Radio Test Report

Salunda Ltd

1701E-HMS (Hawk Maintenance Station)

B

47 CFR Part 15.225 Effective Date 1st October 2022
DXX: Part 15 Low Power Communication Device Transmitter
Test Date: 7th February 2024 to 14th February 2024
Report Number: 02-14468-3-24 Issue 01

The testing was carried out by Kiwa Ltd t/a Kiwa Electrical Compliance, an independent test house, at their test facility located at:

Kiwa Electrical Compliance
Arnolds Court
Arnolds Farm Lane
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This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated April 2017).

Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 14468-3

The equipment noted below has been fully tested by Kiwa Electrical Compliance and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	1701E-HMS (Hawk Maintenance Station)
Model Number:	B
Unique Serial Number:	HMS_000006
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester, Oxfordshire OX26 2UA
Proposed FCC ID:	2ALTW1701HMS
Full measurement results are detailed in Report Number:	02-14468-3-24 Issue 01
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2022 DXX: Part 15 Low Power Communication Device Transmitter

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date of Test: 7th February 2024 to 14th February 2024

Test Engineer:
Jack Chilvers

Jack Chilvers
Digitally signed by: Jack Chilvers
DN: CN = Jack Chilvers email = jack.chilvers@kiwa.com C = GB OU = Kiwa Electrical Compliance
Date: 2024.04.25 07:48:51 Z

Approved By:
Radio Approvals Manager

Digitally signed by: Daniel Sims
DN: CN = Daniel Sims email = Daniel.Sims@kiwa.com C = GB O = Kiwa Electrical Compliance - Brentwood
Date: 2024.04.24 17:58:25 Z

Customer Representative:

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Salunda Limited Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA	
Manufacturer of EUT	Salunda Limited	
Full Name of EUT	1701E-HMS (Hawk Maintenance Station)	
Model Number of EUT	B	
Serial Number of EUT	HMS_000006	
Date Received	7th February 2024	
Date of Test:	7th February 2024 to 14th February 2024	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	24th April 2024	
Main Function	To provide functionality to read NFC from other Salunda products via USB	
Information Specification	Height	20 mm
	Width	100 mm
	Depth	130 mm
	Weight	0.3 kg
	Voltage	5VDC
	Current	0.5A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Desk Top
Choice of model(s) for type tests	Production sample
Antenna details	Integral
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	48 MHz
Lowest Signal generated in EUT	6 MHz
Hardware Version (HVIN)	B2
Software Version	1.0.9.243
Firmware Version (FVIN)	1.8
Type of Equipment	NFC
Technology Type	NFC/ RFID
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	13.56 MHz (Single Frequency)
EUT Declared Modulation Parameters	ASK (ISO 14443A)
EUT Declared Power level	Not Declared
EUT Declared Signal Bandwidths	7 kHz
EUT Declared Channel Spacing's	7 kHz
EUT Declared Duty Cycle	100%
Unmodulated carrier available?	No
Declared frequency stability	Not Declared
FCC Parameters	
FCC Transmitter Class	DXX: Part 15 Low Power Communication Device Transmitter

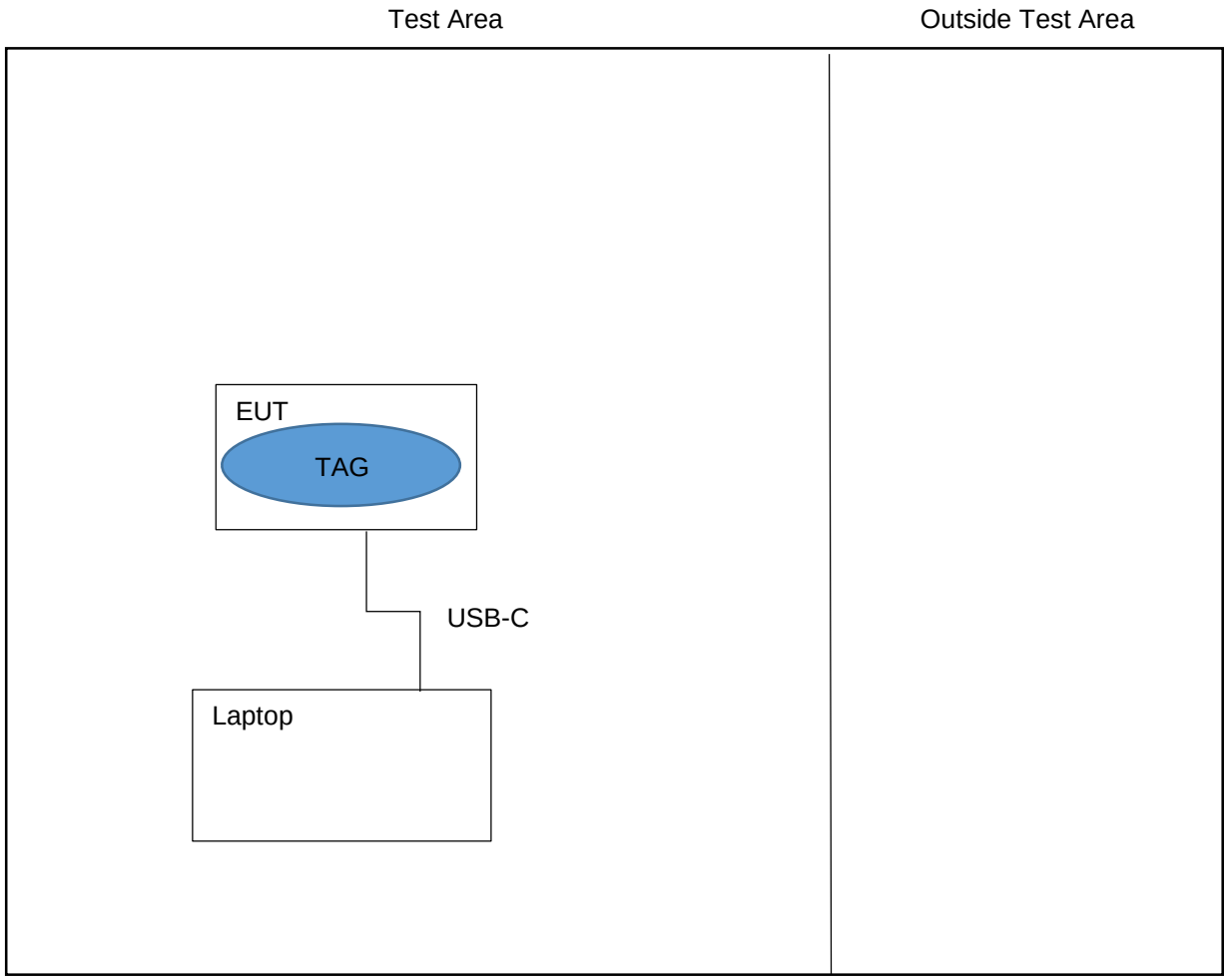
2.3 Functional description

Read / Write NFC from the USB.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Continuously Reading and writing over 13.56 MHz Tag in field	Yes
Mode 2	Continuously Reading and writing over 13.56 MHz Tag out of field	Yes

2.5 Emissions configuration



The unit was powered via USB-C from the ancillary laptop. For conducted tests a test fixture was used.

The unit had two modes; one with tag presented and one with the tag removed from the field. In a pre-test each mode was assessed for 'worst-case' emissions. The EUT had a 100% duty cycle with modulation.

Channel Frequency 13.56 MHz

The ancillary laptop was powered by its internal battery except for AC conducted emissions tests where the laptop was powered by its dedicated mains adapter

For tests performed at extremes of temperature and voltage the EUT was connected using a specialist USB 'break out' lead. This allowed the EUT to be powered by a bench power supply and for the supply voltage to be varied to the extreme voltages stated in section 4.3.

2.5.1 Signal leads

Port Name	Cable Type	Connected
USB	USB-C	Yes

3 Summary of test results

The Hawk Maintenance Station, B was tested for compliance to the following standard:

47 CFR Part 15.225
Effective Date 1st October 2022
DXX: Part 15 Low Power Communication Device Transmitter

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.225(d)	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.209	NOT APPLICABLE[1]
6. Intentional radiator field strength	47 CFR Part 15C Part 15.225(a)	PASSED
7. Occupied bandwidth	47 CFR Part 15C Part 15.215	PASSED
8. Spectrum mask	47 CFR Part 15C Part 15.225	PASSED
9. Frequency stability	47 CFR Part 15C Part 15.225(e)	PASSED

[1] Radiated emissions measurements above 1 GHz are not required. The highest frequency generated or used within the equipment is 48MHz.

4 Specifications

The tests were performed and operated in accordance with Kiwa Electrical Compliance procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2022	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	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

4.2 Deviations

No deviations were applied.

4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	5V DC
T minimum	-20 °C	V minimum	4.75V DC
T maximum	50 °C	V maximum	5.25V DC

Extremes of temperature are based upon the requirements of FCC 47CFR 15.225

Extremes of voltage are based on the standard voltage range of USB powered equipment.
The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:
A test fixture was used for testing.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane and connected to a LISN via a 1m mains cable.

Details of the Peripheral and Ancillary Equipment connected for this test are listed in section 10.

During the initial scan, Mode 1 was found to be worst case mode of operation and was used for final test.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted in the 'Test Equipment' Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection.

All signals within 10dB of the limit were investigated. Tests were performed in Test Site F.

5.1.4 Test equipment

E035, E150, E411, E624, ZSW1

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Plot refs
14468-3 Cond 1 AC Live 9k-150kHz
14468-3 Cond 1 AC Neutral 9k-150kHz
14468-3 Cond 1 AC Live 150k-30MHz
14468-3 Cond 1 AC Neutral 150k-30MHz

Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report./ Only results within 20dB of limits have been reported.

