

Report on the Radio Testing

For

AIR IP Holdings Limited

on

Ooka Sense Station

Report no. TRA-062200-47-00B

2024-04-19

RF914 9.0



Report Number: TRA-062200-47-00B
Issue: B

REPORT ON THE RADIO TESTING OF A
AIR IP Holdings Limited
Ooka Sense Station
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.225

TEST DATE: 2024-03-18 to 2024-03-22

Written by:



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Lab Manager

Date: 2024-04-19

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	2024-04-16	Original
B	2024-04-19	Corrections and amendments throughout document

2 Summary

TEST REPORT NUMBER: TRA-062200-47-00B

WORKS ORDER NUMBER: TRA-062200-03

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): Ooka Sense Station

FCC IDENTIFIER: 2A9JT-AIR-A001B

EUT SERIAL NUMBER: 3001BCD6055B031

MANUFACTURER/AGENT: AIR IP Holdings Limited

ADDRESS: Unit OT 20-33
Level 20, Central Park Offices
Dubai
79947
United Arab Emirates

CLIENT CONTACT: Peter Wilkinson
☎ 07460333665
✉ p.wilkinson@air.global

ORDER NUMBER: PO-012824

TEST DATE: 2024-03-18 to 2024-03-22

TESTED BY: Daniel Winstanley

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	☒	PASS
Occupied bandwidth	15.215(c)	☒	PASS
Field strength of fundamental	15.225(a), (b) and (c)	☒	PASS
Frequency stability	15.225(e)	☒	PASS

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).

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.

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4 Introduction

This report TRA-062200-47-00B presents the results of the Radio testing on an AIR IP Holdings Limited, Ooka Sense Station to specification 47CFR15 Radio Frequency Devices.

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

- | | |
|--|--|
| <input checked="" type="checkbox"/> Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK | <input type="checkbox"/> 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 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.
- ISED RSS-210, Issue 10, December 2019 – Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
- ISED RSS-Gen – General Requirements for Compliance of Radio Apparatus - Issue 5 April 2018
- KDB 174176 D01 Line Conducted FAQ v01r01 - AC Power-Line Conducted Emissions Frequently Asked Questions

5.2 Deviations from Test Standards

The modulation type used by the Ooka Sense Station is ASK. ANSI C63-10 clause 6.9.3, the requirement for calculating the required resolution bandwidth, based upon the occupied bandwidth, as per the calculation does not function correctly, as the bandwidth and the resolution bandwidth continually decrease using the formula stated in ANSI C63-10, and does not result in a meaningful measurement. It was determined to use a resolution bandwidth of 1 kHz for the 20 dB occupied bandwidth measurement.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
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: Ooka Sense Station
- Serial Number: 3001BCD6055B031
- Model Number: Model A001
- Software Revision: GUI V6.01
- Firmware Revision: V1.1.4 BL Test variant (bootloader and test variant)
- Build Level / Revision Number:
 - Control Board – rev E2
 - NFC Board – rev A2
 - Lid LED Ring – rev B2
 - Button Board – rev B2

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.

- Lenovo Thinkpad

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Transmitter tests was as follows: the client supplied test GUI enabled the 13.56 MHz RFID into a continuous modulated test mode.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	13.56 MHz
Modulation type(s):	ASK
Antenna type(s) and gain(s):	Integral Loop
Nominal Supply Voltage:	14.4 Vdc

7.4.2 Antennas

Type:	Molex 146236-2102
Frequency range:	13.56 MHz
Antenna Thickness:	0.17±0.05 mm
Loop Height:	15 mm
Loop Width:	25 mm
Turns:	8
Environmental limits:	-40°C to + 85°C
Mounting:	Peel and Stick

7.5 EUT Description

The Ooka Sense Station is a device that electronically heats a pod containing either a tobacco or non-tobacco formulation thereby generating an inhalable aerosol.

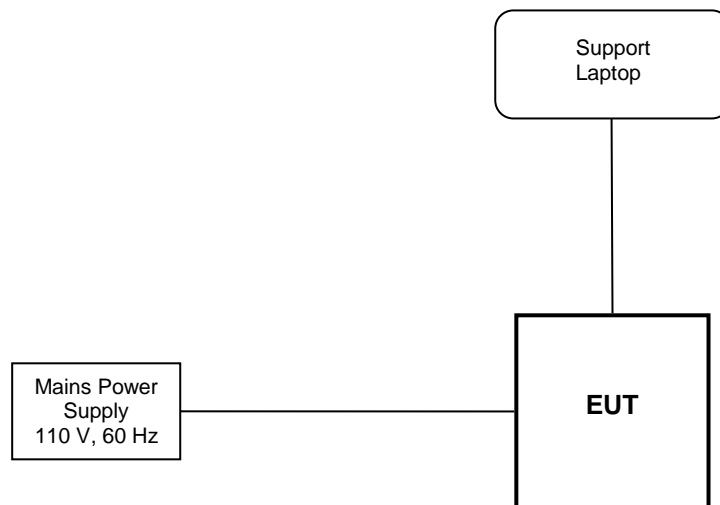
8 Modifications

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 Ooka Sense Station was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 14.4 Vdc, from Lithium batteries. The Ooka Sense Station can also operate whilst connected to the 110 Vac Mains whilst charging the 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
<input checked="" type="checkbox"/>	Standard	-20 to +50 C in 10 degree steps
<input type="checkbox"/>	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
<input checked="" type="checkbox"/>	Mains	110 V ac +/-2 %	85 % and 115 %
<input checked="" type="checkbox"/>	Battery	14.4 Vdc	85 % and 115 %

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	Sk03 Radio Chamber, 3 m
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: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 46 % RH	20 % RH to 75 % RH (as declared)
Supply: 14.4 Vdc	14.4 Vdc 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:

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

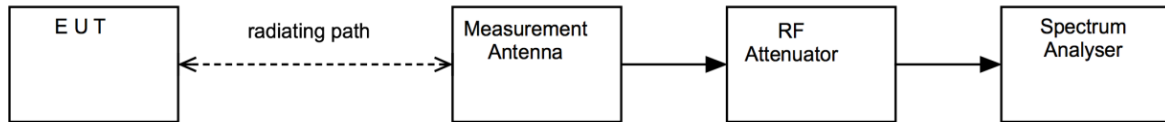
Where,

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);

