Report on the Radio Testing

For

Thermo Shandon Ltd

on

Excelsior RS

Report no. TRA-035454-47-00A

26 September 2018

RF914 4.0

Report Number: TRA-035454-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Thermo Shandon Ltd
Excelsior RS
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.225

TEST DATE: 2018-04-03 to 2018-04-11

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UKAS TESTING 0026

1 Revision Record

Issue Number	***Issue Date***	***Revision History***
A	26 September 2018	Original

2 Summary

TEST REPORT NUMBER:	TRA-035454-47-00A
WORKS ORDER NUMBER:	TRA-035454-02
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
EQUIPMENT UNDER TEST (EUT):	Excelsior RS
FCC IDENTIFIER:	2AP7Q-A84100090
EUT SERIAL NUMBER:	Beta 13
MANUFACTURER/AGENT:	Thermo Shandon Ltd
ADDRESS:	Tudor Road Manor Park Runcorn Cheshire WA7 1TA
CLIENT CONTACT:	Dan Robinson ☎ +44 (0)1482 800237 ✉ daniel.robinson@thermofisher.com
ORDER NUMBER:	AP-70841
TEST DATE:	2018-04-03 to 2018-04-11
TESTED BY:	Steven Garwell 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)	☒	*Pass*
Radiated spurious emissions	15.209	☒	*Note 1*
AC power line conducted emissions	15.207	☒	*Pass*
Occupied bandwidth	15.215(c)	☒	*Pass*
Field strength of fundamental	15.225(a), (b) and (c)	☒	*Pass*
Frequency stability	15.225(e)	☒	*Pass*

Notes:

Note 1: This report only covers part 15.225 (subpart C) intentional radiators with regards to the spurious emission limits. The failed emissions detailed in section 12.7 of this report are not radio related and are covered by the EMC test report TRA-035454-35-00A.

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).

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4 Introduction

This report TRA-035454-47-00A presents the results of the Radio testing on a Thermo Shandon Ltd, Excelsior RS to specification 47CFR15 Radio Frequency Devices.

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

☐	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☒	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK

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

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

FCC Site Listing:
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

There were no deviations from the test standard.

6 Glossary of Terms

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

7 Equipment Under Test

7.1 EUT Identification

- Name: Excelsior RS
- Serial Number: Beta 13
- Model Number: RS
- Software Revision: V0.8.7
- Build Level / Revision Number: Production Level

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:-

The EUT was powered from 120 Vac mains 60 Hz, once the unit had booted up a test script was run from a supplied USB memory stick. The test script enabled the RFID transmitter to transmit a modulated carrier on the operating frequency of 13.56 Megahertz.

7.3.2 Reception

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

No receive tests were carried out, see EMC report TRA-035454-35-00A.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	13.56 MHz
Modulation type(s):	ASK
Occupied channel bandwidth(s):	Wideband
Channel spacing:	Not Applicable
Antenna type(s):	Fixed Inductive Loop
Nominal Supply Voltage:	110 V ac
Location of notice for license exempt use:	Label / user manual / both.

7.5 EUT Description

The EUT is a tissue processor which preserves tissue in wax. The instrument cycles different fluids into the main chamber depending on the required user process.

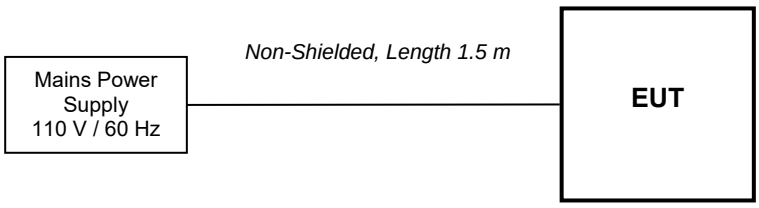
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

