

Report Number: TRA-067716-47-02A
Issue: A

Report on the Radio Testing of a
CORROSION RADAR LIMITED
GEN3 Exi
With Respect to Specifications
FCC 47CFR 15.247
TO SATISFY PERMISSIVE CHANGE REQUIREMENTS OF
KDB 178919 D01 Permissive Change Policy v06

TEST DATE: 27th - 28th October 2025

Tested by: D Winstanley
Radio Senior Test Engineer

Written by:



Digitally signed by Daniel Winstanley
DN: cn=Daniel Winstanley gn=Daniel
Winstanley c=GB United Kingdom l=GB
United Kingdom
Reason: I am the author of this document
Date: 2026-02-23 11:58Z

D Winstanley
Radio Senior Test Engineer

Approved by:



Digitally signed by John
Charters
Date: 2026.02.27 14:54:47 Z

J Charters
Lab Manager

Date: 23rd February 2026

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

RF915 Rev. 16



1 Revision Record

<i>Issue</i>	<i>Issue Date</i>	<i>Revision History</i>
A	23rd February 2026	Original

2 Summary

TEST REPORT NUMBER:	TRA-067716-47-02A
WORKS ORDER NUMBER:	TRA-067716-01
PURPOSE OF TEST:	Class II Permissive Change
TEST SPECIFICATION:	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	GEN3 Exi
FCC IDENTIFIER:	2BTAH-GEN3EXILRV4
EUT SERIAL NUMBER:	100015
MANUFACTURER/AGENT:	CORROSION RADAR LIMITED
ADDRESS:	Future Business Centre King's Hedges Road Cambridge CB4 2HY United Kingdom
CLIENT CONTACT:	Giles Hutchison ☎ +44 (0) 1223 608 861 ✉ g.hutchison@corrosionradar.com
ORDER NUMBER:	CR-PO214
TEST DATE:	27th - 28th October 2025
TESTED BY:	D Winstanley Element

2.1 Test Summary

Test Method and Description		Requirement Clause FCC 47 CFR	Applicable to this equipment	Result / Note
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	☒	Pass
AC power line conducted emissions		15.207	☐	Note 1
6 dB bandwidth		15.247 (a) (2)	☐	Note 1
Occupied bandwidth (99% bandwidth)		N/A	☐	Note 1
Conducted output power	Peak	15.247 (b) (3)	☒	Pass
	Maximum		☐	
Undesirable / unwanted emissions		15.247 (d)	☐	Note 1
Power spectral density		15.247 (e)	☐	Note 1
Pulsed operation correction		15.35 (c)	☐	Note 1

Specific notes:

1. Limited testing was performed to check Carrier power / & transmitter radiated spurious emissions only, as requested by the client, to support Permissive Change requirements of 178919 D01 v06

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.

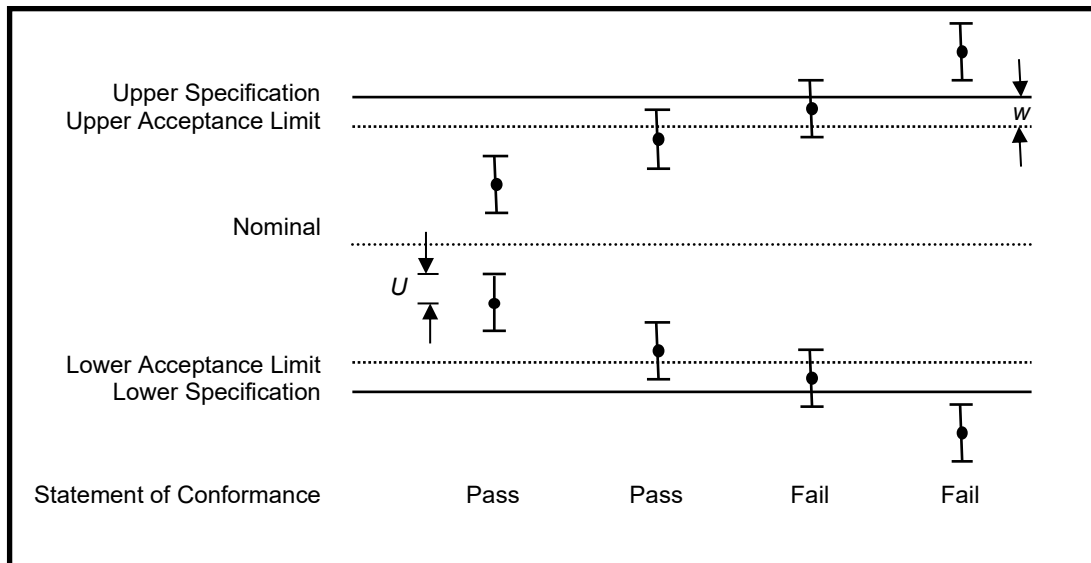
The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

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).

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

The decision rule for compliance is not inherent within this specification and compliance is based on the customer requesting an acceptance rule based on applying a guard band equal to the laboratories 95 % expanded measurement uncertainty for each test.

Graphical Representation of a Pass / Fail Binary Statement When Applying a Guard Band



• = Measured value

U = 95 % expanded measurement uncertainty

w = guard band equal to the laboratories 95 % expanded measurement uncertainty for each test

3 Contents

1	Revision Record	2
2	Summary	3
2.1	Test Summary	4
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
7.4	EUT Radio Parameters	11
7.4.1	General	11
7.4.2	Antennas	11
7.4.3	Product specific declarations	11
7.5	EUT Description	11
8	Modifications	12
9	EUT Test Setup	13
9.1	Block Diagram	13
9.2	General Set-up Photograph	14
9.3	Measurement software	14
10	General Technical Parameters	15
10.1	Normal Conditions	15
10.2	Varying Test Conditions	15
11	Radiated emissions	16
11.1	Definitions	16
11.2	Test Parameters	16
11.3	Test Limit	16
11.4	Test Method	17
11.5	Test Equipment	17
11.6	Test Results	18
12	Maximum peak conducted output power	24
12.1	Definition	24
12.2	Test Parameters	24
12.3	Test Limit	24
12.4	Test Method	25
12.5	Test Equipment	25
12.6	Test Results	26
13	Measurement Uncertainty	28
14	RF Exposure	31

4 Introduction

This report TRA-067716-47-02A presents the results of the Radio testing on a CORROSION RADAR LIMITED, GEN3 Exi to specification FCC Title 47 CFR 15 Radio Frequency Devices.

The testing was carried out for CORROSION RADAR LIMITED by Element, at the address detailed below.

