Radio Test report

FOR

Tunstall Healthcare (UK) Ltd.

ON

312MHz Ei UL Smoke Alarm

DOCUMENT NO. TRA-012941-W-US-01

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TRaC Radio Test Report	**:** TRA-012941-W-US-01
Applicant	**:** Tunstall Healthcare (UK) Ltd.
Apparatus	**:** 312MHz Ei UL Smoke Alarm
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Contents

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: 19/02/13 to 21/02/13

312MHz Ei UL Smoke Alarm

The above equipment was a battery powered smoke alarm that combined a 312MHz transmitter.

1.5 Results Test 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
Radiated Carrier Power	Title 47 of the CFR: Part 15 Subpart (c) 15.231(b)	ANSI C63.10:2009	Pass
Radiated spurious emissions (None and Restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.231(b), 15.205 and 15.209	ANSI C63.10:2009	Pass
Emission Bandwidth	Title 47 of the CFR : Part 15 Subpart (c) 15.231(c)	ANSI C63.10:2009	Pass
Manual Operated Transmitter	Title 47 of the CFR : Part 15 Subpart (c) 15.231(a)(1)	-	Pass
Automatically Activated	Title 47 of the CFR : Part 15 Subpart (c) 15.231(a)(2)	-	Pass
AC Power conducted Emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.207	ANSI C63.10:2009	N/A
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	ANSI C63.4:2009	Pass
AC Power conducted Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.107	ANSI C63.4:2009	N/A
Bandwidth of Momentary Signals (99% OBW)	RSS-210 Issue 8 December 2010 RSS-Gen 4.6.1 Issue 3 December 2010	RSS-210 Issue 8 December 2010: A1.1.3	N/A

Abbreviations used in the above table:

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

Mod	: Modification	ANSI	: American National Standards Institution
CFR	: Code of Federal Regulations	PLCE	: Power Line Conducted Emissions
REFE	: Radiated Electric Field Emissions	N/A	Not Applicable

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

The following page contains the measurement uncertainties for measurements

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.

Test type	Quantity	Quantity frequency range	Uncertainty
Radiated electric field emissions 3m alternative test site Effective Radiated Power 3m alternative test site	Amplitude	30MHz to 300MHz Horizontal	±4.6dB
		30MHz to 300MHz Vertical	±5.1dB
		300MHz to 1000MHz Horizontal	±5.2dB
		300MHz to 1000MHz Vertical	±5.5dB
		1GHz to 26.5GHz Horizontal and Vertical	±4.1dB
Conducted emissions		N/A	±0.9 dB
Absolute RF power (via antenna connector)		N/A	±0.9 dB
PSD		N/A	±0.9 dB
Frequency Range	Frequency	dc to 26.5GHz	3.611kHz

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
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
CDN	: Coupling & decoupling network

A1 Radiated Fundamental Carrier Power

Carrier power was verified with the EUT transmitting on its centre carrier frequency of 312MHz. The formal measurement/s are detailed below:

Test Details: Transmit mode	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.231(b)
Measurement standard	ANSI C63.10:2009
Frequency range	312MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	ANT FACT. (dB/m)	CABLE LOSS (dB)	Measurement distance (m)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	311.996	QP	59.0	13.2	1.1	3	73.3	0	73.3	75.44	-2.14

Notes:

1 As per Radio – Noise Emissions, ANSI C63.10
2 Measuring distances 3m
3 EUT 0.8 metre above ground plane
4 Testing was performed with the EUT orientated in three orthogonal planes, the fundamental carrier (fc) emission was maximised by rotation of EUT, on an automatic turntable and raising and lowering the receiver antenna between 1m & 4m in both Horizontal and vertical polarisations and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
5 The receiver detector at the fundamental carrier (fc) was performed with CISPR16 compliant test receiver with QP detector using a 120kHz RBW
6 Results quoted are extrapolated as indicated.
7 When battery powered the EUT was powered with new batteries

Limits

Radiated Fundamental Field strength limits 47 CFR PART15: Clause 15.231(b)

Fundamental Frequency (MHz)	Field strength of Fundamental (μV/m)	Field strength of spurious emissions (μV/m)	Measurement Distance (m)
40.66-40.70	2250	225	3
70-130	1250	125	3
130-174	[1]1250-3750	[1]125-375	3
174-260	3750	375	3
260-470	**[1]3750-12500**	[1]375-1250	**3**
Above 470	12500	1250	3

[1]As per ANSI C63.10:2009, clause 7.6.2 the limit at the frequency of interest was calculated by linearly-interpolating using the slope-intercept formula:

$$y = mx + b \equiv$$

$$Limit[\mu V/m] = Lim_{lower} + \left[\Delta F \left| \frac{(Lim_{upper} - Lim_{lower})}{(f_{upper} - f_{lower})} \right|\right]$$

The fundamental field strength limit was determined using the table above and linearly-interpolating the limit based on a carrier frequency of 312MHz.

$$Limit[\mu V/m] = 3750 + \left[(312-260)\left|\frac{(12500-3750)}{(470-260)}\right|\right] = 3750 + \left[52 \times \left|\frac{8750}{210}\right|\right]$$

$$Limit[\mu V/m] = 3750 + [52 \times 41.6667] =$$

$$Limit[\mu V/m] = 5916.6684$$

or

$$dB\mu V/m = 20\log 5916.6684 = 75.44 dB\mu V/m$$

Where:

Lim_{lower} = is the limit at the lower frequency of the intended band of operation
Lim_{upper} = is the limit at the upper frequency of the intended band of operation
f_{lower} = is the lower frequency of the intended band of operation
f_{upper} = is the upper frequency of the intended band of operation
$\Delta F = f_c - f_{lower}$
F_c = Center frequency of the emission signal

The limit in dBμV/m is determined by $20\log(Limit[\mu V/m])$

(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:

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

(b) The results displayed take into account applicable antenna factors and cable losses.

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

(d) 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

A2 Radiated Electric Field Emissions 15.231(b), general limits 15.209 and 15.205 Restricted Band

Preliminary emission testing was performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to all spurious emissions and harmonics that fall within the restricted bands listed in Section 15.205. The maximum permitted field strength is listed in Section 15.231(b) and 15.209. The EUT was set to transmit on its fundamental centre frequency at maximum power. The formal measurements are detailed below:

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

10m open area test site : ☐ 3m alternative test site : ☑

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

Test Details: Transmit mode	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.231(b), general limits of 15.209 and restricted band emissions clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 3120MHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

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

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	PRE AMP (dB)	ANT FACT. (dB/m)	CABLE LOSS (dB)	Measurement distance (m)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1.	1559.984	Pk	48.6	34.17	26.0	3.0	1	43.4	-9.5	33.9	74.0	-40.1
2.	1559.984	Av	42.8	34.17	26.0	3.0	1	37.6	-9.5	28.1	54.0	-25.9
3.	1871.984	Pk	48.2	34.09	27.5	3.3	1	44.9	-9.5	35.4	75.44	-40.04
4.	1871.984	Av	43.04	34.09	27.5	3.3	1	39.8	-9.5	30.3	55.44	-25.14

Note

1. No Duty cycle correction was applied to the final result.

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1

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= 100 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=VBW= 1MHz
Average	RBW=VBW= 1MHz

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

Limits

Radiated emission limits 47 CFR PART15: Clause 15.231 (b)

Fundamental Frequency (MHz)	Field strength of Fundamental (μV/m)	Field strength of spurious emissions (μV/m)	Measurement Distance (m)
40.66-40.70	2250	225	3
70-130	1250	125	3
130-174	[1]1250-3750	[1]125-375	3
174-260	3750	375	3
260-470	[1]3750-12500	**[1]375-1250**	**3**
Above 470	12500	1250	3

