

Report Number: TRA-066032-47-00B
Issue: B

Report on the Radio Testing of a
Tire Monitor System Ltd
Tyre pressure sensor
With Respect to Specification
FCC 47CFR 15.231

Test Date: 2024-12-10 to 2025-01-30

Tested by: D Winstanley

Written by:



p.p. S Garwell
Radio Test Engineer

Approved by:

Date: 2nd June 2025

J Charters
Lab Manager

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

RF960 8



1 Revision Record

<i>Issue</i>	<i>Issue Date</i>	<i>Revision History</i>
A	6th March 2025	Original
B	2nd June 2025	Confirmed Equipment calibration dates

2 Summary

Test Report Number:	TRA-066032-47-00B
Works Order Number:	TRA-066032-01
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:	47 CFR 15.231
Equipment Under Test (EUT):	Tyre pressure sensor
FCC Identifier:	TMITMS23F
EUT Serial Number:	00AE
Manufacturer:	Tire Monitor System Ltd
Address:	West Road House 26a West Road Buxton Derbyshire SK17 6HF United Kingdom
Client Contact:	Tim McLeman ☎ +44 (0) 1298 77166 ✉ tim.mcleman@tiremonitorsystem.com
Order Number:	PO15387
Test Date:	2024-12-10 to 2025-01-30
Tested By:	D Winstanley Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause 47 CFR15</i>	<i>Applicable to This Equipment</i>	<i>Result / Note</i>
Radiated Spurious Emissions	15.231(B) / 15.231(E)	☒	Pass
AC Power Line Conducted Emissions	15.207	☐	Note 2
Occupied Bandwidth	15.231(C)	☒	Pass
Field Strength of Fundamental	15.231(B) / 15.231(E)	☒	Pass
Periodic Operation	15.231(A) / 15.231(E)	☒	Pass

Specific notes:

Note 2: The EUT is battery operation only.

General notes:

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

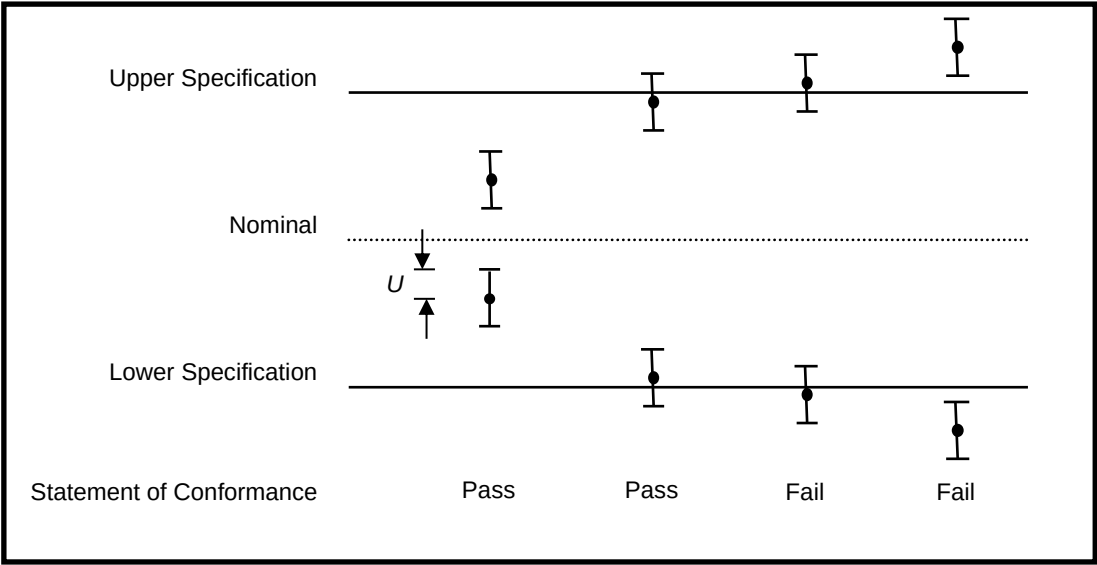
The apparatus was set-up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

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

The decision rule for compliance is inherent within this specification. The measured value related to the corresponding limit is used to decide whether an equipment meets the requirements of the test specification.

