

Report Number: TRA-066060-47-07A
Issue: A

Report on the Radio Testing of an
Elatec GmbH
TWN4 Palon Compact S M LEGIC
With Respect to Specification
FCC 47CFR 15.209

Test Date: 5th November 2024 - 12th December 2024

Tested by: D Winstanley, S Hodgkinson, S Garwell

Written by:

D Winstanley
Radio Senior Test Engineer

Approved by:

J Charters
Lab Manager

Date: 7th January 2025

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

RF959 7



1 Revision Record

<i>Issue</i>	<i>Issue Date</i>	<i>Revision History</i>
A	7th January 2025	Original

2 Summary

Test Report Number: TRA-066060-47-07A

Works Order Number: TRA-066060-00

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 Specifications: 47CFR15.209

Equipment Under Test (EUT): TWN4 Palon Compact S M LEGIC

FCC Identifier: WP5TWN4F24

EUT Serial Number: R2024289057

MANUFACTURER: Elatec GmbH

ADDRESS: Zeppelinstraße 1
82178 Puchheim
Germany

CLIENT CONTACT: Birgit Bachl
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b.bachl@elatec.com

AGENT: Element Materials Technology Straubing GmbH

AGENT ADDRESS: Gustav-Hertz-Str. 35
Straubing
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+49 9421 56868-0
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ORDER NUMBER: DE05100186PO

Test Date: 5th November 2024 - 12th December 2024

Tested By: D Winstanley, S Hodgkinson, S Garwell
Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause 47CFR15</i>	<i>Applicable to This Equipment</i>	<i>Result / Note</i>
Radiated Spurious Emissions, Below 30 MHz	15.209	<input checked="" type="checkbox"/>	Pass
Radiated Spurious Emissions	15.209	<input checked="" type="checkbox"/>	Pass
AC Power Line Conducted Emissions	15.207	<input checked="" type="checkbox"/>	Pass
Occupied Bandwidth	-	<input checked="" type="checkbox"/>	Pass
Field Strength of Fundamental	15.209	<input checked="" type="checkbox"/>	Pass

General Notes:

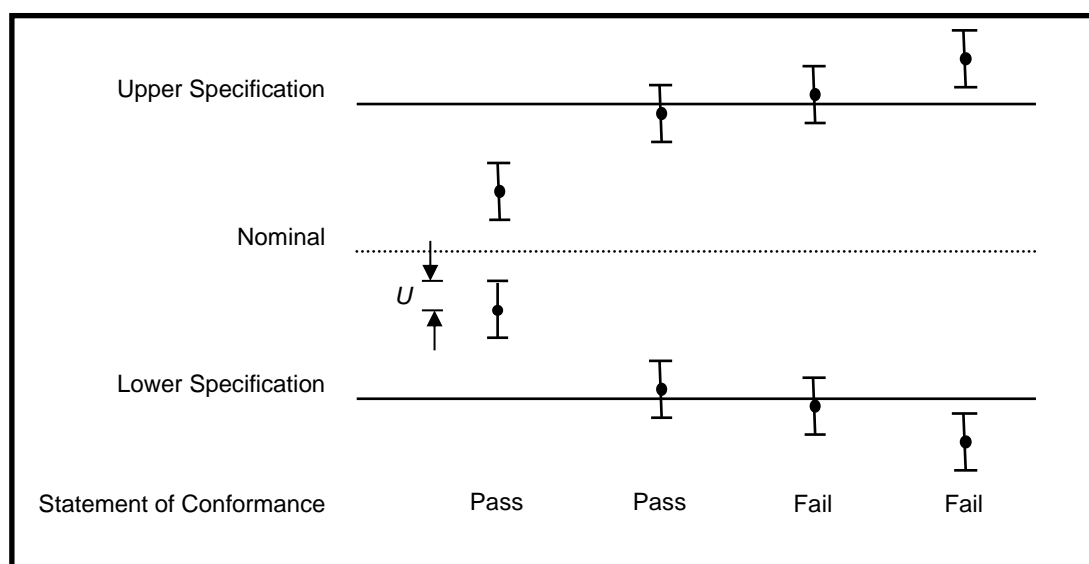
The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set-up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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

Graphical Representation of a Pass / Fail Binary Statement - Simple Acceptance



● = Measured value

U = 95 % expanded measurement uncertainty

3 Contents

1	Revision Record	2
2	Summary	3
2.1	Test Summary	4
3	Contents	5
4	Introduction	6
5	Test Specifications	7
5.1	Normative References	7
5.2	Deviations from Test Standards	7
6	Glossary of Terms	8
7	Equipment Under Test	9
7.1	EUT Identification	9
7.2	System Equipment	9
7.3	EUT Mode of Operation	9
7.3.1	Transmission	9
7.4	EUT Radio Parameters	9
7.4.1	General	9
7.4.2	Antennas	9
7.5	EUT Description	9
8	Modifications	10
9	EUT Test Setup	11
9.1	Block Diagram	11
9.2	General Set-up Photograph	12
9.3	Measurement Software	12
10	General Technical Parameters	13
10.1	Normal Conditions	13
11	Radiated emissions below 30 MHz	14
11.1	Definitions	14
11.2	Test Parameters	14
11.3	Test Method	15
11.4	Test Equipment	16
11.5	Test Results	17
12	Radiated emissions	18
12.1	Definitions	18
12.2	Test Parameters	18
12.3	Test Method	19
12.4	Test Equipment	20
12.5	Test Results	21
13	AC power-line conducted emissions	24
13.1	Definition	24
13.2	Test Parameters	24
13.3	Test Limit	24
13.4	Test Method	25
13.5	Test Set-up Photograph	25
13.6	Test Equipment	25
13.7	Test Results	26
14	Occupied Bandwidth	28
14.1	Definition	28
14.2	Test Parameters	28
14.3	Test Method	28
14.4	Test Equipment	29
14.5	Test Results	29
15	Transmitter output power (fundamental radiated emission)	30
15.1	Definition	30
15.2	Test Parameters	30
15.3	Test Method	31
15.4	Test Equipment	31
15.5	Test Results	31
16	Measurement Uncertainty	32
17	MPE Calculation	35

4 Introduction

This report TRA-066060-47-07A presents the results of the Radio testing on a Elatec GmbH TWN4 Palon Compact S M LEGIC to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Elatec GmbH by Element, at the address detailed below.

