Report on the Radio Testing

For

Widex A/S

on

Widex Beyond Fusion2 (Model. B-F2)

Report no. TRA-029062-01-45-04B

5th April 2016

Report Number: TRA-029062-01-45-04B
Issue: A

REPORT ON THE RADIO TESTING OF A
Widex A/S
Widex Beyond Fusion2 (Model. B-F2)
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: 09 February - 28 March 2016

Written by: A Tosif — A Tosif, Radio Test Engineer

Approved by: John Charters — J Charters, Department Manager- Radio

Digitally signed by John Charters
DN: cn=John Charters, o=Element Materials Technology, ou, email=john.charters@element.com, c=GB
Date: 2016.04.05 16:27:40 +01'00'

Date: 5th April 2016

Element Materials Technology Warwick Ltd.
Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	5th April 2016	Original
B	5th April 2016	AV and PK limit in the tables updated

2 Summary

TEST REPORT NUMBER:	TRA-029062-01-45-04B
WORKS ORDER NUMBER:	TRA-029062-01
PURPOSE OF TEST:	Certification
TEST SPECIFICATION(S):	47CFR15.247 & RSS-247
EQUIPMENT UNDER TEST (EUT):	Widex Beyond Fusion2 (Model. B-F2)
FCC IDENTIFIER:	TTY-BF2
IC IDENTIFIER:	5676B-BF2
EUT SERIAL NUMBER:	123001, 123007 & 123009
MANUFACTURER/AGENT:	Widex A/S
ADDRESS:	Nymoellevej 6 3540 Lynge Denmark
CLIENT CONTACT:	Hans-Otto Bindeballe ☎ +45 44355916 ✉ hob@widex.com
ORDER NUMBER:	132470-1
TEST DATE:	09 February - 28 March 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 emissions – unintentional radiation / receiver emissions		Gen, 7.1.2	15.109	☒	*Pass*
AC power line conducted emissions		Gen, 8.8	15.207	☐	*N/A**
Occupied bandwidth		247, 5.2 (1)	15.247(a)(2)	☒	*Pass*
Conducted carrier power	Peak	247, 5.4 (4)	15.247(b)(3)	☒	*Pass*
	Max.			☐	
Conducted / radiated RF power out-of-band		247, 5.5	15.247(d)	☒	*Pass*
Power spectral density, conducted		247, 5.2 (2)	15.247(e)	☒	*Pass*
Calculation of duty correction		-	15.35(c)	☒	*Pass*

*EUT is a battery powered device.

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

4 Introduction

This report TRA-029062-01-45-04B presents the results of the Radio testing on a Widex A/S, Widex Beyond Fusion2 (Model. B-F2) 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 Widex A/S 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

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

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: Widex Beyond Fusion2 (Model. B-F2)
- Serial Number: 123001, 123007 & 123009
- Model Number: B-F2
- Software Revision: 0.90
- Build Level / Revision Number: P1

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows.

EUT transmitting permanent modulated carrier at bottom, middle and top channels.

7.3.2 Reception

The mode of operation for Rx tests was as follows.

EUT in permanent receive mode at bottom, middle and top channels.

7.4 EUT Radio Parameters

Frequency of operation:	2400 – 2483.5 MHz
Modulation type(s):	GFSK
Channel bandwidth(s):	2 MHz
Channel spacing:	2 MHz
Antenna type(s) and gain(s):	Integral
Nominal Supply Voltage:	1.25 Vdc

7.5 EUT Description

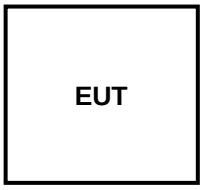
The EUT is a hearing aid and it contains two radios; a 10.6 MHz and a 2.4 GHz Bluetooth Low Energy. This report only covers the Bluetooth LE radio.

8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

The following diagram shows basic EUT interconnections.



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. 1.25 Vdc.

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 Occupied Bandwidth

11.1 Definition

The emission bandwidth (-6 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 6 dB below the maximum in-band spectral density of the modulated signal.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	IC: ANSI C63.10-2013, Clause 6.9 FCC: ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW:	300 kHz
Measurement Span:	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.25 Vdc	New Battery

11.3 Test Limit

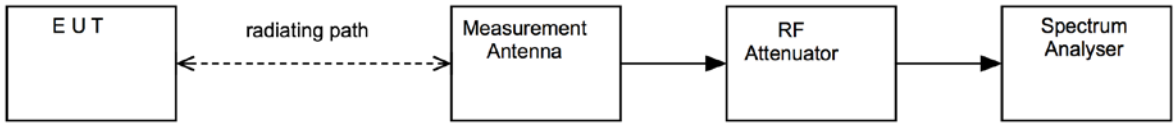
The minimum -6 dB bandwidth shall be at least 500 kHz.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

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

Figure iii Test Setup



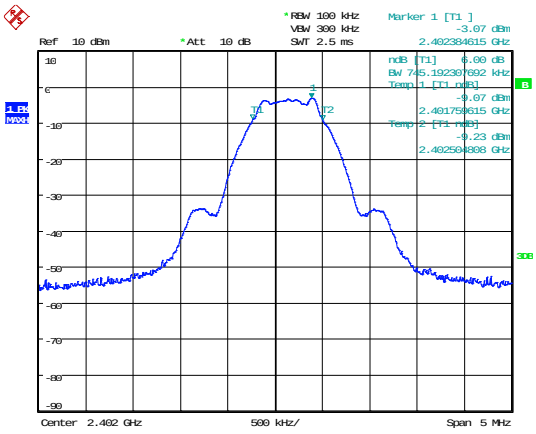
11.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2014	24	21/07/2016
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
Spectrum Analyser	R&S	FSU46	REF910	28/05/2015	12	28/05/2016

11.6 Test Results

Channel Frequency (MHz)	*F_L (MHz)*	*F_H (MHz)*	*6dB Bandwidth (kHz)*	*Result*
2402	2401.759615	2402.504808	745.193	PASS
2440	2439.647436	2440.384615	737.179	PASS
2480	2479.763462	2480.508654	745.192	PASS