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	6
4	Introduction.....	7
5	Test Specifications	8
5.1	Normative References	8
5.2	Deviations from Test Standards	8
6	Glossary of Terms	9
7	Equipment under Test	10
7.1	EUT Identification	10
7.2	System Equipment.....	10
7.3	EUT Mode of Operation.....	10
7.3.1	Transmission	10
7.4	EUT Radio Parameters.....	10
7.4.1	General.....	10
7.5	EUT Description.....	10
8	Modifications.....	11
9	EUT Test Setup	12
9.1	Block Diagram	12
9.2	General Set-up Photograph	12
9.3	Measurement Software.....	13
10	General Technical Parameters	14
10.1	Normal Conditions	14
10.2	Varying Test Conditions.....	14
11	Radiated emissions	15
11.1	Definitions.....	15
11.2	Test Parameters	15
11.3	Test Method.....	16
11.4	Test Equipment.....	18
11.5	Test Results.....	19
12	Occupied Bandwidth.....	20
12.1	Definition.....	20
12.2	Test Parameters	20
12.3	Test Method.....	21
12.4	Test Equipment.....	21
12.5	Test Results.....	21
13	Transmitter field strength	22
13.1	Definition.....	22
13.2	Test Parameters	22
13.3	Test Method.....	23
13.4	Test Equipment.....	23
13.5	Test Results.....	24
14	Periodic operation.....	25
14.1	Definition.....	25
14.2	Test Parameters	25
14.3	Test Method.....	26
14.4	Test Equipment.....	26
14.5	Test Results.....	27
15	Measurement Uncertainty.....	29
16	RF Exposure.....	32
16.1	General SAR test reduction & exclusion guidance	32

4 Introduction

This report TRA-066032-47-00B presents the results of the Radio testing on a Tire Monitor System Ltd, Tyre pressure sensor to specifications 47 CFR Part 15 Radio Frequency Devices.

The testing was carried out for Tire Monitor System Ltd by Element, at the address detailed below.

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

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are 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 validation requirements of ANSI C63.4-2014 amended as per ANSI C63.4a-2017 are met up to 1 GHz.

The test site SVSWR validation 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: Tyre pressure sensor
- Serial Number: 00AE
- Model Number: TMS23Axx
- Software Revision: 3
- Build Level / Revision Number: Pre-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

7.3.1 Transmission

The mode of operation for Transmitter tests was as follows:

The EUT was transmitting a modulated carrier on the frequencies as indicated.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	433.920 MHz
Modulation type:	FM
Occupied channel bandwidth:	100 kHz
ITU emission designator:	F1D
Declared output power:	-30 dBm
Nominal Supply Voltage:	3.6 Vdc from a Lithium Thionyl Chloride 1/10 C (coin cell)
Duty cycle:	0.05% under normal conditions
Antenna Type:	Antenna is integral in the TMS sensor

7.5 EUT Description

The EUT is a Tire Pressure Monitor containing a 433 MHz radio.

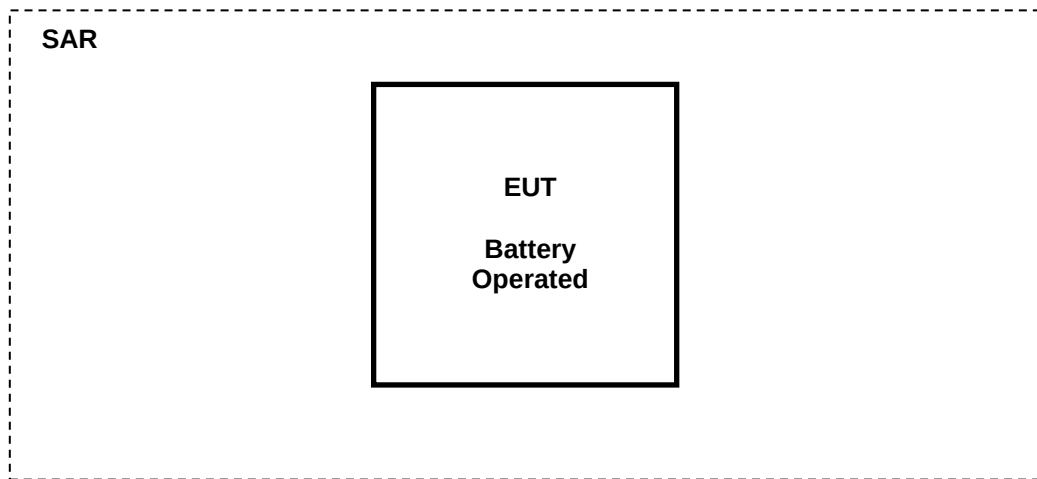
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

