

Report on the Radio Testing
For
Gyrus Medical Ltd
on
VAPR VUE Wireless Footswitch
Report no. TRA-025920-09-45-02B
19th December 2017

RF915 4.0

Report Number: TRA-025920-09-45-02B
Issue: A

REPORT ON THE RADIO TESTING OF A
Gyrus Medical Ltd
VAPR VUE Wireless Footswitch
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: 16th Mar - 10th Apr 2017

Tested and
Written by: A Wong

A Longley / A Tosif / A Wong
Radio Test Engineers

Approved by:
Date: 19th December 2017

J Charters
Department Manager- Radio

Disclaimers:

RF915 4.0

- [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	8 th May 2017	Original
B	18 th December 2017	Correct typos

2 Summary

TEST REPORT NUMBER:	TRA-025920-09-45-02B
WORKS ORDER NUMBER:	TRA-025920-09
PURPOSE OF TEST:	<p>USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.</p> <p>Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radiocommunication Act and 21(1) of the Radiocommunication Regulations.</p>
TEST SPECIFICATION(S):	47CFR15.247 & RSS-247
EQUIPMENT UNDER TEST (EUT):	VAPR VUE Wireless Footswitch
FCC IDENTIFIER:	2ALZC-227214
EUT SERIAL NUMBER:	L31774000020141
MANUFACTURER/AGENT:	Gyrus Medical Ltd
ADDRESS:	Fortran Road St Mellons Cardiff South Glamorgan CF3 0LT
CLIENT CONTACT:	Vincent Corden ☎ 02920 776300 ✉ vincent.corden@olympus-oste.eu
ORDER NUMBER:	334905
TEST DATE:	16th Mar - 10th Apr 2017
TESTED BY:	A Longley / A Tosif / A Wong 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	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions		Gen, 8.8	15.207	<input type="checkbox"/>	N/A (note 1)
Occupied bandwidth		247, 5.2 (1)	15.247(a)(2)	<input checked="" type="checkbox"/>	Pass
Conducted carrier power	Peak	247, 5.4 (4)	15.247(b)(3)	<input checked="" type="checkbox"/>	Pass
	Max.			<input type="checkbox"/>	
Conducted / radiated RF power out-of-band		247, 5.5	15.247(d)	<input checked="" type="checkbox"/>	Pass
Power spectral density, conducted		247, 5.2 (2)	15.247(e)	<input checked="" type="checkbox"/>	Pass

Notes:

1. EUT is battery only powered equipment.

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).

3 Contents

1	Revision Record.....	3
2	Summary.....	4
2.1	Test Summary.....	5
3	Contents.....	6
4	Introduction.....	7
5	Test Specifications.....	8
5.1	Normative References.....	8
5.2	Deviations from Test Standards.....	8
6	Glossary of Terms.....	9
7	Equipment under Test.....	10
7.1	EUT Identification.....	10
7.2	System Equipment.....	10
7.3	EUT Mode of Operation.....	10
7.3.1	Transmission.....	10
7.3.2	Reception.....	10
7.4	EUT Radio Parameters.....	11
7.4.1	General.....	11
7.4.2	Antennas.....	11
7.5	EUT Description.....	11
8	Modifications.....	12
9	EUT Test Setup.....	13
9.1	Block Diagram.....	13
9.2	General Set-up Photograph.....	13
10	General Technical Parameters.....	14
10.1	Normal Conditions.....	14
10.2	Varying Test Conditions.....	14
11	Radiated emissions.....	15
11.1	Definitions.....	15
11.2	Test Parameters.....	15
11.3	Test Limit.....	15
11.4	Test Method.....	16
11.5	Test Set-up Photograph.....	17
11.6	Test Equipment.....	17
11.7	Test Results.....	18
12	Occupied Bandwidth.....	22
12.1	Definition.....	22
12.2	Test Parameters.....	22
12.3	Test Limit.....	22
12.4	Test Method.....	23
12.5	Test Equipment.....	23
12.6	Test Results.....	24
13	Maximum peak conducted output power.....	30
13.1	Definition.....	30
13.2	Test Parameters.....	30
13.3	Test Limit.....	30
13.4	Test Method.....	31
13.5	Test Equipment.....	31
13.6	Test Results.....	31
14	Out-of-band and conducted spurious emissions.....	32
14.1	Definition.....	32
14.2	Test Parameters.....	32
14.3	Test Limit.....	32
14.4	Test Method.....	33
14.5	Test Equipment.....	33
14.6	Test Results.....	34
15	Power spectral density.....	46
15.1	Definition.....	46
15.2	Test Parameters.....	46
15.3	Test Limit.....	46
15.4	Test Method.....	47
15.5	Test Equipment.....	47
15.6	Test Results.....	48
16	Measurement Uncertainty.....	50
17	General SAR test reduction & exclusion guidance / MPE Calculation.....	51
18	RF Exposure Technical Brief.....	53

4 Introduction

This report TRA-025920-09-45-02B presents the results of the Radio testing on a Gyrus Medical Ltd, VAPR VUE Wireless Footswitch 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 Gyrus Medical Ltd by Element, at the address(es) detailed below.

<input checked="" type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input 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.

IC Registration Number(s):

Element Hull	3483A
Element North West	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: VAPR VUE Wireless Footswitch
- Serial Number: L31774000020141
- Model Number: 227214
- 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.

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 follow.
EUT transmitting permanent modulated carrier on bottom, middle or top channel as required.

7.3.2 Reception

The mode of operation for Rx tests was as follows.
EUT in permanent receive mode on bottom, middle or top channel as required channels.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2405 – 2480 MHz
Modulation type(s):	ZigBee
Occupied channel bandwidth(s):	2 MHz
Channel spacing:	5 MHz
Declared output power(s):	5 dBm EIRP
Nominal Supply Voltage:	4.5 V dc

7.4.2 Antennas

Type:	Integral ((Laird NanoBlue))
Frequency range:	2405 – 2480 MHz
Impedance:	50 ohms
Gain:	2 dBi

7.5 EUT Description

The EUT provide remote control to the VAPR Vue Generator. It contains a 2.4 GHz ZigBee radio using 2 dBi NanoBlue antenna.

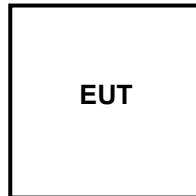
8 Modifications

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:

Confidential

Only available on special request by application.

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. 4.5 V dc.

10.2 Varying Test Conditions

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

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

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

Element Hull	Element Hull
Wireless Lab 2	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	2405 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: 21°C	Standard Requirement: +15 °C to +35 °C
Humidity: 35 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 4.5 Vdc	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

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

11.4 Test Method

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

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

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

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

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

Power values measured on the test receiver / analyzer are converted to field strength, FS, in 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;

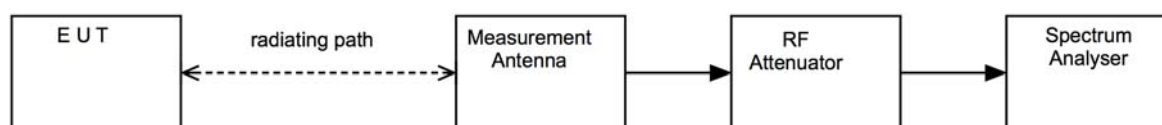
PA is the pre-amplifier gain in dB (where used);

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

Confidential

Only available on special request by application.

11.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU46	R&S	Spectrum Analyser	REF910	05/07/17
3115	EMCO	Horn Antenna	RFG129	09/02/18
Horn	Q-Par	Horn Antenna	RFG629	30/09/17
8449B	Agilent	Pre-Amp (1 – 26.5GHz)	REF913	02/02/18
ATS	Rainford	Ferrite Lined Chamber	REF886	21/07/17
3109	EMCO	Biconical Antenna	RFG095	17/05/19
3146	EMCO	Log Periodic Antenna	RFG191	17/05/19
310	Sonoma	Pre-Amp (9kHz – 1GHz)	REF927	30/06/18
ESVS20	R&S	EMI Test Receiver	RFG126	23/05/17

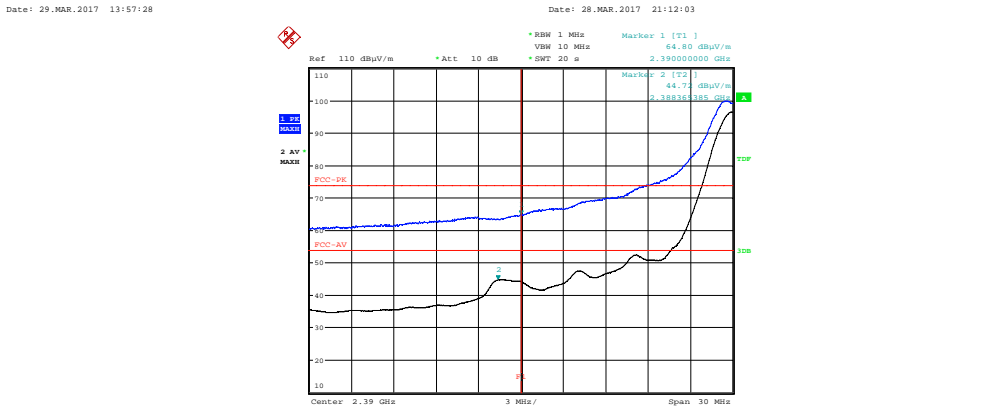
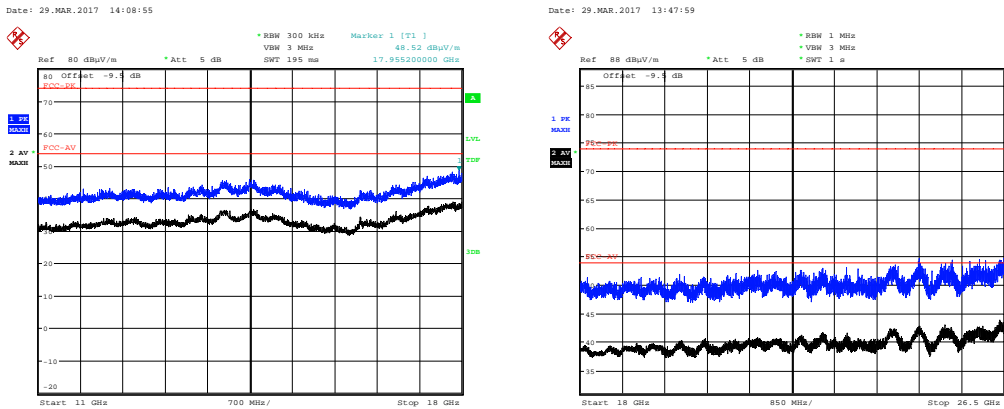
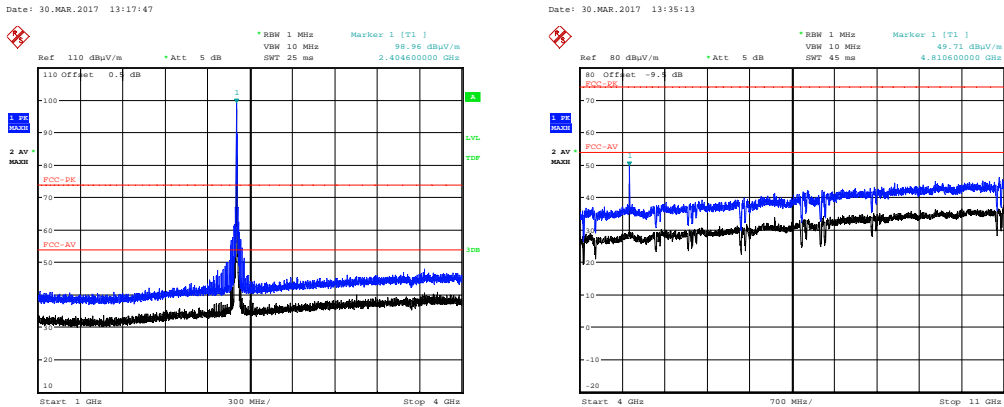
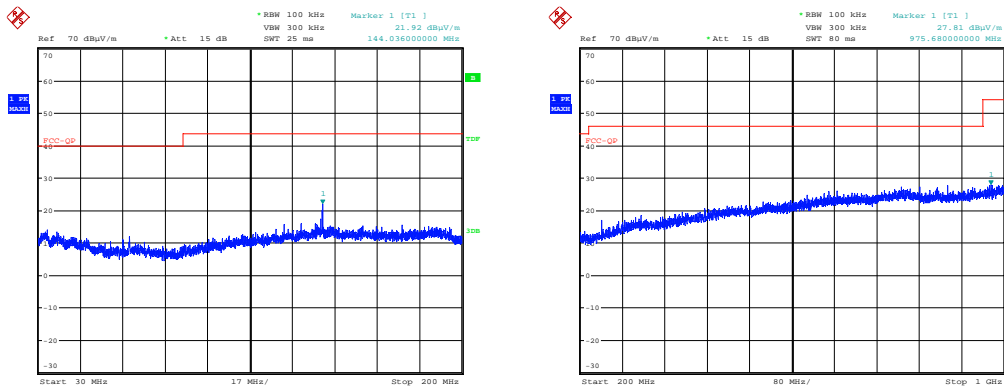
11.7 Test Results

<i>Transmit mode; Channel: 2405 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>
Av	4808.9	50.2	5.5	32.9	35.4	0.0	-9.5	43.7	152.5	500.0

