Report on the Radio Testing

For

Dynamic Load Monitoring

on

TD3.0 Telemetry Dongle

Report no. TRA-058422-47-00B

2024-03-22

Report Number: TRA-058422-47-00B
Issue: B

REPORT ON THE RADIO TESTING OF A
Dynamic Load Monitoring
TD3.0 Telemetry Dongle
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2022-06-16 to 2023-01-06

Tested by:		Steven Garwell
Written by:		Steven Garwell Radio Test Engineer
Approved by:	 Digitally signed by John Charters Date: 2024.04.11 14:44:45 +01'00'	John Charters Department Manager - Radio
Date:	2024-03-22	

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	2023-03-06	Original
B	2024-03-22	Updated plot for frequency separation to show marker frequencies instead of delta, added client declaration in Appendix A to show declared duty cycle.

2 Summary

TEST REPORT NUMBER:	TRA-058422-47-00B
WORKS ORDER NUMBER:	TRA-058422-01
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15.247
FCC IDENTIFIER:	2ASHVTD3.0
EQUIPMENT UNDER TEST (EUT):	TD3.0 Telemetry Dongle
EUT SERIAL NUMBER(S):	10500004 (Radiated), 1050006 (Conducted)
MANUFACTURER/AGENT:	Dynamic Load Monitoring
ADDRESS:	Bridgers Farm Nursling Street Nursling Southampton SO16 0YA United Kingdom
CLIENT CONTACT:	Chris Scrutton ☎ +44 (0)2380 741700 ✉ chris@dlm-uk.com
ORDER NUMBER:	221257
TEST DATE:	2022-06-16 to 2023-01-06
TESTED BY:	Steven Garwell 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	☒	*PASS*
Carrier frequency separation	15.247 (a) (1)	☒	*PASS*
Number of hopping channels	15.247 (a) (1) (i), (ii) and (iii)	☒	*PASS*
Average time of occupancy	15.247 (a) (1) (i), (ii) and (iii)	☒	*PASS*
Maximum peak conducted output power	15.247 (a) (1), (b)(1) and (b)(2)	☒	*PASS*
20 dB emission bandwidth	15.247 (a) (1) (i) and (ii)	☒	*PASS*
Out-of-band emissions	15.247(d)	☒	*PASS*
Calculation of duty correction	-	☒	-

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-058422-47-00B presents the results of the Radio testing on a Dynamic Load Monitoring, TD3.0 Telemetry Dongle to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Dynamic Load Monitoring 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 US-UK MRA,

Designation number(s):

Element Hull	UK2007
Element Skelmersdale	UK2020

IC Registration Numbers:

Element Hull	3483A
Element North West	3930B

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

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: TD3.0 Telemetry Dongle
- Serial Number(s): 10500004 (Radiated), 1050006 (Conducted)
- Model Number: DT105
- Software Revision: 1.0.180
- Build Level / Revision Number: Pro 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.

- *Test Laptop Computer*

7.3 EUT Mode of Operation

The EUT was transmitting on the frequencies as indicated, the EUT was connected to the USB port of a test laptop computer running the DT105 Dongle Setup application. This application was used to program the bottom, middle and top channels of operation as required.

7.4 EUT Radio Parameters

7.4.1 General

Frequencies of operation:	2402 MHz to 2480 MHz
Occupied channel bandwidth:	1 MHz
Channel spacing:	1 MHz
Declared output power:	≤ 20 dBm
Nominal Supply Voltage:	5 Vdc
Duty cycle:	10%
Antenna Type and Gain:	Siretta delta 15 /SMAM/RA/11, Gain = 2 dBi

7.5 EUT Description

The EUT is a USB dongle with 802.15.1 radio.

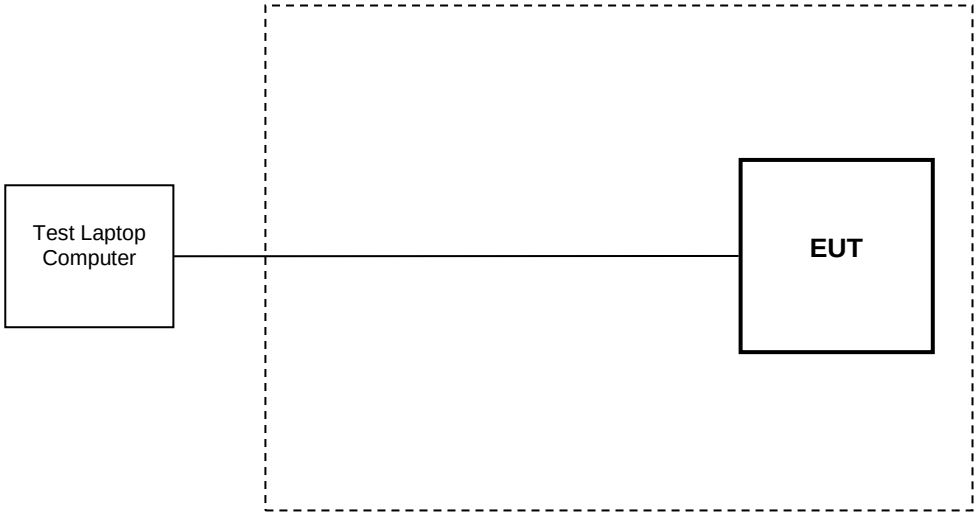
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:

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 E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 5 Vdc via USB.

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 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 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: CISPR average and Peak

Environmental Conditions (Normal Environment)

Temperature: 16 °C	+15 ºC to +35 ºC (as declared)
Humidity: 61 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

11.3 Test Limit

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

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

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:

$$FS = PR + CL + AF – PA + DC – CF$$

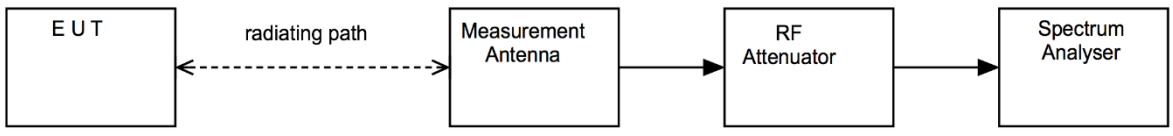
$$Factor = PR + CL + AF$$

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

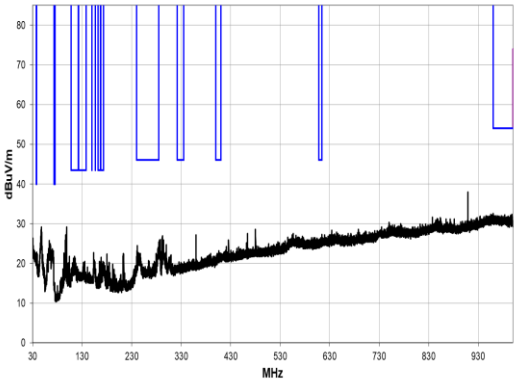


11.5 Test Equipment

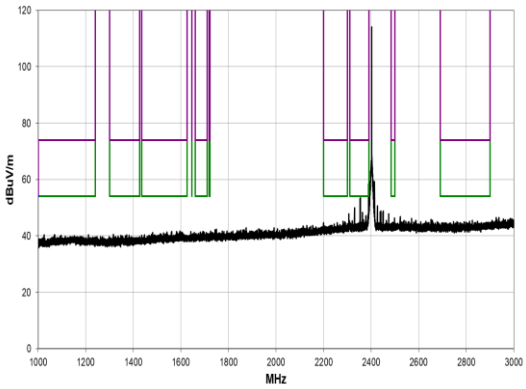
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
EMI Receiver	R&S	ESR26	U489	2023-03-04
1-18GHz Horn	EMCO	3115	L139	2024-07-01
Horn 18-26GHz (&U330)	Flann	20240-20	L263A	2024-06-23
Pre Amp	Agilent	8449B	U457	2023-01-22
Bilog	Chase	CBL611/B	U573	2023-01-28
PreAmp	Watkins Johnson	6201-69	U372	2023-03-01
2.4G Band Stop Filter	BSC	SN 4478	U543	2023-02-03
High Pass Filter	Atlantic Microwave	AFH-07000	U558	2023-02-03
Chamber 1	Rainford EMC	ATS	U387	2023-10-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

