



Radio Test Report

**ASSA ABLOY Global Solutions UK Ltd t/a Traka
Traka21**

KC-1-0156

47 CFR Part 15.225 Effective Date 1st October 2023

DXX: Part 15 Low Power Communication Device Transmitter

Test Date: 7th March 2024 to 12th March 2024

Report Number: 03-14343-3-24 Issue 01

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

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Certificate of Test 14343-3

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:	Traka21
Model (HVIN) Number:	KC-1-0156
Unique Serial Number:	T21K0200026
Applicant:	ASSA ABLOY Global Solutions UK Ltd t/a Traka 30 Stilebrook Road Olney Buckinghamshire MK46 5EA
Proposed FCC ID:	2BGGU-KC10156
Full measurement results are detailed in Report Number:	03-14343-3-24 Issue 01
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2023 DXX: Part 15 Low Power Communication Device Transmitter

NOTE:

Certain tests were not performed based upon applicant's declarations. Certain other requirements are subject to applicant's declaration only and have not been tested/verified. For details refer to section 3 of this report.

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 March 2024 to 12th March 2024

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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	ASSA ABLOY Global Solutions UK Ltd t/a Traka 30 Stilebrook Road Olney Buckinghamshire MK46 5EA	
Manufacturer of EUT	ASSA ABLOY Ltd t/a Traka	
Full Name of EUT	Traka21	
Model (HVIN) Number of EUT	KC-1-0156	
Serial Number of EUT	T21K0200026	
Date Received	29th February 2024	
Date of Test:	7th March 2024 to 12th March 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 July 2024	
Main Function	Electronic Key Management System	
Information Specification	Height	427 mm
	Width	246 mm
	Depth	95 mm
	Weight	3.94 kg
	Voltage	100-240 V AC
	Current	1.6 A
EUT Supplied PSU	Manufacturer	Mean Well
	Model number	GE24I15
	Serial number	OFC2B53167
	Input voltage	100-240 VAC 50-60 Hz
	Input current	0.7 A
	Output	15 VDC 1.6 A 24 W

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Wall Mounted
Choice of model(s) for type tests	Not Specified
Antenna details	Integral spiral inductor PCB trace - 21 PCB coils multiplexed via RF switches
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	480 MHz
Lowest Signal generated in EUT	32.768 kHz
Model/Hardware Version (HVIN)	KC-1-0156
Software Version	v01.07.01
Firmware Version (FVIN)	v01.02.06
Type of Equipment	Standalone
Technology Type	13.56 MHz HF RFID
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	13.553 – 13.567 MHz
EUT Declared Modulation Parameters	ISO 15693 - 26.48kbps
EUT Declared Power level	200 mW
EUT Declared Signal Bandwidths	Not specified
EUT Declared Channel Spacing's	Non-channelised
EUT Declared Duty Cycle	98%
Unmodulated carrier available?	Yes
Declared frequency stability	Not specified
RX Parameters	
Alignment range – receiver	13.553 – 13.567 MHz
EUT Declared RX Signal Bandwidth	Not specified
Receiver Signal Level (RSL)	Not specified
Method of Monitoring Receiver BER	Not specified
General Parameters	
Type of equipment	Standalone
EUT Operating temperature range (environment)	-5°C to +55°C
Battery Type used	Lead Acid battery in event of mains failure
	RFID= 13.56MHz Processor=454MHz Memory=196.36MHz LCD=32.5MHz Crystal=24MHz, 20MHz and 32.768kHz Ethernet clock=50MHz
Frequencies internally generated or used within the EUT	USB=24MHz xtal ref, 480MHz via PLL
FCC Parameters	
FCC Transmitter Class	DXX: Part 15 Low Power Communication Device Transmitter

2.3 Functional description

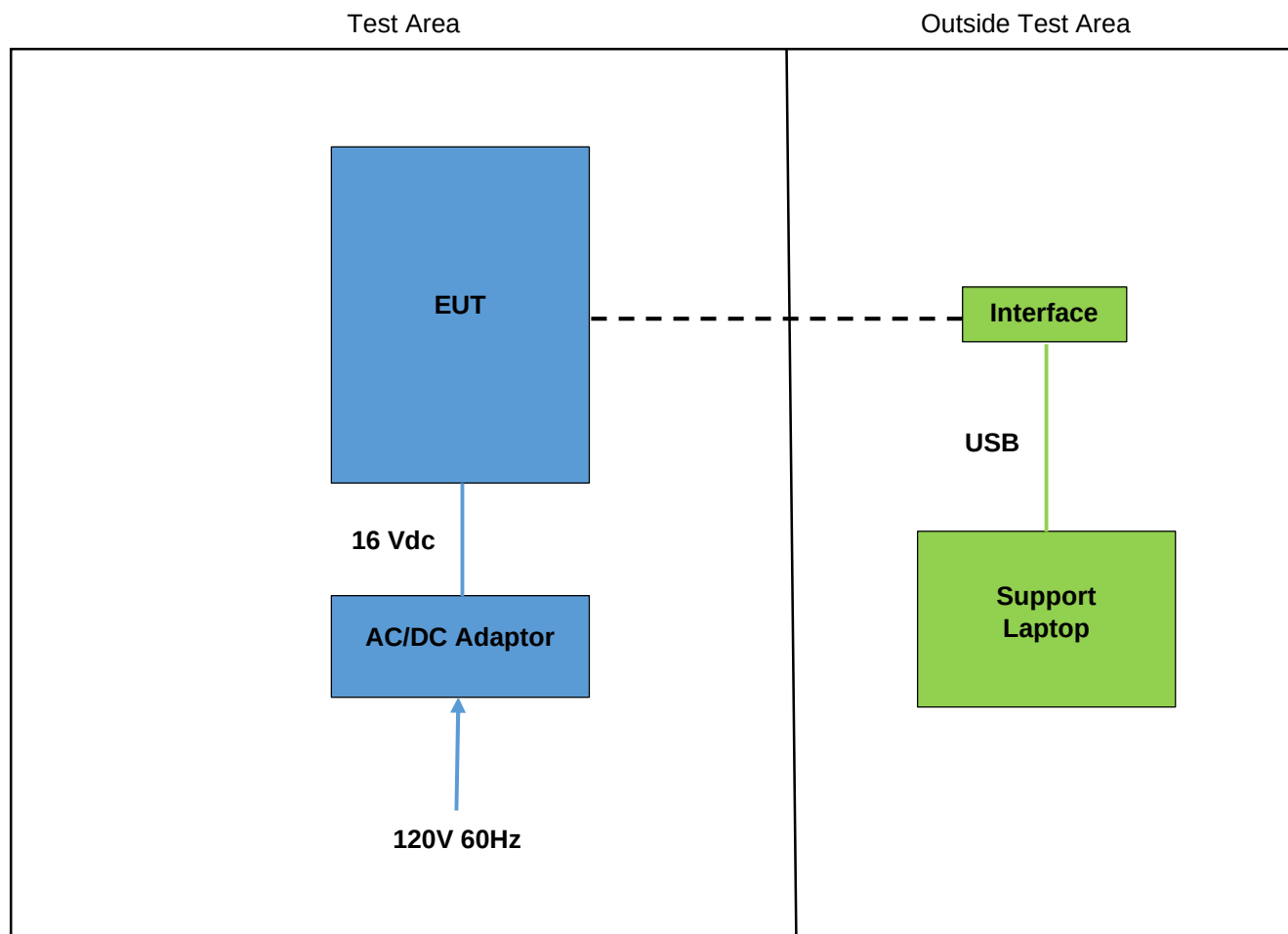
The Traka21 product is an electronic key cabinet used to manage 21 physical keys. The system controls the removal of keys to authorized personnel and logs an audit trail. It consists of a metal and plastic body with a solenoid-actuated locking hinged door. Behind the door are 21 'receptors' used to hold 'iFobs' – these are plastic keyfobs attached to each key bunch to be controlled. The iFobs are inserted into the receptors and held in place with sprung solenoids released under software control. The iFobs are detected and identified using 13.56MHz RFID technology – an RFID coil is embedded in the PCB behind each receptor and the iFob contains a 13.56MHz RFID tag. The user interface is via a 5" colour resistive touch screen. The product is powered from an external mains power brick creating a 15V regulated supply. An optional Ethernet connection is provided. The system can also operate from an internal sealed-lead-acid battery in the event of mains failure.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Constantly Tx 13.56 MHz cycling through all iFobs (1-21) LCD Backlight Bright, Door Open	Yes
Mode 2	EUT constantly transmitting CW coil position 11	Yes
Mode 3	Constantly Tx 13.56 MHz iFobs position 1 only activated, LCD Backlight Bright, Door Open	Yes
Mode 4	Constantly Tx 13.56 MHz iFobs position 11 only activated, LCD Backlight Bright, Door Open	Yes
Mode 5	Constantly Tx 13.56 MHz iFobs position 21 only activated, LCD Backlight Bright, Door Open	Yes

The modes described in this table were investigated and the worst case 'Normal Mode' was used for testing.

2.5 Emissions configuration



The unit was powered from the dedicated AC/DC adapter. The unit was configured with engineering menus in software to allow continuous transmit on a single 'iFob' – Positions 1, 11 and 21 or Normal operation where the 21 RFID tags are continuously scanned in a loop (only 1 of the 21 positions is enabled at any one time).

The EUT had 21 'Receptor' used to hold 'iFobs' – these are plastic keyfobs attached to each key bunch to be controlled. The 'iFobs' are inserted into the receptors and released under software control. The 'iFobs' are detected and identified using 13.56 MHz RFID technology – an RFID coil is embedded in the PCB behind each receptor and the 'iFob' contains a 13.56 MHz RFID tag.

The LCD touchscreen display was permanently on at full brightness during testing. The EUT was investigated for worst case emissions with the door opened and closed as well as with all tags present and removed, the worst case configuration was with the door opened and all tags present.

A support laptop was provided to enable the EUT to be configured in the various test modes provided

Single Channel: 13.56 MHz

2.5.1 Signal leads

Port Name	Cable Type	Connected
DC Power	2 core, unscreened, 1.3m	Yes

3 Summary of test results

The Traka21, was tested for compliance to the following standard(s):

47 CFR Part 15.225
Effective Date 1st October 2023
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 ²
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	PASSED 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 Spectrum investigated up to a frequency of 4.8GHz based on 10 times the highest channel/ signal generated in equipment of 480MHz.

² Spectrum below 30MHz started at a frequency of 32.768 kHz based on the lowest signal used within the equipment as declared by the applicant.

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	2023	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	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	120V AC
T minimum	-20 °C	V minimum	102V AC
T maximum	55 °C	V maximum	138V AC

Extremes of temperature are based upon manufacturer's declaration.

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.

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.

At least 6 signals within 20dB and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site H.

5.1.4 Test equipment

LPE222, LPE373, ZSW1, E412, F238

See Section 9 for more details

5.1.5 Test results

Temperature of test environment 16°C
Humidity of test environment 46%
Pressure of test environment 990kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Plot refs
14343-3 Cond 1 AC Live 150k-30M Average
14343-3 Cond 1 AC Live 150k-30M Quasi-Peak
14343-3 Cond 1 AC Neutral 150k-30M Average
14343-3 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.156	56.0	53.9	-11.8	39.0	-16.7
2	0.199	52.4	49.7	-14.0	34.6	-19.1
3	0.231	48.5	46.1	-16.3	32.1	-20.3
4	0.240	47.2	45.4	-16.7	29.6	-22.5
5	0.262	45.8	42.4	-19.0	24.6	-26.8
6	0.303	43.1	40.2	-20.0	25.9	-24.3
7	0.339	40.3	37.0	-22.2	21.6	-27.6
8	13.560	48.6	46.2	-13.8	41.2	-8.8

Table of signals measured for Cond 1 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.156	55.4	53.6	-12.1	38.0	-17.7
2	0.199	51.6	49.1	-14.6	33.2	-20.5
3	0.237	47.5	45.1	-17.1	30.1	-22.1
4	0.281	44.5	42.0	-18.8	25.3	-25.5
5	0.318	43.4	40.0	-19.8	24.8	-25.0
6	0.349	40.3	36.7	-22.3	21.0	-28.0
7	0.387	35.8	32.9	-25.2	17.3	-30.8
8	13.560	49.0	46.8	-13.2	41.5	-8.5
9	20.560	43.0	39.9	-20.1	32.9	-17.1

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

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. Radiated Emissions testing was performed whilst powered from a 120 VAC 60 Hz power source. 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.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site H.

