

Report Number: TRA-059025-47-00B
Issue: B

Report on the Radio Testing of an
Ampetronic Limited
Auri RM1
With Respect to Specification
FCC 47CFR 15.247

Test Date: 2024-08-23 to 2024-08-30

Tested by: D Winstanley
Radio Senior Test Engineer

Written by:



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Lab Manager

Date: 2024-11-19

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- [2] The results contained in this document relate only to the item(s) tested

RF916 16



1 Revision Record

Issue	Issue Date	Revision History
A	2024-09-30	Original
B	2024-11-19	Update Model Name from Auri to Auri RM1 Corrected numerical antenna gain & relevant figures

2 Summary

Test Report Number:	TRA-059025-47-00B
Works Order Number:	TRA-059025-04
Purpose of Test:	Testing of Radio Frequency Equipment per the Relevant Authorisation Requirements of Chapter 47 of CFR (Code of Federal Regulations) Part 2, Subpart J
Test Specification:	47CFR15.247
Equipment Under Test (EUT):	Auri RM1
FCC Identifier:	2BHN3TX2N
EUT Serial Number:	S33
Manufacturer:	Ampetronic Limited
Address:	Unit 2 Trentside Business Village Farndon Road Newark NG24 4XB United Kingdom
Client Contact:	Matthew Powell ☎ 01636 610062 ex 123 ✉ Matthew.Powell@Ampetronic.com
Order Number:	OPO100000882
Test Date:	2024-08-23 to 2024-08-30
Tested By:	D Winstanley Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause FCC 47 CFR</i>	<i>Applicable to this Equipment</i>	<i>Result / Note</i>
Restricted Bands of Operation	15.205	☒	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
Undesirable / Unwanted Emissions	15.247(d)	☒	Pass
Pulsed Operation Correction	15.35 (c)	☒	Pass
Occupied Bandwidth (99 % Bandwidth)	N/A	☒	Pass

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).

The decision rule for compliance is not inherent within this specification and compliance is based on the customer requesting a simple acceptance rule based on understanding and acceptance of Elements Measurement Uncertainty values.

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4 Introduction

This report TRA-059025-47-00B presents the results of the Radio testing on an Ampetronic Limited, Auri RM1 to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Ampetronic Limited by Element, at the address detailed below.

☒	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK	☐	Element Surrey Hills Unit 15 B Henley Business Park Pirbright Road Normandy Guildford GU3 2DX UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are ISO/IEC 17025:2017 accredited 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 Surrey Hills	UK2027
Element Skelmersdale	UK2020

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

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	Degrees 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
EUT	Equipment Under Test
e.i.r.p.	Equivalent Isotropically Radiated Power
e.r.p.	Effective Radiated Power
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
SISO	Single Input and Single Output
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: Auri RM1
- Serial Number: S33
- Model Number: RM1
- Software Revision: 0.0781
- Build Level / Revision Number: A3 (pre 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.

- Support laptop with internal software scripts to set up the EUT
- Programmable USB cable

7.3 EUT Mode of Operation

The Mode of operation for transmitter tests was as following:

The EUT was transmitting on the frequencies as indicated.

7.4 EUT Radio Parameters

7.4.1 General

Frequencies of Operation:	2402 MHz to 2480 MHz
Modulation Type:	GFSK
Occupied Channel Bandwidth:	1 MHz
Channel Spacing:	2 MHz
Declared Output Power:	≤20 dBm
Nominal Supply Voltage:	3.3 Vdc

7.4.2 Antennas

Manufacturer:	Pulse Electronics
Type:	Chip antenna
Frequency Range:	2400 MHz – 2500 MHz
Impedance:	50Ω
Antenna Type and Gain:	Part Number: ANT3216A063R2400A, Peak Gain: 1.69 dBi
Mounting:	PCB

7.5 EUT Description

The EUT is a frequency hopping Bluetooth® Low Energy RF module used for Auracast.

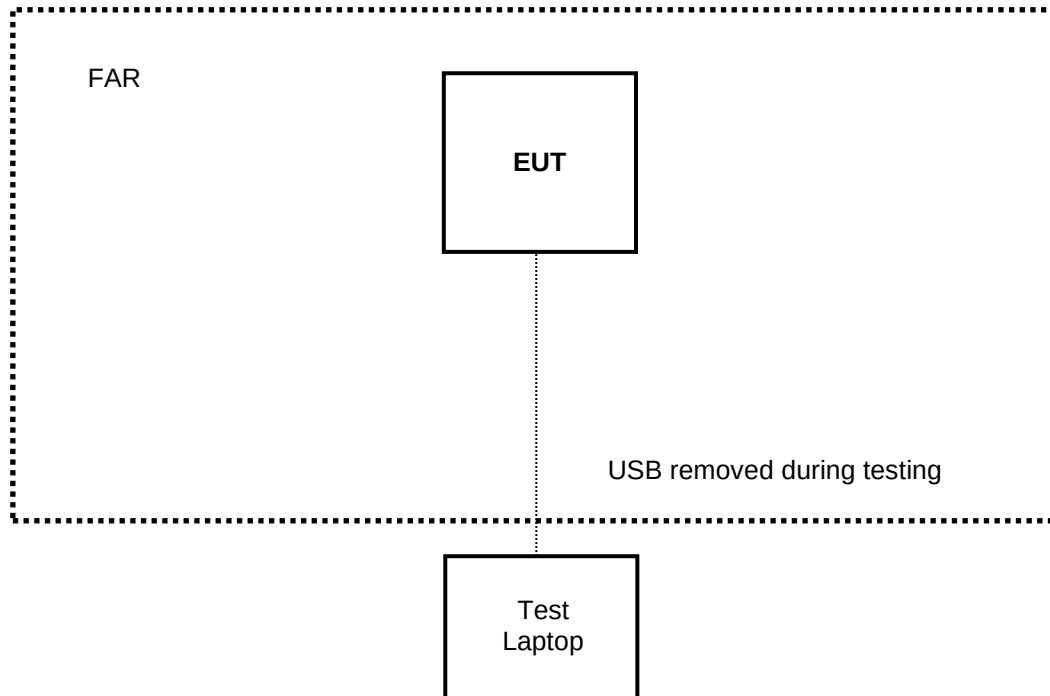
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

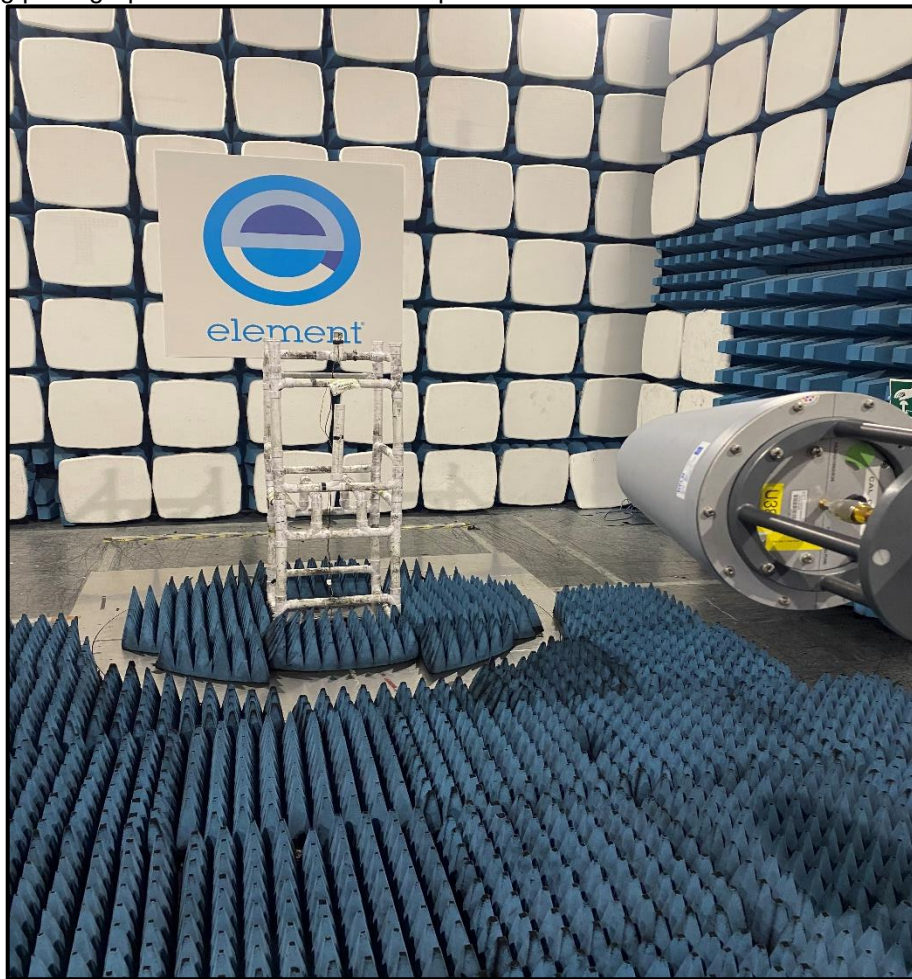
The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



For all tests the EUT was configured with a support laptop and diagnostic cable. An application program was run on the support laptop to configure the EUT.

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 EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 3.3 Vdc from an external power supply.

