

Report on the Radio Testing

For

Pace plc

on

Xi5

Report no. TRA-029286-02-45-00A

23rd May 2016

RF916 3.0

Report Number: TRA-029286-02-45-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Pace plc
Xi5
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 01st March - 15th April 2016

Written by: A Tosif

A Tosif
Radio Test Engineer

Approved by: **John Charters**
Date: 23rd May 2016

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J Charters
Department Manager- Radio

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- [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

RF916 3.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	23rd May 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-029286-02-45-00A
WORKS ORDER NUMBER:	TRA-029286-02
PURPOSE OF TEST:	Certification
TEST SPECIFICATION(S):	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	Xi5
FCC IDENTIFIER:	NQ8PX051AEI
EUT SERIAL NUMBER:	PAW400000753, PAW400000759 and PAW400000782
MANUFACTURER/AGENT:	Pace plc
ADDRESS:	Victoria Road Saltaire Shipley West Yorkshire BD18 3LF United Kingdom
CLIENT CONTACT:	James Humphrey ☎ 01274 537259 ✉ James.Humphrey1@pace.com
ORDER NUMBER:	5185322
TEST DATE:	01st March - 15th April 2016
TESTED BY:	A Tosif 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	☐	Note 1
Carrier frequency separation	247, 5.1 (2)	15.247(a)(1)	☒	Pass
Number of hopping channels	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	Pass
Average time of occupancy	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	Pass
Maximum peak conducted output power	247, 5.4 (1), (2) and (3)	15.247 (a)(1), (b)(1) and (b)(2)	☒	Pass
20dB emission bandwidth	247, 5.1 (1)	15.247(a)(1) (i) and (ii)	☒	Pass
Out-of-band emissions	247, 5.5	15.247(d)	☒	Pass

Notes:

1. See Test report TRA-029286-02-45-03A. 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-029286-02-45-00A presents the results of the Bluetooth Classic Radio testing on a Pace plc, Xi5 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 Pace plc by Element, at the address(es) detailed below.

☒	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☐	Element North West Unit 1 Pendle Place Skemersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

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

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

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

IC Registration Number(s):

Element 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: Xi5
- Serial Number: PAW400000753, PAW400000759 and PAW400000782
- Model Number: PX051AEI
- Software Revision: Not Applicable
- Build Level / Revision Number: DV

Incorporating the following external interconnecting cables, ports or terminals:

	Description	Cable Type	Test Length	Max. Length
1	DC input	2 core unscreened	1.5m	1.5m
2	Ethernet	CAT5e UTP	10m	>3m
3	HDMI in	HDMI unscreened	1m	1m
4	HDMI out	HDMI unscreened	1m	1m
5	Micro USB*	None	N/A	N/A

*The micro USB port is not used in normal operation, so it wasn't terminated during the testing.

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.

EPS-2 (AC Adapter)
Pace HDMI Input Load
Sharp Television
Dell Latitude Laptop
Dell AC/DC Adapter

7.3 EUT Mode of Operation

7.3.1 Transmission

EUT was transmitting permanent modulated carrier using GFSK, QPSK and 8PPSK modulation on bottom, middle and top channels with and without hopping as required. The power setting on the test software (i.e. DigDebug) was set to 10.

7.3.2 Reception

This report covers transmitter operation only, results for unintentional emissions can be found in test report TRA-029286-44-00A.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2400 – 2483.5 MHz
Modulation type(s):	GFSK, QPSK, 8PSK
Occupied channel bandwidth(s):	1 MHz
Channel spacing:	1 MHz
Declared output power(s):	10 mW (10 dBm)
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	110 Vac
Duty cycle:	Up to 100%

7.4.2 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

7.4.3 Antennas

Frequency range:	2400 – 2483.5 MHz
Impedance:	50 Ohms
Gain:	See Table on the next page
Polarisation:	Omni
Beam width:	Not Applicable
Connector type:	U-FL
Mounting:	Case Mounted

Frequency [MHz]	BT [%]	RF4CE [%]
2350	2.0	1.0
2360	2.0	0.9
2370	2.0	0.8
2380	2.0	0.8
2390	1.8	0.9
2400	1.7	0.8
2410	1.7	1.1
2420	1.7	1.4
2430	1.6	1.7
2440	1.6	1.9
2450	1.6	2.2
2460	1.5	2.3
2470	1.4	2.3
2480	1.3	2.2
2490	1.4	2.1
2500	1.3	2.0
2510	1.3	2.0
2520	1.3	2.0
2530	1.2	1.8
2540	1.2	1.4
2550	1.1	1.2
Average	1.6	1.8

7.5 EUT Description

The EUT is a set top box with one HDMI output for connection to a television. The EUT can accept inputs from Wi-Fi, HDMI and Ethernet. The EUT is controlled by remote control over RF4CE and/or Bluetooth.

8 Modifications

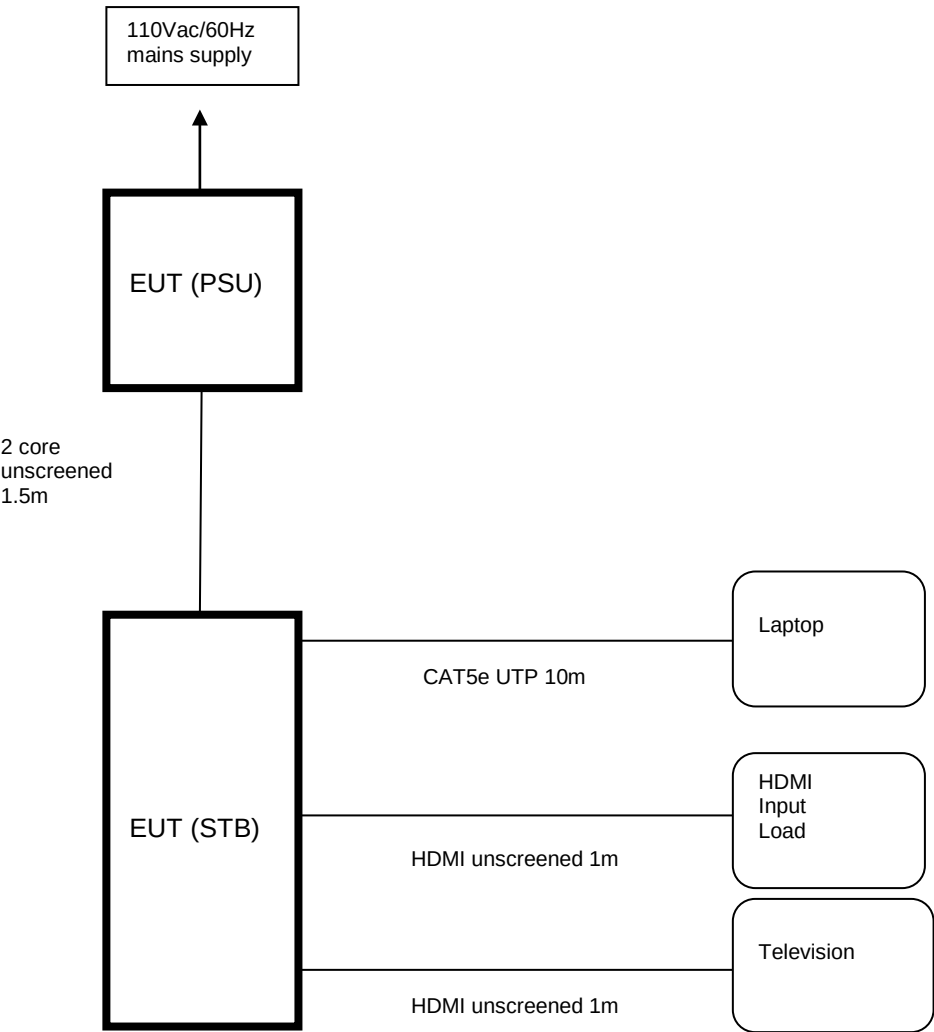
No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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

The following diagram shows basic EUT interconnections with major functional component units, cable type and cable lengths identified in Section **Error! Reference source not found.**.



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 110 Vac 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
☒	Mains	110 V ac +/-2 %	85 % and 115 %
☐	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

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	2402 MHz / 2441 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: 33 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ± 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

<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;

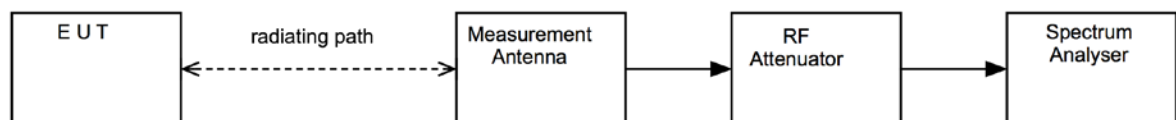
PA is the pre-amplifier gain in dB (where used);

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 Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2014	24	21/07/2016
Biconical Antenna	EMCO	3109	RFG095	09/05/2013	36	09/05/2016
Log Periodic Antenna	EMCO	3146	RFG191	09/05/2013	36	09/05/2016
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (9kHz – 1GHz)	Sonoma	310	REF927	01/07/2014	24	01/07/2016
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
EMI Test Receiver	R&S	ESVS20	RFG126	17/04/2015	12	17/04/2016
Spectrum Analyser	R&S	FSU46	REF910	28/05/2015	12	28/05/2016

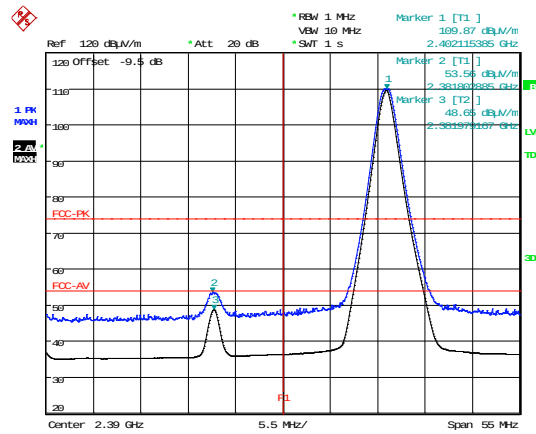
11.6 Test Results

<i>Modulation: GFSK; Channel: 2402 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>
No emissions were detected within 20 dB of the limit										

<i>Modulation: GFSK; Channel: 2441 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>
No emissions were detected within 20 dB of the limit										

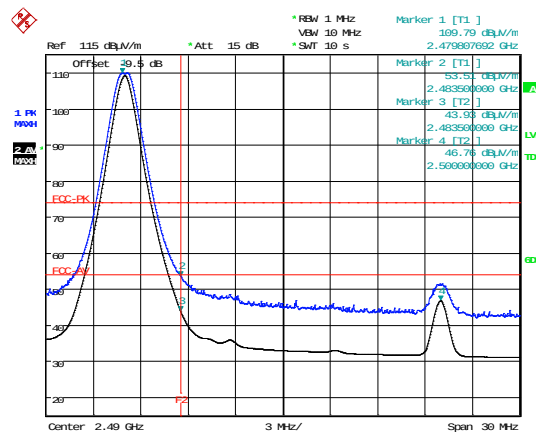
<i>Modulation: GFSK; Channel: 2480 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
No emissions were detected within 20 dB of the limit										

Radiated Bandedge Compliance – GFSK



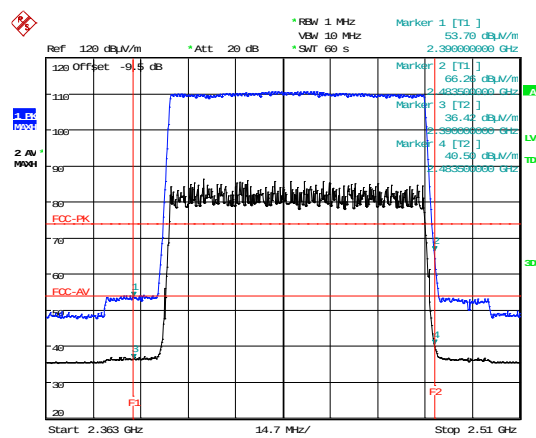
Date: 8.MAR.2016 08:08:28

Lower Bandedge



Date: 4.APR.2016 13:49:28

Upper Bandedge



Date: 11.MAR.2016 14:12:06

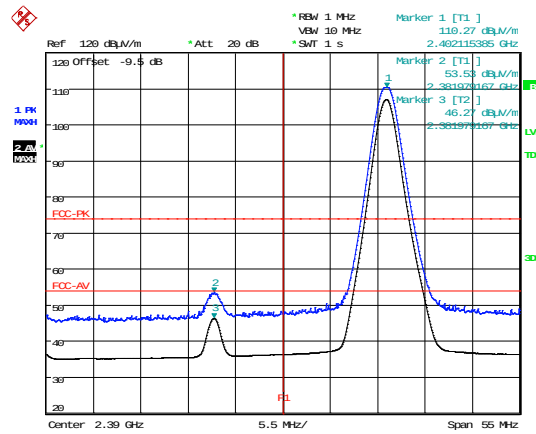
Bandedge with Hopping Enabled

<i>Modulation: QPSK; Channel: 2402 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>
No emissions were detected within 20 dB of the limit										

