

Report on the Radio Testing  
For  
Wearable Technologies Limited  
on  
M028 Connected HUB  
Report no. TRA-044007-45-08A  
4 December 2019

RF914 6.0

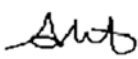


Report Number: TRA-044007-45-08A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
Wearable Technologies Limited  
M028 Connected HUB  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.225

TEST DATE: 01-11-2019 to 07-11-2019

Tested by: A Tosif & A Wong

Written by: 

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Date: 4 December 2019

Disclaimers:

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[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF914 6.0

## 1 Revision Record

<i><b>Issue Number</b></i>	<i><b>Issue Date</b></i>	<i><b>Revision History</b></i>
A	4 December 2019	Original

## 2 Summary

TEST REPORT NUMBER:	TRA-044007-45-08A
WORKS ORDER NUMBER:	TRA-044007-03
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15.225
EQUIPMENT UNDER TEST (EUT):	M028 Connected HUB
FCC IDENTIFIER:	2AU6IWTLM028
MANUFACTURER/AGENT:	Wearable Technologies Limited
ADDRESS:	Unit 12 Warrens Business Park Enderby Leicestershire LE19 4SA United Kingdom
CLIENT CONTACT:	Kevin Bailey ☎ +44 (0)1455 563 000 ✉ kevin.bailey@wearable.technology
ORDER NUMBER:	WTL-0285
TEST DATE:	01-11-2019 to 07-11-2019
TESTED BY:	A Tosif & A Wong Element

## 2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause 47CFR15</i>	<i>Applicable to this equipment</i>	<i>Result / Note</i>
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 type="checkbox"/>	Note 1
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

### Specific Note:

1. The NFC radio is inactive, when the EUT is connected to AC mains.

### General 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 .....	7
5	Test Specifications .....	8
5.1	Normative References .....	8
5.2	Deviations from Test Standards .....	8
6	Glossary of Terms .....	9
7	Equipment under Test .....	10
7.1	EUT Identification .....	10
7.2	System Equipment .....	10
7.3	EUT Mode of Operation .....	10
7.4	EUT Radio Parameters .....	10
7.5	EUT Description .....	10
8	Modifications .....	11
9	EUT Test Setup .....	12
9.1	General Set-up Photograph .....	12
9.2	Measurement software .....	12
10	General Technical Parameters .....	13
10.1	Normal Conditions .....	13
10.2	Varying Test Conditions .....	13
11	Transmitter output power (fundamental radiated emission) .....	14
11.1	Definition .....	14
11.2	Test Parameters .....	14
11.3	Test Limit .....	14
11.4	Test Method .....	15
11.5	Test Equipment .....	15
11.6	Test Results .....	16
12	Radiated emissions below 30 MHz .....	17
12.1	Definitions .....	17
12.2	Test Parameters .....	17
12.3	Test Limit .....	18
12.4	Test Method .....	18
12.5	Test Set-up Photograph .....	19
12.6	Test Equipment .....	19
12.7	Test Results .....	20
13	Radiated emissions .....	21
13.1	Definitions .....	21
13.2	Test Parameters .....	21
13.3	Test Limit .....	21
13.4	Test Method .....	22
13.5	Test Equipment .....	23
13.6	Test Results .....	23
14	Frequency stability .....	24
14.1	Definition .....	24
14.2	Test Parameters .....	24
14.3	Test Limit .....	24
14.4	Test Method .....	24
14.5	Test Equipment .....	25
14.6	Test Results .....	25
15	Occupied Bandwidth .....	26
15.1	Definition .....	26
15.2	Test Parameters .....	26
15.3	Test Limit .....	26
15.4	Test Method .....	26
15.5	Test Equipment .....	27
15.6	Test Results .....	27
16	Measurement Uncertainty .....	28

## 4 Introduction

This report TRA-044007-45-08A presents the results of the Radio testing on a Wearable Technologies Limited, M028 Connected HUB to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Wearable Technologies Limited by Element, at the address detailed below.

<input checked="" type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input 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.

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>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: M028 Connected HUB
- Model Number: M028
- Build Level / Revision Number: REV B1

### **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**

The EUT was transmitting at 13.56 MHz.

### **7.4 EUT Radio Parameters**

The EUT has got multiple radios (i.e. GPS receiver, 13.56 MHz NFC, GSM/LTE, Bluetooth and Wi-Fi). This report only covers 13.56 MHz NFC radio.