LIMITS:
15.207: as given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

UE70 9kHz to 150kHz ±3.76dB, UE71 150kHz to 30MHz ±3.4dB

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes The EUT was powered via an ancillary laptop. The EUT was operated in Mode 1.

5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.

All signals within 10dB of the limit were investigated.

Tests were performed using Test Site H and OATS.

5.2.4 Test equipment

TMS81, ZSW1, E642, F238

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102 kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Plot refs
14468-3 Rad 1 9k-150kHz Para
14468-3 Rad 1 9k-150kHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes The EUT was powered via an ancillary laptop. The EUT was operated in Mode 1.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.

All signals within 10dB of the limit were investigated.

Tests were performed using Test Site H and OATS.

5.3.4 Test equipment

TMS81, ZSW1, E642, F238

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102 kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Plot refs
14468-3 Rad 1 150k-30MHz Para
14468-3 Rad 1 150k-30MHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(d) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes The EUT was powered via an ancillary laptop. The EUT was operated in Mode 1.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber. The antenna was height scanned between 1 and 4 metres and the equipment was rotated 360 degrees to record the worst case emissions. Both Horizontal and vertical polarisations of measuring antenna were tested. Tests were performed in Test Site H

5.4.4 Test equipment

E914, E745, NSA-H, ZSW1, E642, F238

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102 kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Plot refs
14468-3 Rad 1 VHF Horiz
14468-3 Rad 1 VHF Vert
14468-3 Rad 1 UHF Horiz
14468-3 Rad 1 UHF Vert

Table of signals measured for Rad 1 Horizontal Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	52.674	30.9	25.0	-15.0
2	72.904	29.4	24.5	-15.5
3	81.374	25.9	23.0	-17.0
4	103.134	28.2	22.1	-21.4
5	119.347	26.2	20.5	-23.0
6	162.747	30.0	26.8	-16.7
7	176.309	32.2	29.2	-14.3
8	189.872	39.3	37.9	-5.6
9	216.996	36.8	35.0	-11.0
10	244.121	37.3	35.4	-10.6
11	271.245	37.2	34.9	-11.1
12	298.370	37.0	34.8	-11.2
13	332.289	35.8	26.5	-19.5
14	333.091	36.1	26.0	-20.0
15	342.030	31.4	25.6	-20.4
16	349.865	32.2	26.3	-19.7
17	352.627	32.8	28.7	-17.3
18	379.743	37.8	34.3	-11.7
19	406.868	41.1	39.3	-6.7
20	433.992	39.0	36.4	-9.6
21	477.792	33.8	28.4	-17.6
22	651.531	42.3	37.0	-9.0
23	753.583	38.0	32.8	-13.2
24	912.174	41.9	37.4	-8.6

Table of signals measured for Rad 1 Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	53.676	31.2	25.7	-14.3
2	72.881	29.0	23.3	-16.7
3	81.374	26.8	24.3	-15.7
4	103.448	27.8	22.1	-21.4
5	162.747	31.3	28.6	-14.9
6	176.309	29.5	25.8	-17.7
7	189.872	34.0	31.1	-12.4
8	332.619	32.4	25.2	-20.8
9	406.867	36.2	32.9	-13.1
10	497.787	42.8	32.2	-13.8
11	499.102	40.7	31.5	-14.5
12	627.817	36.3	31.3	-14.7
13	651.533	42.0	37.0	-9.0
14	663.281	37.1	31.6	-14.4
15	683.636	37.9	31.8	-14.2
16	698.602	36.7	31.6	-14.4

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

n.b. the general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1000MHz ±6.1dB

5.5 Radiated emissions above 1 GHz

NOT APPLICABLE: Radiated emissions measurements above 1 GHz are not required. The highest frequency generated or used within the equipment is 48MHz.

5.6 Intentional radiator field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.225(a) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.225(a)/(b)/(c)/(d) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes The EUT was powered via an ancillary laptop. The EUT was operated in Mode 1.

5.6.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with final measurements performed on an OATS without a ground plane. The antenna was placed 1m above the ground. Both the equipment and the antenna were rotated 360 degrees to record the maximised emission.

Measurements were made at Site H and OATS.

5.6.4 Test equipment

TMS81, ZSW1, E642, F238

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 20°C
Humidity of test environment 50%
Pressure of test environment 102kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

	Single channel
Duty Cycle (%)	100%
Duty Cycle correction	0.00

	Single channel
Peak Level @ 3 metres (dBµV/m)	66.59
Plot reference	Para Upright Tag in
Antenna Polarisation	Parallel
EUT Polarisation	Upright

Analyser plots can be found in Section 6 of this report.

An extrapolation factor of 40dB/decade per ANSI C63.10:2013 clause 6.4 is applied to the 3m results to give the following field strengths at 30m for comparison to the limits:

Peak Level (dBµV/m) @ 30m	26.59

LIMITS:
15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 dBµV/m @ 30m.
15.225(c) QP/Peak = within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 µV/m @ 30m = 40.5 dBµV/m @ 30m.
15.225(d) QP/Peak = outside of the 13.110-14.010 MHz band shall not exceed the general radiated emissions limits of 15.209.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: <± 3.9 dB

5.7 Occupied bandwidth

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.215 [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was operated in Mode 1.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Analyser settings can be seen on plot in section 6 of this report.

Measurements were made in a semi-anechoic chamber. Tests were performed using Test Site H.

5.7.4 Test equipment

TMS81, ZSW1, E642, F238

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102 kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

	Single channel
20 dB Bandwidth (kHz)	436.0
Plot for 20 dB Bandwidth	14468-3 tag in

FLOW Worst case (MHz)	13.342
FHIGH Worst case (MHz)	13.778

Analyser plots can be found in Section 6 of this report.

LIMITS:
No limits apply however, per 15.215, the 20dB bandwidth of the emission is to remain within the band over expected variations in temperature and supply voltage. It is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimise the possibility of out-of-band operation.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.8 Spectrum mask

5.8.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.225 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(a)/(b)/(c)/(d) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The EUT was measured at a distance of 3 metres. The EUT and antenna were positioned for maximum field strength and referenced to the field strength measured on the OATS. The EUT was operated in Mode 1.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Plots were taken and results were referenced to limits at 30m by using the extrapolation factor of 40dB/decade, per ANSI C63.10 clause 6.4

Measurements were made at Site H.

5.8.4 Test equipment

TMS81, ZSW1, E642, F238

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102 kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Channel	13.56MHz

	Single channel
Nominal, Maximised RF Output / field strength @ 3 metres	66.59
Nominal, Maximised RF Output / field strength @ 30 metres	26.59
Nominal plot reference	14468-3 Spectrum mask @30m

3m result converted to 30m is 26.59 dBuV/m @30m. Analyser plots can be found in Section 6 of this report.

LIMITS:
15.225(a) QP/Peak = the field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 µV/m @ 30m = 84 dBµV/m @ 30m.
15.225(b) QP/Peak = within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 µV/m @ 30m = 50.5 dBµV/m @ 30m.
15.225(c) QP/Peak = within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 µV/m @ 30m = 40.5 dBµV/m @ 30m.
15.225(d) QP/Peak = outside of the 13.110-14.010 MHz band shall not exceed the general radiated emissions limits of 15.209.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 4.1 dB

5.9 Frequency stability

5.9.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.225(e) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.8 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.225(e) [Reference 4.1.1 of this report]

5.9.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of a test fixture. The EUTs' power was varied by using a USB breakout lead connected to a bench PSU. This allowed the voltage end points as stated in section 2.4. The EUT was operated in Mode 1 mode.

5.9.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Temperature stability was achieved at each test level before taking measurements. At nominal temperature the EUT supply was varied.

A spectrum analyser was used and connected to an off-air frequency standard. The Analyser's frequency counter function was used to monitor the frequency of the carrier. The analyser was set with a suitable span, RBW and VBW to allow for a measurement resolution of 1Hz.

Tests were performed using Test Site A.

5.9.4 Test equipment

E227, E813, H071, TMS38, TMS80

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	20°C
Humidity of test environment	48%
Pressure of test environment	102kPa

Band	13.110-14.010 MHz
Power Level	Default
Channel Spacing	Single Channel
Mod Scheme	ASK
Single channel	13.56 MHz

Test conditions		Frequency Error (MHz) Single channel
-20°C	Volts Nominal (5)	13.562319
-10°C	Volts Nominal (5)	13.562317
0°C	Volts Nominal (5)	13.562283
10°C	Volts Nominal (5)	13.562282
20°C	Volts Minimum (4.75)	13.562214
	Volts Nominal (5)	13.562214
	Volts Maximum (5.25)	13.562214
30°C	Volts Nominal (5)	13.562272
40°C	Volts Nominal (5)	13.562217
55°C	Volts Nominal (5)	13.562163
Max Frequency Error per chan (Hz)		+104.5
Max Frequency Error observed (MHz)		0.0001045

