

Report on the Radio Testing  
For  
Third Millennium Systems Ltd  
on  
PRX60BLE  
Report no. TRA-047608-47-00A  
2020-04-03

RF914 6.0



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Report Number: TRA-047608-47-00A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
Third Millennium Systems Ltd  
PRX60BLE  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.225

TEST DATE: 2020-02-12 to 2020-02-27

Tested by:

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Date:

2020-04-03

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

## 1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	2020-04-03	Original

## 2 Summary

TEST REPORT NUMBER:	TRA-047608-47-00A
WORKS ORDER NUMBER:	TRA-047608-02
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):	PRX60BLE
FCC IDENTIFIER:	UTJ-RX60BLE
EUT SERIAL NUMBER:	SAMPLE No: 18
MANUFACTURER/AGENT:	Third Millennium Systems Ltd
ADDRESS:	18/19 Torfaen Business Centre Panteg Way New Inn Pontypool NP4 0LS United Kingdom
CLIENT CONTACT:	Sarah Smith ☎ 01495 751 992 ✉ ssmith@tm-readers.com
ORDER NUMBER:	995445
TEST DATE:	2020-02-12 to 2020-02-27
TESTED BY:	S Garwell M Else D Moncayola Element

## 2.1 Test Summary

<b><i>Test Method and Description</i></b>	<b><i>47CFR15</i></b>	<b><i>Applicable to this equipment</i></b>	<b><i>Result / Note</i></b>
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 Error	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).

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## 4 Introduction

This report TRA-047608-47-00A presents the results of the Radio testing on a Third Millennium Systems Ltd, PRX60BLE to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Third Millennium Systems 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
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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

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

## 7 Equipment Under Test

### 7.1 EUT Identification

- Name: PRX60BLE
- Serial Number: SAMPLE No: 18
- Model Number: RX3K90B
- Software Revision: AVx90\_191231.hex
- Build Level / Revision Number: 100-02406-B

### 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 transmitter tests was as follows:

The unit was tested in normal operation mode forcing the unit to read a card continuously.

### 7.4 EUT Radio Parameters

#### 7.4.1 General

<b>Frequency of operation:</b>	13.56 MHz
<b>Modulation type(s):</b>	ASK
<b>Declared output power(s):</b>	Not stated
<b>Warning against use of alternative antennas in user manual (yes/no):</b>	No
<b>Nominal Supply Voltage:</b>	12 Vdc

#### 7.4.2 Antennas

<b>Type:</b>	TM-125 ANTENNA (100-*****)
<b>Frequency range:</b>	Not Stated
<b>Impedance:</b>	Not Stated
<b>Gain:</b>	Not Stated

### 7.5 EUT Description

The EUT is a dc powered door access control reader with RFID and BTLE. This report covers the 13.56 MHz RFID radio.

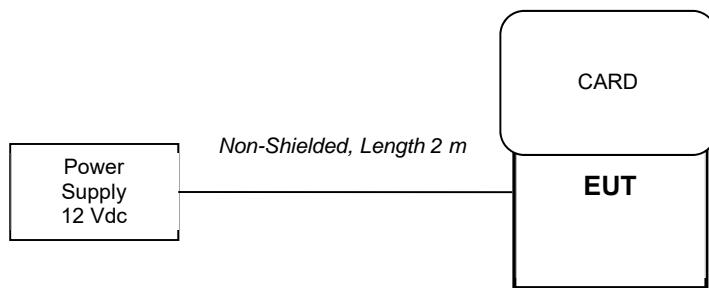
## 8 Modifications

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:



### **9.3 Measurement software**

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5 (See Note)  
Element Transmitter Bench Test (See Note)  
ETS Lindgren EMPower V1.0.4.2

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

## 10 General Technical Parameters

### 10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied 12 Vdc from a power supply.

### 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:

	<b>Category</b>	<b>Variation</b>
<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:

	<b>Category</b>	<b>Nominal</b>	<b>Variation</b>
<input checked="" type="checkbox"/>	Power supply	12 Vdc	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
Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement Distance and Site	3 m
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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 Vdc	12 Vdc (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. $f$ ( $\mu$ A/m) 2,400 / $f$ ( $\mu$ V/m)	300
490 to 1,750	24,000 / 377. $f$ ( $\mu$ A/m) 24,000 / $f$ ( $\mu$ V/m)	30
1,750 to 30,000	30 ( $\mu$ V/m)	30

n.b. Devices operated pursuant to §15.225 / RSS-210 B.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  $\mu$ V/m at the regulatory distance, using:

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

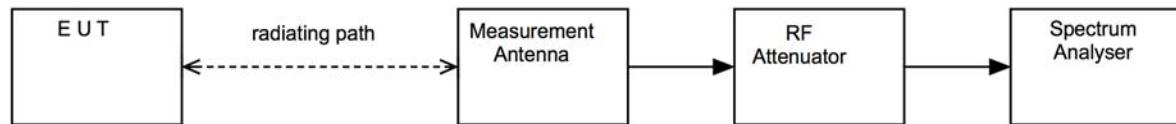
Where,

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 extrapolation from 3 m to 30 m and from 3 m to 300 m.

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

### Figure i Test Setup



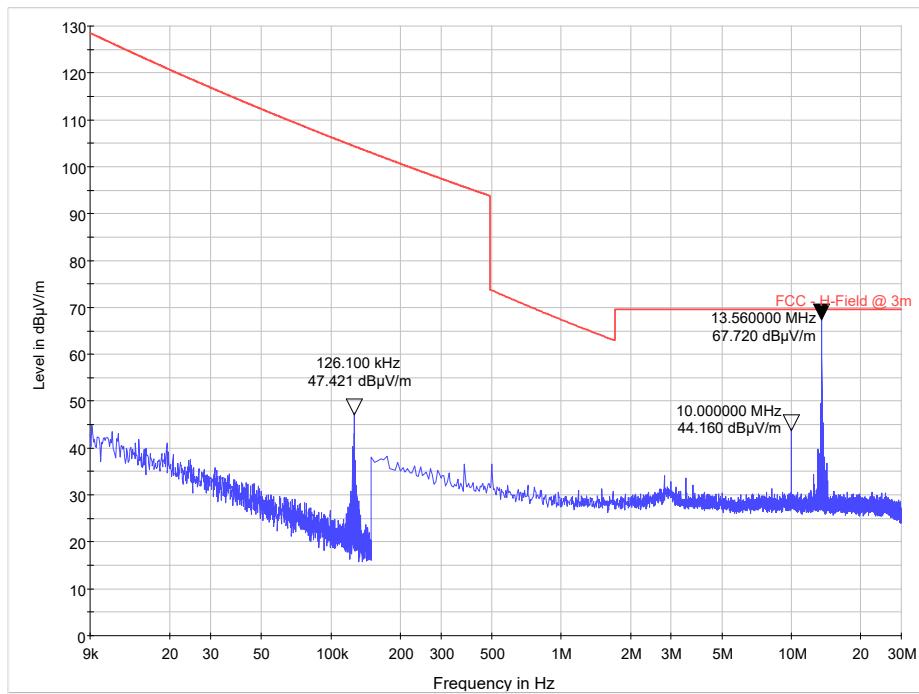
### 11.5 Test Set-up Photograph



### 11.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
hfh2	R&S	Loop Antenna	L007	2020-05-15
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
ESHS10	R&S	Receiver	U003	2020-10-23

## 11.7 Test Results



Modulation: ASK; Higher Power setting						
Emission Frequency (MHz)	Receiver Level (dB $\mu$ V/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength ( $\mu$ V/m)	Result
No significant emissions within 20 dB to 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
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: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 Vdc	12Vdc