### **7.5 EUT Description**

The EUT is a wearable device designed to be integrated into high-visibility vests and with the ability to pair with various sensors such as gas, fall etc.

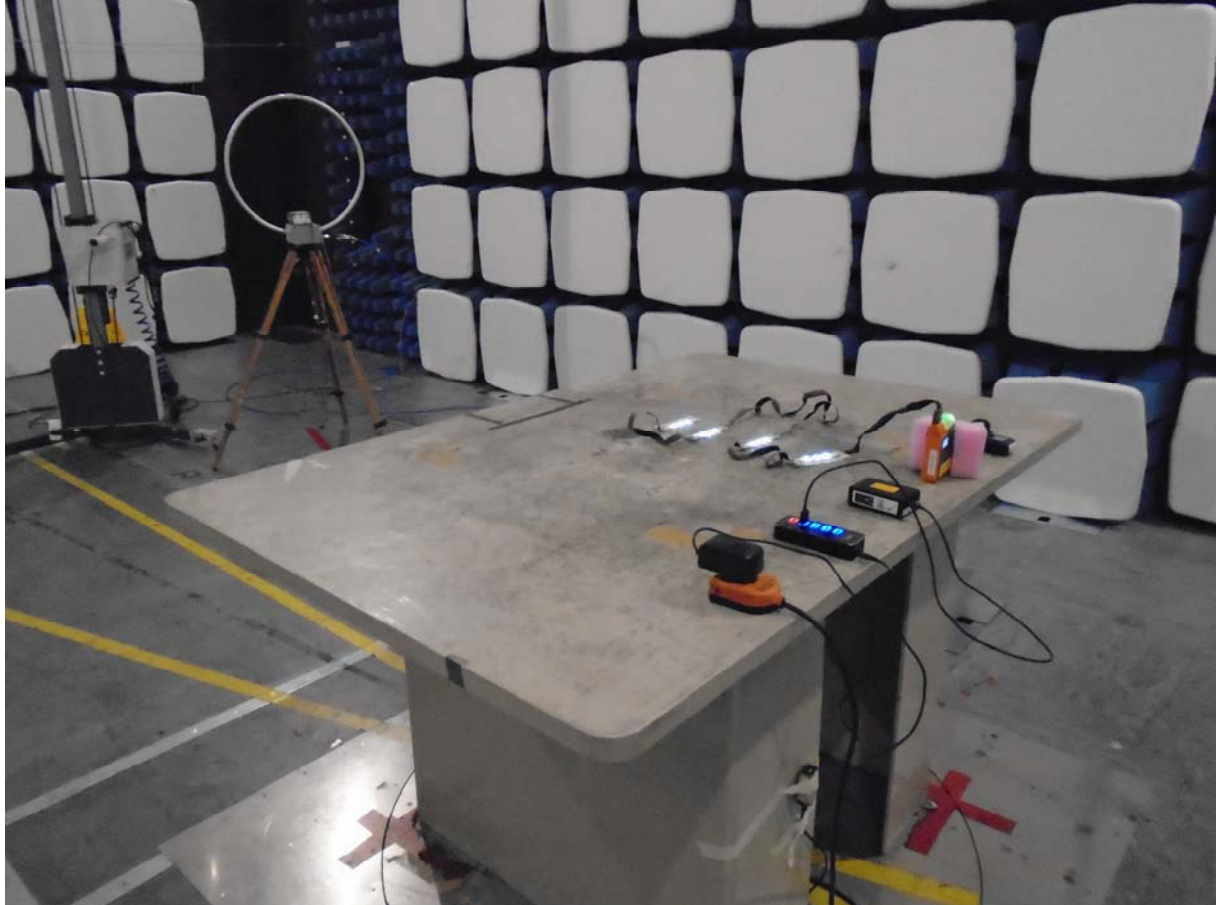
## **8 Modifications**

No modifications were performed during this assessment.

