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Test Report for the FCC and ISED Testing of an K-Mote to FCC Rule 47CFR 15.247 and ISED RSS-247 for R3 IoT Ltd

Test Report number: C14855TR5
Project number: G3474

Author: .....
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Issue	Description						Issue by	Date
5	Copy 1		Copy 2		PDF	√	JB	30th August 2023

Registered Address:
Eurofins York Ltd
i54 Business Park, Valiant Way
Wolverhampton, WV9 5GB, UK

Registered in England and Wales
Company Reg. No. 6048589
VAT Reg. No. GB 887 1276 83

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Test Report Change History

Issue	Date	Modification Details
1	25th October 2022	First Issue
2	29th June 2023	ISED number added
3	4th July 2023	Product name amended
4	20th July 2023	Power settings clarified. PSD values clarified.
5	30th August 2023	Channelization clarified
6		
7		
8		
9		
10		

Section 1 Test Location

All testing was performed at;

Eurofins York	Unit 5
	Speedwell Road
	Castleford
	WF10 5PY
Tel:	01977 731173
Website	http://www.yorkemc.co.uk
UKAS Testing No.	1574

1.1 UKAS Accreditation

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Eurofins York latest accreditation schedule can be found at:
http://www.ukas.org/testing/lab_detail.asp?lab_id=989&location_id=&vMenuOption=3

Eurofins York Castleford Laboratory, is an Accredited facility recognised by the Federal Communications Commission (FCC) for certification testing. The appropriate FCC Designation Number is UK2013, dated 1st March 2021.

Eurofins York Castleford Laboratory is recognised by ISED for certification testing.
ISED Assigned Code: 22959

Section 2 Customer Information

Company name	R3 IoT Ltd
Address	4/2 Turnberry House
	175 West George Street
	Glasgow
	G2 2LB
	United Kingdom
Contact	Kevin Quillien
Email	kevin@r3-iot.com

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	4th August 2022		
EUT name:	K-Mote		
PMN:	K-Mote		
HVIN:	M03		
FVIN:	N/A		
FCC ID:	2BBDU-R3800009300		
ISED number:	30625-R3800009300		
Serial no:	05053 00011		
EUT description:	The primary function of the device is to add LORAWAN capability to wired OEM/COTS sensors which do not already implement it. It is intended to be deployed to remote, outdoor locations. It has one radio interface, a LORAWAN module. The frequency used is selected by software configuration. The K-mote has an internal battery, it may be powered by an AC or DC power input.		
Antenna	D.95.6H31G – Gray Blade 868/915MHz Omnidirectional Dipole Terminal Mount Antenna		
Transmission	Digital Transmission System (DTS) LoRa Radio		
Modulation scheme	LoRa (Chirp spread spectrum)		
Operating frequency band	902MHz to 928MHz		
Channelization:	1.6MHz channel spacing from 903 to 914.2MHz (8 channels)		
No of units tested:	One		
EUT power:	120V, 60Hz, single phase or 4V dc battery or 12VDC supply		
Highest internal frequency:	915MHz		
Size of EUT (m)	Width: 160 mm	Depth: 120 mm	Height: 210 mm
Mode/s of operation:	Continuous transmit of packetized data at top, middle and bottom channels. Channels used: 903.0MHz, 907.8MHz and 914.2MHz		
Test software:	Test Firmware installed and operated using PuTTy via a serial connection to the EUT. The channel frequency was set as appropriate and the lora_power setting was set to a value of 120. This connection was removed during testing once the required test mode was established		
Modifications incorporated during testing:	None		

Ports and Cables	**Cable Length**	**Screened/ unscreened**	**Connected to**
Cable 1	>3, less than 30m	Unscreened	EUT Power

3.2 EUT Photographs

Photographs are supplied separately.

3.3 Configuration of EUT

The apparatus was supplied in one single possible configuration.

3.4 EUT Monitoring/Auxiliary Equipment

None.

3.5 Monitoring Software

None. The channel required was selected via software prior to the testing.

Section 4Test Specifications

For USA:

Regulation / Test Standard	Regulation: Title 47 of the Code of Federal Regulations (CFR) Part 15 (47CFR15) Subpart C – Intentional Radiators Measurement standard: ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Requirement	FCC Rule Part	Comments	Result Summary
6 dB Bandwidth	FCC § 15.247(a)(2)	Applies	Pass
Maximum peak conducted power	FCC § 15.247(b)(3)	Applies	Pass
Power spectral density	FCC § 15.247(e)	Applies	Pass
Band edge compliance	FCC § 15.247(d)	Applies	Pass
Conducted spurious emissions	FCC § 15.247(d)	Applies	Pass
Transmitter radiated spurious emissions – restricted bands	FCC § 15.247(d) FCC § 15.209	Applies	Pass
AC power line conducted emissions	FCC § 15.207	Applies	Pass

For Canada:

Regulation / Test Standard	RSS-247 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices Issue 2 February 2017 And, RSS-Gen — General Requirements for Compliance of Radio Apparatus Issue 5 April 2018 +A1 March 2019 +A2 February 2021

Requirement	**ISED Ragulation**	**Comments**	**Results Summary**
99% Occupied Bandwidth	RSS-Gen 6.6	Applies	Pass
6 dB Bandwidth	ISED RSS-247 § 5.2	Applies	Pass
Maximum peak conducted power	ISED RSS-247 § 5.4	Applies	Pass
Power spectral density	ISED RSS-247 § 5.2	Applies	Pass
Band edge compliance	ISED RSS-247 § 3.3 and 5.5 RSS-GEN Issue 5 Section 8.10	Applies	Pass
Conducted spurious emissions	ISED RSS-247 § 5.5	Applies	Pass
Transmitter radiated spurious emissions	ISED RSS-GEN § 8.9	Applies	Pass
AC power line conducted emissions	ISED RSS-247 § 3.1	Applies	Pass

4.1 Knowledge Database References

The following KDBs were referenced during the testing.
The latest knowledge database references are available via the FCC KDB website at:

https://apps.**fcc**.gov/kdb

4.1.1 Radiated Emissions (30MHz to 1000MHz)

Publication Number	Keyword	Publication Date
913591	Measurement of radiated emissions at the band-edge for a Part 15 RF Device	04/05/2017

4.1.2 Radiated Emissions (1GHz to 40GHz)

Publication Number	Keyword	Publication Date
704992	Test Site Validation Requirements above 1 GHz.	12/06/2015
149045	Comparison Noise Emitter (CNE), reference noise source, .pdf	05/04/2007
913591	Measurement of radiated emissions at the band-edge for a Part 15 RF Device	04/05/2017
934285	Comparison Noise Emitters (CNE), test equipment, Broadband.pdf	05/04/2007

4.2 Compliance Statement

The K-mote, as tested, was shown to meet requirements of the standards listed in Section 4 of this report.

Section 5 Spurious Emission Results – Radiated and Conducted

5.1 Test Specification

FCC Rule Part	47CFR 15.247 (d)
Standard	ANSI C63.10:2013
Measurement Uncertainty Radiated tests	The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95% is +/- 5.85dB for the frequency range 30MHz to 1GHz +/- 4.64dB for the frequency range from 1GHz to 6GHz +/- 4.96dB for the frequency range from 6GHz to 18GHz
Measurement Uncertainty Conducted tests	±1.4dB

5.2 Procedure and Test Software Version

Radiated tests:- 47CFR15.205 and 47CFR15.209

Eurofins York test procedure (30MHz to 1GHz)	CEP23b Issue 8
Eurofins York test procedure (1GHz to 40GHz)	CEP64b Issue 8
Test software	RadiMation Version 2016.2.8

Conducted Tests 47CFR 15.247(d)

ANSi C63.10-2013 Clause reference:	11.11.2 and 11.11.3
Test software	N/A

5.3 Radiated Emissions (30MHz to 1GHz)

Radiated electric field emission measurements are applied as defined in 47CFR15.205 and 47CFR15.209.

5.3.1 Limits at 3m

Frequency (MHz)	Electric Field Strength Limit (dBµV/m) at 3m measurement distance
	Quasi Peak
30 - 88	40.0
88 -216	43.5
216 - 960	46.0
960- 1000	54.0

Note: FCC 47 CFR Part 15 Section 15.209 and 15.205 specifies test limits at 3m

Receiver Settings

Receiver Parameters	Setting
Detector Function	Quasi Peak
Start Frequency	30MHz
Stop Frequency	1000MHz
Resolution Bandwidth	120kHz
Video Bandwidth	Auto

5.3.2 Emissions measurements

5.3.3 Date of Test

10th October 2022

5.3.4 Test Area

LAB 1 (SAC)

5.3.5 Tested by

J Beevers

5.3.6 Test Setup

The EUT was configured in the SAC on an 80cm high polystyrene table.

The measurement was performed with an antenna to EUT separation distance of 3m. The results were maximised in orientation 0-360 degrees and height 1-4m.

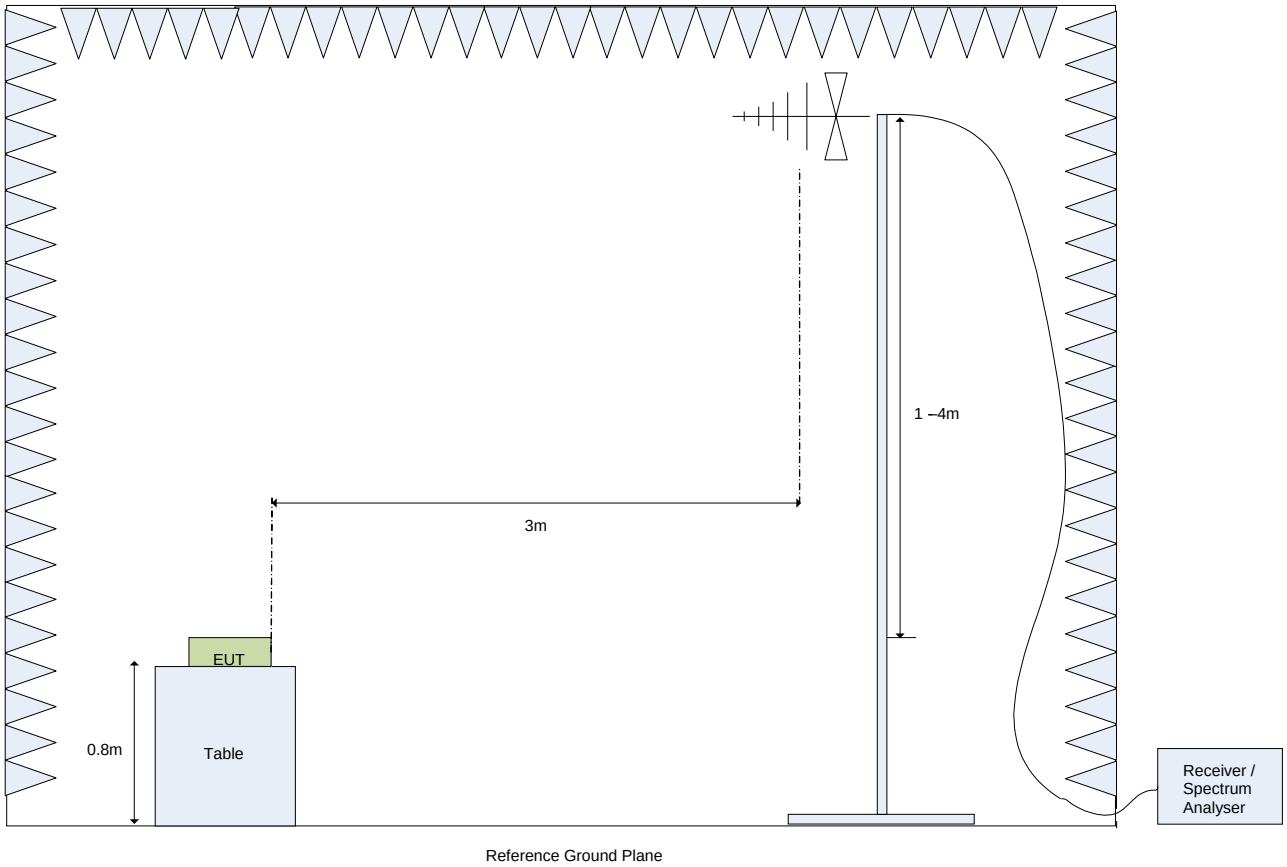


Figure 1 Test Setup for E-Field Measurements from 30MHz to 1GHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.10-2013.

Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.

Operating Mode During testing

During spurious emission testing the equipment under test was set to transmit at the same frequency on the following channels: 903.0MHz, 907.8MHz and 914.2MHz for each modulation scheme used.

The equipment under test was pre-scanned using peak detection when operating for all three methods of powering the equipment on the lowest channel and then on the worst case EUT power (12VDC power) for top middle and bottom channels. Final measurements were performed with the equipment under test operating on 914.2MHz powered by 12VDC.

5.3.7 Electric field emissions, 30MHz to 1GHz

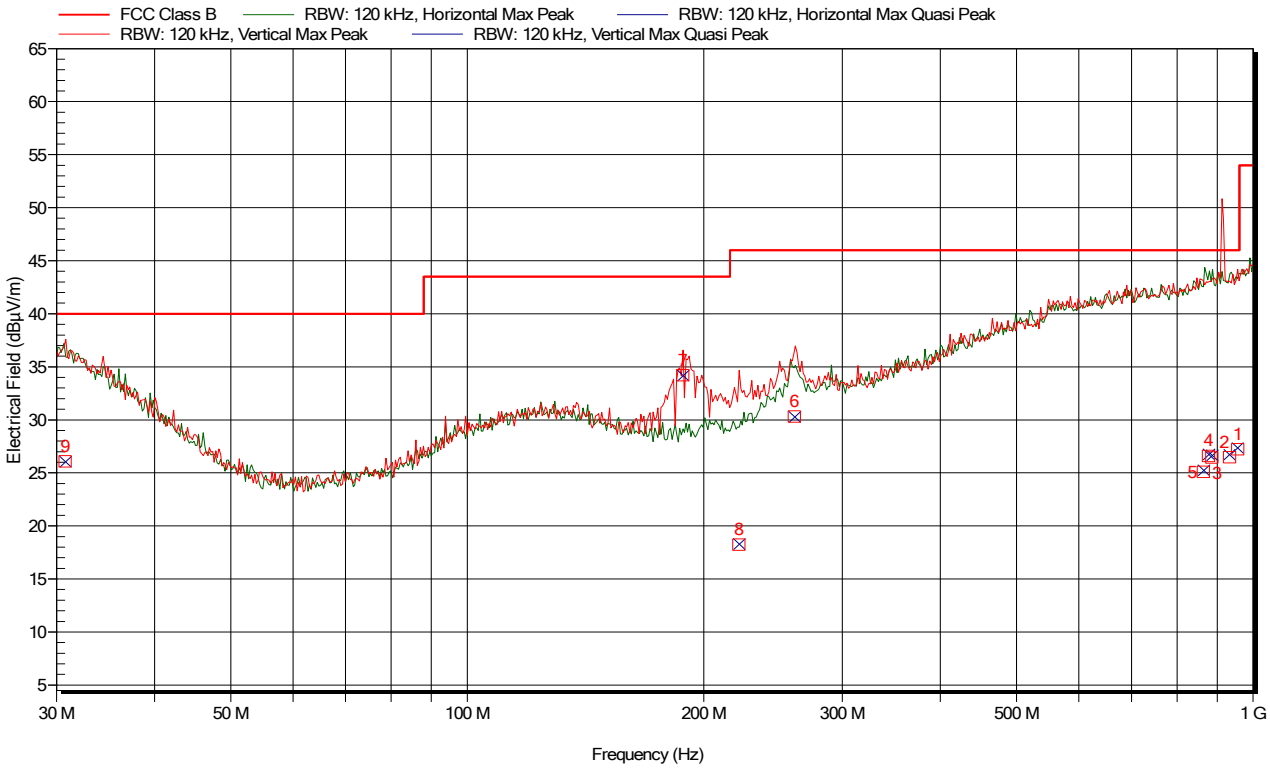


Figure 2 Electric field emissions Plot, 30MHz to 1GHz, 914.2MHz Operation, 12VDC power

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
956.10	27.2	46	-18.8	Pass	135	2.6	Horizontal
932.88	26.5	46	-19.5	Pass	340	1.4	Horizontal
877.02	26.6	46	-19.4	Pass	85	2.2	Horizontal
864.12	25.1	46	-20.9	Pass	35	3.3	Horizontal
260.58	30.3	46	-15.7	Pass	100	1.0	Vertical
188.04	34.2	43.5	-9.3	Pass	69	1.0	Vertical
221.64	18.3	46	-27.7	Pass	290	1.1	Vertical
885.48	26.4	46	-19.6	Pass	55	2.7	Horizontal
30.78	26.1	40	-13.9	Pass	295	1.0	Vertical

Table 1 Electric Field Emissions Peaks, 30MHz to 1GHz. 914.2MHz Operation, 12VDC power

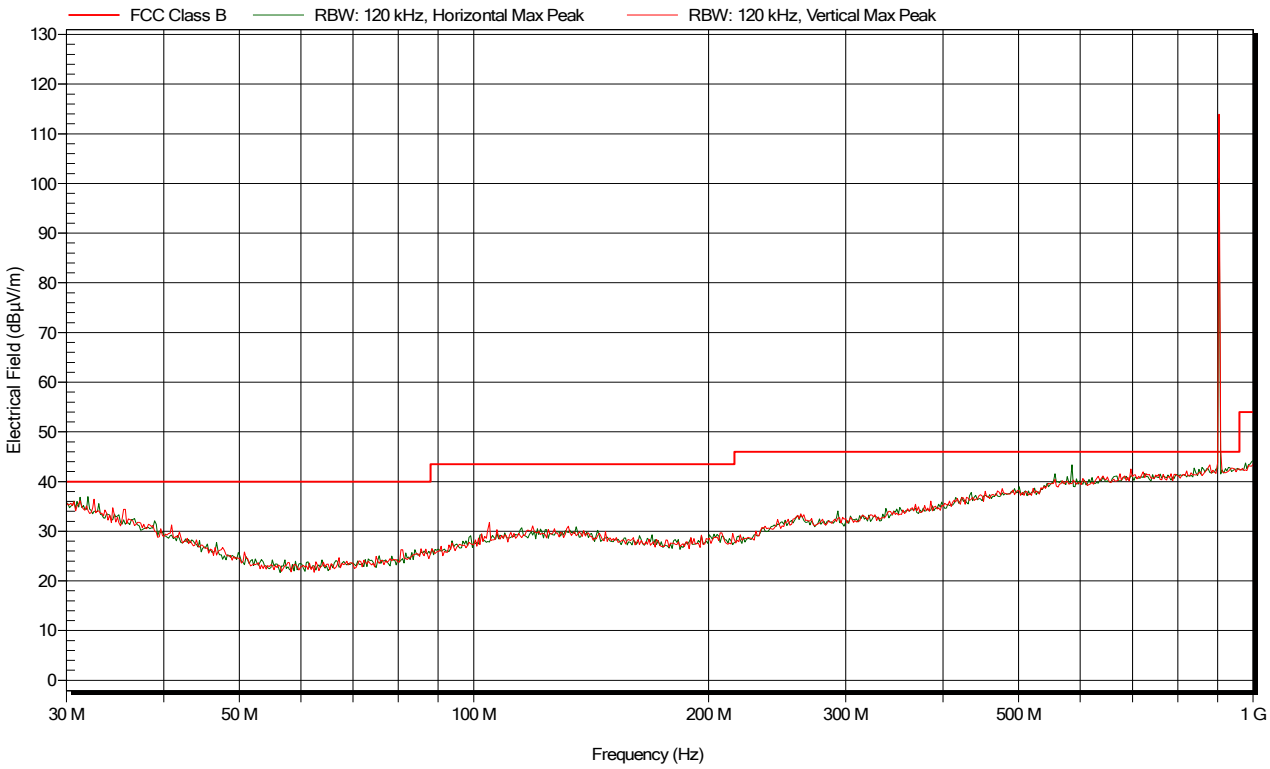


Figure 3 Electric field emissions Plot, 30MHz to 1GHz, Operation on 903.0MHz, Battery power - Peak detector scan

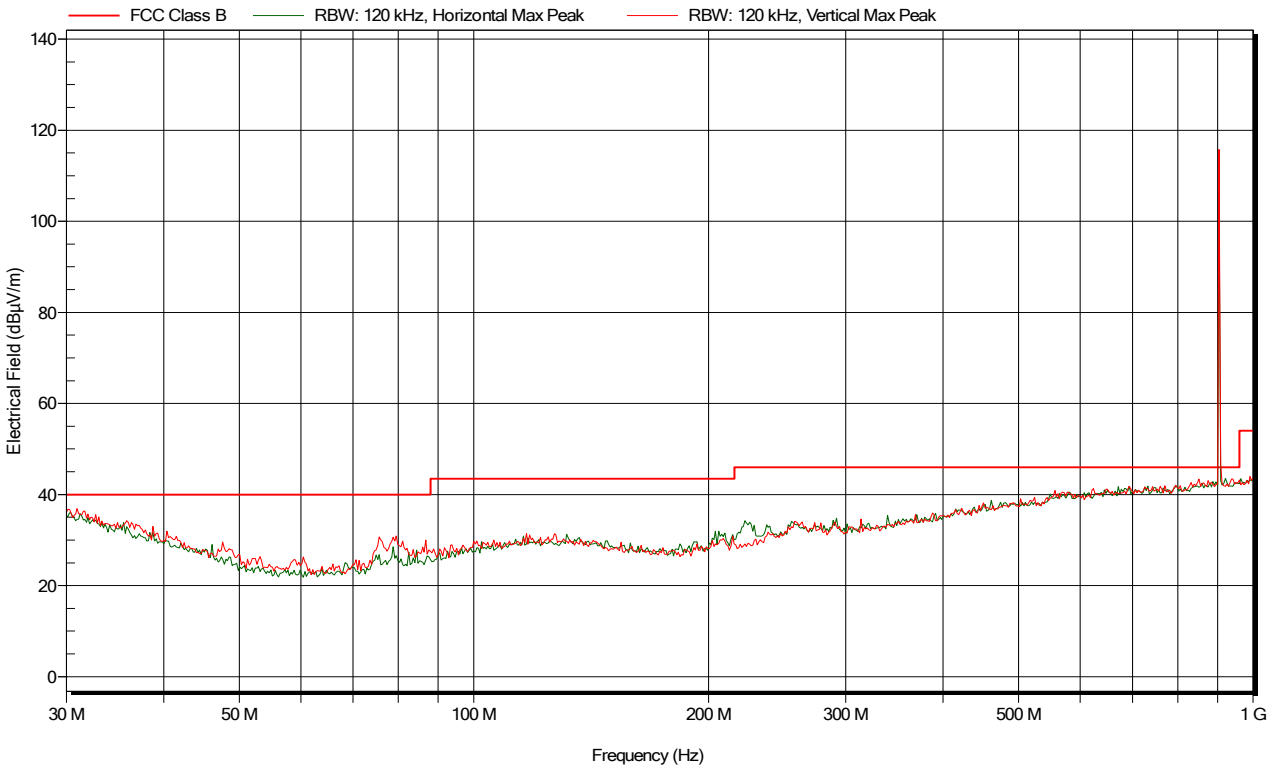


Figure 4 Electric field emissions Plot, 30MHz to 1GHz, Operation on 903.0MHz, AC Mains power - Peak detector scan

