

Report on the Radio Testing

For

Elvie

on

Elvie Pump

Report no. TRA-056398-47-02A

2021-11-22

RF908 5.0

Report Number: TRA-056398-47-02A
Issue: A

REPORT ON THE RADIO TESTING OF A
Elvie
Elvie Pump
WITH RESPECT TO SPECIFICATION
ETSI EN 300 328 V2.2.2 (2019-07)

TEST DATE: 2021-10-28 to 2021-11-05

Tested by:



Steven Garwell, Michael Else

Written by:



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Date: 2021-11-22

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF980 5.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	2021-11-22	Original

2 Summary

TEST REPORT NUMBER:	TRA-056398-47-02A
WORKS ORDER NUMBER:	TRA-056398-00
PURPOSE OF TEST:	Testing of radio equipment construction per article 3.2 of the RE Directive 2014/53/EU
TEST SPECIFICATION:	EN 300 328 V2.2.2
EQUIPMENT UNDER TEST (EUT):	Elvie Pump
EUT SERIAL NUMBER:	ST-14
MANUFACTURER/AGENT:	Elvie
ADDRESS:	2nd Floor 63-66 Hatton Garden London EC1N 8LE United Kingdom
CLIENT CONTACT:	Shiva Golchi ☎ +44 (0)203 745 5201 ✉ shiva.golchi@chiaro.co.uk
ORDER NUMBER:	PO0124733
TEST DATE:	2021-10-28 to 2021-11-05
TESTED BY:	Steven Garwell, Michael Else Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause</i>	<i>Applicable to this equipment</i>	<i>Result / Note</i>
RF output power	4.3.2.2	☒	Pass
Power spectral density	4.3.2.3	☒	Pass
Duty cycle, Tx sequence, Tx gap	4.3.2.4	☐	Note 1
Medium utilization (MU) factor	4.3.2.5	☐	Note 1
Adaptivity (adaptive equipment using modulations other than FHSS)	4.3.2.6	☐	Note 2
Occupied channel bandwidth	4.3.2.7	☒	Pass
Transmitter unwanted emissions in the out-of-band domain	4.3.2.8	☒	Pass
Transmitter unwanted emissions in the spurious domain	4.3.2.9	☒	Pass
Receiver spurious emissions	4.3.2.10	☒	Pass
Receiver blocking	4.3.2.11	☒	Pass
Geo-location capability	4.3.2.12	☐	Note 3

Specific Notes:

1. Only applicable to non-adaptive equipment with the RF Output power level ≥ 10 dBm e.i.r.p
2. Only applicable to adaptive equipment with the RF Output power level ≥ 10 dBm e.i.r.p
3. Declaration only

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-056398-47-02A presents the results of the Radio testing on an Elvie, Elvie Pump to specification EN 300 328 V2.2.2 Wideband transmission systems; Data transmission equipment operating in the 2.4 GHz band; Harmonised Standard for access to radio spectrum.

The testing was carried out for Elvie 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 Skelmersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

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

5 Test Specifications

5.1 Normative References

- ETSI EN 300 328 V2.2.2 (2019-07) – Wideband transmission systems; Data transmission equipment operating in the 2.4 GHz band; Harmonised Standard for access to radio spectrum.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

S	denotes a section reference from the standard, not this document
AC	Alternating Current
ACK	Acknowledgement signal
AFH	Adaptive Frequency Hopping
BW	bandwidth
C	Celsius
CCA	Clear Channel Assessment
COT	Channel Occupancy Time
CSD	Cyclic Shift Diversity
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DAA	Detect And Avoid
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
EN	European Normative document
EUT	Equipment Under Test
FHSS	Frequency Hopping Spread Spectrum
HT	High Throughput
Hz	hertz
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MCS	Modulation and Coding Scheme
MIMO	Multiple-Input/Multiple-Output
min	minimum
MU	Medium Utilization
N/A	Not Applicable
OCBW	Occupied Channel Bandwidth
OFDM	Orthogonal Frequency Division Multiplexing
OOB	Out Of Band
PCB	Printed Circuit Board
PDF	Portable Document Format
PER	Packet Error Rate
PFD	Power Flux Density
PSD	Power Spectral Density
R&TTE	Radio and Telecommunications Terminal Equipment
RE	Radio Equipment
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
Tx	transmitter
UKAS	United Kingdom Accreditation Service
UUT	Unit Under Test
V	volt
VBW	Video BandWidth
W	watt
Ω	ohm

7 Equipment under Test

7.1 EUT Identification

- Name: Elvie Pump
- Serial Number: ST-14
- Model Number: EP01
- Firmware Revision: bt-cert V8.0.0
- Build Level / Revision Number: V2.0.1 (main board), V6.1.1 (Driver board), V4.1.0 (UI board), V2.0.1 (IR board)

7.2 System Equipment

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

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmitter test's where as follows:

The EUT was transmitting a modulated carrier on the frequencies as indicated. This was selectable by pressing buttons on the control pad and the correct mode of operation was visible via a flashing LED.

7.3.2 Reception

The mode of operation for receiver test's where as follows:

The EUT was receiving on the frequencies as indicated. This was selectable by pressing buttons on the control pad and the correct mode of operation was visible via a flashing LED.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	2402 MHz to 2480 MHz
Modulation type:	GFSK
Channel bandwidth:	2 MHz
Channel spacing:	2 MHz
Declared output power:	≤ 6 dBm
Antenna type(s) and gain(s):	Integral (Pulse Larsen – W3008), Gain 1.1 dBi
Nominal Supply Voltage:	3.7 Vdc

7.5 EUT Description

The EUT is an electric breast pump containing a Bluetooth radio.