11.6 Test Results

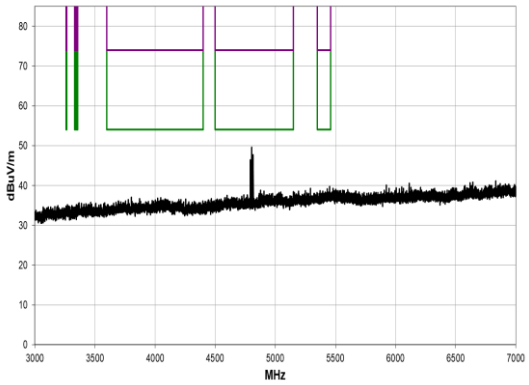
Frequency: 2402 MHz



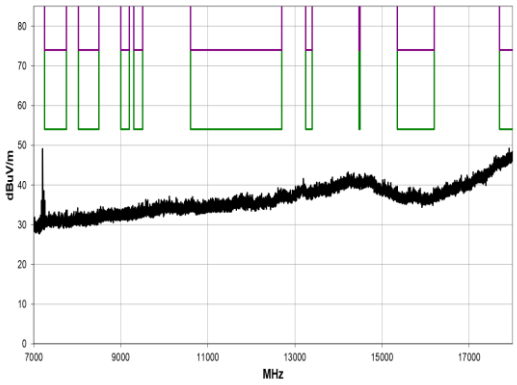
30 MHz to 1 GHz



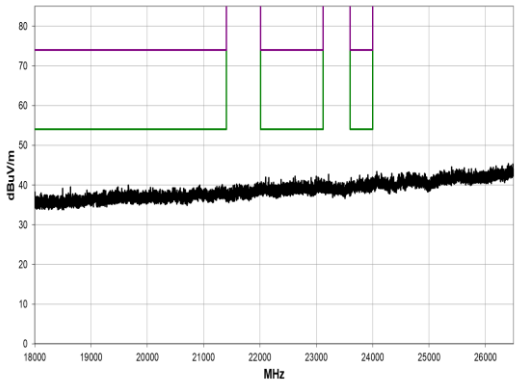
1 GHz to 3 GHz



3 GHz to 7 GHz



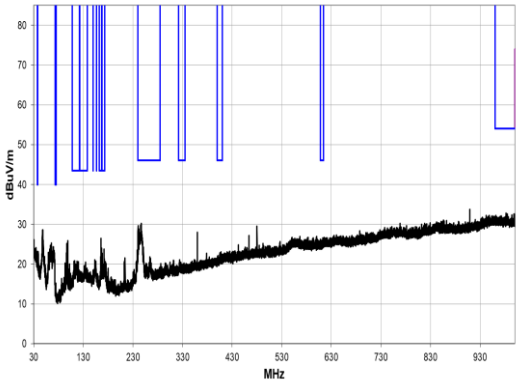
7 GHz to 18 GHz



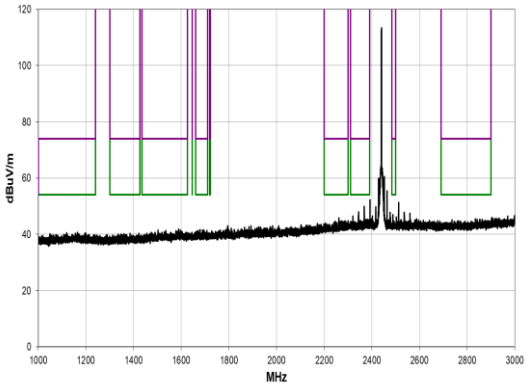
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2389.825	55.3	-3.5	1.5	29.1	-20.0	10.0	Horz	AV	0.0	41.8	54.0	-12.2
2389.825	55.3	-3.5	1.5	29.1		10.0	Horz	PK	0.0	61.8	74.0	-12.2
2354.050	53.8	-3.5	1.7	49.0	-20.0	10.0	Horz	AV	0.0	40.3	54.0	-13.7
2354.050	53.8	-3.5	1.7	49.0		10.0	Horz	PK	0.0	60.3	74.0	-13.7
2330.180	50.2	-3.7	1.5	54.1	-20.0	10.0	Horz	AV	0.0	36.5	54.0	-17.5
2330.180	50.2	-3.7	1.5	54.1		10.0	Horz	PK	0.0	56.5	74.0	-17.5
4803.808	51.8	3.5	1.6	268.2	-20.0	0.0	Vert	AV	0.0	35.3	54.0	-18.7
4803.808	51.8	3.5	1.6	268.2		0.0	Vert	PK	0.0	55.3	74.0	-18.7
4803.700	49.7	3.5	1.5	350.8	-20.0	0.0	Horz	AV	0.0	33.2	54.0	-20.8
4803.700	49.7	3.5	1.5	350.8		0.0	Horz	PK	0.0	53.2	74.0	-20.8

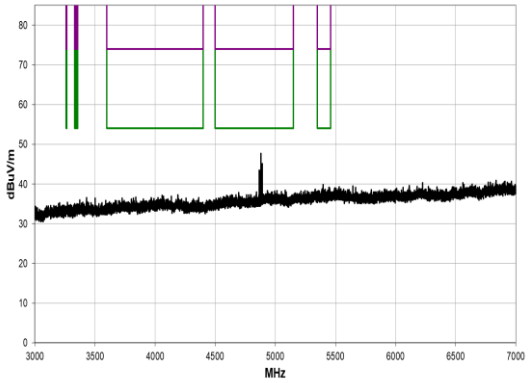
Frequency: 2440 MHz



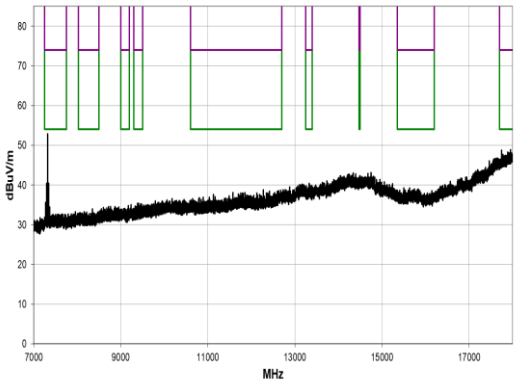
30 MHz to 1 GHz



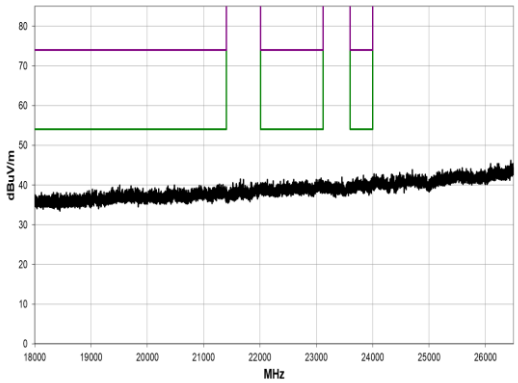
1 GHz to 3 GHz



3 GHz to 7 GHz



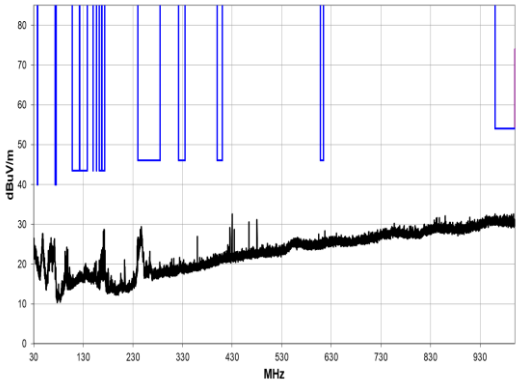
7 GHz to 18 GHz



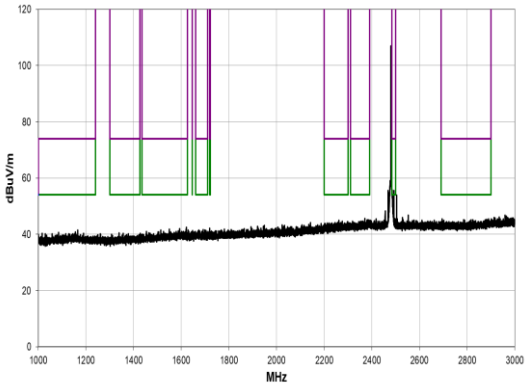
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2367.815	50.4	-3.5	1.5	60.0	-20.0	10.0	Horz	AV	0.0	36.9	54.0	-17.1
2367.815	50.4	-3.5	1.5	60.0		10.0	Horz	PK	0.0	56.9	74.0	-17.1
2343.813	48.5	-3.6	1.5	41.2	-20.0	10.0	Horz	AV	0.0	34.9	54.0	-19.1
2343.813	48.5	-3.6	1.5	41.2		10.0	Horz	PK	0.0	54.9	74.0	-19.1
7320.408	56.5	8.5	1.5	189.1	-20.0	0.0	Horz	AV	-9.5	35.5	54.0	-18.5
7320.408	56.5	8.5	1.5	189.1		0.0	Horz	PK	-9.5	55.5	74.0	-18.5
7319.642	53.8	8.5	1.5	194.9	-20.0	0.0	Vert	AV	-9.5	32.8	54.0	-21.2
7319.642	53.8	8.5	1.5	194.9		0.0	Vert	PK	-9.5	52.8	74.0	-21.2