[1]As per ANSI C63.10:2009, clause 7.6.2 the limit at the frequency of interest was calculated by linearly-interpolating using the slope-intercept formula:

$y = mx + b \equiv$

$$Limit[\mu V/m] = Lim_{lower} + \left[\Delta F \left| \frac{(Lim_{upper} - Lim_{lower})}{(f_{upper} - f_{lower})} \right|\right]$$

The spurious emissions field strength limit was determined using the table above and linearly-interpolating the limit based on a carrier frequency of 312MHz.

$$Limit[\mu V/m] = 375 + \left[(312-260)\left|\frac{(1250-375)}{(470-260)}\right|\right] = 375 + \left[52 \times \left|\frac{875}{210}\right|\right]$$

$$Limit[\mu V/m] = 375 + [52 \times 4.16667] = 591.67$$

$$Limit[\mu V/m] = 591.67$$

or

$$dB\mu V/m = 20\log 591.67 = 55.44 dB\mu V/m$$

Where:

Lim_{lower} = is the limit at the lower frequency of the intended band of operation
Lim_{upper} = is the limit at the upper frequency of the intended band of operation
f_{lower} = is the lower frequency of the intended band of operation
f_{upper} = is the upper frequency of the intended band of operation
$\Delta F = f_c - f_{lower}$
F_c = Center frequency of the emission signal

The limit in dBμV/m is determined by $20\log(Limit[\mu V/m])$

Spurious emissions in the above table are base on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or alternatively, CISPER quasi peak) limits shown in the table above, or to the general limits shown in 47 CFR Part15: Clause 15.209, in the table below, whichever limit permits the higher field strength.

Radiated emission limits (47 CFR Part 15: Clause 15.209) are the general emission limits and emission limits falling within the restricted bands defined in 15.205(a):

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:

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

(b) The results displayed take into account applicable antenna factors and cable losses.

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

(d) 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

A3 20 dB Bandwidth

Title 47 of the CFR 47 Part 15 Subpart (c) 15.231(c) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The formal measurements are detailed below:

Test Details: Transmit mode	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.231(c)
Measurement standard	ANSI C63.10:2009
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Fundamental Carrier Frequency (MHz)	Fl (MHz)	Fh (MHz)	Measured 20 dB Bandwidth (kHz)	Limit (kHz)	Result
312.000	311.996452564	312.003444231	6.991666666	780.0	Pass

Limits

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

EUT Operating Center frequency = 312.0MHz:

Therefore the limit is 0.25% of 312.0MHz:

0.25% of 312.0MHz = $\frac{312 \times 10^6}{100} \times 0.25 = 780.0kHz$

Plots of the 20 dB bandwidth and channel spacing are contained in Appendix B of this test report.

A4 Manual Operated Transmitter

Title 47 of the CFR 47 Part 15 Subpart (c) 15.231(a)(1) requires confirmation/measurement that a manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. The formal measurements are detailed below:

Test Details: Device in Manual Operated Transmit	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.231(a)(1)
Measurement standard	ANSI C63.10:2009
Frequency range	312MHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Fundamental Carrier Frequency (MHz)	Measured Pulse Train Activation Time (s)	Limit (s)	Result
312.000	1.660256	≤ 5	Pass

Limits

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

A5 Automatically Activated Transmitter

Title 47 of the CFR 47 2012 Part 15 Subpart (c) 15.231(a)(2) requires confirmation/measurement that a transmitter activated automatically shall cease transmission within 5 seconds after activation.

Please note that the client has declared compliance to Title 47 of the CFR 47 2012 Part 15 Subpart (c) 15.231(a)(2) as the device under test did not permit the functionality at the time of test.

Limits

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

A6 ac Power Line Conducted Emissions 15.207

The device under test was battery powered only. Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. CFR 47 Part 15 Subpart (c) Clause 15.207(c)

A7 Unintentional Radiated Electric Field Emissions - 15.109

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The maximum permitted field strength is listed in Section 15.109. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

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 : ☑

Test Details: Device in Idle mode	
Regulation	CFR 47 Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.4:2009
Frequency range	30MHz to 10 GHz
EUT sample number	S01, S02 and S03
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1, 2

The worst case radiated emission measurements for spurious emissions in idle mode

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	PRE AMP (dB)	ANT FACT. (dB/m)	CABLE LOSS (dB)	Measurement distance (m)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1.	31.000	QP	21.9	28.0	17.8	0.5	3	12.2	0	12.2	40.0	-27.8
2.	48.000	QP	21.8	27.9	8.6	0.5	3	3.0	0	3.0	40.0	-37.0
3.	150.000	QP	21.6	27.7	11	0.7	3	5.6	0	5.6	43.5	-37.9
4.	266.000	QP	21.5	27.1	13.3	1.3	3	9.0	0	9.0	46.5	-37.5
5.	500.000	QP	22.8	28.5	18	1.6	3	13.9	0	13.9	46.5	-32.6
6.	800.000	QP	22.8	28.5	22.2	2.0	3	18.5	0	18.5	46.5	-28.0

A8 ac Power Line Conducted Emissions 15.107

The device under test was battery powered only. Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines as. CFR 47 Part 15 Subpart (b) Clause 15.107(d)

A9 99% Occupied Bandwidth

Measurement of the occupied bandwidth of the transmission was verified using a spectrum analyser with a 99% occupied bandwidth measuring option installed. The RBW was set to 1% (100kHz) of the selected span (10MHz), and a VBW three times greater than the RBW. The spectrum analyser was then set to take a max hold measurement using a sample detector. The EUT was set to transmit on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details:	
Regulation	RSS-210 Issue 8 December 2010 RSS-Gen 4.6.1 Issue 3 December 2010
Measurement standard	RSS-210 Issue 8 December 2010: A1.1.3 Bandwidth of Momentary Signals
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Fundamental Carrier Frequency (MHz)	Measured 99% Bandwidth (kHz)	Limit (kHz)	Result
312.000	6.7	N/A	N/A

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

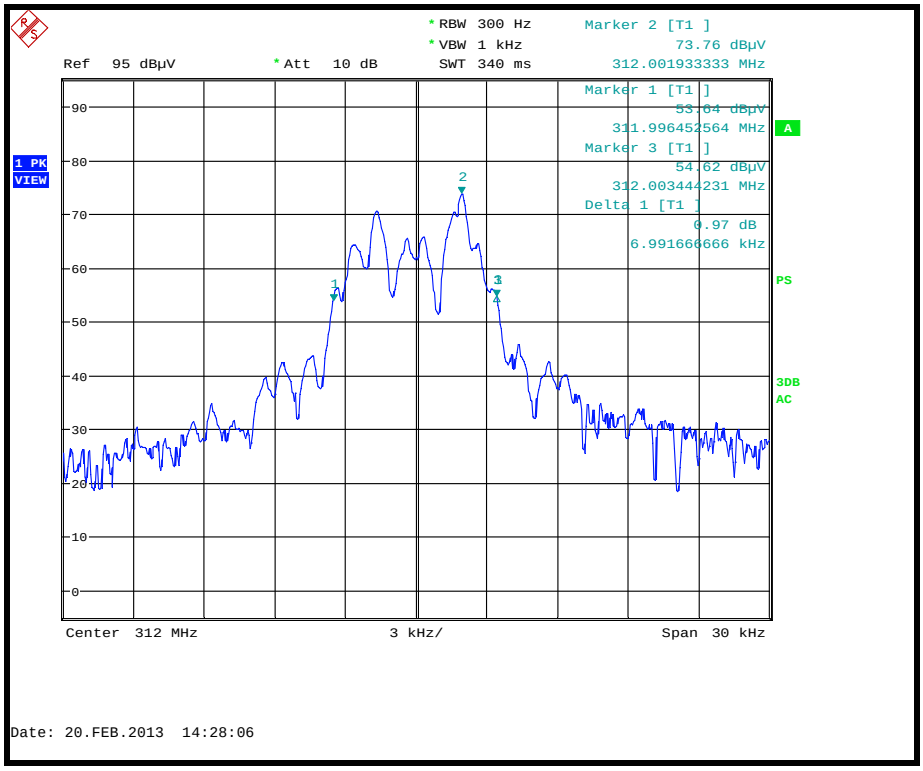
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