Occupied Bandwidth



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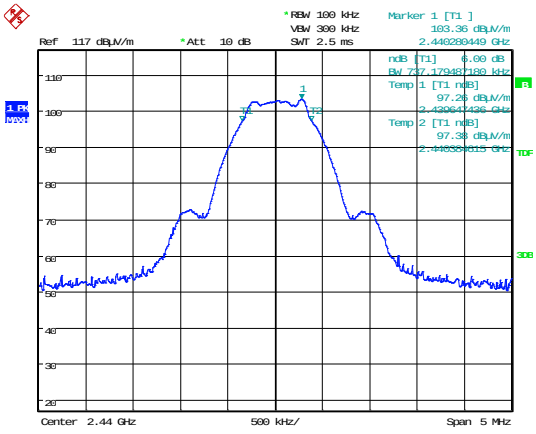
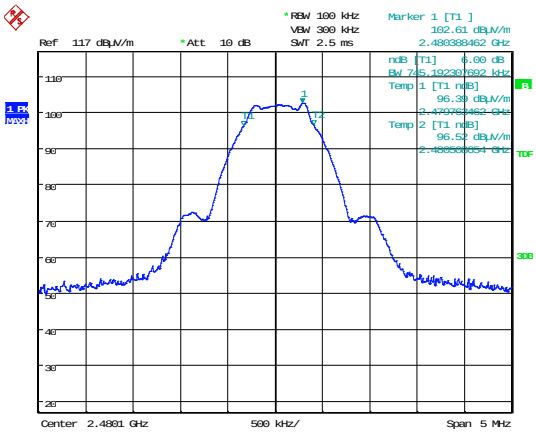
2402 MHz



Date: 28.MAR.2016 09:39:08

2440 MHz



Date: 9.FEB.2016 15:08:19

2480 MHz

12 Maximum peak conducted output power

12.1 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.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
EUT Channel Bandwidths:	2 MHz
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)

12.3 Test Limit

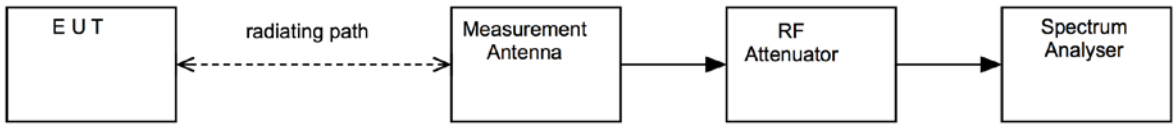
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

12.4 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



12.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2014	24	21/07/2016
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
Spectrum Analyser	R&S	FSU46	REF910	28/05/2015	12	28/05/2016

12.6 Test Results

The following formula was used to convert field strength (FS) in volts/metre to transmitter output power (TP) in watts:

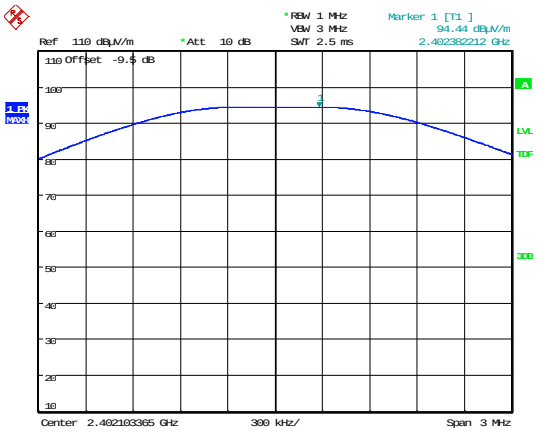
$$TP = (FS \times D)^2 / (30 \times G)$$

Where D is the distance in metres between the two antennas and G is the antenna numerical gain referenced to isotropic gain.

Channel Frequency (MHz)	*Peak Field Strength (dBµV/m)*	*Distance (m)*	*Numerical Antenna Gain*	*Max. Power (W)*	*Result*
2402	94.44	3.00	1.00	0.00083	PASS
2440	94.76	3.00	1.00	0.00090	PASS
2480	94.00	3.00	1.00	0.00075	PASS

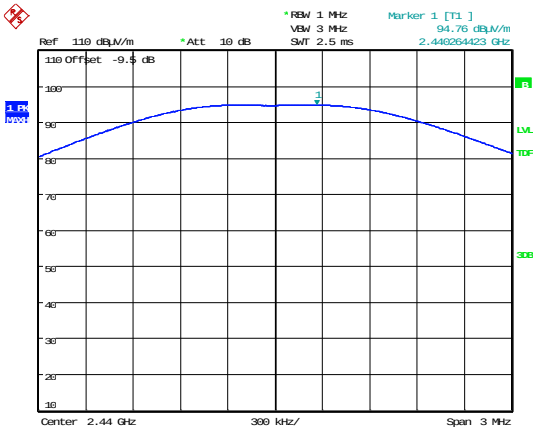
* Antenna gain is unknown, so numeric gain of an ideal isotropic antenna (i.e. 1) is used.

Maximum Peak Power



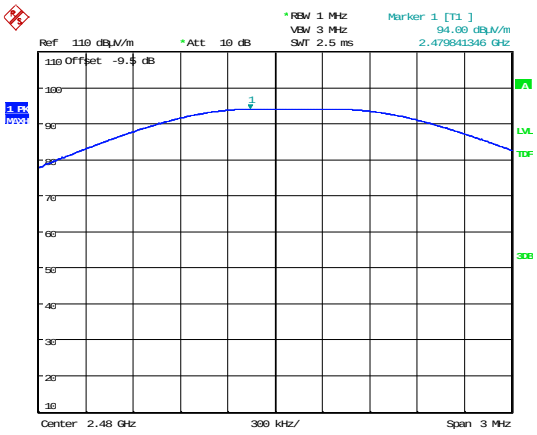
Date: 9.FEB.2016 14:33:10

2402 MHz



Date: 28.MAR.2016 09:36:34

2440 MHz



Date: 9.FEB.2016 15:03:12

2480 MHz

13 Power spectral density

13.1 Definition

The power per unit bandwidth.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	2402 MHz / 2440 MHz / 2480 MHz
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 Span: (requirement 1.5 times Channel BW)	1.1 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.25 Vdc	New Battery

13.3 Test Limit

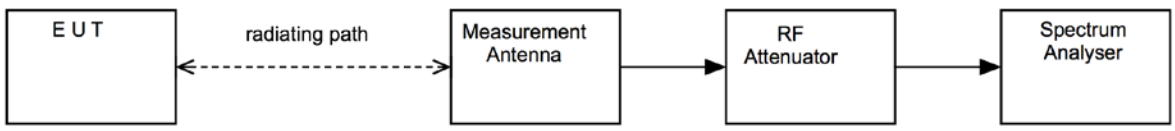
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