5.2.4 Test equipment

TMS81, ZSW1, E412, F238

See Section 9 for more details

5.2.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 102kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Plot refs
14343-3 Rad 1 9k-150kHz Para
14343-3 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. Radiated Emissions testing was performed whilst powered from a 120 VAC 60 Hz power source. 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.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site H.

5.3.4 Test equipment

TMS81, ZSW1, E412, F238

See Section 9 for more details

5.3.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 102kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Plot refs
14343-3 Rad 1 150k-30MHz Para
14343-3 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 ± 3.9 dB

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. Radiated Emissions testing was performed whilst powered from a 120 VAC 60 Hz power source. 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 4metres 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, E412, F238

See Section 9 for more details

5.4.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 100kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Plot refs
14343-3 Rad 1 VHF Horiz
14343-3 Rad 1 VHF Vert
14343-3 Rad 1 UHF Horiz
14343-3 Rad 1 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	57.909	28.1	22.0	-18.0
2	108.900	26.2	20.1	-23.4
3	120.210	29.2	20.7	-22.8
4	124.112	37.4	32.7	-10.8
5	124.934	34.6	30.5	-13.0
6	130.503	28.0	21.6	-21.9
7	138.530	35.0	28.9	-14.6
8	141.879	37.2	28.1	-15.4
9	148.955	34.1	28.4	-15.1
10	157.345	37.8	33.0	-10.5
11	166.153	37.1	35.8	-7.7
12	171.794	33.0	26.4	-17.1

13	173.446	32.6	24.8	-18.7
14	193.363	31.6	26.5	-17.0
15	204.600	30.7	23.5	-20.0
16	208.198	29.5	23.6	-19.9
17	255.508	35.2	29.4	-16.6
18	282.090	35.4	29.4	-16.6
19	325.402	33.3	28.8	-17.2
20	339.836	35.3	32.0	-14.0
21	371.351	37.6	32.8	-13.2
22	379.664	42.3	39.6	-6.4
23	392.726	43.8	42.1	-3.9
24	551.930	33.4	27.8	-18.2
25	596.200	35.3	29.0	-17.0
26	651.565	40.5	34.6	-11.4
27	785.454	39.1	34.9	-11.1
28	912.147	40.9	36.5	-9.5
29	969.571	38.2	32.7	-21.3

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	43.655	30.7	24.9	-15.1
2	46.925	33.4	27.1	-12.9
3	56.958	38.6	34.4	-5.6
4	60.823	38.4	33.8	-6.2
5	63.955	36.1	31.3	-8.7
6	68.101	32.8	25.2	-14.8
7	74.889	30.8	25.6	-14.4
8	109.672	32.0	25.8	-17.7
9	124.113	40.9	35.8	-7.7
10	138.923	37.0	32.5	-11.0
11	141.731	39.7	35.1	-8.4
12	148.002	33.8	26.7	-16.8
13	160.168	34.9	28.7	-14.8
14	166.153	32.7	30.2	-13.3
15	288.000	33.1	29.1	-16.9
16	300.064	34.3	29.3	-16.7
17	319.474	38.0	34.1	-11.9
18	332.657	37.0	33.9	-12.1
19	339.883	37.7	34.2	-11.8
20	354.284	32.9	27.6	-18.4
21	379.679	41.7	38.7	-7.3
22	392.726	41.0	38.8	-7.2
23	518.768	34.0	28.6	-17.4
24	589.090	40.7	36.8	-9.2
25	651.530	41.3	35.6	-10.4
26	785.453	40.8	36.6	-9.4
27	939.000	38.6	32.7	-13.3
28	981.800	42.3	36.4	-17.6

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 ± 6.1 dB

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209/15.225(d) [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 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. Radiated Emissions testing was performed whilst powered from a 120 VAC 60 Hz power source.

The EUT was operated in Mode 1.

5.5.3 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 with appropriate absorbing material for use in this range. The EUT was raised at 1.5 m above the ground plane and the measuring antenna was placed in line with the EUT, which was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1GHz - 6GHz.

Tests were performed in Test Site H.

5.5.4 Test equipment

E412, F238, LPE261, LPE333

See Section 9 for more details

5.5.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 100kPa

Setup Table

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
There were no signals measured within 20 dB of the limit.						

Plots	
14343-3 1-2 GHz Vert	
14343-3 1-2 GHz Horiz	
14343-3 2-5 GHz Vert	
14343-3 2-5 GHz Horiz	
14343-3 5-6 GHz Vert	
14343-3 5-6 GHz Horiz	

Peak detector "Max held" Analyser plots against the Average limit line 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.

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:
1 - 6 GHz ± 4.7 dB.

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 antenna was orientated in both Parallel and Perpendicular polarisations. The EUT was rotated in all three orthogonal planes. The EUT was assessed in its normal used position. 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 OATS.

5.6.4 Test equipment

TMS81, ZSW1, E412, F238

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 8°C
Humidity of test environment 67%
Pressure of test environment 100kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

	Single channel
Peak Level (dBµV/m @ 3 m)	42.25
Plot reference	14343-3 H OATS
Antenna Polarisation	Perpendicular
EUT Polarisation	Upright

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

The above 3 m worst case measurement is extrapolated to 30 m using ANSI C63.10:2013 clause 6.4.4 as follows: -

Using clause 6.4.4.1 Equation (1)

$$\begin{aligned}d_{\text{near field}} &= 47.77 / f_{\text{MHz}} \\&= 47.77 / 13.56 \\&= 3.523 \text{ m}\end{aligned}$$

Using clause 6.4.4.2 Equation (2)

$$\begin{aligned}FS_{\text{limit}} &= FS_{\text{max}} - 40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}}) \\&= 42.25 - 40 \log(3.523 / 3) - 20 \log(30 / 3.523)\end{aligned}$$

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= 20.85 dB μ V/m @ 30 m.

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 μ V/m @ 30m = 84 dB μ V/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 μ V/m @ 30m = 50.5 dB μ V/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 μ V/m @ 30m = 40.5 dB μ V/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:
< $\pm$ 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 tested whilst connected to the AC power for maximised emissions. 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. A 3 kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20 dB bandwidth.

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

5.7.4 Test equipment

TMS81, ZSW1, E412, F238

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 20°C
Humidity of test environment 38%
Pressure of test environment 102kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

	Single channel
20 dB Bandwidth (MHz) Nominal Temp & Volts	0.055118
Plot for 20 dB Bandwidth (MHz) Nominal Temp & Volts	14343-1 20dB BW 300kHzSpan
FLOW Worst case (MHz)	13.532441
FHIGH Worst case (MHz)	13.587559

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's power port was connected to a variable power supply. This allowed the voltage end points to be set as required by the specification.

The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of a test fixture. 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 A.

5.8.4 Test equipment

E555, E755, TMS38, TMS80

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 23°C
Humidity of test environment 40%
Pressure of test environment 101kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

	Single channel
Nominal, Maximised RF Output / field strength	42.25
Nominal plot reference	14343-3 Spectrum Mask Tnom

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

The above 3 m worst case measurement is extrapolated to 30 m using ANSI C63.10:2013 clause 6.4.4 as follows: -

Using clause 6.4.4.1 Equation (1)

$$\begin{aligned}d_{\text{near field}} &= 47.77 / f_{\text{MHz}} \\&= 47.77 / 13.56 \\&= 3.523 \text{ m}\end{aligned}$$

Using clause 6.4.4.2 Equation (2)

$$\begin{aligned}FS_{\text{limit}} &= FS_{\text{max}} - 40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}}) \\&= 42.25 - 40 \log(3.523 / 3) - 20 \log(30 / 3.523) \\&= 20.85 \text{ dB}\mu\text{V/m @ 30 m.}\end{aligned}$$

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 $\mu\text{V/m}$ @ 30m = 84 dB $\mu\text{V/m}$ @ 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 $\mu\text{V/m}$ @ 30m = 50.5 dB $\mu\text{V/m}$ @ 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 $\mu\text{V/m}$ @ 30m = 40.5 dB $\mu\text{V/m}$ @ 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:
< $\pm$ 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's power port was connected to a variable power supply. This allowed the voltage end points to be set as required by the specification.

The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of a test fixture. The EUT was operated in Mode 2.

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. A frequency count was made on a CW signal. At nominal temperature the EUT supply was varied by +/-15% / to manufacturer's end points.

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

E555, E755, TMS38, TMS80

See Section 9 for more details

5.9.5 Test results

Temperature of test environment 22°C
Humidity of test environment 42%
Pressure of test environment 101kPa

Band	13.11-14.01 MHz
Power Level	200 mW
Channel Spacing	Non-Channelised
Mod Scheme	RFID
Single channel	13.56 MHz

Test conditions		Frequency Error (MHz) Single channel
-20°C	Volts Nominal (120)	13.560048
-20°C	Volts Nominal (120)	13.560048
-10°C	Volts Nominal (120)	13.560030
0°C	Volts Nominal (120)	13.560007
10°C	Volts Nominal (120)	13.559997
20°C	Volts Minimum (102)	13.559997
	Volts Nominal (120)	13.559998
	Volts Maximum (138)	13.559996
30°C	Volts Nominal (120)	13.560034
40°C	Volts Nominal (120)	13.560006
50°C	Volts Nominal (120)	13.559968

Max Frequency Error per chan (Hz)	+50 / -2
Max Frequency Error observed (MHz)	0.000050

Note: Error shown is referenced to nominal EUT frequency reading.

Maximum variation observed was +50 Hz

LIMITS:

+/- 0.01%. (+/- 1.356kHz)

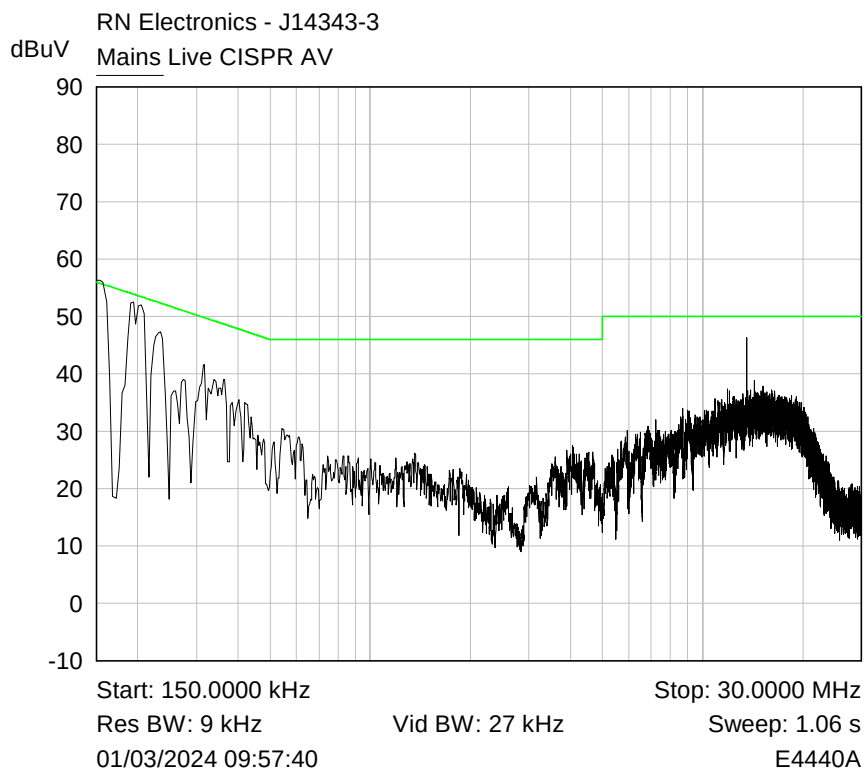
These results show that the EUT has PASSED this test.