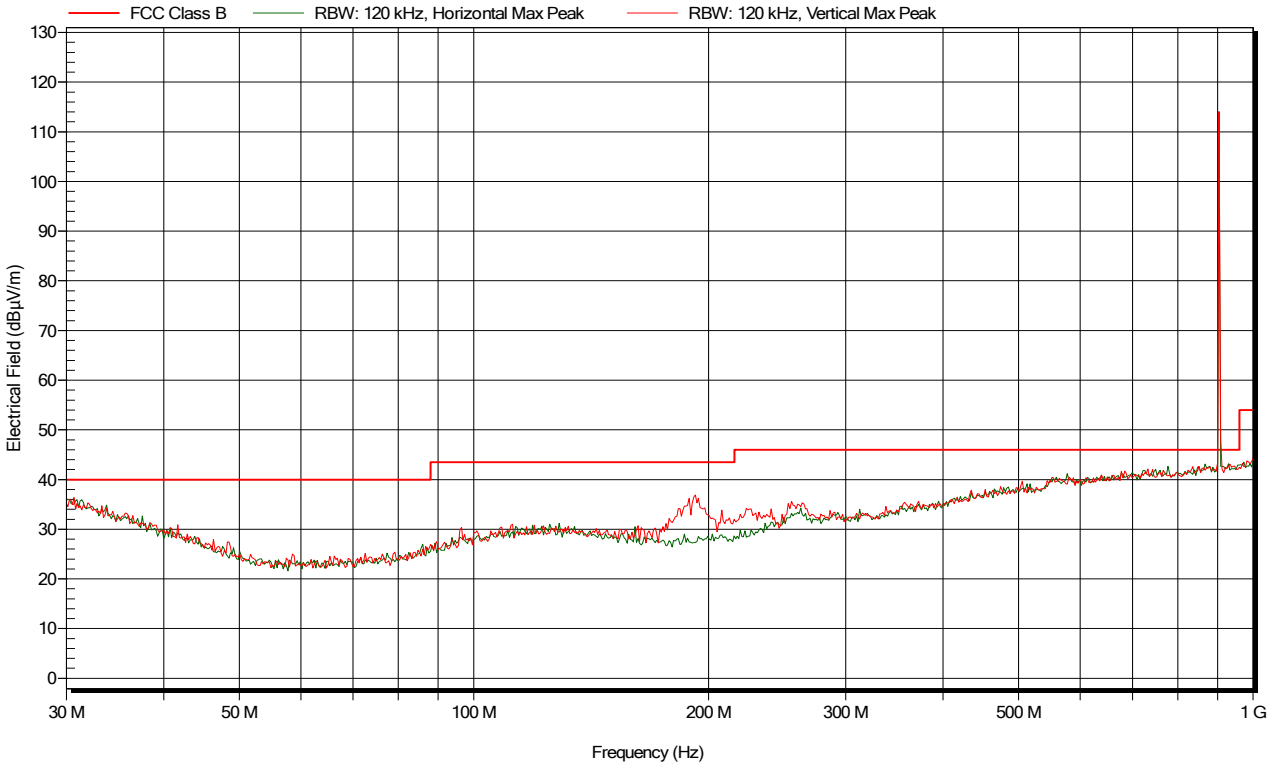


Figure 5 Electric field emissions Plot, 30MHz to 1GHz, Operation on 903.0MHz, 12VDC power - Peak detector scan

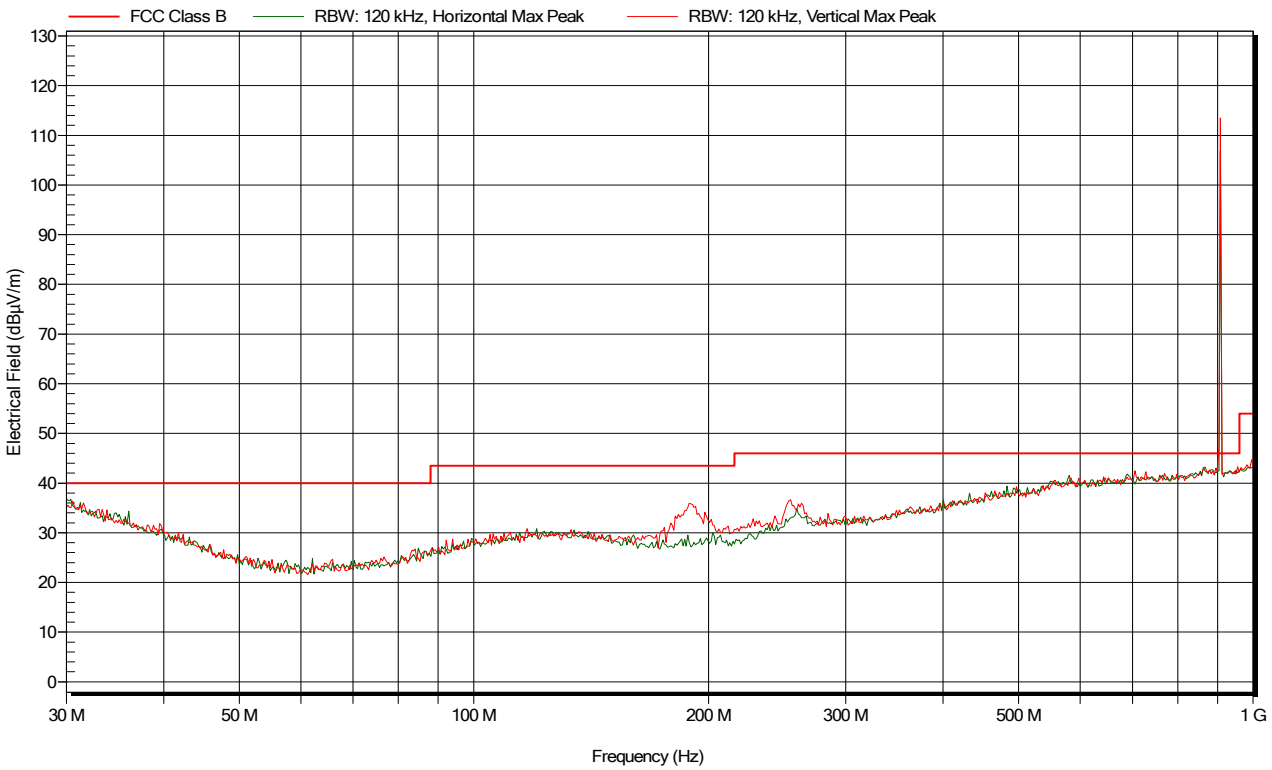


Figure 6 Electric field emissions Plot, 30MHz to 1GHz, Operation on 907.8MHz, 12VDC power - Peak detector scan

5.4 Radiated Emissions (1GHz to 10GHz)

5.4.1 Limits

Frequency (GHz)	Limit (dBµV/m)	Limit (dBµV/m)
	Peak	Average
1-18	74.0	54.0

5.4.2 Receiver Settings

Receiver Parameters	Setting
Detector Function	Average and Peak
Start Frequency	1GHz
Stop Frequency	10GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

5.4.3 Emissions measurements

5.4.4 Date of Test

11th October 2022

5.4.5 Test Area

LAB 1 (SAC)

5.4.6 Tested by

J Beevers

5.4.7 Test Setup

The EUT was configured in the SAC on an 1.5m high table Exploratory measurements on the EUT were carried out to identify suspect frequencies and worst case orientations, see Section 5.4.8.

The measurement was then performed with an antenna to EUT separation distance of 3m.

The antenna was kept in the “cone of radiation” from the EUT and pointed at the area both in azimuth and elevation using the tilt mechanism on the antenna mast.

The results were maximised in orientation 0-360 degrees and height 1-4m.

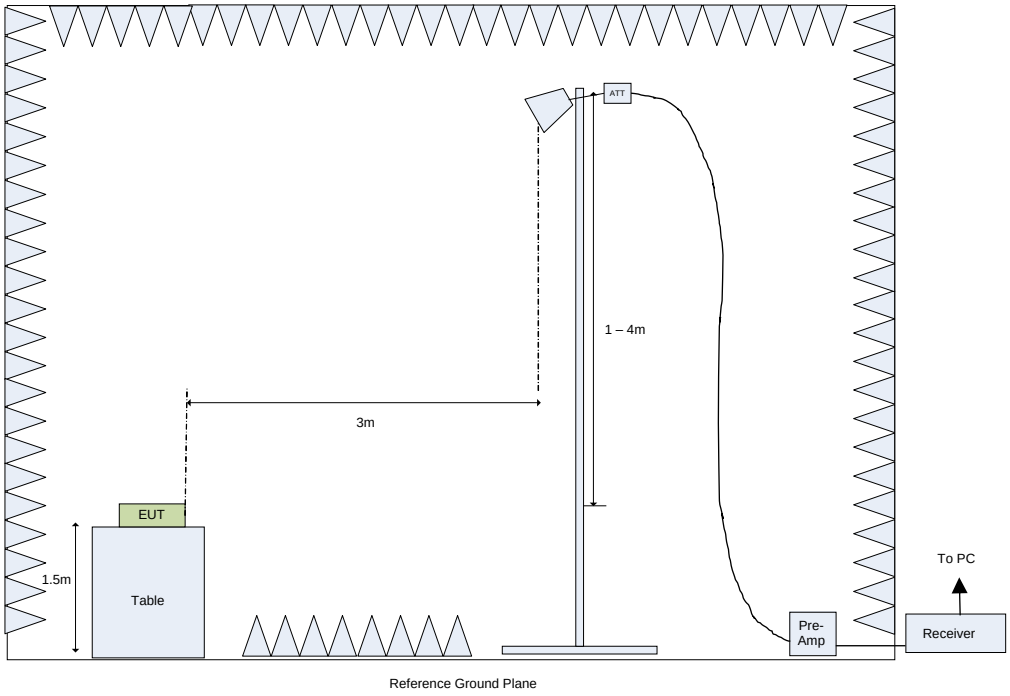


Figure 7 Test Setup for Final E-Field Measurements from 1GHz to 18GHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.4-2010.

Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.

Note 3: On all swept and final measurements made between 1GHz and 10GHz a 1.2GHz Microtronics HPM50108 High Pass filter was placed in the measurement chain between the antenna and pre-amplifier in order to prevent the artificial generation of harmonics within the pre-amplifier.

5.4.8 Exploratory Radiated Emission Maximization

During exploratory testing, suspect emissions from the EUT were identified both in terms of the frequency and directionality. This was achieved by manually positioning the antenna close to the EUT and also by scanning it over all sides of the EUT whilst observing a spectral display. The typical distance between the surface of the EUT and the scanning antenna was circa 30cm.

Frequency (GHz)	Mode of operation	EUT face *	Emissions Angle (w.r.t. turntable)	Height	Polarization
1.810	Transmitting on channel 903MHz	front face	0	1.5	V
2.710	Transmitting on channel 903MHz	front face	0	1.5	V
3.610	Transmitting on channel 903MHz	front face	0	1.5	V
4.519	Transmitting on channel 903MHz	front face	0	1.5	V
5.419	Transmitting on channel 903MHz	front face	0	1.5	V
6.319	Transmitting on channel 903MHz	front face	0	1.5	V
7.219	Transmitting on channel 903MHz	front face	0	1.5	V
9.028	Transmitting on channel 903MHz	front face	0	1.5	V
1.819	Transmitting on channel 907.8MHz	front face	0	1.5	V
2.728	Transmitting on channel 907.8MHz	front face	0	1.5	V
3.628	Transmitting on channel 907.8MHz	front face	0	1.5	V
4.537	Transmitting on channel 907.8MHz	front face	0	1.5	V
5.446	Transmitting on channel 907.8MHz	front face	0	1.5	V
6.355	Transmitting on channel 907.8MHz	front face	0	1.5	V
9.073	Transmitting on channel 907.8MHz	front face	0	1.5	V
1.828	Transmitting on channel 914.2MHz	front face	0	1.5	V
2.746	Transmitting on channel 914.2MHz	front face	0	1.5	V
3.655	Transmitting on channel 914.2MHz	front face	0	1.5	V
4.573	Transmitting on channel 914.2MHz	front face	0	1.5	V
5.482	Transmitting on channel 914.2MHz	front face	0	1.5	V
6.400	Transmitting on channel 914.2MHz	front face	0	1.5	V
7.309	Transmitting on channel 914.2MHz	front face	0	1.5	V
8.227	Transmitting on channel 914.2MHz	front face	0	1.5	V
9.145	Transmitting on channel 914.2MHz	front face	0	1.5	V

Table 2 Frequencies identified during Exploratory Radiated Emission maximization

Note 1 : The front face of the EUT is deemed to be 0°, which is then turned in a clockwise direction through 360°.

