

Report on the Radio Testing

For

Lansinoh Laboratories Sağlık Gereçleri Tasarım Sanayi Tic. Ltd. Sti.

on

Lansinoh BLE4.1 Module

Report no. TRA-030097-47-00A

24th May 2016

Report Number: TRA-030097-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Lansinoh Laboratories Saglık Gereçleri Tasarım Sanayi Tic. Ltd. Sti.
Lansinoh BLE4.1 Module
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: 22nd February - 3rd March 2016

Written by: D Winstanley

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Radio Senior Test Engineer

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J Charters
Department Manager - Radio

Date: 24th May 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

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	24 th May 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-030097-47-00A
WORKS ORDER NUMBER	TRA-030097-00
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. Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radiocommunication Act and 21(1) of the Radiocommunication Regulations.
TEST SPECIFICATION(S):	47CFR15.247 & RSS-247
EQUIPMENT UNDER TEST (EUT):	Lansinoh BLE4.1 Module
FCC IDENTIFIER:	2AHGRBLE4V1M
CERTIFICATION NUMBER	
EUT SERIAL NUMBER:	not applicable
MANUFACTURER/AGENT:	Lansinoh Laboratories Sağlık Gereçleri Tasarım Sanayi Tic. Ltd. Sti.
ADDRESS:	A.O.S.B. M. KEMAL BULVARI 10006 SOK NO:64 35620 CIGLI IZMIR TURKIY
CLIENT CONTACT:	BARBAROS KARADAĞ ☎ +90 232 328 05 56 ✉ barbaroskaradag@lansinoh.com.tr
ORDER NUMBER:	Not Applicable
TEST DATE:	22nd February - 3rd March 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 (restricted bands of operation and cabinet radiation)		Gen, 8.10	15.205	☒	Pass
AC power line conducted emissions		Gen, 8.8	15.207 15.107	☒	Pass
Occupied bandwidth		247, 5.2 (1)	15.247(a)(2)	☒	Pass
Conducted carrier power	Peak	247, 5.4 (4)	15.247(b)(3)	☒	Pass
	Max.			☐	
Conducted / radiated RF power out-of-band		247, 5.5	15.247(d)	☒	Pass
Power spectral density, conducted		247, 5.2 (2)	15.247(e)	☒	Pass
Calculation of duty correction		-	15.35(c)	☐	N/A
Unintentional Radiated Emissions			15.109	☒	Pass

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-030097-47-00A presents the results of the Radio testing on a Lutrons UK Ltd., Lansinoh BLE4.1 Module to specification 47CFR15 Radio Frequency Devices and RSS-247 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for Lutrons UK Ltd. by Element, at the address(es) detailed below.

☐	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☒	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.

IC Registration Number(s):

Element Hull	3483A
Element Skelmersdale	3930B

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

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-247, Issue 1, May 2015 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- 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: Lansinoh BLE4.1 Module
- Serial Number: not applicable
- Model Number: ST Microelectronics BlueNRG-MS
- Software Revision: Module Firmware 7.1e
- Build Level / Revision Number: V1-01

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.

<i>Equipment</i>	: <i>Host PCB for Control & Power</i>
<i>Manufacturer</i>	: <i>Lutrons Ltd</i>
<i>Model</i>	: <i>Not applicable</i>
<i>Serial number</i>	: <i>Not applicable</i>

<i>Equipment</i>	: <i>Power Supply For Host PCB</i>
<i>Manufacturer</i>	: <i>Wendeny Jell Electronics</i>
<i>Model</i>	: <i>BPM10S09G02</i>
<i>Serial number</i>	: <i>82-31-299-1234</i>

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows: Permanently transmitting on a selected channel for modulated and unmodulated carrier

7.3.2 Reception

The mode of operation for Rx tests was as follow: Receiving on a channel previously selected.

7.4 EUT Radio Parameters

7.4.1 General

Frequency band operation (MHz):	2400 – 2483.5
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	2MHz
Channel spacing:	2MHz
Declared output power(s):	4 dBm
Warning against use of alternative antennas in user manual (yes/no):	Not applicable
Nominal Supply Voltage:	3.3 Vdc
Duty cycle:	1% (Typical Use)

7.4.2 Antennas

Type:	PCB Trace
Frequency range:	2400 – 2483.5 MHz
Impedance:	50 Ohms
Gain:	1.95 dBi
Polarisation:	Omni
Connector type:	Integral

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	Not Applicable
Fixed pt-pt operations (yes/no):	No
Installation manual advice on pt-pt operational restrictions (yes/no):	Not Applicable
Fixed pt-mpt operations (yes/no):	No
Simultaneous tx (yes/no):	Not Applicable

7.5 EUT Description

The EUT is a Bluetooth 4.1 radio module

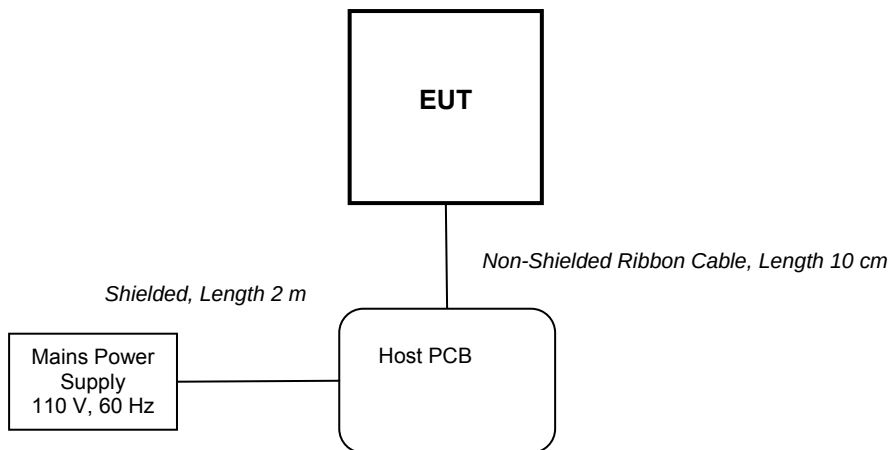
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

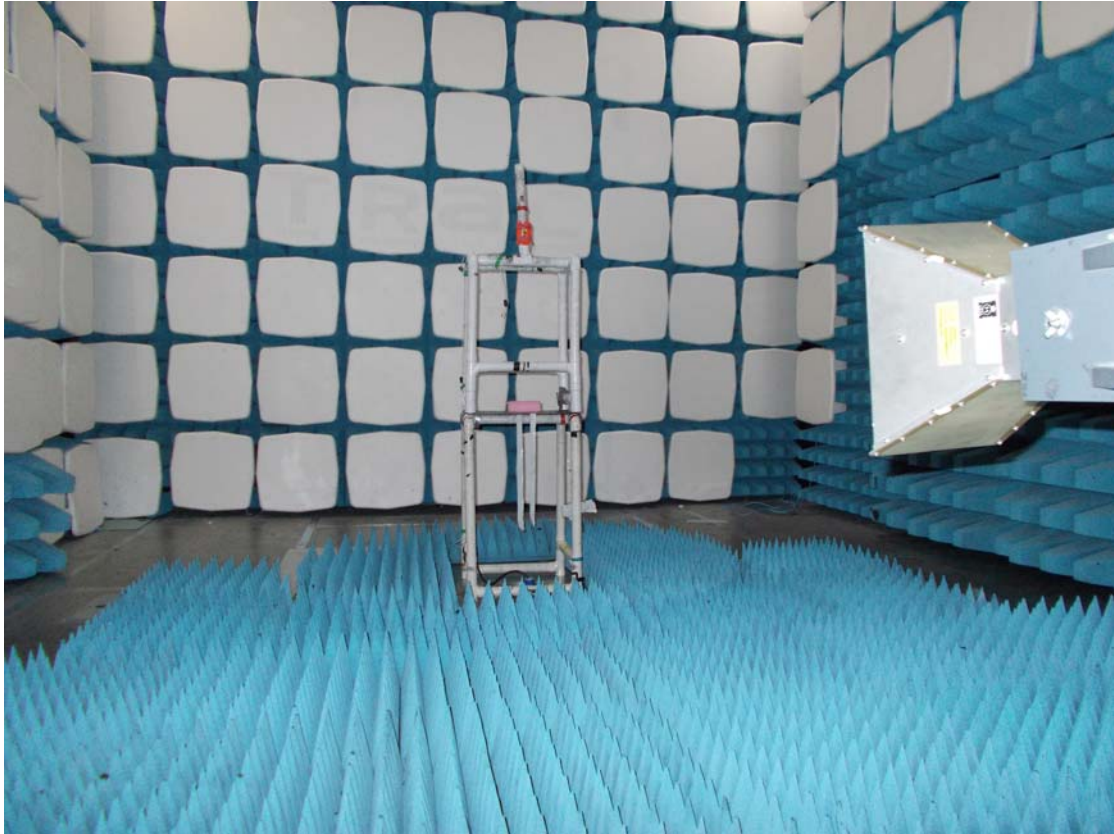
9.1 Block Diagram

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 3.3V dc from host PCB.

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
☐	Mains	110 V ac +/-2 %	85 % and 115 %
☐	Battery	New battery	N/A
☒	Other	3.3Vdc	N/A

11 Radiated emissions

11.1 Definitions

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:	Chamber 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	2402 MHz / 2442 MHz / 2480 MHz
EUT Channel Bandwidths:	1 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: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 28 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 10 % (as declared)

11.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

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

Frequency (MHz)	Field Strength (μV/m at 3 m)
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 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;

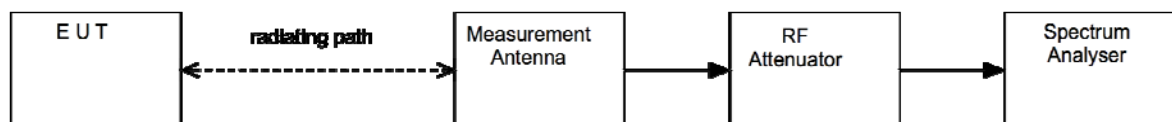
PA is the pre-amplifier gain in dB (where used);

