

**A RADIO TEST REPORT**

**FOR**

**LODAR**

**ON**

**103-12**

**DOCUMENT NO. TRA-020749-04-47-01-E**

**HULL**

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**TRaC Wireless Test Report** : TRA-020749-04-47-01-E

**Applicant** : Lodar

**Apparatus** : 103-12

**Specification(s)** : CFR47 Part 15 & RSS-210

**Purpose of Test** : Certification

**FCCID** : M2H103

**Certification Number** : 11994A-C2H103

**Authorised by** :



: Radio Product Manager

**Issue Date** : 1<sup>st</sup> September 2014

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**Section 1:****Introduction****1.1 General**

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

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## **1.2 Tests Requested By**

This testing in this report was requested by :

Lodar  
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GB  
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## **1.3 Manufacturer**

As Above

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 17<sup>th</sup> – 25<sup>th</sup> April 2014

103-12

The 103-12 is periodically operated device transmitting at 433.4 MHz

## 1.5 Test Result Summary

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

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

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

Test Type	Regulation		Measurement standard	Result
	Title 47 of the CFR: Part 15 Subpart (c)	RSS-210 Issue 8 December 2010		
Spurious Emissions Radiated <1000MHz	15.231b & 15.209	Annex 1 A1.1 RSS-Gen 4.9	ANSI C63.10 RSS-Gen	Pass
Spurious Emissions Radiated >1000MHz	15.231b & 15.209	Annex 1 A1.1 RSS-Gen 4.9	ANSI C63.10 RSS-Gen	Pass
AC Power conducted emissions	15.207	RSS-Gen Issue 3 7.2.4	ANSI C63.10 RSS-Gen	N/A
Intentional Emission Frequency	15.231a	Annex 1 A1.1	ANSI C63.10 RSS-Gen	Pass
Intentional Emission Field Strength	15.231b	Annex 1 A1.1	ANSI C63.10 RSS-Gen	Pass
Intentional Emission Band Occupancy	15.215c	RSS-Gen Issue 3 4.6	ANSI C63.10 RSS-Gen	Pass
Intentional Emission ERP (mW)	N/A	N/A	ANSI C63.10 RSS-Gen	N/A
Unintentional Radiated Spurious Emissions	15.109	RSS-Gen Issue 3 4.10	ANSI C63.10 RSS-Gen	N/A
Antenna Arrangements Integral:	15.203	RSS-Gen Issue 3 7.1.2	-	N/A
Antenna Arrangements External Connector	15.204	RSS-Gen Issue 3 7.1.2	-	Pass
Restricted Bands	15.205	RSS-Gen Issue 3 7.2.2	-	Pass
Maximum Frequency of Search	15.33	RSS-Gen Issue 3 4.9	-	Pass
Extrapolation Factor	15.31(f)	RSS-Gen Issue 3 7.2.7	-	Pass

Abbreviations used in the above table:

CFR : Code of Federal Regulations  
REFE : Radiated Electric Field Emissions

ANSI : American National Standards Institution  
PLCE : Power Line Conducted Emissions

## **1.6 Notes Relating To The Assessment**

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

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

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

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

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

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

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

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

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

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

## **1.7 Deviations from Test Standards**

There were no deviations from the standards tested to.

**Section 2:****Measurement Uncertainty****2.1 Measurement Uncertainty Values**

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

**Radio Testing – General Uncertainty Schedule**

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

**[1] Adjacent Channel Power**

Uncertainty in test result = **1.86dB**

**[2] Carrier Power**

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

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

**[3] Effective Radiated Power**

Uncertainty in test result = **4.71dB**

**[4] Spurious Emissions**

Uncertainty in test result = **4.75dB**

**[5] Maximum frequency error**

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

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

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

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

**[7] Frequency deviation**

Uncertainty in test result = **3.2%**

**[8] Magnetic Field Emissions**

Uncertainty in test result = **2.3dB**

**[9] Conducted Spurious**

Uncertainty in test result – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result – Up to 26GHz = **3.14dB**