<input checked="" type="checkbox"/>	Element Skelmersdale	<input type="checkbox"/>	Element Surrey Hills
	Unit 1		Unit 15 B
	Pendle Place		Henley Business Park
	Skelmersdale		Pirbright Road
	West Lancashire		Normandy
	WN8 9PN		Guildford
	UK		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 ISO/IEC 17025:2017 accredited calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

The test laboratory is accredited for the above sites under the 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

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
°C	Degrees Celsius
CFR	Code of Federal Regulations
CISPR	Comité International Spécial des Perturbations Radioélectriques
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
m	metre
max	maximum
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
QP	Quasi-Peak
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: TWN4 Palon Compact S M LEGIC
- Serial Number: R2024289057
- Model Number: EL20232
- Software Revision: B1.08/NKD4.81/CONT2.02/PIB (Beta 1)
- Build Level / Revision Number: A

7.2 System Equipment

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

- Test Laptop

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows...

The EUT was programmed via a test laptop using client supplied software (ApprovalCommander200). The EUT was tested reading / searching for an RFID tag as specified.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of Operation:	125 kHz
Modulation Type:	ASK
Occupied Channel Bandwidth:	N/A
Channel Spacing:	N/A
Nominal Supply Voltage:	5 Vdc via USB

7.4.2 Antennas

Type:	Inductive Loop
Length / Diameter:	31mm x 31mm
Number of Turns:	88
Mounting:	Adhesive

7.5 EUT Description

The EUT is a RFID reader/writer module with Bluetooth low energy.

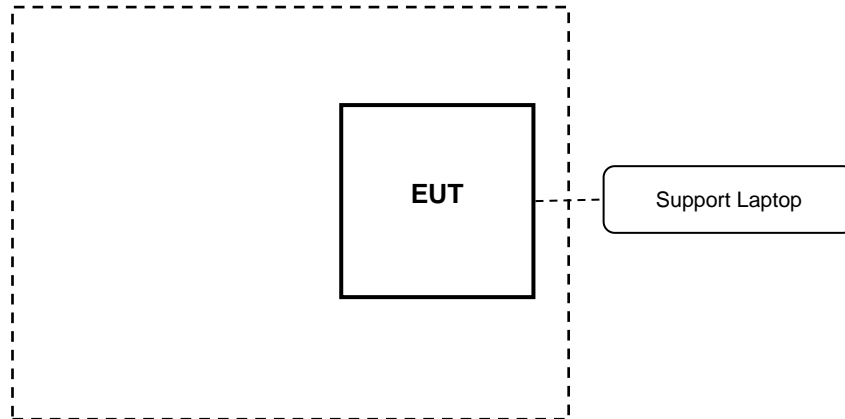
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

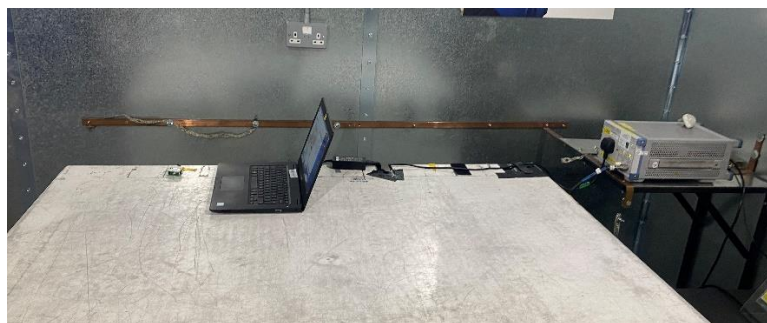
9.1 Block Diagram

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)

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

11 Radiated emissions 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:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
Frequencies Measured:	125 kHz
Deviations From Standard:	None
Measurement Distance and Site	REF940 (SAR), 3m
EUT Height:	1m
Measurement Antenna and Height:	60cm shielded loop; 1m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 – 90 kHz and 110 – 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 46 %RH	20%RH to 75%RH (as declared)
Supply: 5.0 Vdc	

Test Limits

Radiated emissions shall comply with the field strength limits shown in the Table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 6 - General field strength limits at frequencies below 30 MHz

<i>Frequency, f (kHz)</i>	<i>Field Strength</i>	<i>Measurement Distance (m)</i>
9 – 490 ¹	6.37 / f (μA/m) 2,400 / f (μV/m)	300
490 – 1,750	63.7 / f (μA/m) 24,000 / f (μV/m)	30
1,705 – 30,000	0.08 (μA/m) 30 (μV/m)	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

11.3 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 $\mu\text{V/m}$ at the regulatory distance, using:

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

Where,

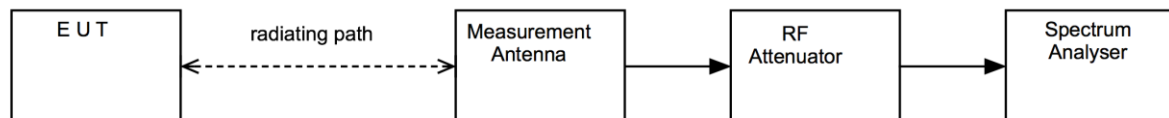
PR is the power recorded on the receiver / spectrum analyzer in dB μV and includes any cable loss, antenna factor and pre-amplifier gain;

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

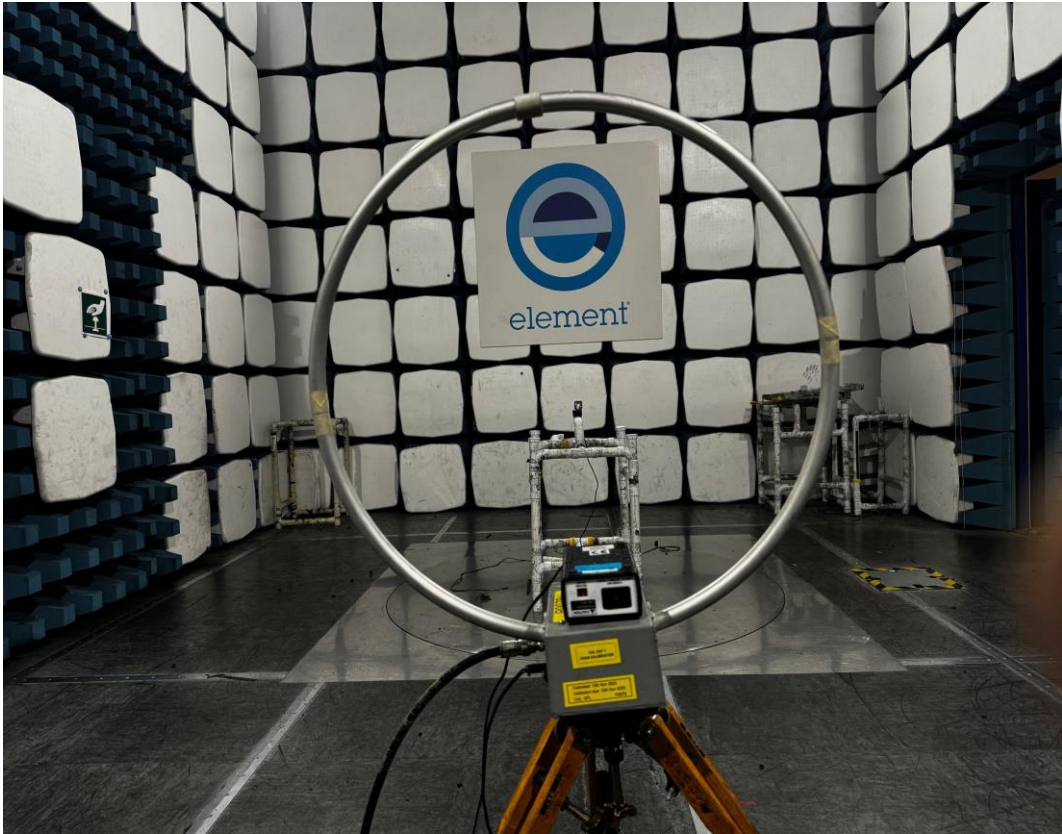
Per FCC 47CFR15.31(f)(2), an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure i Test Setup