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

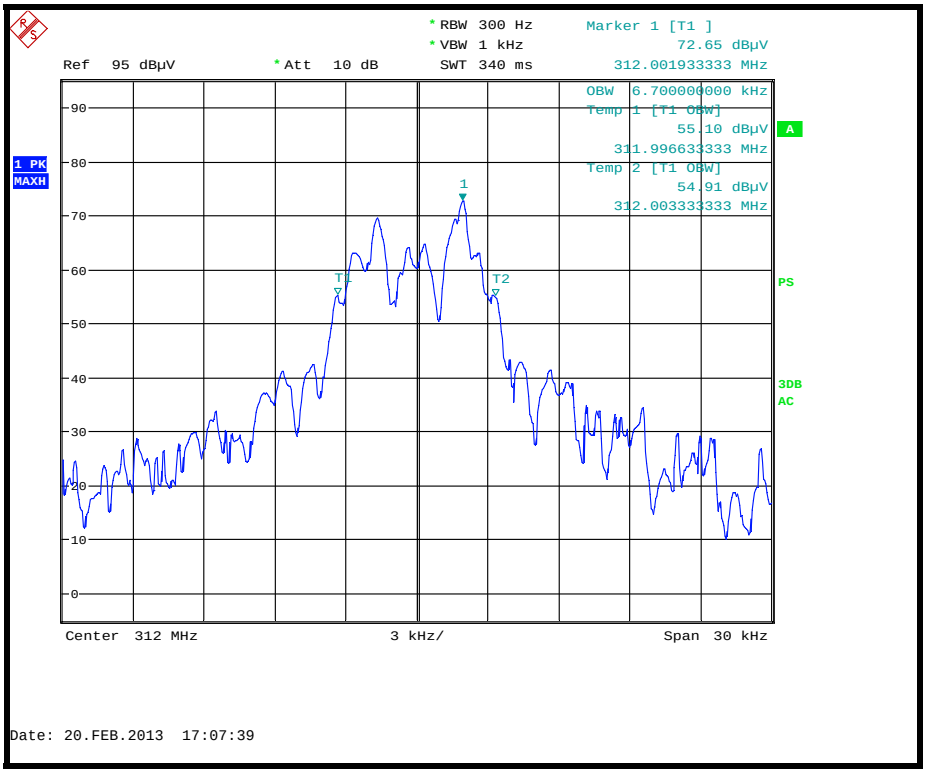
(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

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

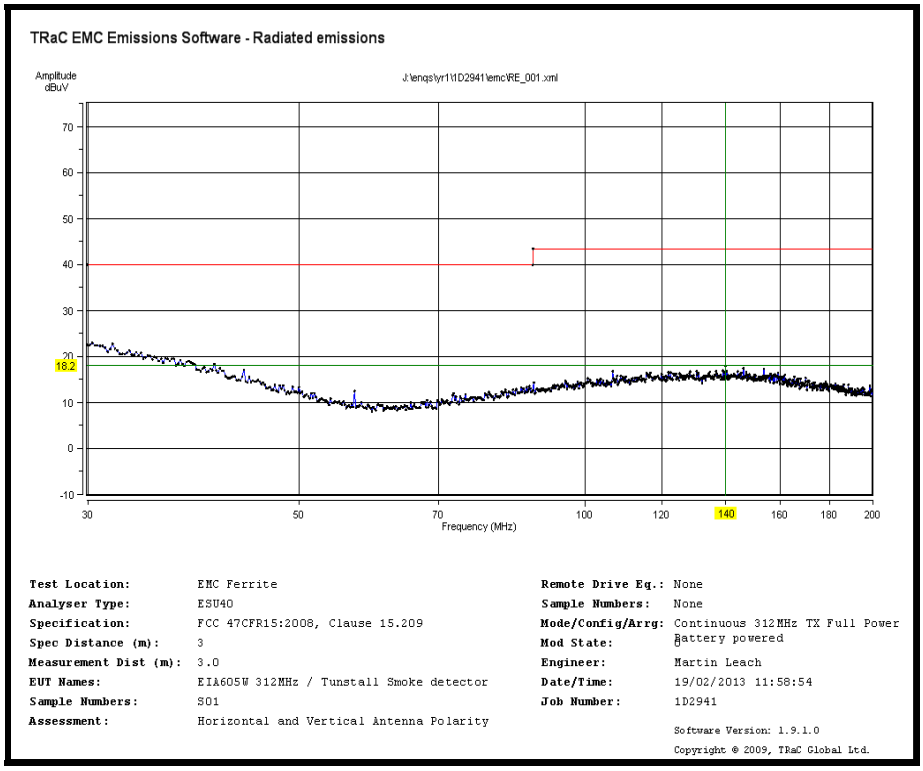
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



