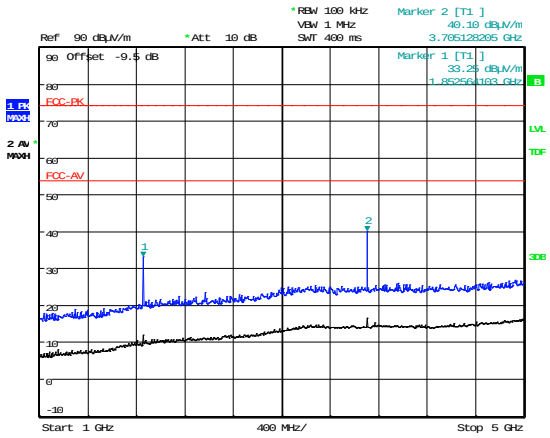
Fc = 915.0 Unintentional Radiated spurious emissions 1 GHz to 5 GHz



Fc = 915.0 Unintentional Radiated spurious emissions 5 GHz to 10 GHz

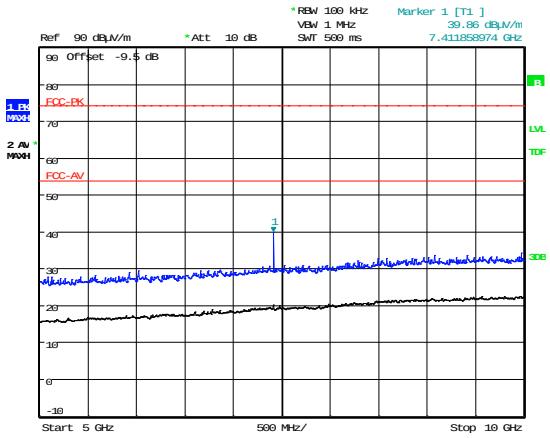


Fc = 927.0 Unintentional Radiated spurious emissions 30 MHz to 1 GHz



Date: 2.AUG.2013 10:18:03

Fc = 927.0 Unintentional Radiated spurious emissions 1 GHz to 5 GHz



Date: 2.AUG.2013 10:19:22

Fc = 927.0 Unintentional Radiated spurious emissions 5 GHz to 10 GHz

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. S01
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
S04	ERA900TRS Mounted into Development board.	01FFD1
S05	ANT900MS	None
S06	ANT-WP915SMA-Y	None
S07	ANT-RP915SMA-Y	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode:
Carrier power Radiated Spurious Emissions Bandwidth	EUT active Transmitting on top middle and bottom channel as required. EUT set to used worst case modulation scheme GFSK, 19200 bps data rate , 9.9kHz deviation, 100kHz channel Spacing

Test	Description of Operating Mode:
Unintentional radiated spurious emissions	EUT active but non-transmitting on the top, middle or bottom channel as required

Test	Description of Operating Mode:
PLCE	EUT active but non-transmitting EUT Active and transmitting EUT set to channel producing highest power

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 : S04
Tests : Radiated Emissions

ERA900-TRS Connections
EUT mounted into development PCB.
Pins 2-9 from ERA900-TRS Module connected to Development Board
Pin 1 Removed.
Integral U-FL connector used for RF output connection to antenna.

Development PCB connections
USB connector to Laptop for setup*
USB connector to PSU

* Only connected during setup.