Test Setup Photograph(s)

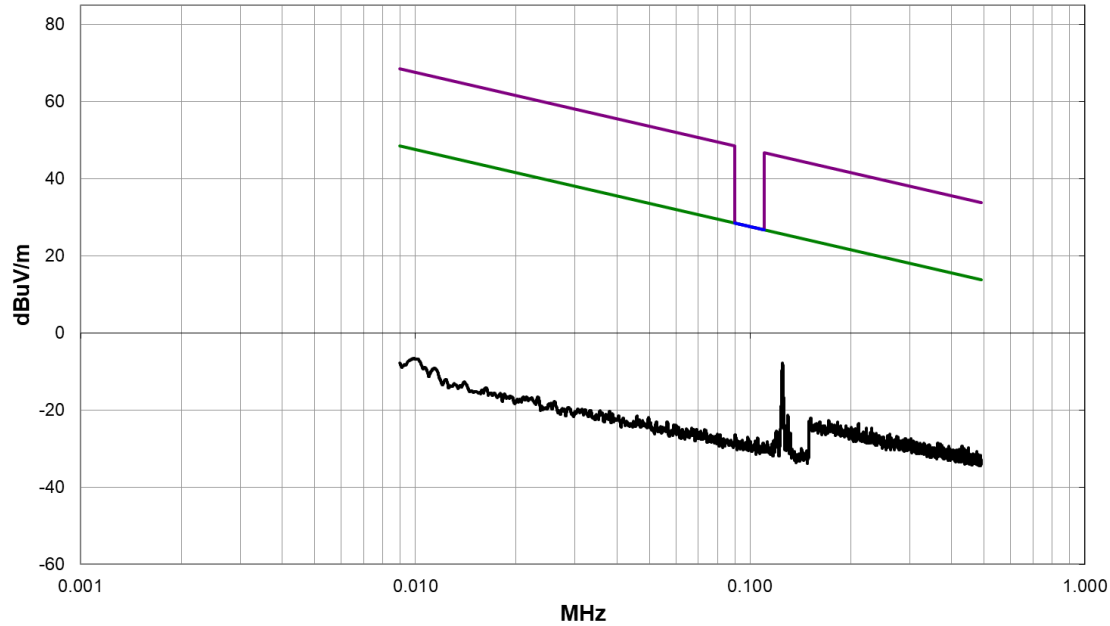


11.4 Test Equipment

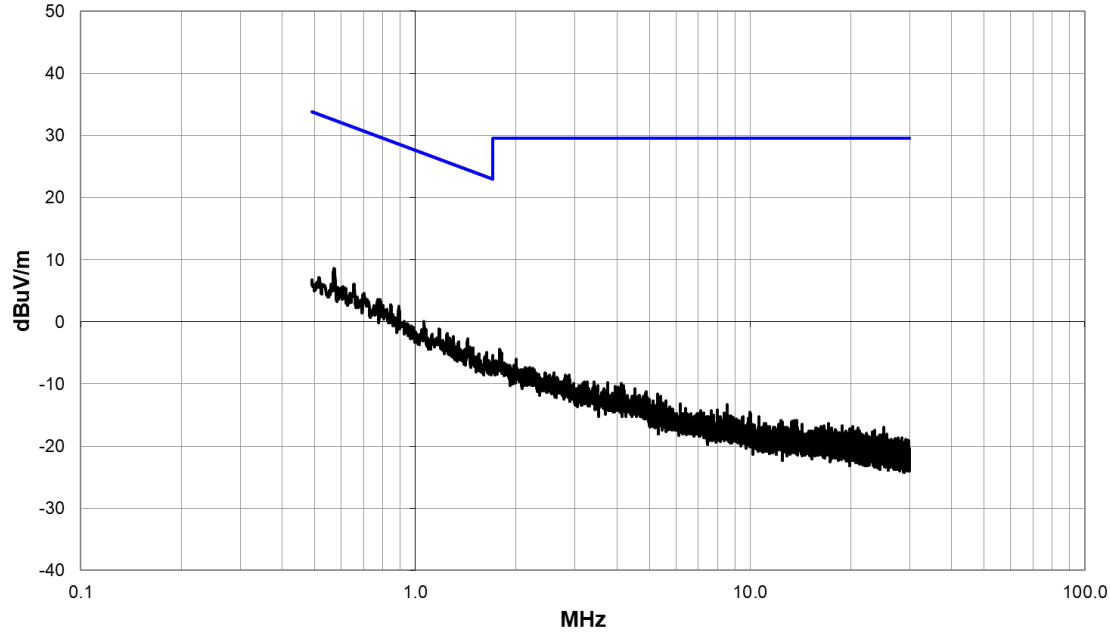
Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR7	R&S	EMI Receiver	U456	2025-03-08
6502	EMCO	Active Loop Antenna	R0079	2025-11-09
ATS	Rainford EMC	Radio Chamber - PP	REF940	2026-01-29
Emissions R5	Element	Radiated Test Software	REF9000	Cal Not Required

11.5 Test Results

Frequency: 125 kHz; Modulation: ASK; Power Setting: Default



490 kHz to 30 MHz



Note: The emission at 125 kHz is the fundamental

Frequency: 125 kHz; Modulation: ASK; Power Setting: Default						
Emission Frequency (MHz)	Receiver Level (dBuV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (uV/m)	Result
No significant emissions within 20 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:	Radio Chamber REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	125 kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak; Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 °C to +35 °C (as declared)
Humidity: 53 %RH	20%RH to 75%RH (as declared)
Supply: 5 Vdc	

Test Limits

Emissions shall comply with the field strength limits shown in the Table 5. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 - General field strength limits at frequencies above 30 MHz

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3m)</i>
30-88	100
88-216	150
216-960	200
Above 960	500

n.b. per FCC 47CFR15.35(b), where an average measurement is specified, the peak limit is 20dB above the average limit.