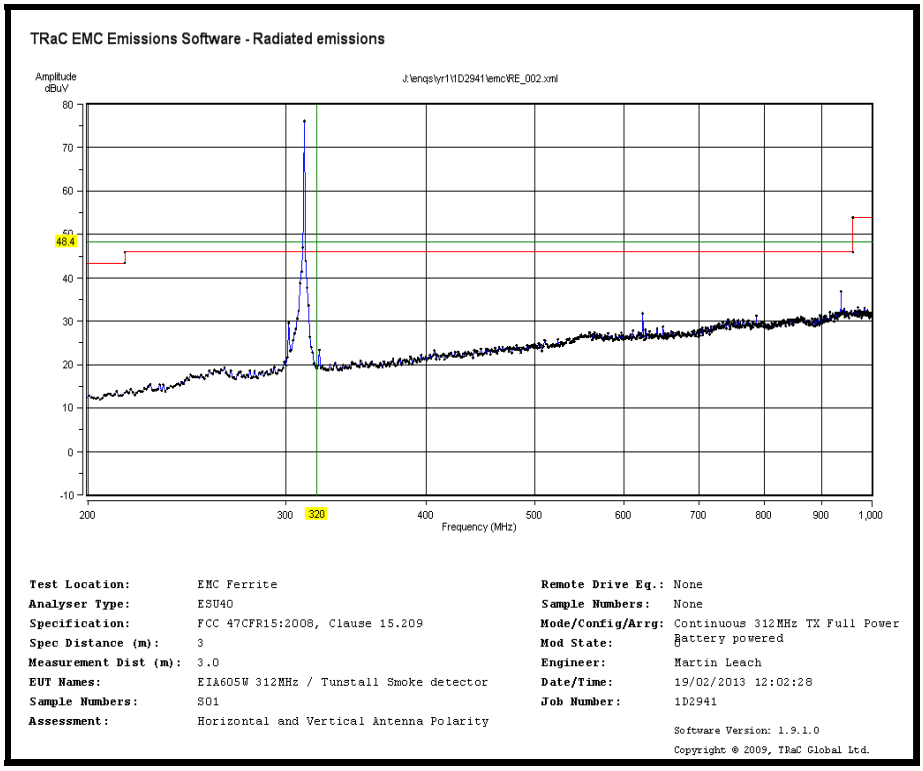
20dB Bandwidth



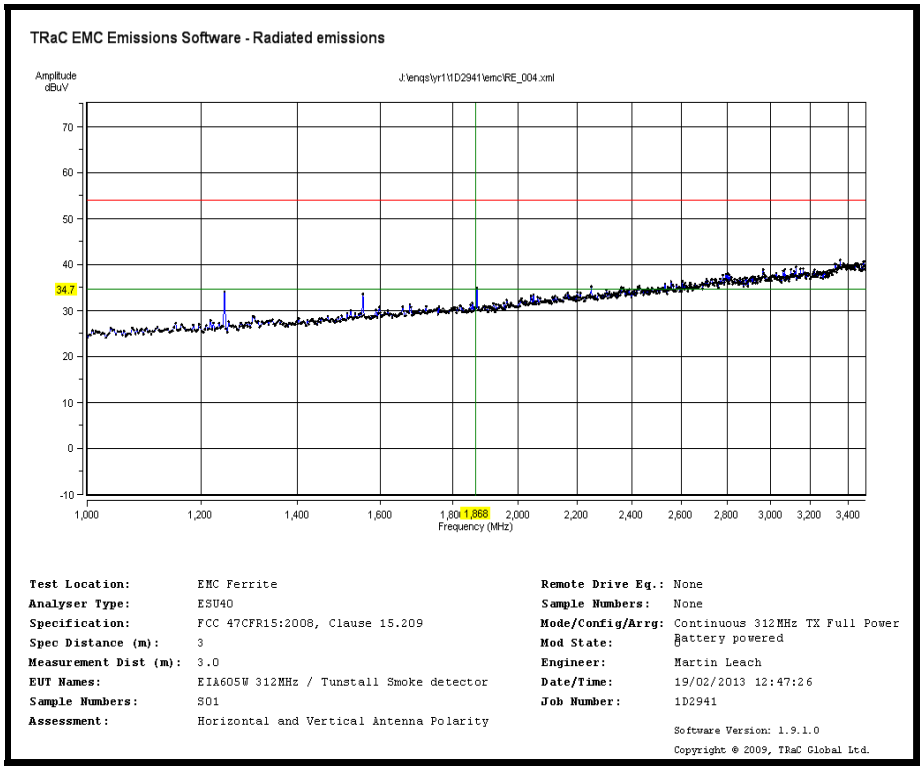
99% Occupied bandwidth



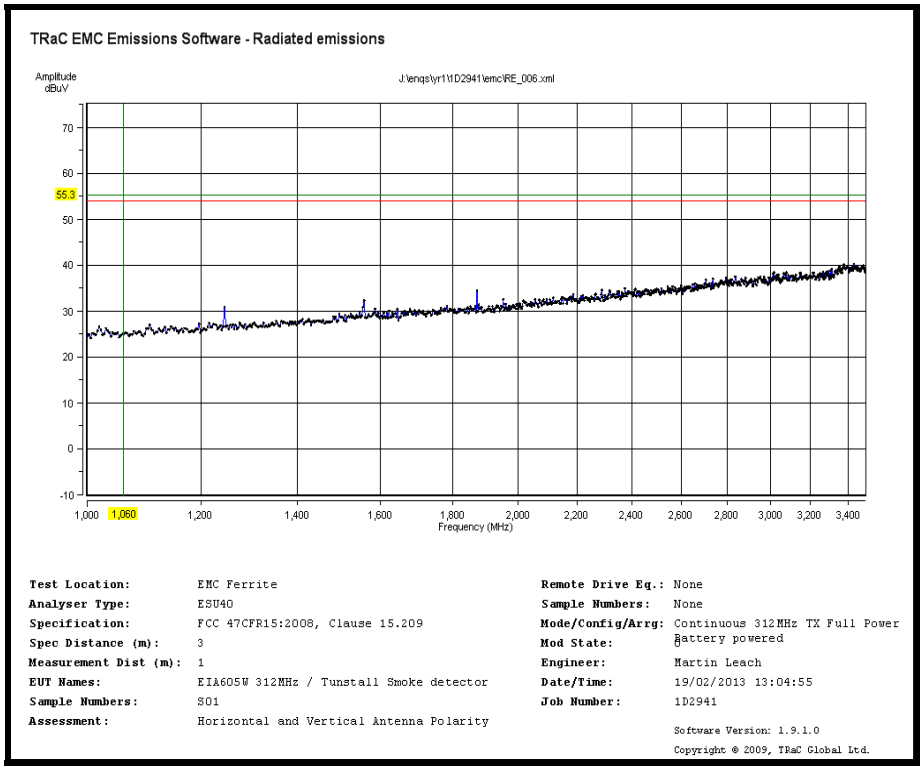
Radiated Transmitter Emissions 30MHz to 200MHz (15.231/15.209)



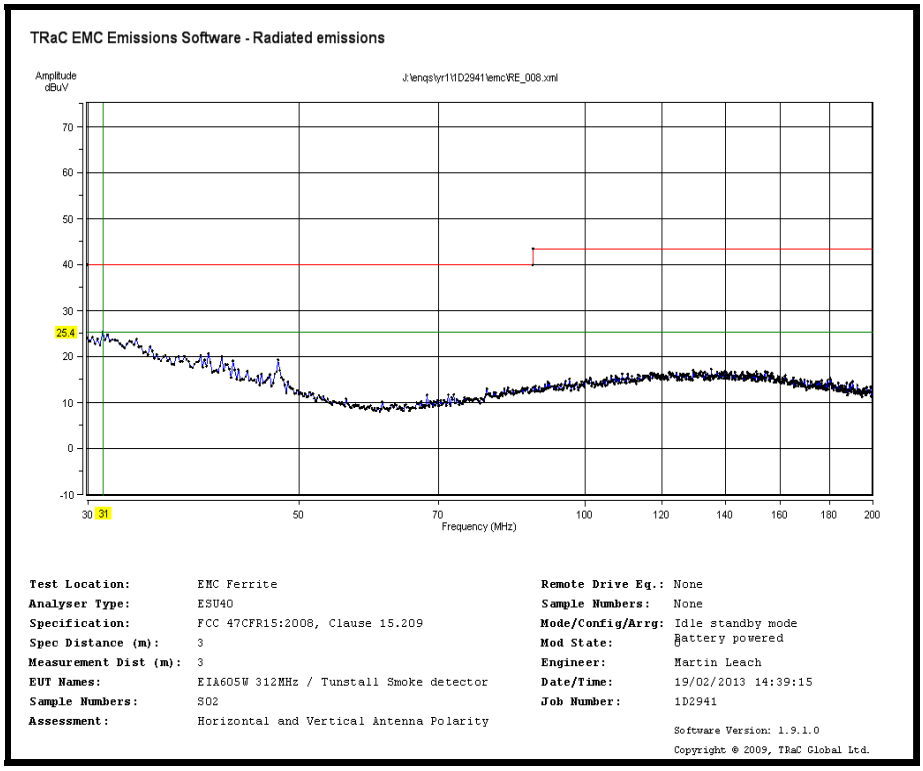
Radiated Transmitter Emissions 30MHz to 1000MHz (15.231/15.209)