<i>Modulation: QPSK; Channel: 2441 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>
No emissions were detected within 20 dB of the limit										

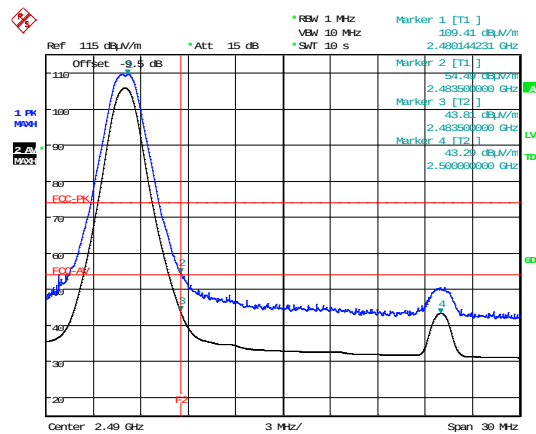
<i>Modulation: QPSK; Channel: 2480 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
No emissions were detected within 20 dB of the limit										

Radiated Bandedge Compliance – QPSK



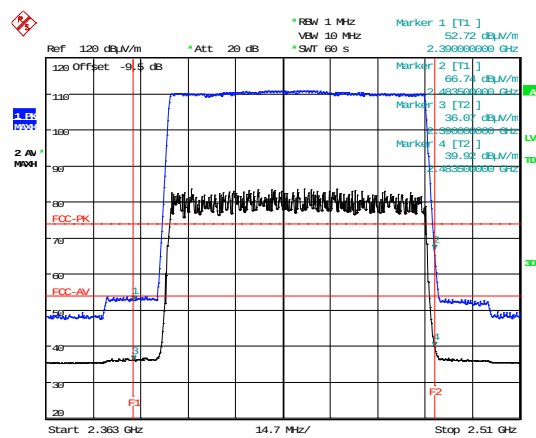
Date: 8.MAR.2016 08:18:25

Lower Bandedge



Date: 4.APR.2016 13:56:56

Upper Bandedge



Date: 11.MAR.2016 14:27:30

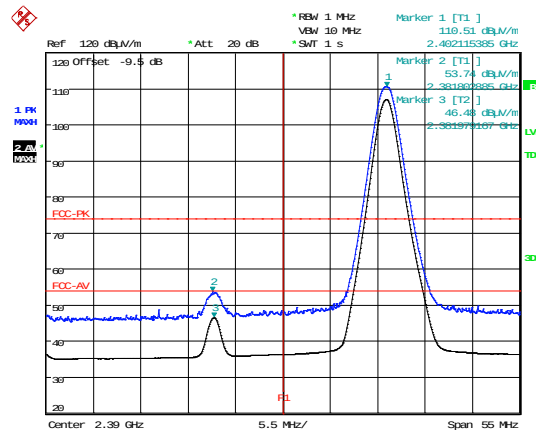
Bandedge with Hopping Enabled

<i>Modulation: 8PSK; Channel: 2402 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>
No emissions were detected within 20 dB of the limit										

<i>Modulation: 8PSK; Channel: 2441 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>
No emissions were detected within 20 dB of the limit										

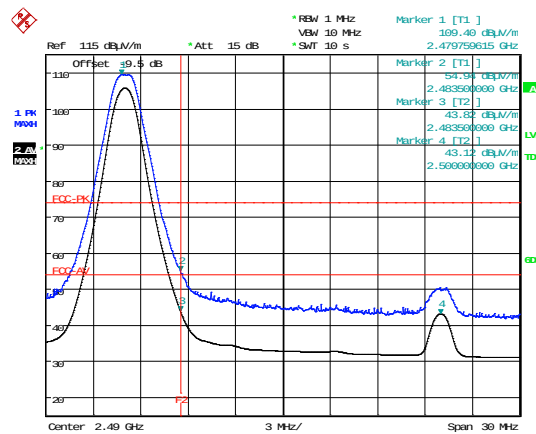
<i>Modulation: 8PSK; Channel: 2480 MHz</i>										
<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
No emissions were detected within 20 dB of the limit										

Radiated Bandedge Compliance – 8PSK



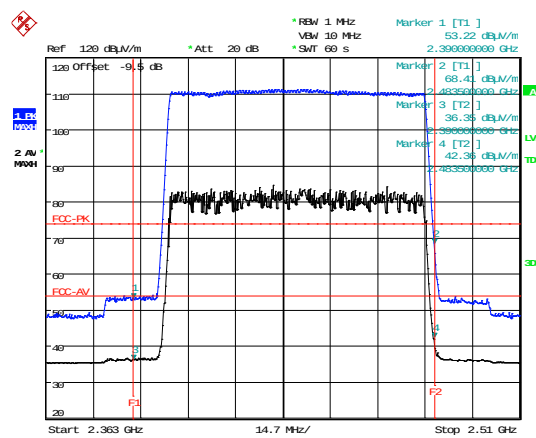
Date: 8.MAR.2016 08:13:18

Lower Bandedge



Date: 4.APR.2016 13:58:49

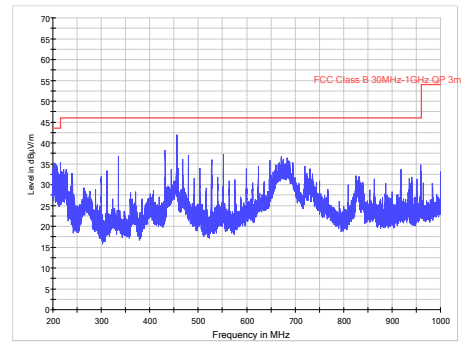
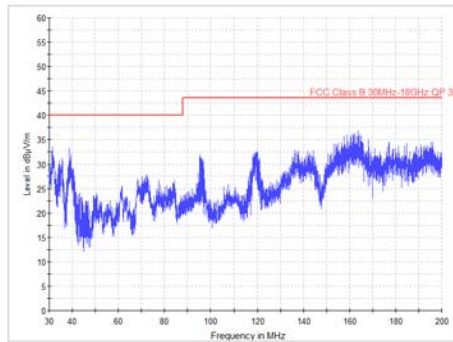
Upper Bandedge



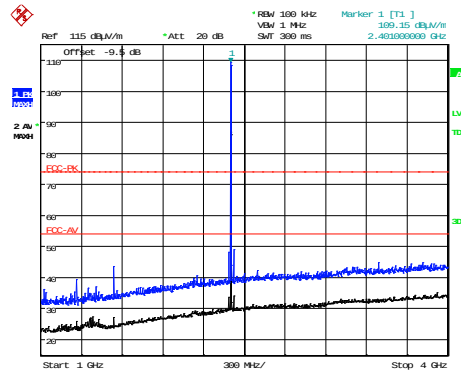
Date: 11.MAR.2016 13:57:33

Bandedge with Hopping Enabled

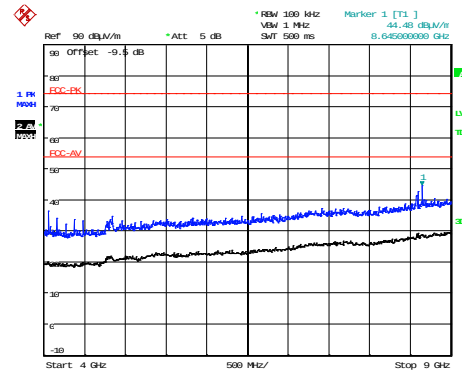
Radiated Spurious Emission - 2402 MHz



30 MHz – 200 MHz



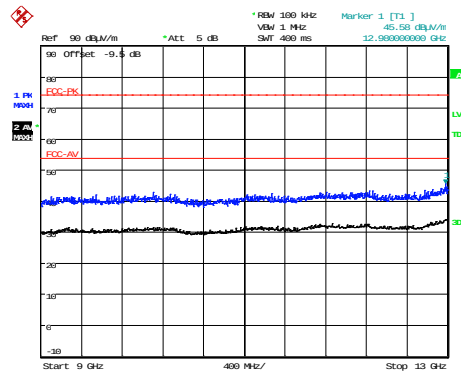
200 MHz – 1 GHz



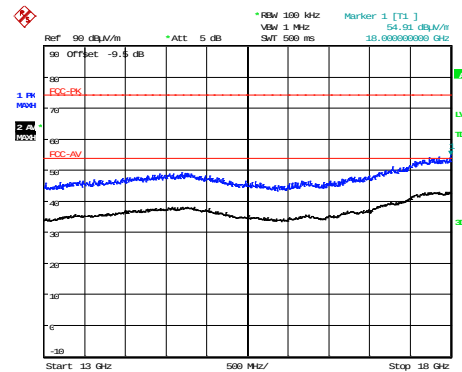
Date: 7.MAR.2016 12:02:02

Date: 7.MAR.2016 10:53:55

1 GHz – 4 GHz



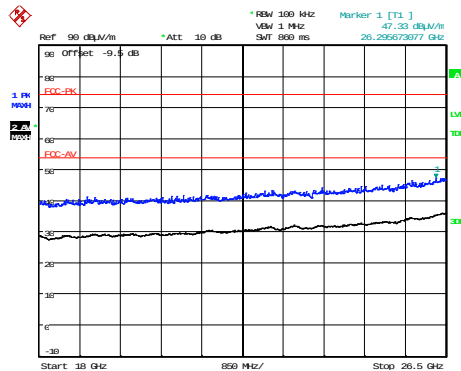
4 GHz - 9 GHz



Date: 7.MAR.2016 10:56:04

Date: 7.MAR.2016 11:04:09

9 GHz – 13 GHz

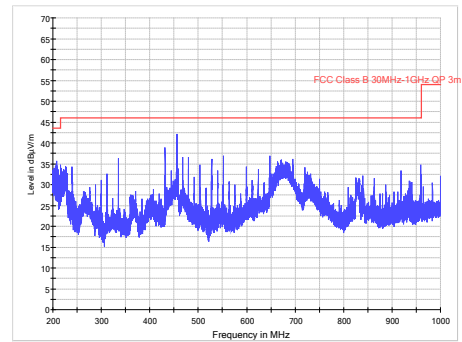
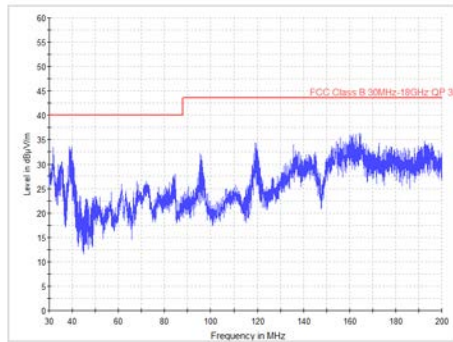