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

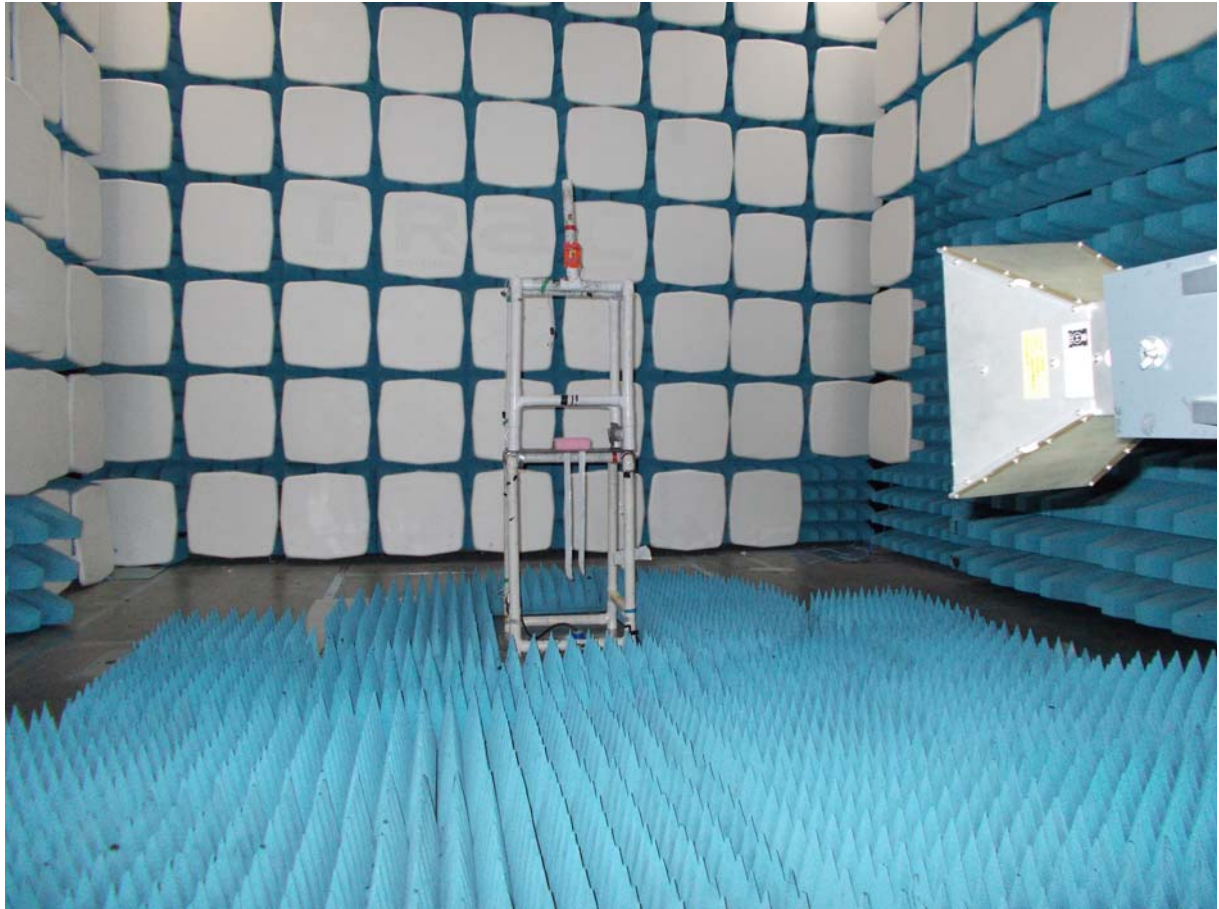
CF is the distance factor in dB (where measurement distance different to limit distance);

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

Figure i Test Setup



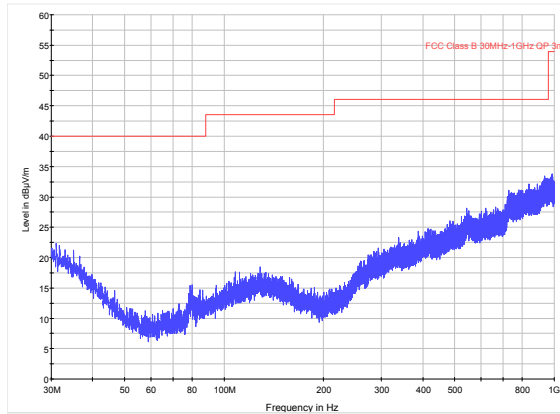
11.5 Test Set-up Photograph



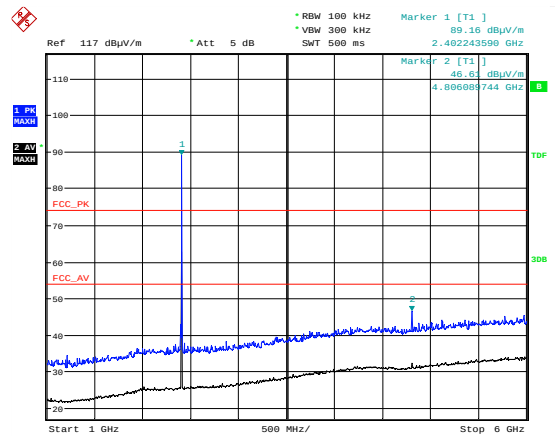
11.6 Test Equipment

<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	FSU46	U281	24/04/2016	12
Horn Antenna	EMCO	3115	TRL139	25/09/2017	24
Pre-Amplifier	Agilent	8449B	TRL572	10/02/2016	12

11.7 Test Results

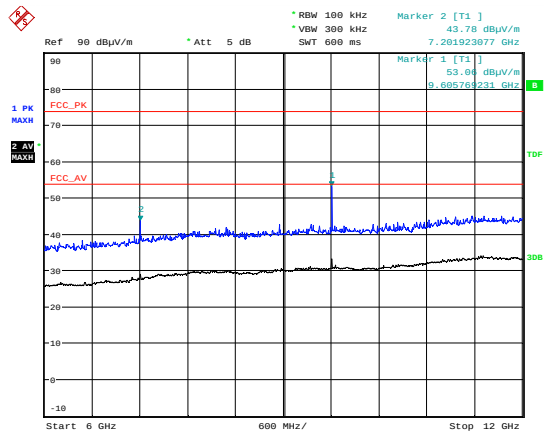


1 – Bottom Channel (30 MHz to 1 GHz).



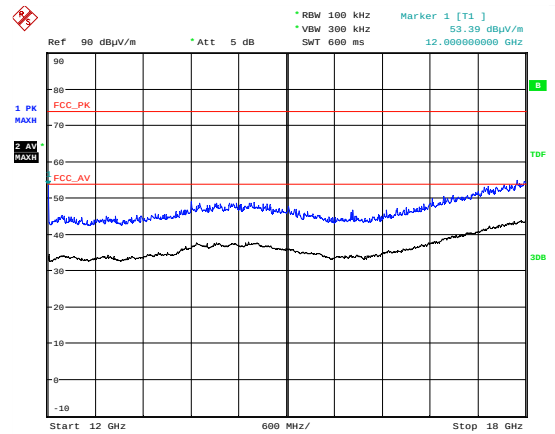
Date: 1.MAR.2016 16:13:19

2 – Bottom Channel (1 GHz to 6 GHz).



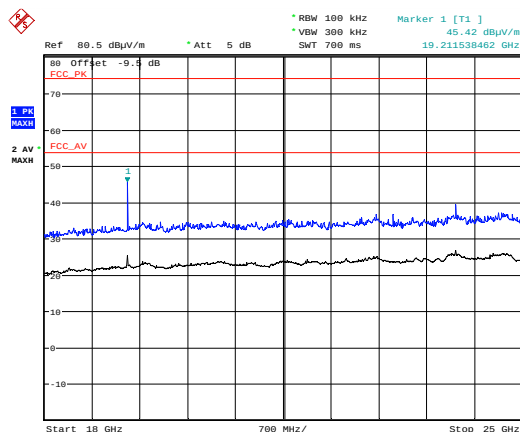
Date: 1.MAR.2016 16:16:45

3 – Bottom Channel (6 GHz to 12 GHz).



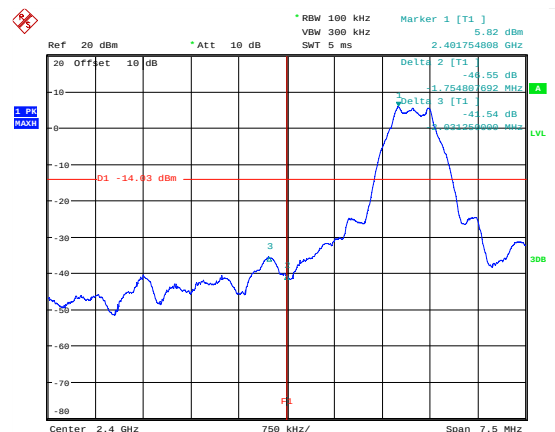
Date: 1.MAR.2016 16:20:41

4 – Bottom Channel (12 GHz to 18 GHz).



Date: 2.MAR.2016 12:24:43

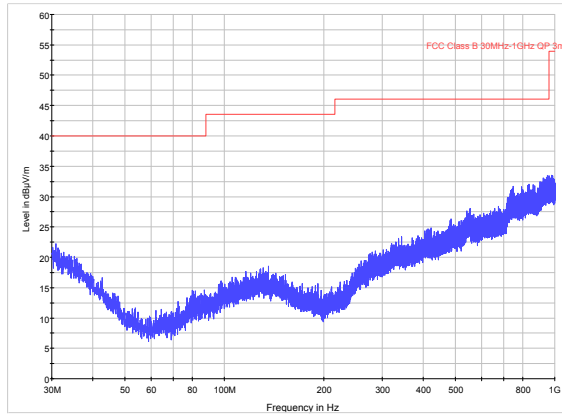
5 – Bottom Channel (18 GHz to 25 GHz).



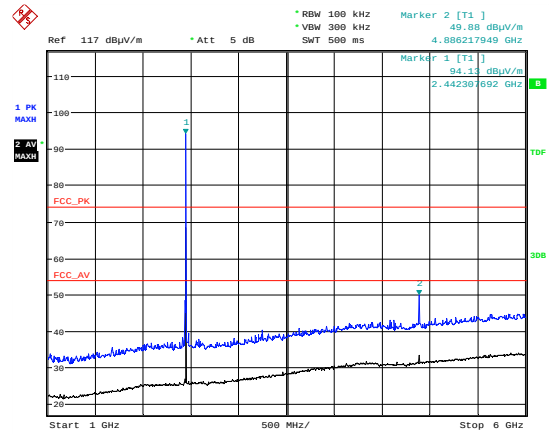
Date: 23.FEB.2016 11:05:05

6 – Lower Band Edge.

<i>High Power; Channel: 2402MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
Pk	4804.32	52.27	5.10	33.10	35.84	0.00	0.00	54.63	538.89	5012
Av	4804.32	43.48	5.10	33.10	35.84	0.00	0.00	45.84	195.88	500
Pk	9607.08	52.25	7.80	37.90	36.71	0.00	0.00	61.24	1153.45	5012
Av	9607.08	41.23	7.80	37.90	36.71	0.00	0.00	50.22	324.34	500
Pk	12008.74	52.58	8.50	39.30	36.18	0.00	0.00	64.20	1621.81	5012
Av	12008.74	40.38	8.50	39.30	36.18	0.00	0.00	52.00	398.11	500
Pk	19534.00	54.20	10.80	37.20	35.55	0.00	-9.54	57.11	716.77	5012
Av	19534.00	41.69	10.80	37.20	35.55	0.00	-9.54	44.60	169.78	500

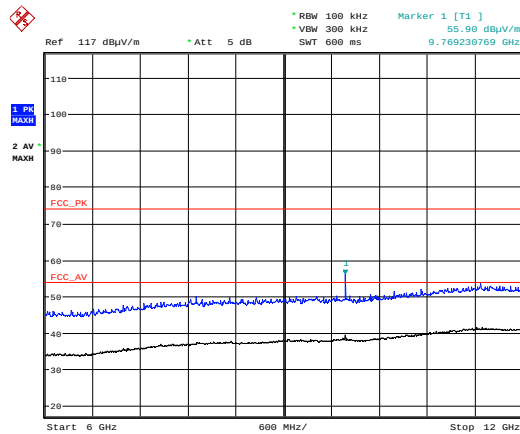


7 – Middle Channel (30 MHz to 1 GHz).



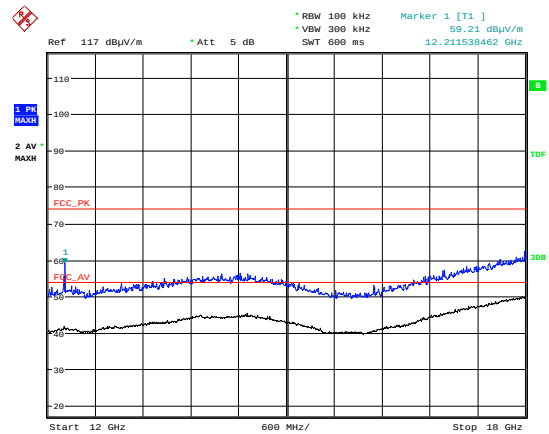
Date: 2.MAR.2016 09:28:21

8 – Middle Channel (1 GHz to 6 GHz).



