Report on the Radio Testing

For

Pet Mate Ltd

on

MiBowl+ (CP501)

Report no. TRA-059540-47-02B

03rd August 2023

Report Number: TRA-059540-47-02B
Issue: B

REPORT ON THE RADIO TESTING OF A
Pet Mate Ltd
MiBowl+ (CP501)
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.209

TEST DATE: 2022-09-20 to 2022-09-21

Tested by: Steven Garwell
Radio Test Engineer

Approved by: Daniel Winstanley
Senior Radio Engineer

Digitally signed by D Winstanley
DN: cn=D Winstanley, o=Element, ou=Radio, email=daniel.winstanley@element.com, c=US
Date: 2023.08.03 15:06:52 +01'00'

Date: 03rd August 2023

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	9th June 2023	Original
B	03rd August 2023	Update FCC ID page 4 and module information page 10

2 Summary

TEST REPORT NUMBER:	TRA-059540-47-02B
WORKS ORDER NUMBER	TRA-059540-00
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 SPECIFICATION:	47CFR 15.209
EQUIPMENT UNDER TEST (EUT):	MiBowl+ (CP501)
FCC IDENTIFIER:	RDY-CP50Z
EUT SERIAL NUMBER:	Test Sample S1
MANUFACTURER/AGENT:	Pet Mate Ltd
ADDRESS:	7-8 Lyon Road Hersham Surrey KT12 3PU
CLIENT CONTACT:	Mike Sankey ☎ 07841827055 ✉ mikes@pet-mate.com
ORDER NUMBER:	1238
TEST DATE:	2022-09-20 to 2022-09-21
TESTED BY:	Steven Garwell Element

2.1 Test Summary

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

Notes:

Note 1: The EUT is battery powered only.

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).

3 Contents

4 Introduction

This report TRA-059540-47-02B presents the results of the Radio testing on a Pet Mate Ltd, MiBowl+ (CP501) to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Pet Mate Ltd by Element, at the address detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

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

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

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

Element Hull	UK2007
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	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment under Test

7.1 EUT Identification

- Name: MiBowl+ (CP501)
- Serial Number: Test Sample S1
- Model Number: CP501
- Software Revision: V5.1.1
- Build Level / Revision Number: Rev-02

7.2 Pre-Approved Module Identification

- Manufacturer: ESPRESSIF SYSTEMS (SHANGHAI). CO., LTD.
- Model Number: ESP32S2WROOM
- FCCID: RDY-CP50Y

7.3 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.

7.4 EUT Mode of Operation

7.4.1 Transmission

The mode of operation for Transmitter tests was as follows:

The EUT was transmitting on the frequencies as indicated.

7.5 EUT Radio Parameters

7.5.1 General

Frequency of operation:	125 kHz & 134 kHz
Modulation type(s):	AM-PSK / AM-FSK
Warning against use of alternative antennas in user manual (yes/no):	No
Nominal Supply Voltage:	6 V dc (via 4 x C type batteries)

Frequency of operation (pre-approved module):	2.412GHz – 2.462GHz
Modulation type(s):	QPSK
Nominal Supply Voltage:	6Vdc from Battery

7.5.2 Antennas

Type:	Custom made antenna (13 turns of 28 swg)

7.6 EUT Description

The EUT is an IoT enabled pet feeding device, which works with RFID. The lid is opened when a RFID tag is detected. When no RFID tag is detected, the lid is closed. Events relating to pet RFID identification are communicated to mobile application devices.

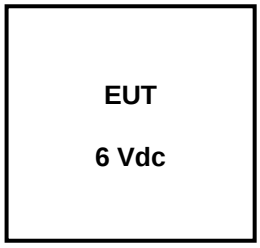
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

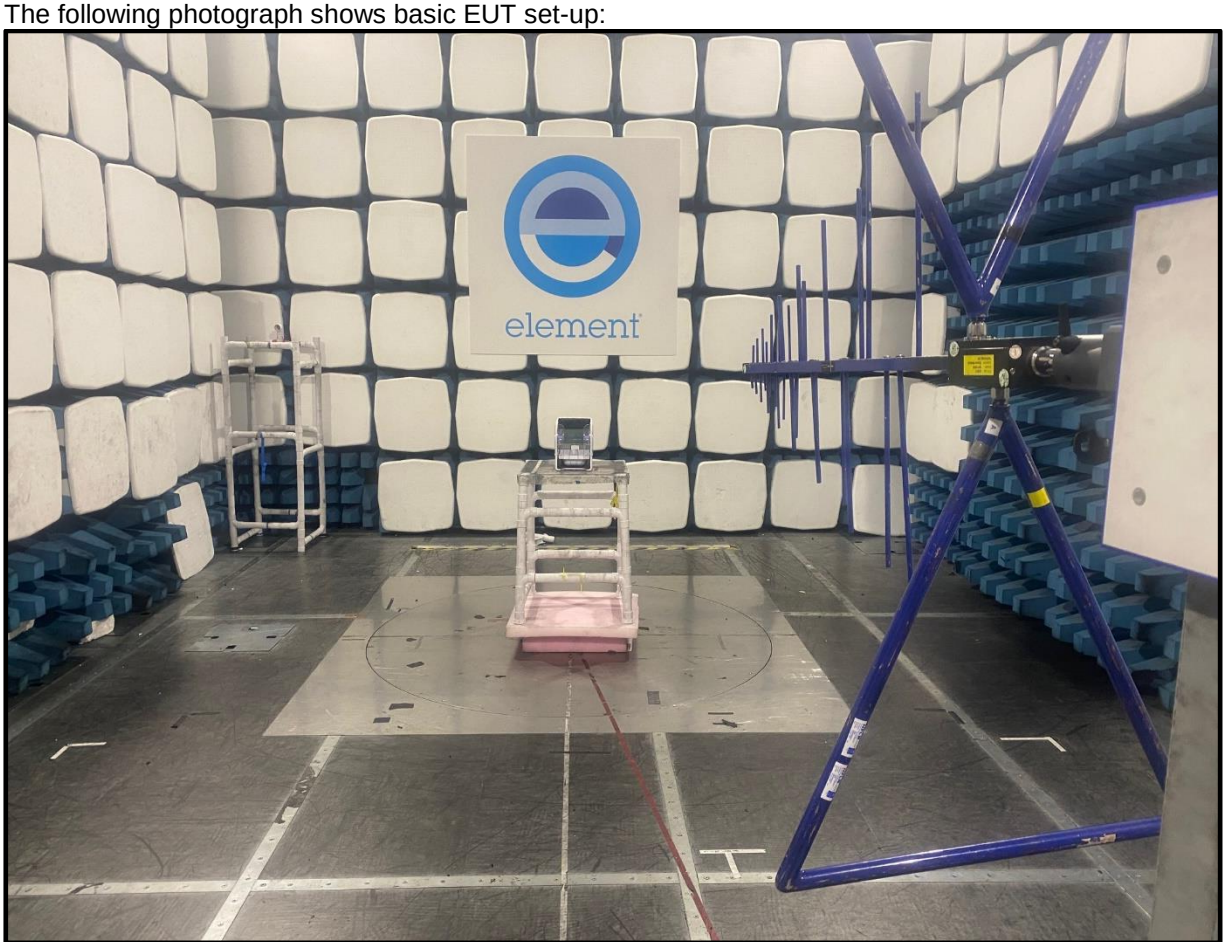
9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