13 GHz -18 GHz

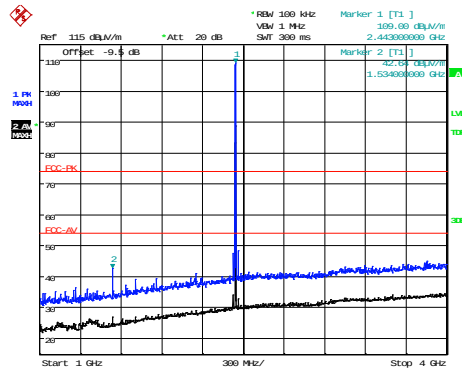
Date: 11.MAR.2016 10:45:28

18 GHz – 26 GHz

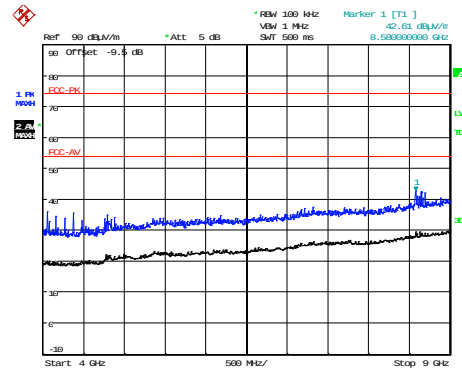
Radiated Spurious Emission - 2441 MHz



30 MHz – 200 MHz



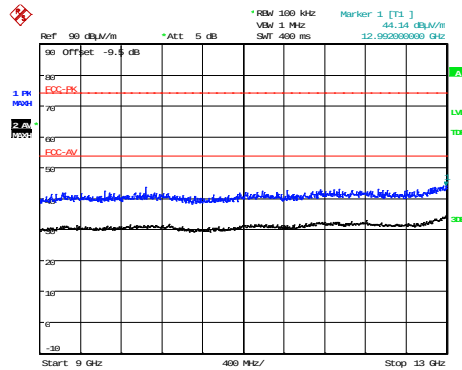
200 MHz – 1 GHz



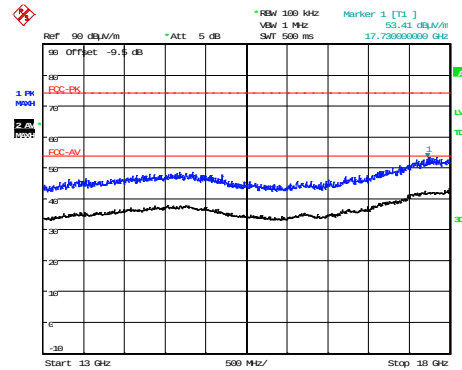
Date: 7.MAR.2016 10:11:25

Date: 7.MAR.2016 11:09:47

1 GHz – 4 GHz



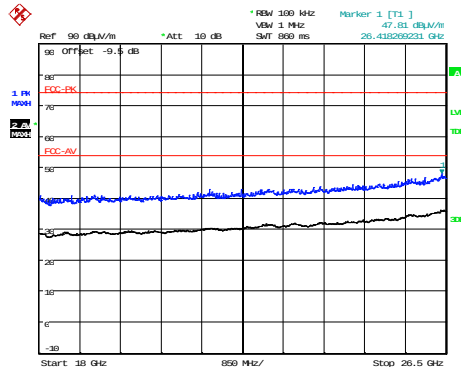
4 GHz - 9 GHz



Date: 7.MAR.2016 11:07:55

Date: 7.MAR.2016 11:06:05

9 GHz – 13 GHz

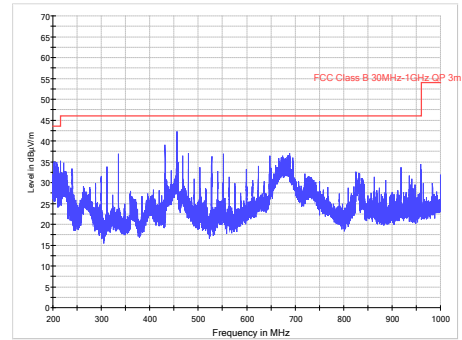
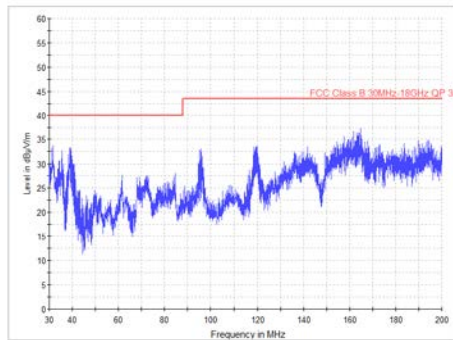


13 GHz -18 GHz

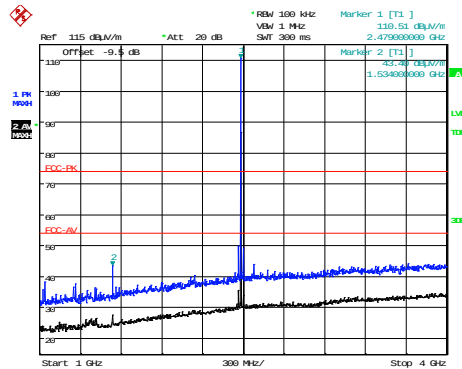
Date: 11.MAR.2016 10:50:53

18 GHz – 26 GHz

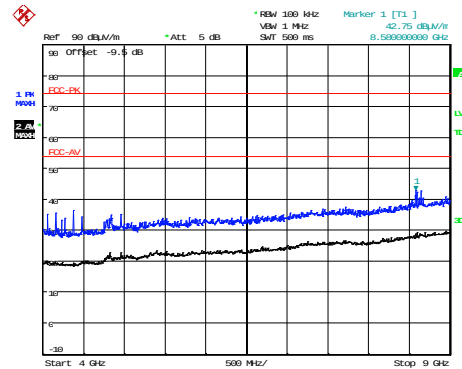
Radiated Spurious Emission - 2480 MHz



30 MHz – 200 MHz



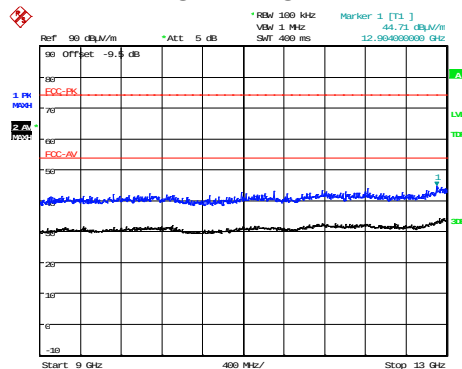
200 MHz – 1 GHz



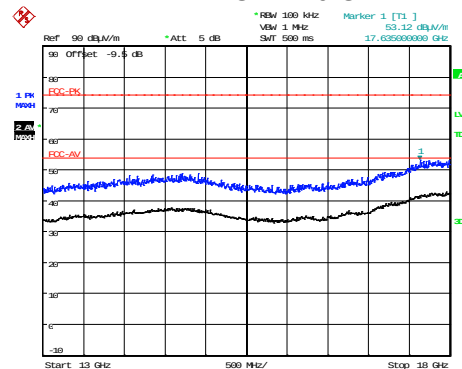
Date: 7.MAR.2016 10:13:42

Date: 7.MAR.2016 11:11:23

1 GHz – 4 GHz



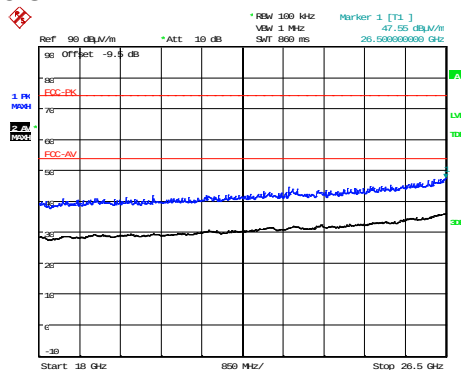
4 GHz - 9 GHz



Date: 7.MAR.2016 11:12:39

Date: 7.MAR.2016 11:13:48

9 GHz – 13 GHz



13 GHz -18 GHz

Date: 11.MAR.2016 10:56:23

18 GHz – 26 GHz

12 Carrier frequency separation

12.1 Definition

The carrier frequency separation is the frequency separation between two adjacent hopping frequencies.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.2
EUT Channels / Frequencies Measured:	2440 MHz & 2441 MHz
EUT Test Modulations:	GFSK / QPSK / 8PSK – hopping enabled
Deviations From Standard:	None
Measurement BW:	200 kHz
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: 110 V ac	110 V ac ± 10 % (as declared)

12.3 Test Limit

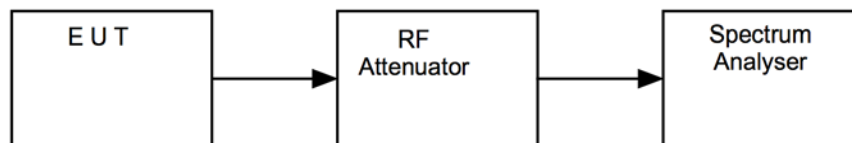
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the emissions of 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 nominal bandwidth.

Figure iii Test Setup



12.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

12.6 Test Results

<i>Power setting: 10</i>			
<i>Modulation</i>	<i>Measured Spacing (kHz)</i>	<i>(2/3) × 20 dB BW (kHz)</i>	<i>Result</i>
GFSK	1000	699.787	PASS
QPSK	1000	929.487	PASS
8PSK	1000	908.119	PASS

13 Number of hopping frequencies

13.1 Definition

The total number of hopping frequencies (the centre frequencies defined within the hopping sequence of a FHSS equipment) which are randomly sequenced in order to spread the transmission.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.3
EUT Channels / Frequencies Measured:	All; 2402 – 2480 MHz
EUT Test Modulations:	GFSK / QPSK / 8PSK – hopping enabled
Deviations From Standard:	None
Measurement BW:	200 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ± 10 % (as declared)

13.3 Test Limit

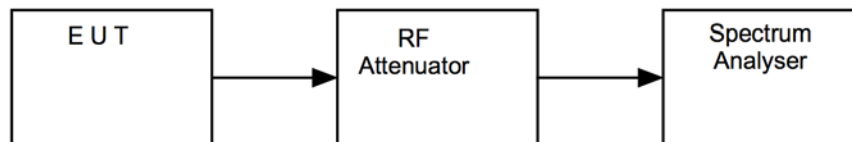
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels; If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz shall use at least 15 hopping channels;
- Frequency hopping systems operating in the band 5725 to 5850 MHz shall use at least 75 hopping channels.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the emissions of 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 nominal bandwidth.

Figure iv Test Setup



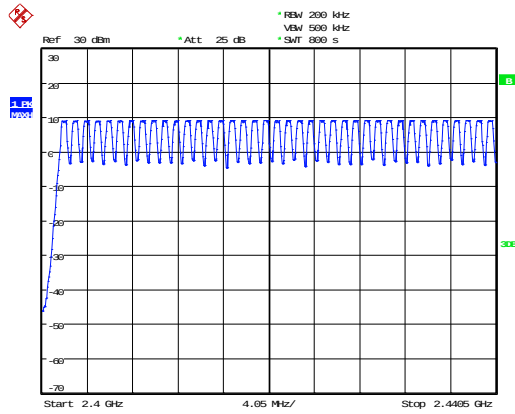
13.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

13.6 Test Results

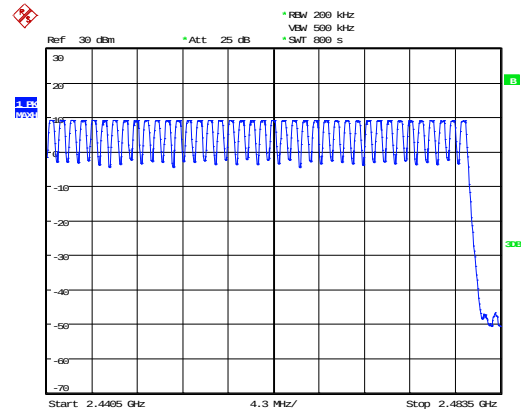
<i>Power setting: 10</i>				
<i>Modulation</i>	<i>Lowest channel, F_{CL} (MHz)</i>	<i>Highest channel, F_{CH} (MHz)</i>	<i>Number of channels observed</i>	<i>Result</i>
GFSK	2402	2480	79	PASS
QPSK	2402	2480	79	PASS
8PSK	2402	2480	79	PASS