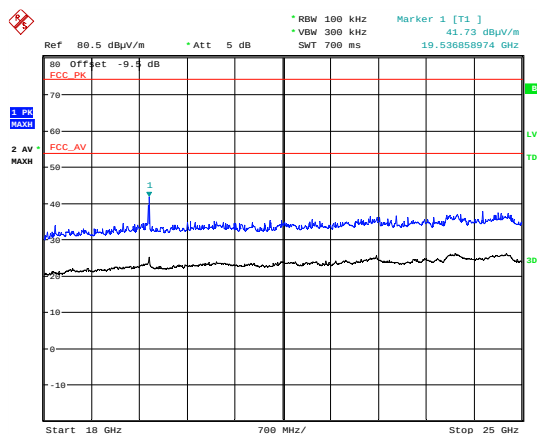
Date: 2.MAR.2016 09:45:39

9 – Middle Channel (6 GHz to 12 GHz).



Date: 2.MAR.2016 09:46:49

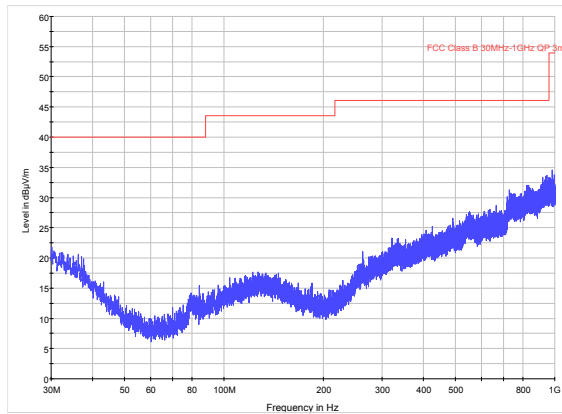
10 – Middle Channel (12 GHz to 18 GHz).



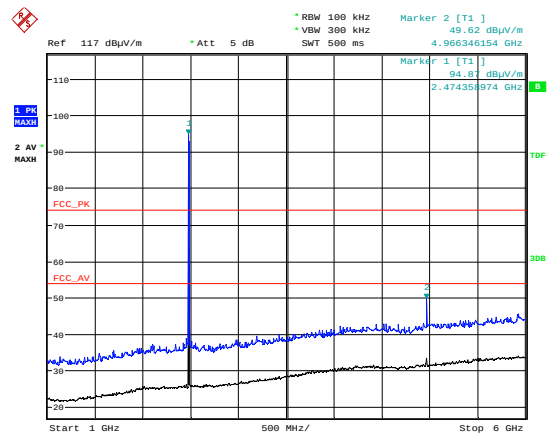
Date: 2.MAR.2016 12:17:59

11 – Middle Channel (18 GHz to 25 GHz).

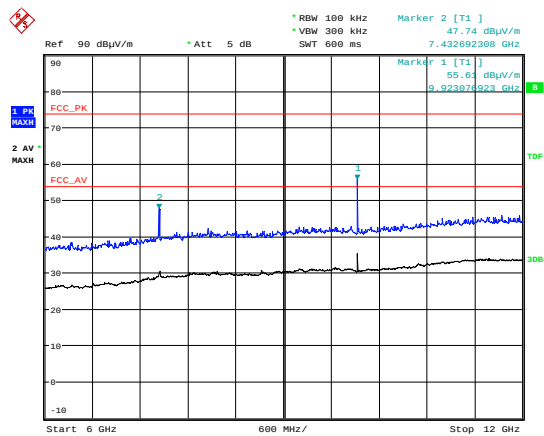
<i>High Power; Channel: 2442 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
Pk	4883.52	53.29	5.20	33.30	35.87	0.00	0.00	55.92	625.17	5012
Av	4883.52	43.34	5.20	33.30	35.87	0.00	0.00	45.97	198.84	500
Pk	7325.25	51.19	6.40	36.40	36.06	0.00	0.00	57.93	787.95	5012
Av	7325.25	39.68	6.40	36.40	36.06	0.00	0.00	46.42	209.41	500
Pk	12208.61	53.03	8.60	39.10	35.95	0.00	0.00	64.78	1733.80	5012
Av	12208.61	40.92	8.60	39.10	35.95	0.00	0.00	52.67	430.03	500
Pk	19534.00	55.31	10.80	37.20	35.55	0.00	-9.54	58.22	814.48	5012
Av	19534.00	43.15	10.80	37.20	35.55	0.00	-9.54	46.06	200.85	500



12 – Top Channel (30 MHz to 1 GHz).

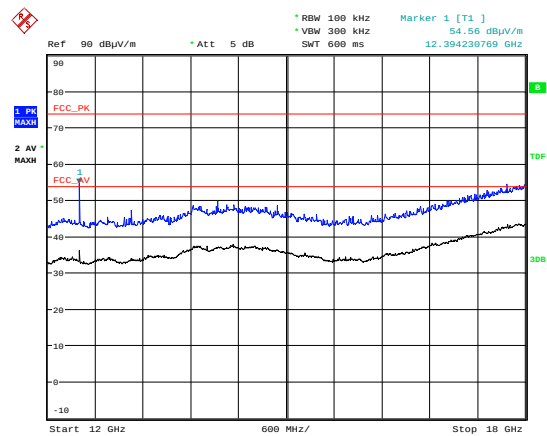


13 – Top Channel (1 GHz to 6 GHz).



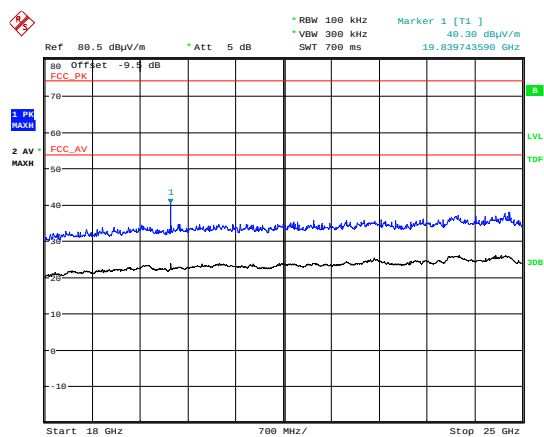
Date: 2.MAR.2016 10:49:36

14 – Top Channel(6 GHz to 12 GHz).



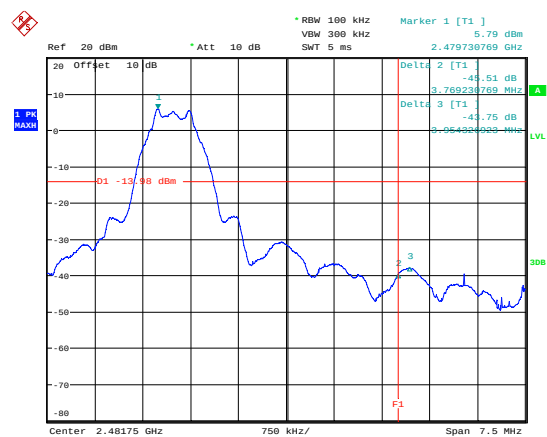
Date: 2.MAR.2016 10:50:43

Figure 15 – Top Channel (12 GHz to 18 GHz).



Date: 2.MAR.2016 12:19:58

16 – Top Channel (18 GHz to 25 GHz).



Date: 23.FEB.2016 11:01:56

17 – Upper Band Edge.

<i>High Power; Channel: 2480 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
Pk	4959.46	52.90	5.20	33.50	35.90	0.00	0.00	55.70	609.54	5012
Av	4959.46	43.09	5.20	33.50	35.90	0.00	0.00	45.89	197.02	500
Pk	7439.31	51.93	6.40	36.70	36.09	0.00	0.00	58.94	885.12	5012
Av	7439.31	40.27	6.40	36.70	36.09	0.00	0.00	47.28	231.21	500
Pk	12398.95	51.91	8.60	38.80	35.73	0.00	0.00	63.58	1510.08	5012
Av	12398.95	39.64	8.60	38.80	35.73	0.00	0.00	51.31	367.71	500
Pk	19838.00	54.55	11.10	37.20	35.93	0.00	-9.54	66.92	739.40	5012
Av	19838.00	42.10	11.10	37.20	35.93	0.00	-9.54	54.47	176.35	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 North Skelmersdale
Test Chamber:	Low Frequency Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	2442 MHz
EUT Modulation:	GFSK
Deviations From Standard:	None
Measurement BW:	10 KHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 23 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 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.

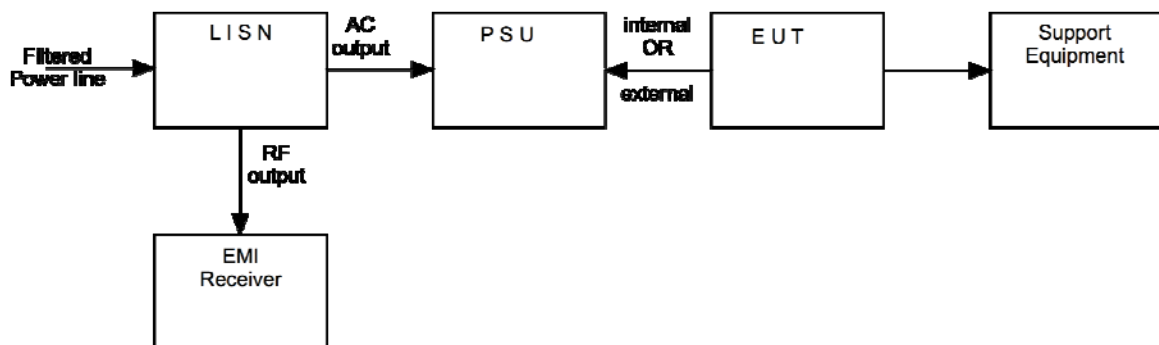
12.4 Test Method

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.