☒	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK	☐	Element Surrey Hills Unit 15 B Henley Business Park Pirbright Road Normandy Guildford GU3 2DX UK
-------------------------------------	--	--------------------------	---

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 C63.10-2020 – 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
- KDB 178919 D01 Permissive Change Policy v06

5.2 Deviations from Test Standards

Limited testing was performed to check transmitter radiated spurious emissions only, as requested by the client, to support Permissive Change requirements of 178919 D01 v06.

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
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: GEN3 Exi
- Serial Number: 100015
- Model Number: EXI-BL
- Software Revision: Firmware V61 production
- Build Level / Revision Number: Production

7.2 System Equipment

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

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

The EUT was programmed from a Laptop Via a USB - serial connection that was disconnected from the Laptop during test. The unit was set to accept commands via serial terminal and the laptop was running MurataLoRaTestTool(v0.0.02), which was used to setup the radio operation. The EUT was set to transmit as per the table below.

Bandwidth:	125 kHz	500 kHz
Frequency of operation:	902.3 MHz / 908.5 MHz / 914.9 MHz	903.0 MHz / 907.8 MHz / 914.2 MHz
Power setting:	20 dBm	20 dBm
PA Boost:	On	On
Spreading Factor:	10	12

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	125 kHz Channel: 902.3 MHz – 914.9 MHz 500 kHz Channel: 903.0 MHz – 914.2 MHz
Modulation type(s):	LoRa
Occupied channel bandwidth(s):	125 kHz / 500 kHz
Power Setting:	20 dBm
Nominal Supply Voltage:	4 Vdc to 24 Vdc; 7.4 Vdc for test
Location of notice for license exempt use:	Label / user manual / both.
Duty cycle:	100% (During test)

7.4.2 Antennas

Type:	TE, ANT-5GW-IPW1-NP
Frequency range:	791 MHz to 960 MHz
Impedance:	50 Ω
SWR:	≤ 3.1
Gain:	2.3 dBi (in the 791 MHz to 960 MHz Range)
Polarisation:	Linear
Beam width:	Omnidirectional
Connector type:	N-Type Connector
Dimensions:	178.0 mm x $\varnothing$ 25.0 mm
Weight:	76.1 g
Environmental limits:	-40 °C to +70 °C

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	Single
Fixed pt-pt operations (yes/no):	No
Installation manual advice on pt-pt operational restrictions (yes/no):	No
Fixed pt-mpt operations (yes/no):	No
Simultaneous tx (yes/no):	No
Professional Installation:	Yes

7.5 EUT Description

The EUT is an Intrinsically Safe Corrosion Monitoring Node that contains Bluetooth Low Energy And LoRa radios.

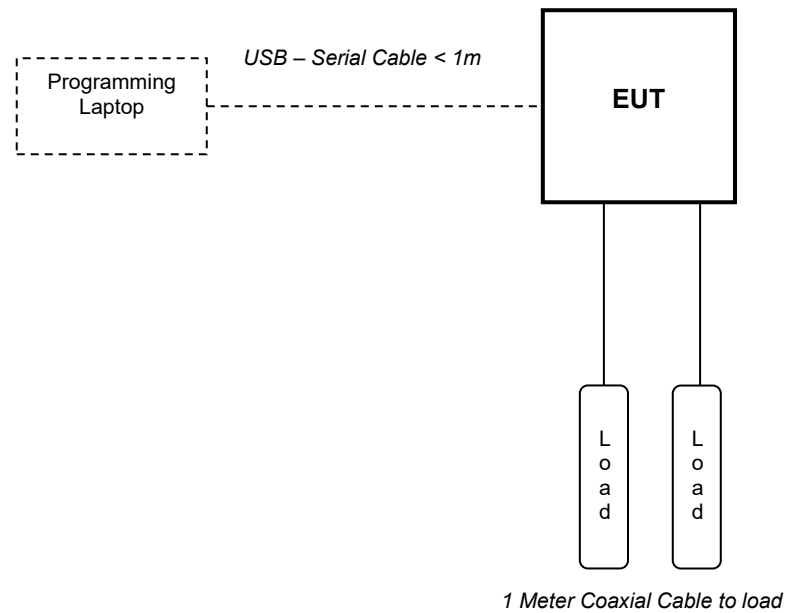
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

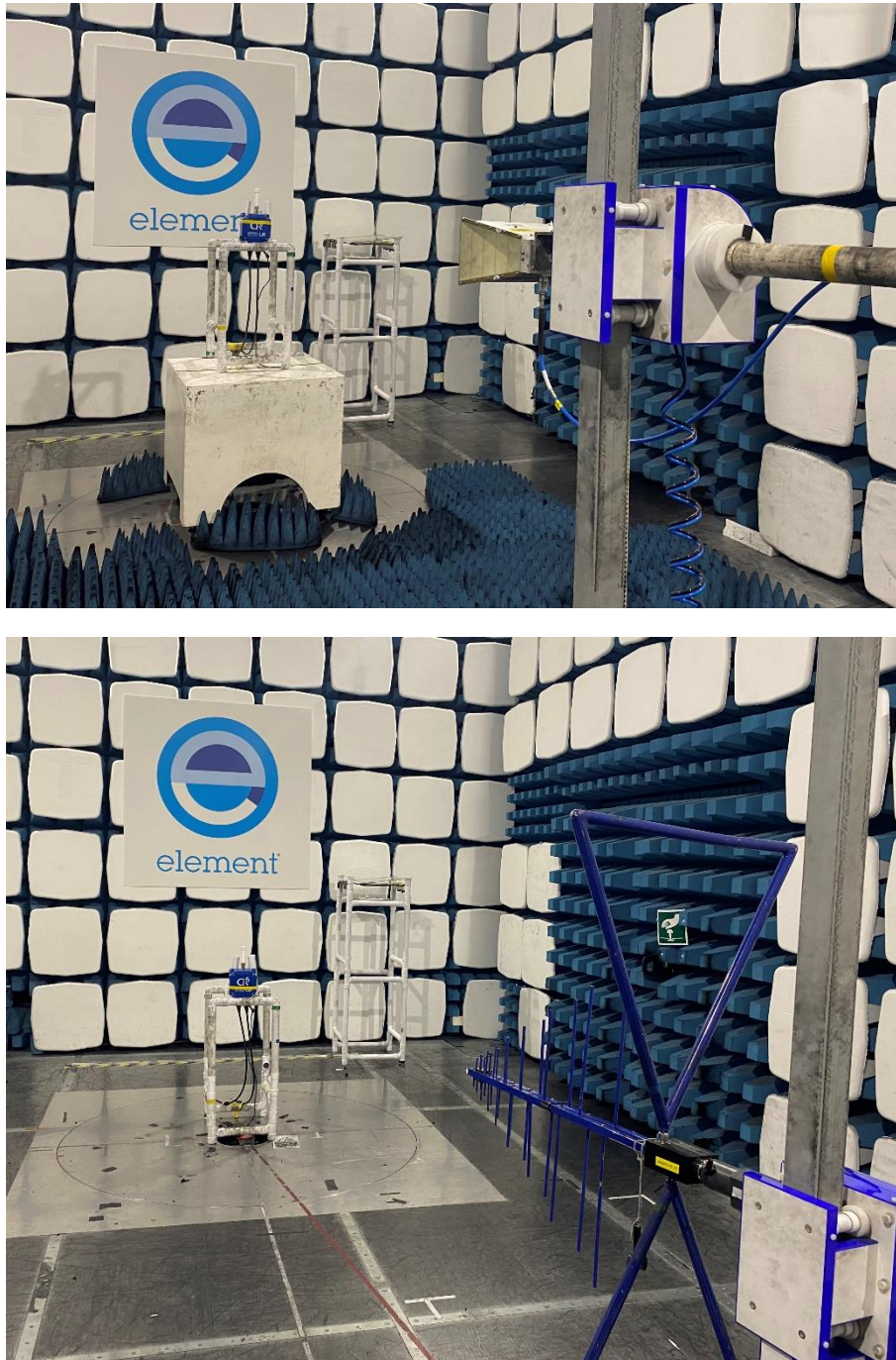
The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



