A RADIO TEST REPORT

FOR

GLOWMOTION TECHNOLOGIES UK LTD

ON

GHOSTBAND

DOCUMENT NO. TRA-022490-00-47-00C

HULL
Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.
T +44 (0)1482 801801 **F** +44 (0)1482 801806 **E** test@tracglobal.com
www.tracglobal.com

UKAS TESTING
0026

TRaC Wireless Test Report	**:** TRA-022490-00-47-00C
Applicant	**:** GlowMotion Technologies UK Ltd
Apparatus	**:** Ghostband
Specification(s)	**:** CFR47 Part 15.247 & RSS-210 Annex 8
Purpose of Test	**: Certification**
FCCID	**: 2ACQ2GB01**
IC ID	**: 12328A-GB01**
Authorised by	**:** 

Total number of pages: 52

0026

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.

Test performed at:

TRaC Global [ ]
Unit E
South Orbital Trading Park
Hedon Road
Hull, HU9 1NJ.
United Kingdom.

Telephone: +44 (0) 1482 801801
Fax: +44 (0) 1482 801806

TRaC Global [X]
Unit 1
Pendle Place
Skelmersdale
West Lancashire, WN8 9PN
United Kingdom

Telephone: +44 (0) 1695 556666
Fax: +44 (0) 1695 577077

Email: test@tracglobal.com
Web site: http://www.tracglobal.com

Tests performed by: A Tosif

Report author: A Tosif

1.2 Tests Requested By

This testing in this report was requested by:

GlowMotion Technologies UK Ltd
Office D2 / Barn 4
Dunston Business Village
Dunston
Stafford
Staffordshire
ST18 9AB

1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 30th July 2014 and 5th August 2014

- Ghostband

The above equipment is a battery powered, DTS multi-channel transceiver operating in the 902MHz to 928 MHz band.

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	Regulations		Measurement standard	Result
Radiated spurious emissions (Restricted bands)	RSS-210 Issue 8 December 2010 Annex 8, A8.5	Title 47 of the CFR: Part 15 Subpart C; 15.247 (d)	ANSI C63.10:2009	Pass
Radiated spurious emissions (Non-restricted bands)	RSS-210 Issue 8 December 2010 Annex 8, A8.5	Title 47 of the CFR: Part 15 Subpart C; 15.247 (d)	ANSI C63.10:2009	Pass
AC Power conducted emissions	RSS-GEN Issue 3 December 2010 Annex 7, 7.2.4	Title 47 of the CFR: Part 15 Subpart C; 15.207	ANSI C63.10:2009	N/A
Occupied Bandwidth	RSS-210 Issue 8 December 2010 Annex 8, A8.2a	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10:2009	Pass
Carrier Power	RSS-210 Issue 8 December 2010 Annex 8, A8.4 (4)	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10:2009	Pass
Power Spectral Density	RSS-210 Issue 8 December 2010 Annex 8, A8.2b	Title 47 of the CFR : Part 15 Subpart C; 15.247(e)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	RSS-GEN Issue 3 December 2010 7.2.2(c)	Title 47 of the CFR: Part 15 Subpart B; 15.109	ANSI C63.10:2009	Pass
RF Safety	RSS-102	Title 47 of the CFR : Part 15 Subpart C; 15.247	-	Pass
Digital Modulation	-	Title 47 of the CFR: Part 15 Subpart C; 15.403	-	Pass

Abbreviations used in the above table:

Mod	: Modification		
CFR	: Code of Federal Regulations	ANSI	: American National Standards Institution
REFE	: Radiated Electric Field Emissions	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 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 (Power Meter) = **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	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
		ATS	: Alternative Test Site
EUT	: Equipment Under Test		
SE	: Support Equipment	Ref	: Reference
		Freq	: Frequency
L	: Live Power Line		
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

A1 6 dB Bandwidth

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a) (2) and RSS-210 Issue 8 December 2010 require the measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(a)(2); RSS-210 Annex 8, A8.2a
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	24˚C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F_{lower} (MHz)	F_{higher} (MHz)	Measured 6 dB Bandwidth (kHz)	Limit (kHz)	Result
903	902.698718	903.352564	653.846	>500	Pass
916	915.692308	916.365385	673.077	>500	Pass
927	926.685897	927.365385	679.487	>500	Pass

Plots of the 6 dB bandwidth are contained in Appendix B of this test report.

A2 Transmitter Peak Output Power

Carrier power was verified with the EUT transmitting on all operating frequencies in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3); RSS-210 Annex 8, A8.2a
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C

Channel Frequency (MHz)	Radiated Peak Carrier Power (dBµV/m)	EIRP (W)	Limit (W)	Result
903	95.24	0.001003	1	Pass
916	96.38	0.001304	1	Pass
927	95.71	0.001117	1	Pass

EIRP calculated from Field Strength as Per ANSI C63.10

Notes:

Radiated Measurement

Measuring distances 3 meters.
EUT 0.8 metre above ground plane.
Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m >30MHz
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes
Maximum results recorded

558074 D01 DTS Meas Guidance v03r01
Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

A3 Transmitter Power Spectral Density

Transmitter Power Spectral Density was verified with the EUT transmitting on all operating frequencies in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(e); RSS-210 Annex 8, A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C

Channel Frequency (MHz)	Radiated Peak Power Spectral Density (dBµV/m)	Power Spectral Density (dBm)	Limit (dBm)	Result
903	92.02	-5.4	8	Pass
916	93.66	-3.7	8	Pass
927	93.03	-4.3	8	Pass

PSD calculated from Field Strength as Per ANSI C63.10

Notes:

Radiated Measurement

Measuring distances 3 meters.
EUT 0.8 metre above ground plane.
Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m >30MHz
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthogonal planes
Maximum results recorded

558074 D01 DTS Meas Guidance v03r01
Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

A4 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The maximum permitted field strength is described in Section 15.247(d) and per RSS – 210 Annex 8, A8.5. The EUT was set to transmit.