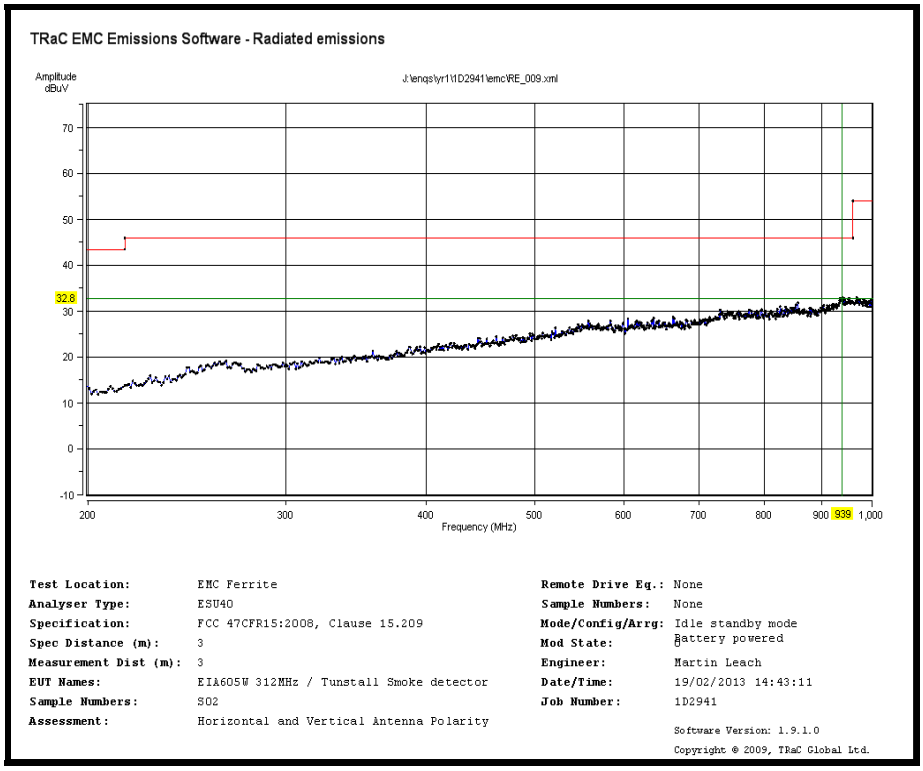
Radiated Transmitter Emissions 1GHz to 3.400GHz (15.231/15.209)



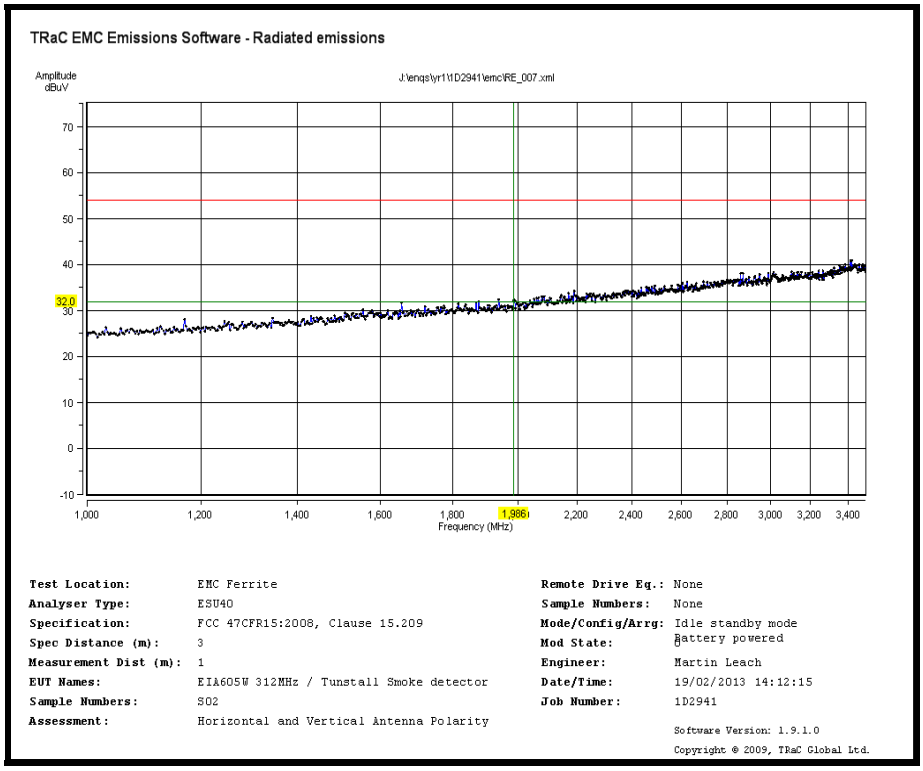
Radiated Transmitter Emissions 1GHz to 3.400GHz (15.231/15.209)



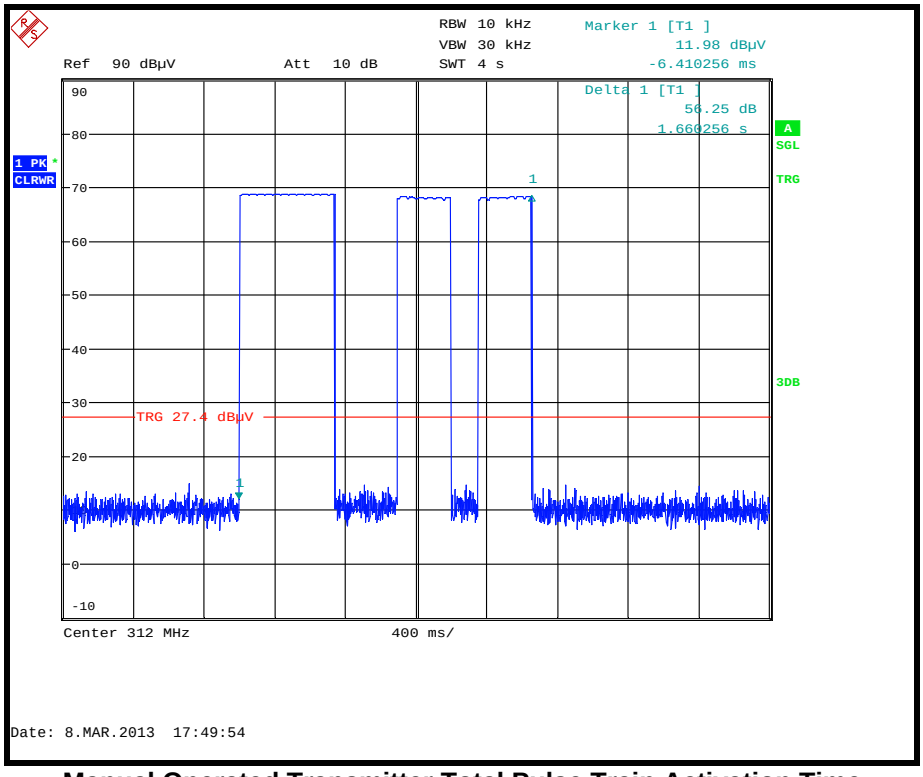
Radiated RX/Idle Mode Emissions 30MHz to 200MHz (15.109)



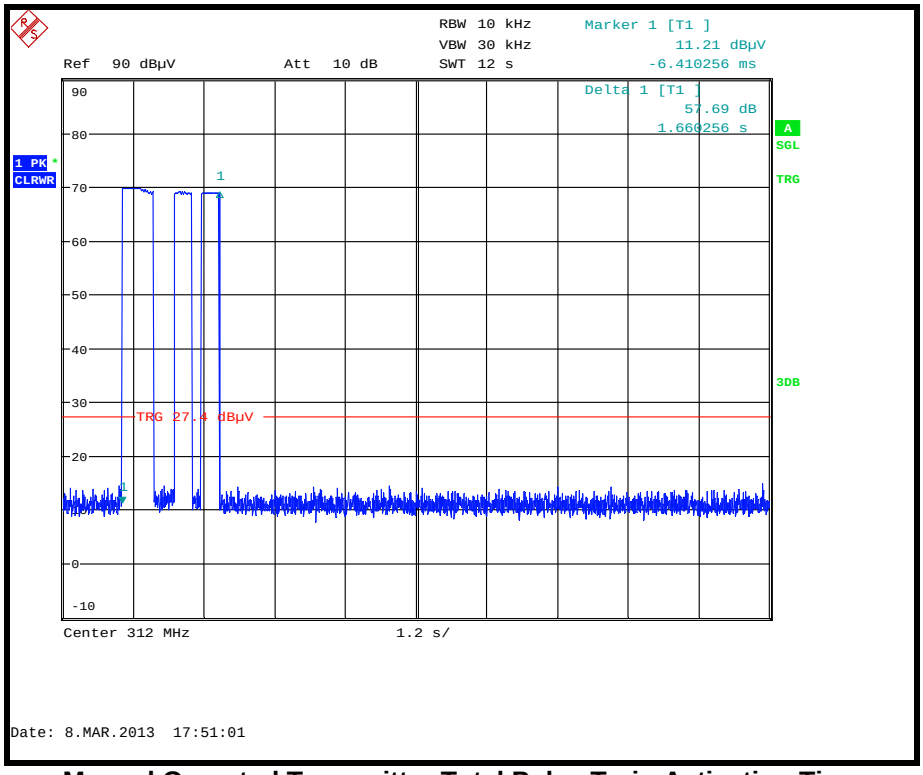
Radiated RX/Idle Mode Emissions 20MHz to 1000MHz (15.109)