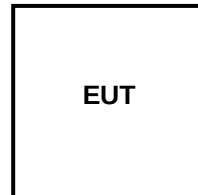
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

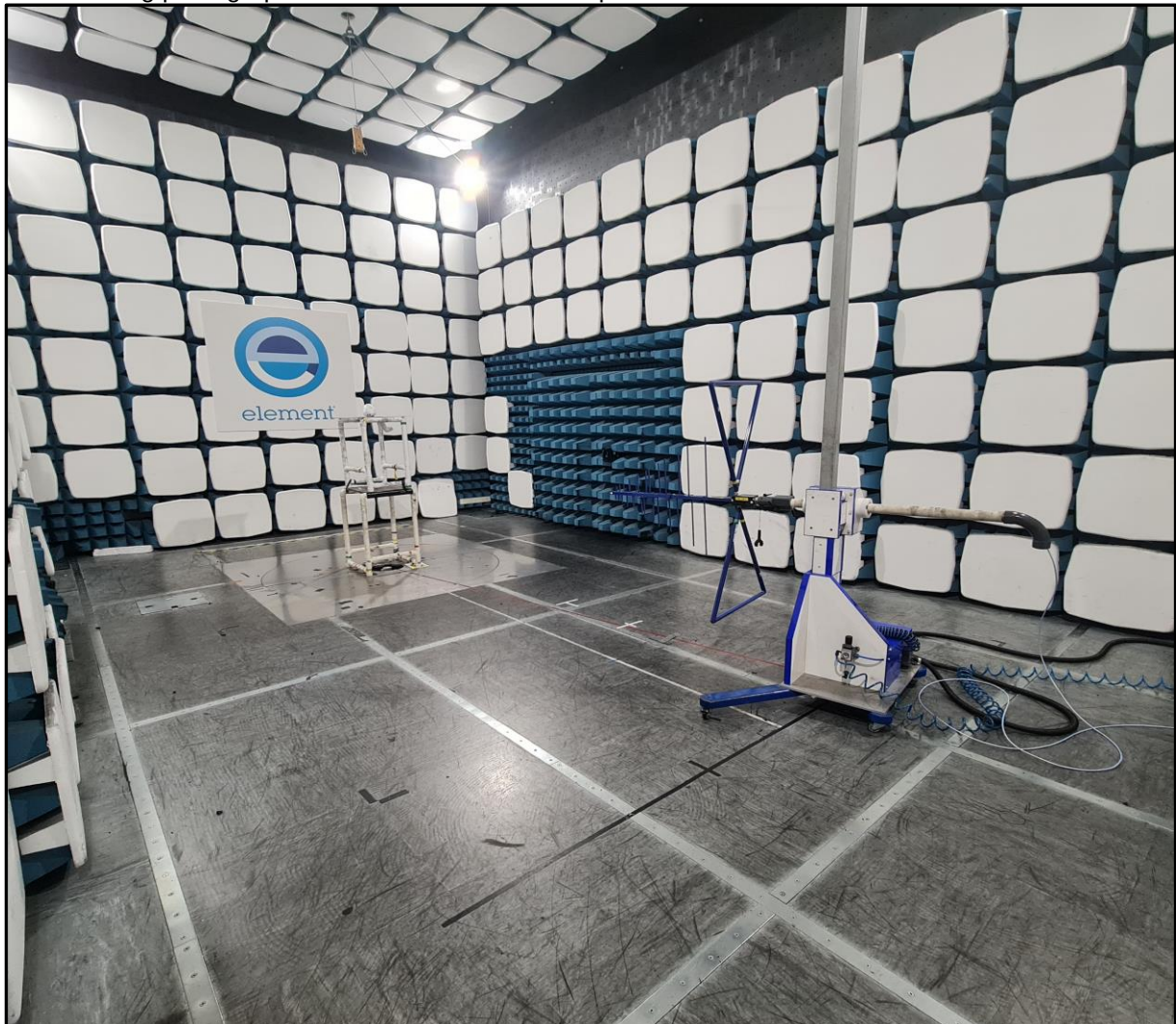
9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph illustrates basic EUT set-up:



10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 3.7 Vdc from an internal Lithium battery.

10.2 Extreme Test Conditions

Where extreme temperatures are required to be tested the following extremes were used:

- +5 °C and +30 °C

11 RF output power

11.1 Definition

The RF output power is defined as the mean equivalent isotropic radiated power (e.i.r.p.) of the equipment during a transmission burst.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	EMC Chamber SK01
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.2
EUT Frequencies Measured:	2402 MHz, 2442 MHz & 2480 MHz
Deviations from Standard:	None
Temperature Extreme Environment Test Range:	+5 °C to +30 °C (as declared)

Environmental Conditions (Normal Environment)

Temperature: 18 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 62 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

For adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be 20 dBm.

The maximum RF output power for non-adaptive equipment shall be declared by the manufacturer and shall not exceed 20 dBm. See § clause 5.4.1m. For non-adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be equal to or less than the value declared by the manufacturer.

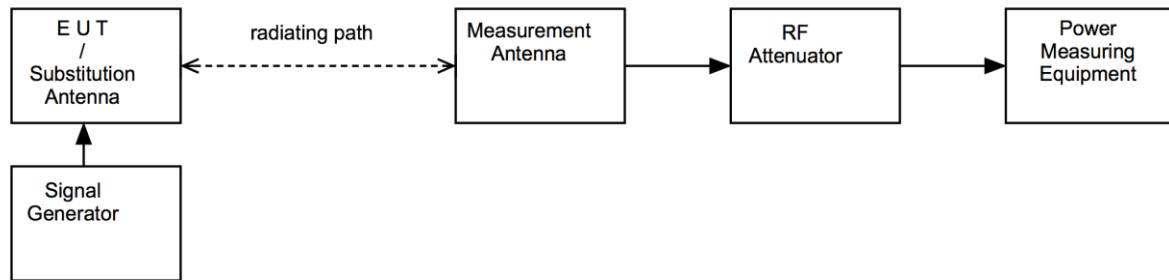
This limit shall apply for any combination of power level and intended antenna assembly.