12.3 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 100kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

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

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

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

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBμV;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

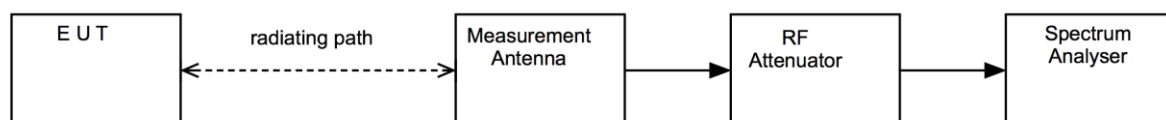
PA is the pre-amplifier gain in dB (where used);

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

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

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

Figure i Test Setup

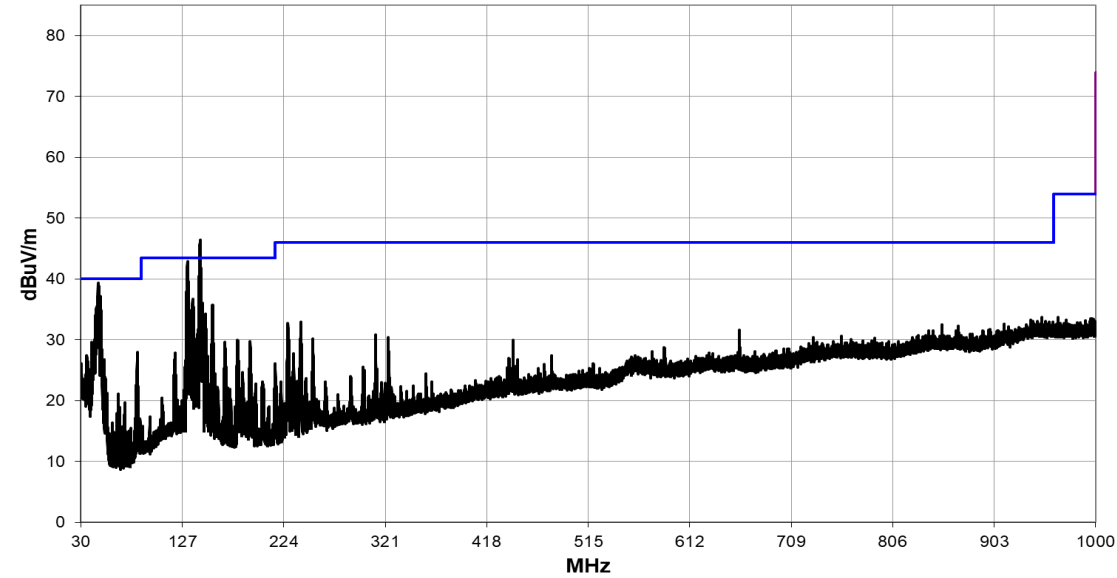


Test Setup Photograph(s)**12.4 Test Equipment**

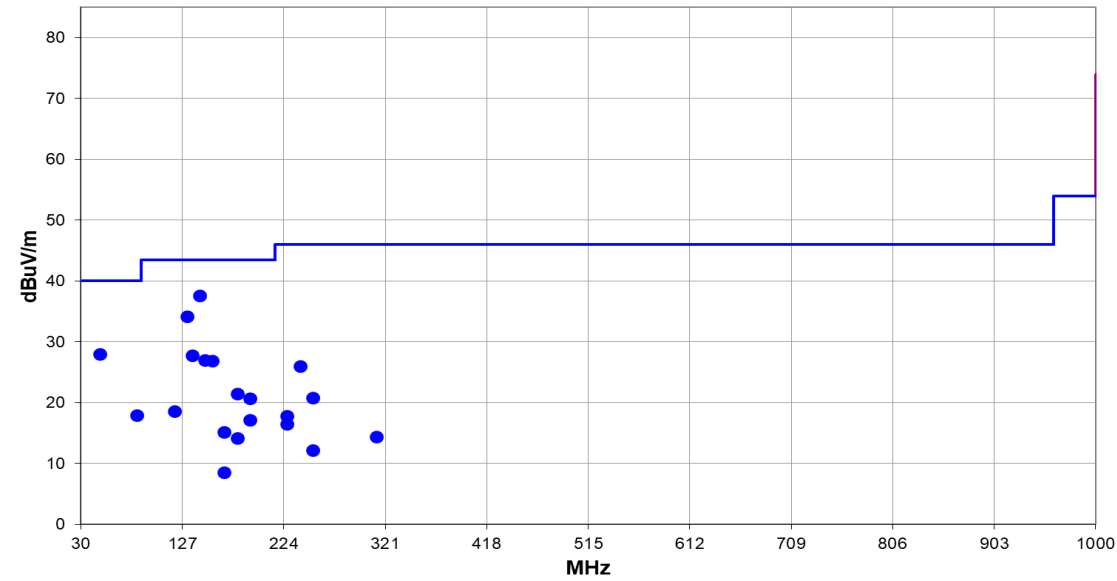
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
PreAmp	Watkins Johnson	6201-69	U372	2025-03-15
ESR7	R&S	EMI Receiver	U456	2025-03-08
Spectrum Analyser	R&S	FSU26	REF909	2025-09-24
Bilog	Chase	CBL611/A	U191	2025-08-11
Pre Amp	Agilent	8449B	U457	2025-01-26
1-18GHz Horn	EMCO	3115	U223	2026-01-17
Horn 18-26GHz (&U330)	Flann	20240-20	L263A	2026-07-23
Radio Chamber - PP	Rainford EMC	ATS	REF940	2026-01-29
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

