

Report on the Radio Testing
For
Draeger Safety UK Ltd
on
BG Proair (without Gauge and HUD)
Report no. TRA-051967-47-08A
2024-10-16

RF914 9.0



Report Number: TRA-051967-47-08A
Issue: A

REPORT ON THE RADIO TESTING OF A
Draeger Safety UK Ltd
BG Proair (without Gauge and HUD)
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.225

TEST DATE: 2023-04-19 to 2023-04-24

Tested by:



Steven Garwell
Radio Test Engineer

Written by:



Steven Garwell
Radio Test Engineer

Approved by:

John Charters
Department Manager - Radio

Date: 2024-10-16

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

RF914 9.0



1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	2024-10-16	Original

2 Summary

TEST REPORT NUMBER:	TRA-051967-47-08A
WORKS ORDER NUMBER:	TRA-051967-19
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION:	47CFR15.225
EQUIPMENT UNDER TEST (EUT):	BG Proair (without Gauge and HUD)
FCC IDENTIFIER:	X6O-BG001
EUT SERIAL NUMBER:	Test Sample 56
MANUFACTURER/AGENT:	Draeger Safety UK Ltd
ADDRESS:	Ullswater Close Blyth Riverside Business Park Blyth NE24 4RG United Kingdom
CLIENT CONTACT:	Eoghan Quigley ☎ 01670 352 891 ✉ eoghan.quigley@draeger.com
ORDER NUMBER:	4302888682
TEST DATE:	2023-04-19 to 2023-04-24
TESTED BY:	Error! Reference source not found. Element

2.1 Test Summary

Test Method and Description	Requirement Clause	Applicable to this equipment	Result / Note
	47CFR15		
Radiated spurious emissions, below 30 MHz	15.225(d)	☒	PASS
Radiated spurious emissions	15.209	☒	PASS
AC power line conducted emissions	15.207	☐	Note 1
Occupied bandwidth	15.215(c)	☒	PASS
Field strength of fundamental	15.225(a), (b) and (c)	☒	PASS
Frequency stability	15.225(e)	☒	PASS

Notes:

Note 1: The EUT is a battery powered device

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).

General notes

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.

3 Contents

1	Revision Record	3
2	Summary	4
2.1	Test Summary	5
3	Contents	6
4	Introduction	7
5	Test Specifications	8
5.1	Normative References	8
5.2	Deviations from Test Standards	8
6	Glossary of Terms	9
7	Equipment Under Test	10
7.1	EUT Identification	10
7.2	System Equipment	10
7.3	EUT Mode of Operation	10
7.3.1	Transmission	10
7.4	EUT Radio Parameters	10
7.4.1	General	10
7.4.2	Antenna Details	10
7.5	EUT Description	10
8	Modifications	11
9	EUT Test Setup	12
9.1	Block Diagram	12
9.2	General Set-up Photograph	12
9.3	Measurement software	13
10	General Technical Parameters	14
10.1	Normal Conditions	14
10.2	Varying Test Conditions	14
11	Radiated emissions below 30 MHz	15
11.1	Definitions	15
11.2	Test Parameters	15
11.3	Test Limit	16
11.4	Test Method	16
11.5	Test Set-up Photograph	17
11.6	Test Equipment	17
11.7	Test Results	18
12	Radiated emissions	19
12.1	Definitions	19
12.2	Test Parameters	19
12.3	Test Limit	19
12.4	Test Method	20
12.5	Test Set-up Photograph	21
12.6	Test Equipment	21
12.7	Test Results	22
13	Occupied Bandwidth	24
13.1	Definition	24
13.2	Test Parameters	24
13.3	Test Limit	24
13.4	Test Method	25
13.5	Test Equipment	25
13.6	Test Results	25
14	Transmitter output power (fundamental radiated emission)	26
14.1	Definition	26
14.2	Test Parameters	26
14.3	Test Limit	26
14.4	Test Method	27
14.5	Test Equipment	27
14.6	Test Set-up Photograph	28
14.7	Test Results	29
15	Frequency stability	30
15.1	Definition	30
15.2	Test Parameters	30
15.3	Test Limit	30
15.4	Test Method	31
15.5	Test Equipment	31
15.6	Test Results	31
16	Measurement Uncertainty	32
17	Appendix A	34
17.1	Antenna Details	34

4 Introduction

This report TRA-051967-47-08A presents the results of the Radio testing on a Draeger Safety UK Ltd, BG Proair (without Gauge and HUD) to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Draeger Safety UK Ltd 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
-------------------------------------	--	--------------------------	---

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.

FCC Site Listing:

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

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

S	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 (nowISED)
ISED	Innovation, Science and Economic Development 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: BG Proair (without Gauge and HUD)
- Serial Number: Test Sample 56
- Model Number: BG Proair
- Software Revision: Not Stated
- Build Level / Revision Number: 1st prototype

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.