**[10] Channel Bandwidth**

Uncertainty in test result = **15.5%**



**[11] Amplitude and Time Measurement – Oscilloscope**

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

**[12] Power Line Conduction**

Uncertainty in test result = **3.4dB**

**[13] Spectrum Mask Measurements**

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

**[14] Adjacent Sub Band Selectivity**

Uncertainty in test result = **1.24dB**

**[15] Receiver Blocking – Listen Mode, Radiated**

Uncertainty in test result = **3.42dB**

**[16] Receiver Blocking – Talk Mode, Radiated**

Uncertainty in test result = **3.36dB**

**[17] Receiver Blocking – Talk Mode, Conducted**

Uncertainty in test result = **1.24dB**

**[18] Receiver Threshold**

Uncertainty in test result = **3.23dB**

**[19] Transmission Time Measurement**

Uncertainty in test result = **7.98%**

## **Section 3:**

## **Modifications**

### **3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment

## Section 4

## General Test Procedures

### 4.1 Radiated Test Setup and Procedures

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

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

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

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

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

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

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

where

PR is the power recorded on receiver / spectrum analyzer (dBuV)

AF is the test antenna factor in dB/m,

CL is the cable loss in dB,

PA is the pre-amplifier gain dB, (when applicable)

DC is duty correction factor (when applicable) in dB, and

CF is a distance correction (employed only if 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 (mutil 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 are made on frequencies identified from the preview scans and fundamental emission(s). Measurements 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  $10^0$  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 transmitters 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 ( eg. FHSS timing) the measurement can only be made

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 (eg 6dB, 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 Transmitter Intentional Emission Radiated**

Carrier power was verified with the EUT transmitting Test Details:	
Regulation	Part 15 Clause 15.231(b), RSS-210 Annex 1 A1.1
Measurement standard	ANSI C63.10:2009, RSS-Gen
EUT sample number	S15
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

FREQ. (MHz)	DETECTOR TYPE	MEASUREMENT Rx. READING (dBµV)	CABLE LOSS (dB)	ANT FACTOR (dB/m)	FIELD STRENGTH (dBµV/m)	DUTY CYCLE CORRECTION (dB)	FIELD STRENGTH (mV/m)
433.43	Peak	66.8	2.5	16.4	85.7	-	19.28
433.43	Average	66.8	2.5	16.4	85.7	6.6	9.02
Limit value @ fc			Peak			109.9 mV/m	
			Average			10.99 mV/m	

- Notes:**
- 1 Results quoted are extrapolated as indicated
  - 2 Receiver detector @ fc = Peak 120kHz bandwidth as per 15.231(b)(2)
  - 3 As average measurements are performed peak requirements of 15.35 apply
  - 4 When battery powered the EUT was powered with new batteries
  - 5 Limit = Linear interpolation 260MHz = 1500 µV/m / 470MHz = 5000µV/m
  - 6 See Appendix E for duty cycle correction

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

**A2 Occupied Bandwidth**

Carrier power was verified with the EUT transmitting Test Details:	
Regulation	Part 15 Clause 15.215(c), RSS-GEN Section 4.9
Measurement standard	ANSI C63.10:2009, RSS-Gen
EUT sample number	S15
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

Band occupancy @ -20 dBc		
Fc	f lower	f higher
433.428717	433.4183	433.438813
Band occupancy @ -20 dBc		20.5128204 kHz
Limit		
The 99% bandwidth shall be no wider than 0.25% of the centre frequency		1.08 MHz

Band occupancy @ 99%		
Fc	f lower	f higher
433.418077 MHz	433.407179 MHz	433.430416 MHz
Band occupancy @ 99%		23.237179 kHz
Limit		
The 99% bandwidth shall be no wider than 0.25% of the centre frequency		1.08 MHz



**A3 Timing**

Carrier power was verified with the EUT transmitting Test Details:	
Regulation	Part 15 Clause 15.231(a), RSS-210 Annex 1 A1.1.1
Measurement standard	ANSI C63.10:2009, RSS-Gen
EUT sample number	S16
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

Activation type	Timing	Limit
Manual Activation TX After Manual Release	83.33 ms	Automatically deactivate the transmitter within not more than 5 seconds of being released

See Appendix B for plots

EUT does not utilise supervision transmissions

EUT does not automatically transmit

The result above is based on the longest observed time over multiple trigger cycles.