11.3 Test Method

11.3.1 Radiated measurement

With the EUT connected as per Figure i-a, the EUT fundamental frequency was maximised by rotating the EUT through 360°, in three orthogonal planes, and adjusting the measurement antenna height through 1-4m. The EUT was substituted with a known signal generator and antenna and the maximum of all signals was recorded. The measurements were made in both horizontal and vertical polarisation.

Figure i-a Test Setup

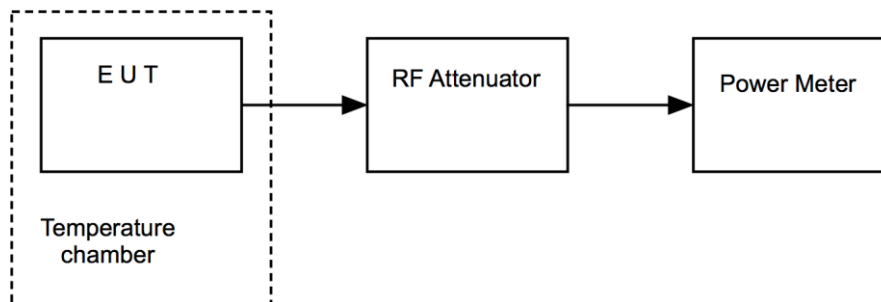


11.3.2 Conducted measurement

With the EUT connected as per Figure i-b, the power of the EUT was measured at the antenna port and the result calculated by relating back to the radiated power.

For single antenna output devices, power was measured at the antenna port. For, multiple antenna output devices, power was measured as the combination of all ports simultaneously.

Figure i-b Test Setup



11.4 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	FSU46	REF910	2021-11-18
1-18GHz Horn	EMCO	3115	L139	2023-07-27
1-18GHz Horn	EMCO	3115	U223	2021-11-05
Signal Generator	R&S	SMBV100A	U674	2022-05-27
Pre Amp	Agilent	8449B	L572	2022-10-29
Power Meter	Dare	RPR3006W	REF2223	2022-03-10
Temperature Indicator	Fluke	52 Series II	L426	2022-07-01
Temperature Chamber	Votsch	VT 4002	U521	Use L426

11.5 Test Results

Frequency: 2402 MHz; Power Setting: 6 dBm; Modulation: GFSK; Data rate: 1 Mbps					
Test Environment		Measured Power, A (dBm)	Test Fixture Loss (dB)	RF power, P (dBm)	Result
V _{nominal}	T _{nominal}	2.40	0	2.40	Pass
	T _{minimum}	2.60	0	2.60	Pass
	T _{maximum}	2.20	0	2.20	Pass

Frequency: 2442 MHz; Power Setting: 6 dBm; Modulation: GFSK; Data rate: 1 Mbps					
Test Environment		Measured Power, A (dBm)	Test Fixture Loss (dB)	RF power, P (dBm)	Result
V _{nominal}	T _{nominal}	2.70	0	2.70	Pass
	T _{minimum}	2.90	0	2.90	Pass
	T _{maximum}	2.50	0	2.50	Pass

Frequency: 2480 MHz; Power Setting: 6 dBm; Modulation: GFSK; Data rate: 1 Mbps					
Test Environment		Measured Power, A (dBm)	Test Fixture Loss (dB)	RF power, P (dBm)	Result
V _{nominal}	T _{nominal}	3.30	0	3.30	Pass
	T _{minimum}	3.50	0	3.50	Pass
	T _{maximum}	3.10	0	3.10	Pass

12 Power Spectral Density

12.1 Definition

The Power Spectral Density is the mean equivalent isotropically radiated power (e.i.r.p.) spectral density in a 1 MHz bandwidth during a transmission burst.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.3
EUT Frequencies Measured:	2402 MHz, 2442 MHz & 2480 MHz
Measurement Bandwidth:	10 kHz
Measurement Detector:	RMS
Deviations from Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 18 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 45 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

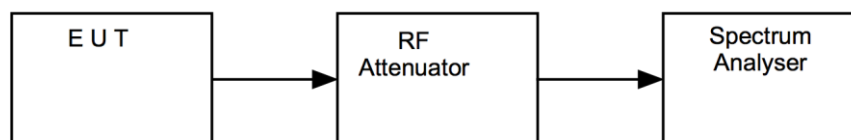
For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10 dBm per MHz.

12.3 Test Method

With the EUT connected as per Figure ii, the power density of the EUT was measured on a spectrum analyser, normalised against the previously measured RF output power.

All modulation schemes, bandwidths and data rates were used to observe the worst case configuration.