9.3 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5 (See Note)
Element Transmitter Bench Test (See Note)
ETS Lindgren EMPower V1.0.4.2

Note:

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

General Technical Parameters

9.4 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 6 Vdc from 4 x C type batteries.

9.5 Varying Test Conditions

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

	Category	***Nominal***	***Variation***
☐	Power supply	12 Vdc	-
☒	Battery	New battery	N/A

10 Radiated emissions below 30 MHz

10.1 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.

10.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Chamber 01
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Frequencies Measured:	125 kHz, 134 kHz
Deviations From Standard:	None
Measurement Distance and Site	3 m
EUT Height:	1 m
Measurement Antenna and Height:	60 cm shielded loop; 1 m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 6.Vdc	6.Vdc (as declared)

10.3 Test Limit

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

Frequency, f (kHz)	*Field Strength*	*Measurement Distance (m)*
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.

10.4 Test Method

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

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 9 kHz RBW.

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

Emissions between 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

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

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

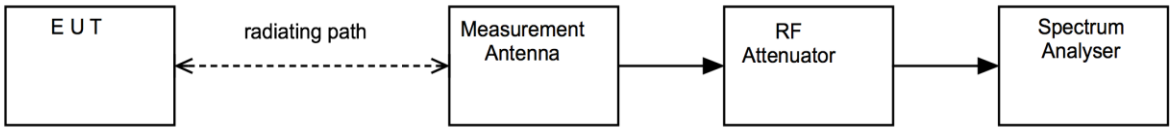
Where,

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

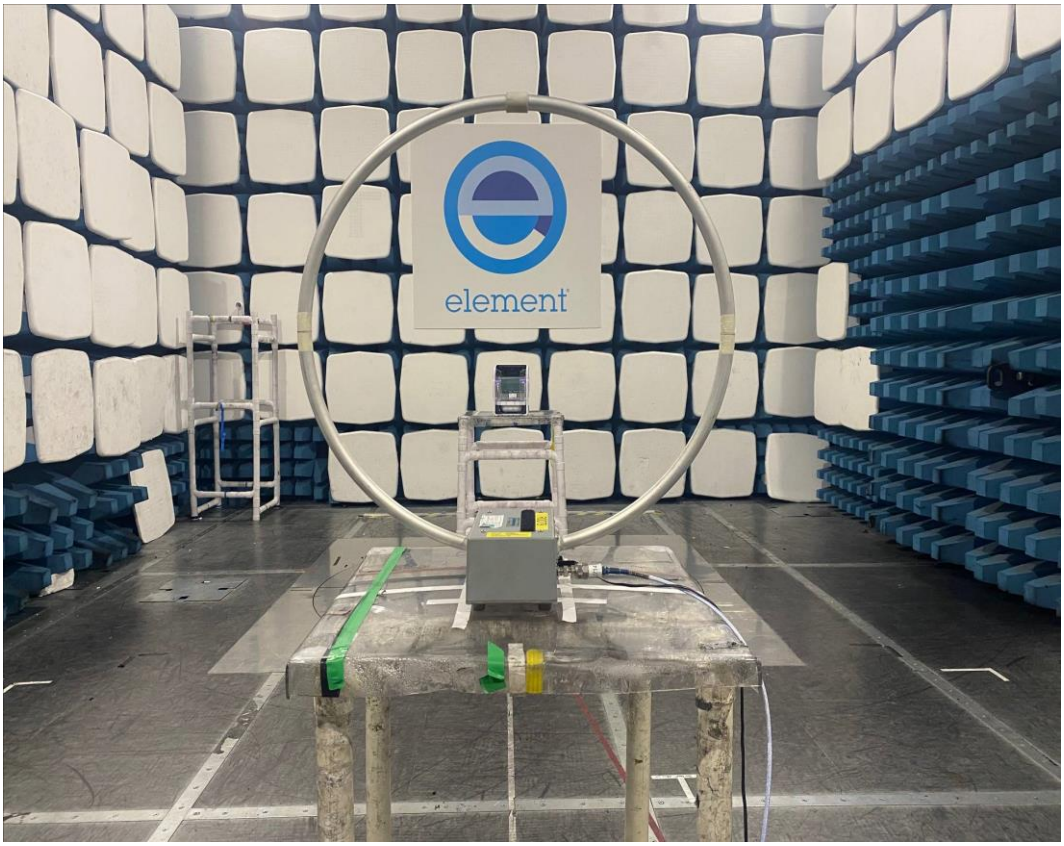
Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure i Test Setup



