

Report on the Radio Testing
For
Buddi Limited
on
SmartTag Location
Report no. TRA-021068-08-47-00B
17th August 2016

Report Number: TRA-021068-08-47-00B
Issue: B

REPORT ON THE RADIO TESTING OF A
Buddi Limited
SmartTag Location
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.249 & IC RSS-210 Annex 2.9

TEST DATE: 1st - 9th February 2016

Written by: D Winstanley

D Winstanley
Radio Senior Test Engineer

Approved by:

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Department Manger - Radio

Date: 17th August 2016

Disclaimers:



- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
- [2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF922 2.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	23 rd February 2016	Original
B	17 th August 2016	Update to name and model number

2 Summary

TEST REPORT NUMBER:	TRA-021068-08-47-00B
WORKS ORDER NUMBER	TRA-021068-08
PURPOSE OF TEST:	<p>USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.</p> <p>Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radio communication Act and 21(1) of the Radio communication Regulations.</p>
TEST SPECIFICATION(S):	47CFR15.249 & RSS-210 Annex 2.9
EQUIPMENT UNDER TEST (EUT):	SmartTag Location
FCC IDENTIFIER:	ZDLST2
IC NUMBER:	20371-ST2
EUT SERIAL NUMBER:	not applicable
MANUFACTURER/AGENT:	Buddi Limited
ADDRESS:	Talbot House 17 Church Street Rickmansworth Hertfordshire WD3 1DE
CLIENT CONTACT:	<p>Charles Lewinton</p> <p></p> <p> charles@buddi.co.uk</p>
ORDER NUMBER:	Not Applicable
TEST DATE:	1st - 9th February 2016
TESTED BY:	D Winstanley Element

2.1 Test Summary

Test Method and Description	Requirement Clause		Applicable to this equipment	Result / Note
	RSS	47CFR15		
Radiated spurious emissions	210, A2.9(b)	15.249(d)	☒	Pass
AC power line conducted emissions	Gen, 8.8	15.207	☒	Pass
Occupied bandwidth	Gen, 6.6	15.215(c)	☒	Pass
Field strength of fundamental	210, A2.9(a)	15.249(a)	☒	Pass
Calculation of duty correction ¹	-	15.35(c)	☒	N/A

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, 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. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-021068-08-47-00B presents the results of the Radio testing on a Buddi Limited, SmartTag Location to specification 47CFR15 Radio Frequency Devices and RSS-210 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for Buddi Limited by Element, at the address(es) detailed below.

<input type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input checked="" type="checkbox"/>	Element Skelmersdale Unit 1 Pendle Place Skemersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

IC Registration Number(s):

Element North West 3930B

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- Industry Canada RSS-210, Issue 8, December 2010 – Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
- Industry Canada RSS-Gen, Issue 4, November 2014 – General Requirements for Compliance of Radio Apparatus.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: SmartTag Location
- Serial Number: not applicable
- Model Number: S1-BUD-B-TE2RA-WIUS
- Software Revision: 1.5
- Build Level / Revision Number: Production

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Sample Number: S1
Type Of Equipment: on body charger
Part Number: T5-SMS-OBCHBK-D

Sample Number: S2
Type Of Equipment: Power Supply for on body charger

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows...

Transmitting a modulated carrier on top and bottom operating frequencies at 100 % duty cycle.
Transmitting in normal operation for duty cycle measurements.

7.3.2 Reception

Not Applicable. Standby mode only.

7.4 EUT Radio Parameters

7.4.1 General

Frequencies of operation:	914.5 MHz and 921.0 MHz
Modulation type(s):	FSK
Occupied channel bandwidth(s):	70kHz
Channel spacing:	Not Applicable, Wideband
ITU emission designator(s):	70k0F1D
Nominal Supply Voltage:	3.7Vdc
Duty cycle:	5.75%

7.4.2 Antennas

Type:	Integral PCB
Frequency range:	914.5 MHz – 921.0 MHz
Impedance:	50Ohms
Polarisation:	Omni directional
Connector type:	Integral – Not Applicable

7.5 EUT Description

The EUT is Offender monitoring tag with Wi-Fi

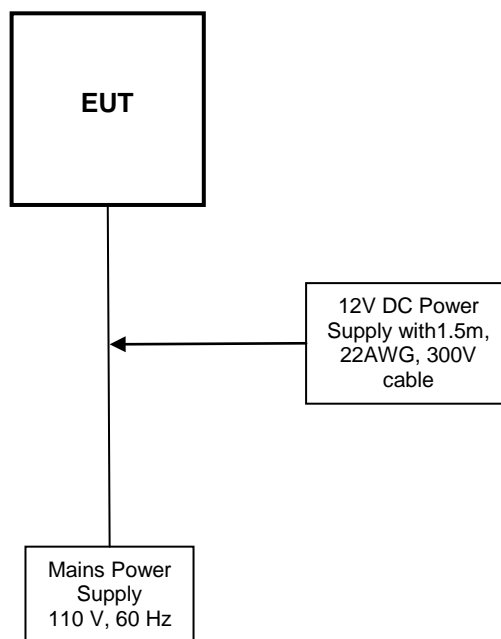
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was batteries and power supply with charger to connect to 110 V ac, 60 Hz, from the mains.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

	Category	Nominal	Variation
<input type="checkbox"/>	Mains	110 V ac +/- 2 %	85 % and 115 %
<input checked="" type="checkbox"/>	Battery	Fully Charged	N/A

11 Radiated emissions

11.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions

Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	914.5 MHz and 921
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

11.3 Test Limit

Except for harmonics, out-of-band emissions shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits listed in FCC 47CFR15.209 / RSS-Gen {see table below}, whichever is less stringent.

Harmonics shall be limited to a maximum level of 0.5 mV/m measured at 3 metres.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3 m)</i>
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

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. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

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).