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: 903 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d); RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz – 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	HIGH PASS FILTER LOSS (dB)	DUTY CYCLE CORR. (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2709.0 pk	70.9	3.1	29.2	36.0	0.8	-	68.0	2511.9	5000
2.	2709.0 av	70.9	3.1	29.2	36.0	0.8	-20.6	47.4	234.4	500
3.	3612.1 pk	65.1	3.1	31.3	35.8	0.3	-	64.0	1586.7	5000
4.	3612.1 av	65.1	3.1	31.3	35.8	0.3	-20.6	43.4	148.1	500
5.	4515.1 pk	66.2	3.5	32.2	35.6	0.2	-	66.5	2111.1	5000
6.	4515.1 av	66.2	3.5	32.2	35.6	0.2	-20.6	45.9	197.0	500
7.	5418.1 pk	52.5	3.9	34.0	35.7	0.3	-	55.0	562.3	5000
8.	5418.1 av	52.5	3.9	34.0	35.7	0.3	-20.6	34.4	52.5	500

Please not that emissions may be in both FCC and IC or FCC / IC listed restricted band only.

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted bands are listed below:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
No were emissions detected within 20dB of the limit							

Radiated Electric Field Emissions continued:

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

Test Details: 916 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d); RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz to 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C
Photographs	Appendix F

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	HIGH PASS FILTER LOSS (dB)	DUTY CYCLE CORR. (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2748.1 pk	73.0	3.1	29.1	36.0	0.8	-	70.0	3155.0	5000
2.	2748.1 av	73.0	3.1	29.1	36.0	0.8	-20.6	49.4	294.4	500
3.	3664.1 pk	63.7	3.1	31.6	35.7	0.3	-	63.0	1417.4	5000
4.	3664.1 av	63.7	3.1	31.6	35.7	0.3	-20.6	42.4	132.3	500
5.	4580.2 pk	63.5	3.5	32.3	35.6	0.2	-	63.9	1566.8	5000
6.	4580.2 av	63.5	3.5	32.3	35.6	0.2	-20.6	43.3	146.2	500

Please not that emissions may be in both FCC and IC or FCC / IC listed restricted band only.

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted bands are listed below:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
No emissions were detected within 20dB of the limit							

Radiated Electric Field Emissions continued:

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

Test Details: 927 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d); RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz to 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C
Photographs	Appendix F

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	HIGH PASS FILTER LOSS (dB)	DUTY CYCLE CORR. (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2781.1 pk	70.0	3.1	29.1	36.0	0.7	-	66.9	2218.2	5000
2.	2781.1 av	70.0	3.1	29.1	36.0	0.7	-20.6	46.3	207.0	500
3.	3708.1 pk	62.8	3.1	31.8	35.7	0.3	-	62.3	1295.7	5000
4.	3708.1 av	62.8	3.1	31.8	35.7	0.3	-20.6	41.7	120.9	500
5.	4635.1 pk	70.8	3.6	32.3	35.6	0.2	-	71.3	3681.3	5000
6.	4635.1 av	70.8	3.6	32.3	35.6	0.2	-20.6	50.7	343.6	500
7.	8343.2 pk	49.8	4.6	37.1	36.4	0.3	-	55.4	586.8	5000
8.	8343.2 av	49.8	4.6	37.1	36.4	0.3	-20.6	34.8	54.8	500

Please not that emissions may be in both FCC and IC or FCC / IC listed restricted band only.

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted bands are listed below:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
No emissions were detected within 20dB of the limit							

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 Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
4 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.
5 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

These settings as per ANSI C63.10

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) and RSS-Gen 4.3.

Radiated emission limits (47 CFR Part 15: Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a) and RSS-Gen 7.2.2:

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

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d) and Annex 8, A8.5:

The limit in 100 kHz RBW = (Maximum Peak Carrier measured in 100 kHz RBW)-20dB

Where:

The maximum peak power was measured using a spectrum analyser using a 100 kHz resolution bandwidth.

Channel Frequency (MHz)	Measured Peak Carrier in 100kHz RBW (dBµV/m)	Measured Peak Carrier –20dB (dBµV/m)	Emission Limit In a 100 kHz RBW (dBµV/m)
903	92.02	72.02	72.02
916	93.66	73.66	73.66
927	93.03	73.03	73.03

Notes:

(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:

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

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

(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 Antenna Gain

Not Applicable as radiated measurements only were performed.

As Per ANSI C63.10

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.

Based on the above information G is taken as 1.64 for this device.

A6 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The maximum permitted field strength is listed in Section 15.109 and in RSS- GEN Section 7.2.3. 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 : [X]

Test Details: 903 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109; RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C
Photographs	Appendix F

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	No emissions were detected within 20dB of the limit								

Unintentional Radiated Electric Field Emissions continued:

Test Details: 916 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109; RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C
Photographs	Appendix F

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	No emissions were detected within 20dB of the limit								

Unintentional Radiated Electric Field Emissions continued:

Test Details: 927 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109; RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 10GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23.3˚C
Photographs	Appendix F

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	No emissions were detected within 20dB of the limit								

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 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) and RSS-Gen 4.3.

Radiated emission limits 47 CFR Part 15: Clause 15.209 and RSS – GEN Section 7.2.3 for all emissions:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength (dBµV/m)
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.

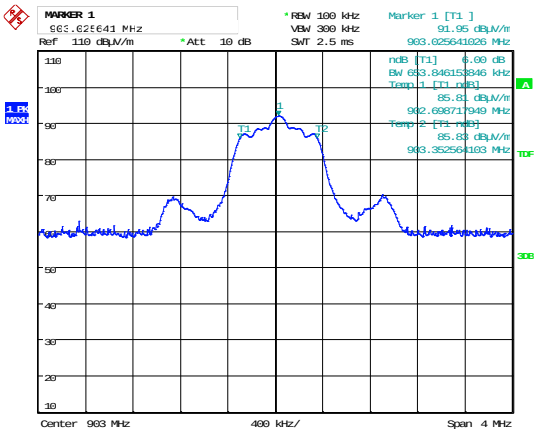
(b) The time and date on the plots do not necessarily equate to the time of the test.