10.5 Test Set-up Photograph

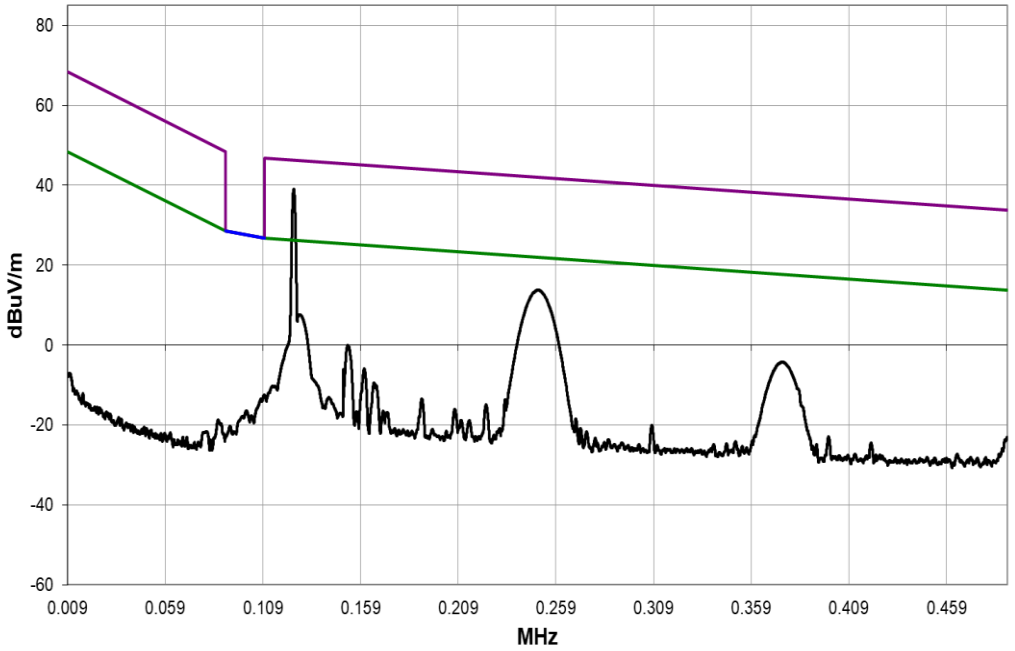


10.6 Test Equipment

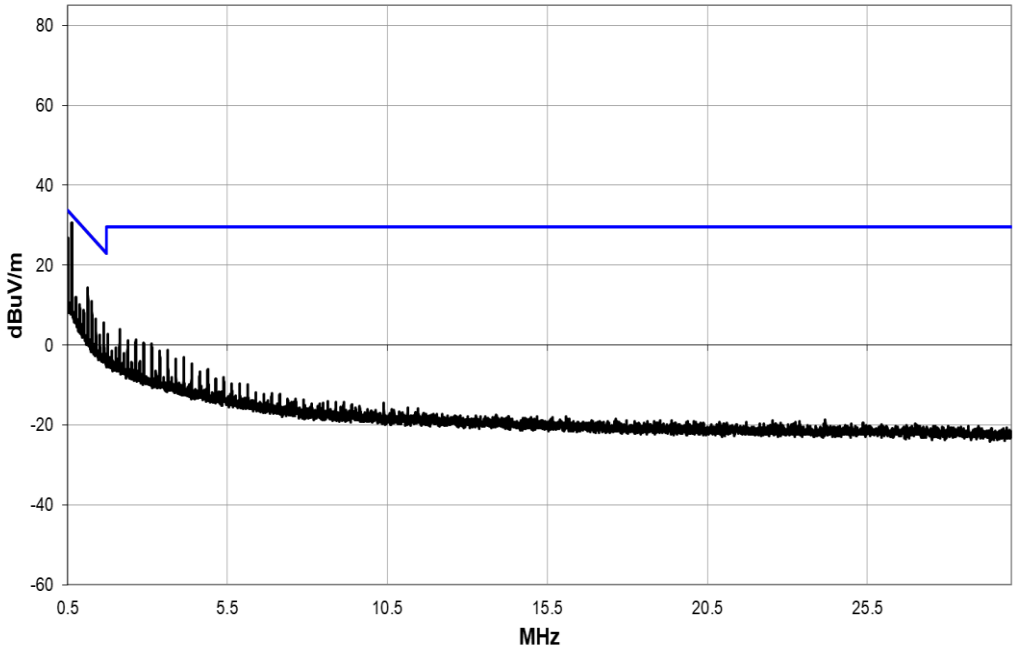
Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
EMI Receiver	R&S	ESR7	U456	2023-01-25
Active Loop Antenna	EMCO	6502	R0079	2023-06-16
Chamber 1	Rainford EMC	ATS	U387	2023-10-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