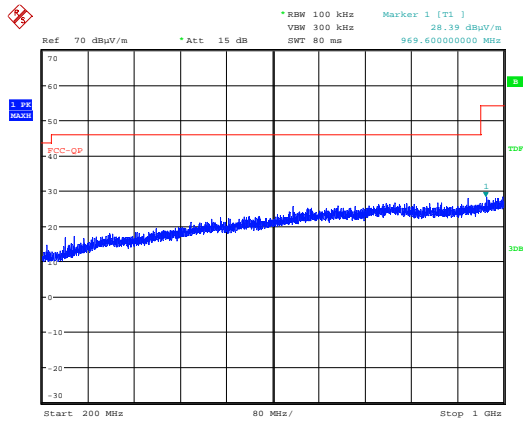
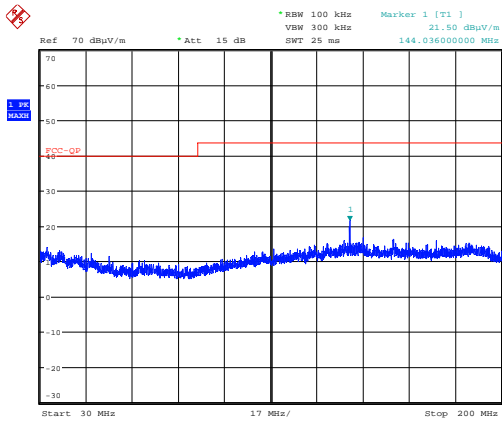
<i>Transmit mode; Channel: 2440 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
Av	4879.0	48.9	5.4	33.1	35.4	0.0	-9.5	42.5	133.3	500.0
Av	7318.0	45.9	6.7	36.1	35.7	0.0	-9.5	43.5	149.1	500.0

<i>Transmit mode; 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>
Av	4959.0	52.6	5.3	33.2	35.4	0.0	-9.5	46.1	202.5	500.0
Av	7438.6	48.1	6.5	36.3	35.7	0.0	-9.5	45.7	192.0	500.0

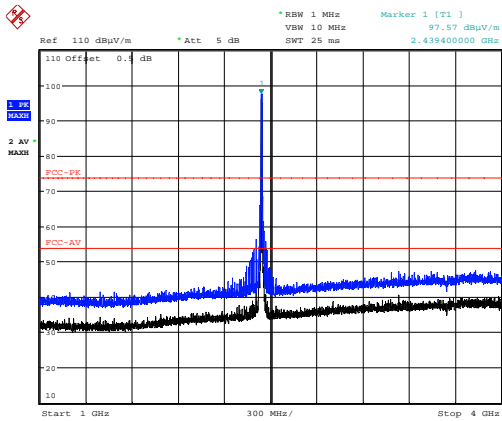
Transmit mode; Channel: 2405 MHz



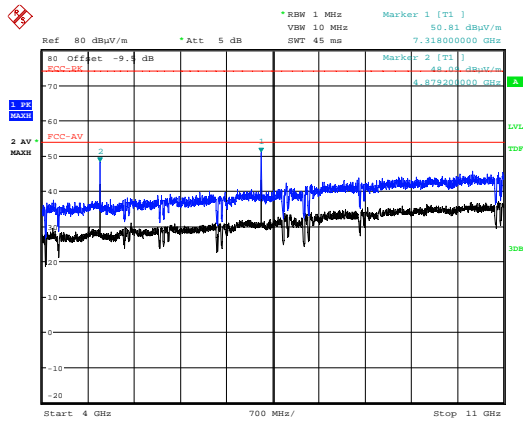
Transmit mode; Channel: 2440 MHz



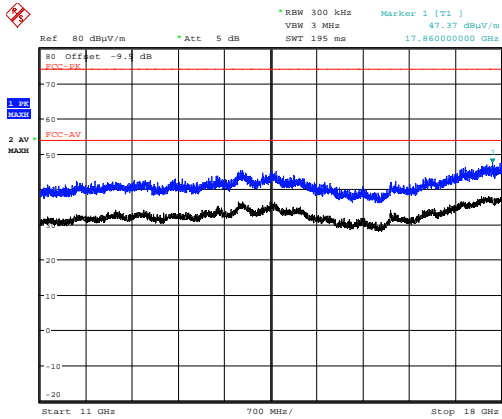
Date: 30.MAR.2017 13:49:10



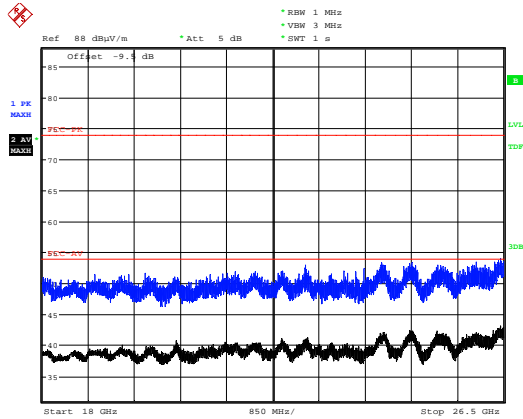
Date: 30.MAR.2017 13:37:13



Date: 29.MAR.2017 14:11:31



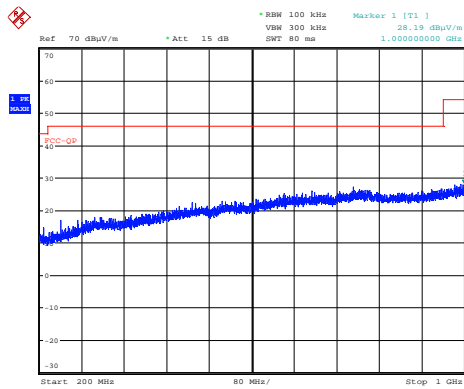
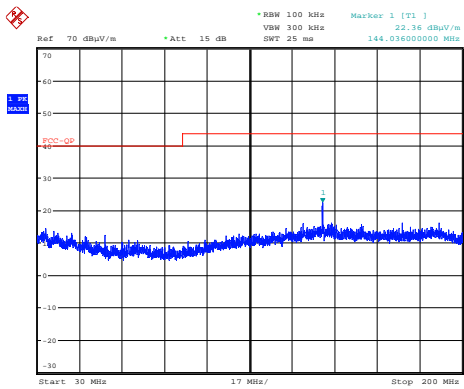
Date: 29.MAR.2017 13:51:08



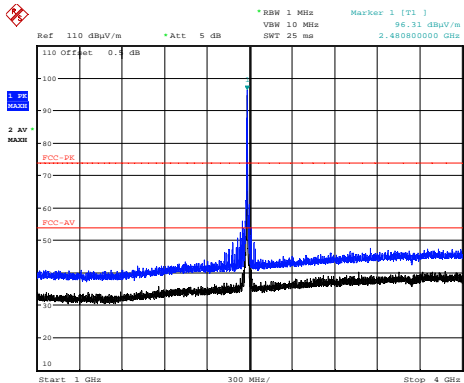
Date: 29.MAR.2017 13:59:03

Date: 28.MAR.2017 21:20:39

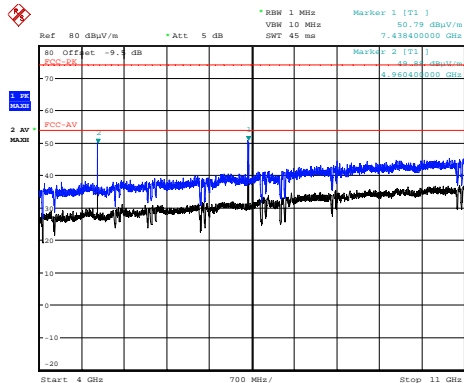
Transmit mode; Channel: 2480 MHz



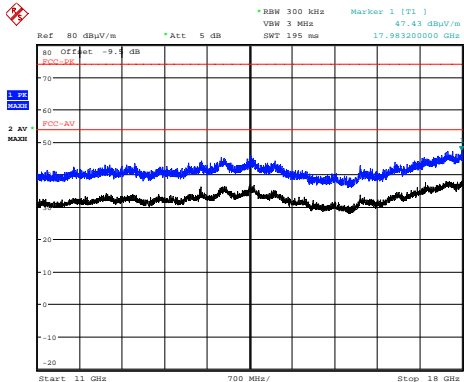
Date: 30.MAR.2017 13:19:10



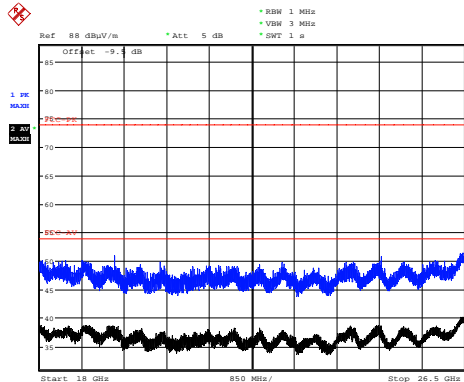
Date: 30.MAR.2017 13:38:27



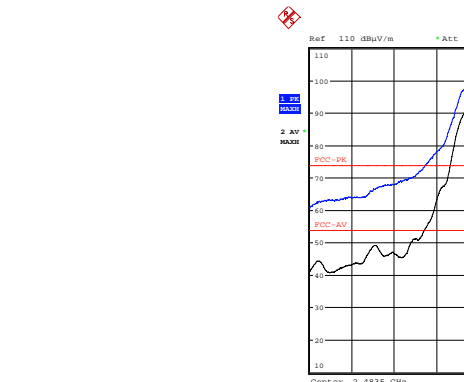
Date: 29.MAR.2017 14:07:25



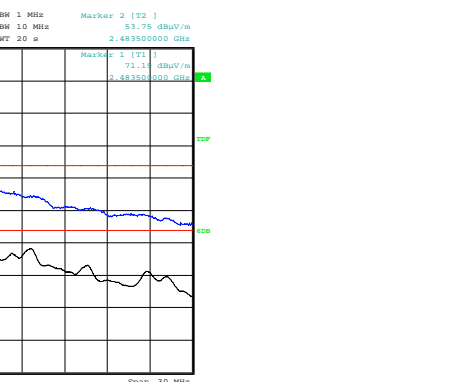
Date: 29.MAR.2017 13:52:49



Date: 29.MAR.2017 14:00:32



Date: 28.MAR.2017 21:24:41



Date: 29.MAR.2017 12:36:57

12 Occupied Bandwidth

12.1 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.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	IC: ANSI C63.10-2013, Clause 6.9 FCC: ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
EUT Test Modulations:	Zigbee
Deviations From Standard:	None
Measurement BW:	100 kHz (30 kHz IC)
(IC requirement: 1% to 5% OBW; FCC requirement: 100 kHz)	
Spectrum Analyzer Video BW:	300 kHz (100 kHz IC)
(requirement at least 3x RBW)	
Measurement Span:	5 MHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 33 % RH	20 % RH to 75 % RH (as declared)
Supply: 4.5 V dc	As declared

12.3 Test Limit

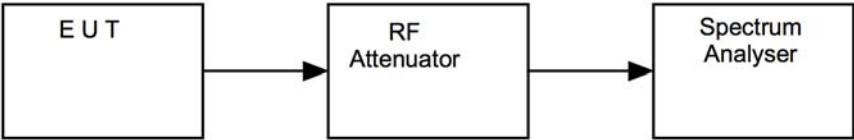
The minimum -6 dB bandwidth shall be at least 500 kHz.