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:	U387, 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: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 °C to +35 °C (as declared)
Humidity: 62 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	As declared

11.3 Test Limit

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

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

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3 m)</i>	<i>Field Strength (dBμV/m at 3 m)</i>
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 dB μ V/m at the regulatory distance, using:

$$FS = PR + CL + AF - PA + DC - CF$$

$$\text{Factor} = CL + AF - PA$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB μ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

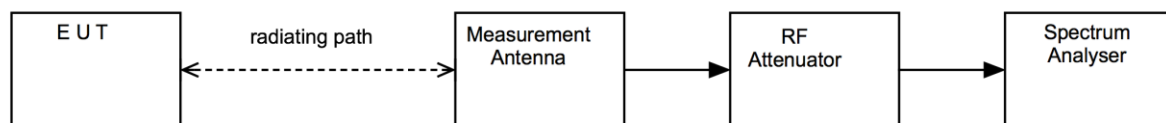
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure i Test Setup

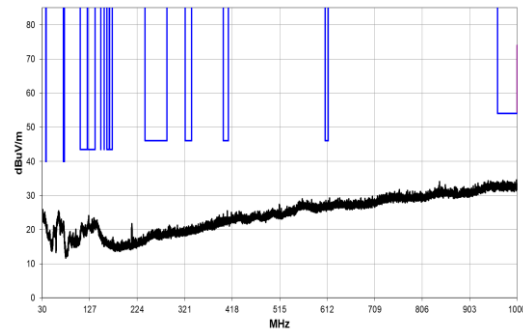


11.5 Test Equipment

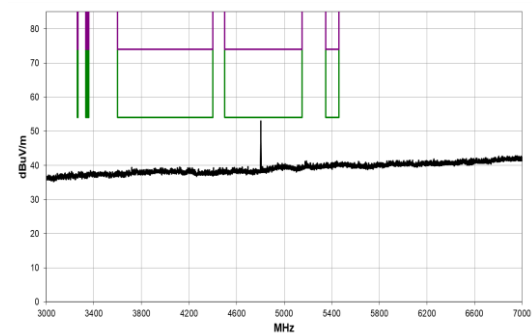
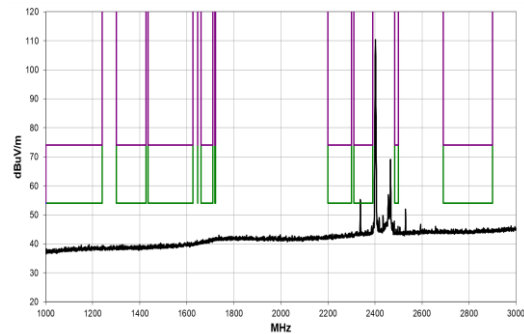
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU50	U544	2024-11-28
1-18GHz Log Periodic	R&S	HL050	U385	2026-01-16
Pre Amp	Agilent	8449B	L572	2024-10-30
Horn Antenna	A Info Inc	LB-180400-25-C-KF	REF2246	2024-09-23
Bilog	Chase	CBL611/B	U573	2024-10-14
Pre Amp	AMETEK	LNA6901	U711	2025-04-11
2.4G Band Stop Filter	BSC	SN 4478	U543	2025-02-15
High Pass Filter	Atlantic Microwave	AFH-07000	U558	2025-02-15
Attenuator	AtlanTecRF Microwave	10dB SMA Attenuator	U633	Cal In use
Chamber 1	Rainford EMC	ATS	U387	2026-01-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal Not Required

11.6 Test Results

Frequency: 2402 MHz; Power Setting: 19 dBm; Modulation: GFSK; Data Rate: 1 Mbps

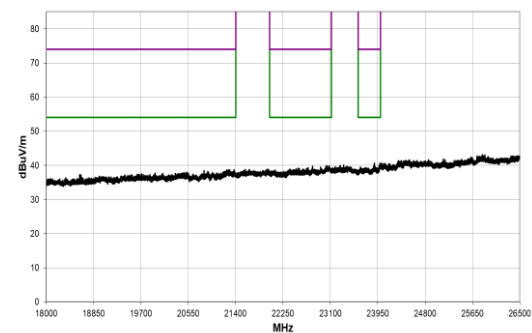
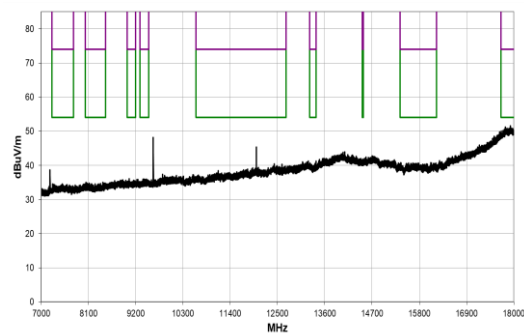


30 MHz to 1 GHz



1 GHz to 3 GHz

3 GHz to 7 GHz

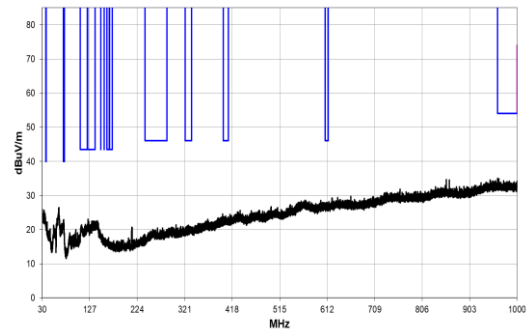


7 GHz to 18 GHz

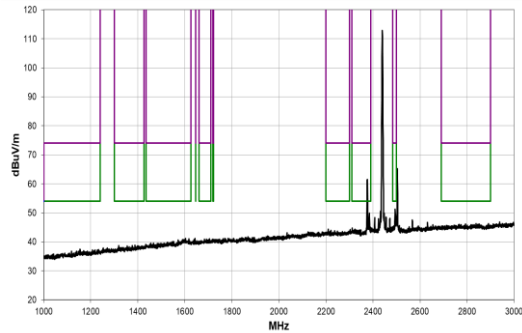
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2497.933	34.9	-3.1	1.93	172.1	3.0	10.0	Horz	AV	0.0	41.8	54.0	-12.2
2386.108	34.7	-3.5	1.9	185.0	3.0	10.0	Horz	AV	0.0	41.2	54.0	-12.8
2386.133	32.9	-3.5	1.6	75.9	3.0	10.0	Vert	AV	0.0	39.4	54.0	-14.6
2497.442	32.3	-3.1	1.6	153.2	3.0	10.0	Vert	AV	0.0	39.2	54.0	-14.8
2497.608	48.6	-3.1	1.93	172.1	3.0	10.0	Horz	PK	0.0	55.5	74.0	-18.5
2385.950	48.6	-3.5	1.9	185.0	3.0	10.0	Horz	PK	0.0	55.1	74.0	-18.9
2497.342	47.5	-3.1	1.6	153.2	3.0	10.0	Vert	PK	0.0	54.4	74.0	-19.6
2388.733	47.3	-3.5	1.6	75.9	3.0	10.0	Vert	PK	0.0	53.8	74.0	-20.2
4804.058	44.5	3.1	1.6	132.9	3.0	0.0	Horz	AV	0.0	47.6	54.0	-6.4
4803.133	40.7	3.1	1.89	252.8	3.0	0.0	Vert	AV	0.0	43.8	54.0	-10.2
4803.025	54.6	3.1	1.6	132.9	3.0	0.0	Horz	PK	0.0	57.7	74.0	-16.3
4803.983	51.6	3.1	1.89	252.8	3.0	0.0	Vert	PK	0.0	54.7	74.0	-19.3
12007.920	40.2	11.7	1.58	233.8	1.0	0.0	Horz	AV	-9.5	42.4	54.0	-11.6
12008.120	34.5	11.7	1.28	238.2	1.0	0.0	Vert	AV	-9.5	36.7	54.0	-17.3
12010.130	52.1	11.7	1.58	233.8	1.0	0.0	Horz	PK	-9.5	54.3	74.0	-19.7
12009.870	48.8	11.7	1.28	238.2	1.0	0.0	Vert	PK	-9.5	51.0	74.0	-23.0

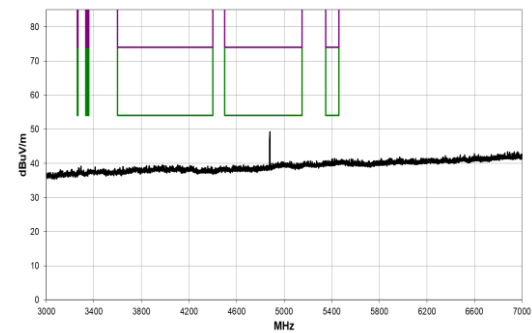
Frequency: 2440 MHz; Power Setting: 19 dBm; Modulation: GFSK; Data Rate: 1 Mbps