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 degrees 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dB μ V/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB μ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

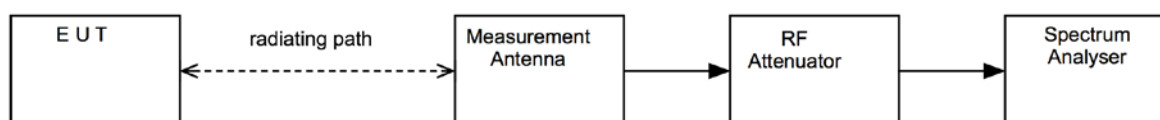
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

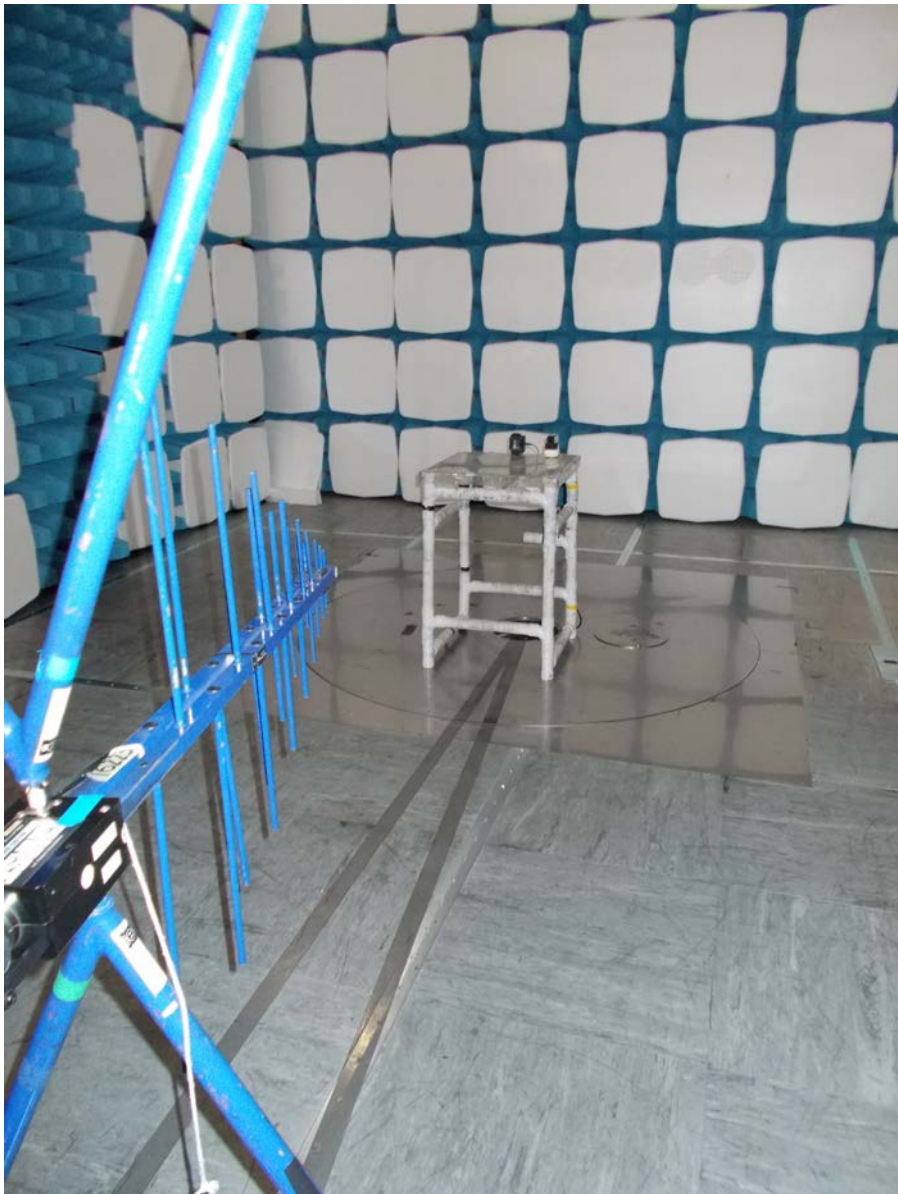
CF is the distance factor in dB (where measurement distance different to limit distance);

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

Figure i Test Setup



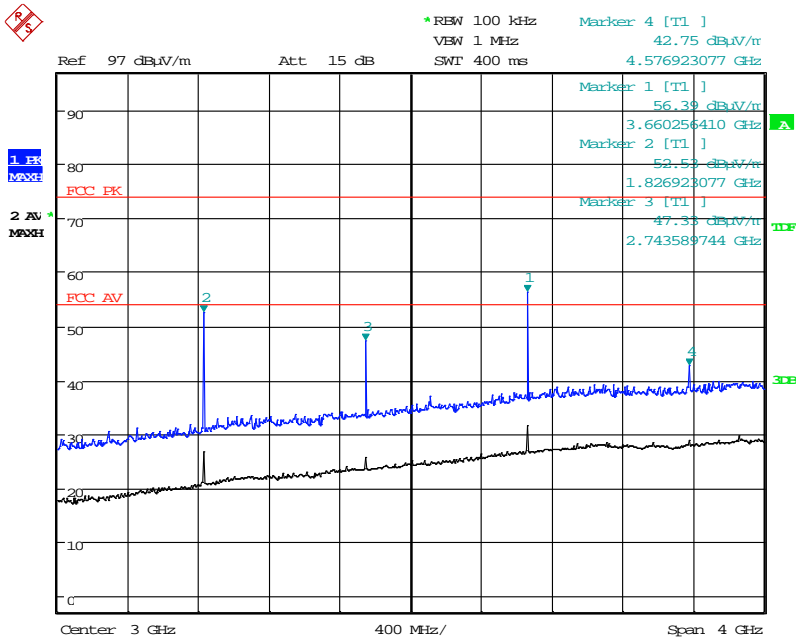
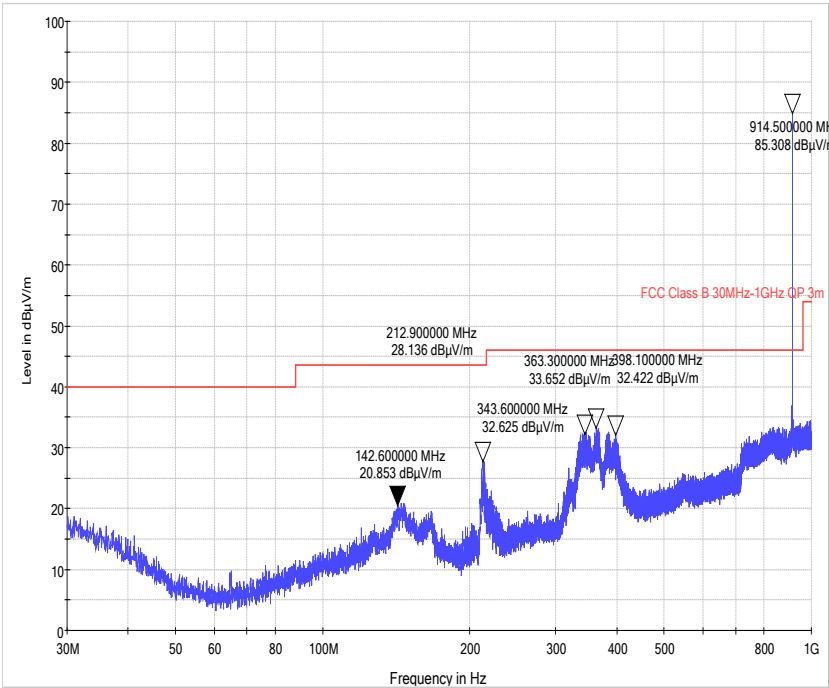
11.5 Test Set-up Photograph