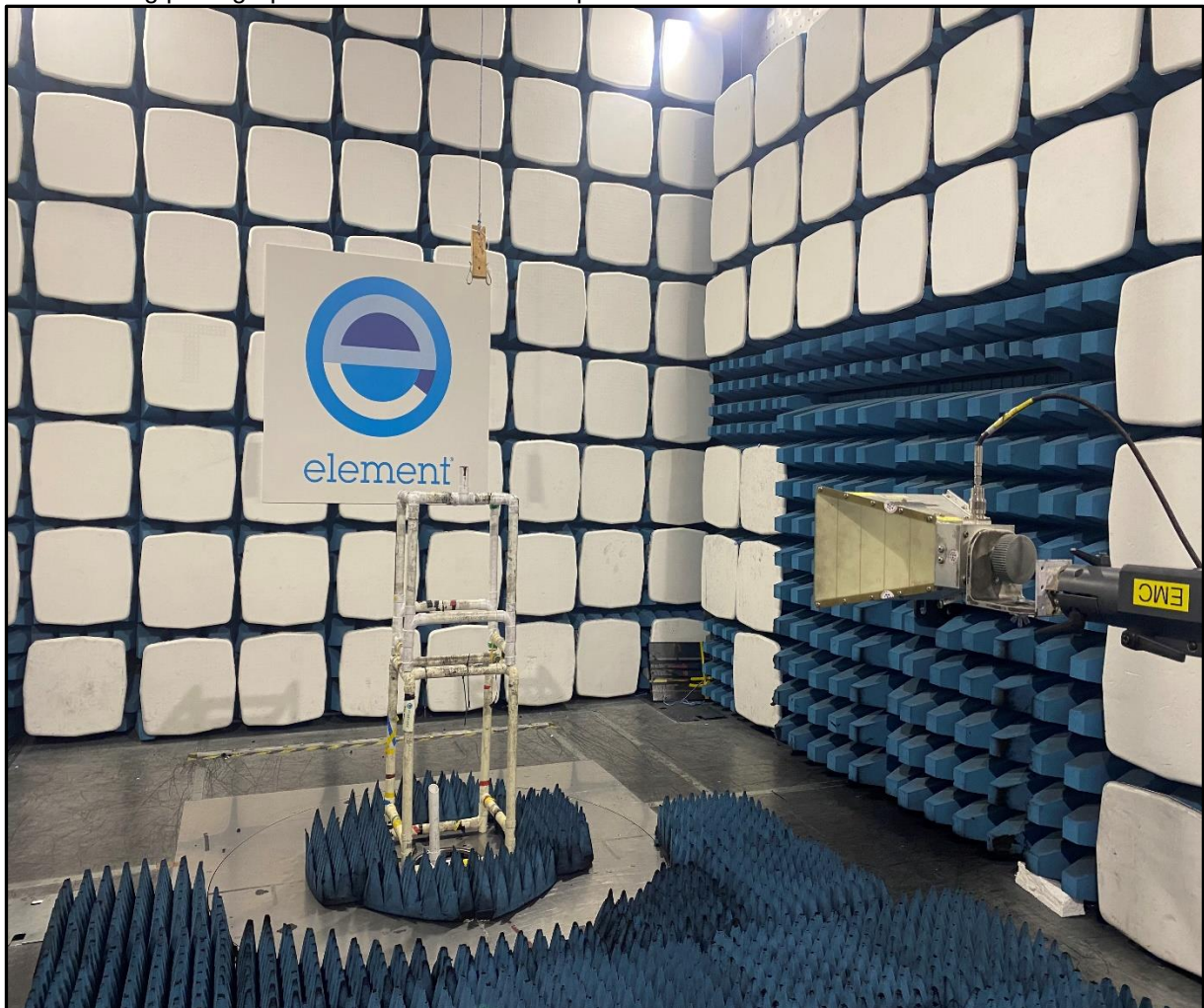
9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph 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 3.6 Vdc from a Lithium Thionyl Chloride 1/10 C (coin cell).

10.2 Varying Test Conditions

No testing at extremes was undertaken during this assessment.

11 Radiated emissions

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:	Chamber 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequencies Measured:	433.920 MHz
EUT Channel Bandwidths:	100 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: 17 °C	+15 °C to +35 °C (as declared)
Humidity: 42% RH	20% RH to 75% RH (as declared)
Supply: 3.6 Vdc	3.6 Vdc (as declared)

Test Limits

Emissions 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 at frequencies above 30 MHz

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

Per FCC 47CFR15.35(b) / ISSED RSS-Gen 8.1, where an average measurement is specified, the peak limit is 20 dB above the average limit.

11.3 Test Method

With the EUT setup as per section 9 of this report and connected as per the test set-up figure below, the emissions from the EUT were measured on a spectrum analyser / 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 / diagrams 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;

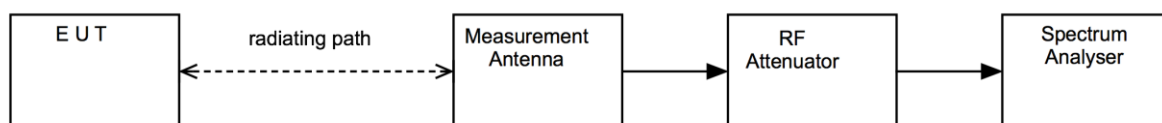
PA is the pre-amplifier gain in dB (where used);

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 different to limit distance);

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

Test Set-up



Test Setup Photograph(s)



