

Report on the Radio Testing
For
Magicard Ltd
on
Ultima
Report no. TRA-041439-47-00A
17 September 2018

RF914 4.0

Report Number: TRA-041439-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Magicard Ltd
Ultima
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.225

TEST DATE: 11th July 2018

Tested by:

D Moncayola
Radio Test Engineer

Approved by:

John Charters
Department Manager- Radio

Date: 17 September 2018

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
- [2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF914 4.0



1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	17 September 2018	Original

2 Summary

TEST REPORT NUMBER:	TRA-041439-47-00A
WORKS ORDER NUMBER:	TRA-041439-01
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION(S):	47CFR15.225 & RSS-210 Annex 2.6
EQUIPMENT UNDER TEST (EUT):	Ultima
FCC IDENTIFIER:	XDW3680-0001
EUT SERIAL NUMBER:	66801903
MANUFACTURER/AGENT:	Magicard Ltd
ADDRESS:	Hampshire Road Weymouth Dorset DT4 9XD United Kingdom
CLIENT CONTACT:	Tim Last ☎ 01305 470263 ✉ tim.last@magicard.com
ORDER NUMBER:	689
TEST DATE:	11th July 2018
TESTED BY:	D Moncayola Element

2.1 Test Summary

Test Method and Description	Requirement Clause	Applicable to this equipment	Result / Note
	47CFR15		
Radiated spurious emissions, below 30 MHz	15.225(d)	<input checked="" type="checkbox"/>	Pass
Radiated spurious emissions	15.209	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions	15.207	<input checked="" type="checkbox"/>	Pass
Occupied bandwidth	15.215(c)	<input checked="" type="checkbox"/>	Pass
Field strength of fundamental	15.225(a), (b) and (c)	<input checked="" type="checkbox"/>	Pass
Frequency stability	15.225(e)	<input checked="" type="checkbox"/>	Pass

Notes:

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

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

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

3 Contents

1	Revision Record	3
2	Summary	4
2.1	Test Summary	5
3	Contents	6
4	Introduction	8
5	Test Specifications	9
5.1	Normative References	9
5.2	Deviations from Test Standards	9
6	Glossary of Terms	10
7	Equipment Under Test	11
7.1	EUT Identification	11
7.2	System Equipment	11
7.3	EUT Mode of Operation	11
7.3.1	Transmission	11
7.4	EUT Radio Parameters	11
7.4.1	General	11
7.5	EUT Description	12
8	Modifications	13
9	EUT Test Setup	14
9.1	Block Diagram	14
9.2	General Set-up Photograph	14
10	General Technical Parameters	15
10.1	Normal Conditions	15
10.2	Varying Test Conditions	15
11	Radiated emissions below 30 MHz	16
11.1	Definitions	16
11.2	Test Parameters	16
11.3	Test Limit	17
11.4	Test Method	17
11.5	Test Set-up Photograph	18
11.6	Test Equipment	19
11.7	Test Results	20
12	Radiated emissions	21
12.1	Definitions	21
12.2	Test Parameters	21
12.3	Test Limit	21
12.4	Test Method	22
12.5	Test Set-up Photograph	23
12.6	Test Equipment	24
12.7	Test Results	25
13	AC power-line conducted emissions	26
13.1	Definition	26
13.2	Test Parameters	26
13.3	Test Limit	26
13.4	Test Method	27
13.5	Test Set-up Photograph	28
13.6	Test Equipment	29
13.7	Test Results	30
14	Occupied Bandwidth	32
14.1	Definition	32
14.2	Test Parameters	32
14.3	Test Limit	32
14.4	Test Method	33
14.5	Test Equipment	34
14.6	Test Results	35
15	Transmitter output power (fundamental radiated emission)	36
15.1	Definition	36
15.2	Test Parameters	36
15.3	Test Limit	36
15.4	Test Method	37
15.5	Test Equipment	38
15.6	Test Results	39
16	Frequency stability	40
16.1	Definition	40
16.2	Test Parameters	40

16.3 Test Limit 40

16.4 Test Method..... 41

16.5 Test Equipment 42

16.6 Test Results..... 43

17 Measurement Uncertainty..... 44

4 Introduction

This report TRA-041439-47-00A presents the results of the Radio testing on a Magicard Ltd, Ultima to specification 47CFR15 Radio Frequency Devices.