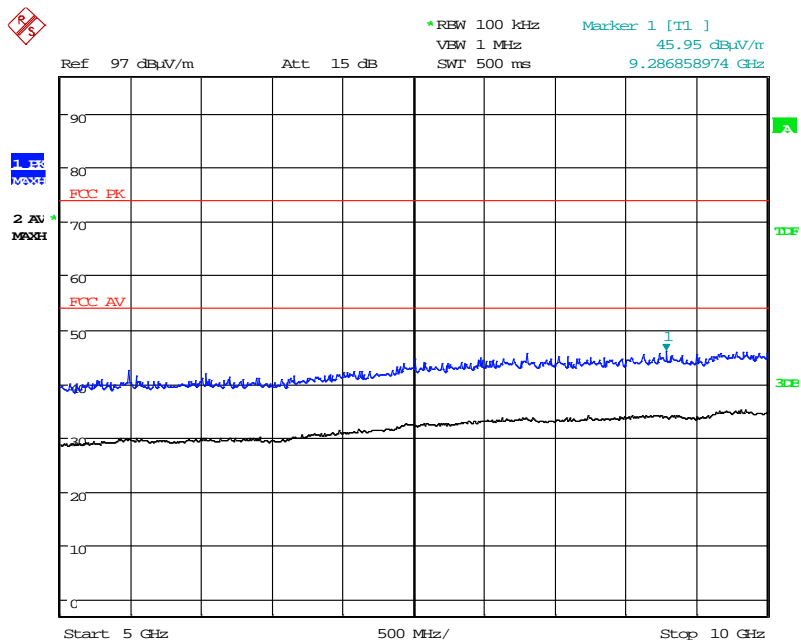
11.6 Test Equipment

<i>Type of Equipment</i>	<i>Maker/Supplier</i>	<i>Model Number</i>	<i>Element Number</i>	<i>Calibration Due Date</i>	<i>Calibration Interval</i>
Bilog	Chase	CBL611/A	UH191	26/02/2017	24
ESVS10	R&S	ESVS10	L352	07/08/2016	12
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016	12
Horn Antenna	EMCO	3115	TRL139	25/09/2017	24
Pre-Amplifier	Agilent	8449B	TRL572	10/02/2016	12

11.7 Test Results

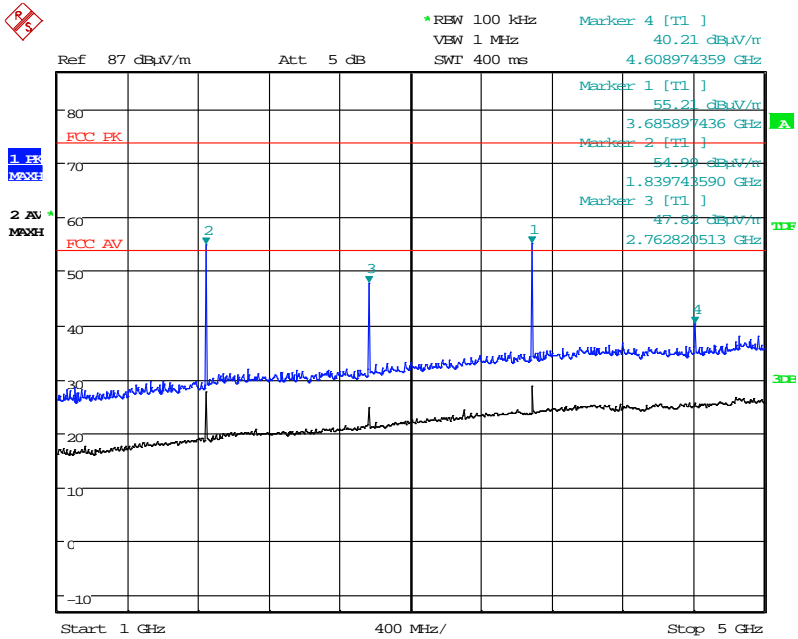
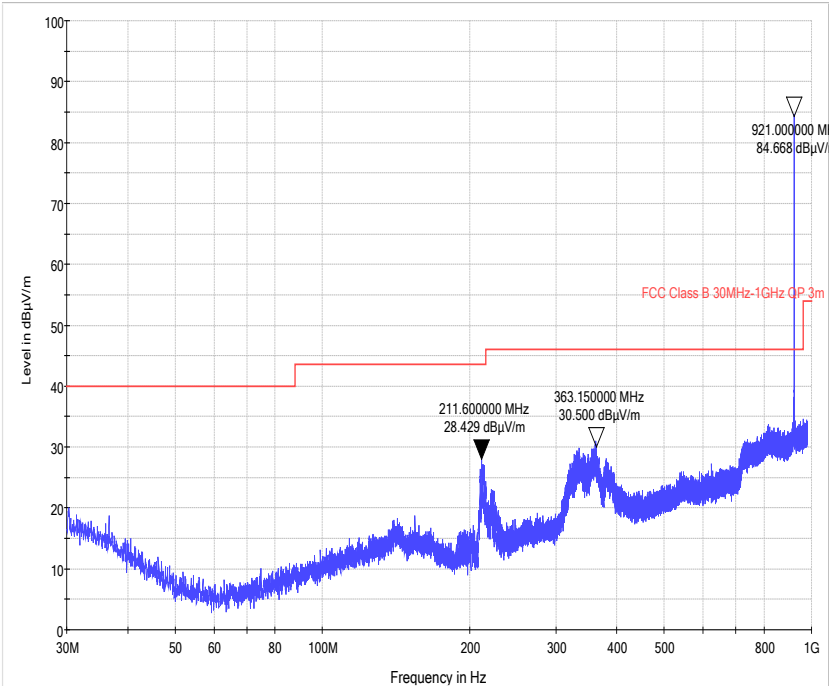