12.4 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

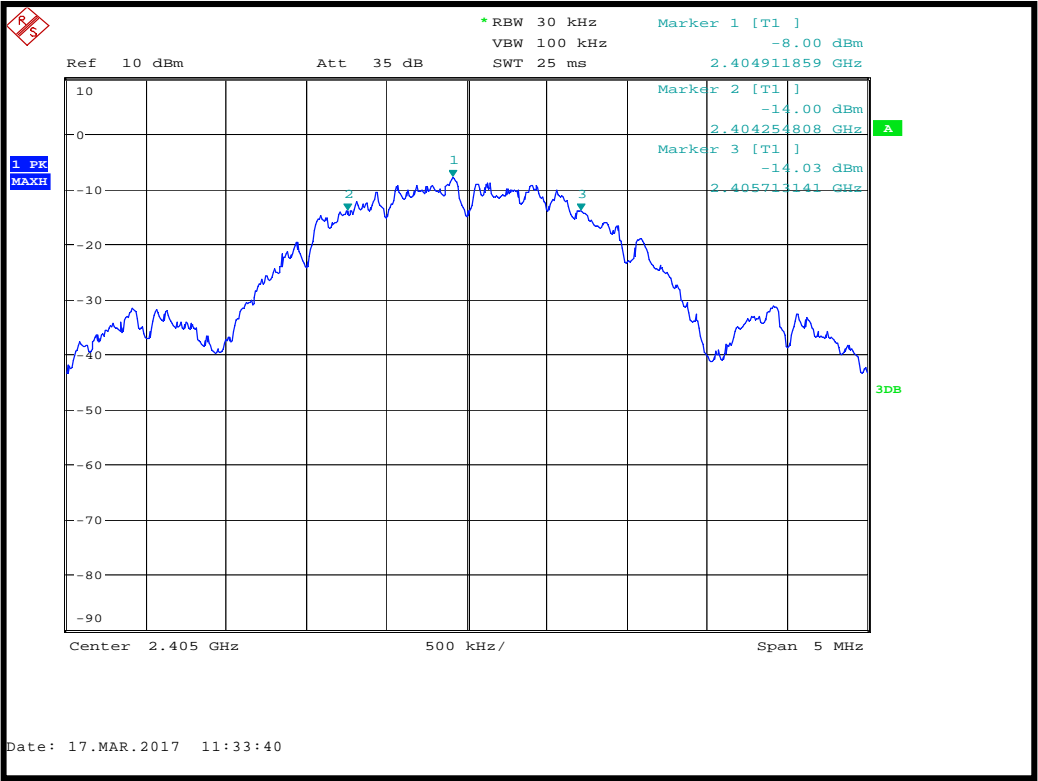


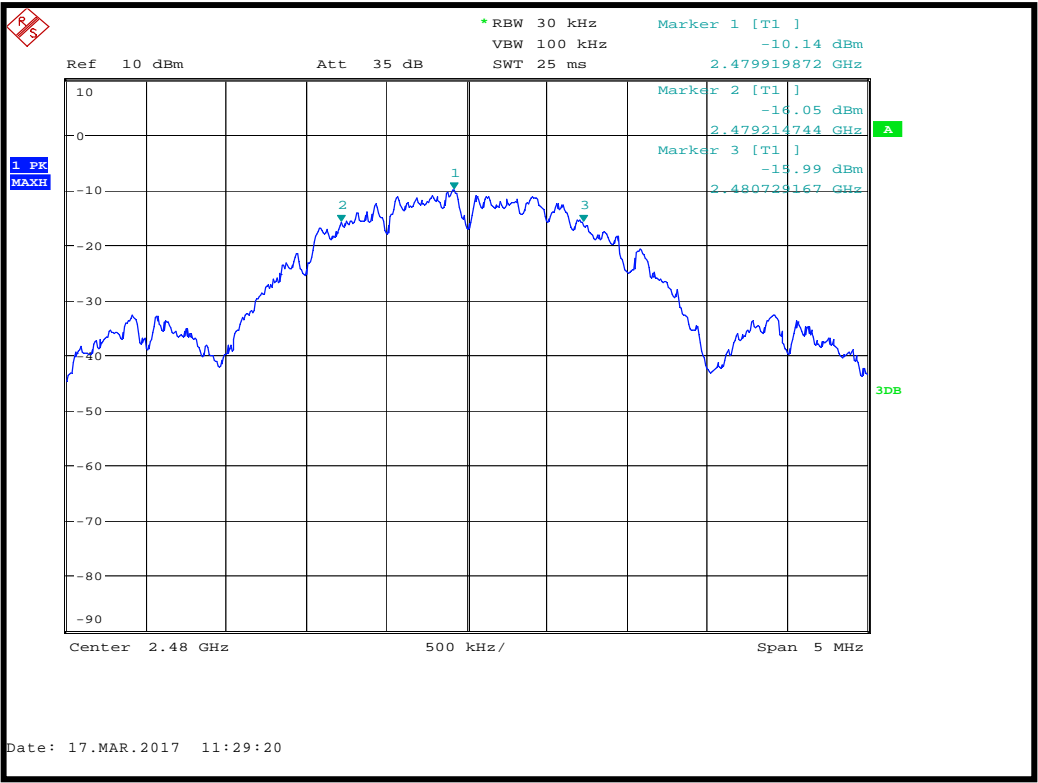
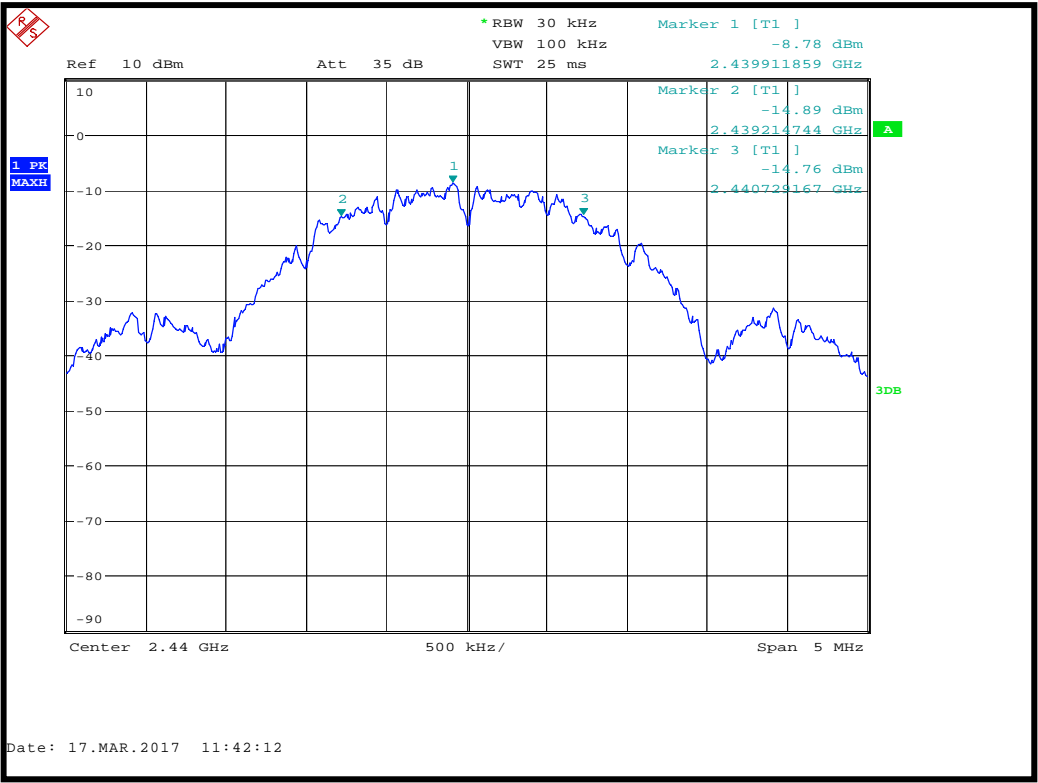
12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	02/05/2017

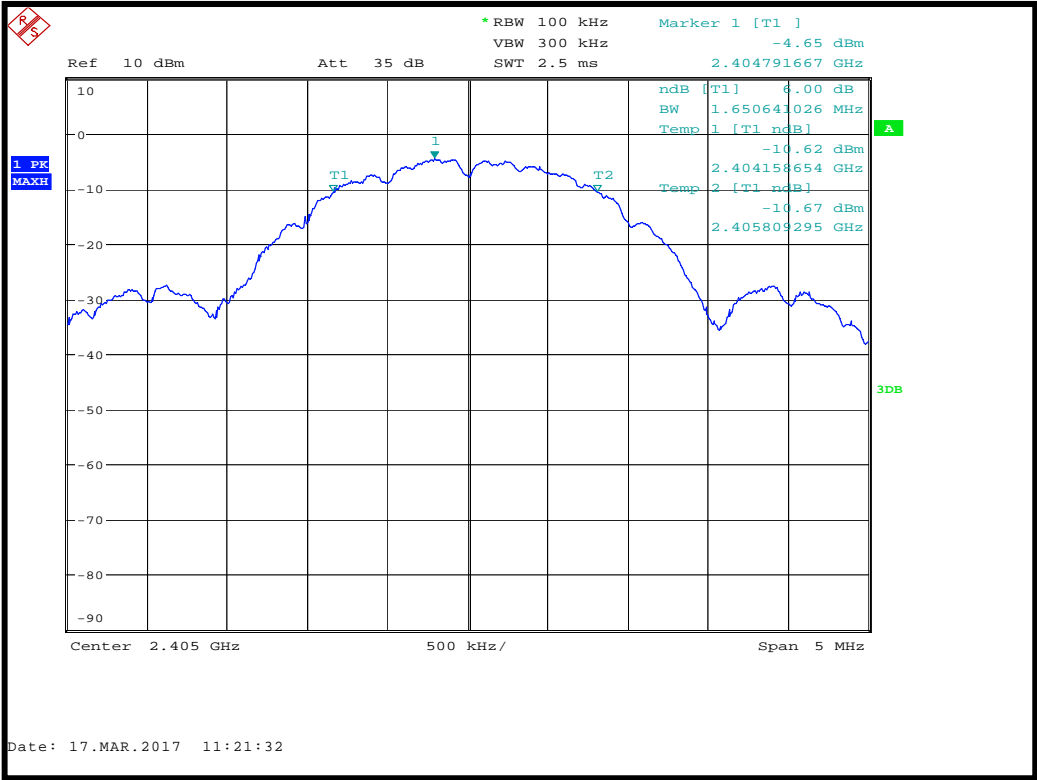
12.6 Test Results

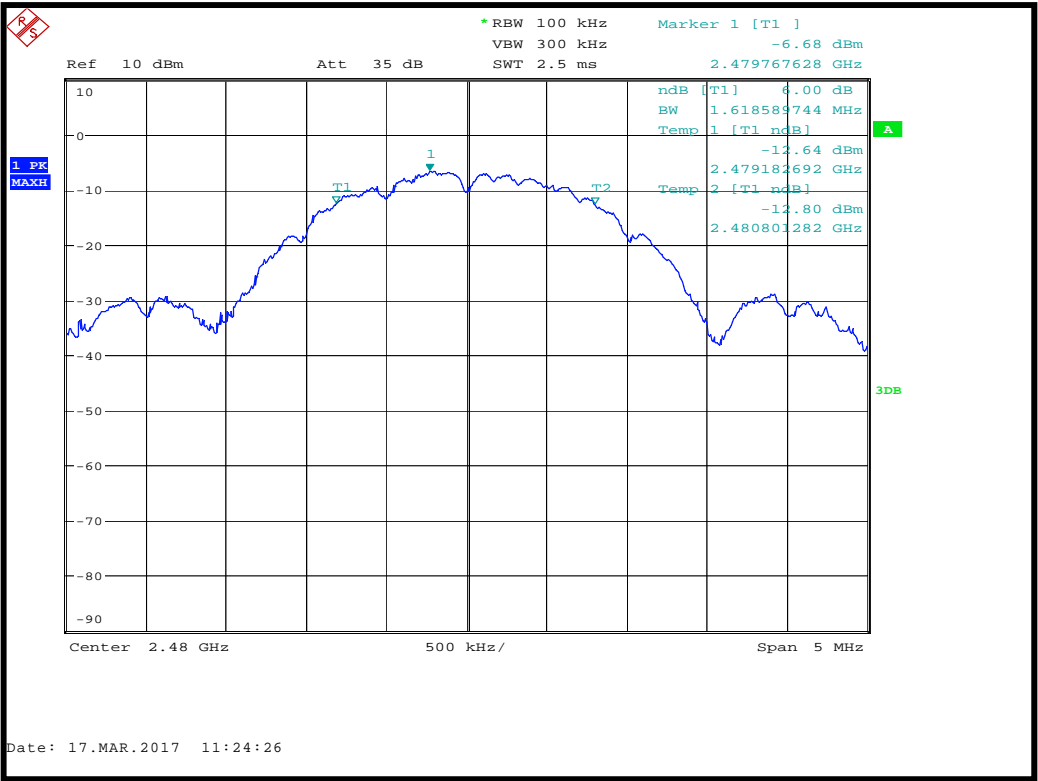
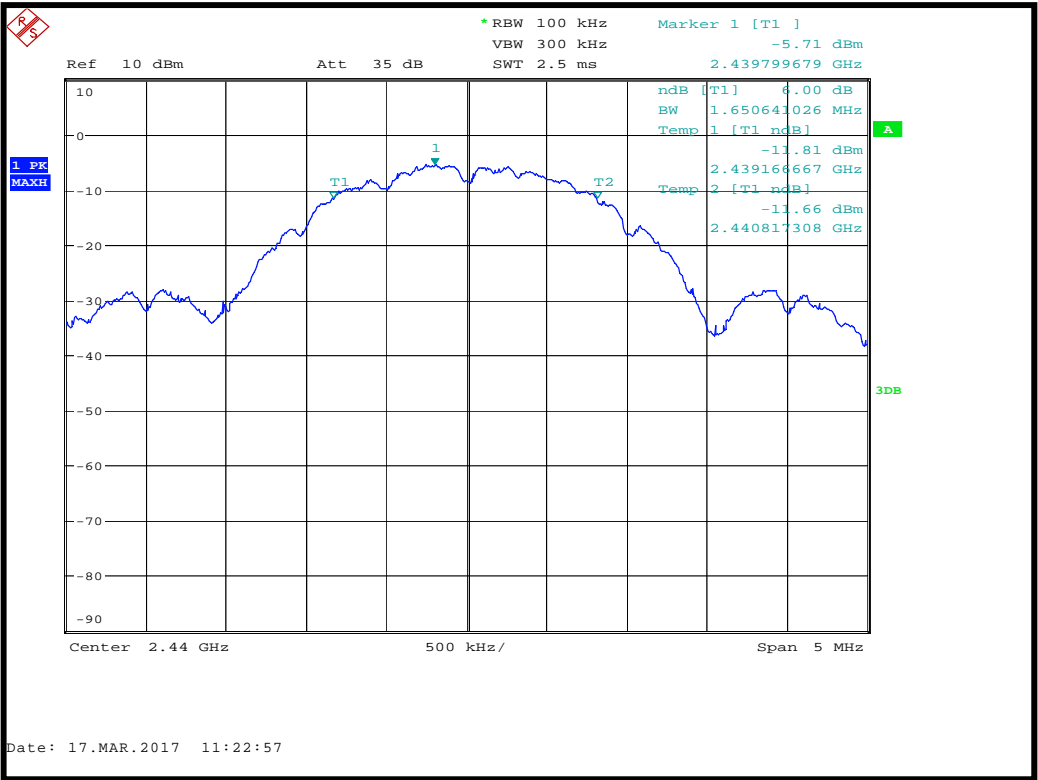
RSS-247. Modulation: Zigbee; Power setting: Full				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	6dB Bandwidth (kHz)	Result
2405	2404.254808	2405.712141	1457.333	PASS
2440	2439.214744	2440.729167	1514.423	PASS
2480	2479.214744	2480.729167	1514.423	PASS



