

Report on the Radio Testing

For

Pace plc

on

DOCSIS 3 HYBRID GATEWAY STB

Report no. TRA-028175-47-05B

18th May 2016

RF915 2.0

Report Number: TRA-028175-47-05B
Issue: B

REPORT ON THE RADIO TESTING OF A
Pace plc
DOCSIS 3 HYBRID GATEWAY STB
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 1st October - 13th November 2015

Written by: D Winstanley

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Radio Test Engineers

Approved by:

J Charters
Department Manager - Radio

Date: 18th 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

RF915 2.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	2 nd December 2015	Original
B	18th May 2016	Change of FCCID

2 Summary

TEST REPORT NUMBER: TRA-028175-47-05B

WORKS ORDER NUMBER: TRA-028175-00

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): 47CFR15.247

EQUIPMENT UNDER TEST (EUT): DOCSIS 3 HYBRID GATEWAY STB

FCC IDENTIFIER: NQ8ND7507

EUT SERIAL NUMBER: FN34A152840077

MANUFACTURER/AGENT: Pace plc

ADDRESS: Victoria Road
Saltaire
Shipley
West Yorkshire
BD18 3LF
United Kingdom

CLIENT CONTACT: Robert Turner
☎ 01274 537080
✉ robert.turner@pace.com

ORDER NUMBER: Not Applicable

TEST DATE: 1st October - 13th November 2015

TESTED BY: D Winstanley, A Tosif
Element

2.1 Test Summary

Test Method and Description		Requirement Clause 47CFR15	Applicable to this equipment	Result / Note
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions		15.207	<input type="checkbox"/>	Note 1
Occupied bandwidth		15.247(a)(2)	<input checked="" type="checkbox"/>	Pass
Conducted carrier power	Peak	15.247(b)(3)	<input checked="" type="checkbox"/>	Pass
	Max.		<input type="checkbox"/>	
Conducted RF power out-of-band		15.247(d)	<input checked="" type="checkbox"/>	Pass
Power spectral density, conducted		15.247(e)	<input checked="" type="checkbox"/>	Pass
Calculation of duty correction		15.35(c)	<input type="checkbox"/>	N/A

Notes:

1. See Test report TRA-028175-47-06A. AC Power line Conducted emissions were recorded with all radio devices active simultaneously

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-028175-47-05B presents the radiated emissions results of the 2.4 GHz Bluetooth Low Energy Radio testing on a Pace plc, DOCSIS 3 HYBRID GATEWAY STB to specification 47CFR15 Radio Frequency Devices

The testing was carried out for Pace plc 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 |
|--|--|

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 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-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: DOCSIS 3 HYBRID GATEWAY STB
- Serial Number: FN34A152840077
- Model Number: ND7506
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

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.

- Name: HDMI HDCP Ready Unit
- Sample Number: S03
- Serial Number: DP2012110417
- Model Number: None

- Name: Arris Cadant C3 CMTS
- Sample Number: S04
- Serial Number: 65000181-002109
- Model Number: None

- Name: PX031ECB Box
- Sample Number: S05
- Serial Number: PADA00015189
- Model Number: None

- Name: Dell Latitude Laptop
- Sample Number: S06
- Serial Number: SAL-17646
- Model Number: D430

- Name: Dell Latitude Laptop
- Sample Number: S07
- Serial Number: PACE0000019241
- Model Number: E6400

- Name: AOC 4K Television
- Sample Number: TRA-024769S07
- Serial Number: HCXE8JA002064
- Model Number: None

7.3 EUT Mode of Operation

7.3.1 Transmission

The EUT was under the control of test software named 'digidebug' which when run exercised the EUT in its worst case configuration. While the test was running the EUT was decoding AV (audio visual) data from a MOCA (Multimedia over Coax Alliance) stream and then displaying it via HDMI at 2160p resolution. The EUT was connected to a DOCSIS head end. The HDD of the EUT was also active, with data being written to it and then read back. An internal SD card was inserted in order that the SD card TX and RX clock lines (50MHz) were active. A source playing HD AV was connected to the HDMI input of the EUT. Both USB ports were connected to USB 3.0 memory sticks. All other ports were terminated appropriately.

Bluetooth Low Energy transmitter control was Blue tool software provided by the manufacturer of the Bluetooth hardware. The commands provided by the manufacturer setup the device into a permanent modulated transmit mode on the required channel.

7.3.2 Reception

This report covers transmitter operation only, results for unintentional emissions can be found in test report TRA-028175-44-00A

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2400 – 2483.5 MHz
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	1 MHz
Channel spacing:	2 MHz
Declared output power(s):	Up to 1 Watt (conducted)
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	110 Vac
Location of notice for license exempt use:	Label / user manual / both.
Duty cycle:	Upto 100 %

7.4.2 Antennas

Type:	PCB printed Antenna
Frequency range:	2400 – 2483.5 MHz
Impedance:	50 Ohms
Gain:	
Polarisation:	Omni
Beam width:	Not Applicable
Connector type:	U-FL
Mounting:	Case Mounted

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):	Not Applicable
Simultaneous tx (yes/no):	Yes

7.5 EUT Description

The EUT is a DOCSIS 3 Gateway, delivering broadband to the home via Ethernet or 2.4GHz Wi-Fi. The Gateway is capable of taking IP sourced video streams and displaying them on a TV via HDMI 2, Component and CVBS. It can connect to client boxes, routing video to up to three additional rooms within the home. Primary connection to the clients is via 5GHz Wi-Fi (802.11ac) but the client can also be connected via MOCA or Ethernet. Bluetooth is implemented on the Gateway to provide the option to connect to a smart remote control.