**A4 Radiated Electric Field Emissions**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to all spurious emissions and harmonics emissions. The EUT was set to transmit as required.

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

3m open area test site : ☐

3m alternative test site : ☒

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

Test Details:	
Regulation	Part 15 Clause 15.231(b) & 15.209, RSS-210 Annex 1 A1.1 RSS-Gen 4.9
Measurement standard	ANSI C63.10:2009, RSS-Gen
Frequency range	S15
EUT sample number	0
Modification state	None
SE in test environment	None
SE isolated from EUT	Refer to Appendix C
EUT set up	1 & 2
Photographs (Appendix F)	S15

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)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1 (Pk)	3467.315	51.94	3	30.8	35.9	49.84	-	310.46	5000
2 (Av)	3467.315	40.26	3	30.8	35.9	38.16	-	80.91	500

**Notes:**

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

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

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

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

Frequency of emission (MHz)	Field strength $\mu\text{V/m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V/m}$
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:

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

- (b) The levels may have been rounded for display purposes.
- (c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

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

**A5 Unintentional Radiated Emissions**

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

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

3m open area test site : ☐ 3m alternative test site : ☒

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

Test Details:	
Regulation	Part 15 Clause 15.109, RSS-Gen 4.10
Measurement standard	ANSI C63.10:2009, RSS-Gen
Frequency range	S15
EUT sample number	0
Modification state	None
SE in test environment	None
SE isolated from EUT	Refer to Appendix C
EUT set up	1 & 2
Photographs (Appendix F)	S15

The worst case radiated emission measurements for spurious emissions 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)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1	No Significant Emissions were detected.								

**Notes:**

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

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

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

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

Frequency of emission (MHz)	Field strength $\mu\text{V/m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V/m}$
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:

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

- (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 :

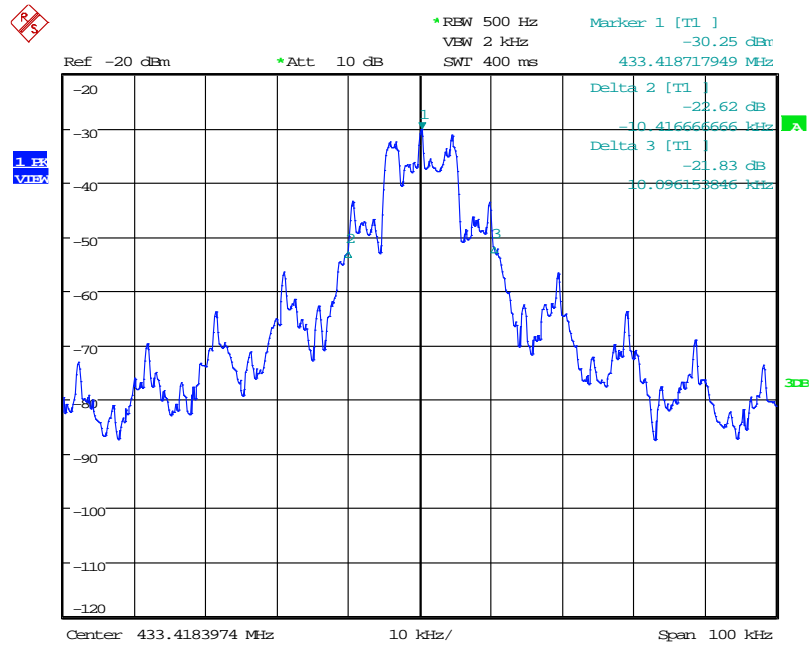
	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓	✓	✓	✓
Effect of EUT internal configuration on emission levels	✓	✓	✓	✓
Effect of Position of EUT cables & samples on emission levels	✓	✓	✓	✓
(i) Parameter defined by standard and / or single possible, refer to Appendix 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.

