



2360

Radio Test Report

Eccel Technology Ltd

Action Cam User Interface RFID Unit

000443

47 CFR Part 15.225 Effective Date 1st October 2018
DXX: Part 15 Low Power Communication Device Transmitter
Test Date: 5th June 2020 to 30th June 2020
Report Number: 06-12244-1-20 Issue 02
Supersedes report: 06-12244-1-20 issue 01

R.N. Electronics Ltd.

Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

www.RNelectronics.com

Telephone: +44 (0) 1277 352219
Email: sales@RNelectronics.com

This report is not to be reproduced by any means except in full and in any case not without the written approval of R.N. Electronics Ltd.



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

Certificate of Test 12244-1

The equipment noted below has been fully tested by R.N. Electronics Limited 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:	Action Cam User Interface RFID Unit
Model Number:	000443
Unique Serial Number:	000001
Applicant:	Eccel Technology Ltd 198 Station Road, Glenfield Leicester, Leicestershire LE3 8GT
Full measurement results are detailed in Report Number:	06-12244-1-20 Issue 02
Test Standards:	47 CFR Part 15.225 Effective Date 1st October 2018 DXX: Part 15 Low Power Communication Device Transmitter

NOTE:

Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer 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: 5th June 2020 to 30th June 2020

Test Engineer:

Approved By:
Radio Approvals Manager

Customer Representative:



0 Revision History

Issue Number	Revision History	Page Reference(s)
01	First Issue	-
02	<i>Updated report issued date</i>	5
	<i>Added 15.205 and 15.209 references to table</i>	10
	<i>Edited text to confirm use of suitable antenna load per FCC requirements.</i>	13
	<i>Added extra radiated emissions photo</i>	68

1 Contents

0	Revision History.....	3
1	Contents.....	4
2	Equipment under test (EUT)	5
2.1	Equipment specification	5
2.2	Configurations for testing.....	6
2.3	Functional description	7
2.4	Modes of operation	7
2.5	Emissions configuration	8
3	Summary of test results.....	10
4	Specifications	11
4.1	Relevant standards	11
4.2	Deviations	11
4.3	Tests at extremes of temperature & voltage	11
4.4	Test fixtures	11
5	Tests, methods and results.....	12
5.1	AC power line conducted emissions.....	12
5.2	Radiated emissions 9 - 150 kHz.....	16
5.3	Radiated emissions 150 kHz - 30 MHz.....	18
5.4	Radiated emissions 30 MHz -1 GHz.....	21
5.5	Radiated emissions above 1 GHz	24
5.6	Intentional radiator field strength	25
5.7	Occupied bandwidth.....	27
5.8	Spectrum mask	30
5.9	Frequency stability	32
6	Plots/Graphical results.....	34
6.1	AC power line conducted emissions.....	34
6.2	Radiated emissions 9 - 150 kHz.....	40
6.3	Radiated emissions 150 kHz - 30 MHz.....	42
6.4	Radiated emissions 30 MHz -1 GHz.....	44
6.5	Occupied bandwidth.....	46
6.6	Spectrum mask	48
7	Explanatory Notes	50
7.1	Explanation of Table of Signals Measured.....	50
7.2	Explanation of limit line calculations for radiated measurements	51
8	Photographs.....	53
8.1	EUT Front View.....	53
8.2	EUT Reverse Angle	55
8.3	EUT Left side View.....	56
8.4	EUT Right side View	57
8.5	EUT Antenna	58
8.6	EUT Display	59
8.7	EUT Internal photos	60
8.8	EUT ID Label	64
8.9	EUT Chassis	64
8.10	AC power line conducted emissions.....	65
8.11	Radiated emissions 150 kHz - 30 MHz.....	66
8.12	Radiated emissions 30 MHz -1 GHz.....	68
8.13	Radiated emission diagrams	69
8.14	AC powerline conducted emission diagram	70
9	Test equipment calibration list	71
10	Auxiliary and peripheral equipment	72
10.1	Customer supplied equipment.....	72
10.2	RN Electronics supplied equipment.....	72
11	Condition of the equipment tested	73
11.1	Modifications before test.....	73
11.2	Modifications during test.....	74
12	Description of test sites.....	75
13	Abbreviations and units	76

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Eccel Technology Ltd 198 Station Road Glenfield Leicester Leicestershire LE3 8GT	
Manufacturer of EUT	Eccel Technology Ltd	
Full Name of EUT	Action Cam User Interface RFID Unit	
Model Number of EUT	000443	
Serial Number of EUT	000001	
Date Received	29th May 2020	
Date of Test:	5th June 2020 to 30th June 2020	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	1 st October 2020	
Main Function	RFID Waypoint Recorder and user instruction display.	
Information Specification	Height	142 mm
	Width	216 mm
	Depth	31 mm
	Weight	0.5 kg
	Voltage	44 - 57 VDC (PoE)
	Current	Not declared

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Wall mounted
Choice of model(s) for type tests	Sample
Antenna details	Integral PCB track antenna
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	50 MHz
Lowest Signal generated in EUT	12 MHz
Hardware Version	1.3
Software Version	Not applicable
Firmware Version	1.3
Type of Equipment	User interface
Technology Type	RFID
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	13.56 MHz
EUT Declared Modulation Parameters	ISO15693
EUT Declared Power level	Not declared
EUT Declared Signal Bandwidths	Not declared
EUT Declared Channel Spacing's	Single channel
EUT Declared Duty Cycle	100%
Unmodulated carrier available?	No
Declared frequency stability	20 ppm
RX Parameters	
Alignment range – receiver	13.56 MHz
EUT Declared RX Signal Bandwidth	Not declared
Receiver Signal Level (RSL)	Not applicable
Method of Monitoring Receiver BER	Not applicable
FCC Parameters	
FCC Transmitter Class	FCC DXX: Part 15 Low Power Communication Device Transmitter

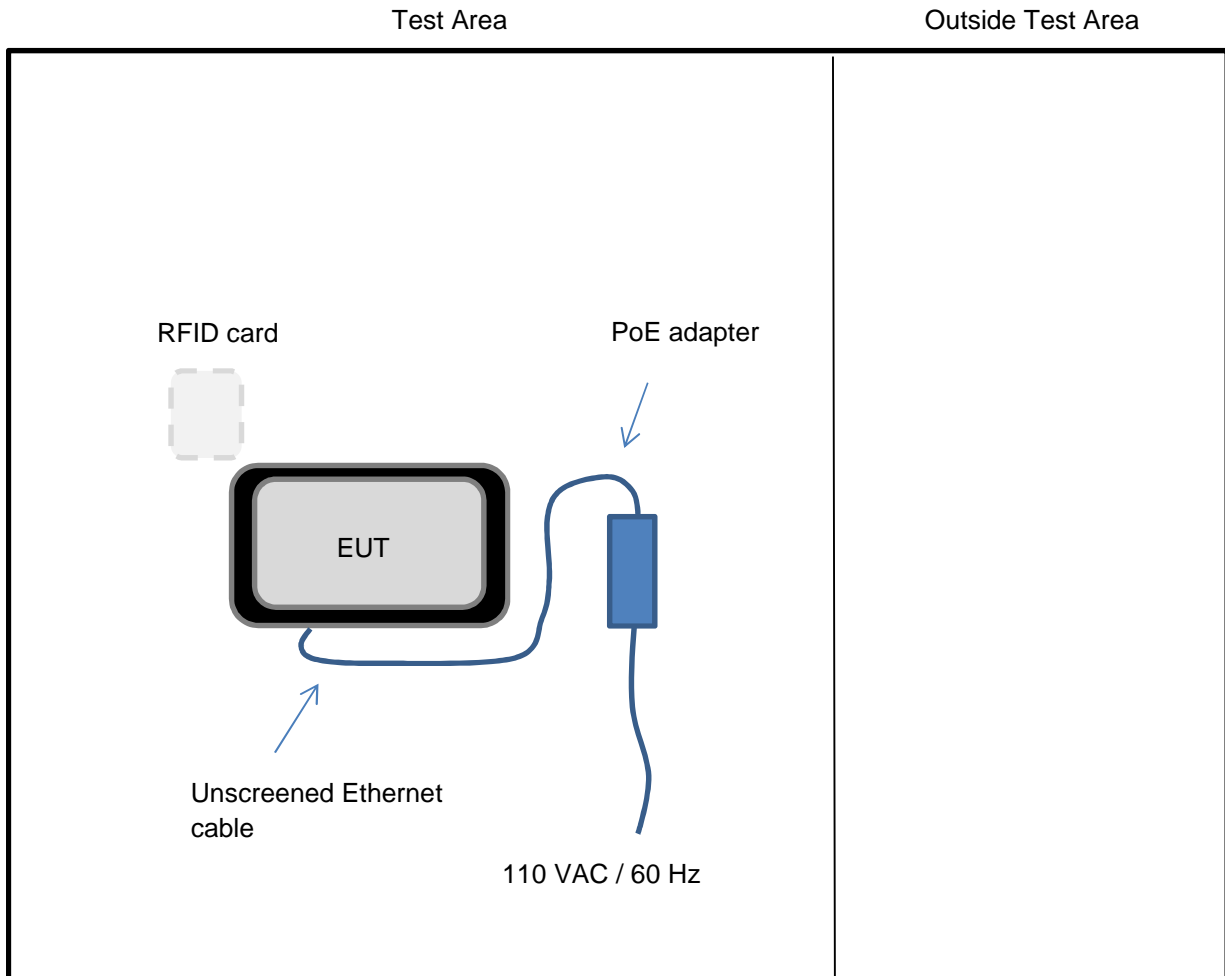
2.3 Functional description

The EUT is an LCD display with RFID reader. The EUT is powered using an off-the-shelf Power over Ethernet (PoE) adapter via the EUT's Ethernet port.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX (No tag)	The RFID reader is active and transmitting at 13.56 MHz. The reader is awaiting presentation of an RFID tag	Yes
TX (Tag presented)	The RFID reader is active and transmitting at 13.56 MHz. An RFID tag is presented to the reader.	Yes

2.5 Emissions configuration



The EUT was powered using an off the shelf Power over Ethernet adapter (PoE). The PoE adapter was powered using 110 VAC 60 Hz power source. The EUT's RFID radio was continuously transmitting upon power-up. For the purposes of test, the applicant provided a typical RFID card used with the EUT. To determine 'worst-case' emissions, a pre-test was performed where the EUT was tested with and without the RFID card in close proximity. It was found that there was no discernible difference between these modes and therefore for full test the EUT was tested without presentation of the RFID card.

For tests performed at extremes of temperature and voltage, a modified Ethernet cable was used so that a bench power supply could be connected so that the supply voltage could be set to the levels as stated in section 4.3.

The frequency of the RFID reader was 13.56 MHz (single frequency) and the power was set by the applicant to the maximum setting available to the end-user.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Debug	6-way	No*
Power	RJ45	Yes

*The applicant states that debug port is used for firmware upgrade and debug purposes only and not used by the end-user.

3 Summary of test results

The Action Cam User Interface RFID Unit, 000443 was tested for compliance to the following standard :

47 CFR Part 15.225 Effective Date 1st October 2018
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, 15.205	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209, 15.205	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.225(d), 15.209, 15.205	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.209, 15.205	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 50 MHz.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2018	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	48V DC
T minimum	-20 °C	V minimum	44V DC
T maximum	50 °C	V maximum	57V DC

Extremes of voltage are based on the standard maximum and minimum voltages required for PoE devices.

Extremes of temperature are based upon the requirements of 47 CFR Part 15C

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, there was no discernible difference between test modes so for full-test the EUT was tested in TX (No tag) mode.

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 F.