Figure ii Test Setup



12.4 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	FSU46	REF910	2021-11-18
Attenuator	AtlanTecRF Microwave	10dB SMA Attenuator	U633	Cal In use

12.5 Test Results

Frequency: 2402 MHz; Power Setting: 6 dBm; Bandwidth: 1 MHz; Modulation: GFSK; Data Rate: 1 Mbps				
Measurements				Result
RF output power, P (dBm)	Total element power, P_{Sum} (dBm)	Normalisation factor, C_{Corr} (dB)	Max. PSD (dBm/MHz)	
2.40	2.53	-0.13	2.35	Pass

Frequency: 2442 MHz; Power Setting: 6 dBm; Bandwidth: 1 MHz; Modulation: GFSK; Data Rate: 1 Mbps				
Measurements				Result
RF output power, P (dBm)	Total element power, P_{Sum} (dBm)	Normalisation factor, C_{Corr} (dB)	Max. PSD (dBm/MHz)	
2.70	2.07	0.63	2.65	Pass

Frequency: 2480 MHz; Power Setting: 6 dBm; Bandwidth: 1 MHz; Modulation: GFSK; Data Rate: 1 Mbps				
Measurements				Result
RF output power, P (dBm)	Total element power, P_{Sum} (dBm)	Normalisation factor, C_{Corr} (dB)	Max. PSD (dBm/MHz)	
3.30	2.33	0.97	3.25	Pass

13 Occupied Channel Bandwidth

13.1 Definition

The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.7
EUT Frequencies Measured:	2402 MHz & 2480 MHz
Deviations from Standard:	None
Measurement BW:	20 kHz
Measurement Detector:	RMS

Environmental Conditions (Normal Environment)

Temperature: 18 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 45 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

The Occupied Channel Bandwidth shall fall completely within the band given in § table 1.

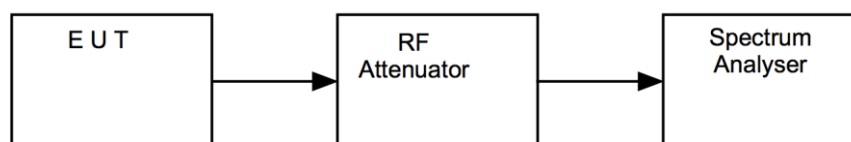
In addition, for non-adaptive equipment using wide band modulations other than FHSS and with e.i.r.p greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.

13.3 Test Method

With the EUT connected as per Figure vi, 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 vi Test Setup

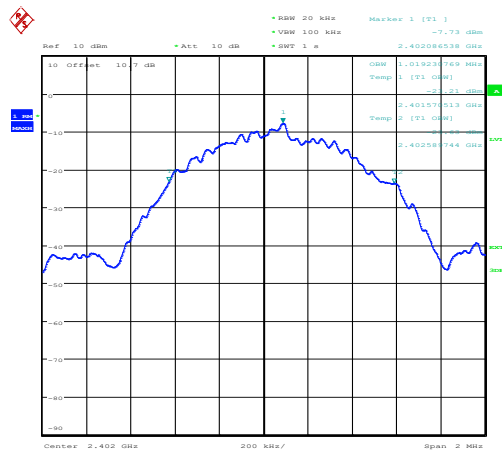


13.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU46	REF910	2021-11-18
Attenuator	AtlanTecRF Microwave	10dB SMA Attenuator	U633	Cal In use

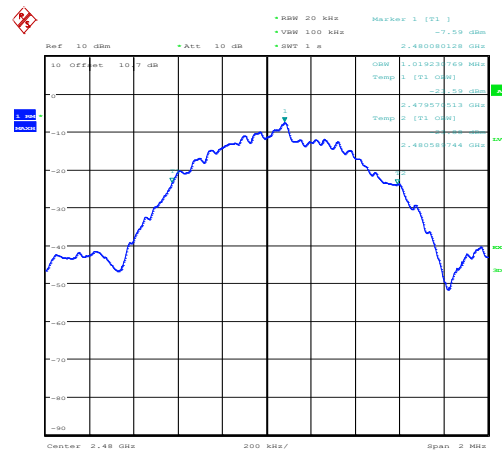
13.5 Test Results

Modulation: GFSK; Power setting; 6 dBm; Data rate: 1 Mbps				
Fc (MHz)	Fi (MHz)	Fh (MHz)	99% Bandwidth (MHz)	Result
2402	2401.570513	2402.589744	1.019230	Pass
2480	2479.570513	2480.589744	1.019230	Pass



Date: 4.NOV.2021 15:35:24

2402 MHz



Date: 4.NOV.2021 15:37:14

2480 MHz

14 Transmitter unwanted emissions in the out-of-band domain

14.1 Definition

Transmitter unwanted emissions in the out-of-band domain are emissions when the equipment is in Transmit mode, on frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.8
EUT Frequencies Measured:	2402 MHz & 2480 MHz
Deviations From Standard:	None
Measurement Detector:	RMS
Deviations from Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 18 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 45 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in figure 3.