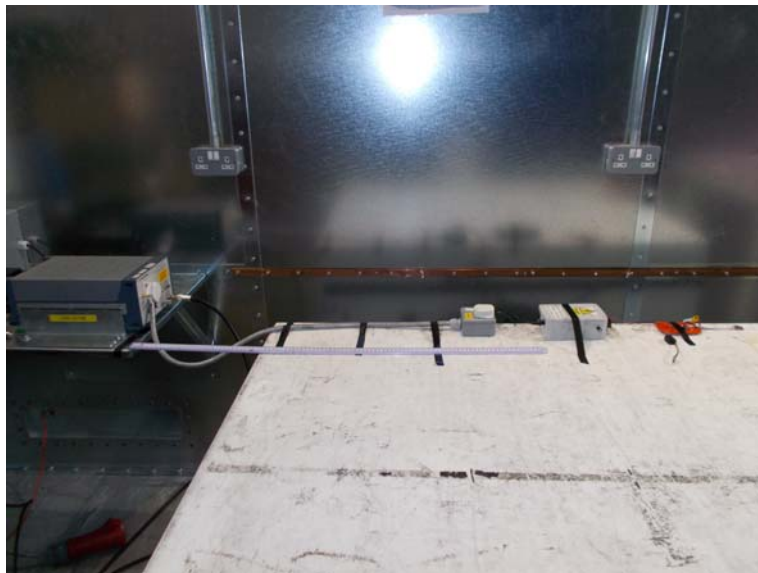
AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

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





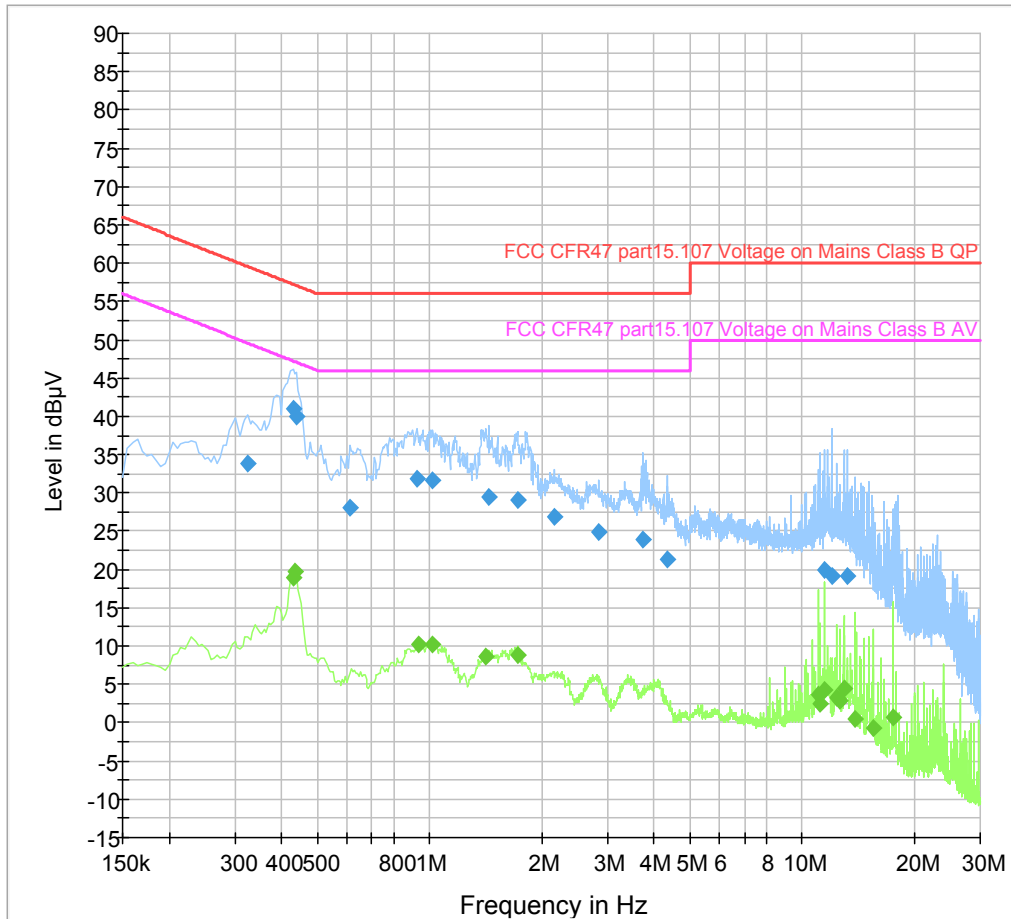
12.6 Test Equipment

<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>
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

Transmit mode Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195



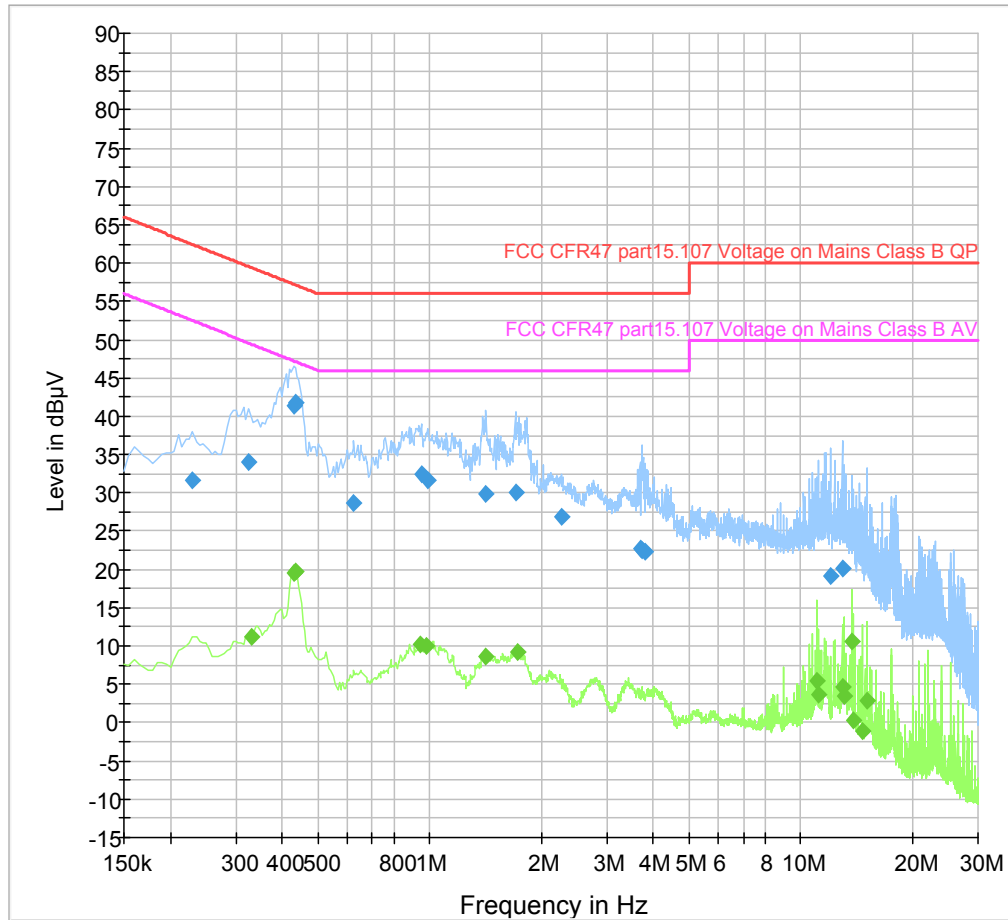
AC power-line conducted emissions, Transmit mode
Results measured using the average detector

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.430000	19.0	2000.0	10.000	GND	L1	0.1	28.2	47.3	PASS
0.435000	19.7	2000.0	10.000	GND	N	0.1	27.4	47.2	PASS
0.935000	10.2	2000.0	10.000	GND	N	0.2	35.8	46.0	PASS
1.015000	10.1	2000.0	10.000	GND	L1	0.2	35.9	46.0	PASS
1.410000	8.6	2000.0	10.000	GND	N	0.2	37.4	46.0	PASS
1.720000	8.8	2000.0	10.000	GND	N	0.2	37.2	46.0	PASS
11.035000	3.8	2000.0	10.000	GND	L1	0.9	46.2	50.0	PASS
11.125000	2.4	2000.0	10.000	GND	N	0.8	47.6	50.0	PASS
11.465000	4.2	2000.0	10.000	GND	L1	0.9	45.8	50.0	PASS
12.315000	3.3	2000.0	10.000	GND	N	0.9	46.7	50.0	PASS
12.570000	2.8	2000.0	10.000	GND	N	0.9	47.2	50.0	PASS
12.905000	4.4	2000.0	10.000	GND	N	0.9	45.6	50.0	PASS
13.845000	0.6	2000.0	10.000	GND	N	1.0	49.4	50.0	PASS
15.540000	-0.7	2000.0	10.000	GND	N	1.2	50.7	50.0	PASS
17.580000	0.6	2000.0	10.000	GND	N	1.4	49.4	50.0	PASS

AC power-line conducted emissions, Transmit mode Results measured using the quasi-peak detector									
Frequency (MHz)	QuasiPeak (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)	Comment
0.325000	33.8	2000.0	10.000	GND	N	0.1	25.8	59.6	PASS
0.430000	41.0	2000.0	10.000	GND	L1	0.1	16.3	57.3	PASS
0.440000	40.1	2000.0	10.000	GND	L1	0.1	17.0	57.1	PASS
0.610000	28.1	2000.0	10.000	GND	N	0.1	27.9	56.0	PASS
0.925000	31.8	2000.0	10.000	GND	N	0.2	24.2	56.0	PASS
1.020000	31.7	2000.0	10.000	GND	N	0.2	24.3	56.0	PASS
1.440000	29.4	2000.0	10.000	GND	N	0.2	26.6	56.0	PASS
1.725000	29.1	2000.0	10.000	GND	N	0.2	26.9	56.0	PASS
2.165000	26.8	2000.0	10.000	GND	N	0.2	29.2	56.0	PASS
2.835000	24.8	2000.0	10.000	GND	L1	0.3	31.2	56.0	PASS
3.725000	24.0	2000.0	10.000	GND	L1	0.3	32.0	56.0	PASS
4.330000	21.4	2000.0	10.000	GND	L1	0.4	34.6	56.0	PASS
11.465000	20.0	2000.0	10.000	GND	L1	0.9	40.0	60.0	PASS
11.975000	19.2	2000.0	10.000	GND	L1	1.0	40.8	60.0	PASS
13.250000	19.1	2000.0	10.000	GND	L1	1.1	40.9	60.0	PASS

Receive mode Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195



AC power-line conducted emissions, Receive mode
Results measured using the average detector

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.330000	11.3	2000.0	10.000	GND	N	0.1	38.2	49.5	PASS
0.430000	19.5	2000.0	10.000	GND	N	0.1	27.8	47.3	PASS
0.435000	19.8	2000.0	10.000	GND	N	0.1	27.3	47.2	PASS
0.945000	10.2	2000.0	10.000	GND	N	0.2	35.8	46.0	PASS
0.975000	10.0	2000.0	10.000	GND	N	0.2	36.0	46.0	PASS
1.410000	8.6	2000.0	10.000	GND	N	0.2	37.4	46.0	PASS
1.725000	9.2	2000.0	10.000	GND	N	0.2	36.8	46.0	PASS
11.040000	5.4	2000.0	10.000	GND	L1	0.9	44.6	50.0	PASS
11.120000	3.7	2000.0	10.000	GND	L1	0.9	46.3	50.0	PASS
12.905000	4.7	2000.0	10.000	GND	L1	1.1	45.3	50.0	PASS
13.080000	3.5	2000.0	10.000	GND	N	1.0	46.5	50.0	PASS
13.665000	10.7	2000.0	10.000	GND	L1	1.1	39.3	50.0	PASS
13.845000	0.3	2000.0	10.000	GND	L1	1.2	49.7	50.0	PASS
14.690000	-1.0	2000.0	10.000	GND	N	1.1	51.0	50.0	PASS
15.030000	2.9	2000.0	10.000	GND	N	1.1	47.1	50.0	PASS

AC power-line conducted emissions, Receive mode
Results measured using the quasi-peak detector

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.230000	31.7	2000.0	10.000	GND	L1	0.1	30.8	62.4	PASS
0.325000	34.0	2000.0	10.000	GND	N	0.1	25.6	59.6	PASS
0.430000	41.3	2000.0	10.000	GND	L1	0.1	15.9	57.3	PASS
0.435000	41.9	2000.0	10.000	GND	N	0.1	15.3	57.2	PASS
0.625000	28.7	2000.0	10.000	GND	N	0.1	27.3	56.0	PASS
0.950000	32.4	2000.0	10.000	GND	N	0.2	23.6	56.0	PASS
0.990000	31.5	2000.0	10.000	GND	L1	0.2	24.5	56.0	PASS
1.420000	29.9	2000.0	10.000	GND	N	0.2	26.1	56.0	PASS
1.700000	30.1	2000.0	10.000	GND	N	0.2	25.9	56.0	PASS
2.260000	26.9	2000.0	10.000	GND	N	0.2	29.1	56.0	PASS
3.685000	22.7	2000.0	10.000	GND	L1	0.3	33.3	56.0	PASS
3.740000	22.6	2000.0	10.000	GND	N	0.3	33.4	56.0	PASS
3.815000	22.3	2000.0	10.000	GND	N	0.3	33.7	56.0	PASS
11.975000	19.1	2000.0	10.000	GND	N	0.9	40.9	60.0	PASS
12.905000	20.1	2000.0	10.000	GND	L1	1.1	39.9	60.0	PASS

13 Occupied Bandwidth

13.1 Definition

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:	IC: ANSI C63.10-2013, Clause 6.9 FCC: ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	2402 / 2442 / 2480
EUT Test Modulations:	GSFK
Deviations From Standard:	None
Measurement BW:	
(IC requirement: 1% to 5% OBW;	100 kHz
FCC requirement: 100 kHz)	
Spectrum Analyzer Video BW:	300 kHz
(requirement at least 3x RBW)	
Measurement Span:	5 MHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 22 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 10 % (as declared)

13.3 Test Limit

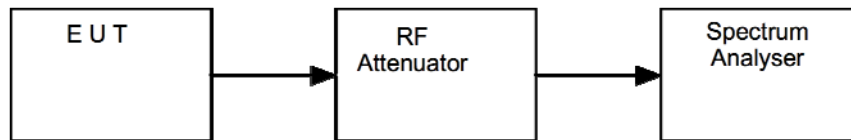
The minimum -6 dB bandwidth shall be at least 500 kHz.