5.1.4 Test equipment

E150, E035, ZSW1, E624, E411

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	101 kPa

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

Plot refs	
12244-1 Cond 1 AC Live 150k-30M Average	
12244-1 Cond 1 AC Live 150k-30M Quasi-Peak	
12244-1 Cond 1 AC Neutral 150k-30M Average	
12244-1 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	0.173	56.2	50.2	-14.6	30.4	-24.4
2	0.220	50.4	44.1	-18.7	24.9	-27.9
3	0.309	42.6	35.1	-24.9	19.4	-30.6
4	0.336	38.0	32.5	-26.8	11.0	-38.3
5	0.416	41.2	37.5	-20.0	35.3	-12.2
6	8.436	38.1	35.0	-25.0	28.7	-21.3
7	13.561	70.2	70.1	10.1	69.4	19.4*

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	0.166	57.0	50.8	-14.4	30.8	-24.4
2	0.169	56.2	49.7	-15.3	30.6	-24.4
3	0.211	52.0	45.1	-18.1	26.5	-26.7
4	0.223	50.4	43.3	-19.4	23.7	-29.0
5	0.312	41.3	34.9	-25.0	15.2	-34.7
6	0.393	41.7	39.3	-18.7	37.6	-10.4
7	8.307	39.0	34.9	-25.1	28.7	-21.3
8	13.561	70.4	70.3	10.3	69.5	19.5*

*The results tables above show the fundamental frequency of the EUT at 13.56 MHz exceeding the limit. This was due to the EUTs integral antenna radiating the fundamental carrier on to the 1 metre mains lead used as part of the test setup. To confirm that the emission was radiated by the EUTs' radio and not conducted, the test was repeated with the EUTs' integral antenna terminated in a suitable load per FCC requirements.

Please refer to the following result tables for the test with the antenna disconnected.

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (antenna disconnected)
Single channel	13.56 MHz

Plot refs	
12244-1 Cond 2 AC Live 150k-30M Average	
12244-1 Cond 2 AC Live 150k-30M Quasi-Peak	
12244-1 Cond 2 AC Neutral 150k-30M Average	
12244-1 Cond 2 AC Neutral 150k-30M Quasi-Peak	

Table of signals measured for Cond 2 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.152	57.9	53.8	-12.1	34.1	-21.8
2	0.165	55.6	50.4	-14.8	31.2	-24.0
3	0.220	49.1	42.2	-20.6	23.3	-29.5
4	0.234	47.5	41.1	-21.2	24.0	-28.3
5	0.248	46.4	39.2	-22.6	20.9	-30.9
6	0.263	44.7	37.8	-23.5	18.5	-32.8
7	0.411	41.0	39.2	-18.4	36.6	-11.0
8	7.806	40.2	37.5	-22.5	31.6	-18.4
9	13.560	24.6	20.9	-39.1	15.5	-34.5

Table of signals measured for Cond 2 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.153	58.2	53.3	-12.5	34.9	-20.9
2	0.163	56.6	51.7	-13.6	31.9	-23.4
3	0.197	52.2	46.0	-17.7	27.8	-25.9
4	0.198	51.3	46.0	-17.7	27.7	-26.0
5	0.202	51.6	44.9	-18.6	27.2	-26.3
6	0.249	45.9	39.7	-22.1	21.9	-29.9
7	0.287	42.1	36.0	-24.6	17.1	-33.5
8	8.403	38.0	35.4	-24.6	29.4	-20.6
9	13.560	24.5	22.0	-38.0	16.5	-33.5

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

LIMITS:

15.207: 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:

150kHz to 30MHz \pm 3.6dB

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 operated in TX (No tag) mode.

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 M.

5.2.4 Test equipment

TMS81, ZSW1, E624, E411

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 101kPa

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

Plot refs
12244-1 Rad 1 9k-150kHz Para
12244-1 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 ± 3.9 dB

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 operated in TX (No tag) mode.

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 M.

5.3.4 Test equipment

TMS81, ZSW1, E624, E411

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	101kPa

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

Plot refs
12244-1 Rad 1 150k-30MHz Para
12244-1 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. The EUT was operated in TX (No tag) mode.

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 M.

5.4.4 Test equipment

LPE364, E743, NSA-M, ZSW1, E624, E411

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	101kPa

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

Plot refs
12244-1 Rad 1 VHF Horiz
12244-1 Rad 1 VHF Vert
12244-1 Rad 1 UHF Horiz
12244-1 Rad 1 UHF Vert

Table of signals measured for Rad 2 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	201.904	33.7	30.6	-12.9
2	203.187	33.3	29.9	-13.6
3	205.839	34.0	31.5	-12.0
4	207.139	33.8	31.5	-12.0
5	211.092	33.2	30.5	-13.0
6	250.000	35.4	33.4	-12.6
7	449.999	36.5	34.2	-11.8
8	511.873	38.1	33.6	-12.4
9	549.999	38.9	36.8	-9.2
10	607.244	38.9	33.5	-12.5
11	631.367	41.2	35.6	-10.4

Table of signals measured for Rad 2 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	40.682	35.4	33.9	-6.1
2	52.620	36.7	33.1	-6.9
3	62.154	35.3	32.7	-7.3
4	129.720	39.2	36.1	-7.4
5	250.000	28.6	23.7	-22.3
6	449.999	37.4	35.0	-11.0
7	549.999	37.8	35.1	-10.9
8	583.151	39.2	34.6	-11.4
9	607.390	40.2	35.4	-10.6
10	630.790	40.6	36.4	-9.6
11	654.835	37.7	32.4	-13.6

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 ±6.1dB

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 50 MHz.

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) [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 operated in TX (No tag) mode.

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 and/ or on an OATS. This site is listed with the FCC.

Both the equipment and the antenna were rotated 360 degrees to record the maximised emission.

Measurements were made at Site OATS.

5.6.4 Test equipment

E410, E642, E856, TMS81

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 16°C
 Humidity of test environment 60%
 Pressure of test environment 101kPa

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

	Single channel
Peak Level (dBµV/m @ 3 metres)	88.6
Plot reference	12244-1 FS OATS
Antenna Polarisation	Parallel
EUT Polarisation	Upright
Peak Level (dBµV/m @ 30 metres)	48.6

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 (dB μ V/m @ 3m) – 40 dB = Peak level (dB μ V/m @ 30m)

88.6 dB μ V/m – 40 dB = 48.6 (dB μ V/m @ 30m)

LIMITS:

15.225(a) QP/Peak = the field strength of any emissions within the band 13.110-14.010 MHz shall not exceed 15,848 μ V/m @ 30m = 84 dB μ V/m @ 30m.

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 operated in TX (No tag) and TX (Tag presented) modes.

5.7.3 Test procedure

Tests were performed using Test Site R.
 Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 10kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20 dB bandwidth.

5.7.4 Test equipment

E412, E843 E807

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 101kPa

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (with tag)
Single channel	13.56 MHz

	Single channel
20 dB Bandwidth (MHz) Nominal Temp & Volts	0.109
Plot for 20 dB Bandwidth (MHz) Nominal Temp & Volts	12244-1 With tag

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (without tag)
Single channel	13.56 MHz

	Single channel
20 dB Bandwidth (MHz) Nominal Temp & Volts	0.275
Plot for 20 dB Bandwidth (MHz) Nominal Temp & Volts	12244-1 No tag

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) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was placed on a bench and measurements were made via a test fixture and referenced to the field strength measured on the OATS. The EUT was operated in TX (No tag) and TX (Tag presented) modes.

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 R.

5.8.4 Test equipment

E412, E422

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 20°C
 Humidity of test environment 60%
 Pressure of test environment 101kPa

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (With tag)
Single channel	13.56 MHz

	Single channel
Nominal, Maximised RF Output / field strength	48.6
Nominal plot reference	12241-1 Spectrum mask at 30metres - Card presented

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (without tag)
Single channel	13.56 MHz

	Single channel
Nominal, Maximised RF Output / field strength	48.6
Nominal plot reference	12241-1 Spectrum mask at 30metres - No Card

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 13.110-14.010 MHz shall not exceed 15,848 $\mu\text{V/m}$ @ 30m = 84 $\text{dB}\mu\text{V/m}$ @ 30m.

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

A modified Ethernet cable was used to connect the EUT to a variable power supply. This allowed the voltage end points to be set as declared by the manufacturer.

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 TX (No tag) and TX (Tag presented) modes.

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 to the applicant declared end points.

A max-held spectrum analyser 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 R.

5.9.4 Test equipment

E412, E422, E807, E843, L264, S036

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (with card)
Single channel	13.56 MHz

Test conditions		Frequency Error (MHz) Single channel
-20°C	Volts Nominal (48)	13.560749
-10°C	Volts Nominal (48)	13.560745
0°C	Volts Nominal (48)	13.560757
10°C	Volts Nominal (48)	13.560737
20°C	Volts Minimum (44)	13.560692
	Volts Nominal (48)	13.560694
	Volts Maximum (57)	13.560682
30°C	Volts Nominal (48)	13.560683
40°C	Volts Nominal (48)	13.560673
50°C	Volts Nominal (48)	13.560670

Max Frequency Error per chan (Hz)	+757
-----------------------------------	------

Band	13.110-14.010 MHz
Power Level	Maximum
Channel Spacing	Single Channel
Mod Scheme	ASK (without card)
Single channel	13.56 MHz

Test conditions		Frequency Error (MHz) Single channel
-20°C	Volts Nominal (48)	13.560736
-10°C	Volts Nominal (48)	13.560749
0°C	Volts Nominal (48)	13.560743
10°C	Volts Nominal (48)	13.560742
20°C	Volts Minimum (44)	13.560692
	Volts Nominal (48)	13.560692
	Volts Maximum (57)	13.560683
30°C	Volts Nominal (48)	13.560678
40°C	Volts Nominal (48)	13.560673
50°C	Volts Nominal (48)	13.560682
Max Frequency Error per chan (Hz)		+749

Maximum variation observed was +757 Hz

LIMITS:

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

These results show that the EUT has PASSED this test.

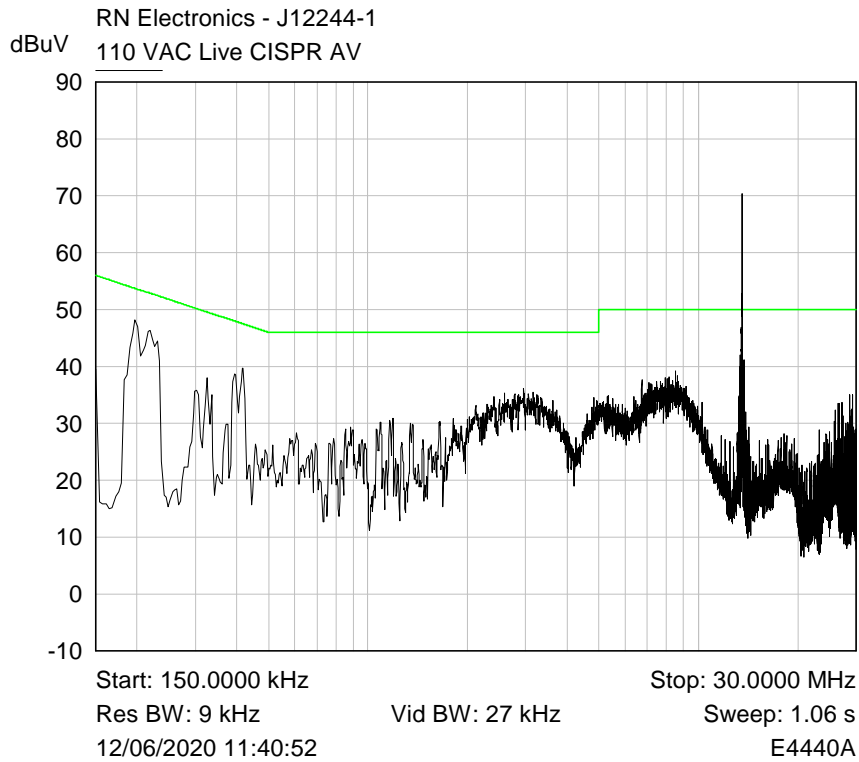
The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