### 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 dB $\mu$ V/m at the regulatory distance, using:

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

$$\text{Factor} = CL + AF - PA$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB $\mu$ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

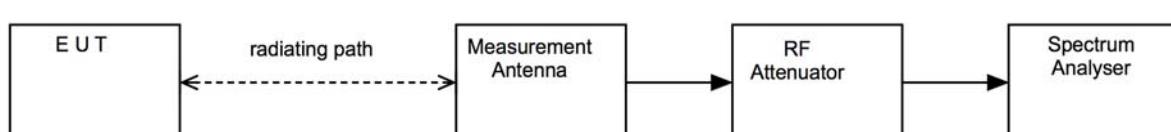
PA is the pre-amplifier gain in dB (where used);

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



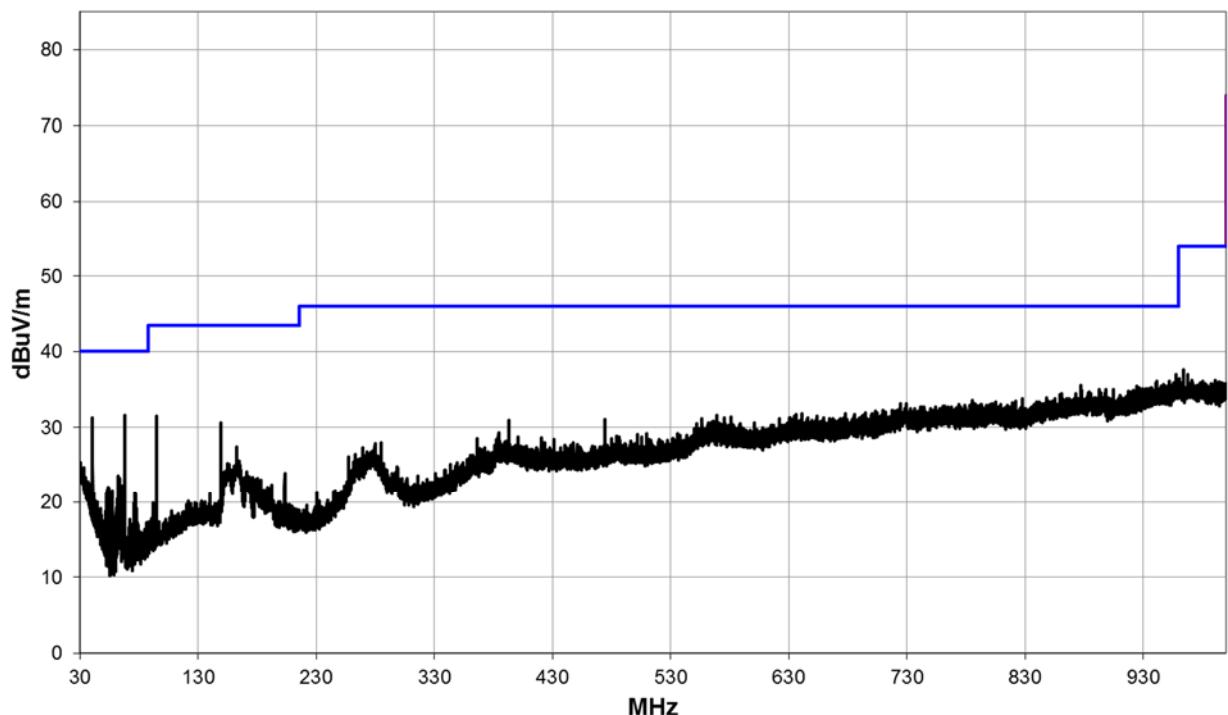
## 12.5 Test Set-up Photograph



## 12.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
CBL611/A	Chase	Bilog	U573	2021-09-19
6201-69	Watkins Johnson	PreAmp	U372	2020-02-25
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
ESR7	R&S	EMI Receiver	U456	2020-11-25

## 12.7 Test Results



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
67.832	16.8	13.1	2.21	156.9	3.0	0.0	Vert	QP	0.0	29.9	40.0	-10.1	PASS
40.706	9.4	19.9	1.0	81.0	3.0	0.0	Vert	QP	0.0	29.3	40.0	-10.7	PASS
94.920	13.3	16.4	1.0	279.0	3.0	0.0	Vert	QP	0.0	29.7	43.5	-13.8	PASS

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

### Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 Vdc	12 Vdc (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 $\mu$ 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.