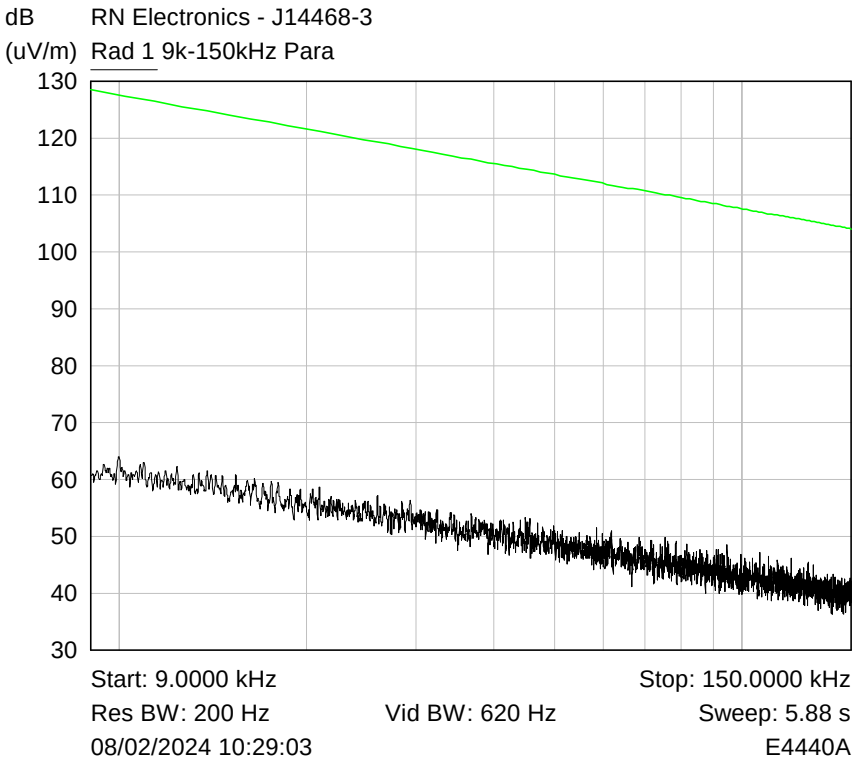
LIMITS:
+/- 0.01%. (+/- 1.356kHz)
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 0.0002 ppm (PSA Ext Ref)

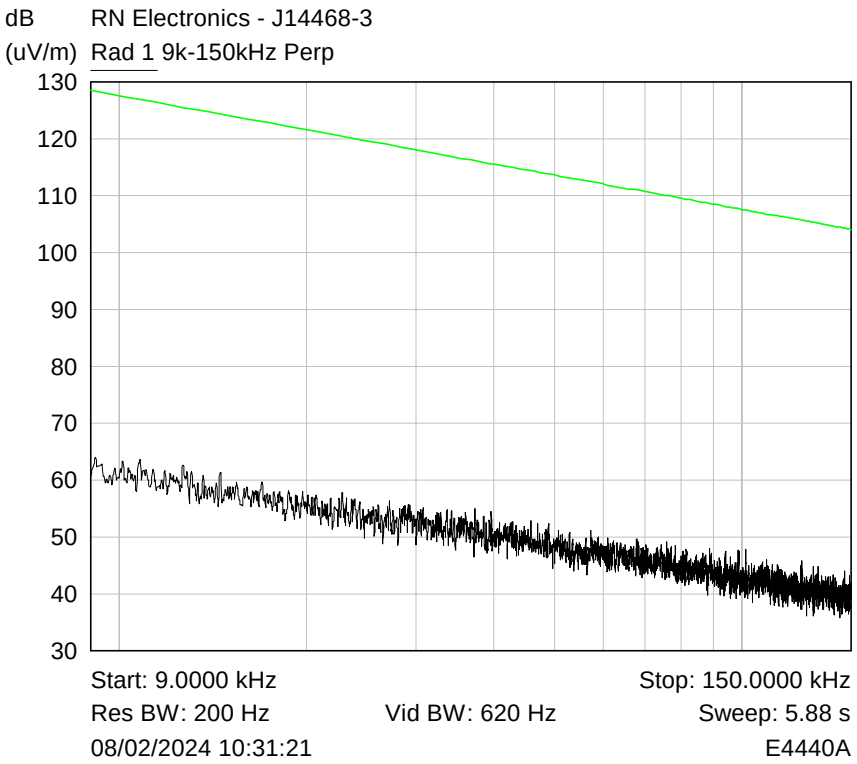
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 13.110-14.010 MHz, Power Default, Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz



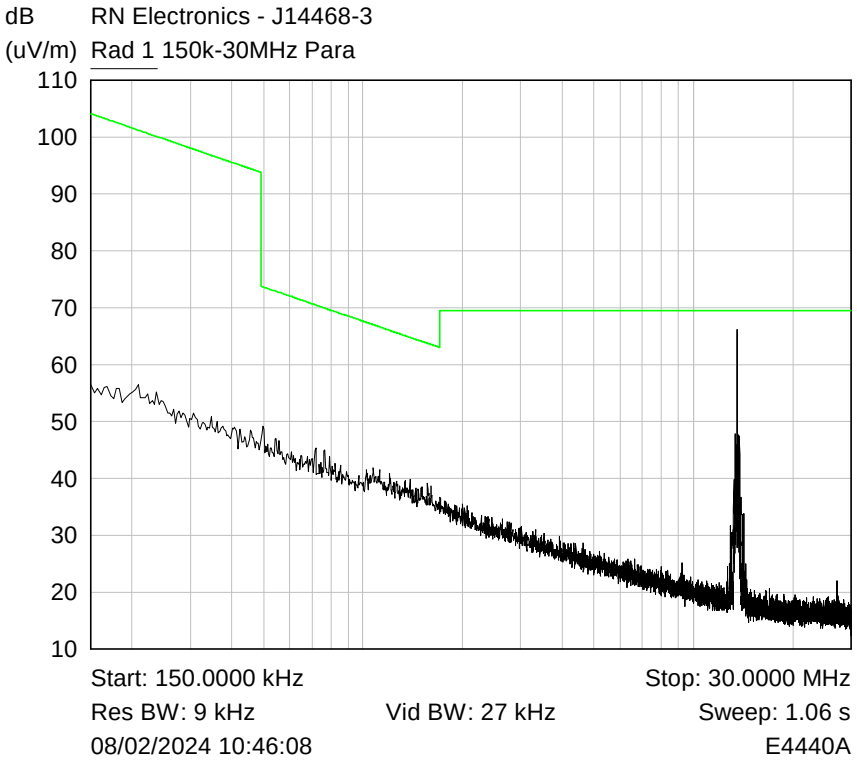
Plot of 9k-150kHz Parallel



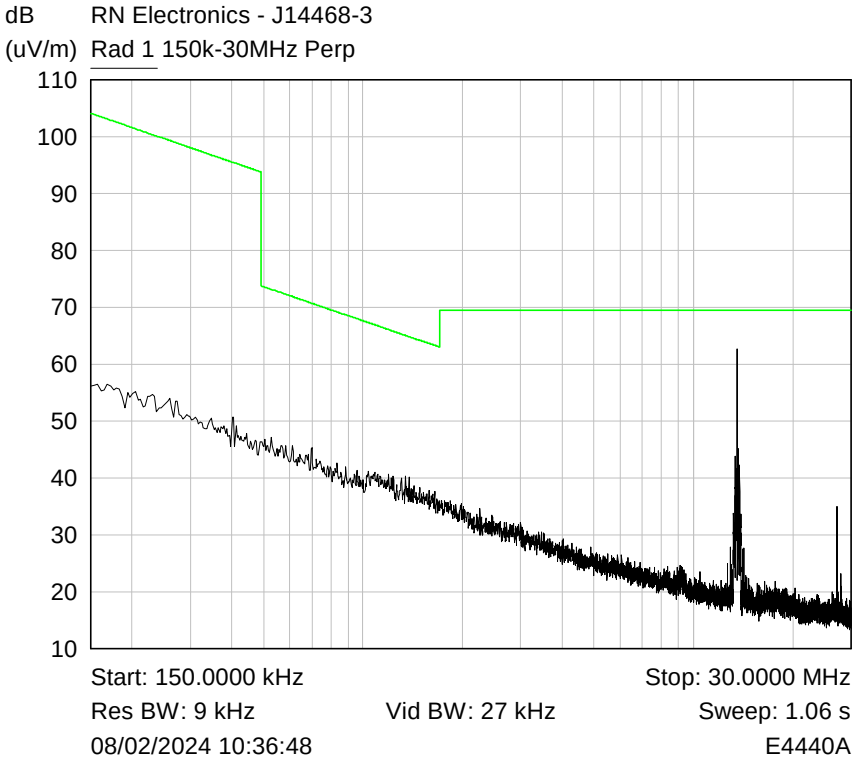
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 13.110-14.010 MHz, Power Default, Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz



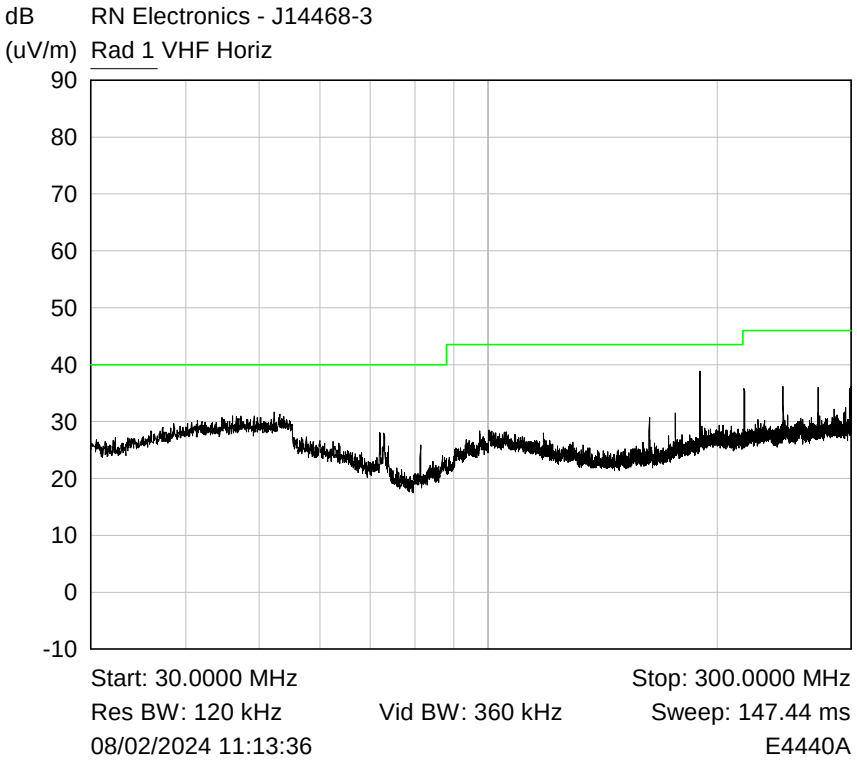
Plot of 150kHz-30MHz Parallel



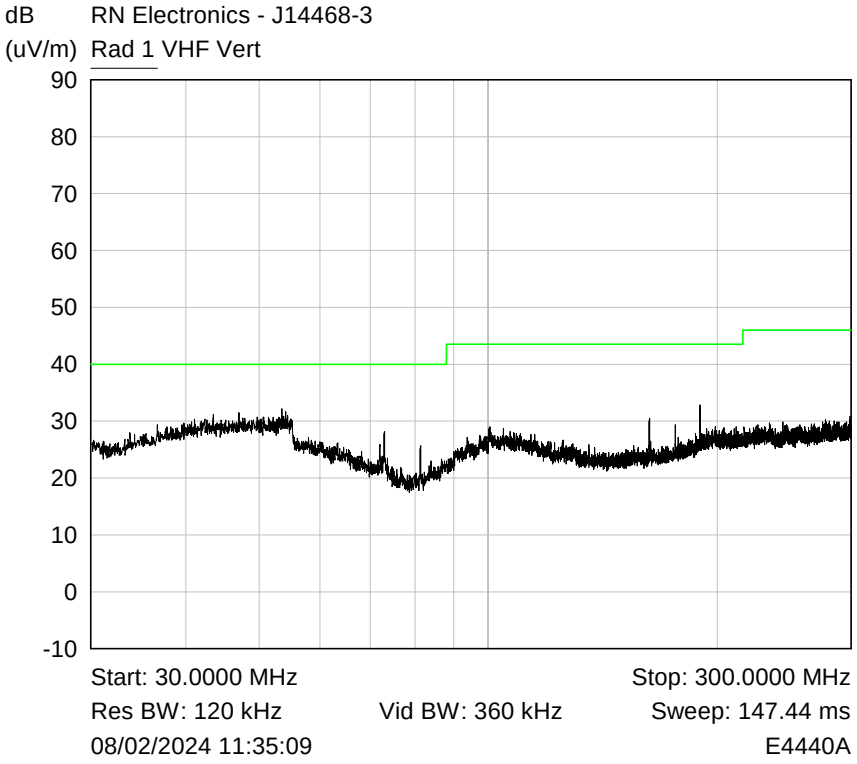
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

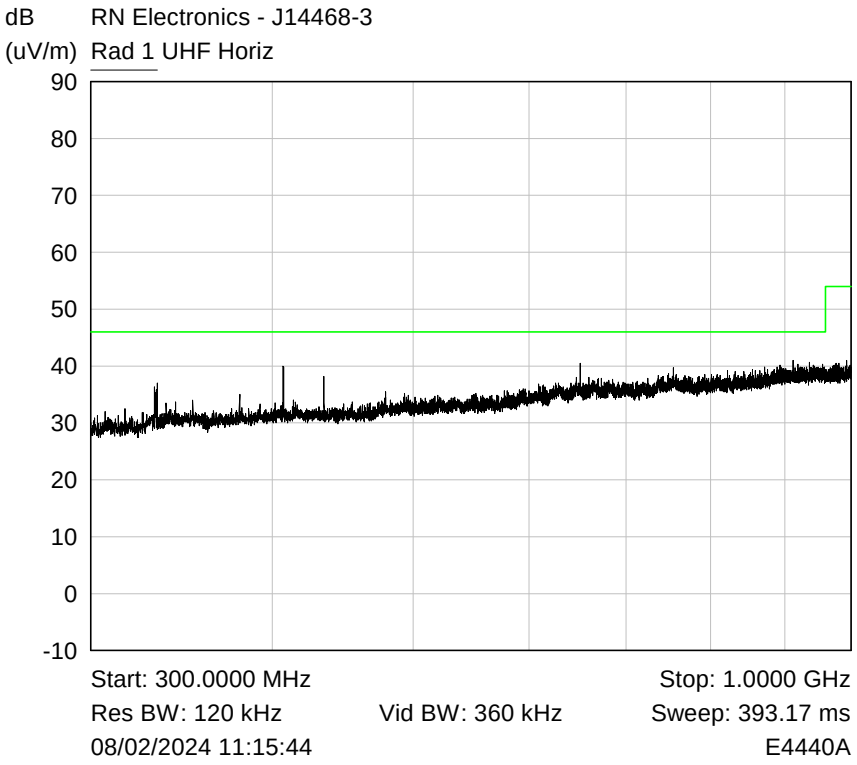
RF Parameters: Band 13.110-14.010 MHz, Power Default, Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz



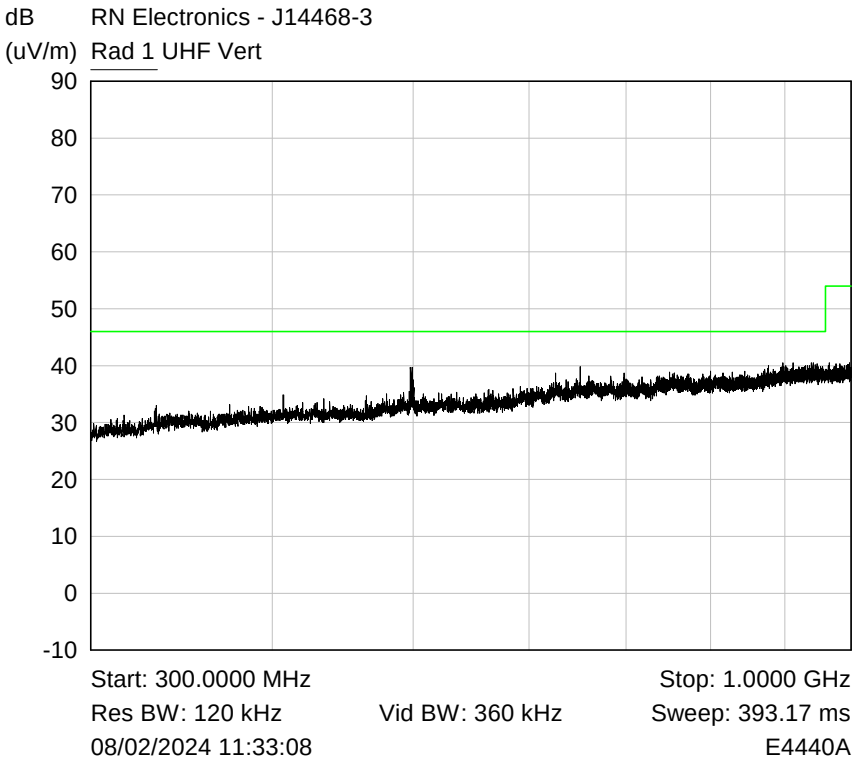
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.



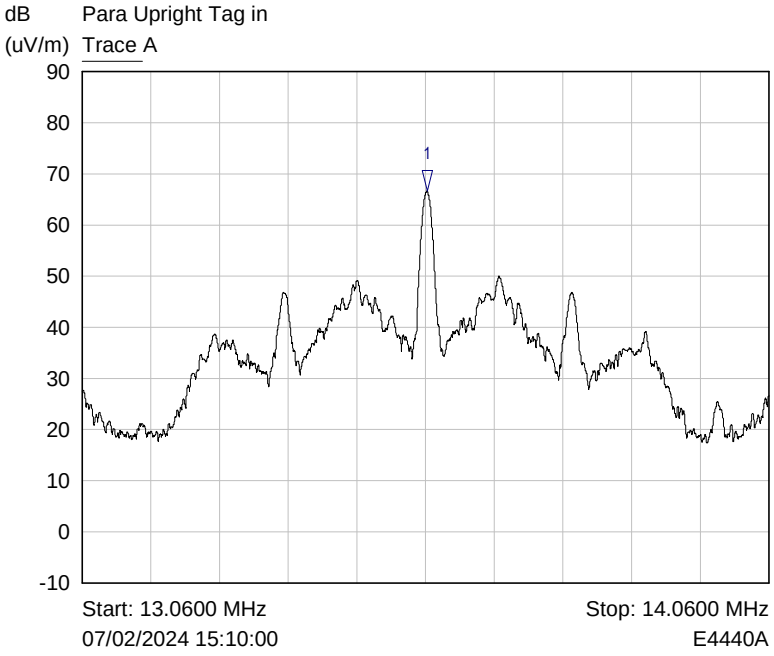
Plot of Peak emissions for UHF Horizontal against the QP limit line.



Plot of Peak emissions for UHF Vertical against the QP limit line.