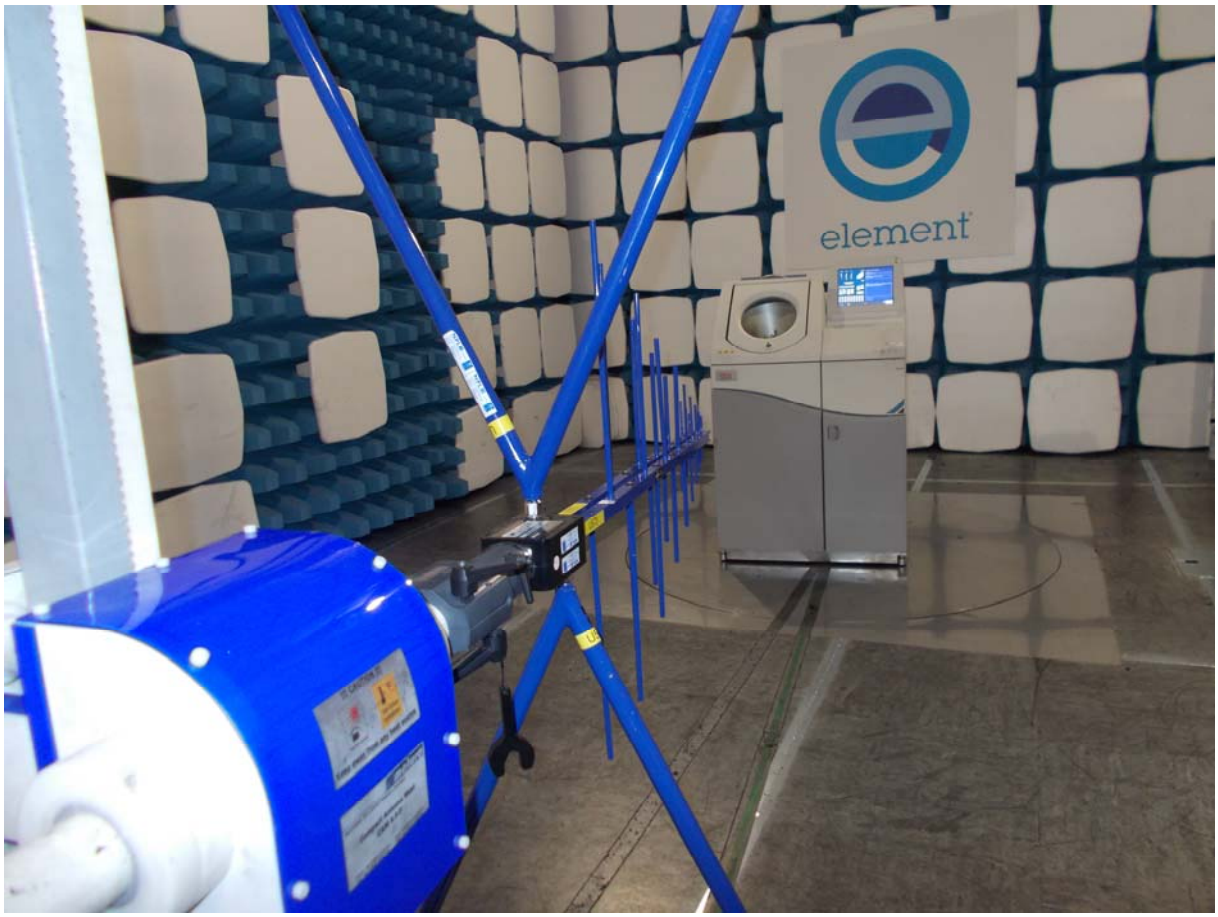
9.1 Block Diagram

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***
☒	Standard	-20 to +50 C in 10 degree steps
☐	Extended	N/A

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***
☒	Mains	110 V ac	85 % and 115 %
☐	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 Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement Distance and Site	10 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: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (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

Frequency, f (kHz)	*Field Strength*	*Measurement Distance (m)*
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 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 360º, in three orthogonal planes, and adjusting the measurement antenna azimuth.