30 MHz to 1 GHz



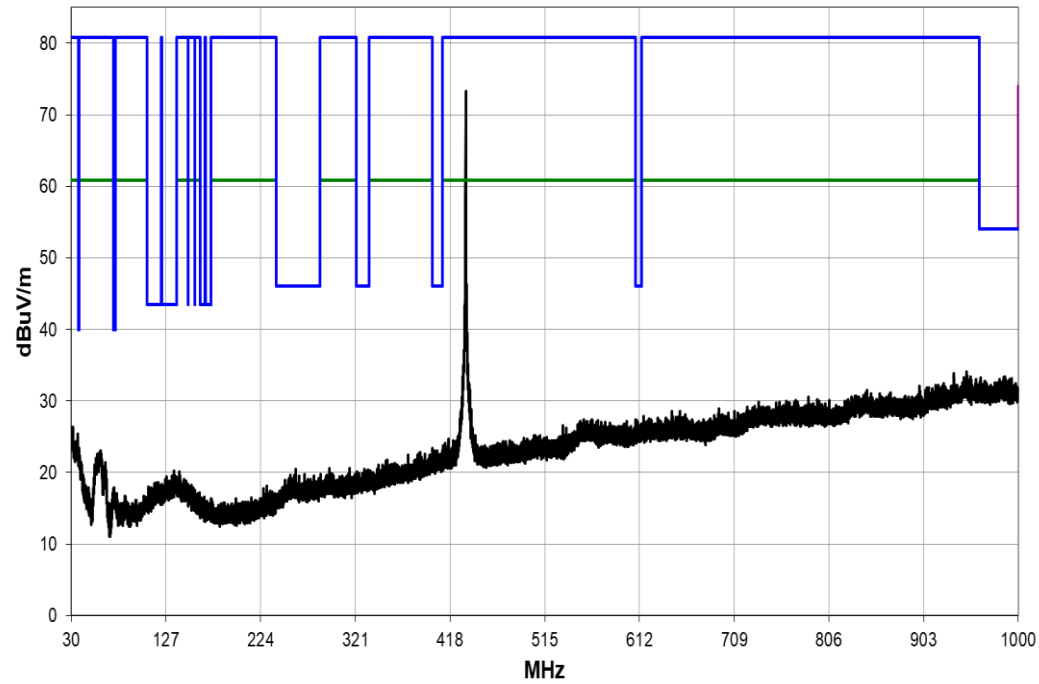
Above 1 GHz

11.4 Test Equipment

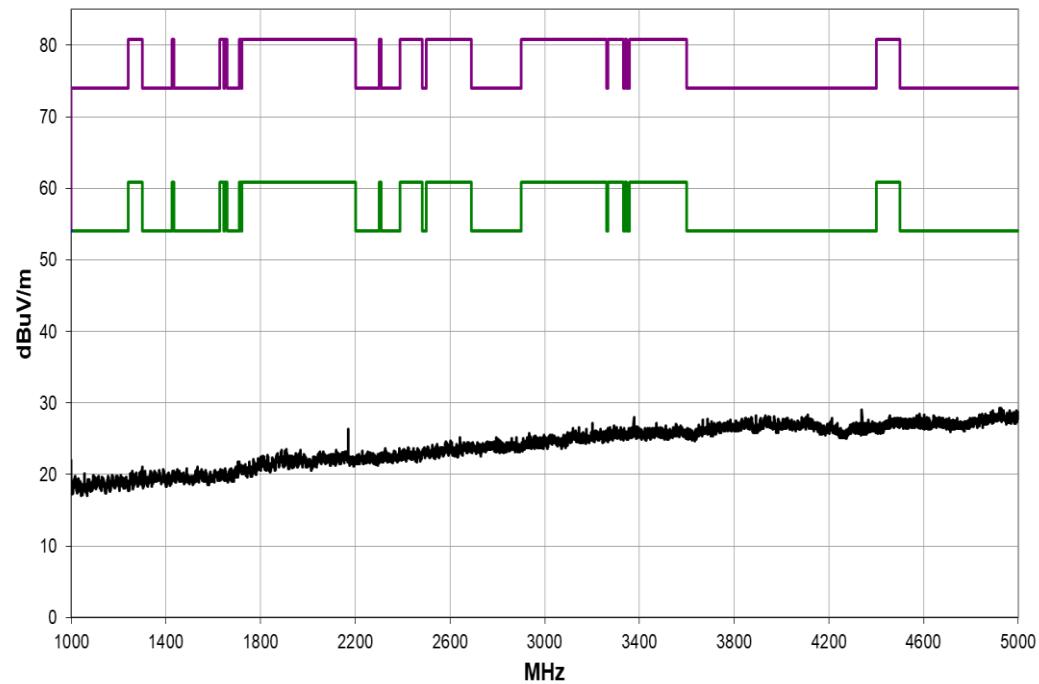
<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	ESR 7	U727	2025-05-17
Bilog	Chase	CBL611/A	U191	2025-08-11
Pre Amp	AMETEK	LNA6901	U711	2025-04-11
Horn Antenna	EMCO	3115	L138	2026-06-11
Pre Amp	Agilent	8449B	U457	2025-01-26
Chamber 1	Rainford EMC	ATS	U387	2026-01-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal Not Required