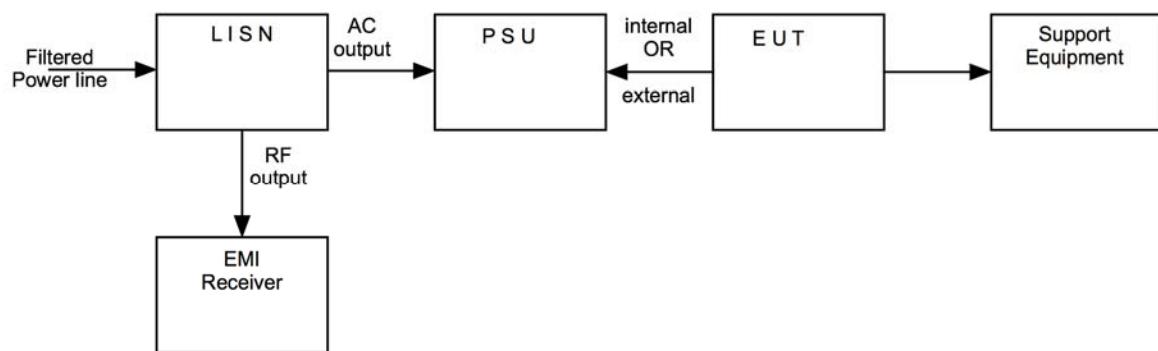
### 13.4 Test Method

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

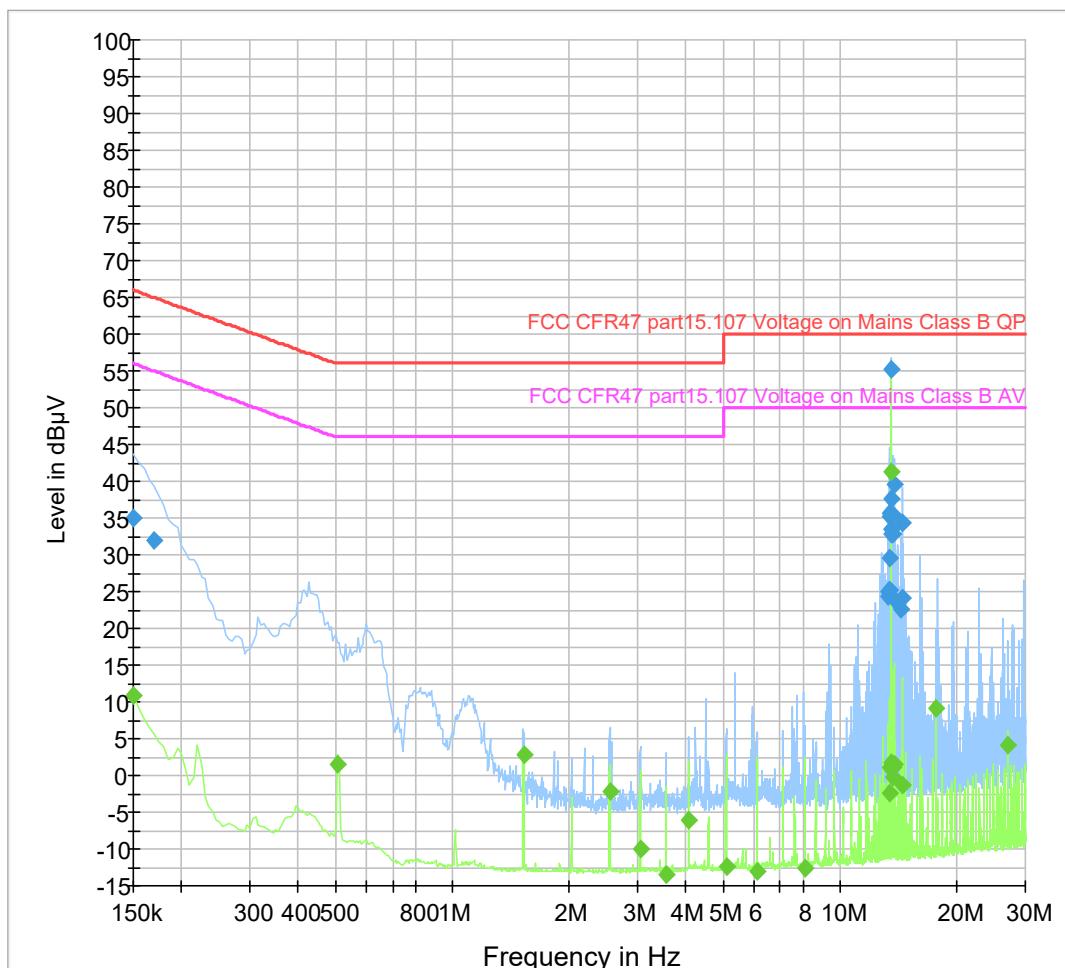


**13.6 Test Equipment**

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESH3-Z5.831.5	R&S	Lisn	U195	2020-10-04
ESHS10	R&S	Receiver	U003	2020-10-23

### 13.7 Test Results

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH195 +UH559



AC power-line conducted emissions, Transmit mode									
Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)	Comment
0.150000	35.1	2000.0	10.000	GND	N	10.0	30.9	66.0	Pass
0.170000	31.9	2000.0	10.000	GND	N	10.0	33.0	65.0	Pass
13.240000	25.1	2000.0	10.000	GND	L1	10.8	34.9	60.0	Pass
13.275000	24.4	2000.0	10.000	GND	L1	10.9	35.6	60.0	Pass
13.390000	25.3	2000.0	10.000	GND	L1	10.9	34.7	60.0	Pass