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

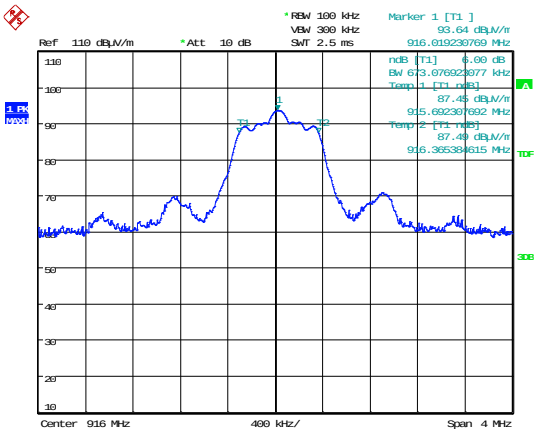
(d) Appendix C details the numbering system used to identify the sample and its modification state.

(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.

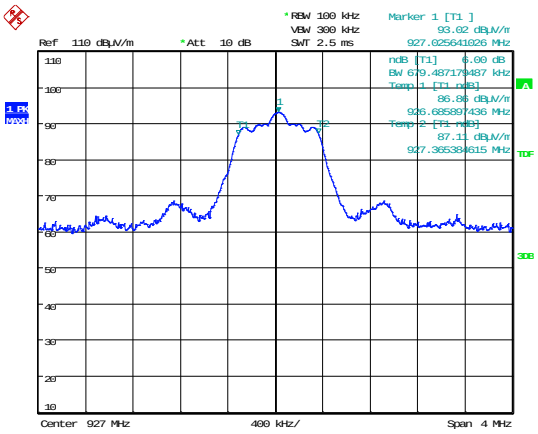
6dB Bandwidth



903 MHz

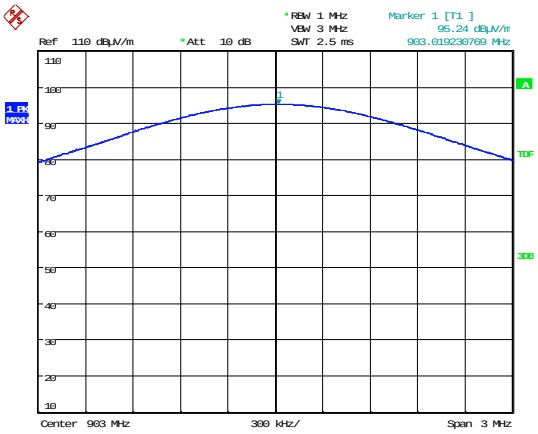


916 MHz



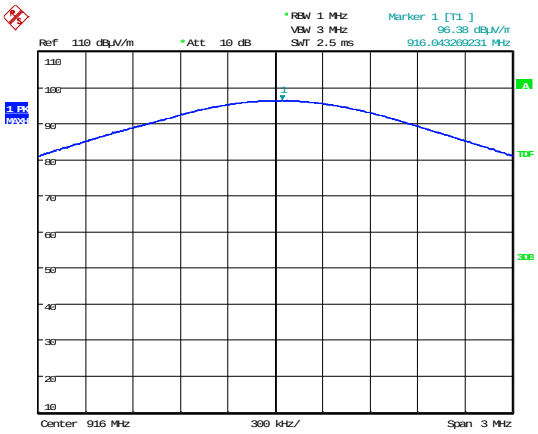
927 MHz

Carrier Power



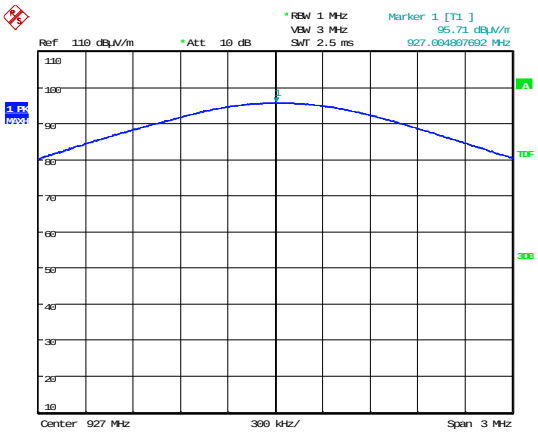
Date: 4.AUG.2014 17:32:55