1. Laptop Computer – Dell Latitude E6410

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Transmitter tests was as follows:

The EUT was transmitting on the frequencies as indicated, the frequencies were programmed using Hterm 0.8.5 software which was supplied on a test laptop.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	13.56 MHz
Modulation type:	ASK
Declared output power(s):	Not Stated
Nominal Supply Voltage:	7.5 V dc via 5 X AA Alkaline cells

7.4.2 Antenna Details

Antenna Type:	Loop Antenna
Dimensions:	Width 30mm, Height 30mm
Number of Turns:	5

7.5 EUT Description

The EUT is an Open circuit breathing apparatus with compressed air cylinder used for Fire Fighting.

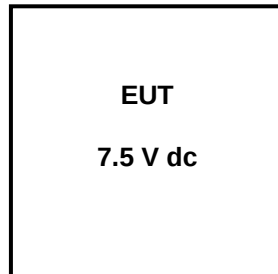
8 Modifications

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 (See Note)
Element Transmitter Bench Test (See Note)
ETS Lindgren EMPower V1.0.4.2

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

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 7.5 V dc from 5 x AA Alkaline batteries.

10.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	Variation
☒	Standard	-20 to +50 C in 10 degree steps
☐	Extended	

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power and frequency error testing the following variations were made:

	Category	Nominal	Variation
☐	Mains	110 V ac +/- 2 %	85 % and 115 %
☒	Battery	New battery	7.5 V dc +/- 15% of rated voltage

11 Radiated emissions below 30 MHz

11.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

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:	SK03 Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement Distance and Site	10 m, OATS without ground plane.
EUT Height:	1 m
Measurement Antenna and Height:	60 cm shielded loop; 1 m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: +22 °C	+15 °C to +35 °C (as declared)
Humidity: 31 % RH	20 % RH to 75 % RH (as declared)
Supply: 7.5 V dc	7.5 V dc (as declared)

11.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

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

<i>Frequency, f (kHz)</i>	<i>Field Strength</i>	<i>Measurement Distance (m)</i>
9 to 490	2,400 / 377.f (μA/m) 2,400 / f (μV/m)	300
490 to 1,750	24,000 / 377.f (μA/m) 24,000 / f (μV/m)	30
1,750 to 30,000	30 (μV/m)	30

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the EUT fundamental frequency was maximised by rotating the EUT through 360°, in three orthogonal planes, and adjusting the measurement antenna azimuth.

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 9 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 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in μV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

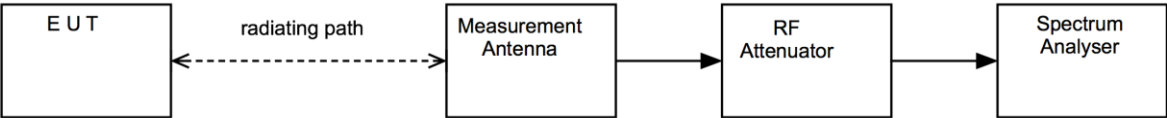
Where,

PR is the power recorded on the receiver / spectrum analyzer in dBμV and includes any cable loss, antenna factor and pre-amplifier gain;
CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