6.4 Intentional radiator field strength

RF Parameters: Band 13.110-14.010 MHz, Power Default (Not Declared), Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz

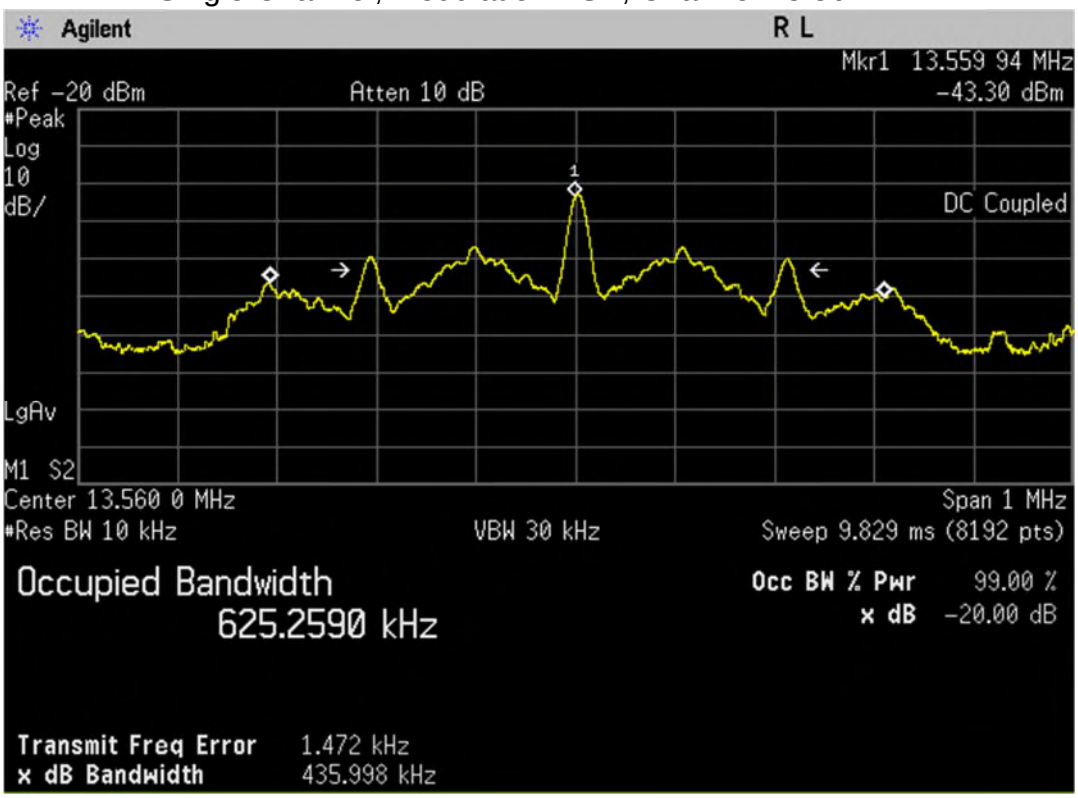


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5624 MHz	66.59 dB(uV/m)	

Plot of Parallel polarisation and EUT in Upright position

6.5 Occupied bandwidth

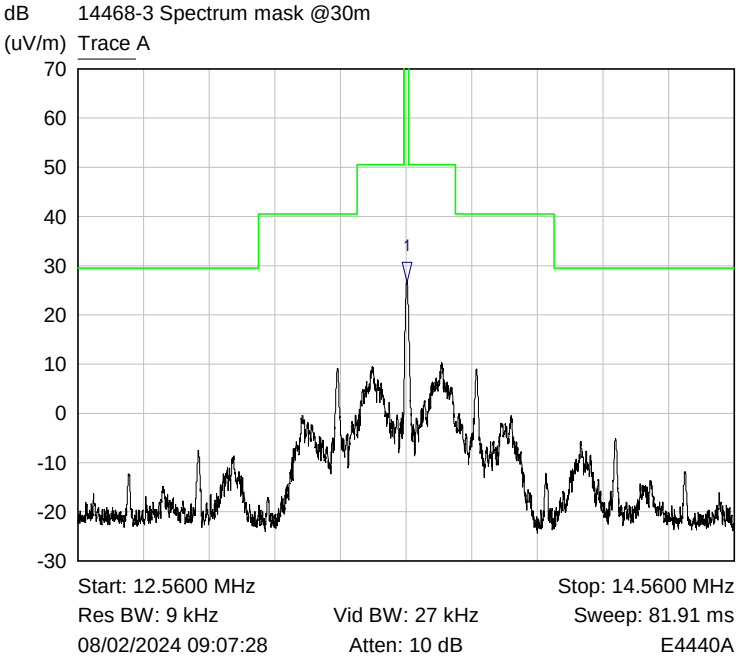
RF Parameters: Band 13.110-14.010 MHz, Power Default (Not Declared), Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz



Plot for 20 dB Bandwidth (MHz) Nominal Temp & Volts

6.6 Spectrum mask

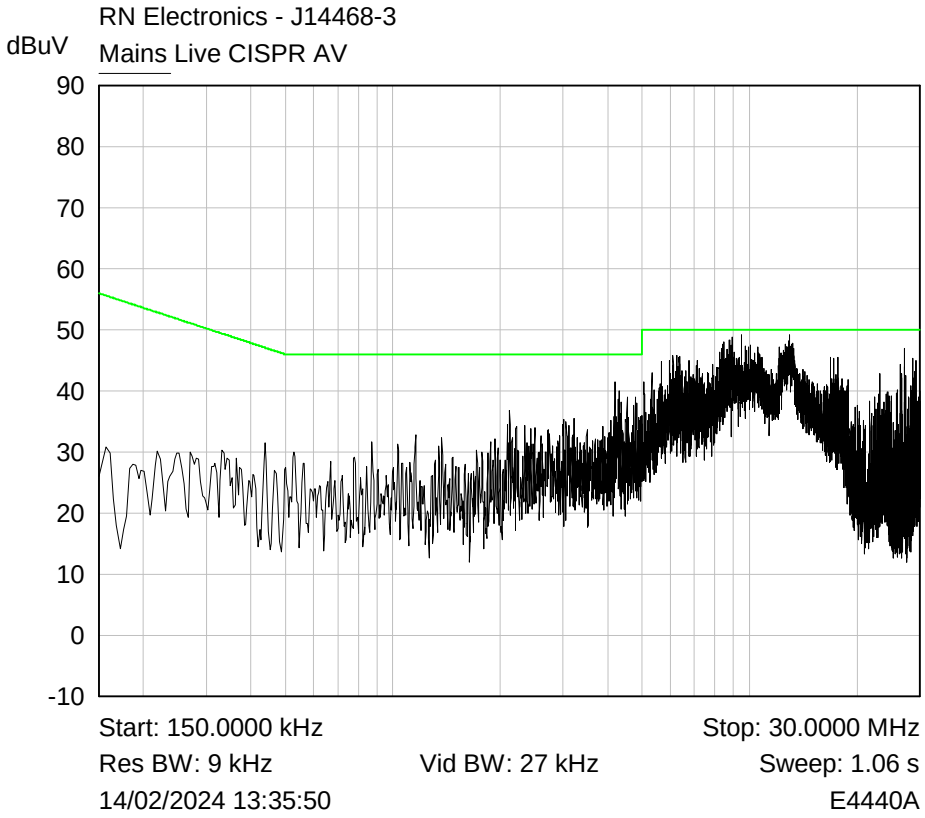
RF Parameters: Band 13.110-14.010 MHz, Power Default (Not Declared), Channel Spacing Single Channel, Modulation ASK, Channel 13.56 MHz



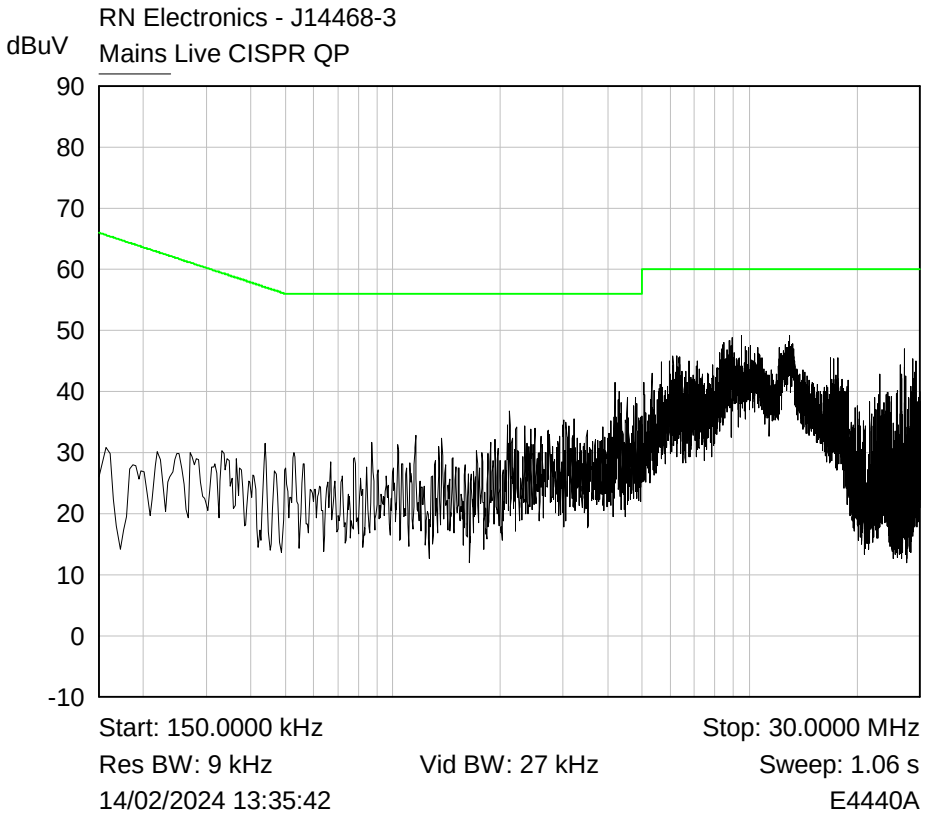
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5623 MHz	26.59 dB(uV/m)	