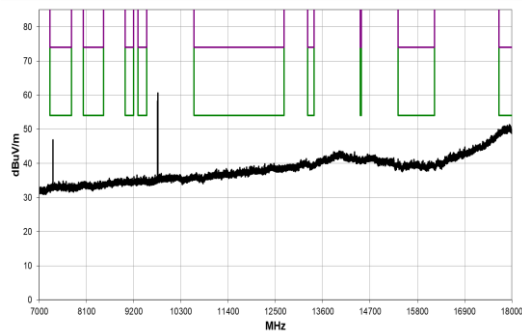
30 MHz to 1 GHz



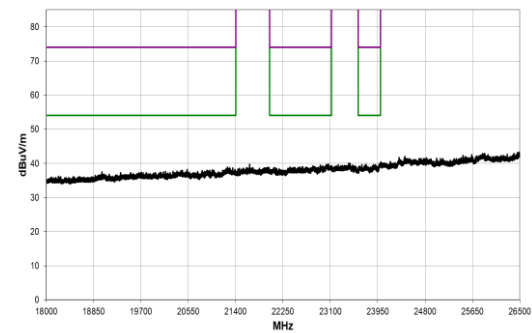
1 GHz to 3 GHz



3 GHz to 7 GHz



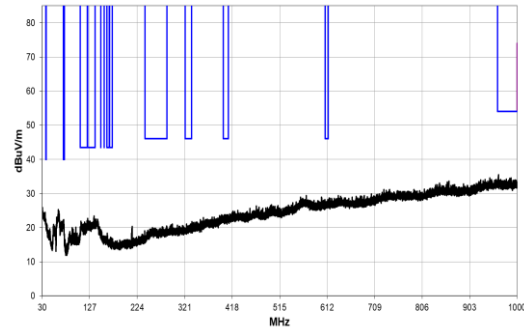
7 GHz to 18 GHz



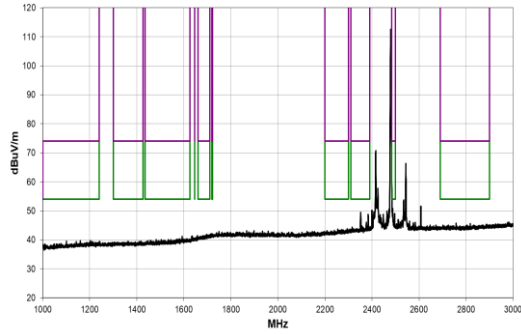
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2375.983	44.1	-3.5	1.64	185.9	3.0	10.0	Horz	AV	0.0	50.6	54.0	-3.4
2375.925	41.2	-3.5	2.03	99.2	3.0	10.0	Vert	AV	0.0	47.7	54.0	-6.3
2376.233	59.9	-3.5	1.64	185.9	3.0	10.0	Horz	PK	0.0	66.4	74.0	-7.6
2375.675	56.8	-3.5	2.03	99.2	3.0	10.0	Vert	PK	0.0	63.3	74.0	-10.7
2493.925	34.1	-3.1	1.61	8.0	3.0	10.0	Horz	AV	0.0	41.0	54.0	-13.0
2494.492	34.0	-3.1	1.72	94.0	3.0	10.0	Vert	AV	0.0	40.9	54.0	-13.1
2385.250	34.4	-3.5	1.42	358.2	3.0	10.0	Horz	AV	0.0	40.9	54.0	-13.1
2385.425	33.8	-3.5	1.44	94.8	3.0	10.0	Vert	AV	0.0	40.3	54.0	-13.7
2494.408	52.1	-3.1	1.61	8.0	3.0	10.0	Horz	PK	0.0	59.0	74.0	-15.0
2385.325	52.3	-3.5	1.42	358.2	3.0	10.0	Horz	PK	0.0	58.8	74.0	-15.2
2493.958	50.9	-3.1	1.72	94.0	3.0	10.0	Vert	PK	0.0	57.8	74.0	-16.2
2385.008	50.7	-3.5	1.44	94.8	3.0	10.0	Vert	PK	0.0	57.2	74.0	-16.8
4879.700	40.1	3.4	1.6	136.9	3.0	0.0	Horz	AV	0.0	43.5	54.0	-10.5
4879.650	39.9	3.4	1.6	254.2	3.0	0.0	Vert	AV	0.0	43.3	54.0	-10.7
4878.917	50.7	3.4	1.6	254.2	3.0	0.0	Vert	PK	0.0	54.1	74.0	-19.9
4880.150	50.5	3.4	1.6	136.9	3.0	0.0	Horz	PK	0.0	53.9	74.0	-20.1
7318.733	46.0	7.9	1.57	259.9	1.0	0.0	Vert	AV	-9.5	44.4	54.0	-9.6
7319.400	43.1	7.9	1.77	205.9	1.0	0.0	Horz	AV	-9.5	41.5	54.0	-12.5
7318.750	55.4	7.9	1.57	259.9	1.0	0.0	Vert	PK	-9.5	53.8	74.0	-20.2
7320.067	54.6	7.9	1.77	205.9	1.0	0.0	Horz	PK	-9.5	53.0	74.0	-21.0

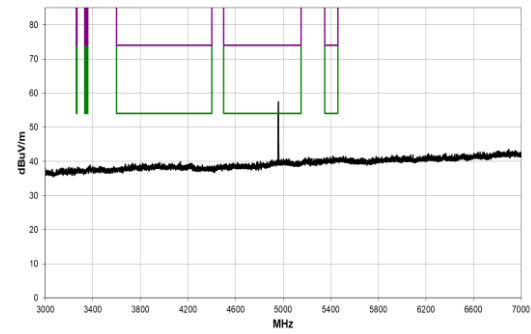
Frequency: 2480 MHz; Power Setting: 19 dBm; Modulation: GFSK; Data Rate: 1 Mbps



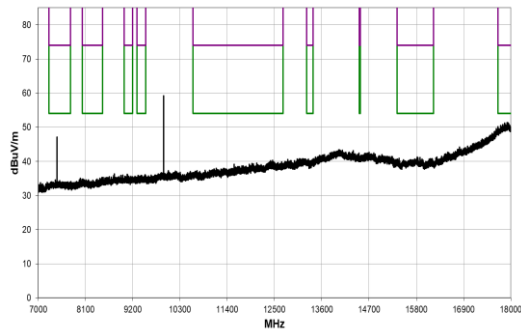
30 MHz to 1 GHz



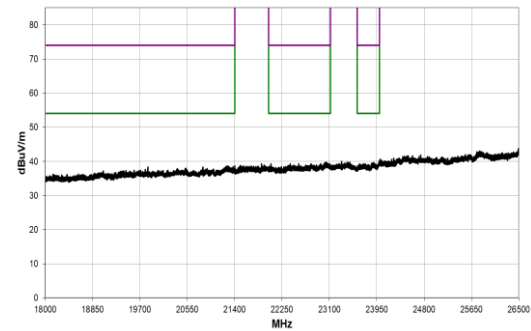
1 GHz to 3 GHz



3 GHz to 7 GHz

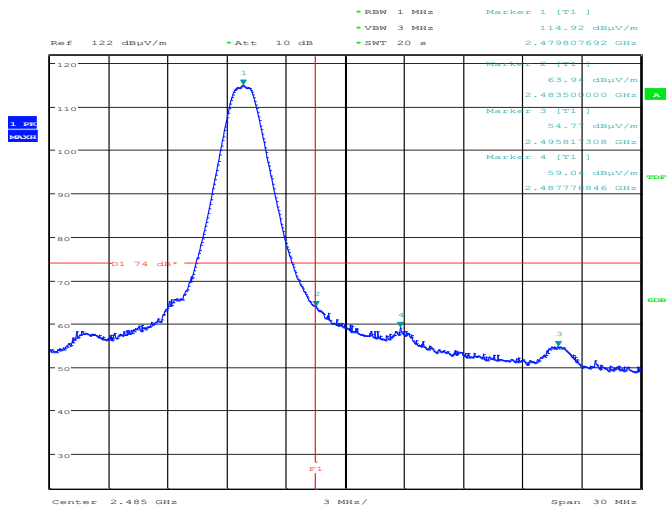


7 GHz to 18 GHz



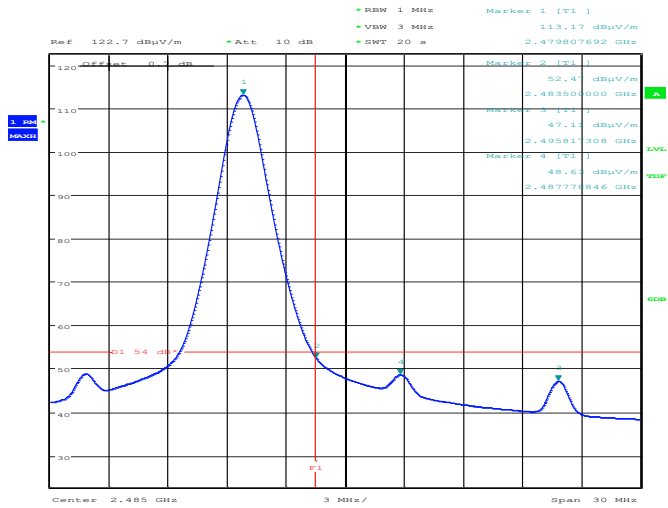
18 GHz to 26.5 GHz

Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
2495.650	37.7	-3.1	1.6	218.0	3.0	10.0	Horz	AV	0.0	44.6	54.0	-9.4
2487.967	36.8	-3.1	1.6	126.2	3.0	10.0	Vert	AV	0.0	43.7	54.0	-10.3
2485.850	36.8	-3.2	1.6	8.0	3.0	10.0	Horz	AV	0.0	43.6	54.0	-10.4
2495.592	36.1	-3.1	1.55	122.9	3.0	10.0	Vert	AV	0.0	43.0	54.0	-11.0
2351.583	35.6	-3.6	1.38	359.0	3.0	10.0	Horz	AV	0.0	42.0	54.0	-12.0
2351.717	35.5	-3.6	1.91	125.0	3.0	10.0	Vert	AV	0.0	41.9	54.0	-12.1
2383.358	35.0	-3.5	1.88	212.8	3.0	10.0	Horz	AV	0.0	41.5	54.0	-12.5
2384.092	34.3	-3.5	1.6	131.9	3.0	10.0	Vert	AV	0.0	40.8	54.0	-13.2
2316.867	32.3	-3.6	3.28	130.1	3.0	10.0	Horz	AV	0.0	38.7	54.0	-15.3
2315.125	32.3	-3.6	1.03	304.9	3.0	10.0	Vert	AV	0.0	38.7	54.0	-15.3
2487.483	51.8	-3.2	1.6	8.0	3.0	10.0	Horz	PK	0.0	58.6	74.0	-15.4
2485.575	50.6	-3.2	1.6	126.2	3.0	10.0	Vert	PK	0.0	57.4	74.0	-16.6
2495.508	50.0	-3.1	1.6	218.0	3.0	10.0	Horz	PK	0.0	56.9	74.0	-17.1
2351.842	49.7	-3.6	1.91	125.0	3.0	10.0	Vert	PK	0.0	56.1	74.0	-17.9
2351.817	49.5	-3.6	1.38	359.0	3.0	10.0	Horz	PK	0.0	55.9	74.0	-18.1
2496.433	48.7	-3.1	1.55	122.9	3.0	10.0	Vert	PK	0.0	55.6	74.0	-18.4
2383.767	49.0	-3.5	1.88	212.8	3.0	10.0	Horz	PK	0.0	55.5	74.0	-18.5
2383.800	48.1	-3.5	1.6	131.9	3.0	10.0	Vert	PK	0.0	54.6	74.0	-19.4
2314.917	47.3	-3.6	1.03	304.9	3.0	10.0	Vert	PK	0.0	53.7	74.0	-20.3
2315.075	46.8	-3.6	3.28	130.1	3.0	10.0	Horz	PK	0.0	53.2	74.0	-20.8
4959.117	47.9	3.7	1.42	139.8	3.0	0.0	Horz	AV	0.0	51.6	54.0	-2.4
4959.642	46.7	3.7	1.62	215.0	3.0	0.0	Vert	AV	0.0	50.4	54.0	-3.6
4959.183	56.6	3.7	1.42	139.8	3.0	0.0	Horz	PK	0.0	60.3	74.0	-13.7
4959.058	55.0	3.7	1.62	215.0	3.0	0.0	Vert	PK	0.0	58.7	74.0	-15.3
7440.192	46.1	8.0	1.52	168.8	1.0	0.0	Vert	AV	-9.5	44.6	54.0	-9.4
7440.242	44.2	8.0	1.61	204.0	1.0	0.0	Horz	AV	-9.5	42.7	54.0	-11.3
7440.133	55.6	8.0	1.52	168.8	1.0	0.0	Vert	PK	-9.5	54.1	74.0	-19.9
7438.675	54.5	8.0	1.61	204.0	1.0	0.0	Horz	PK	-9.5	53.0	74.0	-21.0