<± 0.7 ppm

6 Plots/Graphical results

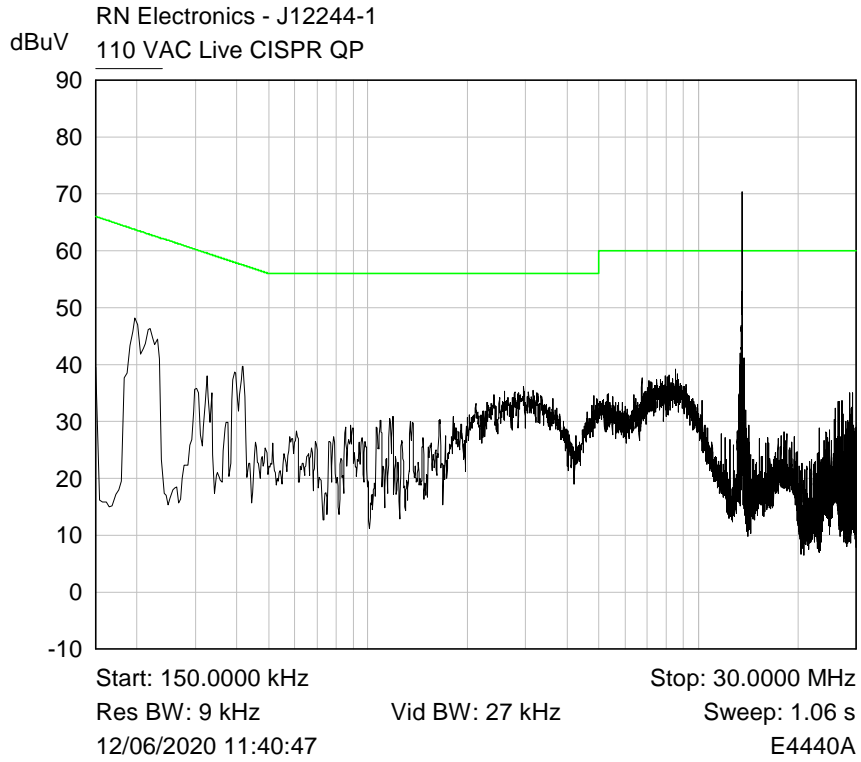
6.1 AC power line conducted emissions

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693, Channel 13.56 MHz



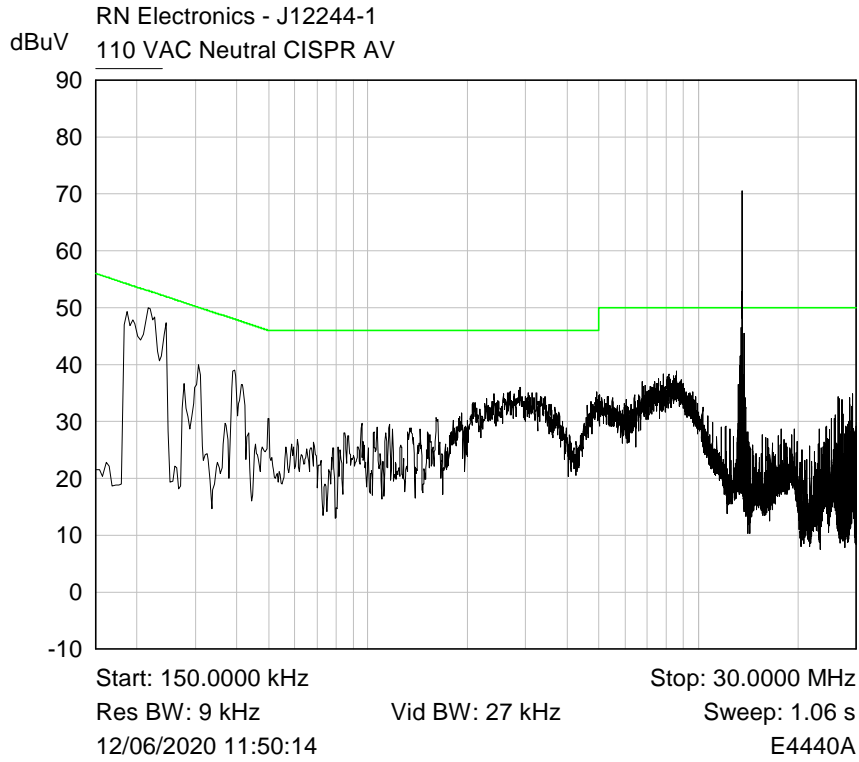
Plot of Live150k-30M Average

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



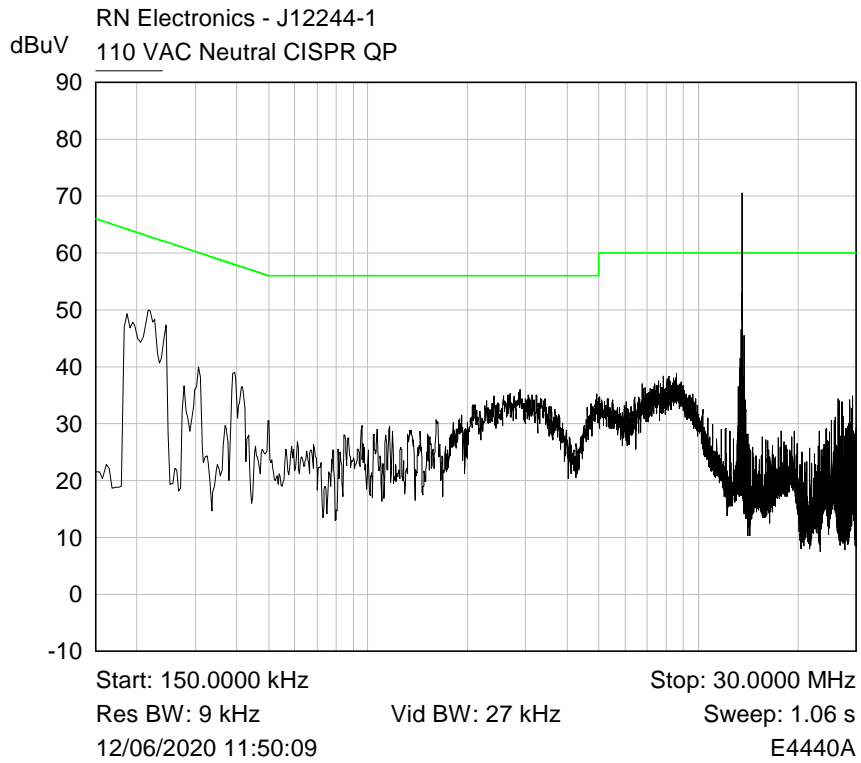
Plot of Live150k-30M Quasi-Peak

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



Plot of Neutral150k-30M Average

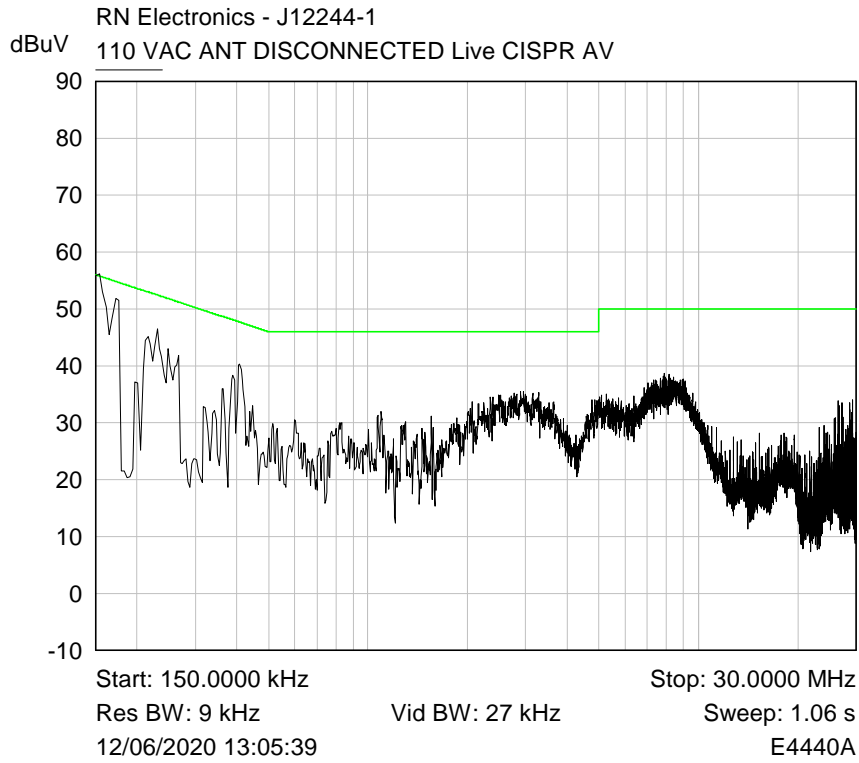
Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead



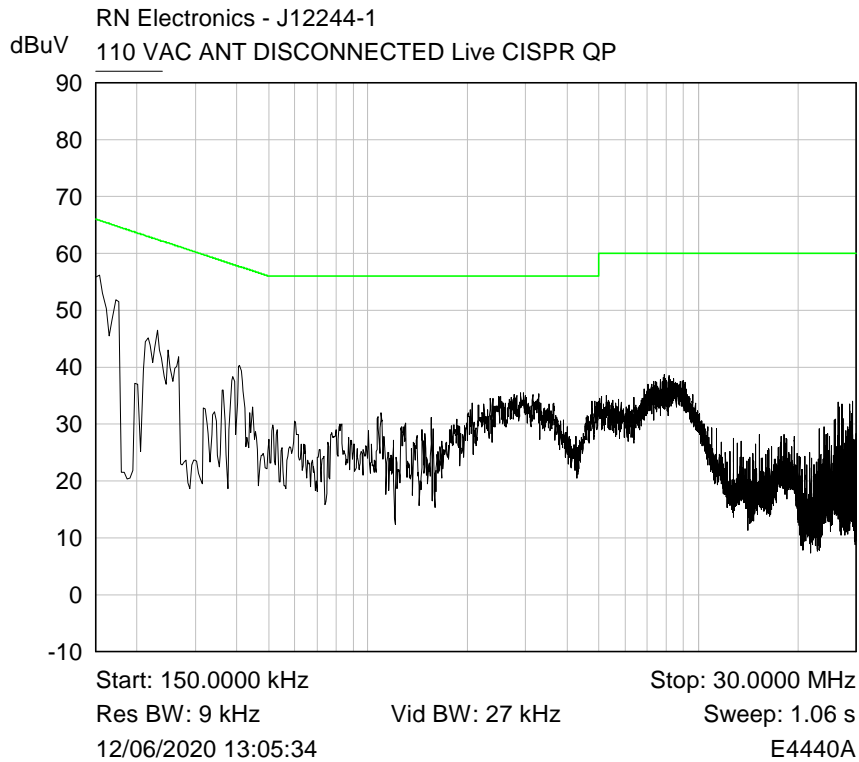
Plot of Neutral150k-30M Quasi-Peak

Note: The emission that exceeds the limit line is the fundamental carrier of the 13.56 MHz transmitter radiating on to the mains lead

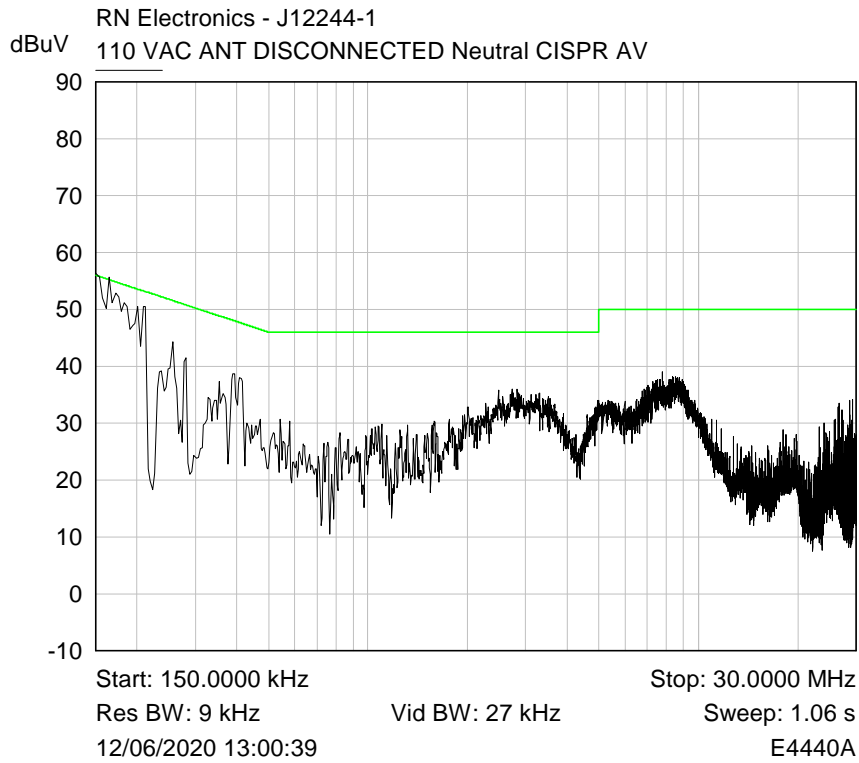
RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693 (antenna disconnected), Channel 13.56 MHz