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

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

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

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

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

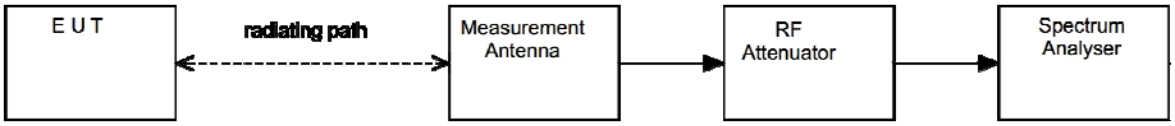
Where,

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

Per FCC 47CFR15.31(f)(2), 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

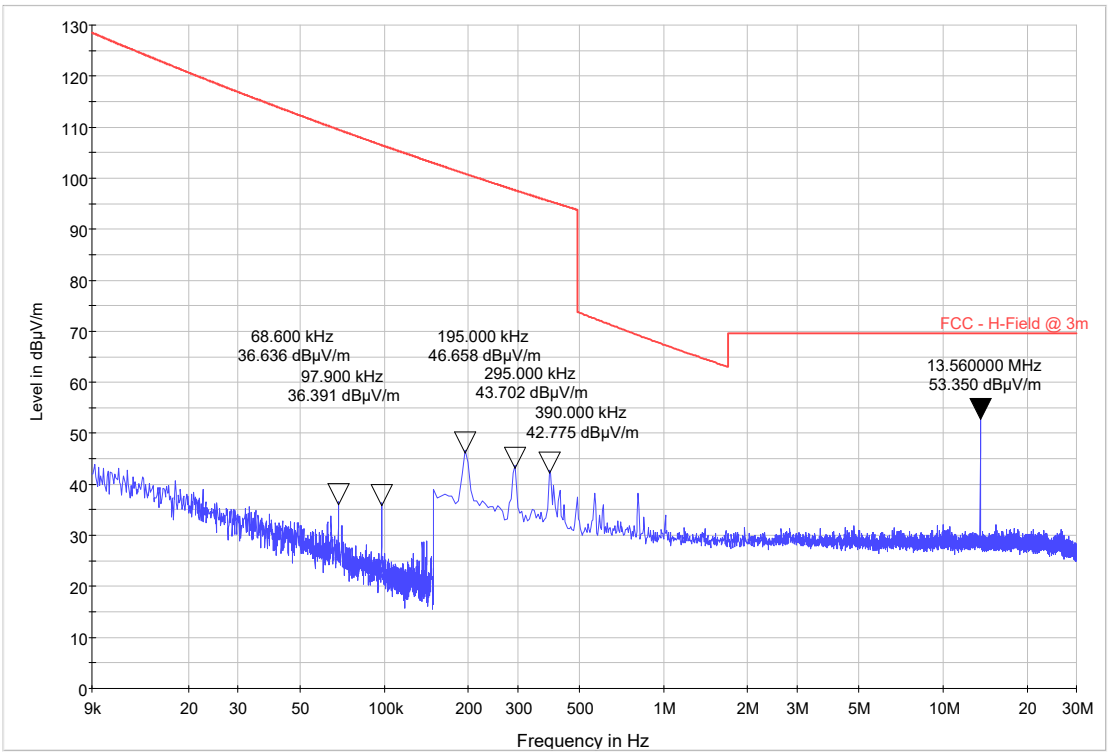


11.5 Test Set-up Photograph

11.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR26	R&S	EMI Receiver	U489	2018-05-04
hfh2	R&S	Loop Antenna	L007	2018-04-12

11.7 Test Results



9 kHz to 30 MHz

EUT Frequency; 13.56 MHz:						
Emission Frequency (MHz)	***Receiver Level (dBµV/m)***	***Measurement Distance (m)***	***Limit Distance (m)***	***Extrapolation Factor (dB)***	***Field Strength (µV/m)***	***Result***
No emissions within 20 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 Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 300 MHz: 120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (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

Frequency (MHz)	*Field Strength (µV/m at 3 m)*
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:

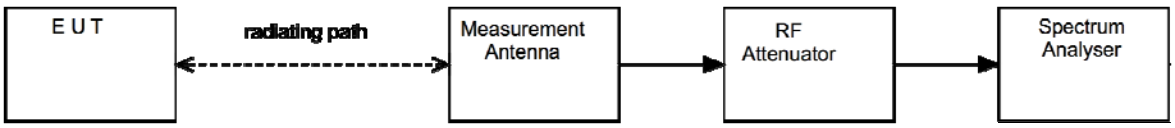
$$FS = PR + CL + AF - PA + DC - CF$$

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



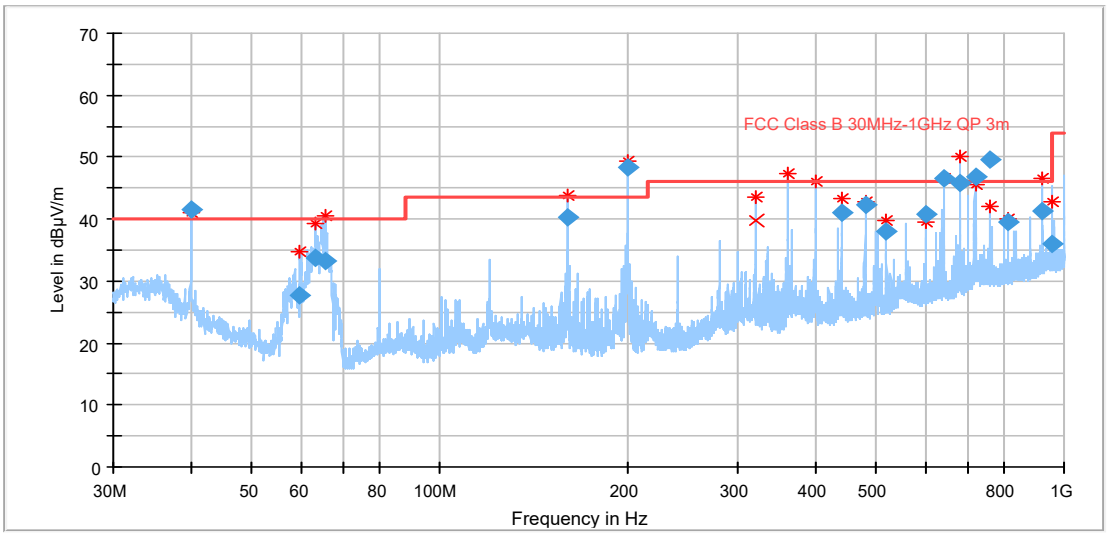
12.5 Test Set-up Photograph

12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR26	R&S	EMI Receiver	U489	2018-05-04
CBL611/A	Chase	Bilog	U191	2019-02-23

12.7 Test Results

Full Spectrum



Note 1: This report only covers part 15.225 (subpart C) intentional radiators with regards to the spurious emission limits. The failed emissions detailed in this section of the report are not radio related and are covered by the EMC test report TRA-035454-35-00A.

As can be seen below the 40 MHz signal complete with its associated harmonics is prevalent with the transmitter situated inside the device as depicted in Figure1.

The emissions shown in Figure 2 show the emissions from the radio board only, although the harmonic of the fundamental exceeds the 15.209 limit this does not occur when the radio module is fitted internal to the device due to screening effect.

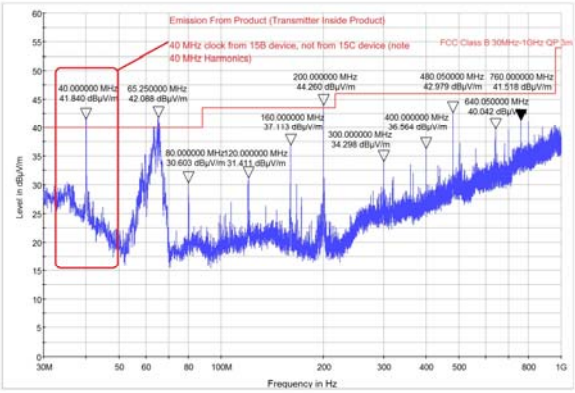


Figure 1

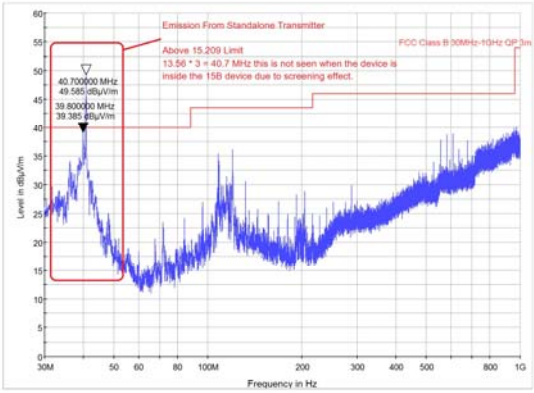


Figure 2

Picture to show EUT radio board setup.

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:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Frequency Measured:	13.56 MHz
EUT Channel Bandwidths:	Wideband
EUT Modulation:	ASK
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 36 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (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 (dBµV)*	
	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.