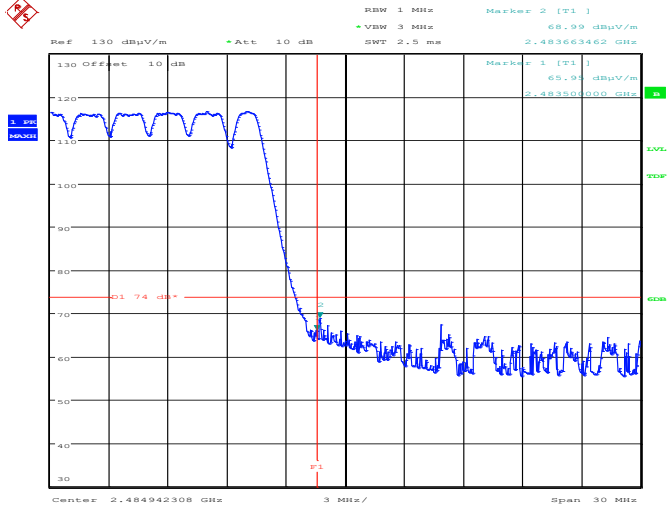
Date: 27.AUG.2024 15:54:51

Upper Band Edge - Peak



Date: 27.AUG.2024 15:58:11

Upper Band Edge - Average



Date: 30.AUG.2024 12:05:44

Upper 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:	LF Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequencies Measured:	2440 MHz
EUT Channel Bandwidths:	1 MHz
EUT Modulation:	GFSK
Deviations From Standard:	None
Measurement BW:	9 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 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 (dB μ V)	
	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.

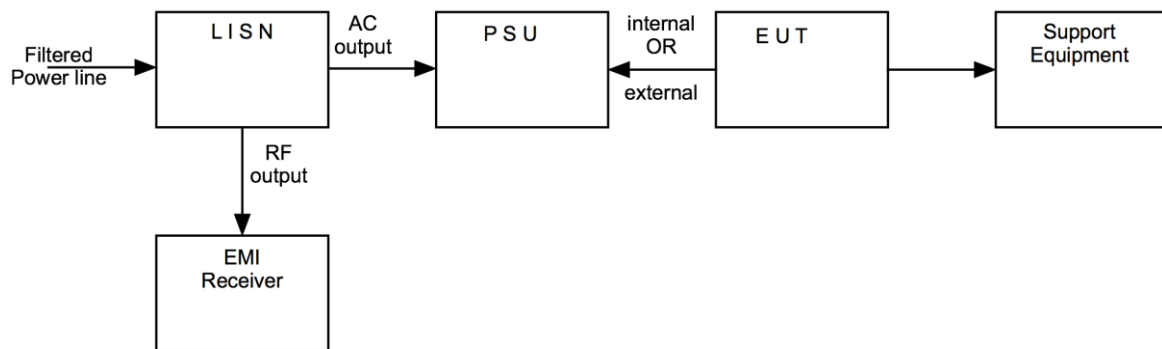
12.3 Test Method

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



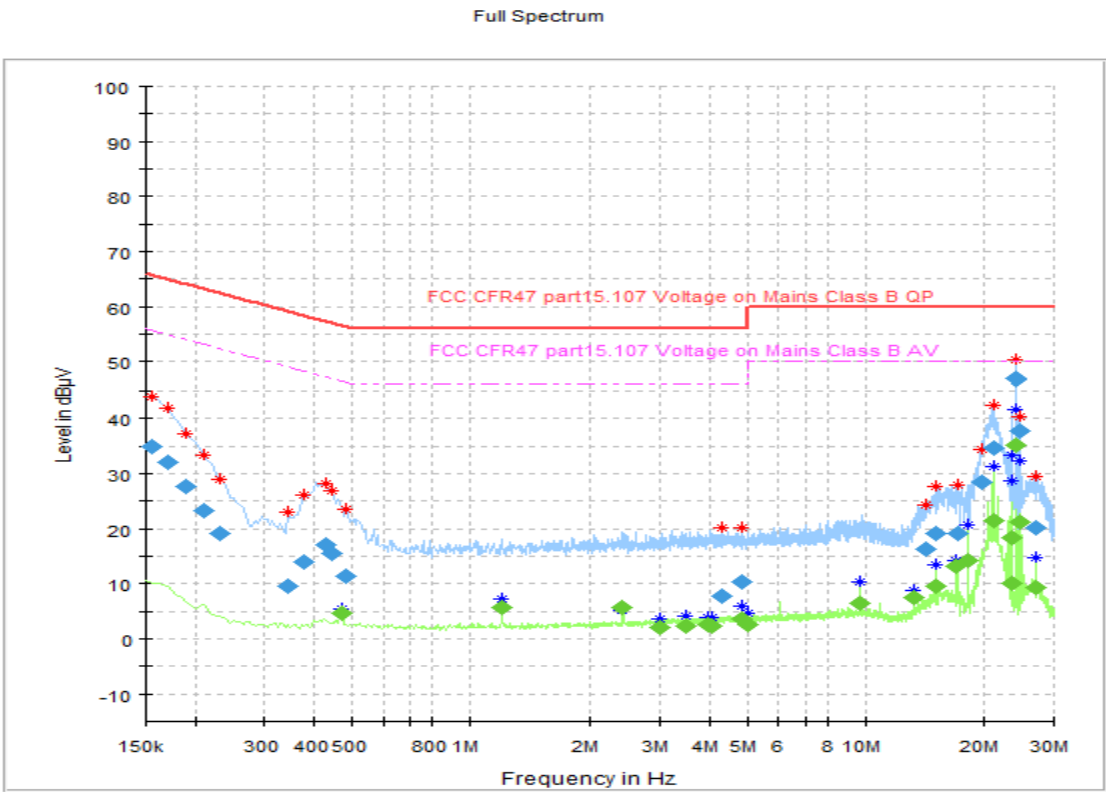
12.4 Test Set-up Photograph



12.5 Test Equipment

Equipment		Equipment	Element	Due For
Description	Manufacturer	Type	No	Calibration
Spectrum Analyser	R&S	ESR 7	U727	2025-05-17
Lisn	R&S	ENV216	U396	2025-05-16
Pulse Limiter	R&S	ESH3-Z2	U443	2025-03-11

12.6 Test Results



Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line
0.155000	34.89	---	65.73	30.84	2000.0	9.000	N
0.170000	31.93	---	64.96	33.03	2000.0	9.000	N
0.190000	27.59	---	64.04	36.45	2000.0	9.000	N
0.210000	23.37	---	63.21	39.84	2000.0	9.000	N
0.230000	19.01	---	62.45	43.44	2000.0	9.000	N
0.345000	9.51	---	59.08	49.57	2000.0	9.000	L1
0.380000	13.99	---	58.28	44.29	2000.0	9.000	L1
0.430000	17.03	---	57.25	40.22	2000.0	9.000	N
0.445000	15.45	---	56.97	41.51	2000.0	9.000	N
0.470000	---	4.61	46.51	41.91	2000.0	9.000	N
0.485000	11.40	---	56.25	44.86	2000.0	9.000	N
1.205000	---	5.63	46.00	40.37	2000.0	9.000	L1
2.410000	---	5.70	46.00	40.30	2000.0	9.000	L1
2.990000	---	2.07	46.00	43.93	2000.0	9.000	L1
3.485000	---	2.33	46.00	43.67	2000.0	9.000	L1
3.955000	---	2.53	46.00	43.47	2000.0	9.000	L1
4.055000	---	2.42	46.00	43.58	2000.0	9.000	L1
4.320000	7.72	---	56.00	48.28	2000.0	9.000	N
4.820000	10.41	---	56.00	45.59	2000.0	9.000	L1
4.825000	---	3.58	46.00	42.42	2000.0	9.000	L1
4.995000	---	2.68	46.00	43.32	2000.0	9.000	L1
9.645000	---	6.51	50.00	43.49	2000.0	9.000	L1
13.255000	---	7.43	50.00	42.57	2000.0	9.000	L1
14.220000	16.32	---	60.00	43.68	2000.0	9.000	L1
15.000000	19.16	---	60.00	40.84	2000.0	9.000	L1
15.010000	---	9.46	50.00	40.54	2000.0	9.000	L1
16.870000	---	13.06	50.00	36.94	2000.0	9.000	L1
17.170000	19.10	---	60.00	40.90	2000.0	9.000	L1
18.080000	---	14.26	50.00	35.74	2000.0	9.000	N
19.610000	28.37	---	60.00	31.63	2000.0	9.000	L1
21.010000	---	21.40	50.00	28.60	2000.0	9.000	N
21.010000	34.74	---	60.00	25.26	2000.0	9.000	L1
23.510000	---	10.00	50.00	40.00	2000.0	9.000	N
23.580000	---	18.38	50.00	31.62	2000.0	9.000	N
24.010000	---	35.20	50.00	14.80	2000.0	9.000	N
24.040000	47.07	---	60.00	12.93	2000.0	9.000	L1
24.465000	---	21.13	50.00	28.87	2000.0	9.000	N
24.465000	37.70	---	60.00	22.30	2000.0	9.000	L1
27.005000	---	9.31	50.00	40.69	2000.0	9.000	N
27.020000	20.04	---	60.00	39.96	2000.0	9.000	N

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 Channels / Frequencies Measured:	2402 MHz – 2480 MHz – All Hopping
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	50 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 Vdc (as declared)

13.3 Test Limit

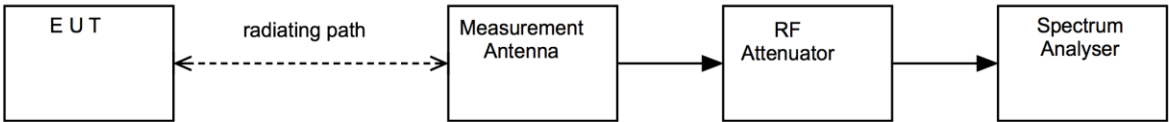
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies 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