903 MHz



Date: 4.AUG.2014 17:27:56

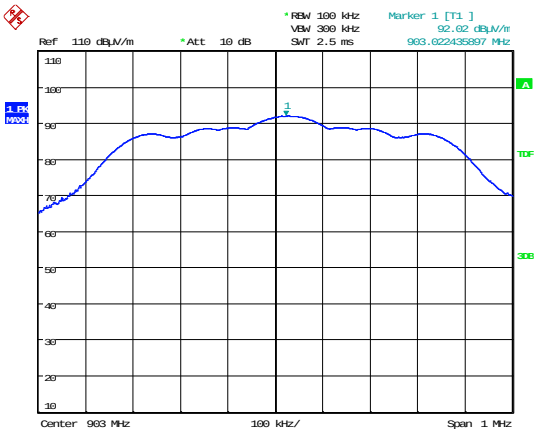
916 MHz



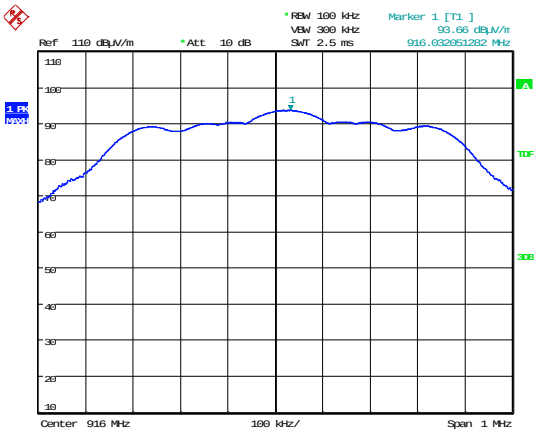
Date: 4.AUG.2014 17:17:44

927 MHz

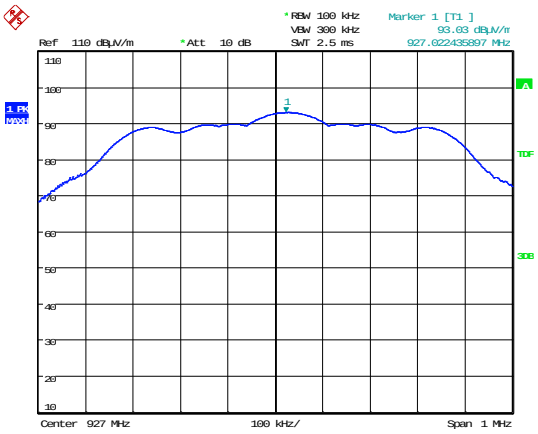
Power Spectral Density



903 MHz

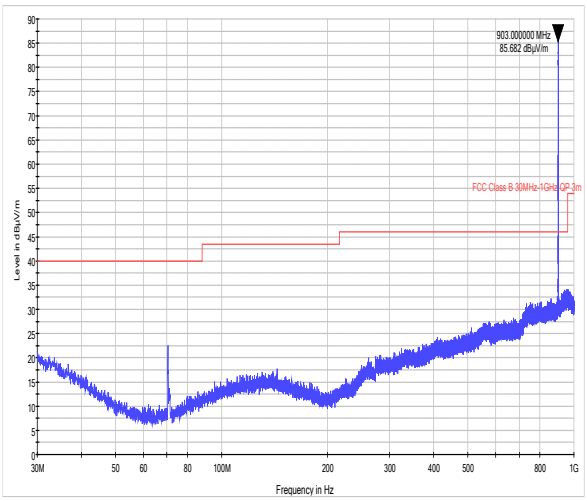


916 MHz

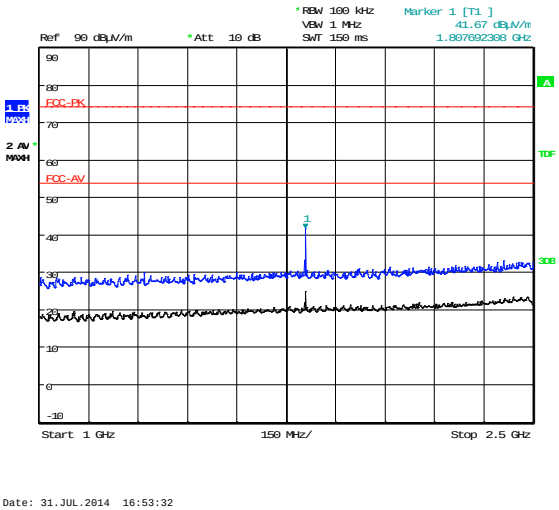


927 MHz

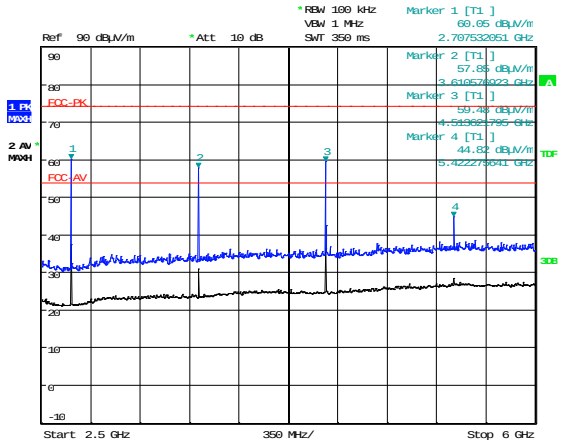
Radiated Spurious Emissions– 903MHz



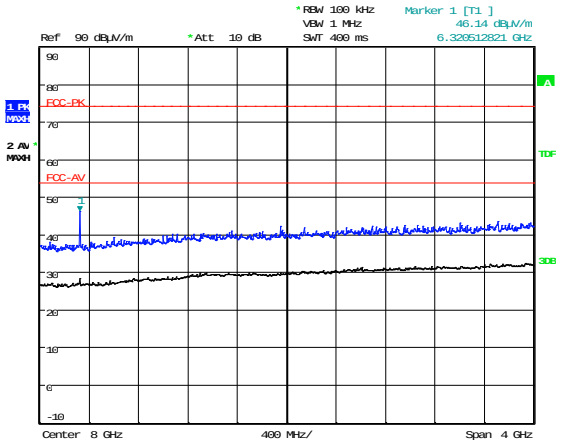
30 MHz to 1 GHz



1 GHz to 2.5 GHz