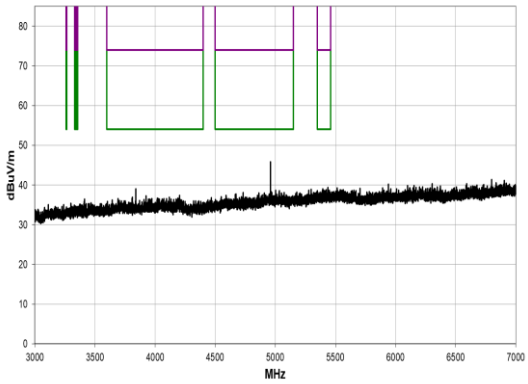
Frequency: 2480 MHz



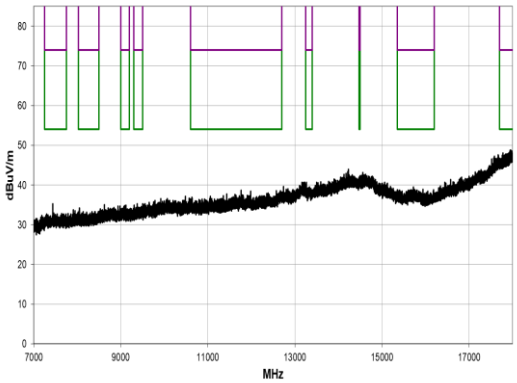
30 MHz to 1 GHz



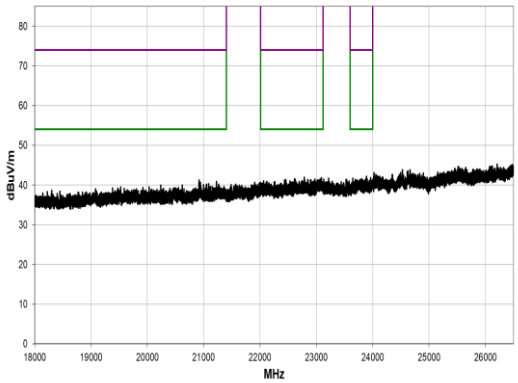
1 GHz to 3 GHz



3 GHz to 7 GHz



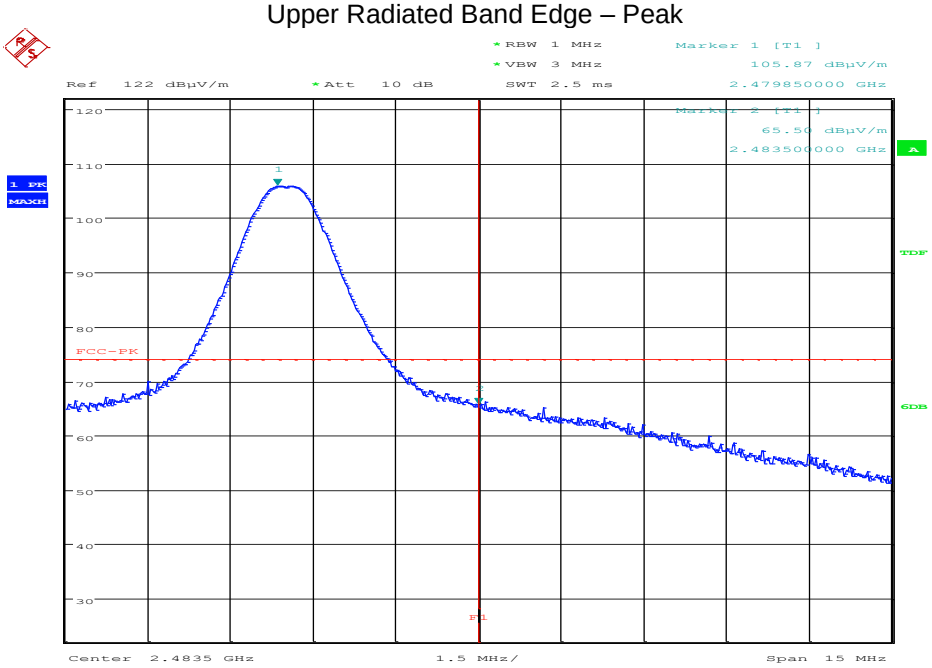
7 GHz to 18 GHz



18 GHz to 26.5 GHz

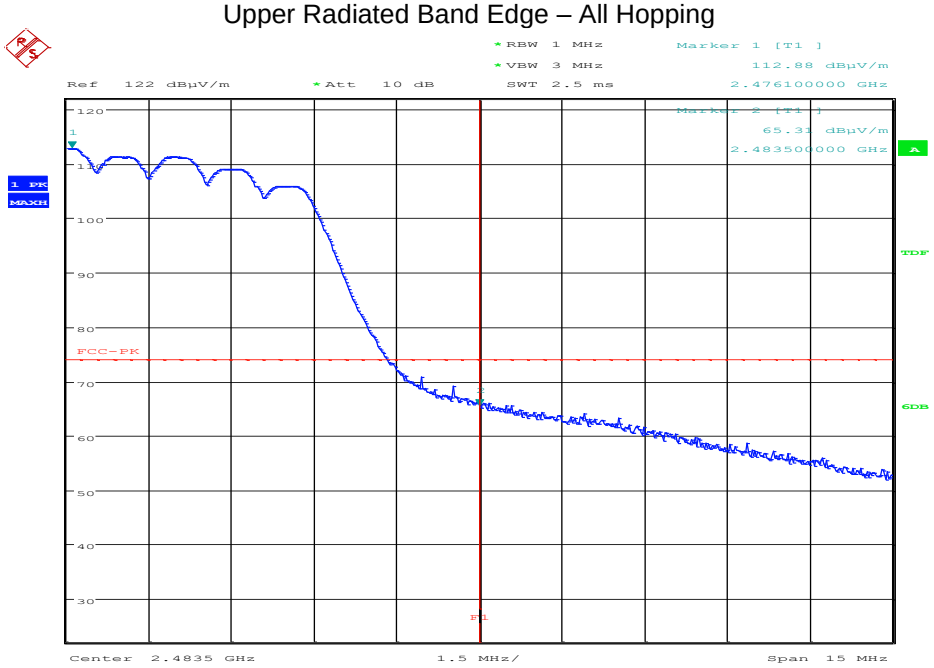
Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2483.720	66.1	-3.5	1.8	150.0	-20.0	10.0	Vert	AV	0.0	52.6	54.0	-1.4
2483.720	66.1	-3.5	1.8	150.0		10.0	Vert	PK	0.0	72.6	74.0	-1.4
2492.287	54.4	-3.4	1.8	51.0	-20.0	10.0	Horz	AV	0.0	41.0	54.0	-13.0
2492.287	54.4	-3.4	1.8	51.0		10.0	Horz	PK	0.0	61.0	74.0	-13.0

Upper Radiated Band Edge – Peak



Bandedge Average Level Assessment					
Frequency (MHz)	***Peak Level (dBuV/m)***	***Duty Cycle Correction Factor (dBm)***	***Average Level (dBuV/m)***	***Limit (dBuV/m)***	***Result***
2483.5	65.5	-20	45.5	54	PASS

Upper Radiated Band Edge – All Hopping



12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Transient Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequencies Measured:	2440 MHz
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 53 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average****
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

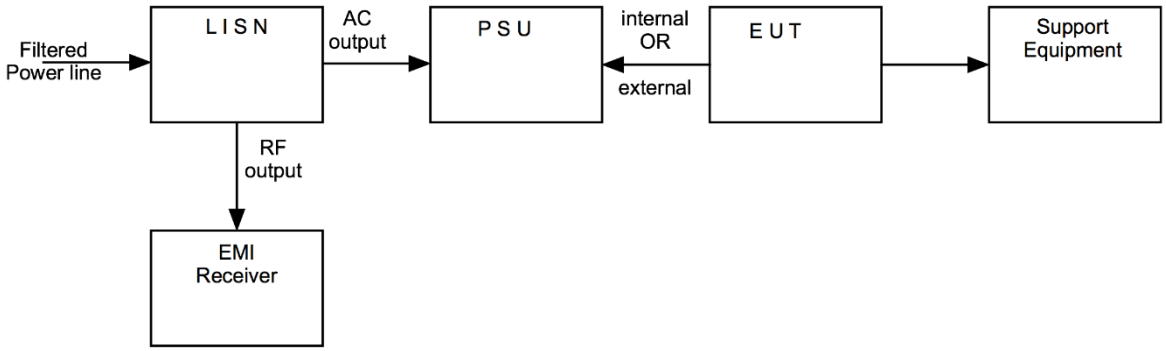
12.3 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup

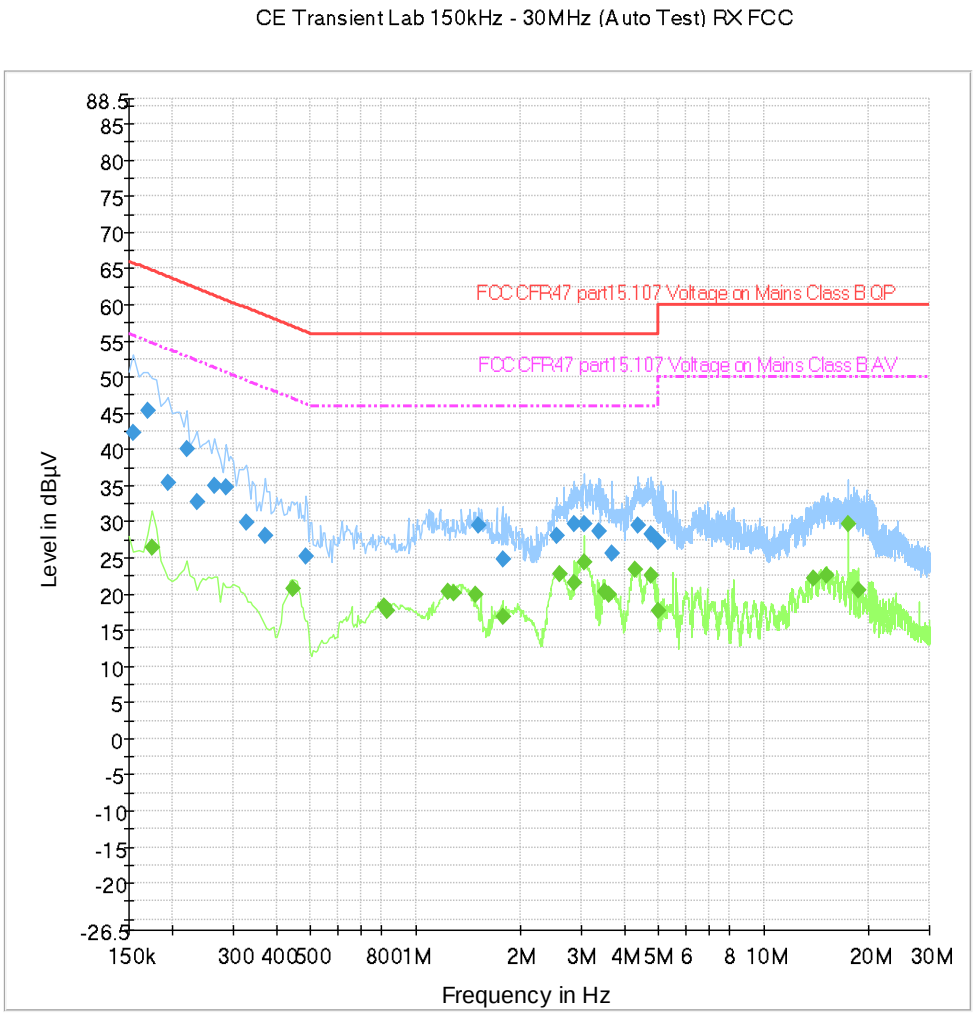


12.4 Test Set-up Photograph

12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	R&S	ESR 7	U727	2023-04-27
Lisn	R&S	ENV216	U396	2023-05-23
Pulse Limiter	R&S	ESH3-Z2	U559	2023-01-26