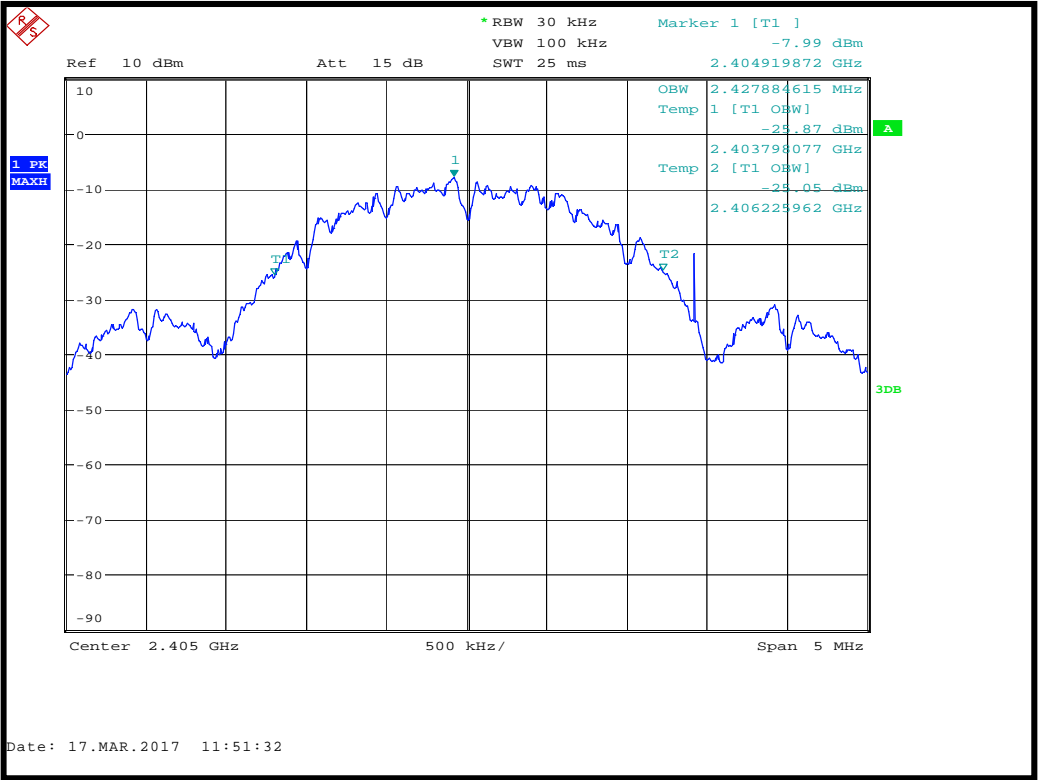


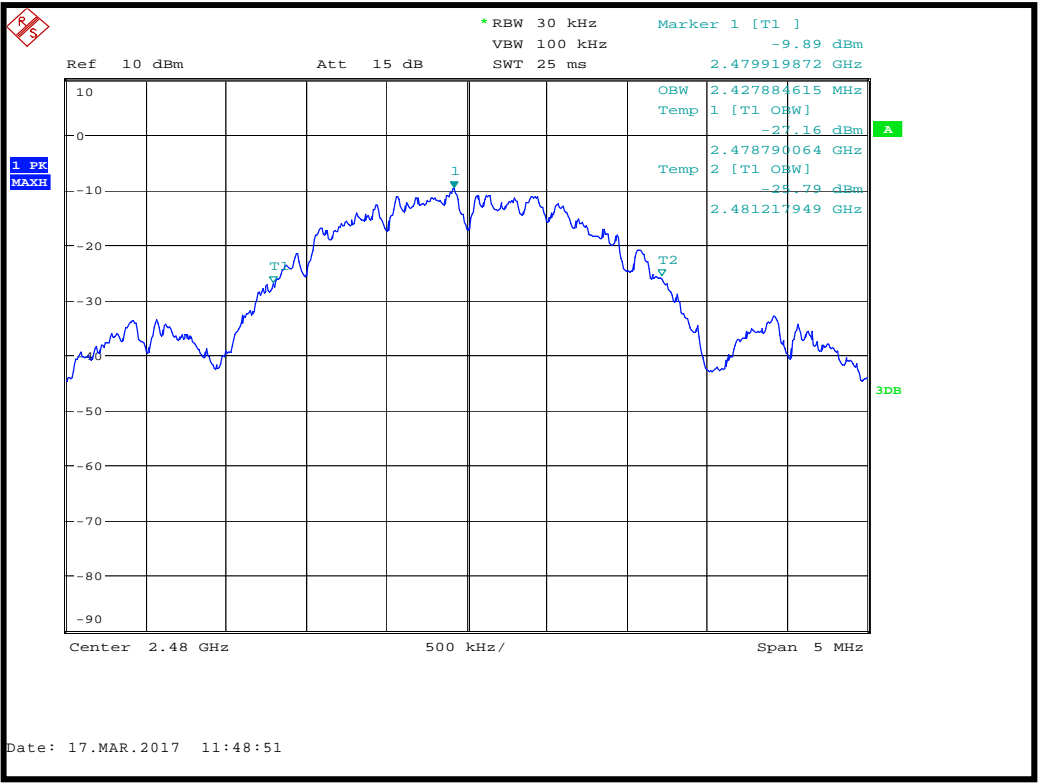
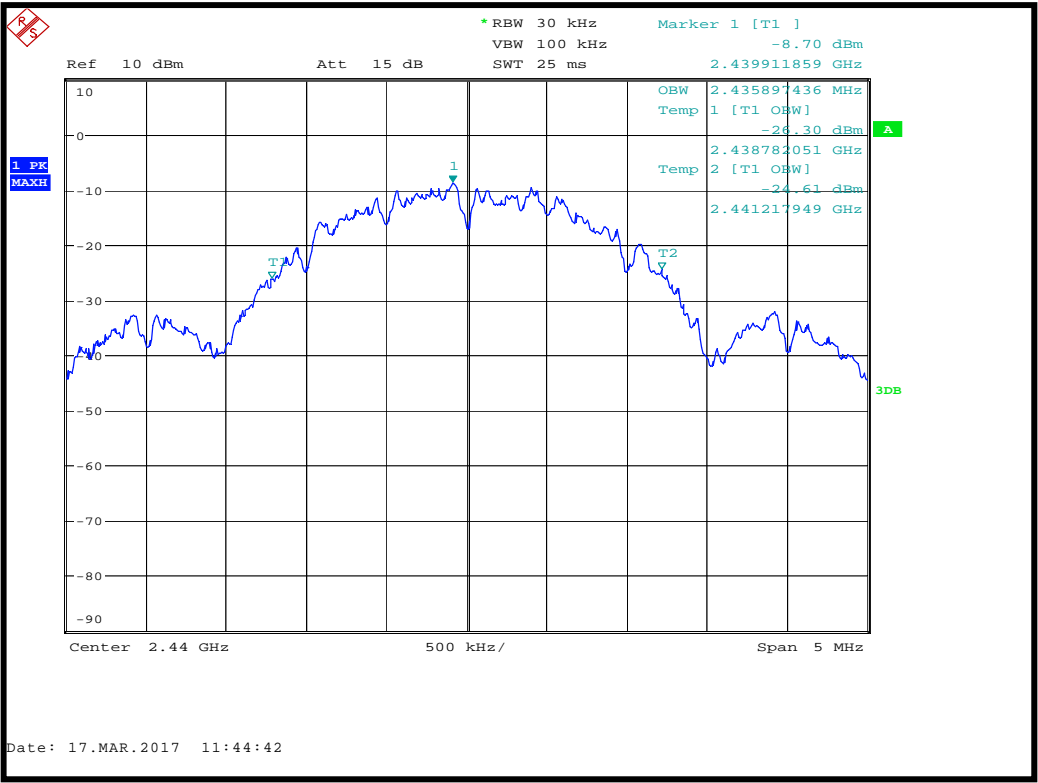
FCC 15.247. Modulation: Zigbee; Power setting: Full				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	6dB Bandwidth (MHz)	Result
2405	2404.158654	2405.809295	1650.641026	PASS
2440	2439.166667	2440.817308	1650.641026	PASS
2480	2479.182692	2480.801282	1618.589744	PASS





RSS-210. Modulation: Zigbee; Power setting: Full				
Channel Frequency (MHz)	F _L (MHz)	F _H (MHz)	99% Bandwidth (kHz)	Result
2405	2403.798077	2406.225962	2.427884615	PASS
2440	2438.782051	2441.217949	2.435897436	PASS
2480	2478.790064	2481.217949	2.427884615	PASS





13 Maximum peak conducted output power

13.1 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.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 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: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

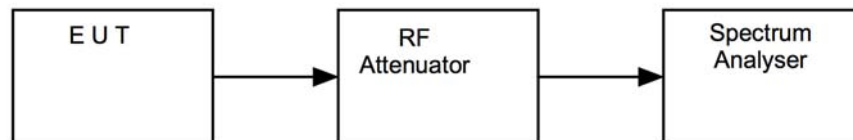
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

13.4 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



13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	02/05/2017

13.6 Test Results

<i>Modulation: Zigbee; Power setting: Full</i>				
<i>Channel Frequency (MHz)</i>	<i>Analyzer Level (dBm)</i>	<i>Cable loss (dB)</i>	<i>Power (mW)</i>	<i>Result</i>
2405	-0.24	0	0.946	PASS
2440	-0.98	0	0.798	PASS
2480	-2.12	0	0.614	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 Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)
Supply: 4.5 Vdc	As declared

14.3 Test Limit

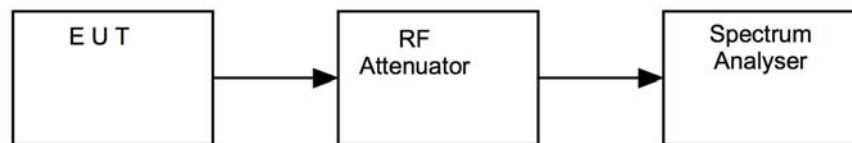
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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.

Figure v Test Setup

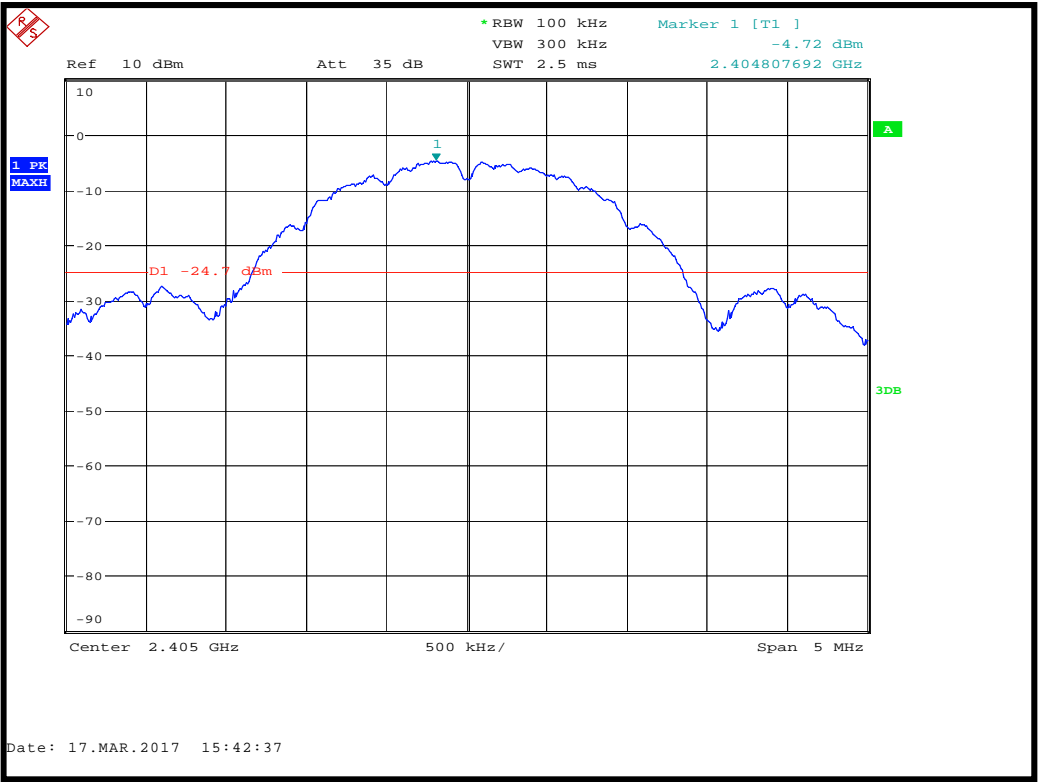


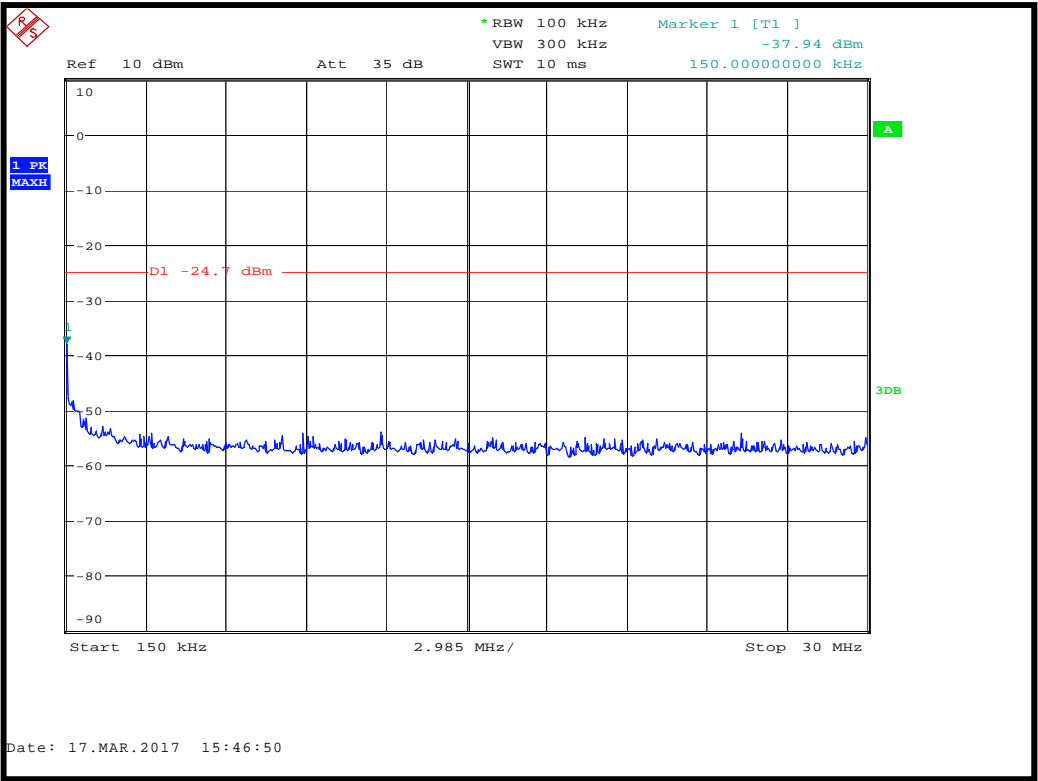
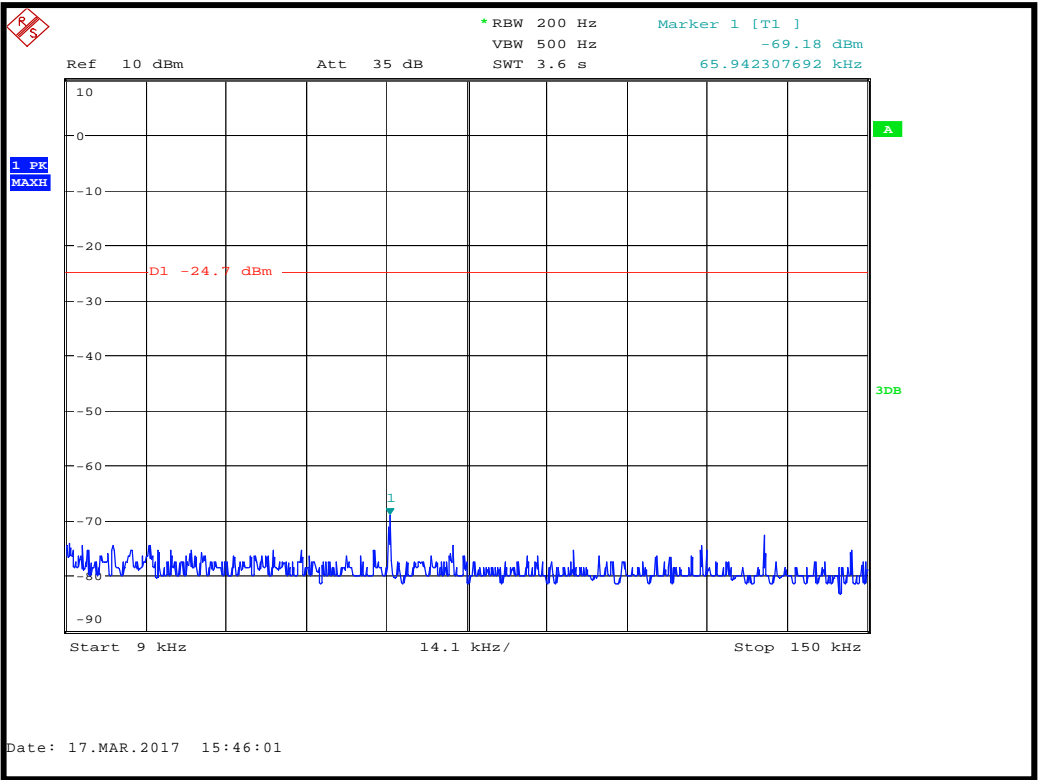
14.5 Test Equipment