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

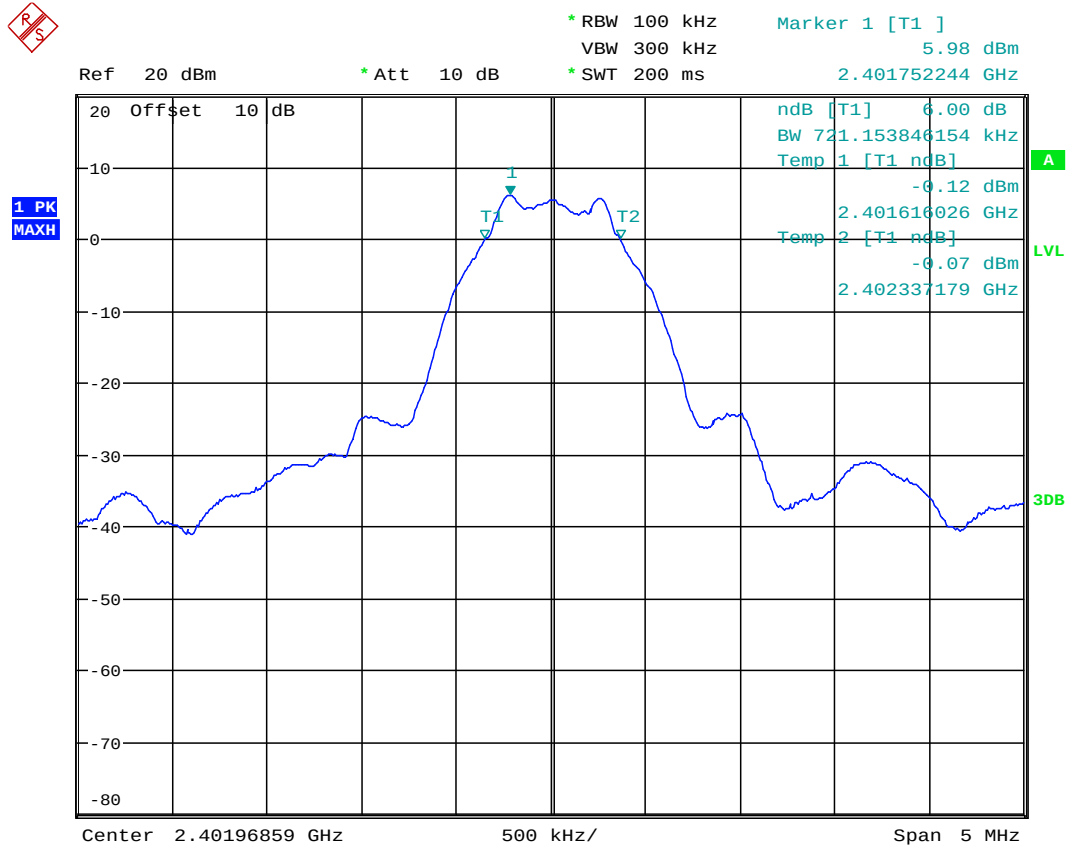


13.5 Test Equipment

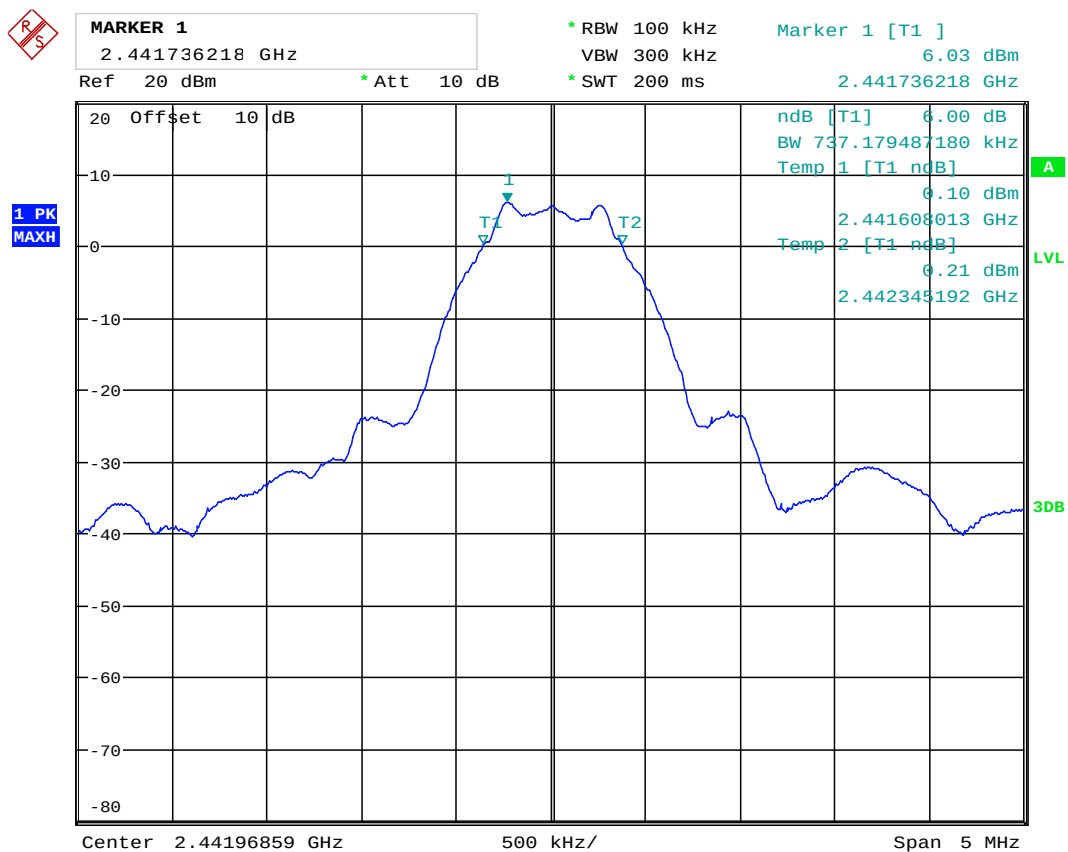
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>	<i>Calibration Interval</i>
Spectrum Analyser	R & S	FSU26	U281	24/04/2016	12

13.6 Test Results

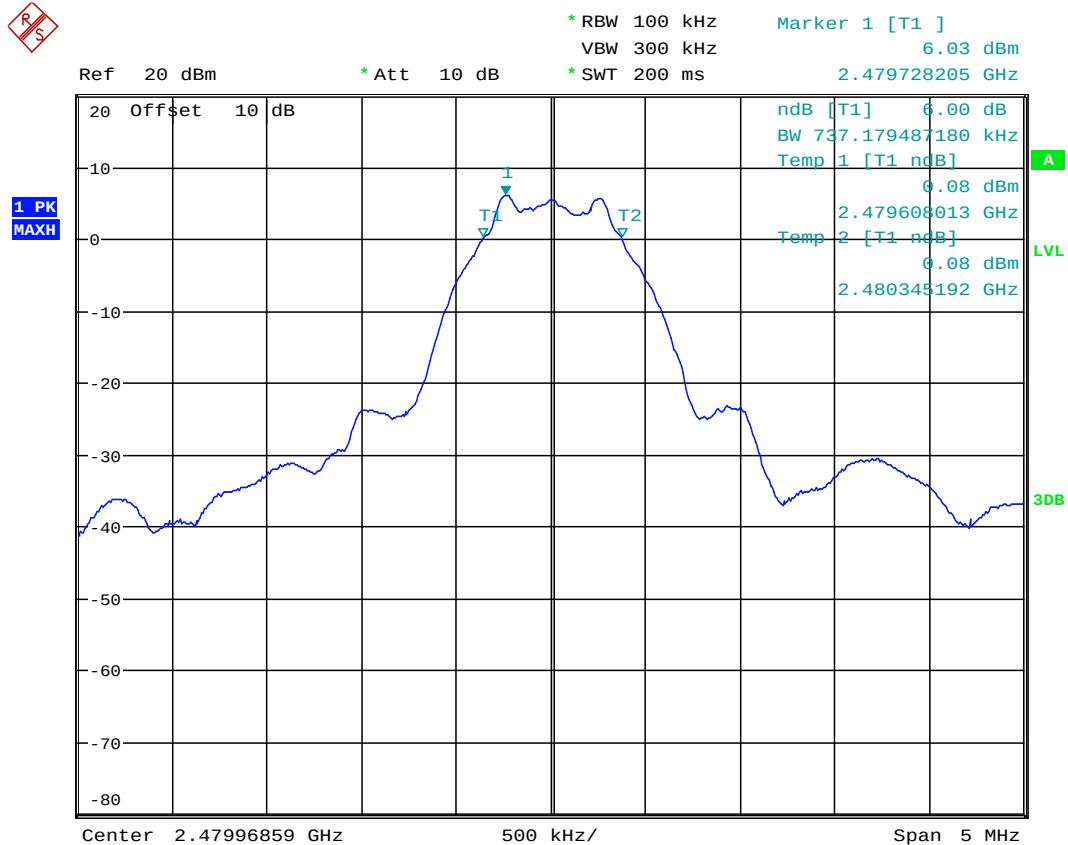
<i>FCC 15.247. Modulation: GFSK; Data rate: 1Mbit; Power setting: 7 dBm</i>				
<i>Channel Frequency (MHz)</i>	<i>F_L (MHz)</i>	<i>F_H (MHz)</i>	<i>6dB Bandwidth (kHz)</i>	<i>Result</i>
2402	2401.616	2402.337	721.153	PASS
2442	2441.608	2442.345	737.179	PASS
2480	2479.608	2480.345	737.179	PASS



Date: 22.FEB.2016 13:19:02



Date: 22.FEB.2016 13:15:47



Date: 22.FEB.2016 13:17:01

14 Maximum peak conducted output power

14.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	2402 / 2442 / 2480
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

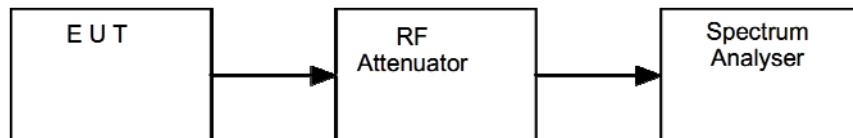
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

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	FSU 46	U281	24/04/2016	12

14.6 Test Results

Modulation: GFSK; Data rate: 1 Mbit/s; Max Power setting				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (mW)	Result
2402	6.41	0.00	4.375	PASS
2442	6.42	0.00	4.385	PASS
2480	6.43	0.00	4.395	PASS

15 Out-of-band and conducted spurious emissions

15.1 Definition

Out-of-band emission.

Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Spurious emission.

Emission on a frequency or frequencies that 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.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	2402 / 2442 / 2480
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 24 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 10 % (as declared)

15.3 Test Limit

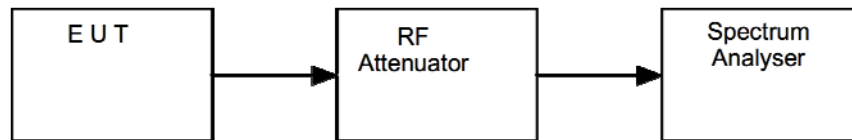
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in FCC 47CFR15.209(a) / RSS-Gen is not required.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions from the EUT were 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 v Test Setup



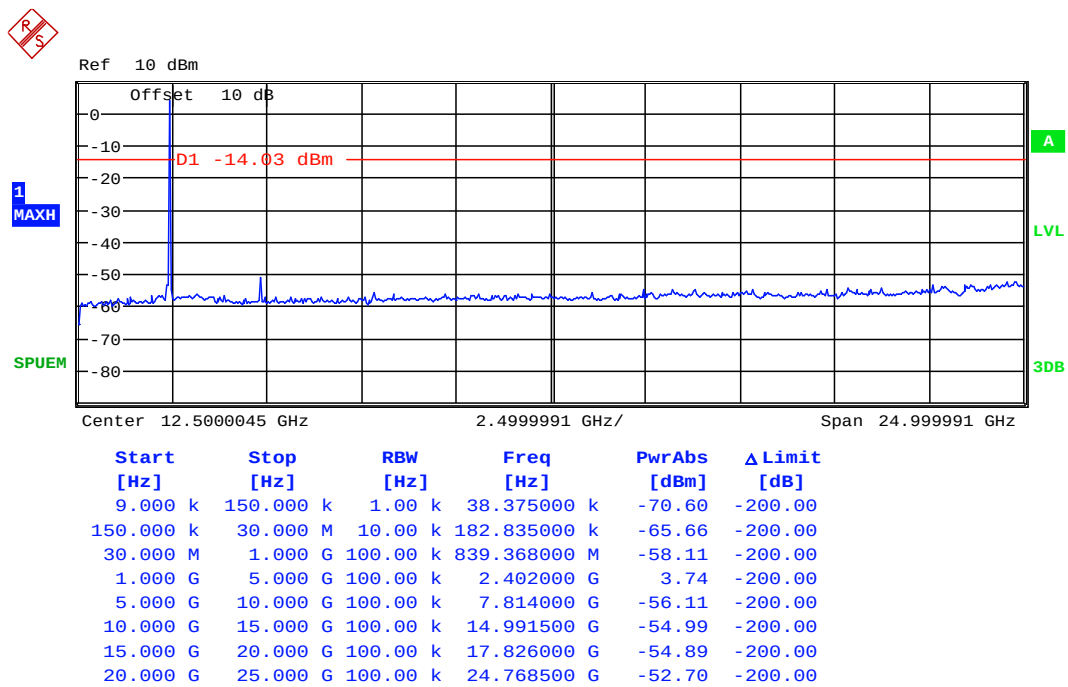
15.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>	<i>Calibration Interval</i>
Spectrum Analyser	R & S	FSU26	U281	24/04/2016	12

15.6 Test Results

Modulation: GSKF; Data rate: 1 MBit; Power setting: 7 dbm						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2402	2405	12.9	14.5	N/A	N/A	PASS

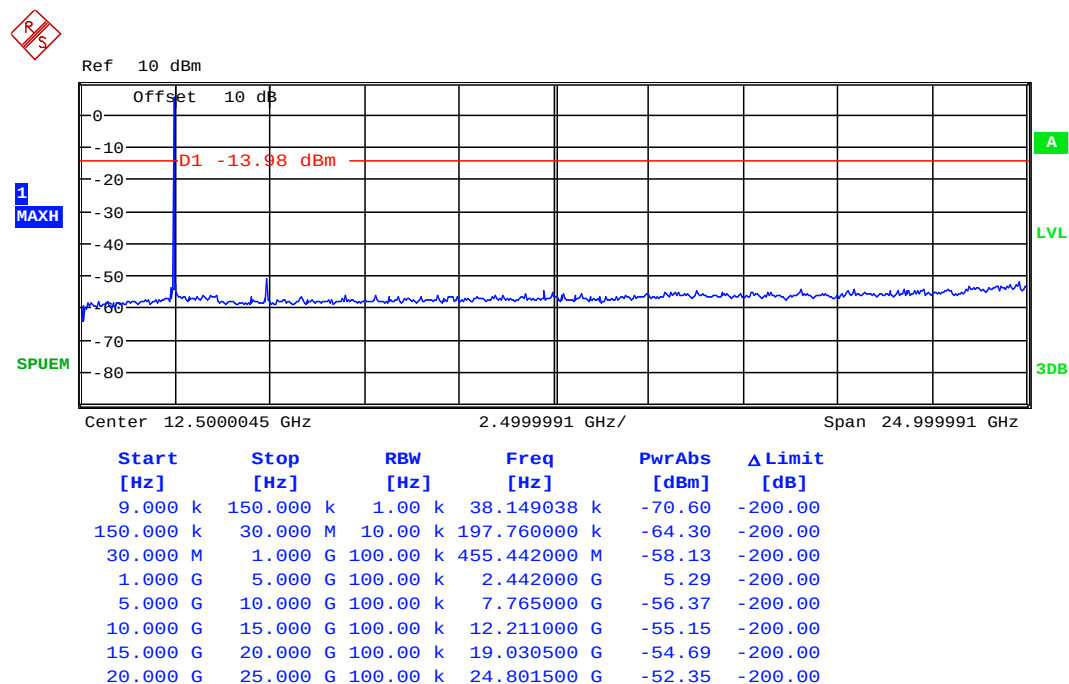
No significant emission within 20dBs of the limit



Date: 22.FEB.2016 16:08:21

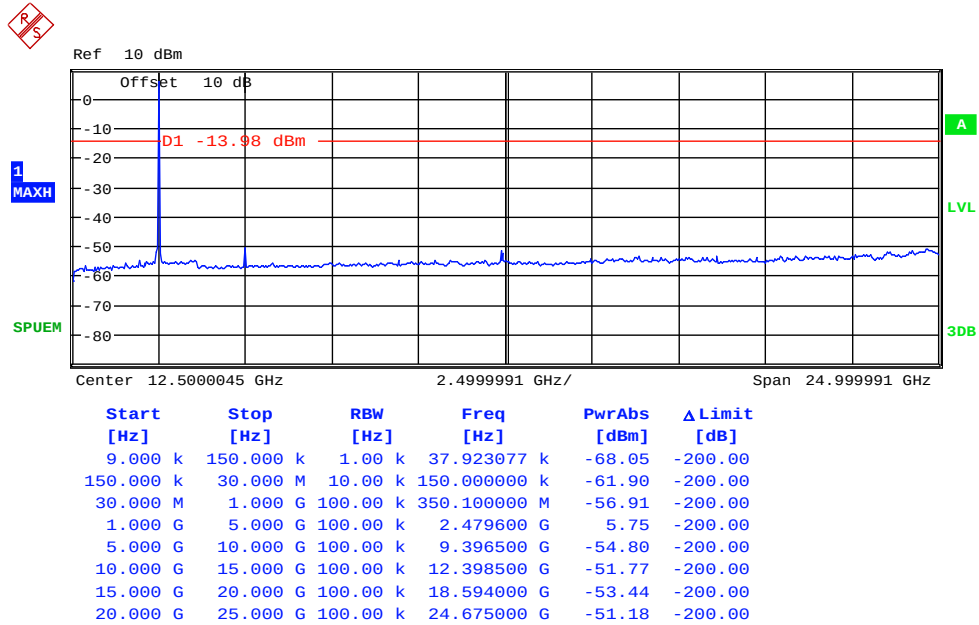
Modulation: GSKF; Data rate: 1 MBit; Power setting: 7 dbm						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2442	2440	12.9	14.5	N/A	N/A	PASS

No significant emission within 20dBs of the limit



Date: 22.FEB.2016 15:59:01

Modulation: GSKF; Data rate: 1 MBit; Power setting: 7 dbm						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2480	2475	12.9	14.5	N/A	N/A	PASS



Date: 22.FEB.2016 15:55:52

16 Power spectral density

16.1 Definition

The power per unit bandwidth.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	2402 / 2442 / 2480
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 1.5 times Channel BW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 24 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 10% (as declared)

16.3 Test Limit

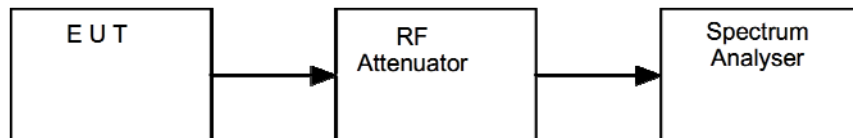
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account.