12.6 Test Results



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.155000	42.2	2000.0	10.000	On	N	19.6	23.5	65.7
0.170000	45.3	2000.0	10.000	On	N	19.6	19.6	65.0
0.195000	35.4	2000.0	10.000	On	L1	19.7	28.4	63.8
0.220000	40.0	2000.0	10.000	On	N	19.6	22.8	62.8
0.235000	32.8	2000.0	10.000	On	L1	19.7	29.5	62.3
0.265000	34.9	2000.0	10.000	On	N	19.7	26.4	61.3
0.285000	34.8	2000.0	10.000	On	L1	19.8	25.9	60.7
0.325000	29.9	2000.0	10.000	On	L1	19.8	29.7	59.6
0.370000	28.0	2000.0	10.000	On	L1	19.8	30.5	58.5
0.485000	25.3	2000.0	10.000	On	L1	19.8	31.0	56.3
1.520000	29.5	2000.0	10.000	On	N	19.8	26.5	56.0
1.780000	24.8	2000.0	10.000	On	N	19.8	31.2	56.0
2.535000	28.0	2000.0	10.000	On	N	19.8	28.0	56.0
2.860000	29.6	2000.0	10.000	On	N	19.8	26.4	56.0
3.050000	29.7	2000.0	10.000	On	N	19.9	26.3	56.0
3.350000	28.7	2000.0	10.000	On	N	19.9	27.3	56.0
3.675000	25.6	2000.0	10.000	On	N	19.9	30.4	56.0
4.360000	29.5	2000.0	10.000	On	N	19.9	26.5	56.0
4.730000	28.4	2000.0	10.000	On	L1	20.0	27.6	56.0
4.965000	27.3	2000.0	10.000	On	N	20.0	28.7	56.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.175000	26.4	2000.0	10.000	On	N	19.6	28.3	54.7
0.445000	20.6	2000.0	10.000	On	N	19.7	26.3	47.0
0.810000	18.2	2000.0	10.000	On	N	19.8	27.8	46.0
0.825000	17.7	2000.0	10.000	On	N	19.8	28.3	46.0
1.240000	20.2	2000.0	10.000	On	N	19.8	25.8	46.0
1.290000	20.1	2000.0	10.000	On	N	19.8	25.9	46.0
1.485000	19.9	2000.0	10.000	On	N	19.8	26.1	46.0
1.780000	16.8	2000.0	10.000	On	N	19.8	29.2	46.0
2.590000	22.8	2000.0	10.000	On	N	19.8	23.2	46.0
2.860000	21.5	2000.0	10.000	On	N	19.8	24.5	46.0
3.050000	24.4	2000.0	10.000	On	N	19.9	21.6	46.0
3.495000	20.3	2000.0	10.000	On	N	19.9	25.7	46.0
3.605000	20.0	2000.0	10.000	On	N	19.9	26.0	46.0
4.255000	23.4	2000.0	10.000	On	N	19.9	22.6	46.0
4.735000	22.5	2000.0	10.000	On	N	20.0	23.5	46.0
4.965000	17.7	2000.0	10.000	On	N	20.0	28.3	46.0
13.970000	22.1	2000.0	10.000	On	L1	20.6	27.9	50.0
15.145000	22.5	2000.0	10.000	On	L1	20.7	27.5	50.0
17.575000	29.6	2000.0	10.000	On	L1	20.9	20.4	50.0
18.695000	20.6	2000.0	10.000	On	L1	21.0	29.4	50.0

13 Carrier frequency separation

13.1 Definition

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

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.2
EUT Frequencies Measured:	All; 2402 to 2480 MHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

13.3 Test Limit

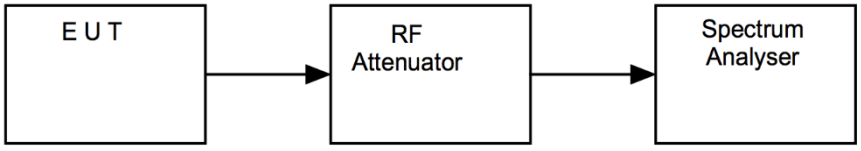
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies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

13.4 Test Method

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

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

Figure iii Test Setup

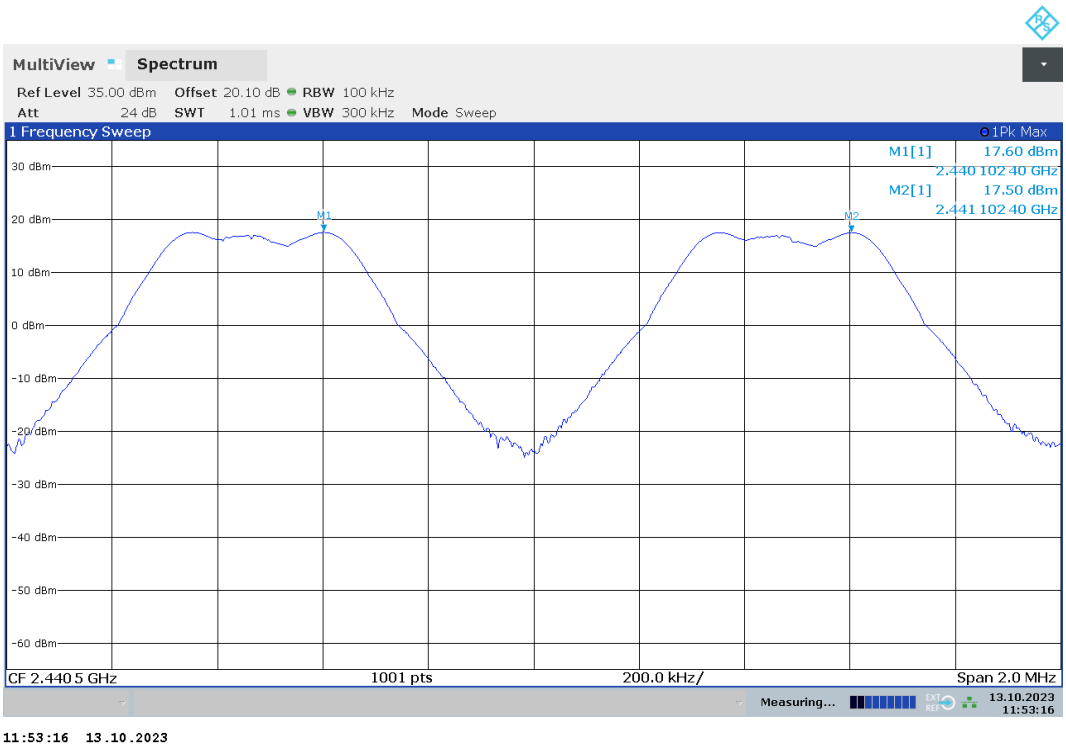


13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
Spectrum Analyser	R&S	FSW 43	U728	2024-05-10
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

13.6 Test Results

Channel: All (Hopping); Power setting: Default				
Data Rate	**$F1_c$ (MHz)**	**$F2_c$ (MHz)**	**Channel Separation, $F2_c - F1_c$ (kHz)**	**Result**
1 Mbps	2440.10240	2441.10240	1000.00	PASS



2402 MHz to 2480 MHz – ALL HOPPING

14 Number of hopping frequencies

14.1 Definition

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

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.3
EUT Frequencies Measured:	All; 2402 – 2480 MHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

14.3 Test Limit

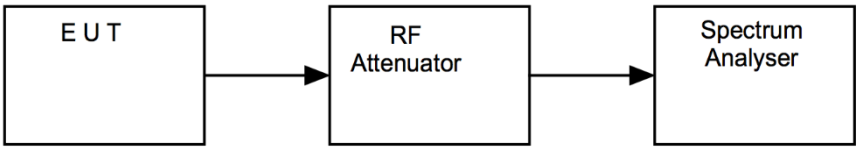
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels;
  If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;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