11.5 Test Results

Frequency: 433.92 MHz; Modulation: FSK; Power setting: Default



30 MHz to 1 GHz



1 GHz to 5 GHz

Frequency: 433.92 MHz; Modulation: FSK; Power setting: Default				
Detector	Emission Frequency (MHz)	Emission Field Strength (dBµV/m at 3 m)	Field Strength Limit (dBµV/m at 3 m)	Result
No significant emissions within 20 dB of the limit				Pass

12 Occupied Bandwidth

12.1 Definition

Occupied bandwidth

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

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.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequency Measured:	433.920 MHz
EUT Channel Bandwidths:	100 kHz
EUT Test Modulations:	FSK
Deviations From Standard:	None
Measurement BW: (requirement: 1% to 5% OBW)	2 kHz
Spectrum Analyzer Video BW: (requirement at least 3 x RBW)	30 kHz
Measurement Span: (requirement 2 to 5 times OBW)	200 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 39% RH	20% RH to 75% RH (as declared)
Supply: 3.6 Vdc	3.6 Vdc (as declared)

Test Limits

ISED RSS-210:

The 99% bandwidth of momentarily operated devices shall be less or equal to 0.25% of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the 99% bandwidth shall be less or equal to 0.5% of the centre frequency.

FCC 47 CFR 15.231:

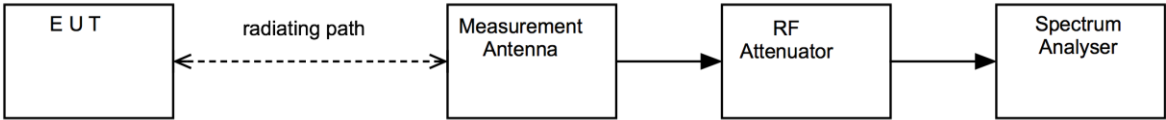
The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

12.3 Test Method

With the EUT setup as per section 9 of this report and connected as per the test set-up figure below, 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.

Test Set-up

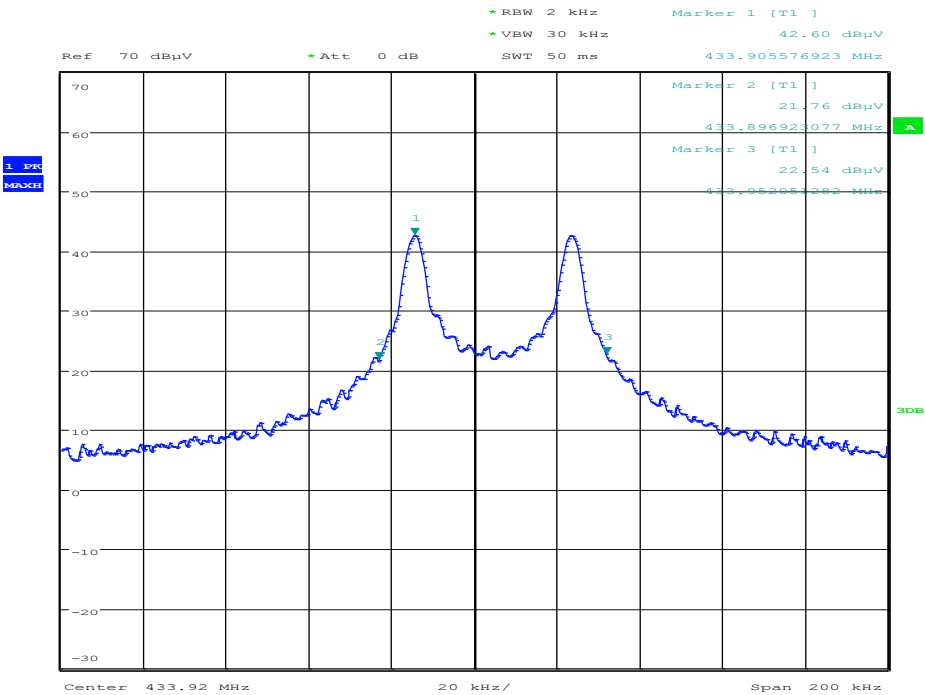


12.4 Test Equipment

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

12.5 Test Results

47 CFR 15.231; Modulation: FSK; Power setting: Default			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20dB Bandwidth (kHz)
433.920	433.896923077	433.952051282	55.128



Date: 10.MAR.2003 00:52:03

20 dB OCBW

13 Transmitter field strength

13.1 Definition

The fundamental signal field strength at a defined distance from the EUT.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Chamber 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 / 6.6
EUT Frequency Measured:	433.920 MHz
EUT Channel Bandwidths:	100 kHz
Deviations From Standard:	None
Measurement BW:	200 kHz
Spectrum Analyzer Video BW: (requirement at least 3 x RBW)	1 MHz
Measurement Detector:	Up to 1 GHz: Quasi-peak Above 1 GHz: Average RMS and Peak

Environmental Conditions (Normal Environment)

Temperature: 17 °C	+15 °C to +35 °C (as declared)
Humidity: 42 % RH	20% RH to 75% RH (as declared)

Test Limits

ISED RSS-210 A1.2 & FCC 47 CFR 15.231(b)

The field strength of emissions from momentarily operated intentional radiators shall not exceed the limits outlined in the table 'permissible field strength limits for momentarily operated devices', below, based on the average value of the measured emissions. The requirements of the Pulsed Operation section of RSS-Gen / 47 CFR 15.35 apply for averaging pulsed emissions and limiting peak emissions.