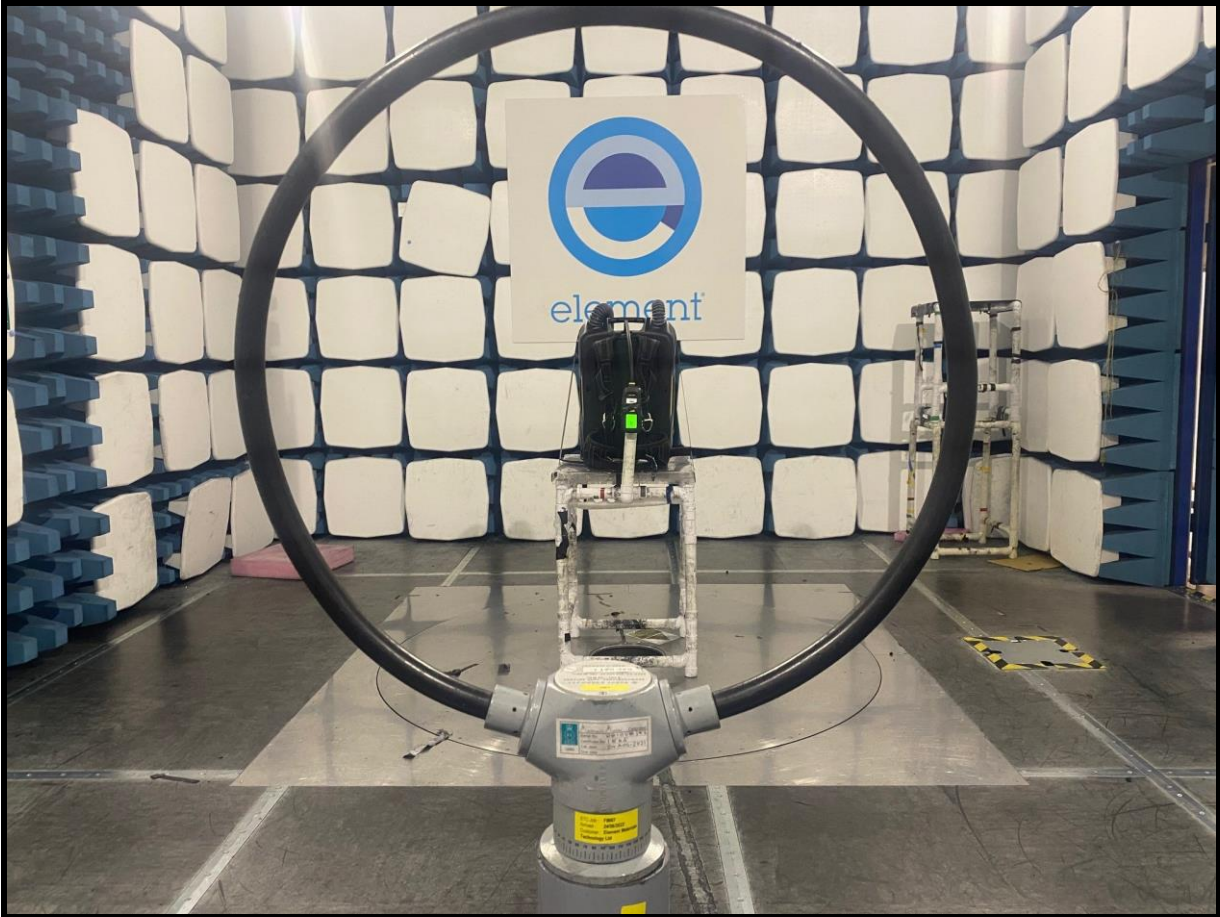
Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure i Test Setup