10.7 Test Results

Frequency: 125 kHz



9 kHz to 490 kHz

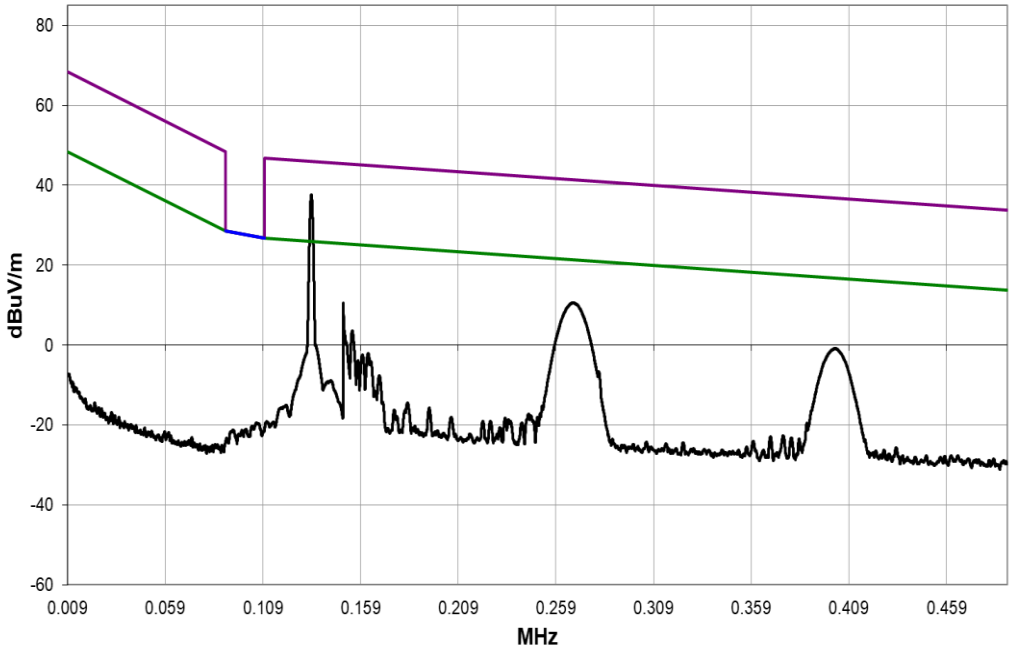


490 kHz to 30 MHz

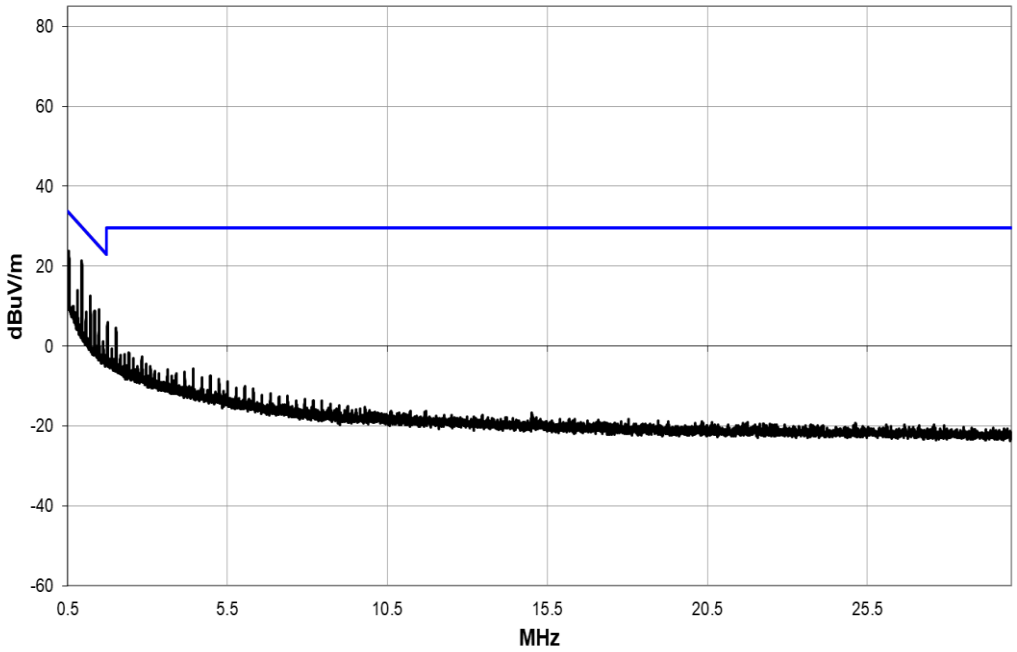
Freq (MHz)	Amplitude (dBuV)	Factor (dB/m)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
0.250	83.3	10.3	1.0	172.1	3.0	0.0	Horz	AV	-80.0	13.6	19.7	-6.1

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)
0.627	58.1	10.5	1.0	172.1	3.0	0.0	Horz	QP	-40.0	28.6	31.7	-3.1
0.503	53.6	10.4	1.0	171.1	3.0	0.0	Horz	QP	-40.0	24.0	33.6	-9.6

Frequency: 134 kHz



9 kHz to 490 kHz



490 kHz to 30 MHz

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)
0.268	80.1	10.4	1.0	169.1	3.0	0.0	Horz	AV	-80.0	10.5	19.1	-8.6

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)
0.941	48.7	10.5	1.0	162.1	3.0	0.0	Horz	QP	-40.0	19.2	28.2	-9.0
0.539	51.1	10.5	1.0	166.1	3.0	0.0	Horz	QP	-40.0	21.6	33.0	-11.4

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 01
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequencies Measured:	125 kHz, 134 kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 300 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)
Supply: 6 Vdc	6 Vdc (as declared)

11.3 Test Limit

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

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

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

11.4 Test Method

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

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

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

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

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

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

$$FS = PR + CL + AF – PA + DC – CF$$

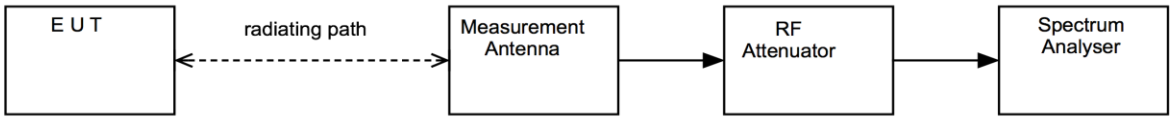
$$Factor = CL + AF – PA$$

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 is different to limit distance);