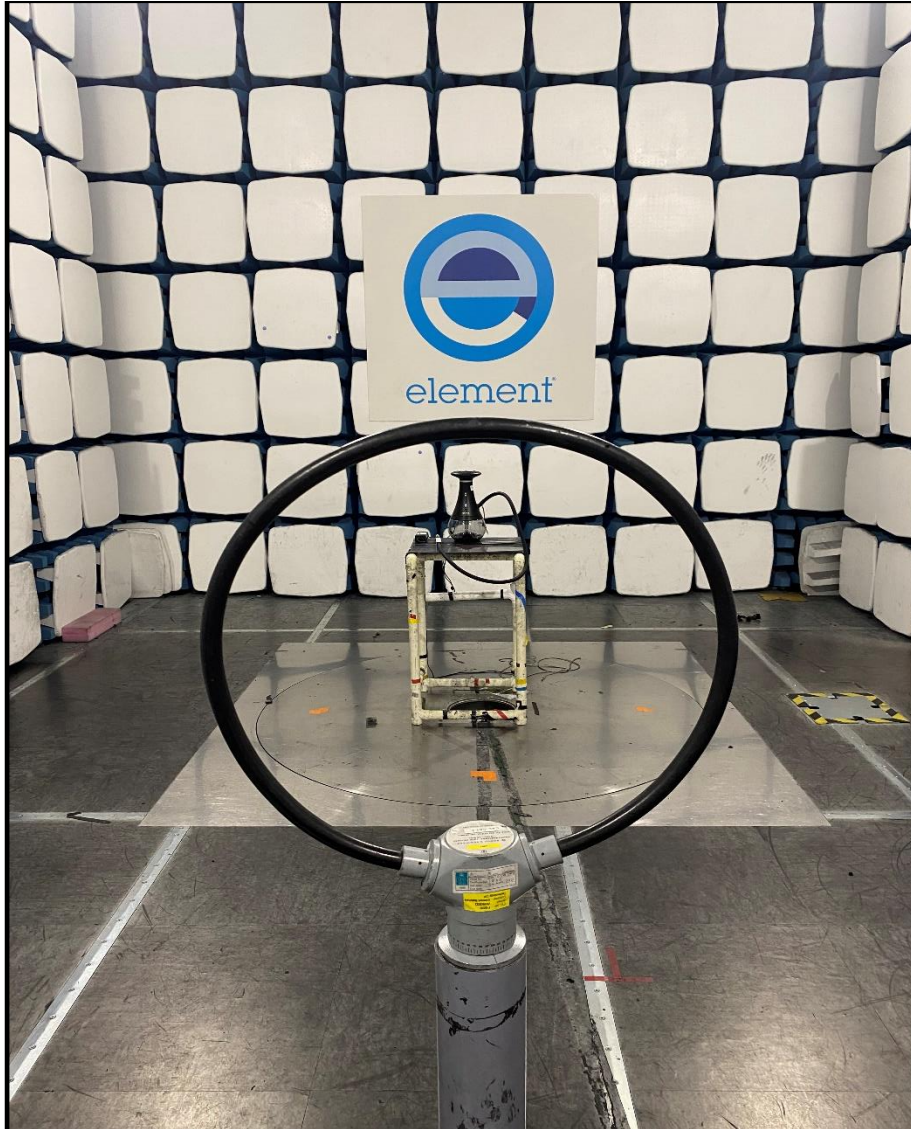
Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure i Test Setup



11.5 Test Set-up Photograph

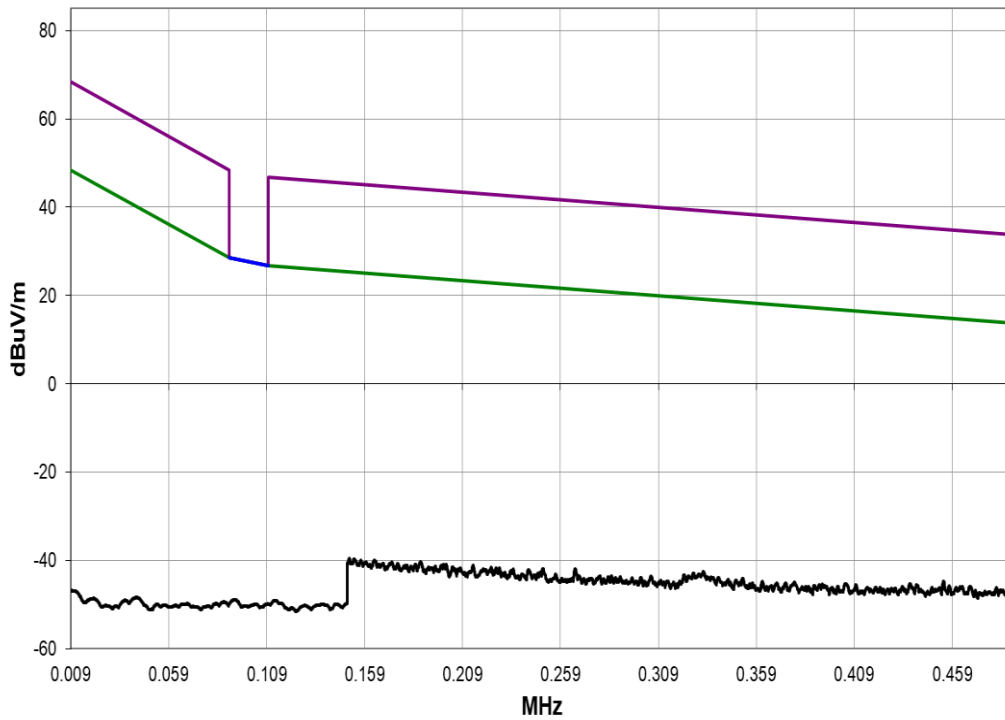


11.6 Test Equipment

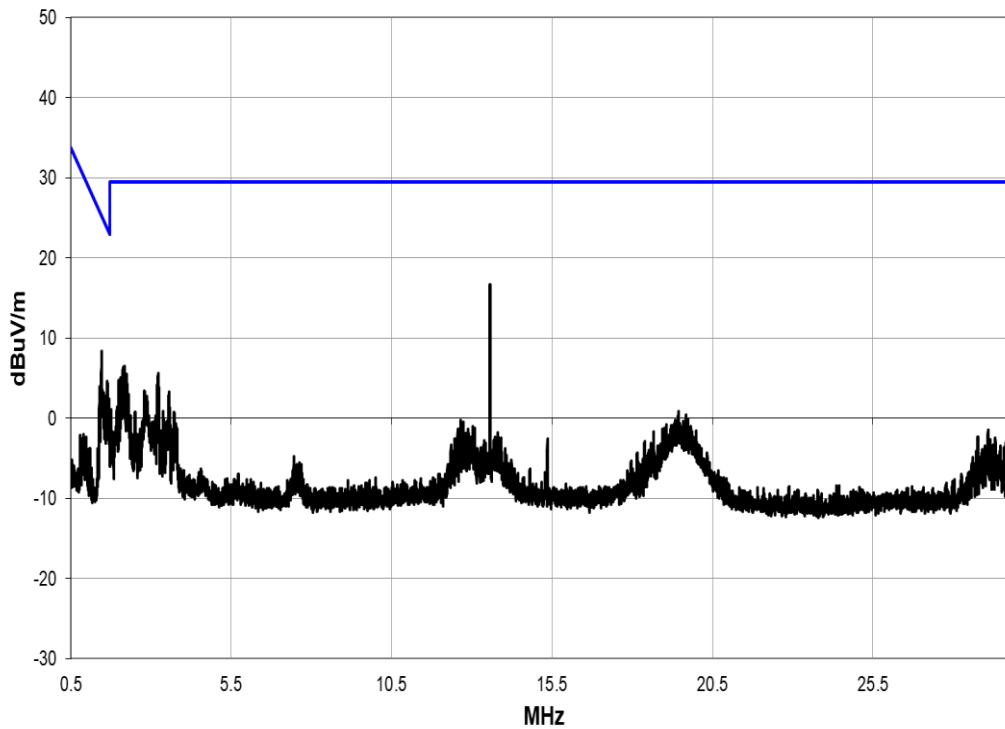
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
ESR 7	R&S	Spectrum Analyser	U727	2024-05-09
Loop Antenna	R&S	hfh2	L007	2024-10-11
Radio Chamber - PP	Rainford EMC	ATS	REF940	2026-01-29
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