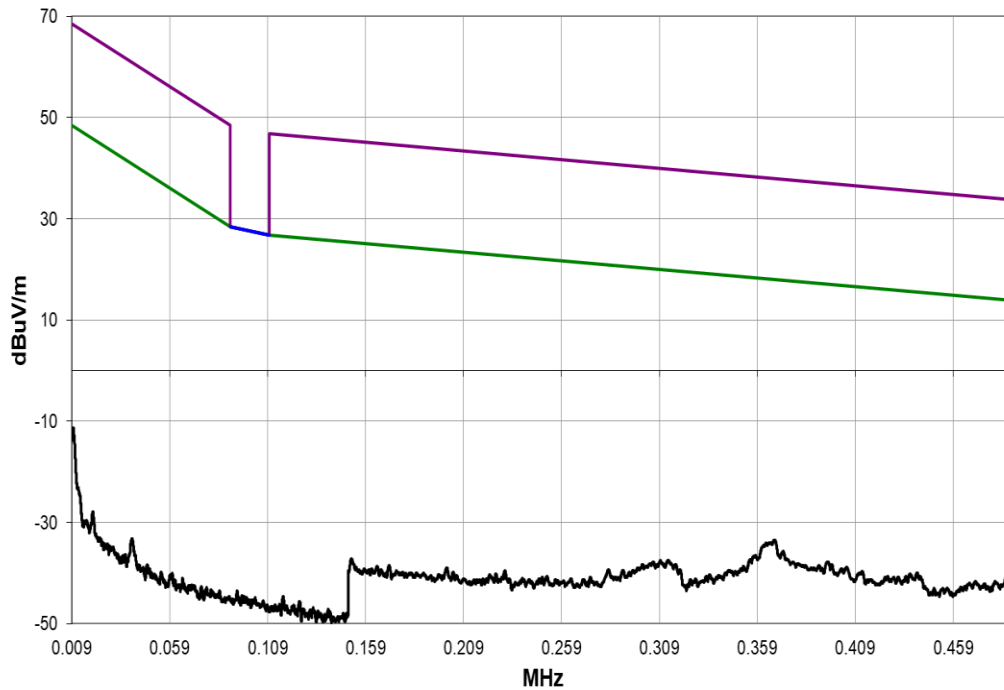
11.5 Test Set-up Photograph



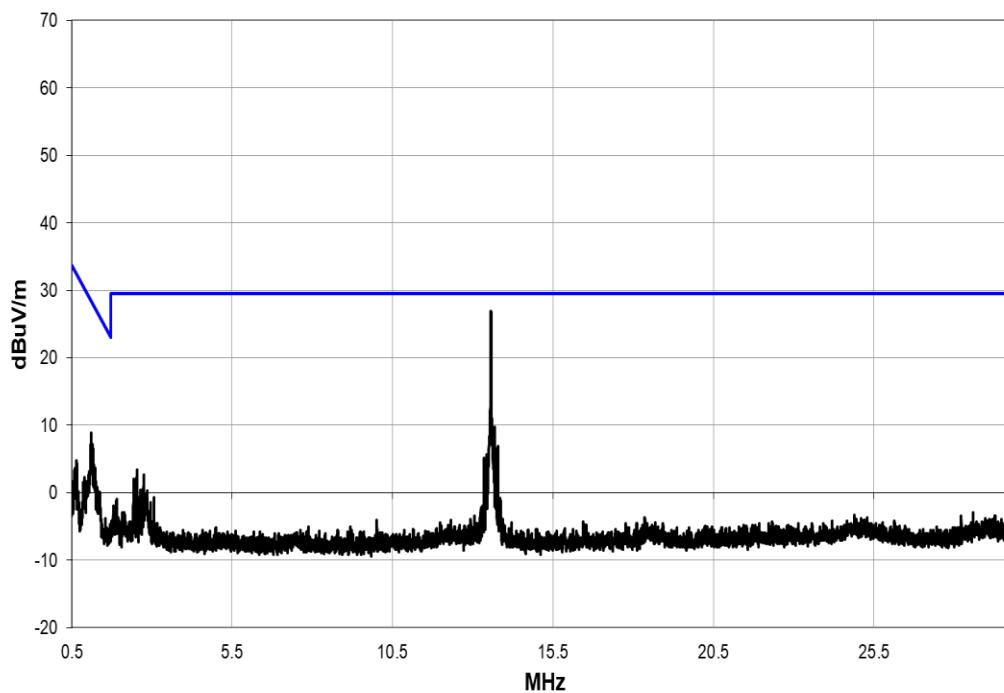
11.6 Test Equipment

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
EMI Receiver	R&S	ESR26	U489	2023-09-30
Loop Antenna	R&S	hfh2	L007	2023-09-09
Radio Chamber - PP	Rainford EMC	ATS	REF940	2023-11-06
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

11.7 Test Results



9 kHz to 490 kHz



490 kHz to 30 MHz

Frequency: 13.56 MHz; Modulation: ASK						
Emission Frequency (MHz)	Receiver Level (dBμV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (μV/m)	Result
No significant emissions within 20 dB of the limit						PASS

Note: the RFID transmitters for the Backplate and the Gauge were transmitting at the same time for the duration of this test.

12 Radiated emissions

12.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

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.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	SK03 Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 300 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: +22 °C	+15 °C to +35 °C (as declared)
Humidity: 31 % RH	20 % RH to 75 % RH (as declared)
Supply: 7.5 V dc	7.5 V dc (as declared)

12.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

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

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, 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;

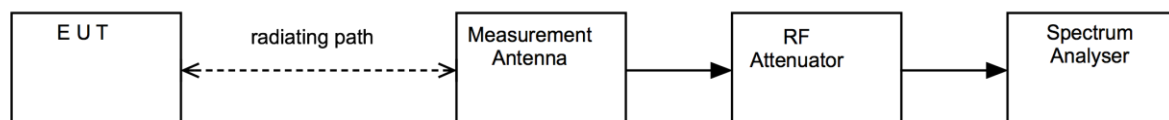
PA is the pre-amplifier gain in dB (where used);

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 is different to limit distance);