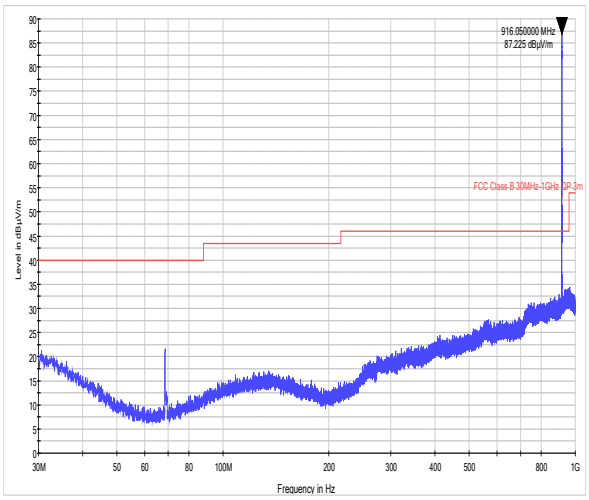


2.5 GHz to 6 GHz

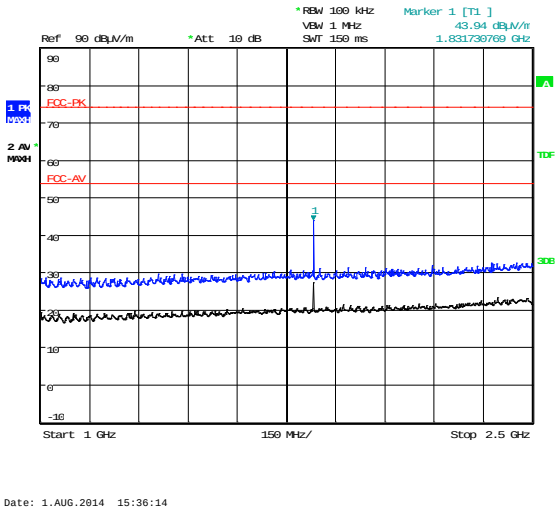


6 GHz to 10 GHz

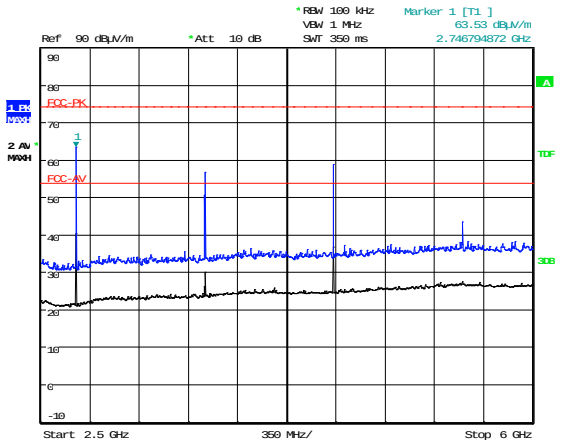
Radiated Spurious Emissions– 916MHz



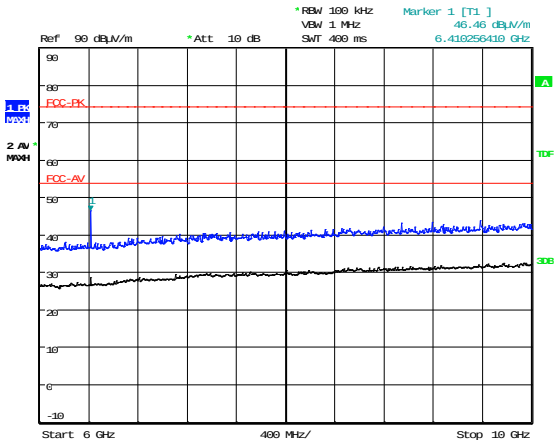
30 MHz to 1 GHz



1 GHz to 2.5 GHz

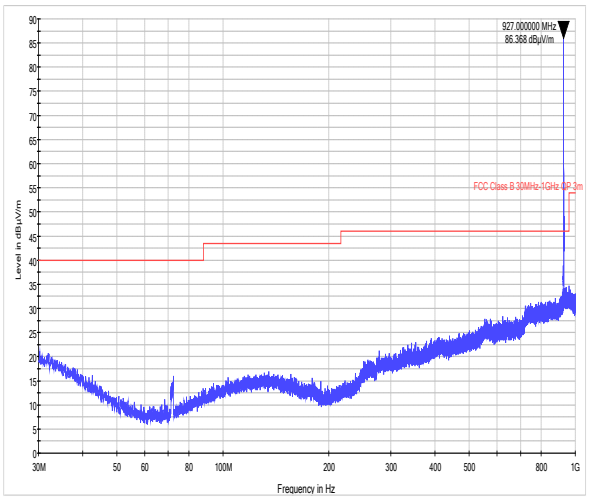


2.55 GHz to 6 GHz

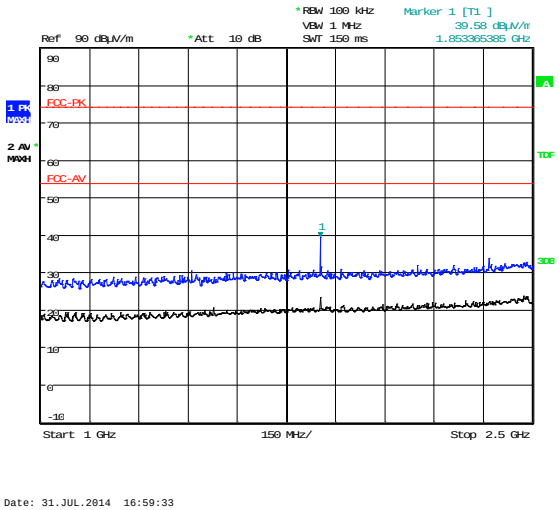


6 GHz to 10 GHz

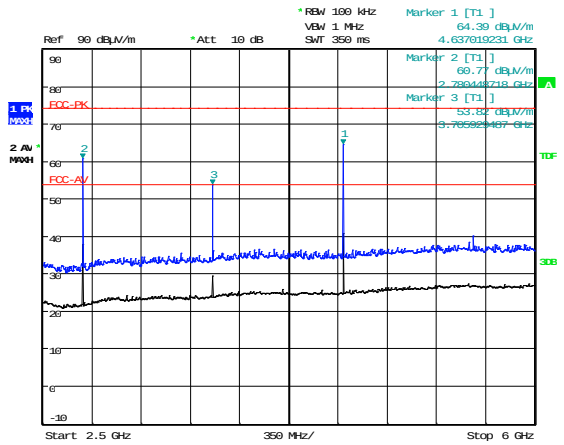
Radiated Spurious Emissions– 927MHz



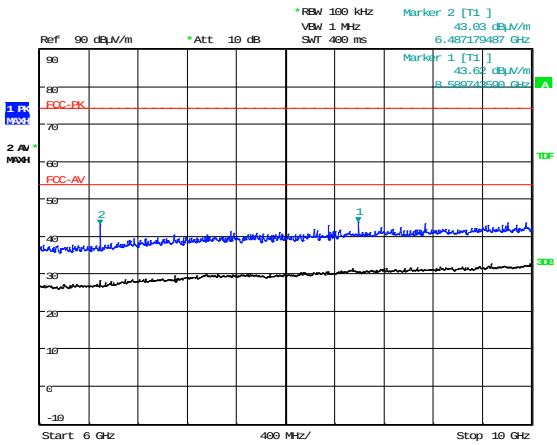