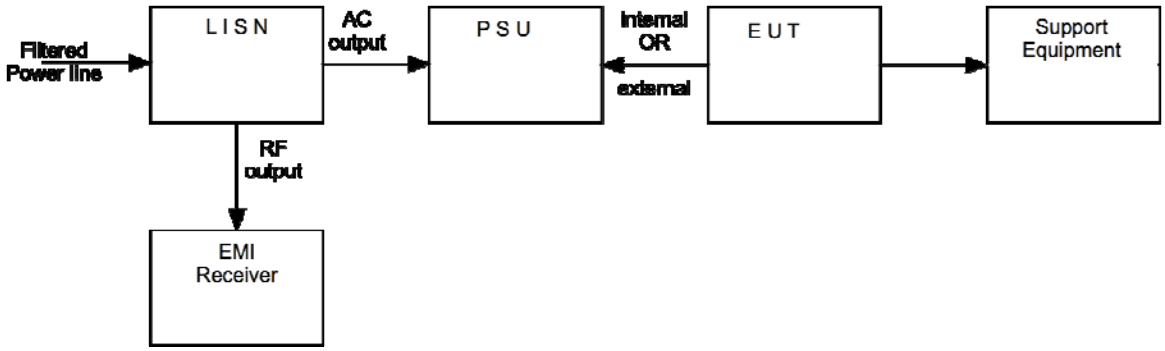
13.4 Test Method

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

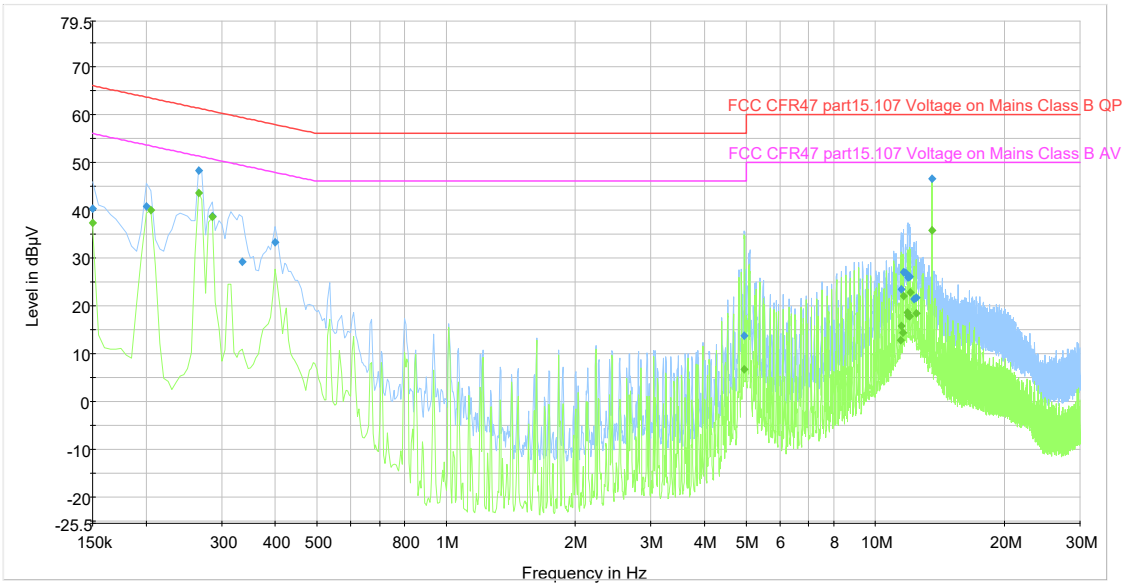


13.5 Test Set-up Photograph

13.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESH3-Z5.831.5	R&S	Lisn	U195	2018-08-16
ESHS10	R&S	Receiver	U187	2017-10-25

13.7 Test Results



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Comment
0.150000	40.3	2000.0	10.000	GND	N	0.1	PASS
0.200000	40.8	2000.0	10.000	GND	L1	0.2	PASS
0.265000	48.2	2000.0	10.000	GND	N	0.1	PASS
0.285000	38.8	2000.0	10.000	GND	N	0.2	PASS
0.335000	29.2	2000.0	10.000	GND	N	0.1	PASS
0.400000	33.2	2000.0	10.000	GND	L1	0.2	PASS
4.950000	13.8	2000.0	10.000	GND	L1	0.4	PASS
11.475000	23.4	2000.0	10.000	GND	N	0.7	PASS
11.620000	27.0	2000.0	10.000	GND	N	0.7	PASS
11.755000	26.9	2000.0	10.000	GND	N	0.7	PASS
11.900000	26.0	2000.0	10.000	GND	N	0.7	PASS
12.030000	26.0	2000.0	10.000	GND	L1	0.8	PASS
12.315000	21.4	2000.0	10.000	GND	L1	0.8	PASS
12.455000	21.6	2000.0	10.000	GND	L1	0.8	PASS
13.560000	46.6	2000.0	10.000	GND	N	0.8	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 Bandwidths:	Wideband
EUT Test Modulations:	ASK
Deviations From Standard:	None
Measurement BW: (requirement: 1% to 5% OBW)	10 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 V ac	110 V ac ±10 % (as declared)