Nominal Temperature, Nominal Voltage

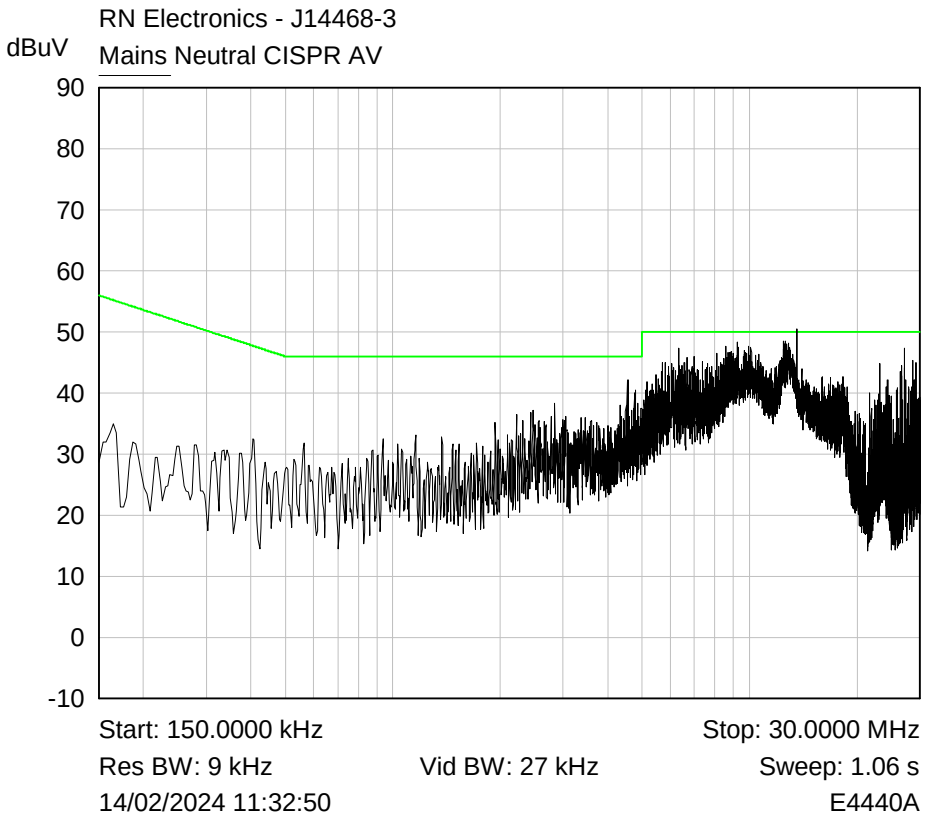
6.7 AC powerline conducted emission



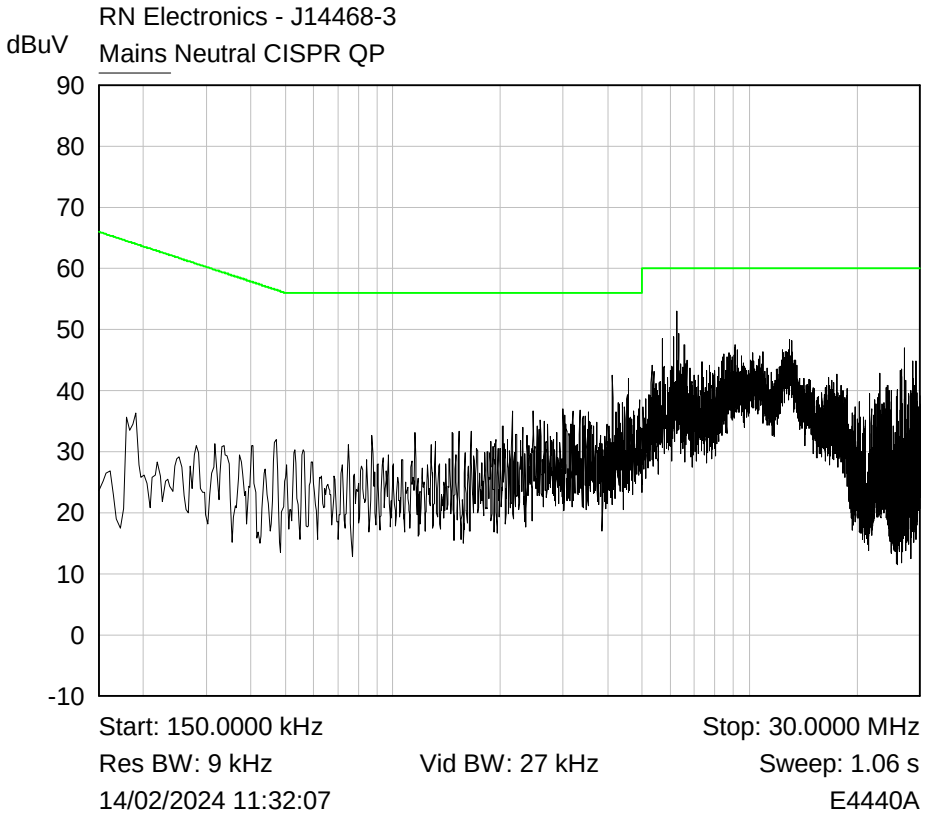
Peak emissions 150 kHz - 30 MHz on the live terminal against the average limit line.



Peak emissions 150 kHz - 30 MHz on the live terminal against the quasi-peak limit line.



Peak emissions 150 kHz - 30 MHz on the neutral terminal against the average limit line.



Peak emissions 150 kHz - 30 MHz on the neutral terminal against the quasi-peak limit line.

Table of signals measured for Live 150kHz - 30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.157	38.8	32.6	-33.0	24.7	-30.9
2	1.031	34.1	30.6	-25.4	21.9	-24.1
3	2.250	37.3	34.2	-21.8	22.2	-23.8
4	3.000	38.8	36.1	-19.9	28.5	-17.5
5	3.526	36.8	29.8	-26.2	22.0	-24.0
6	4.750	40.9	36.5	-19.5	27.0	-19.0
7	5.255	40.7	34.6	-25.4	24.5	-25.5
8	5.500	45.1	41.3	-18.7	28.5	-21.5
9	5.688	47.1	44.0	-16.0	30.3	-19.7
10	6.062	47.1	42.8	-17.2	32.2	-17.8
11	7.063	43.4	40.0	-20.0	33.3	-16.7
12	7.719	47.8	44.0	-16.0	36.3	-13.7
13	8.156	48.0	43.8	-16.2	32.3	-17.7
14	8.874	46.0	42.8	-17.2	33.2	-16.8
15	9.406	45.9	41.2	-18.8	32.4	-17.6
16	9.812	45.3	40.9	-19.1	32.8	-17.2
17	10.248	43.8	39.6	-20.4	30.9	-19.1
18	10.758	41.9	37.6	-22.4	29.4	-20.6
19	12.792	46.1	45.2	-14.8	38.4	-11.6
20	14.450	36.5	32.1	-27.9	24.8	-25.2
21	14.967	34.4	30.1	-29.9	23.1	-26.9
22	16.126	37.4	34.5	-25.5	27.9	-22.1
23	17.188	39.4	36.2	-23.8	28.2	-21.8
24	18.230	40.0	34.0	-26.0	25.0	-25.0
25	18.906	38.0	34.3	-25.7	26.2	-23.8
26	19.708	37.8	35.4	-24.6	33.4	-16.6
27	20.001	38.8	37.2	-22.8	34.8	-15.2
28	20.258	38.6	36.8	-23.2	34.3	-15.7
29	20.808	37.5	35.9	-24.1	33.4	-16.6
30	21.052	36.2	35.0	-25.0	32.6	-17.4
31	21.663	40.3	39.2	-20.8	36.6	-13.4
32	21.907	38.9	37.2	-22.8	34.3	-15.7
33	22.212	38.0	36.4	-23.6	32.9	-17.1
34	22.579	39.4	37.9	-22.1	34.5	-15.5
35	22.884	40.0	38.6	-21.4	35.2	-14.8
36	23.128	45.6	44.4	-15.6	41.0	-9.0
37	23.739	39.6	37.7	-22.3	34.5	-15.5
38	24.044	41.2	39.8	-20.2	36.9	-13.1
39	24.349	42.2	41.4	-18.6	39.1	-10.9
40	24.533	41.2	40.3	-19.7	38.0	-12.0
41	24.899	40.3	39.3	-20.7	37.4	-12.6
42	25.693	41.7	40.5	-19.5	38.8	-11.2
43	25.876	41.5	40.8	-19.2	39.4	-10.6
44	25.998	40.7	39.8	-20.2	38.2	-11.8
45	26.487	44.3	43.6	-16.4	42.1	-7.9
46	27.158	45.2	44.4	-15.6	42.7	-7.3
47	27.342	43.4	42.4	-17.6	40.5	-9.5
48	27.891	40.8	40.0	-20.0	38.2	-11.8
49	28.563	43.8	42.8	-17.2	40.5	-9.5
50	28.685	46.7	45.4	-14.6	43.0	-7.0
51	29.112	44.3	43.0	-17.0	40.5	-9.5
52	29.235	45.8	44.7	-15.3	42.7	-7.3

