

Report on the Radio Testing
For
AGD Systems Ltd
on
MC-133 Radio Antenna Module
Report no. TRA-0258970-CO04-47-00A
8th January 2016

Report Number: TRA-0258970-CO04-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
AGD Systems Ltd
MC-133 Radio Antenna Module
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.245

TEST DATE: 3rd - 11th November 2015

Written by: D Winstanley

D Winstanley
Radio Senior Test Engineer

Approved by:

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Department Manager - Radio

Date: 8th January 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

RF923 2.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	8th January 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-0258970-CO04-47-00A
WORKS ORDER NUMBER	TRA-025897-00
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION(S):	47CFR15.245
EQUIPMENT UNDER TEST (EUT):	MC-133 Radio Antenna Module
FCC IDENTIFIER:	WH3-MC-133
EUT SERIAL NUMBER:	Not Applicable
MANUFACTURER/AGENT:	AGD Systems Ltd
ADDRESS:	White Lion House Gloucester Road Staverton Cheltenham Gloucestershire GL51 0TF United Kingdom
CLIENT CONTACT:	Rob Fyfe ☎ 01452 854212 ✉ rob.fyfe@agd-systems.com
ORDER NUMBER:	Not Applicable
TEST DATE:	3rd - 11th November 2015
TESTED BY:	D Winstanley Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause 47CFR15</i>	<i>Applicable to this equipment</i>	<i>Result / Note</i>
Radiated spurious emissions	15.245(b)	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions	15.207	<input checked="" type="checkbox"/>	Pass
Occupied bandwidth	15.215(c)	<input checked="" type="checkbox"/>	Pass
Field strength of fundamental	15.249(b)	<input checked="" type="checkbox"/>	Pass
Calculation of duty correction	15.35(c)	<input type="checkbox"/>	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-0258970-CO04-47-00A presents the results of the Radio testing on a AGD Systems Ltd, MC-133 Radio Antenna Module to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for AGD Systems Ltd 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 Skelmersdale 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.

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-310, Issue 3, December 2010 – Licence-exempt Radio Apparatus (All Frequency Bands): Category II 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: MC-133 Radio Antenna Module
- Serial Number: Not Applicable
- Model Number: MC-133
- Software Revision: Not Applicable
- Build Level / Revision Number: Issue 1

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.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

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

The EUT was set to transmit at maximum power with the FMCW swept either over a 10MHz range or a 30 MHz range.

7.3.2 Reception

The EUT receiver is co-located with a permanently transmitting transmitter

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	24.125 GHz
Modulation type(s):	FMCW
Occupied channel bandwidth(s):	10 MHz or 30 MHz
Channel spacing:	Not Applicable
Declared output power(s):	20 dBm
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	3.3 Vdc
Location of notice for license exempt use:	Label / user manual / both.
Method of prevention of use on non-US / non-Canadian frequencies:	Not Applicable
Duty cycle:	10% - 100 % (100% for test)

7.4.2 Antennas

Type:	<i>Integral / Patch</i>
Frequency range:	24.125 GHz
Impedance:	<i>Not Applicable</i>
Gain:	<i>Not Applicable</i>
Polarisation:	<i>Vertical / Horizontal</i>
Beam width:	<i>Typical 30 °</i>
Connector type:	<i>Not Applicable</i>
Mounting:	<i>8 Way Header</i>

7.5 EUT Description

The EUT is a FMCW Radio Antenna Module operating at 24.125 GHz

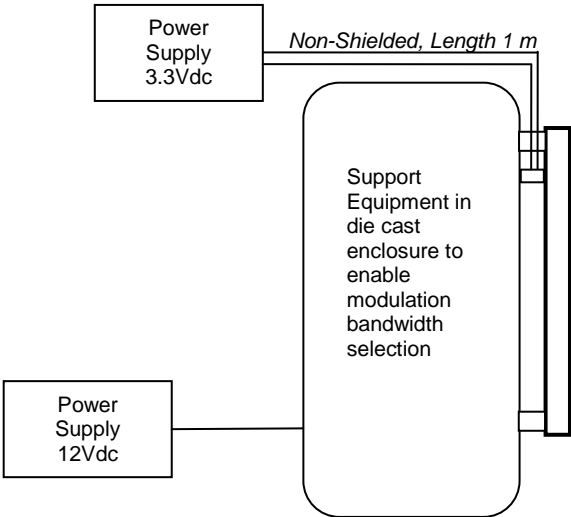
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