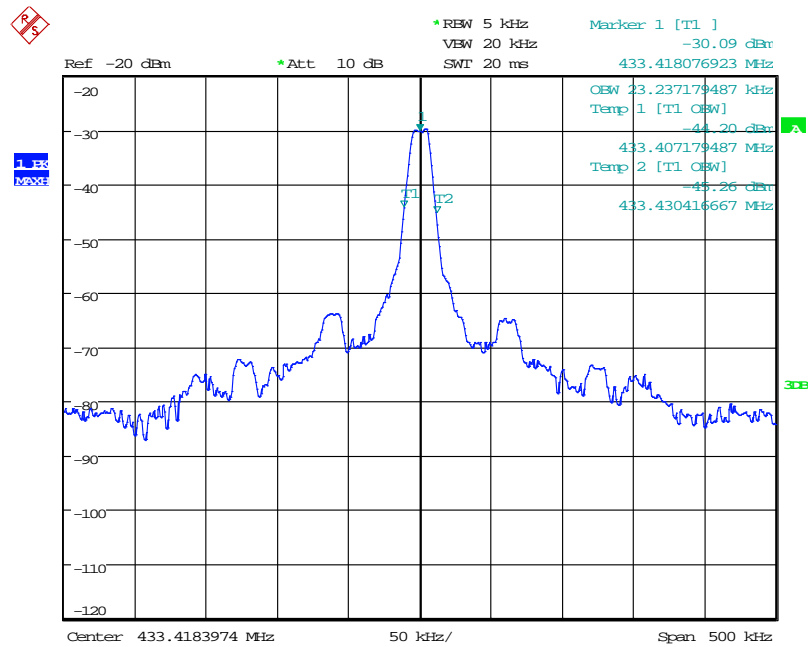
Notes:

- (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.