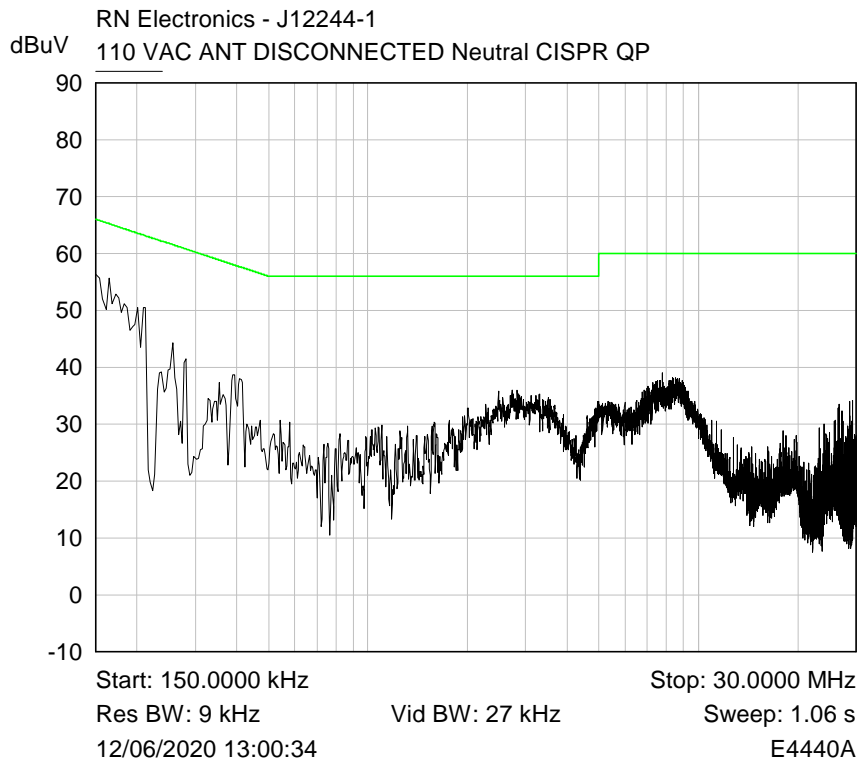
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



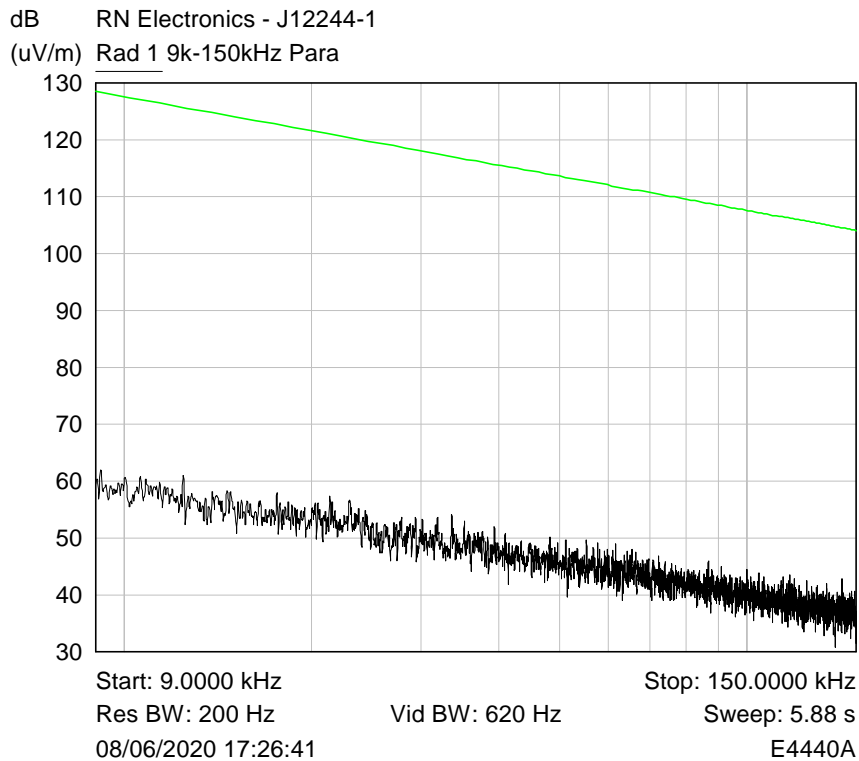
Plot of Neutral150k-30M Average



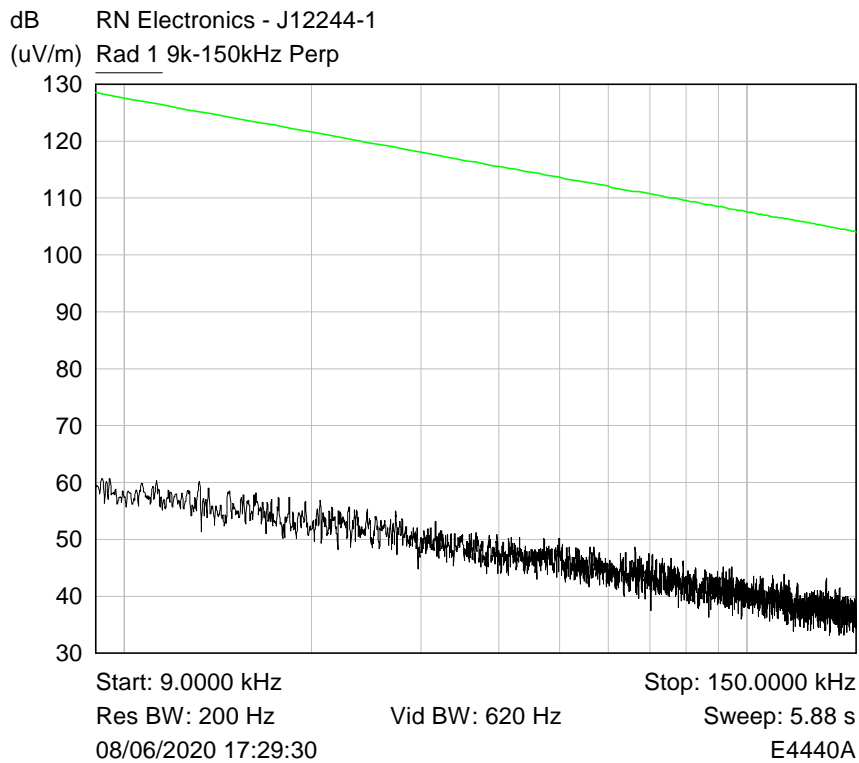
Plot of Neutral150k-30M Quasi-Peak

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693, Channel 13.56 MHz



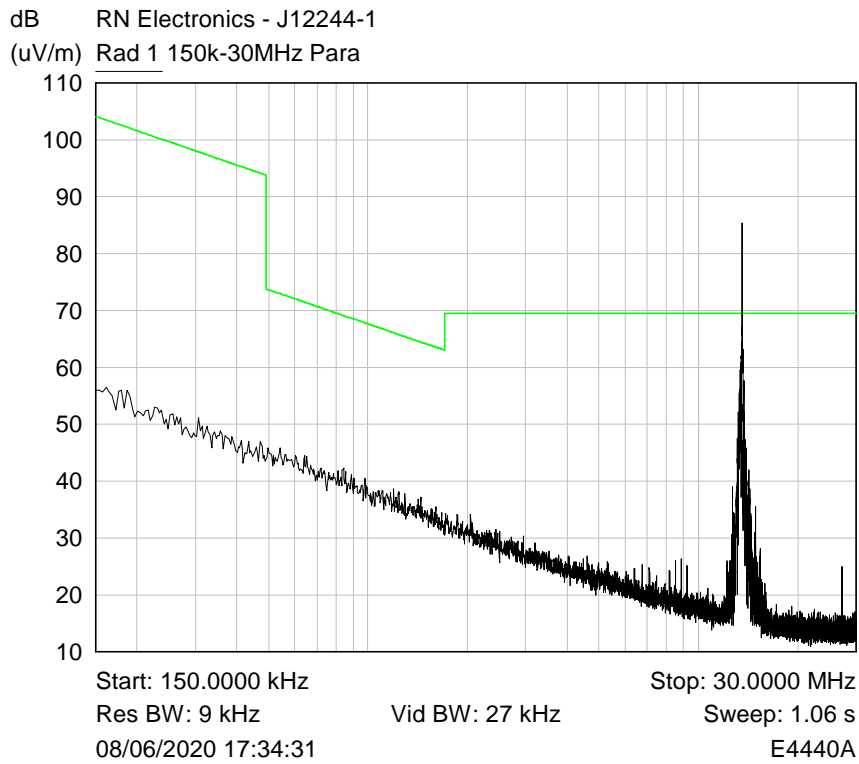
Plot of 9k-150kHz Parallel



Plot of 9k-150kHz Perpendicular

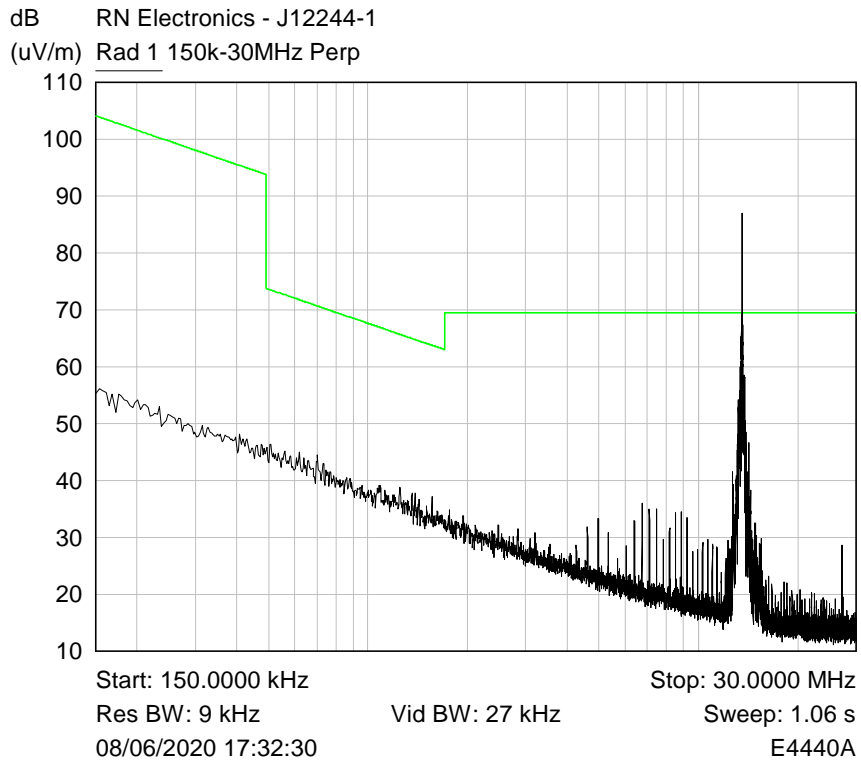
6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693, Channel 13.56 MHz



Plot of 150kHz-30MHz Parallel

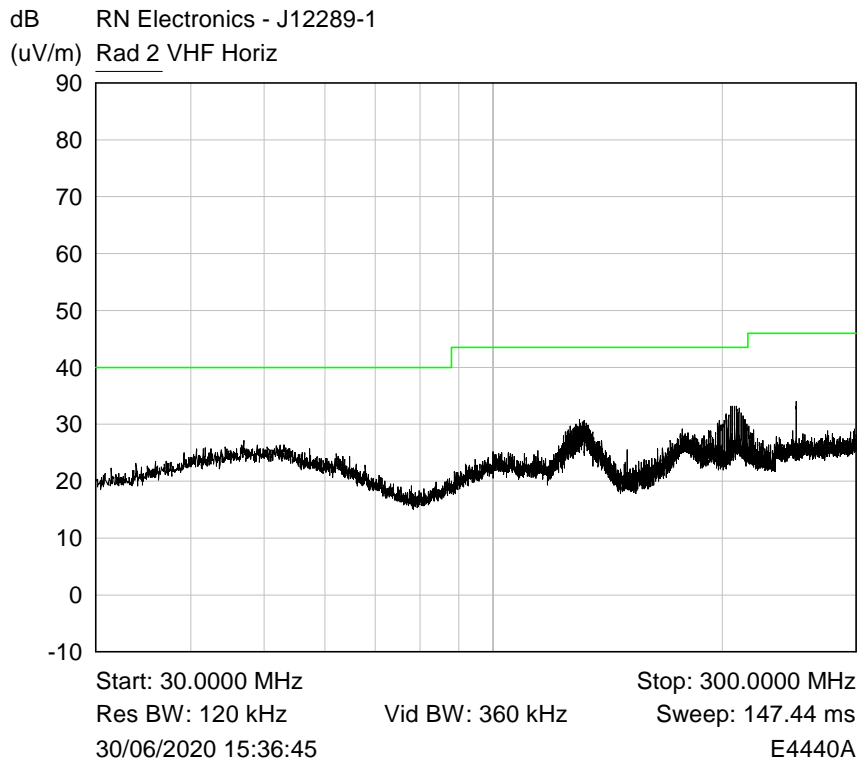
Note: Plot shows the fundamental carrier at 13.56 MHz