13.4 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



13.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2014	24	21/07/2016
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
Spectrum Analyser	R&S	FSU46	REF910	28/05/2015	12	28/05/2016

13.6 Test Results

The following formula was used to convert field strength (FS) in volts/metre to power spectral density (TP) in watts:

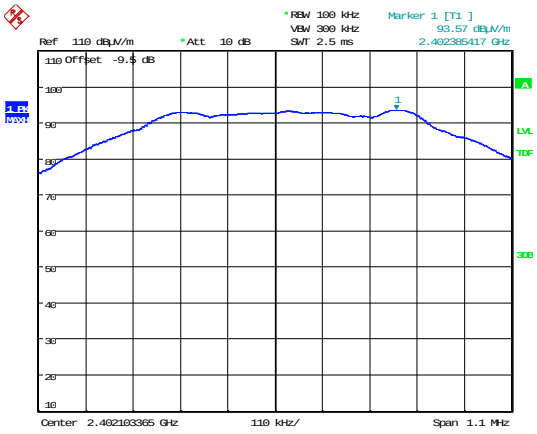
$TP = (FS \times D)^2 / (30 \times G)$

where D is the distance in meters between the two antennas and G is the antenna numerical gain referenced to isotropic gain.

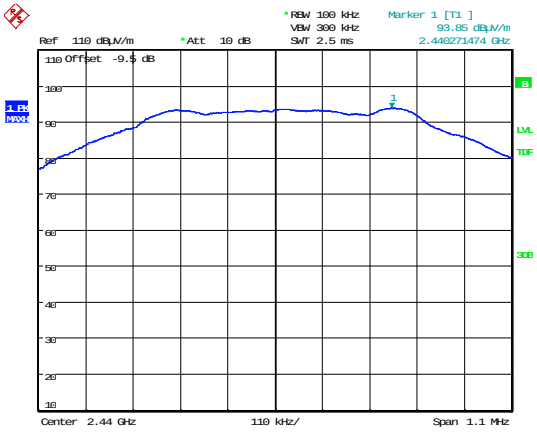
Channel Frequency (MHz)	*Peak Field Strength (dBµV/m)*	*Distance (m)*	*Numerical Antenna Gain*	*Max. Power Spectral Density (W)*	*Max. Power Spectral Density (dBm)*	*Result*
2402	93.6	3.0	1.0*	0.00068	-1.7	PASS
2440	93.9	3.0	1.0*	0.00073	-1.4	PASS
2480	93.1	3.0	1.0*	0.00061	-2.1	PASS

* Antenna gain is unknown, so numeric gain of an ideal isotropic antenna (i.e. 1) is used.

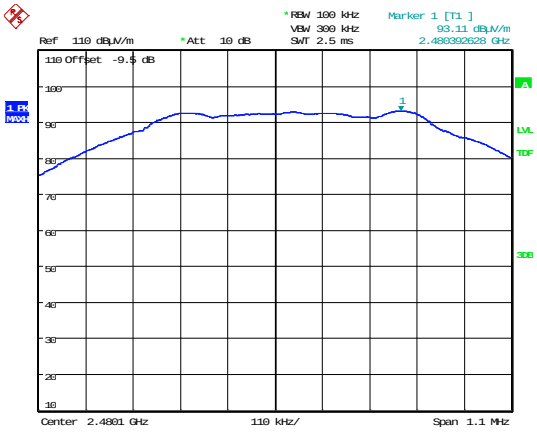
Power spectral density



2402 MHz



2440 MHz



2480 MHz

14 Out-of-band and 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.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

14.2 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 / 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: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.25 Vdc	New Battery

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. In addition, radiated emissions which fall in the restricted bands, as defined in FCC 47CFR15.205(a)/RSS-Gen, must also comply with the radiated emission limits specified in FCC 47CFR15.209(a)/RSS-Gen.

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

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

14.4 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:

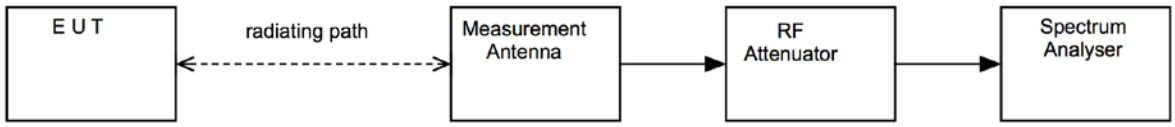
$$FS = PR + CL + AF – PA + DC – CF$$

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



14.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
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

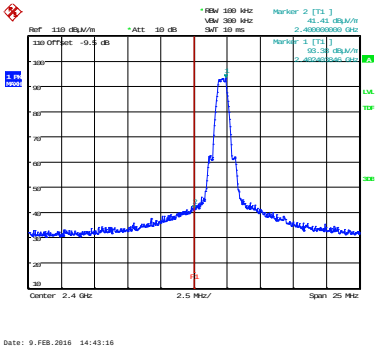
14.6 Test Results

Channel: 2402 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4804.0	50.2	7.7	33.0	34.6	n/a	-9.5	46.8	218.8	500.0
PK	7206.0	62.5	11.2	35.9	34.8	n/a	-9.5	65.3	1840.8	5000.0
AV	7206.0	62.5	11.2	35.9	34.8	-20.0	-9.5	45.3	184.1	500.0
PK	9608.0	58.0	15.0	37.9	35.3	n/a	-9.5	66.1	2018.4	5000.0
AV	9608.0	58.0	15.0	37.9	35.3	-20.0	-9.5	46.1	201.8	500.0

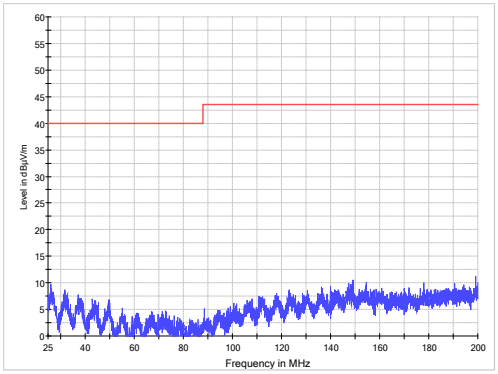
Channel: 2440 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4880.0	48.6	9.2	33.2	34.6	n/a	-9.5	46.9	221.3	500.0
PK	7320.0	64.2	11.3	36.2	34.8	n/a	-9.5	67.4	2344.2	5000.0
AV	7320.0	64.2	11.3	36.2	34.8	-20.0	-9.5	47.4	234.4	500.0
PK	9760.0	59.3	14.2	37.9	35.3	n/a	-9.5	66.6	2138.0	5000.0
AV	9760.0	59.3	14.2	37.9	35.3	-20.0	-9.5	46.6	213.8	500.0