----- Indicates only connected during radio setup

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

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 7.4 V DC Li-ion from the batteries supplied for test by the manufacturer.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band.

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

	Category	Nominal	Variation
☐	Mains	110 VAC +/-2 %	85 % and 115 %
☒	Battery	New battery (Fully Charged)	N/A

11 Radiated emissions

11.1 Definitions

Spurious emissions

Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Chamber 1
Test Standard and Clause:	ANSI C63.10-2020, Clause 6.5 and 6.6
EUT Frequencies Measured:	902.3 MHz / 908.5 MHz / 914.9 MHz 903.0 MHz / 907.8 MHz / 914.2 MHz
Deviations from Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak; Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 19 - 21 °C	+15 °C to +35 °C (as declared)
Humidity: 46 - 48 % RH	20 %RH to 75 %RH (as declared)

11.3 Test Limit

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

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

<i>Frequency (MHz)</i>	<i>Field Strength (μV/m at 3 m)</i>	<i>Field Strength (dBμV/m at 3 m)</i>
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

On frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function. On frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

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

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

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

Power values measured on the test receiver / analyzer are converted to field strength, FS, in 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;

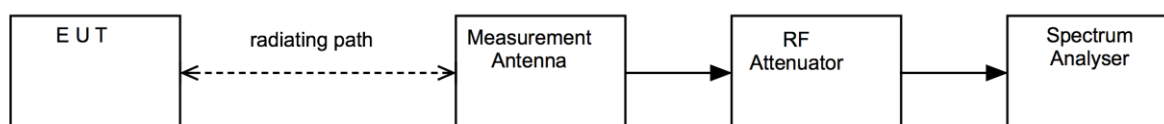
PA is the pre-amplifier gain in dB (where used);

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



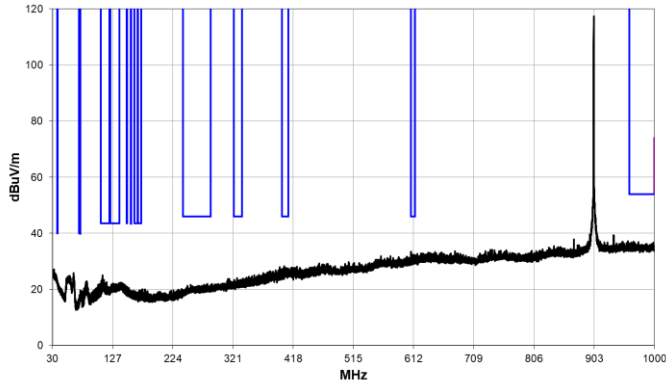
11.5 Test Equipment

<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
ESR 7	R&S	Spectrum Analyser	U727	2026-06-13
ESR26	R&S	EMI Receiver	U489	2025-11-05
LNA6901	AMETEK	Pre Amp	U711	2026-04-24
8449B	Agilent	Pre Amp	U457	2026-02-04
CBL611/A	Chase	Bilog	U191	2027-03-07
3115	EMCO	1-18GHz Horn	L139	2026-08-21
VHF-1500+	MiniCircuits	High Pass Filter	U519	2026-02-17

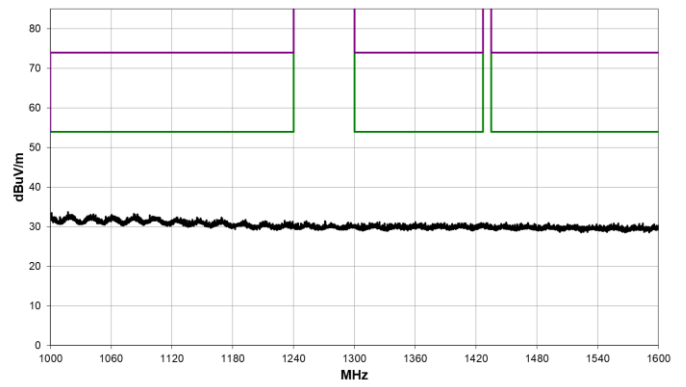
11.6 Test Results

Frequency: 902.3 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 125 kHz								
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Pk	2707.315	48.3	-1.9	0.0	0.0	46.4	54.0	-7.6

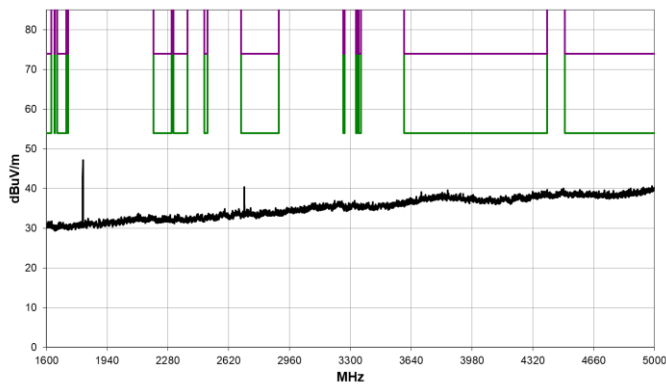
Where Peak level meets average limit by ≥ 3 dB peak only recorded