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

<input type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input checked="" type="checkbox"/>	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK
--------------------------	---	-------------------------------------	--

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

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

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

5.2 Deviations from Test Standards

The EUT was left powered on for the duration of the frequency stability tests.

6 Glossary of Terms

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

7 Equipment Under Test

7.1 EUT Identification

- Name: Ultima
- Serial Number: 66801903
- Model Number: 3680-0001
- Software Revision: v 1.0
- Build Level / Revision Number: Pre-production

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmit tests was as follows:-

For ac power-line operation the device was transmitting in normal operational mode in worst case scenario (film door open). For all other tests the device was supplied with test firmware allowing a higher duty cycle to facilitate testing.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	13.56 MHz
Modulation type:	ASK
Occupied channel bandwidth:	5 kHz
Channel spacing:	Not Applicable
ITU emission designator:	A1D
Declared output power:	0.2 W
Nominal Supply Voltage:	110 V, 60 Hz
Duty cycle:	2.1 %

7.5 EUT Description

The EUT is a thermal reverse-transfer ID card printer. A thermal print head is used to create an image on a piece of film, which is then transferred to a plastic card using a heated roller. The unit has a RFID system to control the status of the film.

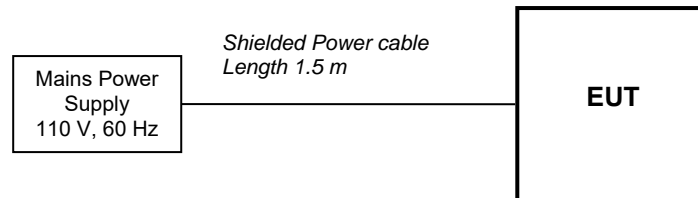
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up.



10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 110 V ac, 60 Hz, from the mains.

10.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	Variation
<input checked="" type="checkbox"/>	Standard	-20 to +50 C in 10 degree steps
<input type="checkbox"/>	Extended	

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

	Category	Nominal	Variation
<input checked="" type="checkbox"/>	Mains	110 V ac +/-2 %	85 % and 115 %
<input type="checkbox"/>	Battery	New battery	N/A

11 Radiated emissions below 30 MHz

11.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions

Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Frequency Measured:	13.56 MHz
EUT Channel Bandwidth:	5 kHz
Deviations From Standard:	None
Measurement Distance and Site:	3 m, OATS without ground plane.
EUT Height:	1 m
Measurement Antenna and Height:	60 cm shielded loop; 1 m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac (as declared)

11.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies Below 30 MHz

<i>Frequency, f (kHz)</i>	<i>Field Strength</i>	<i>Measurement Distance (m)</i>
9 to 490	2,400 / 377.f (μA/m) 2,400 / f (μV/m)	300
490 to 1,750	24,000 / 377.f (μA/m) 24,000 / f (μV/m)	30
1,750 to 30,000	30 (μV/m)	30