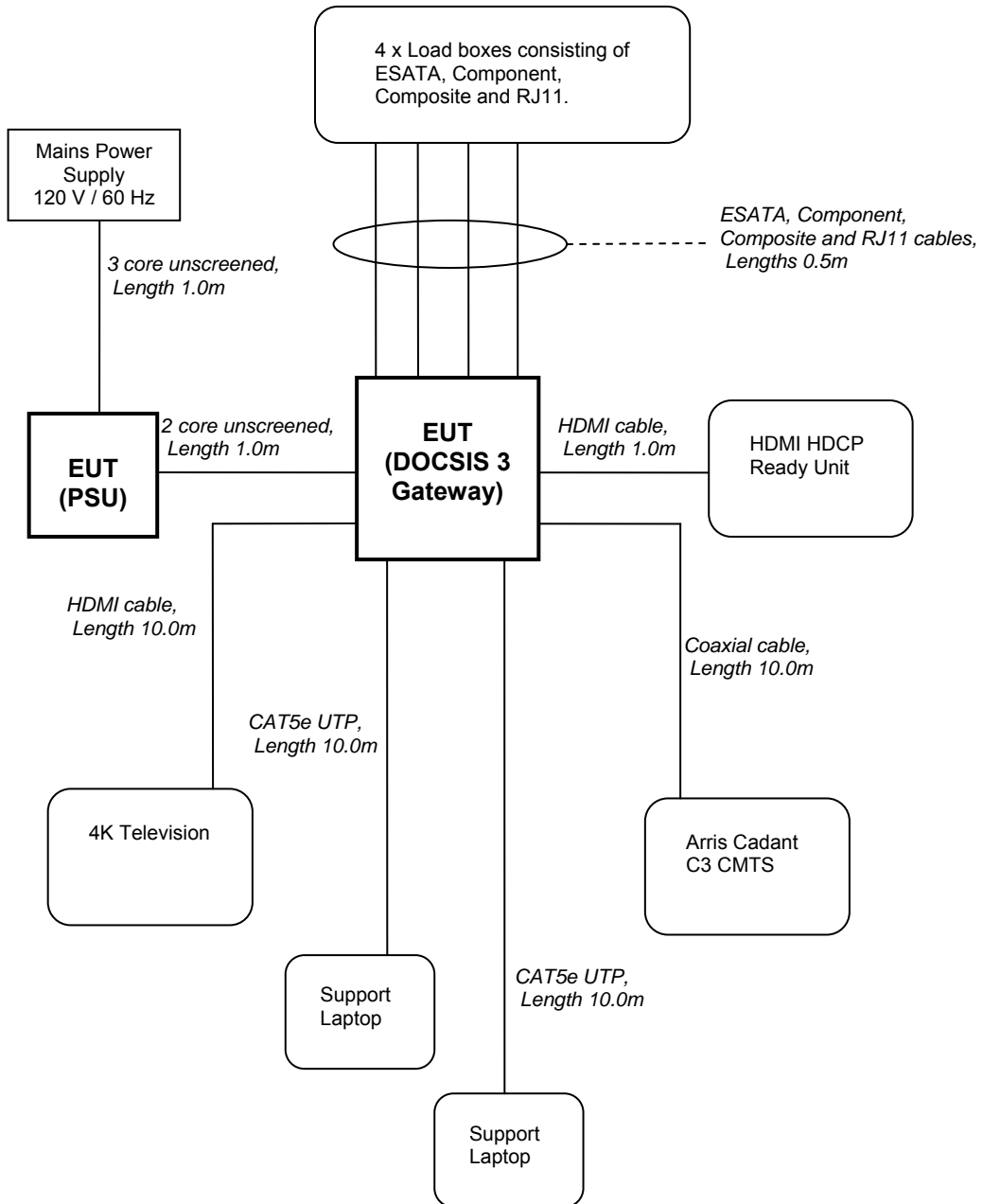
8 Modifications

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:



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 approx. 5 V dc from the adaptor / 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 checked="" type="checkbox"/>	Mains	110 V ac +/-2 %	85 % and 115 %
<input type="checkbox"/>	Battery	New battery	N/A

11 Occupied Bandwidth

11.1 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.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	FCC: ANSI C63.10-2013, Clause 11.8, KDB 558074
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	5 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW: (FCC requirement: 100 kHz)	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 2 to 5 times OBW)	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110V ac	110 V ac ±10 % (as declared)

11.3 Test Limit

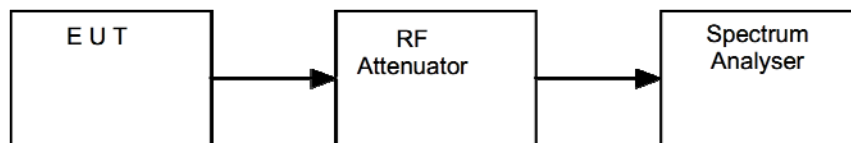
The minimum -6 dB bandwidth shall be at least 500 kHz.