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 vi Test Setup

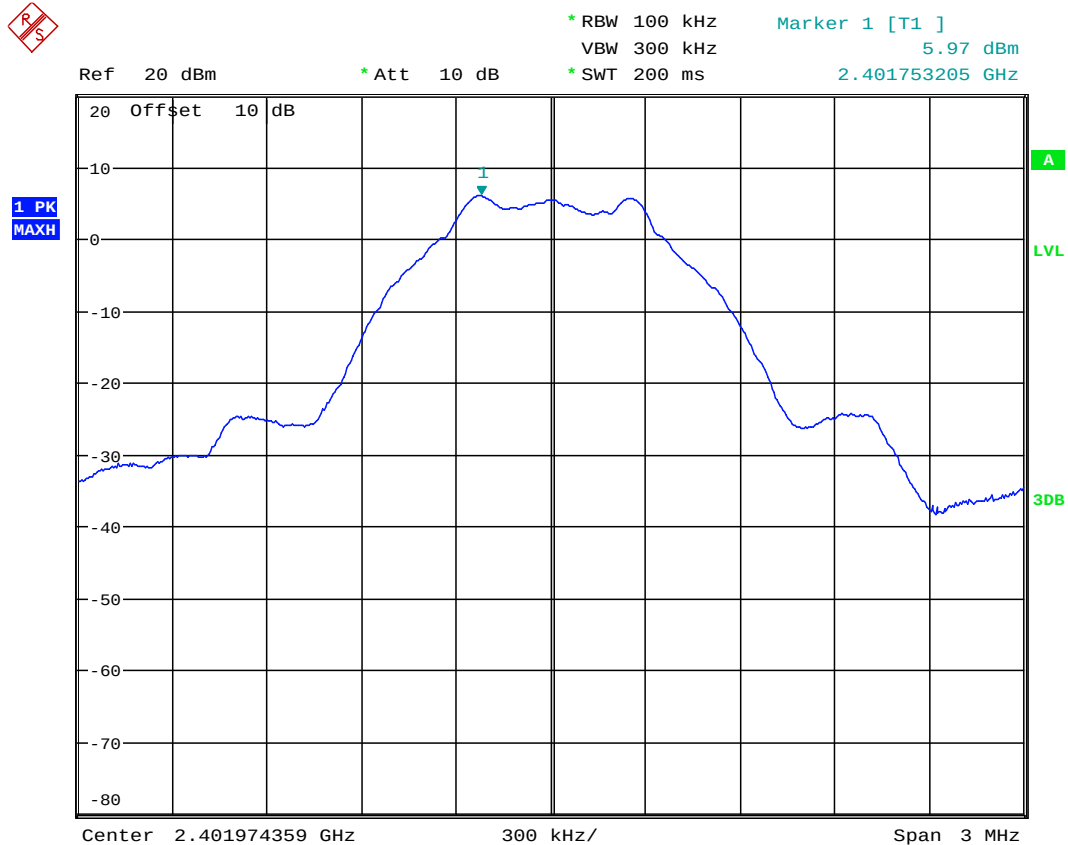


16.5 Test Equipment

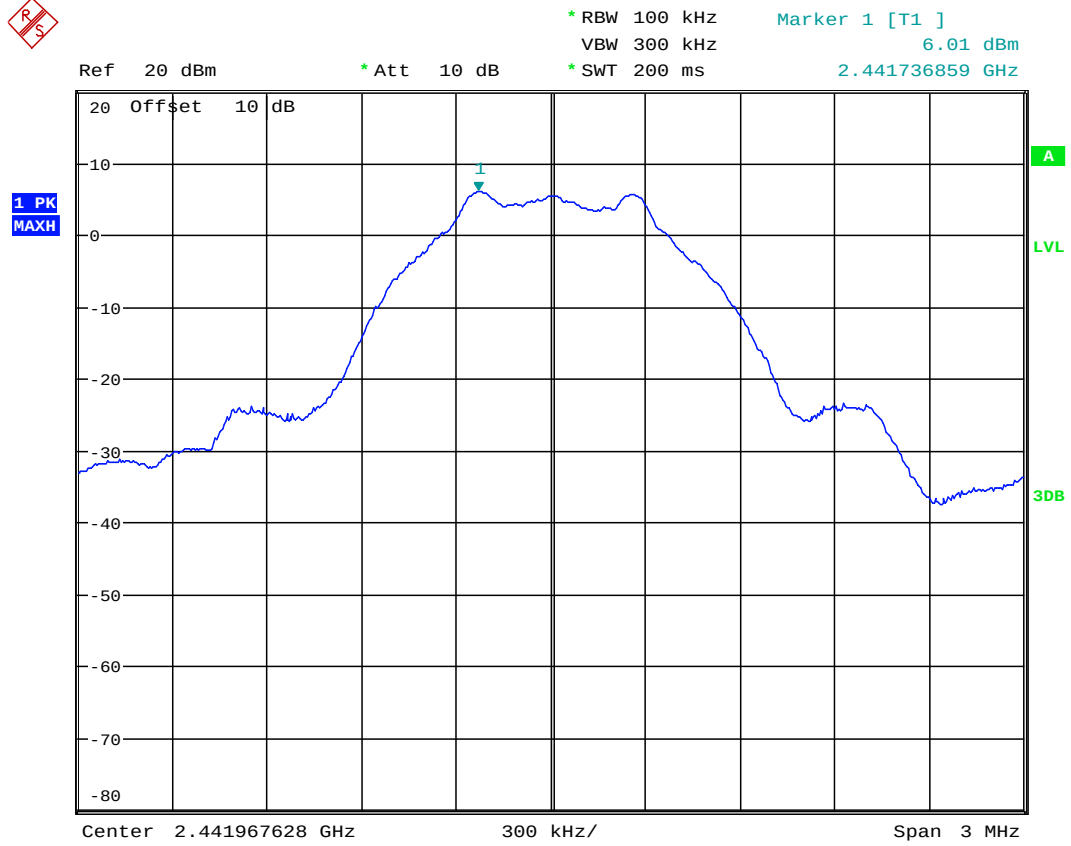
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>	<i>Calibration Interval</i>
Spectrum Analyser	R & S	FSU26	U281	24/04/2016	12

16.6 Test Results

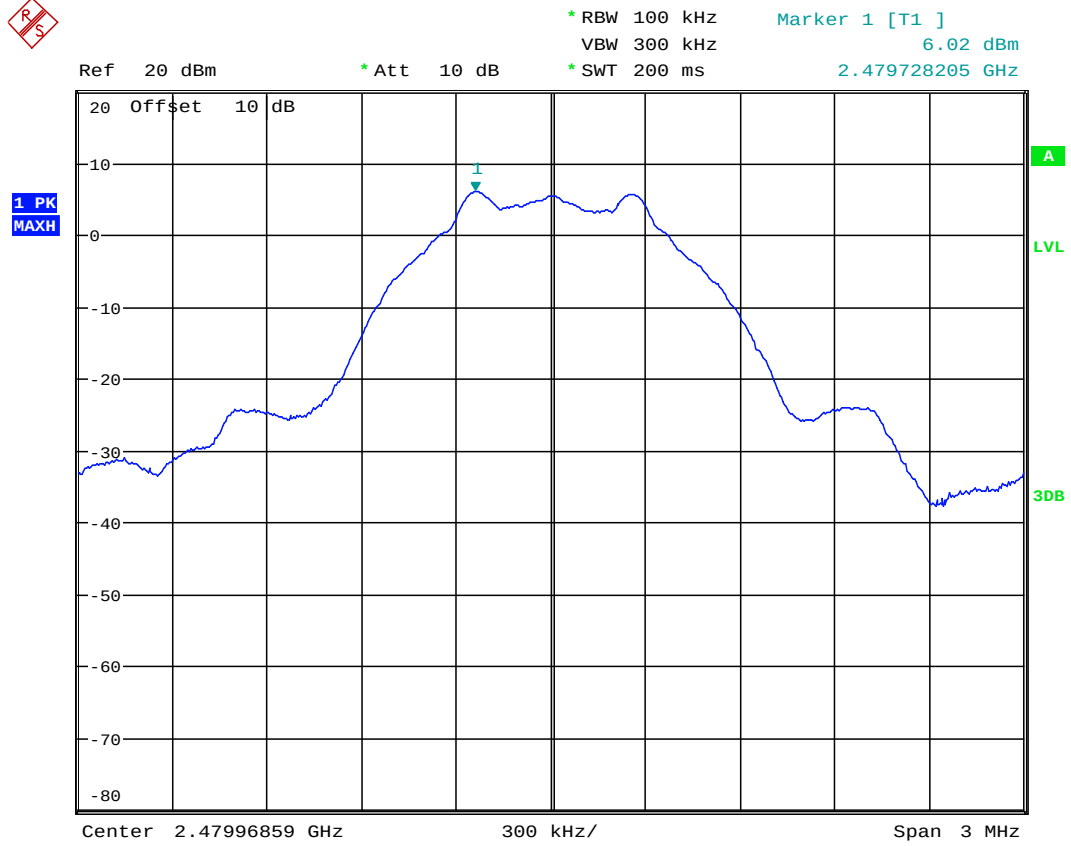
<i>Modulation: GFSK; Data rate: 1Mbit/s.</i>				
<i>Channel Frequency (MHz)</i>	<i>Analyzer Level (dBm)</i>	<i>Cable loss (dB)</i>	<i>Power (dBm)</i>	<i>Result</i>
2402	5.97	0.00	5.97	PASS
2442	6.02	0.00	6.02	PASS
2480	6.02	0.00	6.02	PASS



Date: 22.FEB.2016 13:06:44



Date: 22.FEB.2016 13:05:18



Date: 22.FEB.2016 13:08:21

17 Radiated emissions – unintentional radiation / receiver emissions

17.1 Definitions

Receiver spurious emissions

The radio frequency signals generated within the receiver, which may cause interference to other equipment. This includes the period during which the equipment is scanning or switching channels.

Unintentional radiator

A device that generates RF energy which is not intended to be radiated for reception by a radio receiver.

17.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Chamber 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	2402 MHz / 2442 MHz / 2480 MHz
EUT Channel Bandwidths:	1 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: Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 22 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 V dc	3.3 V dc $\pm$ 10 % (as declared)

17.3 Test Limit

Note:

Only radio communication receivers operating in stand-alone mode within the band 30 to 960 MHz, as well as scanner receivers, are subject to requirements, as described above. All other receivers are exempted from any certification, testing, labelling and reporting requirements.

However, all receivers in all frequency bands shall comply with the limits set forth in FCC 47CFR15B / IC RSS-Gen even in cases where testing, reporting and/or certification are not required.

Receiver Radiated Limits

<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

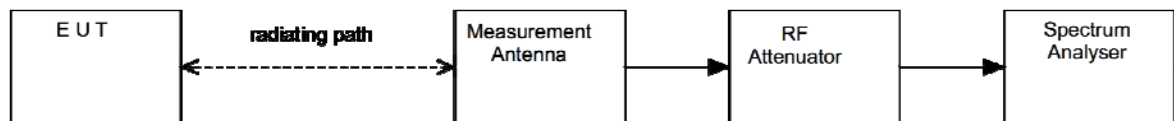
17.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1 GHz, from 1 to 4 m; above 1 GHz as necessary) in order to maximise emissions.

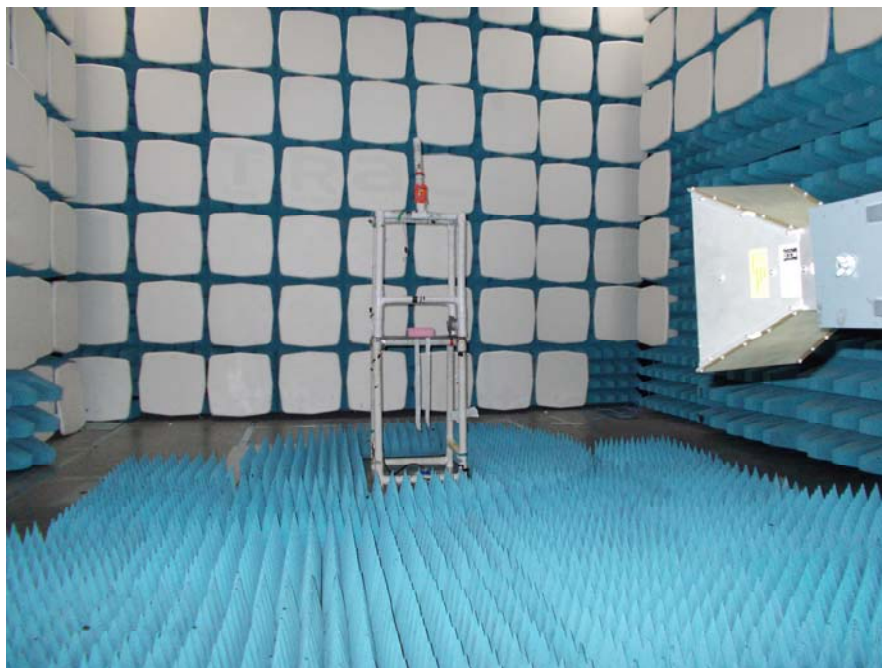
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency.