Channel: 2480 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4960.0	47.1	10.0	33.4	34.6	n/a	-9.5	46.5	211.3	500.0
PK	7440.0	63.9	11.4	36.4	34.8	n/a	-9.5	67.4	2344.2	5000.0
AV	7440.0	63.9	11.4	36.4	34.8	-20.0	-9.5	47.4	234.4	500.0
PK	9921.0	58.2	13.9	38.0	35.3	n/a	-9.5	65.3	1840.8	5000.0
AV	9921.0	58.2	13.9	38.0	35.3	-20.0	-9.5	45.3	184.1	500.0

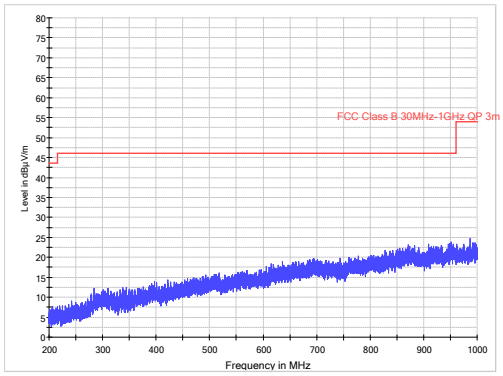
Transmitter Radiated Emissions – 2402 MHz



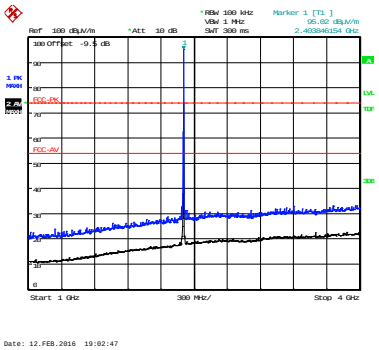
Lower Band Edge



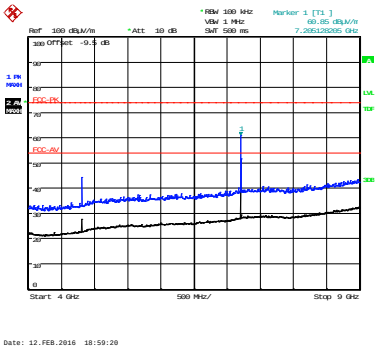
25 MHz – 200 MHz



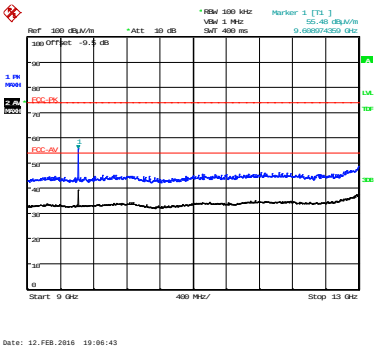
200 MHz – 1 GHz



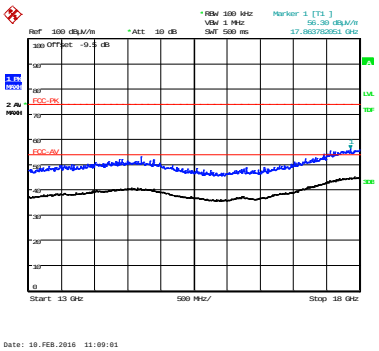
1 GHz – 4 GHz



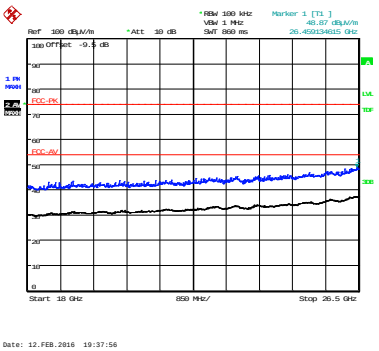
4 GHz – 9 GHz



9 GHz – 13 GHz

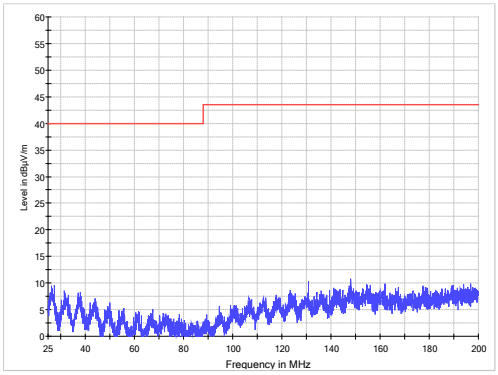


13 GHz – 18 GHz

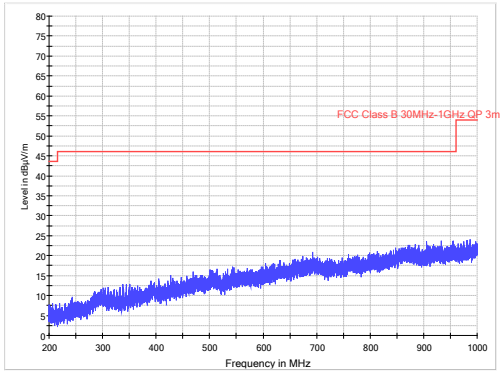


18 GHz – 26 GHz

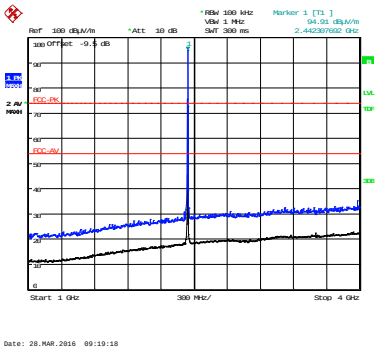
Transmitter Radiated Emissions – 2440 MHz