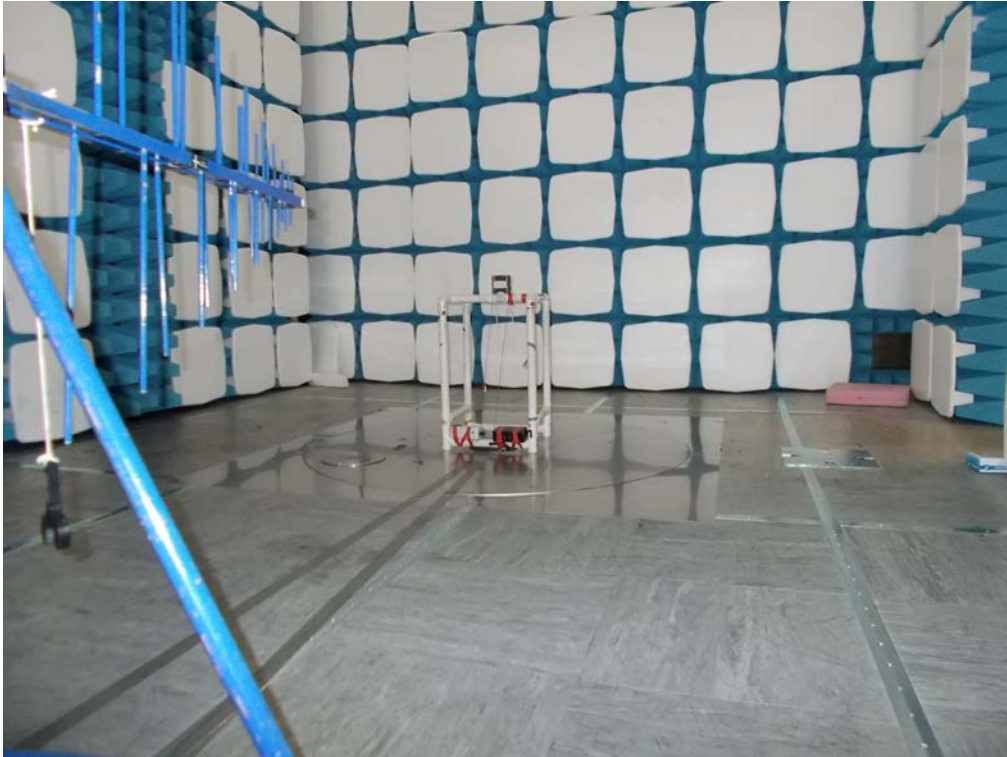
9.1 Block Diagram

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 EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 3.3 Vdc from a power supply.

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	110V ac +/- 2 %	85 % and 115 %
<input type="checkbox"/>	Battery	New battery	N/A
<input checked="" type="checkbox"/>	Other	3.3Vdc	+ / - 5%

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:	24.125 GHz
EUT Channel Bandwidths:	10 MHz & 30 MHz
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: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	as declared

11.3 Test Limit

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

<i>Fundamental frequency (MHz)</i>	<i>Field strength of fundamental (mV/m at 3 m)</i>	<i>Field strength Of harmonics (mV/m at 3 m)</i>
24075–24175	2500	25.0

Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in § 15.205, shall not exceed the general field strength limits.

Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

- (i) For the second and third harmonics of field disturbance sensors operating in the 24075–24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.
- (ii) For all other field disturbance sensors, 7.5 mV/m.
- (iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075–24175 MHz band, fully comply with the limits given in § 15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as fork lifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits, whichever is the lesser attenuation

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

The emission limits shown above are based on measurement instrumentation employing an average detector.

The provisions in § 15.35 for limiting peak emissions apply

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 dBμV/m at the regulatory distance, using:

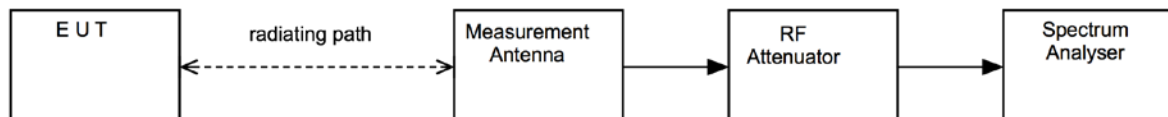
$$FS = PR + CL + AF - PA + DC - CF$$

Where,

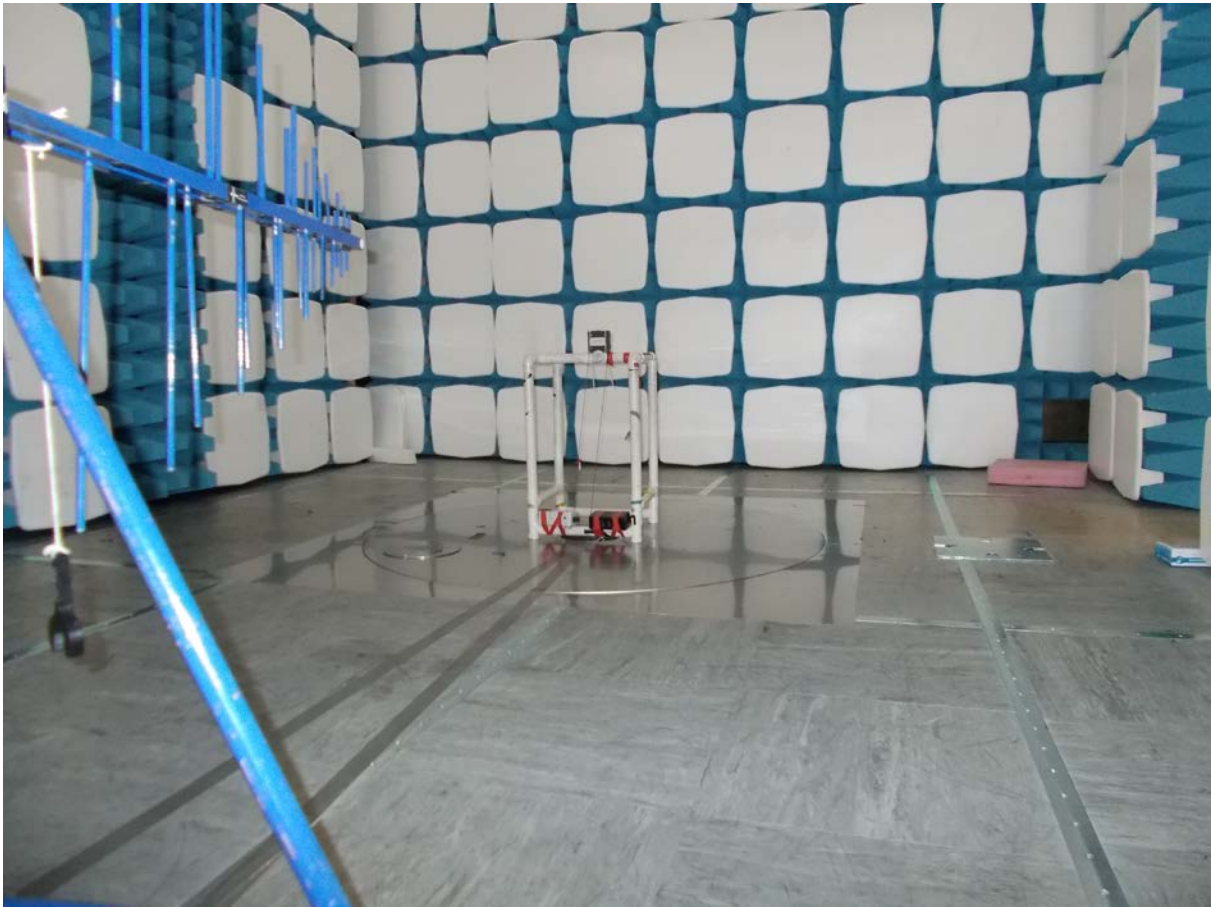
PR is the power recorded on the receiver / spectrum analyzer in dBμV;
 CL is the cable loss in dB;
 AF is the test antenna factor in dB/m;
 PA is the pre-amplifier gain in dB (where used);
 DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
 CF is the distance 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



Test Set-up Photograph



11.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
Bilog Antenna	Chase	CBL611/A	U191	26/02/2017	24
Horn Antenna	EMCO	3115	L139	25/09/2017	24
Spectrum Analyser	R&S	FSU46	U281	24/04/2016	12
Spectrum Analyser	HP	8563A	L654	11/12/2015	12
Harmonic Mixer (33 GHz -50 GHz)	Agilent	11970Q	U365	16/07/2010	N/A
Harmonic Mixer (50 GHz -75 GHz)	Agilent	11970V	U366	21/07/2010	N/A
Harmonic Mixer (75 GHz -110 GHz)	Agilent	11970W	U367	02/07/2010	N/A
Standard Gain Horn (18 GHz-26.5 GHz)	Flann	20240-20	L300	10/02/2016	N/A
Standard Gain Horn (50 GHz-75 GHz)	Flann	25240-20	U368	See note	N/A
Standard Gain Horn (75 GHz -110)	Flann	27240-20	U369	See note	N/A
Standard Gain Horn (33 GHz -50 GHz)	Flann	23240-20	L264/A	See note	N/A
Standard Gain Horn (26 GHz -40 GHz)	Flann	22240-20	L301	See note	N/A

ANSI C63.10 - 4.4.3 a) Antenna calibration

Standard gain horns need not be periodically recalibrated, unless damage or deterioration is suspected or known to have occurred. If a standard gain horn is not periodically recalibrated, then its critical dimensions (see IEEE Std 1309-2005) shall be verified and documented on an annual basis

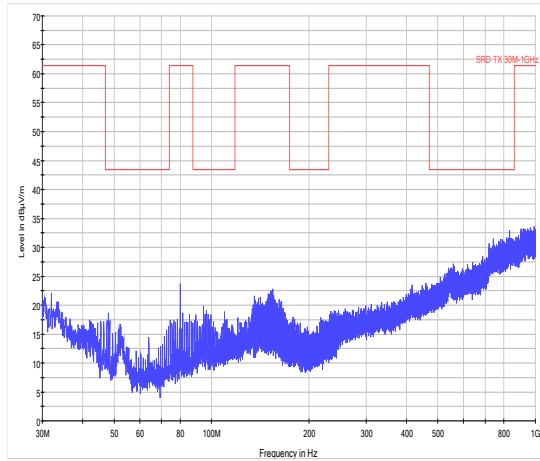
11.6 Test Results

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)
Emission Regardless of Operating Bandwidth										
QP	80.00	19.2	1.3	7.8	0.00	0.00	0.00	28.3	26.00	100
Pk	5210.34	45.53	4.50	34.00	35.94	0.00	0.00	48.09	253.80	5012
Av	5210.34	38.24	4.50	34.00	35.94	0.00	0.00	40.80	109.65	500