13.405000	29.5	2000.0	10.000	GND	N	10.8	30.5	60.0	Pass
13.440000	35.3	2000.0	10.000	GND	N	10.8	24.7	60.0	Pass
13.460000	35.7	2000.0	10.000	GND	L1	10.9	24.3	60.0	Pass
13.480000	33.6	2000.0	10.000	GND	N	10.8	26.4	60.0	Pass
13.505000	33.5	2000.0	10.000	GND	L1	10.9	26.5	60.0	Pass
13.535000	37.6	2000.0	10.000	GND	L1	10.9	22.4	60.0	Pass
13.555000	55.1	2000.0	10.000	GND	N	10.8	4.9	60.0	Pass
13.590000	32.8	2000.0	10.000	GND	L1	10.9	27.2	60.0	Pass
13.630000	32.8	2000.0	10.000	GND	N	10.8	27.2	60.0	Pass
13.670000	35.4	2000.0	10.000	GND	L1	10.9	24.6	60.0	Pass
13.770000	39.5	2000.0	10.000	GND	N	10.8	20.5	60.0	Pass
13.845000	24.0	2000.0	10.000	GND	N	10.8	36.0	60.0	Pass
14.335000	22.6	2000.0	10.000	GND	L1	10.9	37.4	60.0	Pass
14.400000	24.2	2000.0	10.000	GND	L1	10.9	35.8	60.0	Pass
14.410000	34.4	2000.0	10.000	GND	L1	10.9	25.6	60.0	Pass