Alternatively, compliance with the limits in the table below may be demonstrated using a CISPR quasi-peak detector.

Permissible Field Strength Limits for Momentarily Operated Devices

Fundamental frequency (MHz)	Field strength ($\mu\text{V/m}$ at 3m)	Region
40.66 – 40.70	2250	USA only
70 – 130	1250	USA and Canada
130 – 174	1250 to 3750*	USA and Canada
174 – 260	3750	USA and Canada
260 – 470	3750 to 12500*	USA and Canada
Above 470	12500	USA and Canada

* Linear interpolation with frequency, f, in MHz:
 For 130-174 MHz: Field Strength ($\mu\text{V/m}$) = $(56.81818 \times f) - 6136.3636$
 For 260-470 MHz: Field Strength ($\mu\text{V/m}$) = $(41.6667 \times f) - 7083.3333$

ISED RSS-210 A1.5 & FCC 47 CFR 15.231(e)

Devices not meeting the requirements in the table 'permissible field strength limits for momentarily operated devices' above shall comply with the requirements outlined in the table 'reduced field strength limits for momentarily operated devices', below.

Reduced Field Strength Limits for Momentarily Operated Devices

Fundamental frequency (MHz)	Field strength (µV/m at 3m)	Region
40.66 – 40.70	1000	USA only
70 – 130	500	USA and Canada
130 – 174	500 to 1500*	USA and Canada
174 – 260	1500	USA and Canada
260 – 470	1500 to 5000*	USA and Canada
Above 470	5000	USA and Canada

* Linear interpolation with frequency, f, in MHz:

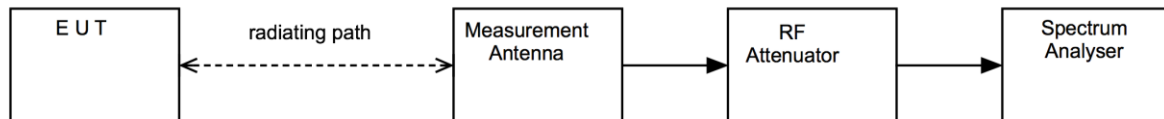
For 130-174 MHz: Field Strength (µV/m) = $(22.72727 \times f) - 2454.555$

For 260-470 MHz: Field Strength (µV/m) = $(16.6667 \times f) - 2833.3333$

13.3 Test Method

With the EUT setup as per section 9 of this report and connected as the test set-up figure below, 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.

Test Set-up**13.4 Test Equipment**

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	ESR 7	U727	2025-05-17
Bilog	Chase	CBL611/A	U191	2025-08-11
Pre Amp	AMETEK	LNA6901	U711	2025-04-11
Chamber 1	Rainford EMC	ATS	U387	2026-01-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal Not Required

13.5 Test Results

<i>Modulation: FSK; Power setting: Default</i>								
<i>Freq</i>	<i>Amplitude</i>	<i>Factor</i>	<i>Test</i>	<i>Detector</i>	<i>Adjusted</i>	<i>Spec.</i>	<i>Compared to</i>	<i>Result</i>
<i>(MHz)</i>	<i>(dBuV)</i>	<i>(dBm)</i>	<i>Distance</i>		<i>(dBuV/m)</i>	<i>Limit</i>	<i>Spec.</i>	
			<i>(meters)</i>			<i>(dBuV/m)</i>	<i>(dB)</i>	
433.920	71.9	-3.3	3	QP	68.6	72.9	-4.3	Pass

14 Periodic operation

14.1 Definition

The Transmission Period is the total time during which the transmitter emits a signal or sequence of signals. The Silent Period is the time between successive Transmission Periods.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.4
Frequency Measured:	433.92 MHz
Channel loading:	Maximum
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 38 % RH	20% RH to 75% RH (as declared)

Test Limits

47 CFR 15.231(e)

Following are the requirements for devices with reduced field strengths:

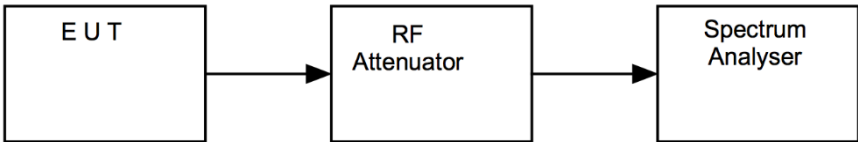
- (b) In addition, devices operated under the provisions of this section shall be capable of automatically limiting their operation so that the duration of each transmission is not greater than 1 second and the silent period between transmissions is at least 30 times the duration of the transmission, but not less than 10 seconds under any circumstances. However, devices that are designed for limited use for the purpose of initial programming, reprogramming or installing, and not for regular operations, may operate for up to 5 seconds, provided such devices are used only occasionally in connection with each unit being programmed or installed.