## 9 EUT Test Setup

### 9.1 General Set-up Photograph

The following photograph shows basic radiated EUT set-up:



### 9.2 Measurement software

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

*Element Emissions R5*

## 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 was 3.7 Vdc from internal battery.

### 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	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:

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

## 11 Transmitter output power (fundamental radiated emission)

### 11.1 Definition

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

### 11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Antenna:	Active Loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
Frequency Measured:	13.56 MHz

### Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 43 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	As declared

### 11.3 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

### 11.4 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,

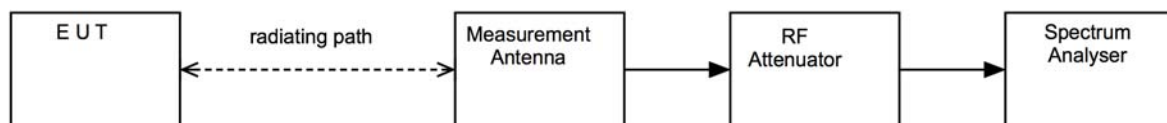
PR is the power recorded on the receiver / spectrum analyzer in  $\text{dB}\mu\text{V}$  and includes any cable loss, antenna factor and pre-amplifier gain;

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

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

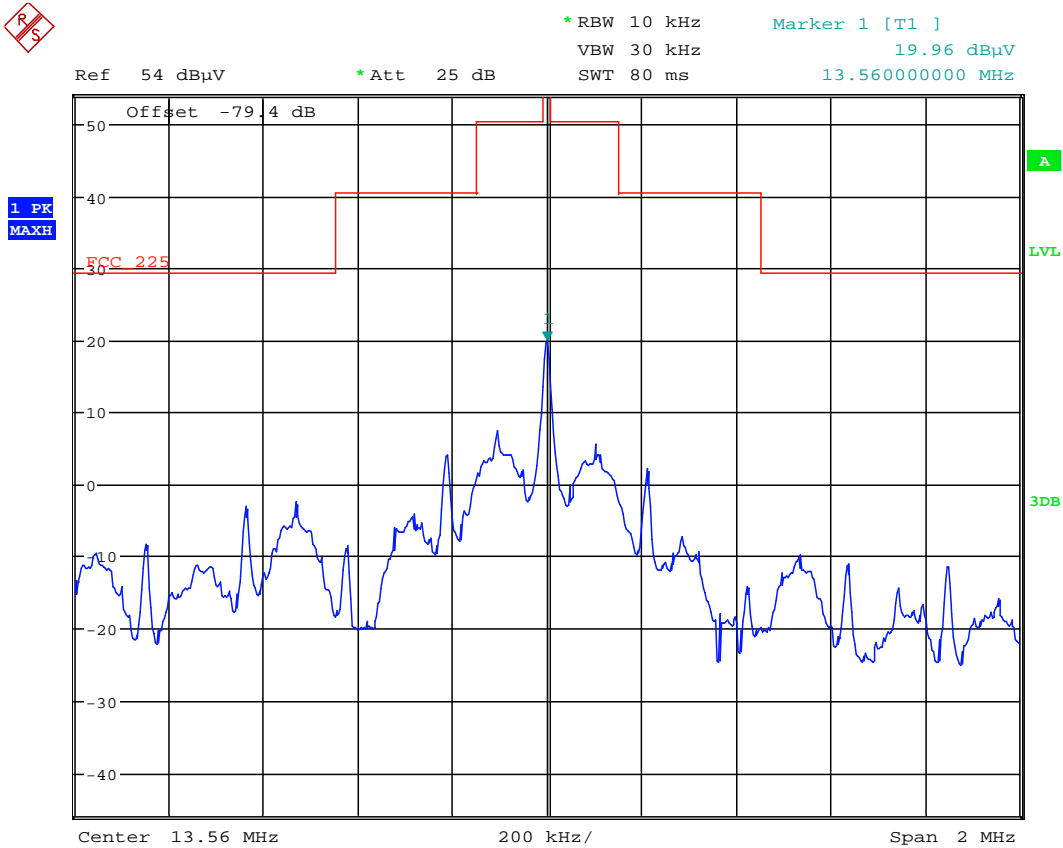


### 11.5 Test Equipment.

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Ferrite Lined Chamber	Rainford	ATS	REF886	2020-07-29
Active Loop Antenna	EMCO	6502	R0079	2021-06-17
Spectrum Analyser	R&S	FSU50	U544	2020-06-05
Spectrum Analyser	Agilent	N9030A	REF2167	2020-08-12

11.6 Test Results

Channel Frequency (MHz)	Receiver Level (dBμV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (dBμV/m)	Field Strength (μV/m)	Result
13.56	59.9	3	30	-40	19.9	9.9	PASS



