Report on the Radio Testing

For

Inova Design Solutions Ltd (Bodytrak)

on

Bodytrack I

Report no. TRA-054222-47-11B

6th June 2022

Report Number: TRA-054222-47-11B
Issue: B

REPORT ON THE RADIO TESTING OF A
Inova Design Solutions Ltd (Bodytrak)
Bodytrack I
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 12th - 25th January 2022

Tested by: D Winstanley, M Else

Written by: D Winstanley
Radio Senior Test Engineer

Approved by: J Charters
Lab Manager

Date: 6th June 2022

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	1st February 2022	Original
B	6th June 2022	Photographs removed due to short term confidently requirement Model Number updated

2 Summary

TEST REPORT NUMBER:	TRA-054222-47-11B
WORKS ORDER NUMBER:	TRA-054222-01
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	Bodytrack I
FCC IDENTIFIER:	2A3CVA
EUT SERIAL NUMBER:	SE25082021
MANUFACTURER/AGENT:	Inova Design Solutions Ltd (Bodytrak)
ADDRESS:	86-90 Paul Street London EC2A 4NE United Kingdom
CLIENT CONTACT:	Dmitry Iakovlev ☎ +44 (0)203 432 5439 ✉ dmitry.iakovlev@bodytrak.co
ORDER NUMBER:	PO-0001
TEST DATE:	12th - 25th January 2022
TESTED BY:	D Winstanley Element

2.1 Test Summary

Test Method and Description		*Requirement Clause 47CFR15*	*Applicable to this equipment*	*Result / Note*
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.247 (d)	☒	*Pass*
AC power line conducted emissions		15.207	☐	*Note 1*
Occupied bandwidth		15.247 (a) (2)	☒	*Pass*
Conducted carrier power	Peak	15.247 (b) (3)	☒	*Pass*
	Max.		☐	
Out of band emissions		15.247 (d)	☒	*Pass*
Power spectral density		15.247 (e)	☒	*Pass*
Calculation of duty correction		-	☒	-

Specific Note:

1. The EUT has got a rechargeable battery, but as per client's declaration, it doesn't transmit while charging.

General 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-054222-47-11B presents the results of the Radio testing on a Inova Design Solutions Ltd (Bodytrak), Bodytrack I to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Inova Design Solutions Ltd (Bodytrak) by Element, at the address detailed below.

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

☐ Element Skelmersdale
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:
The test laboratory is accredited for the above sites under the following US-UK MRA, Designation numbers.

Element Hull	UK2007
Element Skelmersdale	UK2020

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.

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: Bodytrack I
- Serial Number: SE25082021
- Model Number: BCP1N
- Software Revision: 4119
- Build Level / Revision Number: Production

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

The EUT was programed with test modes that when enables caused the unit to transmit on the required channel with the detailed operating mode

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2412 MHz -2462 MHz
Modulation type(s):	DSSS, OFDM
Occupied channel bandwidth(s):	20 MHz
Channel spacing:	5 MHz
ITU emission designator(s):	GXW
Declared output power(s):	<20 dBm
Warning against use of alternative antennas in user manual (yes/no):	N/A integral antenna
Nominal Supply Voltage:	3.7 Vdc
Location of notice for license exempt use:	Label / user manual / both.

7.4.2 Antennas

Type:	Antennova SR4W035
Frequency range:	2.4 – 2.5 (GHz)
Impedance:	50 Ω
VSWR:	1.85:1
Gain:	3.5 dBi Peak
Polarisation:	Linear
Beam width:	Wideband
Connector type:	SMD
Length:	6.0mm
Weight:	4.0mm
Environmental limits:	-40°C to140°C
Mounting:	Soldered

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	Single
Fixed pt-pt operations (yes/no):	No
Installation manual advice on pt-pt operational restrictions (yes/no):	N/A
Fixed pt-mpt operations (yes/no):	No
Simultaneous tx (yes/no):	N/A

7.5 EUT Description

The EUT is a personal wearable device and is comprised of a miniature earpiece with integrated sensors connected to a torso-worn communication pack. The normal power source applied was 3.7 Vdc from internal Li-Po Rechargeable battery.

8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections:

9.2 General Set-up Photograph

No Photographs due to confidentiality requirement.

9.3 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5
Element Transmitter Bench Test
ETS Lindgren EMPower V1.0.4.2

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 3.7 Vdc from internal Li-Po Rechargeable battery.

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.

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 Vac +/-2 %	85 % and 115 %
☒	Battery	New battery	Fully Charged

11 Radiated emissions

11.1 Definitions

Spurious emissions
Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

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

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Chamber 01
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	2412 MHz, 2437 MHz & 2462 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: 16°C	+15 ºC to +35 ºC (as declared)
Humidity: 37 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	As declared

11.3 Test Limit

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

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

Frequency (MHz)	*Field Strength (µV/m at 3 m)*	*Field Strength (dBµV/m at 3 m)*
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

On frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function. On frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

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:

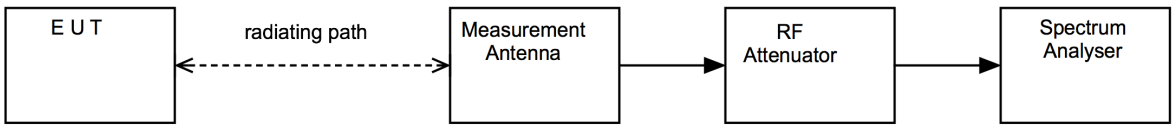
$$FS = PR + CL + AF – PA + DC – CF$$

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

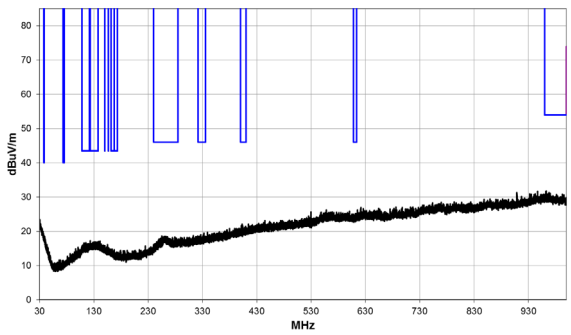


11.5 Test Equipment

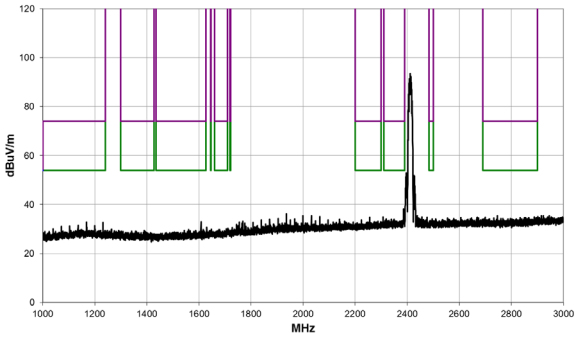
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ATS	Rainford EMC	Chamber 1	U387	2023-10-24
Emissions R5	Element	Radiated Test Software	REF9000	Cal not required
ESR26	R&S	EMI Receiver	U489	2022-03-04
FSU26	R&S	Spectrum Analyser	U405	2022-03-31
FSU46	R&S	Spectrum Analyser	REF910	2022-12-22
3115	EMCO	1-18GHz Horn	L139	2023-07-27
AFH-07000	Atlantic Microwave	High Pass Filter	U558	2022-01-30
SH4141	BSC	High Pass Filter	REF977	2022-01-30
SN 4478	BSC	2.4G Band Stop Filter	U543	2022-01-30
VHF-1500+	MiniCircuits	High Pass Filter	U519	2022-01-30
20240-20	Flann	Horn 18-26GHz (&U330)	L300	2022-04-23
CBL611/B	Chase	Bilog	U573	2023-01-28
LNA6901	AMETEK	Pre Amp	U711	2022-02-03
8449B	Agilent	Pre Amp	L572	2022-10-29
6201-69	Watkins Johnson	PreAmp	U372	2022-03-01

11.6 Test Results

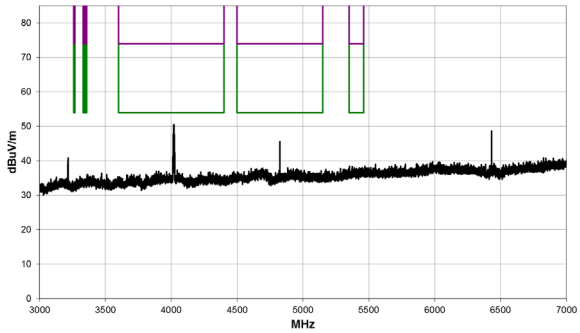
Bottom Channel: 2412 MHz



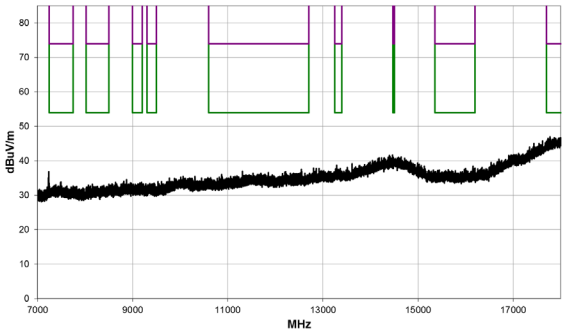
30 MHz to 1 GHz



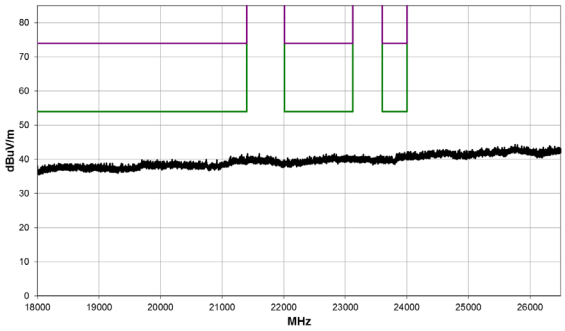
1 GHz to 3 GHz



3 GHz to 7 GHz



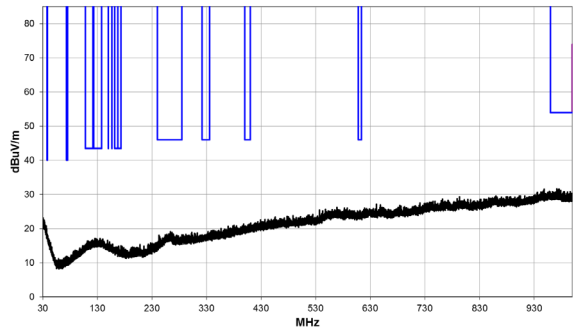
7 GHz to 18 GHz



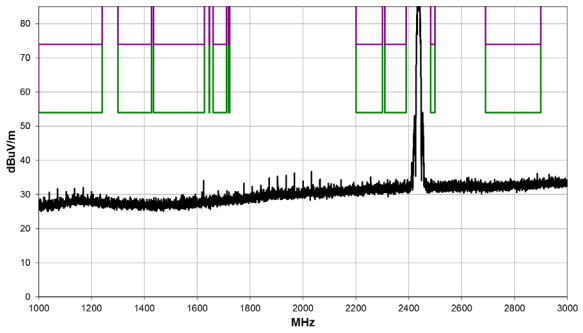
18 GHz to 26.5 GHz

Frequency: 2412 MHz; Channel: 1; DSSS1.								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
AV	4019.283	44.2	1.2	6.8	0.0	52.2	54.0	-1.9
PK	4018.483	57.2	1.2	0.0	0.0	58.4	74.0	-15.6
AV	4824.083	39.0	2.2	6.8	0.0	48.0	54.0	-6.0
PK	4824.083	50.8	2.2	0.0	0.0	53.0	74.0	-21.0

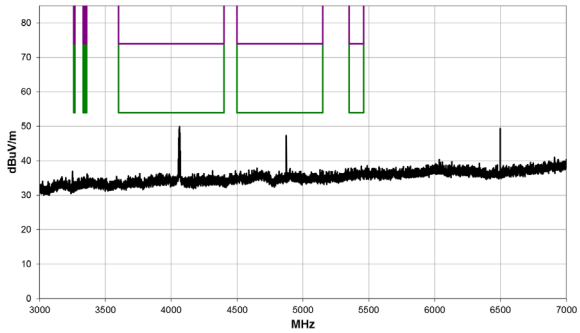
Middle Channel: 2437 MHz



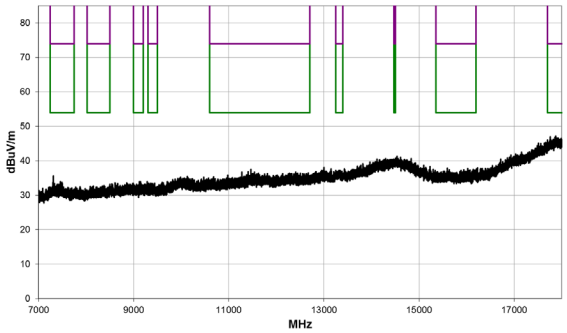
30 MHz to 1 GHz



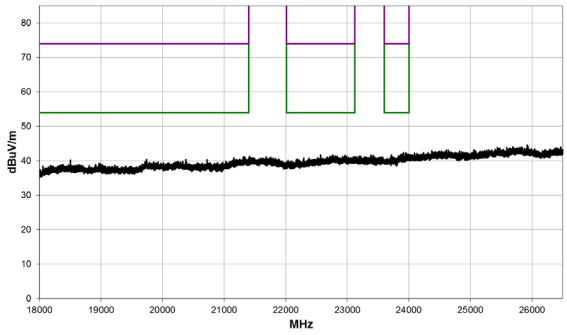
1 GHz to 3 GHz



3 GHz to 7 GHz



7 GHz to 18 GHz

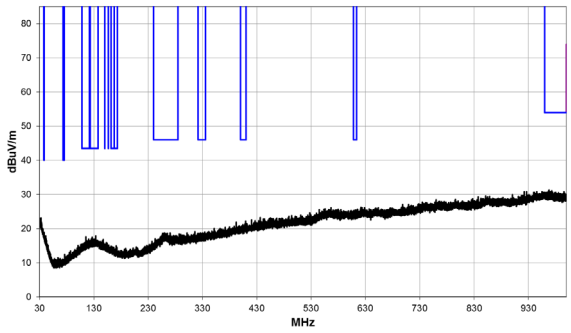


18 GHz to 26.5 GHz

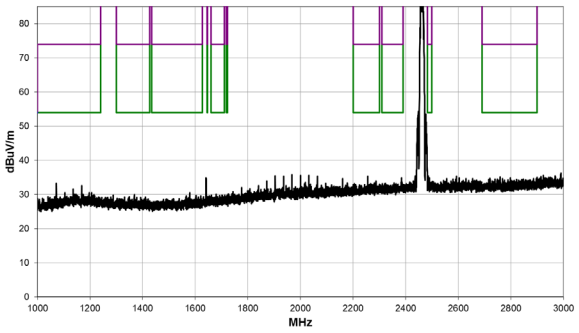
Frequency: 2437 MHz; Channel:6; DSSS1.								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
AV	4063.450	42.8	1.2	6.8	0.0	50.8	54.0	-3.2
PK	4062.725	55.9	1.2	0.0	0.0	57.1	74.0	-16.9
AV	4874.092	37.8	2.4	6.8	0.0	47.0	54.0	-7.0
PK	4874.242	49.3	2.4	0.0	0.0	51.7	74.0	-22.3
PK*	7313.292	51.9	6.5	0.0	-9.5	48.9	54.0	-5.1

*Peak emission passes average limit, Only peak measured.