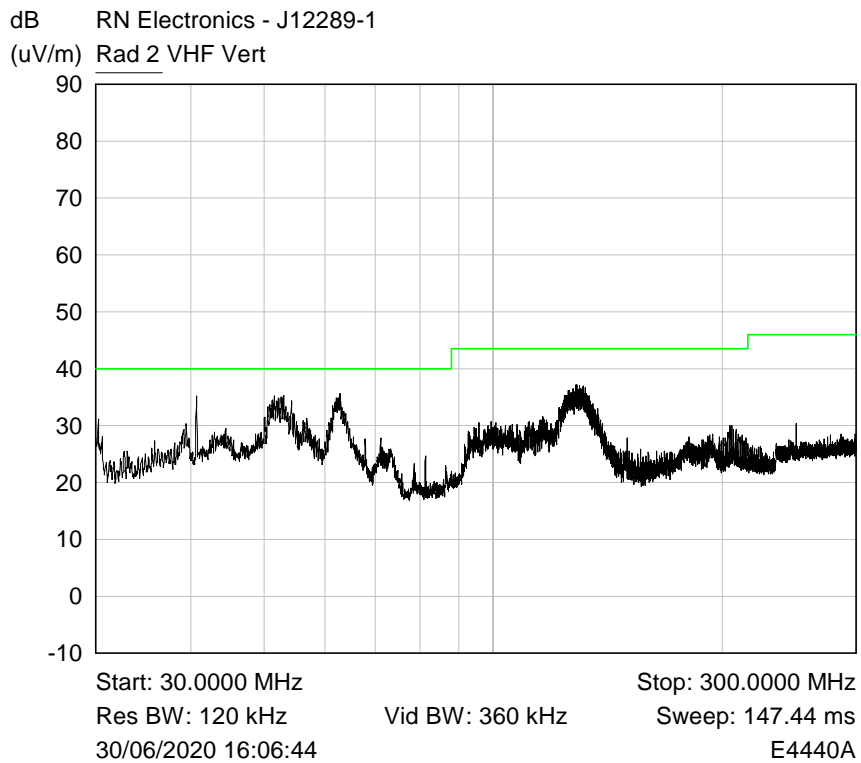
Plot of 150kHz-30MHz Perpendicular
Note: Plot shows the fundamental carrier at 13.56 MHz

6.4 Radiated emissions 30 MHz -1 GHz

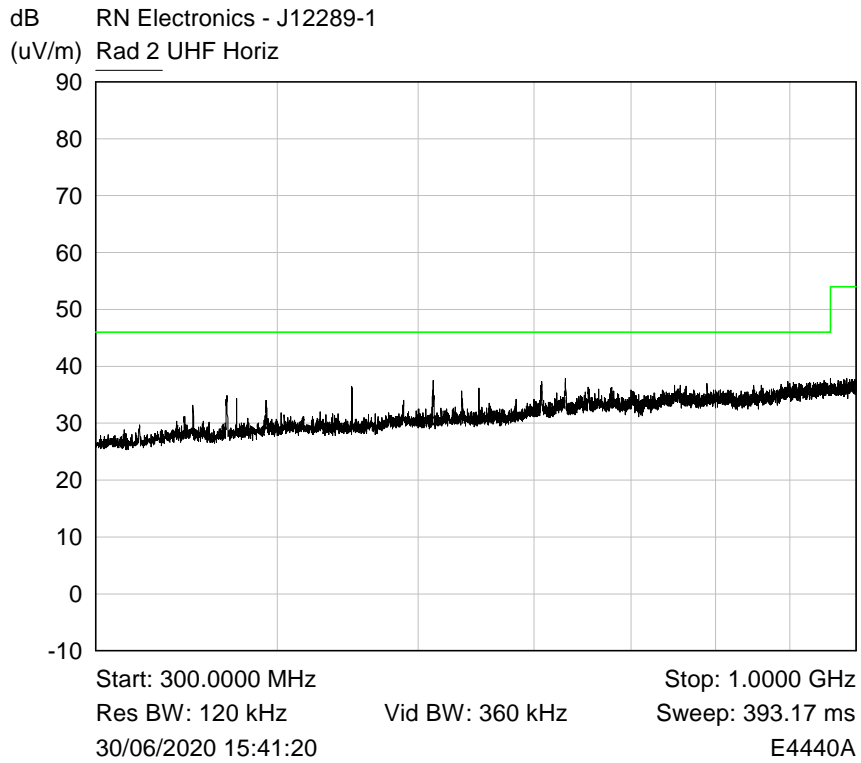
RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693, Channel 13.56 MHz



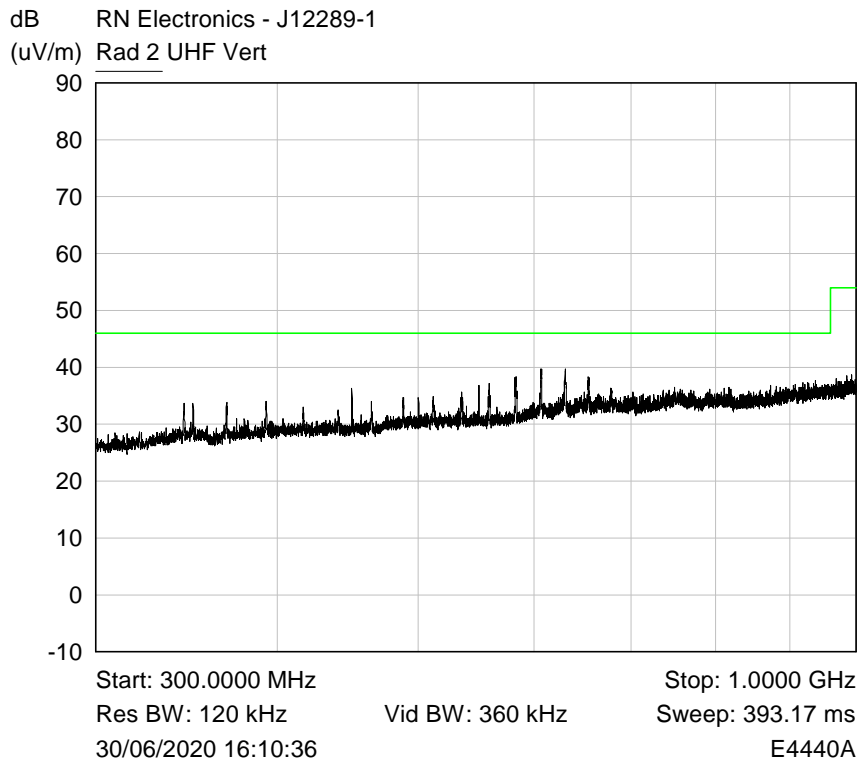
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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.

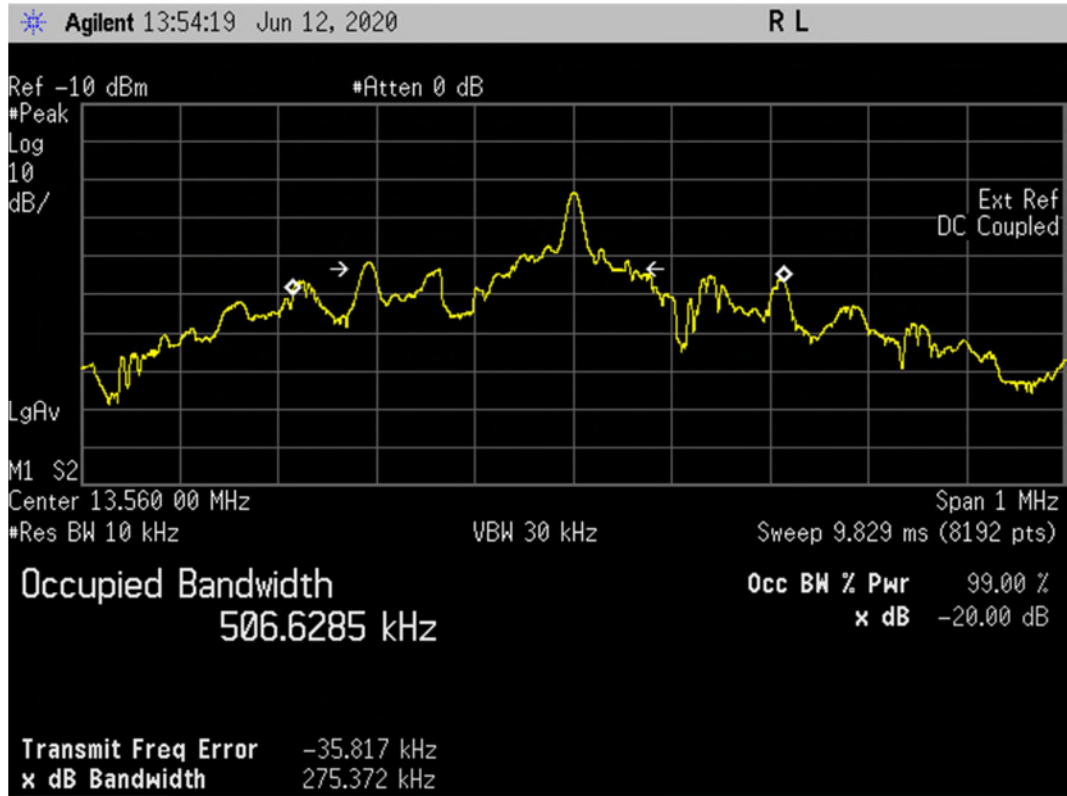
6.5 Occupied bandwidth

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693 (With tag), Channel 13.56 MHz



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

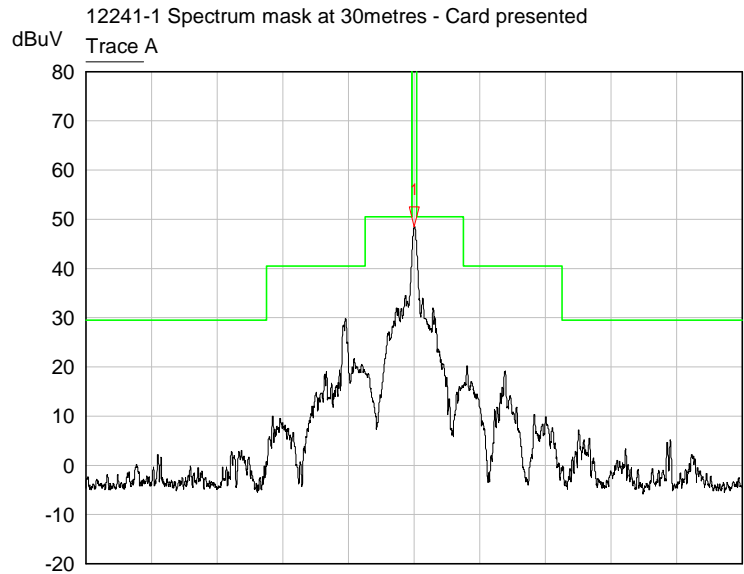
RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693 (without tag), Channel 13.56 MHz



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

6.6 Spectrum mask

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693 (With tag), Channel 13.56 MHz