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

Figure ii Test Setup



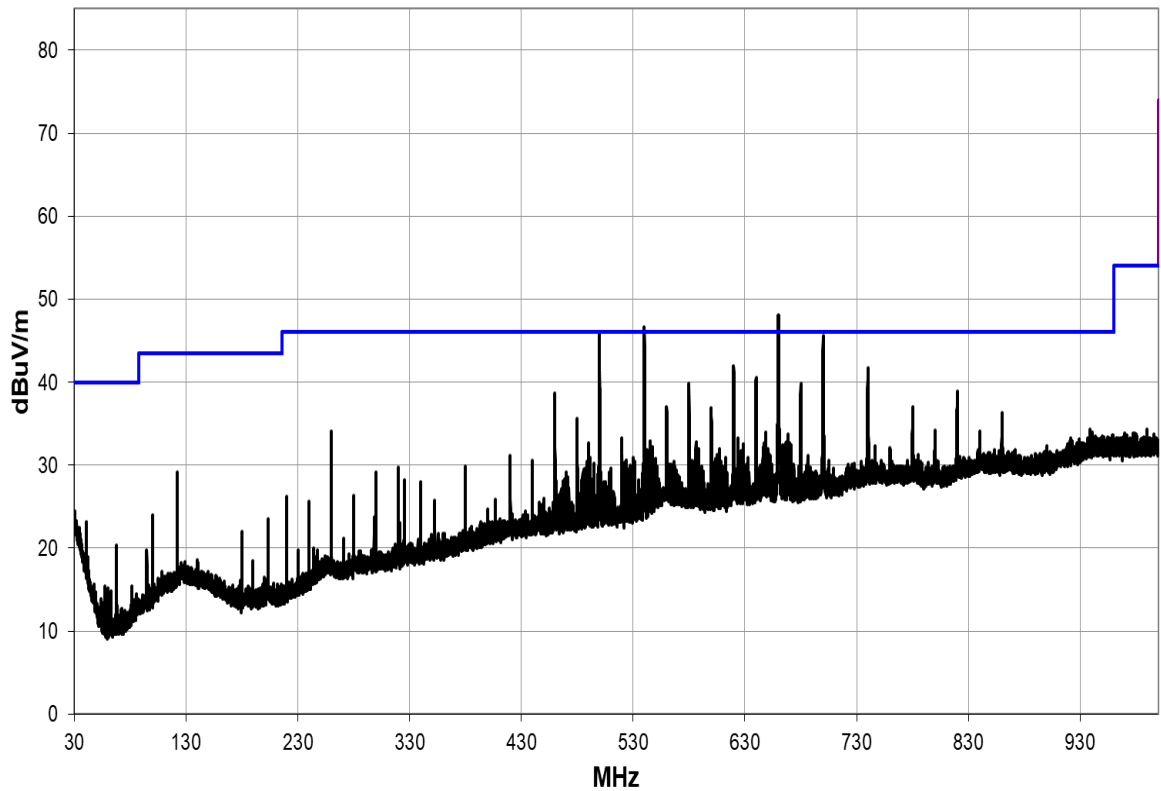
12.5 Test Set-up Photograph



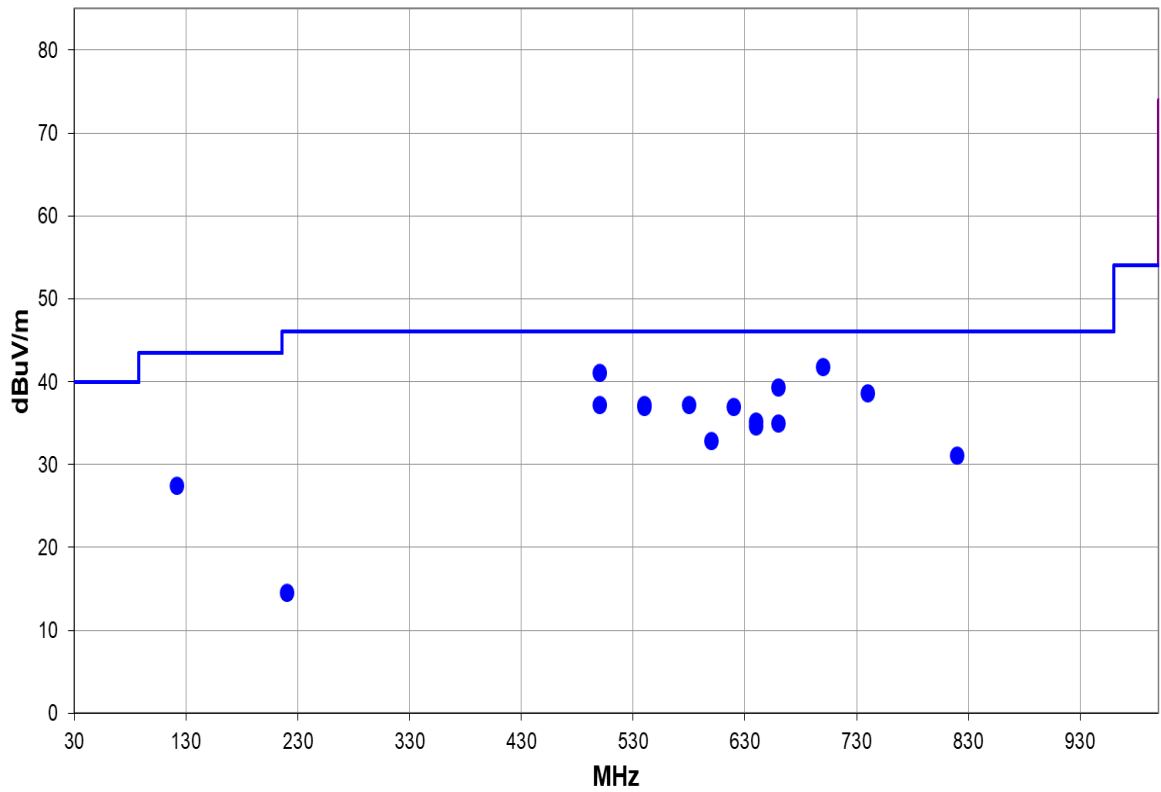
12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
EMI Receiver	R&S	ESR26	U489	2023-09-30
Bilog	Chase	CBL611/A	U191	2025-02-22
PreAmp	Watkins Johnson	6201-69	U372	2024-03-07
Radio Chamber - PP	Rainford EMC	ATS	REF940	2023-11-06
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