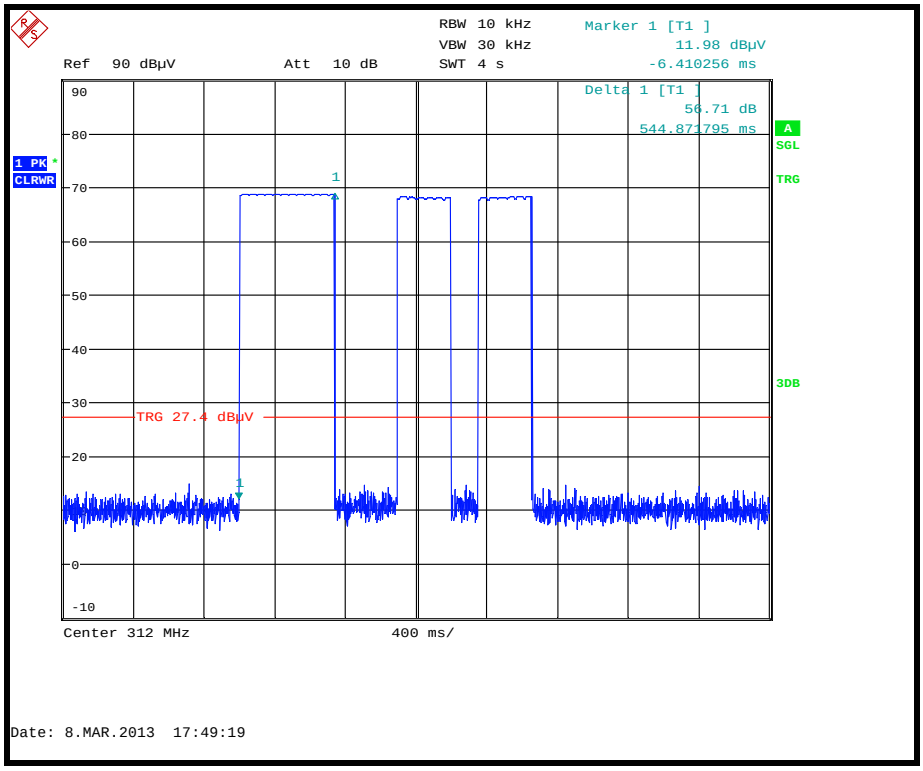
Radiated Transmitter Emissions 1GHz to 3.400GHz (15.109)



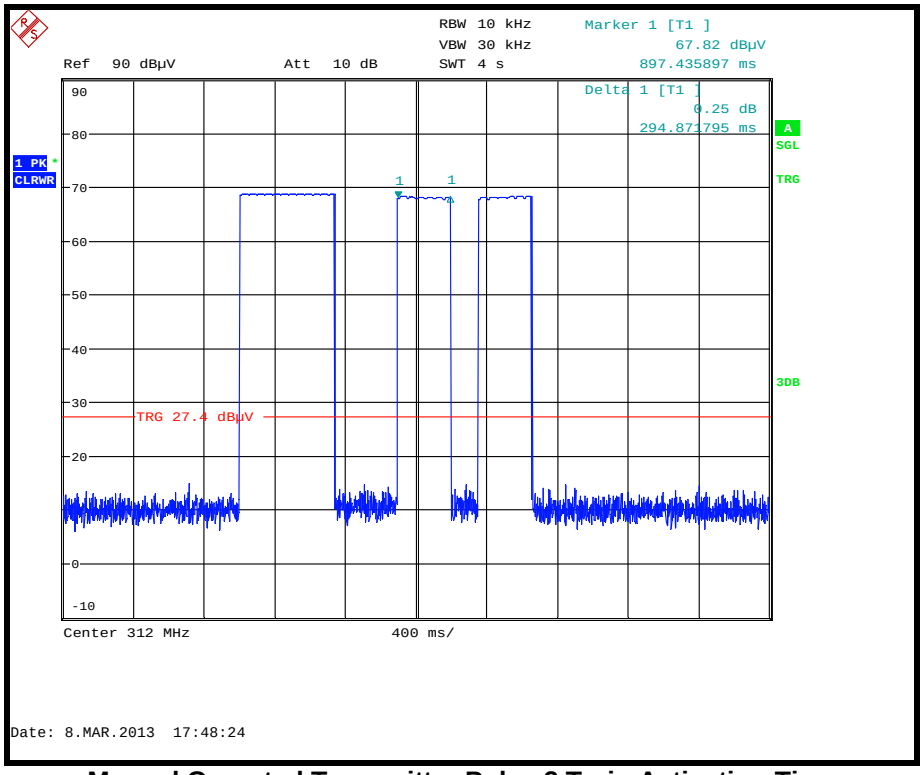
Manual Operated Transmitter Total Pulse Train Activation Time



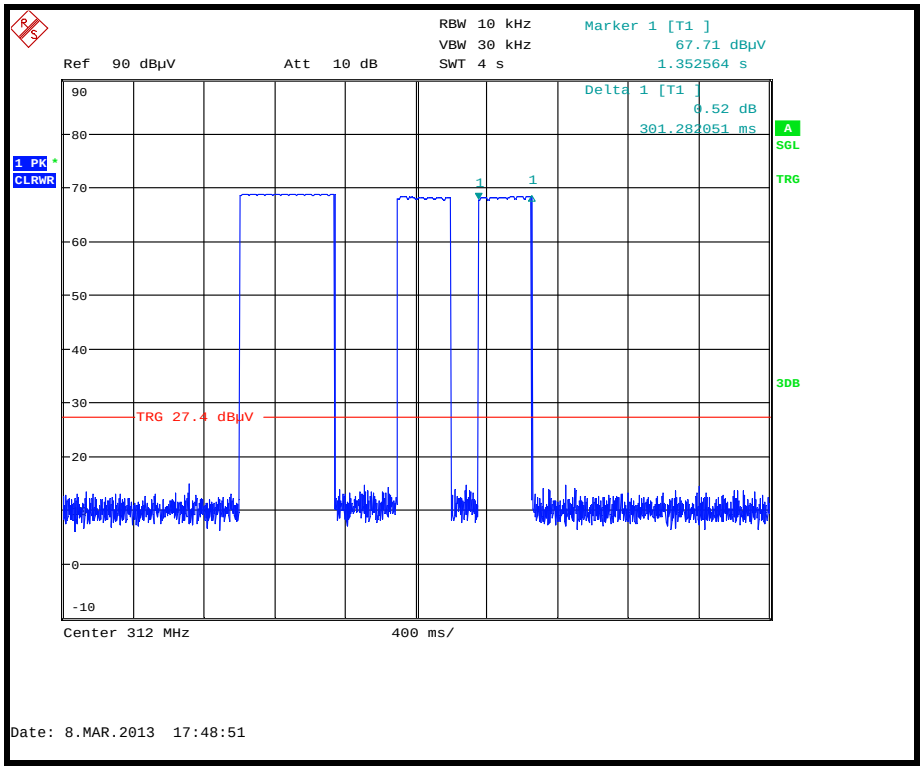
Manual Operated Transmitter Total Pulse Train Activation Time



Manual Operated Transmitter Pulse 1 Train Activation Time



Manual Operated Transmitter Pulse 2 Train Activation Time



Manual Operated Transmitter Pulse 3 Train Activation Time

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.