5.4.9 Electric field emissions, 1GHz to 10GHz

The equipment under test was pre-scanned using peak detection when operating for all three methods of powering the equipment on the lowest channel and then on the worst case EUT power (12VDC power) for top middle and bottom channels. Final measurements were performed with the equipment under test operating on 914.2MHz powered by 12VDC.

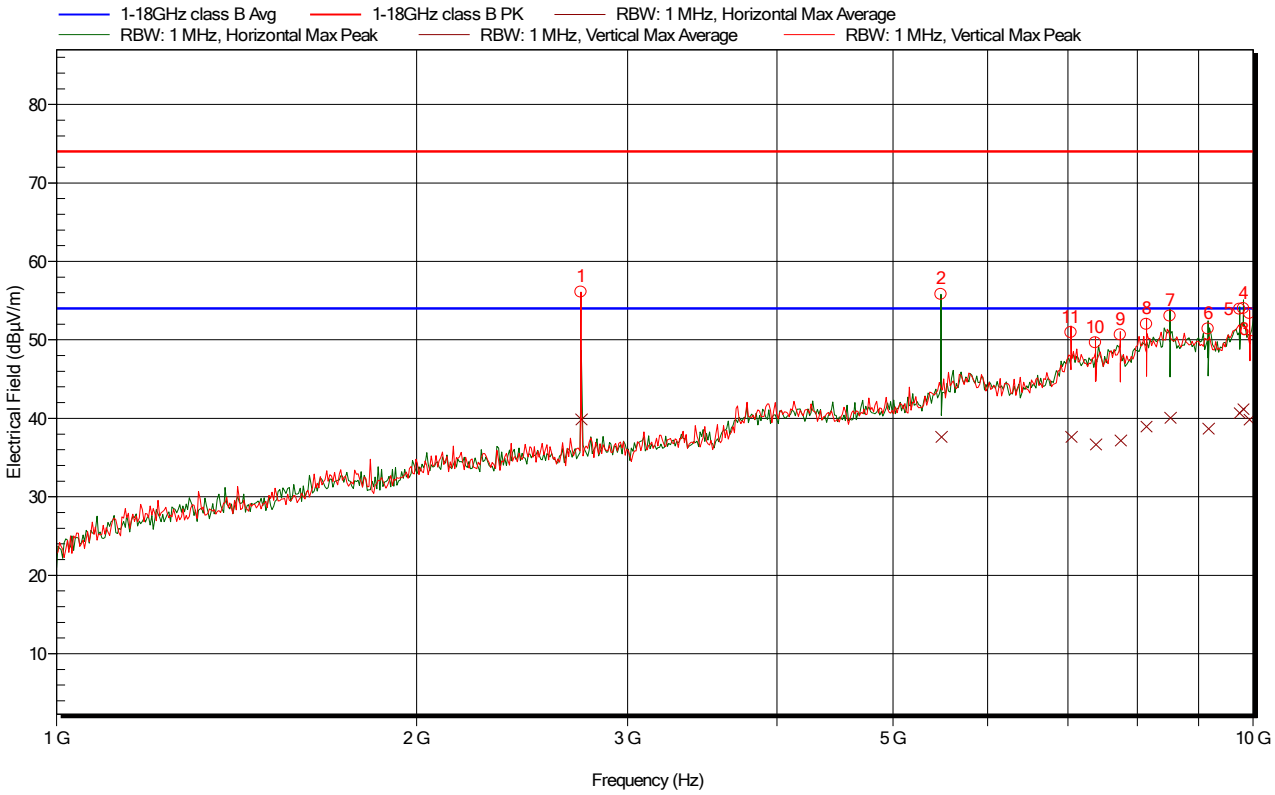


Figure 8 Electric field emissions Plot, 1GHz to 10GHz. Operation on 914.2MHz, 12VDC power

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
9.742	40.65	54	-13.35	Pass	200	1.1 m	Horizontal
9.813	41.15	54	-12.85	Pass	305	1.7	Horizontal
9.934	39.83	54	-14.17	Pass	255	3.3	Vertical
5.486	37.69	54	-16.31	Pass	320	1.1	Horizontal
2.743	39.91	54	-14.09	Pass	130	1.5	Vertical
9.169	38.75	54	-15.25	Pass	225	3.3	Horizontal
8.521	40.12	54	-13.88	Pass	95	2.9	Horizontal
8.146	38.95	54	-15.05	Pass	240	1.7	Vertical
7.743	37.24	54	-16.76	Pass	5	1.7	Vertical
7.384	36.73	54	-17.27	Pass	110	1.1	Vertical
7.045	37.68	54	-16.32	Pass	260	2.1	Vertical

Table 3 Electric Field Emissions Peaks, 1GHz to 10GHz – Operation on 914.2MHz, 12VDC power

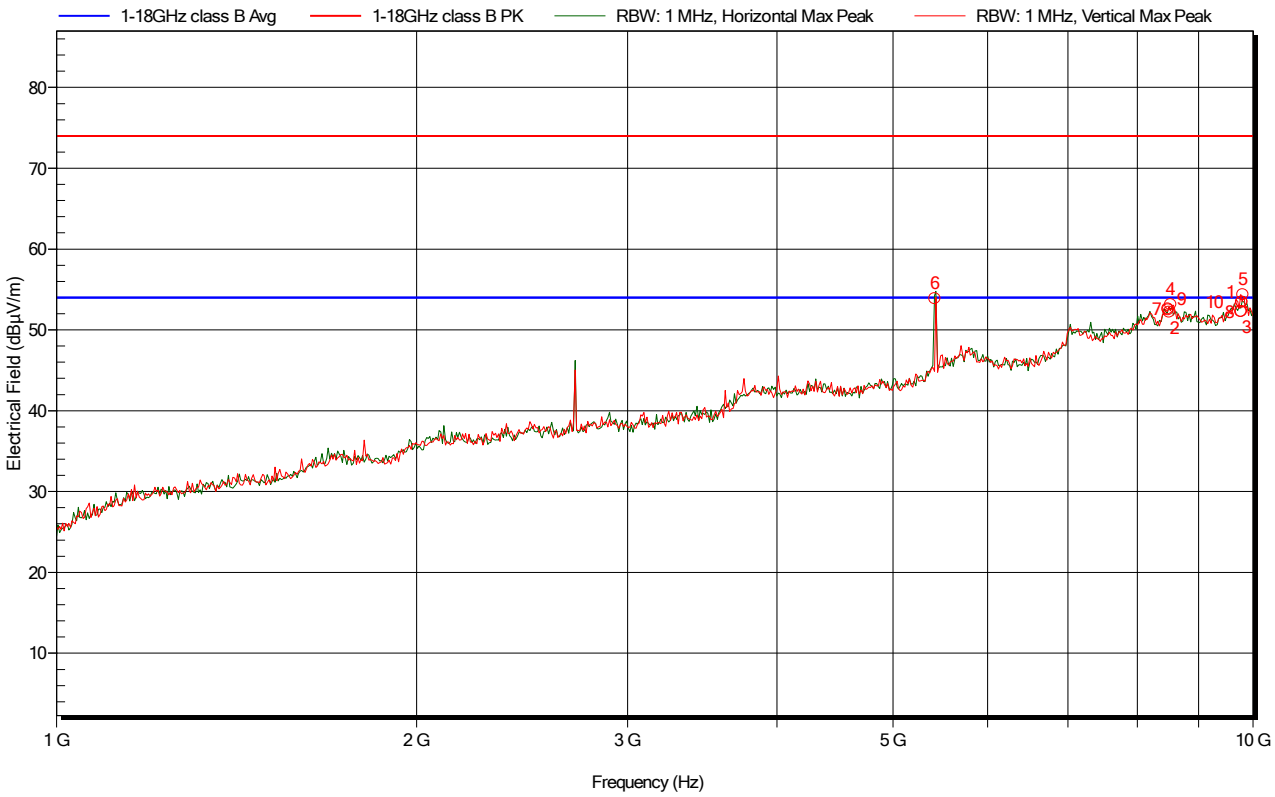


Figure 9 Electric field emissions Plot, 1GHz to 10GHz, Operation on 903.0MHz, Battery power - Peak detector scan

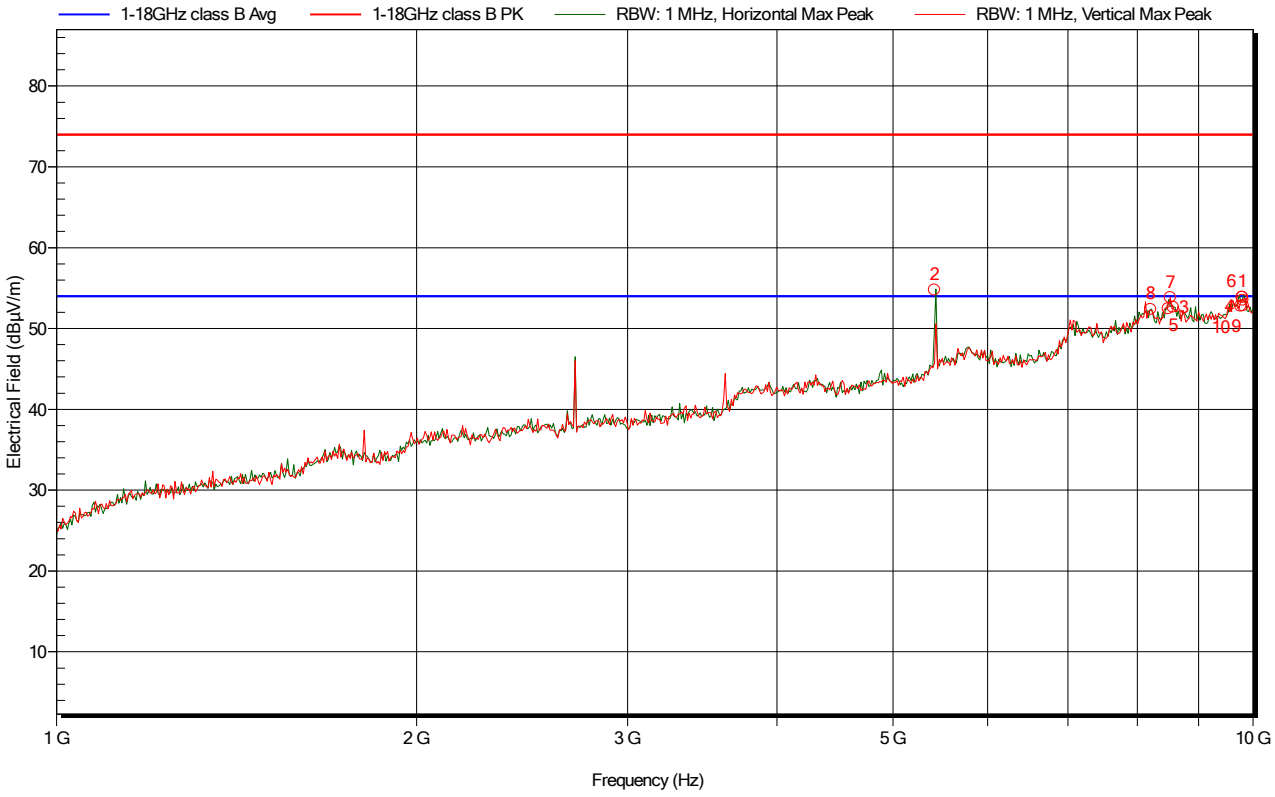


Figure 10 Electric field emissions Plot, 1GHz to 10GHz, Operation on 903.0MHz, AC Mains power – Peak detector scan