14.4 Test Method

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

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

Figure iv Test Setup

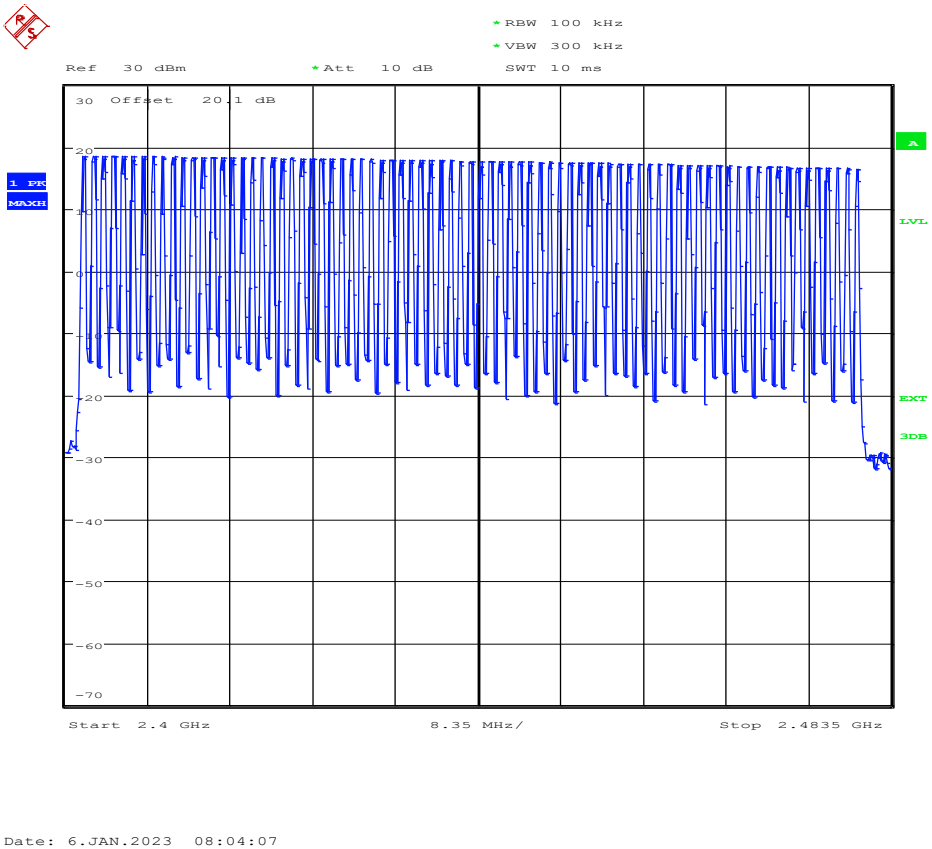


14.5 Test Equipment

Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

14.6 Test Results

Channel: All (Hopping); Power setting: Default				
Data Rate	*Lowest channel, F_{CL} (MHz)*	*Highest channel, F_{CH} (MHz)*	*Number of channels observed*	*Result*
1 Mbps	2402	2480	79	PASS



2402 MHz to 2480 MHz – ALL HOPPING

15 Average channel occupancy

15.1 Definition

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

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.4
EUT Number of hopping channels:	79
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

15.3 Test Limit

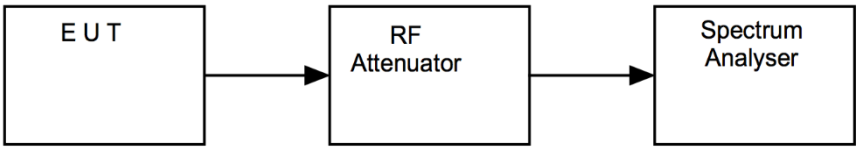
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period;
  If the -20 dB bandwidth of the hopping channel is 250 kHz or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

15.4 Test Method

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

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

Figure v Test Setup

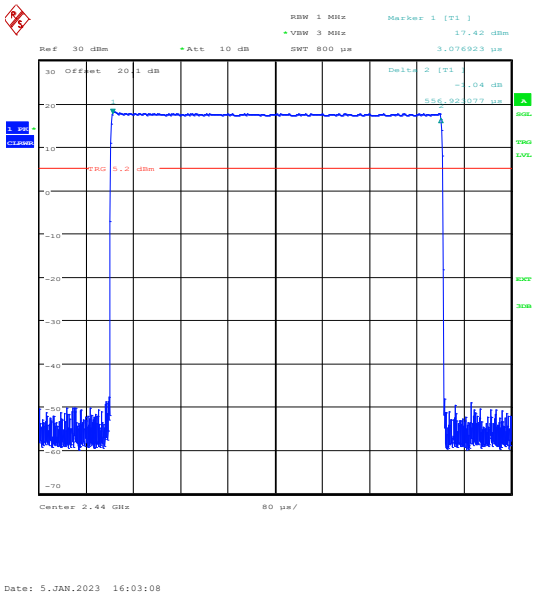


15.5 Test Equipment

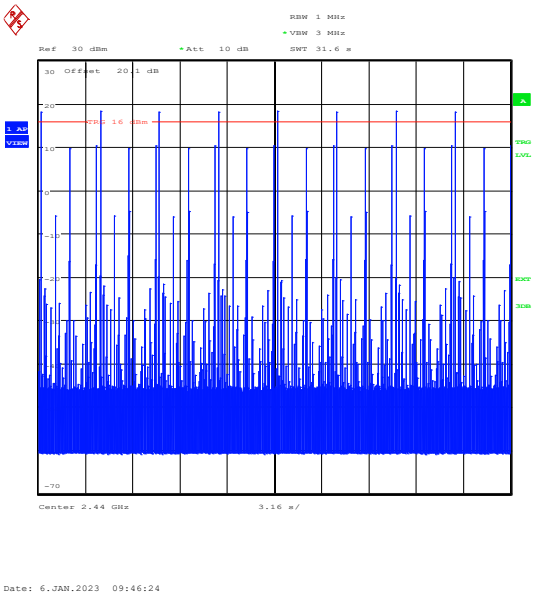
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

15.6 Test Results

Channel: All (Hopping); Power setting Default				
Individual occupancy time (ms)	*Observation period (s)*	*Number of hops observed*	*Average time of occupancy (s)*	*Result*
0.556923077	31.6	8	0.004455385	PASS



TX on (Hopping)



Number of transmissions during observation period

16 Maximum peak conducted output power

16.1 Definition

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

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 MHz
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	2 MHz
Spectrum Analyzer Video BW:	10 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

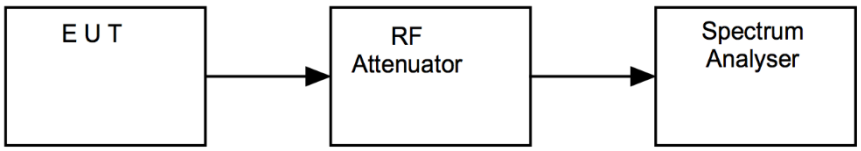
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels;
  the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p.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

16.4 Test Method

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

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

Figure vi Test Setup

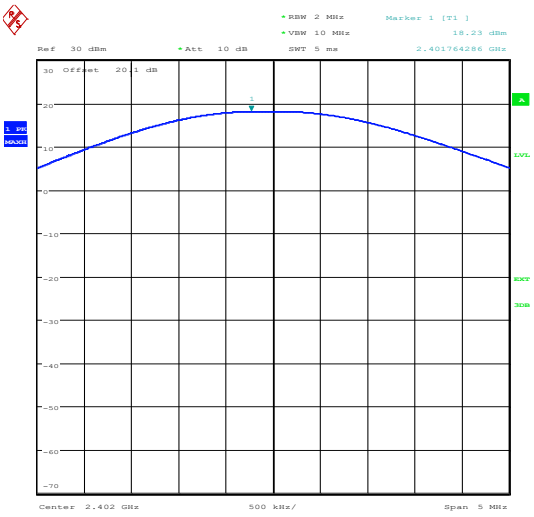


16.5 Test Equipment

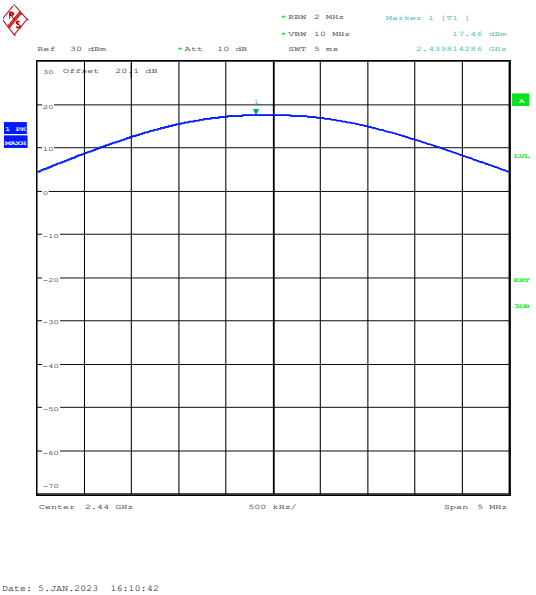
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

16.6 Test Results

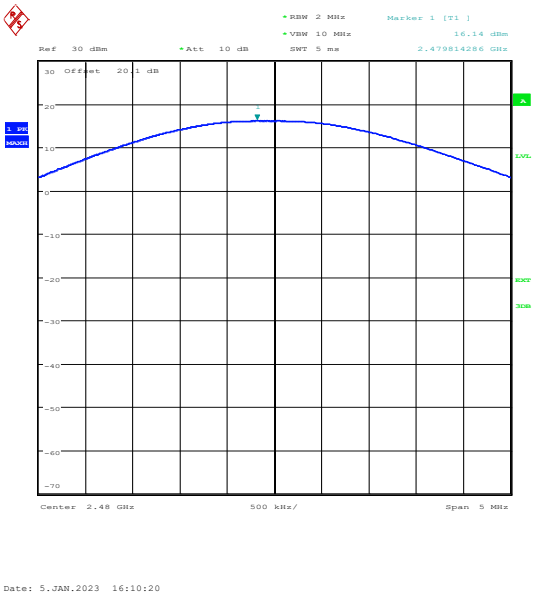
Data rate: 1 Mbps; Power setting: Default					
Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Maximum peak conducted output power (W)***	***Antenna gain (dBi)***	***E.I.R.P. (W)***	***Result***
2402	18.23	0.0665	2	0.1054	PASS
2440	17.46	0.0557	2	0.0883	PASS
2480	16.14	0.0411	2	0.0652	PASS



2402 MHz



2440 MHz



2480 MHz

17 Occupied Bandwidth

17.1 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.