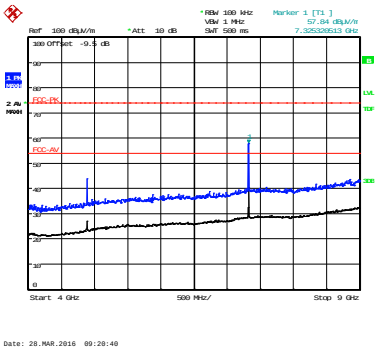
25 MHz – 200 MHz



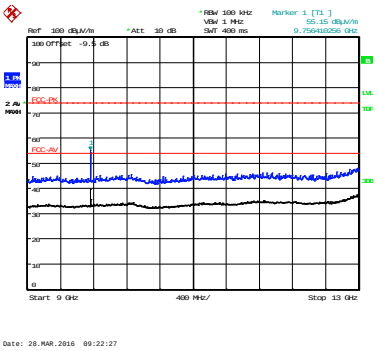
200 MHz – 1 GHz



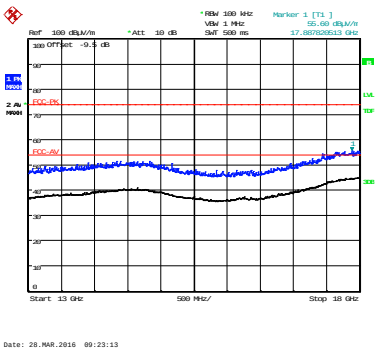
1 GHz – 4 GHz



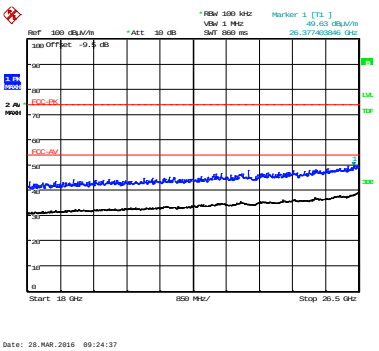
4 GHz – 9 GHz



9 GHz – 13 GHz

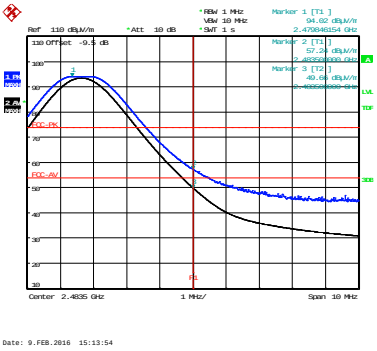


13 GHz – 18 GHz

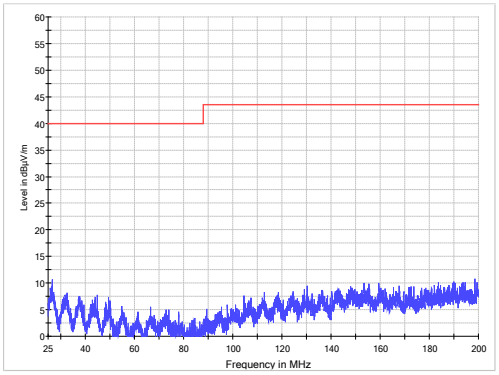


18 GHz – 26 GHz

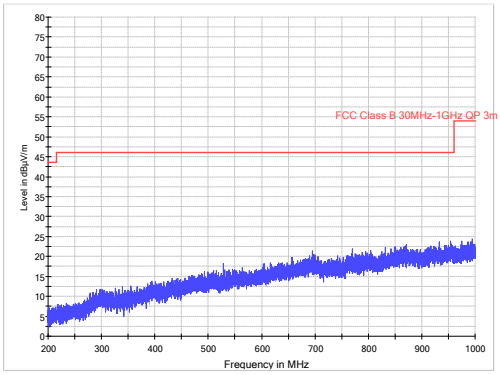
Transmitter Radiated Emissions – 2480 MHz



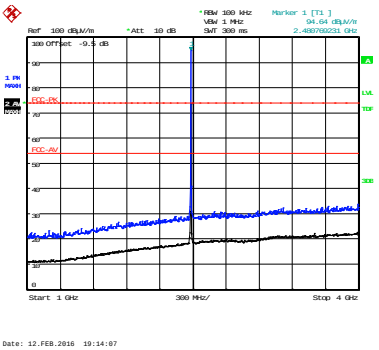
Lower Band Edge



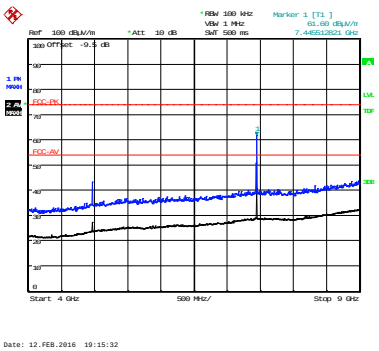
25 MHz – 200 MHz



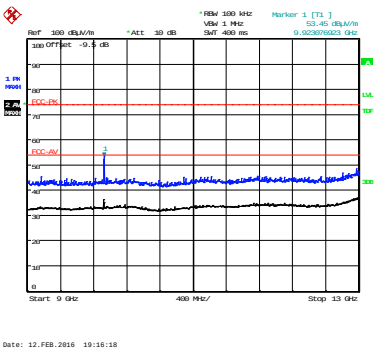
200 MHz – 1 GHz



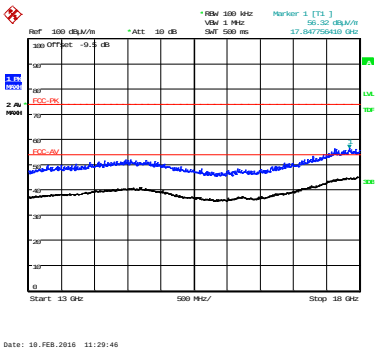
1 GHz – 4 GHz



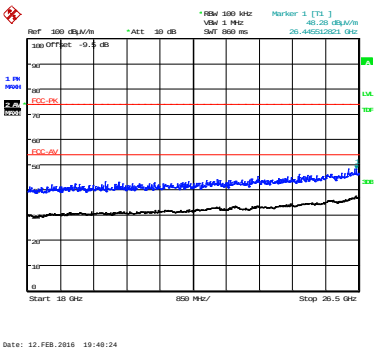
4 GHz – 9 GHz



9 GHz – 13 GHz



13 GHz – 18 GHz



18 GHz – 26 GHz

15 Radiated emissions – unintentional radiation / receiver emissions

15.1 Definitions

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

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

15.2 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 / 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: Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.25 Vdc	New Battery

15.3 Test Limit

Note:

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

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

Receiver Radiated Limits

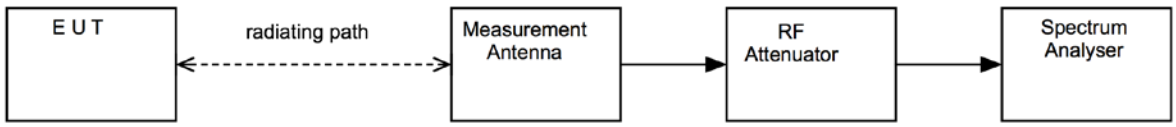
Frequency (MHz)	***Field Strength (µV/m at 3 m)***
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

15.4 Test Method

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

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency.
Pre-scan plots are shown with a peak detector and 100 kHz RBW.