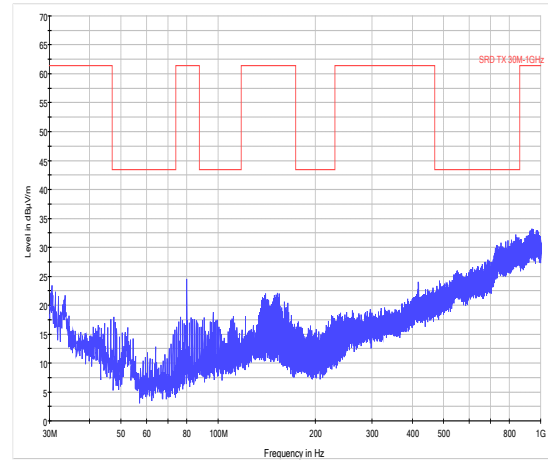
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Field Strength (mV/m)	Limit (mV/m)
10 MHz Operating Bandwidth										
Pk	48250.0	67.93*	0	42.65	0	0	-29.54	81.04	11.27	75.0
Av	48250.0	33.43*	0	42.65	0	0	-29.54	46.54	0.21	7.5
30 MHz Operating Bandwidth										
Pk	48250.0	67.93*	0	42.65	0	0	-29.54	81.04	11.27	75.0
Av	48250.0	28.43*	0	42.65	0	0	-29.54	41.54	0.12	7.5

* Includes 23.6dB Conversion Loss for mixer

AV levels determined by reduction of VBW to 10Hz

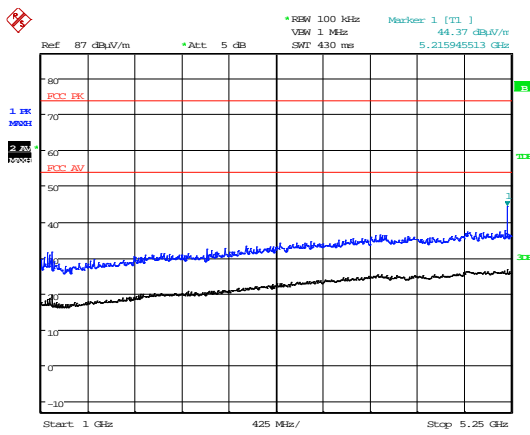


10 MHz Sweep



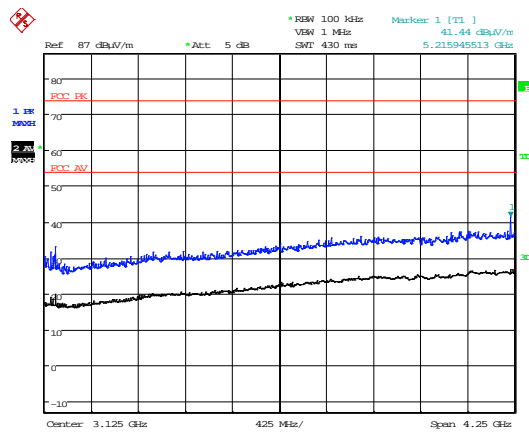
30 MHz – 1GHz

30 MHz Sweep



Date: 3.NOV.2015 15:03:41

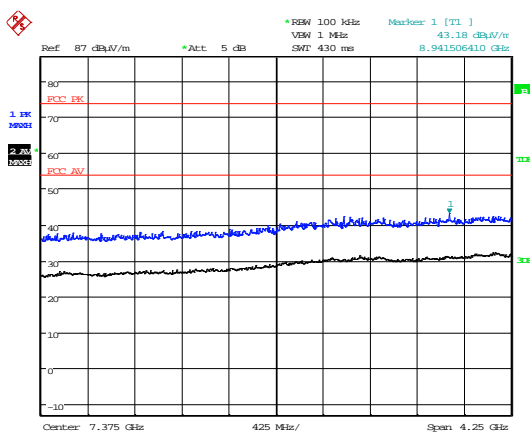
10 MHz Sweep



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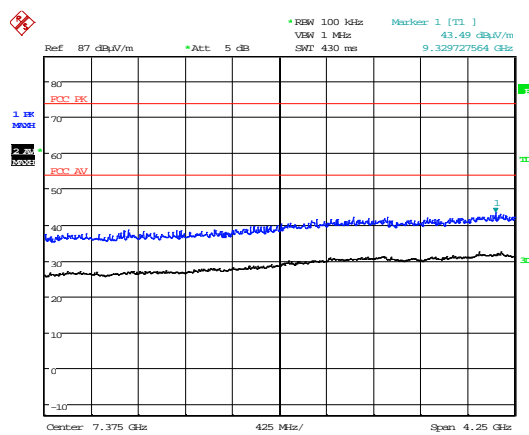
1GHz – 5GHz