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

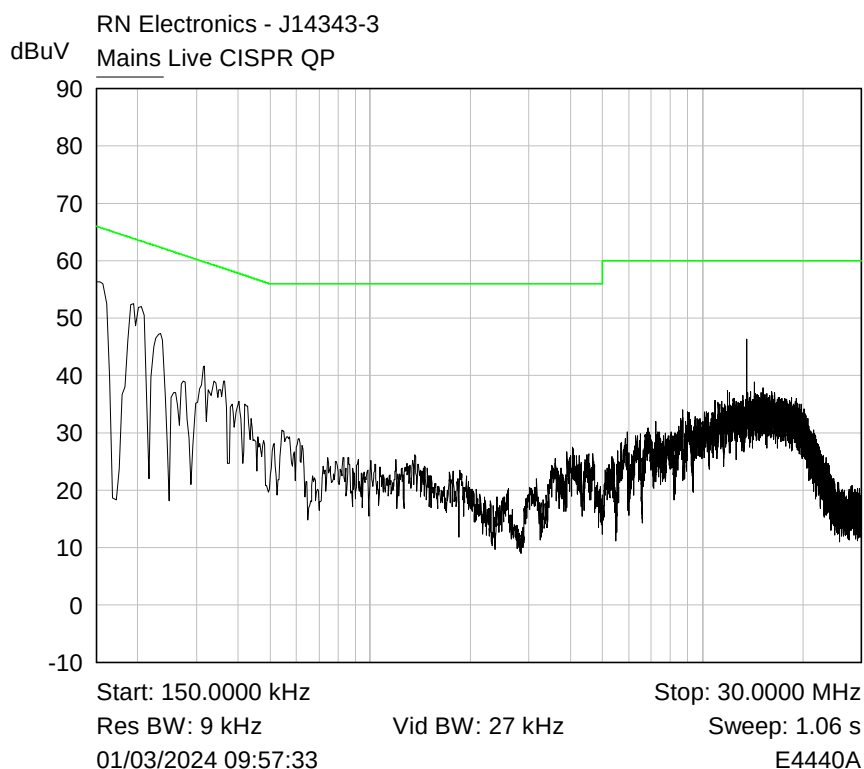
6.1 AC power line conducted emissions

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz



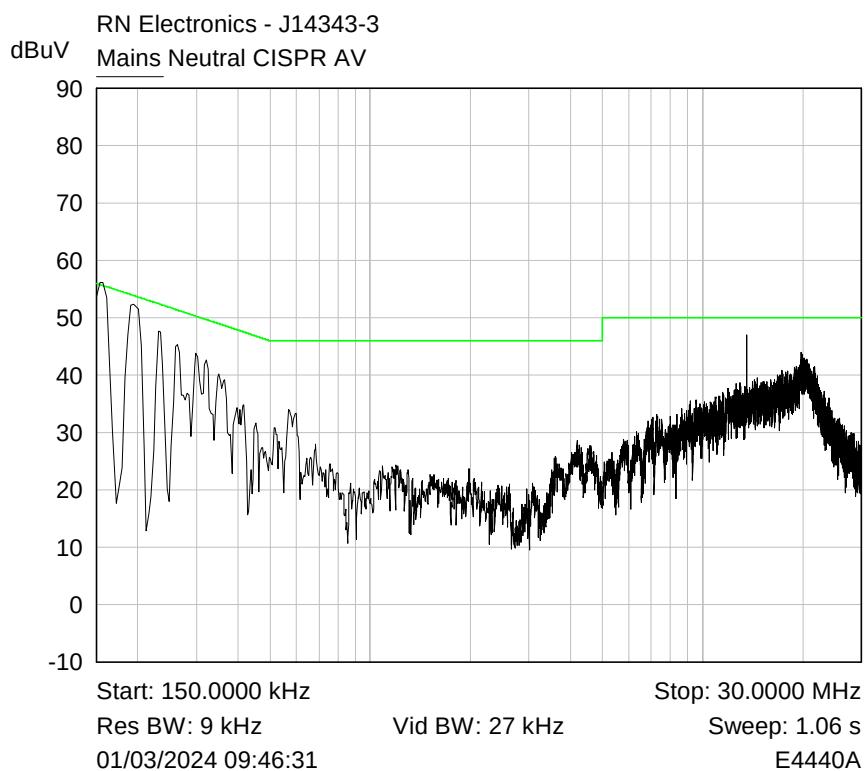
Plot of Live150k-30M Average

Note: Signal on plot is 13.56 MHz intentional transmission



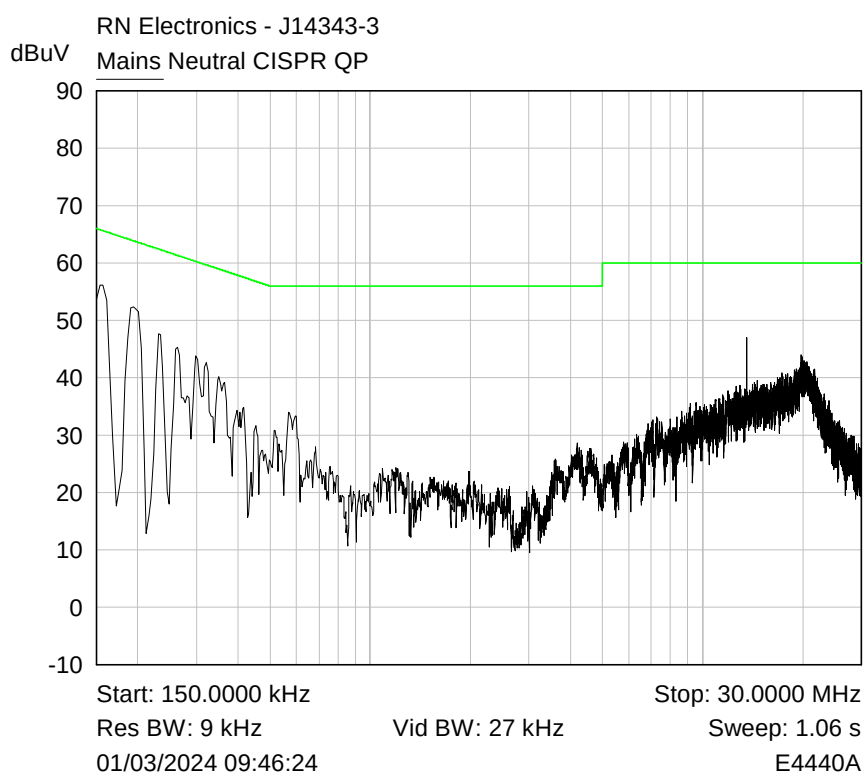
Plot of Live150k-30M Quasi-Peak

Note: Signal on plot is 13.56 MHz intentional transmission



Plot of Neutral150k-30M Average

Note: Signal on plot is 13.56 MHz intentional transmission

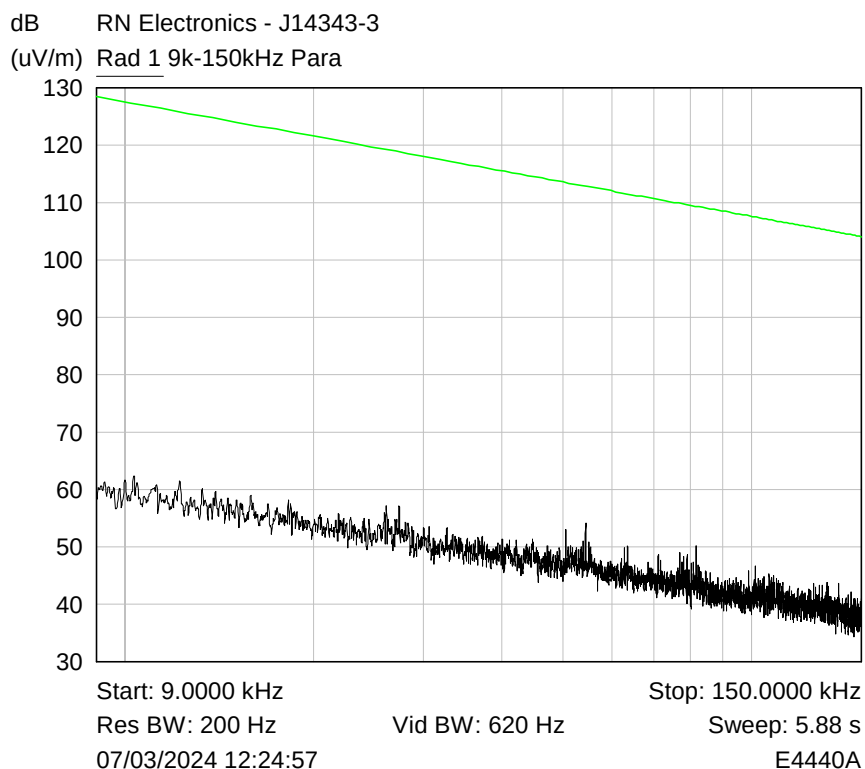


Plot of Neutral150k-30M Quasi-Peak

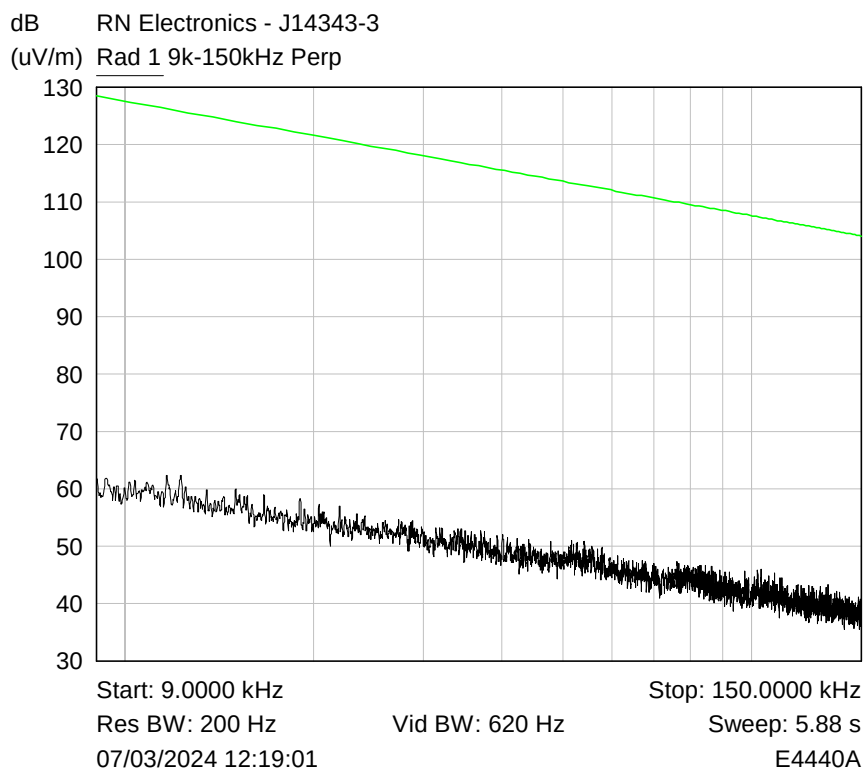
Note: Signal on plot is 13.56 MHz intentional transmission