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

11.4 Test Method

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

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

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

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

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

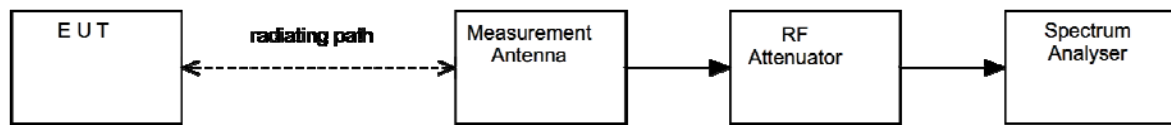
$$FS = 10^{(PR - CF) / 20}$$

Where,

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

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

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

Figure i Test Setup

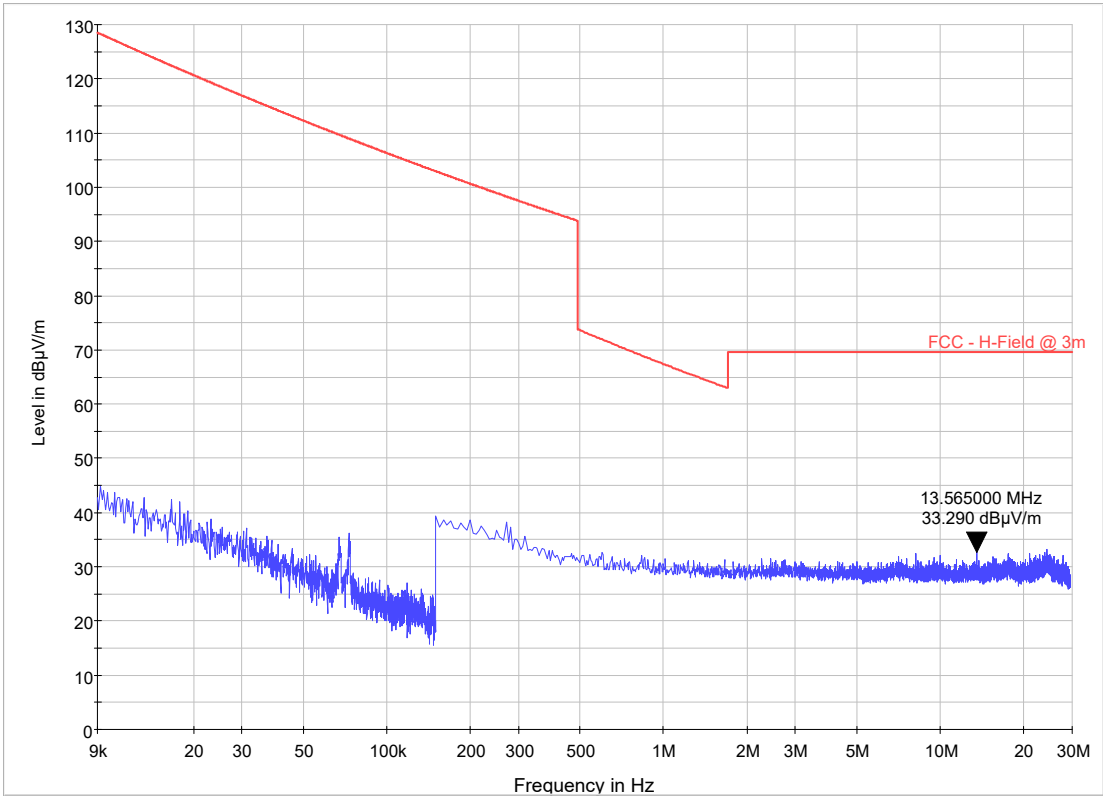
11.5 Test Set-up Photograph



11.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2019-05-10
ESHS10	R&S	Receiver	U003	2018-08-29

11.7 Test Results



Modulation: ASK; Power setting: Highest power setting:						
Emission Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Result
No emissions within 10 dB of the limit						PASS

12 Radiated emissions

12.1 Definitions

Out-of-band emissions

Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions

Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands

A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequency Measured:	13.56 MHz
EUT Channel Bandwidth:	5 kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 300 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac (as declared)

12.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

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

12.4 Test Method

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

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

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

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

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

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

$$FS = PR + CL + AF - PA + DC - CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBμV;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

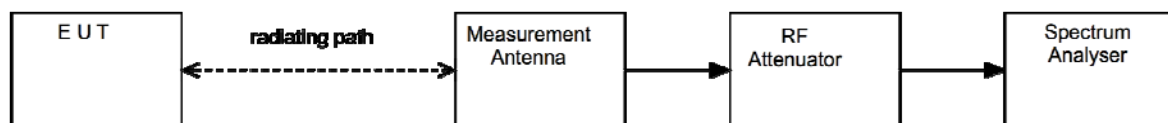
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

CF is the distance factor in dB (where measurement distance is different to limit distance);