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

Figure ii Test Setup



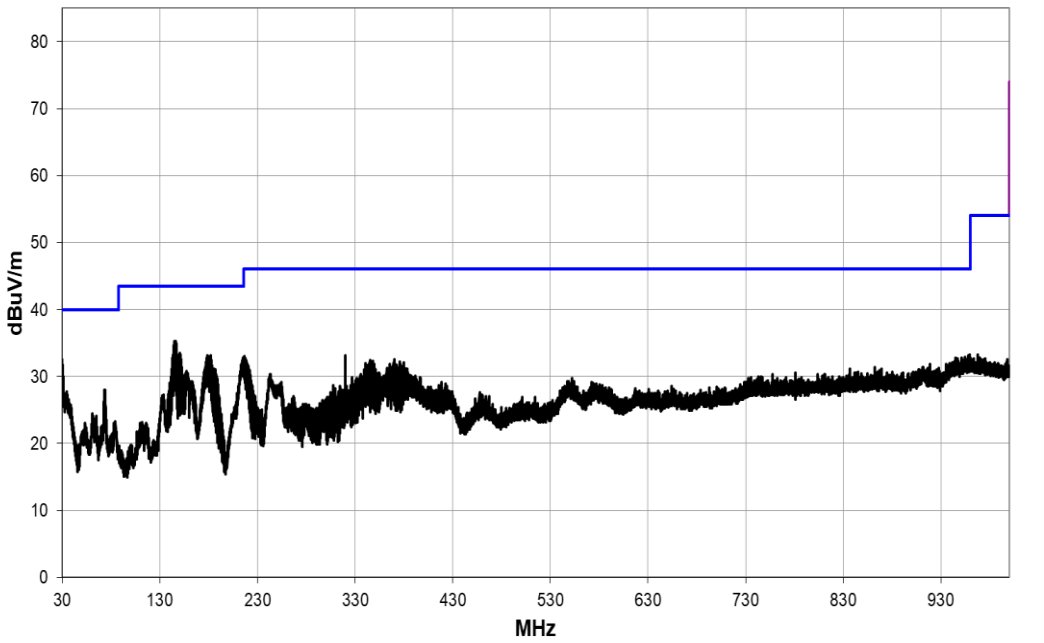
11.5 Test Set-up Photograph

11.6 Test Equipment

Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
EMI Receiver	R&S	ESR7	U456	2023-01-25
Bilog	Chase	CBL611/A	L290	2023-03-24
Pre Amp	AMETEK	LNA6901	U711	2023-03-14
Chamber 1	Rainford EMC	ATS	U387	2023-10-24
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

11.7 Test Results

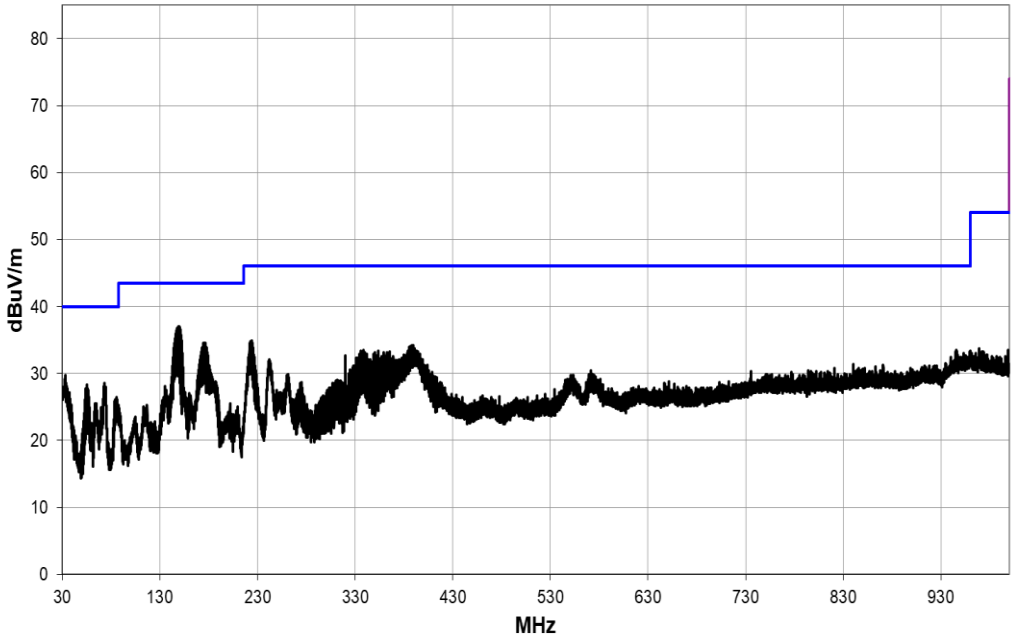
Frequency: 125 kHz



30 MHz to 1 GHz

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)
146.518	44.4	-10.2	1.0	178.1	3.0	0.0	Vert	QP	0.0	34.2	43.5	-9.3
145.018	43.5	-10.1	1.0	160.1	3.0	0.0	Vert	QP	0.0	33.4	43.5	-10.1
30.137	33.4	-3.8	1.03	236.1	3.0	0.0	Vert	QP	0.0	29.6	40.0	-10.4
146.770	43.0	-10.2	1.0	181.2	3.0	0.0	Vert	QP	0.0	32.8	43.5	-10.7
150.523	41.7	-10.5	1.0	176.9	3.0	0.0	Vert	QP	0.0	31.2	43.5	-12.3
178.521	43.0	-12.3	1.0	158.9	3.0	0.0	Vert	QP	0.0	30.7	43.5	-12.8
182.279	42.1	-12.3	1.0	176.1	3.0	0.0	Vert	QP	0.0	29.8	43.5	-13.7
320.023	38.7	-7.7	1.5	150.8	3.0	0.0	Vert	QP	0.0	31.0	46.0	-15.0
345.270	37.2	-7.0	1.0	1.1	3.0	0.0	Horz	QP	0.0	30.2	46.0	-15.8
30.138	27.8	-3.8	1.0	70.9	3.0	0.0	Horz	QP	0.0	24.0	40.0	-16.0
375.014	36.0	-6.3	1.0	228.1	3.0	0.0	Horz	QP	0.0	29.7	46.0	-16.3