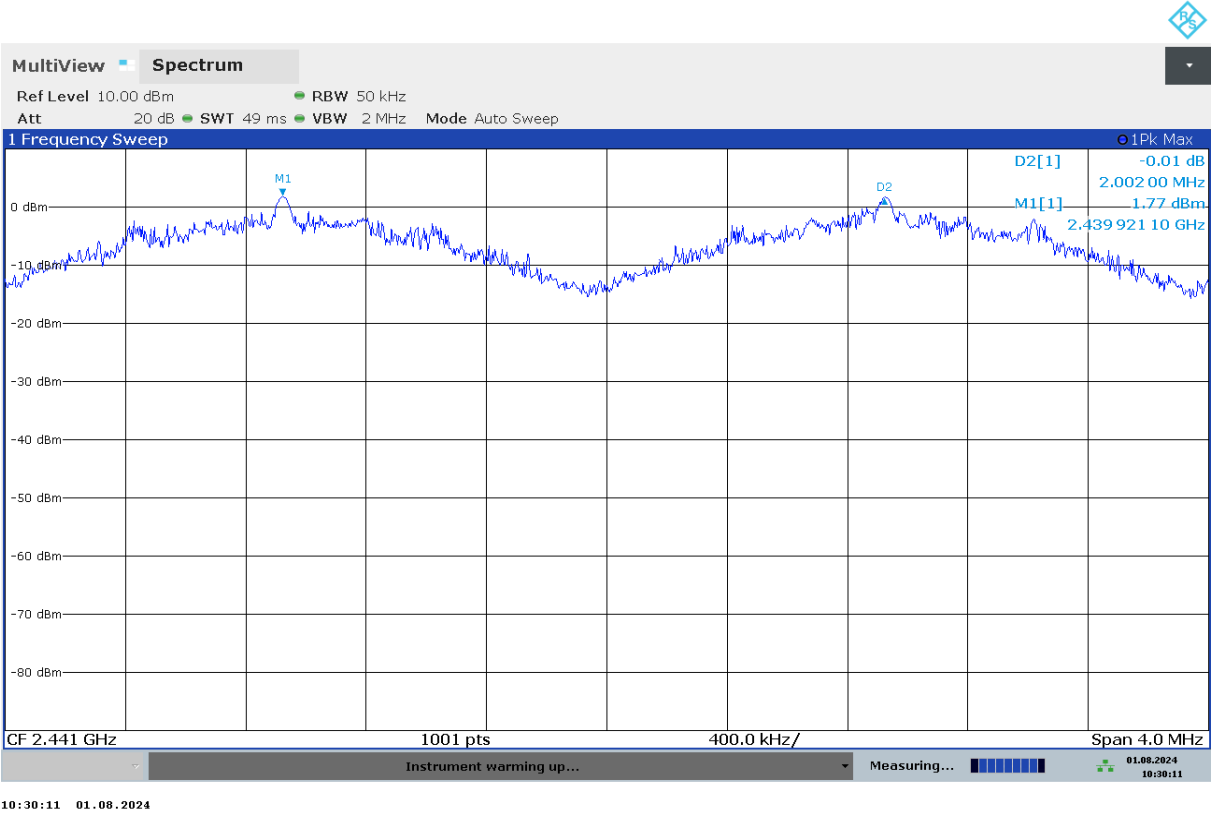


13.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSW 43	U728	2025-06-12

13.6 Test Results

Frequency: 2441 MHz; Modulation: GFSK; Power setting: 19 dBm				
Data Rate	F1 _c (MHz)	F2 _c (MHz)	Channel Separation, F2 _c – F1 _c (MHz)	Result
1 Mbps	2439.92110	2441.9231	2.002	Pass



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:	2402 – 2480 MHz – All Hopping
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	500 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 Vdc (as declared)

14.3 Test Limit

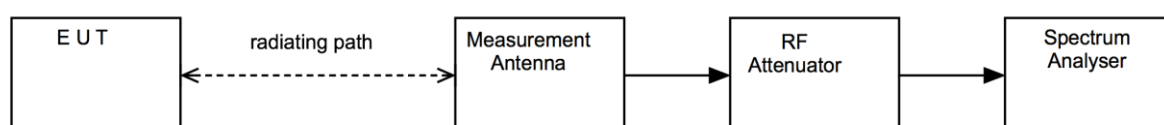
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels; If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;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

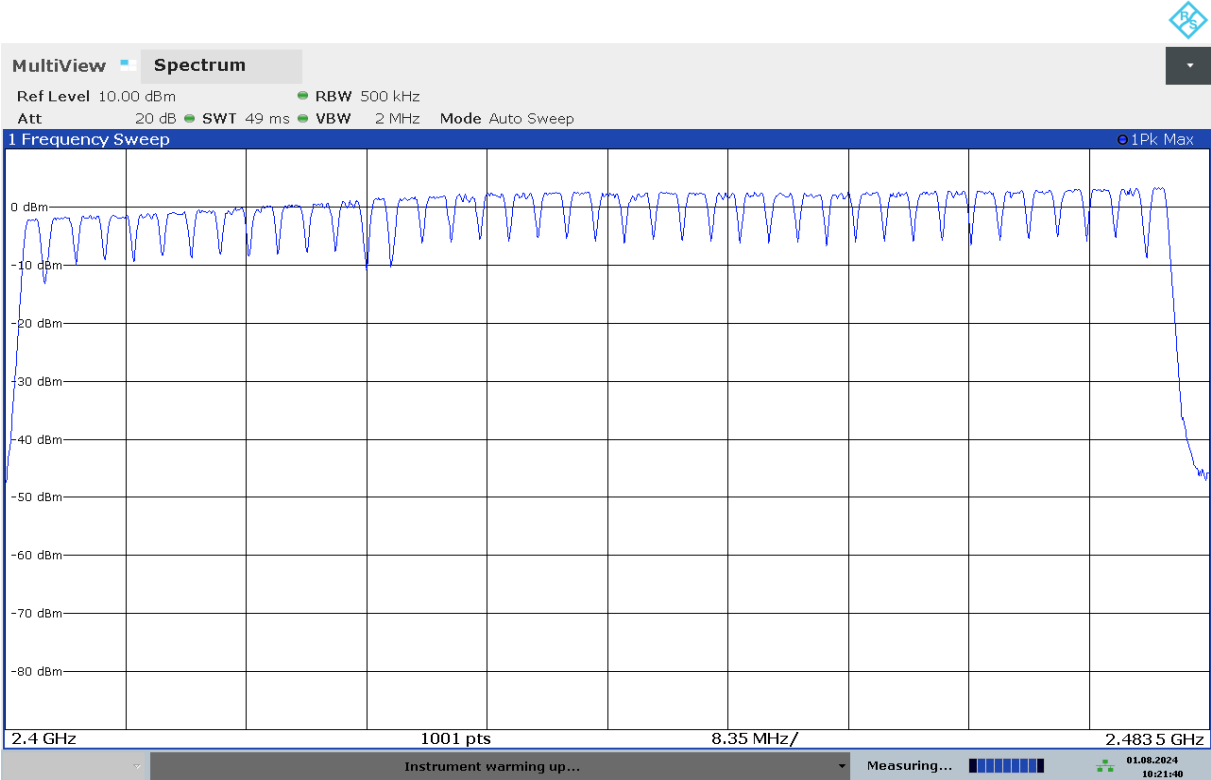


14.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSW 43	U728	2025-06-12

14.6 Test Results

Modulation: GFSK ; Power setting: 19 dBm				
Data Rate	Lowest channel, F _{CL} (MHz)	Highest channel, F _{CH} (MHz)	Number of channels observed	Result
1 Mbps	2402	2480	40	Pass



10:21:41 01.08.2024

2400 MHz – 2483.5 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 Frequencies Measured:	2402 MHz – 2480 MHz – All Hopping
EUT Number of hopping channels:	40
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	500 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 Vdc (as declared)

15.3 Test Limit

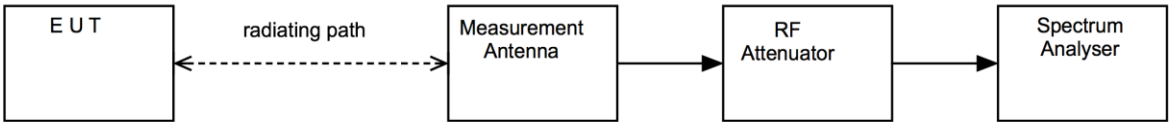
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period;
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, 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

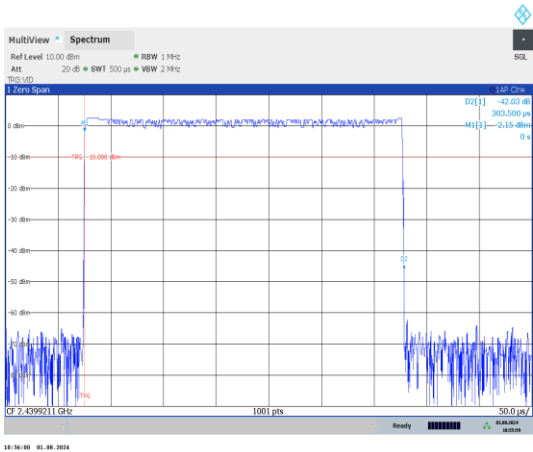


15.5 Test Equipment

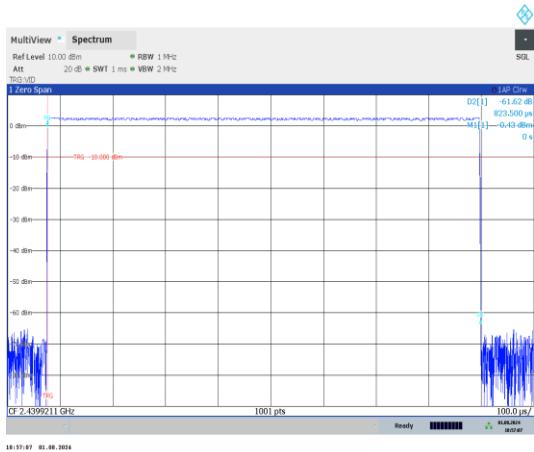
Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSW 43	U728	2025-06-12