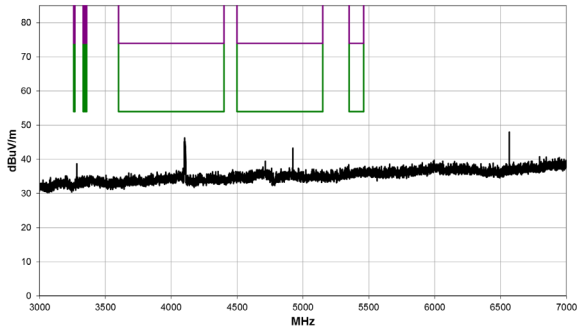
Top Channel: 2462 MHz



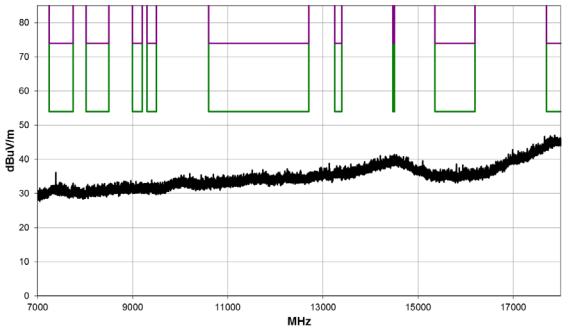
30 MHz to 1 GHz



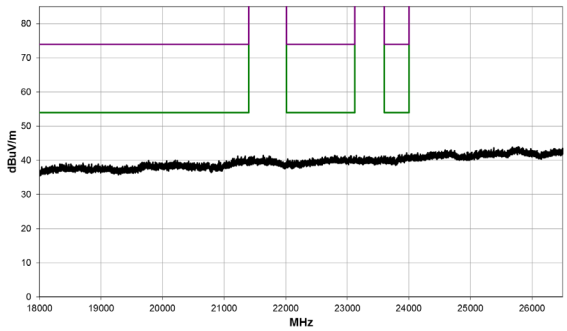
1 GHz to 3 GHz



3 GHz to 7 GHz



7 GHz to 18 GHz

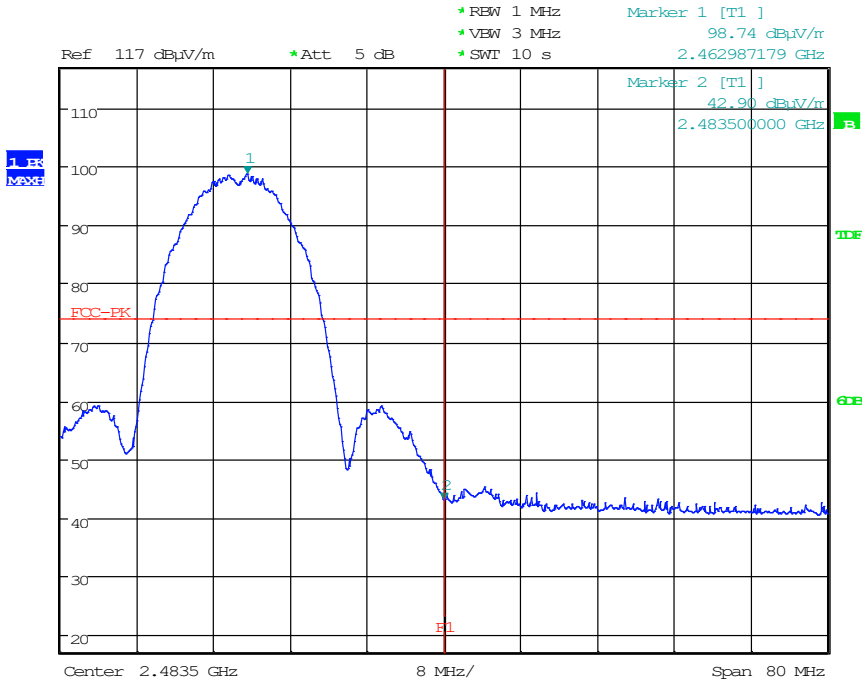


18 GHz to 26.5 GHz

Frequency: 2462 MHz; Channel: 11; DSSS1.								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
AV	4104.167	41.0	1.2	6.8	0.0	49.0	54.0	-5.1
PK	4102.125	54.1	1.2	0.0	0.0	55.3	74.0	-18.7
AV	4924.075	36.7	2.5	6.8	0.0	46.0	54.0	-8.0
PK	4923.975	49.2	2.5	0.0	0.0	51.7	74.0	-22.3
PK*	7387.292	51.6	6.5	0.0	-9.5	48.6	54.0	-5.4

*Peak emission passes average limit, Only peak measured.

Upper Radiated Band Edge, Peak
802.11 b 1Mb/s



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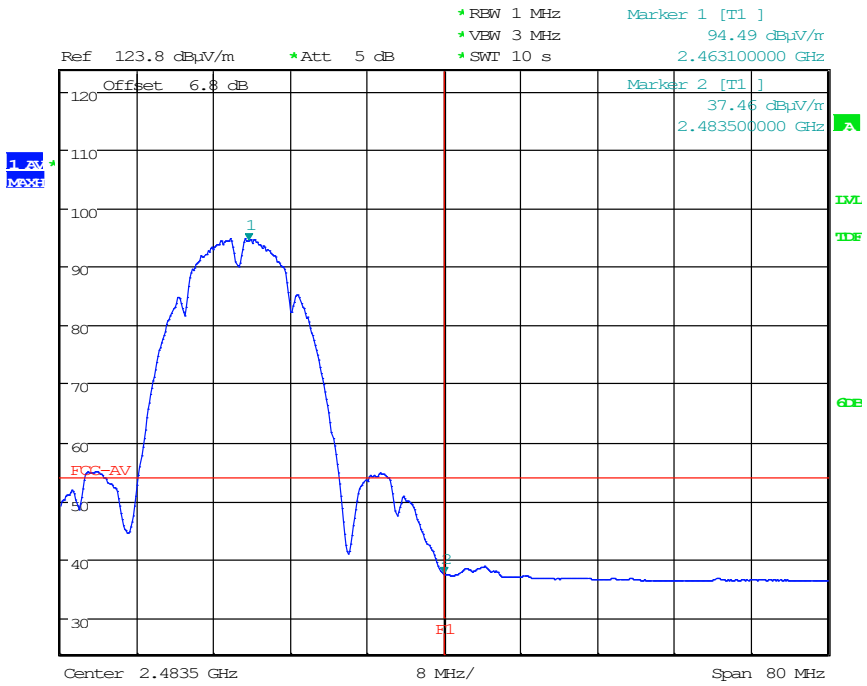
Upper Radiated Band Edge, Average
802.11 b 1Mb/s



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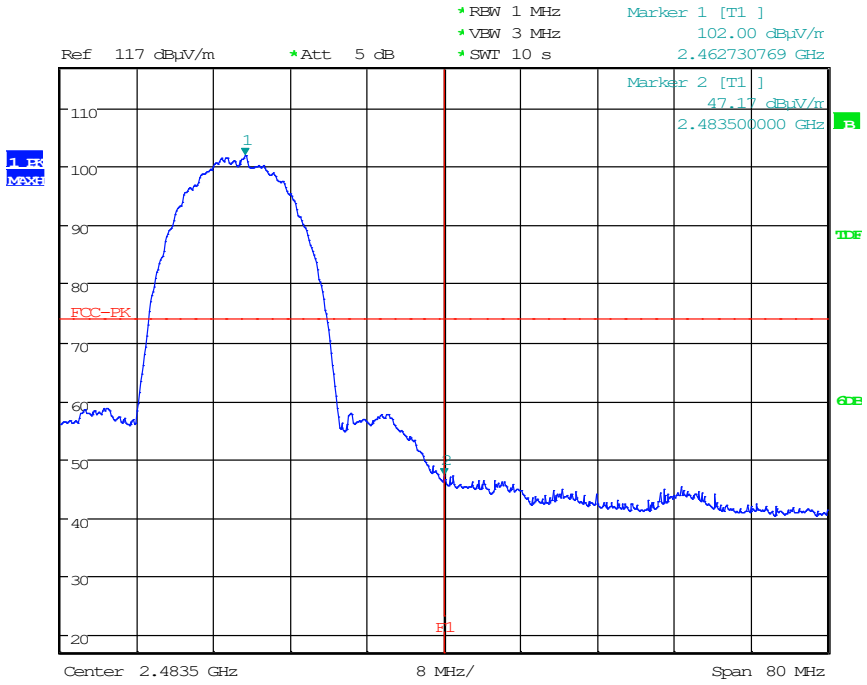
Upper Radiated Band Edge, Peak
802.11 b 11Mb/s



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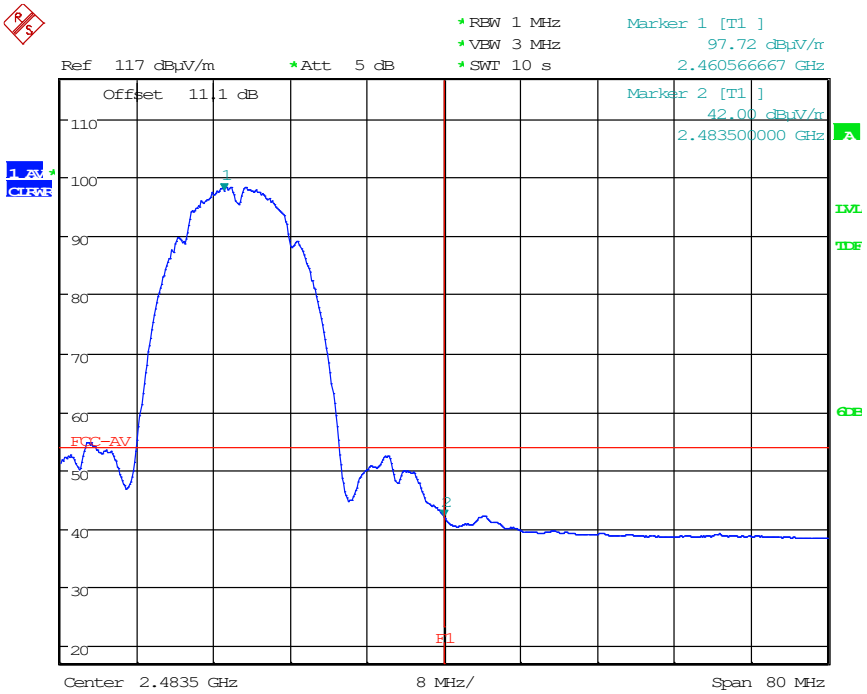
Upper Radiated Band Edge, Average
802.11 b 11Mb/s



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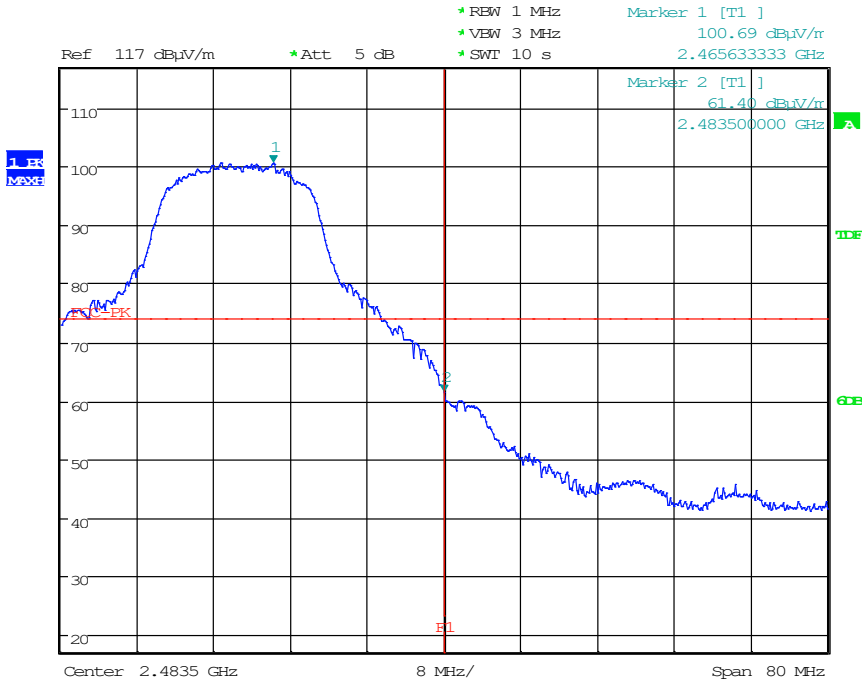
Upper Radiated Band Edge, Peak
802.11 g 6Mb/s



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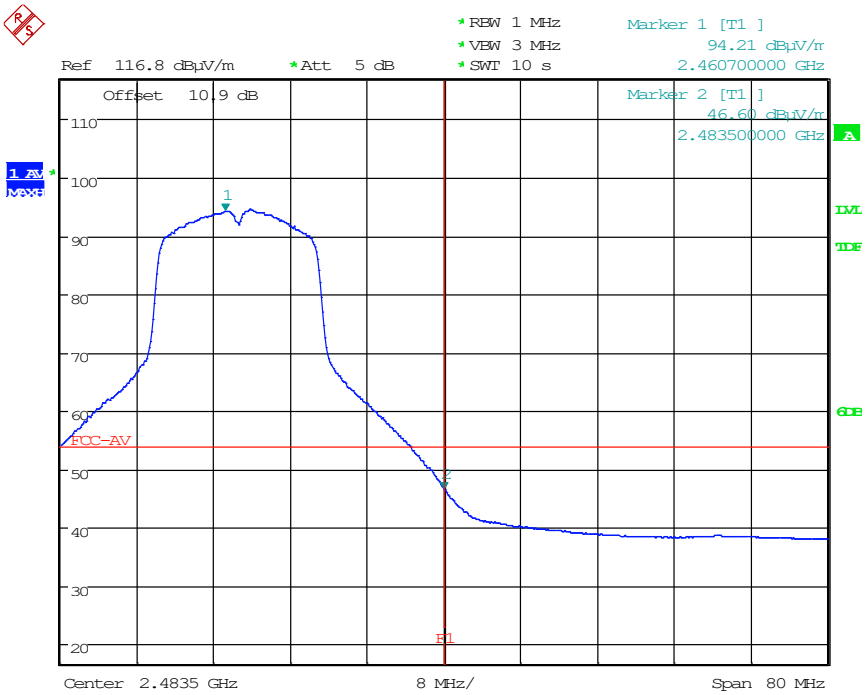
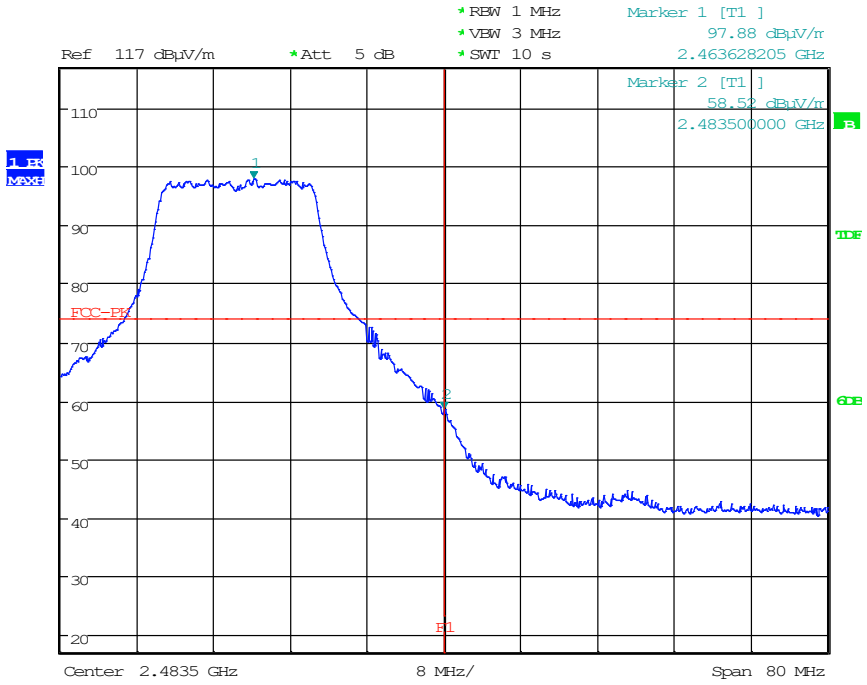
Upper Radiated Band Edge, Average
802.11 g 6Mb/s