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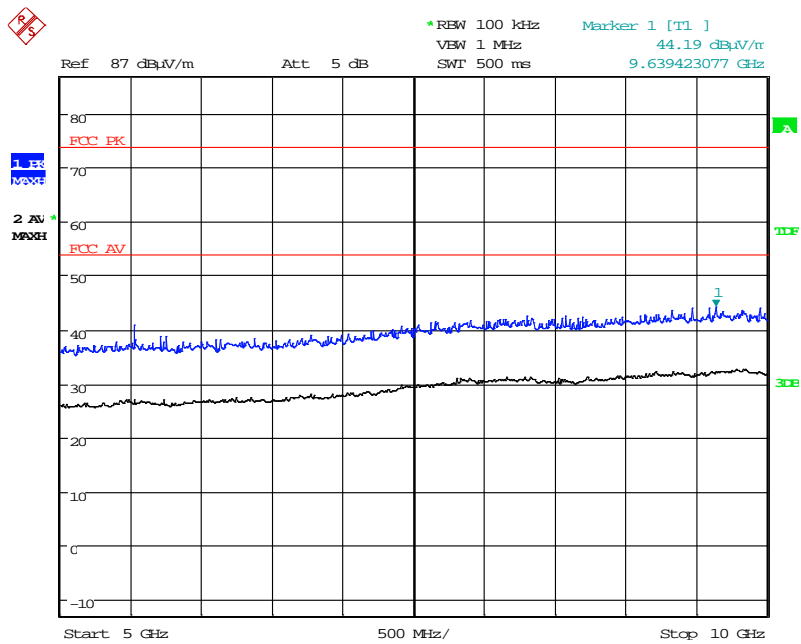


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High Power; Channel: 914.5 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
Pk	1829.006	65.10	3.0	27.1	36.37	0.00	0.00	58.83	873.98	5012
Av	1829.006	65.10	3.0	27.1	36.37	24.81	0.00	34.02	50.23	500
Pk	2743.509	55.67	3.2	29.0	36.12	0.00	0.00	51.75	386.81	5012
Av	2743.509	55.67	3.2	29.0	36.12	24.81	0.00	26.94	22.23	500
Pk	3657.852	59.77	3.7	31.7	35.94	0.00	0.00	59.23	915.17	5012
Av	3657.852	59.77	3.7	31.7	35.94	24.81	0.00	34.42	52.60	500
Pk	4572.499	52.53	4.2	32.5	35.95	0.00	0.00	53.28	461.32	5012
Av	4572.499	52.53	4.2	32.5	35.95	24.81	0.00	28.47	26.52	500



Date: 5.FEB.2016 11:38:52



Date: 5.FEB.2016 11:37:23

High Power; Channel: 921 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
Pk	1841.891	66.58	2.7	27.2	36.36	0.00	0.00	60.12	1013.91	5012
Av	1841.891	66.58	2.7	27.2	36.36	24.81	0.00	35.31	58.28	500
Pk	2762.98	56.45	3.3	29.1	36.11	0.00	0.00	52.74	433.51	5012
Av	2762.98	56.45	3.3	29.1	36.11	24.81	0.00	27.93	24.92	500
Pk	3683.974	61.90	3.7	31.7	35.91	0.00	0.00	61.39	1173.55	5012
Av	3683.974	61.90	3.7	31.7	35.91	24.81	0.00	36.58	67.45	500
Pk	4604.967	52.11	4.2	32.6	35.94	0.00	0.00	52.97	445.14	5012
Av	4604.967	52.11	4.2	32.6	35.94	24.81	0.00	28.16	25.59	500

12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	914.5 MHz
Deviations From Standard:	None
Measurement BW:	9 KHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac $\pm 10\%$ (as declared)

12.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	Conducted limit (dB μ V)	
	Quasi-Peak	Average**
0.15 to 0.5	66 to 56	56 to 46
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.

**A linear average detector is required.

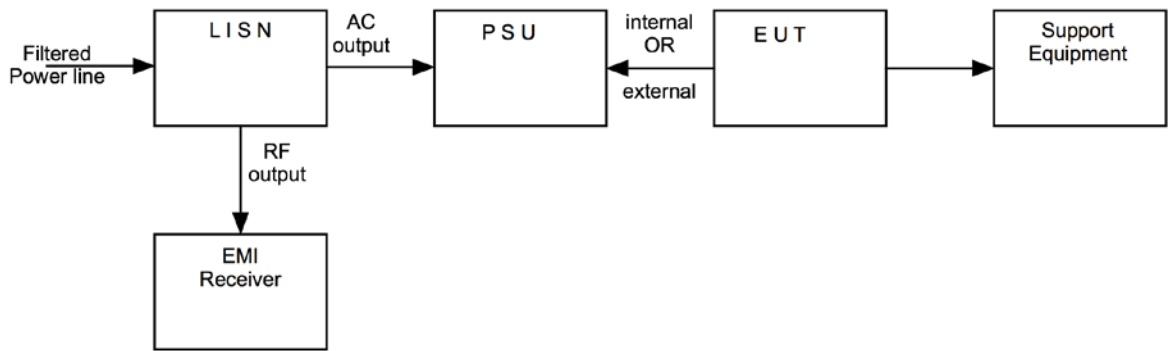
12.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