Frequency: 134 kHz



30 MHz to 1 GHz

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)
149.033	45.8	-10.3	1.0	177.9	3.0	0.0	Vert	QP	0.0	35.5	43.5	-8.0
150.910	45.7	-10.5	1.0	189.9	3.0	0.0	Vert	QP	0.0	35.2	43.5	-8.3
147.694	45.4	-10.2	1.0	197.8	3.0	0.0	Vert	QP	0.0	35.2	43.5	-8.3
176.369	46.8	-12.2	1.0	166.1	3.0	0.0	Vert	QP	0.0	34.6	43.5	-8.9
174.494	46.3	-12.0	1.0	166.8	3.0	0.0	Vert	QP	0.0	34.3	43.5	-9.2
145.817	43.7	-10.1	1.0	199.8	3.0	0.0	Vert	QP	0.0	33.6	43.5	-9.9
152.251	41.9	-10.6	1.0	165.0	3.0	0.0	Vert	QP	0.0	31.3	43.5	-12.2
148.498	41.4	-10.3	1.5	85.0	3.0	0.0	Horz	QP	0.0	31.1	43.5	-12.4
338.781	38.9	-7.1	1.0	358.0	3.0	0.0	Horz	QP	0.0	31.8	46.0	-14.2
387.960	37.5	-5.8	1.0	2.2	3.0	0.0	Horz	QP	0.0	31.7	46.0	-14.3
353.657	38.1	-6.8	1.03	214.9	3.0	0.0	Horz	QP	0.0	31.3	46.0	-14.7
365.582	37.7	-6.4	1.0	228.8	3.0	0.0	Horz	QP	0.0	31.3	46.0	-14.7

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.

20 dB bandwidth
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequencies Measured:	125 kHz, 134 kHz
EUT Test Modulations:	AM-PSK / AM-FSK
Deviations From Standard:	None
Measurement BW: (Irequirement: 1% to 5% OBW)	1 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	10 kHz
Measurement Span: (requirement 2 to 5 times OBW)	10 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 52 % RH	20 % RH to 75 % RH (as declared)
Supply: 6 Vdc	6 Vdc (as declared)

12.3 Test Limit

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

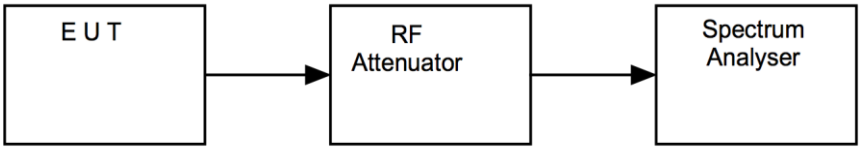
Federal Communications Commission:
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise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

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the bandwidth of the EUT was measured on a spectrum analyser.