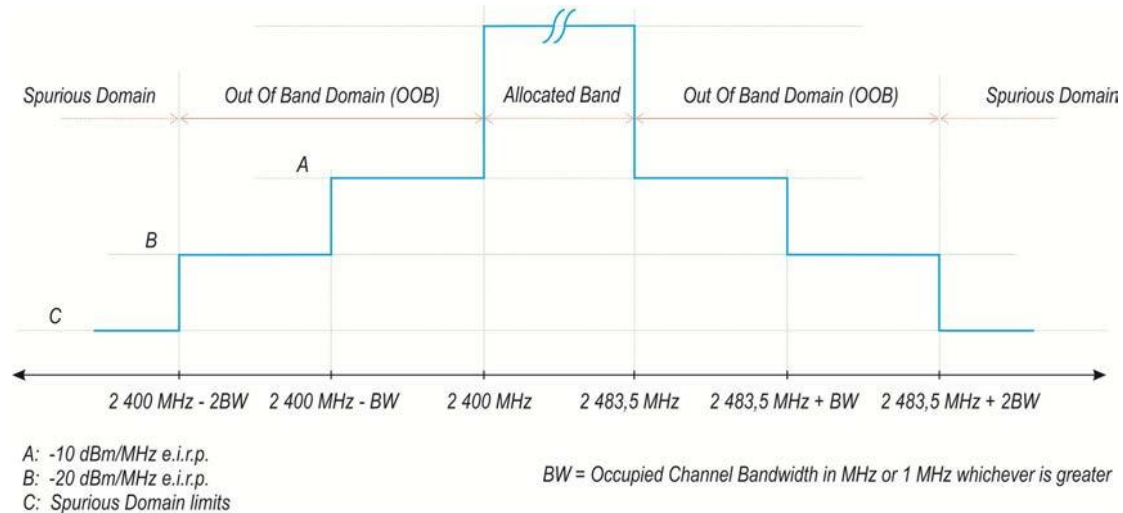


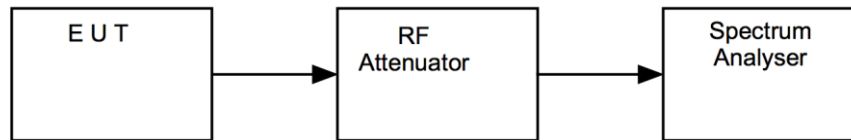
Figure 3: Transmit mask

NOTE: Within the 2 400 MHz to 2 483,5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in § clause 4.3.2.7.

14.3 Test Method

With the EUT connected as per Figure vii, the RF spectrum from the EUT was observed. All modulation schemes, data rates and power settings were used to observe the worst case configuration.

Figure vii Test Setup



14.4 Test Equipment

<i>Equipment</i>		<i>Equipment</i>	<i>Element</i>	<i>Due For</i>
<i>Description</i>	<i>Manufacturer</i>	<i>Type</i>	<i>No</i>	<i>Calibration</i>
Spectrum Analyser	R&S	FSU46	REF910	2021-11-18
Attenuator	AtlanTecRF Microwave	10dB SMA Attenuator	U633	Cal In use

14.5 Test Results

<i>Bandwidth</i>	<i>Modulation / Data Rate</i>	<i>FL-BW to FL-2BW (dBm/MHz)</i>	<i>FL to FL-BW (dBm/MHz)</i>	<i>FH to FH+BW (dBm/MHz)</i>	<i>FH+BW to FH+2BW (dBm/MHz)</i>	<i>Result</i>
2 MHz	1 Mbps	-56.53	-54.08	-56.91	-58.9	Pass

15 Transmitter unwanted emissions in the spurious domain

15.1 Definition

Transmitter unwanted emissions in the spurious domain are emissions outside the allocated band and outside the Out-of-band Domain as indicated in § figure 3 when the equipment is in Transmit mode.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	EMC Chamber SK01
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.9
EUT Frequencies Measured:	2402 MHz & 2480 MHz
Deviations from Standard:	None
Measurement BW:	100 kHz (30 MHz – 1 GHz); 1 MHz (1 GHz-12.75 GHz)
Measurement Detector:	RMS

Environmental Conditions (Normal Environment)

Radiated

Temperature: 18 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 62 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 12.

Table 12: Transmitter limits for spurious emissions

Frequency range	Maximum power	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87,5 MHz	-36 dBm	100 kHz
87,5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 694 MHz	-54 dBm	100 kHz
694 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12,75 GHz	-30 dBm	1 MHz

NOTE: In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted). For emissions radiated by the cabinet or emissions radiated by integral antenna equipment (without antenna connectors), these limits are e.r.p. for emissions up to 1 GHz and e.i.r.p. for emissions above 1 GHz.

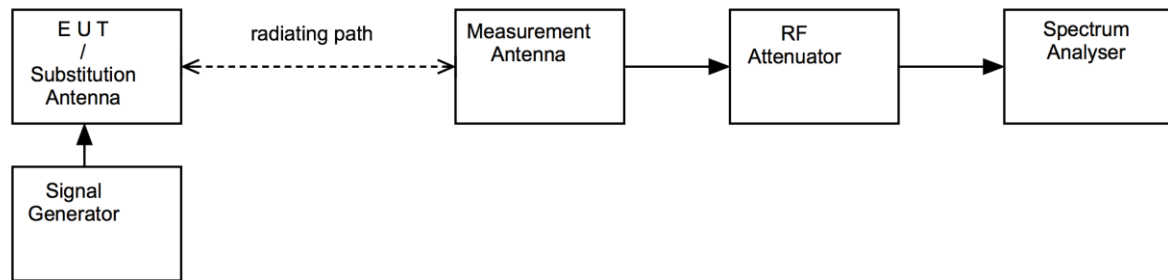
15.3 Test Method

With the EUT connected as per Figure ix, the RF spectrum of the EUT was observed as the EUT was rotated through 360 degrees.

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.

Following a peak pre-scan, all emissions identified as more than 6 dB below the limit were measured individually with RMS detector.