Table of signals measured for Neutral 150kHz - 30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	4.687	37.2	33.3	-22.7	24.0	-22.0
2	4.750	40.8	37.3	-18.7	27.4	-18.6
3	4.938	43.6	39.5	-16.5	25.1	-20.9
4	4.968	43.3	39.6	-16.4	24.2	-21.8
5	5.375	47.9	43.4	-16.6	30.7	-19.3
6	5.688	48.3	45.3	-14.7	31.2	-18.8
7	5.781	47.7	43.0	-17.0	30.7	-19.3
8	5.875	43.8	40.6	-19.4	31.4	-18.6
9	6.061	46.5	43.0	-17.0	32.5	-17.5
10	6.125	47.4	44.8	-15.2	34.9	-15.1
11	6.156	45.7	43.0	-17.0	35.2	-14.8
12	6.220	47.1	42.6	-17.4	31.8	-18.2
13	6.281	46.6	42.2	-17.8	30.2	-19.8
14	6.281	46.8	42.2	-17.8	30.2	-19.8
15	6.313	47.5	43.3	-16.7	35.8	-14.2
16	6.342	46.3	43.4	-16.6	35.5	-14.5
17	6.407	46.7	43.2	-16.8	32.6	-17.4
18	7.313	46.9	42.6	-17.4	31.7	-18.3
19	7.375	48.4	45.0	-15.0	35.9	-14.1
20	7.719	44.0	40.8	-19.2	35.9	-14.1
21	8.749	51.4	47.6	-12.4	35.6	-14.4
22	8.782	47.7	44.8	-15.2	37.2	-12.8
23	8.968	48.7	44.6	-15.4	34.6	-15.4
24	9.060	51.5	45.7	-14.3	35.0	-15.0
25	9.124	50.9	46.3	-13.7	35.8	-14.2
26	9.503	48.6	44.1	-15.9	34.9	-15.1
27	9.625	45.5	41.8	-18.2	34.4	-15.6
28	9.689	46.5	42.9	-17.1	34.9	-15.1
29	9.813	48.8	43.2	-16.8	34.8	-15.2
30	10.032	48.4	45.6	-14.4	37.0	-13.0
31	12.405	46.4	42.8	-17.2	36.1	-13.9
32	12.497	46.9	42.7	-17.3	35.6	-14.4
33	12.562	50.0	45.7	-14.3	38.8	-11.2
34	12.594	49.5	45.5	-14.5	38.4	-11.6
35	12.653	47.8	42.6	-17.4	35.7	-14.3
36	12.747	48.9	45.2	-14.8	38.3	-11.7
37	12.813	48.3	44.8	-15.2	37.8	-12.2
38	12.967	49.1	45.1	-14.9	38.1	-11.9
39	13.047	46.3	43.3	-16.7	36.7	-13.3
40	13.095	47.2	43.6	-16.4	36.5	-13.5
41	13.436	45.1	41.1	-18.9	34.6	-15.4
42	13.563	48.0	46.6	-13.4	38.1	-11.9
43	14.255	42.7	38.9	-21.1	31.6	-18.4
44	14.550	42.7	37.5	-22.5	29.8	-20.2
45	14.734	41.4	37.2	-22.8	29.7	-20.3
46	14.961	40.0	36.5	-23.5	29.0	-21.0
47	16.063	45.5	41.2	-18.8	31.7	-18.3
48	16.250	44.8	41.5	-18.5	31.0	-19.0
49	16.437	43.3	38.9	-21.1	29.2	-20.8
50	16.717	43.2	39.1	-20.9	29.8	-20.2
51	16.842	45.3	40.6	-19.4	31.0	-19.0

52	17.124	44.5	40.3	-19.7	33.2	-16.8
53	17.312	44.8	41.0	-19.0	31.9	-18.1
54	17.561	43.3	39.3	-20.7	30.8	-19.2
55	17.717	44.1	39.5	-20.5	32.3	-17.7
56	17.938	44.1	39.1	-20.9	32.1	-17.9
57	18.001	44.9	41.3	-18.7	34.4	-15.6
58	18.344	43.1	38.1	-21.9	30.5	-19.5
59	19.313	38.5	35.3	-24.7	21.6	-28.4
60	19.709	38.3	36.3	-23.7	33.5	-16.5
61	20.001	39.1	37.2	-22.8	34.8	-15.2
62	20.258	38.2	36.8	-23.2	34.3	-15.7
63	20.380	37.5	35.6	-24.4	32.4	-17.6
64	20.808	37.0	35.7	-24.3	33.4	-16.6
65	21.113	35.4	34.2	-25.8	32.1	-17.9
66	21.663	40.7	39.3	-20.7	36.6	-13.4
67	21.724	34.5	32.8	-27.2	29.9	-20.1
68	21.907	38.4	37.0	-23.0	34.2	-15.8
69	22.029	36.0	34.1	-25.9	30.9	-19.1
70	22.212	37.9	36.2	-23.8	32.8	-17.2
71	22.395	36.4	35.2	-24.8	31.5	-18.5
72	22.456	39.3	38.1	-21.9	34.7	-15.3
73	22.579	39.9	38.0	-22.0	34.4	-15.6
74	22.884	40.1	38.7	-21.3	35.1	-14.9
75	23.067	41.3	40.2	-19.8	36.8	-13.2
76	23.128	45.4	44.3	-15.7	41.0	-9.0
77	24.349	42.6	41.6	-18.4	39.1	-10.9
78	24.533	41.4	40.3	-19.7	38.0	-12.0
79	25.876	41.5	40.8	-19.2	39.4	-10.6
80	26.487	44.4	43.6	-16.4	42.2	-7.8
81	26.548	43.4	42.7	-17.3	41.3	-8.7
82	26.548	44.2	43.4	-16.6	41.8	-8.2
83	26.609	45.1	44.4	-15.6	42.7	-7.3
84	27.158	45.6	44.7	-15.3	42.8	-7.2
85	27.342	42.7	41.7	-18.3	40.3	-9.7
86	27.891	41.4	40.5	-19.5	38.4	-11.6
87	28.441	41.6	40.5	-19.5	37.9	-12.1
88	28.502	41.5	40.5	-19.5	38.1	-11.9
89	28.624	42.6	41.6	-18.4	39.2	-10.8
90	28.685	46.8	45.5	-14.5	43.2	-6.8
91	28.868	41.2	40.0	-20.0	37.6	-12.4
92	29.112	43.5	42.4	-17.6	40.5	-9.5
93	29.235	46.7	45.4	-14.6	42.9	-7.1
94	29.906	41.4	40.4	-19.6	37.8	-12.2

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. Kiwa Electrical Compliance calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.

(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m

(c) limit of 30 µV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBµV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

Additional calculation examples per ANSI C63.10 clause 9.4 – 9.6 equations 21, 22, 25 & 26:

Equation 21: $E_{Linear} = 10^{((E_{log}-120)/20)}$

And therefore equation 21 transposed is: $E_{Log} = 20xLog(E_{Linear}) +120$

Where:

E_{Linear} is the field strength of the emission in V/m

E_{Log} is the field strength of the emissions in dBµV/m

Equation 22: $EIRP = E_{Meas} + 20log(d_{Meas}) -104.7$

Where:

EIRP is equivalent isotropically radiated power in dBm

E_{Meas} is the field strength of the emission at the measurement distance in dBµV/m

d_{Meas} is the measurement distance in metres

Equation 25: $PD = EIRP_{Linear} / 4\pi d^2$

And therefore equation 25 transposed is: $EIRP_{Linear} = PD \times 4\pi d^2$

Where:

PD is the power density at distance specified by the limit, in W/m^2

$EIRP_{Linear}$ is the equivalent isotropically radiated power in Watts

d is the distance at which the power density limit is specified in metres

Equation 26: $PD = E^2_{Speclimit} / 377$

And therefore equation 26 transposed is: $E_{Spec\ limit} = \sqrt{(PD \times 377)}$

Where:

PD is the power density at distance specified by the limit, in W/m^2

$E_{spec\ limit}$ is the field strength at the distance specified by the limit in V/m

Example:

Radiated spurious emissions limit at 3metres of $90pW/cm^2$.

$90pW/cm^2 \times 100^2 = 0.9\ \mu W/m^2$ = (EIRP Linear)

Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876$ W

And

Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.

And

Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3$dBµV/m @ 3m.

8 Photographs

No photographs included due to confidentiality request of client.