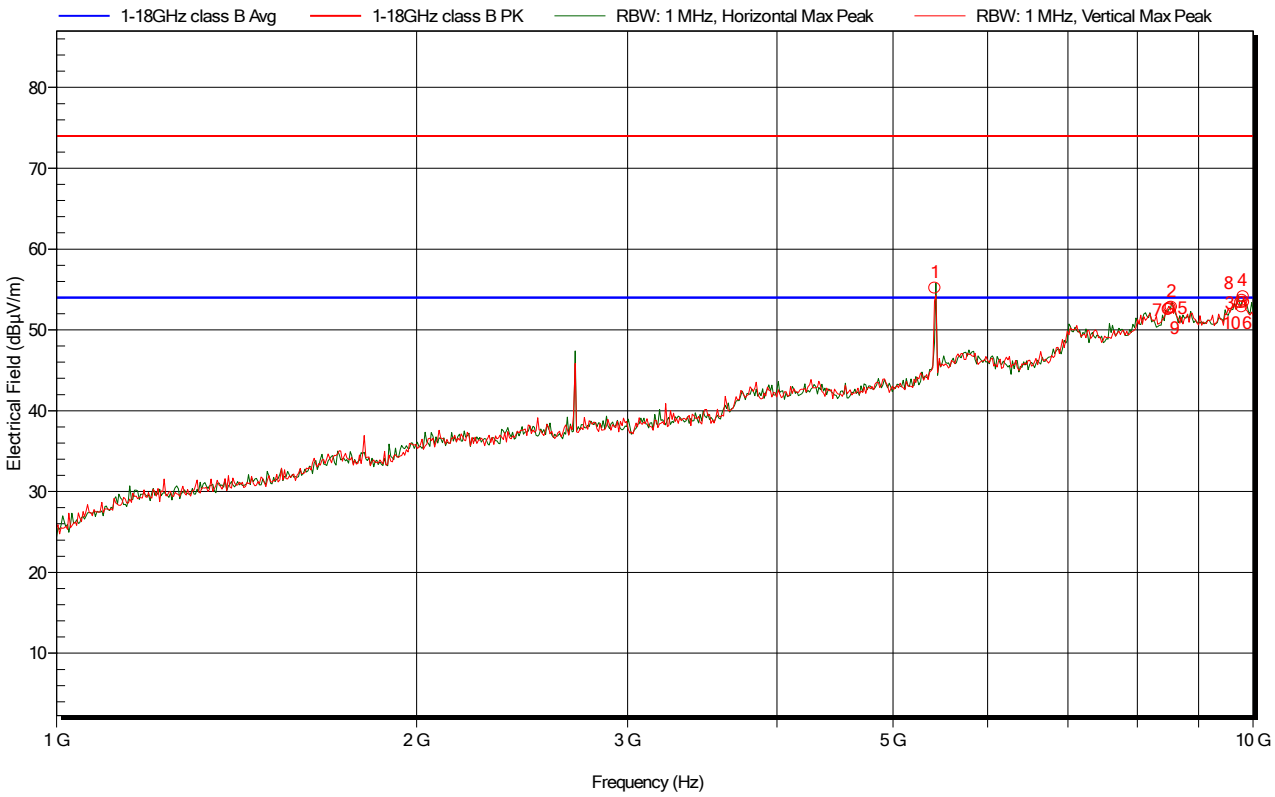


Figure 11 Electric field emissions Plot, 1GHz to 10GHz, Operation on 903.0MHz, 12VDC power - Peak detector scan

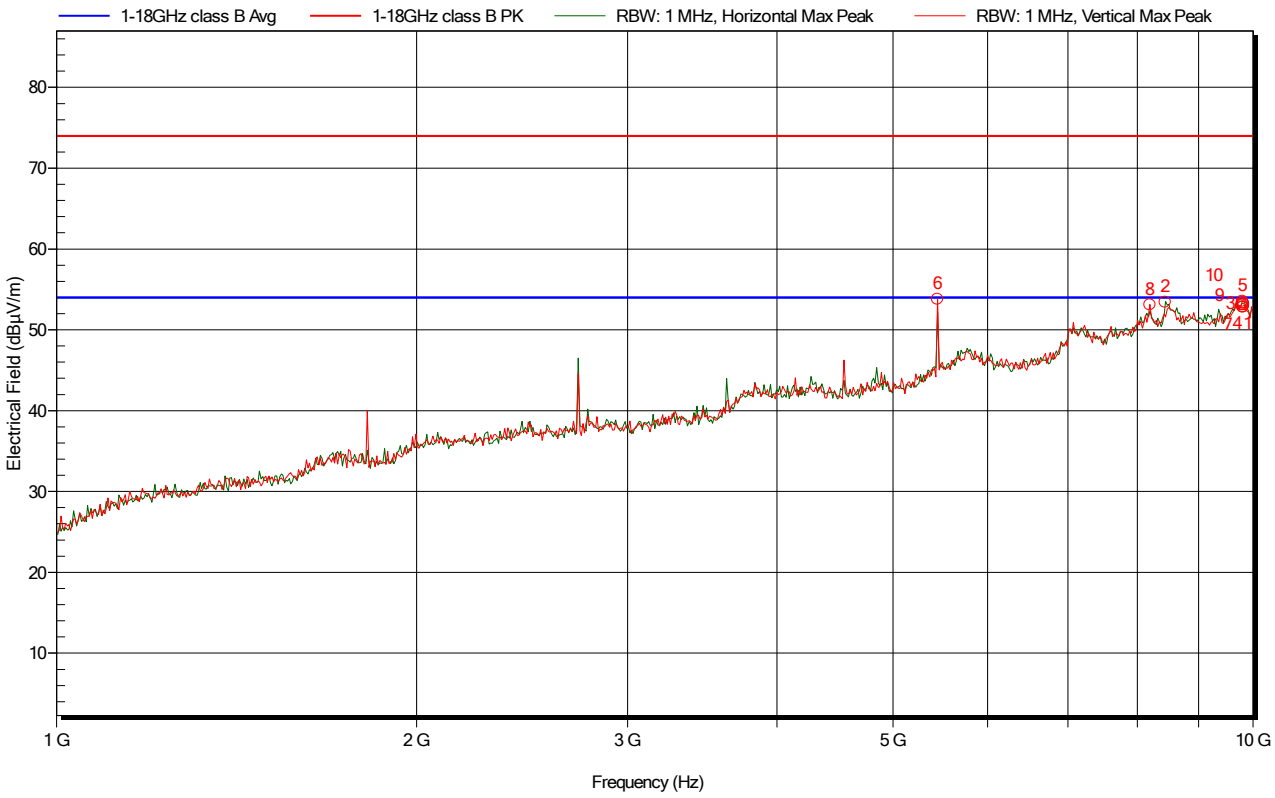


Figure 12 Electric field emissions Plot, 1GHz to 10GHz, Operation on 907.8MHz, 12VDC power – Peak detector scan

5.4.10 Example field strength calculation

The total average corrections are shown in the above table. This correction figure consists of Preamplifier gain (PG), Antenna factor (AF); and Cable loss (CL), and where necessary distance extrapolation factor (dB).

Field strength (FS) is calculated as follows:

FS (dBµV/m) = Indicated Signal Level (dBµV) + extrap(dB) - PG (dB) + AF (dB) + CL (dB)

5.4.11 Sample Data

From Figure 8 and table 3, The Average level at 7.045GHz is calculated as follows:

FS (dBµV/m) = 41.10(dBµV) – 51.32(dB) +39.77(dB/m) +8.13 (dB) = 37.68BµV/m

5.5 Conducted Spurious Emissions 9kHz to 10GHz

5.5.1 Limits

Frequency (MHz)	Limit, 47CFR 15.247(d)
	Peak
0.009 – 25000	-20dBc

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.11.2

Receiver Parameters	Setting
Detector Function	Peak
Start Frequency	9kHz
Stop Frequency	10000MHz
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

5.5.2 Emissions measurements

5.5.3 Date of Test

10th October 2022

5.5.4 Test Area

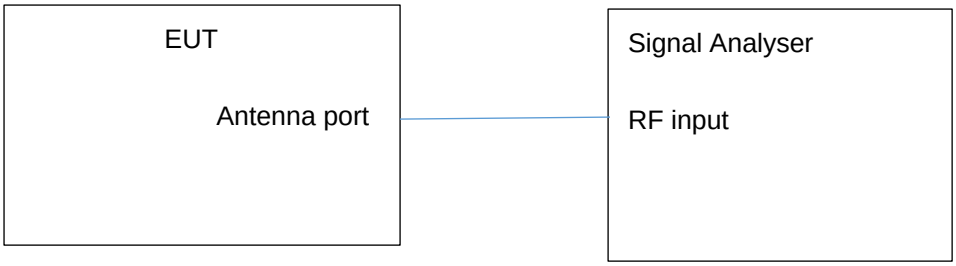
LAB 1

5.5.5 Tested by

J Beevers

5.5.6 Test Setup

The antenna port was connected directly to the signal analyser.



5.5.7 Test Results

The results of the conducted spurious emissions are stated below and by the signal analyser images.

All disturbances detected were > 20dB below the carrier.

5.5.8 Antenna port conducted emissions, 9kHz to 10GHz

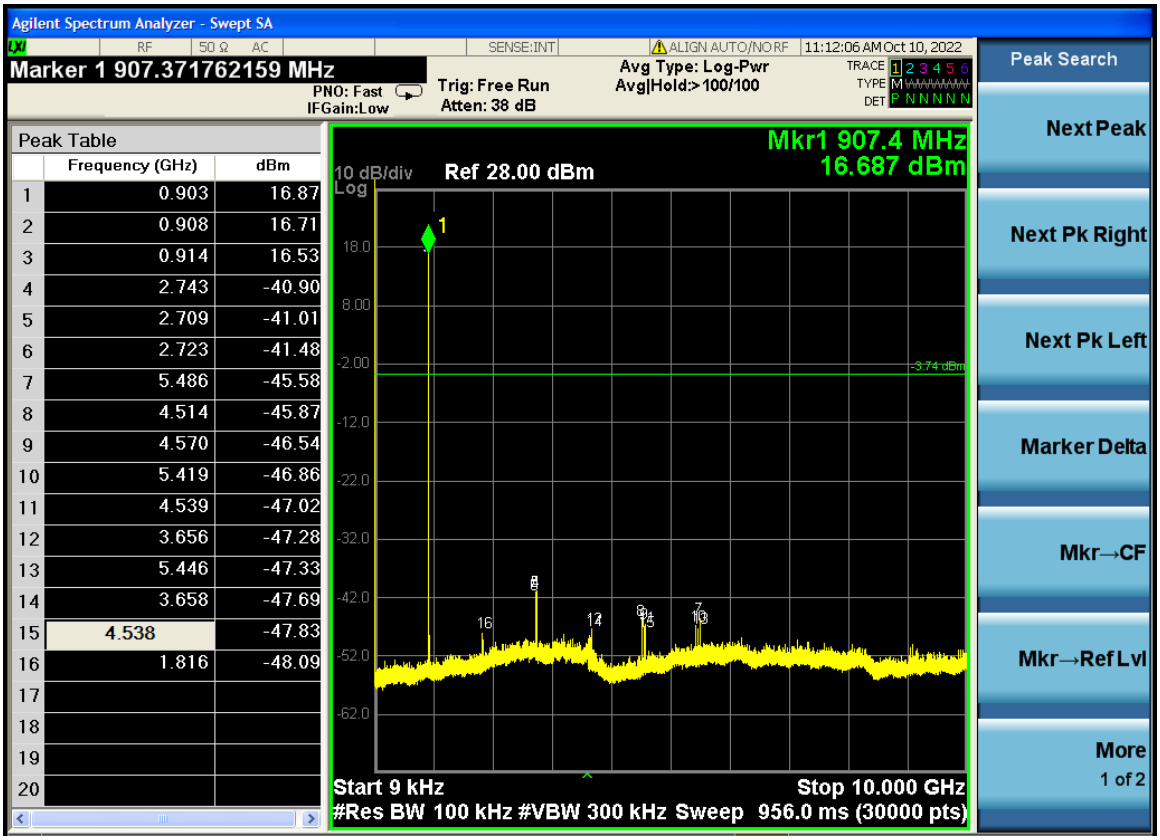


Figure 13 Conducted emissions 9kHz to 10GHz. Operation on channel 903.0MHz.