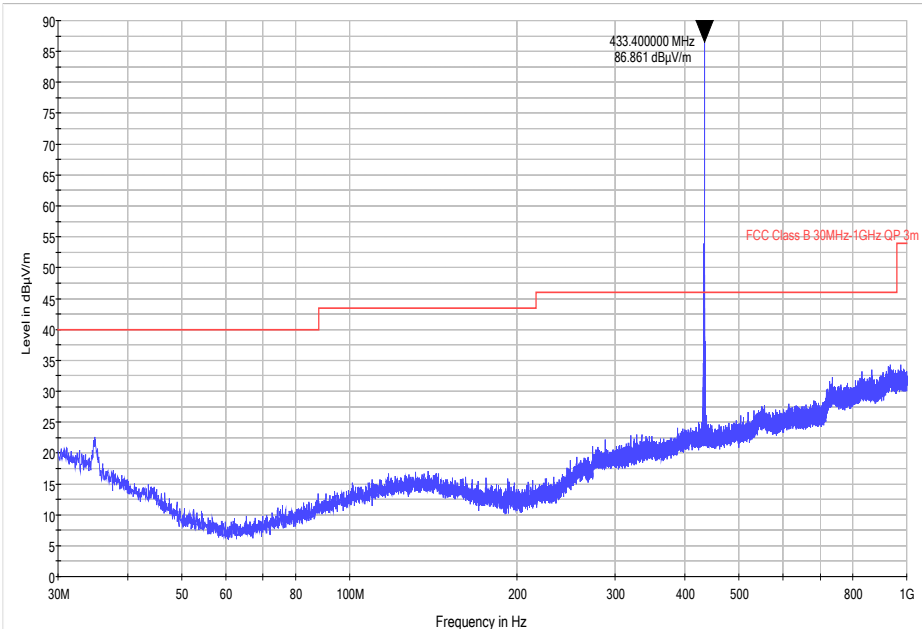
Date: 25.APR.2014 15:40:53

## 20dB Bandwidth

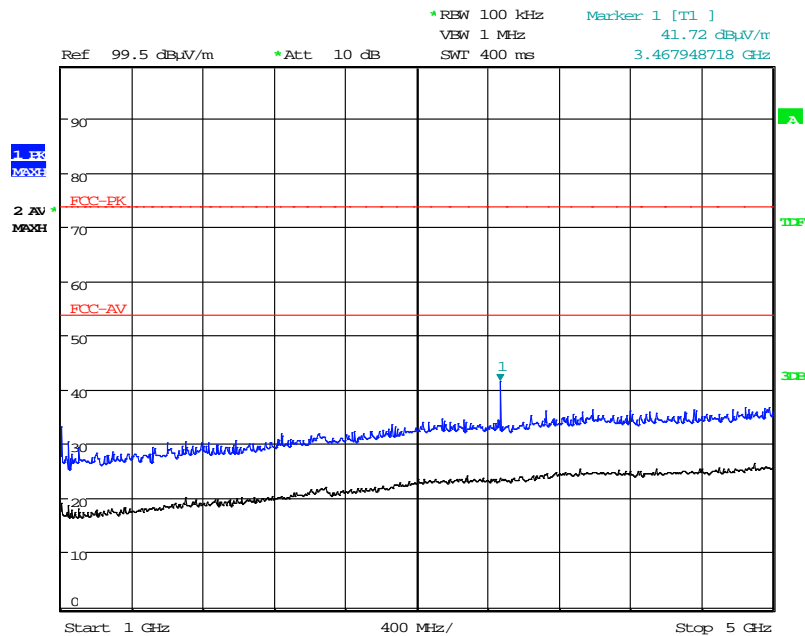


Date: 25.APR.2014 15:39:13

## 99% Bandwidth



Radiated spurious emissions 30 MHz to 1 GHz

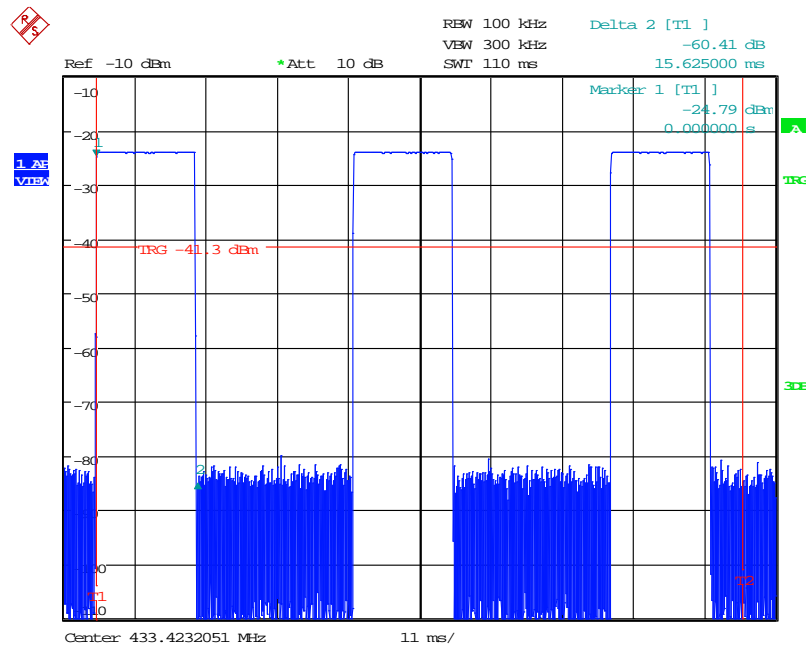


Date: 22.APR.2014 11:31:46

Radiated spurious emissions 1 GHz to 5 GHz

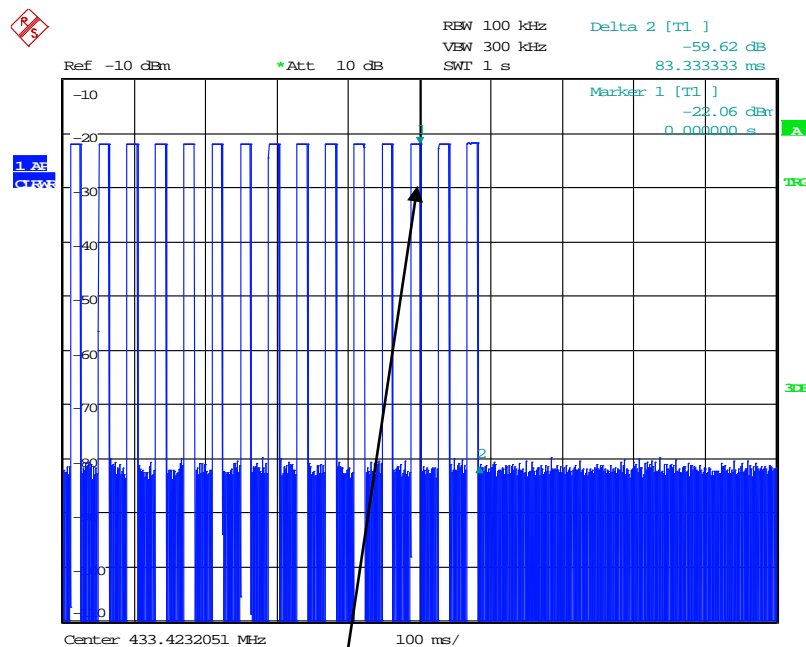


Ton – 100 ms Period



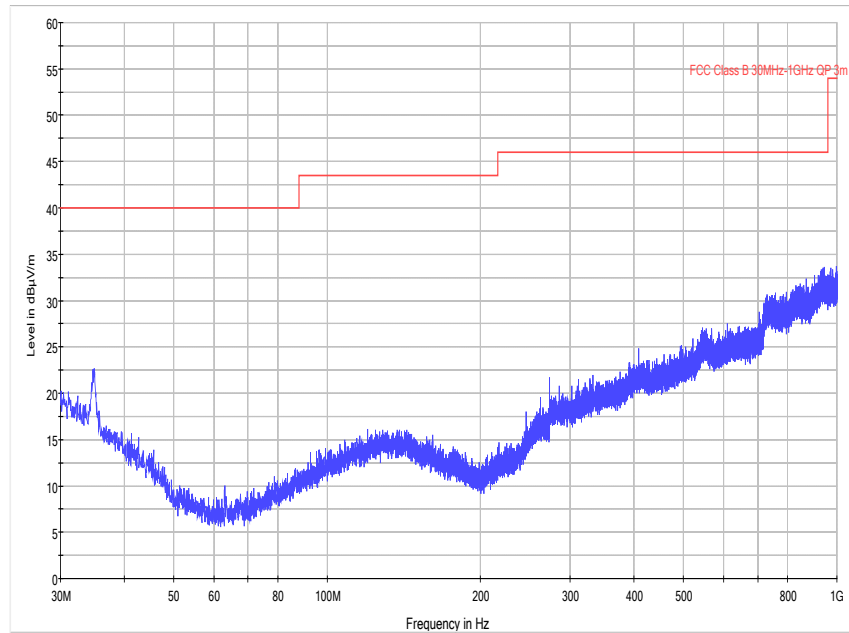
Date: 25.APR.2014 15:06:39

### Manual Trigger - Switch off after Button Release

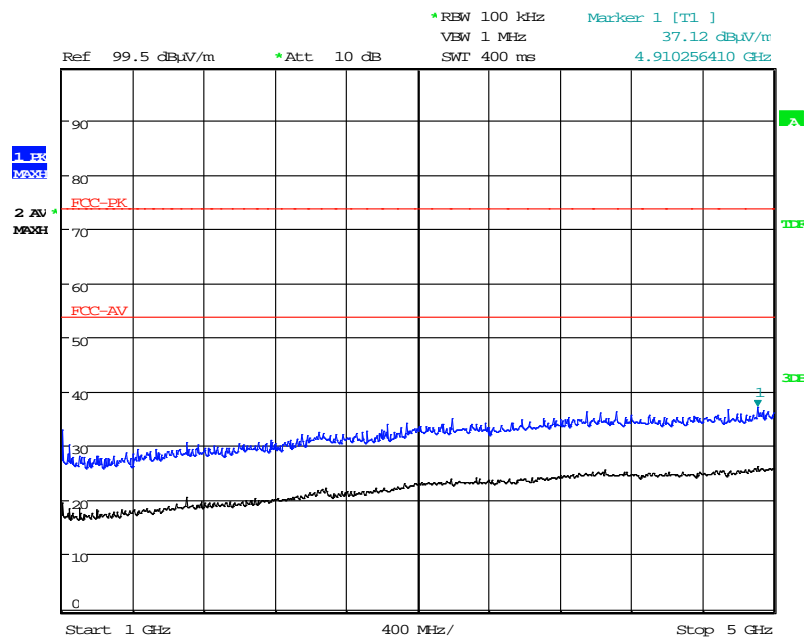


Date: 25.APR.2014 13:57:58

## Button Release



### Unintentional Radiated spurious emissions 30 MHz to 1 GHz



Date: 22.APR.2014 11:35:16

### Unintentional Radiated spurious emissions 1 GHz to 5 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
S15	103-12 (Permanent TX)	#15
S16	103-12 (Normal operation)	#16

**C2) EUT Operating Mode During Testing.**

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

Test	Description of Operating Mode:
All Transmitter Tests	EUT active and transmitting

Test	Description of Operating Mode:
Unintentional Radiated Spurious emissions	EUT active but non-transmitting.