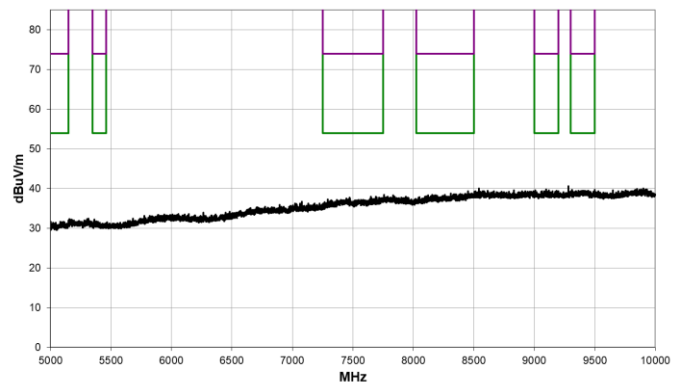
30 MHz – 1 GHz



1 GHz – 1.6 GHz



1.6 GHz – 5 GHz

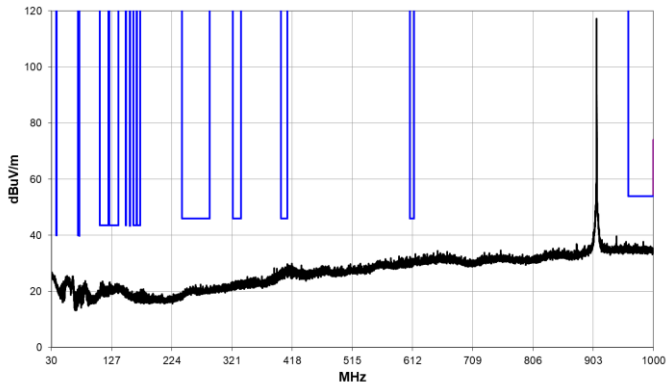


5 GHz – 10 GHz

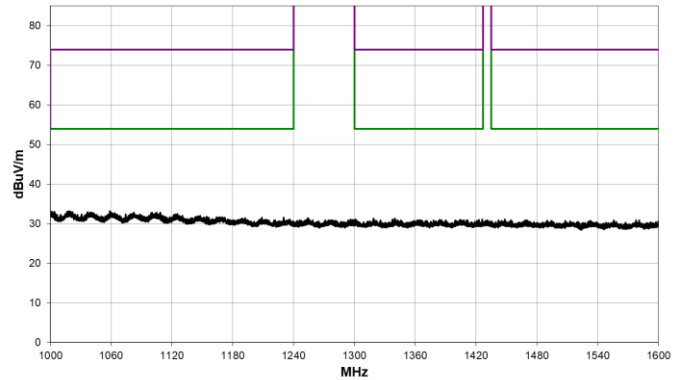
Frequency: 908.5 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 125 kHz

Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Pk	2725.691	47.8	-1.9	0.0	0.0	45.9	54.0	-8.1

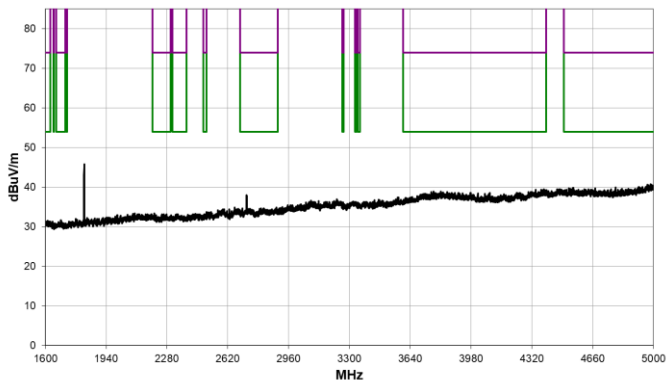
Where Peak level meets average limit by ≥ 3 dB peak only recorded



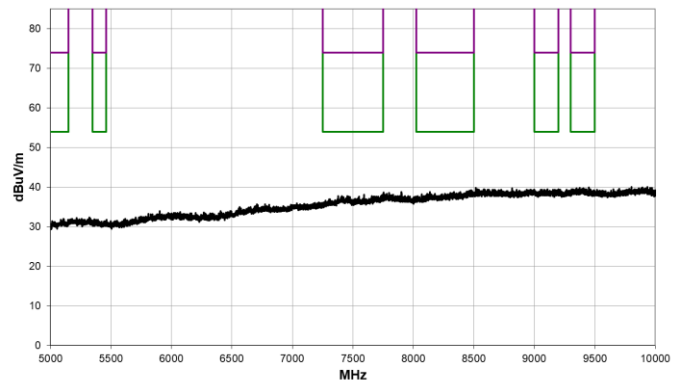
30 MHz – 1 GHz



1 GHz – 1.6 GHz



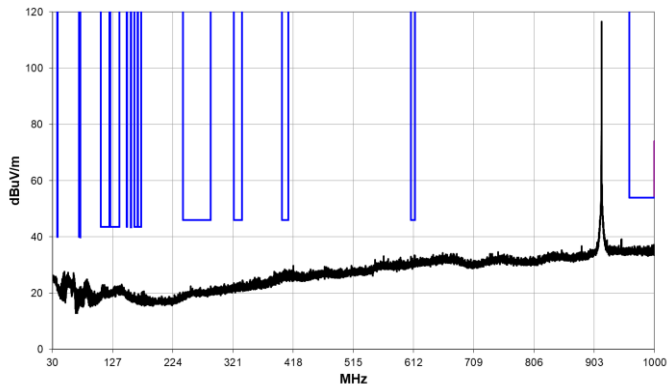
1.6 GHz – 5 GHz



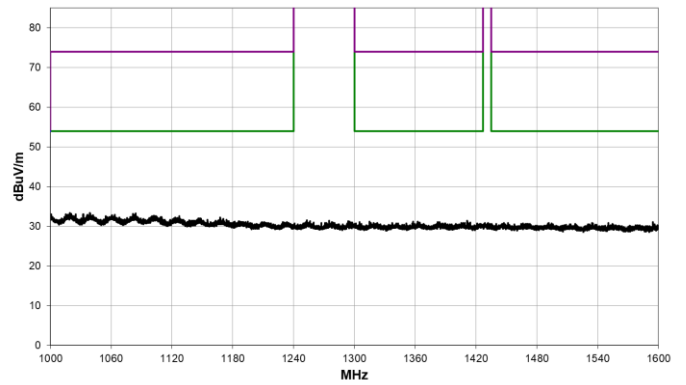
5 GHz – 10 GHz

Frequency: 914.9 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 125 kHz

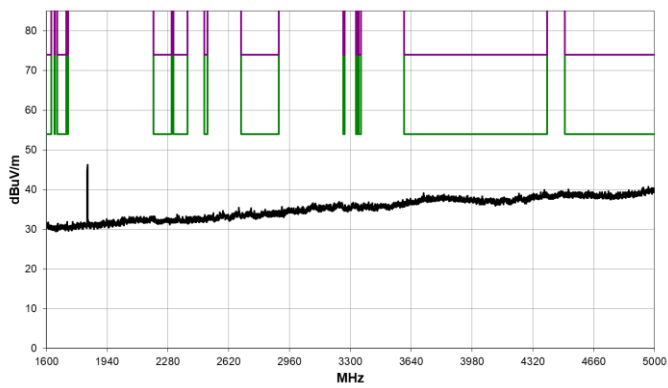
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
No Significant emissions within 20 dB of the limit								