Figure viii Test Setup



15.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
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

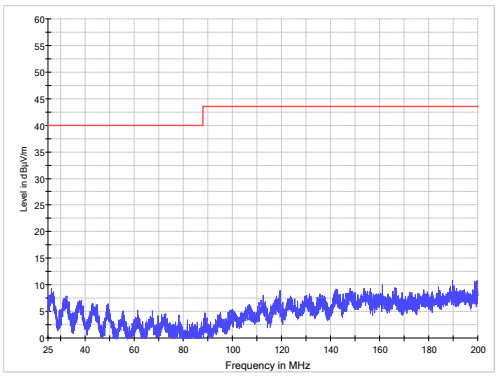
15.6 Test Results

Channel: 2402 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4806.2	37.7	7.5	33.0	34.6	n/a	-9.5	34.1	50.7	500.0

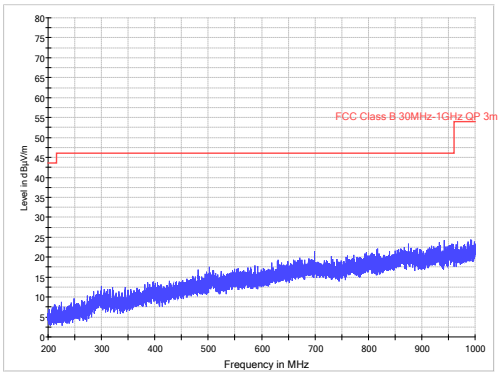
Channel: 2440 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4884.3	37.7	9.0	33.2	34.6	n/a	-9.5	35.8	61.7	500.0

Channel: 2480 MHz										
Emission	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
AV	4962.3	38.6	10.0	33.4	34.6	n/a	-9.5	37.9	78.5	500.0

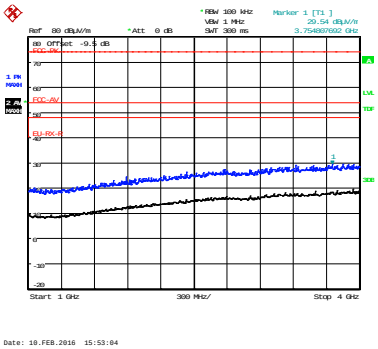
Unintentional Radiated Emissions – 2402 MHz



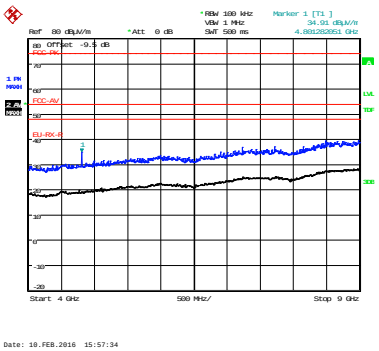
25 MHz – 200 MHz



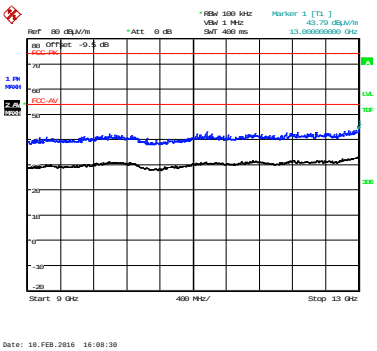
200 MHz – 1 GHz



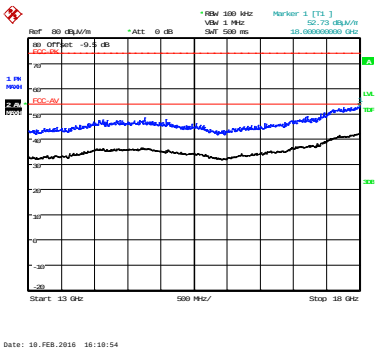
1 GHz – 4 GHz



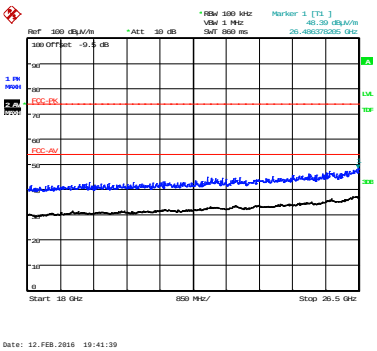
4 GHz – 9 GHz



9 GHz – 13 GHz

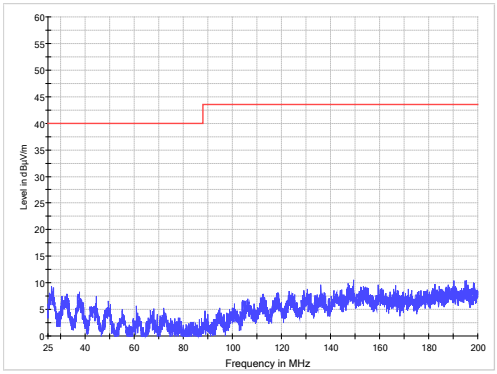


13 GHz – 18 GHz

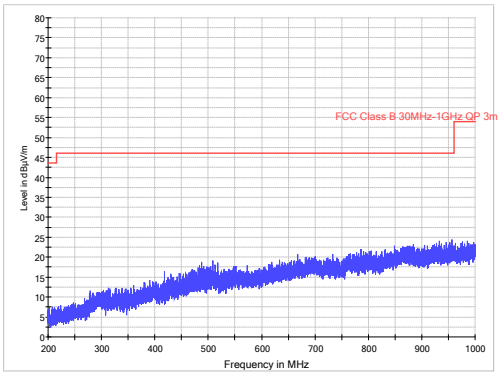


18 GHz – 26 GHz

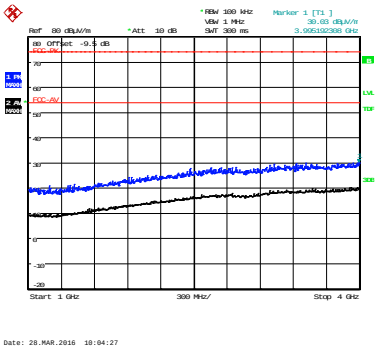
Unintentional Radiated Emissions – 2440 MHz