30 MHz to 1 GHz



1 GHz to 2.5 GHz

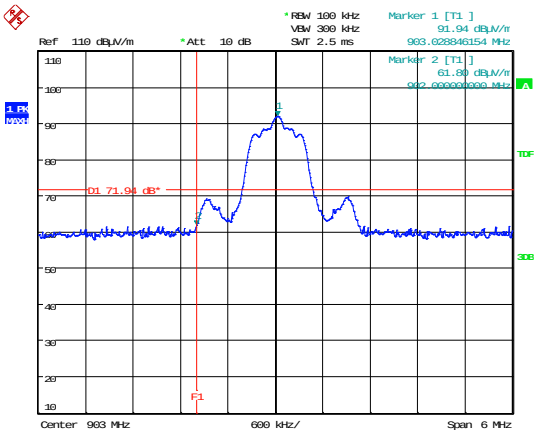


2.55 GHz to 6 GHz

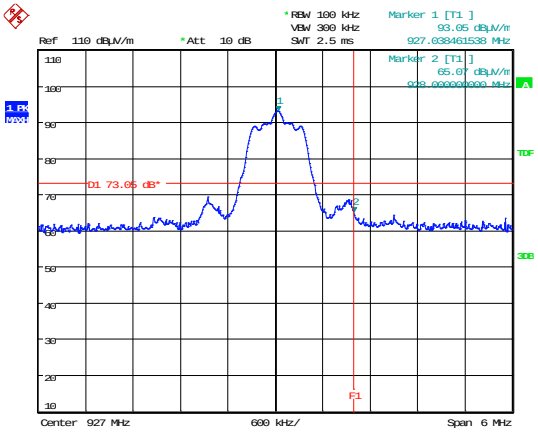


6 GHz to 10 GHz

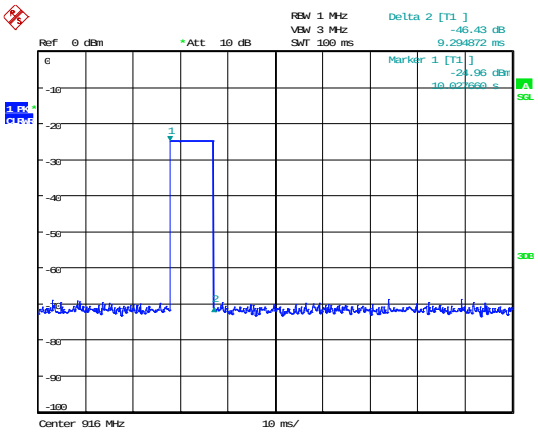
Radiated Band Edge Compliance and Transmitter On Time



Lower Band Edge

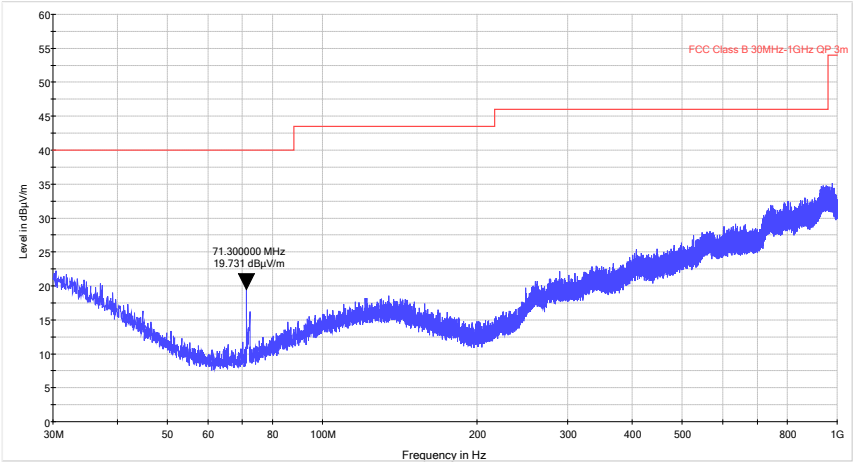


Upper Band Edge

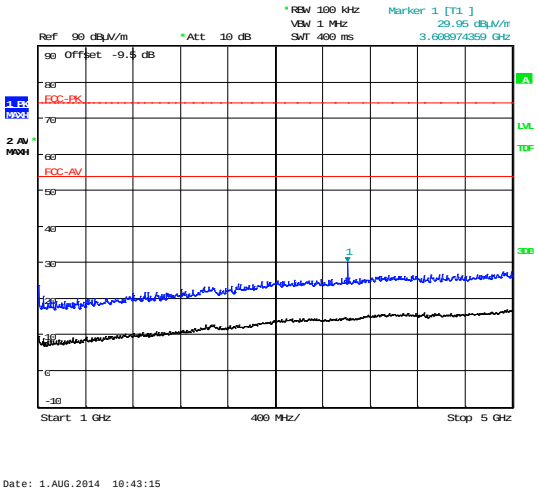


Transmitter On Time in 100ms

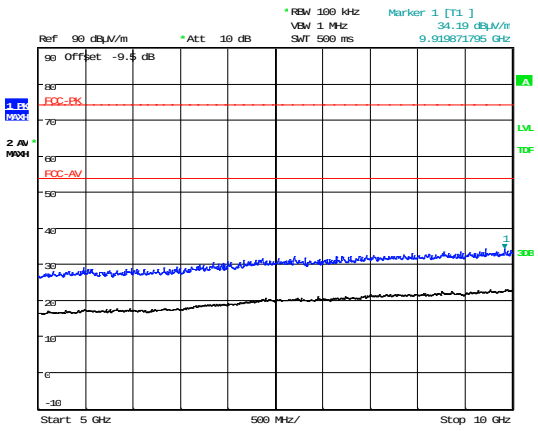
Unintentional Radiated Spurious emissions– 903MHz