17.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 MHz – Hopping stopped
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	20 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	100 kHz
Measurement Span: (requirement 2 to 5 times OBW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

17.3 Test Limit

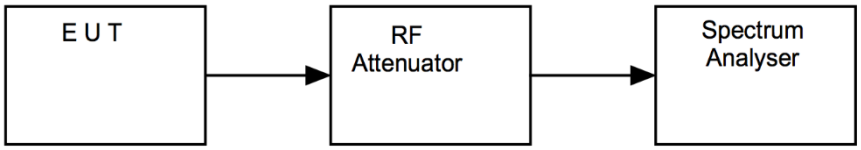
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz
-

17.4 Test Method

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

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

Figure vii Test Setup

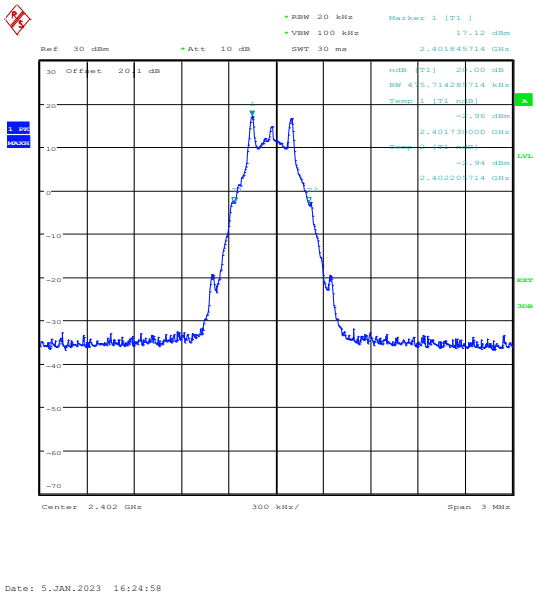


17.5 Test Equipment

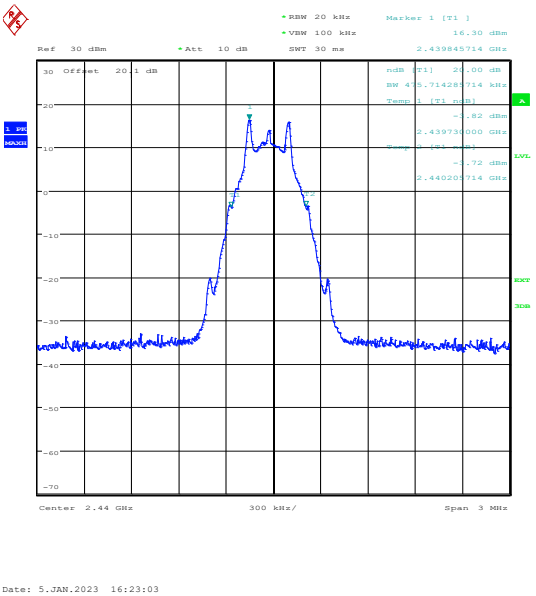
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

17.6 Test Results – 20 dB Bandwidth

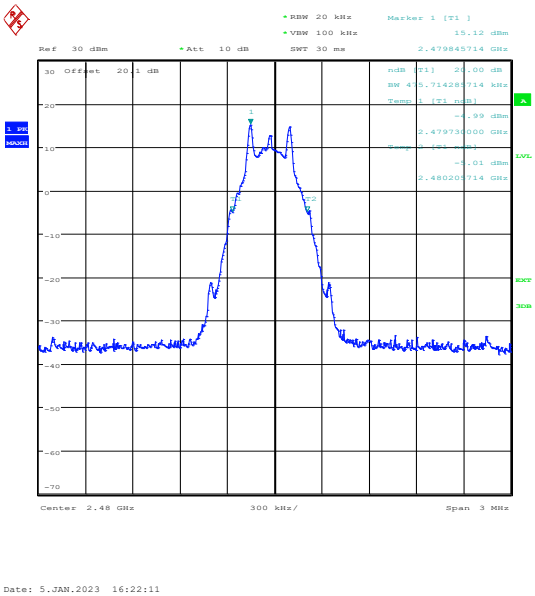
Data rate: 1 Mbps; Power setting: Default				
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***20dB Bandwidth (kHz)***	***Result***
2402	2401.730000	2402.205714	475.714	PASS
2440	2439.730000	2440.205714	475.714	PASS
2480	2479.730000	2480.205714	475.714	PASS



2402 MHz



2440 MHz



2480 MHz

18 Out-of-band and conducted spurious emissions

18.1 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.

18.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.8
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 MHz
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Detector:	Peak
Measurement Range:	9 kHz to 25 GHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

18.3 Test Limits

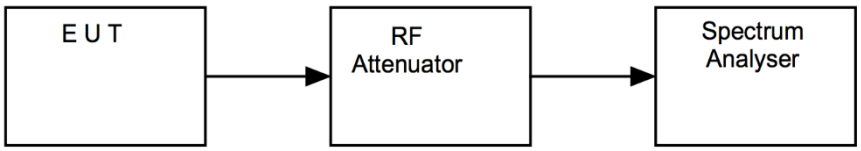
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either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

18.4 Test Method

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

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

Figure viii Test Setup

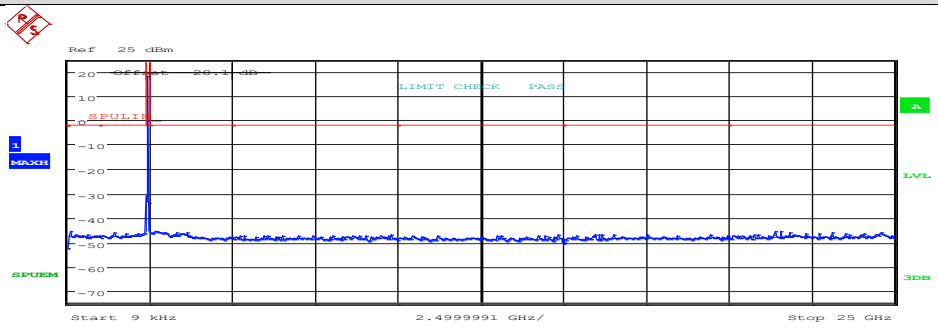


18.5 Test Equipment

Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

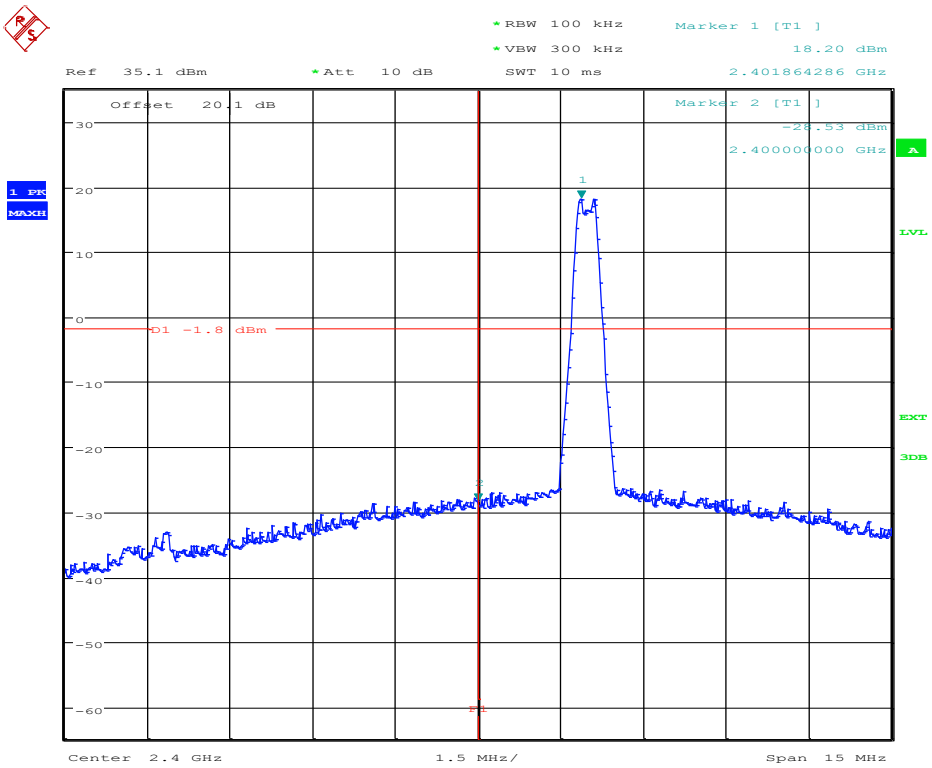
18.6 Test Results

Frequency: 2402 MHz; Bandwidth: 1 MHz; Power setting: Default



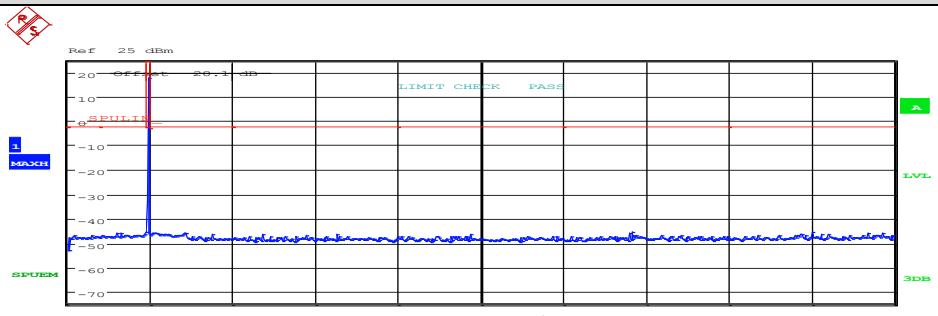
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.225962 k	-58.73	-57.05
150.000 k	30.000 M	10.00 k	173.880000 k	-52.80	-51.12
30.000 M	1.000 G	100.00 k	87.650333 M	-45.51	-43.83
1.000 G	2.400 G	100.00 k	2.398460 G	-31.77	-30.09
2.400 G	2.483 G	2.00 M	2.401971 G	18.30	-11.70
2.483 G	5.000 G	100.00 k	2.644304 G	-45.50	-43.82
5.000 G	10.000 G	100.00 k	9.767000 G	-47.19	-45.51
10.000 G	15.000 G	100.00 k	14.816500 G	-47.01	-45.33
15.000 G	20.000 G	100.00 k	15.950000 G	-46.91	-45.23
20.000 G	25.000 G	100.00 k	21.402500 G	-45.66	-43.98