Date: 5.NOV.2019 16:12:00



## 12 Radiated emissions below 30 MHz

### 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 Hull
Test Chamber:	Wireless Laboratory 2
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:	3 m, SAR
EUT Height:	0.8 m
Measurement Antenna and Height:	Active 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: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 43 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	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 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 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

### 12.4 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:

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

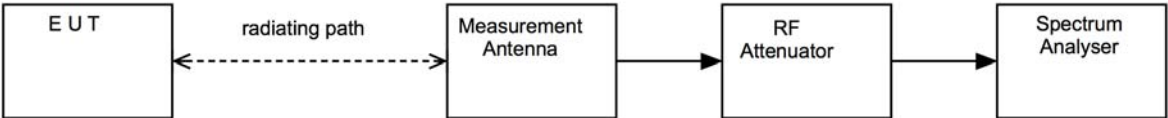
Where,

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);

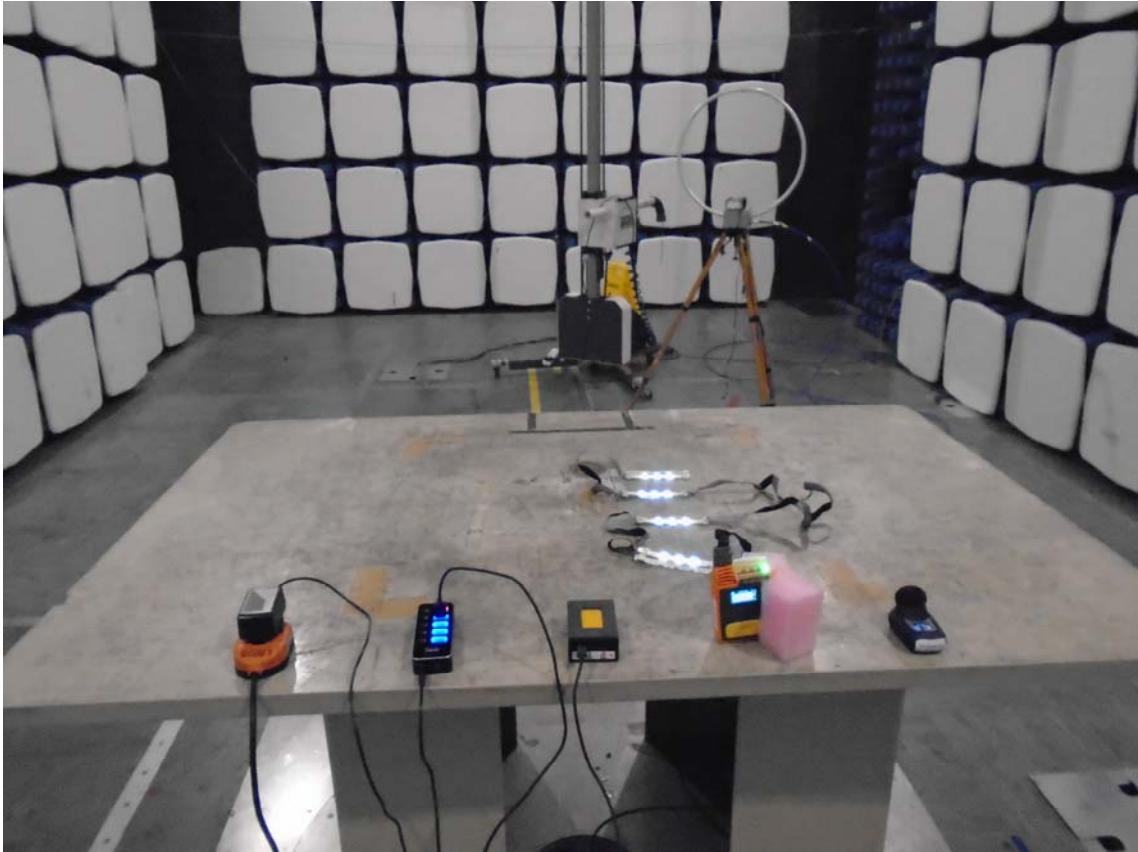
Per FCC 47CFR15.31(f)(2), an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