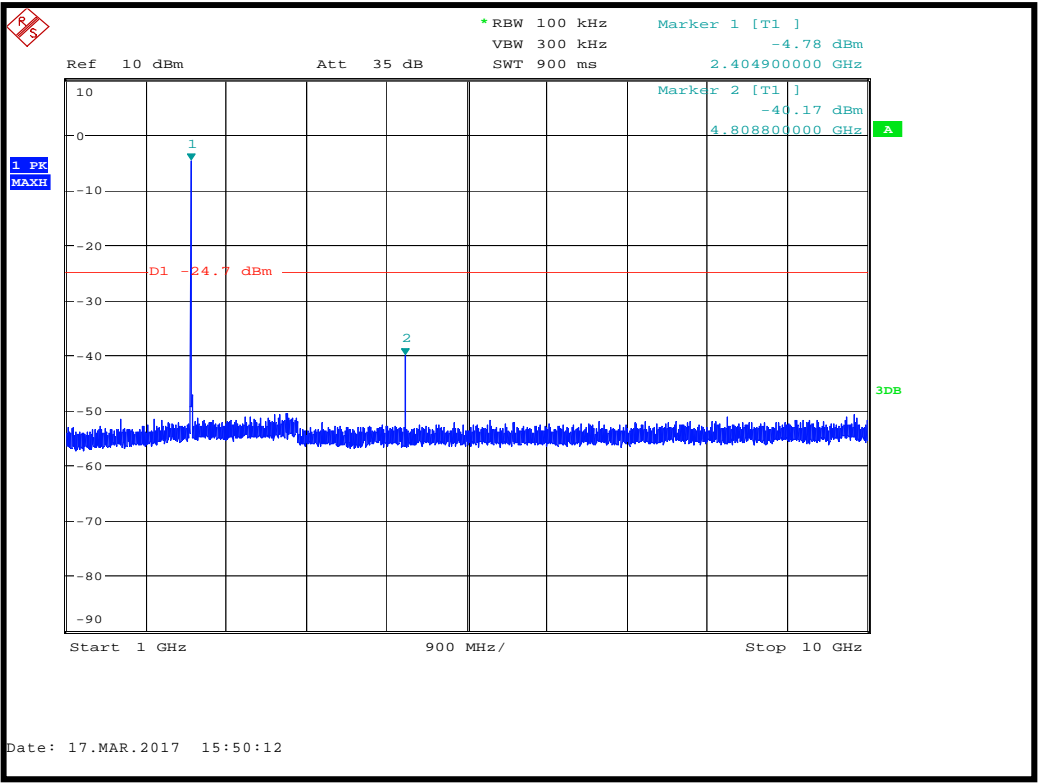
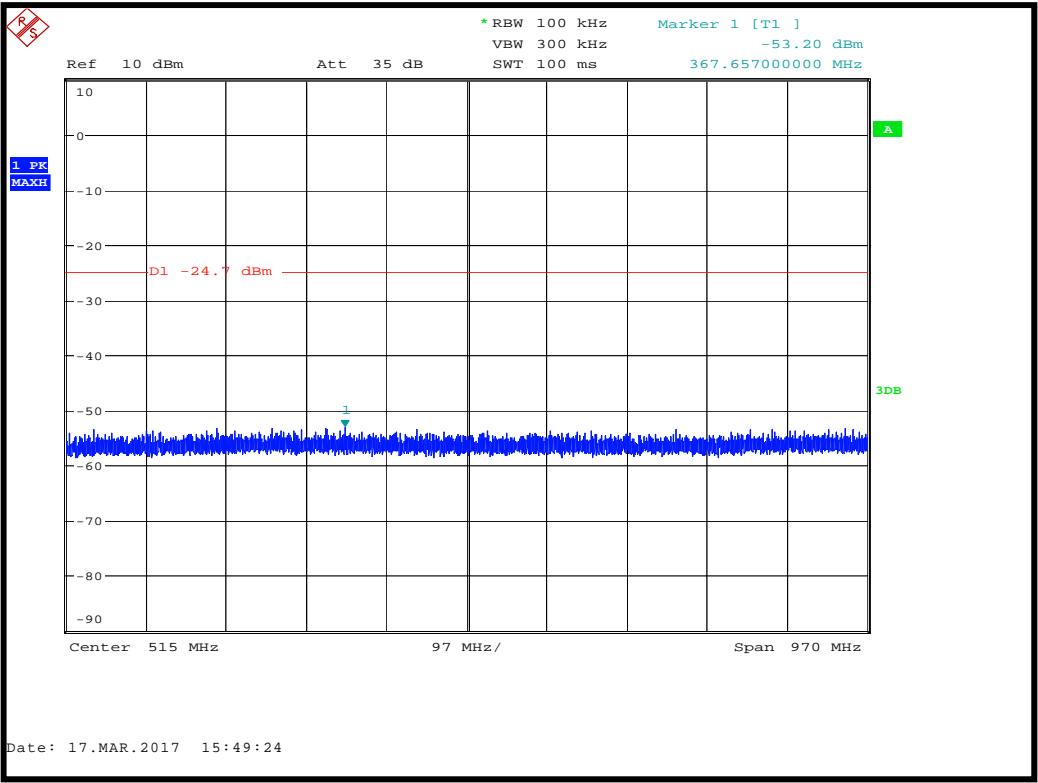
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	02/05/2017

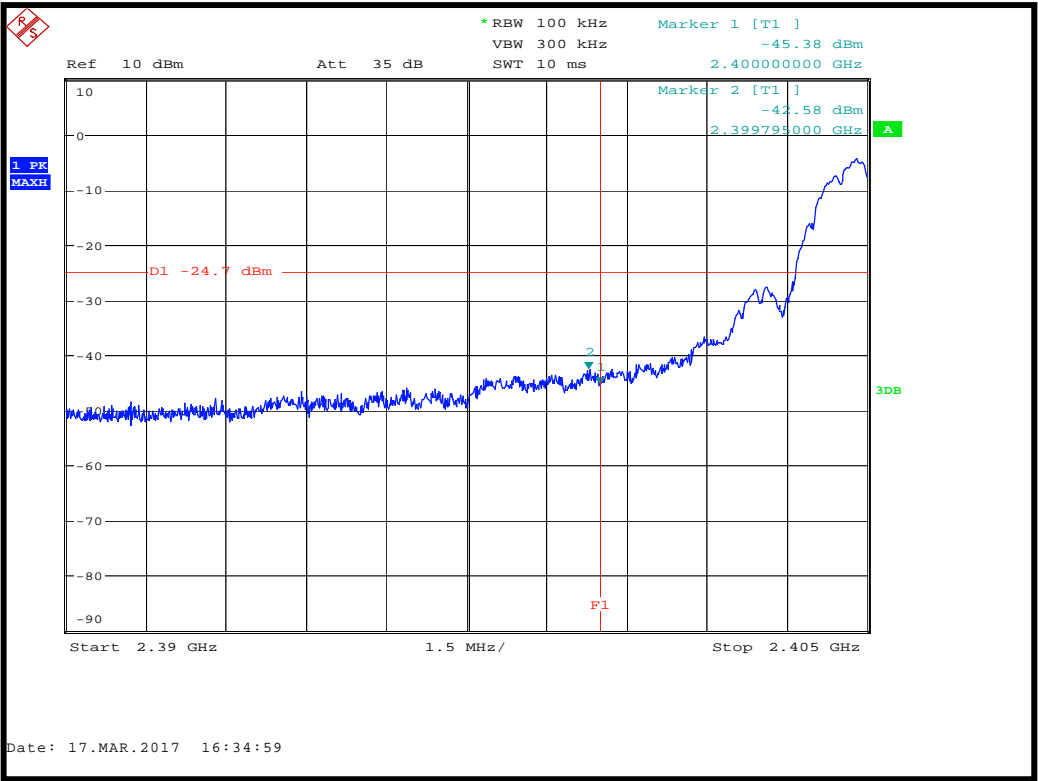
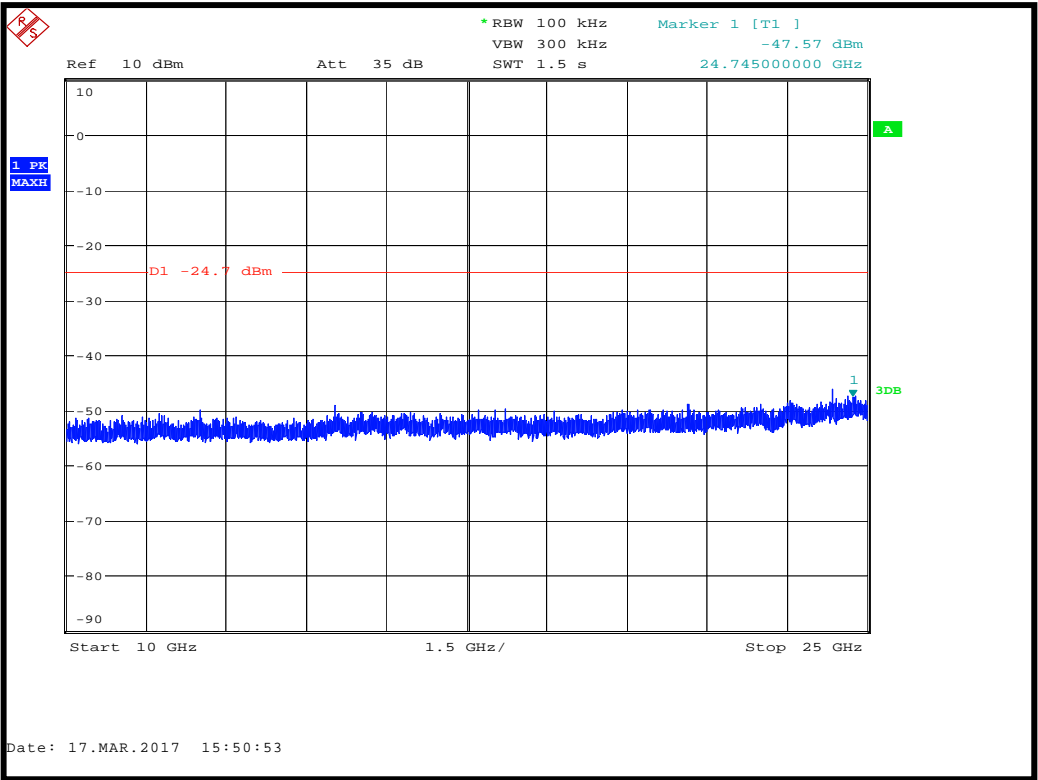
14.6 Test Results

Channel: 2405 MHz; Modulation: Zigbee; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2405	2405	-4.72	-4.72	N/A	N/A	PASS
2405	0.066	-69.18	-69.18	-24.7	-44.48	PASS
2405	0.150	-37.94	-37.94	-24.7	-13.24	PASS
2405	367.657	-53.2	-53.2	-24.7	-28.50	PASS
2405	4808.800	-40.17	-40.17	-24.7	-15.47	PASS
2405	24745.000	-47.57	-47.57	-24.7	-22.87	PASS