11.4 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



11.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Spectrum Analyser	R&S	FSU26	UH405	11/05/2016
10 dB Attenuator	Radiall	R411820121	N/A	In Use
20 dB Attenuator	Radiall	R411810121	N/A	In Use

11.6 Test Results

FCC 15.247. Modulation: GFSK				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	6dB Bandwidth (kHz)	Result
2402	2401.607372	2402.344551	737.179	PASS
2440	2439.607372	2440.344551	737.179	PASS
2480	2479.607032	2480.344551	737.519	PASS

12 Radiated emissions

12.1 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.

12.2 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:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 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: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110V ac	230 V ac \pm 10 % (as declared)

12.3 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 (μ V/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

12.4 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;

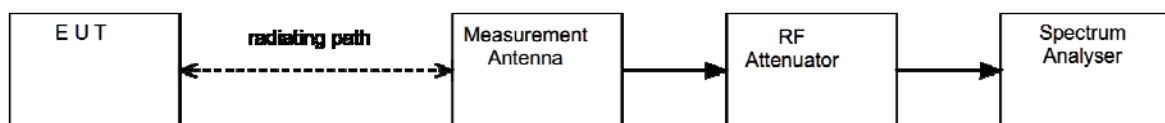
PA is the pre-amplifier gain in dB (where used);

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



12.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Bilog	Chase	CBL611/A	UH191	26/02/2017
ESVS10	R&S	ESVS10	L352	07/08/2016
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Horn Antenna	EMCO	3115	L139	20/09/2015
Pre-Amplifier	Agilent	8449B	L572	10/02/2016
Horn Antenna	Flann	20240-20	L300	10/02/2016
Horn Antenna	Flann	22240-20	L301	Note 1
Filter	BSC	SN 4478	U543	23/08/2017

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

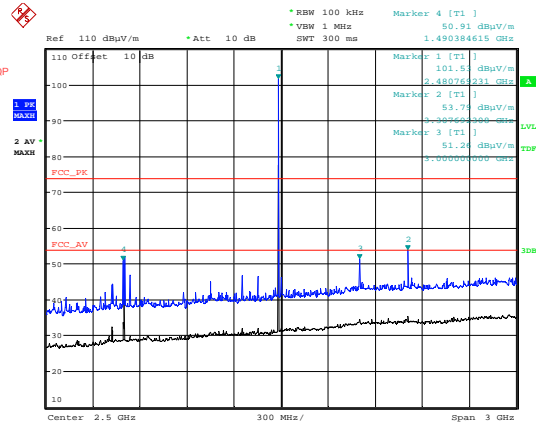
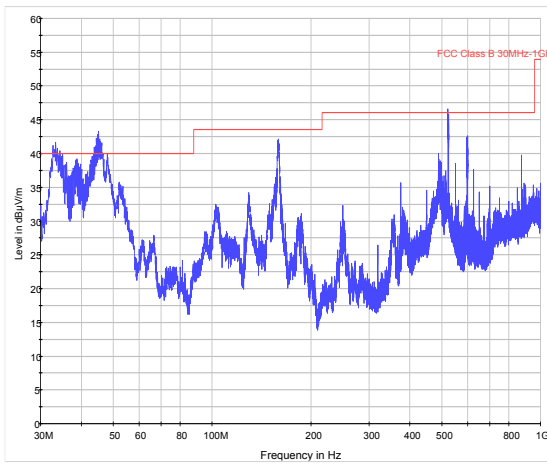
12.6 Test Results

2402 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
Pk	4803.97	49.77	5.10	33.10	35.91	0.00	0.00	52.06	400.87	5012
Av	4803.97	37.47	5.10	33.10	35.91	0.00	0.00	39.76	97.27	500

2440 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
Pk	4879.97	50.93	5.20	33.30	35.90	0.00	0.00	53.53	474.79	5012
Av	4879.97	39.88	5.20	33.30	35.90	0.00	0.00	42.48	133.05	500

2480 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB μ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
Pk	4959.95	49.77	5.10	33.50	35.89	0.00	0.00	52.48	420.73	5012
Av	4959.95	37.22	5.10	33.50	35.89	0.00	0.00	39.93	99.20	500