Start: 12.5600 MHz Stop: 14.5600 MHz

Res BW: 10 kHz

Vid BW: 30 kHz

Sweep: 19.11 ms

PASS

11/06/2020 13:15:59

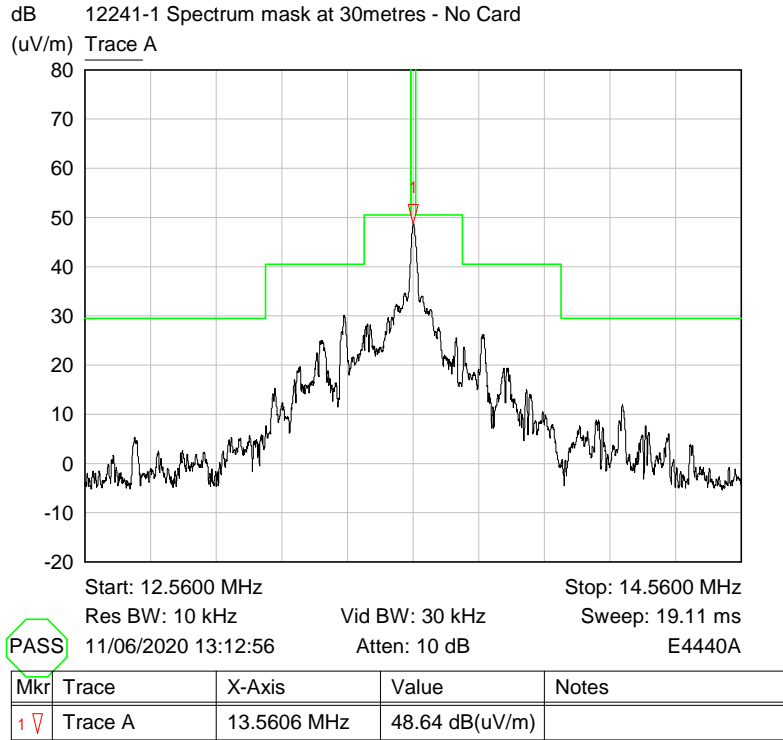
Atten: 10 dB

E4440A

Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	13.5606 MHz	48.56 dBuV	

Nominal Temperature, Nominal Voltage

RF Parameters: Band 13.110-14.010 MHz, Power Maximum, Channel Spacing Single Channel, Modulation ISO15693 (without tag), Channel 13.56 MHz



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 (dB μ V)	Pk - Lim 1 (dB)	QP Amp (dB μ V)	QP - Lim1 (dB)	Av Amp (dB μ V)	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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 (dB μ V) is the level of received signal that was measured in dB above 1 μ V 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 $\mu\text{V}/\text{m}$ at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in $\text{dB}\mu\text{V}/\text{m}$ referenced to the measuring instrument inputs. RN Electronics 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 $500 \mu\text{V}/\text{m}$ equates to $20.\log(500) = 54 \text{ dB } \mu\text{V}/\text{m}$.

(b) limit of $300 \mu\text{V}/\text{m}$ at 10m equates to $20.\log(300 \cdot 10/3) = 60 \text{ dB } \mu\text{V}/\text{m}$ at 3m

(c) limit of $30 \mu\text{V}/\text{m}$ at 30m, but below 30MHz, equates to $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V}/\text{m}$ 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: $E_{\text{Linear}} = 10^{(E_{\text{Log}} - 120)/20}$

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 $\text{dB}\mu\text{V}/\text{m}$

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 $\text{dB}\mu\text{V}/\text{m}$

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/m^2

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

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

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

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

Where:

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

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

Example:

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

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

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

And

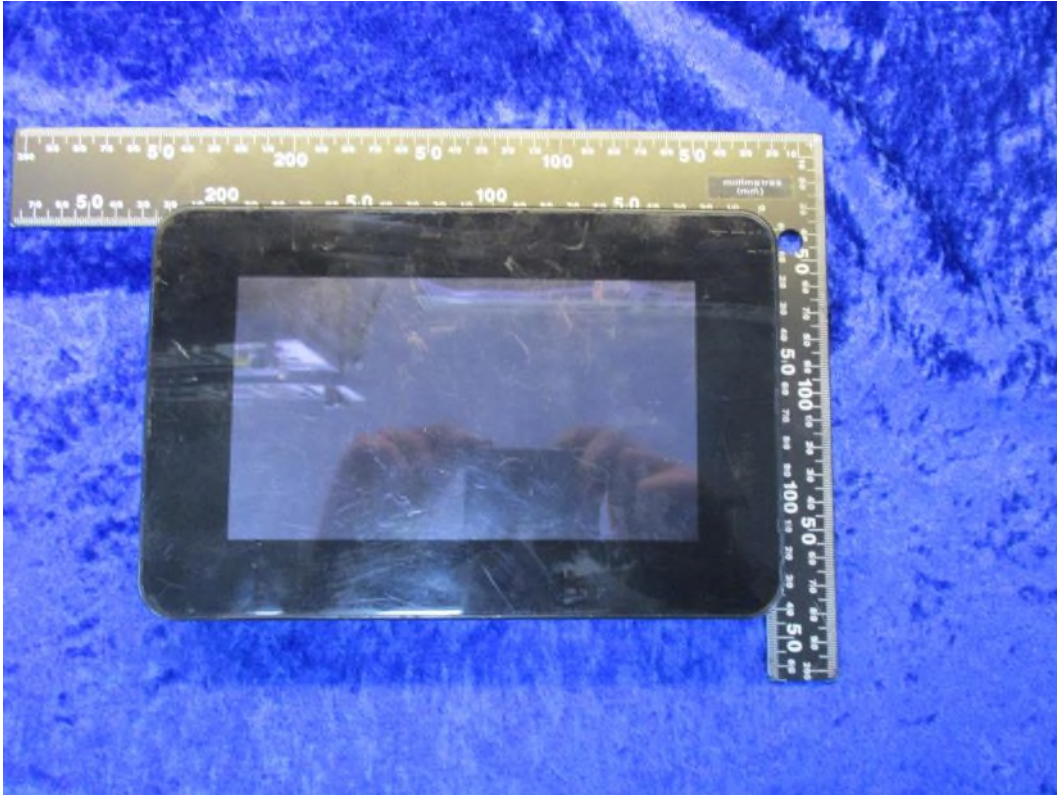
$$\text{Equation 26 transposed: } E_{\text{Spec limit}} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m.}$$

And

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

8 Photographs

8.1 EUT Front View



Photograph shows the RFID card used for tests.



8.2 EUT Reverse Angle



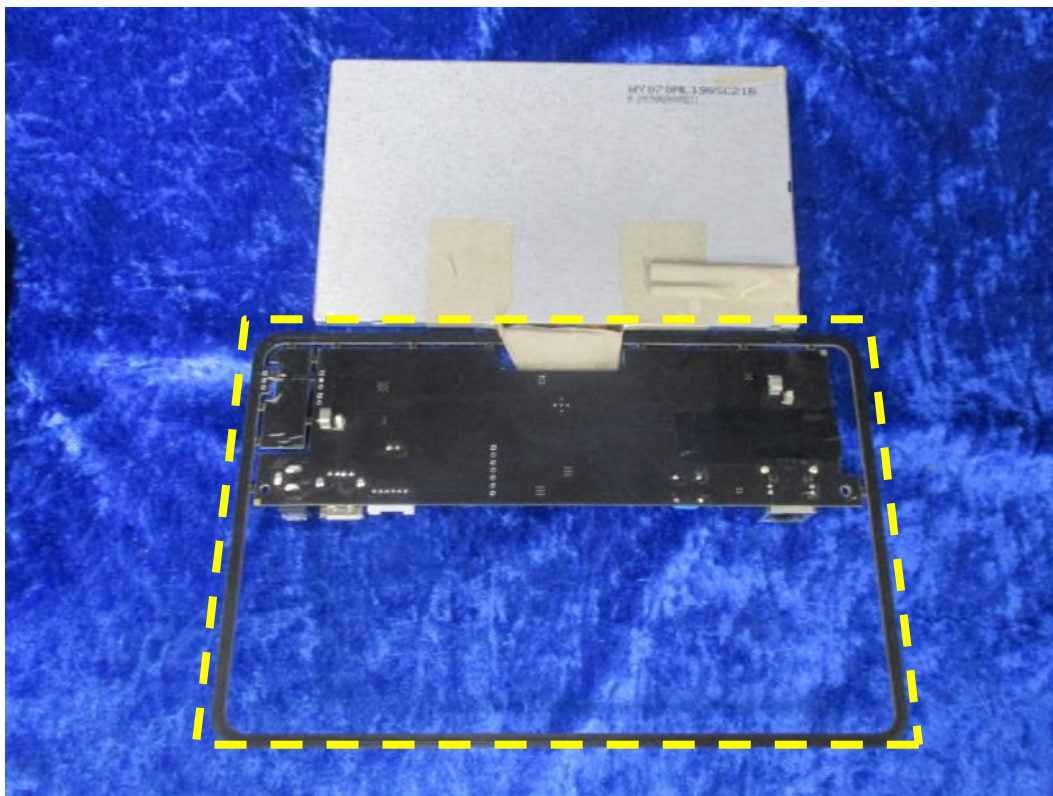
8.3 EUT Left side View



8.4 EUT Right side View



8.5 EUT Antenna

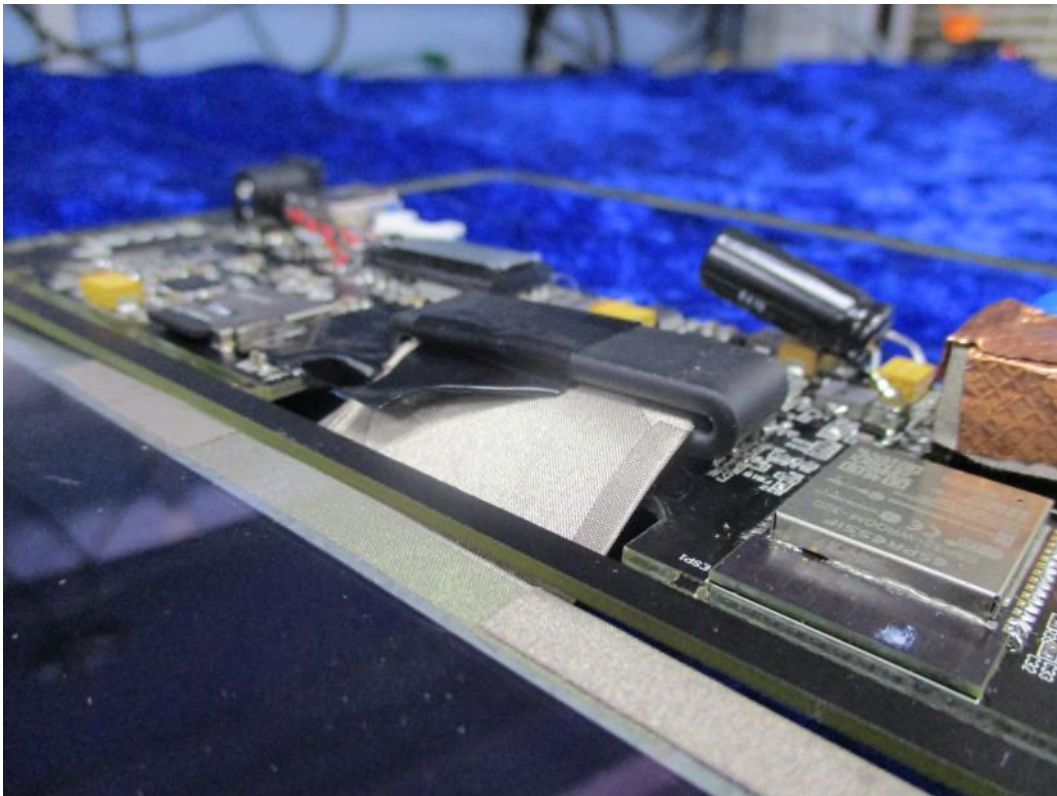


Photograph shows the EUT's PCB etched coil antenna (highlighted)