12.5 Test Results

30 MHz-1 GHz Scan

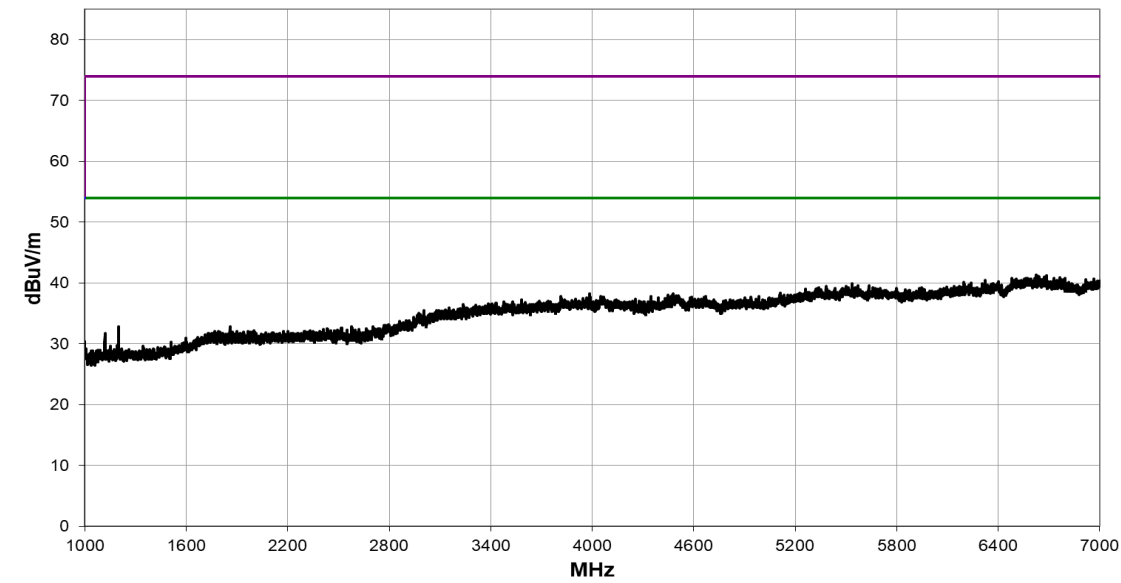


30 MHz-1 GHz Maximisation

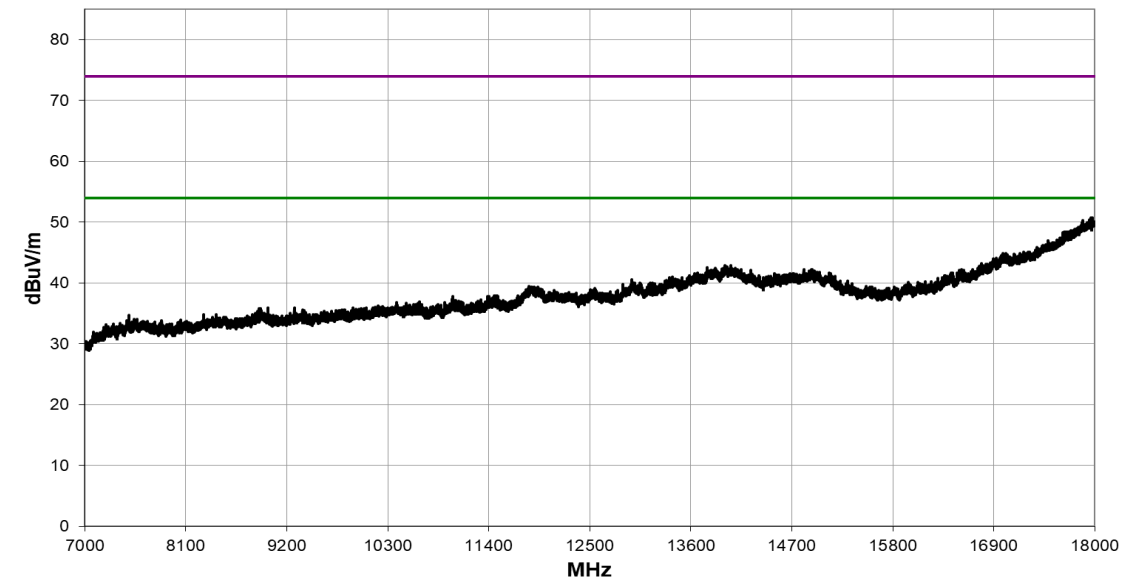


Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
144.060	47.4	-9.8	1.0	330.1	3.0	0.0	Vert	QP	0.0	37.6	43.5	-5.9
132.078	43.5	-9.4	1.0	225.0	3.0	0.0	Vert	QP	0.0	34.1	43.5	-9.4
48.705	41.2	-13.3	1.0	270.0	3.0	0.0	Vert	QP	0.0	27.9	40.0	-12.1
137.026	37.3	-9.6	1.0	270.1	3.0	0.0	Vert	QP	0.0	27.7	43.5	-15.8
149.021	36.9	-10.0	1.0	360.0	3.0	0.0	Vert	QP	0.0	26.9	43.5	-16.6
156.043	37.4	-10.6	1.0	360.0	3.0	0.0	Vert	QP	0.0	26.8	43.5	-16.7
240.023	35.8	-9.8	1.5	135.0	3.0	0.0	Vert	QP	0.0	26.0	46.0	-20.0

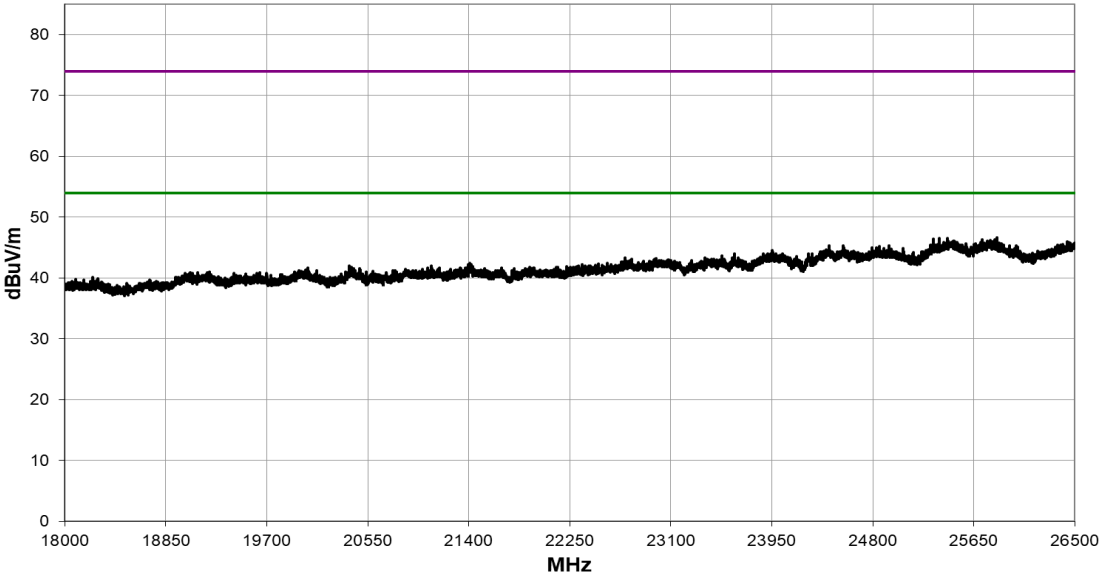
1 GHz-7 GHz Scan



7 GHz- 18 GHz Scan



18 GHz- 26.5 GHz Scan



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 (U390)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	125.0 kHz
EUT Channel Bandwidths:	Wideband
EUT Modulation:	ASK
Deviations From Standard:	None
Measurement BW:	9 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 16 °C	+15 °C to +35 °C (as declared)
Humidity: 39 % RH	20 % RH to 75 % RH (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 (dBµV)	
	Quasi-Peak	Average**
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.