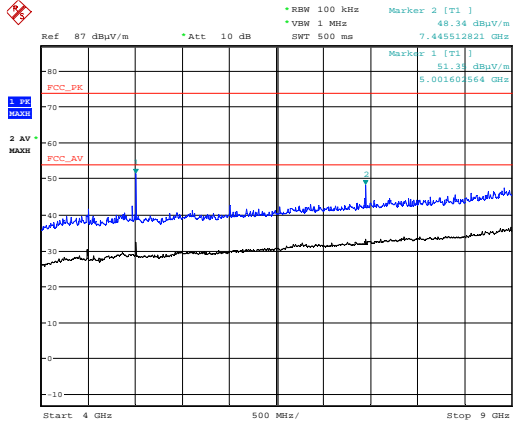
2402 MHz



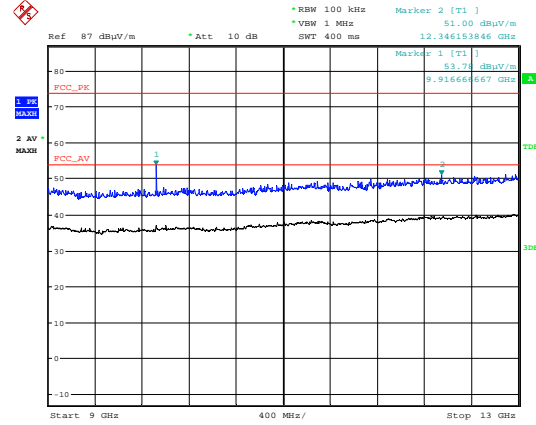
Date: 2.OCT.2015 13:45:12

30 MHz – 1 GHz

1 GHz – 4 GHz



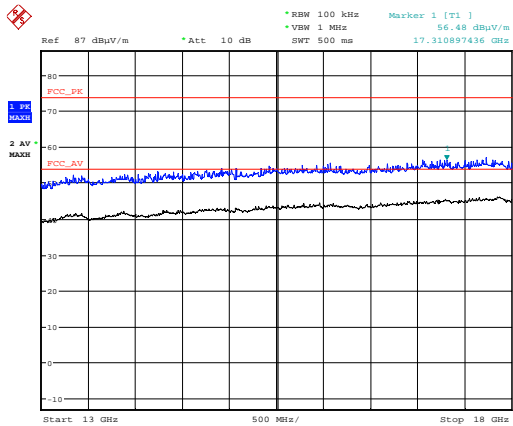
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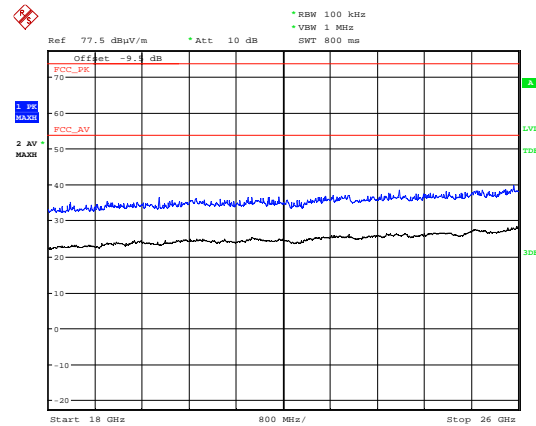
Date: 2.OCT.2015 12:28:47

4 GHz – 9 GHz

9 GHz – 13 GHz



Date: 2.OCT.2015 12:24:01

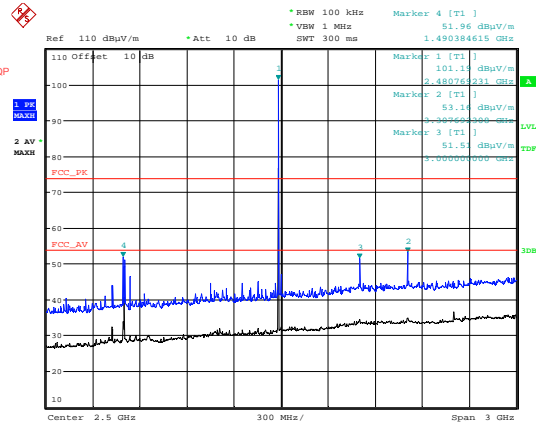
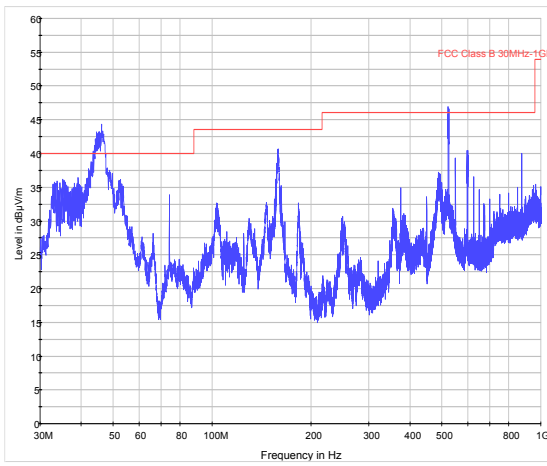