11.7 Test Results

EUT powered from battery



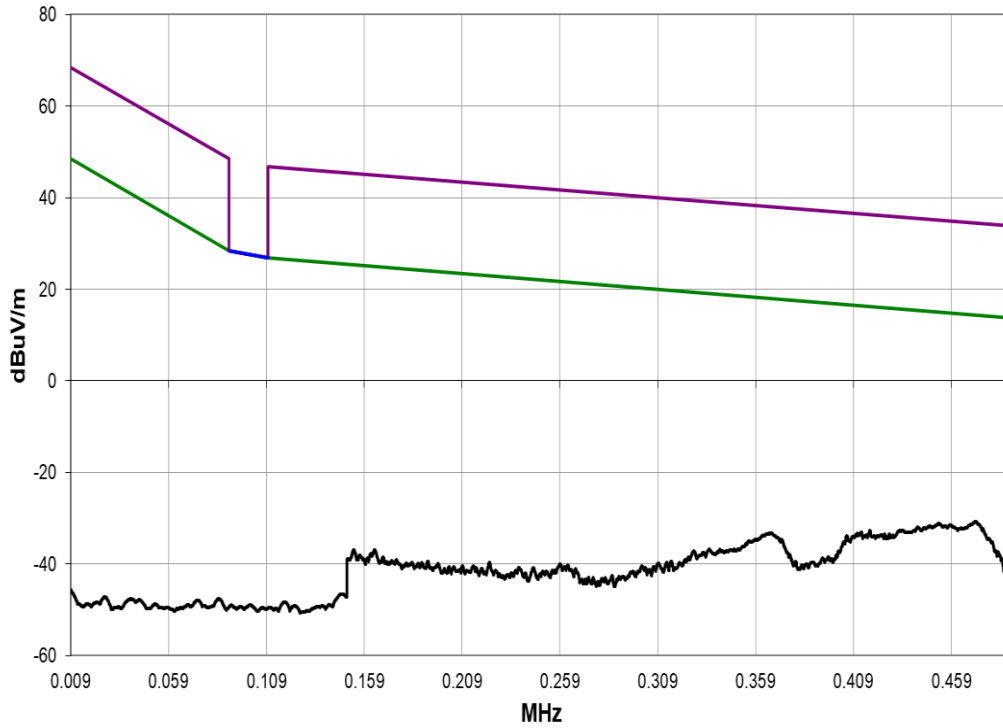
9 kHz to 490 kHz



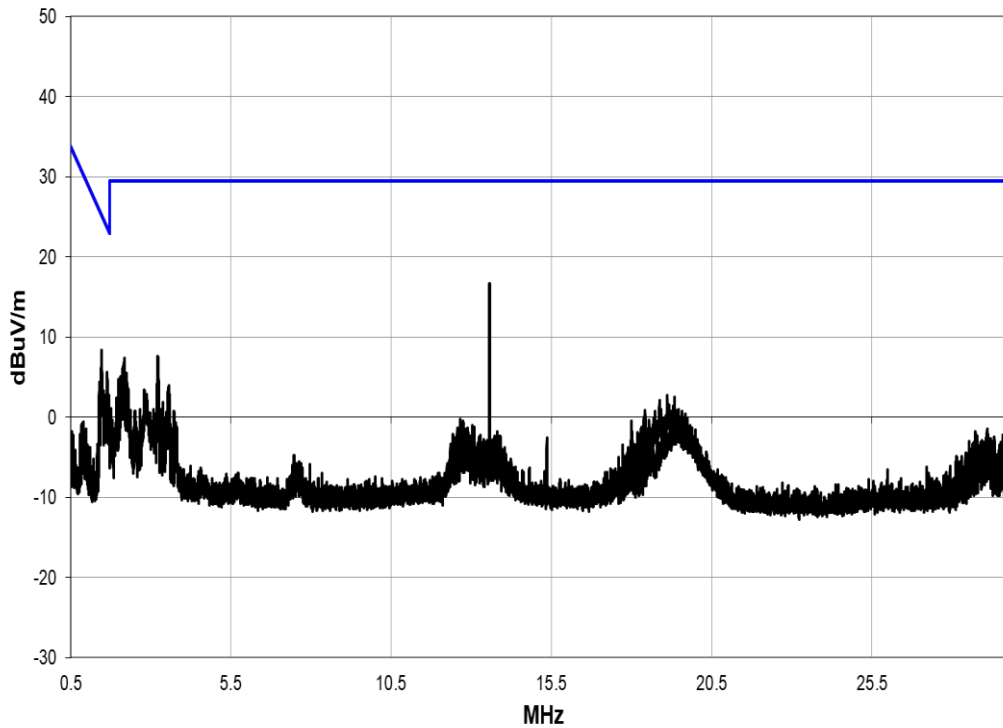
490 kHz to 30 MHz

13.56 MHz; EUT powered from battery						
Emission Frequency (MHz)	Receiver Level (dB μ V/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (μ V/m)	Result
No significant emissions within 10 dB of the limit						PASS

EUT powered from power supply



9 kHz to 490 kHz



490 kHz to 30 MHz

13.56 MHz; EUT powered from power supply						
Emission Frequency (MHz)	Receiver Level (dB μ V/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (μ V/m)	Result
No significant emissions within 10 dB of the limit						PASS

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
Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1000 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (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

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3 m)</i>
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);