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

Figure i Test Setup



12.5 Test Set-up Photograph



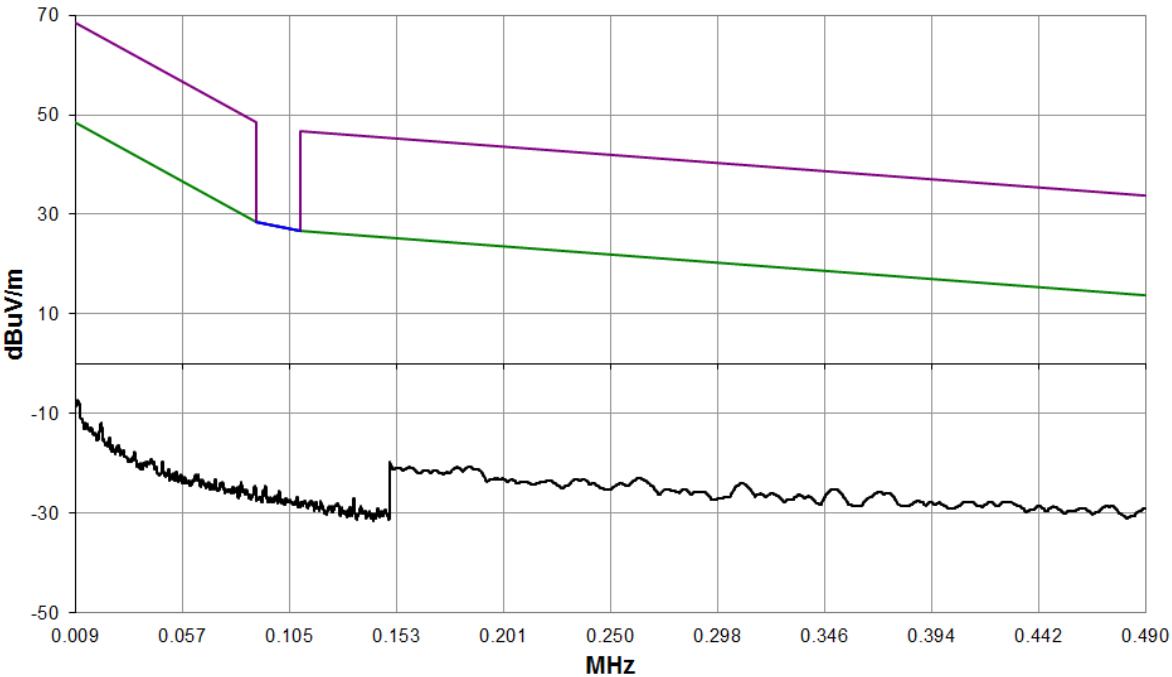
12.6 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Ferrite Lined Chamber	Rainford	ATS	REF886	2020-07-29
Spectrum Analyser	Agilent	N9030A	REF2167	2020-08-12
Active Loop Antenna	EMCO	6502	R0079	2021-06-17