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	08/05/2013	12	08/05/2014
UH004	ESVS10	Receiver	R&S	11/02/2013	12	11/02/2014
UH028	UHALP 9108	Log Periodic Ant	Schwarbeck	08/07/2013	24	08/07/2015
UH29	VHBA 9123	Bicone Antenna	Schwarbeck	19/08/2013	24	19/08/2015
UH093	CBL6112B	Bilog	Chase	08/07/2013	24	08/07/2015
UH096	6960B	Power meter	Marconi	04/11/2012	12	04/11/2013
UH122	TDS520B	Oscilloscope	Tektronix	11/04/2012	24	11/04/2014
UH129	6924	Power Sensor	Marconi	03/12/2012	12	03/12/2013
UH187	ESHS10	Receiver	R&S	11/02/2013	12	11/02/2014
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
UH195	ESH3-Z5.831.5	Lisn	R&S	03/07/2013	12	03/07/2014
UH228	6920	Power Sensor	Marconi	03/12/2012	12	03/12/2013
UH281	FSU46	Spectrum Analyser	R&S	06/03/2013	12	06/03/2014
UH385	HL 050	Log Periodic Antenna	R&S	16/07/2012	24	16/07/2014
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	12	04/07/2014
UH388	ATS	Chamber 2	Rainford EMC	04/07/2013	12	04/07/2014
UH396	ENV216	Lisn	R&S	30/04/2013	12	30/04/2014
UH403	ESCI 7	Recevier	R&S	12/08/2013	12	12/08/2014
UH405	FSU26	Spectrum Analyser	R&S	20/03/2013	12	20/03/2014
UH420	CBL6112	Bilog	Chase	06/07/2012	24	06/07/2014
L005	CMTA52	Communications Analyser	R&S	27/03/2013	12	27/03/2014
L007	hfh2	Loop Antenna	R&S	17/10/2013	24	17/10/2015
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L139	3115	1-18GHz Horn	EMCO	20/09/2013	24	20/09/2015
L176	2042	Signal Generator	Marconi	20/11/2012	12	20/11/2013
L254	2042	Signal Generator	Marconi	19/12/2012	12	19/12/2013
L193	VHA 9103 balu	Bicone Antenna	Chase	19/06/2012	24	19/06/2014
L203	UPA6108	Log Periodic Ant	Chase	19/06/2012	24	19/06/2014
L263/A	20240-20	Horn 18-26GHz	Flann	17/11/2011	24	17/11/2013
L290	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	17/11/2011	24	17/11/2013
L317	ESVS10	Receiver	R&S	09/01/2013	12	09/01/2014
L415	ESVS20	Receiver	R&S	27/08/2013	12	27/08/2014
L426	52 Series II	Temperature Indicator	Fluke	29/04/2013	12	29/04/2014
L572	8449B	Pre Amp	Agilent	12/12/2012	24	12/12/2014
REF909	FSU26	Spectrum Analyser	R&S	04/02/2013	12	04/02/2014
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	12	09/07/2014
REF976	34405a	Multimeter	Agilent	26/04/2013	12	26/04/2014
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015

Appendix D: **Additional Information**

LPRS **ANT-900MS/MR**

ANT-900MS/MR

868-915MHz flexible ¼ wave whip Antenna

Electrical Specifications	
Frequency Range	868-915MHz
Nominal Impedance	50 Ω
Maximum Input Power	50W
Gain	3dBi
Radiation	Omni-directional
Polarization	Vertical
VSWR	≤1.5
Connector	SMA male straight or right angled

Mechanical Specifications	
Radiator material	Copper
Antenna cover	Plastic
Antenna dimensions	110mm x 10mm (MS) Straight 95mm x 10mm (MR) Right Angle
Antenna weight	9g (MS) 10g (MR)
Working Temp	-20°C to 85°C
Storage Temperature	-40°C to 90°C

Order Code	ANT-900MS ANT-900MR

Accessories	
Description	**Order Code**
PCB mount SMA connector	SMACONNECTOR
Right angled PCB mount SMA connector	SMARACONNECTOR
SMA bulkhead Jack	SMAENDBLKHD-JK
U.FL to SMA female jack 100mm	ARW-CAB-SMA-UFL-10

ANT-900MS_MR V1.2 www.lprs.co.uk LPRS 2012

LPRS

ANT-WP915SMA-Y

ANT-WP915SMA-Y

902-928MHz Waterproof Whip Antenna

Electrical Specifications	
Frequency Range	902-928MHz
Nominal Impedance	50 Ω
Maximum Input Power	50W
Polarization	Vertical
Radiation Pattern	Omni
Gain	2.5dBi
VSWR	≤1.5
Connector	SMA Male