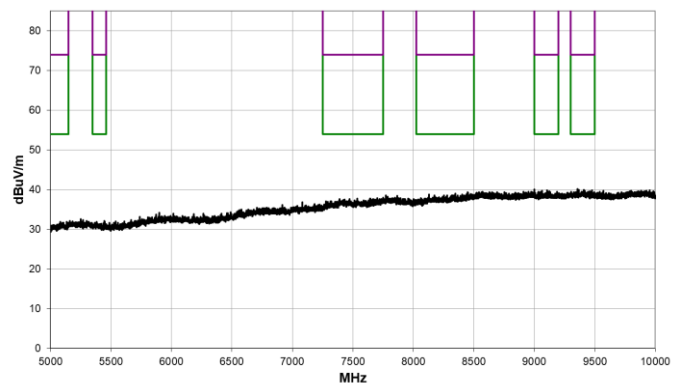
30 MHz – 1 GHz



1 GHz – 1.6 GHz



1.6 GHz – 5 GHz

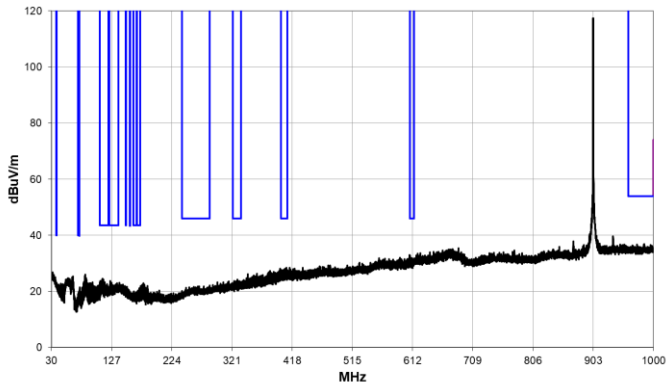


5 GHz – 10 GHz

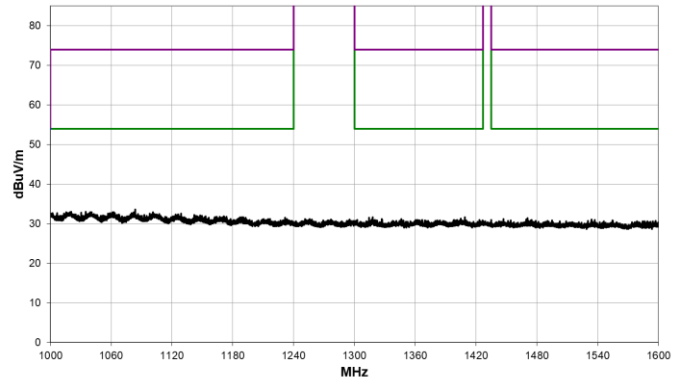
Frequency: 903.0 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 500 kHz

Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Pk	2708.948	49.1	-1.9	0.0	0.0	47.2	54.0	-6.8

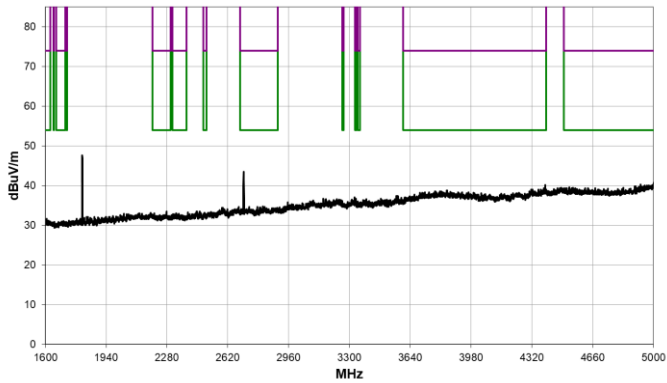
Where Peak level meets average limit by ≥ 3 dB peak only recorded



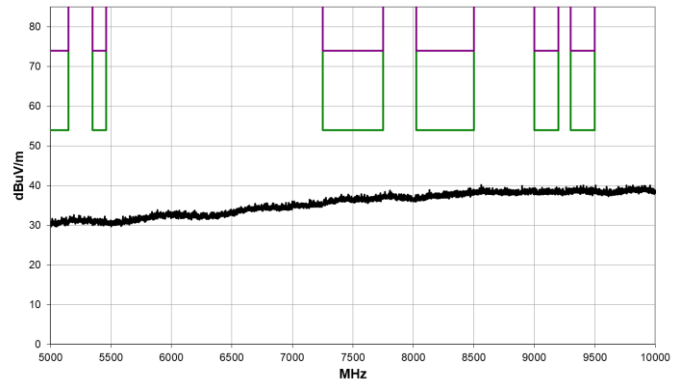
30 MHz – 1 GHz



1 GHz – 1.6 GHz



1.6 GHz – 5 GHz

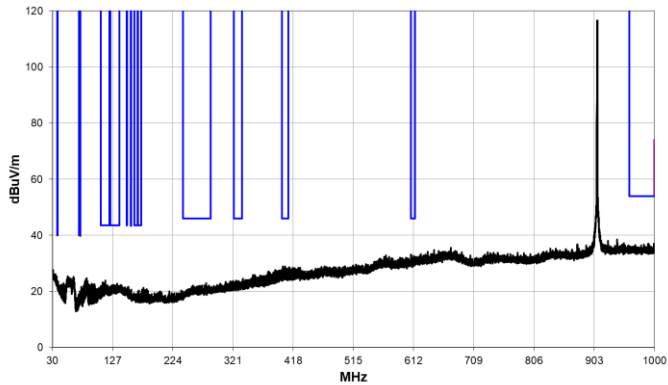


5 GHz – 10 GHz

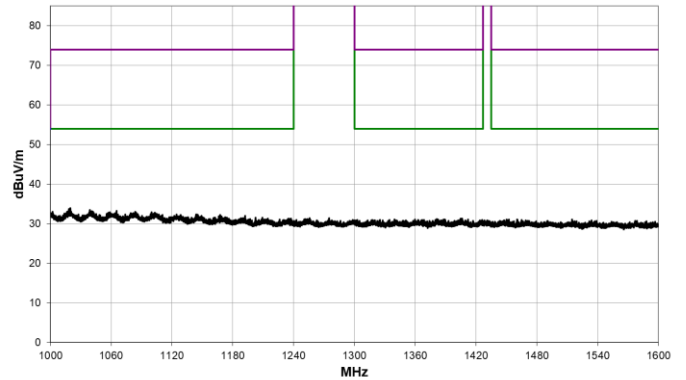
Frequency: 907.8 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 500 kHz

Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Pk	2723.484	48.1	-1.9	0.0	0.0	46.2	54.0	-7.8

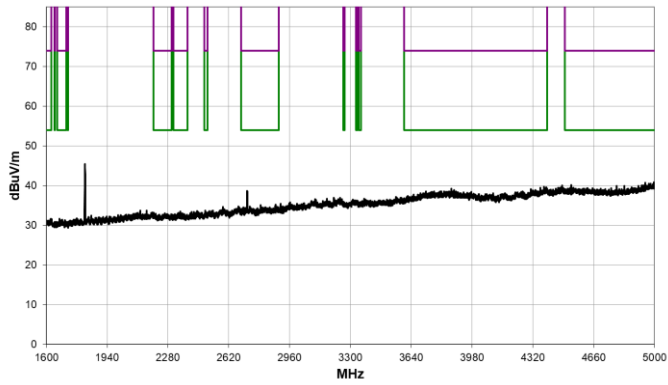
Where Peak level meets average limit by ≥ 3 dB peak only recorded



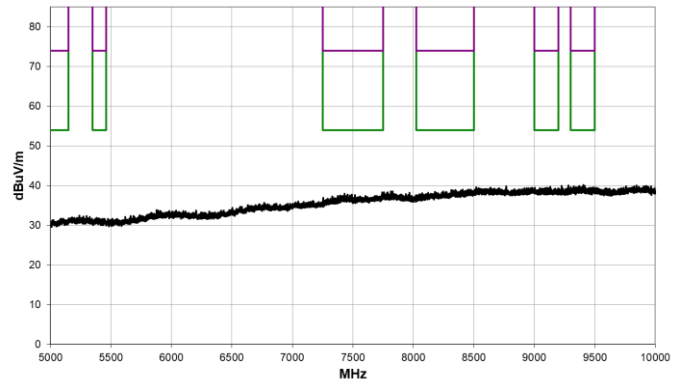
30 MHz – 1 GHz



1 GHz – 1.6 GHz



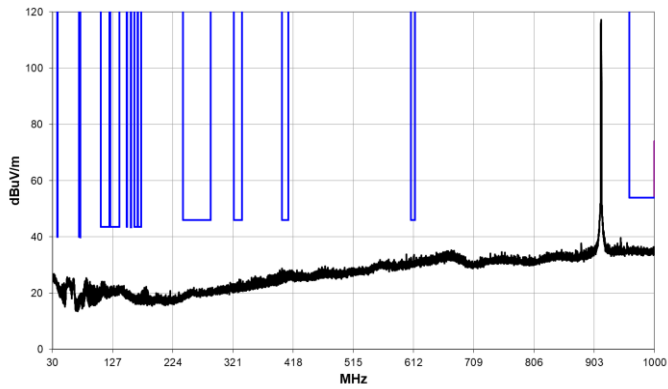
1.6 GHz – 5 GHz



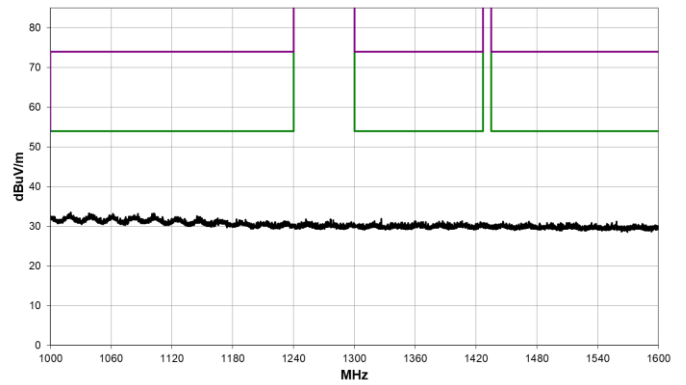
5 GHz – 10 GHz

Frequency: 914.2 MHz; Power Setting: 20dBm; Modulation: LoRa; Bandwidth: 500 kHz

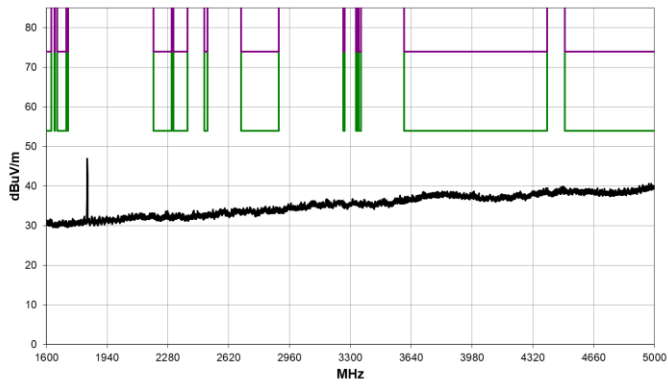
Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Factor (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
No Significant emissions within 20 dB of the limit								



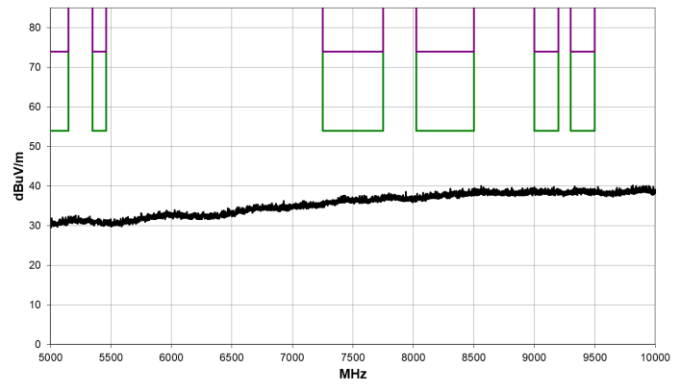
30 MHz – 1 GHz



1 GHz – 1.6 GHz



1.6 GHz – 5 GHz



5 GHz – 10 GHz

12 Maximum peak conducted output power

12.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The effective isotropic radiated power (EIRP) is defined as the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2020, Clause 11.9
EUT Channels / Frequencies Measured:	902.3 MHz / 908.5 MHz / 914.9 MHz 903.0 MHz / 907.8 MHz / 914.2 MHz
EUT Channel Bandwidths:	125 kHz / 500 kHz
Deviations From Standard:	None
Measurement BW:	5kHz / 10 kHz
Measurement Detector:	RMS
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 44 %RH	20 %RH to 75 %RH (as declared)

12.3 Test Limit

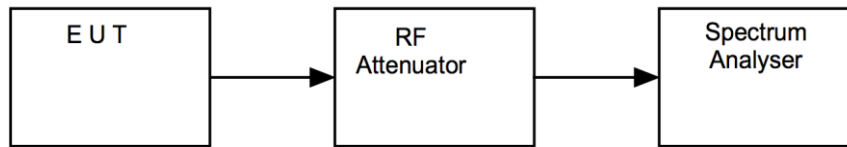
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