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

Figure iv Test Setup

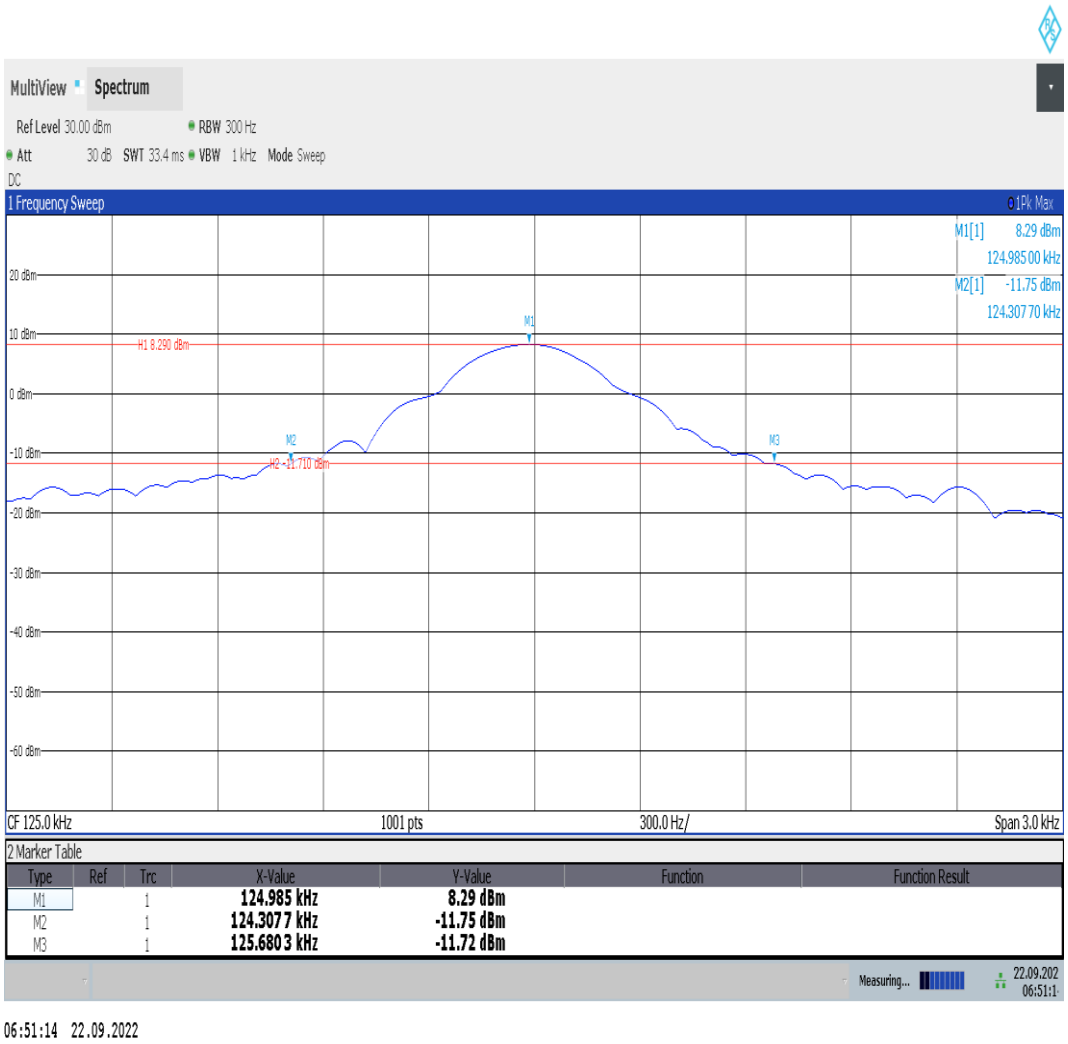


12.5 Test Equipment

Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSW 43	U728	2023-04-26

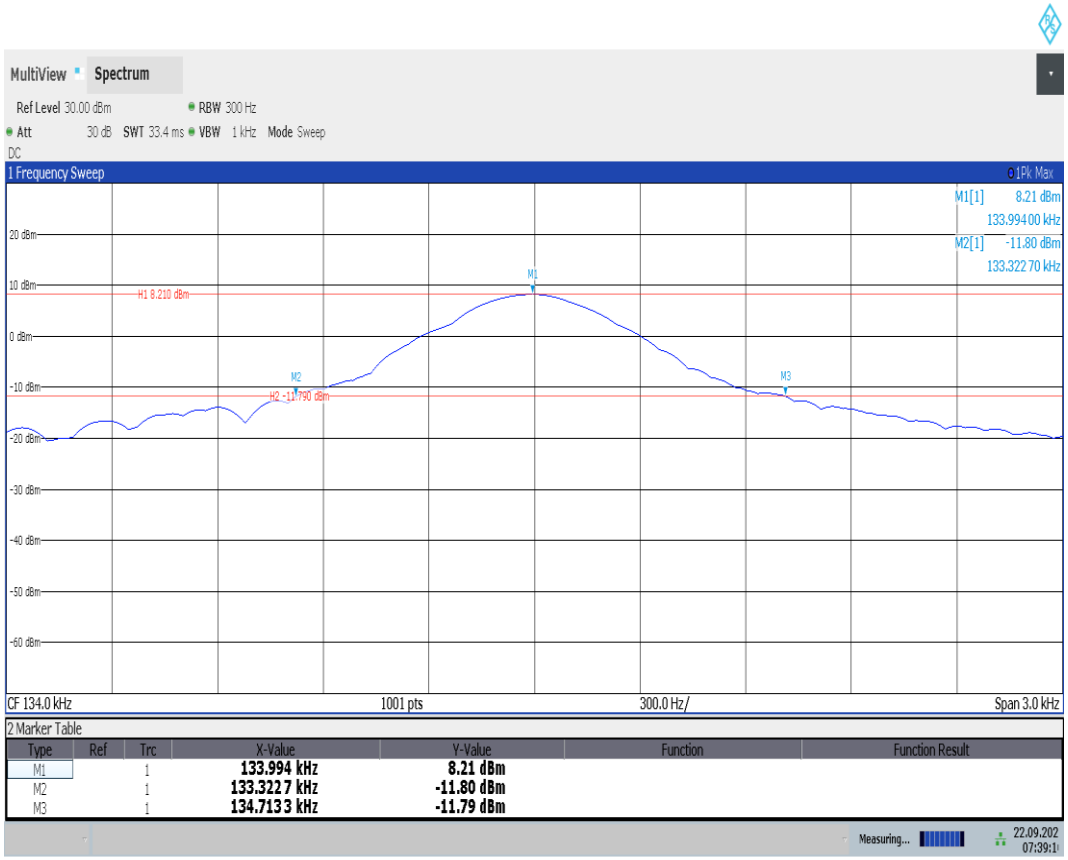
12.6 Test Results

15.209. Modulation: AM-PSK / AM-FSK; Frequency 125 kHz			
Channel Frequency (kHz)	***F_L (kHz)***	***F_H (kHz)***	***20 dB Bandwidth (kHz)***
125	124.3077	125.6803	1.3726



Frequency: 125 kHz 20 dB OCBW

15.209. Modulation: AM-PSK / AM-FSK; Frequency 134 kHz			
Channel Frequency (kHz)	***F_L (kHz)***	***F_H (kHz)***	***20 dB Bandwidth (kHz)***
134	133.3227	134.7133	1.3906



Frequency: 134 kHz 20 dB OCBW

13 Transmitter output power (fundamental radiated emission)

13.1 Definition

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

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	OATS
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Frequencies Measured:	125 kHz, 134 kHz
Deviations From Standard:	None
Measurement BW:	200 Hz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	1 kHz
Measurement Detector:	Quasi-peak
Voltage Extreme Environment Test Range:	Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 ºC to +35 ºC (as declared)
Humidity: 59 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

ISED RSS-210:
Transmitters whose wanted and unwanted emissions fall within the general field strength limits specified in RSS-Gen may operate in any of the frequency bands, other than the restricted bands listed in RSS-Gen and the TV bands, and shall be certified under RSS-210. Under no circumstance shall the level of any unwanted emissions exceed the level of the fundamental emissions

FCC 47CFR15.209(a):
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 / RSS-Gen

Frequency (MHz)	*Field Strength (µV/m)*	*Measurement distance (m)*
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

13.4 Test Method

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

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

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

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

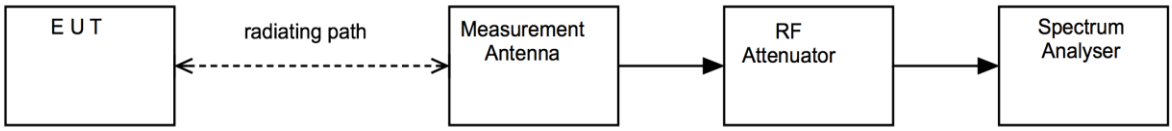
Where,

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

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 59.08 dB per decade was used for measurement distances of 10 m to 300 m.