Date: 6.JAN.2023 15:13:31



Date: 5.JAN.2023 14:32:15

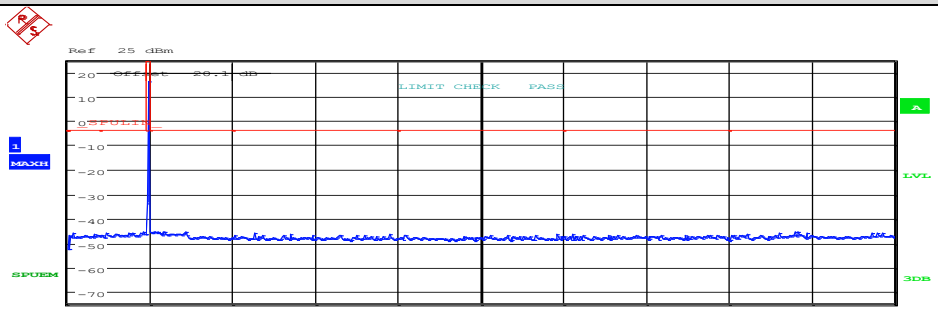
Frequency: 2402 MHz; Bandwidth: 1 MHz; Power setting: Default



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	12.163462 k	-58.46	-55.98
150.000 k	30.000 M	10.00 k	173.880000 k	-53.22	-50.74
30.000 M	1.000 G	100.00 k	708.482667 M	-46.89	-44.41
1.000 G	2.400 G	100.00 k	2.379140 G	-45.78	-43.30
2.400 G	2.483 G	2.00 M	2.439763 G	17.49	-12.51
2.483 G	5.000 G	100.00 k	3.559555 G	-45.83	-43.35
5.000 G	10.000 G	100.00 k	5.898000 G	-46.65	-44.17
10.000 G	15.000 G	100.00 k	12.164000 G	-46.65	-44.17
15.000 G	20.000 G	100.00 k	17.081250 G	-45.74	-43.26
20.000 G	25.000 G	100.00 k	22.517500 G	-45.74	-43.26

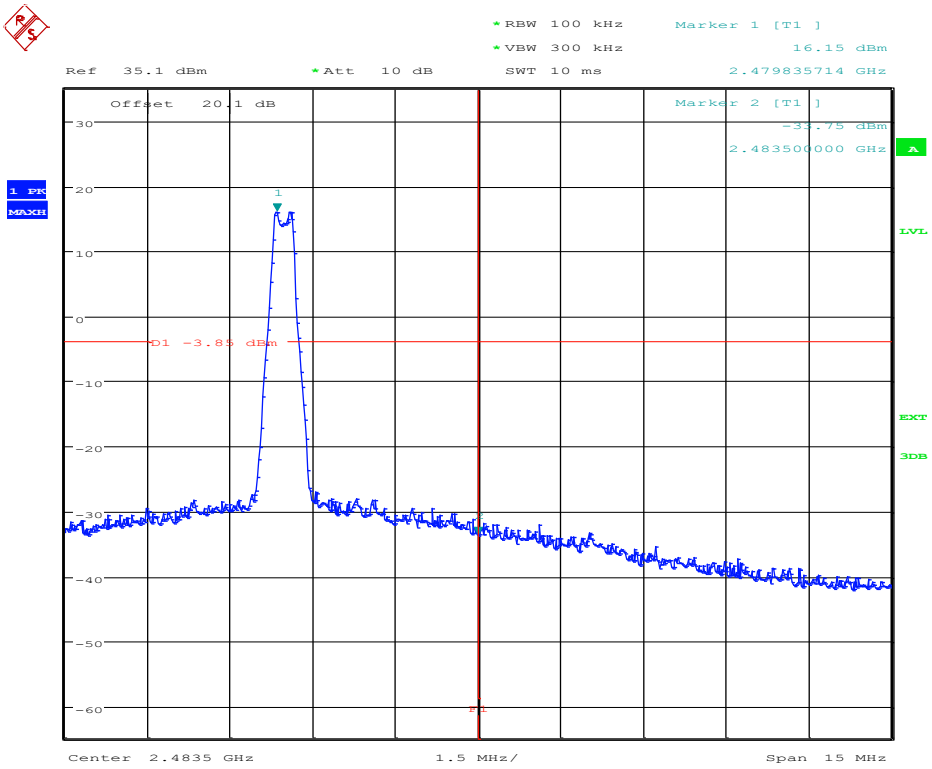
Date: 6.JAN.2023 15:10:43

Frequency: 2480 MHz; Bandwidth: 1 MHz; Power setting: Default



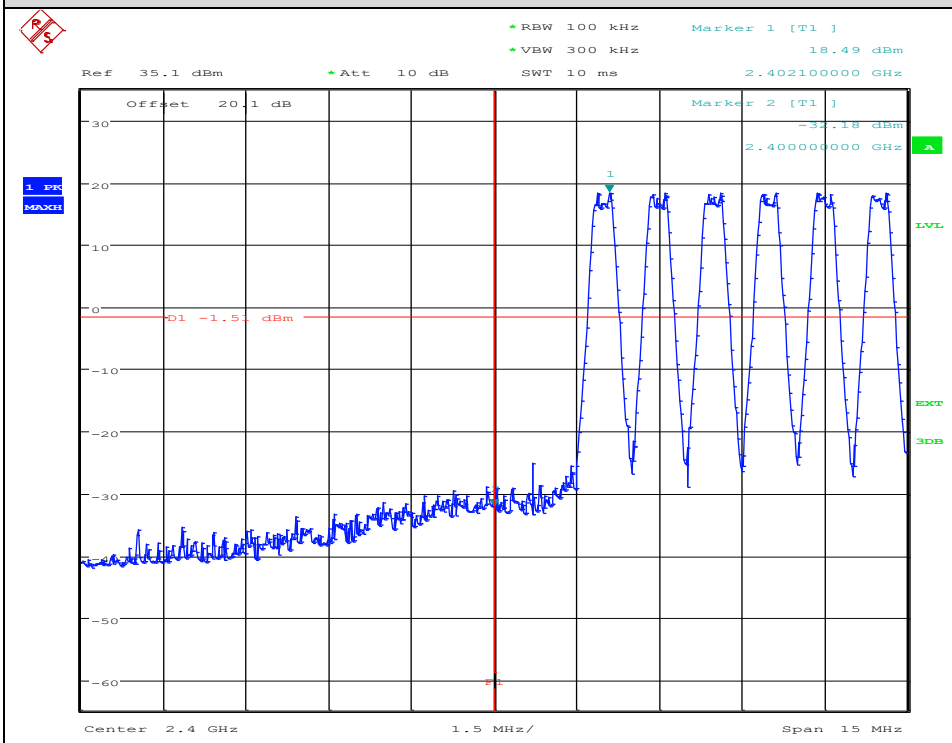
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.225962 k	-56.79	-53.23
150.000 k	30.000 M	10.00 k	155.970000 k	-52.58	-49.02
30.000 M	1.000 G	100.00 k	165.638333 M	-46.30	-42.74
1.000 G	2.400 G	100.00 k	2.274000 G	-45.58	-42.02
2.400 G	2.483 G	2.00 M	2.480035 G	16.31	-13.69
2.483 G	5.000 G	100.00 k	2.484003 G	-34.08	-30.52
5.000 G	10.000 G	100.00 k	5.645500 G	-46.21	-42.65
10.000 G	15.000 G	100.00 k	14.772000 G	-46.78	-43.22
15.000 G	20.000 G	100.00 k	15.266250 G	-46.70	-43.14
20.000 G	25.000 G	100.00 k	21.980000 G	-45.67	-42.11