**A linear average detector is required.

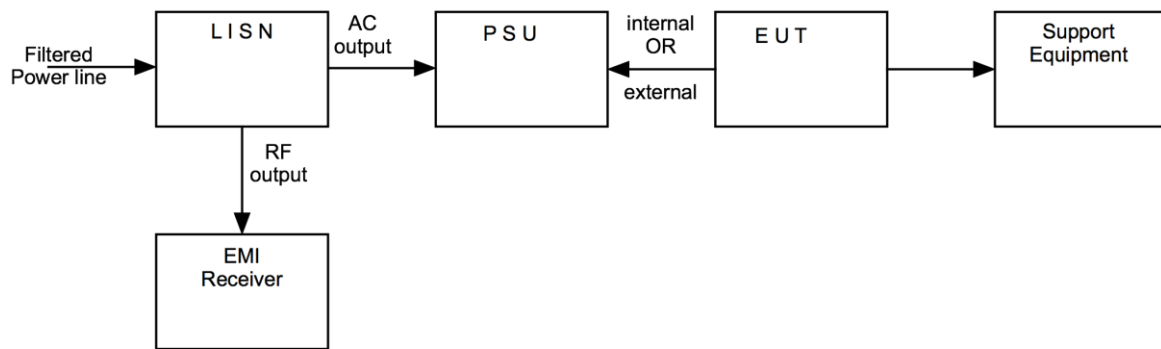
13.4 Test Method

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

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

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

Figure ii Test Setup



13.5 Test Set-up Photograph

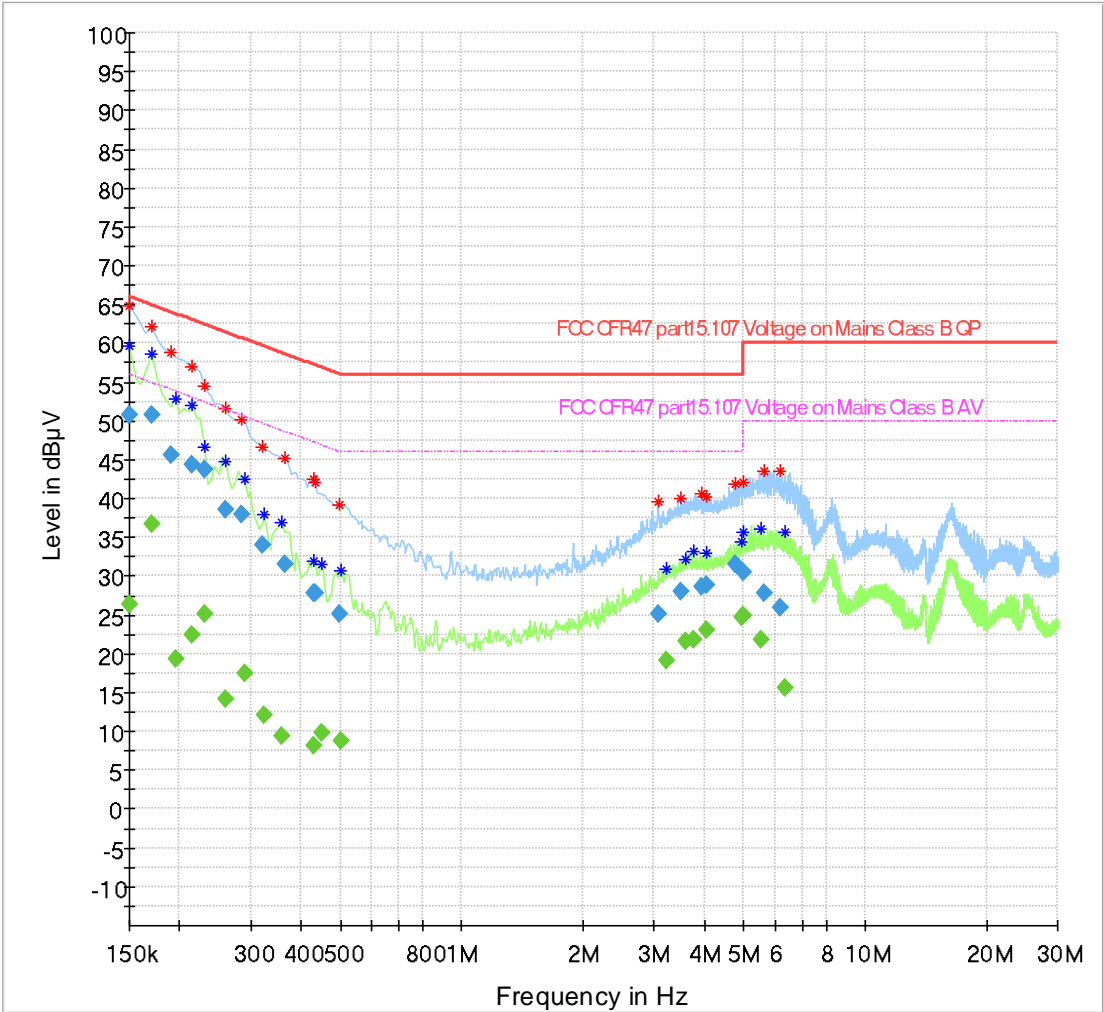


13.6 Test Equipment

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
ENV216	R&S	Lisn	U396	2025-05-16
ESR7	R&S	EMI Receiver	U456	2025-03-08
ESH3-Z2	R&S	Pulse Limiter	U559	2025-02-12

13.7 Test Results

Frequency: 125 kHz; Modulation: ASK; Power Setting: Default – Searching for TAG
Full Spectrum



Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line
0.150000	50.67	---	66.00	15.33	2000.0	9.000	N
0.150000	---	26.42	56.00	29.58	2000.0	9.000	N
0.169900	50.80	---	64.97	14.16	2000.0	9.000	N
0.169900	---	36.70	54.97	18.27	2000.0	9.000	N
0.189800	45.68	---	64.05	18.37	2000.0	9.000	L1
0.194775	---	19.40	53.83	34.43	2000.0	9.000	N
0.214675	44.27	---	63.02	18.76	2000.0	9.000	N
0.214675	---	22.48	53.02	30.55	2000.0	9.000	N
0.229600	43.67	---	62.46	18.80	2000.0	9.000	N
0.229600	---	25.21	52.46	27.25	2000.0	9.000	N
0.259450	---	14.25	51.45	37.20	2000.0	9.000	N
0.259450	38.65	---	61.45	22.80	2000.0	9.000	L1
0.284325	37.96	---	60.69	22.73	2000.0	9.000	N
0.289300	---	17.57	50.54	32.98	2000.0	9.000	N
0.319150	33.98	---	59.73	25.75	2000.0	9.000	N
0.324125	---	12.19	49.60	37.41	2000.0	9.000	N
0.358950	---	9.43	48.75	39.32	2000.0	9.000	N
0.363925	31.58	---	58.64	27.06	2000.0	9.000	N
0.428600	---	8.24	47.28	39.04	2000.0	9.000	N
0.428600	27.76	---	57.28	29.52	2000.0	9.000	N
0.433575	27.89	---	57.18	29.29	2000.0	9.000	N
0.448500	---	9.90	46.90	37.01	2000.0	9.000	N
0.498250	25.22	---	56.03	30.81	2000.0	9.000	N
0.503225	---	8.71	46.00	37.29	2000.0	9.000	N
3.065350	25.21	---	56.00	30.79	2000.0	9.000	N
3.204650	---	19.08	46.00	26.92	2000.0	9.000	N
3.503150	27.95	---	56.00	28.05	2000.0	9.000	N
3.582750	---	21.53	46.00	24.47	2000.0	9.000	L1
3.751900	---	21.89	46.00	24.11	2000.0	9.000	N
3.950900	28.72	---	56.00	27.28	2000.0	9.000	N
4.025525	---	23.05	46.00	22.95	2000.0	9.000	N
4.050400	28.77	---	56.00	27.23	2000.0	9.000	N
4.776750	31.48	---	56.00	24.52	2000.0	9.000	N
4.940925	---	24.65	46.00	21.35	2000.0	9.000	L1
4.970775	30.50	---	56.00	25.50	2000.0	9.000	N
4.995650	---	24.90	46.00	21.10	2000.0	9.000	N
5.518025	---	21.87	50.00	28.13	2000.0	9.000	N
5.642400	27.72	---	60.00	32.28	2000.0	9.000	N
6.139900	25.90	---	60.00	34.10	2000.0	9.000	N
6.348850	---	15.55	50.00	34.45	2000.0	9.000	N

14 Occupied Bandwidth

14.1 Definition

20dB 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
Frequencies Measured:	125 kHz
EUT Test Modulations:	ASK
Deviations From Standard:	None
Measurement BW:	1 kHz
(requirement: 1% to 5% OBW)	
Spectrum Analyzer Video BW:	3 KHz
(requirement at least 3x RBW)	
Measurement Span:	26 kHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22.3 °C	+15 °C to +35 °C (as declared)
Humidity: 45 %RH	20%RH to 75%RH (as declared)
Supply: 5 Vdc	

Test Limits

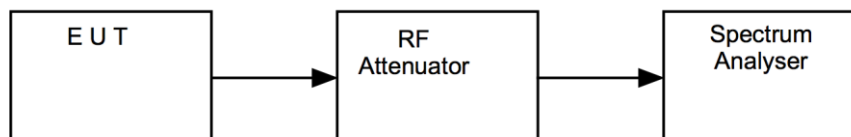
No requirement specified.

14.3 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

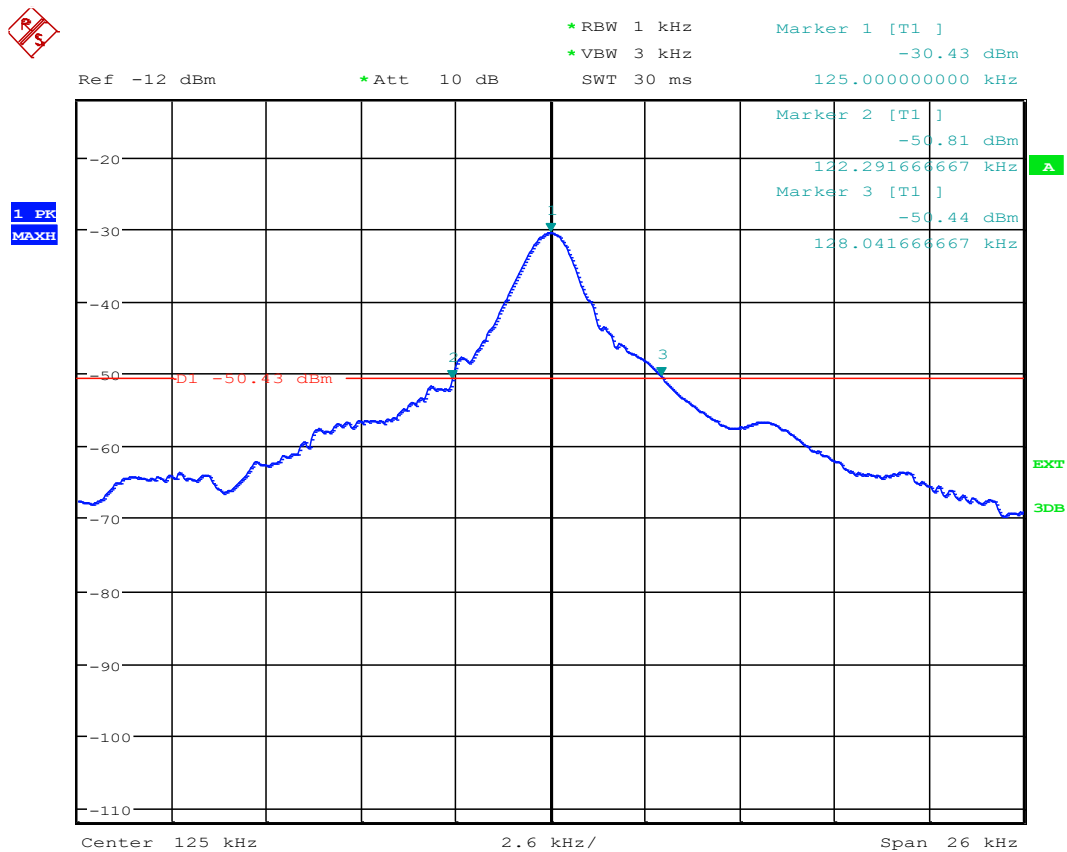


14.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU26	REF909	2025-09-24

14.5 Test Results

Modulation: ASK; Power setting: Default – With TAG			
Channel Frequency (kHz)	F _L (kHz)	F _H (kHz)	20 dB Bandwidth (kHz)
125.0	122.291666667	128.041666667	5.75



Note: The resolution bandwidth requirement of meeting the 1% to 5% of the resulting 20 dB bandwidth for AM RFID type radio devices cannot be resolved. As the resolution bandwidth is reduced, the 20 dB bandwidth will also reduce. This scenario will continue, and the resulting bandwidth measurement will just continue to reduce to nothing. Therefore, a wider resolution bandwidth was used, which was greater than the 5% requirement.