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

Figure ii Test Setup



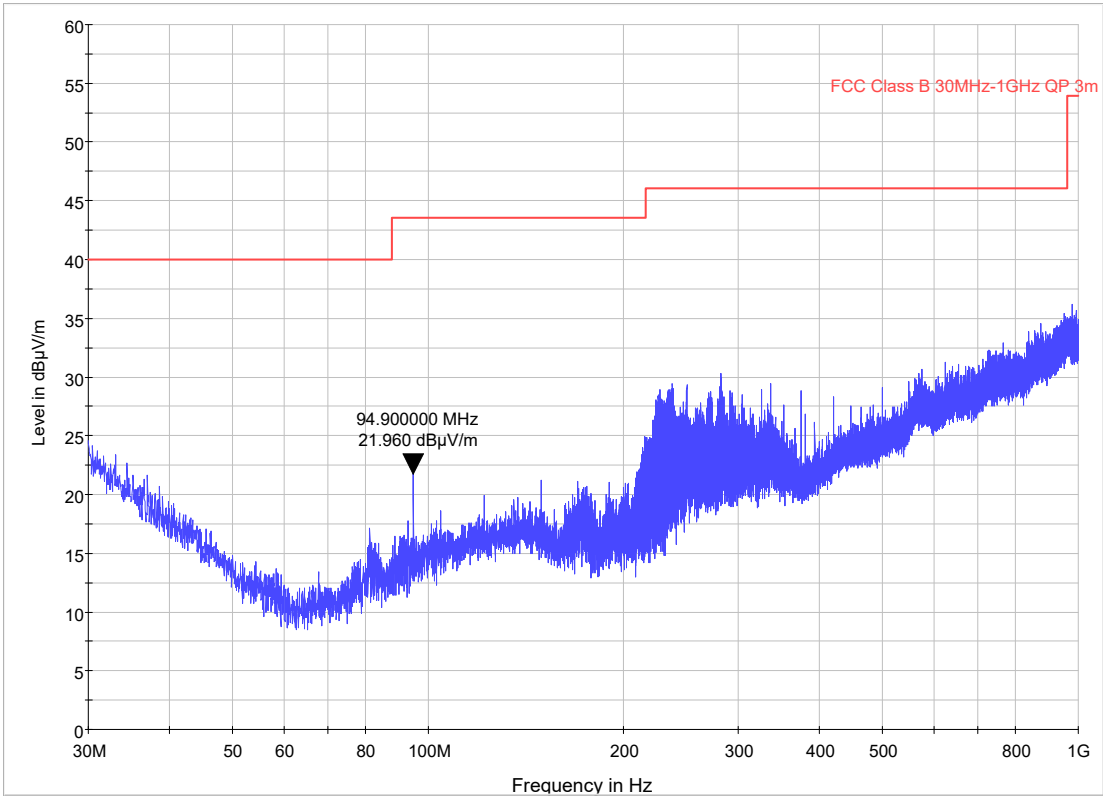
12.5 Test Set-up Photograph



12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
CBL611/A	Chase	Bilog	U573	2019-08-02
ESR7	R&S	EMI Receiver	U456	2018-09-12

12.7 Test Results



High Power; Frequency: 13.56 MHz:										
Detector	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No emissions within 10 dB of the limit										

13 AC power-line conducted emissions

13.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	LF Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequency Measured:	13.56 MHz
EUT Channel Bandwidth:	5 kHz
EUT Modulation:	ASK
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac (as declared)

13.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	Conducted limit (dB μ V)	
	Quasi-Peak	Average**
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.

**A linear average detector is required.

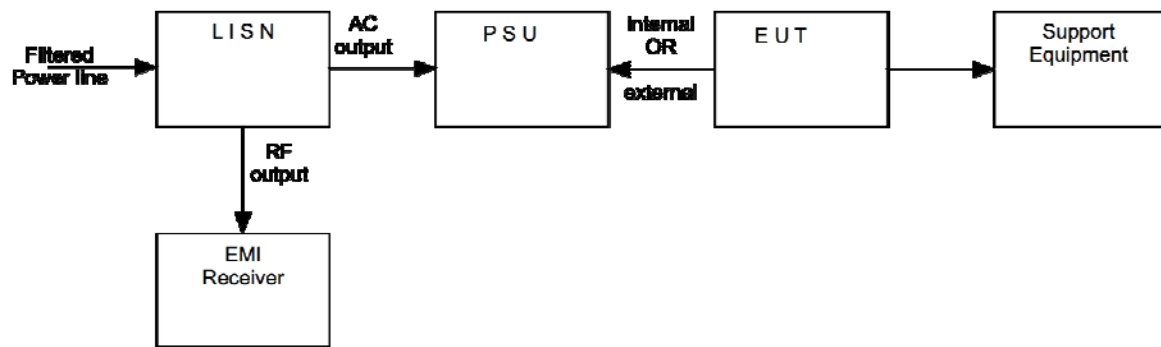
13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure iii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure iii Test Setup