30 MHz Sweep



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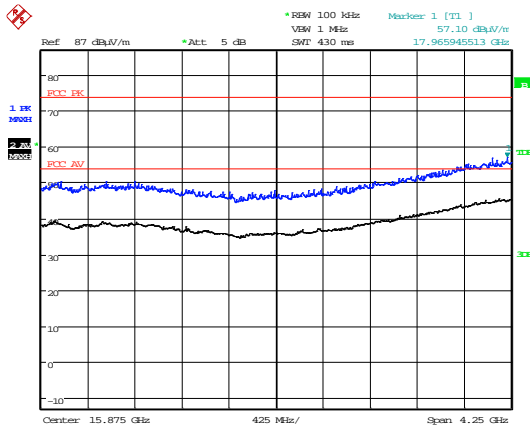
10 MHz Sweep



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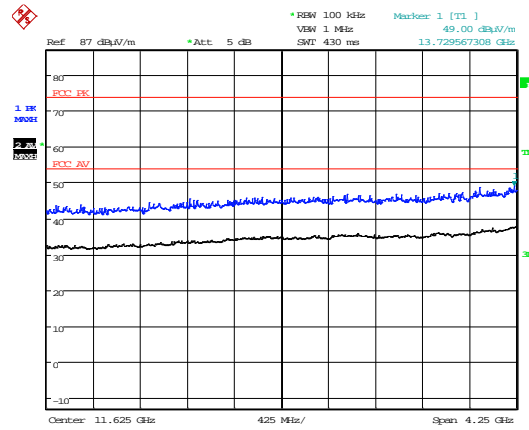
5GHz – 9GHz

30 MHz Sweep



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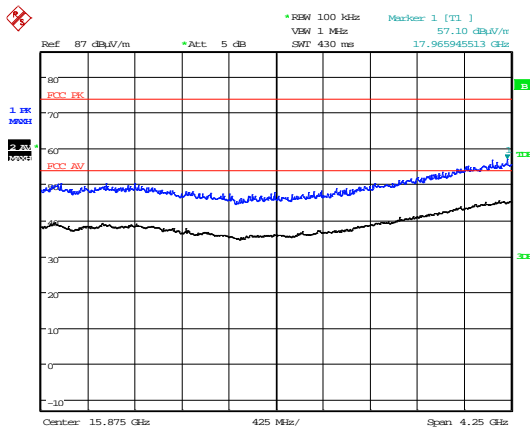
10 MHz Sweep



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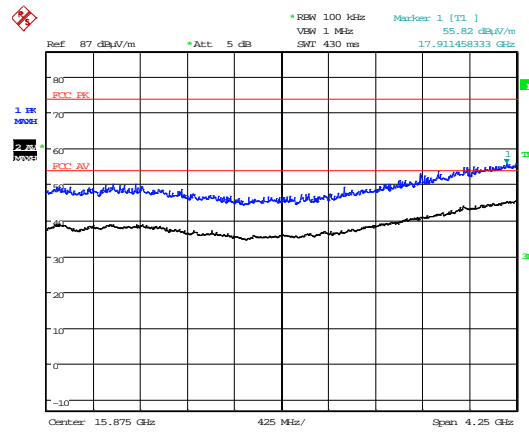
9GHz – 13GHz

30 MHz Sweep



Date: 3.NOV.2015 14:59:26

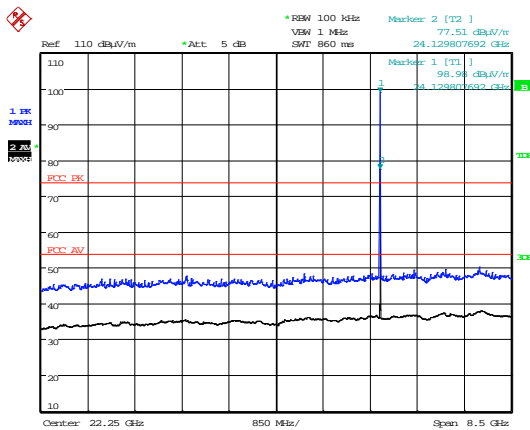
10 MHz Sweep



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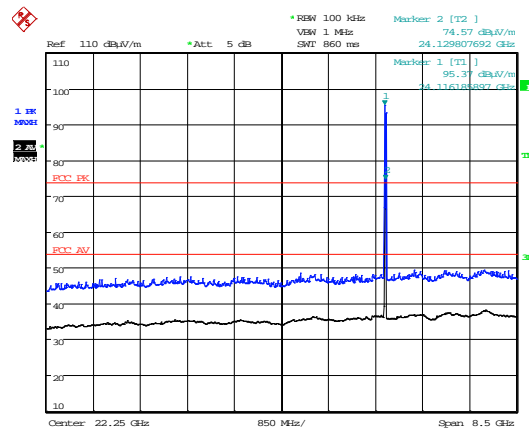
13GHz – 18GHz

30 MHz Sweep



Date: 3.NOV.2015 15:21:15

10 MHz Sweep



Date: 3.NOV.2015 15:27:18

18GHz – 26.5GHz

30 MHz Sweep

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:	Transient Lab (U390)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	24.125 GHz
EUT Channel Bandwidths:	10 MHz and 30 MHz
EUT Modulation:	FMCW
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (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 (dBµV)	
	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.