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:	OATS
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 / 6.6
EUT Frequency Measured:	125.0 kHz
EUT Channel Bandwidths:	Wideband
Deviations From Standard:	None
Measurement BW:	200 Hz
Measurement Detector:	Average

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 °C to +35 °C (as declared)
Humidity: 40 %RH	20%RH to 75%RH (as declared)

Test Limits

Except as provided in § paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76– 88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

Table of the general field strength limits per 15.209

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m)</i>	<i>Measurement distance (m)</i>
0.009-0.490	2400/f(kHz)	300
0.490-1.705	24000/f(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

15.3 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,

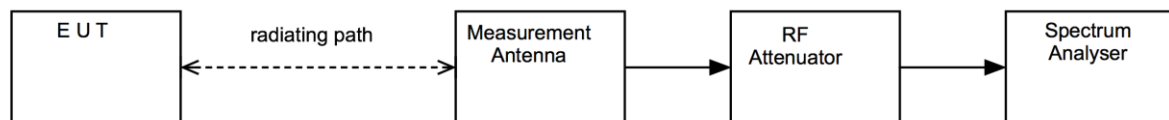
PR is the power recorded on the receiver / spectrum analyzer in dB μV and includes any cable loss, antenna factor and pre-amplifier gain;

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

Per FCC 47CFR15.31(f)(2), 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 v 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>
EMI Receiver	R&S	ESR7	U456	2025-03-08
Active Loop Antenna	EMCO	6502	R0079	2025-11-09

15.5 Test Results

<i>Frequency: 125 kHz; Modulation: ASK; Power Setting: Default – With TAG</i>								
<i>Channel Frequency (kHz)</i>	<i>Receiver Level (dB$\mu\text{V/m}$)</i>	<i>Measurement Distance (m)</i>	<i>Limit Distance (m)</i>	<i>Extrapolation Factor (dB)</i>	<i>Field Strength (dB$\mu\text{V/m}$)</i>	<i>Result ($\mu\text{V/m}$)</i>	<i>Limit ($\mu\text{V/m}$)</i>	<i>Result</i>
125	60.30	3	300	80.00	-19.7	0.104	19.200	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) Sampling Power Meter to 8 GHz	MU4001	0.9 dB
Carrier Power and PSD - Spectrum Analysers	MU4004	1.7 dB
Adjacent Channel Power	MU4002	1.9 dB
Transmitter conducted spurious emissions (Including emissions due to intermodulation)	MU4041	0.9 dB
Conducted power and spurious emissions 40 GHz to 50 GHz	MU4042	2.4 dB
Conducted power and spurious emissions 50 GHz to 75 GHz	MU4043	2.5 dB
Conducted power and spurious emissions 75 GHz to 110 GHz	MU4044	2.4 dB
Input and output intermodulation	MU4053	1.6 dB
Radiated RF Power and Spurious emissions ERP and EIRP		
Effective Radiated Power Reverb Chamber	MU4020	3.7 dB
Effective Radiated Power	MU4021	4.7 dB
TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna	MU4046	5.3 dB
TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna	MU4047	5.1 dB
TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn	MU4048	2.7 dB
TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn	MU4049	2.7 dB
In-band (3450-3980 MHz) TRP using CATR_ASH_B2	MU4051	4.1 dB
Cellular Effective radiated RF power in a SAC between 30 MHz to 180 MHz	MU4052	6.3 dB
Cellular Effective radiated RF power in a SAC between 180 MHz to 1 GHz	MU4052	3.5 dB
Cellular Effective radiated RF power in a SAC between 1 GHz and 18 GHz	MU4052	2.8 dB
Cellular Effective radiated RF power in a SAC between 18 GHz to 26 GHz	MU4052	2.8 dB
Cellular Effective radiated RF power in a FAR between 30 MHz to 180 MHz	MU4052	5.4 dB
Cellular Effective radiated RF power in a FAR between 180 MHz to 1 GHz	MU4052	2.9 dB
Cellular Effective radiated RF power in a FAR between 1 GHz and 18 GHz	MU4052	2.6 dB
Cellular Effective radiated RF power in a FAR between 18 GHz to 26 GHz	MU4052	2.7 dB
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz (Including emissions due to intermodulation)	MU4037	4.7 dB
Radiated Spurious Emissions 1-18 GHz (Including emissions due to intermodulation)	MU4032	4.5 dB
E Field Emissions 18 GHz to 26 GHz	MU4024	3.2 dB
E Field Emissions 26 GHz to 40 GHz	MU4025	3.3 dB
E Field Emissions 40 GHz to 50 GHz	MU4026	3.5 dB
E Field Emissions 50 GHz to 75 GHz	MU4027	3.6 dB
E Field Emissions 75 GHz to 110 GHz	MU4028	3.6 dB

Test/Measurement	Budget Number	MU
Radiated Magnetic Field Emissions	MU4031	2.3 dB
Frequency Measurements		
Frequency Deviation	MU4022	3.7 kHz
Frequency error using CMTA test set	MU4023	113.441 Hz
Frequency error using GPS locked frequency source	MU4045	0.0413 ppm
Bandwidth/Spectral Mask Measurements		
Channel Bandwidth	MU4005	3.87%
Transmitter Mask Amplitude	MU4039	1.3 dB
Transmitter Mask Frequency	MU4040	2.59%
Time Domain Measurements		
Transmission Time	MU4038	4.40%
Dynamic Frequency Selection (DFS) Parameters		
DFS Analyser - Measurement Time	MU4006	678.984 µs
DFS Generator - Frequency Error	MU4007	91.650 Hz
DFS Threshold Conducted	MU4008	1.3 dB
DFS Threshold Radiated	MU4009	3.2 dB
Receiver Parameters		
EN 300 328 Receiver Blocking	MU4010	1.1 dB
EN 301 893 Receiver Blocking	MU4011	1.1 dB
EN 303 340 Adjacent Channel Selectivity	MU4012	1.1 dB
EN 303 340 Overloading	MU4013	1.1 dB
EN 303 340 Receiver Blocking	MU4014	1.1 dB
EN 303 340 Receiver Sensitivity	MU4015	0.9 dB
EN 303 372-1 Image Rejection	MU4016	1.4 dB
EN 303 372-1 Receiver Blocking	MU4017	1.1 dB
EN 303 372-2 Adjacent Channel Selectivity	MU4018	1.1 dB
EN 303 372-2 Dynamic Range	MU4019	0.9 dB
Receiver Blocking Talk Mode Conducted	MU4033	1.2 dB
Receiver Blocking Talk Mode- radiated	MU4034	3.4 dB
Rx Blocking, listen mode, blocking level	MU4035	3.2 dB
Rx Blocking, listen mode, radiated Threshold Measurement	MU4036	3.4 dB
Adjacent Sub Band Selectivity	MU4003	4.2 dB

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

17 MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20 cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \text{ re - arranged } R = \sqrt{\frac{EIRP}{S 4\pi}}$$

Where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Result

Channel Frequency (MHz)	EIRP (mW)	Power density at 20cm (S) (mW/cm²)	Power density limit (S) (mW/cm²)	Distance (R) cm required to be less than the power density limit
0.125	0.00000003	0.0000000000006	*(100)	0.0000049

* = Plane-wave equivalent power density