15.6 Test Results

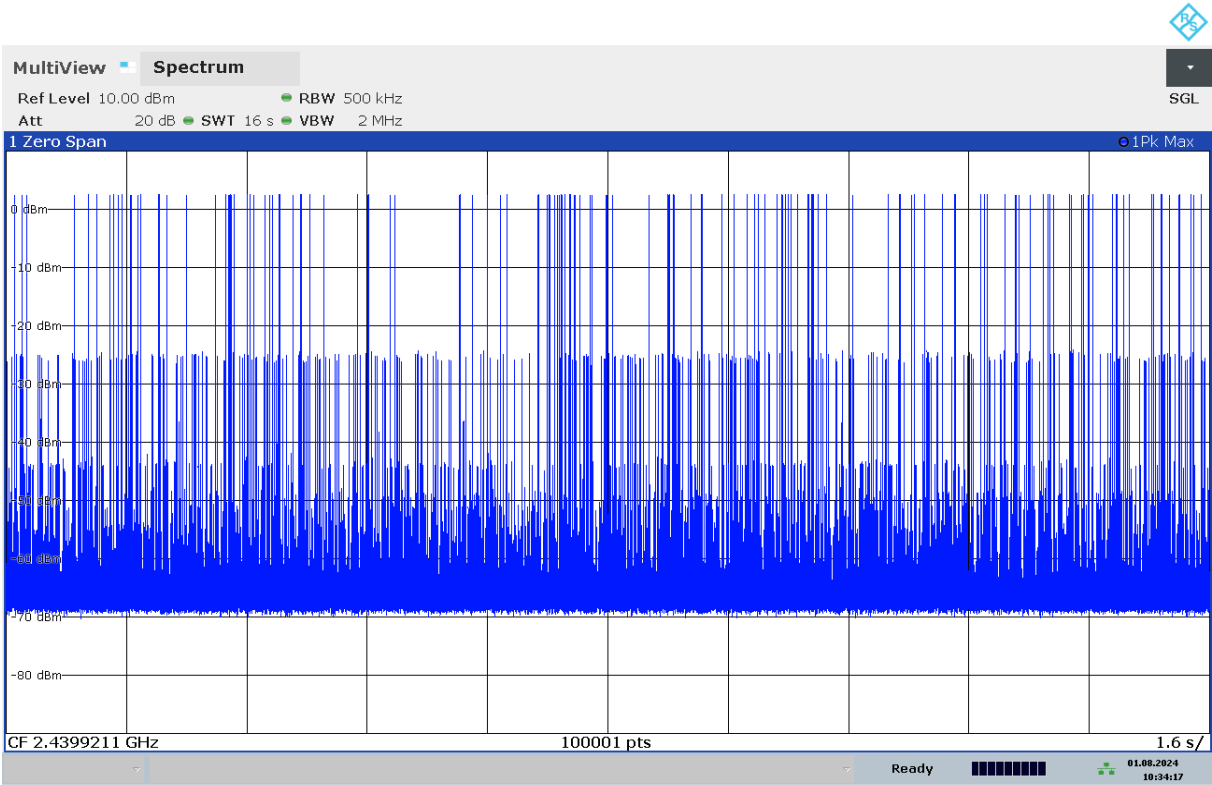
T _{occ} (ms)	MP (s)	MPTX	AOT (s)	Total AOT (s)	Limit (s)	Result
0.3035	16	104	0.031564	0.049681	0.4	Pass
0.8235		22	0.018117		0.4	Pass



Tx on period - short



Tx on period - long



10:34:17 01.08.2024

Number of transmissions observed (MPTX)

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:	U387, Chamber 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Frequencies Measured:	2402 MHz, 2440 MHz & 2480 MHz – hopping disabled.
EUT Channel Bandwidths:	1 MHz
Deviations From Standard:	None
Measurement BW:	2 MHz
Spectrum Analyzer Video BW:	10 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 °C to +35 °C (as declared)
Humidity: 63 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

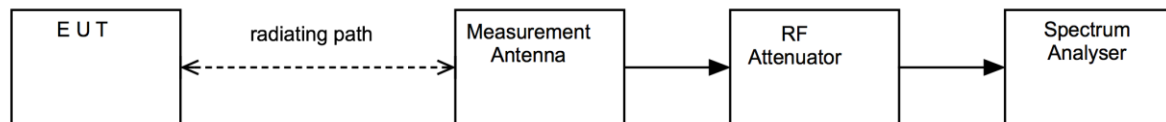
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. 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

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU50	U544	2024-11-28
1-18GHz Log Periodic	R&S	HL050	U385	2026-01-16
Pre Amp	Agilent	8449B	L572	2024-10-30
Chamber 1	Rainford EMC	ATS	U387	2026-01-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal Not Required

16.6 Test Results

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

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

where D is the distance in metres between the two antennas and G is the antenna numerical gain (1.48) referenced to isotropic gain (1.69 dBi).

<i>Modulation: GFSK; Data rate: 1 Mbps; Power setting: 19 dBm</i>						
<i>Channel Frequency (MHz)</i>	<i>Peak Field Strength (dBμV/m)</i>	<i>Peak Field Strength (V/m)</i>	<i>Distance (m)</i>	<i>Numerical Antenna Gain</i>	<i>Maximum peak conducted output power (W)</i>	<i>Result</i>
2402	112.1	0.40272	3	1.48	0.032875	Pass
2440	115.9	0.62373	3	1.48	0.078859	Pass
2480	115.4	0.58884	3	1.48	0.070284	Pass

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
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW:	50 kHz
(requirement: 1 % to 5 % OBW)	
Spectrum Analyzer Video BW:	200 kHz
(requirement at least 3x RBW)	
Measurement Span:	5 MHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

c

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 Vdc (as declared)

17.3 Test Limit

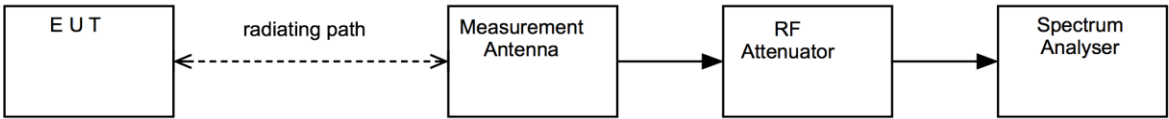
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz

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

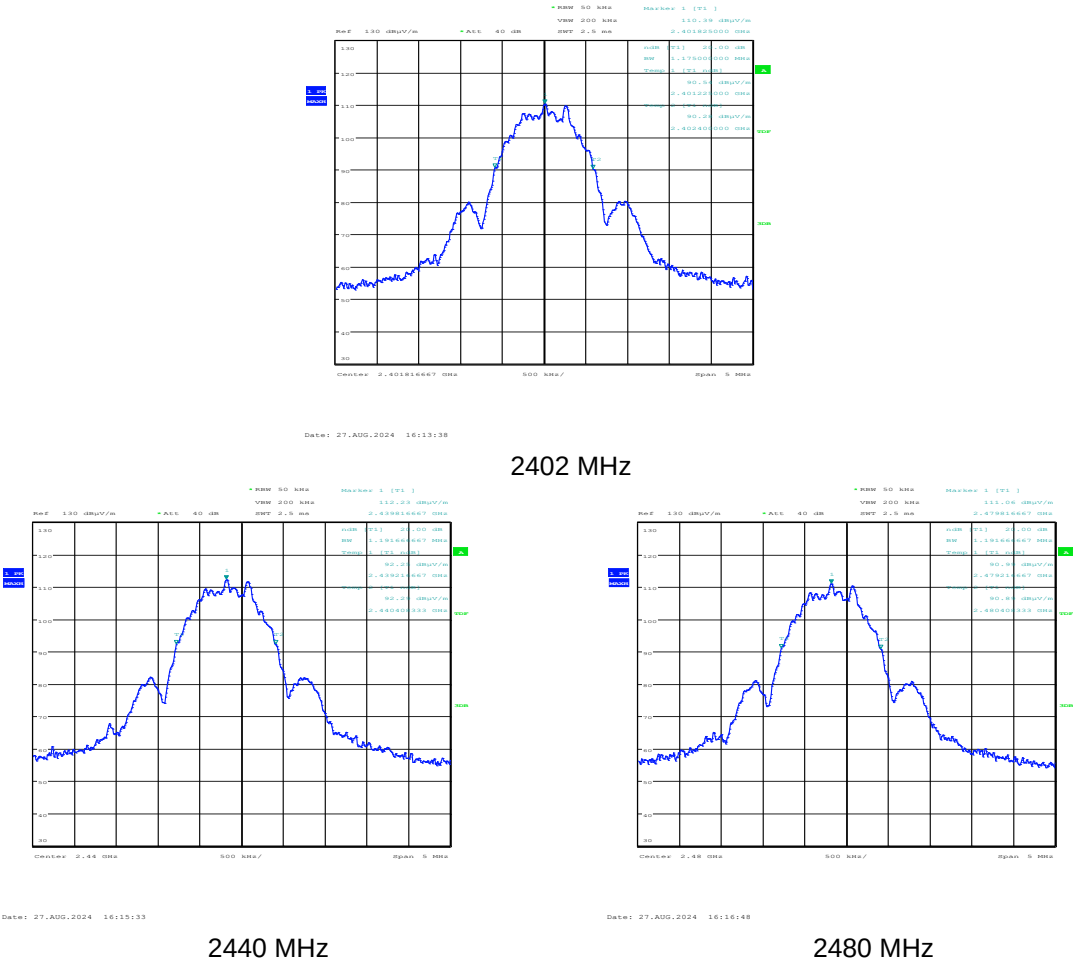


17.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU50	U544	2024-11-28

17.6 Test Results

15.247; 20 dB Bandwidth; Modulation: GFSK; Data rate: 1 Mbps; Power setting: 19 dBm				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20dB Bandwidth (kHz)	Result
2402	2401.225000	2402.400000	1175.000000	Pass
2440	2439.216667	2440.408333	1191.666000	Pass
2480	2479.216667	2480.408333	1191.666000	Pass



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
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 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.3 Vdc	3.3 Vdc (as declared)

18.3 Test Limits

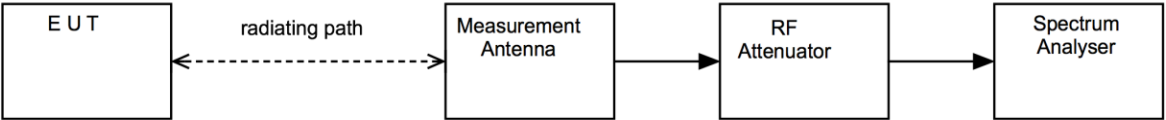
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either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