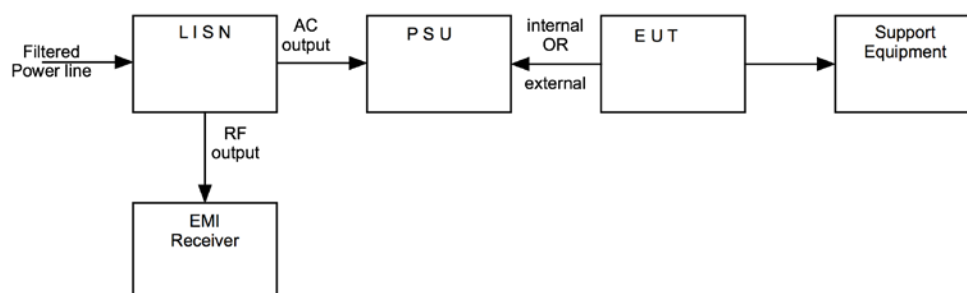
12.4 Test Method

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



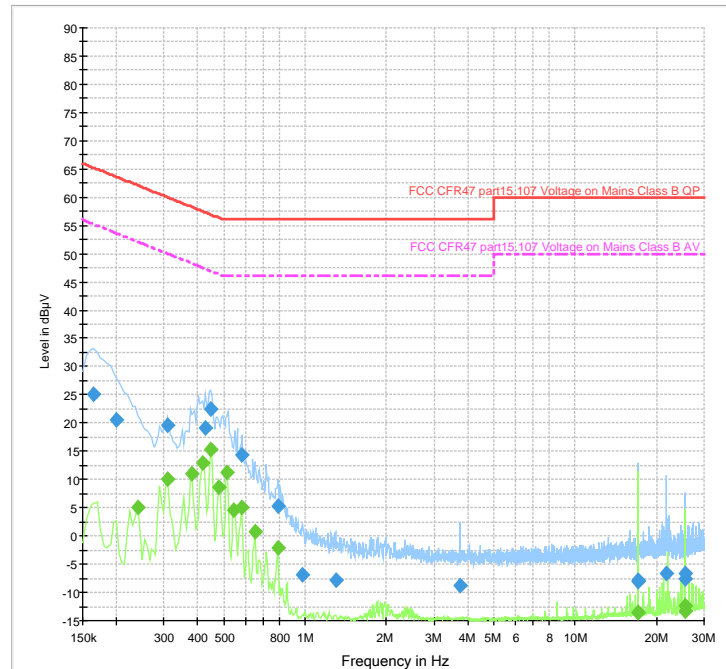
12.6 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date	Calibration Interval
LISH	R&S	ENV216	U396	01/07/2016	12
EMI Receiver	R&S	ESHS10	U003	25/06/2017	12

12.7 Test Results

10 MHz Sweep

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH396



Final Result 1 – Quasi Peak Detector

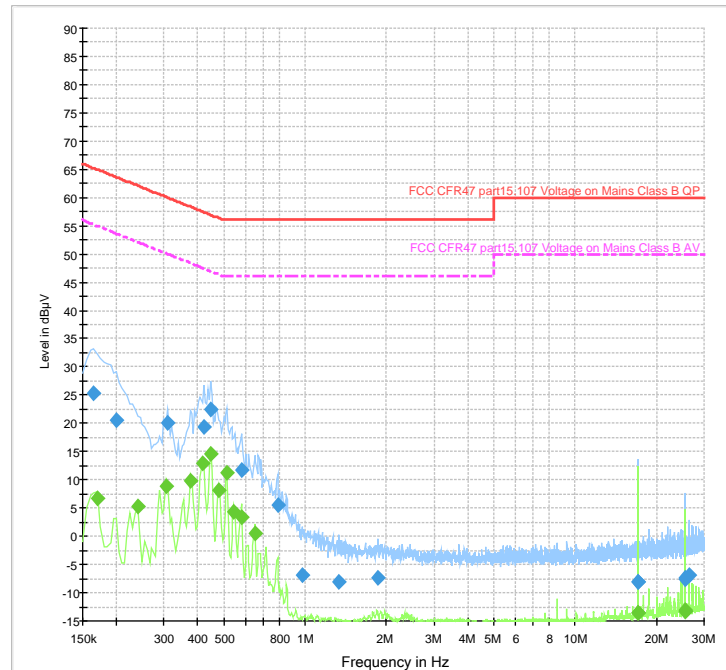
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.425000	19.0	2000.0	10.000	On	N	9.6	38.3	57.3
0.445000	22.5	2000.0	10.000	On	N	9.6	34.5	57.0

Final Result 2 – Average Detector

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.380000	10.9	2000.0	10.000	On	L1	9.6	37.4	48.3
0.415000	12.8	2000.0	10.000	On	L1	9.6	34.7	47.5
0.445000	15.2	2000.0	10.000	On	L1	9.6	31.8	47.0
0.480000	8.6	2000.0	10.000	On	L1	9.6	37.8	46.3
0.515000	11.3	2000.0	10.000	On	L1	9.6	34.7	46.0