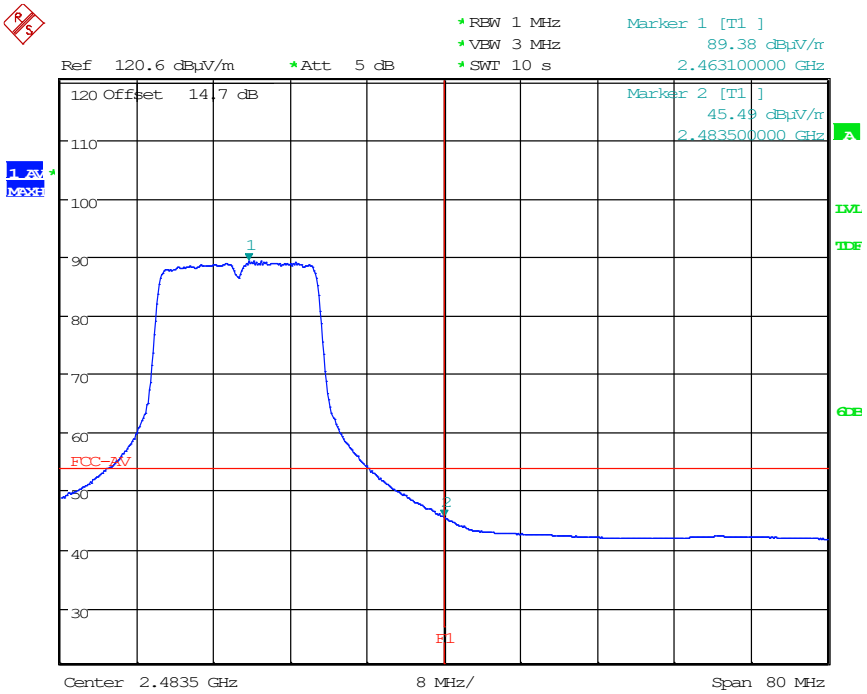
Date: 27.JAN.2022 09:35:52

Upper Radiated Band Edge, Peak
802.11 g 54Mb/s



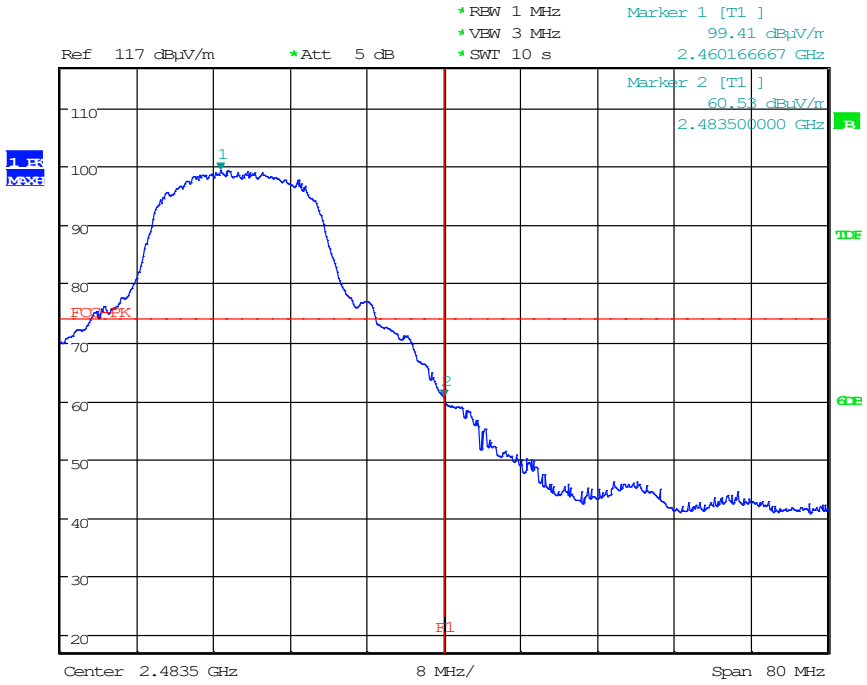
Date: 25.JAN.2022 14:30:35

Upper Radiated Band Edge, Average
802.11 g 54Mb/s



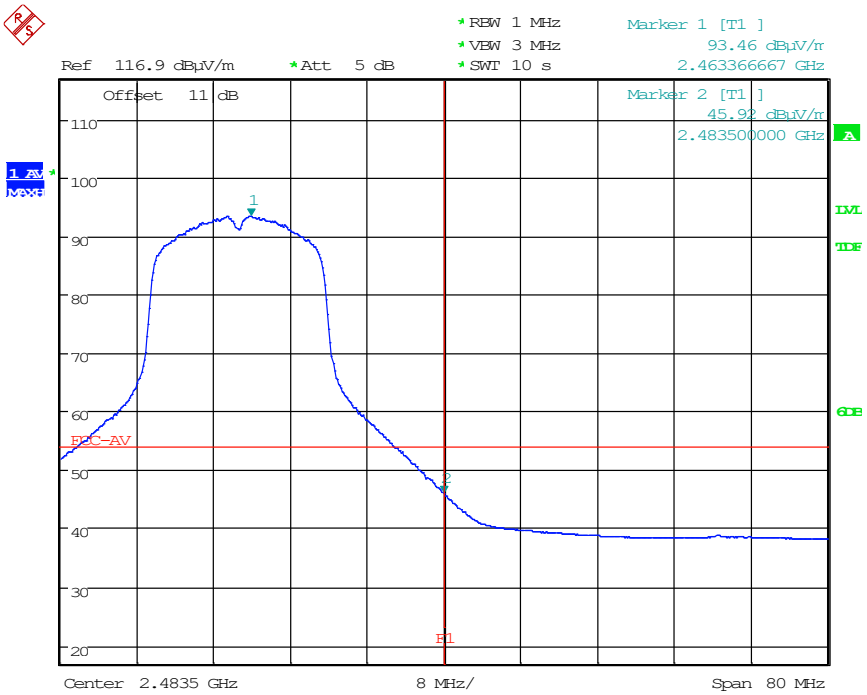
Date: 27.JAN.2022 09:42:59

Upper Radiated Band Edge, Peak
802.11 n MCS0



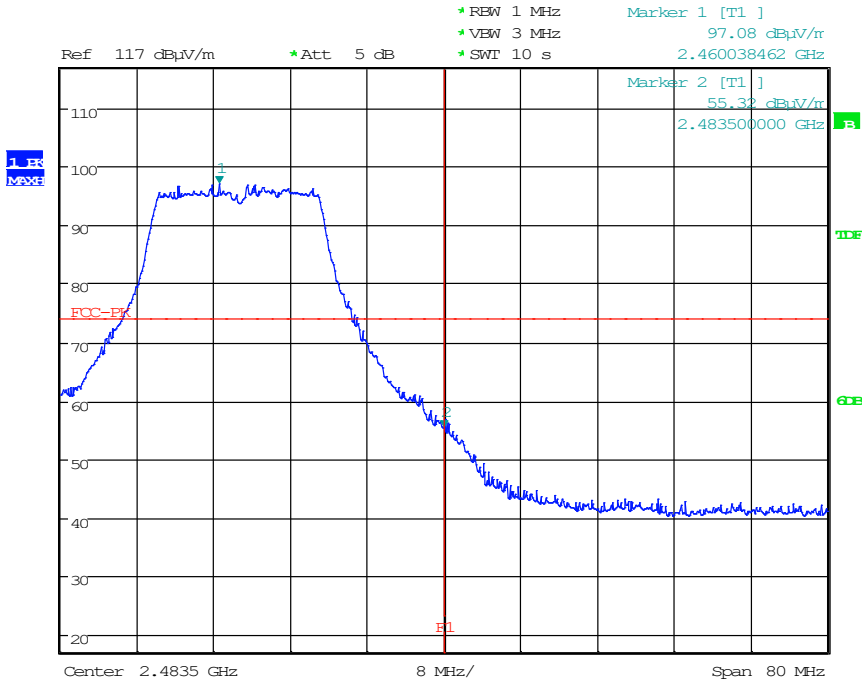
Date: 25.JAN.2022 14:33:28

Upper Radiated Band Edge, Average
802.11 n MCS0



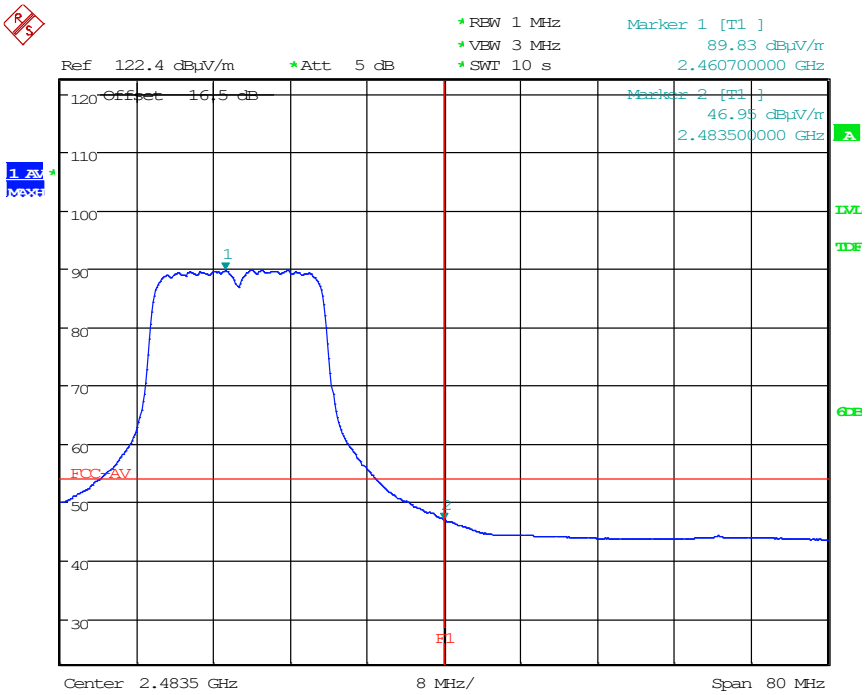
Date: 27.JAN.2022 09:45:04

Upper Radiated Band Edge, Peak
802.11 n MCS7



Date: 25.JAN.2022 14:36:40

Upper Radiated Band Edge, Average
802.11 n MCS7



Date: 27.JAN.2022 09:47:03

12 Occupied Bandwidth

12.1 Definition

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

The 99% emission bandwidth is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	20 MHz
EUT Test Modulations:	DSSS, OFDM
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Span: (requirement 2 to 5 times OBW)	50 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)

12.3 Test Limit

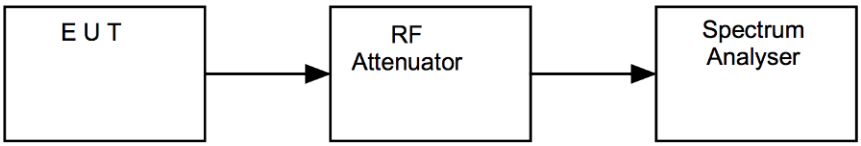
The minimum -6 dB bandwidth shall be at least 500 kHz.

12.4 Test Method

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

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

Figure iii Test Setup

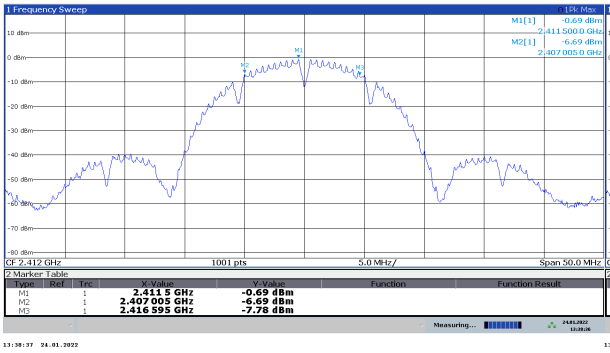


12.5 Test Equipment

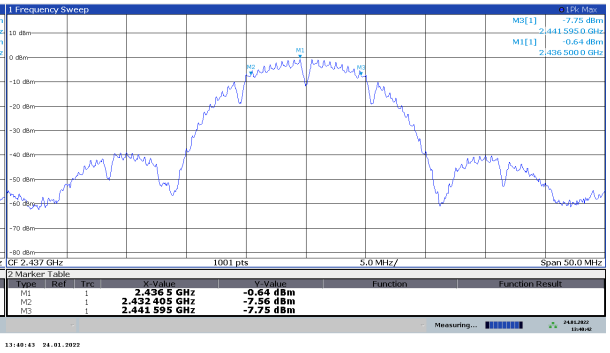
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSW 43	R&S	Spectrum Analyser	U728	2022-04-20
ATT20KXP-483001-S4S5	Atlantec Microwave	20 dB attenuator	N/A	In Use

12.6 Test Results

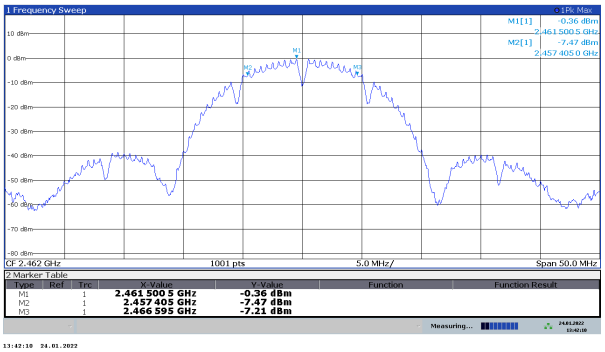
Bandwidth Type: 6 dB; Modulation: 802.11b; Data rate: 1mbps				
Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***Bandwidth (MHz)***	***Result***
2412	2407.005000	2416.595000	9.590	PASS
2437	2432.405000	2441.595000	9.190	PASS
2462	2457.505000	2466.595000	9.090	PASS