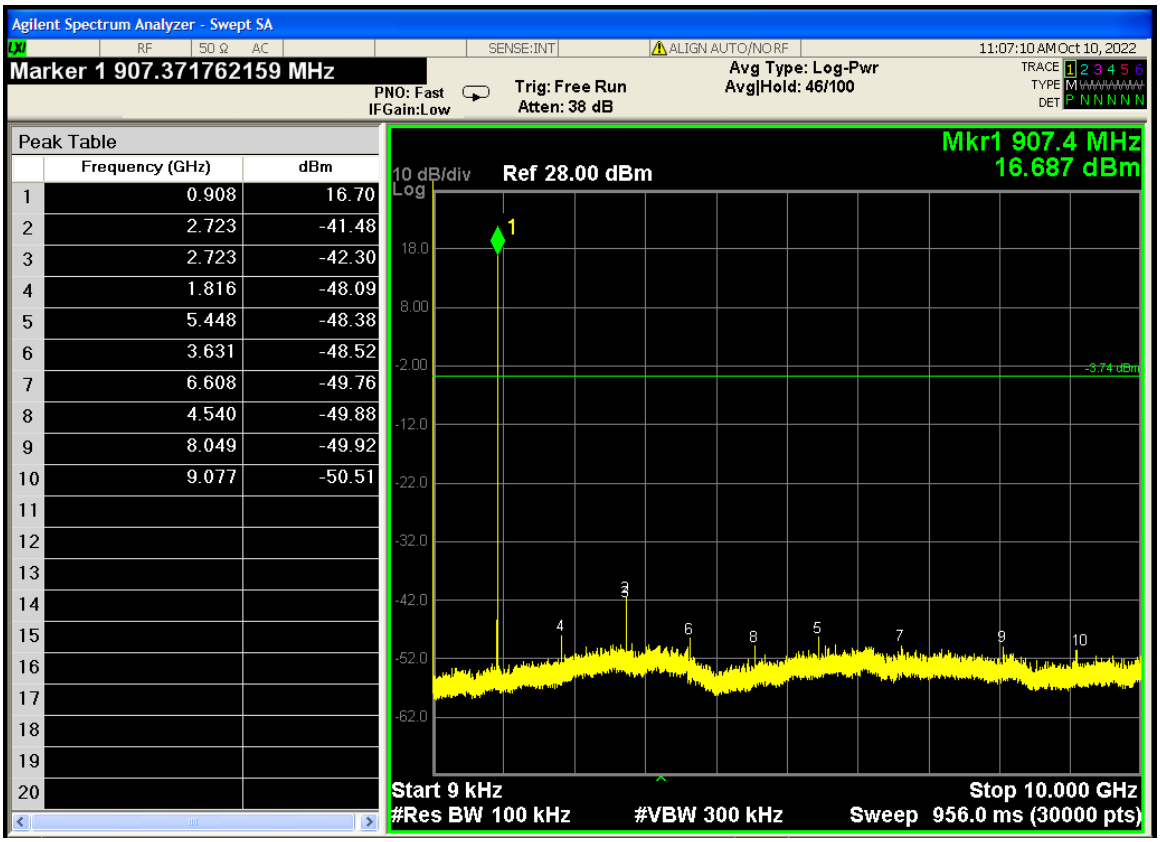


Figure 14 Conducted emissions 9kHz to 10GHz. Operation on channel 907.8MHz.

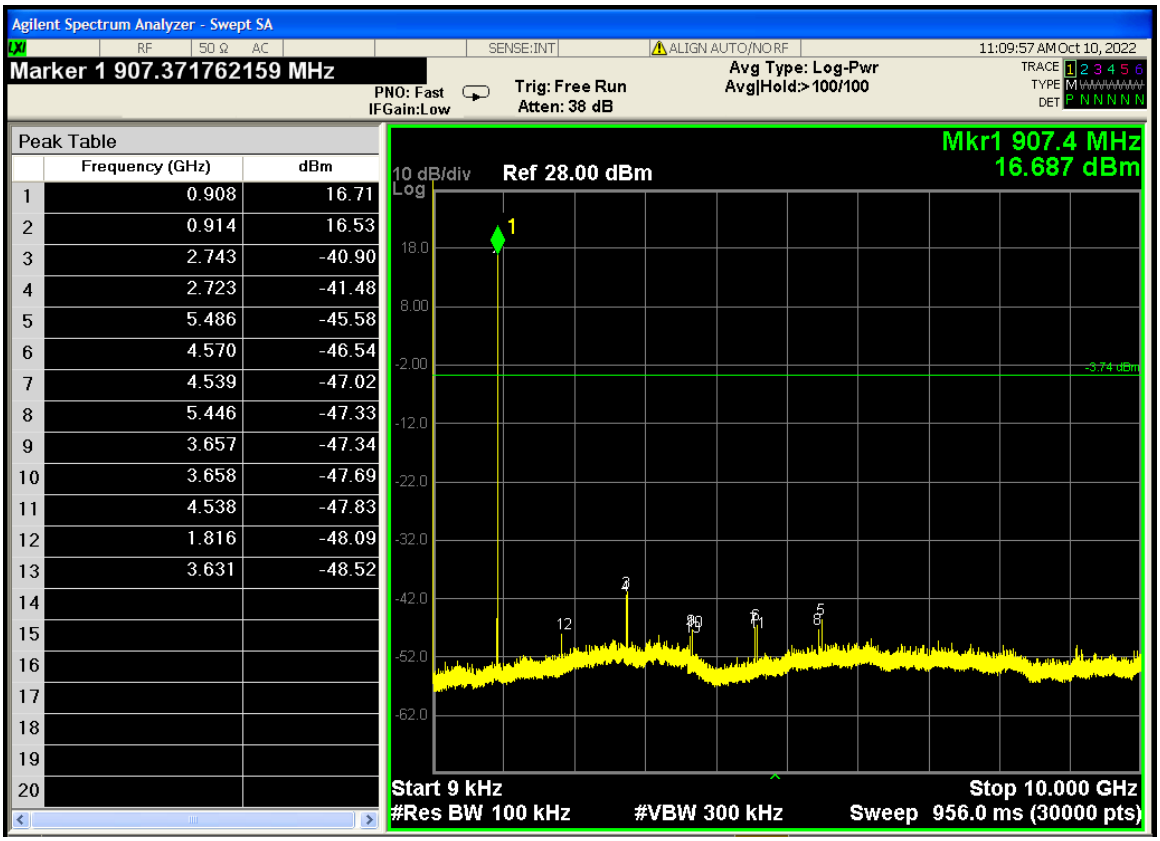


Figure 15 Conducted emissions 9kHz to 10GHz. Operation on channel 914.2MHz.

Section 6 6dB Bandwidth and 99% Occupied Bandwidth

6.1 Test Specification

FCC Rule Part	46CFR 15.247 (b)(2)
Standard	ANSI C63.10:2013

6.2 Procedure and Test Software Version

Conducted Tests

ANSi C63.10-2013 Clause reference:	11.9.1.1 (RBW>DTS bandwidth)
Test software	N/A

Frequency (MHz)	**Limit, 47CFR 15.247(a)(2) 6dB bandwidth**
	Peak
902MHz to 928MHz	At least 500kHz

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.8.1

Receiver Parameters	**Setting**
Detector Function	Peak
Span	3MHz (700kHz 99% OBW)
Resolution Bandwidth	100kHz (10kHz 99% OBW)
Video Bandwidth	300kHz (30kHz 99% OBW)
Sweep rate	Auto couple
Trace mode	Max hold

6.2.1 Emissions measurements

6.2.2 Date of Test

7th October 2022

6.2.3 Test Area

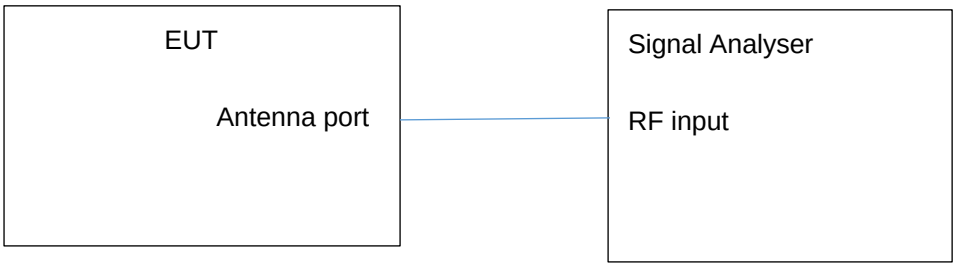
LAB 1

6.2.4 Tested by

J Beevers

6.2.5 Test Setup

The antenna port was connected directly to the signal analyser.



6.2.6 Test Results

The results of the 6dB bandwidth measurements are stated in the table below and by the signal analyser images.

Channel (MHz)	99% Occupied Bandwidth (kHz)	Measured 6dB bandwidth (kHz)	Minimum requirement (kHz)	Figure	Result
903.0	556.23	732.2	500.0	16 and 19	Pass
907.8	554.09	760.0	500.0	17 and 20	Pass
914.2	606.31	761.3	500.0	18 and 21	Pass