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz



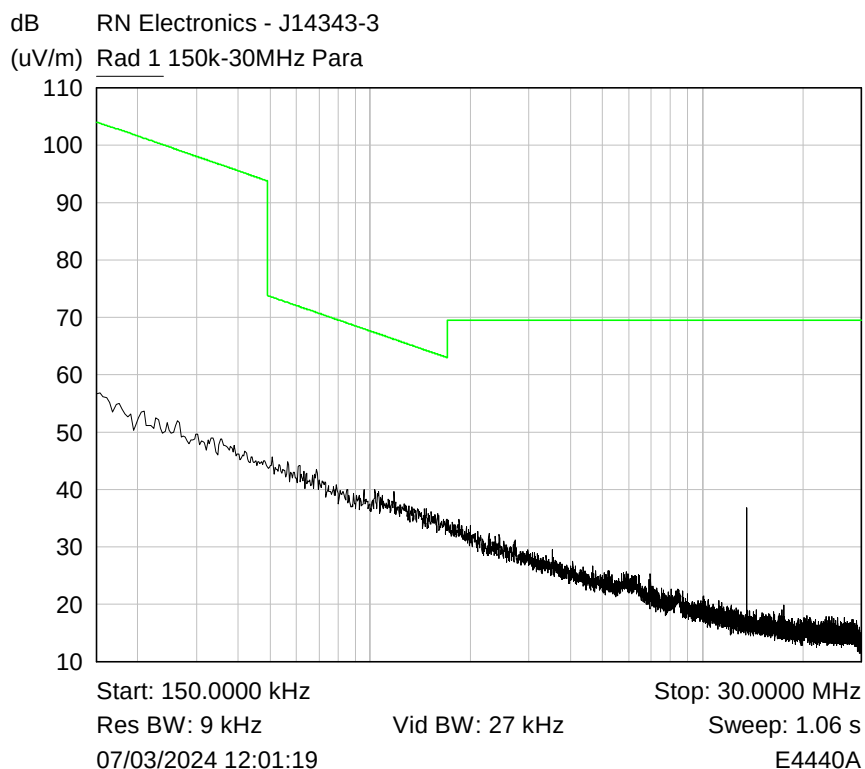
Plot of 9k-150kHz Parallel



Plot of 9k-150kHz Perpendicular

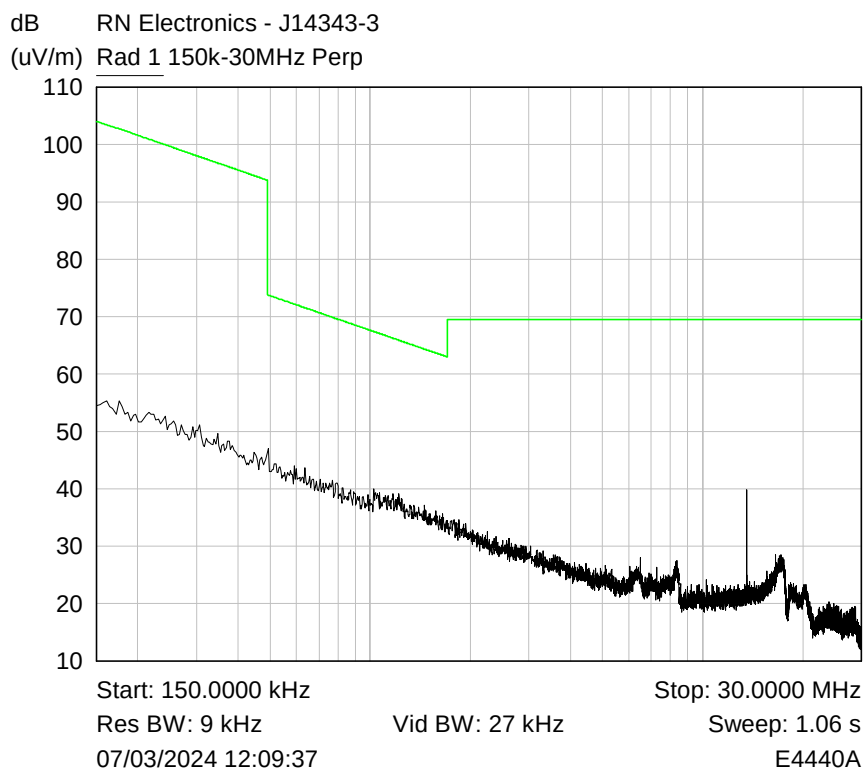
6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz



Plot of 150kHz-30MHz Parallel

Note: Signal on plot is 13.56 MHz intentional transmission



Plot of 150kHz-30MHz Perpendicular

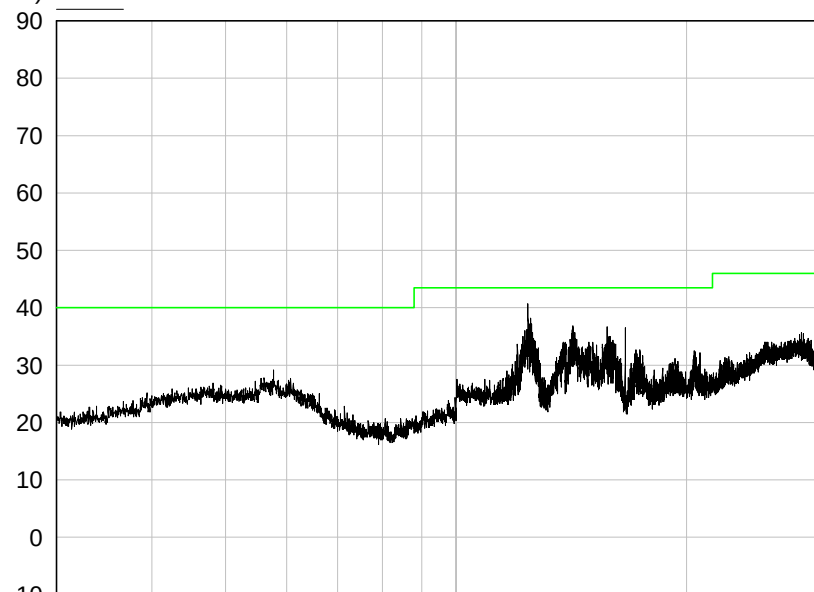
Note: Signal on plot is 13.56 MHz intentional transmission

6.4 Radiated emissions 30 MHz -1 GHz

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz

dB RN Electronics - J14343-3

(uV/m) Rad 1 VHF Horiz



Start: 30.0000 MHz

Stop: 300.0000 MHz

Res BW: 120 kHz

Vid BW: 360 kHz

Sweep: 147.44 ms

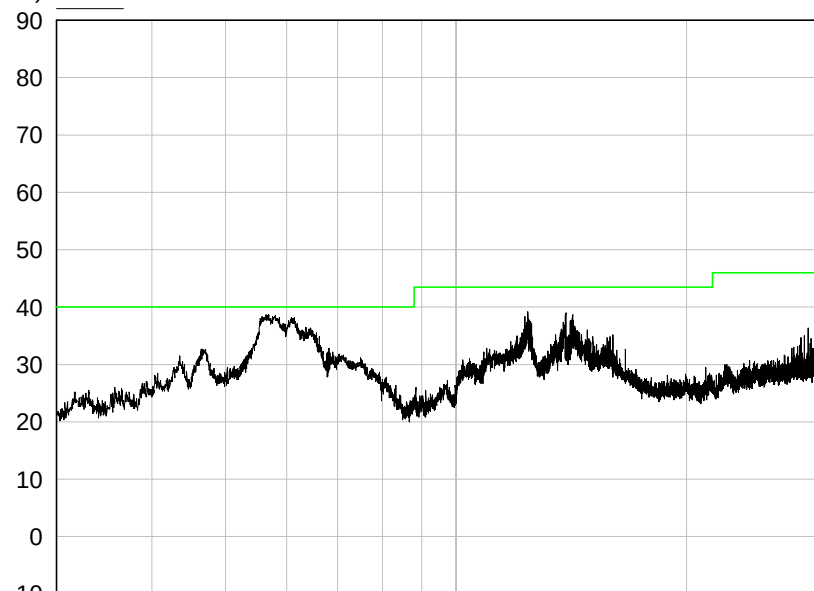
07/03/2024 13:53:27

E4440A

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

dB RN Electronics - J14343-3

(uV/m) Rad 1 VHF Vert



Start: 30.0000 MHz

Stop: 300.0000 MHz

Res BW: 120 kHz

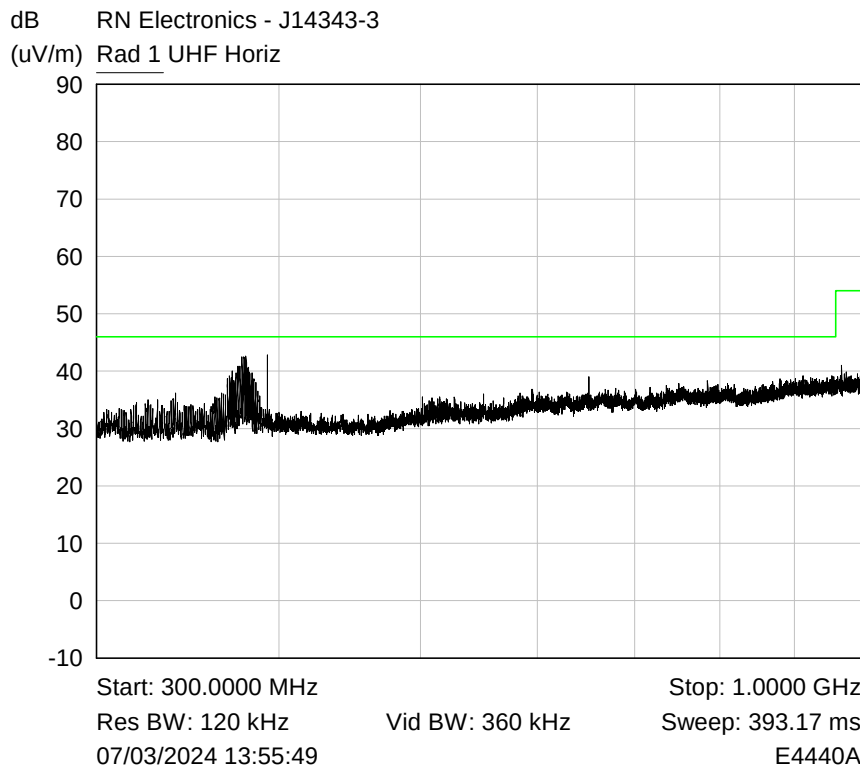
Vid BW: 360 kHz

Sweep: 147.44 ms

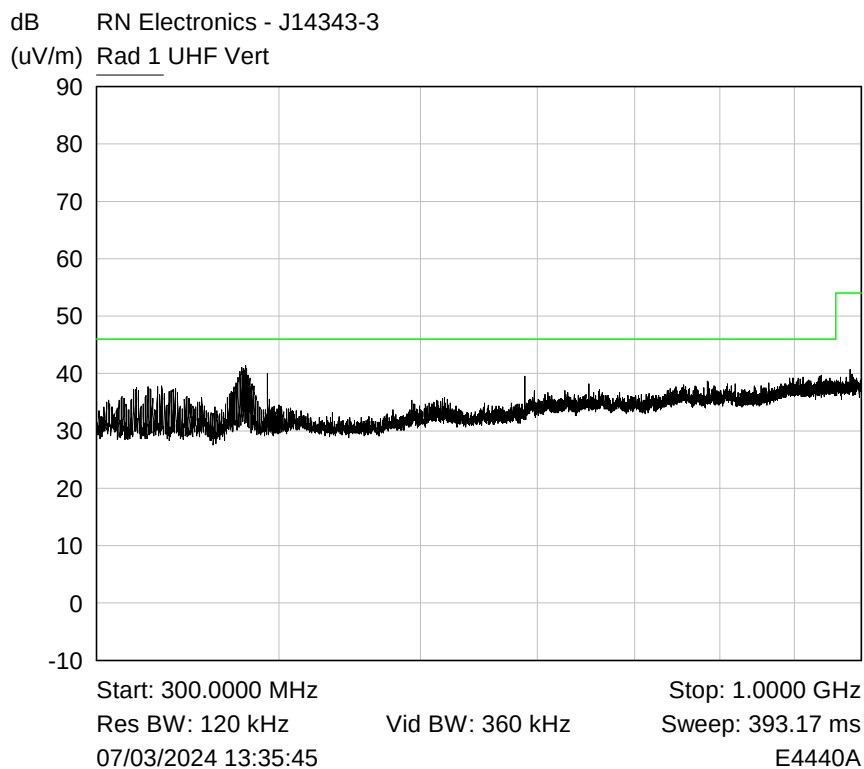
07/03/2024 13:29:55

E4440A

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



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



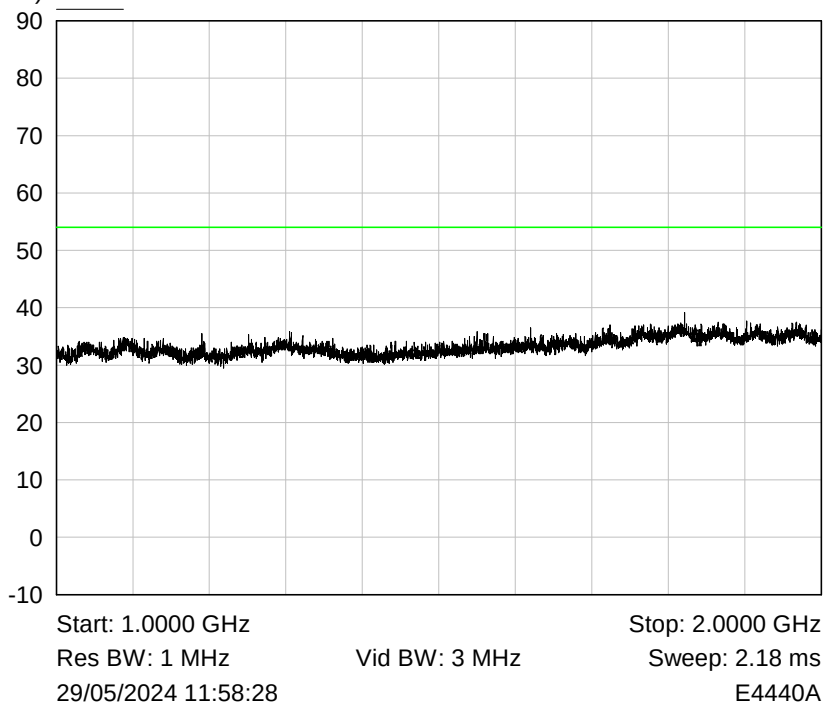
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.5 Radiated emissions above 1 GHz