Date: 2.OCT.2015 11:47:09

13 GHz – 18 GHz

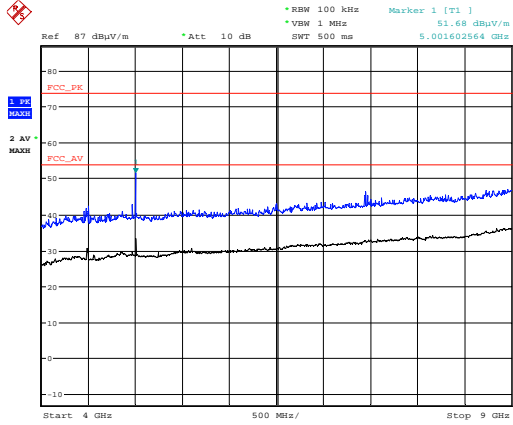
18 GHz – 25 GHz

2440 MHz



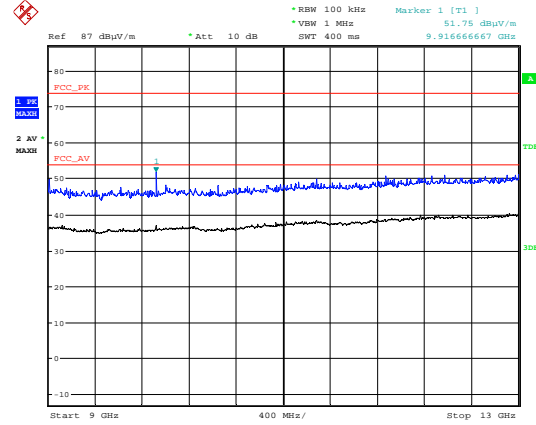
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30 MHz – 1 GHz



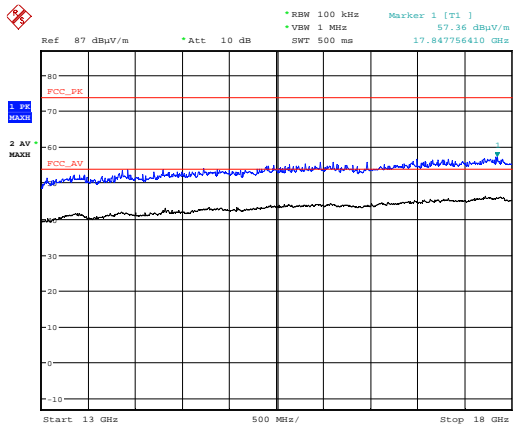
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1 GHz – 4 GHz



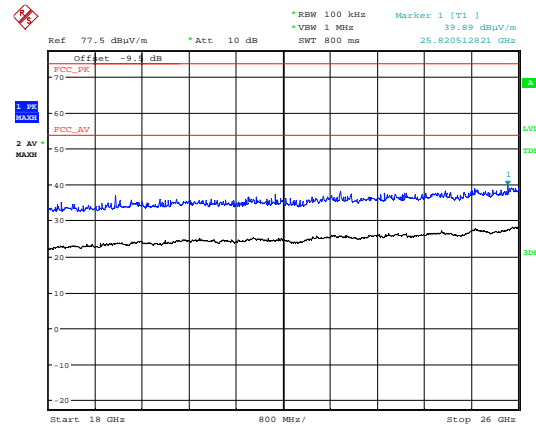
Date: 2.OCT.2015 12:30:05

4 GHz – 9 GHz



Date: 2.OCT.2015 12:17:56

9 GHz – 13 GHz

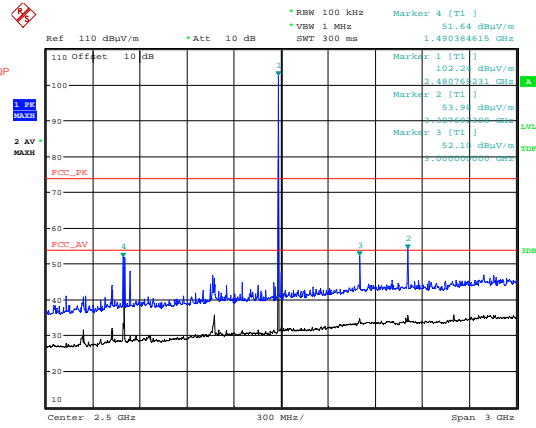
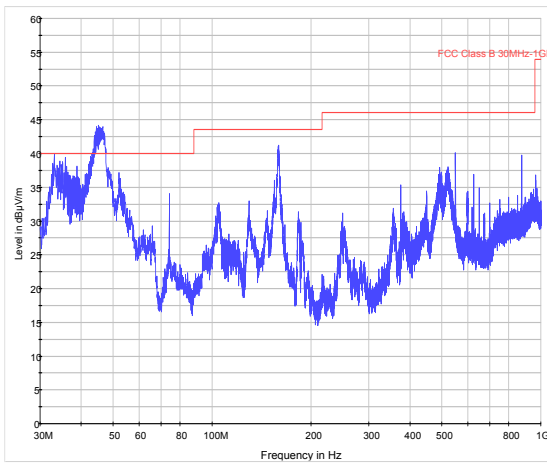