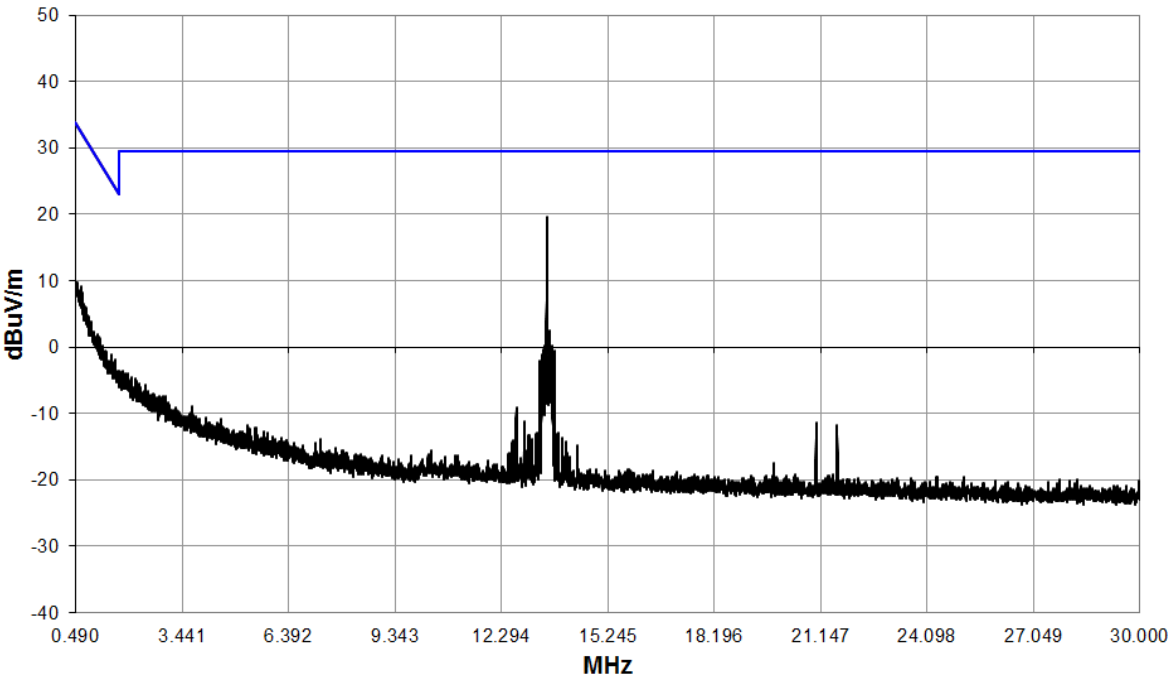
12.7 Test Results

Emission Frequency (MHz)	Receiver Level (dBμV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (μV/m)	Result
No emissions were detected within 10 dB of the limit						

From 9 kHz to 490 kHz



From 490 kHz to 30 MHz



## 13 Radiated emissions

### 13.1 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.

### 13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Laboratory 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	120 kHz
Measurement Detector:	Quasi-peak

#### Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 °C to +35 °C (as declared)
Humidity: 43 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	As declared

### 13.3 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 (<math>\mu</math>V/m at 3 m)</i>
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

### 13.4 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;

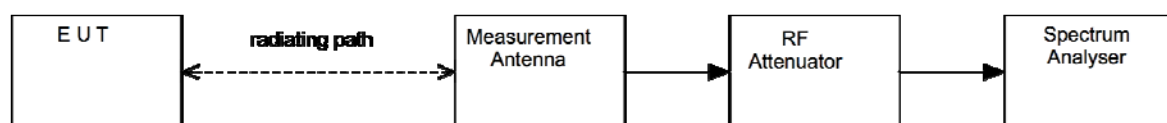
PA is the pre-amplifier gain in dB (where used);

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**



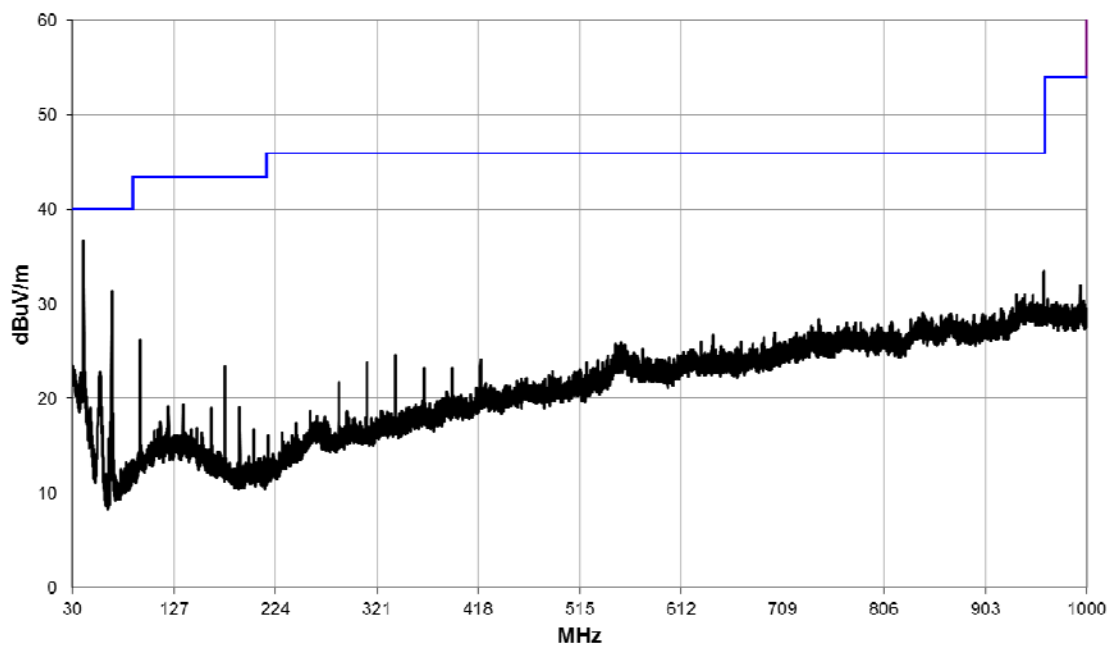
### 13.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Bilog Antenna	Chase	CBL6111B	REF2233	2020-08-17
Pre-Amp (9 kHz - 1 GHz)	Sonoma	310	REF927	2020-05-29
Ferrite Lined Chamber	Rainford	ATS	REF886	2020-07-29
Spectrum Analyser	Agilent	N9030A	REF2167	2020-08-12