14.3 Test Limit

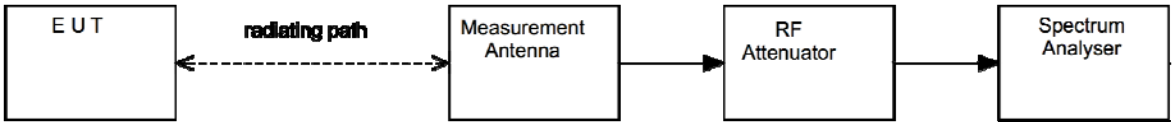
Federal Communications Commission:
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise 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.

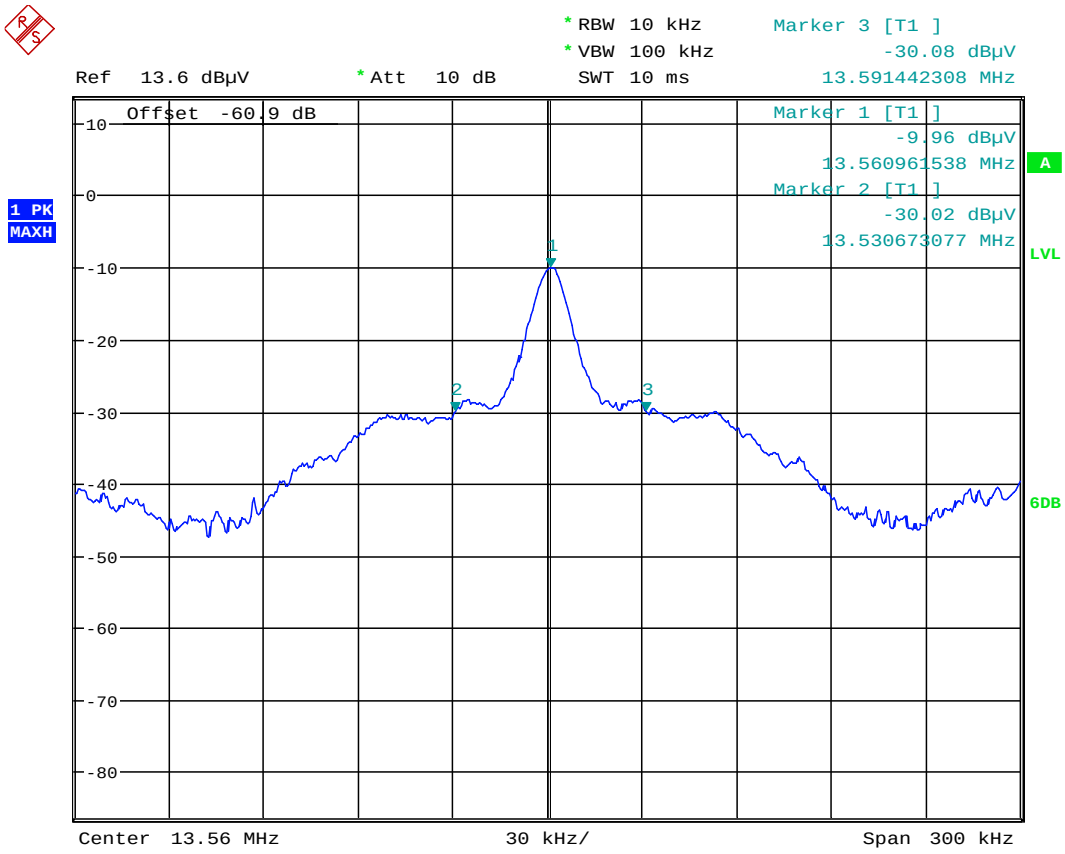
Figure iv Test Setup



14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2019/04/12
ESHS10	R&S	Receiver	U003	2018/08/29
FSU46	R&S	Spectrum Analyser	U281	2018/06/19