Figure ix Test Setup

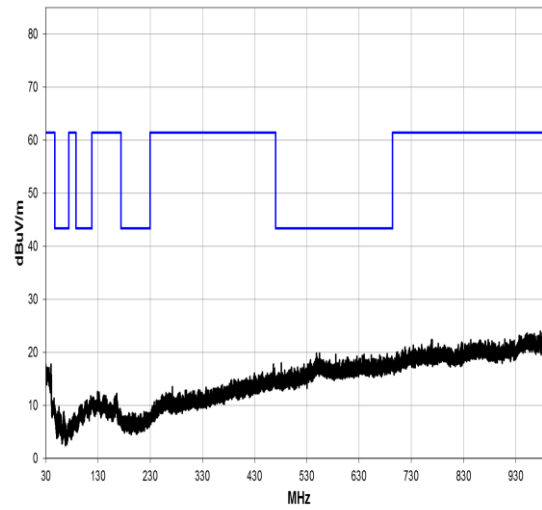


15.4 Test Equipment

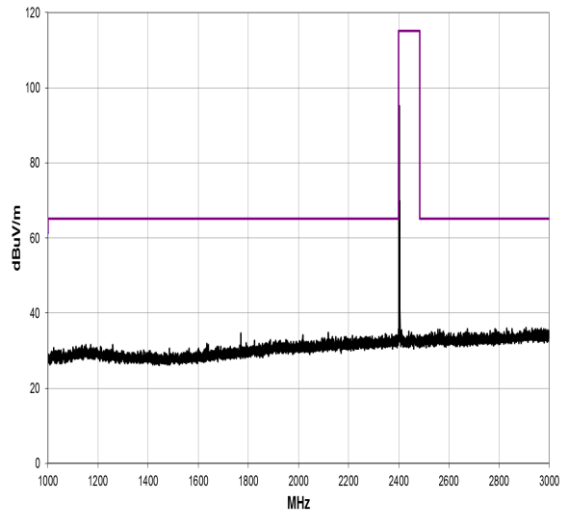
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required
Chamber 1	Rainford EMC	ATS	U387	2021-09-09
Bilog	Chase	CBL611/B	U573	2023-01-28
Spectrum Analyser	R&S	FSU46	REF910	2021-11-18
Pre Amp	AMETEK	LNA6901	U711	2022-02-03
1-18GHz Horn	EMCO	3115	L139	2023-07-27
Pre Amp	Agilent	8449B	U457	2022-02-02
1-18GHz Horn	EMCO	3115	U223	2021-11-05
Signal Generator	R&S	SMB100A	U677	2022-01-26
High Pass Filter	BSC	SH4141	REF977	2022-01-30

15.5 Test Results

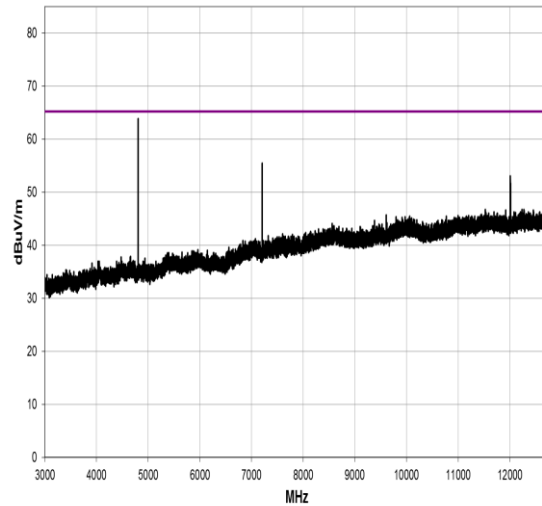
Bottom Channel: 2402 MHz



30 MHz to 1 GHz



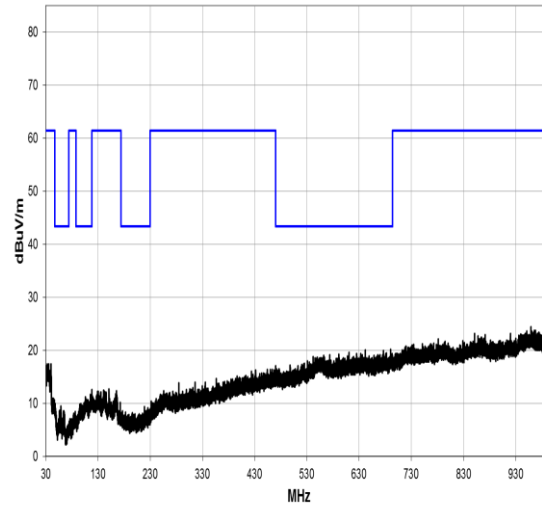
1 GHz to 3 GHz



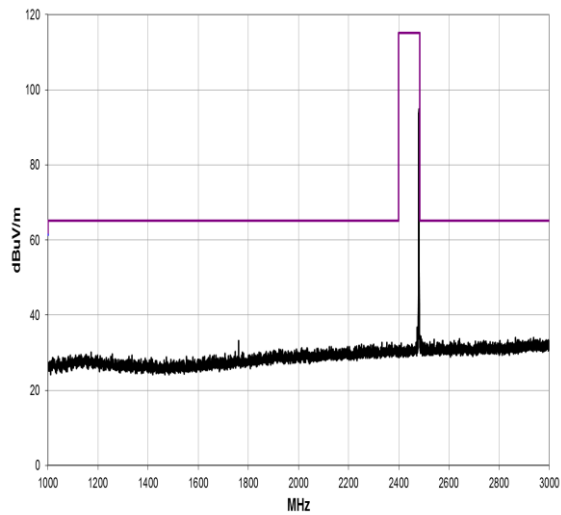
3 GHz to 12.75 GHz

Frequency: 2402 MHz; Power Setting: 6 dBm; Modulation: GFSK					
Emission	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
1	4804.09	-30.63	-30.00	-0.63	Pass
2	7205.78	-38.40	-30.00	-8.40	Pass
3	12009.52	-44.03	-30.00	-14.03	Pass