12.7 Test Results



This plot shows 30 MHz to 1 GHz – Prescan



This plot shows final measurements taken with QP detector

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)
700.042	40.0	1.8	1.5	311.9	3.0	0.0	Vert	QP	0.0	41.8	46.0	-4.2
500.040	42.7	-1.6	1.0	20.0	3.0	0.0	Vert	QP	0.0	41.1	46.0	-4.9
660.127	37.8	1.5	1.5	327.9	3.0	0.0	Vert	QP	0.0	39.3	46.0	-6.7
740.070	35.3	3.3	1.5	296.0	3.0	0.0	Vert	QP	0.0	38.6	46.0	-7.4
540.088	38.0	-0.8	1.0	40.0	3.0	0.0	Vert	QP	0.0	37.2	46.0	-8.8
580.013	36.6	0.6	1.0	312.0	3.0	0.0	Vert	QP	0.0	37.2	46.0	-8.8
500.027	38.8	-1.6	1.0	247.0	3.0	0.0	Horz	QP	0.0	37.2	46.0	-8.8
620.069	35.7	1.3	1.0	314.0	3.0	0.0	Vert	QP	0.0	37.0	46.0	-9.0
540.026	37.7	-0.8	1.67	244.0	3.0	0.0	Horz	QP	0.0	36.9	46.0	-9.1
639.998	33.7	1.5	1.5	313.0	3.0	0.0	Vert	QP	0.0	35.2	46.0	-10.8
660.049	33.5	1.5	1.2	37.1	3.0	0.0	Horz	QP	0.0	35.0	46.0	-11.0
640.020	33.1	1.5	1.5	284.1	3.0	0.0	Vert	QP	0.0	34.6	46.0	-11.4
599.996	32.4	0.5	1.0	62.1	3.0	0.0	Vert	QP	0.0	32.9	46.0	-13.1
820.113	27.4	3.7	1.0	83.1	3.0	0.0	Horz	QP	0.0	31.1	46.0	-14.9
122.063	37.1	-9.7	1.0	360.1	3.0	0.0	Vert	QP	0.0	27.4	43.5	-16.1

Note: the RFID transmitters for the Backplate and the Gauge were transmitting at the same time for the duration of this test.

13 Occupied Bandwidth

13.1 Definition

Occupied bandwidth

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the 99 % *emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth

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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequencies Measured:	13.56 MHz
EUT Test Modulations:	ASK
Deviations From Standard:	None
Measurement BW:	1 kHz
(requirement: 1% to 5% OBW)	3 kHz
Spectrum Analyzer Video BW:	
(requirement at least 3x RBW)	
Measurement Span:	20 kHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: +21 °C	+15 °C to +35 °C (as declared)
Humidity: 37 % RH	20 % RH to 75 % RH (as declared)
Supply: 7.5 V dc	7.5 V dc (as declared)

13.3 Test Limit

Industry Canada:

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99 % emission bandwidth, as calculated or measured.

Federal Communications Commission:

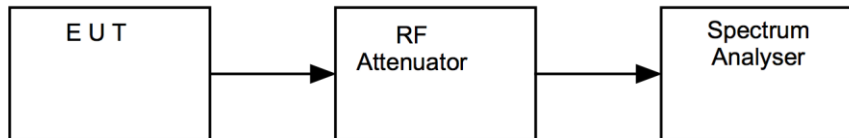
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, 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 iv Test Setup