30 MHz to 1 GHz

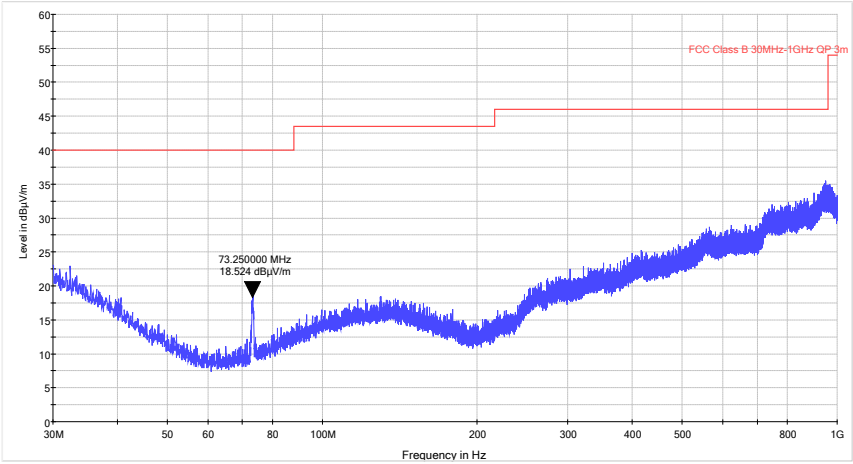


1 GHz to 5 GHz

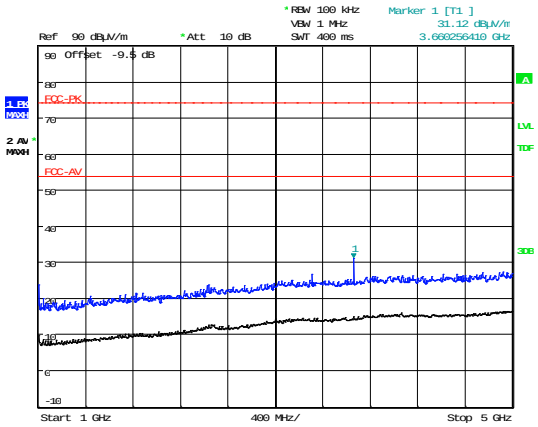


5 GHz to 10 GHz

Unintentional Radiated Spurious emissions– 916MHz

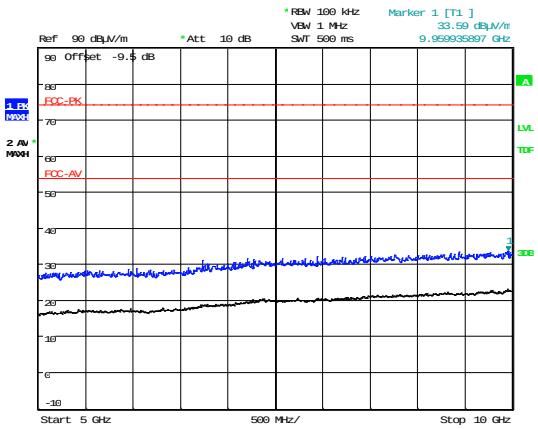


30 MHz to 1 GHz



Date: 1.AUG.2014 10:49:11

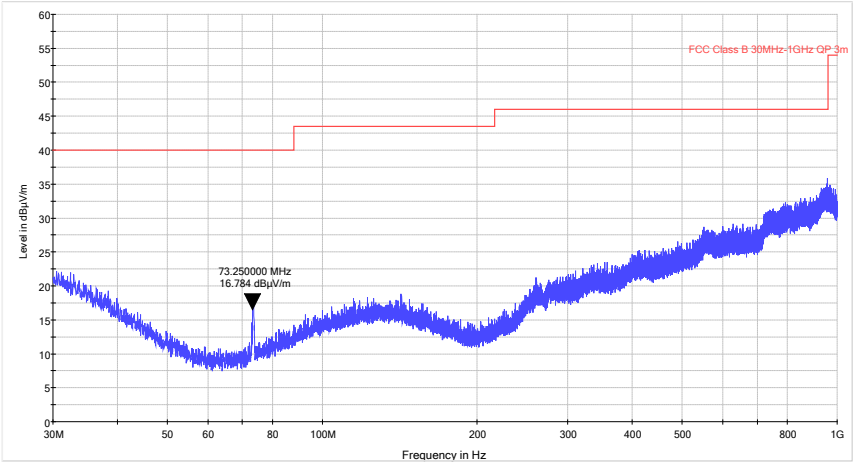
1 GHz to 5 GHz



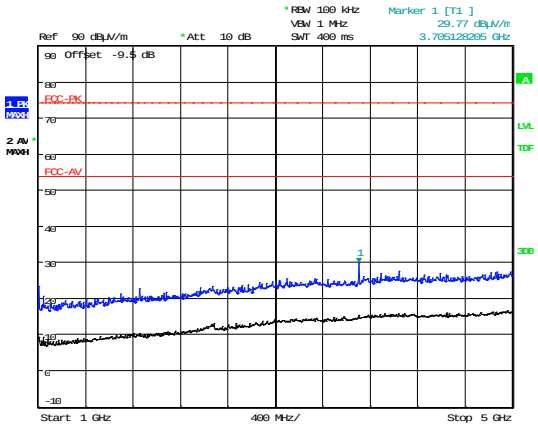
Date: 1.AUG.2014 10:50:11

5 GHz to 10 GHz

Unintentional Radiated Spurious emissions– 927MHz

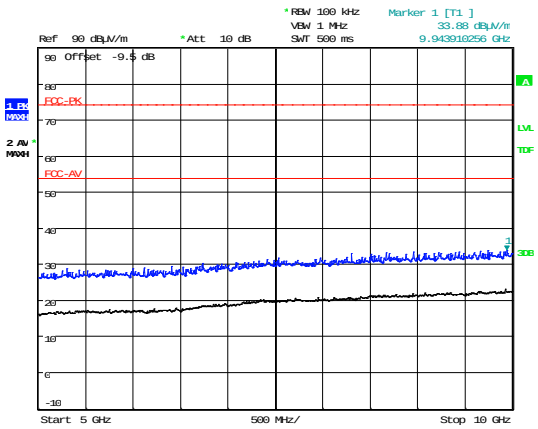


30 MHz to 1 GHz



Date: 1.AUG.2014 10:57:12

1 GHz to 5 GHz



Date: 1.AUG.2014 10:56:20

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
S01	Ghostband	006026

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

Sample No.	Description	Identification
None		

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

Identification	Description
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
All transmitter tests detailed in this report	EUT transmitting BPSK-40-ALT modulated carrier with the power level (on software) set to 25

Test	Description of Operating Mode: Receive
Receiver radiated spurious emissions	EUT in receive mode

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 : S01
Tests : All

Port	Description of Cable Attached	Cable length	Equipment Connected
EUT is a battery powered device with no external ports			

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
L317	ESVS10	Receiver	R&S	12/02/2014	12	12/02/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	24	09/07/2015
L572	8449B	Pre Amp	Agilent	11/02/2014	12	11/02/2015

Appendix D: Additional Information

No additional information is included within this test report.