2412 MHz

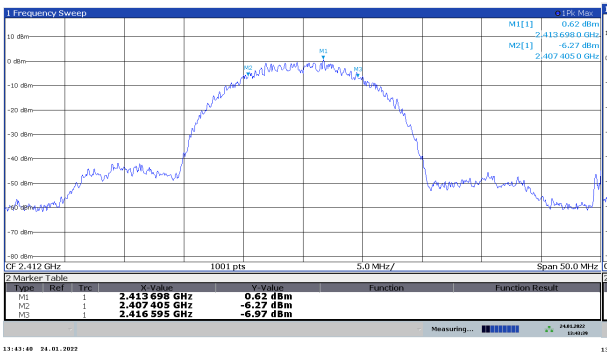


2437 MHz

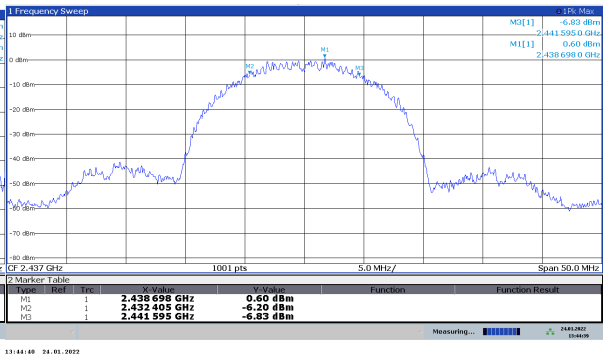


2462 MHz

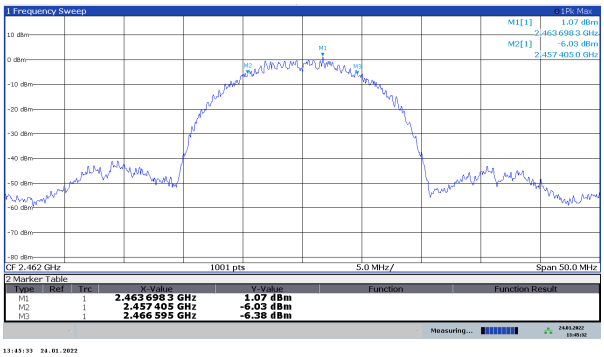
Bandwidth Type: 6 dB; Modulation: 802.11b; Data rate: 11mbps				
Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***Bandwidth (MHz)***	***Result***
2412	2407.405000	2416.595000	9.190	PASS
2437	2432.405000	2441.595000	9.190	PASS
2462	2457.405000	2466.595000	9.190	PASS



2412 MHz

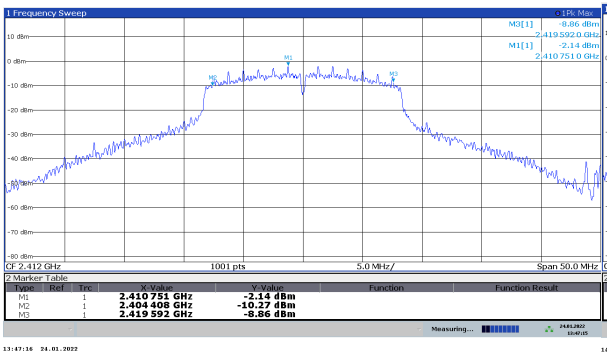


2437 MHz

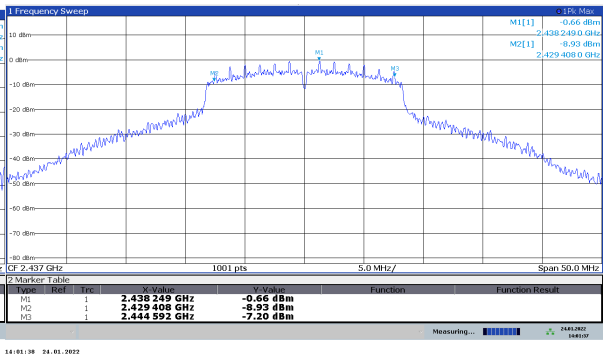


2462 MHz

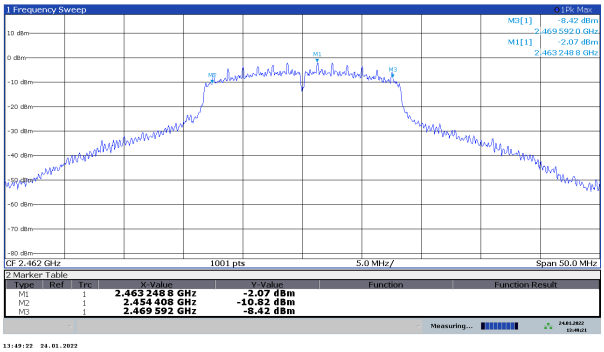
Bandwidth Type: 6 dB; Modulation: 802.11g; Data rate: 6mbps				
Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**Bandwidth (MHz)**	**Result**
2412	2404.408000	2419.592000	15.184	PASS
2437	2429.408000	2444.592000	15.184	PASS
2462	2454.406000	2469.592000	15.186	PASS



2412 MHz

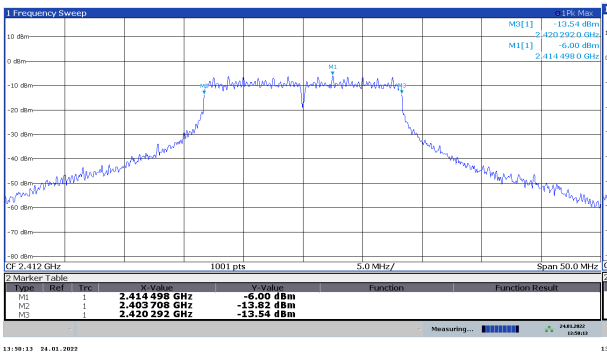


2437 MHz

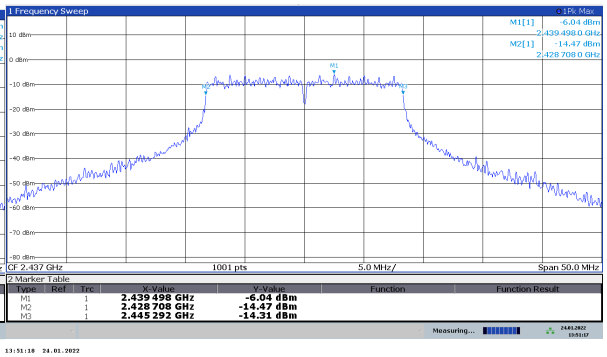


2462 MHz

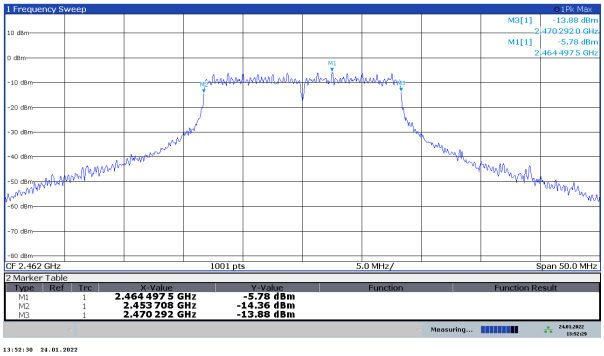
Bandwidth Type: 6 dB; Modulation: 802.11g; Data rate: 54mbps				
Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***Bandwidth (MHz)***	***Result***
2412	2403.708000	2420.292000	16.584	PASS
2437	2428.708000	2445.292000	16.584	PASS
2462	2453.708000	2470.292000	16.584	PASS



2412 MHz

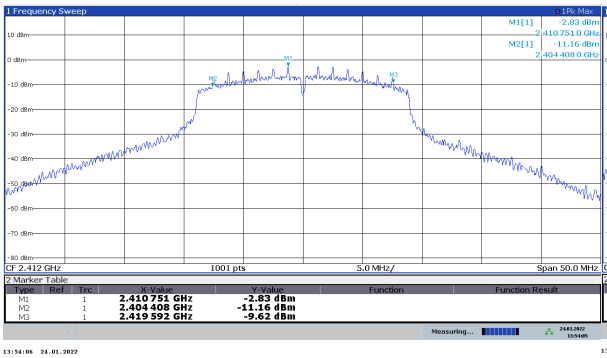


2437 MHz

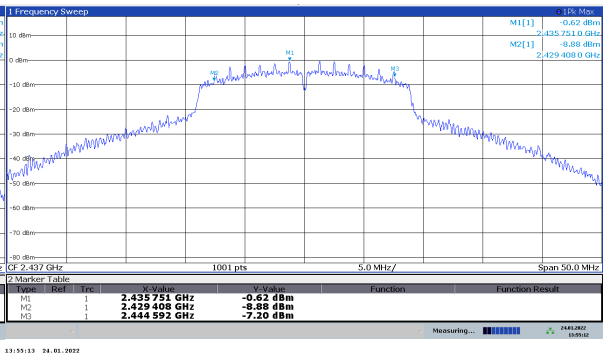


2462 MHz

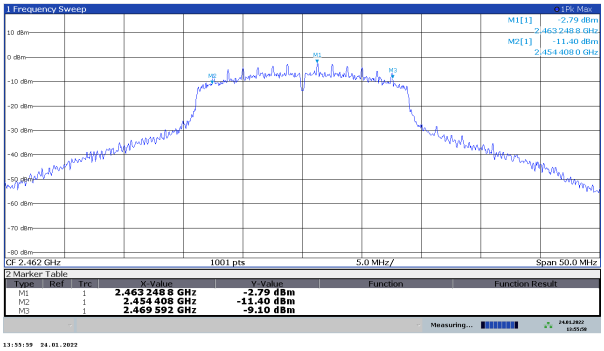
Bandwidth Type: 6 dB; Modulation: 802.11n; Data rate: MCS7				
Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**Bandwidth (MHz)**	**Result**
2412	2404.408000	2419.592000	15.184	PASS
2437	2429.408000	2444.592000	15.184	PASS
2462	2454.408000	2469.592000	15.184	PASS



2412 MHz

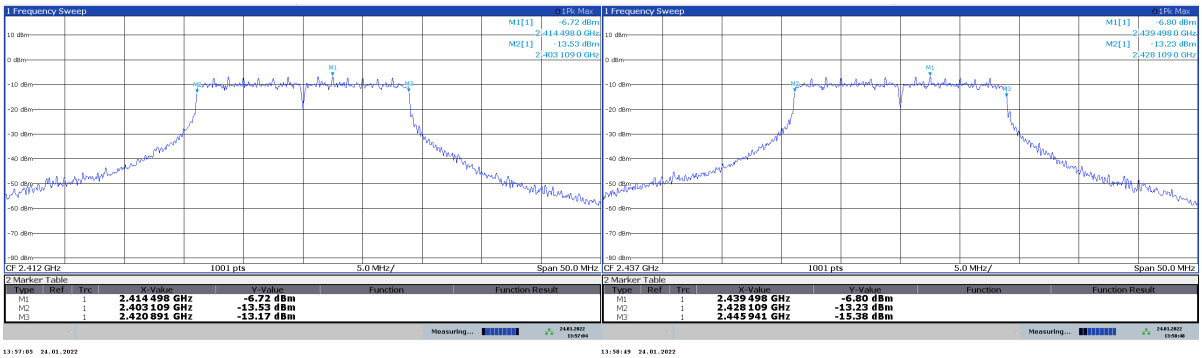


2437 MHz

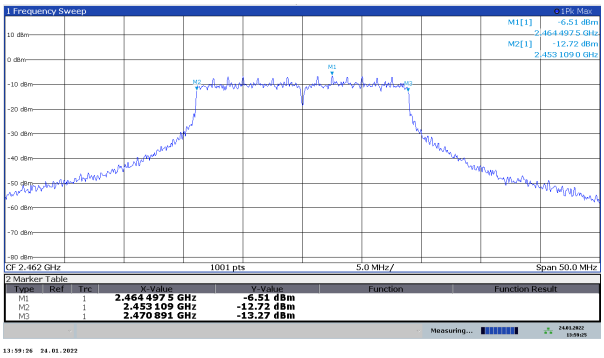


2462 MHz

Bandwidth Type: 6 dB; Modulation: 802.11n; Data rate: MCS7				
Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**Bandwidth (MHz)**	**Result**
2412	2403.109000	2420.891000	17.782	PASS
2437	2428.109000	2445.941000	17.832	PASS
2462	2453.109000	2470.891000	17.782	PASS



2412 MHz 2437 MHz



2462 MHz

13 Maximum peak conducted output power

13.1 Definition

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

The effective isotropic radiated power (EIRP) is defined as the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	2412 MHz, 2437 MHz & 2462 MHz
EUT Channel Bandwidths:	20 MHz
Deviations From Standard:	None
Measurement BW:	N/A, Wideband Peak Power Meter
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	N/A
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

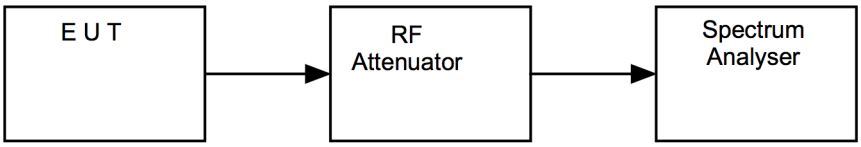
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

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

Figure iv Test Setup



13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
7002-006	ETS Lindgren	Power Meter	REF2286	2022-11-02
ATT20KXP-483001-S4S5	Atlantec Microwave	20 dB attenuator	N/A	In Use

13.6 Test Results

Modulation: 802.11b; Data rate: 1mbps			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	12.2	16.60	Pass
2437	12.5	17.78	Pass
2462	12.4	17.38	Pass

Modulation: 802.11b; Data rate: 11mbps			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	12.4	17.38	Pass
2437	12.4	17.38	Pass
2462	12.7	18.62	Pass

Modulation: 802.11g; Data rate: 6mbps			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	13.7	23.44	Pass
2437	13.7	23.44	Pass
2462	13.4	21.88	Pass

Modulation: 802.11g; Data rate: 54mbps			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	12.4	17.38	Pass
2437	12.3	16.98	Pass
2462	12.3	16.98	Pass

Modulation: 802.11n; Data rate: MCS0			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	13.2	20.89	Pass
2437	13.7	23.44	Pass
2462	13.1	20.42	Pass

Modulation: 802.11n; Data rate: MCS7			
Frequency (MHz)	***Maximum peak conducted output power***		***Result***
	(dBm)	***(mW)***	
2412	12.3	16.98	Pass
2437	11.8	15.14	Pass
2462	12.0	15.85	Pass

14 Out-of-band and conducted spurious emissions

14.1 Definition

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

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	20 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Detector:	Peak
Measurement Range:	9kHz to 25 GHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

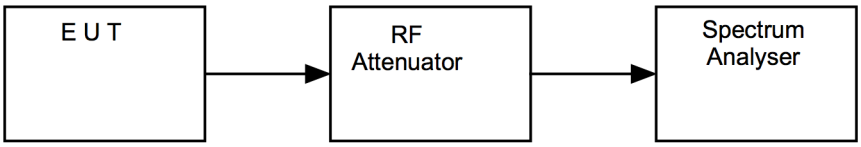
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either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