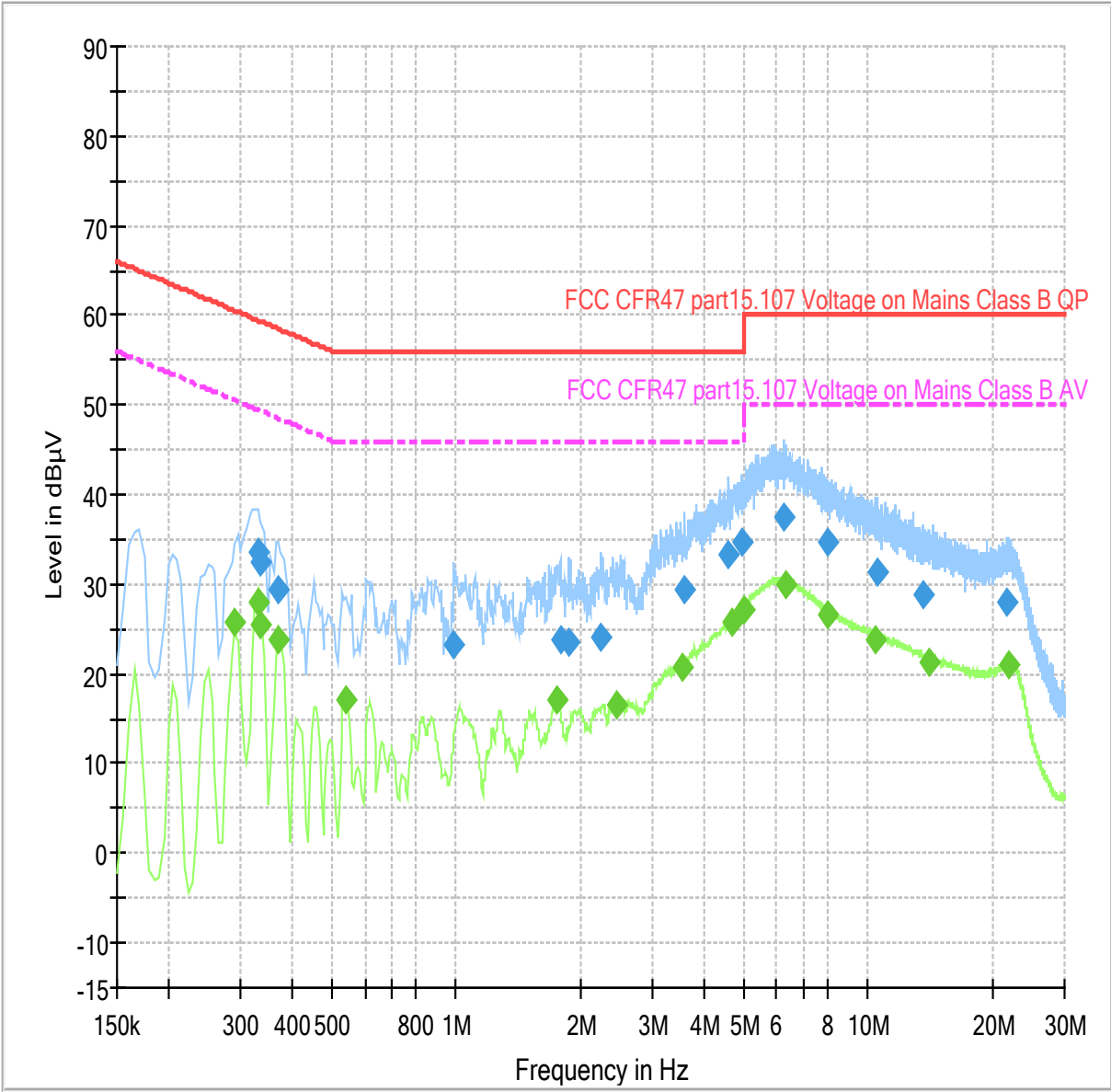
12.5 Test Set-up Photograph



12.6 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
LISN	R&S	ESH3-Z5.831.5	U195	04/06/2016	12
EMI Receiver	R&S	ESHS10	U003	25/06/2016	12

12.7 Test Results



12.8 Final Results 1

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.330000	33.6	2000.0	10.000	GND	L1	0.1	25.9	59.5
0.335000	32.6	2000.0	10.000	GND	N	0.1	26.7	59.3
0.370000	29.4	2000.0	10.000	GND	L1	0.1	29.1	58.5
0.985000	23.2	2000.0	10.000	GND	L1	0.2	32.8	56.0
1.790000	23.9	2000.0	10.000	GND	L1	0.2	32.1	56.0
1.880000	23.7	2000.0	10.000	GND	L1	0.2	32.3	56.0
2.255000	24.2	2000.0	10.000	GND	N	0.2	31.8	56.0
3.585000	29.5	2000.0	10.000	GND	N	0.3	26.5	56.0
4.595000	33.2	2000.0	10.000	GND	N	0.3	22.8	56.0
4.945000	34.7	2000.0	10.000	GND	N	0.4	21.3	56.0
6.260000	37.6	2000.0	10.000	GND	N	0.4	22.4	60.0
8.015000	34.6	2000.0	10.000	GND	N	0.6	25.4	60.0
10.520000	31.4	2000.0	10.000	GND	N	0.7	28.6	60.0
13.590000	28.9	2000.0	10.000	GND	N	1.0	31.1	60.0
21.740000	28.1	2000.0	10.000	GND	N	1.6	31.9	60.0