8.6 EUT Display



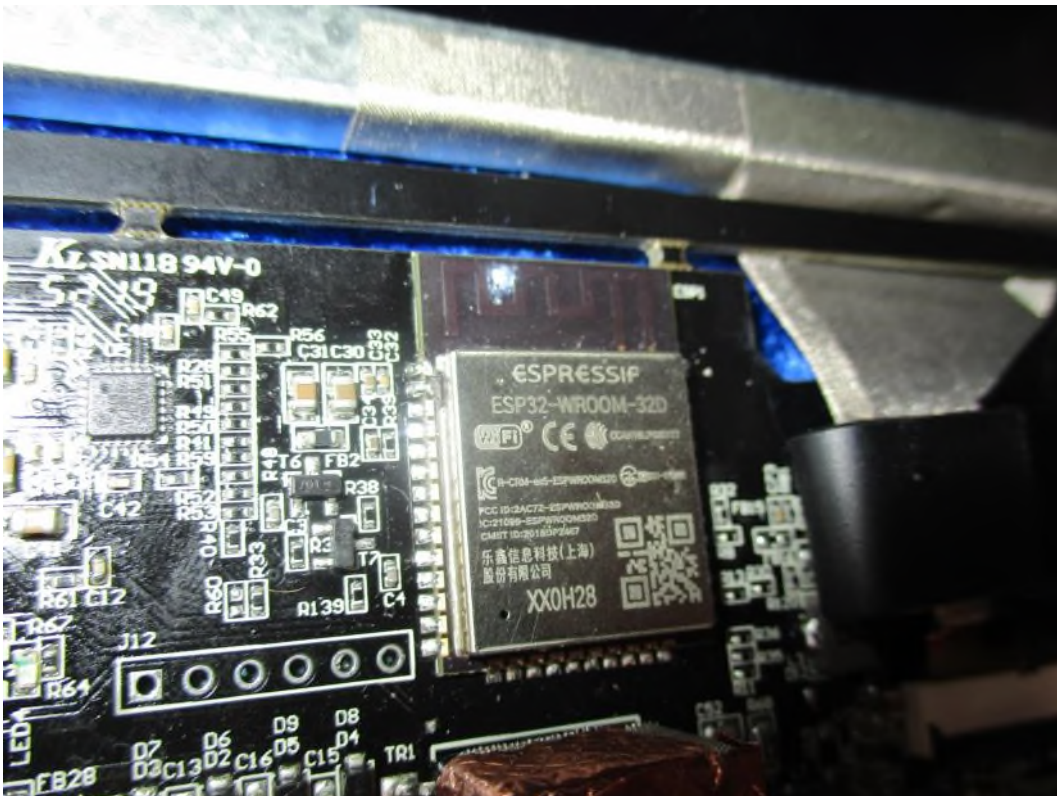
8.7 EUT Internal photos



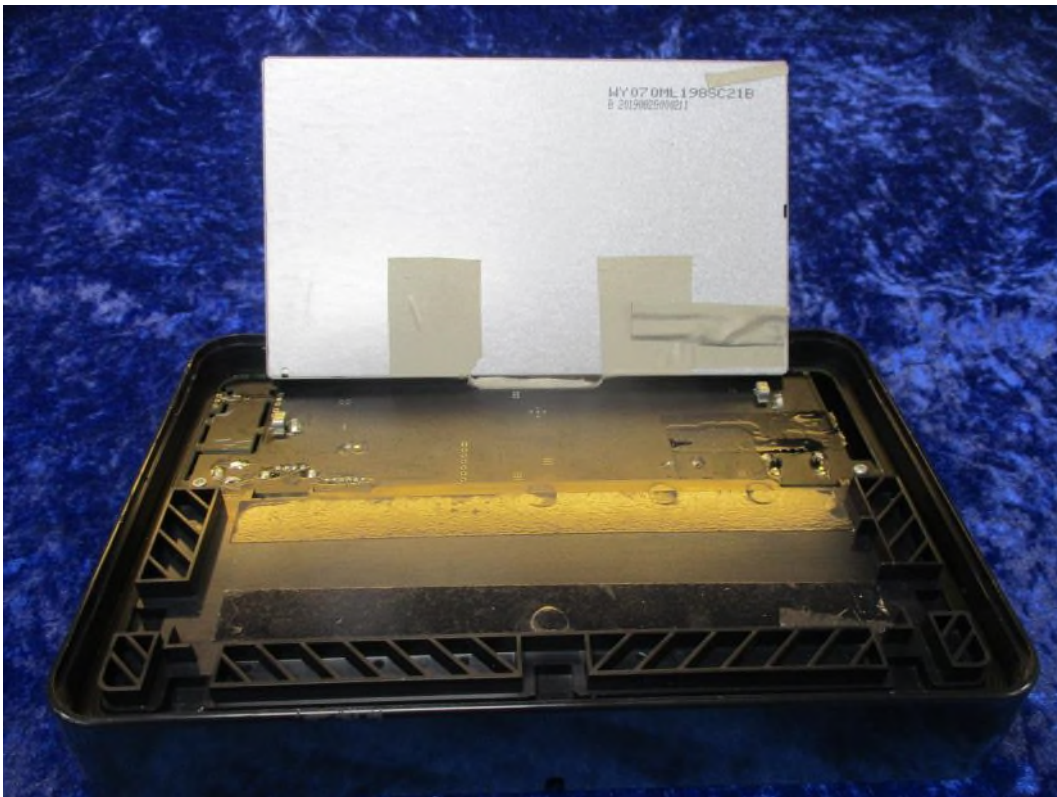
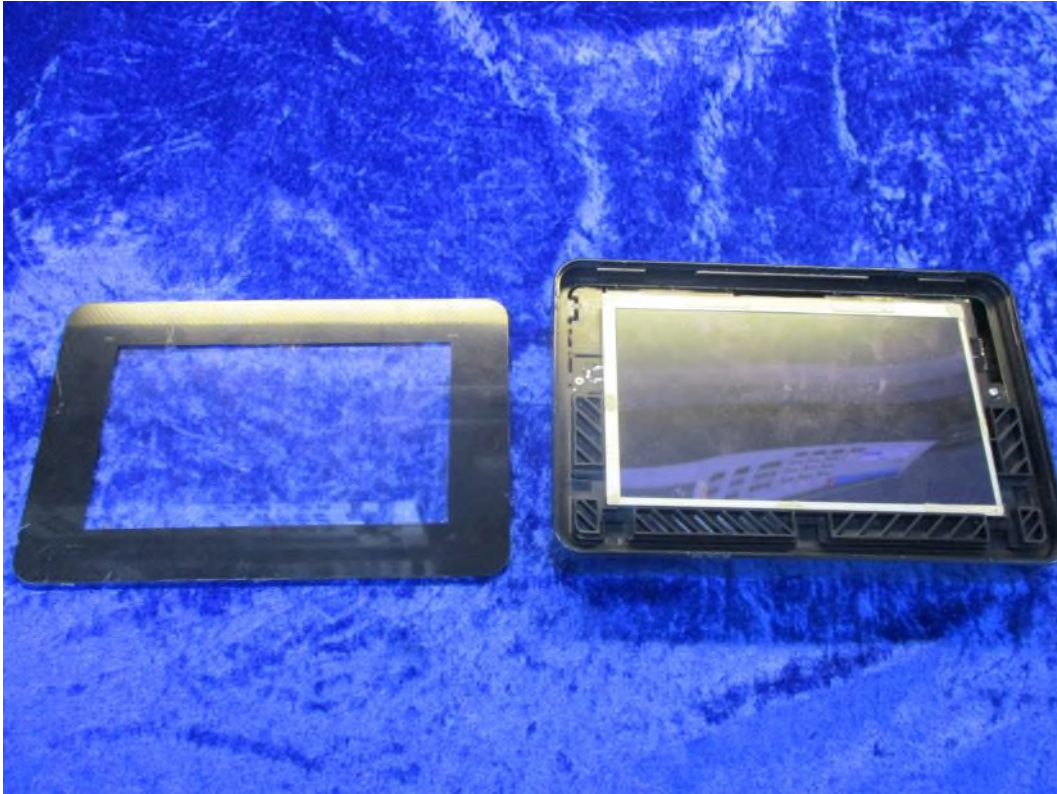
Photograph shows ferrite fitted to the LCD flexi-cable.



Photograph shows the debug port, and internal USB and DC sockets. The USB and DC ports are not accessible to the end-user. The applicant declares that the debug port is used for firmware / debug purposes only.



Photograph shows the EUT Wi-Fi / Bluetooth module. The applicant declares this is not operational on the current product.



Photograph shows conductive tape on the rear of the LCD screen.