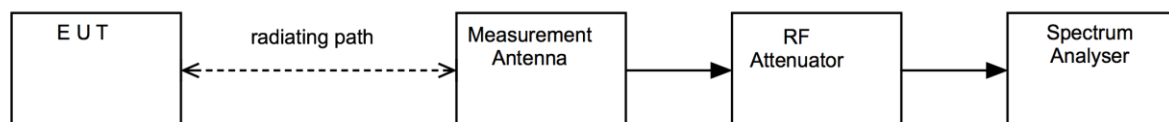
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

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

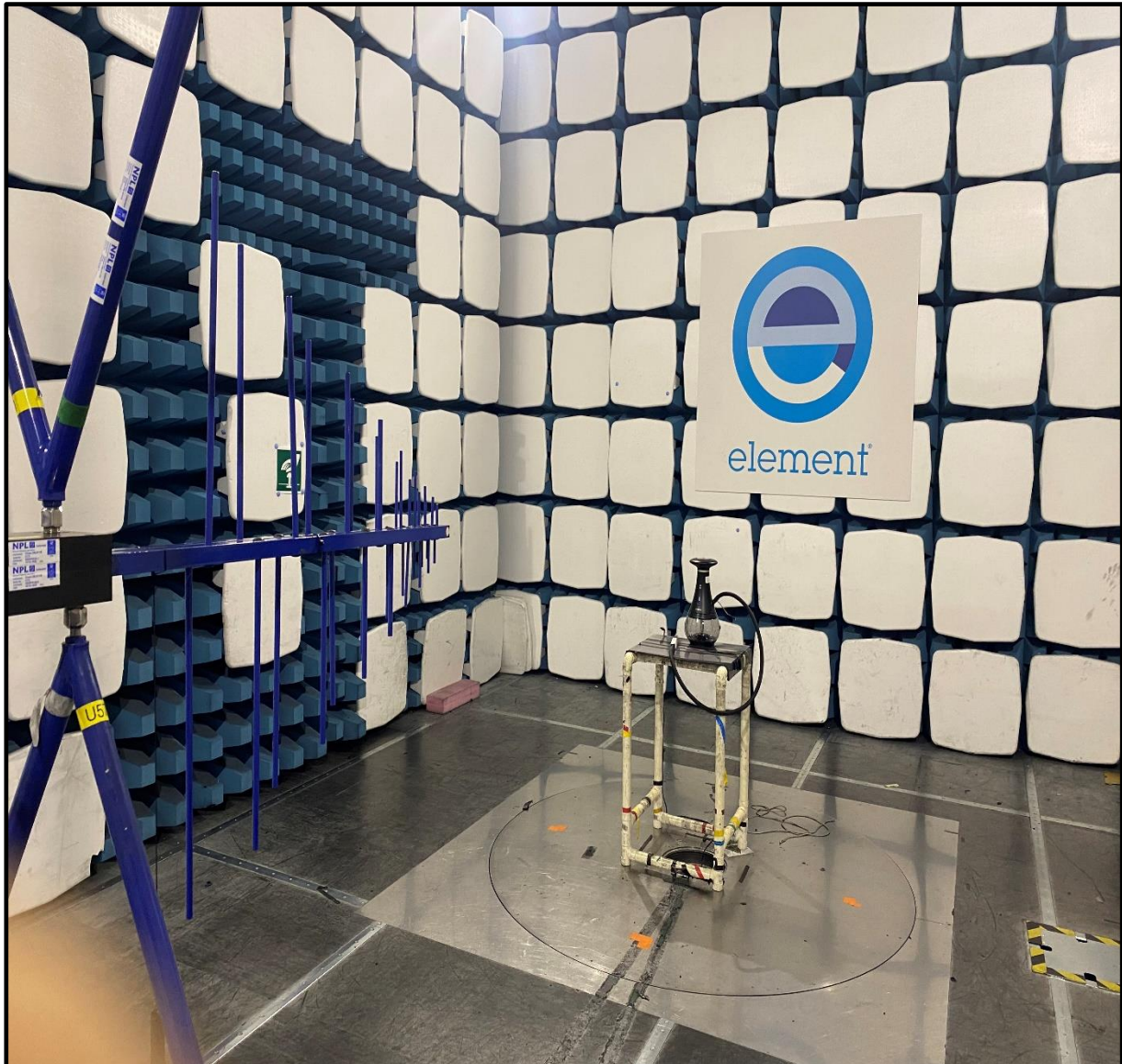
This field strength value is then compared with the regulatory limit.

Only the highest 6 emissions are recorded for each mode of operation.

Figure ii Test Setup



12.5 Test Set-up Photograph

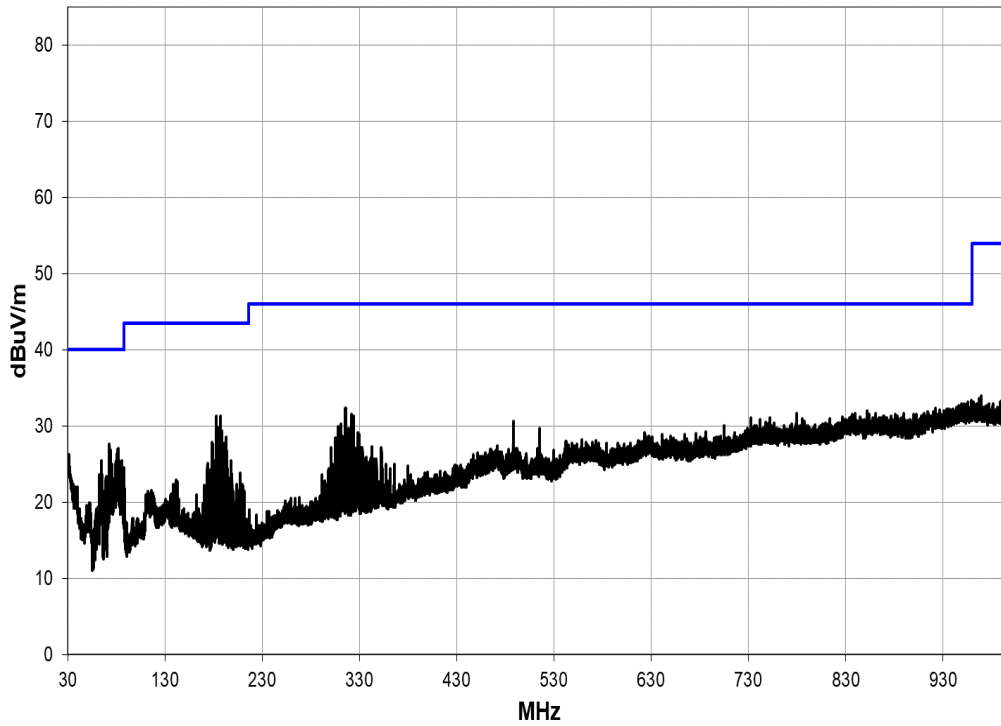


12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR 7	R&S	Spectrum Analyser	U727	2024-05-09
LNA6901	AMETEK	Pre Amp	U711	2024-04-12
CBL611/B	Chase	Bilog	U573	2024-10-14
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required