12.9 Final Results 2

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.290000	25.9	2000.0	10.000	GND	L1	0.1	24.7	50.5
0.330000	27.9	2000.0	10.000	GND	L1	0.1	21.5	49.5
0.335000	25.5	2000.0	10.000	GND	L1	0.1	23.8	49.3
0.370000	23.8	2000.0	10.000	GND	L1	0.1	24.7	48.5
0.540000	17.1	2000.0	10.000	GND	L1	0.1	28.9	46.0
1.755000	17.0	2000.0	10.000	GND	L1	0.2	29.0	46.0
2.445000	16.7	2000.0	10.000	GND	L1	0.2	29.3	46.0
3.545000	20.8	2000.0	10.000	GND	L1	0.3	25.2	46.0
4.670000	25.6	2000.0	10.000	GND	L1	0.4	20.4	46.0
4.995000	27.1	2000.0	10.000	GND	L1	0.4	18.9	46.0
6.280000	30.0	2000.0	10.000	GND	L1	0.5	20.0	50.0
8.020000	26.6	2000.0	10.000	GND	L1	0.6	23.4	50.0
10.465000	23.8	2000.0	10.000	GND	L1	0.8	26.2	50.0
14.060000	21.2	2000.0	10.000	GND	L1	1.2	28.8	50.0
22.065000	20.9	2000.0	10.000	GND	N	1.6	29.1	50.0

13 Occupied Bandwidth

13.1 Definitions

Occupied bandwidth

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the *99 % emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	914.5 MHz and 921.0 MHz
Deviations From Standard:	None
Measurement BW:	1 kHz
Spectrum Analyzer Video BW:	3 kHz
Measurement Span:	345 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 48 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

Industry Canada:

If the frequency stability of the license-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required provided that the occupied bandwidth of the license-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54 to 72 MHz, 76 to 88 MHz, 174 to 216 MHz, 470 to 608 MHz and 614 to 806 MHz.

Federal Communications Commission:

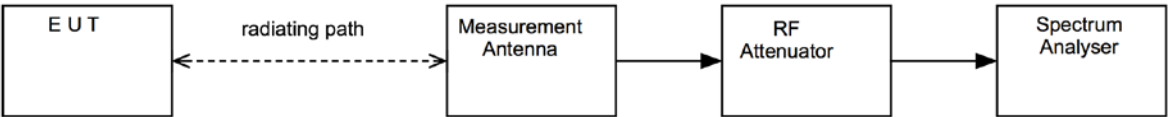
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iii Test Setup