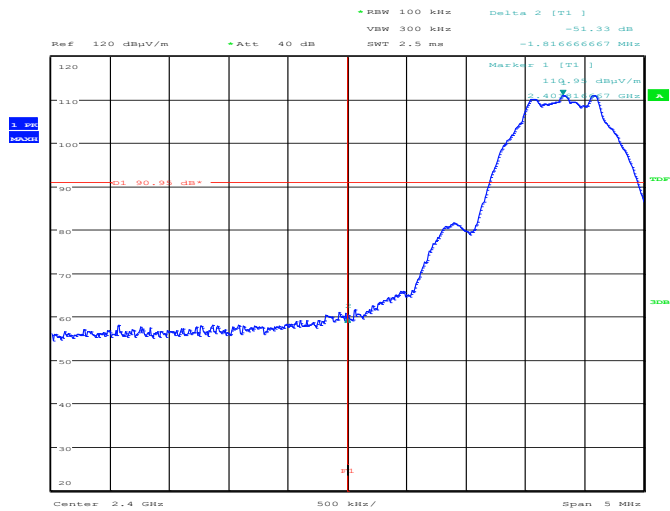
Figure viii Test Setup



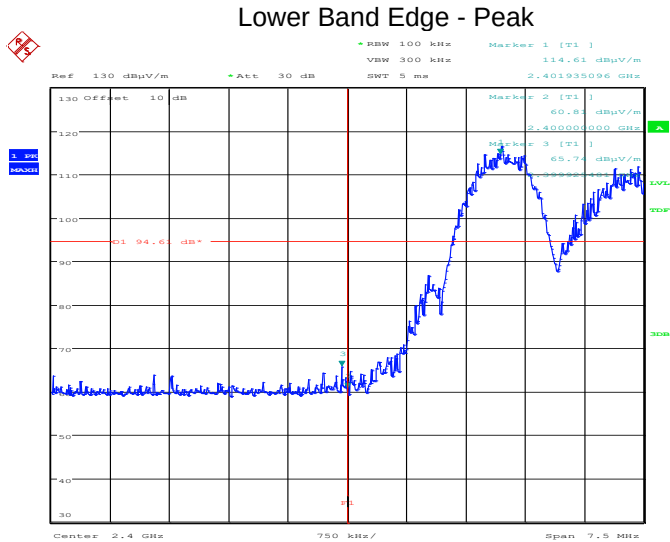
18.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU50	U544	2024-11-28
Attenuator	AtlanTecRF Microwave	10dB SMA Attenuator	U633	Cal In use

18.6 Test Results



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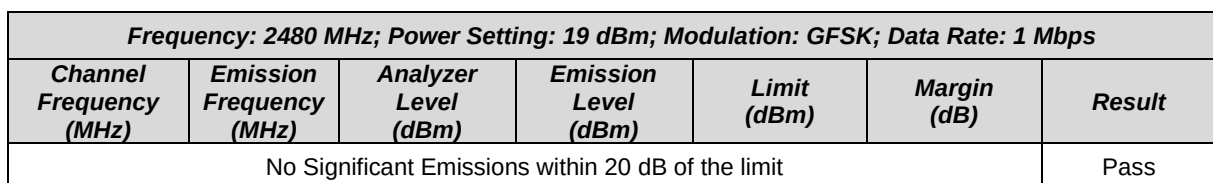
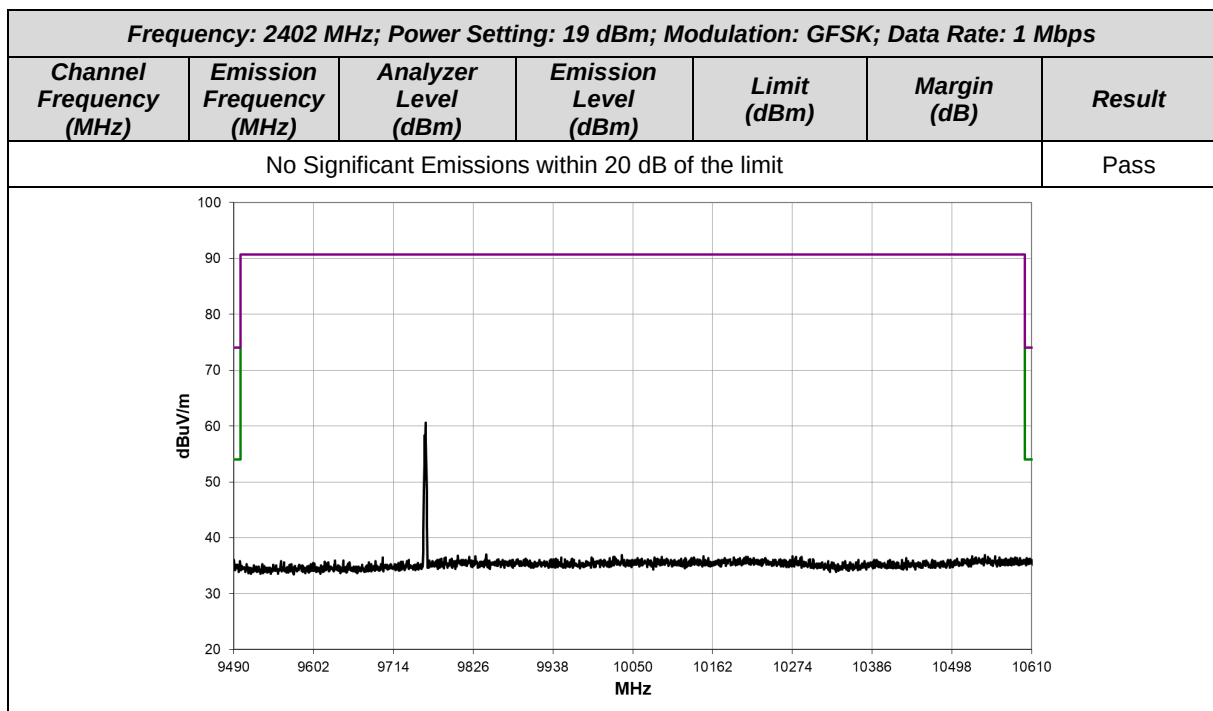
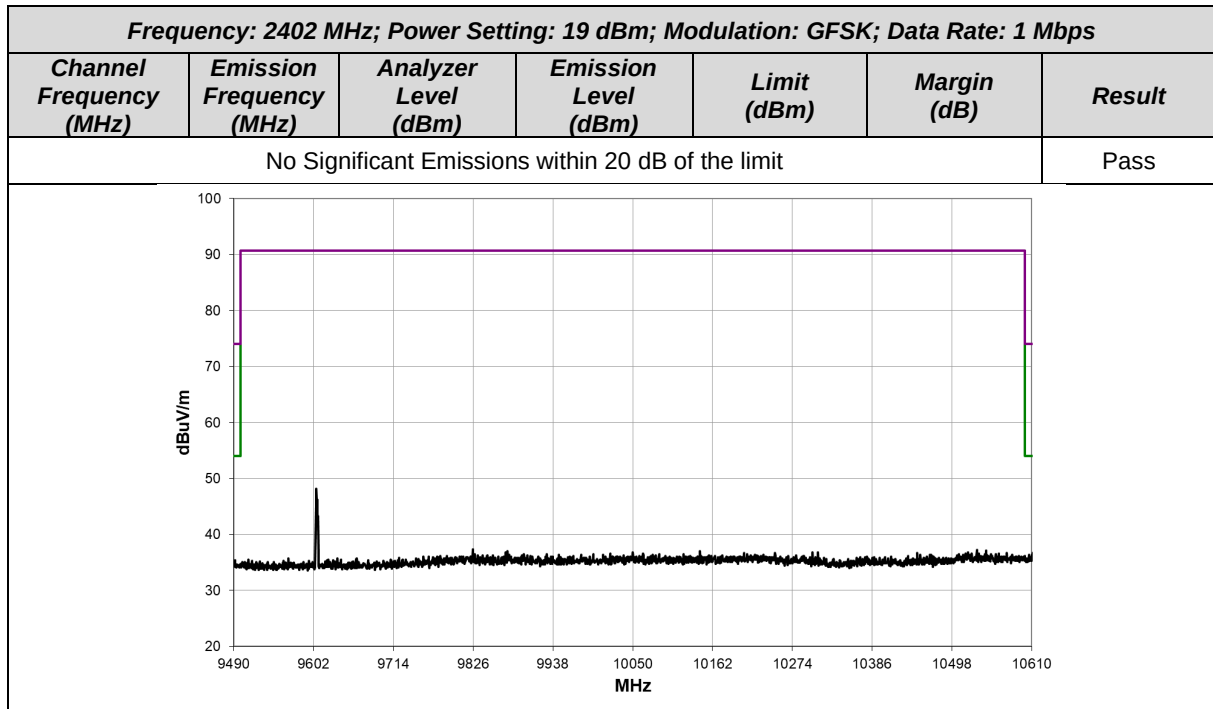
Lower Band Edge – All Hopping