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

Figure iv Test Setup

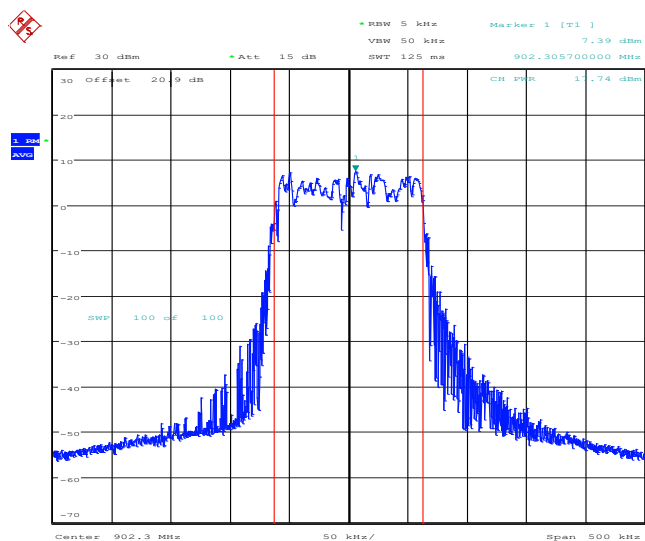


12.5 Test Equipment

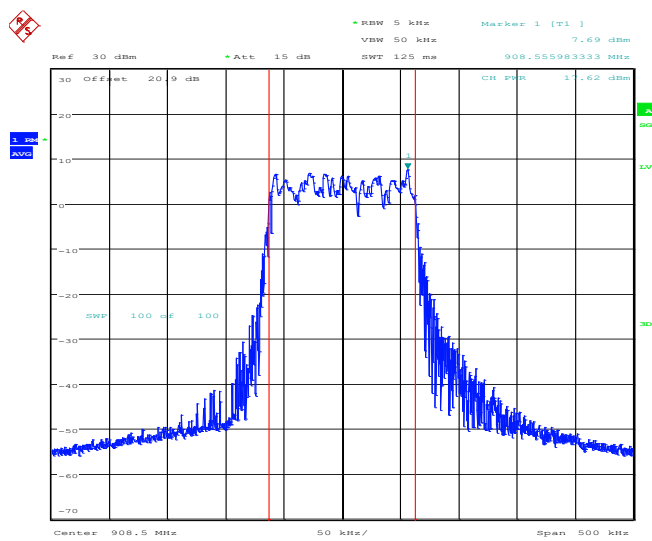
<i>Equipment Type</i>	<i>Manufacturer</i>	<i>Equipment Description</i>	<i>Element No</i>	<i>Due For Calibration</i>
FSU46	R&S	Spectrum Analyser	REF910	2026-02-27
1944 BW-N20 W5+	MCL	20 dB	UH715	Calibrate in Use
SMBV100A	R&S	Signal Generator	U674	2026-06-16

12.6 Test Results

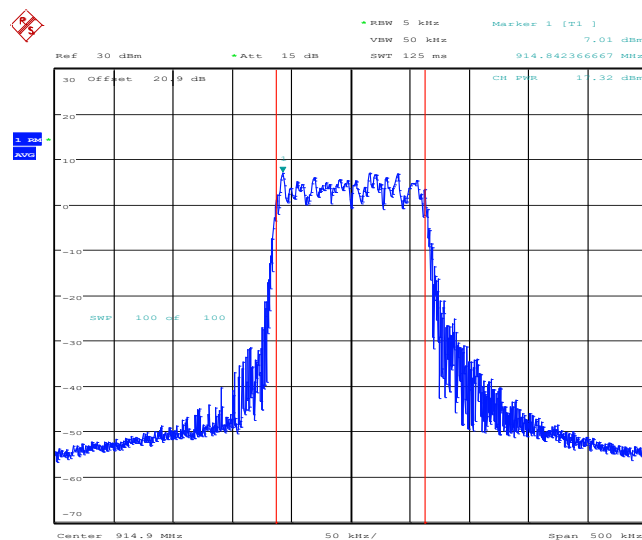
Modulation: LoRa ; Bandwidth: 125 kHz; Power setting: 20 dBm			
Frequency (MHz)	Maximum Average Conducted Output Power		Result
	(dBm)	(mW)	
902.3	17.74	59.43	Pass
908.5	17.62	57.81	Pass
914.9	17.32	53.95	Pass