20 dB Bandwidth:			
Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***20 dB Bandwidth (kHz)***
13.56	13.530673077	13.591442308	60.769231



Date: 16.MAY.2018 12:37:27

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:	OATS
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Frequency Measured:	13.56 MHz
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);

Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 ºC to +35 ºC (as declared)
Humidity: 41 % 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

Frequency range (MHz)	*Field strength (µV/m at 30m)*	*Field strength (dBµV/m at 30m)*
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 µV/m at the regulatory distance, using:

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

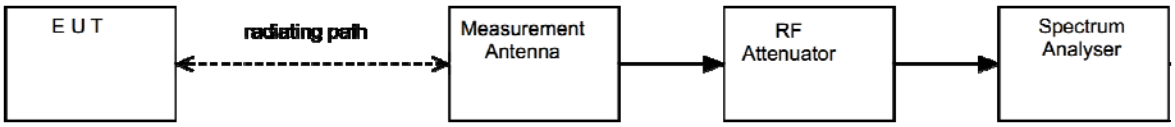
Where,

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 v Test Setup



15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESR26	R&S	EMI Receiver	U489	2018-05-04
hfh2	R&S	Loop Antenna	L007	2018-04-12

15.6 Test Results

EUT Frequency; 13.56 MHz:						
Channel Frequency (MHz)	***Receiver Level (dBµV/m)***	***Measurement Distance (m)***	***Limit Distance (m)***	***Extrapolation Factor (dB)***	***Field Strength (µV/m)***	***Result***
13.56	30	3	30	40	0.316	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
Frequencies Measured:	13.56 MHz
Modulation:	Off
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	-20 to +50 C
Voltage Extreme Environment Test Range:	Mains Power = ±15% of Nominal

Environmental Conditions (Normal Environment)

Temperature: 18 °C	Standard Requirement: +20 ºC
Humidity: 41 %RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

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

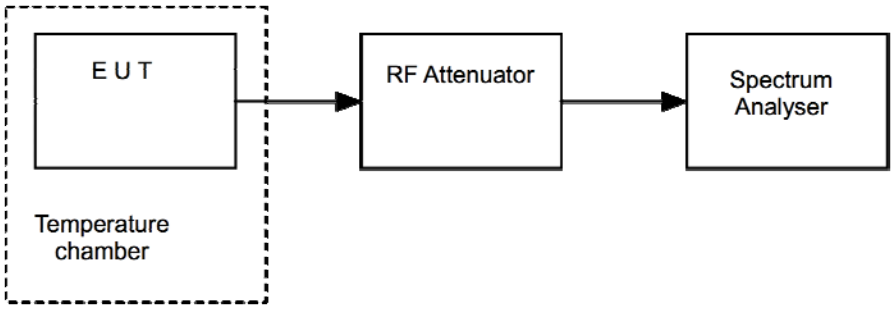
16.4 Test Method

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
Multimeter	Agilent	34405a	REF976	2019-01-17
Spectrum Analyser	R&S	FSU46	U281	2018-06-19
Temperature Indicator	Fluke	52 Series II	L426	2018-05-24
Temperature Chamber	Votsch	VT 4002	U521	Use L426

16.6 Test Results

EUT Frequency; 13.56 MHz:					
Test Environment		***Measured Frequency (MHz)***	***Frequency error (kHz)***	***Frequency error (%)***	***Result***
-20 C	$V_{nominal}$	13.56096154	0.1603	0.0012	PASS
-10 C	$V_{nominal}$	13.56096154	0.1603	0.0012	PASS
0 C	$V_{nominal}$	13.56080128	0.0000	0.0000	PASS
+10 C	$V_{nominal}$	13.56080128	0.0000	0.0000	PASS
+20 C	$V_{minimum}$	13.56080128	0.0000	0.0000	PASS
	$V_{nominal}$	13.56080128	N/A	N/A	N/A
	$V_{maximum}$	13.56080128	0.0000	0.0000	PASS
+30 C	$V_{nominal}$	13.56080128	0.0000	0.0000	PASS
+40 C	$V_{nominal}$	13.56080128	0.0000	0.0000	PASS
+50 C	$V_{nominal}$	13.56080128	0.0000	0.0000	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**