**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 : S15  
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
None			

\* Only connected during setup.

**C5 Details of Equipment Used**

TRAC Ref	Type	Description	Manufacturer	Date Calibrated.	Calibration Period	Due For Calibration
TRLUH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
TRL138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
TRL139	3115	1-18GHz Horn	EMCO	20/09/2013	24	20/09/2015
TRL572	8449B	Pre Amp	Agilent	11/02/2014	12	11/02/2015
TRLUH004	ESVS10	Receiver	R&S	27/02/2014	12	27/02/2015
TRLUH093	CBL6112B	Bilog	Chase	08/07/2013	24	08/07/2015



**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 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 =  $20 \times (\text{Log}_{10} \text{ Calculated Duty Cycle})$

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

Ton = 15.625 ms  
TX in 100 ms Period = 3  
TX in 100 ms Period =  $3 \times 15.625 \equiv 46.875\text{ms}$

$$= \frac{46.875\text{ms}}{100\text{ms}} = 0.46875$$

0.46875 or 46.875%

Correction factor (dB) =  $20 \times (\text{Log}_{10} 0.46875) = -6.6\text{dB}$

## **Appendix F:**

## **Photographs and Figures**

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: 103-12 Overview.
2. Radiated electric field emissions arrangement: 103-12 Close up.