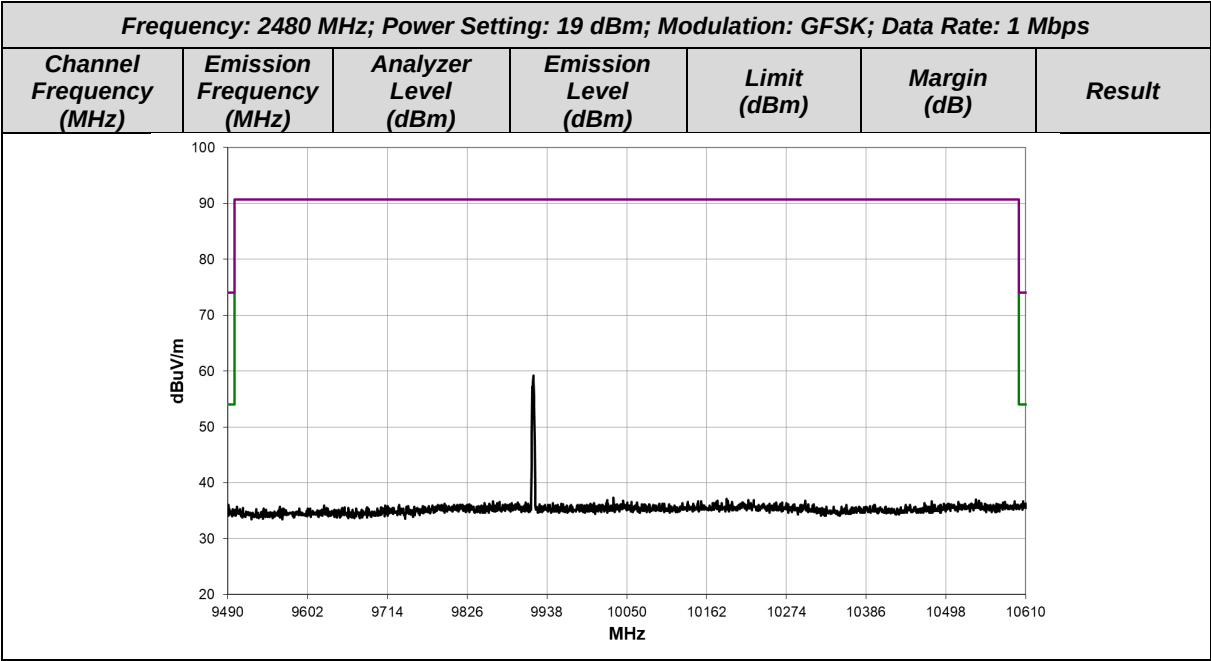
Modulation: GFSK; Data rate: 1 Mbps; Power setting: 19 dBm						
Channel Frequency (MHz)	Emission Frequency (MHz)	Analyzer Level (dBm)	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
No significant emissions within 20 dB of the limit						Pass

Except for the emissions show in the plots below, all other spurious emissions from the device meet the general spurious emissions limit of 15.209, 15.247 (d) states emission are not required to be below this limit.

According to 15.247(d) emissions falling outside of restricted frequency band a 20 dBc limit in a 100 kHz measurement bandwidth is applicable.

The below emissions are measured in a 1MHz RBW and in this larger RBW are not within 20 dB of the 20 dBc limit.





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.

19.2 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: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)

19.3 Test Limit

N/A.

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 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.

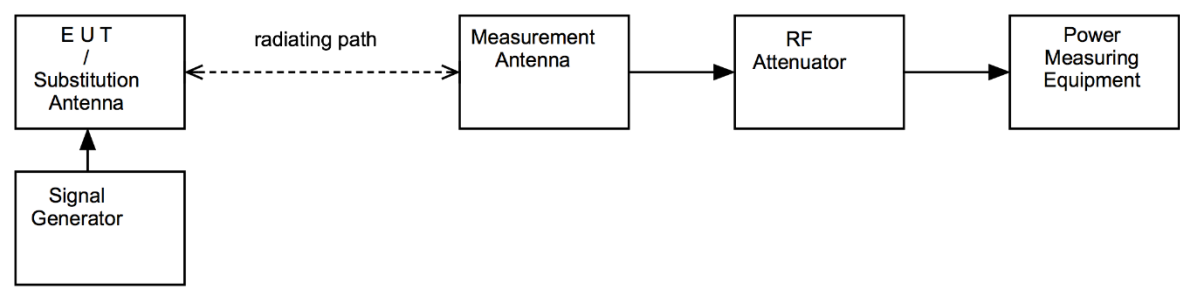
The duty cycle correction factor, DC, shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as:

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 ($D \geq 98\%$) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Figure vii Test Setup

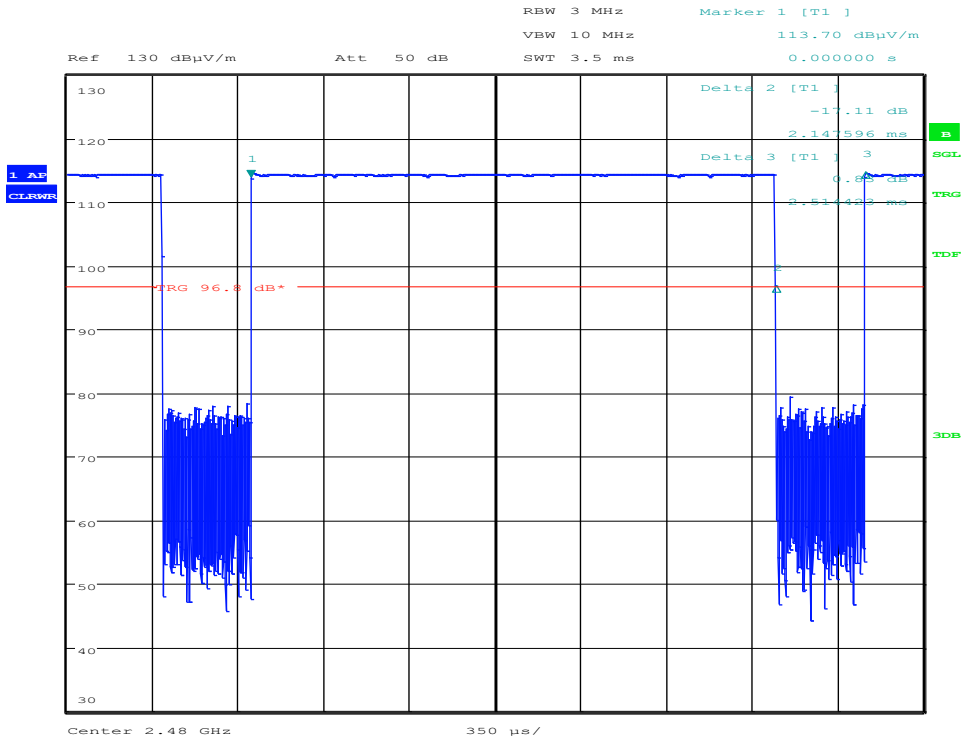


19.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU50	U544	2024-11-28

19.6 Test Results

Frequency: 2480 MHz; Modulation: GFSK; Power Setting: 19 dBm				
Test Environment		TxOn time (ms)	Frame Period (ms)	Calculated Factor (dB)
Vnominal	Tnominal	2.147596	2.514423	0.7



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Note: 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.

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 connector) Sampling Power Meter to 8 GHz	MU4001	0.9 dB
Carrier Power and PSD - Spectrum Analysers	MU4004	1.7 dB
Adjacent Channel Power	MU4002	1.9 dB
Transmitter conducted spurious emissions (Including emissions due to intermodulation)	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
In-band (3450-3650 MHz) TRP using CATR_ASH_B2	MU4051	4.1 dB
Cellular Radiated Spurious Emissions in a SAC 30 MHz to 180 MHz	MU4052	6.3 dB
Cellular Radiated Spurious Emissions in a SAC 180 MHz to 18 GHz	MU4052	3.6 dB
Cellular Radiated Spurious Emissions in a FAR 30 MHz to 180 MHz	MU4052	5.4 dB
Cellular Radiated Spurious Emissions in a FAR 180 MHz to 18 GHz	MU4052	3.0 dB
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz (Including emissions due to intermodulation)	MU4037	4.7 dB
Radiated Spurious Emissions 1-18 GHz (Including emissions due to intermodulation)	MU4032	4.5 dB
E Field Emissions 18 GHz to 26 GHz	MU4024	3.2 dB
E Field Emissions 26 GHz to 40 GHz	MU4025	3.3 dB
E Field Emissions 40 GHz to 50 GHz	MU4026	3.5 dB
E Field Emissions 50 GHz to 75 GHz	MU4027	3.6 dB
E Field Emissions 75 GHz to 110 GHz	MU4028	3.6 dB
Radiated Magnetic Field Emissions	MU4031	2.3 dB

Test/Measurement	Budget Number	MU
Frequency Measurements		
Frequency Deviation	MU4022	3.7 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	678.984 µs
DFS Generator - Frequency Error	MU4007	91.650 Hz
DFS Threshold Conducted	MU4008	1.3 dB
DFS Threshold Radiated	MU4009	3.2 dB
Receiver Parameters		
EN 300 328 Receiver Blocking	MU4010	1.1 dB
EN 301 893 Receiver Blocking	MU4011	1.1 dB
EN 303 340 Adjacent Channel Selectivity	MU4012	1.1 dB
EN 303 340 Overloading	MU4013	1.1 dB
EN 303 340 Receiver Blocking	MU4014	1.1 dB
EN 303 340 Receiver Sensitivity	MU4015	0.9 dB
EN 303 372-1 Image Rejection	MU4016	1.4 dB
EN 303 372-1 Receiver Blocking	MU4017	1.1 dB
EN 303 372-2 Adjacent Channel Selectivity	MU4018	1.1 dB
EN 303 372-2 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

Test/Measurement	Budget Number	MU
Rohde & Schwarz TS8997		
Carrier frequency	MU4050	5.2 ppm
RF Output Power	MU4050	1.0 dB
Peak Power	MU4050	0.8 dB
Power Spectral Density	MU4050	1.0 dB
Occupied Channel Bandwidth	MU4050	2.08 %
Transmitter unwanted emissions in-band	MU4050	0.9 dB
Transmitter unwanted emissions in the spurious domain 30 MHz to 1 GHz	MU4050	0.6 dB
Transmitter unwanted emissions in the spurious domain 1 GHz to 12.75 GHz	MU4050	1.8 dB
Receiver Spurious emission 30 MHz to 1 GHz	MU4050	0.6 dB
Receiver Spurious emission 1 GHz to 12.75 GHz	MU4050	1.8 dB
Duty Cycle	MU4050	0.02 %
Tx Sequence	MU4050	0.02 %
Tx Gap	MU4050	0.02 %
Medium Utilisation	MU4050	0.1 %
Accumulated Transmit Time	MU4050	0.01 %
Minimum Frequency Occupation Time	MU4050	0.01 %
Hopping Frequency Separation	MU4050	0.6 %
Receiver blocking (for bit streams)	MU4050	3.0 dB
Channel Access Mechanism / Adaptivity / DFS / Contention Based Protocol	MU4050	1.8 dB

21 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.

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

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)	SAR Exclusion Threshold at 50 mm (mW)	SAR Evaluation
2440	78.88	96.0	Not Required

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