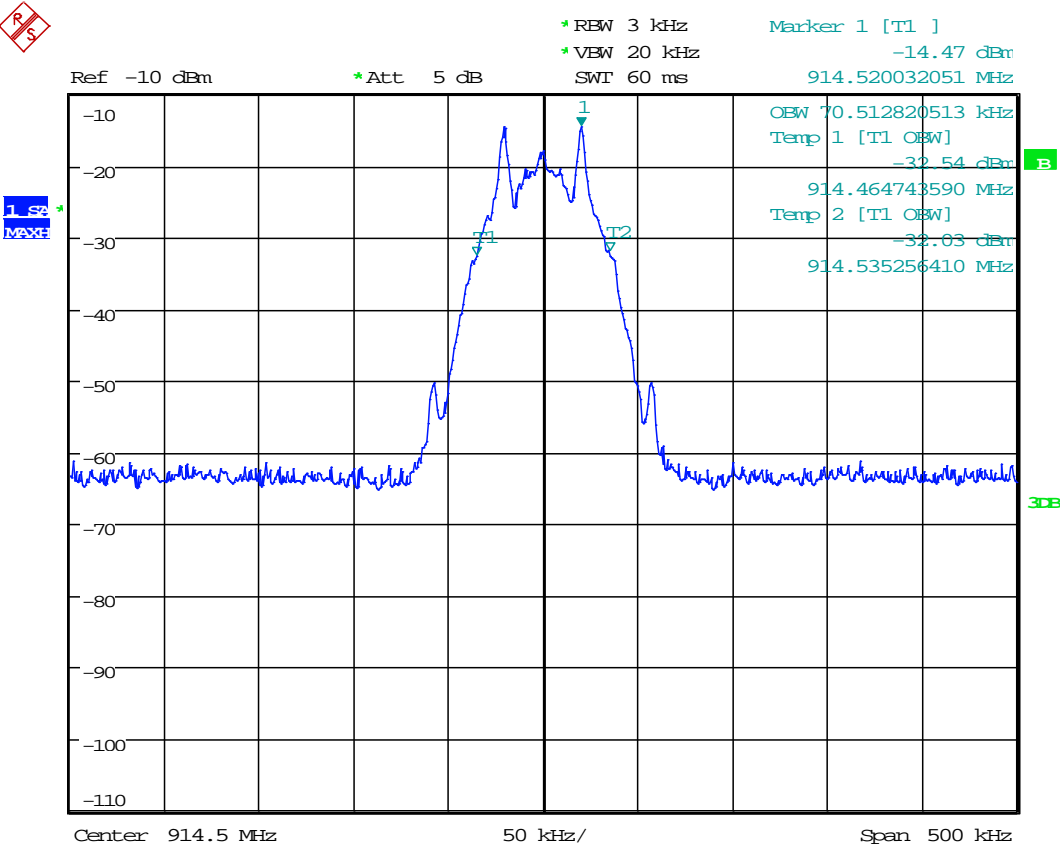


13.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016	12

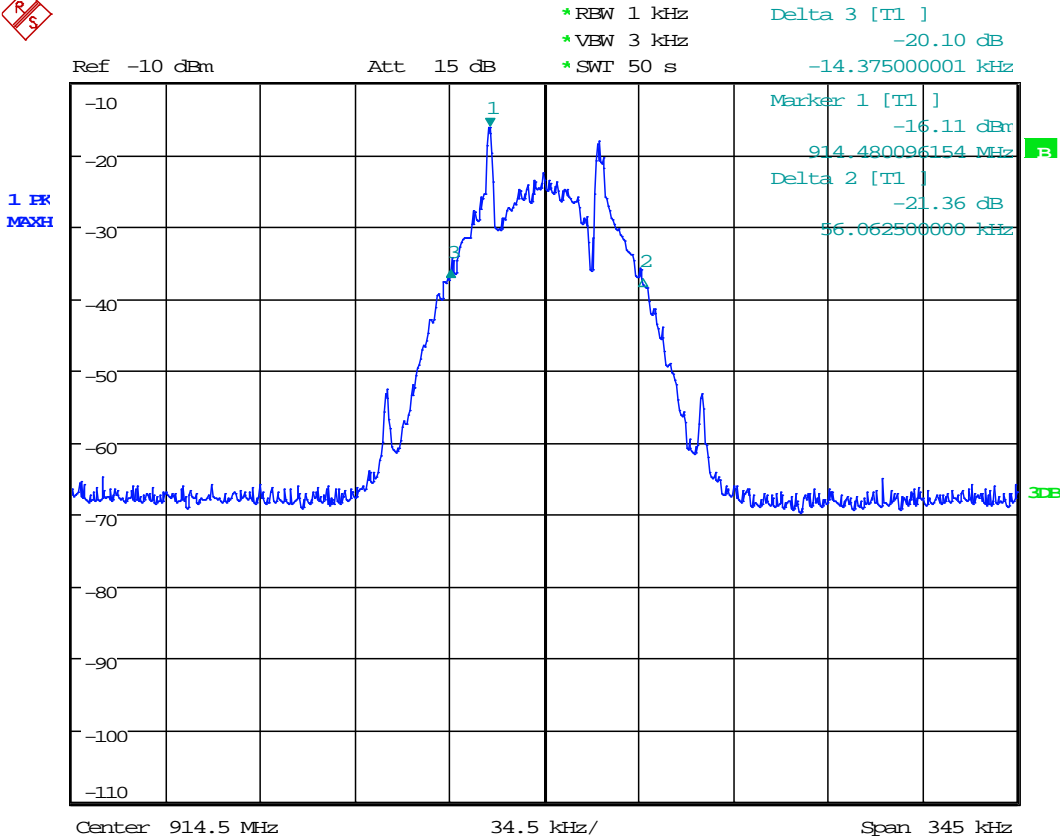
13.6 Test Results

99% Bandwidth Bottom Channel				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	99% Bandwidth (kHz)	Result
914.5	914.464743	914.535256	70.512	PASS



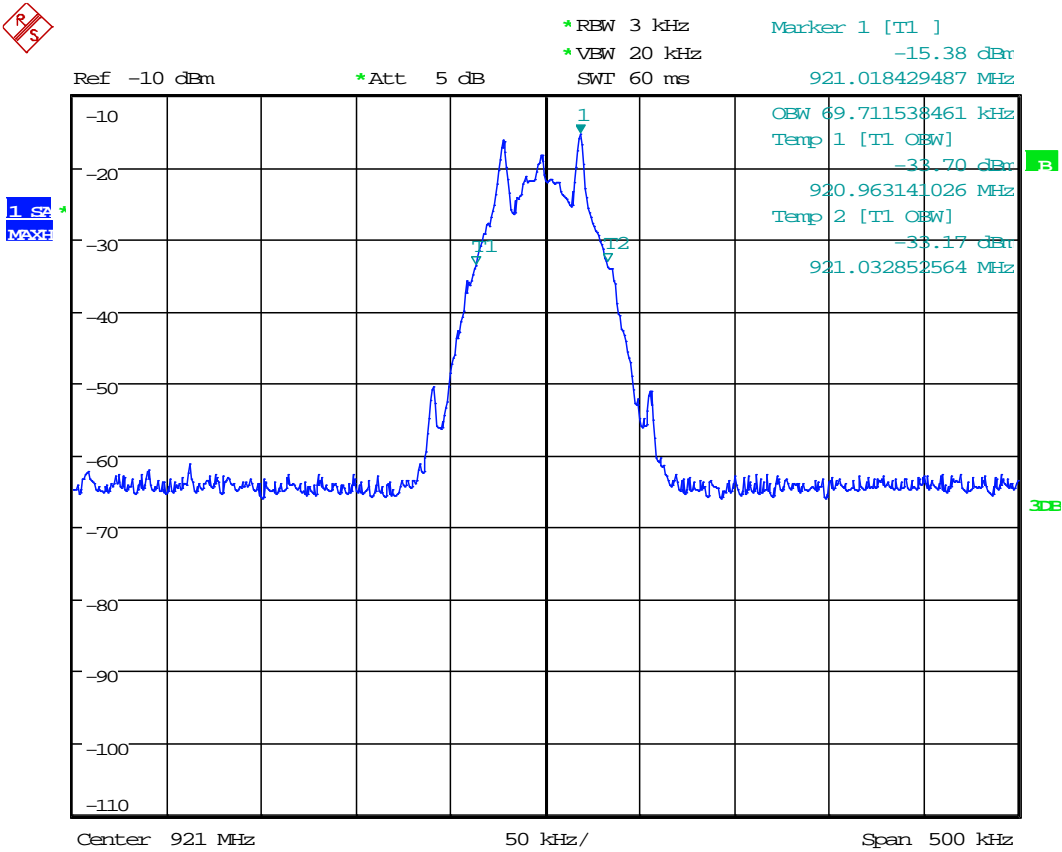
Date: 8.FEB.2016 13:35:23

20 dB Bandwidth Bottom Channel				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	20dB Bandwidth (kHz)	Result
914.5	914.5361587	914.4657212	70.4375	PASS