Photograph 1



Photograph 2

**Appendix G:****MPE Calculation****KDB 447498****47 CFR §§1.1307 and 2.1091**

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 1mW/cm<sup>2</sup> power density limit, as required under FCC rules.

**Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

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

where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP figure was calculated from the peak field strength figure quoted on page 12.

Result

Prediction Frequency (MHz)	Maximum EIRP	Power density limit (S) (mW/cm <sup>2</sup> )	Distance (R) cm required to be less than 0.289mW/cm <sup>2</sup>
433.43	0.0068 mW	0.289	0.14

**Appendix H:****Variants**

<b>Model</b>	<b>Tested</b>	<b>Variation from tested Model</b>
103-1	No	Identical PCB, Smaller Enclosure, Less Buttons
103-2	No	Identical PCB, Smaller Enclosure, Less Buttons
103-4	No	Identical PCB, Smaller Enclosure, Less Buttons
103-6	No	Identical PCB, Smaller Enclosure, Less Buttons
103-8	No	Identical PCB, Smaller Enclosure, Less Buttons
103-10	No	Identical PCB, Smaller Enclosure, Less Buttons
103-12	Yes	N/A
103-14	No	Identical PCB, Identical Enclosure, More Buttons
103-16	No	Identical PCB, Identical Enclosure, More Buttons