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

Figure viii Test Setup



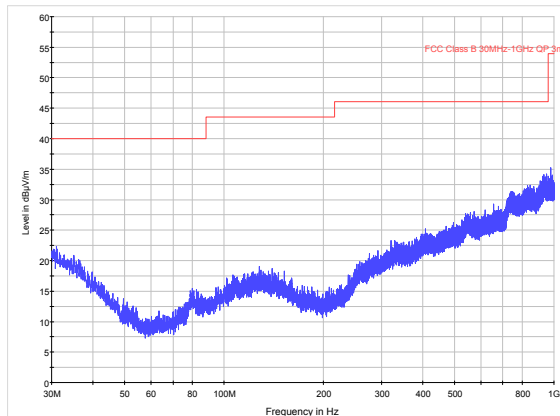
Test Setup Photograph(s)



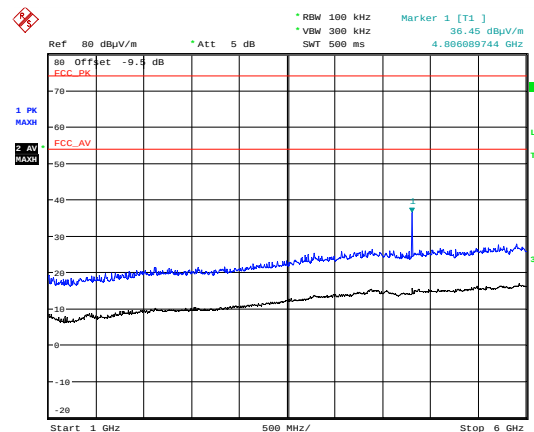
17.5 Test Equipment

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
Spectrum Analyser	R&S	FSU46	U281	24/04/2016	12
Horn Antenna	EMCO	3115	TRL139	25/09/2017	24
Pre-Amplifier	Agilent	8449B	TRL572	10/02/2016	12

17.6 Test Results

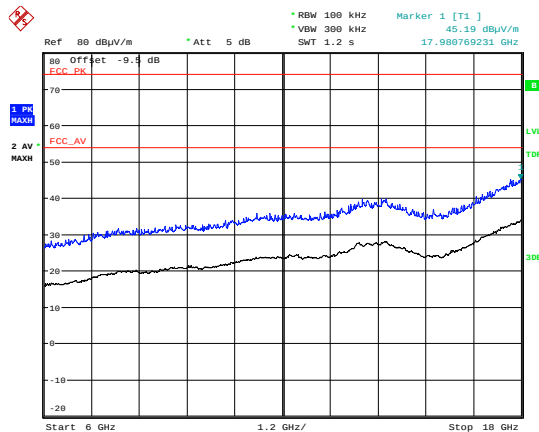


1 – Bottom Channel (30 MHz to 1 GHz).



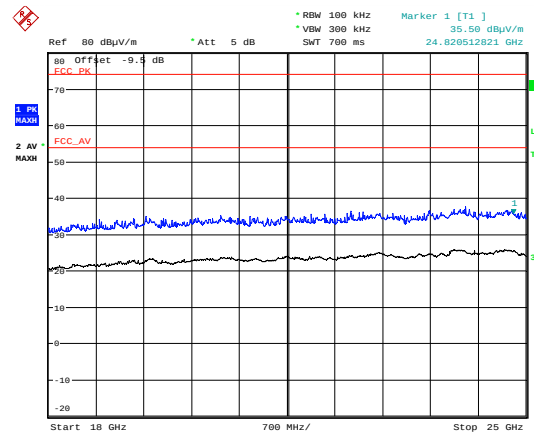
Date: 3.MAR.2016 10:38:59

2 – Bottom Channel (1 GHz to 6 GHz).



Date: 3.MAR.2016 10:49:45

3 – Bottom Channel (6 GHz to 18 GHz).

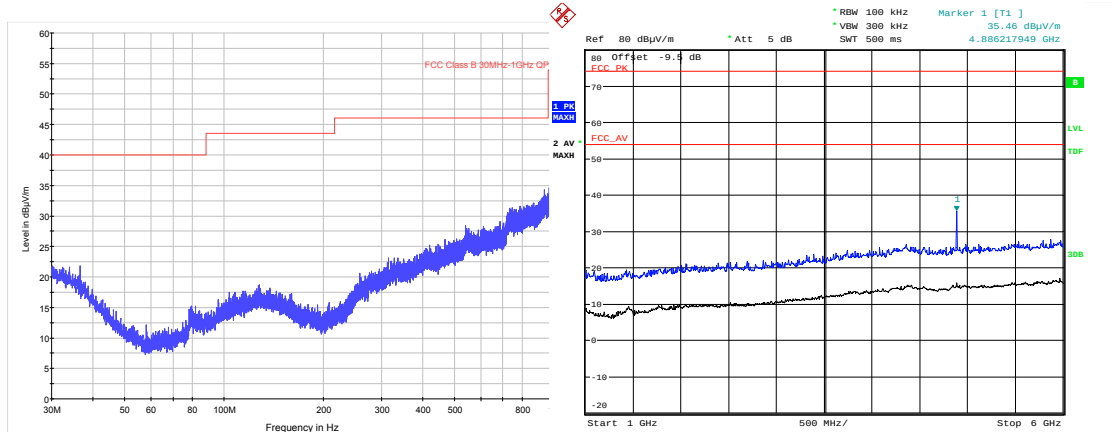


Date: 3.MAR.2016 12:22:34

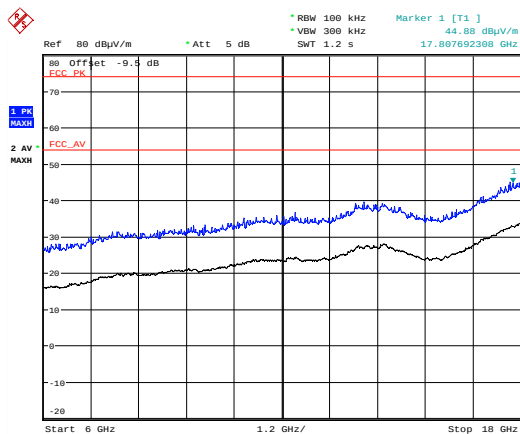
4 – Bottom Channel (18 GHz to 25 GHz).

High Power; Channel: 2402 MHz

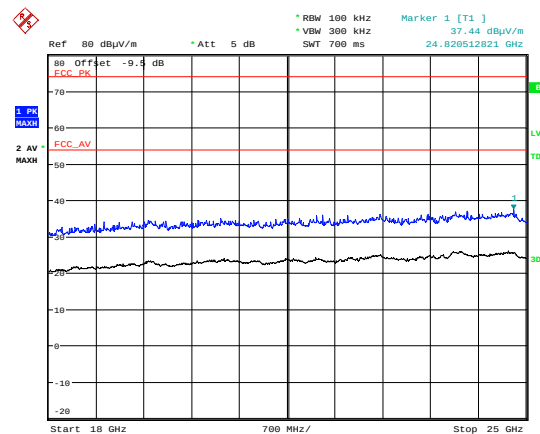
Detector	Freq. (MHz)	Measured Emission (dBμV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m)	Extrap'n Factor (dB)	Field Strength (μV/m)	Limit (μV/m)
Pk	4801.21	51.42	5.10	33.10	35.84	44.24	-9.54	162.88	5012
Av	4801.21	45.82	5.10	33.10	35.84	44.24	-9.54	85.48	500



Date: 3.MAR.2016 11:35:18



Date: 3.MAR.2016 11:39:08

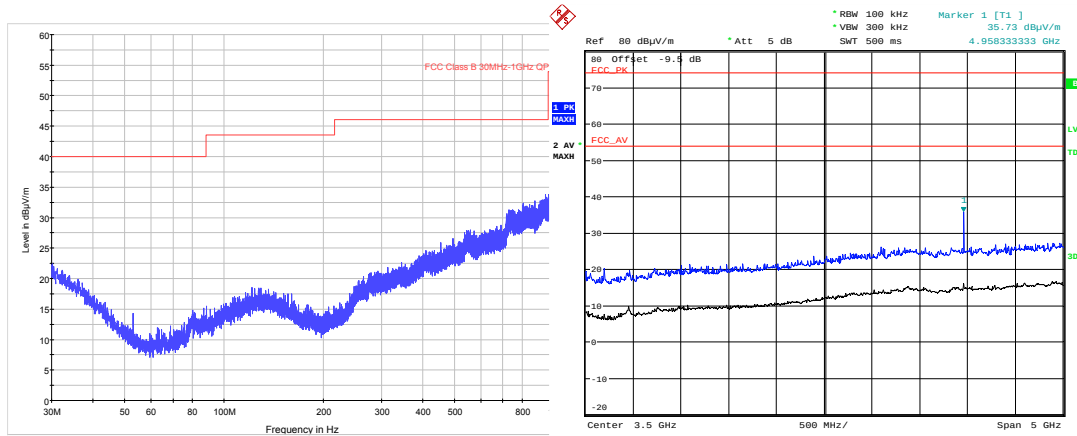


Date: 3.MAR.2016 12:21:15

High Power; Channel: 2442 MHz

Detector	Freq. (MHz)	Measured Emission (dBμV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m)	Extrap'n Factor (dB)	Field Strength (μV/m)	Limit (μV/m)
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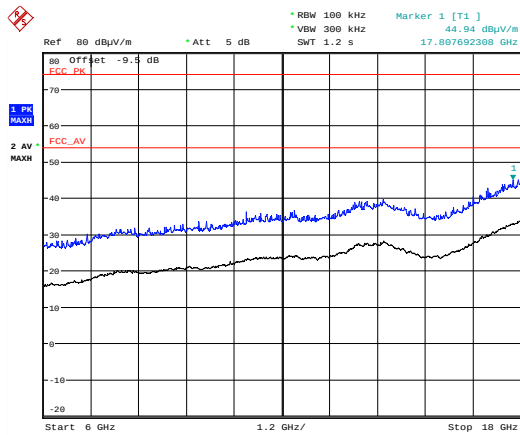
<i>High Power; Channel: 2442 MHz</i>									
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Measured Emission (dBμV/m)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Extrap'n Factor (dB)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
Pk	4881.24	53.02	5.20	33.30	35.87	46.11	-9.54	202.01	5012
Av	4881.24	48.34	5.20	33.30	35.87	41.43	-9.54	117.86	500



9 – Top Channel (30 MHz to 1 GHz).

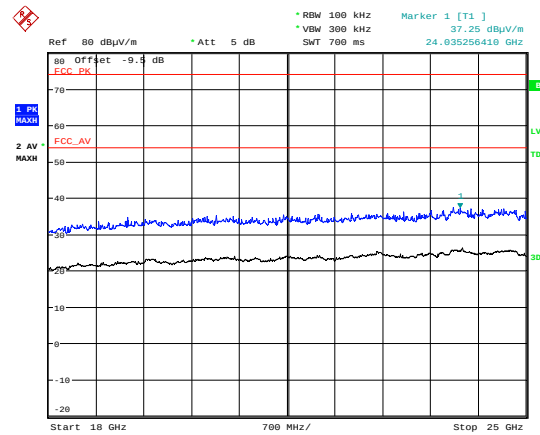
Date: 3.MAR.2016 11:55:21

10 – Top Channel (1 GHz to 6 GHz).



Date: 3.MAR.2016 11:56:32

11 – Top Channel (6 GHz to 18 GHz).



Date: 3.MAR.2016 12:16:48

12 – Top Channel (18 GHz to 25 GHz).

High Power; Channel: high 2480 MHz									
Detector	Freq. (MHz)	Measured Emission (dBμV/m)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m)	Extrap'n Factor (dB)	Field Strength (μV/m)	Limit (μV/m)
Pk	4957.19	54.51	5.20	33.50	35.90	47.77	-9.54	244.56	5012
Av	4957.19	49.75	5.20	33.50	35.90	43.01	-9.54	141.38	500

18 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] Radiated 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**

[2] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[4] Conducted carrier power

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

[5] Conducted / radiated RF power out-of-band

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

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

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

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

[6] Power spectral density

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