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz

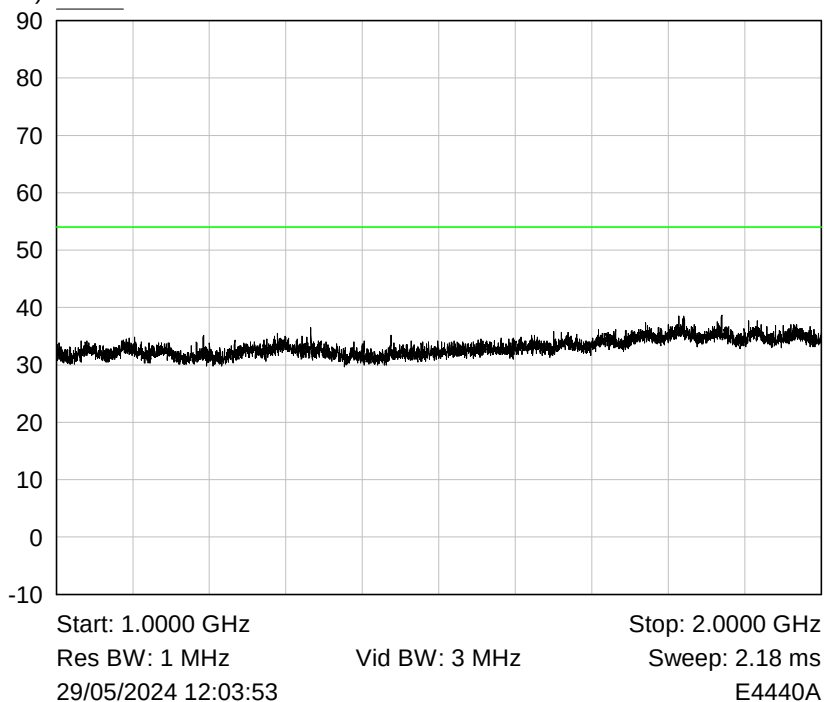
dB 14343-3 1-2 GHz Vert

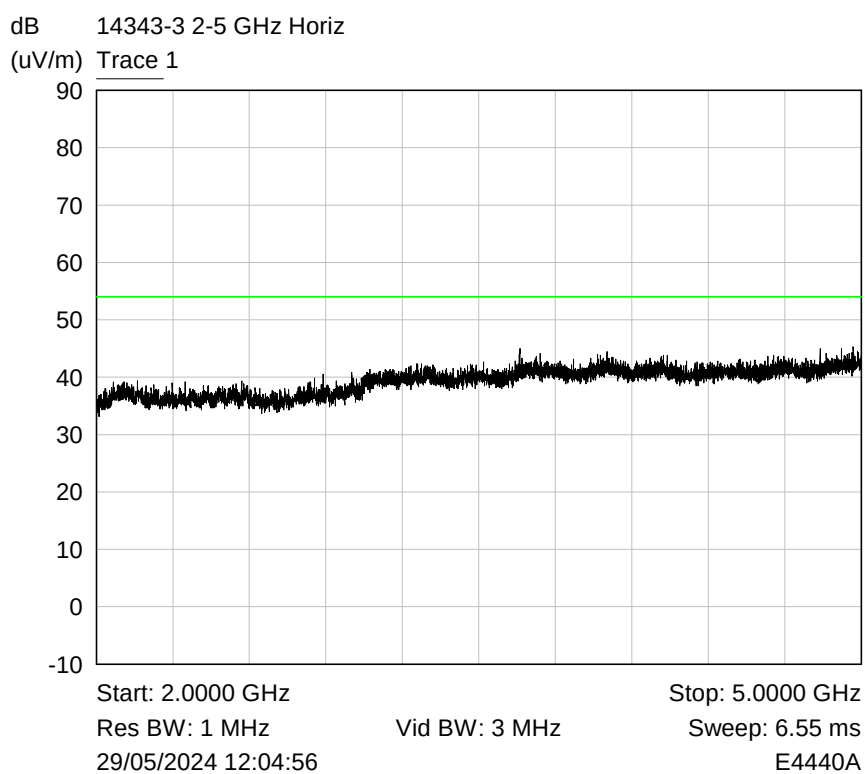
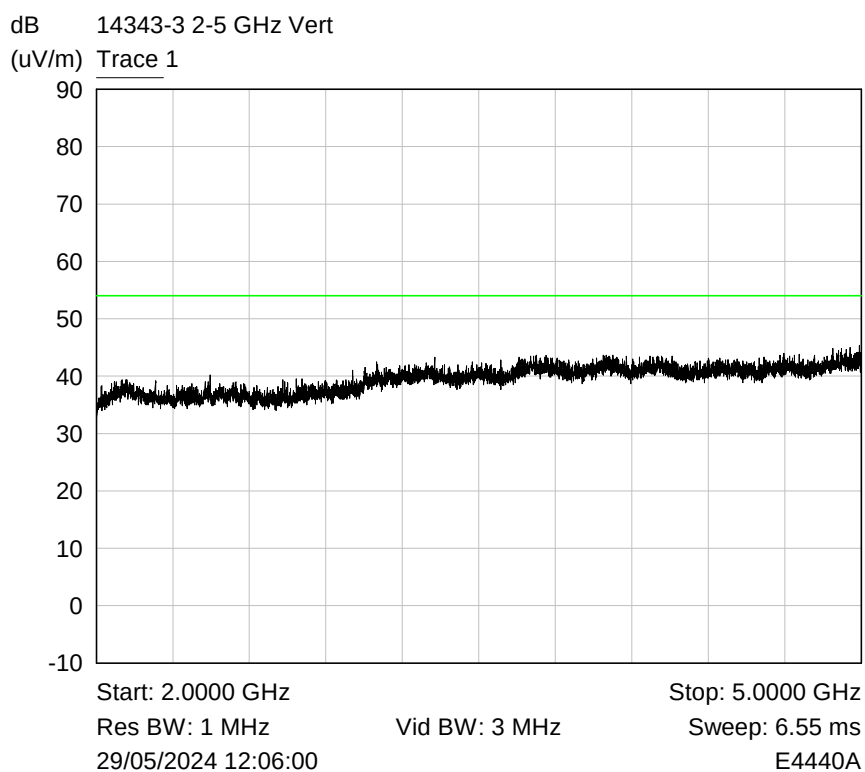
(uV/m) Trace 1

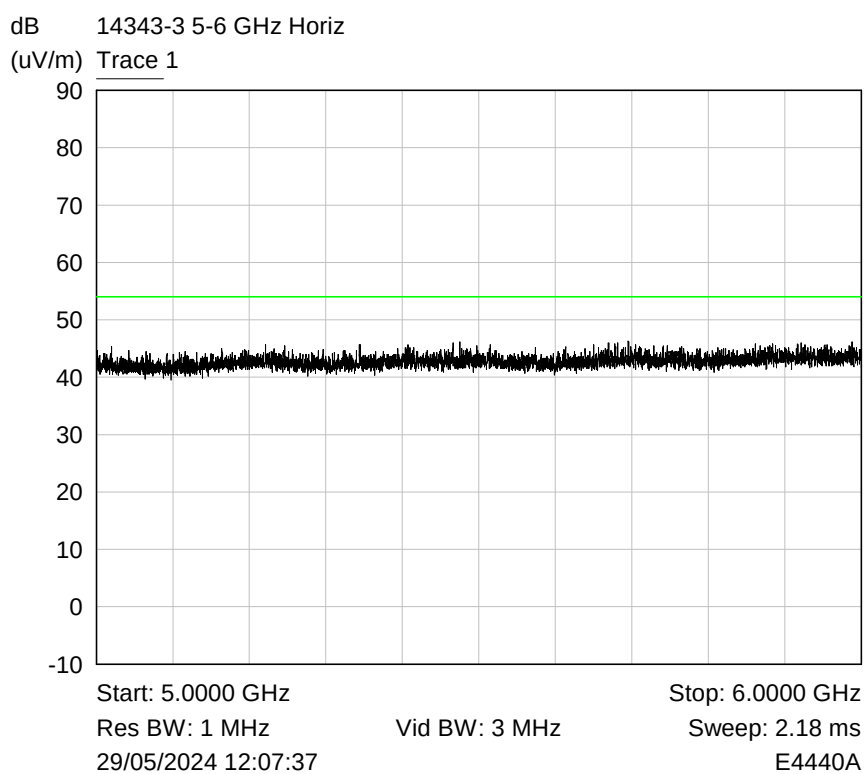
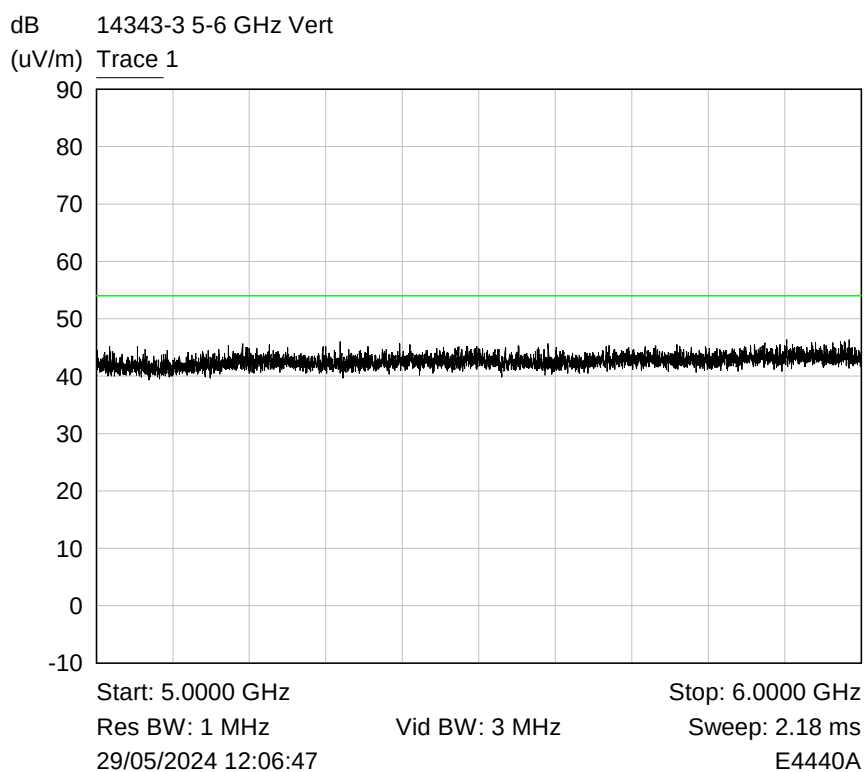