8.8 EUT ID Label



8.9 EUT Chassis

The EUT has no chassis

8.10 AC power line conducted emissions



8.11 Radiated emissions 150 kHz - 30 MHz



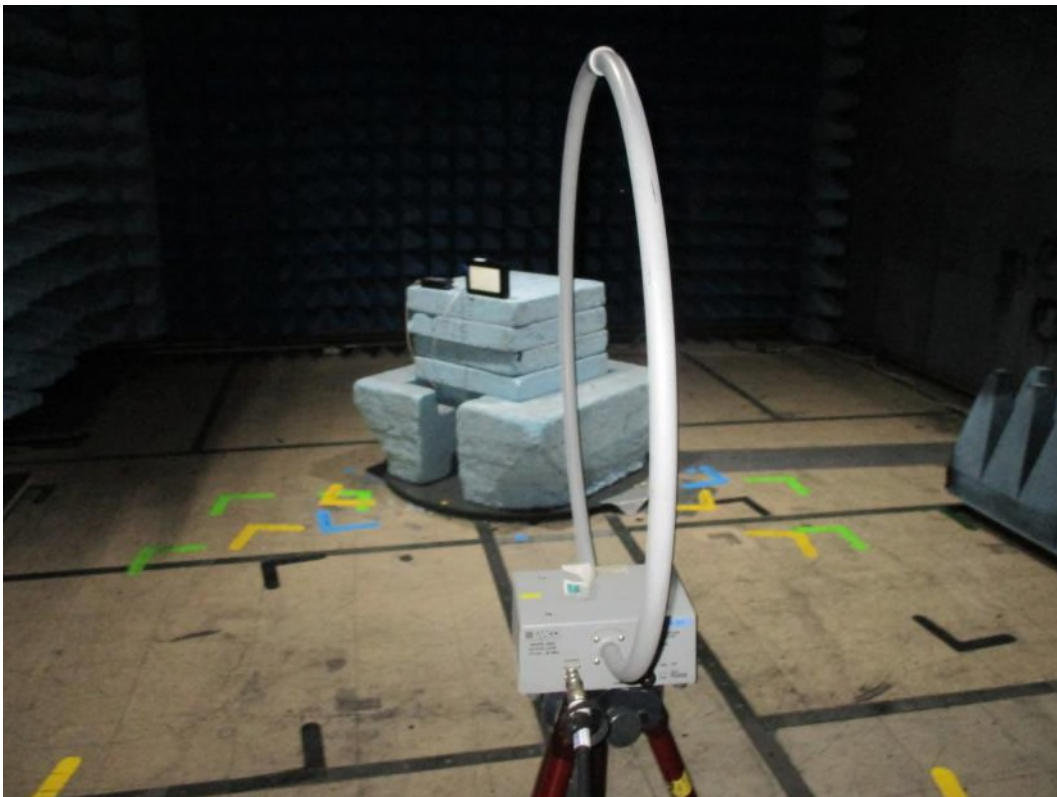
Site OATS



Site OATS

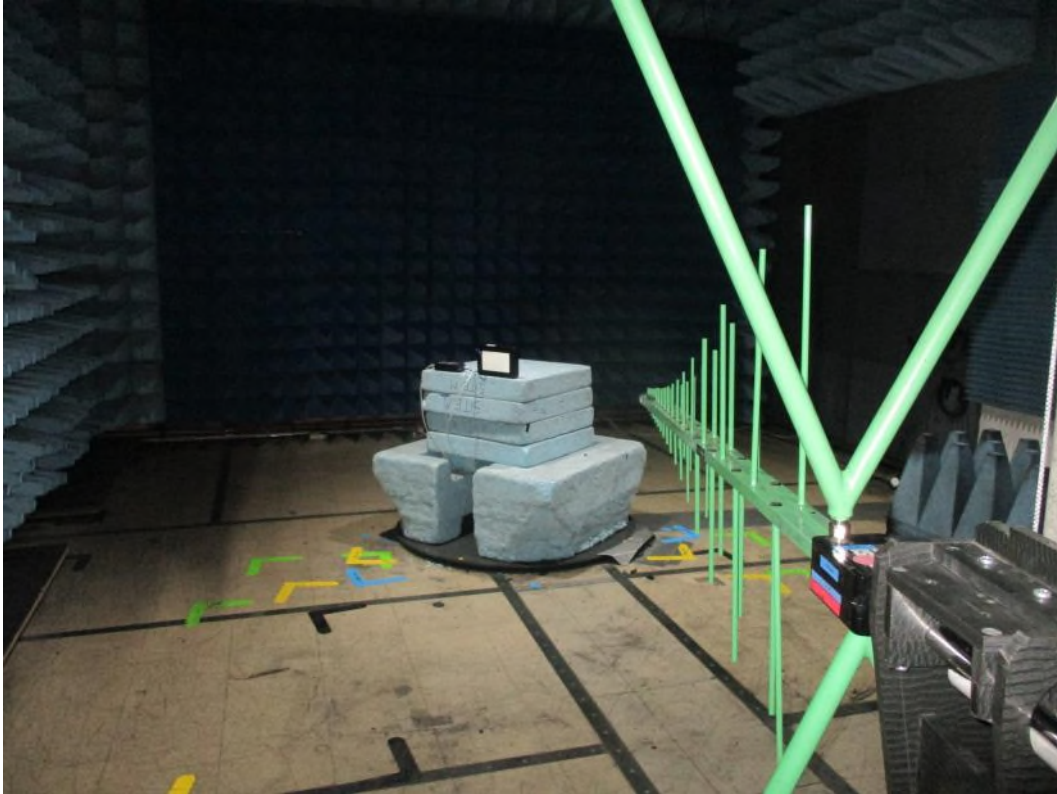


Site OATS



Site M

8.12 Radiated emissions 30 MHz -1 GHz



Site M



8.13 Radiated emission diagrams

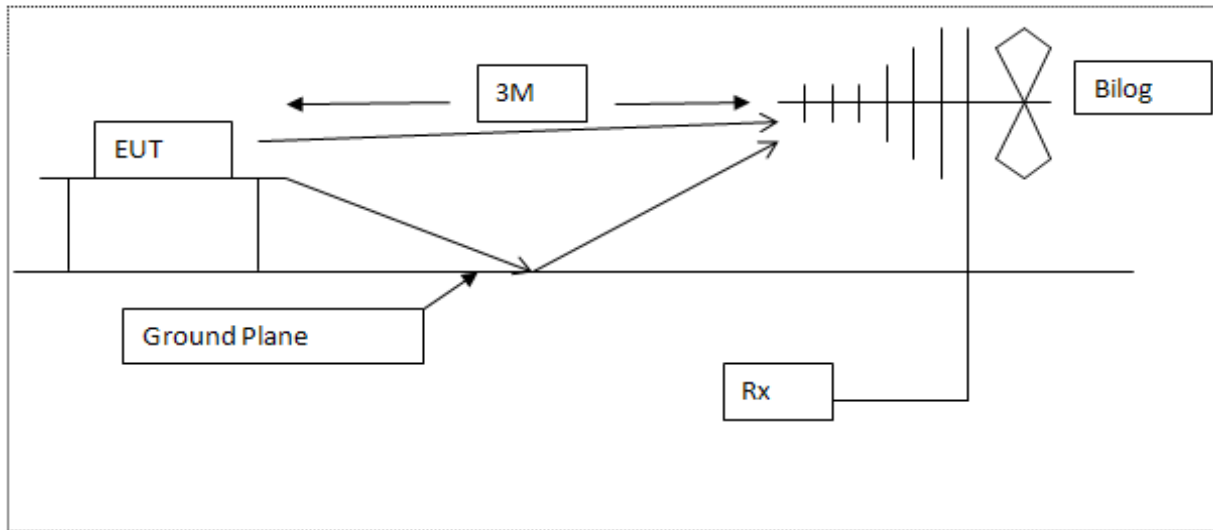


Diagram of the radiated emissions test setup 30 - 1000 MHz

8.14 AC powerline conducted emission diagram

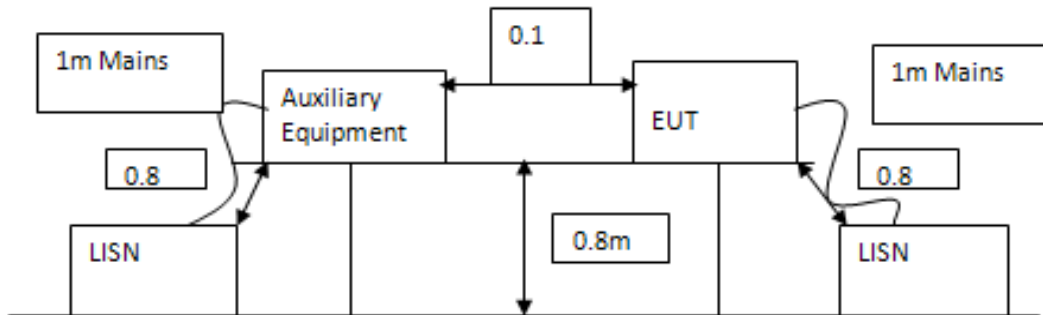


Diagram of the AC conducted emissions test setup

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd 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
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	16-Dec-2019	12 months
E150	MN2050	LISN 13A	Chase	22-Apr-2020	12 months
E410	N5181A	Signal Generator 3 GHz MXG	Agilent Technologies	13-Jul-2018	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	11-Jul-2019	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	17-Jul-2018	24 months
E422	34401A	Digital Multimeter 6.5 digit	Agilent Technologies	03-Apr-2020	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	07-Mar-2020	24 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	11-Dec-2019	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	07-Feb-2020	12 months
E807	10MHz OCXO	Frequency Standard 10MHz OCXO	BG7TBL	11-Dec-2019	12 months
E843	G3RUH	10MHz GPS Disciplined Oscillator	G3RUH - James Miller	03-Mar-2020	6 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	11-Dec-2019	12 months
L264	DT75	Digital Thermometer	Instrotech Ltd	16-Dec-2019	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	07-Mar-2020	24 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	09-Jan-2019	36 months
S036	FMH1 420	Temperature & Humidity Test Chamber	JTS Ltd	Not applicable	
TMS81	6502	Antenna Active Loop	EMCO	24-Jun-2019	24 months
ZSW1	V2.4	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	ICODE SLI	RFID contactless smart card	Not stated	Not stated

10.2 RN Electronics supplied equipment

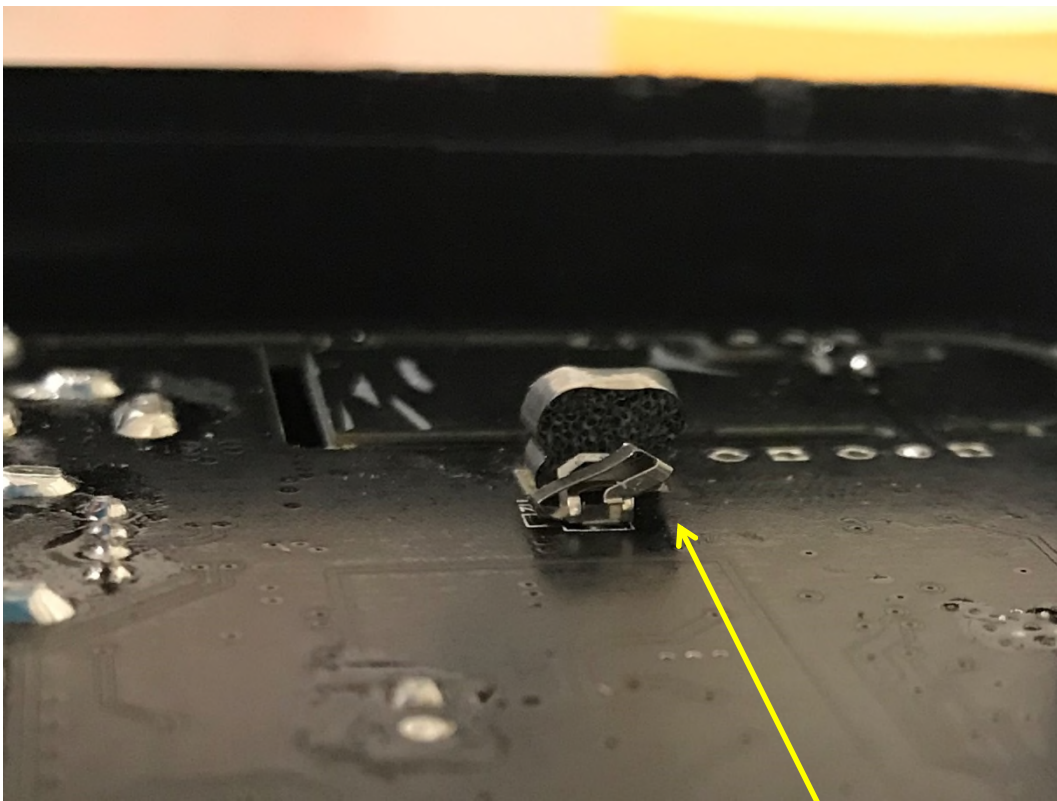
RN No.	Model No.	Description	Manufacturer	Serial No
E465	PCR2000LA	AC Power Source 2kVA	Kikusui	HJ000995

11 Condition of the equipment tested

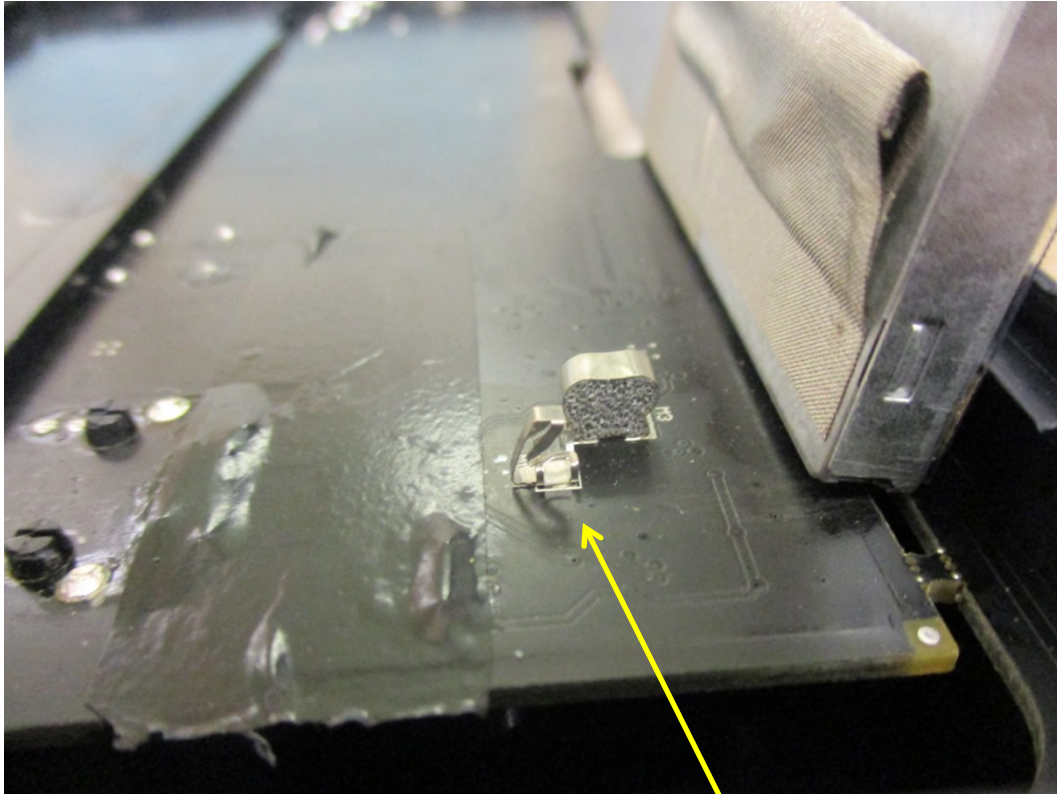
In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

Test	Modification	Time of modification	Photo Reference
TX Rad Em Field strength 30M-1G	Bending the grounding spring finger away from the PCB to increase the height so that a connection is made between the PCB and the LCD screen bezel.	Before testing	MOD1.jpg



Before: Spring finger 'squashed-down'



After: Spring finger bent up.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 293246 IC 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. 293246 IC Registration No. 5612A-2
Site J	Transient Laboratory
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246 IC 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. 293246 IC Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

RN Electronics CAB identifier as issued by FCC is UK0015

13 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	decibel	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	decibel relative to 1µA/m	ppm	Parts per million
dBµV	decibel relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	decibel relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibel relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		