Number of hopping frequencies



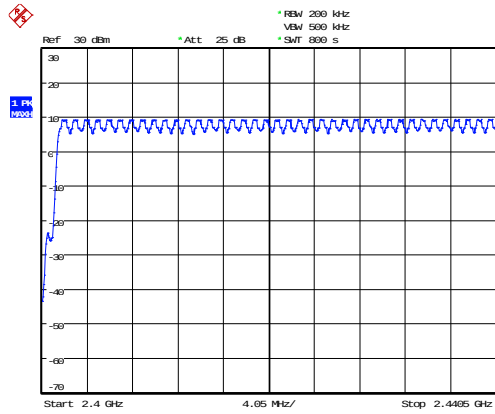
Date: 10.MAR.2016 11:24:58

GFSK 0-38



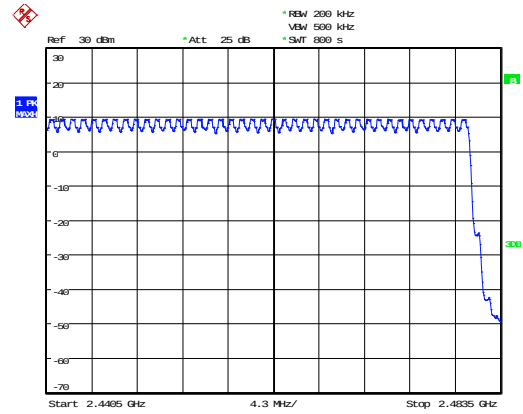
Date: 10.MAR.2016 11:10:40

GFSK 39-78



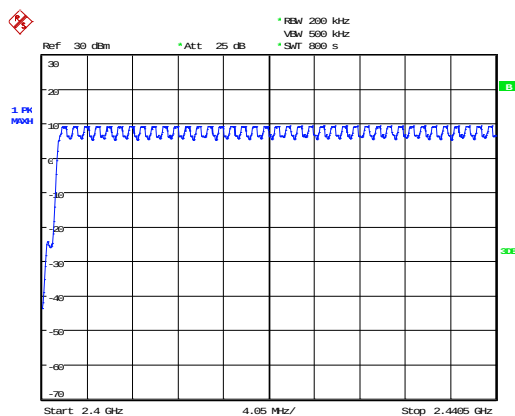
Date: 10.MAR.2016 11:42:09

QPSK 0-38



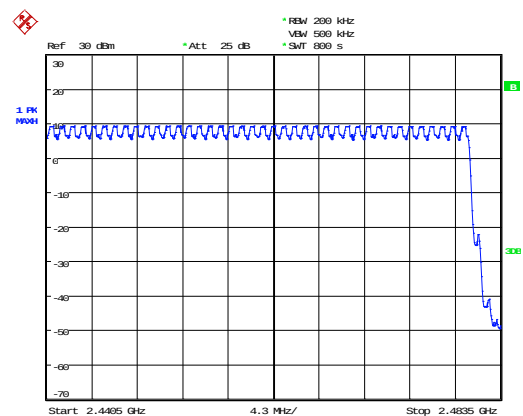
Date: 10.MAR.2016 12:10:54

QPSK 39-78



Date: 10.MAR.2016 10:27:25

8PSK 0-38



Date: 10.MAR.2016 10:55:14

8PSK 39-78

14 Average channel occupancy

14.1 Definition

The channel occupancy is the total of the transmitter 'on' times, during an observation period, on a particular hopping frequency.

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.4
EUT Channels / Frequencies Measured:	2441 MHz
EUT 20dB bandwidth:	kHz
EUT Number of hopping channels:	79
EUT Test Modulations:	GFSK / QPSK / 8PSK – hopping enabled
Deviations From Standard:	None
Measurement BW:	1 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (as declared)

14.3 Test Limit

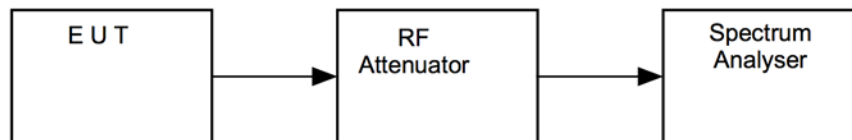
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period;
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10 second period;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed;
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions of the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. A number of hops were observed to confirm consistency of the dwell time / observe the worst case. All modulation schemes, data rates and power settings were used to observe the worst-case configuration.

Figure v Test Setup



14.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

14.6 Test Results

<i>Power setting: 10</i>					
<i>Modulation</i>	<i>Individual occupancy time (ms)</i>	<i>Observation period (s)</i>	<i>Number of hops observed</i>	<i>Average time of occupancy (s)</i>	<i>Result</i>
GFSK	2.91	31.6	111	0.32	PASS
QPSK	2.92	31.6	106	0.31	PASS
8PSK	2.92	31.6	105	0.31	PASS

15 Maximum peak conducted output power

15.1 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.

15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Channels / Frequencies Measured:	2402 MHz / 2441 MHz / 2480 MHz–hopping disabled.
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	2 MHz
Spectrum Analyzer Video BW:	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: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

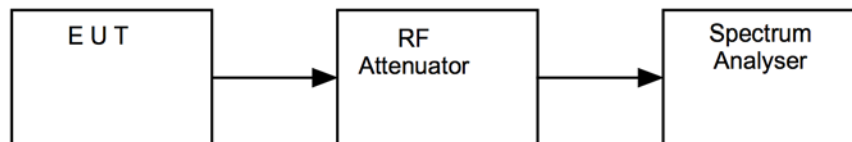
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels;
the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels.
- For frequency hopping systems operating in the band 2400 to 2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W;
for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. The e.i.r.p. shall not exceed 4 W.
- For frequency hopping systems operating in the band 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W.
- Point-to-point systems in the bands 2400-2483.5 MHz and 5725 to 5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, 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 vi Test Setup



15.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

15.6 Test Results

<i>Modulation: GFSK; Power setting: 10</i>					
<i>Channel Frequency (MHz)</i>	<i>Maximum peak conducted output power (dBm)</i>	<i>Maximum peak conducted output power (W)</i>	<i>Antenna gain (dBi)</i>	<i>E.I.R.P. (W)</i>	<i>Result</i>
2402	9.1	0.0081	1.7	0.0120	PASS
2441	9.3	0.0084	1.7	0.0125	PASS
2480	9.1	0.0081	1.7	0.0120	PASS

16 Occupied Bandwidth

16.1 Definition

The emission bandwidth (-20 dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20 dB below the maximum in-band spectral density of the modulated signal.

16.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	2402 MHz / 2441 MHz / 2480 MHz – hopping stopped.
EUT Channel Bandwidths:	1 MHz
EUT Test Modulations:	GFSK / QPSK / 8PSK
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	50 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	200 kHz
Measurement Span: (requirement 2 to 5 times OBW)	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

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

16.3 Test Limit

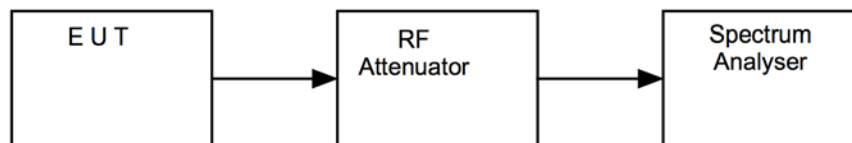
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, 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 vii Test Setup



16.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

16.6 Test Results

<i>Modulation: GFSK; Data rate: 1 Mbps; Power setting: 10</i>				
<i>Channel Frequency (MHz)</i>	<i>F_L (MHz)</i>	<i>F_H (MHz)</i>	<i>20dB Bandwidth (kHz)</i>	<i>Result</i>
2402	2401.447115	2402.496795	1049.680	PASS
2441	2440.447115	2441.496795	1049.680	PASS
2480	2479.447115	2480.496795	1049.680	PASS

<i>Modulation: QPSK; Data rate: 2 Mbps; Power setting: 10</i>				
<i>Channel Frequency (MHz)</i>	<i>F_L (MHz)</i>	<i>F_H (MHz)</i>	<i>20dB Bandwidth (kHz)</i>	<i>Result</i>
2402	2401.286859	2402.681090	1394.231	PASS
2441	2440.286859	2441.681090	1394.231	PASS
2480	2479.286859	2480.681090	1394.231	PASS

<i>Modulation: 8PSK; Data rate: 3 Mbps; Power setting: 10</i>				
<i>Channel Frequency (MHz)</i>	<i>F_L (MHz)</i>	<i>F_H (MHz)</i>	<i>20dB Bandwidth (kHz)</i>	<i>Result</i>
2402	2401.302885	2402.665064	1362.179	PASS
2441	2440.302885	2441.665064	1362.179	PASS
2480	2479.302885	2480.665064	1362.179	PASS

17 Out-of-band and conducted spurious emissions

17.1 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.

17.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.8
EUT Channels / Frequencies Measured:	2402 MHz / 2441 MHz / 2480 MHz
EUT Channel Bandwidths:	1 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: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (as declared)

17.3 Test Limits

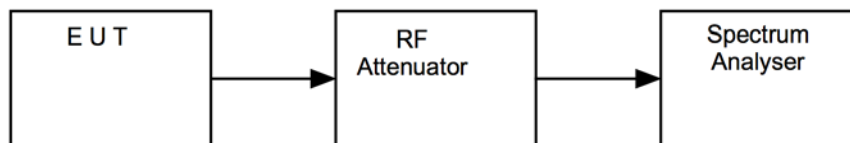
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either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

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 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 viii Test Setup



17.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016

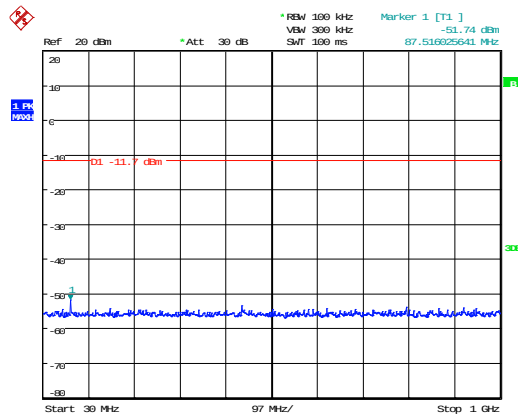
17.6 Test Results

<i>Modulation: GFSK; Data rate: 1 Mbps; Power setting: 10</i>						
<i>Channel Frequency (MHz)</i>	<i>Emission Frequency (MHz)</i>	<i>Analyzer Level (dBm)</i>	<i>Emission Level (dBm)</i>	<i>Limit (dBm)</i>	<i>Margin (dB)</i>	<i>Result</i>
No emissions were detected within 20 dB of the limit						

<i>Modulation: QPSK; Data rate: 2 Mbps; Power setting: 10</i>						
<i>Channel Frequency (MHz)</i>	<i>Emission Frequency (MHz)</i>	<i>Analyzer Level (dBm)</i>	<i>Emission Level (dBm)</i>	<i>Limit (dBm)</i>	<i>Margin (dB)</i>	<i>Result</i>
No emissions were detected within 20 dB of the limit						

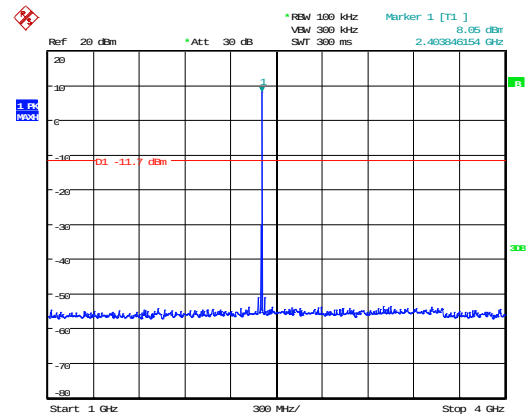
<i>Modulation: 8PSK; Data rate: 3 Mbps; Power setting: 10</i>						
<i>Channel Frequency (MHz)</i>	<i>Emission Frequency (MHz)</i>	<i>Analyzer Level (dBm)</i>	<i>Emission Level (dBm)</i>	<i>Limit (dBm)</i>	<i>Margin (dB)</i>	<i>Result</i>
No emissions were detected within 20 dB of the limit						