dB 14343-3 1-2 GHz Horiz

(uV/m) Trace 1

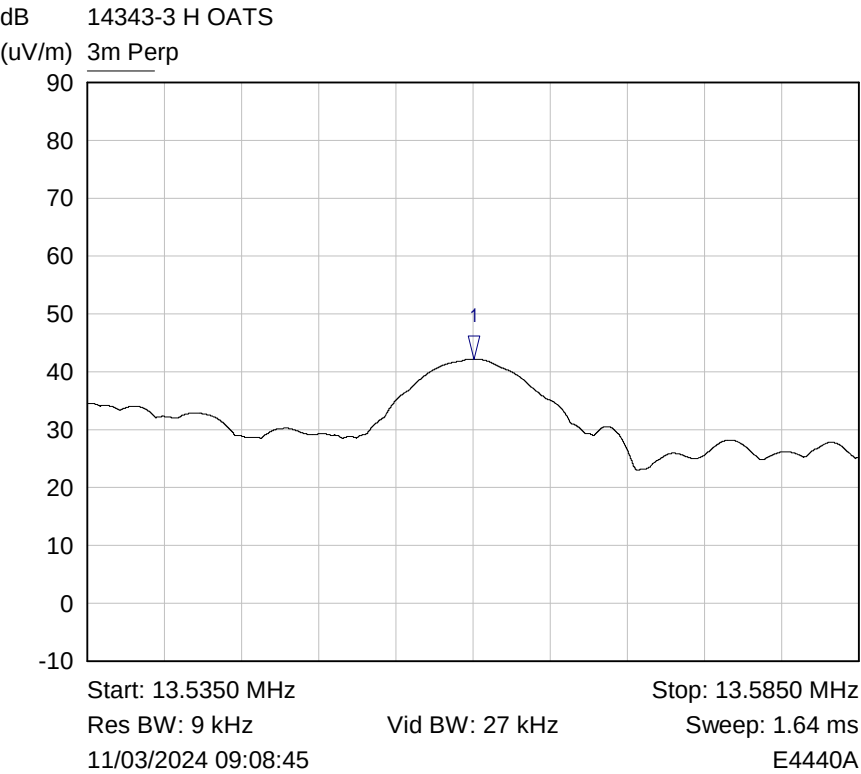






6.6 Intentional radiator field strength

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	3m Perp	13.5601 MHz	42.25 dB(uV/m)	

Intentional radiator field strength

6.7 Occupied bandwidth

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz



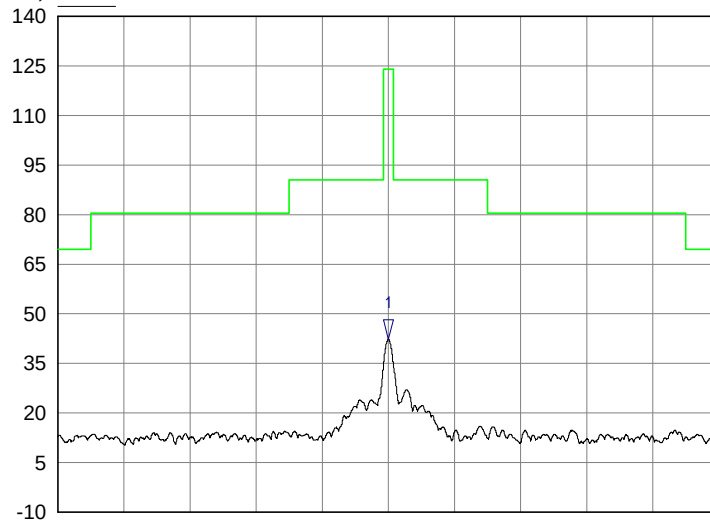
Plot for 20 dB Bandwidth (MHz) Nominal Temp & Volts

6.7 Spectrum mask

RF Parameters: Band 13.11-14.01 MHz, Power 200 mW, Channel Spacing Non-Channelised, Modulation RFID, Channel 13.56 MHz

dB 14343-3 Spectrum Mask Tnom

(uV/m) Trace A



Start: 13.060000 MHz

Stop: 14.060000 MHz

Res BW: 9 kHz

Vid BW: 27 kHz

Sweep: 2.00 ms

12/03/2024 10:00:27

N9030B

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.559950 MHz	42.2500 dB(uV/m)	

Nominal Temperature, Nominal Voltage

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 (dBμV)	Pk – Lim 1 (dB)	QP Amp (dBμV)	QP - Lim1 (dB)	Av Amp (dBμV)	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 $20 \cdot \log(500) = 54$ dB μV/m.

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

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

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QMF21J - Issue 05 - KEC Issue 04; 47 CFR Part 15C 2022

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: $E_{\text{Linear}} = 10^{((E_{\text{Log}} - 120)/20)}$

And therefore equation 21 transposed is: $E_{\text{Log}} = 20 \times \log(E_{\text{Linear}}) + 120$

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

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: $\text{PD} = \text{EIRP}_{\text{Linear}} / 4\pi d^2$

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

Where:

PD is the power density at distance specified by the limit, in W/m²

$\text{EIRP}_{\text{Linear}}$ is the equivalent isotropically radiated power in Watts

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

Equation 26: $\text{PD} = E_{\text{Spec limit}}^2 / 377$

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

Where:

PD is the power density at distance specified by the limit, in W/m²

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

Example:

Radiated spurious emissions limit at 3metres of 90pW/cm².

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

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

And

$$\text{Equation 26 transposed: } E_{\text{Spec limit}} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m.}$$

And

$$\text{Equation 21 transposed: } E_{\text{Log}} = 20 \log(0.01842) + 120 = 85.3\text{dB}\mu\text{V/m @ 3m.}$$

8 Photographs

8.1 EUT Front View





8.2 EUT Reverse Angle





8.3 EUT Left side View

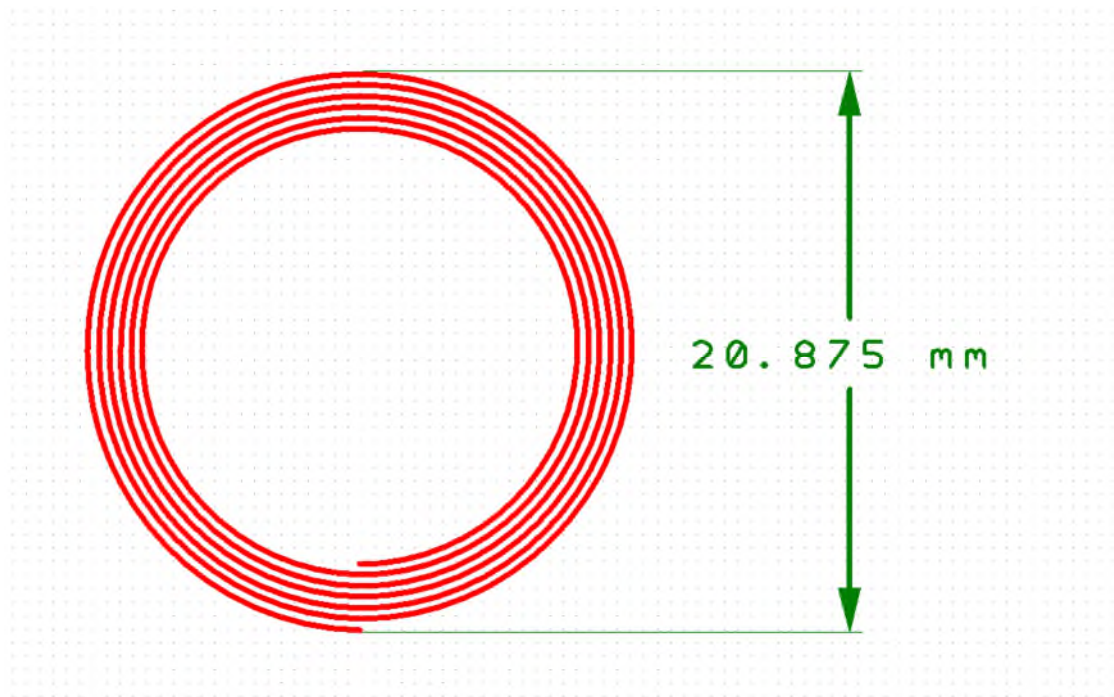


8.4 EUT Right side View



8.5 EUT Antenna Port

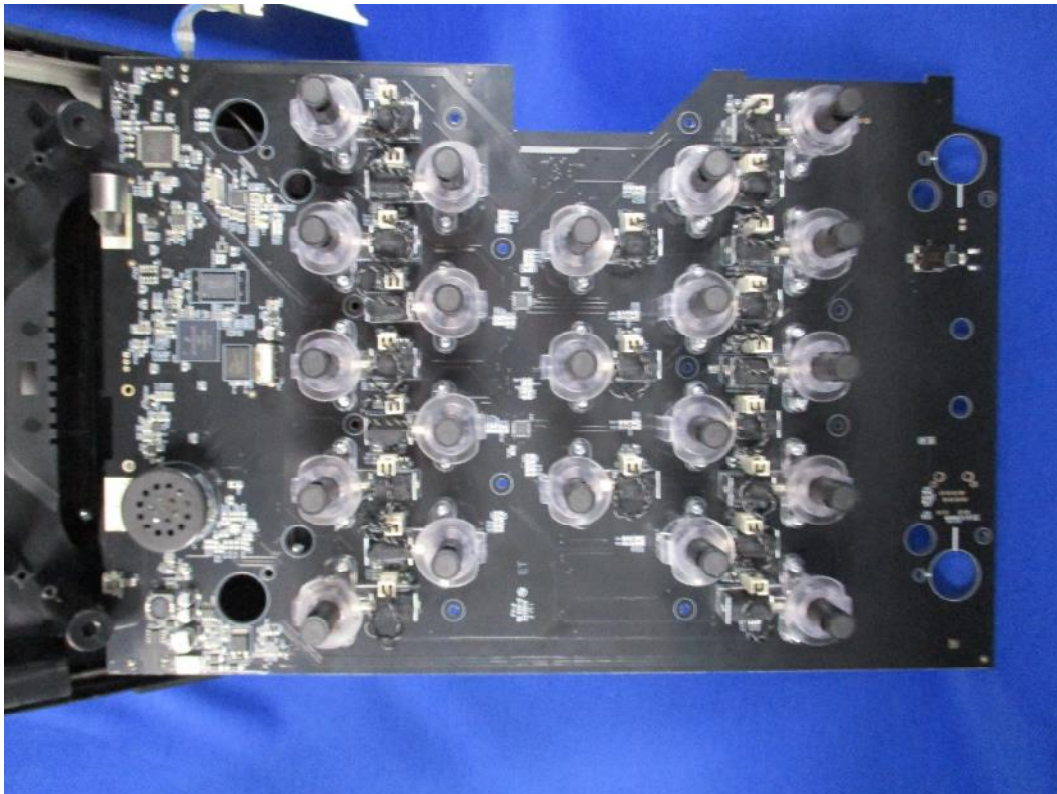
Antenna Coils are located on an internal layer of the main PCB; A Coil dimension diagram has been included for reference.