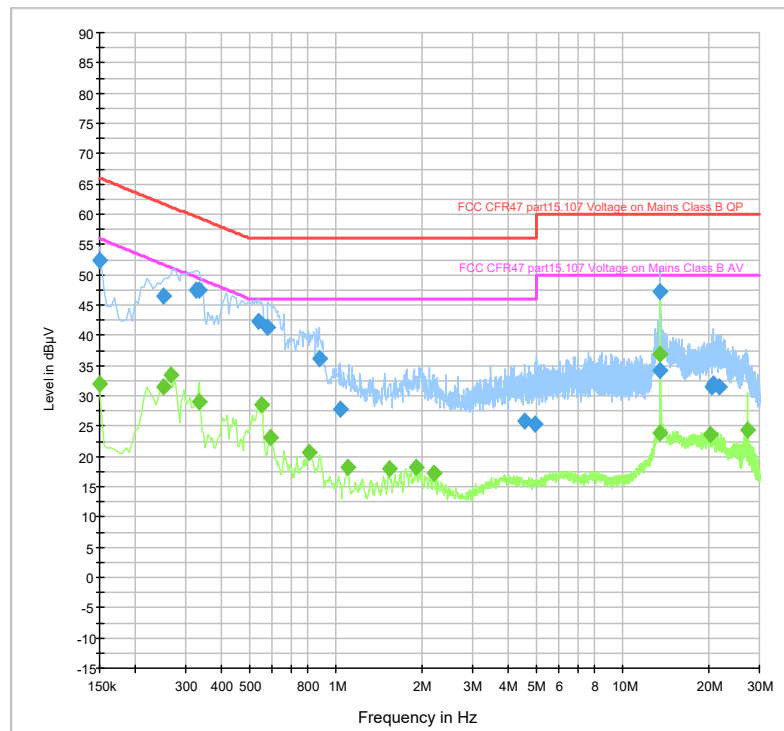
13.5 Test Set-up Photograph



13.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESHS10	R&S	Receiver	U003	2018-08-29
ENV216	R&S	Lisn	U396	2018-07-05

13.7 Test Results



AC power-line conducted emissions, Transmit mode:						
Results measured using the average detector						
Frequency (MHz)	Bandwidth (kHz)	Conductor	Result (dBμV)	Specification Limit (dBμV)	Margin (dB)	Result Summary
0.150000	10.000	L1	31.9	56.0	24.1	PASS
0.250000	10.000	N	31.5	51.8	20.2	PASS
0.265000	10.000	N	33.4	51.3	17.8	PASS
0.335000	10.000	N	29.1	49.3	20.2	PASS
0.550000	10.000	N	28.5	46.0	17.5	PASS
0.590000	10.000	N	23.1	46.0	22.9	PASS
0.810000	10.000	N	20.8	46.0	25.2	PASS
1.095000	10.000	N	18.1	46.0	27.9	PASS
1.535000	10.000	N	17.8	46.0	28.2	PASS
1.895000	10.000	N	18.3	46.0	27.7	PASS
2.200000	10.000	N	17.1	46.0	28.9	PASS
13.530000	10.000	N	23.9	50.0	26.1	PASS
13.565000	10.000	L1	37.0	50.0	13.0	PASS
20.245000	10.000	N	23.7	50.0	26.3	PASS
27.115000	10.000	N	24.3	50.0	25.7	PASS