Spurious emissions – 2402 MHz GFSK



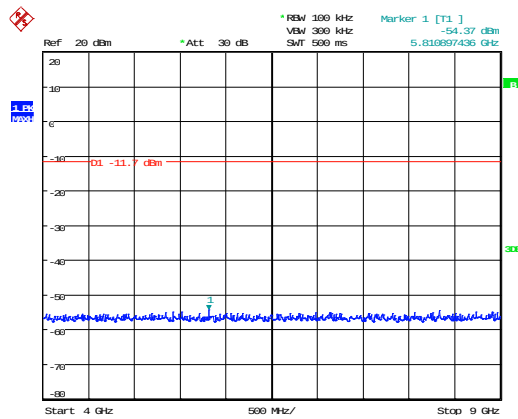
Date: 10.MAR.2016 07:26:55

30 MHz – 1 GHz



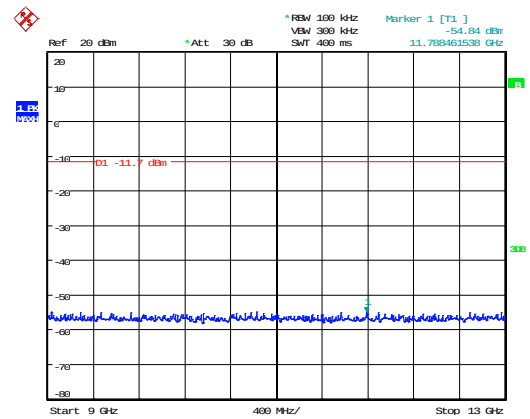
Date: 10.MAR.2016 07:27:23

1 GHz – 4 GHz



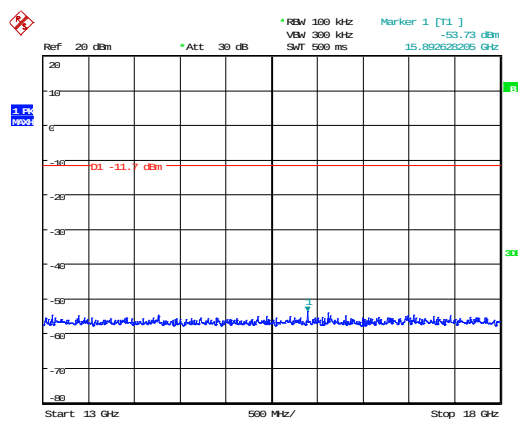
Date: 10.MAR.2016 07:27:39

4 GHz – 9 GHz



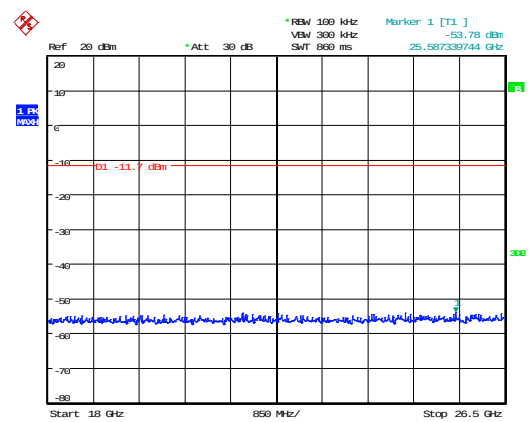
Date: 10.MAR.2016 07:27:53

9 GHz – 13 GHz



Date: 10.MAR.2016 07:28:08

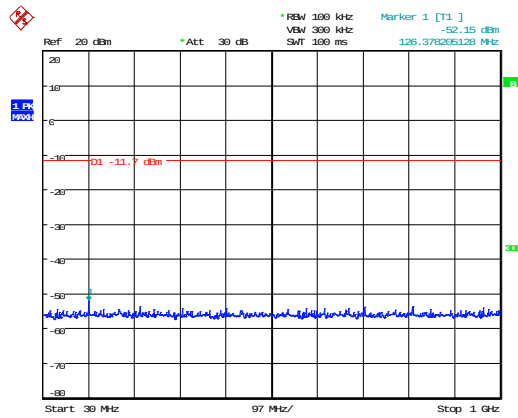
13 GHz – 18 GHz



Date: 10.MAR.2016 07:28:34

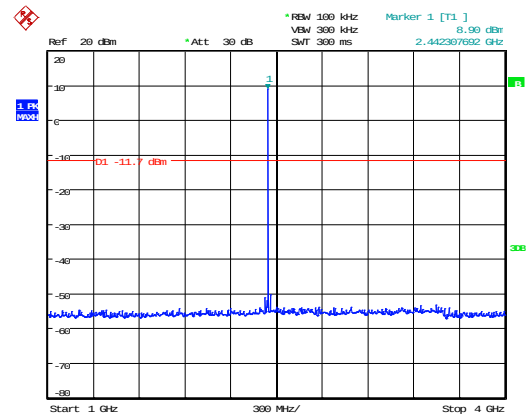
18 GHz – 26.5 GHz

Spurious emissions – 2441 MHz GFSK



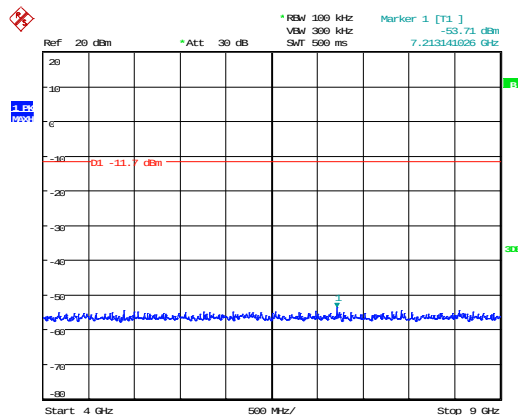
Date: 10.MAR.2016 07:31:09

30 MHz – 1 GHz



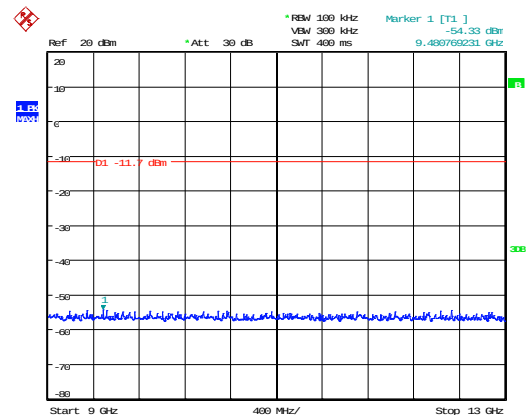
Date: 10.MAR.2016 07:31:43

1 GHz – 4 GHz



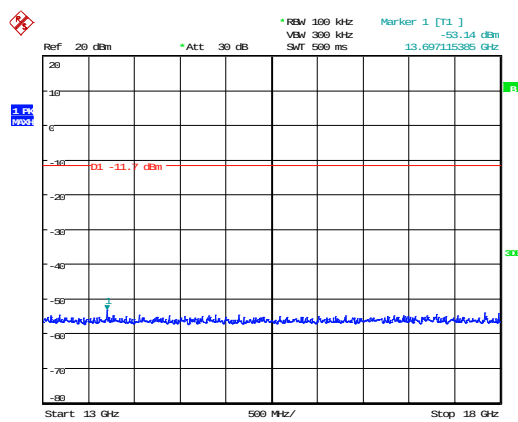
Date: 10.MAR.2016 07:32:03

4 GHz – 9 GHz



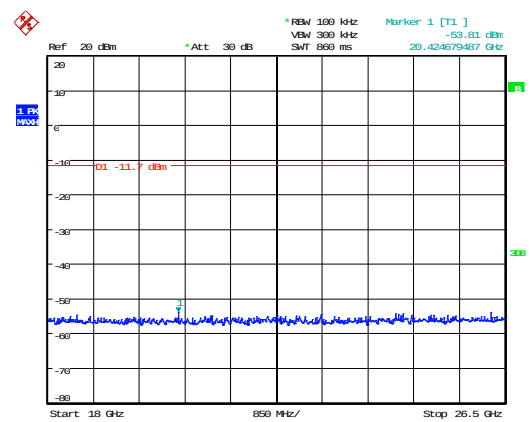
Date: 10.MAR.2016 07:32:23

9 GHz – 13 GHz



Date: 10.MAR.2016 07:32:51

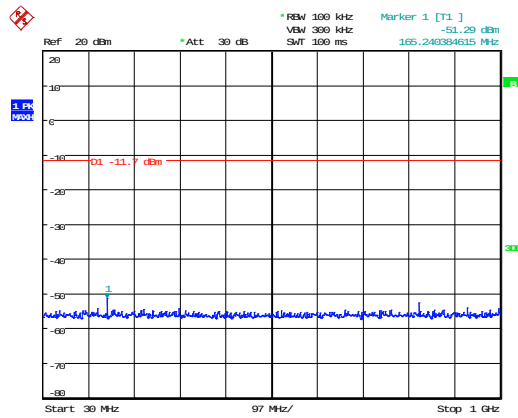
13 GHz – 18 GHz



Date: 10.MAR.2016 07:33:09

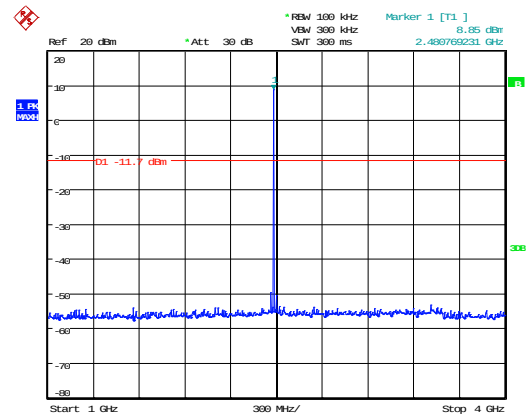
18 GHz – 26.5 GHz

Spurious emissions – 2480 MHz GFSK



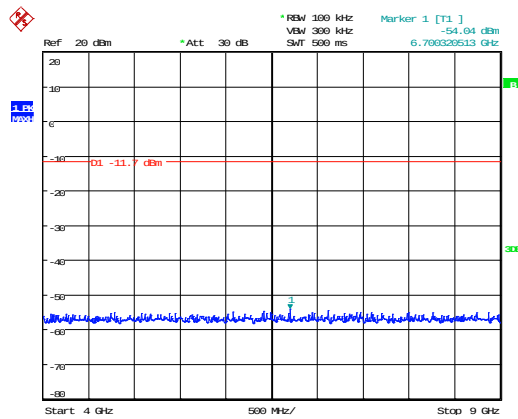
Date: 10.MAR.2016 07:34:12

30 MHz – 1 GHz



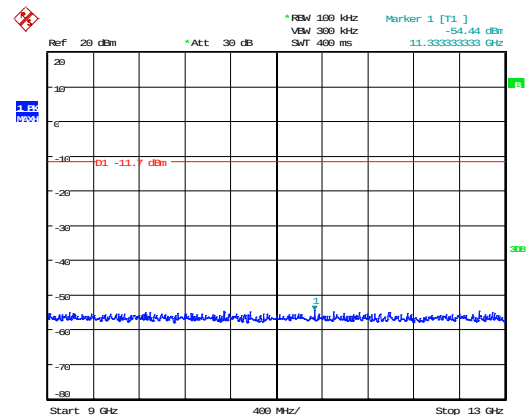
Date: 10.MAR.2016 07:34:32

1 GHz – 4 GHz



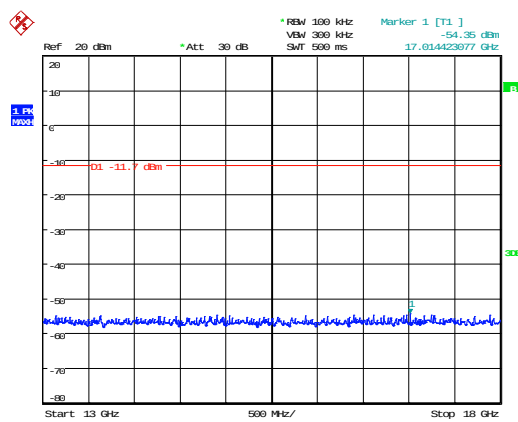
Date: 10.MAR.2016 07:34:48

4 GHz – 9 GHz



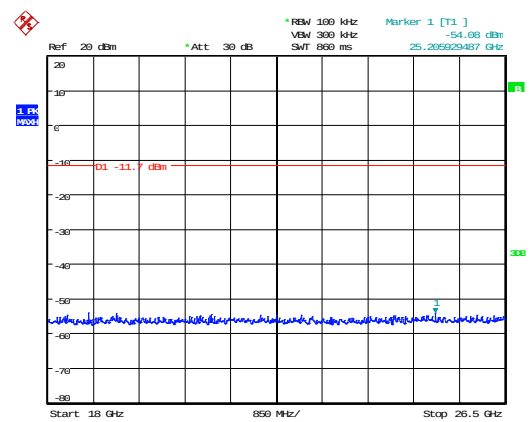
Date: 10.MAR.2016 07:35:03

9 GHz – 13 GHz