Table 4 Bandwidth Measurements

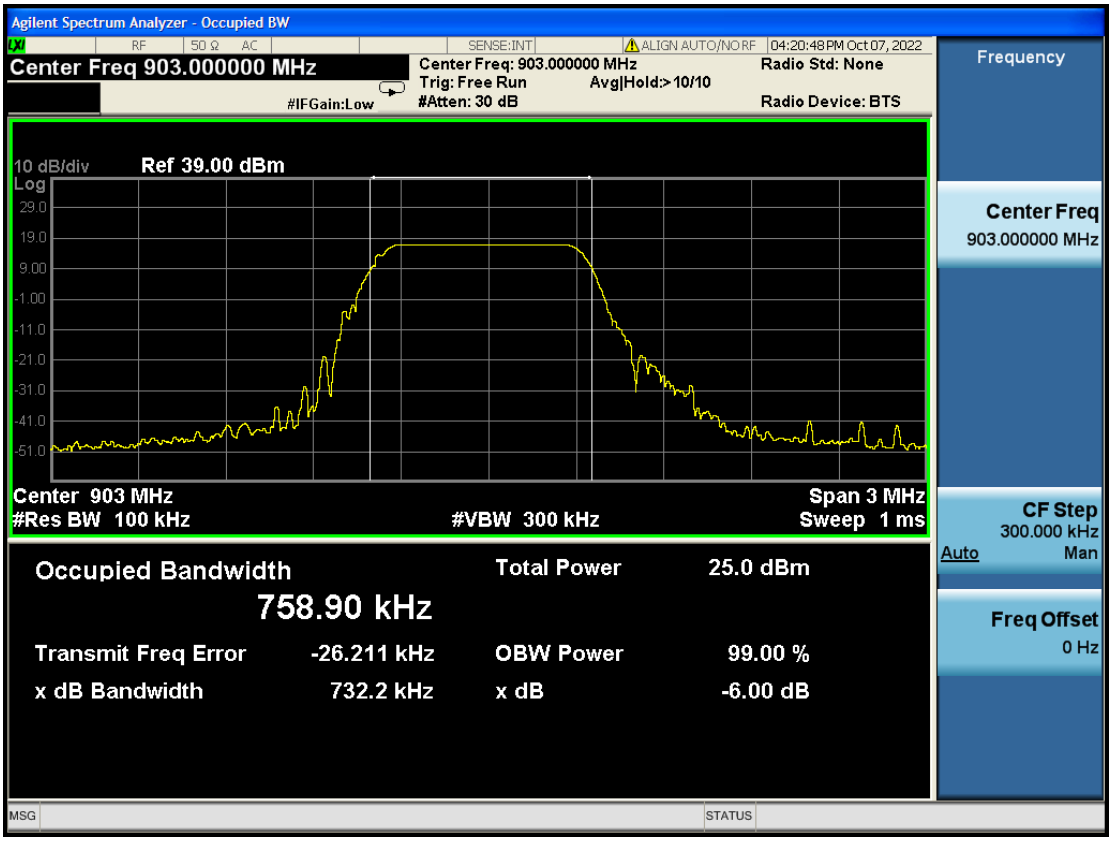


Figure 16 Bandwidth at 6dB Point. Operation on channel 903.0MHz

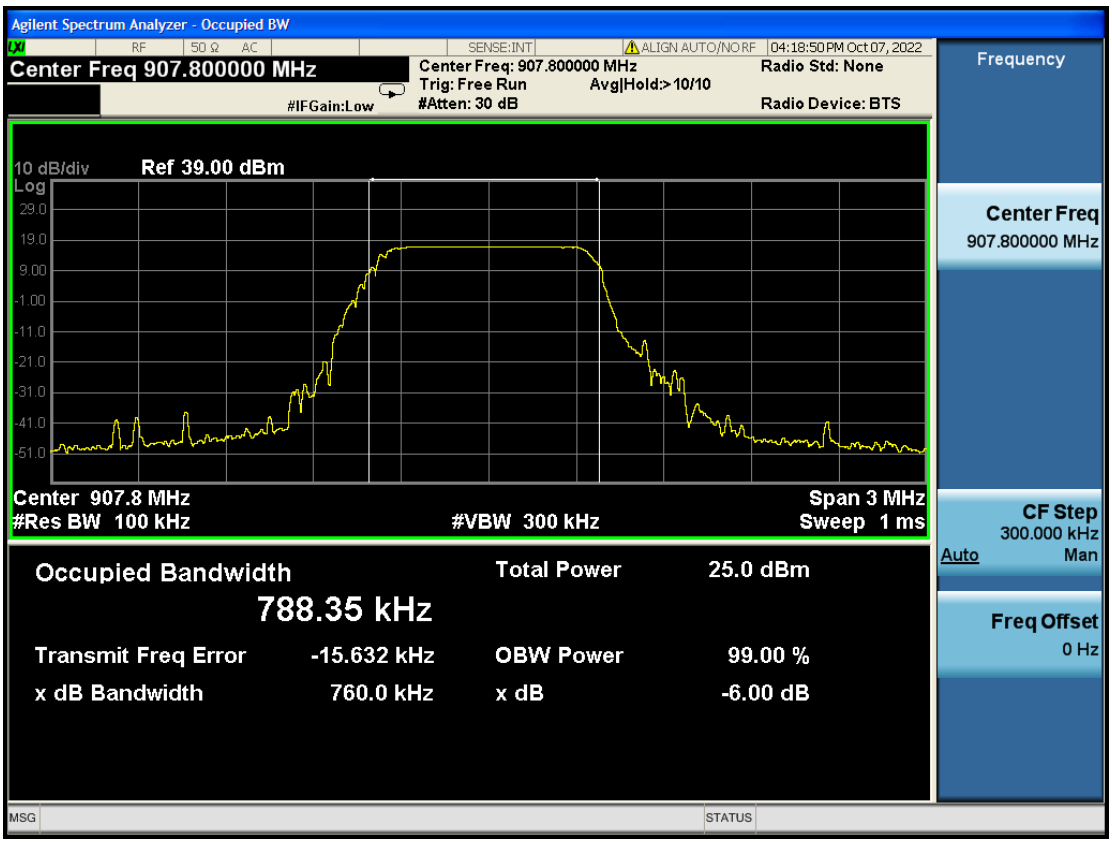


Figure 17 Bandwidth at 6dB Point. Operation on channel 907.8MHz

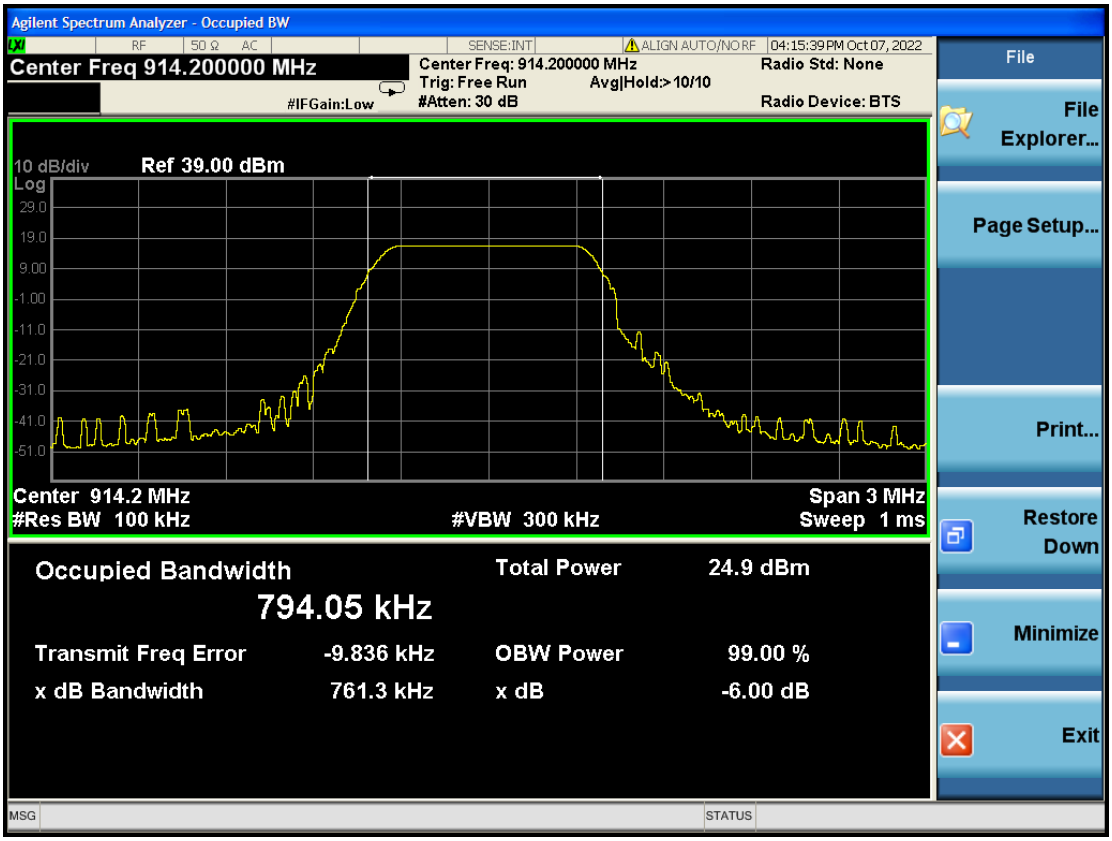


Figure 18 Bandwidth at 6dB Point. Operation on channel 914.2MHz

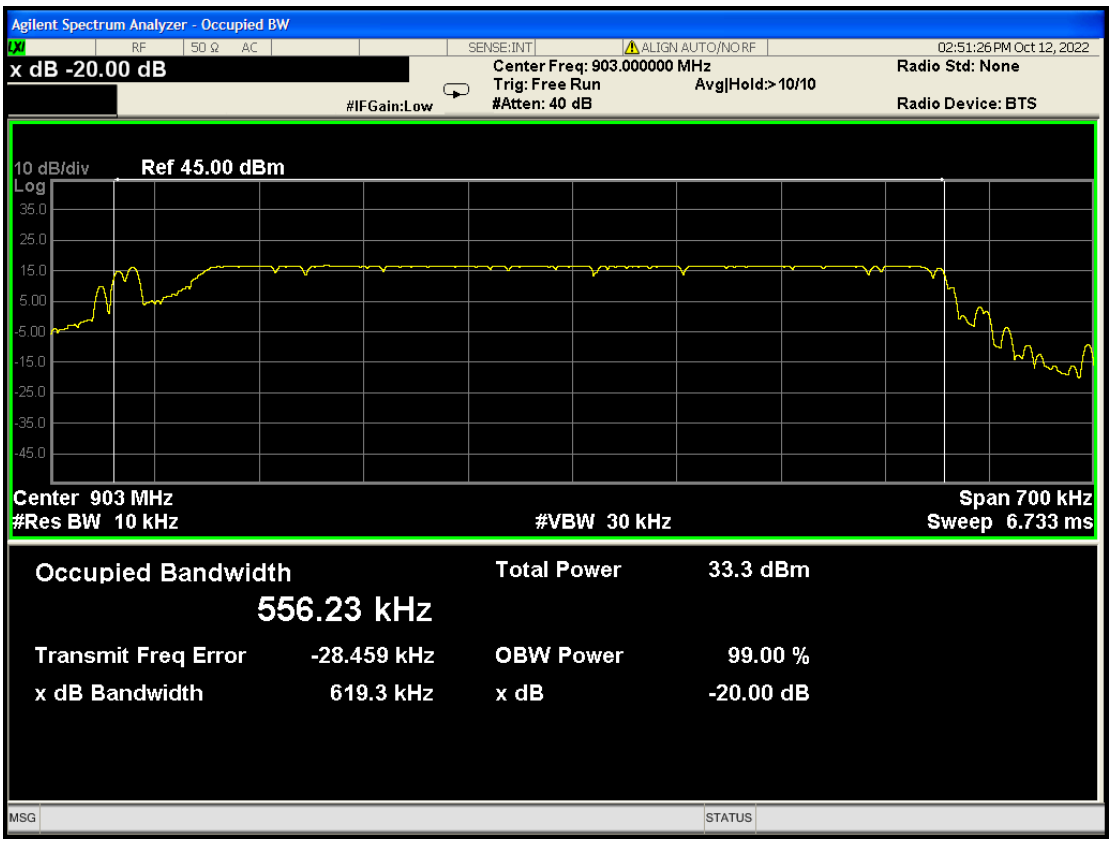


Figure 19 99% Occupied Bandwidth. Operation on channel 903.0MHz

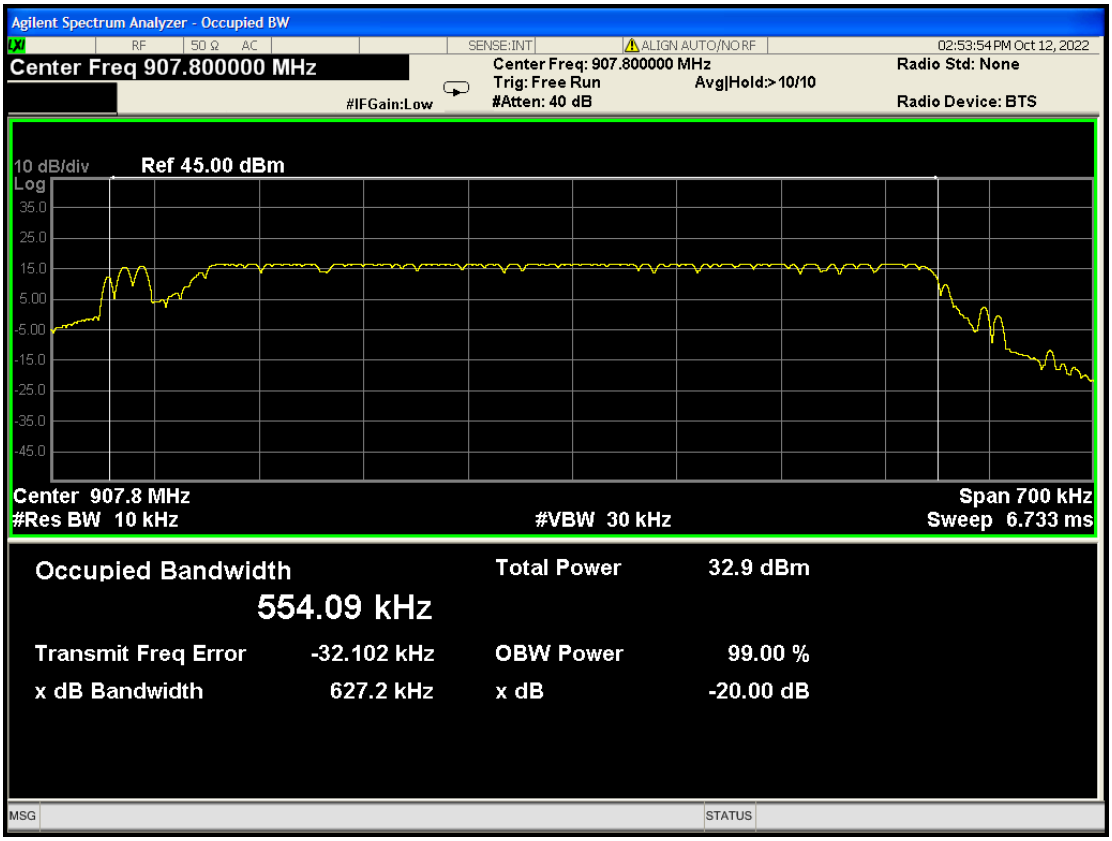


Figure 20 99% Occupied Bandwidth. Operation on channel 907.8MHz

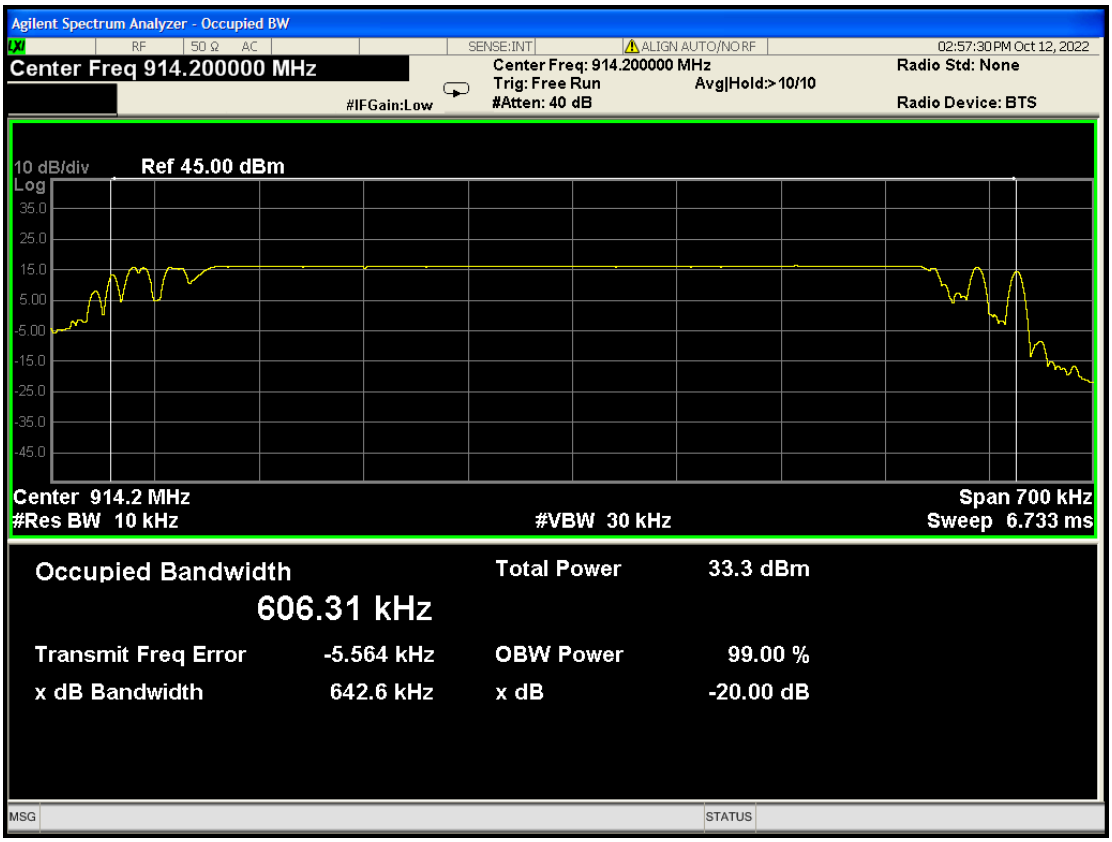


Figure 21 99% Occupied Bandwidth. Operation on channel 914.2MHz

Section 7 Peak Output Power

7.1 Test Specification

FCC Rule Part	46CFR 15.247 (b)(3)
Standard	ANSI C63.10:2013

7.2 Procedure and Test Software Version

Conducted Tests

ANSi C63.10-2013 Clause reference:	11.9.1.1 (RBS>DTS bandwidth)
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(b)(2)
	Peak
2400MHz to 2483.5MHz	1 watt

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.11.2