14.3 Test Method

With the EUT setup as per section 9 of this report and connected as per the test set-up figure below, the RF spectrum from the EUT was observed.

The measurements were performed when the EUT detected a change in pressure to indicate a change in state.

Test Set-up

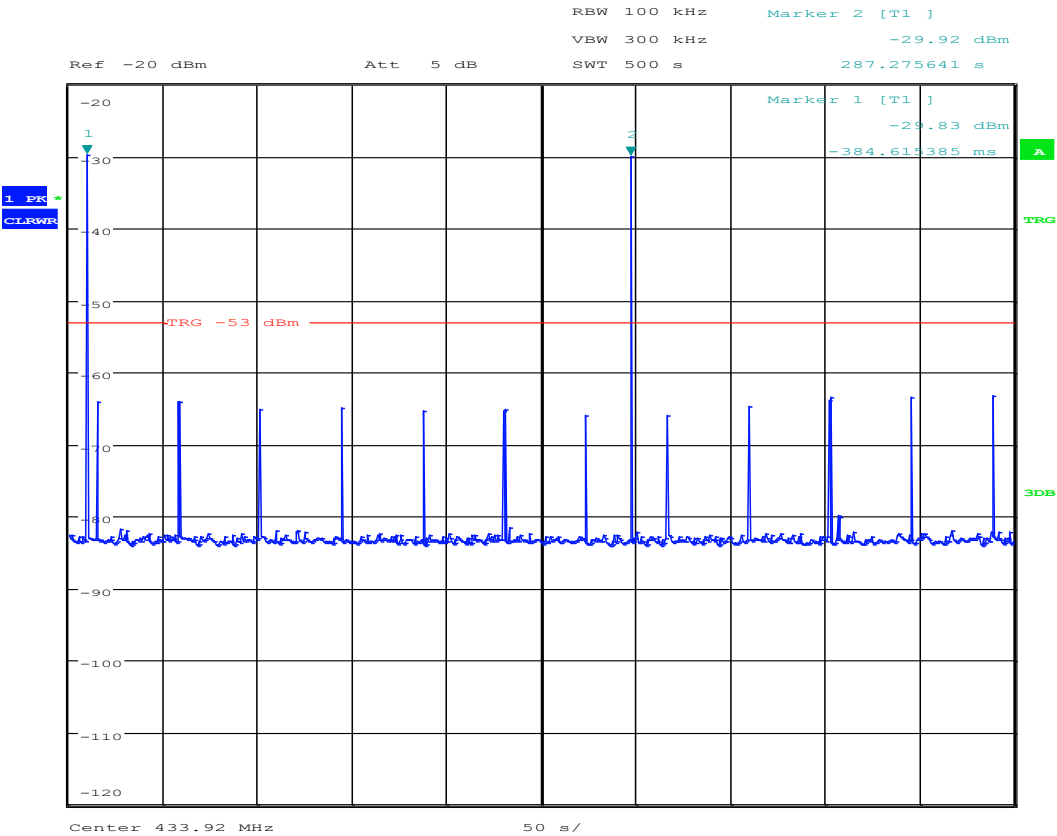


14.4 Test Equipment

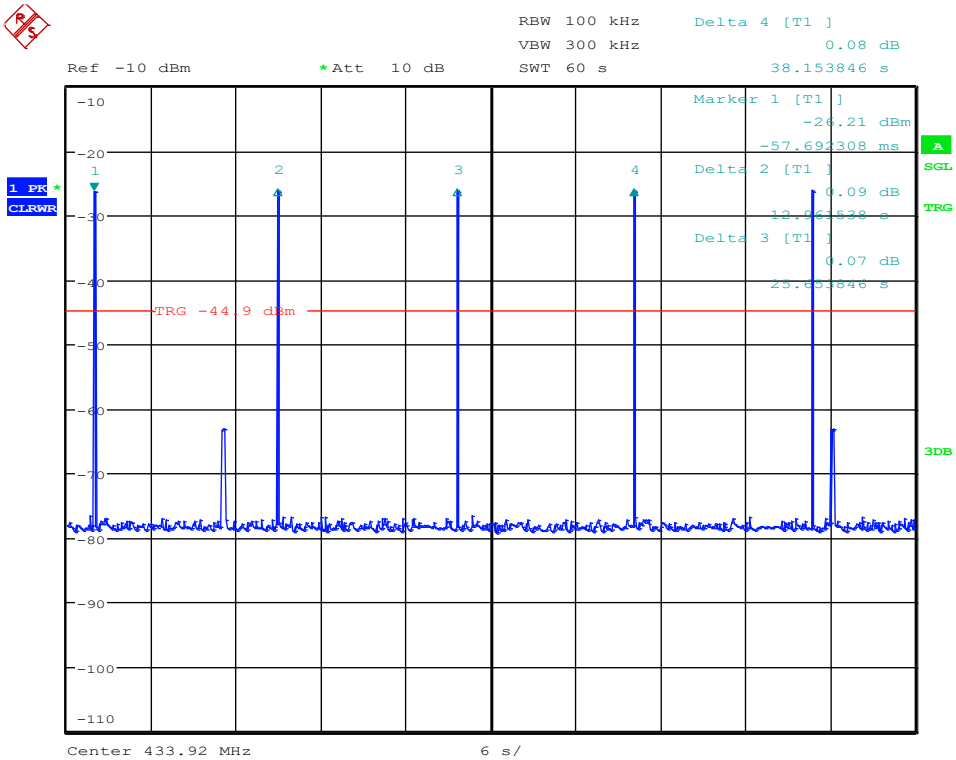
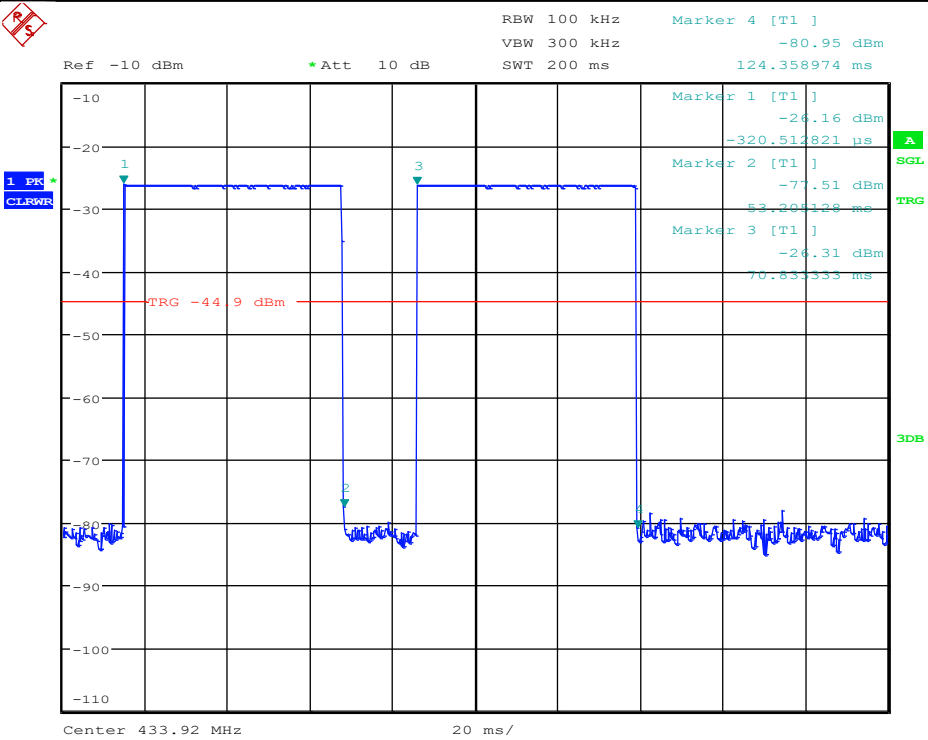
Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU26	REF909	2025-09-24

14.5 Test Results

Supervision Transmissions						
Test Environment		Frequency (MHz)	Observation Period (s)	Supervision Transmission (s)	Limit (s)	Result
V _{nominal}	T _{nominal}	433.92	500	287.276	1	Pass



Change of state (Pressure) timings						
Frequency (MHz)	Observation Period (s)	Single Transmission Time (ms)	Number of transmissions During change of state	Total TX Time during change of state (s)	Limit (s)	Result
433.92	6	106.72	5	0.533	1	Pass



15 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

Test/Measurement	Budget Number	MU
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
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 %
Receiver blocking (for bit streams)	MU4050	3.0 dB
Channel Access Mechanism / Adaptivity / DFS / Contention Based Protocol	MU4050	1.8 dB

16 RF Exposure

16.1 General SAR test reduction & exclusion guidance

KDB 447498

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 in the range 100 MHz to 6 GHz, and for test separation distance of ≤ 50 mm, is determined as follows.

$$\text{SAR Exclusion Threshold (SARET)} = (\text{NT} \times \text{TSD}_A) / \sqrt{f_{\text{GHz}}}$$

Where,

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

TSD_A = Minimum Test separation distance or 50 mm (whichever is lower)

f_{GHz} = Transmit frequency in GHz

<i>Channel Frequency (MHz)</i>	<i>Maximum Conducted Power (mW)</i>	<i>SAR Exclusion Threshold at 5 mm (mW)</i>	<i>SAR Evaluation</i>
433.920	0.00217	22.8	Not Required

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