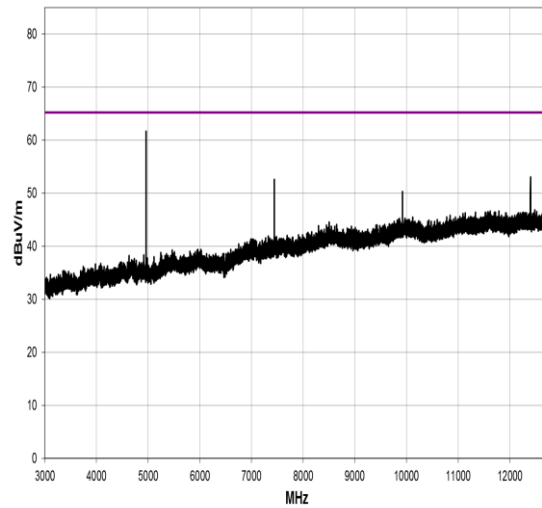
Top Channel: 2480 MHz



30 MHz to 1 GHz



1 GHz to 3 GHz



3 GHz to 12.75 GHz

Frequency: 2480 MHz; Power Setting: 6 dBm; Modulation: GFSK					
Emission	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
1	4960.03	-30.69	-30.00	-0.69	Pass
2	7439.75	-41.18	-30.00	-11.18	Pass
3	12399.31	-40.31	-30.00	-10.31	Pass
4	9919.48	-45.17	-30.00	-15.17	Pass

16 Receiver spurious emissions

16.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	EMC Chamber SK01
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.10
EUT Frequencies Measured:	2402 MHz & 2480 MHz
Deviations from Standard:	None
Measurement BW:	100 kHz (30 MHz – 1 GHz); 1 MHz (1 GHz-12.75 GHz)
Measurement Detector:	RMS

Environmental Conditions (Normal Environment)

Radiated

Temperature: 17.5 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 62 %RH	Standard Requirement: 20%RH to 75%RH
Supply: 3.7 Vdc	3.7 Vdc (as declared)

Test Limits

The spurious emissions of the receiver shall not exceed the values given in table 13.

NOTE: In case of equipment with antenna connectors, these limits apply to emissions at the antenna port (conducted). For emissions radiated by the cabinet or emissions radiated by integral antenna equipment (without antenna connectors), these limits are e.r.p. for emissions up to 1 GHz and e.i.r.p. for emissions above 1 GHz.

Table 13: Spurious emission limits for receivers

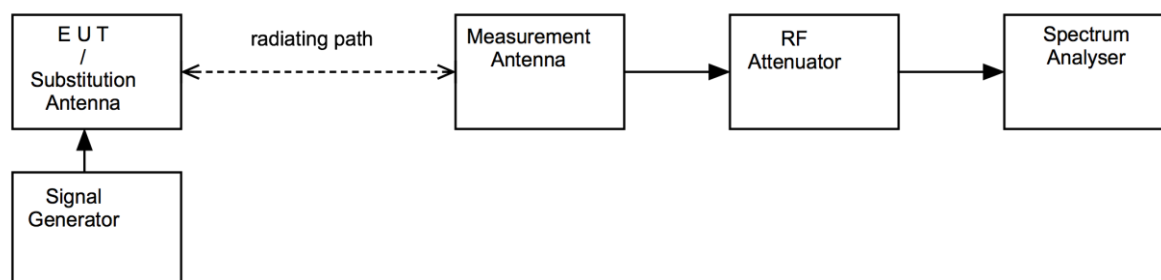
<i>Frequency range</i>	<i>Maximum power</i>	<i>Measurement bandwidth</i>
30 MHz to 1 GHz	-57 dBm	100 kHz
1 GHz to 12,75 GHz	-47 dBm	1 MHz

16.3 Test Method

With the EUT setup connected as per Figure xi, the RF spectrum of the EUT was observed. The measurements were performed with EUT set in receive only mode.

Following a peak pre-scan, all emissions identified as more than 6 dB below the limit were measured individually with RMS detector.

Figure xi Test Setup

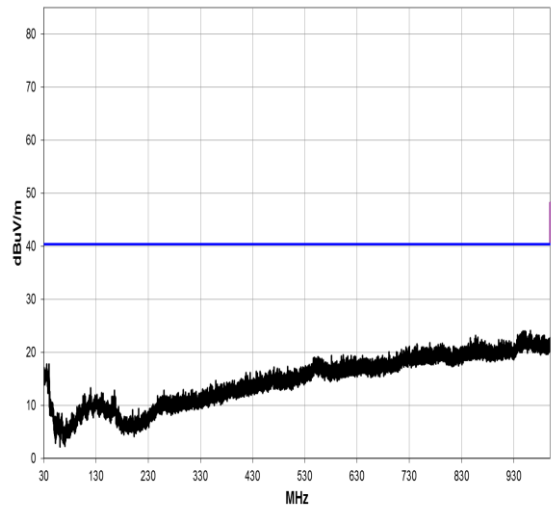


16.4 Test Equipment

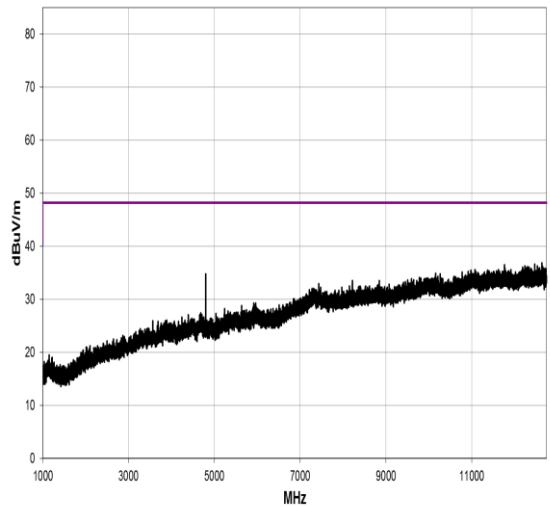
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required
Chamber 1	Rainford EMC	ATS	U387	2021-09-09
Bilog	Chase	CBL611/B	U573	2023-01-28
Spectrum Analyser	R&S	FSU46	REF910	2021-11-18
Pre Amp	AMETEK	LNA6901	U711	2022-02-03
1-18GHz Horn	EMCO	3115	L139	2023-07-27
Pre Amp	Agilent	8449B	U457	2022-02-02