C1) Test samples

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

Sample No.	Description	Identification
S01	Battery powered 312MHz Ei UL Smoke Alarm	None
S02	Battery powered 312MHz Ei UL Smoke Alarm	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode: Transmit (CW)
Radiated Carrier Power Radiated spurious emissions: (None and Restricted bands)	The EUT (S01) was transmitting a CW signal on maximum power transmitting at a fundamental operating frequency of 312.000MHz and was powered via a new battery.

Test	Description of Operating Mode: Transmit (modulated)
Emission Bandwidth, Manual Operated Transmitter	The EUT (S02) was transmitting a modulated carrier using FSK on maximum power transmitting at a fundamental operating frequency of 312.000MHz when the “TEST &”HUSH” button was pushed. and was powered via a new battery

Test	Description of Operating Mode: Idle/Receive
Radiated Electric Field Emissions 15.109 digital circuitry	The EUT (S02) was continuously in idle mode and was powered via a new battery.

C3) EUT Configuration Information.

Sample	Internal Configuration Details
All	Single possible internal configuration

C4)List of EUT Ports

The table below describes the termination of EUT ports:

Sample : S01
Tests : All tests detailed in this report

Port	Description of Cable Attached	Cable length	Equipment Connected
dc power port	None	N/A	Duracell Pile Alcaline MN1606 6LR61 9Vdc battery

Sample : S02
Tests : All tests detailed in this report

Port	Description of Cable Attached	Cable length	Equipment Connected
dc power port	None	N/A	Duracell Pile Alcaline MN1606 6LR61 9Vdc battery

C5 Details of Equipment Used

For Conducted Measurements

TRaC REF/RFG No	Type	Description	Manufacturer	Date Calibrated
REF847	ESU	EMI Test Receiver (Spectrum analyser)	R & S	21/11/12

For Radiated Measurements:

TRaC REF/RFG No	Type	Description	Manufacturer	Date Calibrated
274	Lab 10	Ferrite Lined Chamber	TRaC	01/08/12
679	CBL6111	BILOG Antenna	Chase	05/05/11
682	HL050	Log P Antenna 0.85 to 26.5GHz	R & S	16/07/12
008	8447D	Pre Amp	HP	16/02/12
307	8449B	HF Pre Amp (1 to 26.5GHz)	HP	29/02/12
REF847	ESU	EMI Test Receiver (Spectrum analyser)	R & S	21/11/12
643	-	48 inch HF coaxial cable	Sucoflex	22/10/12
651	-	7m HF coaxial cable	Sucoflex	
678	-	8m HF coaxial cable	Sucoflex	22/10/12

Appendix D: **Additional Information**

Client declaration giving details of when the transmitter is activated automatically

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From: Kevin Avery [mailto:Kevin.Avery@tunstall.com]
Sent: 25 February 2013 09:54
To: Martin Leach
Subject: Re 312Mhz FCC smoke detector

Hi Martin

Just to confirm the message sent from the test button on the smoke head and the Automatic signal when the detector is activated is the same radio message type …

Our logo should appear on bottom of this email.

Best regards

Kevin Avery

Kevin Avery

System Consultant Business Development

t: +44 1977 660580

m: +44 7831 614640

f:

e: Kevin.Avery@tunstall.com

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 plots 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 as shown from the plots in contained in appendix B of this test report.

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

e.g, calculation of a pulse train with two different pulse durations with a pulse train period (T) = 70ms.

Sub Pulse	*Duration (ms)*	*Number of Pulses*	*Sub Pulse "On Time (ms)*
1	*10*	*1*	*10*
2	*5*	*1*	*5*
3	*10*	*1*	*10*
		Total On Time (ms)	*25*

When the average value of the pulsed emission from an EUT must be determined, the average can be found by measuring the peak pulse amplitude and determining the duty cycle correction factor of the pulse modulation.

$$\delta(dB) = 20\log\left[\sum\left(nt_1 + mt_2 + ... + \xi t_x\right)T\right]$$

Where:

n is the number of pulses of duration t_1
m is the number of pulses of duration t_2
ξ is the number of pulses of duration t_x
T is the period of the pulse train or 100ms if the pulse train length is > 100ms

$$\delta = (10 + 5 + 10)/70$$

$$\delta = 25/70 = 0.36$$

Duty cycle correction Factor = $\delta(dB) = 20\log(\delta)$

$$\delta(dB) = 20\log(0.36) = -8.9$$

The correction factor can then be applied to the peak pulse amplitude to find the average emission. This correction is applied for all emissions including the fundamental and harmonics.

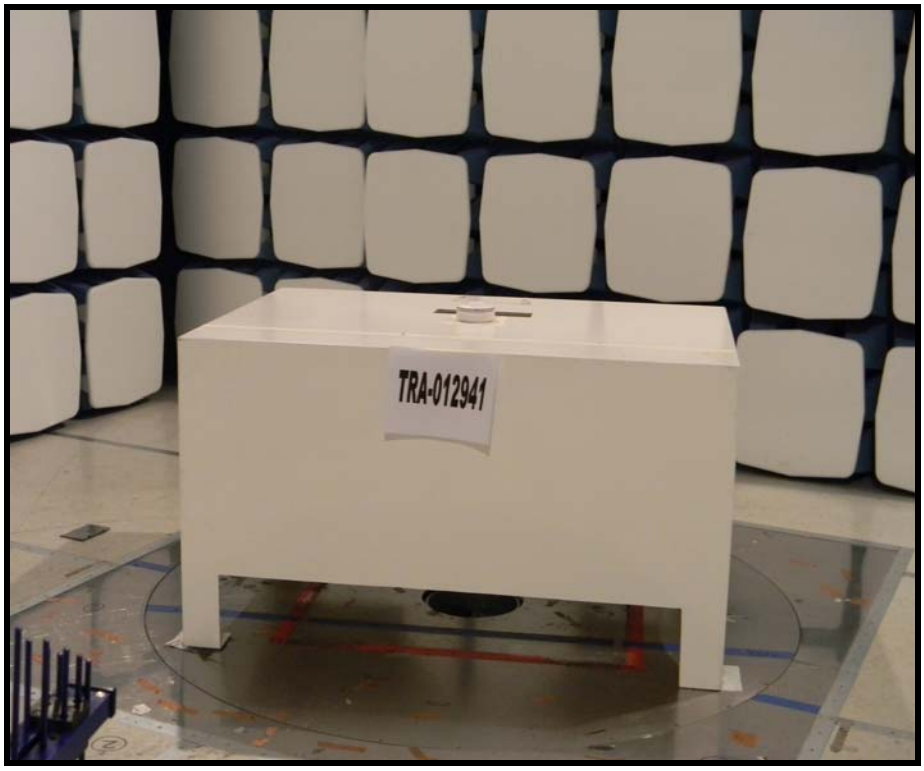
Note

No Duty cycle correction has been calculated or applied within this test report.