<i>Results measured using the quasi-peak detector:</i>						
<i>Frequency (MHz)</i>	<i>Bandwidth (kHz)</i>	<i>Conductor</i>	<i>Result (dBuV)</i>	<i>Specification Limit (dBuV)</i>	<i>Margin (dB)</i>	<i>Result Summary</i>
0.150000	10.000	L1	52.4	66.0	13.6	PASS
0.250000	10.000	N	46.6	61.8	15.2	PASS
0.325000	10.000	N	47.5	59.6	12.1	PASS
0.335000	10.000	N	47.5	59.3	11.8	PASS
0.535000	10.000	N	42.2	56.0	13.8	PASS
0.580000	10.000	N	41.3	56.0	14.7	PASS
0.875000	10.000	N	36.1	56.0	19.9	PASS
1.040000	10.000	N	27.8	56.0	28.2	PASS
4.565000	10.000	L1	25.8	56.0	30.2	PASS
4.970000	10.000	L1	25.4	56.0	30.6	PASS
13.475000	10.000	N	34.1	60.0	25.9	PASS
13.565000	10.000	L1	47.3	60.0	12.7	PASS
20.450000	10.000	N	31.6	60.0	28.4	PASS
20.690000	10.000	N	31.9	60.0	28.1	PASS
21.835000	10.000	N	31.5	60.0	28.5	PASS

14 Occupied Bandwidth

14.1 Definition

Occupied bandwidth

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

20 dB bandwidth

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

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Frequency Measured:	13.56 MHz
EUT Channel Bandwidth:	5 kHz
EUT Test Modulations:	ASK
Deviations From Standard:	Fix RBW used. 1% to 5% not achievable with ASK modulation
Measurement BW:	1 kHz
(requirement: 1% to 5% OBW)	
Spectrum Analyzer Video BW:	3 kHz
(requirement at least 3x RBW)	
Measurement Span:	20 kHz
(requirement 2 to 5 times OBW)	
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 45 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac (as declared)

14.3 Test Limit

Federal Communications Commission:

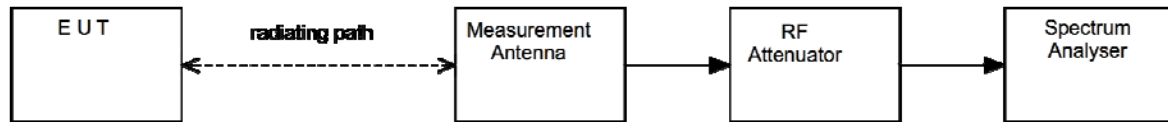
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

14.4 Test Method

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

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

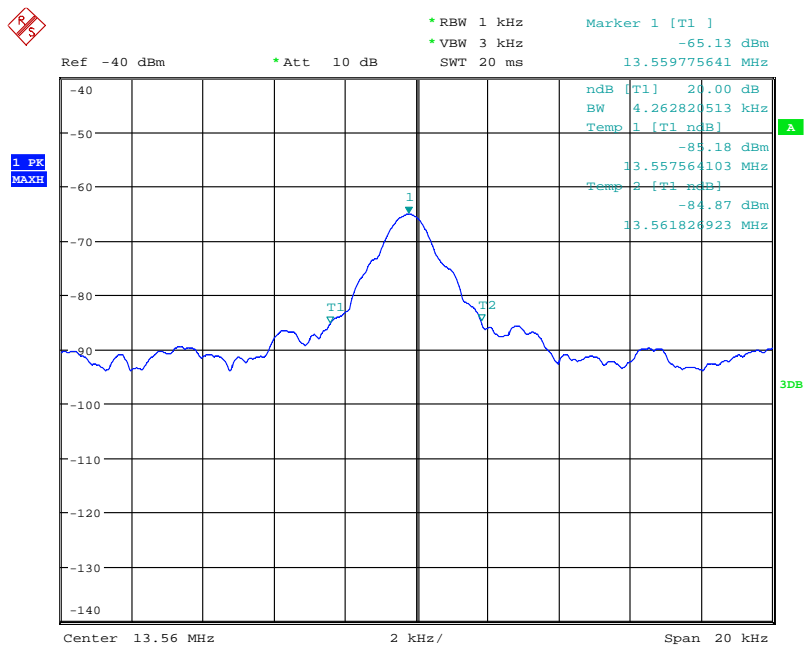
Figure iv Test Setup



14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	2019-05-22

14.6 Test Results



Date: 6.JUN.2018 15:38:30

Modulation: ASK; Higher Power setting:			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (kHz)
13.56	13.5576	13.5618	4.2