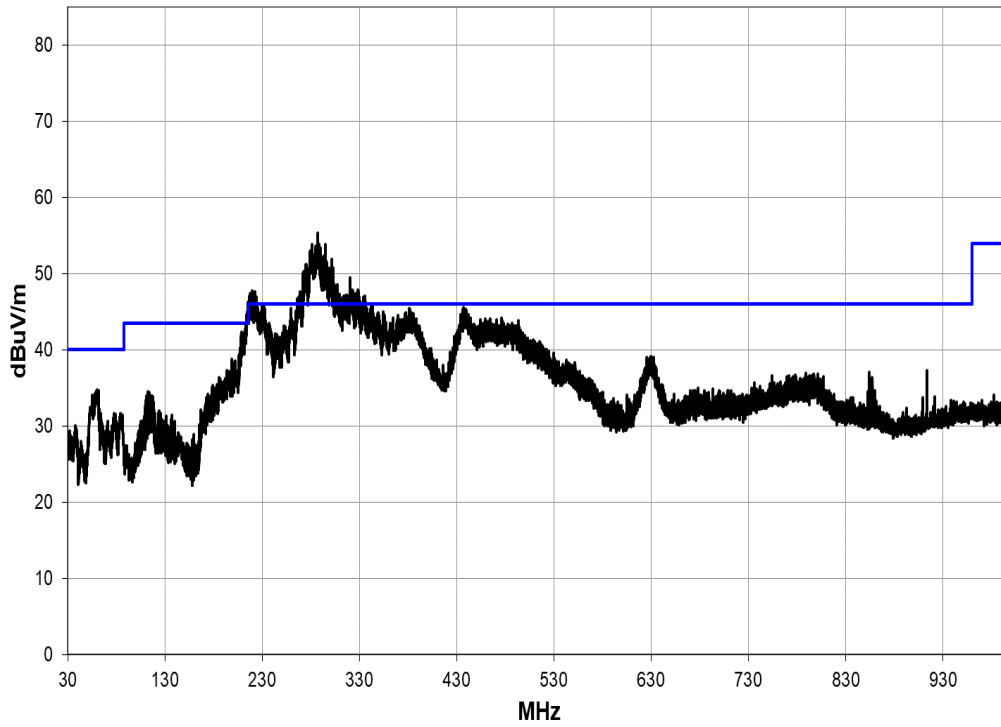
12.7 Test Results

EUT Powered from Battery



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB/m)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
182.533	43.2	28.6	1.0	15.1	1.6	0.0	Vert	PK	0.0	31.3	43.5	-12.2
186.849	43.2	28.6	1.0	15.1	1.6	0.0	Vert	PK	0.0	31.3	43.5	-12.2
72.874	42.6	28.6	2.0	12.6	1.0	0.0	Vert	PK	0.0	27.6	40.0	-12.4
959.454	26.9	28.4	2.0	30.9	4.0	0.0	Horz	PK	0.0	33.4	46.0	-12.6
82.089	41.1	28.6	1.5	13.4	1.1	0.0	Vert	PK	0.0	27.0	40.0	-13.0
81.071	41.1	28.6	2.0	13.3	1.1	0.0	Vert	PK	0.0	26.9	40.0	-13.1

EUT Powered from Power Supply



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)
290.791	52.2	-7.7	1.07	177.0	3.0	0.0	Horz	QP	0.0	44.5	46.0	-1.5
328.239	51.3	-7.0	1.0	182.0	3.0	0.0	Horz	QP	0.0	44.3	46.0	-1.7
319.645	51.1	-7.3	1.04	178.0	3.0	0.0	Horz	QP	0.0	43.8	46.0	-2.2
286.960	50.8	-7.8	1.28	175.9	3.0	0.0	Horz	QP	0.0	43.0	46.0	-3.0
316.531	50.3	-7.3	1.0	173.9	3.0	0.0	Horz	QP	0.0	43.0	46.0	-3.0
297.618	49.5	-7.6	1.14	157.9	3.0	0.0	Horz	QP	0.0	41.9	46.0	-4.1

Note: as per ANSI C63.10, clause 6.5.4 only the 6 highest emissions relative to the limit have been recorded.

13 AC power-line conducted emissions

13.1 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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Transient Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequencies Measured:	13.56 MHz
EUT Bandwidth:	Wideband
EUT Modulation:	ASK
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 Vac as declared

13.3 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.

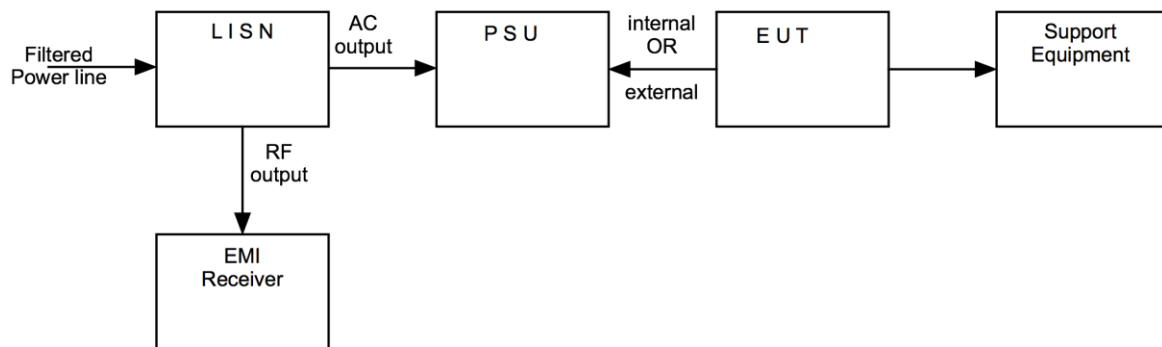
13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure iii, 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 iii Test Setup