8.1 Radiated emission diagrams

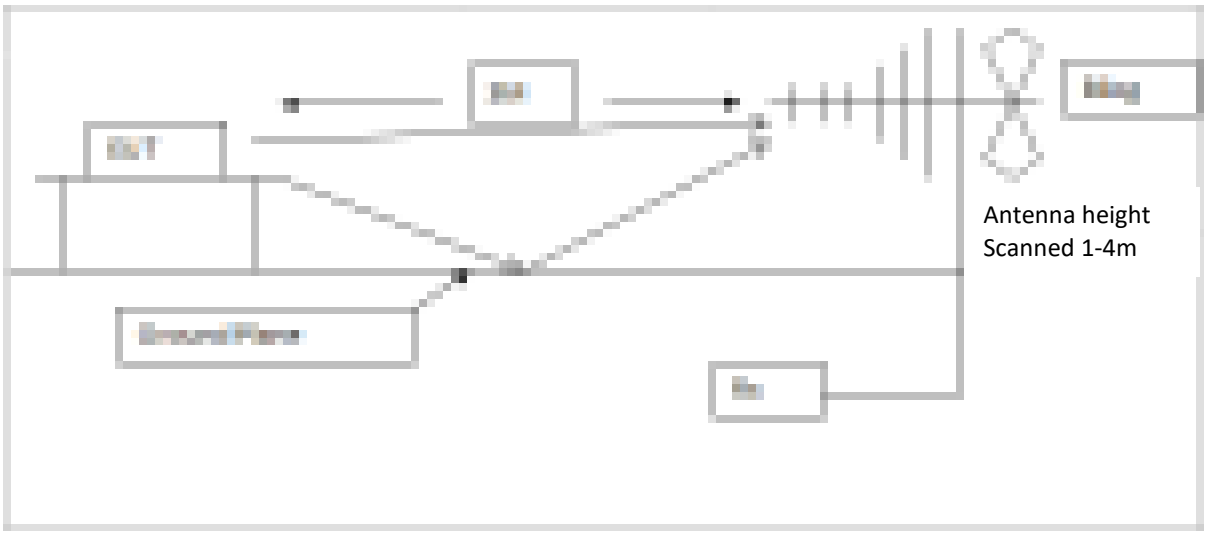


Diagram of the radiated emissions test setup 30 - 1000 MHz

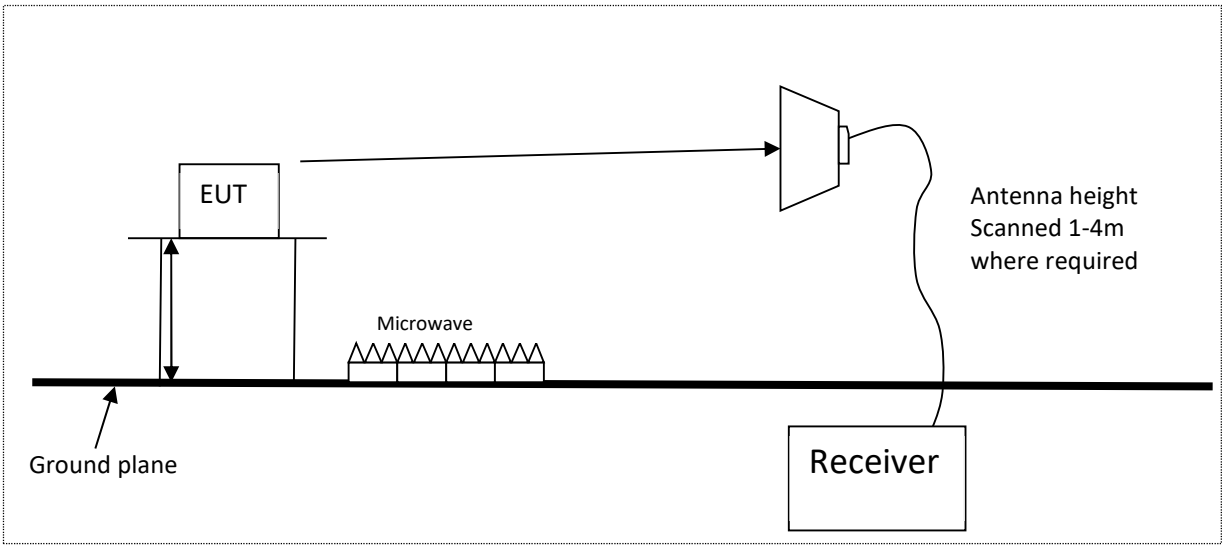


Diagram of the radiated emissions test setup above 1GHz

8.2 AC powerline conducted emission diagram

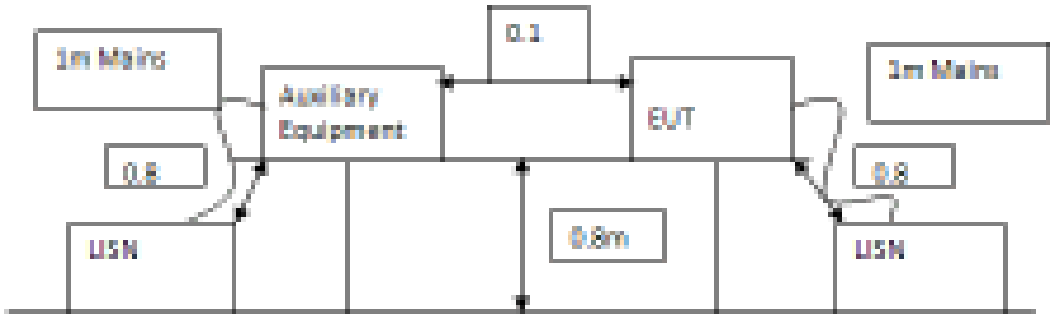


Diagram of the AC conducted emissions test setup

9 Test equipment calibration list

The following is a list of the test equipment used by Kiwa Electrical Compliance to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E227	6632A	PSU System DC Power Supply	Hewlett Packard	#20-Mar-2023	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	24-Nov-2023	24 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	#24-Feb-2023	12 months
E813	34401A	Digital Multimeter 6.5 digit	Hewlett Packard	#22-Mar-2023	12 months
E914	VULB 9163	Antenna BiLog 30MHz to 3GHz	Schwarzbeck	#23-Apr-2022	24 months
F238	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	23-Aug-2023	12 months
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	12-Dec-2022	24 months
NSA-H	NSA - H	NSA - Site H	RN Electronics	17-May-2023	36 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	#13-Mar-2023	12 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components	#01-Feb-2024	12 months
TMS81	6502	Antenna Active Loop	EMCO	17-Aug-2023	24 months
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	Not Applicable	

Equipment was within calibration dates for tests and has been re-calibrated since/during date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	Latitude 7490	Laptop	Dell	83KL1X2
2	-	Tag	Salunda Ltd	58999905

10.2 Kiwa Electrical Compliance supplied equipment

No Kiwa Electrical Compliance supplied ancillary equipment was used.

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by Kiwa Electrical Compliance.

11.2 Modifications during test

No modifications were made during test by Kiwa Electrical Compliance.

12 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 654321, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 654321, ISED Registration No. 5612A-2, VCCI Registration No. 4065

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 654321, ISED Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 654321, ISED Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
CAB identifier as issued by FCC is UK2015

13 Abbreviations and units

%	Percent
λ	Wavelength
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ACK	ACKnowledgement
ACP	Adjacent Channel Power
AFA	Adaptive Frequency Agility
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ANSI	American National Standards Institute
ATPC	Automatic Transmit Power Control
AVG	Average
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BT	BlueTooth
BLE	BlueTooth Low Energy
BW	Bandwidth
ºC	Degrees Celsius
C/I	Carrier / Interferer
CAC	Channel Availability Check
CCA	Clear Channel Assessment
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
CISPR	Comité International Spécial des Perturbations Radioélectriques
cm	centimetre
COFDM	Coherent OFDM
COT	Channel Occupancy Time
CS	Channel Spacing
CW	Continuous Wave
DAA	Detect And Avoid
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBµV/m	deciBels relative to 1µV/m
dBc	deciBels relative to Carrier
dBd	deciBels relative to dipole gain
dBi	deciBels relative to isotropic gain
dBm	deciBels relative to 1mW
dBr	deciBels relative to a maximum value
dBW	deciBels relative to 1W
DC	Direct Current
DFS	Dynamic Frequency Selection
DMO	Dynamic Modulation Order
DSSS	Direct Sequence Spread Spectrum
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
emf	electromotive force
ERC	European Radiocommunications Committee
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
EU	European Union
EUT	Equipment Under Test
FCC	Federal Communications Commission
FER	Frame Error Rate
FHSS	Frequency Hopping Spread Spectrum
FM	Frequency Modulation
FSK	Frequency Shift Keying
FSS	Fixed Satellite Service
g	Grams
GHz	GigaHertz
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
ISED	Innovation Science and Economic Development
ITU	International Telecommunications Union
KDB	Knowledge DataBase

kg	kilogram
kHz	kiloHertz
kPa	Kilopascal
LBT	Listen Before Talk
LISN	Line Impedance Stabilisation Network
LNA	Low Noise Amplifier
LNB	Low Noise Block
LO	Local Oscillator
m	metre
mA	milliAmps
max	maximum
Mbit/s	MegaBits per second
MCS	Modulation and Coding Scheme
MHz	MegaHertz
mic	Microphone
MIMO	Multiple Input, Multiple Output
min	minimum
mm	millimetres
ms	milliseconds
mW	milliWatts
NA	Not Applicable
NFC	Near Field Communications
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OBW	Occupied Band Width
OCW	Occupied Channel Width
OFDM	Orthogonal Frequency Division Multiplexing
OOB	Out Of Band
ppm	Parts per million
PER	Packet Error Rate
PK	Peak
PMR	Private Mobile Radio
PRBS	Pseudo Random Bit Sequence
PRF	Pulse Repetition Frequency
PSD	Power Spectral Density
PSU	Power Supply Unit
pW	picoWatts
QAM	Quadrature Amplitude Modulation
QP	Quasi Peak
QPSK	Quadrature Phase Shift Keying
RBW	Resolution Band Width
RED	Radio Equipment Directive
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RFID	Radio Frequency IDentification
RLAN	Radio Local Area Network
RMS	Root Mean Square
RNSS	Radio Navigation Satellite Service
RSL	Received Signal Level
RSSI	Received Signal Strength Indicator
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	Signal to Noise And Distortion
SRD	Short Range Device
Tx	Transmitter
UKAS	United Kingdom Accreditation Service
UKCA	United Kingdom Conformity Assessed
UKRER	United Kingdom Radio Equipment Regulations
UHF	Ultra High Frequency
U-NII	Unlicensed National Information Infrastructure
USB	Universal Serial Bus
UWB	Ultra Wide Band
V	Volts
V/m	Volts per metre
VBW	Video Band Width
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
W	Watts

====== END OF TEST REPORT ======