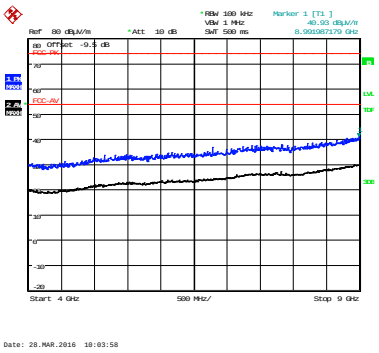
25 MHz – 200 MHz



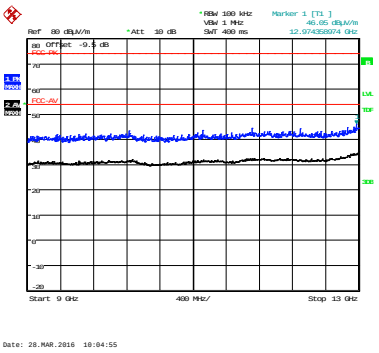
200 MHz – 1 GHz



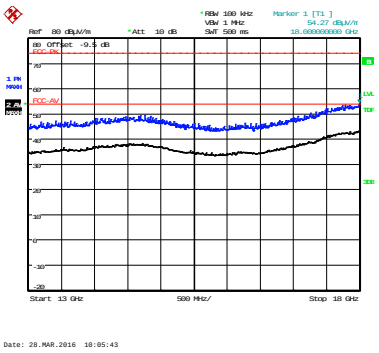
1 GHz – 4 GHz



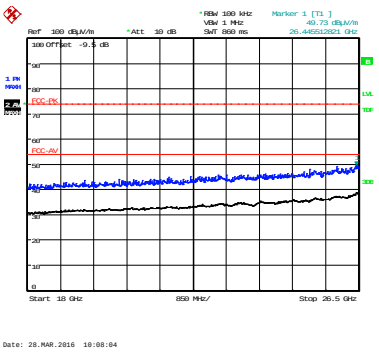
4 GHz – 9 GHz



9 GHz – 13 GHz

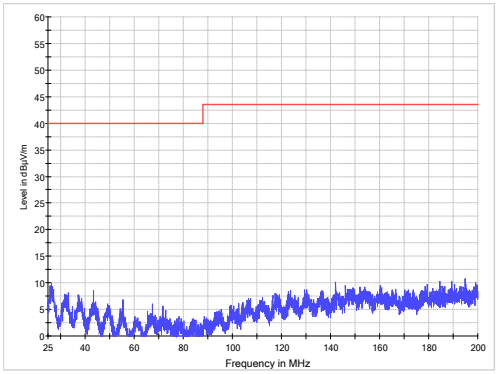


13 GHz – 18 GHz

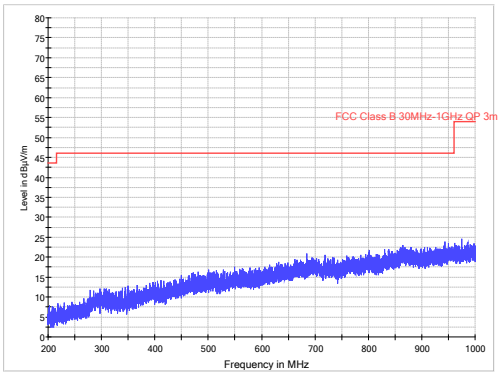


18 GHz – 26 GHz

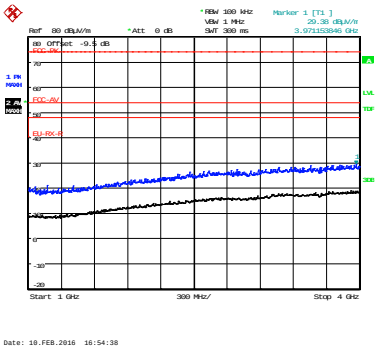
Unintentional Radiated Emissions – 2480 MHz



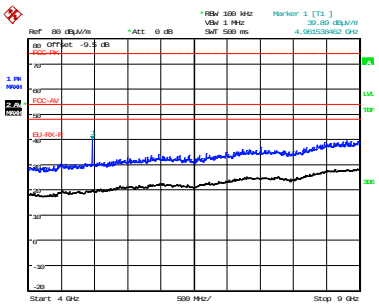
25 MHz – 200 MHz



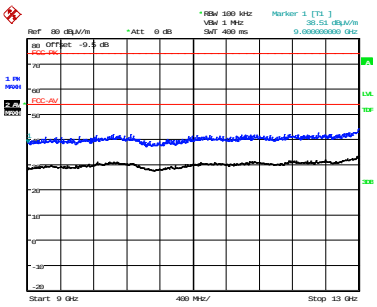
200 MHz – 1 GHz



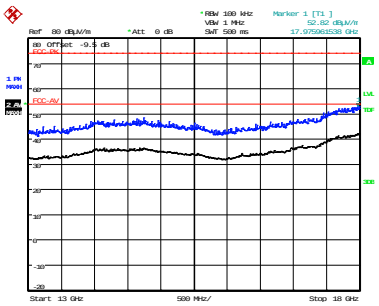
1 GHz – 4 GHz



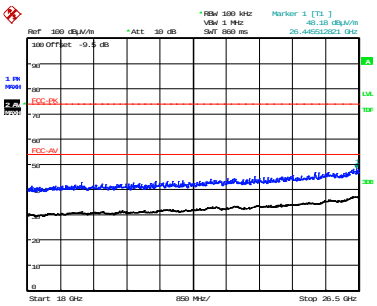
4 GHz – 9 GHz



9 GHz – 13 GHz



13 GHz – 18 GHz



18 GHz – 26 GHz

16 Duty Cycle

16.1 Definition

The ratio of the sum of all pulse durations to the total period, during a specified period of operation. The duty cycle is determined on the basis of one complete pulse train for pulse trains not exceeding 100 milliseconds. Where the pulse train exceeds 100 milliseconds, the duty cycle is determined on the basis of the 100 millisecond interval with the highest average value of emission.