Date: 2.OCT.2015 11:48:26

13 GHz – 18 GHz

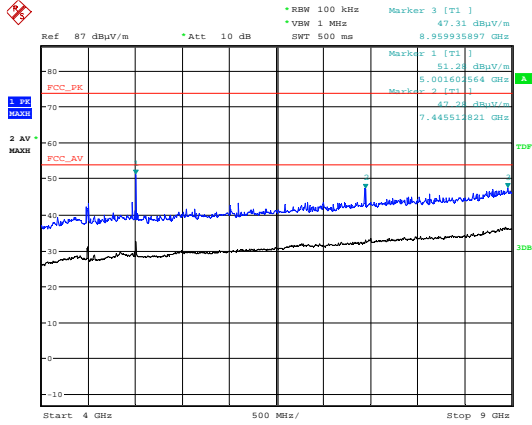
18 GHz – 25 GHz

2480 MHz



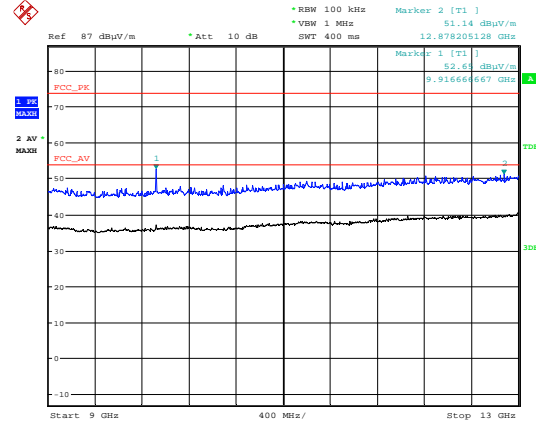
Date: 2.OCT.2015 13:49:46

30 MHz – 1 GHz



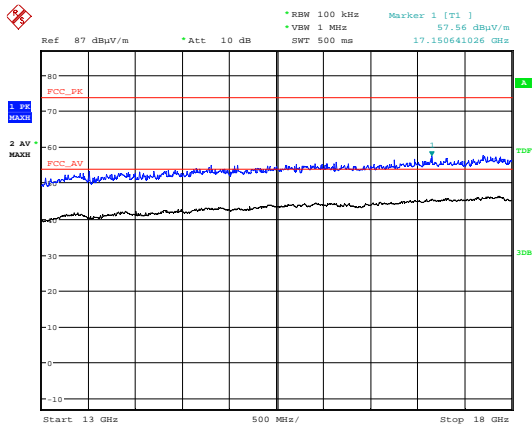
Date: 2.OCT.2015 12:36:17

1 GHz – 4 GHz



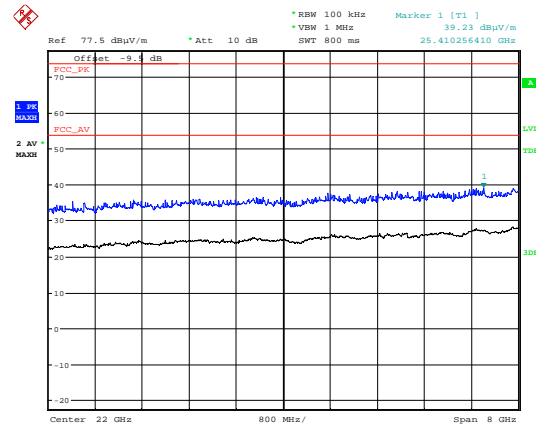
Date: 2.OCT.2015 12:34:41

4 GHz – 9 GHz



Date: 2.OCT.2015 12:13:36

9 GHz – 13 GHz



Date: 2.OCT.2015 11:52:01

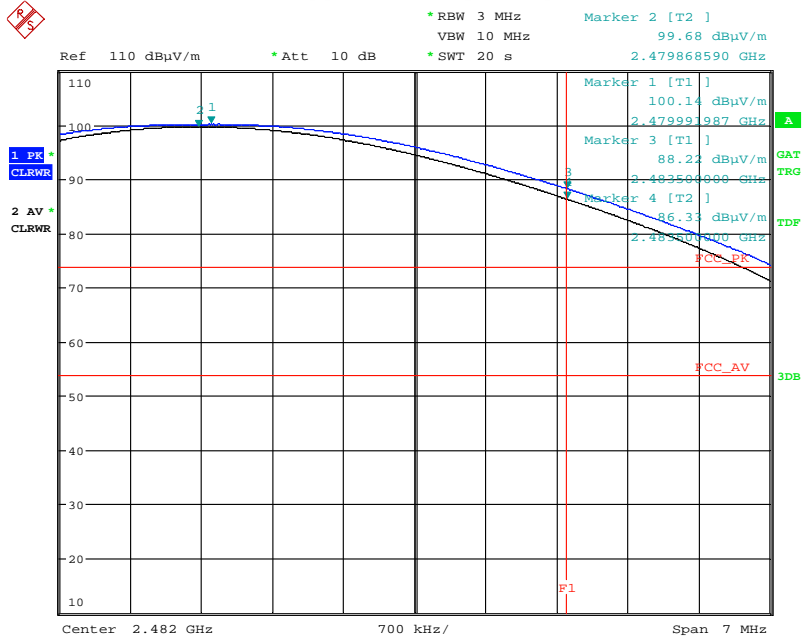
13 GHz – 18 GHz

18 GHz – 25 GHz

Upper bandedge measurements using marker delta method

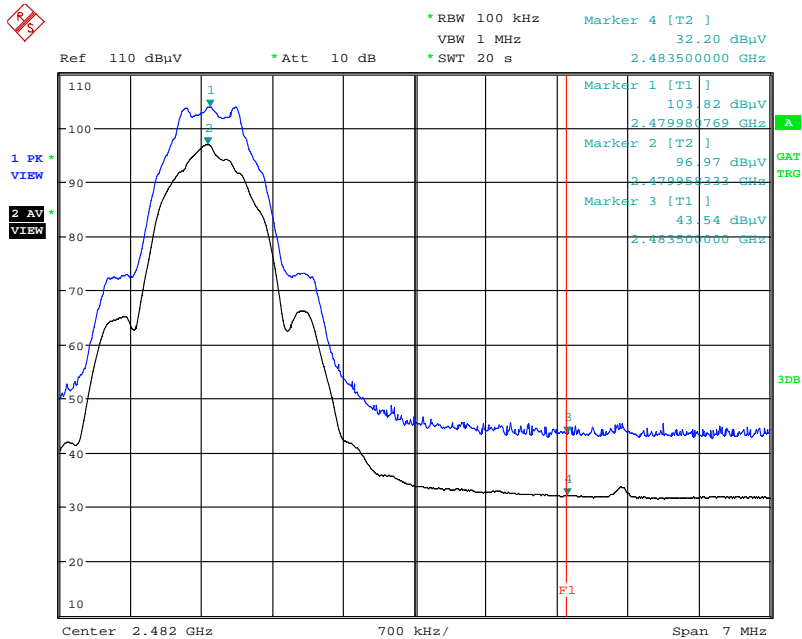
2480 MHz				
Measurement	Peak Detector		Average Detector	
Carrier power (3MHz RBW)	100.09	dBuV/m	99.64	dBuV/m
Peak Level in (100kHz RBW)	103.82	dBuV	97	dBuV
delta in 100kHz	-59.86	dB	-63.17	dB
Power At Bandedge	40.23	dBuV/m	36.47	dBuV/m
Limit	74	dBuV/m	54	dBuV/m
Margin	-33.77	dB	-17.53	dB

Upper band edge compliance



Date: 9.NOV.2015 10:28:44

Power in 3 MHz bandwidth



Date: 9.NOV.2015 10:34:39

Power and Levels @ Bandedge in 100 kHz for delta levels

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 Lab
Test Standard and Clause:	FCC: ANSI C63.10-2013, Clause 11.8, KDB 558074