30 MHz Sweep

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH396



Final Result 1 – Quasi Peak Detector

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.165000	25.4	2000.0	10.000	On	N	9.6	39.8	65.2
0.420000	19.4	2000.0	10.000	On	N	9.6	38.1	57.4
0.445000	22.4	2000.0	10.000	On	L1	9.6	34.6	57.0

Final Result 2 – Average Detector

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.375000	9.8	2000.0	10.000	On	L1	9.6	38.6	48.4
0.415000	12.9	2000.0	10.000	On	L1	9.6	34.6	47.5
0.445000	14.6	2000.0	10.000	On	L1	9.6	32.3	47.0
0.480000	8.3	2000.0	10.000	On	L1	9.6	38.1	46.3
0.515000	11.2	2000.0	10.000	On	N	9.6	34.8	46.0

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 (20 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 20 dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	24.125 GHz
EUT Channel Bandwidths:	10 MHz and 30 MHz
EUT Test Modulations:	FMCW
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	200 kHz / 1 MHz
Measurement Span: (requirement 2 to 5 times OBW)	50 MHz / 100 MHz
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)
Supply: 3.V/dc	230 V ac ±10 % (as declared)

13.3 Test Limit

Federal Communications Commission:

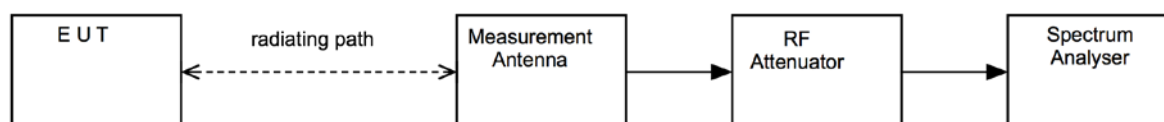
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific 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

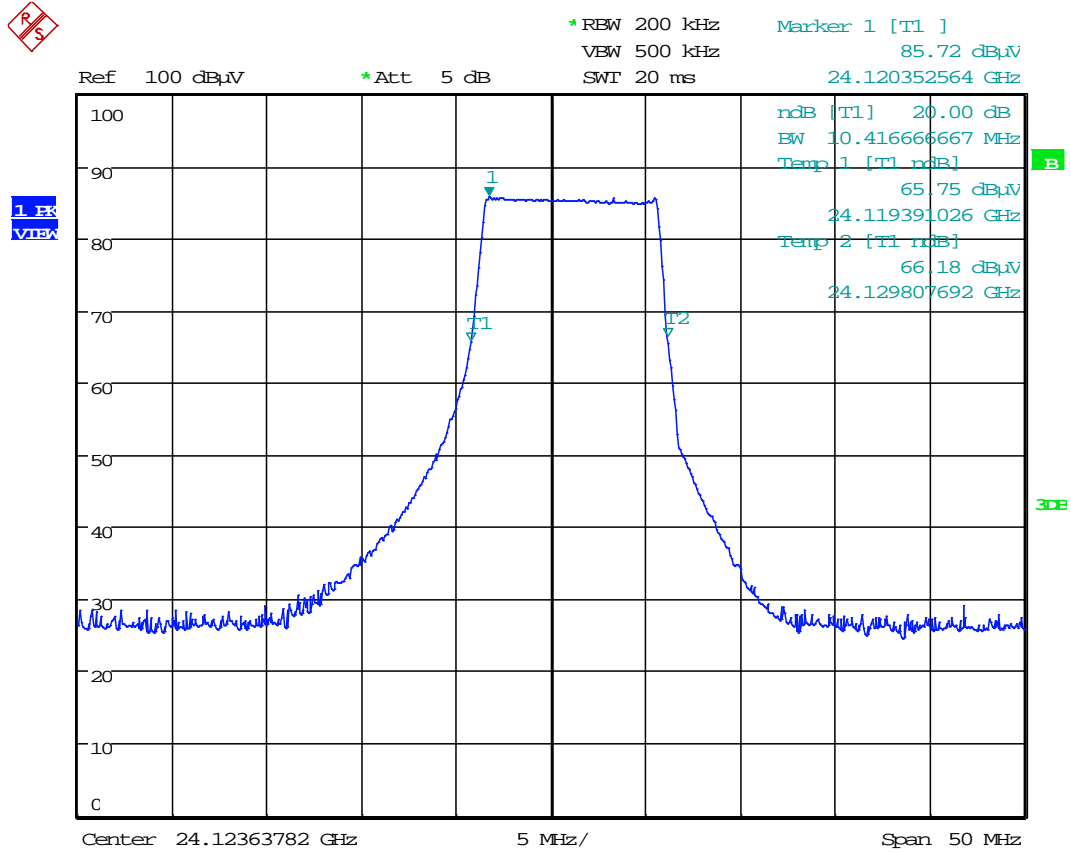


13.5 Test Equipment

<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>
Spectrum Analyser	R&S	FSU46	U281	24/04/2016	12
Horn Antenna	Flann	20240-20	L300	10/02/2016	24