16.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	REF886
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.5
EUT Channels / Frequencies Measured:	2402 MHz
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 28 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.25 Vdc	New Battery

16.3 Test Limit

N/A.
Note, the maximum duty cycle correction factor which may be used is 20 dB.

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the duty of the EUT was calculated from the sum of total on and off times over the observation period.

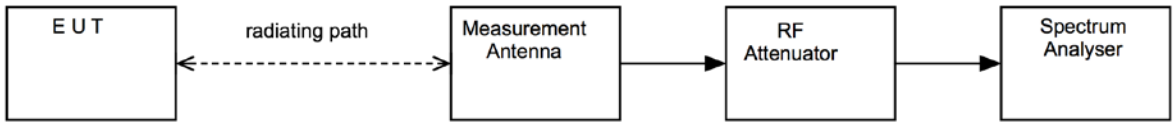
The measurements were performed with EUT set at its maximum duty. All modulation schemes, bandwidths, data rates and power settings were used to observe the worst-case configuration.

The duty cycle correction factor, DC, is used to adjust peak emissions (voltage) to give an average value and is calculated by:

$$DC = 20 \log (\text{duty ratio})$$

Where, duty ratio is total on-time divided by total off-time in the worst-case pulse train or 100 ms, whichever is longer.

Figure vii Test Setup



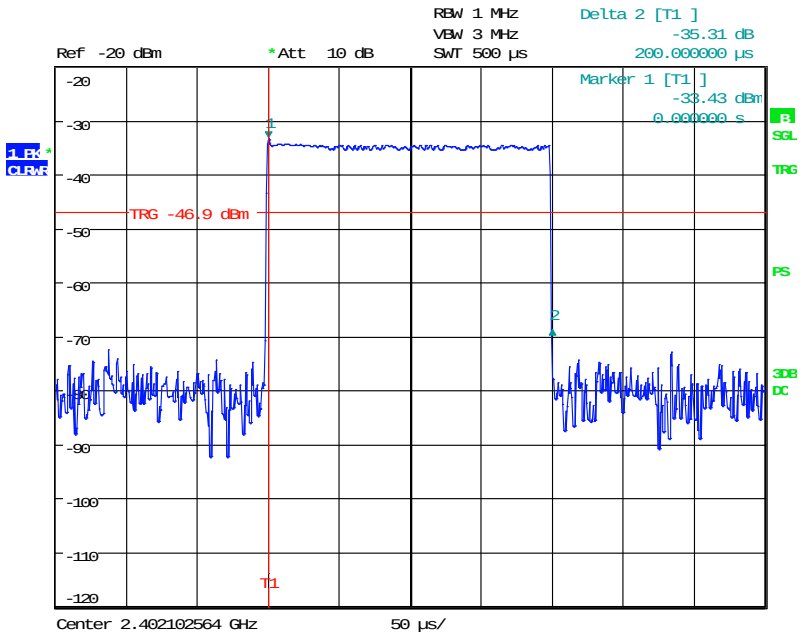
16.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	21/07/2014	24	21/07/2016
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
Spectrum Analyser	R&S	FSU46	REF910	28/05/2015	12	28/05/2016

16.6 Test Results

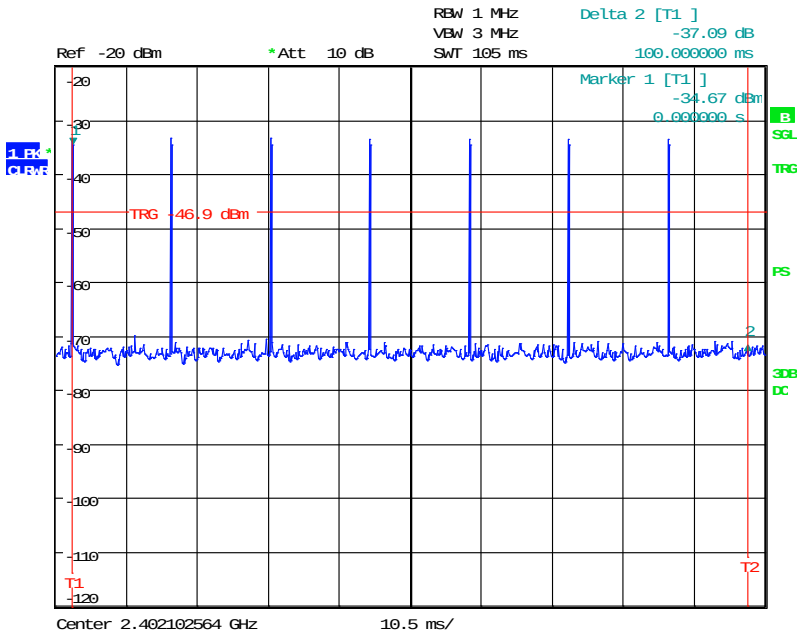
Frequency: 2402 MHz							
Test Environment		*Single Pulse TxOn time (ms)*	*Total number of pulses*	*Total TxOn time (ms)*	*Observation period (ms)*	*Duty (%)*	*Calculated Factor*
$V_{nominal}$	$T_{nominal}$	0.2	7	1.4	100.0	1.4	-37.1

Duty Cycle



Date: 27.FEB.2003 08:18:54

Single Pulse TxOn Time



Date: 27.FEB.2003 08:20:47

Total Number of Pulses in 100 ms

17 Measurement Uncertainty

Calculated Measurement Uncertainties

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

[1] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[2] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[4] Conducted carrier power

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

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

Uncertainty in test result – up to 8.1 GHz = **3.31 dB**
Uncertainty in test result – 8.1 GHz to 15.3 GHz = **4.43 dB**
Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[6] Power spectral density

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

18 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) * √ 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 x TSDA) / √ 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 2.402 GHz

SARET = [(3.0 x 5) / √2.402]
SARET = 9.68 mW

Operating Frequency 2.440 GHz

SARET = [(3.0 x 5) / √2.440]
SARET = 9.60 mW

Operating Frequency 2.480 GHz

SARET = [(3.0 x 5) / √2.480]
SARET = 9.53 mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
2402	0.83	9.68	Not Required
2440	0.90	9.60	Not Required
2480	0.75	9.53	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

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than the power density limit
2440	0.90	1.00	0.27

Note: EIRP is calculated from maximum radiated field strength.

19 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
2402	0.83	4.26	Not Required
2440	0.90	4.05	Not Required
2480	0.75	3.94	Not Required

Note: EIRP calculated from maximum radiated field strength.