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	5 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW: (FCC requirement: 100 kHz)	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 2 to 5 times OBW)	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110V ac	110 V ac ±10 % (as declared)

13.3 Test Limit

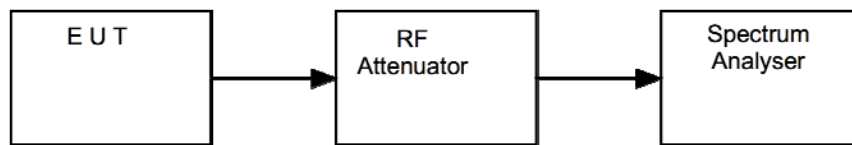
The minimum -6 dB bandwidth shall be at least 500 kHz.

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

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Spectrum Analyser	R&S	FSU26	UH405	11/05/2016
10 dB Attenuator	Radiall	R411820121	N/A	In Use

13.6 Test Results

FCC 15.247. Modulation: GFSK				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	6dB Bandwidth (kHz)	Result
2402	2401.607372	2402.344551	737.179	PASS
2440	2439.607372	2440.344551	737.179	PASS
2480	2479.607032	2480.344551	737.519	PASS

14 Out-of-band and conducted spurious emissions

14.1 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.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	5 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	>100kHz
Measurement Detector:	Peak
Measurement Range:	9kHz to 25 GHz

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110V ac	230 V ac ±10 % (as declared)

14.3 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.

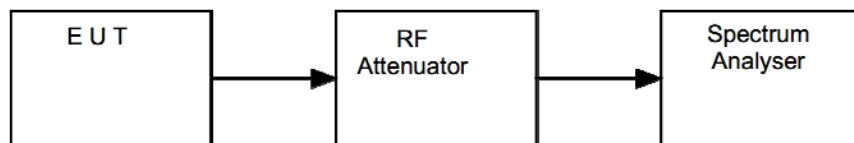
14.4 Test Method

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.