AC power-line conducted emissions, Transmit mode									
Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)	Comment
0.150000	10.8	2000.0	10.000	GND	N	10.0	45.2	56.0	Pass
0.505000	1.5	2000.0	10.000	GND	L1	10.0	44.5	46.0	Pass
1.525000	2.8	2000.0	10.000	GND	N	10.1	43.2	46.0	Pass
2.540000	-2.2	2000.0	10.000	GND	N	10.1	48.2	46.0	Pass
3.045000	-10.1	2000.0	10.000	GND	L1	10.1	56.1	46.0	Pass
3.555000	-13.4	2000.0	10.000	GND	L1	10.2	59.4	46.0	Pass
4.065000	-6.1	2000.0	10.000	GND	N	10.2	52.1	46.0	Pass
5.075000	-12.4	2000.0	10.000	GND	L1	10.3	62.4	50.0	Pass
6.090000	-13.0	2000.0	10.000	GND	L1	10.4	63.0	50.0	Pass
8.120000	-12.7	2000.0	10.000	GND	L1	10.5	62.7	50.0	Pass
13.405000	-2.3	2000.0	10.000	GND	N	10.8	52.3	50.0	Pass
13.460000	1.1	2000.0	10.000	GND	L1	10.9	48.9	50.0	Pass
13.480000	1.7	2000.0	10.000	GND	N	10.8	48.3	50.0	Pass
13.555000	41.3	2000.0	10.000	GND	N	10.8	8.7	50.0	Pass
13.630000	1.1	2000.0	10.000	GND	N	10.8	48.9	50.0	Pass
13.700000	-0.1	2000.0	10.000	GND	L1	10.9	50.1	50.0	Pass
13.775000	1.6	2000.0	10.000	GND	N	10.8	48.4	50.0	Pass
14.410000	-1.3	2000.0	10.000	GND	L1	10.9	51.3	50.0	Pass
17.575000	9.2	2000.0	10.000	GND	N	11.1	40.8	50.0	Pass
27.120000	4.1	2000.0	10.000	GND	N	11.5	45.9	50.0	Pass

## 14 Occupied Bandwidth

### 14.1 Definition

#### 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 Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
Frequency Measured:	13.56 MHz
EUT Test Modulations:	ASK
Deviations From Standard:	None
Measurement BW:	1 kHz
Spectrum Analyzer Video BW:	3 KHz
Measurement Span: (requirement 2 to 5 times OBW)	20 kHz
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 40 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 Vdc	12 Vdc (as declared)

### 14.3 Test Limit

#### Federal Communications Commission:

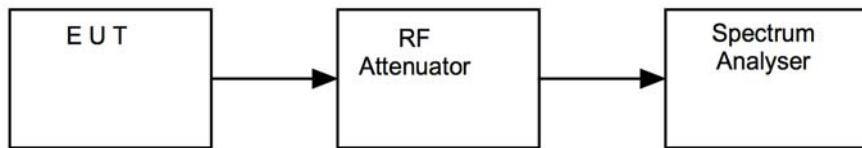
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

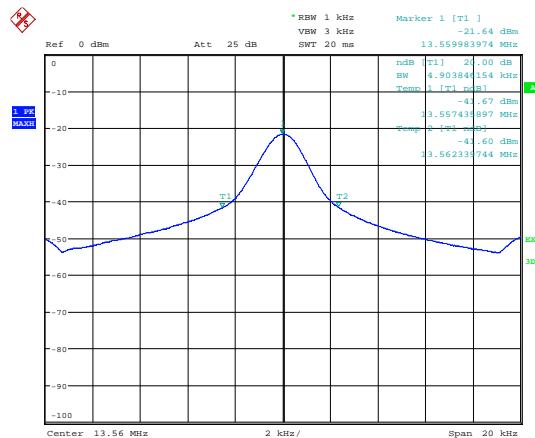


#### 14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU46	R&S	Spectrum Analyser	REF910	2020-10-17

#### 14.6 Test Results

15.225. Modulation: ASK; Highest Power setting			
Channel Frequency (MHz)	$F_L$ (MHz)	$F_H$ (MHz)	20 dB Bandwidth (kHz)
13.56	13.557435897	13.562339744	4.903846154