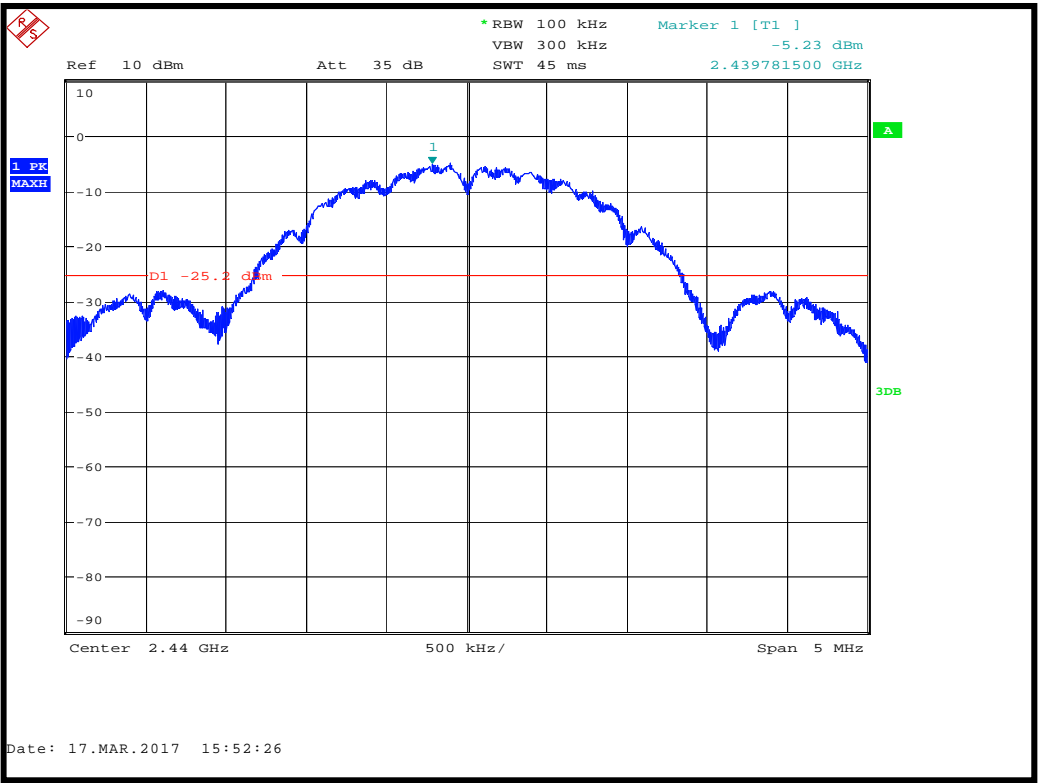


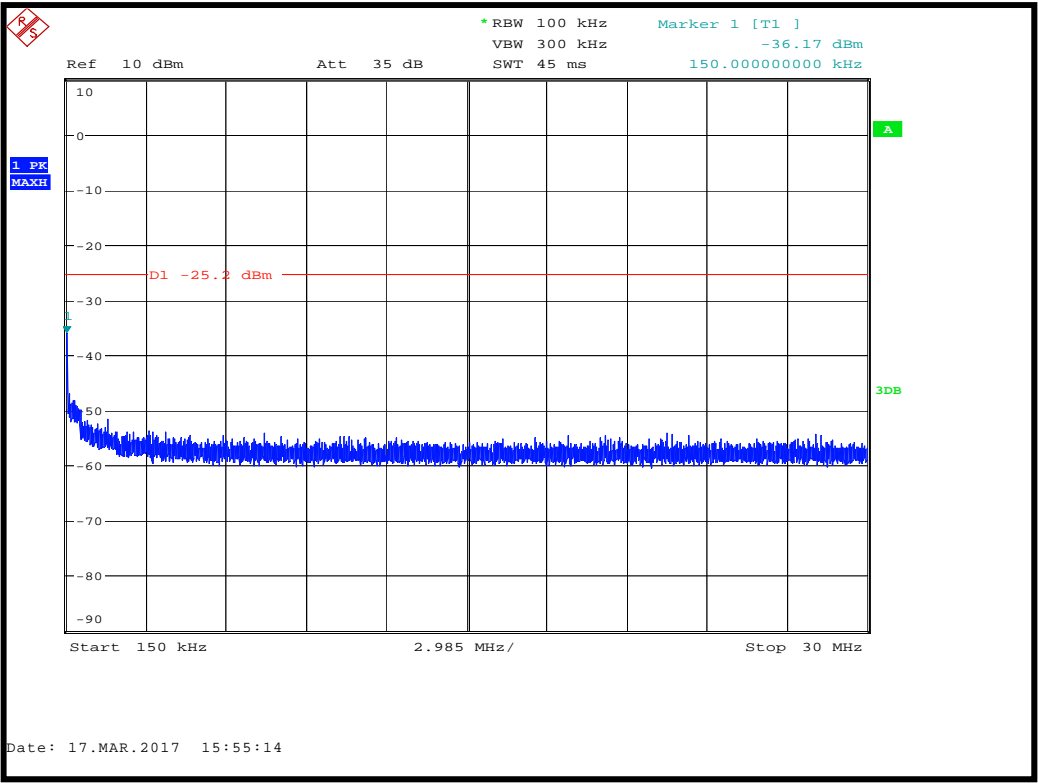
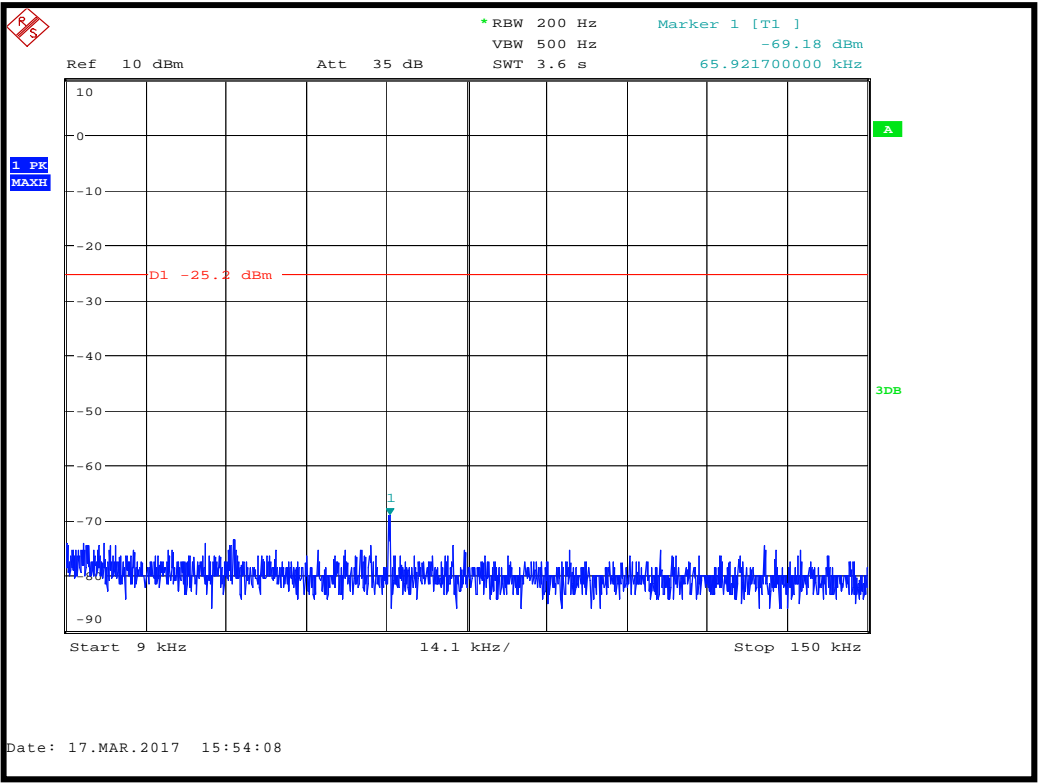


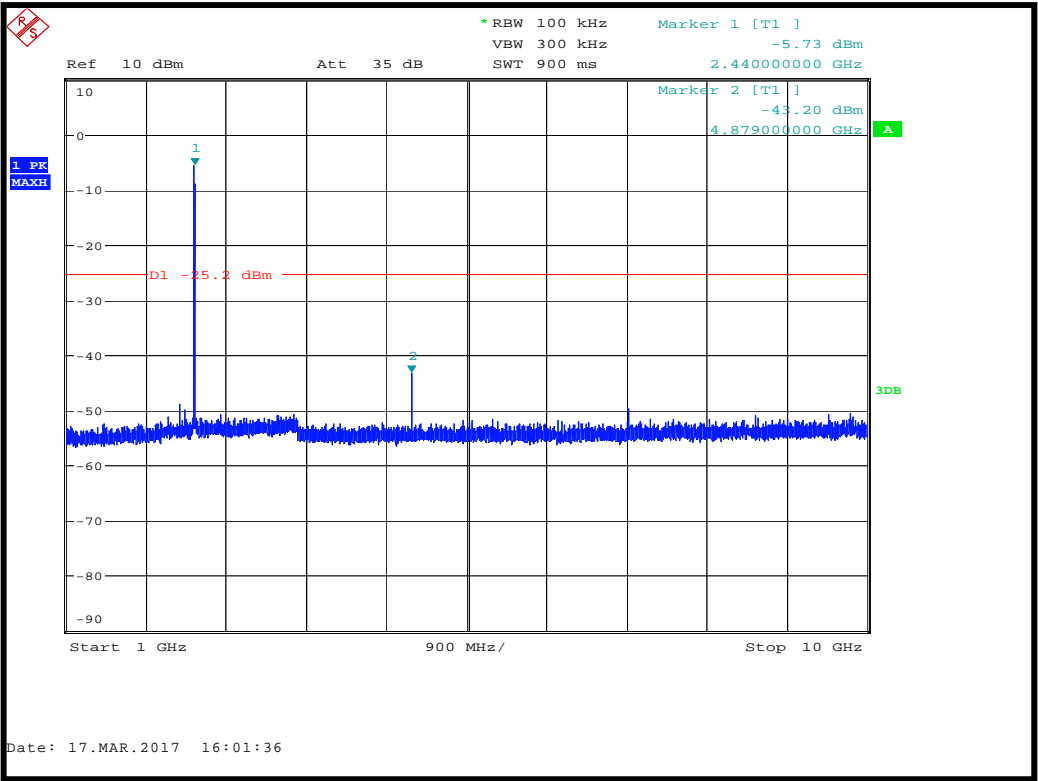
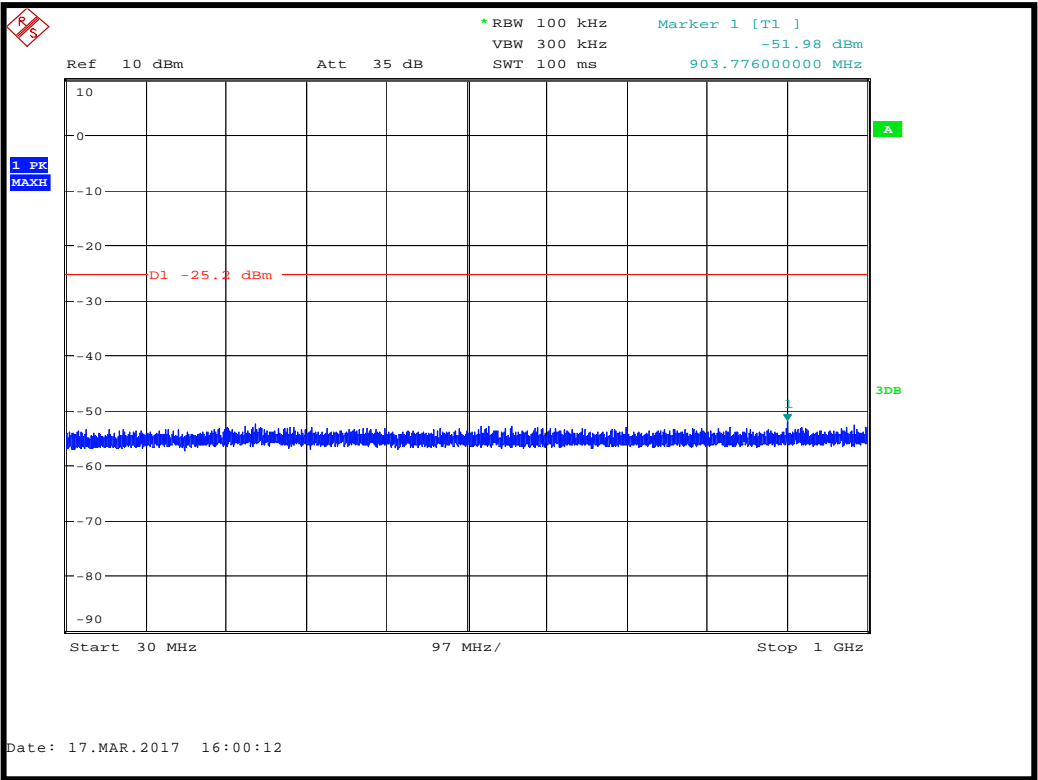