Date: 6.JAN.2023 15:06:24

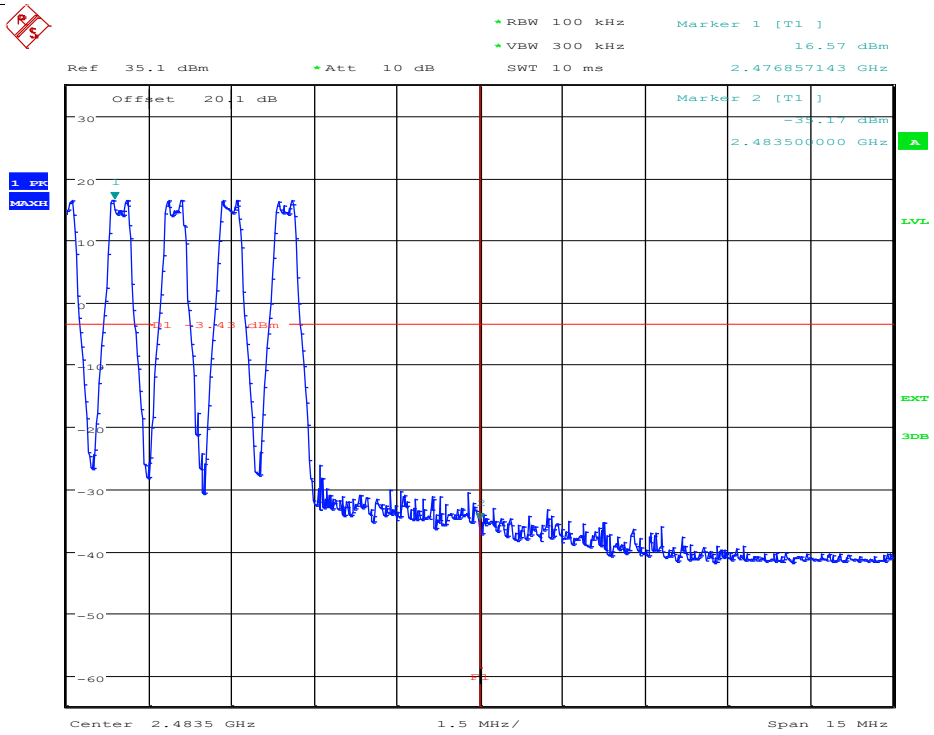


Date: 5.JAN.2023 14:30:54

Channel: All (Hopping); Power setting: Default



Date: 5.JAN.2023 15:07:31



Date: 5.JAN.2023 15:56:43

19 Duty Cycle

19.1 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.

19.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.5
EUT Frequencies Measured:	All Hopping
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 5 Vdc	5 Vdc (as declared)

19.3 Test Limit

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

19.4 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.

[1] Single antenna output devices

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

[2] Multiple antenna output devices

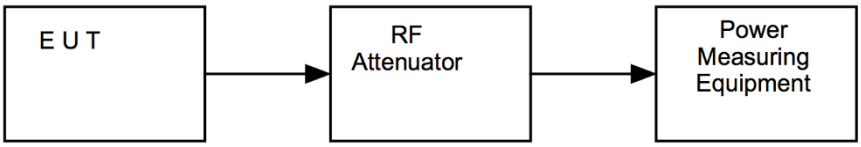
Duty was measured as the combination of all ports simultaneously / at a distance of 3 m.

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

DC = 20 log (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

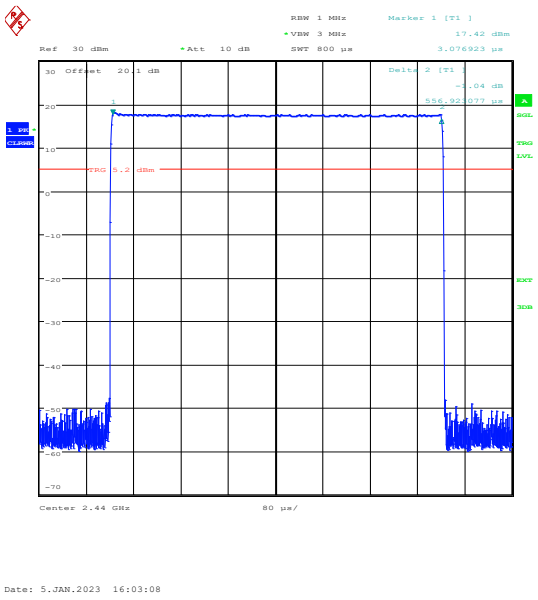


19.5 Test Equipment

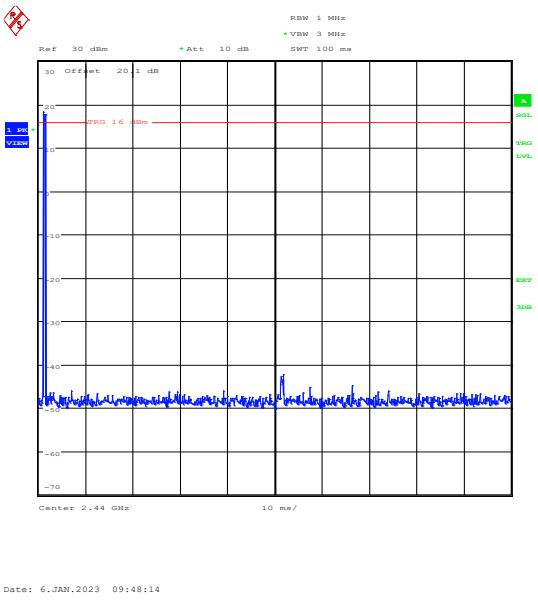
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU26	U405	2023-04-21
Attenuator	AtlanTecRF Microwave	20dB SMA Attenuator	U632	Cal in use

19.6 Test Results

Frequency: All Hopping				
Test Environment		*Total TxOn time (ms)*	*Observation period (ms)*	*Calculated Factor*
$V_{nominal}$	$T_{nominal}$	0.556923077	100	45.1



Tx on time

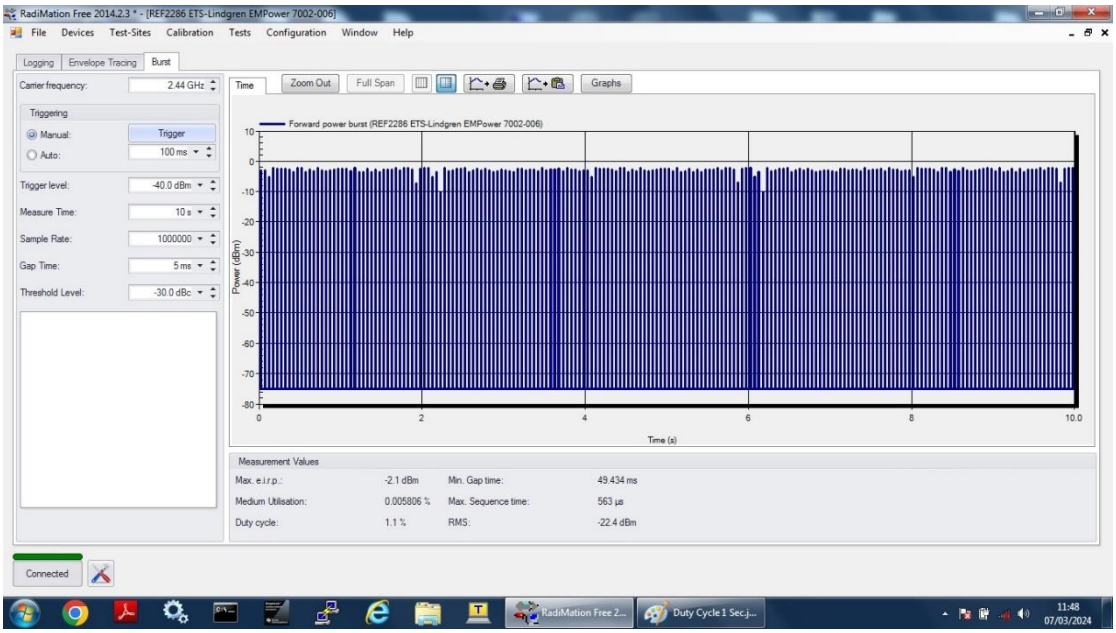


No of Tx in 100ms

Note: the duty cycle of 20 dB applied is stricter that that measured as per client declaration in Appendix A.

Note: The plots above show measurements for single channel operation only, these are used for Average to Peak corrections for emissions testing.

Frequency: All Hopping (Normal Operation)			
Test Environment		Duty Cycle (%)	Observation period (S)
$V_{nominal}$	$T_{nominal}$	1.1	10



Note: The above plot shows the duty cycle for normal operation and is used for the time averaging power assessment for SAR evaluation.

20 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**

21 Appendix A – Client Declaration

Dynamic Load Monitoring (UK) Ltd
DLM House, Bridgers Farm, Nursling Street, Nursling, Southampton, SO16 0YA
T: +44 (0)2380 741 700 E: sales@dlm-uk.com W: dlm-uk.com

31/10/2023

Element Materials Technology
100 Frobisher Business Park
Malvern
Worcestershire
WR14 1BX
UK

To whom it may concern,

The following statement is Dynamic Load Monitoring's duty cycle declaration:

The worst case transmit duty cycle is 2 x 2.5 ms per 50 ms, ie 10% worst case transmit duty cycle.

This gives a 20 dB reduction in the average.

Therefore this comfortably meets the standard.

Sincerely,

Chris Scrutton
Technical Director
02380 741700

22 General SAR test reduction & exclusion guidance

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 frequencies in the range 100 MHz to 6 GHz, and for test separation distance of ≤ 50 mm, is determined as follows.

$$\text{SAR Exclusion Threshold (SARET)} = (NT \times TSD_A) / \sqrt{f_{GHz}}$$

Where,

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
TSD_A = Minimum Test separation distance or 50 mm (whichever is lower)
f_{GHz} = Transmit frequency in GHz

Channel Frequency (MHz)	***Maximum Conducted Power (mW)***	***Duty Cycle (%)***	***Time Averaged Maximum Conducted Power (mW)***	***SAR Exclusion Threshold at 5 mm (mW)***	***SAR Evaluation***
2402	66.527	1.1	0.732	9.678	Not Required
2440	55.719	1.1	0.613	9.603	Not Required
2480	41.115	1.1	0.452	9.525	Not Required

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