Date: 10.MAR.2016 07:35:19

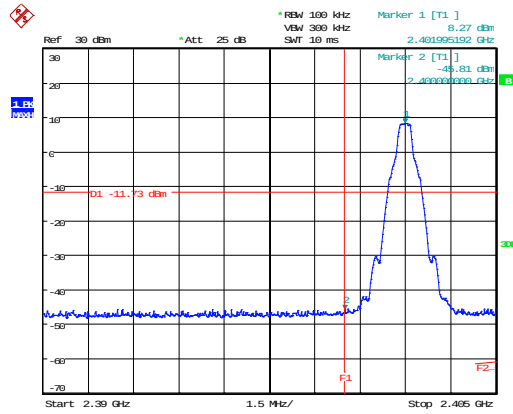
13 GHz – 18 GHz



Date: 10.MAR.2016 07:35:44

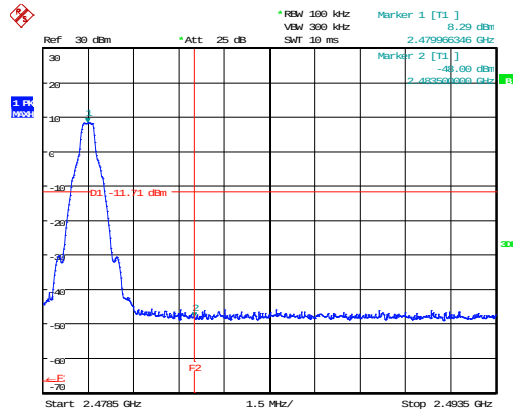
18 GHz – 26.5 GHz

Out-of-band Emissions - GFSK



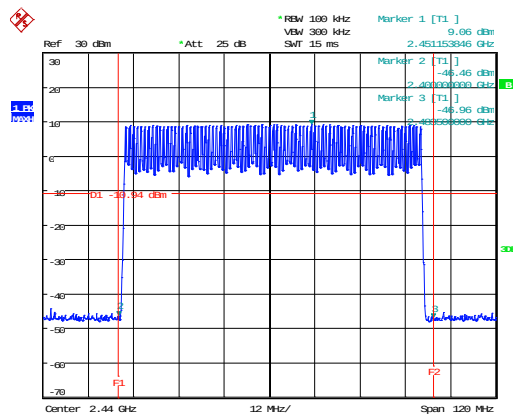
Date: 9.MAR.2016 12:59:48

Conducted Lower Bandedge – Non-hopping



Date: 9.MAR.2016 13:33:25

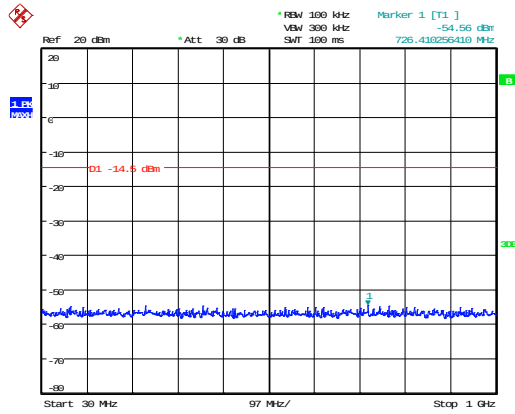
Conducted Upper Bandedge – Non-hopping



Date: 9.MAR.2016 12:17:32

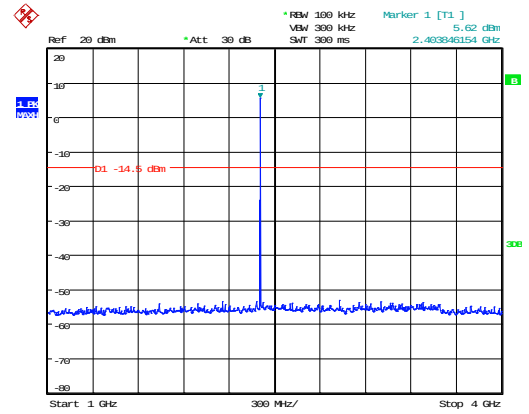
Conducted Upper Bandedge – Hopping

Spurious emissions – 2402 MHz QPSK



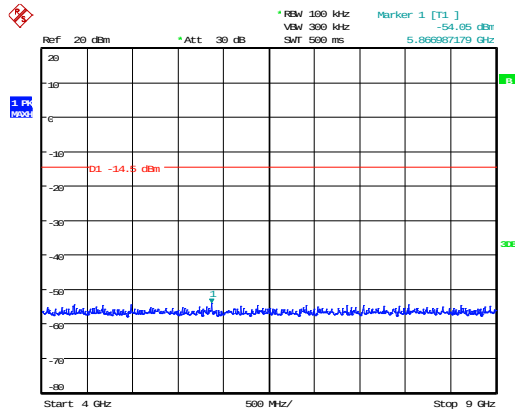
Date: 10.MAR.2016 07:38:34

30 MHz – 1 GHz



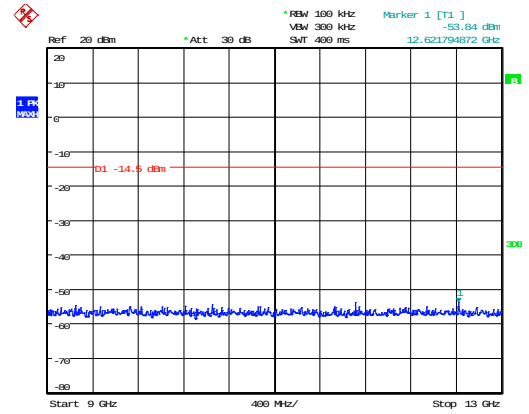
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1 GHz – 4 GHz



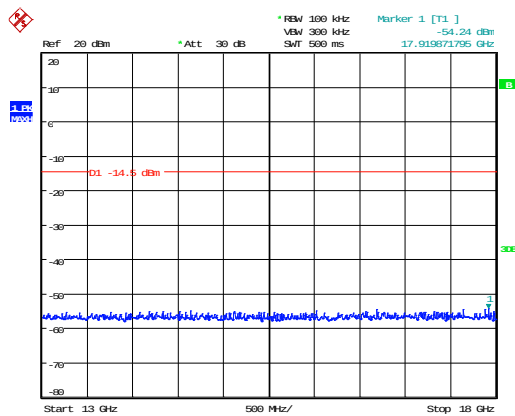
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4 GHz – 9 GHz



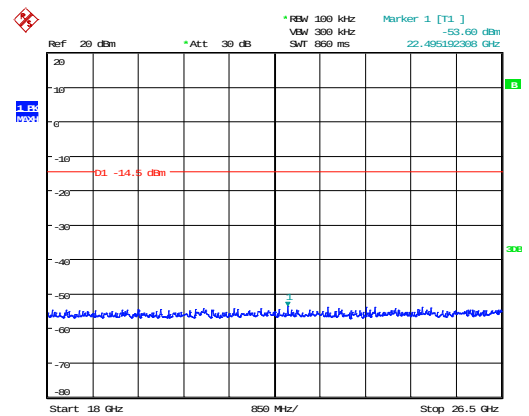
Date: 10.MAR.2016 07:39:19

9 GHz – 13 GHz



Date: 10.MAR.2016 07:39:35

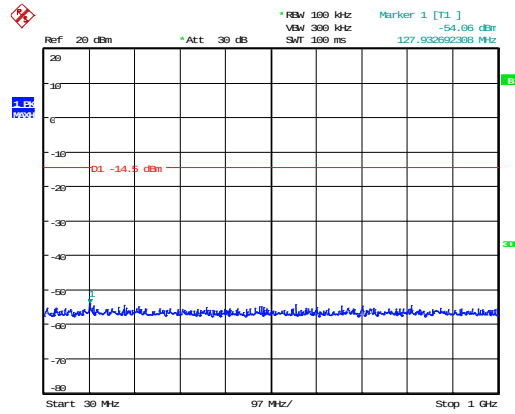
13 GHz – 18 GHz



Date: 10.MAR.2016 07:40:07

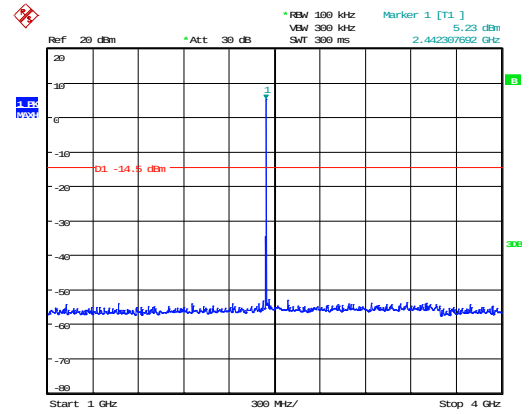
18 GHz – 26.5 GHz

Spurious emissions – 2441 MHz QPSK



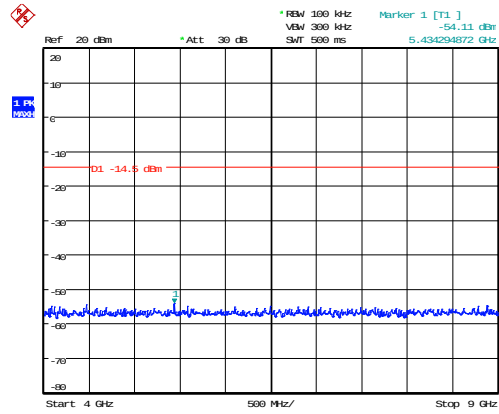
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30 MHz – 1 GHz



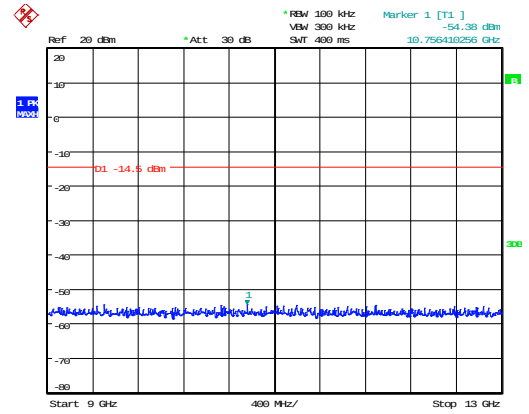
Date: 10.MAR.2016 07:42:02

1 GHz – 4 GHz



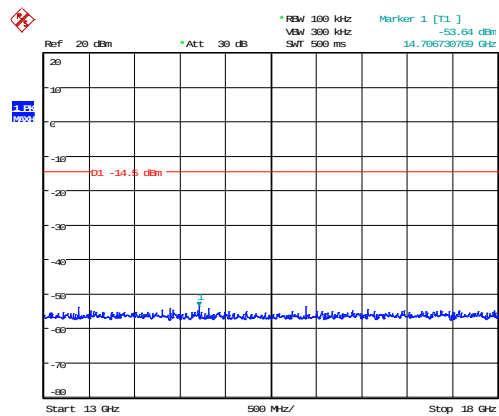
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4 GHz – 9 GHz