16.5 Test Results

Bottom Channel: 2402 MHz



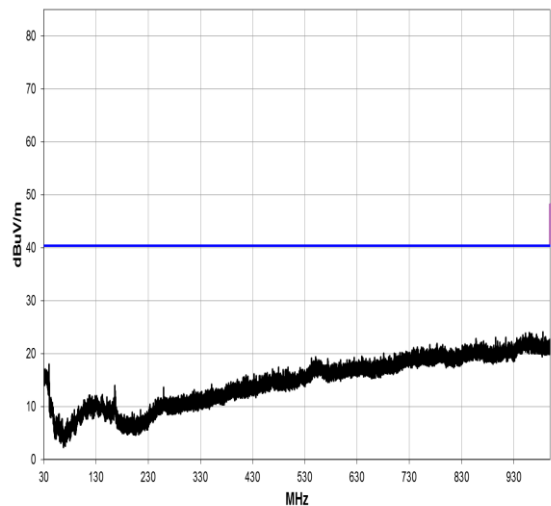
30 MHz to 1 GHz



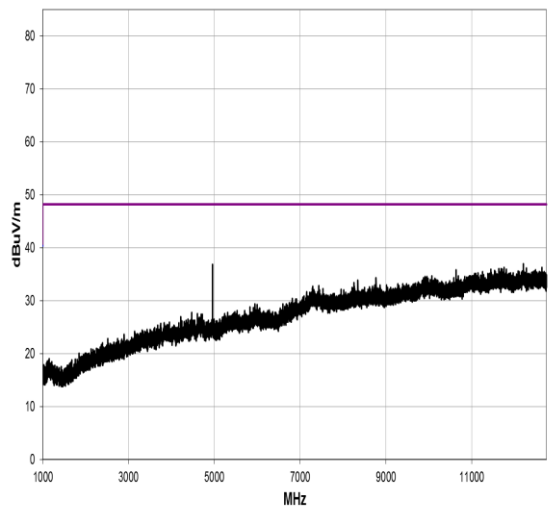
1 GHz to 12.75 GHz

Frequency: 2402 MHz; Receive Mode					
Emission	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
No significant emissions within 10 dB of the limit.					Pass

Top Channel: 2480 MHz



30 MHz to 1 GHz



1 GHz to 12.75 GHz

Frequency: 2480 MHz; Receive Mode					
Emission	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
No significant emissions within 10 dB of the limit.					Pass

17 Receiver Blocking

17.1 Definition

Receiver blocking is a measure of the ability of the equipment to receive a wanted signal on its operating channel without exceeding a given degradation in the presence of an unwanted signal (blocking signal) on frequencies other than those of the operating band.

17.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Blocking Laboratory
Test Standard and Clause:	ETSI EN 300 328 V2.2.2 (2019-07), Clause 5.4.11
Receiver Category:	2
Receiver Performance:	PER less than or equal to 10%
EUT Frequencies Measured:	2402 MHz & 2480 MHz
Deviations from Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 20 °C	Standard Requirement: +15 °C to +35 °C
Humidity: 50 %RH	Standard Requirement: 20%RH to 75%RH

Test Limits

While maintaining the minimum performance criteria as defined in § clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined in table 15.

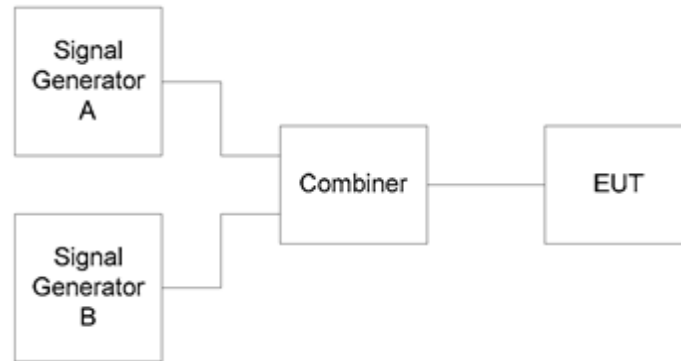
Table 15: Receiver Blocking parameters for Receiver Category 2 equipment

<i>Wanted signal mean power from companion device (dBm)</i>	<i>Blocking signal Frequency [MHz]</i>	<i>Blocking signal power [dBm] (see note 2)</i>	<i>Type of blocking signal</i>
(-139 dBm + 10 × log ₁₀ (OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P_{min} + 26 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

17.3 Test Method

With the EUT fixed on a single operating channel and connected as per Figure x, the wanted signal (Gen A) was set to -68.6 dBm. The blocking signal (Gen B) was then introduced at the levels specified, and the response of the EUT was monitored.

Figure x Test Setup



17.4 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	ESR 7	U727	2022-03-30
Signal Generator	R&S	SMBV100A	U674	2022-05-27
Variable Attenuator	Agilent	8494A / 8495A	U453	Calibrate In Use
Combiner	Agilent	11667A	U303	Calibrate In Use

17.5 Test Results

<i>Applied signals</i>				<i>PER (%)</i>	<i>Result</i>
<i>Wanted Signal Frequency (MHz)</i>	<i>Wanted Signal Level (dBm)</i>	<i>Blocking Signal Frequency (MHz)</i>	<i>Blocking Signal Level (dBm)</i>		
2402	-68.6	2 300	>-24	0%	PASS
2402	-68.6	2 380	>-24	0%	PASS
2480	-68.6	2 504	>-24	0%	PASS
2480	-68.6	2 584	>-24	0%	PASS

18 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) 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