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

Figure v Test Setup



13.5 Test Equipment

Equipment Type	*Manufacturer*	*Equipment Description*	*Element No*	*Due For Calibration*
Receiver	R&S	ESHS10	U003	2021-12-11
Active Loop Antenna	EMCO	6502	R0079	2023-06-16

13.6 Test Set-up Photograph

13.7 Test Results

Modulation: AM-PSK / AM-FSK; Frequency 125 kHz						
Channel Frequency (kHz)	***Receiver Level (dBµV/m)***	***Measurement Distance (m)***	***Limit Distance (m)***	***Extrapolation Factor (dB)***	***Field Strength (µV/m)***	***Result***
125	86.50	10	300	59.08	27.42	PASS

Modulation: AM-PSK / AM-FSK; Frequency 134 kHz						
Channel Frequency (kHz)	***Receiver Level (dBµV/m)***	***Measurement Distance (m)***	***Limit Distance (m)***	***Extrapolation Factor (dB)***	***Field Strength (µV/m)***	***Result***
134	86.1	10	300	59.08	27.02	PASS

14 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 connecter) Dare RPR3006W Power Head	MU4001	**0.9 dB**
Carrier Power and PSD - Spectrum Analysers	MU4004	**0.9 dB**
Adjacent Channel Power	MU4002	**1.9 dB**
Transmitter conducted spurious emissions	MU4041	**0.9 dB**
Conducted power and spurious emissions 40 GHz to 50 GHz	MU4042	**2.4 dB**
Conducted power and spurious emissions 50 GHz to 75 GHz	MU4043	**2.5 dB**
Conducted power and spurious emissions 75 GHz to 110 GHz	MU4044	**2.4 dB**
Radiated RF Power and Spurious emissions ERP and EIRP		
Effective Radiated Power Reverb Chamber	MU4020	**3.7 dB**
Effective Radiated Power	MU4021	**4.7 dB**
TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna	MU4046	**5.3 dB**
TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna	MU4047	**5.1 dB**
TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn	MU4048	**2.7 dB**
TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn	MU4049	**2.7 dB**
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz	MU4037	**4.7 dB**
Radiated Spurious Emissions 1-18 GHz	MU4032	**4.5 dB**
E Field Emissions 18GHz to 26 GHz	MU4024	**3.2 dB**
E Field Emissions 26GHz to 40 GHz	MU4025	**3.3 dB**
E Field Emissions 40GHz to 50 GHz	MU4026	**3.5 dB**
E Field Emissions 50GHz to 75 GHz	MU4027	**3.6 dB**
E Field Emissions 75GHz to 110 GHz	MU4028	**3.6 dB**
Radiated Magnetic Field Emissions	MU4031	**2.3 dB**
Frequency Measurements		
Frequency Deviation	MU4022	**0.316 kHz**
Frequency error using CMTA test set	MU4023	**113.441 Hz**
Frequency error using GPS locked frequency source	MU4045	**0.0413 ppm**
Bandwidth/Spectral Mask Measurements		
Channel Bandwidth	MU4005	**3.87 %**
Transmitter Mask Amplitude	MU4039	**1.3 dB**
Transmitter Mask Frequency	MU4040	**2.59 %**
Time Domain Measurements		
Transmission Time	MU4038	**4.40 %**
Dynamic Frequency Selection (DFS) Parameters)		
DFS Analyser - Measurement Time	MU4006	**679 µs**
DFS Generator - Frequency Error	MU4007	**92 Hz**
DFS Threshold Conducted	MU4008	**1.3 dB**
DFS Threshold Radiated	MU4009	**3.2 dB**

Test/Measurement	Budget Number	MU
Receiver Parameters		
EN300328 Receiver Blocking	MU4010	**1.1 dB**
EN301893 Receiver Blocking	MU4011	**1.1 dB**
EN303340 Adjacent Channel Selectivity	MU4012	**1.1 dB**
EN303340 Overloading	MU4013	**1.1 dB**
EN303340 Receiver Blocking	MU4014	**1.1 dB**
EN303340 Receiver Sensitivity	MU4015	**0.9 dB**
EN303372-1 Image Rejection	MU4016	**1.4 dB**
EN303372-1 Receiver Blocking	MU4017	**1.1 dB**
EN303372-2 Adjacent Channel Selectivity	MU4018	**1.1 dB**
EN303372-2 Dynamic Range	MU4019	**0.9 dB**
Receiver Blocking Talk Mode Conducted	MU4033	**1.2 dB**
Receiver Blocking Talk Mode- radiated	MU4034	**3.4 dB**
Rx Blocking, listen mode, blocking level	MU4035	**3.2 dB**
Rx Blocking, listen mode, radiated Threshold Measurement	MU4036	**3.4 dB**
Adjacent Sub Band Selectivity	MU4003	**4.2 dB**

15 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.

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

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

The SAR Test Exclusion Threshold for frequencies below 100 MHz, and for test separation distance of ≤ 50 mm, is determined as follows.

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

Where,

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
TSD_A = 50 mm
f_{MHz} = Transmit frequency in MHz

Channel Frequency (MHz)	***Maximum Conducted Power (mW)***	***SAR Exclusion Threshold at 5 mm (mW)***	***SAR Evaluation***
0.125	0.9	925.7	Not Required
0.134	0.8	918.5	Not Required

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

16 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

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged } R = \sqrt{\frac{EIRP}{S4\pi}}$$

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 limit (S) (mW/cm^2)***	***Distance (R) cm required to be less than the power density limit***
0.125	0.9	Not Applicable	Not Applicable
0.134	0.8	Not Applicable	Not Applicable