14.4 Test Method

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

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

Figure v Test Setup



As Per ANSI C63.10 5.6.2.2 Determining worst-case mode

For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

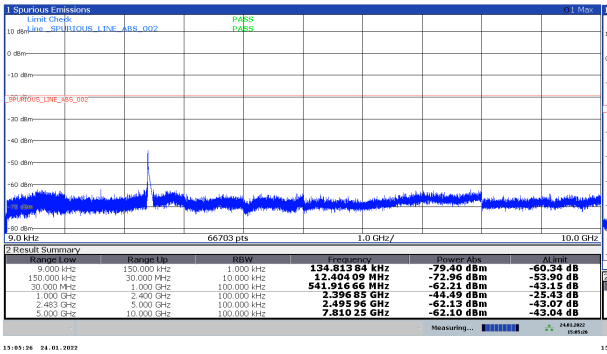
Spurious emissions are limited by family to highest output power and/or PSD.
Bandedge Measurements are recorded for all modes of operation

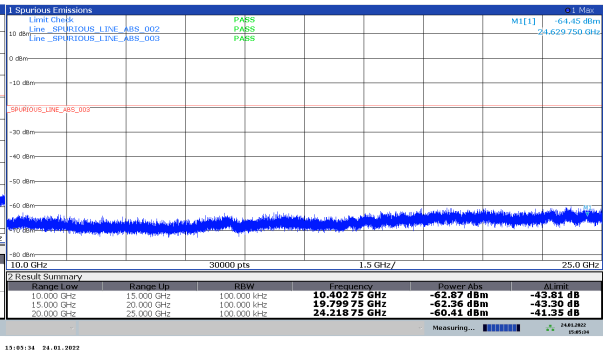
14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSW 43	R&S	Spectrum Analyser	U728	2022-04-20
ATT20KXP-483001-S4S5	Atlantec Microwave	20 dB attenuator	N/A	In Use

14.6 Test Results

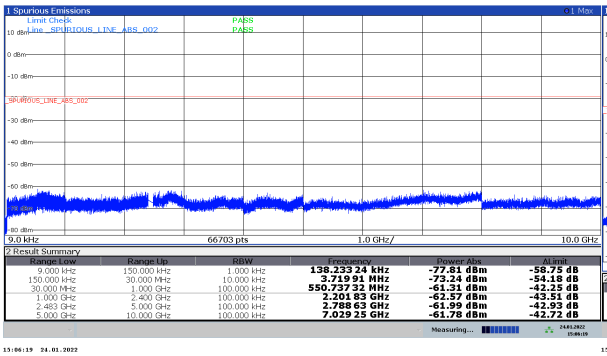
Modulation: 802.11b; Data rate: 11 mbps; Frequency 2412 MHz						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions within 20 dB of the limit						

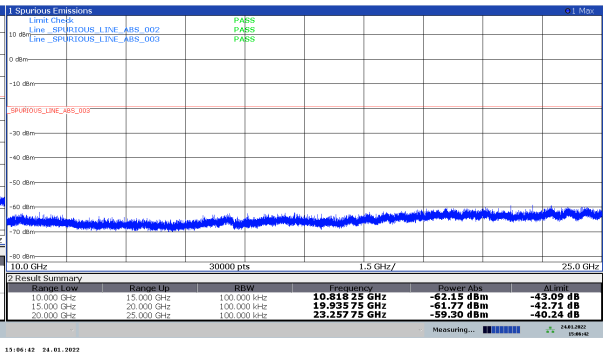




9 kHz – 10 GHz 10 GHz – 25 GHz

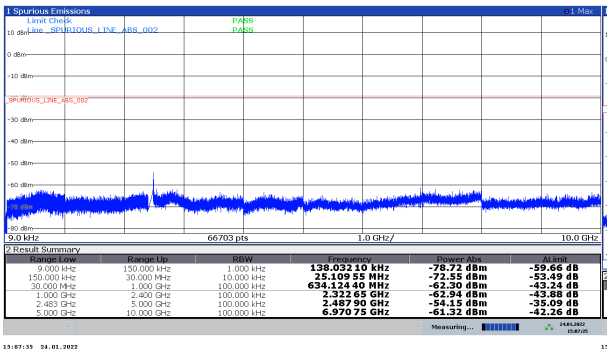
Modulation: 802.11b; Data rate: 11 mbps; Frequency 2437 MHz						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions within 20 dB of the limit						

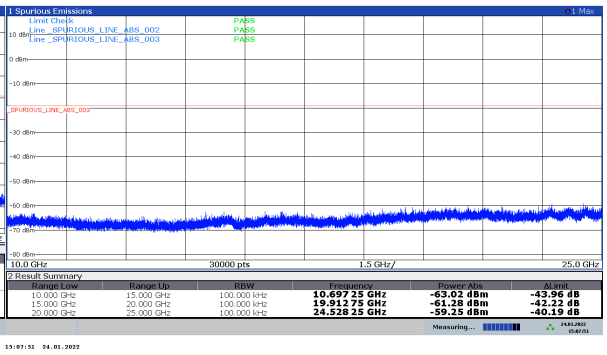




9 kHz – 10 GHz 10 GHz – 25 GHz

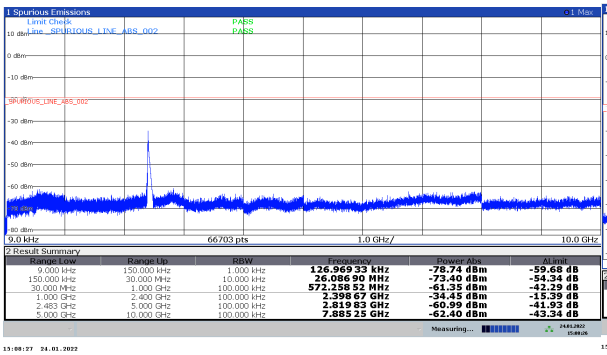
Modulation: 802.11b; Data rate: 11 mbps; Frequency 2462 MHz						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
No Significant Emissions within 20 dB of the limit						



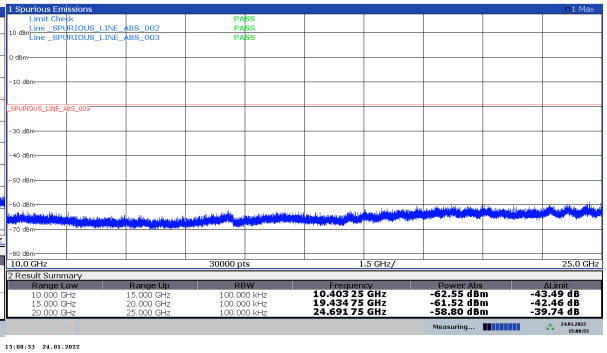


9 kHz – 10 GHz 10 GHz – 25 GHz

Modulation: 802.11g; Data rate: 6 mbps; Frequency 2412 MHz						
Channel Frequency (MHz)	**Emission Frequency (MHz)**	**Analyzer Level (dBm)**	**Emission Level (dBm)**	**Limit (dBm)**	**Margin (dB)**	**Result**
No Significant Emissions within 20 dB of the limit						

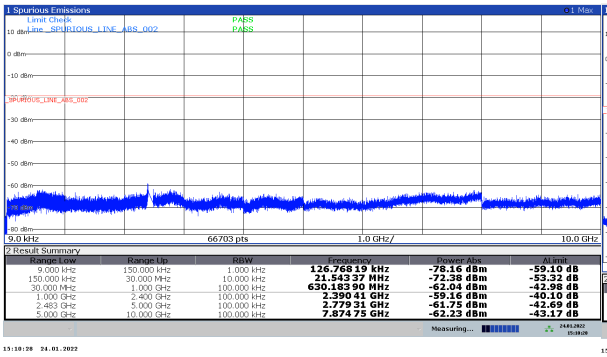


9 kHz – 10 GHz

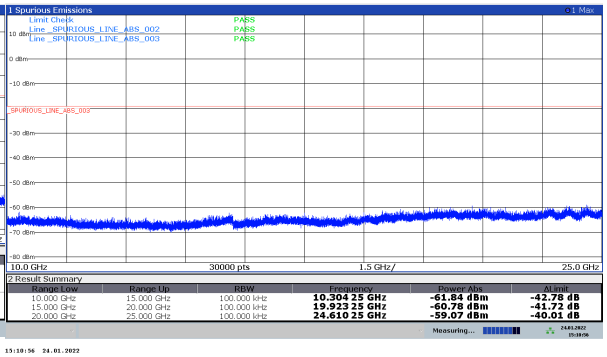


10 GHz – 25 GHz

Modulation: 802.11g; Data rate: 6 mbps; Frequency 2437 MHz						
Channel Frequency (MHz)	**Emission Frequency (MHz)**	**Analyzer Level (dBm)**	**Emission Level (dBm)**	**Limit (dBm)**	**Margin (dB)**	**Result**
No Significant Emissions within 20 dB of the limit						

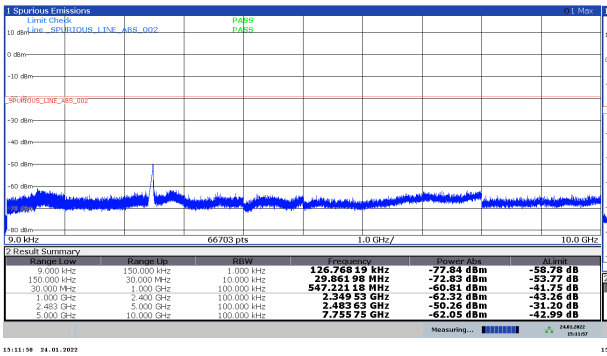


9 kHz – 10 GHz

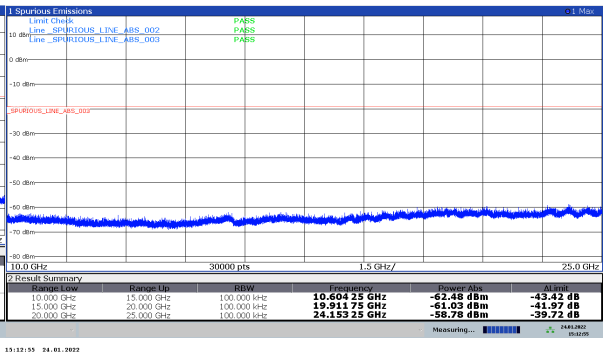


10 GHz – 25 GHz

Modulation: 802.11g; Data rate: 6 mbps; Frequency 2462 MHz						
Channel Frequency (MHz)	**Emission Frequency (MHz)**	**Analyzer Level (dBm)**	**Emission Level (dBm)**	**Limit (dBm)**	**Margin (dB)**	**Result**
No Significant Emissions within 20 dB of the limit						