Mechanical Specifications	
Material	Thermoplastic Polyester Elastomer TPEE
Antenna dimensions	90mm x 12mm
Antenna weight	11g
Ambient Temperature	-40°C to 60°C

Order Code	ANT-WP915SMA-Y

Accessories	
Description	**Order Code**
PCB mount SMA connector	SMACONNECTOR
Right angled PCB mount SMA connector	SMARACONNECTOR
SMA bulkhead Jack	SMAENDBLKHD-JK
U.FL to SMA female jack 100mm	ARW-CAB-SMA-UFL-10

LPRS

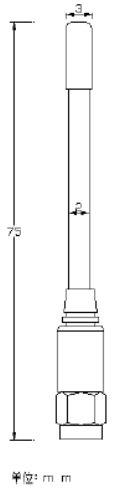
ANT-RP915SMA-Y

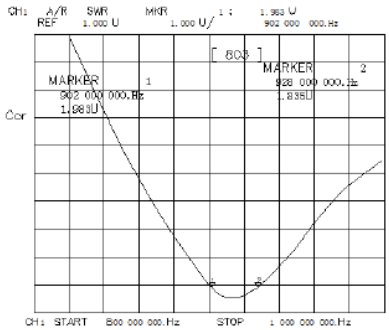
ANT-RP915SMA-Y

902-928MHz Reverse Polarity SMA Antenna

Electrical Specifications	
Frequency Range	902-928MHz
Nominal Impedance	50 Ω
Maximum Input Power	20W
Polarization	Vertical
Radiation Pattern	Omni
Gain	2dB
VSWR	≤1.2
Connector	RP SMA

Mechanical Specifications	
Material	Rugged Antenna
Antenna dimensions	75mm x 8mm
Antenna weight	5g
Ambient Temperature	-40°C to 60°C





Order Code	ANT-RP915SMA-Y

Version	Date	Revision	Known Issues
V1.0	18/03/2013	Initial release	

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 was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plot of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths 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 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was 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)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

$$\text{Duty cycle} = \frac{\text{the sum of the highest average value pulsewidths over 100ms}}{100\text{ms}}$$

e.g.

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

0.07459 or 7.459%

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

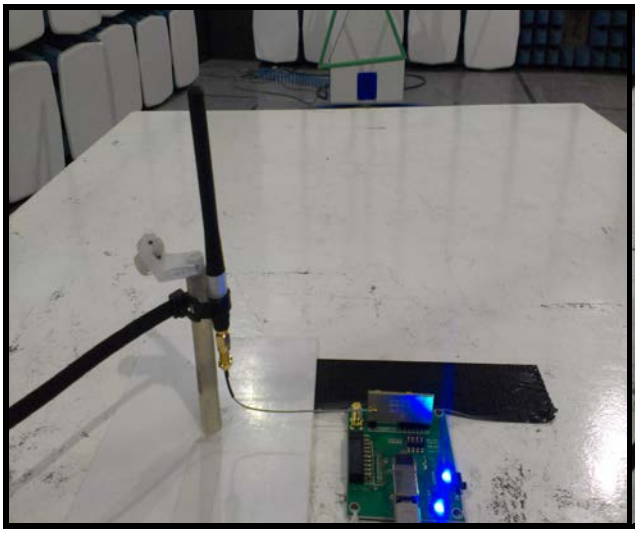
Duty cycle correction may not be applicable / required by the device covered in this report.
The correction factor above is for example of how the correction is calculated.
Any applicable duty cycle used will be recorded in the relevant results sections of this report.