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 pulse widths 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 pulse widths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was 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 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.

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.

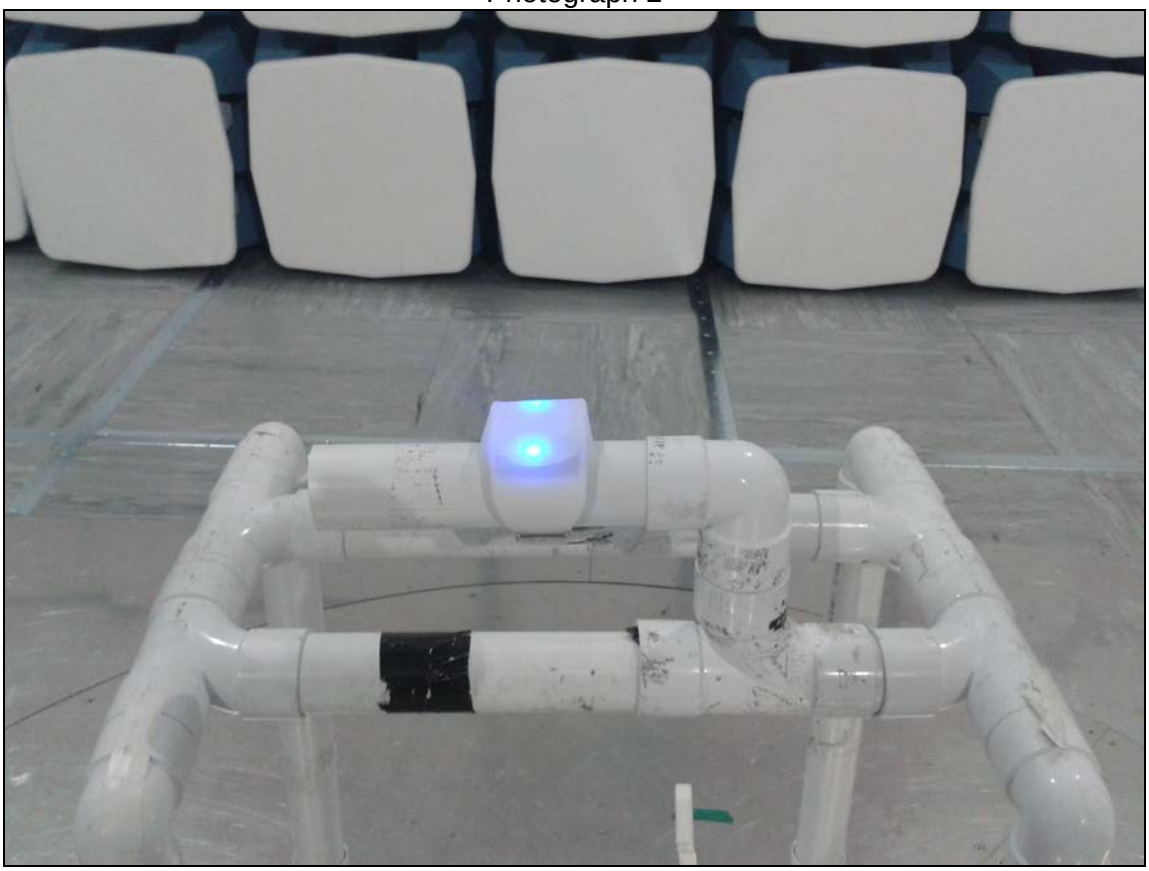
Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: overview.
2. Radiated electric field emissions arrangement: close up.

Photograph 1

Photograph 2



Appendix G: MPE Calculation

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.

In the frequency range below 100 MHz to 6 GHz and test separation distance of 50mm, the SAR Test Exclusion Threshold for operation at 903.3, 915.25 and 927.6 MHz will be determined as follows

SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

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) (inc tune up)
TSD^{A}	=	Min Test separation Distance or 50mm (whichever is lower) = 50

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

Not applicable as TSD^{A} <50mm

Operating Frequency 903 MHz

MP= [(3.0 x 5) / √0.903]
MP= [15 / √0.9503]
MP= 15.78mW
The calculated output power 0.6mw (Peak) is less than the SAR Exclusion Threshold of 15.78mW.

Operating Frequency 916 MHz

MP= [(3.0 x 5) / √0.916]
MP= [15 / √0.916]
MP= 15.67 mW
The calculated output power 0.8mW (Peak) is less than the SAR Exclusion Threshold of 16.38mW.

Operating Frequency 927 MHz

MP= { [(3.0 x 5) / √0.927]
MP= { [15 / √0.927]
MP= 15.58 mW
The calculated output power 0.7mW (Peak) is less than the SAR Exclusion Threshold of 16.18mW.

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

47 CFR §§1.1307, 2.1091 and RSS-102

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 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 0.6mW/cm^2 (60W/m^2 for Industry Canada) power density limit, as required under FCC and IC rules

Prediction of MPE limit at a given distance

Using KDB 447498 for guidance

$$S = \frac{1.64ERP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{1.64ERP}{S4\pi}}$$

Where:

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

Result:

Prediction Frequency (MHz)	Maximum ERP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.6mW/cm^2
916.0	0.8	0.6	0.4

HULL
Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.
T +44 (0)1482 801801 **F** +44 (0)1482 801806 **E** test@tracglobal.com
www.tracglobal.com