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## 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:	Radio Chamber
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	9 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	30 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**

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  $\mu\text{V}/\text{m}$  at the regulatory distance, using:

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

Where,

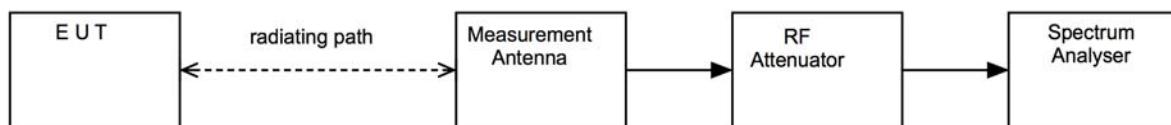
PR is the power recorded on the receiver / spectrum analyzer in  $\text{dB}\mu\text{V}$  and includes any cable loss, antenna factor and pre-amplifier gain;  
CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for extrapolation from 10 m to 30 m.

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor for 3 m to 10 m of 19.08 dB was determined from measurements at 3 and 10 metres.

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

#### Figure v Test Setup

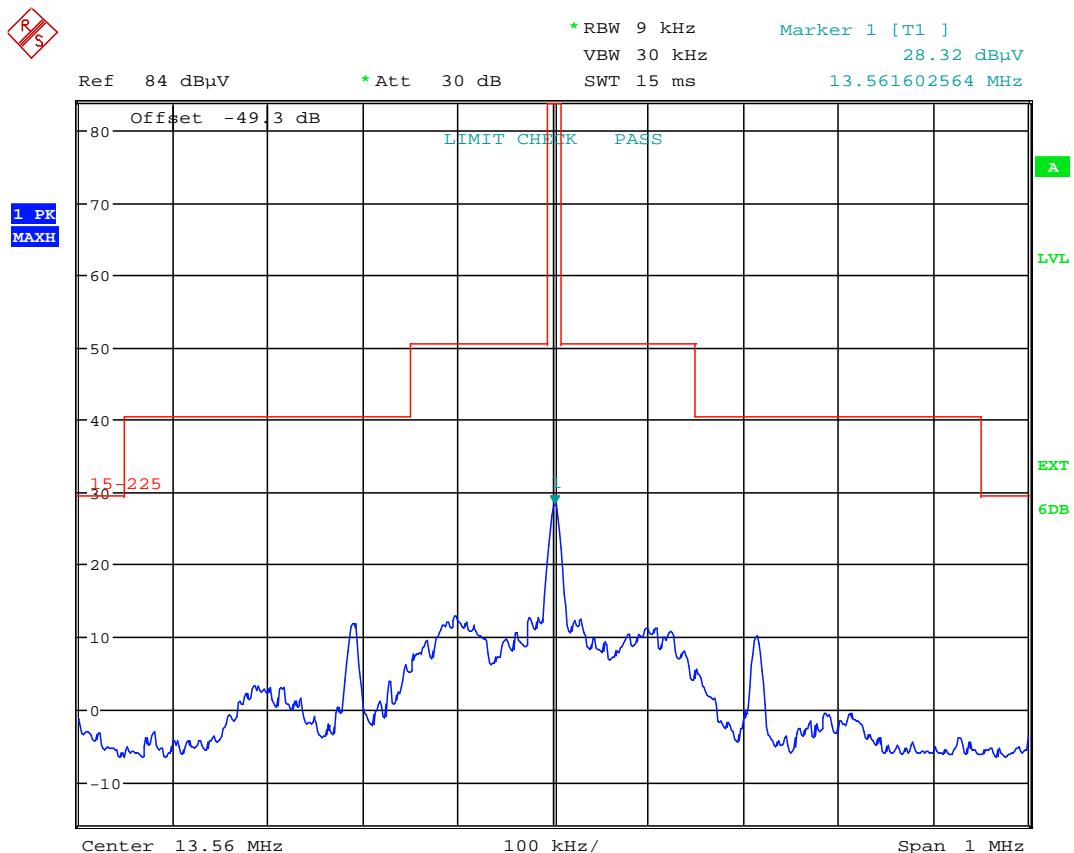


#### 15.5 Test Equipment

Equipment		Equipment	Element	Due For
Type	Manufacturer	Description	No	Calibration
hfh2	R&S	Loop Antenna	L007	2020-05-15
ATS	Rainford EMC	Radio Chamber - PP	REF940	2021-12-09
ESHS10	R&S	Receiver	U003	2020-10-23

## 15.6 Test Results

Modulation: ASK; Higher Power Setting						
Channel Frequency (MHz)	Receiver Level (dB $\mu$ V/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (dB $\mu$ V/m)	Result
13.56	66.10	3	30	37.78	28.32	PASS
13.56	47.40	10	30	19.08	28.32	PASS