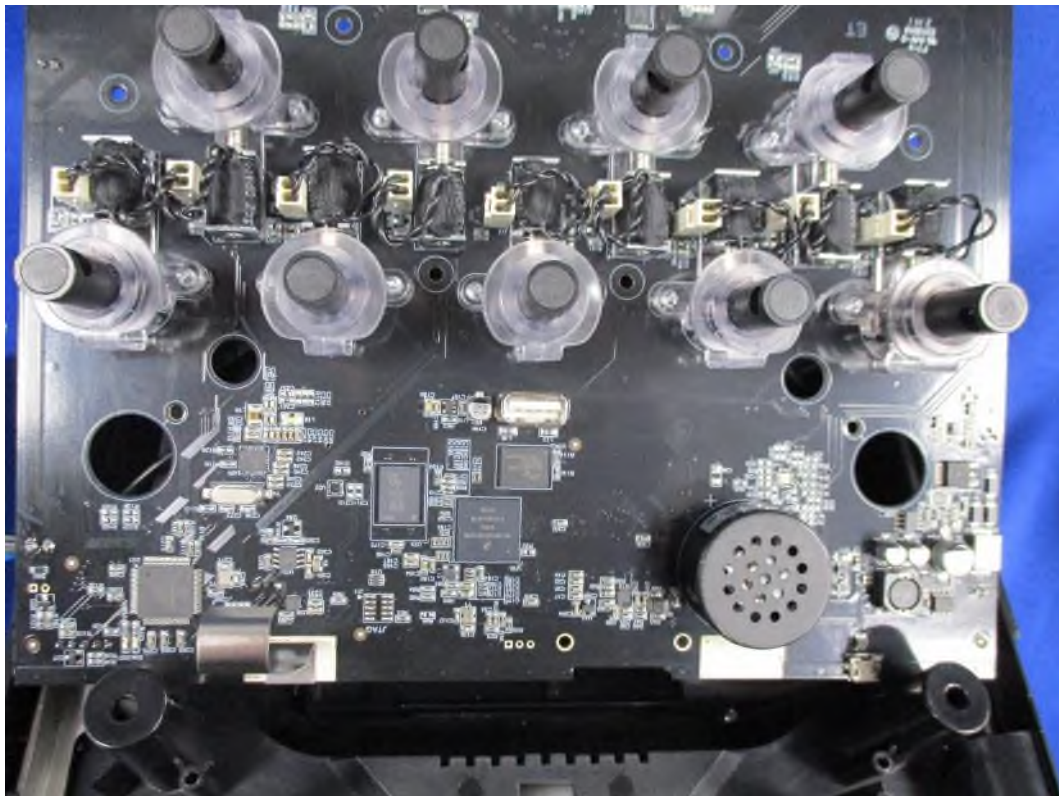
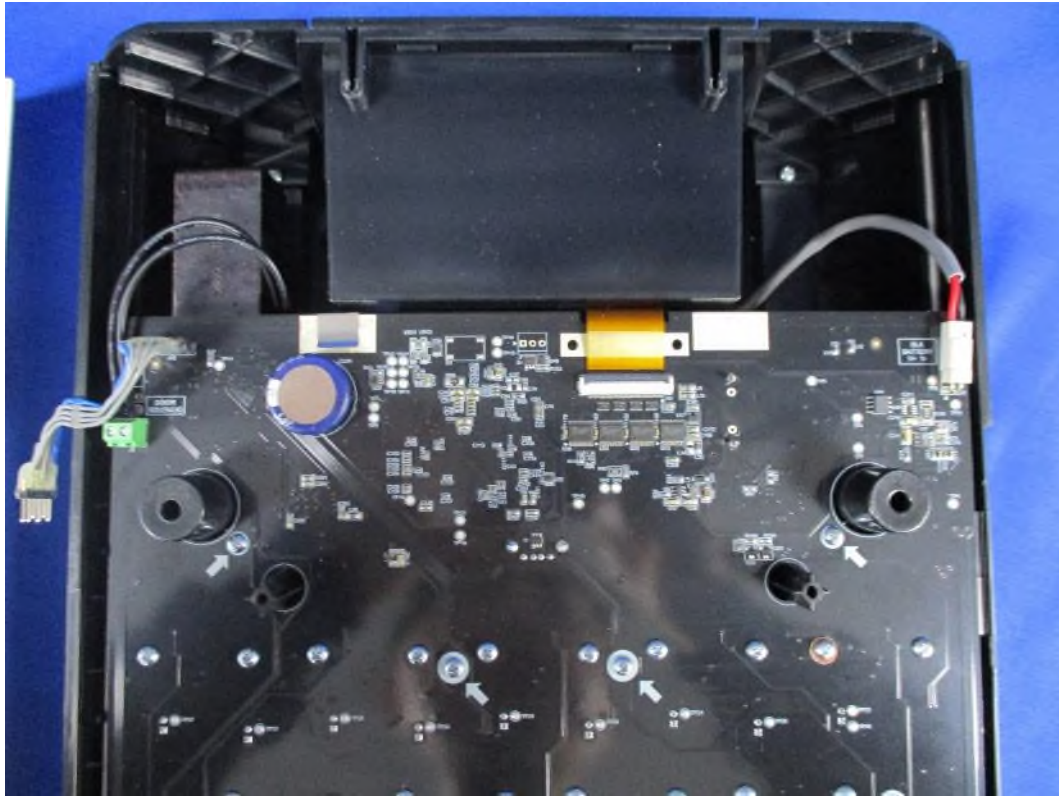