### 13.6 Test Results

<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Factor (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
QP	40.7	49.2	-11.8	0.0	37.4	74.1	100.0
QP	67.8	49.9	-19.6	0.0	30.3	32.7	100.0

30 MHz to 1 GHz



## 14 Frequency stability

### 14.1 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.

### 14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.8
Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	-20 °C to +50 °C
Voltage Extreme Environment Test Range:	3.14 Vdc to 4.26 Vdc

#### Environmental Conditions (Normal Environment)

Temperature: 20 °C	Standard Requirement: +20 °C
Humidity: 51 %RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	As declared

### 14.3 Test Limit

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

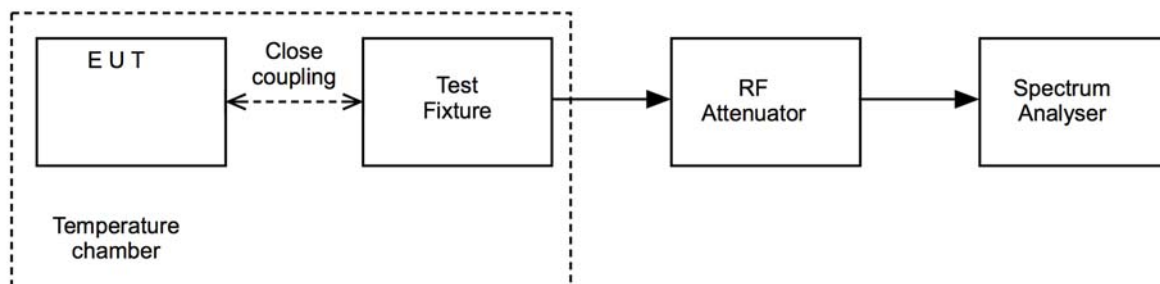
### 14.4 Test Method

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

Measurements were made once temperature stability was achieved at each temperature.

Per ANSI C63.4, measurements were made, once temperature stabilisation was reached at intervals of zero, two, five and ten minutes after switching on the EUT. Only the worst case results are given.

**Figure v Test Setup**





### 14.5 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU50	U544	2020-06-05
Thermometer	Fluke	53 II B	REF2110	2020-06-24
Multimeter	Agilent	34405A	REF887	2020-10-07
Temperature Chamber	JTS	ETC/JTS/2/01	RFG365	Cal with REF2110
Power Supply	HP	6220B	RFG464	Cal with REF887

### 14.6 Test Results

<i>Test Environment</i>		<i>Measured Frequency (MHz)</i>	<i>Frequency error (kHz)</i>	<i>Frequency error (%)</i>	<i>Result</i>
-20 °C	V <sub>nominal</sub>	13.559809	-0.191000	-0.001409	PASS
-10 °C	V <sub>nominal</sub>	13.559817	-0.183000	-0.001350	PASS
0 °C	V <sub>nominal</sub>	13.559807	-0.193000	-0.001423	PASS
+10 °C	V <sub>nominal</sub>	13.559785	-0.215000	-0.001586	PASS
+20 °C	V <sub>minimum</sub>	13.559740	-0.260000	-0.001917	PASS
	V <sub>nominal</sub>	13.559737	-0.263000	-0.001940	PASS
	V <sub>maximum</sub>	13.559737	-0.263000	-0.001940	PASS
+30 °C	V <sub>nominal</sub>	13.559729	-0.271000	-0.001999	PASS
+40 °C	V <sub>nominal</sub>	13.559705	-0.295000	-0.002176	PASS
+50 °C	V <sub>nominal</sub>	13.559713	-0.287000	-0.002117	PASS

## 15 Occupied Bandwidth

### 15.1 Definition

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.