15 Transmitter output power (fundamental radiated emission)

15.1 Definition

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

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Far Field
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Frequencies Measured:	13.56 MHz
EUT Channel Bandwidth:	5 kHz
Deviations From Standard:	None
Measurement BW:	9 kHz
Measurement Detector:	Quasi-peak
Voltage Extreme Environment Test Range:	Mains Power = 85% and 115% of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

The field strength measured at 30 m shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

<i>Frequency range (MHz)</i>	<i>Field strength (μV/m at 30m)</i>	<i>Field strength (dBμV/m at 30m)</i>
13.110 – 13.410	106	40.5
13.410 – 13.553	334	50.5
13.553 – 13.567	15,848	84.0
13.567 – 13.710	334	50.5
13.710 – 14.010	106	40.5

15.4 Test Method

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

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

Power values measured on the test receiver / analyzer are converted to field strength, FS, in $\mu\text{V/m}$ at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

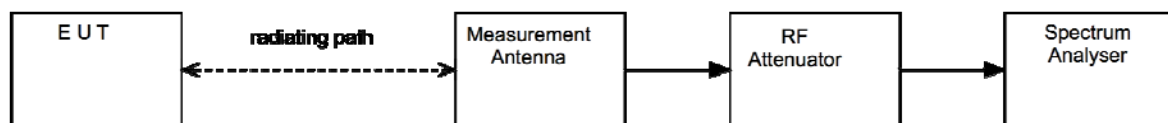
Where,

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

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

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

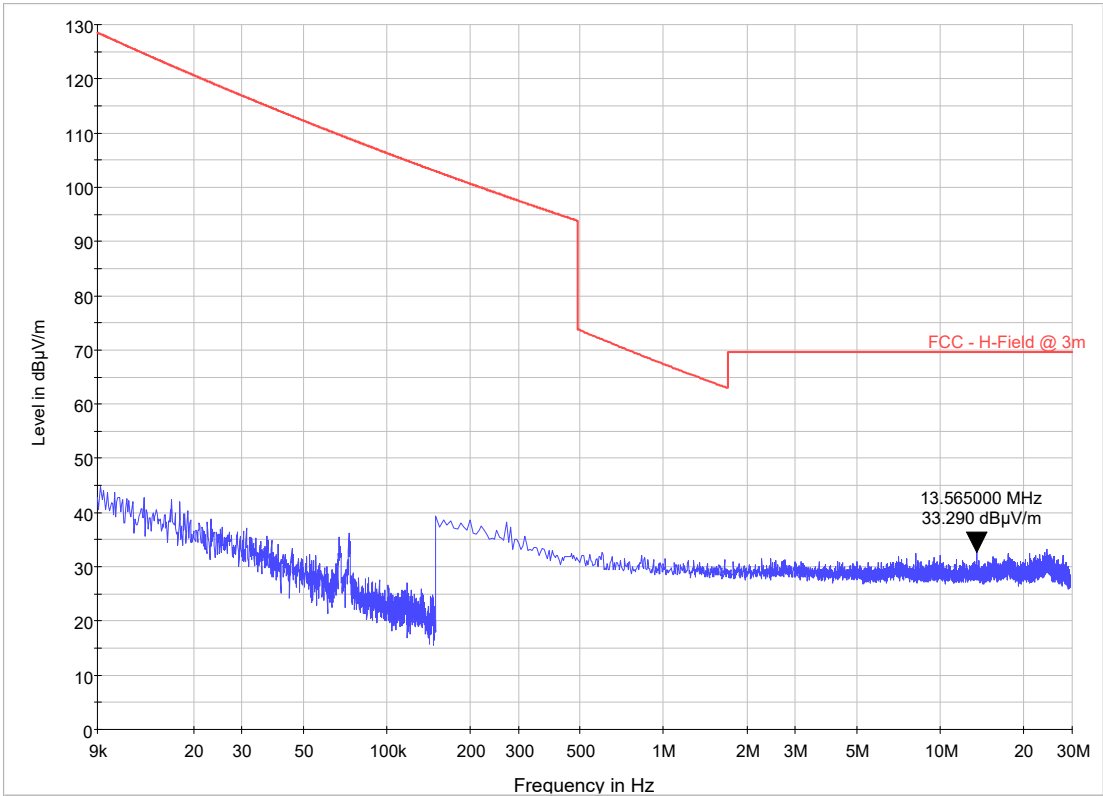
Figure v Test Setup



15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2019-05-10
ESHS10	R&S	Receiver	U003	2018-08-29

15.6 Test Results



Modulation: ASK; Power setting: Higher power setting:						
Channel Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Result
13.56	39.7	3	30	40	0.966	PASS

16 Frequency stability

16.1 Definition

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.8
Frequency Measured:	13.56 MHz
Modulation:	ASK
Deviations From Standard:	EUT was left ON for the duration of the test.