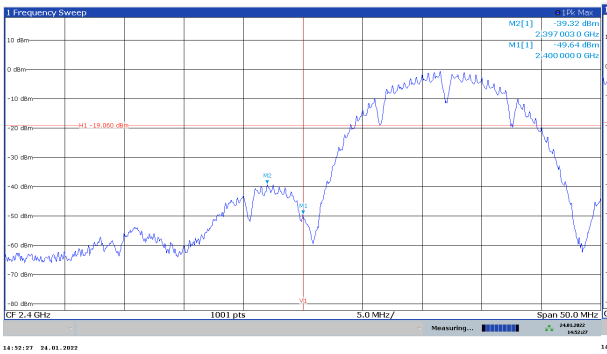


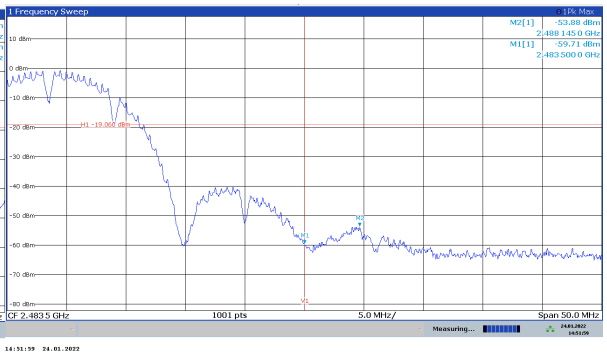
9 kHz – 10 GHz



10 GHz – 25 GHz

802.11b 1mbps bandedge compliance

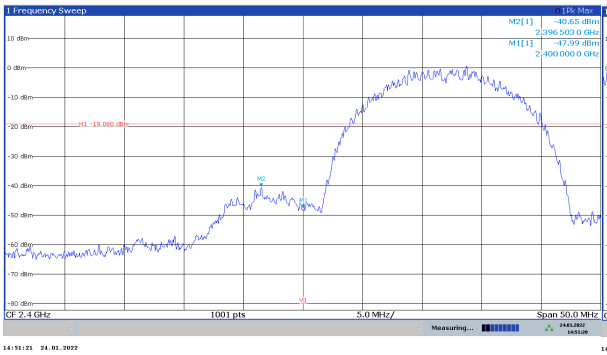


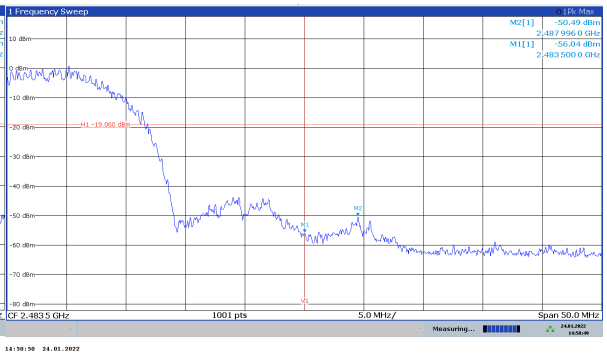


2412 MHz

2462 MHz

802.11b 11mbps bandedge compliance

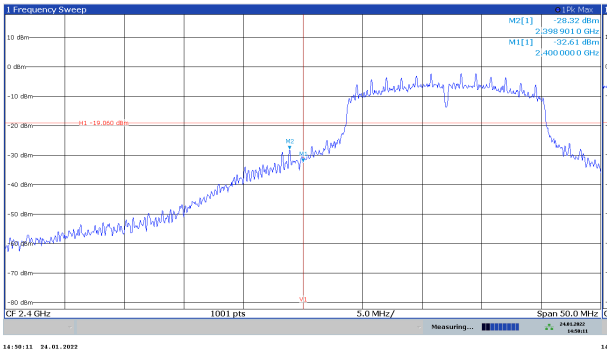


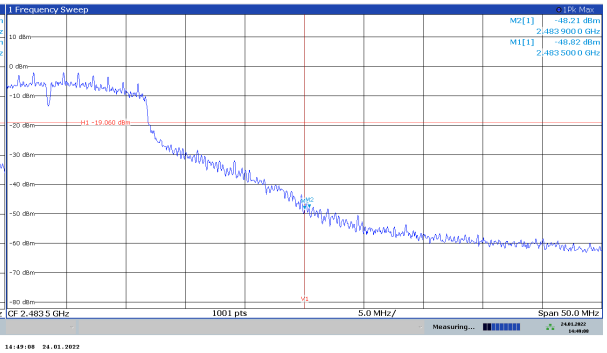


2412 MHz

2462 MHz

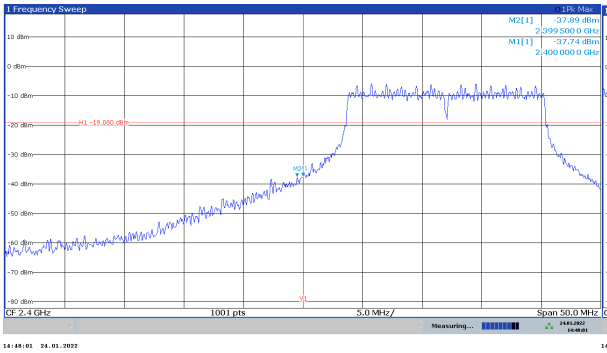
802.11g 6mbps bandedge compliance

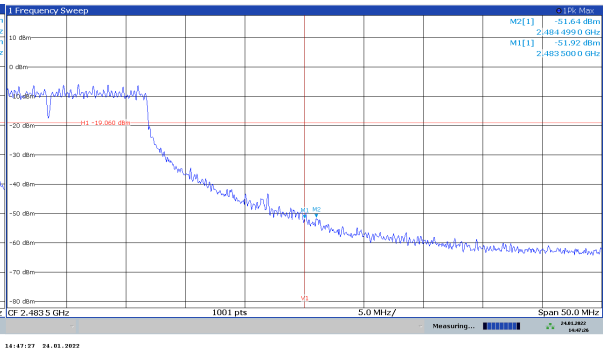




2412 MHz 2462 MHz

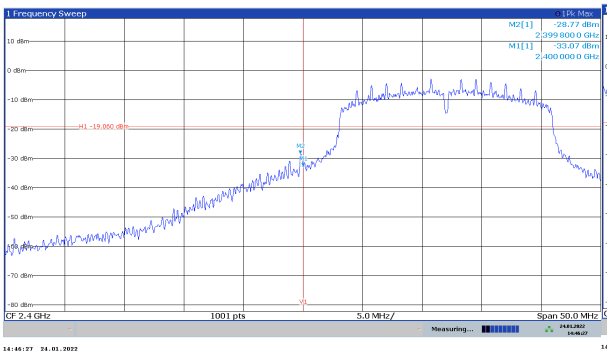
802.11g 54mbps bandedge compliance

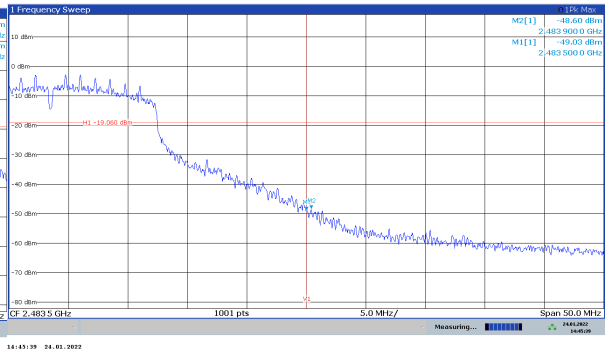




2412 MHz 2462 MHz

802.11n MCS0 bandedge compliance

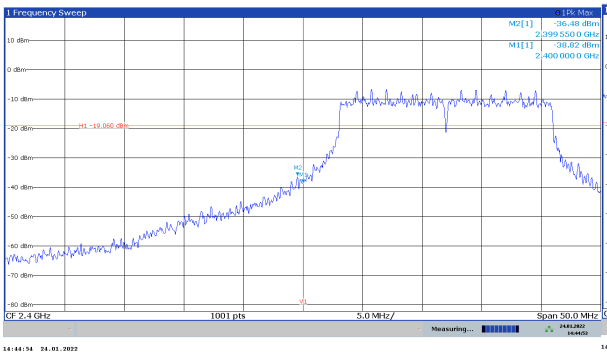


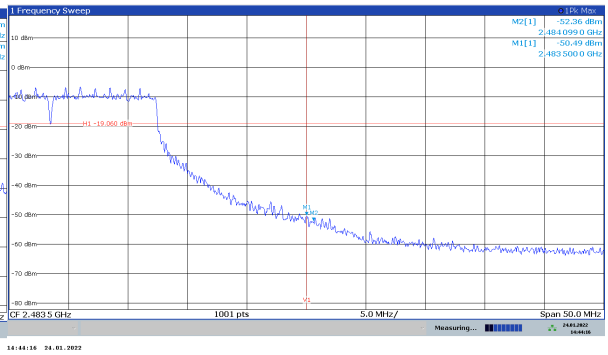


2412 MHz

2462 MHz

802.11n MCS7 bandedge compliance





2412 MHz

2462 MHz

15 Power spectral density

15.1 Definition

The power per unit bandwidth.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	20 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Span: (requirement 1.5 times Channel BW)	50 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

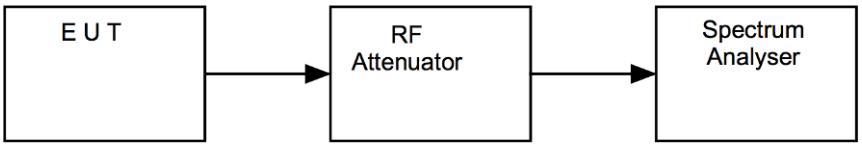
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

15.4 Test Method

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

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

Figure vi Test Setup

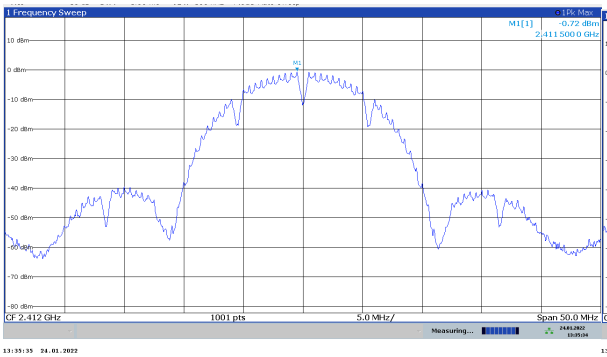


15.5 Test Equipment

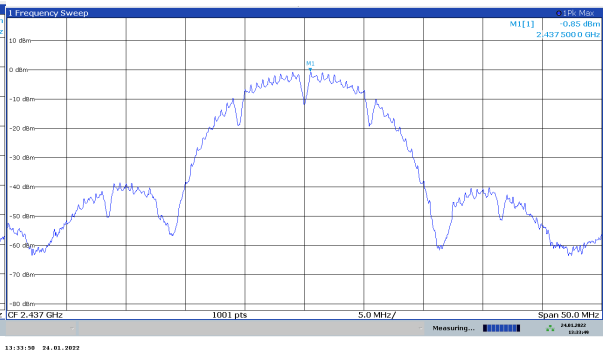
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSW 43	R&S	Spectrum Analyser	U728	2022-04-20
ATT20KXP-483001-S4S5	Atlantec Microwave	20 dB attenuator	N/A	In Use

15.6 Test Results

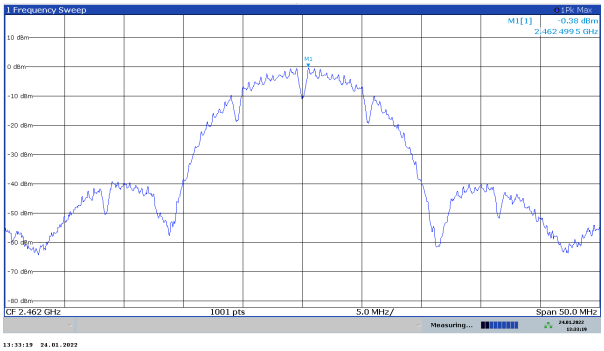
Modulation: 802.11b; Data rate: 1mbps				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-18.42	17.7	-0.72	PASS
2437	-18.55	17.7	-0.85	PASS
2462	-18.08	17.7	-0.38	PASS



2412 MHz

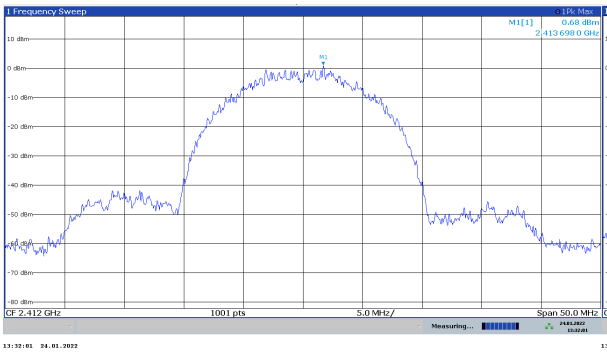


2437 MHz

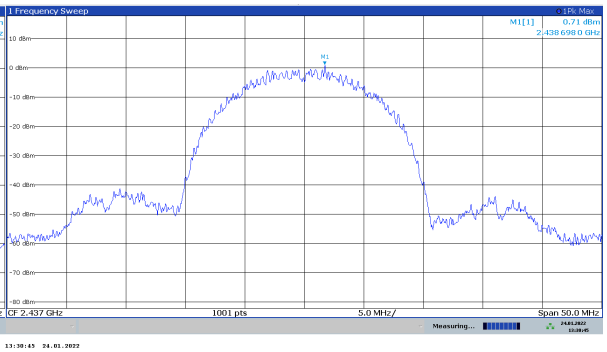


2462 MHz

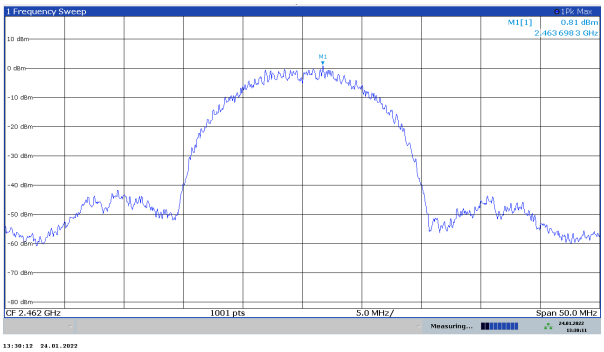
Modulation: 802.11b; Data rate: 11mbps				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-16.96	17.7	0.74	PASS
2437	-16.99	17.7	0.71	PASS
2462	-16.76	17.7	0.94	PASS



2412 MHz

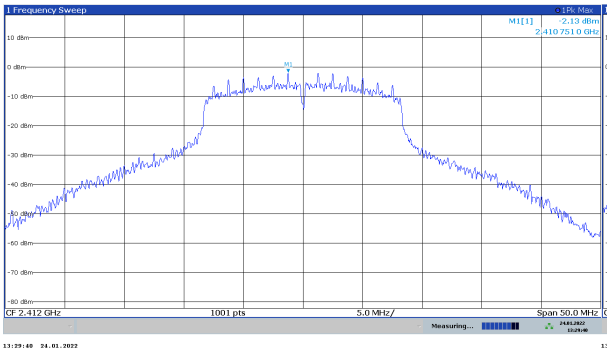


2437 MHz

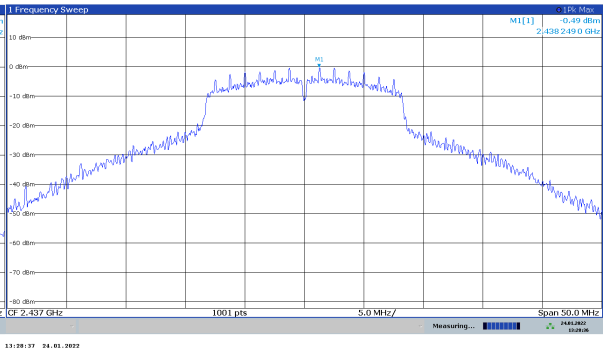


2462 MHz

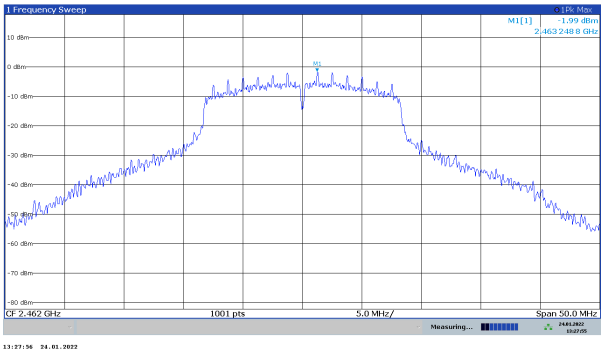
Modulation: 802.11g; Data rate: 6mbps				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-19.83	17.7	-2.13	PASS
2437	-18.19	17.7	-0.49	PASS
2462	-19.69	17.7	-1.99	PASS



2412 MHz

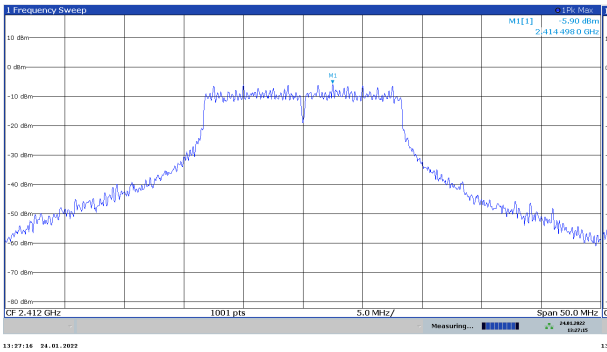


2437 MHz

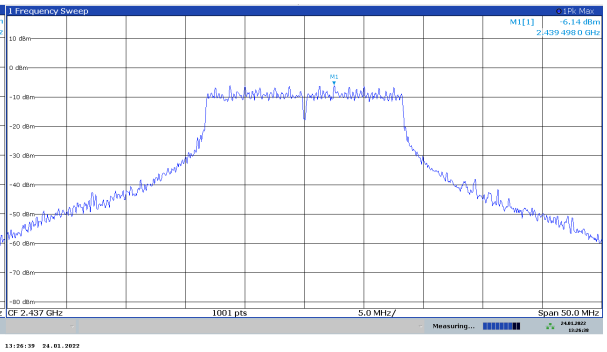


2462 MHz

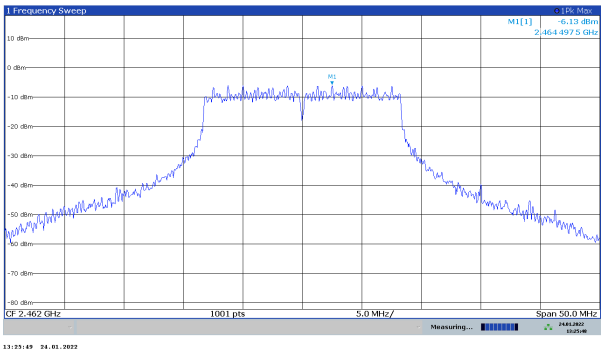
Modulation: 802.11g; Data rate: 54mbps				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-23.6	17.7	-5.9	PASS
2437	-23.82	17.7	-6.12	PASS
2462	-23.57	17.7	-5.87	PASS