13.6 Test Results

Modulation: 10 MHz Sweep				
Channel Frequency (GHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (MHz)	Result
24.125 GHz	24119.391026	24129.807692	10.41667	PASS

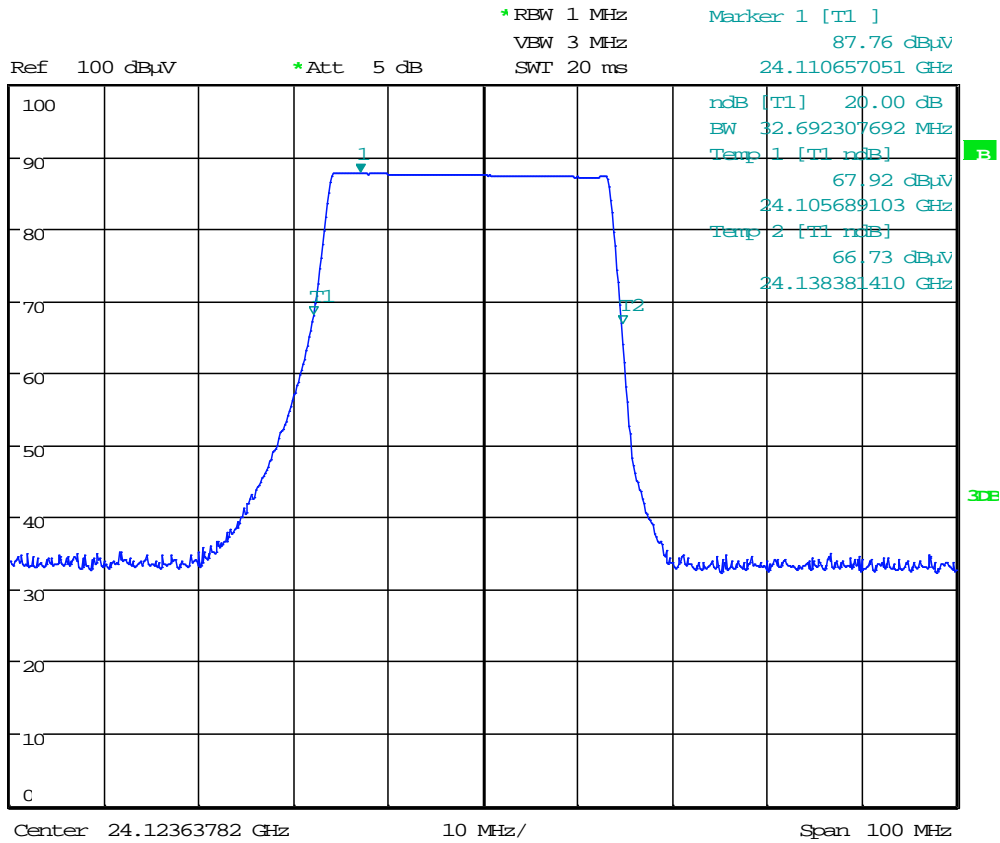


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Modulation: 30 MHz Sweep				
Channel Frequency (GHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (MHz)	Result
24.125 GHz	24105.689103	24138.381410	32.69231	PASS



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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 / 6.6
EUT Channels / Frequencies Measured:	24.125GHz
EUT Channel Bandwidths:	10MHz and 30 MHz
Deviations From Standard:	None
Measurement BW:	Wideband Power Meter
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	Not Applicable
Measurement Detector:	Average RMS
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 °C to +35 °C (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

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

Field Strength Limits for License-Exempt Transmitters for Any Application

<i>Fundamental frequency (GHz)</i>	<i>Field strength (mV/m at 3 m)</i>	<i>Detector</i>
24.075 to 24.175	2500	Average, RMS

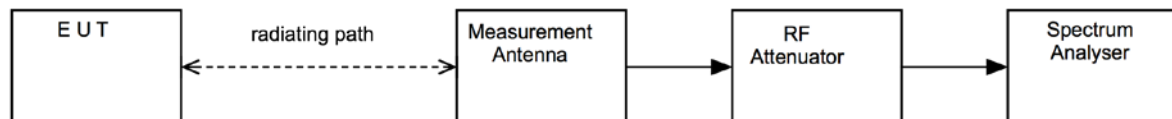
n.b. per FCC 47CFR15.245(b)(4), peak limit is 20 dB above average.

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
Spectrum Analyser	R&S	FSU46	U281	24/04/2016	12
Horn Antenna	Flann	20240-20	L300	10/02/2016	24
Power Sensor	Marconi	6924	U129	12/01/2016	12
Power Meter	Marconi	6960B	U096	13/01/2016	12

14.6 Test Results

Modulation: 10 MHz Sweep							
Freq. (GHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m)	Field Strength (mV/m)	Result
24.125	97.92	N/A	37.6	35.4	110.82	347.54	PASS

Modulation: 30 MHz Sweep							
Freq. (GHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m)	Field Strength (mV/m)	Result
24.125	98.17	N/A	37.6	35.4	111.07	357.68	PASS

15 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 %**