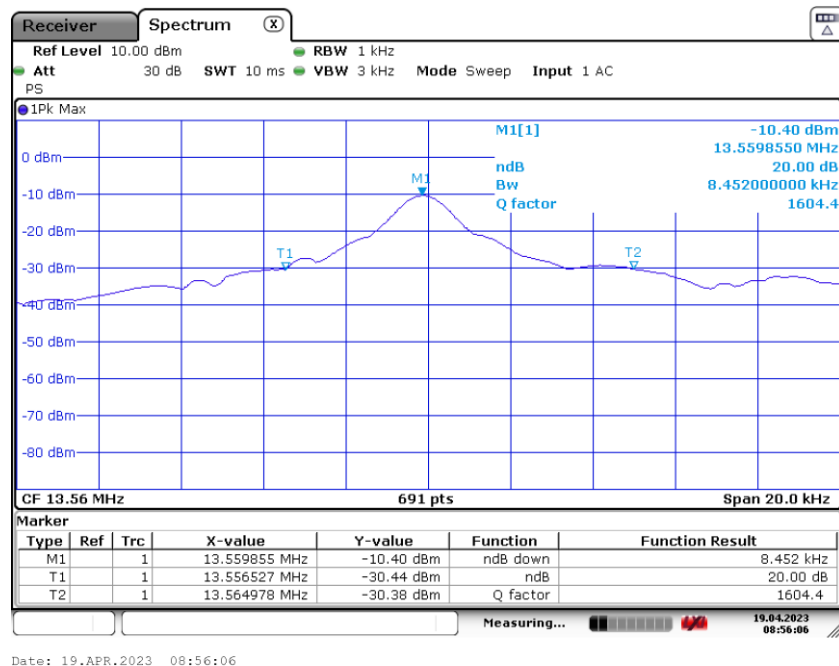


13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
EMI Receiver	R&S	ESR26	U489	2023-09-30

13.6 Test Results

15.225; Modulation: ASK; Frequency: 13.56 MHz			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (kHz)
13.56	13.556527	13.564978	8.452000



14 Transmitter output power (fundamental radiated emission)

14.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	OATS
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	9 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	30 kHz
Measurement Detector:	Quasi-peak
Voltage Extreme Environment Test Range:	Mains Power = 85% and 115% of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: +21 °C	+15 °C to +35 °C (as declared)
Humidity: 37 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

The field strength measured at 30 m shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

<i>Frequency range (MHz)</i>	<i>Field strength (μV/m at 30m)</i>	<i>Field strength (dBμV/m at 30m)</i>
13.110 – 13.410	106	40.5
13.410 – 13.553	334	50.5
13.553 – 13.567	15,848	84.0
13.567 – 13.710	334	50.5
13.710 – 14.010	106	40.5

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, 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.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in $\mu\text{V/m}$ at the regulatory distance, using:

$$FS = 10 (PR - CF) / 20$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in $\text{dB}\mu\text{V}$ and includes any cable loss, antenna factor and pre-amplifier gain;

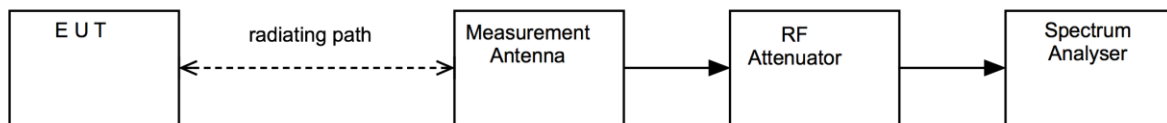
CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements from 10 metres to 30 metres

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 11.77 dB per decade was determined from measurements at 3 metres to 10 metres.

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

Figure v Test Setup



14.5 Test Equipment

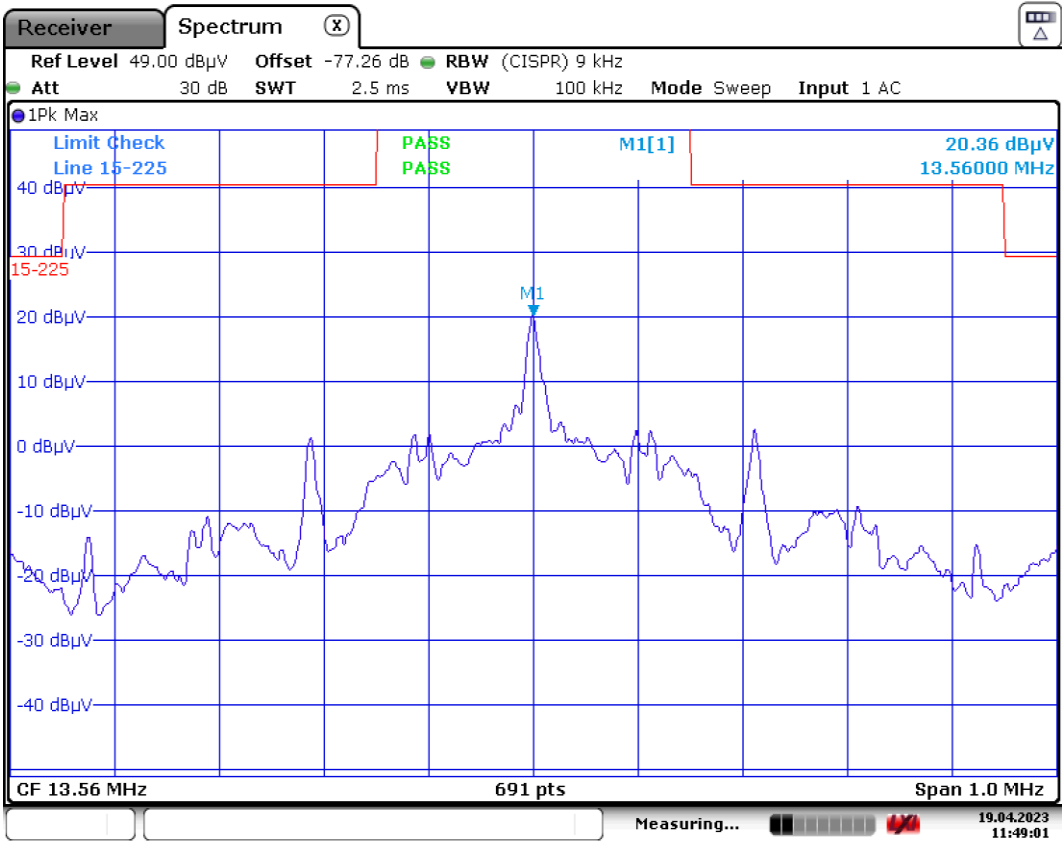
<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
EMI Receiver	R&S	ESR26	U489	2023-09-30
Loop Antenna	R&S	hfh2	L007	2023-09-09