13.5 Test Set-up Photograph

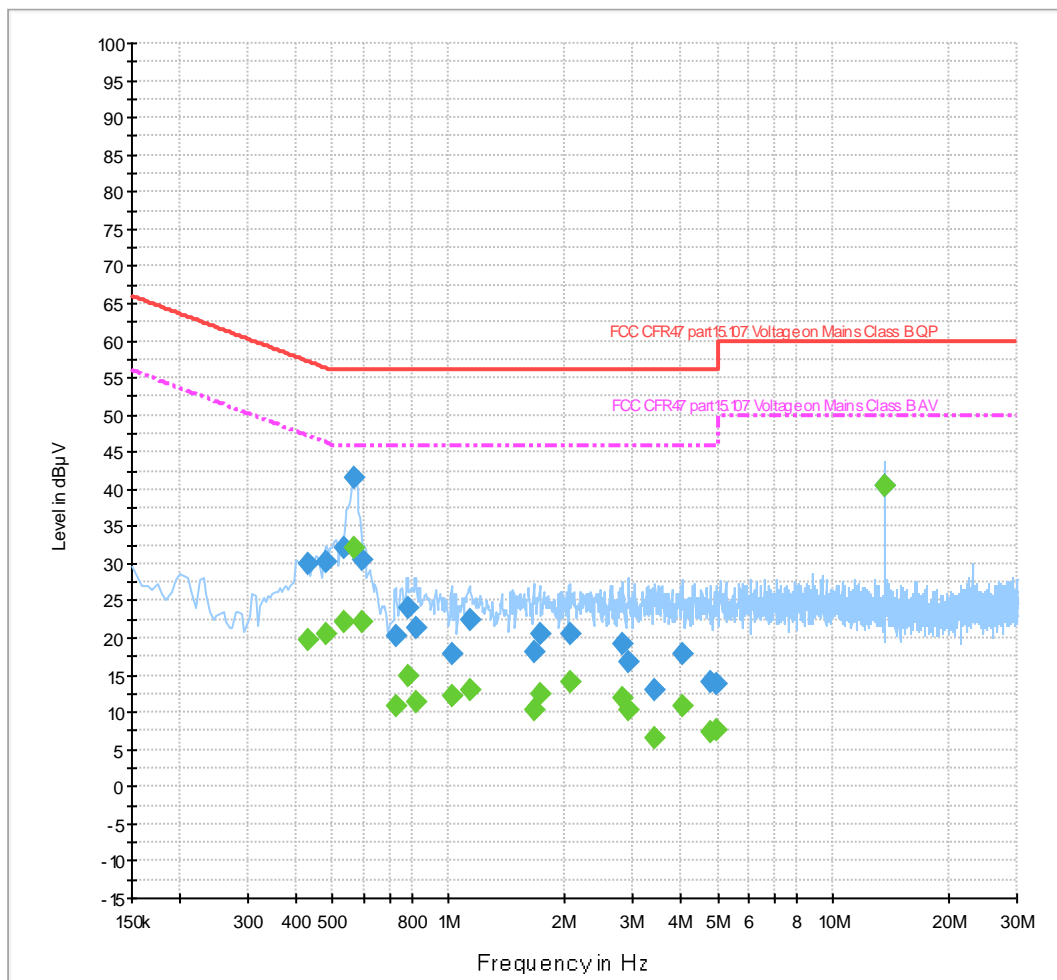


13.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR 7	R&S	Spectrum Analyser	U727	2024-05-09
Pulse Limiter	R&S	ESH3-Z2	U443	2025-03-11
Lisn	R&S	ENV216	U396	2024-05-22

13.7 Test Results

CE LF Lab 150kHz - 30MHz (Auto Test) RX FCC Sweep



Quasi Peak

Frequency (MHz)	QuasiPeak (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)	Comment
0.428600	29.9	2000.0	9.000	Off	N	19.5	27.4	57.3	PASS
0.478350	30.2	2000.0	9.000	Off	L1	19.5	26.2	56.4	PASS
0.533075	32.2	2000.0	9.000	Off	L1	19.5	23.8	56.0	PASS
0.567900	41.5	2000.0	9.000	Off	L1	19.5	14.5	56.0	PASS
0.597750	30.6	2000.0	9.000	Off	L1	19.5	25.4	56.0	PASS
0.727100	20.3	2000.0	9.000	Off	N	19.5	35.7	56.0	PASS
0.781825	24.0	2000.0	9.000	Off	L1	19.5	32.0	56.0	PASS
0.821625	21.4	2000.0	9.000	Off	L1	19.5	34.6	56.0	PASS
1.015650	17.8	2000.0	9.000	Off	L1	19.5	38.2	56.0	PASS
1.135050	22.4	2000.0	9.000	Off	L1	19.5	33.6	56.0	PASS
1.667375	18.2	2000.0	9.000	Off	L1	19.5	37.8	56.0	PASS
1.727075	20.7	2000.0	9.000	Off	L1	19.5	35.3	56.0	PASS
2.060400	20.5	2000.0	9.000	Off	L1	19.5	35.5	56.0	PASS
2.821575	19.2	2000.0	9.000	Off	L1	19.5	36.8	56.0	PASS
2.936000	16.9	2000.0	9.000	Off	L1	19.5	39.1	56.0	PASS
3.443450	13.0	2000.0	9.000	Off	N	19.6	43.0	56.0	PASS
4.045425	18.0	2000.0	9.000	Off	L1	19.6	38.0	56.0	PASS
4.791675	14.0	2000.0	9.000	Off	L1	19.6	42.0	56.0	PASS
4.985700	13.8	2000.0	9.000	Off	N	19.6	42.2	56.0	PASS
13.557625	40.4	2000.0	9.000	Off	L1	19.7	19.6	60.0	PASS

Average

Frequency (MHz)	Average (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)	Comment
0.428600	19.7	2000.0	9.000	Off	N	19.5	27.6	47.3	PASS
0.478350	20.6	2000.0	9.000	Off	L1	19.5	25.8	46.4	PASS
0.533075	22.2	2000.0	9.000	Off	L1	19.5	23.8	46.0	PASS
0.567900	32.2	2000.0	9.000	Off	L1	19.5	13.8	46.0	PASS
0.597750	22.1	2000.0	9.000	Off	L1	19.5	23.9	46.0	PASS
0.727100	10.8	2000.0	9.000	Off	N	19.5	35.2	46.0	PASS
0.781825	14.9	2000.0	9.000	Off	L1	19.5	31.1	46.0	PASS
0.821625	11.4	2000.0	9.000	Off	L1	19.5	34.6	46.0	PASS
1.015650	12.2	2000.0	9.000	Off	L1	19.5	33.8	46.0	PASS
1.135050	13.1	2000.0	9.000	Off	L1	19.5	32.9	46.0	PASS
1.667375	10.4	2000.0	9.000	Off	L1	19.5	35.6	46.0	PASS
1.727075	12.6	2000.0	9.000	Off	L1	19.5	33.4	46.0	PASS
2.060400	14.1	2000.0	9.000	Off	L1	19.5	31.9	46.0	PASS
2.821575	11.9	2000.0	9.000	Off	L1	19.5	34.1	46.0	PASS
2.936000	10.4	2000.0	9.000	Off	L1	19.5	35.6	46.0	PASS
3.443450	6.5	2000.0	9.000	Off	N	19.6	39.5	46.0	PASS
4.045425	10.8	2000.0	9.000	Off	L1	19.6	35.2	46.0	PASS
4.791675	7.5	2000.0	9.000	Off	L1	19.6	38.5	46.0	PASS
4.985700	7.7	2000.0	9.000	Off	N	19.6	38.3	46.0	PASS
13.557625	40.4	2000.0	9.000	Off	L1	19.7	9.6	50.0	PASS

14 Occupied Bandwidth

14.1 Definition

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.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
Frequency Measured:	13.56 MHz
EUT Channel Bandwidths:	Wideband
EUT Test Modulations:	ASK
Deviations From Standard:	See note below
Measurement BW:	See Note
(Requirement: 1% to 5% OBW)	
Spectrum Analyzer Video BW:	See Note
(requirement at least 3x RBW)	
Measurement Span:	See Note
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)

Note: The modulation type used by the Ooka Sense Station is ASK. ANSI C63-10 clause 6.9.3, the requirement for calculating the required resolution bandwidth, based upon the occupied bandwidth, as per the calculation does not function correctly, as the bandwidth and the resolution bandwidth continually decrease using the formula stated in ANSI C63-10, and does not result in a meaningful measurement.