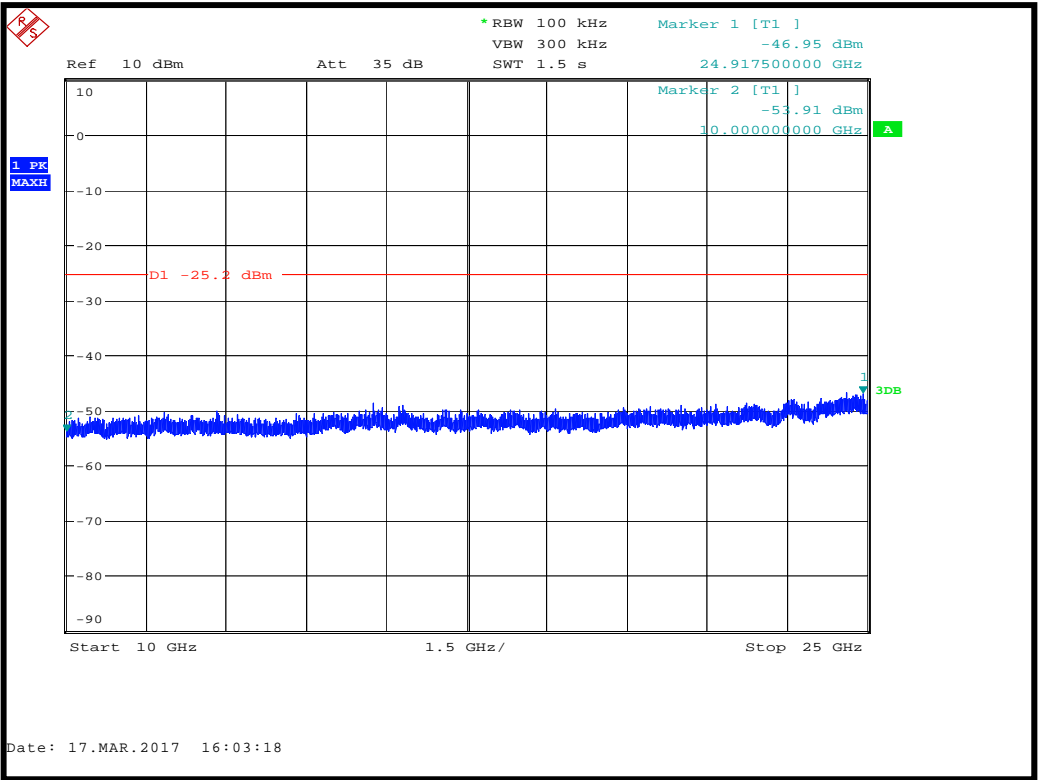


Channel: 2440 MHz; Modulation: Zigbee; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2440	2440	-5.23	-5.23	N/A	N/A	PASS
2440	0.066	-69.18	-69.18	-25.2	-43.98	PASS
2440	0.150	-36.17	-36.17	-25.2	-10.97	PASS
2440	903.776	-51.98	-51.98	-25.2	-26.78	PASS
2440	4879.000	-43.20	-43.20	-25.2	-18.00	PASS
2440	24917.500	-46.95	-46.95	-25.2	-21.75	PASS

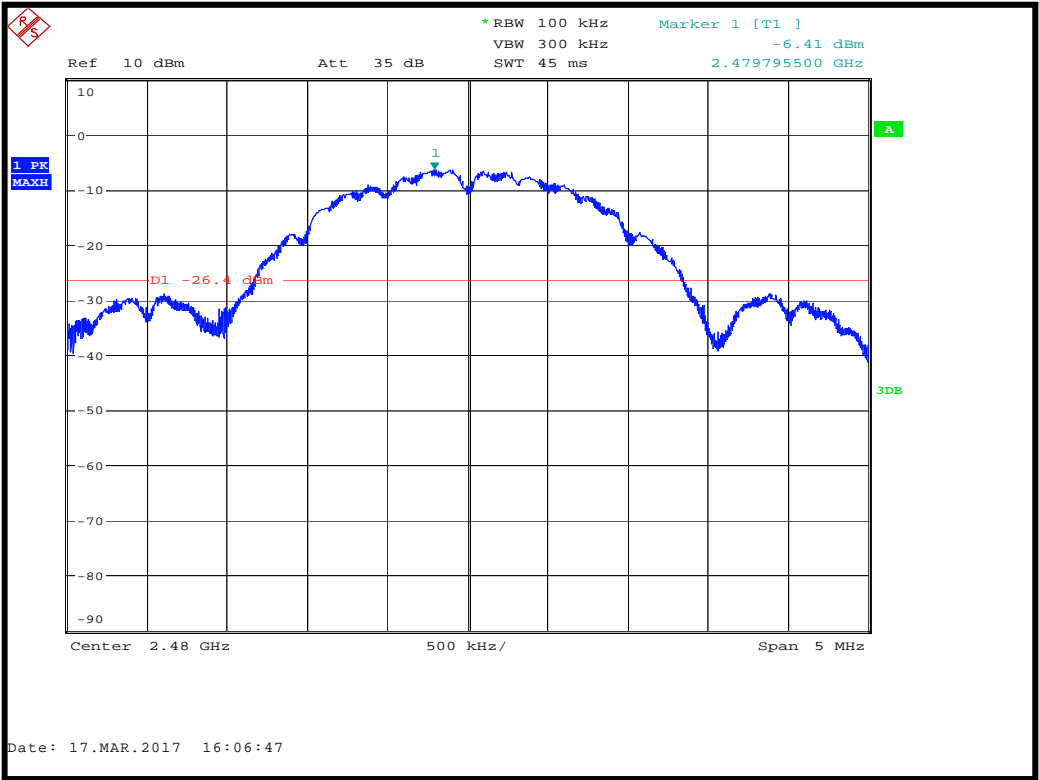


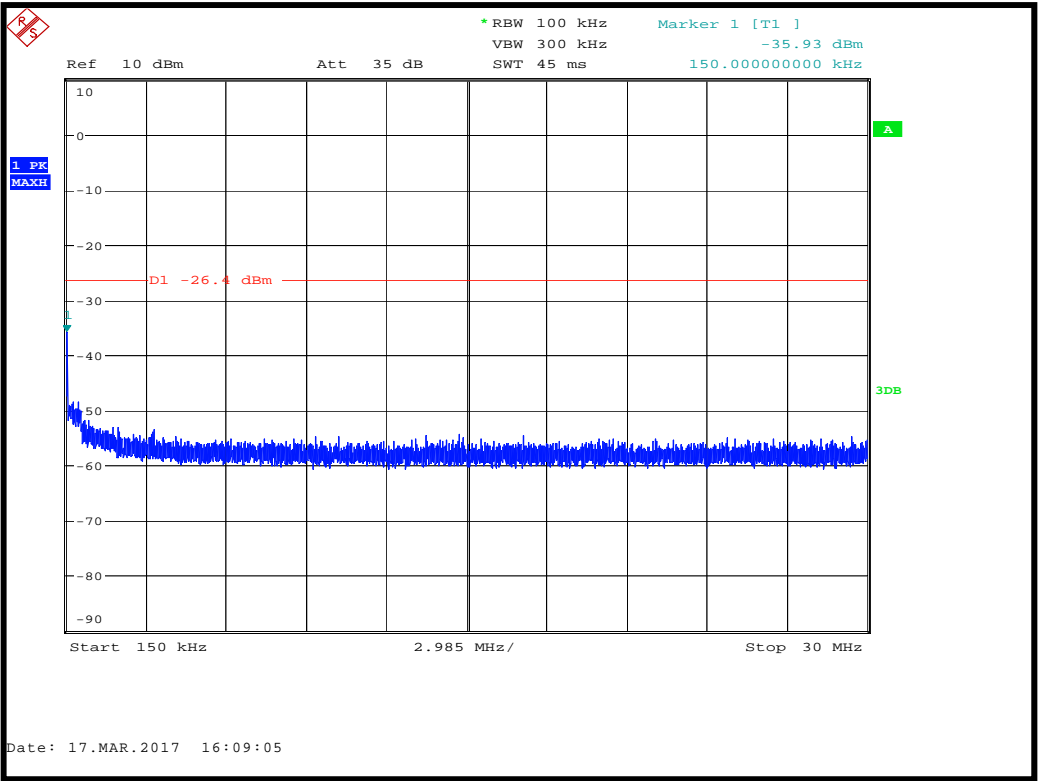
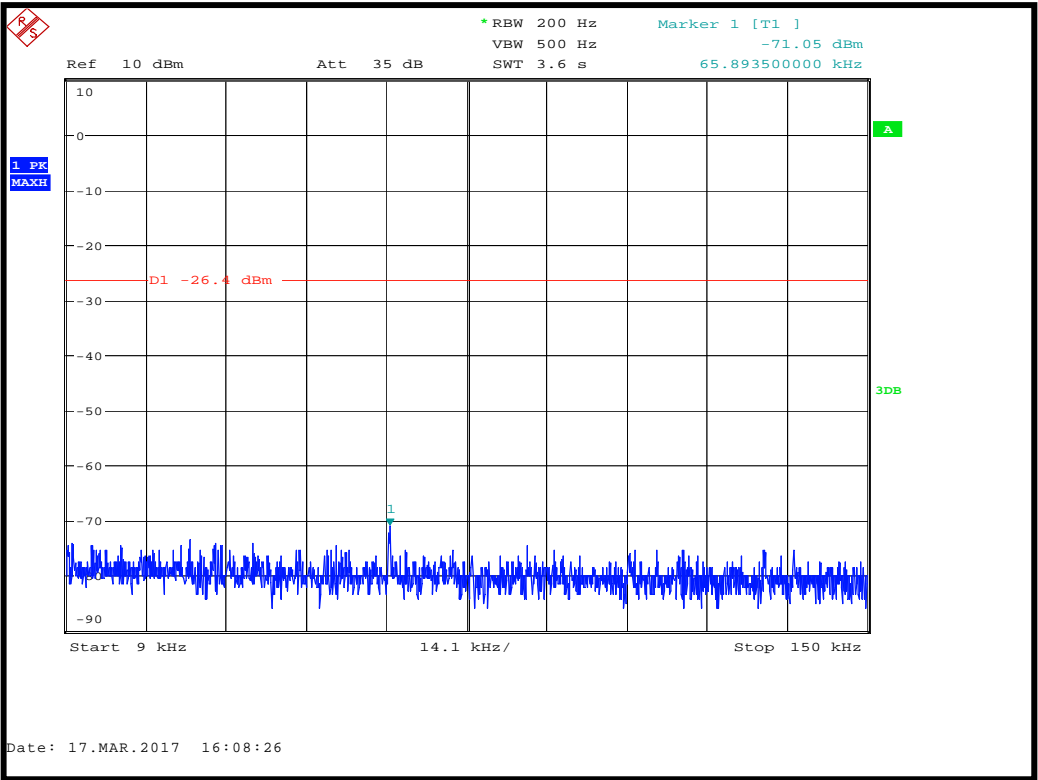


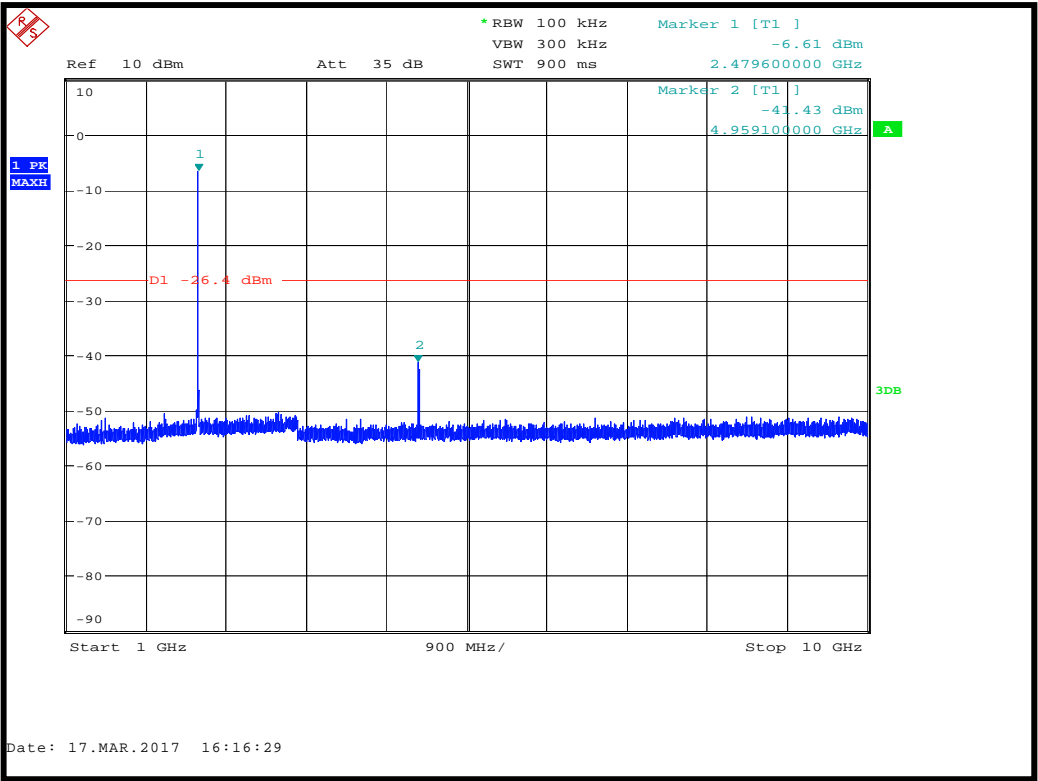
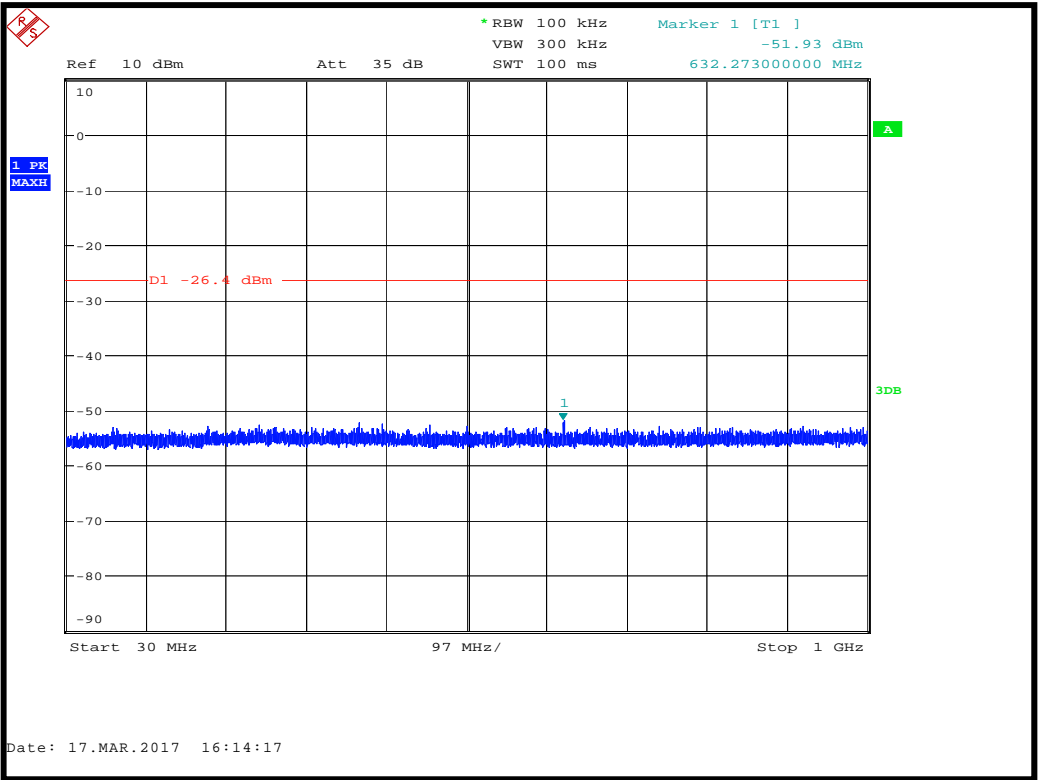