Temperature Extreme Environment Test Range:	-20 to +50 C
Voltage Extreme Environment Test Range:	Mains Power = ±15% of Nominal; IC: Battery: nominal and end point; FCC: Battery: new battery.

Environmental Conditions (Normal Environment)

Temperature: 20 °C	Standard Requirement: +20 °C
Humidity: 45 %RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

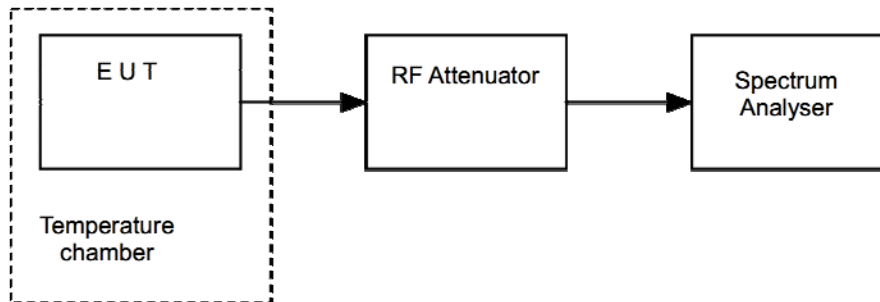
Carrier frequency stability shall be maintained to ±0.01% (±100 ppm).

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the frequency was measured under varying conditions of temperature and supply voltage.

The measurements were performed with EUT set in a CW mode of operation. Measurements were made once temperature stability was achieved at each temperature.

Figure v Test Setup



16.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	2019-05-22
52 Series II	Fluke	Temperature Indicator	L426	2019-06-18
34405a	Agilent	Multimeter	REF976	2019-01-17
ETS	ETS-S1000CHS	Temperature Chamber	U522	Use L426
8A	RS	Variable Transformer	U034	Use REF976

16.6 Test Results

EUT Frequency: 13.56 MHz:					
Test Environment		Measured Frequency (MHz)	Frequency error (kHz)	Frequency error (%)	Result
-20 C	V _{nominal}	13.55975962	0.0000	0	PASS
-10 C	V _{nominal}	13.55983974	0.0801	0.0006	PASS
0 C	V _{nominal}	13.55983974	0.0801	0.0006	PASS
+10 C	V _{nominal}	13.55983974	0.0801	0.0006	PASS
+20 C	V _{minimum}	13.55975962	0.0000	0	PASS
	V _{nominal}	13.55975962	N/A	N/A	N/A
	V _{maximum}	13.55975962	0.0000	0	PASS
+30 C	V _{nominal}	13.55975962	0.0000	0	PASS
+40 C	V _{nominal}	13.55975962	0.0000	0	PASS
+50 C	V _{nominal}	13.55975962	0.0000	0	PASS

17 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Radiated emissions below 30 MHz

Uncertainty in test result (9 kHz to 30 MHz) = **2.3 dB**

[2] Spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113 ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265 ppm**