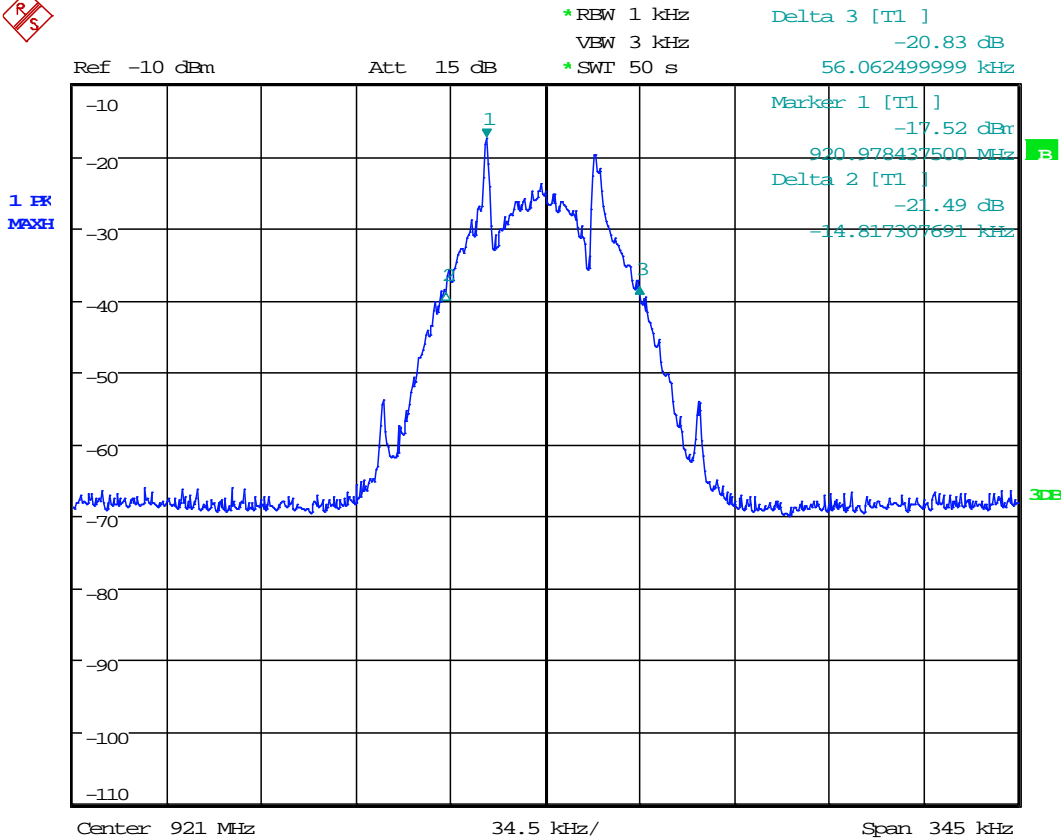
Date: 8.FEB.2016 12:14:35

99% Bandwidth Top Channel				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	99% Bandwidth (kHz)	Result
921.0	920.963141	921.032852	69.7115	PASS



Date: 8.FEB.2016 13:37:29

20 dB Bandwidth Top Channel				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	20dB Bandwidth (kHz)	Result
921	920.9636	921.03450	70.879806	PASS



Date: 8.FEB.2016 12:08:35

14 Transmitter output power (fundamental radiated emission)

14.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	914.5 MHz and 921.0 MHz
Deviations From Standard:	None
Measurement BW:	120 kHz
Measurement Detector:	Up to 1 GHz: Quasi-peak
Voltage Extreme Environment Test Range:	Battery Power = Fully Charged

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

The field strength measured at 3 metres shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

<i>Fundamental frequency (MHz)</i>	<i>Field strength (mV/m at 3 m)</i>	<i>Detector</i>
902 to 928	50	Quasi-Peak

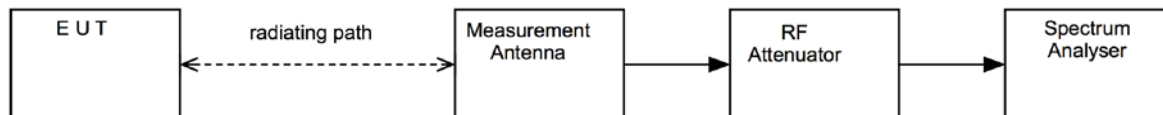
n.b. per FCC 47CFR15.249(e) / RSS-Gen 8.1, peak limit is 20 dB above average.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup



14.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
Bilog	Chase	CBL611/A	UH191	26/02/2017	24
ESVS10	R&S	ESVS10	L352	07/08/2016	12

14.6 Test Results

Channel Frequency (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBuV/m)	Distance Extrap'n Factor (dB)	Field Strength (mV/m)
914.5	60.6	4.1	23.43	N/A	88.13	-	25.5
921.0	59.1	4.1	23.65	N/A	86.85	-	22.0

15 Duty Cycle

15.1 Definition

The ratio of the sum of all pulse durations to the total period, during a specified period of operation. The duty cycle is determined on the basis of one complete pulse train for pulse trains not exceeding 100 milliseconds. Where the pulse train exceeds 100 milliseconds, the duty cycle is determined on the basis of the 100 millisecond interval with the highest average value of emission.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	914.5 MHz and 921.0 MHz
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 48 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

N/A.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the duty of the EUT was calculated from the sum of total on and off times over the observation period.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, bandwidths, data rates and power settings were used to observe the worst-case configuration.

[1] Single antenna output devices

Duty was measured at the antenna port / at a distance of 3 m.

[2] Multiple antenna output devices

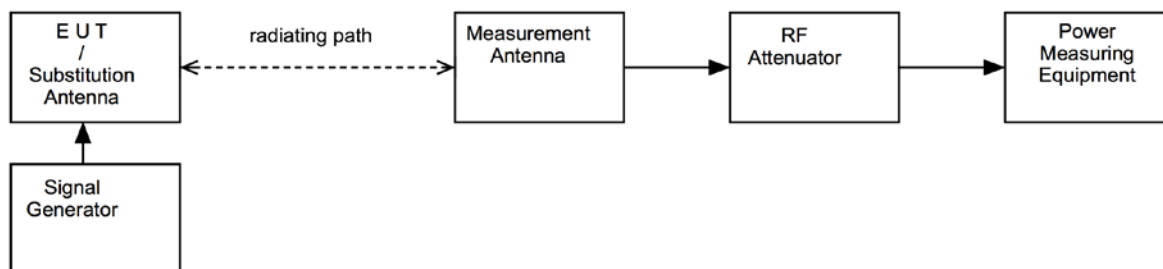
Duty was measured as the combination of all ports simultaneously / at a distance of 3 m.

The duty cycle correction factor, DC, is used to adjust peak emissions (voltage) to give an average value and is calculated by:

$$DC = 20 \log (\text{duty ratio})$$

Where, duty ratio is total on-time divided by total off-time in the worst-case pulse train or 100 ms, whichever is longer.

Figure vii Test Setup



15.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016	12

15.6 Test Results

Test Environment		Single Channel TxOn time (ms)	Total TxOn time (ms)	Observation period (ms)	Duty (%)	Calculated Factor (dB)
V _{nominal}	T _{nominal}	5.75	5.75	100	5.75	24.81

16 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Carrier power

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

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

[2] Spurious emissions

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

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

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113 ppm**

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

[6] Duty cycle

Uncertainty in test result = **7.98 %**