902.3 MHz



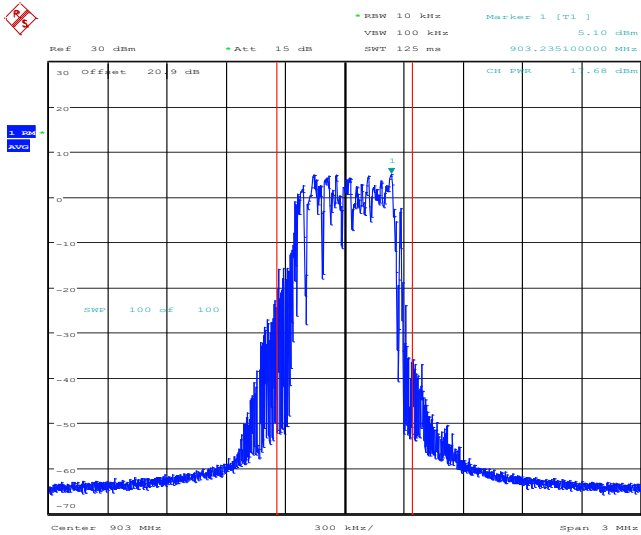
908.5 MHz



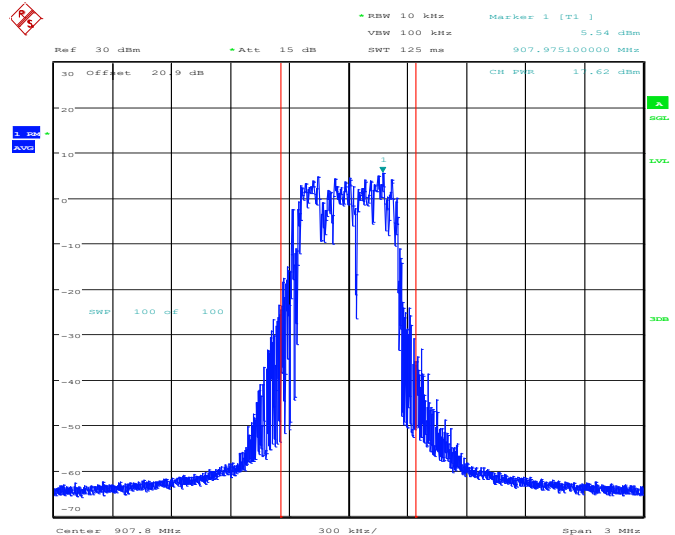
914.9 MHz

Modulation: LoRa ; Bandwidth: 500 kHz; Power setting: 20 dBm

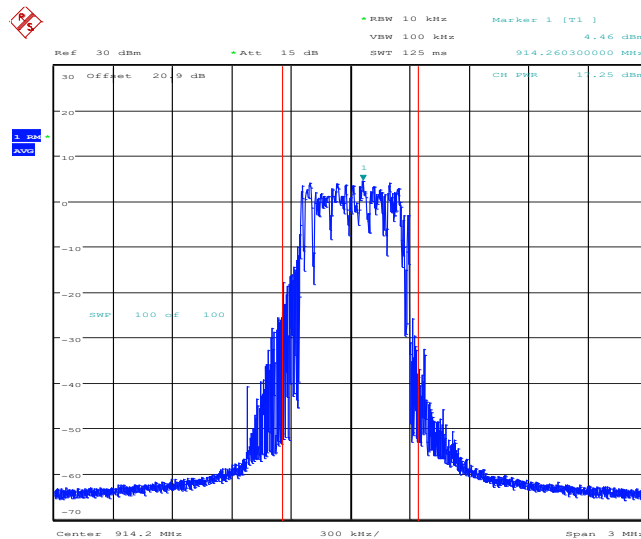
Frequency (MHz)	Maximum Average Conducted Output Power		Result
	(dBm)	(mW)	
903.0	17.68	58.61	Pass
907.8	17.62	57.81	Pass
914.2	17.25	53.09	Pass



903.0 MHz



907.8 MHz



914.2 MHz

13 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
Radiated Magnetic Field Emissions	MU4031	2.3 dB
Frequency Measurements		
Frequency Deviation	MU4022	3.7 kHz

Test/Measurement	Budget Number	MU
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
<i>Rohde & Schwarz TS8997</i>		
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 %
Adjacent Channel Selectivity / Receiver blocking (for bit streams)	MU4050	3.0 dB
Generated signal level: Channel Access Mechanism / DFS / Contention Based Protocol	MU4050	1.8 dB

14 RF Exposure

Overview

Human exposure to RF emissions from mobile devices (47 CFR §2.1091) may be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and/or power density, as appropriate, since exposures are assumed to occur at distances of 20 cm or more from persons. ANSI C95.1:2005 + Amd 1:2010 specifies a minimum separation distance of 20 cm for performing reliable field measurements to determine adherence to MPE limits. If the minimum separation distance between a transmitter and nearby persons is more than 20 cm under normal operating conditions, compliance with MPE limits may be determined at such distance from the transmitter. When applicable, operation instructions and prominent warning labels may be used to alert the exposed persons to maintain a specified distance from the transmitter or to limit their exposure durations and usage conditions to ensure compliance. If the use of warning labels on a transmitter is not effective or desirable, the alternative of performing SAR evaluation with the device at its closest range to persons under normal operating conditions may be used. The field strength and power density limits adopted by the FCC are based on whole-body averaged exposure and the assumption of RF field levels relate most accurately to estimating whole-body averaged SAR. This means some local values of exposures exceeding the stated field strength and power density limits may not necessarily imply non-compliance if the spatial average of spatially averaged RF fields over the exposed portions of a person's body does not exceed the limits.

COMPLIANCE WITH FCC 2.1091

47 CFR §1.1307

“(b)(1) Requirements. (i) With respect to the limits on human exposure to RF provided in §1.1310 of this chapter, applicants to the Commission for the grant or modification of construction permits, licenses or renewals thereof, temporary authorities, equipment authorizations, or any other authorizations for radiofrequency sources must either:

(A) Determine that they qualify for an exemption pursuant to §1.1307(b)(3);

(B) Prepare an evaluation of the human exposure to RF radiation pursuant to §1.1310 and include in the application a statement confirming compliance with the limits in §1.1310; or

(C) Prepare an Environmental Assessment if those RF sources would cause human exposure to levels of RF radiation in excess of the limits in §1.1310.

47 CFR §2.1091

“A mobile device is defined as a transmitting device 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 the RF source's radiating structure(s) and the body of the user or nearby persons. In this context, the term “fixed location” means that the device is physically secured at one location and is not able to be easily moved to another location while transmitting. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal desktop computer, are considered to be mobile devices if they meet the 20-centimeter separation requirement.”

The device will only be used with a separation distance between the antenna and the body of the user or nearby persons as shown in the table below and can therefore be considered a mobile transmitter per 47 CFR 2.1091(b).

COMPLIANCE WITH FCC KDB 447498 D01 General RF Exposure Guidance v06

"KDB 447498 D01 General RF Exposure Guidance v06" provides the procedures, requirements, and authorization policies for mobile and portable devices.

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously are covered in section 7.1.

Devices containing multiple transmitters capable of simultaneous transmissions are covered in section 7.2.

Limits for General Population /Uncontrolled Exposure: 47 CFR 1.1310

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 30	824/f	2.19/f	*(180/f ²)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500			f/1500	30
1500 - 100000			1	30

f = frequency in MHz

* = Plane-wave equivalent power density

Power Density

The exposure level for the radio is evaluated at a 20 cm distance from the radio's transmitting antenna using the general equation:

$$S = \frac{P * G}{4 * \pi * R^2}$$

Where: S = power density (mW/cm²)

P = power input to the antenna (mW)

G = numeric power gain relative to an isotropic radiator

R = distance to the center of the radiation of the antenna (20 cm = limit for MPE estimates)

P*G = EIRP

Solving for S, the maximum power density 20 cm from the transmitting antenna is determined. This level is then compared to the applicable limit for the transmit frequency. If limits were not met at the 20 cm boundary the evaluation distance is increased until the limit is met as shown in the table below.

For co-located radios, the ratio of the calculated level to the limit is determined. The ratios for each co-located radio are summed. If the sum is less than or equal to one, then the device is excluded from testing and is deemed compliant.

Assessment

The standalone MPE and summed MPE ratios are summarized in the following table(s):

Radio	Transmit Frequency (MHz)	Conducted Output Power	Power Tolerance (dB)	Duty Cycle	Antenna Assembly Gain (dBi)	Minimum Separation Distance (cm)	Power Density (mW/cm ²)	Limit (mW/cm ²)	Compliant
LoRa	902.3-914.9	20 dBm	0.0	100.0%	2.3	20	0.034	0.6	yes

The information in the table above was obtained from:

The rated value was used in these calculations. Rated Power (20 dBm as programmed)