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## 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 Chamber
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.8
Channels / 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:	12 Vdc power supply = $\pm 15\%$ of Nominal;

### Environmental Conditions (Normal Environment)

Temperature: 20 °C	Standard Requirement: +20 °C
Humidity: 40 %RH	20 % RH to 75 % RH (as declared)

### 16.3 Test Limit

Carrier frequency stability shall be maintained to  $\pm 0.01\%$  ( $\pm 100$  ppm).

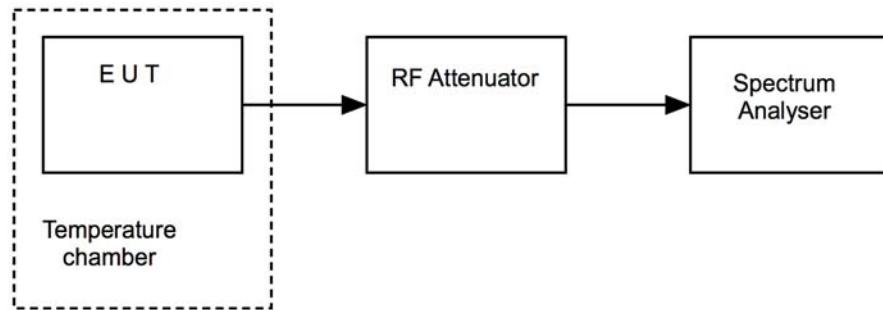
#### 16.4 Test Method

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
IPS-303DD	ISO-Tech	Power Supply	U515	Use REF976
FSU46	R&S	Spectrum Analyser	REF910	2020-10-17
52 Series II	Fluke	Temperature Indicator	L426	2020-06-28
34405a	Agilent	Multimeter	REF976	2020-11-21
VT 4002	Votsch	Temperature Chamber	U521	Use L426

## 16.6 Test Results

EUT Frequency: Low				
Test Environment		Measured Frequency (MHz)	Frequency error (kHz)	Result
-20 C	V <sub>nominal</sub>	13.5600641	0.048077	PASS
-10 C	V <sub>nominal</sub>	13.56008974	0.073718	PASS
0 C	V <sub>nominal</sub>	13.56007372	0.057692	PASS
+10 C	V <sub>nominal</sub>	13.56003205	0.016025	PASS
+20 C	V <sub>minimum</sub>	13.56000962	-0.006411	PASS
	V <sub>nominal</sub>	13.56001603	0	N/A
	V <sub>maximum</sub>	13.56000641	-0.009616	PASS
+30 C	V <sub>nominal</sub>	13.55996474	-0.051282	PASS
+40 C	V <sub>nominal</sub>	13.55991506	-0.100962	PASS
+50 C	V <sub>nominal</sub>	13.55990224	-0.113782	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**