Reference and band edge plots taken for chain with highest output power level, spurious emissions plots taken for each chain, plot for chain with highest output power only recorded below

Figure v Test Setup

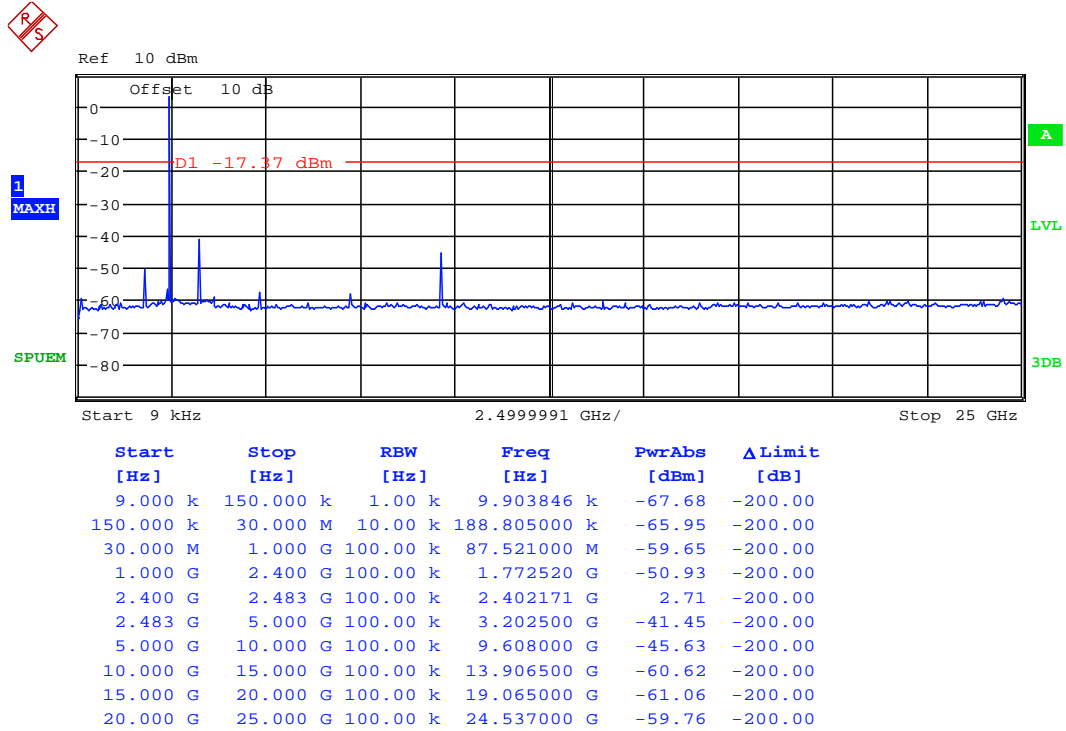


14.5 Test Equipment

<i>Type of Equipment</i>	<i>Maker/Supplier</i>	<i>Model Number</i>	<i>Element Number</i>	<i>Calibration Due Date</i>
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Spectrum Analyser	R&S	FSU26	UH405	11/05/2016
10 dB Attenuator	Radiall	R411820121	N/A	In Use

14.6 Test Results

2402 MHz						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions Within 20 dB of Limit						PASS



Date: 10.NOV.2015 13:56:32

15 Power spectral density

15.1 Definition

The power per unit bandwidth.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	5 MHz
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)	3MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110V ac	230 V ac \pm 10% (as declared)

15.3 Test Limit

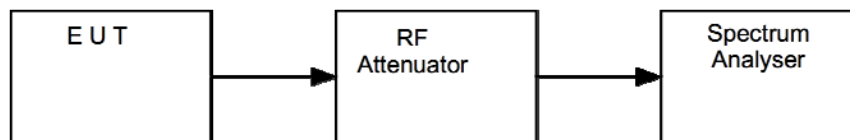
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

15.4 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



15.5 Test Equipment

<i>Type of Equipment</i>	<i>Maker/Supplier</i>	<i>Model Number</i>	<i>Element Number</i>	<i>Calibration Due Date</i>
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Spectrum Analyser	R&S	FSU26	UH405	11/05/2016
10 dB Attenuator	Radiall	R411820121	N/A	In Use

15.6 Test Results

<i>FCC 15.247. Modulation: GFSK</i>		
<i>Channel Frequency (MHz)</i>	<i>PSD (dBm)</i>	<i>Result</i>
2402	2.63	PASS
2440	2.85	PASS
2480	2.88	PASS

16 Maximum peak conducted output power

16.1 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.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	3 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	10 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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 14 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

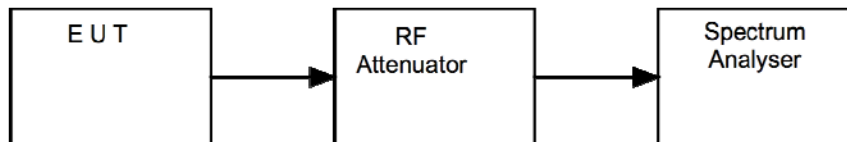
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

16.4 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



16.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Spectrum Analyser	R&S	FSU26	UH405	11/05/2016
10 dB Attenuator	Radiall	R411820121	N/A	In Use

16.6 Test Results

FCC 15.247. Modulation: GFSK				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (mW)	Result
2402	-5.95	10.00	4.05	PASS
2440	-5.73	10.00	4.27	PASS
2480	-5.68	10.00	4.32	PASS

17 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**