2412 MHz

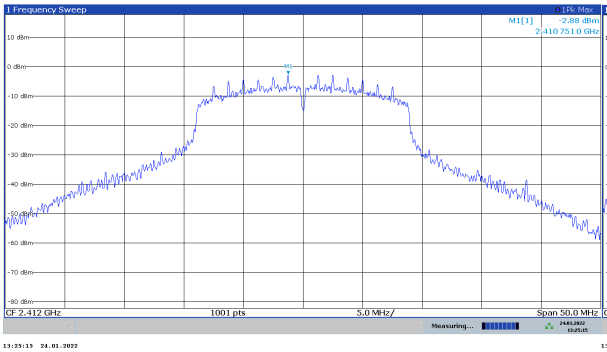


2437 MHz

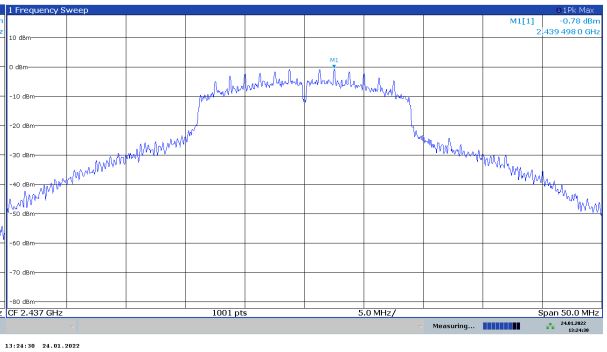


2462 MHz

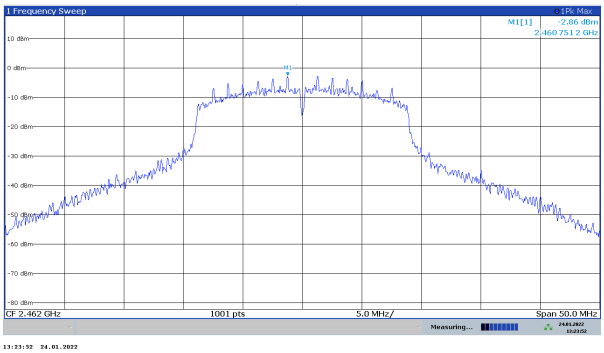
Modulation: 802.11n; Data rate: MCS0				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-20.58	17.7	-2.88	PASS
2437	-18.45	17.7	-0.75	PASS
2462	-20.56	17.7	-2.86	PASS



2412 MHz

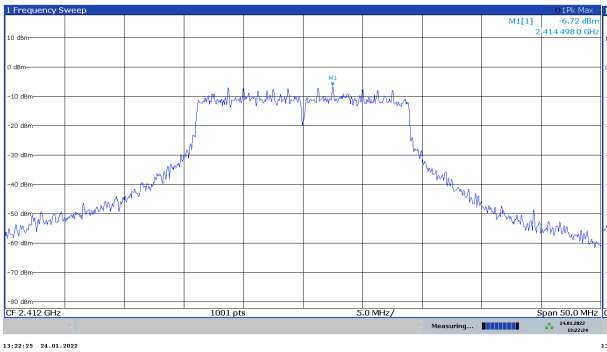


2437 MHz

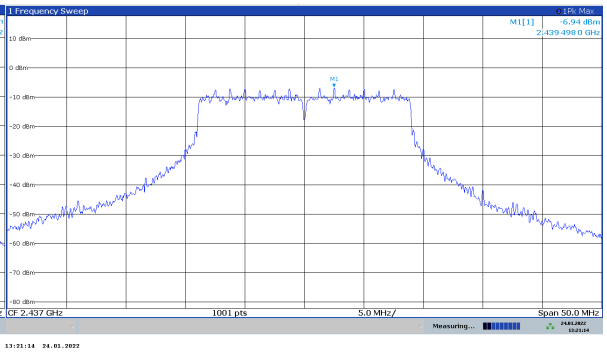


2462 MHz

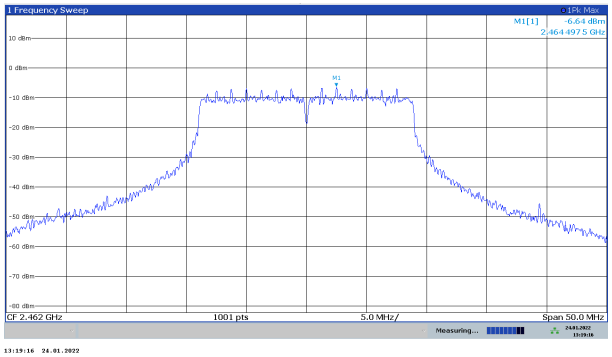
Modulation: 802.11n; Data rate: MCS7				
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Cable loss (dB)***	***Power (dBm)***	***Result***
2412	-24.42	17.7	-6.72	PASS
2437	-24.64	17.7	-6.94	PASS
2462	-24.34	17.7	-6.64	PASS



2412 MHz



2437 MHz



2462 MHz

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.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.6
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 16 °C	+15 ºC to +35 ºC (as declared)
Humidity: 37 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

N/A.

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 measured
[1] Single antenna output devices

Duty was measured at the antenna port / at a distance of 3 m.

[2] Multiple antenna output devices

Duty was measured as the combination of all ports simultaneously / at a distance of 3 m.

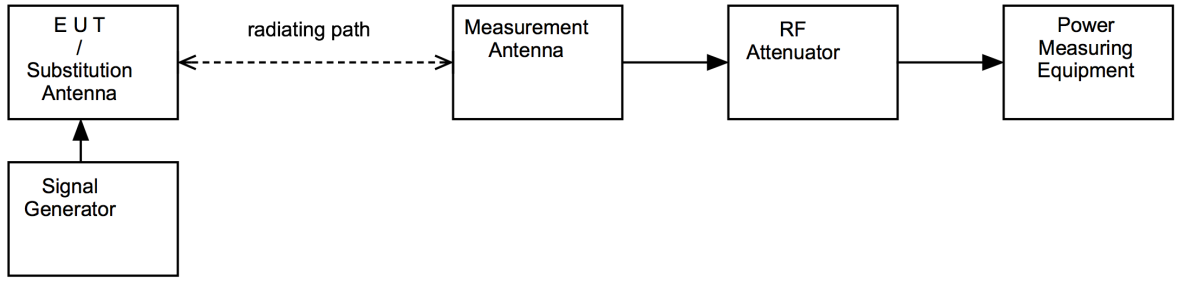
The duty cycle correction factor, DC, shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as:

1) If power averaging (rms) mode was used in step f), then the applicable correction factor is [10 log (1 / *D*)], where *D* is the duty cycle.

2) If linear voltage averaging mode was used in step f), then the applicable correction factor is [20 log (1 / *D*)], where *D* is the duty cycle.

3) If a specific emission is demonstrated to be continuous (*D* ≥ 98%) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Figure vii Test Setup



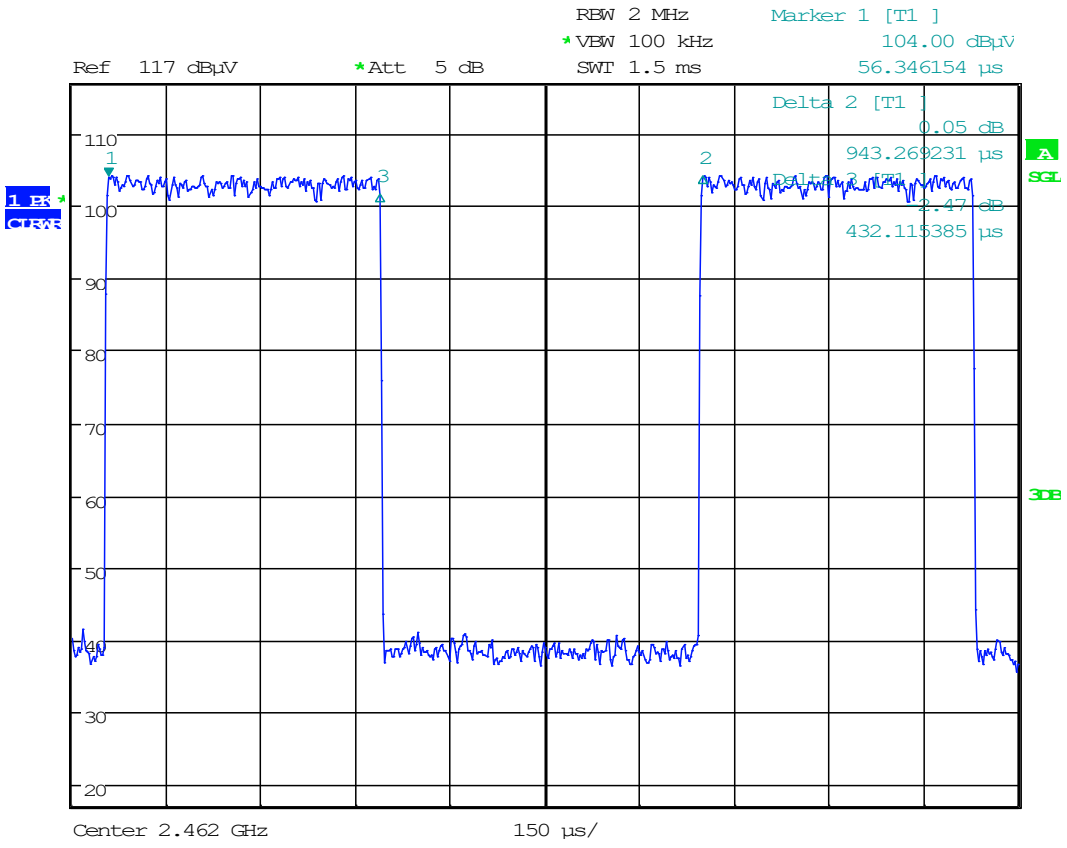
16.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU26	R&S	Spectrum Analyser	U405	2022-03-31
8449B	Agilent	Pre Amp	L572	2022-10-29
3115	EMCO	1-18GHz Horn	L139	2023-07-27
ATS	Rainford EMC	Chamber 1	U387	2023-10-24
Emissions R5	Element	Radiated Test Software	REF9000	Cal not required

16.6 Test Results

WiFi 802.11.b 1Mb/s

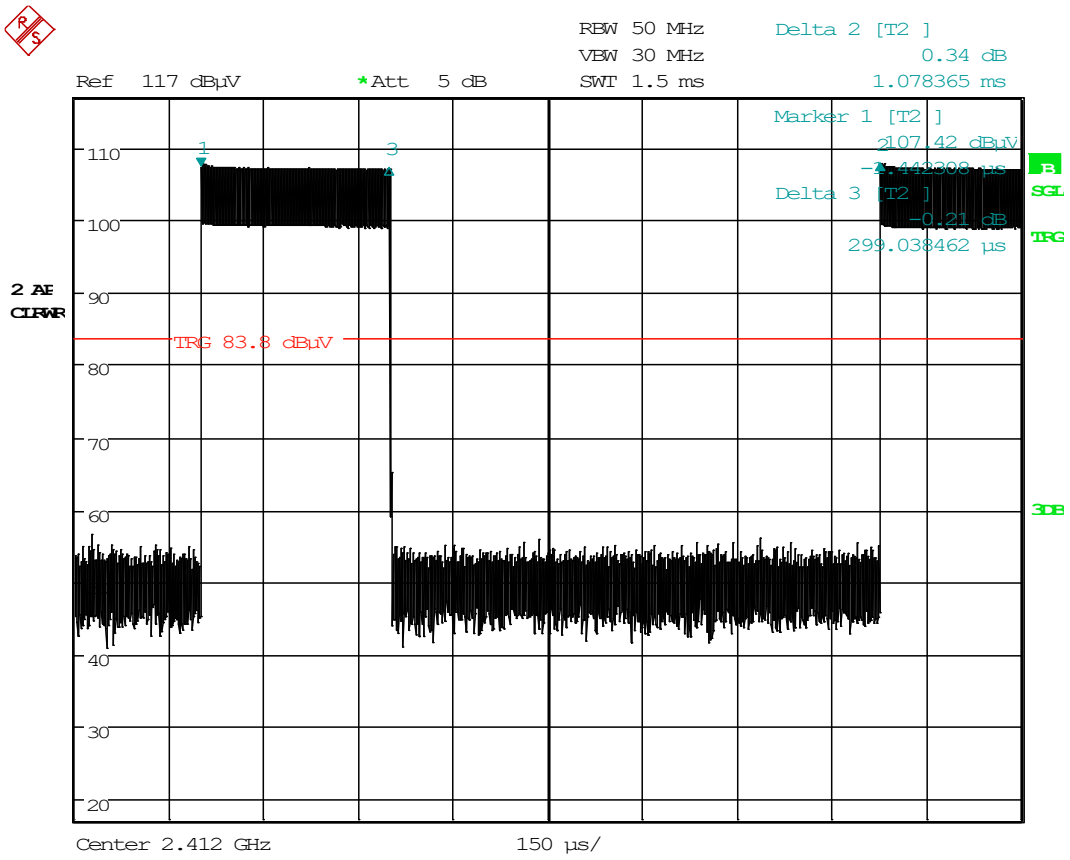
WiFi; 802.11.b 1Mb/s; DSSS1;				
Test Environment		***TxOn time (us)***	***Frame Period (us)***	***Calculated Factor (dB)***
$V_{nominal}$	$T_{nominal}$	432.11	943.26	6.8



Date: 25.JAN.2022 13:00:33

WiFi 802.11.b 11Mb/s

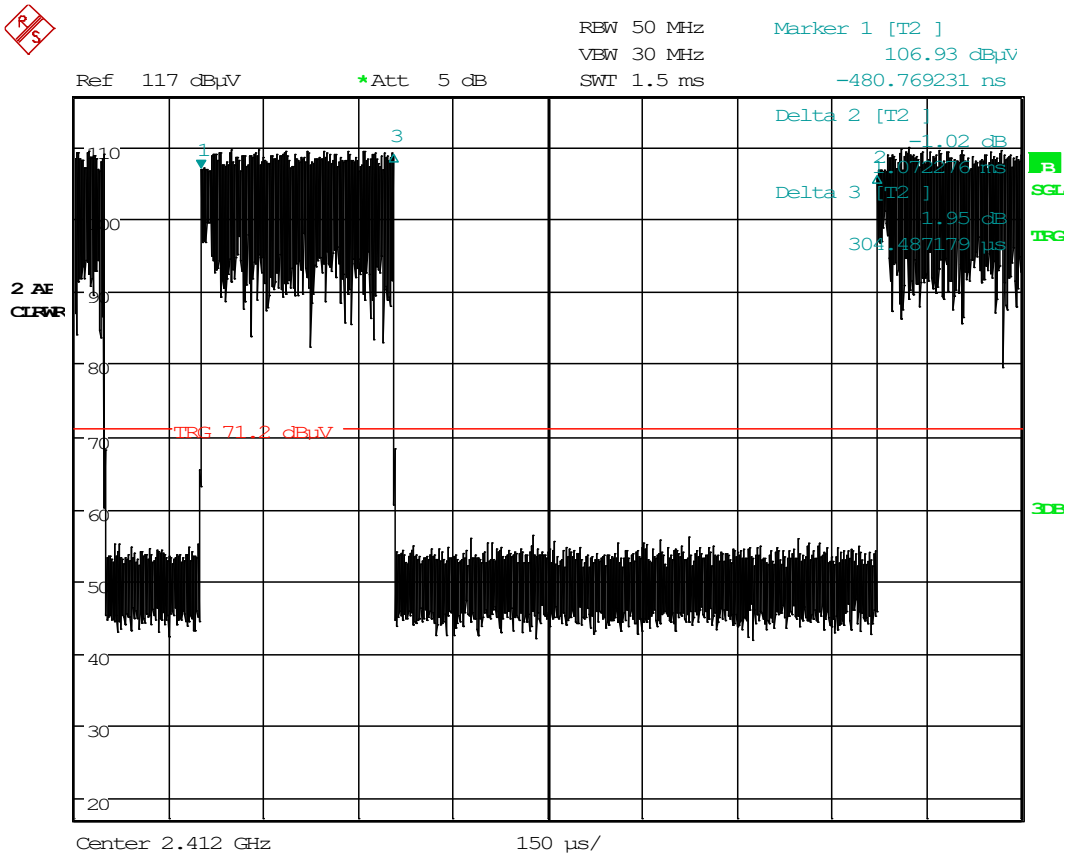
WiFi; 802.11.b 11Mb/s; CCK11;				
Test Environment		TxOn time (ms)	Frame Period (ms)	Calculated Factor (dB)
$V_{nominal}$	$T_{nominal}$	0.299	1.078	11.1