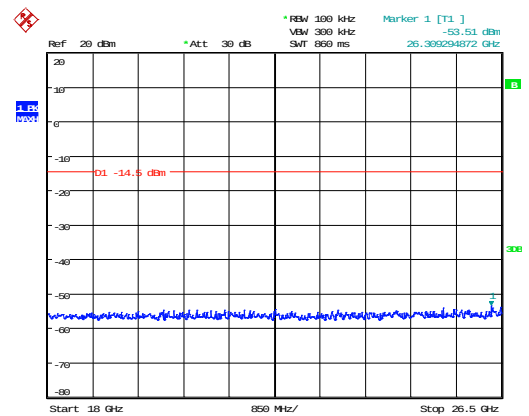
Date: 10.MAR.2016 07:42:27

9 GHz – 13 GHz



Date: 10.MAR.2016 07:42:48

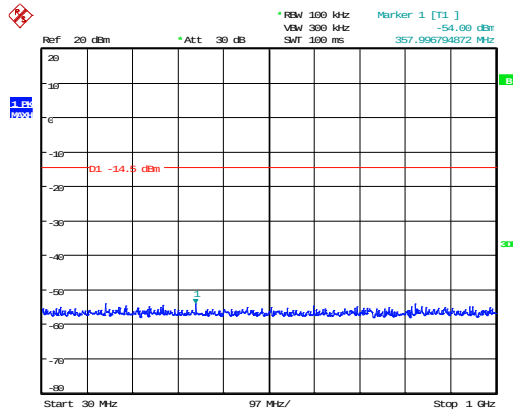
13 GHz – 18 GHz



Date: 10.MAR.2016 07:43:06

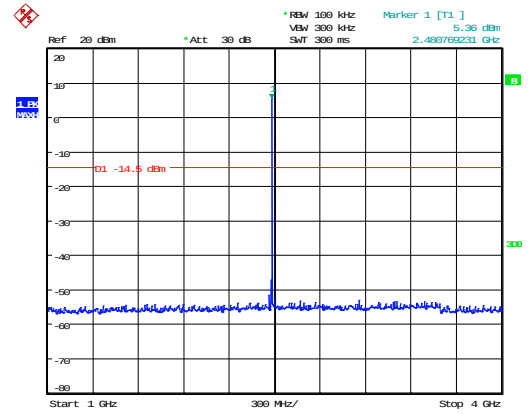
18 GHz – 26.5 GHz

Spurious emissions – 2480 MHz QPSK



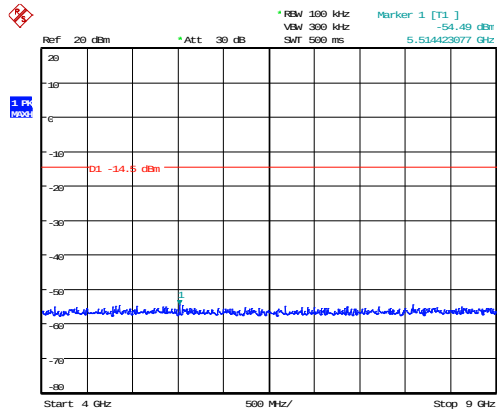
Date: 10.MAR.2016 07:43:32

30 MHz – 1 GHz



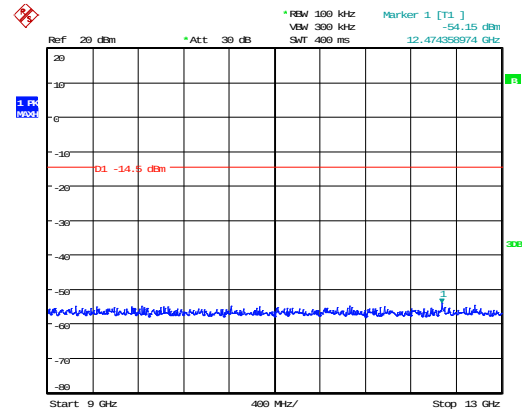
Date: 10.MAR.2016 07:44:20

1 GHz – 4 GHz



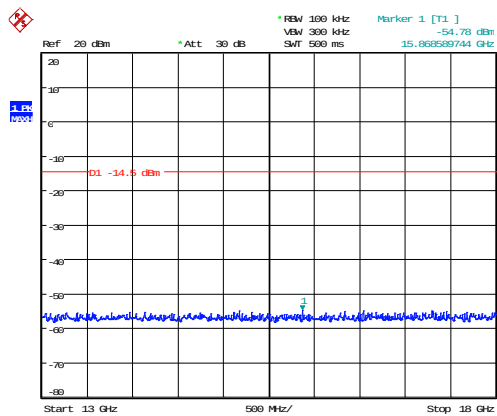
Date: 10.MAR.2016 07:47:35

4 GHz – 9 GHz



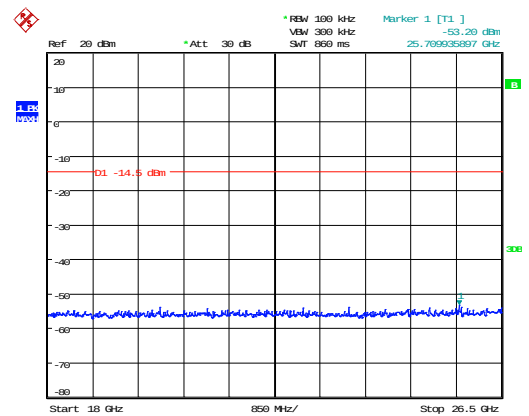
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9 GHz – 13 GHz