14.6 Test Set-up Photograph



14.7 Test Results

Modulation: ASK; Frequency: 13.56 MHz								
Channel Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (dBµV/m)	Result (µV/m)	Limit (µV/m)	Result
13.56	51.21	3	30	30.85	20.36	10.417	15848	PASS
13.56	39.44	10	30	19.08	20.36	10.417	15848	PASS



Date: 19.APR.2023 11:49:02

15 Frequency stability

15.1 Definition

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.8
EUT Frequencies Measured:	13.56 MHz
Modulation:	Off
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	-20 to +50 C
Voltage Extreme Environment Test Range:	7.5 V dc = $\pm 15\%$ of Rated Voltage;

Environmental Conditions (Normal Environment)

Temperature: +22 °C	Standard Requirement: +20 °C
Humidity: 35 %RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

15.4 Test Method

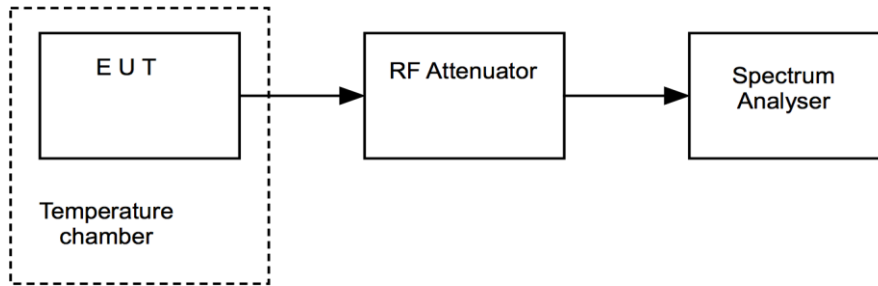
With the EUT setup as per section 9 of this report and connected as per Figure v, the frequency was measured under varying conditions of temperature and supply voltage.

The measurements were performed with EUT set in a CW mode of operation.

Measurements were made once temperature stability was achieved at each temperature.

Per ANSI C63.4, measurements were made, once temperature stabilisation was reached at intervals of zero, two, five and ten minutes after switching on the EUT. Only the worst case results are given.

Figure v Test Setup



15.5 Test Equipment

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
EMI Receiver	R&S	ESR26	U489	2023-09-30
VT 4002	Votsch	Temperature Chamber	U521	Use L426
Temperature Indicator	Digitron	2000T	U720	2023-05-09
Power Supply	ISO-Tech	IPS 303A	U748	Use REF976
Multimeter	Agilent	34405a	REF976	2024-01-24

15.6 Test Results

<i>EUT Frequency: 13.56 MHz; Power On</i>				
<i>Test Environment</i>		<i>Measured Frequency (MHz)</i>	<i>Frequency error (kHz)</i>	<i>Result</i>
-20 °C	V _{nominal}	13.55971	0.0000	PASS
-10 °C	V _{nominal}	13.55971	0.0000	PASS
0 °C	V _{nominal}	13.55971	0.0000	PASS
+10 °C	V _{nominal}	13.55971	0.0000	PASS
+20 °C	V _{minimum}	13.55971	0.0000	PASS
	V _{nominal}	13.55971	0.0000	N/A
	V _{maximum}	13.55971	0.0000	PASS
+30 °C	V _{nominal}	13.55971	0.0000	PASS
+40 °C	V _{nominal}	13.55971	0.0000	PASS
+50 °C	V _{nominal}	13.55971	0.0000	PASS

16 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

17 Appendix A

17.1 Antenna Details