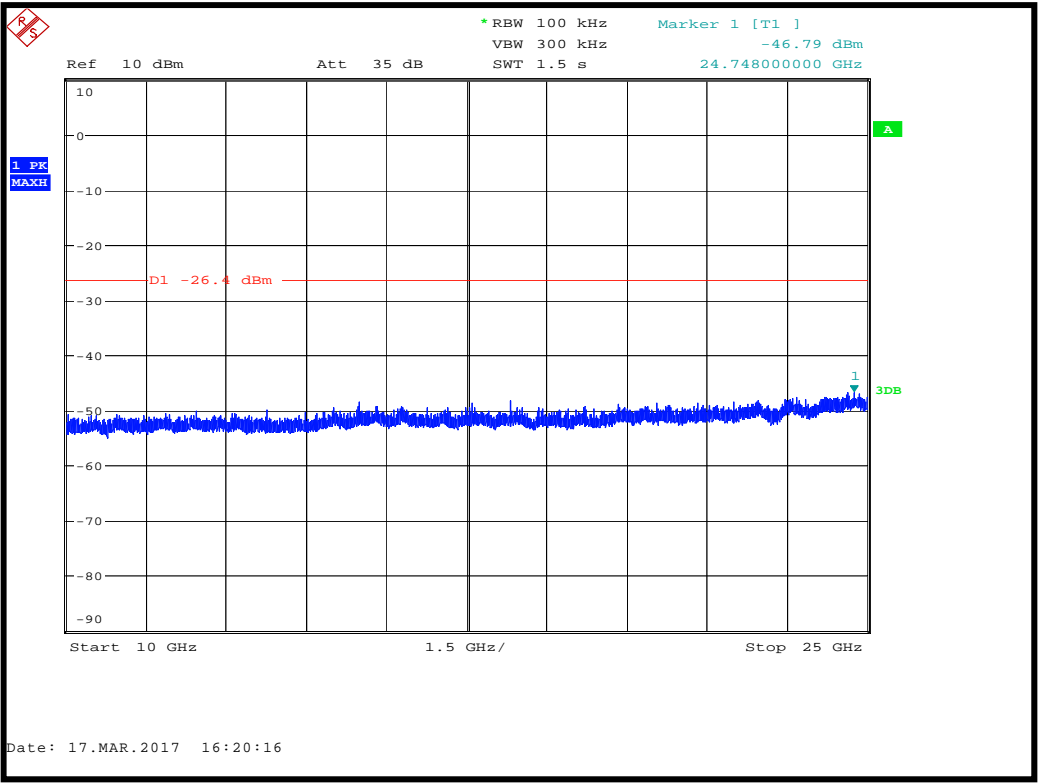


Channel: 2480 MHz; Modulation: Zigbee; Power setting: Full						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2480	2480	-6.41	-6.41	N/A	N/A	PASS
2480	0.066	-71.05	-71.05	-26.4	-44.65	PASS
2480	0.150	-35.93	-35.93	-26.4	-9.53	PASS
2480	632.273	-51.93	-51.93	-26.4	-25.53	PASS
2480	4959.100	-41.43	-41.43	-26.4	-15.03	PASS
2480	24748.000	-46.79	-46.79	-26.4	-20.39	PASS









15 Power spectral density

15.1 Definition

The power per unit bandwidth.

15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab4
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	3 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	10 kHz
Measurement Span: (requirement 1.5 times Channel BW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)
Supply: 4.5 V dc	As declared

15.3 Test Limit

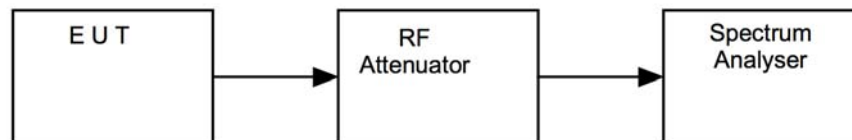
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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

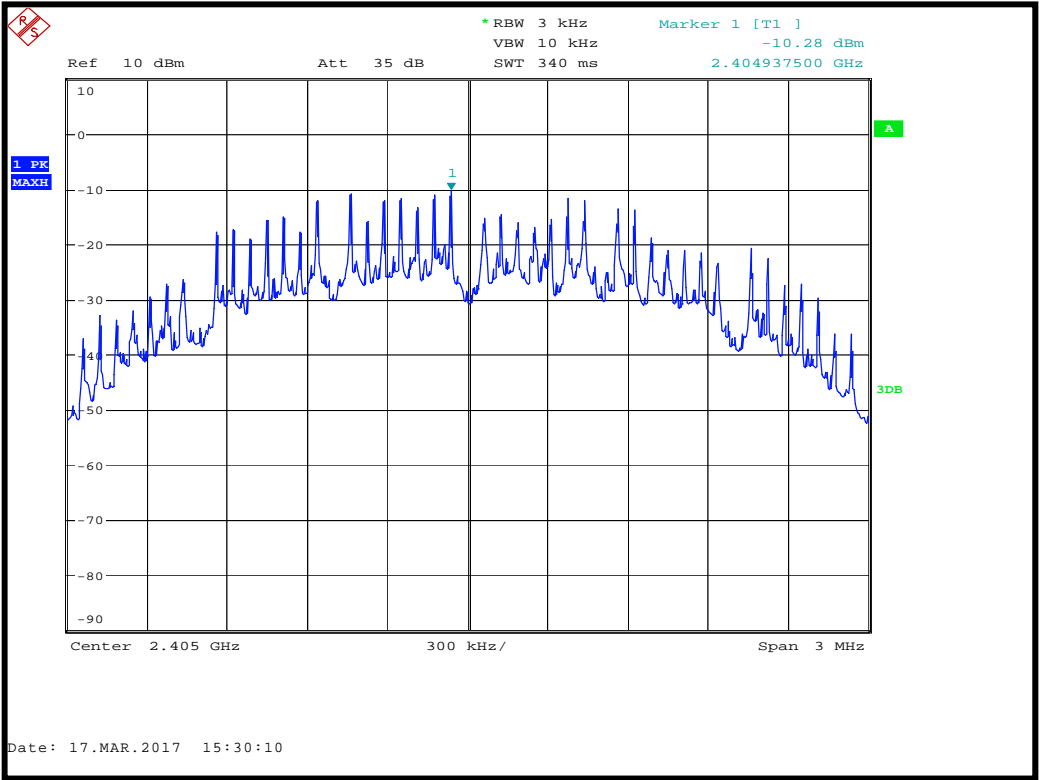


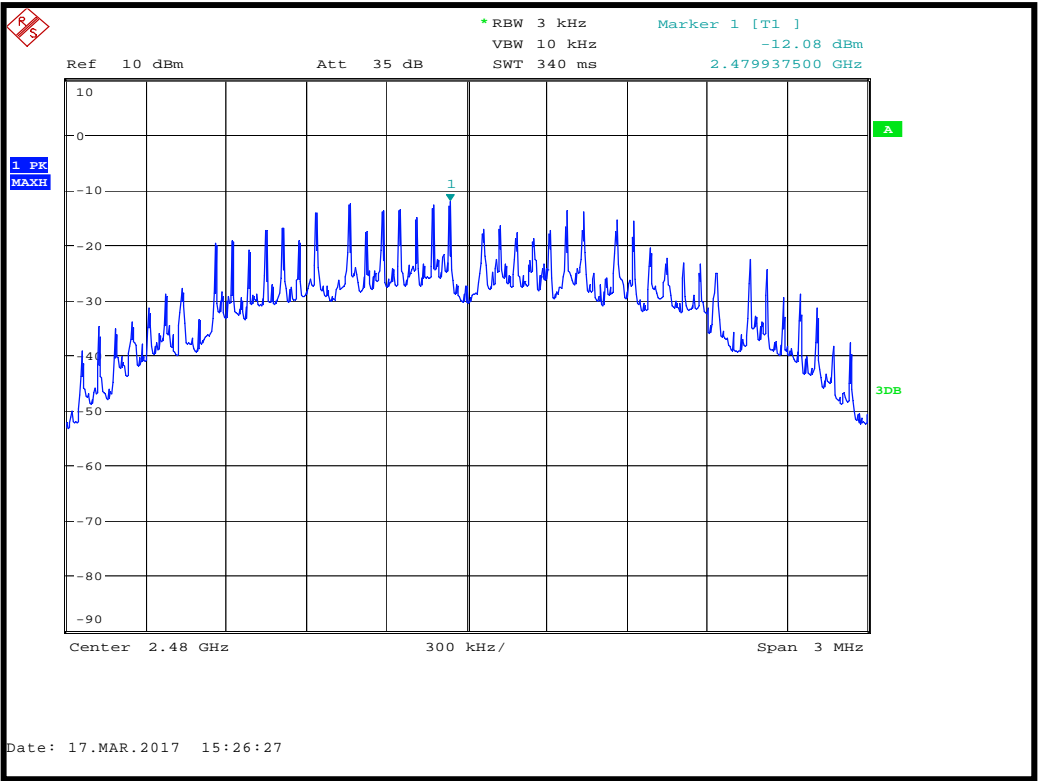
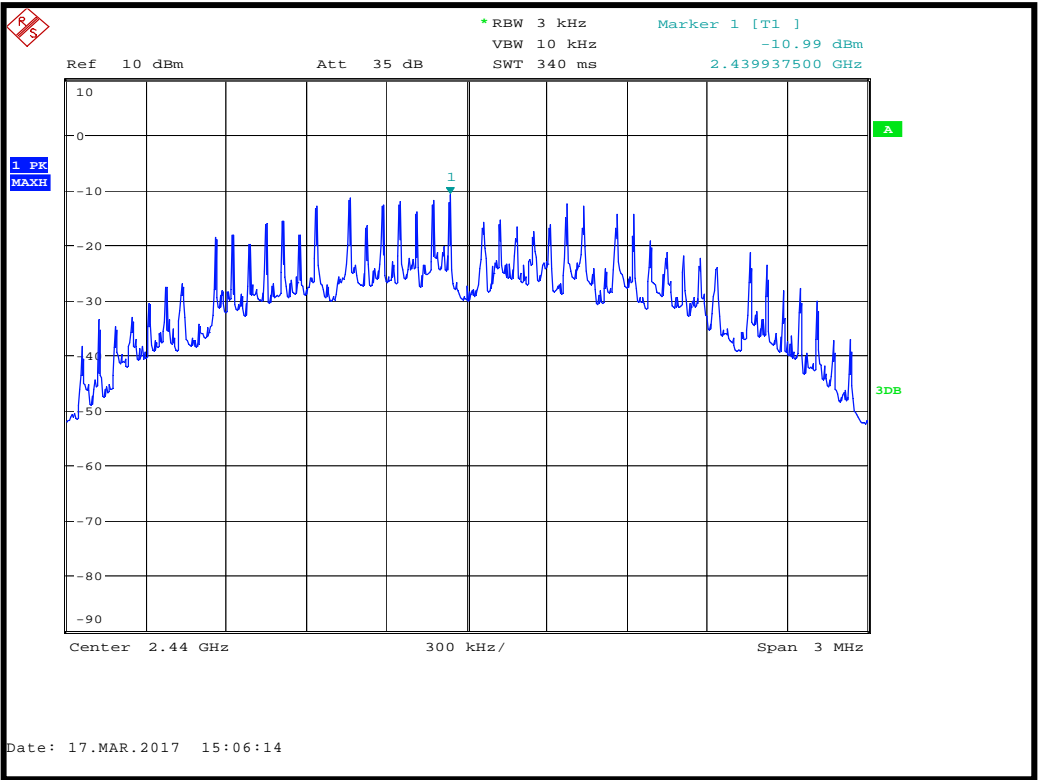
15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	REF909	02/05/2017

15.6 Test Results

Modulation: Zigbee; Power setting: Full				
Channel Frequency (MHz)	Analyzer Level (dBm)	Cable loss (dB)	Power (dBm)	Result
2405	-10.28	0	-10.28	PASS
2440	-10.99	0	-10.99	PASS
2480	-12.08	0	-12.08	PASS





16 Measurement Uncertainty

Calculated Measurement Uncertainties

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

[1] 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**

17 General SAR test reduction & exclusion guidance / MPE Calculation

KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

The SAR Test Exclusion Threshold for operation in the 2400 – 2483.5 MHz band will be determined as follows

SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

Step 1

$$NT = [(MP/TSDA) * \sqrt{fGHz}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

MP = Max Power of channel (mW) (inc tune up)

TSDA = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT \times TSDA) / \sqrt{fGHz}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSDB - 50mm) * 10\}$$

Where:

TSDB = Min Test separation Distance (mm) = 50

Note: Step 2 is not required here as the TSDA is 5mm.

Operating Frequency 2.405 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.402}] \\ \text{SARET} &= 9.68 \text{ mW} \end{aligned}$$

Operating Frequency 2.440 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.440}] \\ \text{SARET} &= 9.60 \text{ mW} \end{aligned}$$

Operating Frequency 2.480 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.480}] \\ \text{SARET} &= 9.53 \text{ mW} \end{aligned}$$

Channel Frequency (MHz)	Max. Output Power (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
2405	0.946	9.68	Not Required
2440	0.798	9.60	Not Required
2480	0.614	9.53	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

18 RF Exposure Technical Brief

RSS-102 issue 5

2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance.

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold at distance of ≤ 5 mm (mW)	SAR Evaluation
2405	1.50	4.26	Not Required
2440	1.26	4.05	Not Required
2480	0.97	3.94	Not Required