### 15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
Frequency Measured:	13.56 MHz
Deviations From Standard:	None
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 48 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.7 Vdc	As declared

### 15.3 Test Limit

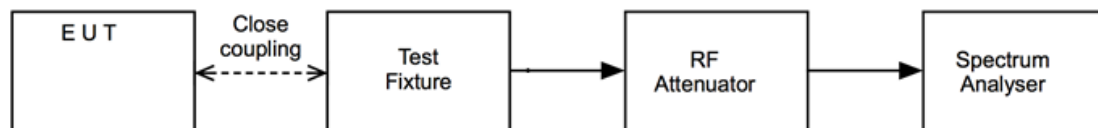
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

### 15.4 Test Method

With the EUT 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**

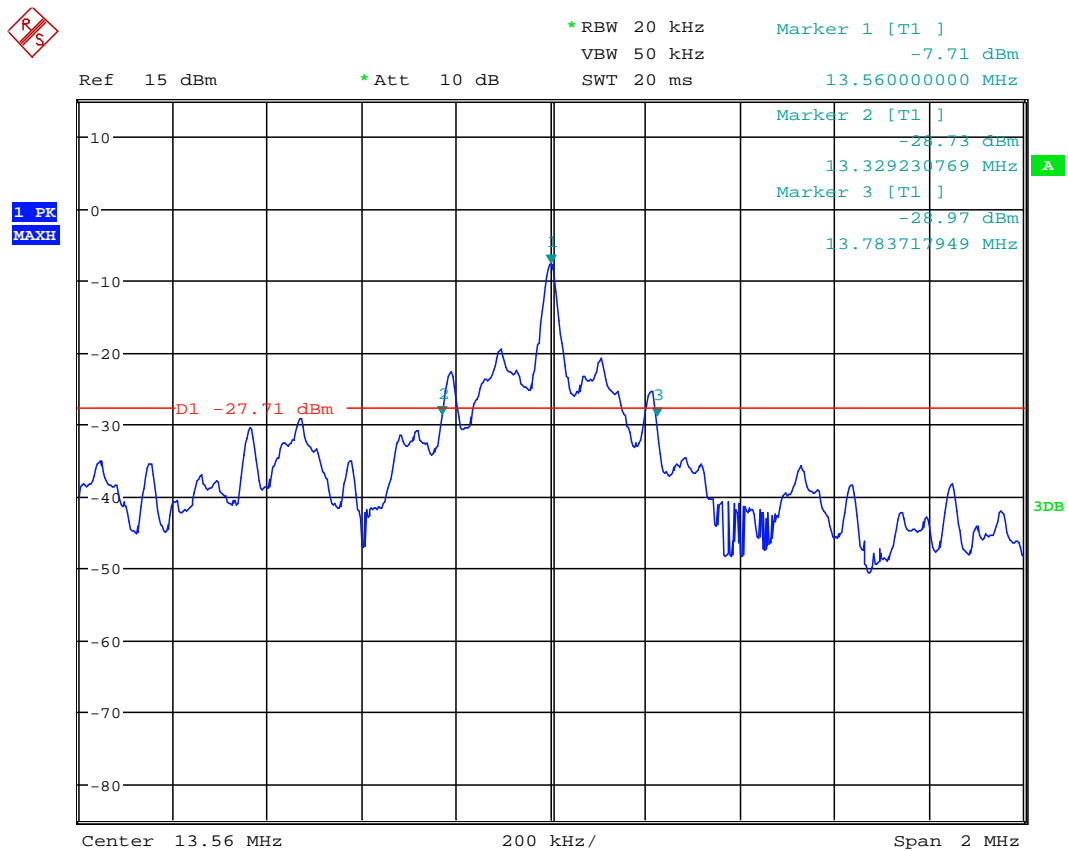


## 15.5 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Due For Calibration
Spectrum Analyser	R&S	FSU50	U544	2020-06-05

## 15.6 Test Results

Channel Frequency (MHz)	$F_L$ (MHz)	$F_H$ (MHz)	20 dB Bandwidth (kHz)
13.56	13.329231	13.783718	454.487



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## 16 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**