8.6 EUT Display & Controls



8.7 EUT Internal photos



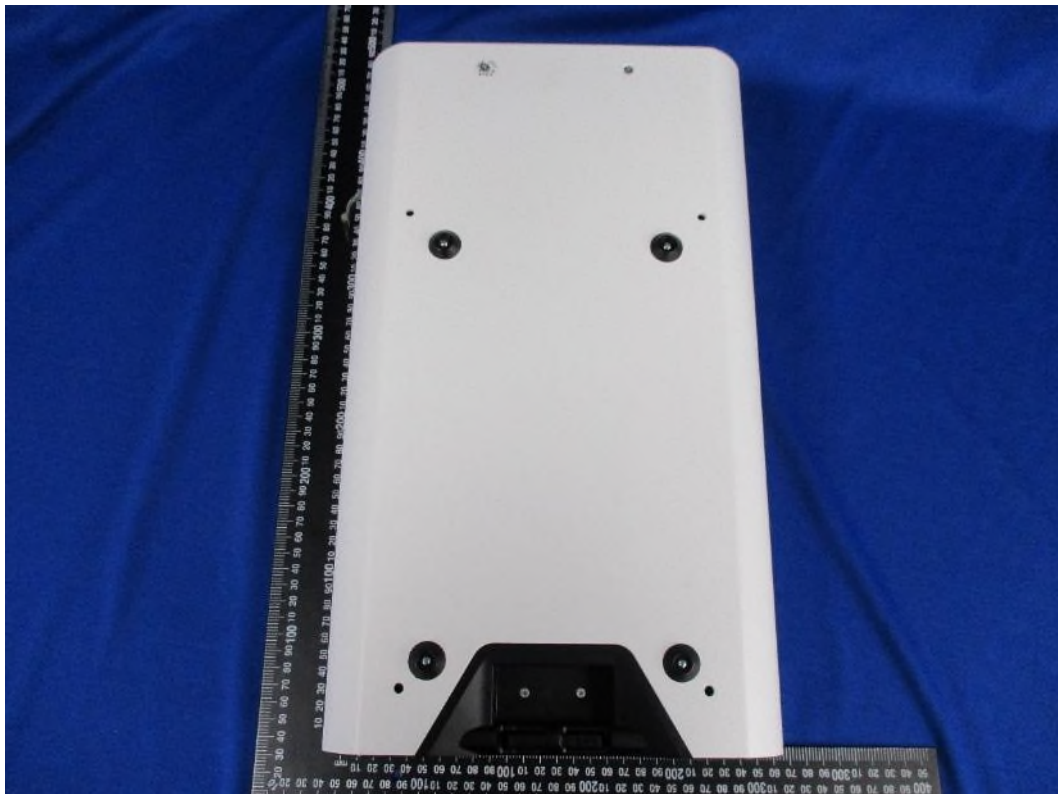


8.8 EUT ID Label





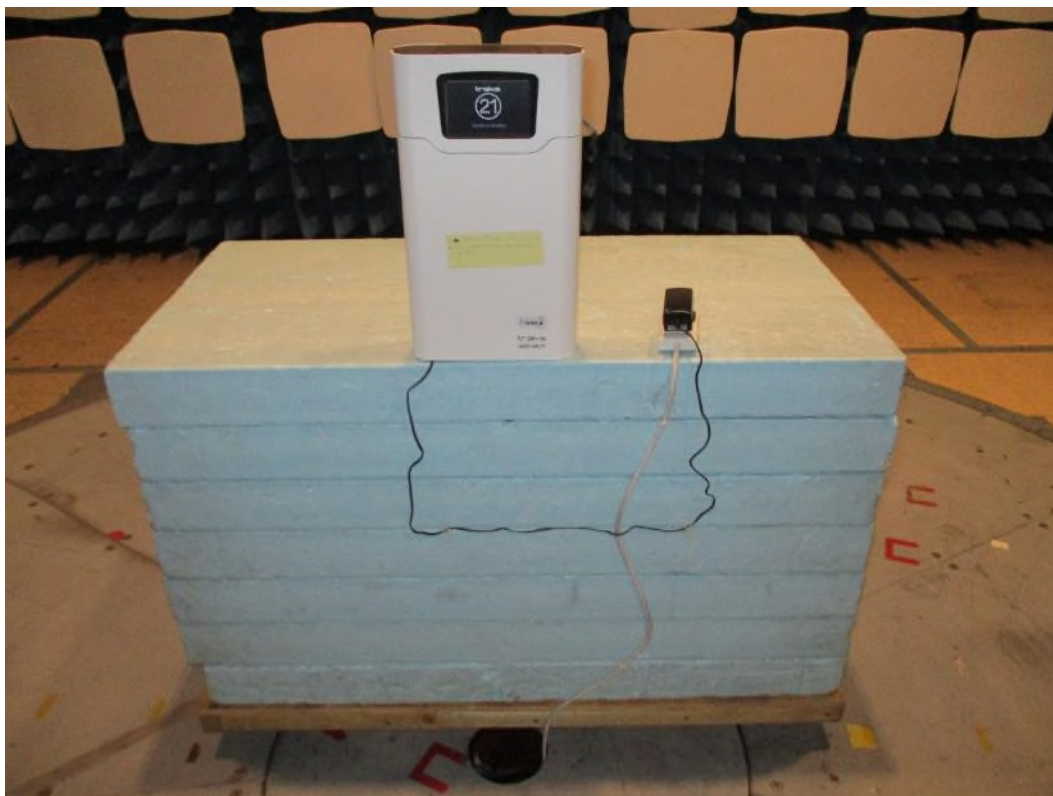
8.9 EUT Chassis



8.10 AC power line conducted emissions



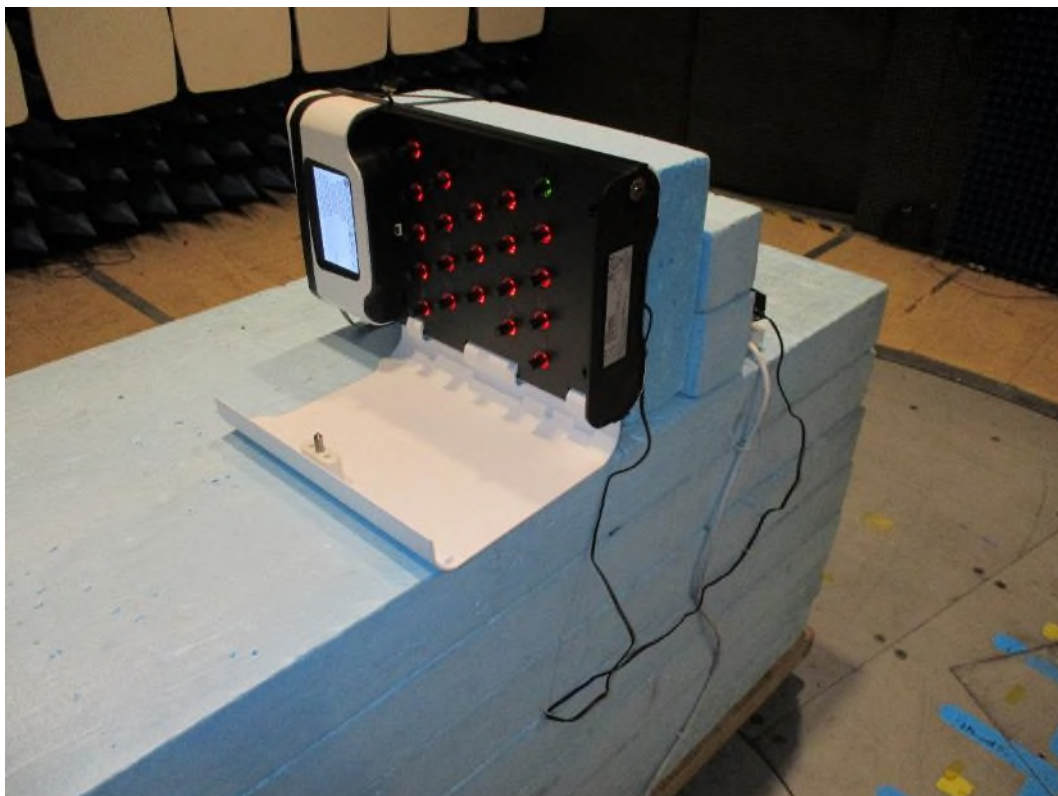
8.11 Radiated emissions 9 kHz - 30 MHz



Upright Position

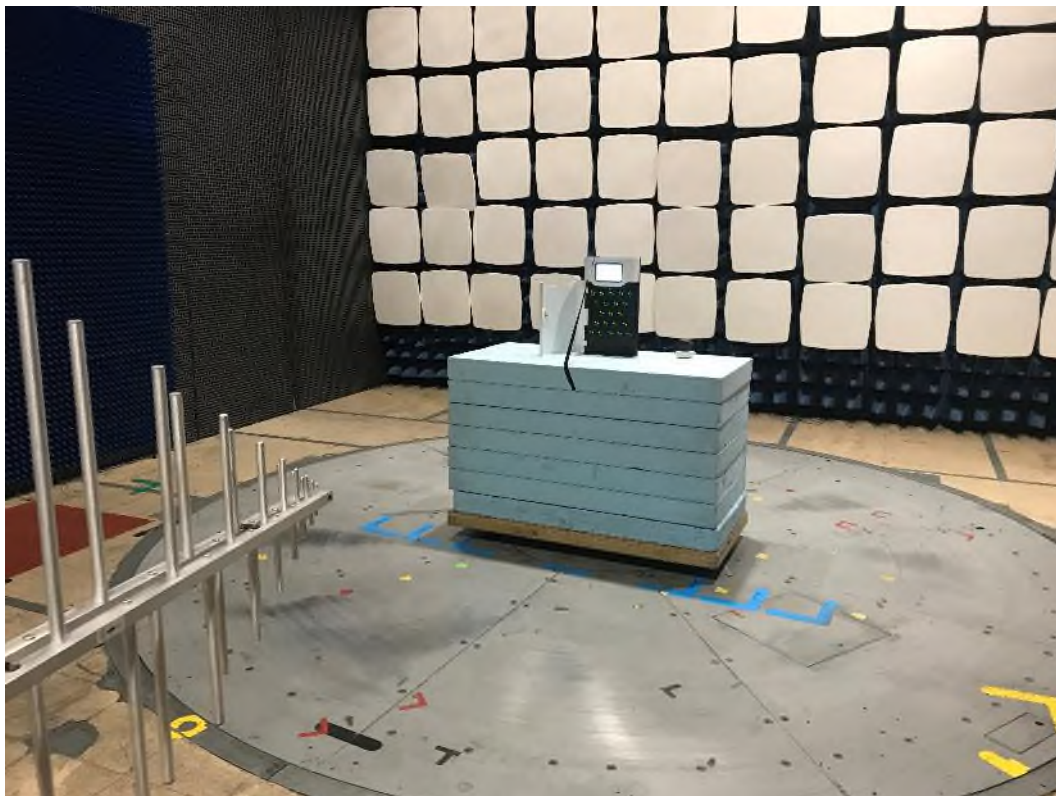


Flat Position

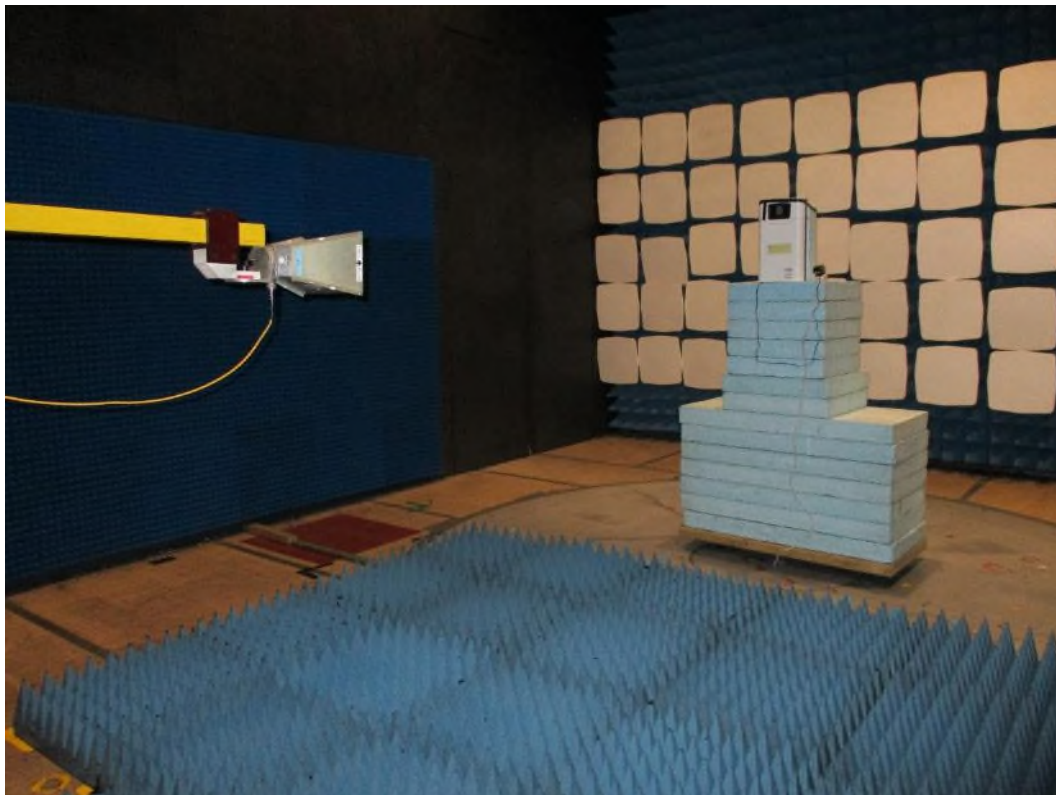


Side Position

8.12 Radiated emissions 30 MHz -1 GHz



8.13 Radiated emissions above 1 GHz



8.14 Radiated emission diagrams

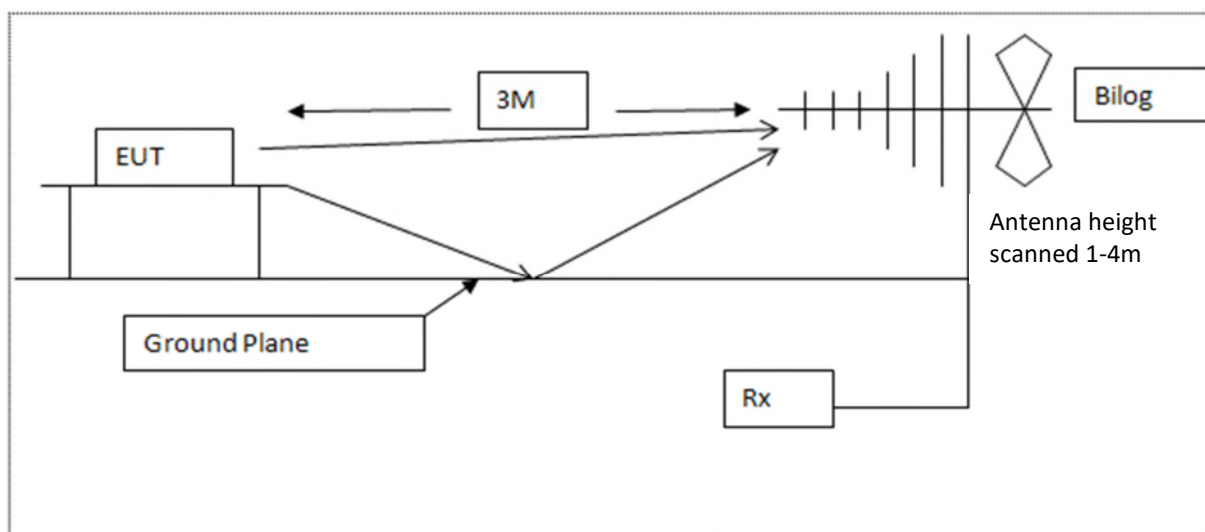


Diagram of the radiated emissions test setup 30 - 1000 MHz

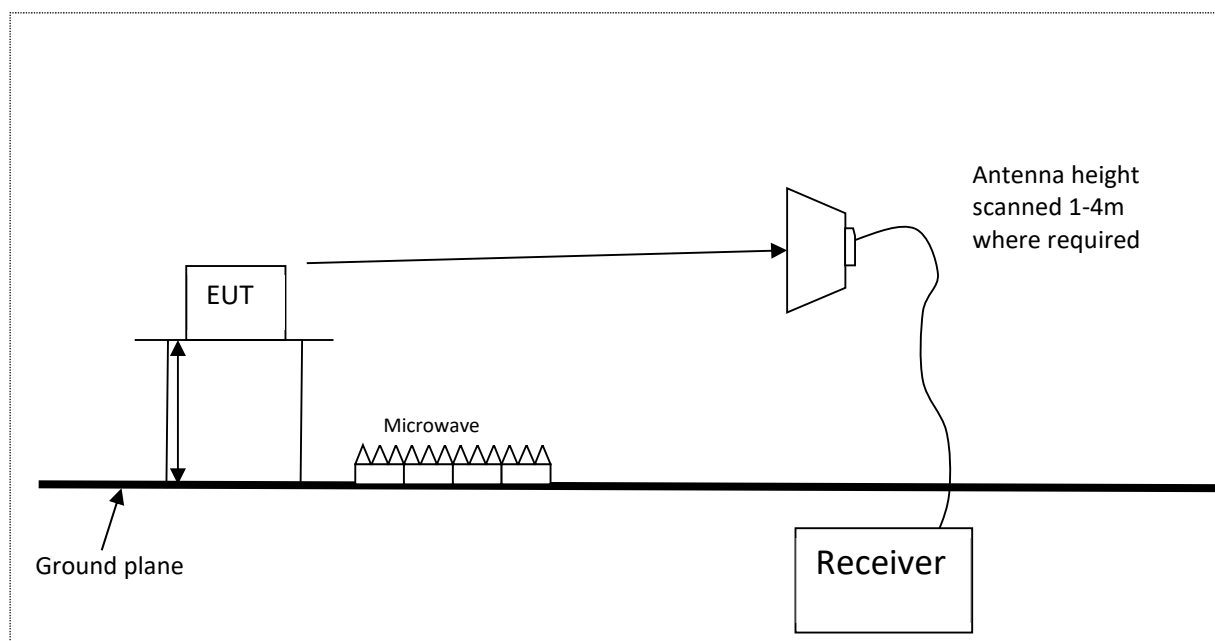


Diagram of the radiated emissions test setup above 1GHz

8.16 AC powerline conducted emission diagram

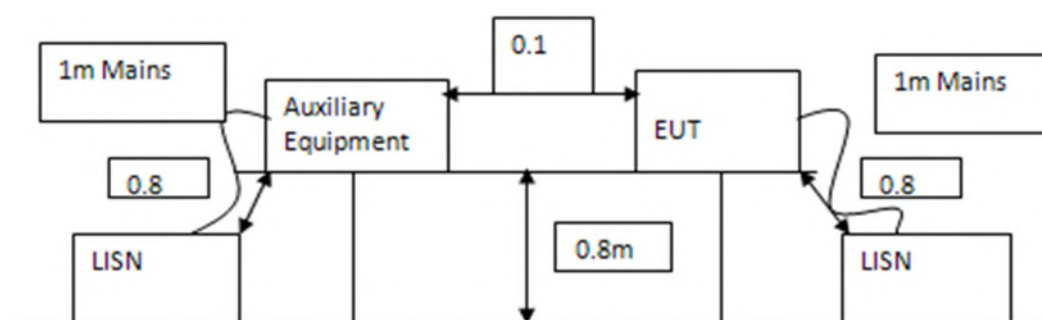


Diagram of the AC conducted emissions test setup

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.

KEC No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	22-Sep-2023	24 months
E555	CMV 5E-1	Variac 5A	Carroll & Meynell Ltd	08-Jan-2024	12 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	22-Feb-2024	12 months
E755	N9030B	PXA Signal Analyser 3 Hz to 50 GHz	Keysight Technologies	14-Aug-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
LPE222	MN2050	LISN Artificial Mains Network	Chase	15-May-2023	12 months
LPE261	3115	Horn Antenna 1 - 18 GHz	EMCO	05-May-2023	12 months
LPE333	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	01-Jun-2023	12 months
LPE373	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	30-Jun-2023	12 months
NSA-H	NSA - H	NSA - Site H	RN Electronics	17-May-2023	36 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	22-Feb-2024	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	

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	PP35L	Laptop	Dell	201908150000010

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

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

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