Date: 10.MAR.2016 07:45:00

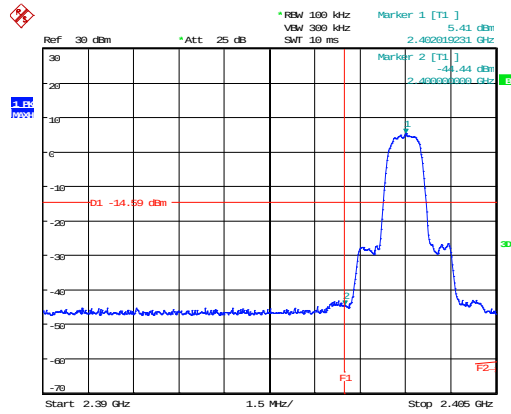
13 GHz – 18 GHz



Date: 10.MAR.2016 07:47:19

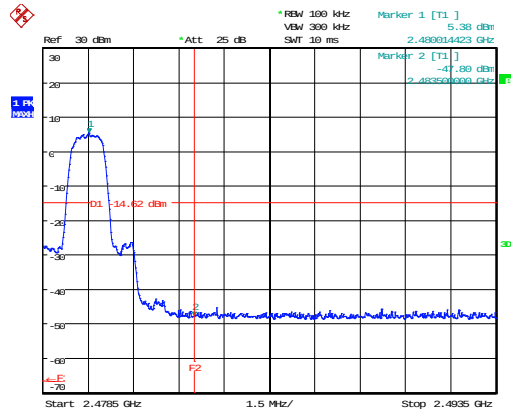
18 GHz – 26.5 GHz

Out-of-band Emissions - QPSK



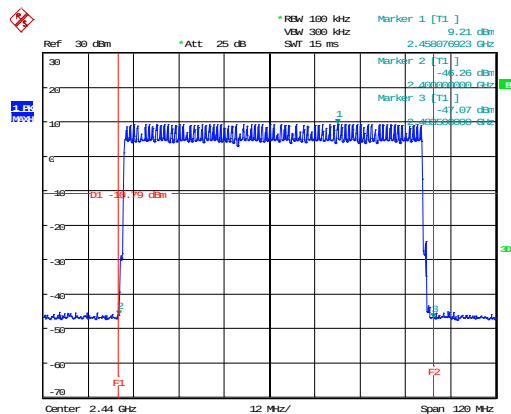
Date: 9.MAR.2016 13:14:36

Conducted Lower Bandedge – Non-hopping



Date: 9.MAR.2016 13:38:27

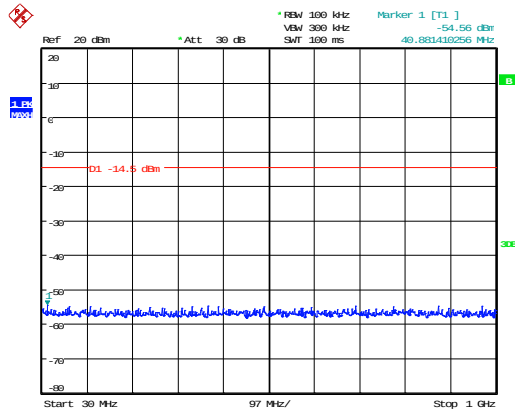
Conducted Upper Bandedge – Non-hopping



Date: 9.MAR.2016 12:54:35

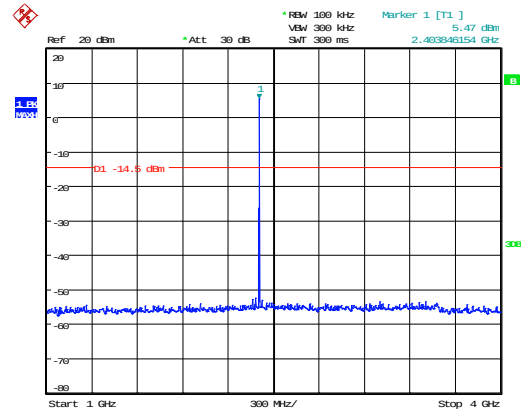
Conducted Upper Bandedge – Hopping

Spurious emissions – 2402 MHz 8PSK



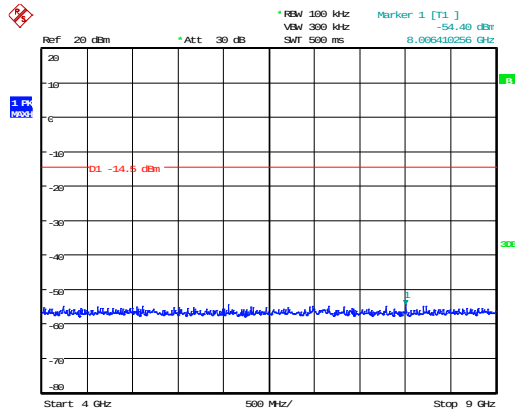
Date: 10.MAR.2016 07:51:56

30 MHz – 1 GHz



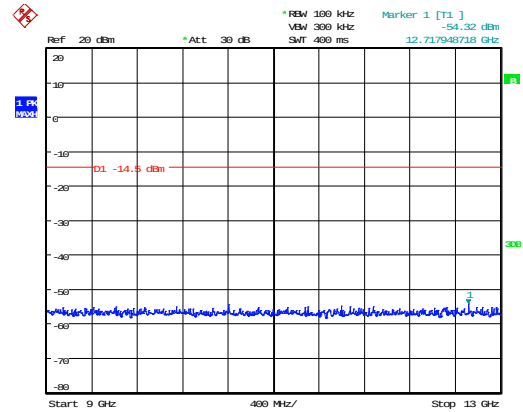
Date: 10.MAR.2016 07:51:43

1 GHz – 4 GHz



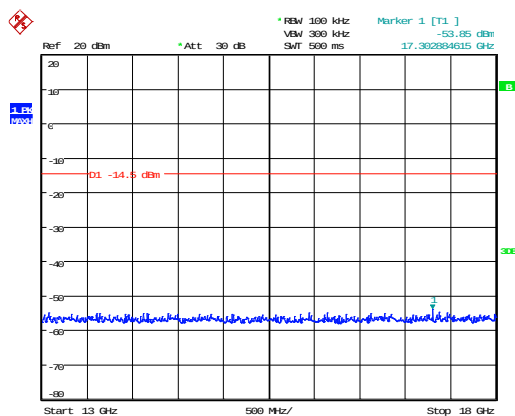
Date: 10.MAR.2016 07:52:08

4 GHz – 9 GHz



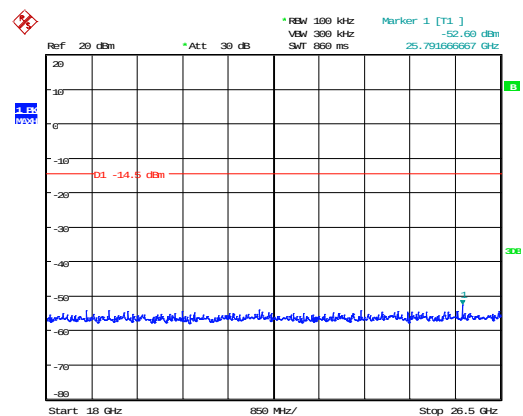
Date: 10.MAR.2016 07:52:20

9 GHz – 13 GHz



Date: 10.MAR.2016 07:52:34

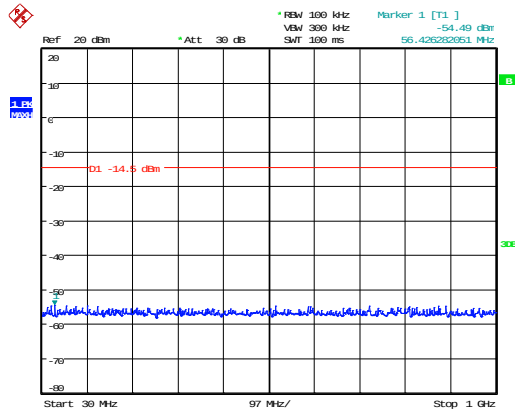
13 GHz – 18 GHz



Date: 10.MAR.2016 07:52:48

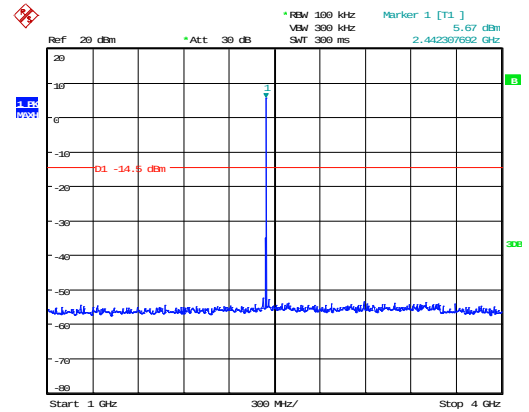
18 GHz – 26.5 GHz

Spurious emissions – 2441 MHz 8PSK



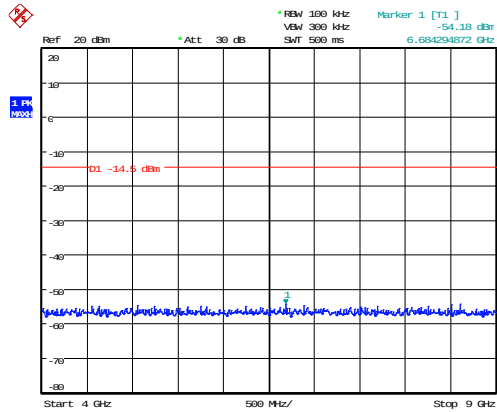
Date: 10.MAR.2016 07:53:18

30 MHz – 1 GHz



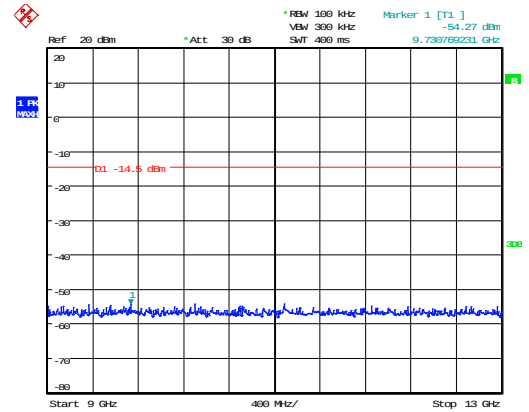
Date: 10.MAR.2016 07:53:43

1 GHz – 4 GHz



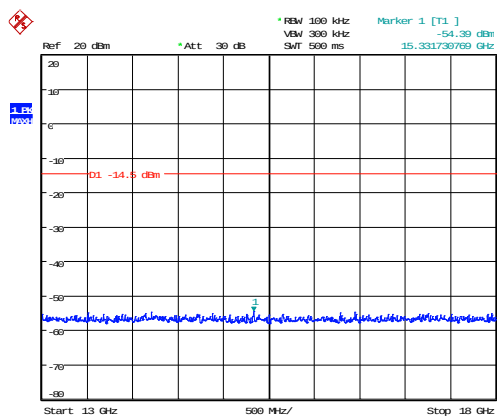
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4 GHz – 9 GHz



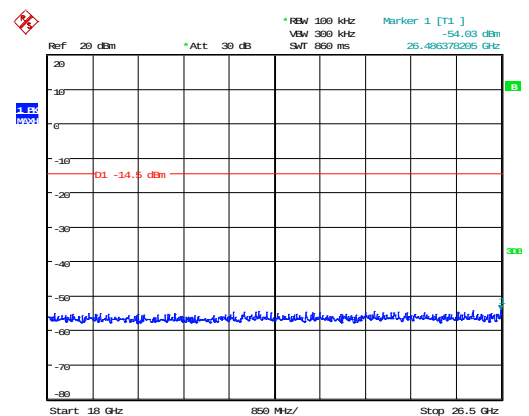
Date: 10.MAR.2016 07:54:13

9 GHz – 13 GHz



Date: 10.MAR.2016 07:54:27

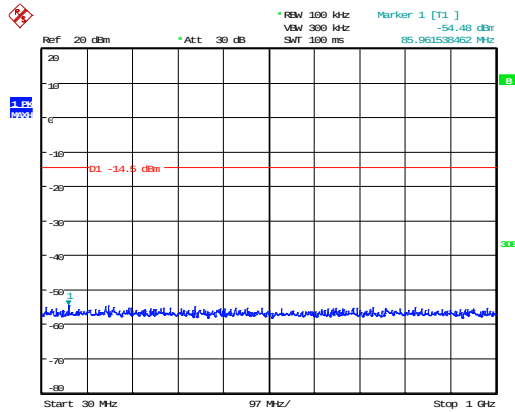
13 GHz – 18 GHz



Date: 10.MAR.2016 07:54:41

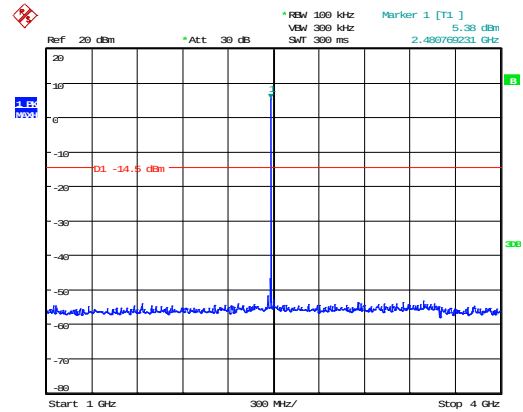
18 GHz – 26.5 GHz

Spurious emissions – 2480 MHz 8PSK



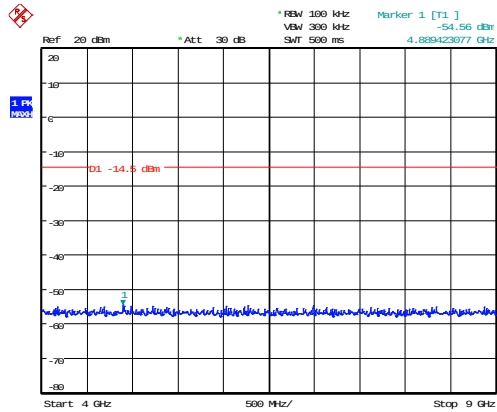
Date: 10.MAR.2016 07:55:21

30 MHz – 1 GHz



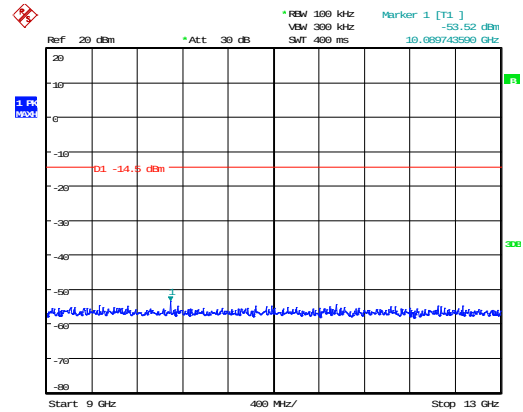
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1 GHz – 4 GHz



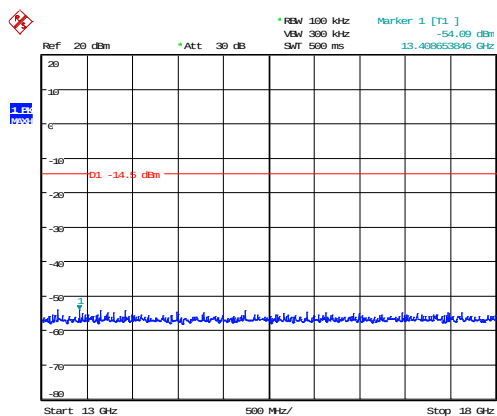
Date: 10.MAR.2016 07:55:59

4 GHz – 9 GHz



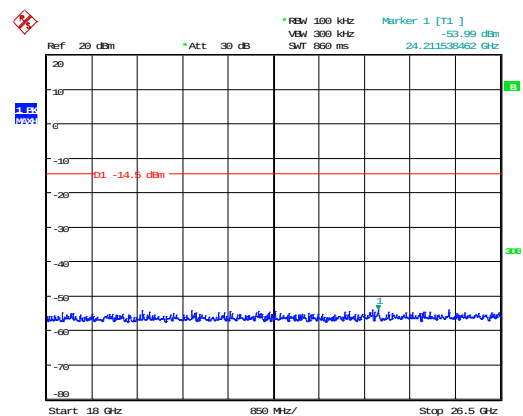
Date: 10.MAR.2016 07:56:29

9 GHz – 13 GHz



Date: 10.MAR.2016 07:56:33

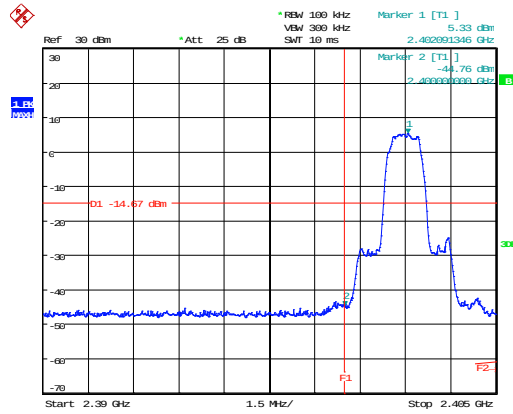
13 GHz – 18 GHz



Date: 10.MAR.2016 07:56:49

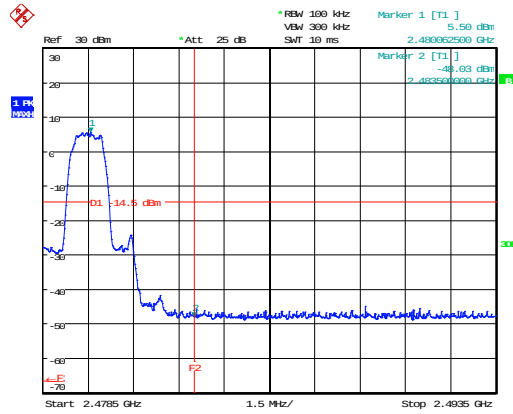
18 GHz – 26.5 GHz

Out-of-band Emissions - 8PSK



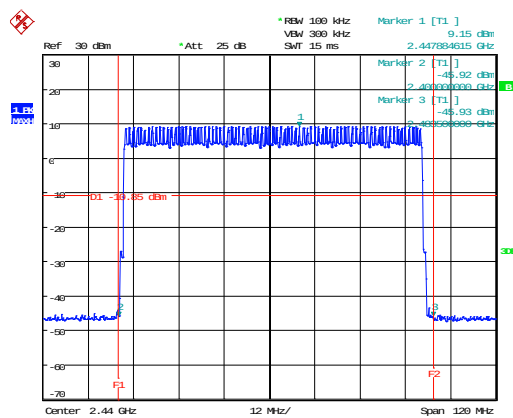
Date: 9.MAR.2016 13:19:23

Conducted Lower Bandedge – Non-hopping



Date: 9.MAR.2016 13:31:48

Conducted Upper Bandedge – Non-hopping



Date: 9.MAR.2016 12:42:29

Conducted Upper Bandedge – Hopping

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] Frequency separation

Uncertainty in test result (Spectrum Analyser) = **3.6 kHz**

[7] Accumulated channel occupancy time

Uncertainty in test result = **7.98 %**

19 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

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

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) = 50 mm (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.

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

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 50 mm.

Operating Frequency 2.402 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.402}] \\ \text{SARET} &= 96.8 \text{ mW} \end{aligned}$$

Operating Frequency 2.441 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.441}] \\ \text{SARET} &= 96.0 \text{ mW} \end{aligned}$$

Operating Frequency 2.480 GHz

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.480}] \\ \text{SARET} &= 95.3 \text{ mW} \end{aligned}$$

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
2402	12.0	96.8	Not Required
2441	12.5	96.0	Not Required
2480	12.0	95.3	Not Required

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

MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \text{ re - arranged } R = \sqrt{\frac{EIRP}{S 4\pi}}$$

Where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Result

Prediction Frequency (MHz)	EIRP (mW)	Power density limit (S) (mW/cm ²)	Distance (R) cm required to be less than the power density limit
2441	12.5	1.00	0.998