Appendix F: Photographs and Figures

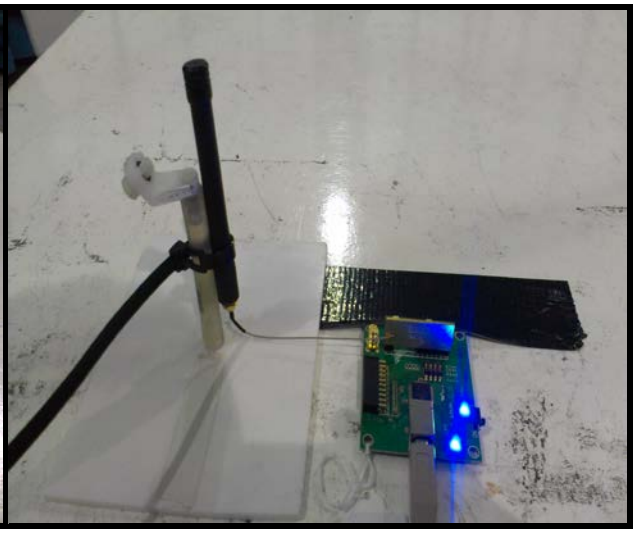
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Overview.
2. Radiated electric field emissions arrangement: close up 3dBi Antenna.
3. Radiated electric field emissions arrangement: close up Waterproof Antenna.
4. Radiated electric field emissions arrangement: close up R-SMA Antenna.
5. Radiated electric field emissions arrangement: close up ¼ Wave Antenna.
6. AC Powerline emissions arrangement: Overview.

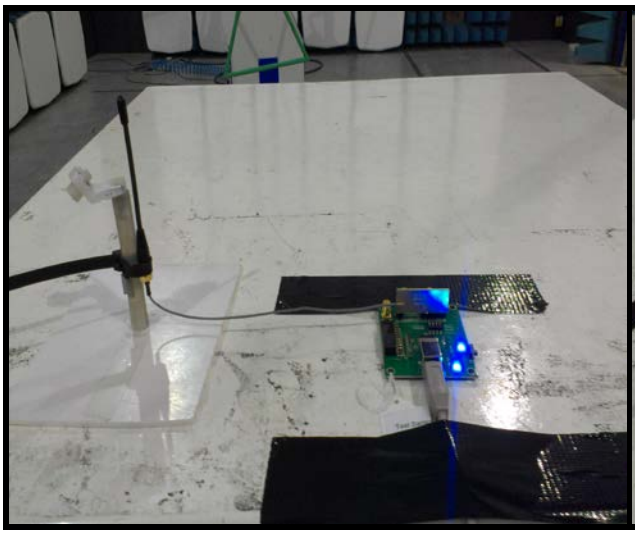
Photograph 1



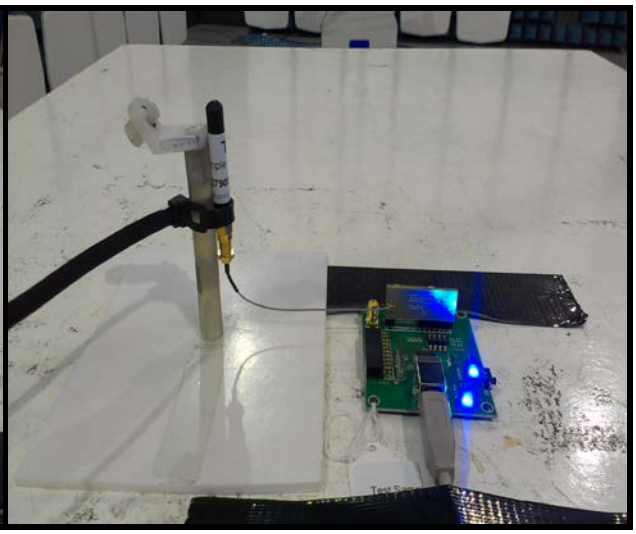
Photograph 2 - 3dBi Antenna



Photograph 3 – Waterproof Antenna



Photograph 4 – R-SMA Antenna



Photograph 5 – ¼ Wave Antenna

Photograph 6

Appendix G: MPE Calculation

OET Bulletin No. 65, Supplement C 01-01

47 CFR §§1.1307 and 2.1091 – RSS-102

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

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 centimetres 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 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 0.61mW/cm^2 or 6.1 W/m^2 power density limit, as required.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01 / 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 measurement was performed using a signal substitution method.

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.61mW/cm^2
915	0.558	0.61	0.27

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