Appendix F: Photographs and Figures

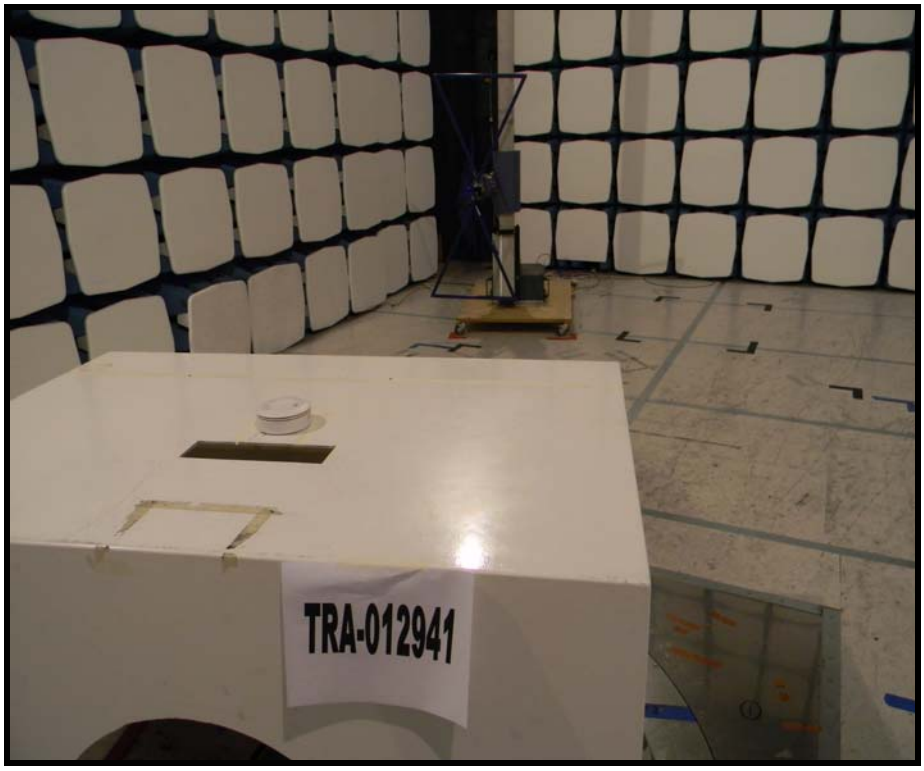
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: front view.
2. Radiated electric field emissions arrangement: front view.
3. Radiated electric field emissions arrangement: rear view.
4. Photo of the EUT Front Face (Top)
5. Photo of the EUT Top cover removed
6. Photo of the EUT Top cover removed
7. Photo of the EUT Top cover removed
8. Photo of the EUT internal PCB (rear view)
9. Photo of the EUT Rear Face (Bottom)
10. Photo of the EUT Bottom cover removed.
11. Photo of the EUT Bottom cover removed.
12. Photo of the EUT Bottom / Radio PCB removed
13. Radio PCB only (Front Face)
14. Radio PCB only (Rear Face)



Photograph 1

Photograph 2



Photograph 3

Photograph 4

Photograph 5

Photograph 6

Photograph 7

Photograph 8

Photograph 9

Photograph 10

Photograph 11

Photograph 12

Photograph 13

Photograph 14

Appendix G: MPE Calculation

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC 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 0.208mW/cm^2 power density limit, as required under FCC rules.

Prediction of MPE limit at a given distance

Equation from page 19 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2} \text{ or } \frac{EIRP}{4\pi R^2} \quad \text{re - arranged} \quad R = \sqrt{\frac{P\ G}{S\ 4\pi}} \text{ or } \sqrt{\frac{EIRP}{S\ 4\pi}}$$

where:

S = power density (Limit) (in appropriate units, e.g. mW/cm^2)
EIRP = equivalent (or effective) isotropically radiated power (mW)
R = distance to the center of radiation of the antenna (cm)
P = power input to the antenna (mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
(***numeric*** gain. = $G = 10^{\frac{dB}{10}}$

Result

Prediction Frequency (MHz)	FIELD ST'GH (dBµV/m) @ 3m	Maximum EIRP (dBm)	Maximum EIRP (mW)	Power density limit f/1500 (S) (mW/cm^2)	Distance (R) cm required to be less than 0.208 mW/cm^2
312	73.3	-21.96	0.006371512	0.208	0.049372447

Note: As Per ANSI C63.10-2009 Clause 7.8.2

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

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 G is unknown, then G=1.64 when calculating the ERP and G=1 when calculating the EIRP)

RSS-102 Issue 4 March 2010

Radio frequency radiation exposure evaluation:

For purposes of these requirements mobile devices are defined 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 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 2.08W/m^2 power density limit, as required.

Prediction of MPE limit at a given distance

Equation from page 19 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2} \text{ or } \frac{EIRP}{4\pi R^2} \quad \text{re - arranged} \quad R = \sqrt{\frac{P\ G}{S\ 4\pi}} \text{ or } \sqrt{\frac{EIRP}{S\ 4\pi}}$$

where:

S = power density (Limit) (in appropriate units, e.g. W/m^2)
EIRP = equivalent (or effective) isotropically radiated power (W)
R = distance to the centre of radiation of the antenna (m)
P = power input to the antenna (W)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
(***numeric*** gain. = $G = 10^{\frac{dB}{10}}$

Result

Prediction Frequency (MHz)	FIELD ST'GH (dBµV/m) @ 3m	Maximum EIRP (dBm)	Maximum EIRP (W)	Power density limit f/150 (S) (W/m^2)	Distance (R) cm required to be less than 2.08 W/m^2
312	73.3	-21.96	0.000006371512	2.08	0.000493724

Note: As Per ANSI C63.10-2009 Clause 7.8.2

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

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 G is unknown, then G=1.64 when calculating the ERP and G=1 when calculating the EIRP)

Appendix H: FCC CFR47 Part 15(c) / IC RSS-210 Comparison Table

The following table summarises the results of the assessment to RSS-210:

Test Type	FCC Regulation	IC Regulation	Measurement standard	Result
Radiated Carrier Power	Title 47 of the CFR: Part 15 Subpart (c) 15.231(b)	RSS-210 Issue 8 December 2010 Annex A1 Section A1.1	RSS-Gen Issue 3 December 2010 section 4.8 / ANSI C63.10:2009	Pass
Radiated spurious emissions (None and Restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.231(b) 15.205 and 15.209	RSS-210 Issue 8 December 2010 Annex A1 Section A1.1 RSS-Gen Issue 3 December 2010 Section 7.2.2 and 7.2.5	RSS-GEN Issue 3, December 2010 / ANSI C63.10:2009	Pass
20dB Emission Bandwidth	Title 47 of the CFR : Part 15 Subpart (c) 15.231(c)	N/A	ANSI C63.10:2009	Pass
Manual Operated Transmitter	Title 47 of the CFR : Part 15 Subpart (c) 15.231(a)(1)	RSS-210 Issue 8 December 2010 Annex A1 Section A1.1.1(a)	-	Pass
Automatically Activated	Title 47 of the CFR : Part 15 Subpart (c) 15.231(a)(2)	RSS-210 Issue 8 December 2010 Annex A1 Section A1.1.1(b)	-	Pass
AC Power conducted Emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.207	RSS- GEN Issue 3, December 2010 Section 7.2.4	RSS-GEN Issue 3, December 2010 / ANSI C63.10:2009	N/A
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	CAN/CSA-CEI/IEC CISPR 22:02	RSS- GEN Issue 3, December 2010 / ANSI C63.10 2009	Pass
AC Power conducted Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.107	CAN/CSA-CEI/IEC CISPR 22:02	ANSI C63.4:2009 2009	N/A
Bandwidth of Momentary Signals (99% OBW)	N/A	RSS-210 Issue 8 December 2010 Annex A1 Section A1.1.3	RSS-Gen Issue 3 December 2010 section 4.6.1	N/A

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