Date: 26.JAN.2022 17:41:12

WiFi 802.11.g 6Mb/s

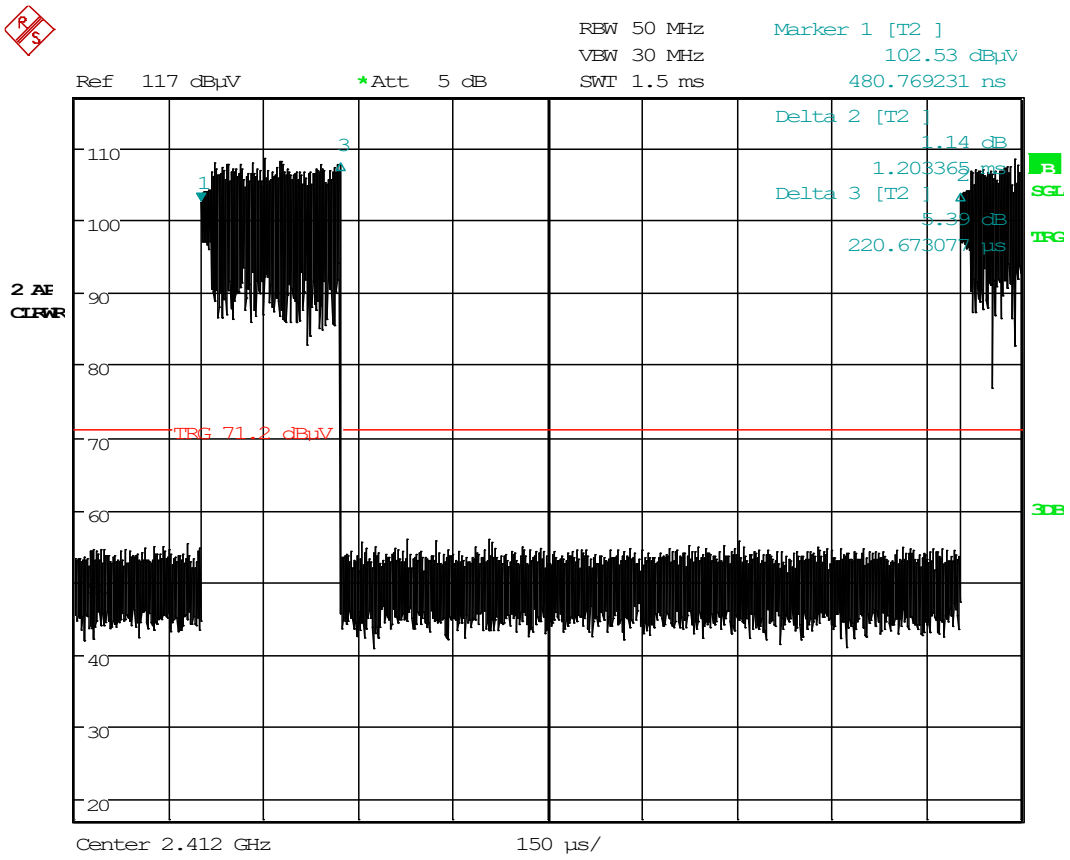
WiFi; 802.11.g 6Mb/s; OFDM6;				
Test Environment		***TxOn time (ms)***	***Frame Period (ms)***	***Calculated Factor (dB)***
$V_{nominal}$	$T_{nominal}$	0.304	1.072	10.9



Date: 26.JAN.2022 17:48:16

WiFi 802.11.g 54Mb/s

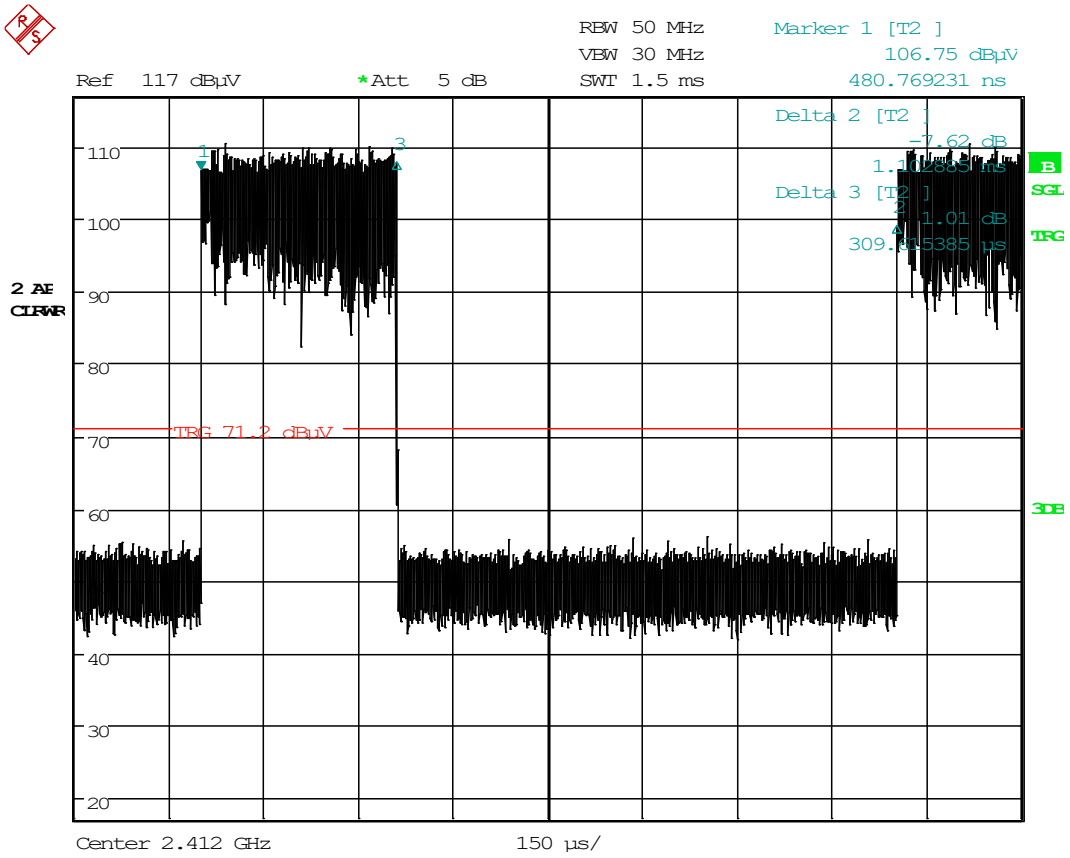
WiFi; 802.11.g 54Mb/s; OFDM54;				
Test Environment		***TxOn time (ms)***	***Frame Period (ms)***	***Calculated Factor (dB)***
$V_{nominal}$	$T_{nominal}$	0.220	1.203	14.7



Date: 27.JAN.2022 08:59:31

WiFi 802.11.n 7.2Mb/s

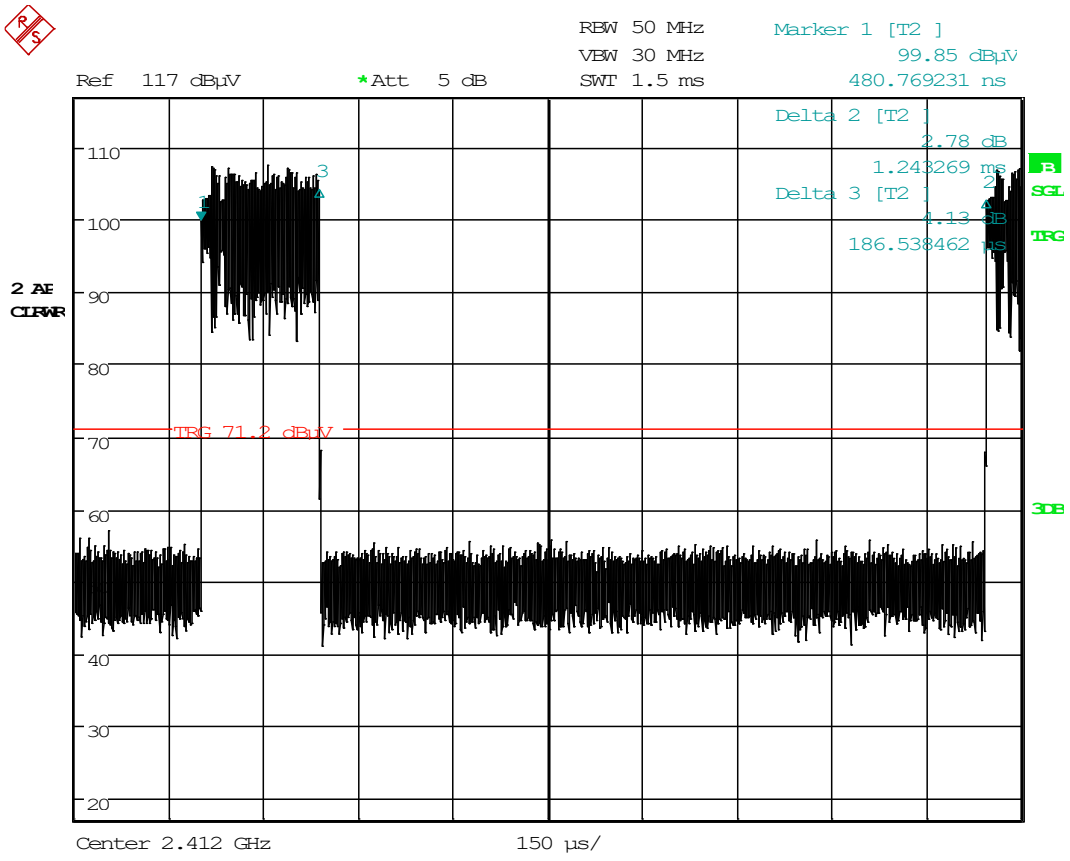
WiFi; 802.11.n; MCS0;				
Test Environment		***TxOn time (ms)***	***Frame Period (ms)***	***Calculated Factor (dB)***
$V_{nominal}$	$T_{nominal}$	0.309	1.102	11



Date: 27.JAN.2022 09:03:36

WiFi 802.11.n 72.2 Mb/s

WiFi; 802.11.n; MCS7;				
Test Environment		**TxOn time (ms)**	**Frame Period (ms)**	**Calculated Factor (dB)**
$V_{nominal}$	$T_{nominal}$	0.186	1.243	16.5



Date: 27.JAN.2022 09:06:50

17 Measurement Uncertainty

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence where no required test level exists.

Test/Measurement	Budget Number	MU
Conducted RF Power, Power Spectral Density, Adjacent Channel Power and Spurious emissions		
Absolute RF power (via antenna connecter) Dare RPR3006W Power Head	MU4001	**0.9 dB**
Carrier Power and PSD - Spectrum Analysers	MU4004	**0.9 dB**
Adjacent Channel Power	MU4002	**1.9 dB**
Transmitter conducted spurious emissions	MU4041	**0.9 dB**
Conducted power and spurious emissions 40 GHz to 50 GHz	MU4042	**2.4 dB**
Conducted power and spurious emissions 50 GHz to 75 GHz	MU4043	**2.5 dB**
Conducted power and spurious emissions 75 GHz to 110 GHz	MU4044	**2.4 dB**
Radiated RF Power and Spurious emissions ERP and EIRP		
Effective Radiated Power Reverb Chamber	MU4020	**3.7 dB**
Effective Radiated Power	MU4021	**4.7 dB**
TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna	MU4046	**5.3 dB**
TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna	MU4047	**5.1 dB**
TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn	MU4048	**2.7 dB**
TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn	MU4049	**2.7 dB**
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz	MU4037	**4.7 dB**
Radiated Spurious Emissions 1-18 GHz	MU4032	**4.5 dB**
E Field Emissions 18GHz to 26 GHz	MU4024	**3.2 dB**
E Field Emissions 26GHz to 40 GHz	MU4025	**3.3 dB**
E Field Emissions 40GHz to 50 GHz	MU4026	**3.5 dB**
E Field Emissions 50GHz to 75 GHz	MU4027	**3.6 dB**
E Field Emissions 75GHz to 110 GHz	MU4028	**3.6 dB**
Radiated Magnetic Field Emissions	MU4031	**2.3 dB**
Frequency Measurements		
Frequency Deviation	MU4022	**0.316 kHz**
Frequency error using CMTA test set	MU4023	**113.441 Hz**
Frequency error using GPS locked frequency source	MU4045	**0.0413 ppm**
Bandwidth/Spectral Mask Measurements		
Channel Bandwidth	MU4005	**3.87 %**
Transmitter Mask Amplitude	MU4039	**1.3 dB**
Transmitter Mask Frequency	MU4040	**2.59 %**
Time Domain Measurements		
Transmission Time	MU4038	**4.40 %**
Dynamic Frequency Selection (DFS) Parameters)		
DFS Analyser - Measurement Time	MU4006	**679 µs**
DFS Generator - Frequency Error	MU4007	**92 Hz**
DFS Threshold Conducted	MU4008	**1.3 dB**
DFS Threshold Radiated	MU4009	**3.2 dB**

Test/Measurement	Budget Number	MU
Receiver Parameters		
EN300328 Receiver Blocking	MU4010	**1.1 dB**
EN301893 Receiver Blocking	MU4011	**1.1 dB**
EN303340 Adjacent Channel Selectivity	MU4012	**1.1 dB**
EN303340 Overloading	MU4013	**1.1 dB**
EN303340 Receiver Blocking	MU4014	**1.1 dB**
EN303340 Receiver Sensitivity	MU4015	**0.9 dB**
EN303372-1 Image Rejection	MU4016	**1.4 dB**
EN303372-1 Receiver Blocking	MU4017	**1.1 dB**
EN303372-2 Adjacent Channel Selectivity	MU4018	**1.1 dB**
EN303372-2 Dynamic Range	MU4019	**0.9 dB**
Receiver Blocking Talk Mode Conducted	MU4033	**1.2 dB**
Receiver Blocking Talk Mode- radiated	MU4034	**3.4 dB**
Rx Blocking, listen mode, blocking level	MU4035	**3.2 dB**
Rx Blocking, listen mode, radiated Threshold Measurement	MU4036	**3.4 dB**
Adjacent Sub Band Selectivity	MU4003	**4.2 dB**