It was determined to use a resolution bandwidth of 1 kHz for the 20 dB occupied bandwidth.

14.3 Test Limit

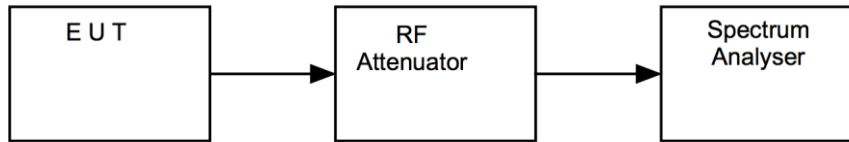
Federal Communications Commission:

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.

14.4 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.

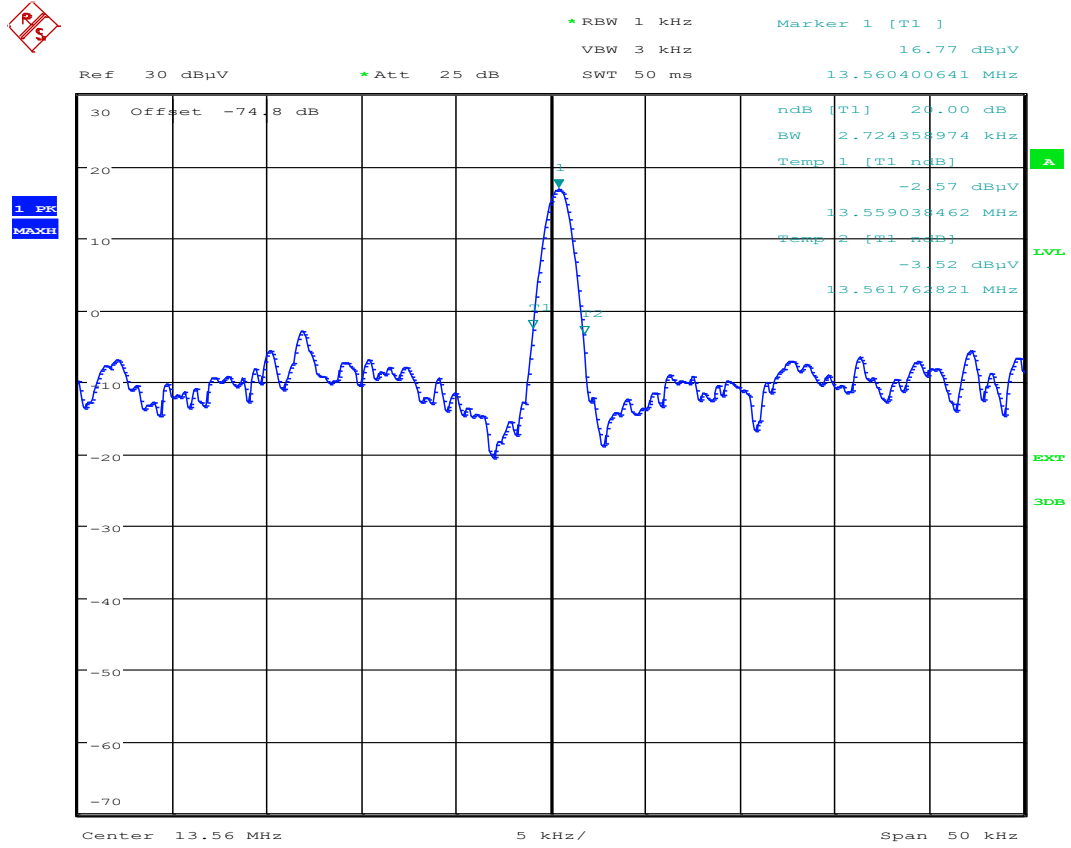
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup**14.5 Test Equipment**

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	2024-05-22

14.6 Test Results

15.225. Modulation: ASK			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (kHz)
13.56	13.559038462	13.561762821	2.724359



15 Transmitter output power (fundamental radiated emission)

15.1 Definition

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

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	ATS / OATS
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
Frequency Measured:	13.56 MHz
EUT Channel Bandwidths:	Wideband
Deviations From Standard:	None
Measurement BW:	10 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)

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)

15.3 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

15.4 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,

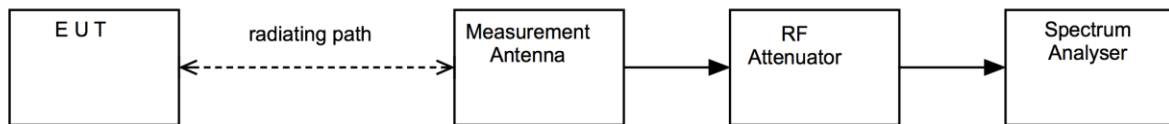
- PR is the power recorded on the receiver / spectrum analyzer in $\text{dB}\mu\text{V}$ and includes any cable loss, antenna factor and pre-amplifier gain;
- CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

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

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 20.8 dB per decade was determined from measurements at 1 and 3 metres.

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

Figure v Test Setup

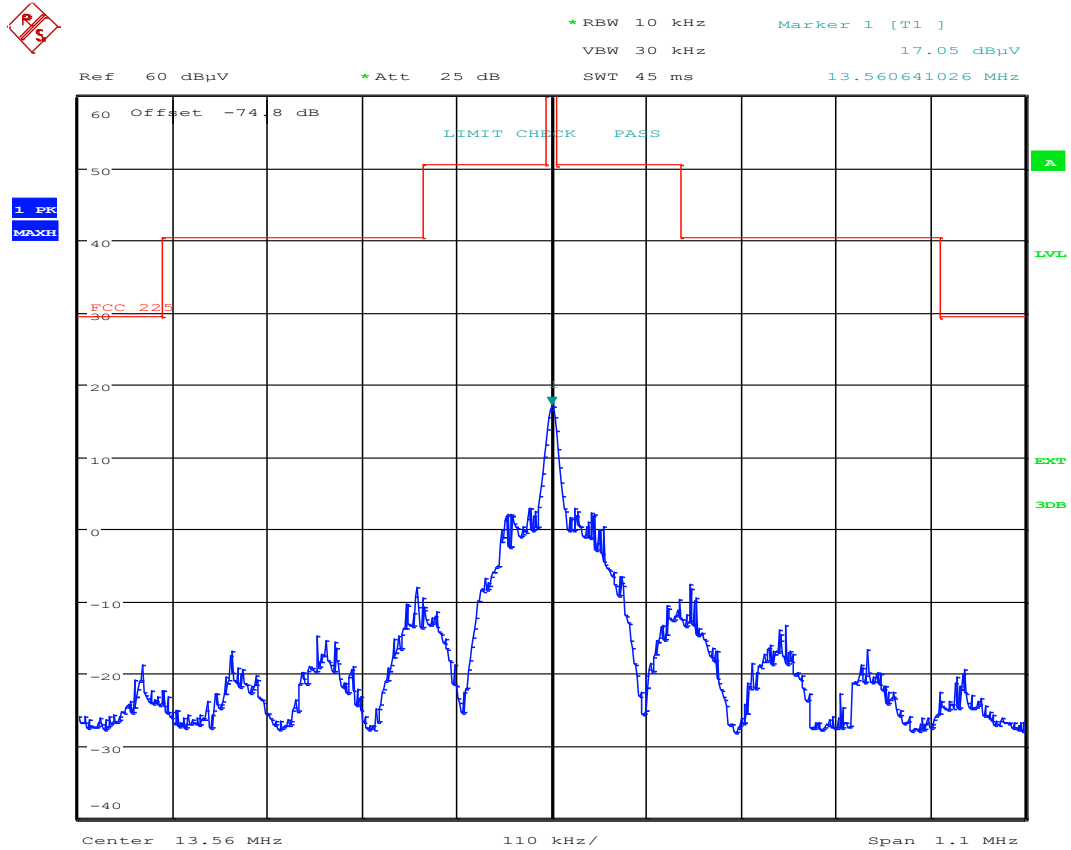


15.5 Test Equipment

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU26	U405	2024-05-22
hfh2	R&S	Loop Antenna	L007	2024-10-11

15.6 Test Results

13.56 MHz						
Channel Frequency (MHz)	Receiver Level (dBμV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (μV/m)	Result
13.56	77.80	1	30	60.80	7.079	PASS
13.56	57.00	3	30	40.00	7.079	PASS



16 Frequency stability

16.1 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.

16.2 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:	On
Deviations From Standard:	EUT was left ON for the duration of the test.
Temperature Extreme Environment Test Range:	-20 °C to +50 °C
Voltage Extreme Environment Test Range:	Mains Power = $\pm 15\%$ of Nominal; Battery = $\pm 15\%$ of Nominal;

Environmental Conditions (Normal Environment)

Temperature: 21 °C	Standard Requirement: +20 °C
Humidity: 45 %RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

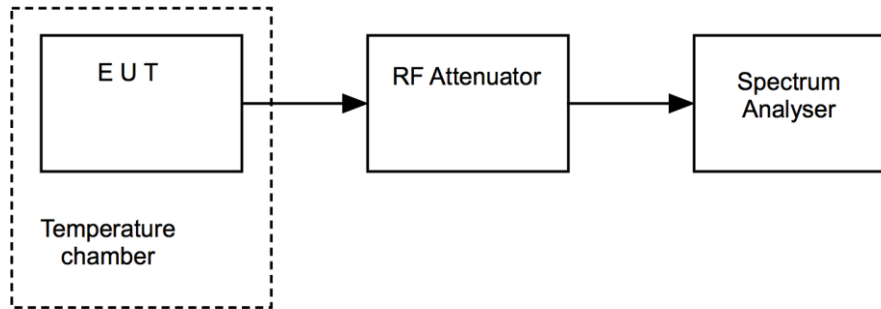
Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

16.4 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.

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

Figure v Test Setup



16.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Temperature Chamber	Votsch	VT 4002	U521	Use U720		
Temperature Indicator	Digitron	2000T	U720	2023-06-01	12	2024-06-01
Spectrum Analyser	R&S	FSU26	U405	2023-05-22	12	2024-05-22
Multimeter	Agilent	34405a	REF976	2024-01-26	12	2025-01-26
Power Supply	ISO-Tech	IPS 303A	U748	Use REF976		
AC Power supply	Kikusui	PCR4000L	U580	Use REF976		

16.6 Test Results

Power Supply Vnom (Vdc)	Temperature (°C)	Frequency (MHz)	Result (kHz)	Limit = ± 0.01%= 1.3562kHz
110	+50 °C	13.560215	-0.237	PASS
110	+40 °C	13.560265	-0.187	PASS
110	+30 °C	13.560337	-0.115	PASS
110	+20 °C	13.560452	0.000	PASS
110	+10 °C	13.560506	0.054	PASS
110	0 °C	13.560586	0.134	PASS
110	-10 °C	13.560657	0.205	PASS
110	-20 °C	13.560701	0.249	PASS
Battery Voltage (Vdc) 85% - 115%	Temperature (°C)	Frequency (MHz)	Result (kHz)	Limit = ± 0.01%= 1.3562kHz
16.56	+20 °C	13.560486	0.034	PASS
12.24	+20 °C	13.560472	0.020	PASS
Power Supply Voltage (Vdc) 85% - 115%	Temperature (°C)	Frequency (MHz)	Result (kHz)	Limit = ± 0.01%= 1.3562kHz
93.5	+20 °C	13.560452	0.000	PASS
126.5	+20 °C	13.560452	0.000	PASS

17 Measurement Uncertainty

Radio Testing – General Uncertainty Schedule

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

Test/Measurement	Budget Number	MU
Conducted RF Power, Power Spectral Density, Adjacent Channel Power and Spurious emissions		
Absolute RF power (via antenna 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

18 Appendix A - General SAR test reduction & exclusion guidance

KDB 447498 D01 General RF Exposure Guidance V06

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 below 100 MHz, and for test separation distance of ≤ 50 mm, is determined as follows.

$$\text{SAR Exclusion Threshold (SARET)} = [(NT \times \text{TSD}_A) / \sqrt{0.1}] \times [1 + \text{Log}(100 / f_{\text{MHz}})] \times 1/2$$

Where,

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

$\text{TSD}_A = 50$ mm

f_{MHz} = Transmit frequency in MHz

<i>Channel Frequency (MHz)</i>	<i>Calculated Power EIRP (mW)</i>	<i>SAR Exclusion Threshold at 5 mm (mW)</i>	<i>SAR Evaluation</i>
13.56	0.000002	443.0	Not Required

Note: The maximum power was calculated from the field strength recorded in section 15.6.

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