Receiver Parameters	Setting
Detector Function	Peak
Span	3MHz
Resolution Bandwidth	1MHz (>DTS Bandwidth)
Video Bandwidth	3MHz
Sweep rate	Auto couple
Trace mode	Max hold

7.2.1 Emissions measurements

7.2.2 Date of Test

7th October 2022

7.2.3 Test Area

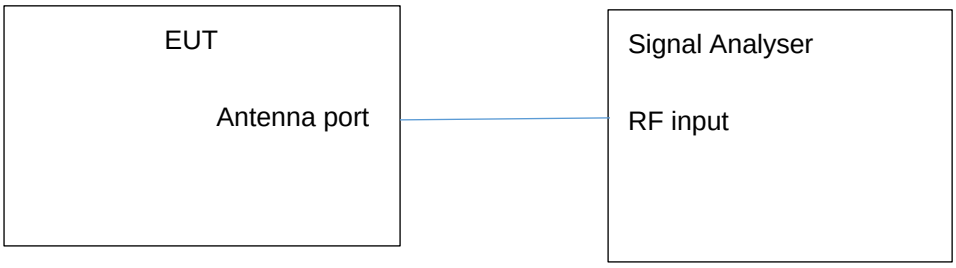
LAB 1

7.2.4 Tested by

J Beevers

7.2.5 Test Setup

The antenna port was connected directly to the signal analyser.



7.2.6 Test Result

The results of the peak output power measurements are stated in the table below and by the signal analyser images.
The cable loss was determined to be 0.2dB. This was taken into account for the below values.

Channel (MHz)	Peak Power (dBm)	Peak Power (Watts)	Limit (Watts)	Figure
903.0	16.79	0.048	1	22
907.8	16.64	0.046	1	23
914.2	16.43	0.044	1	24

Table 5 Peak Output Power Measurements

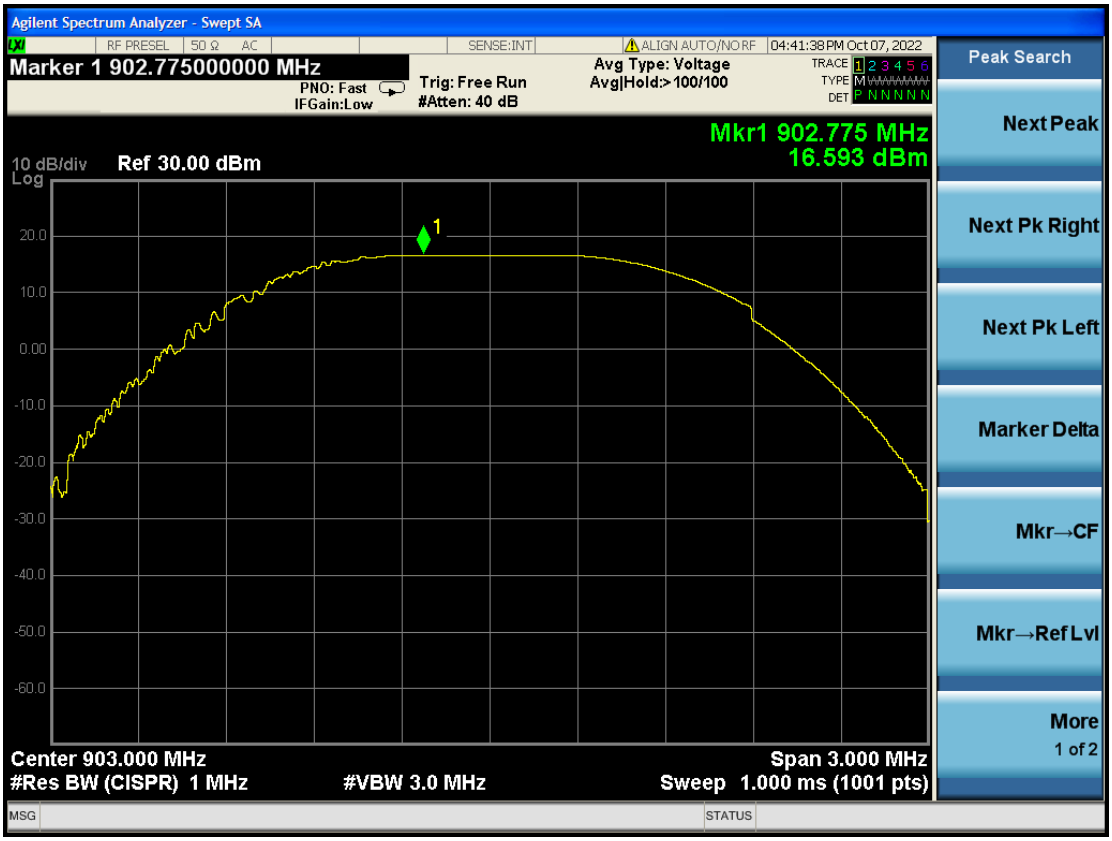


Figure 22 Peak output power, Operation on channel 903.0MHz

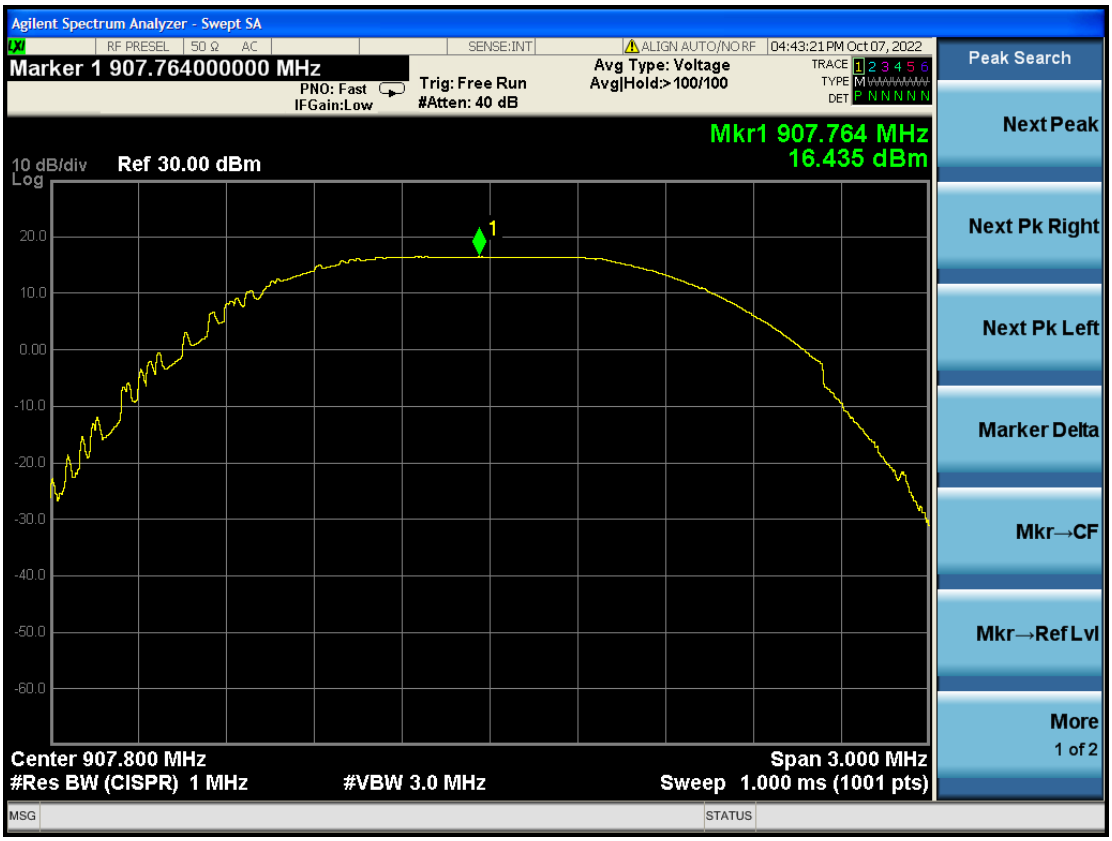


Figure 23 Peak output power, Operation on channel 907.8MHz

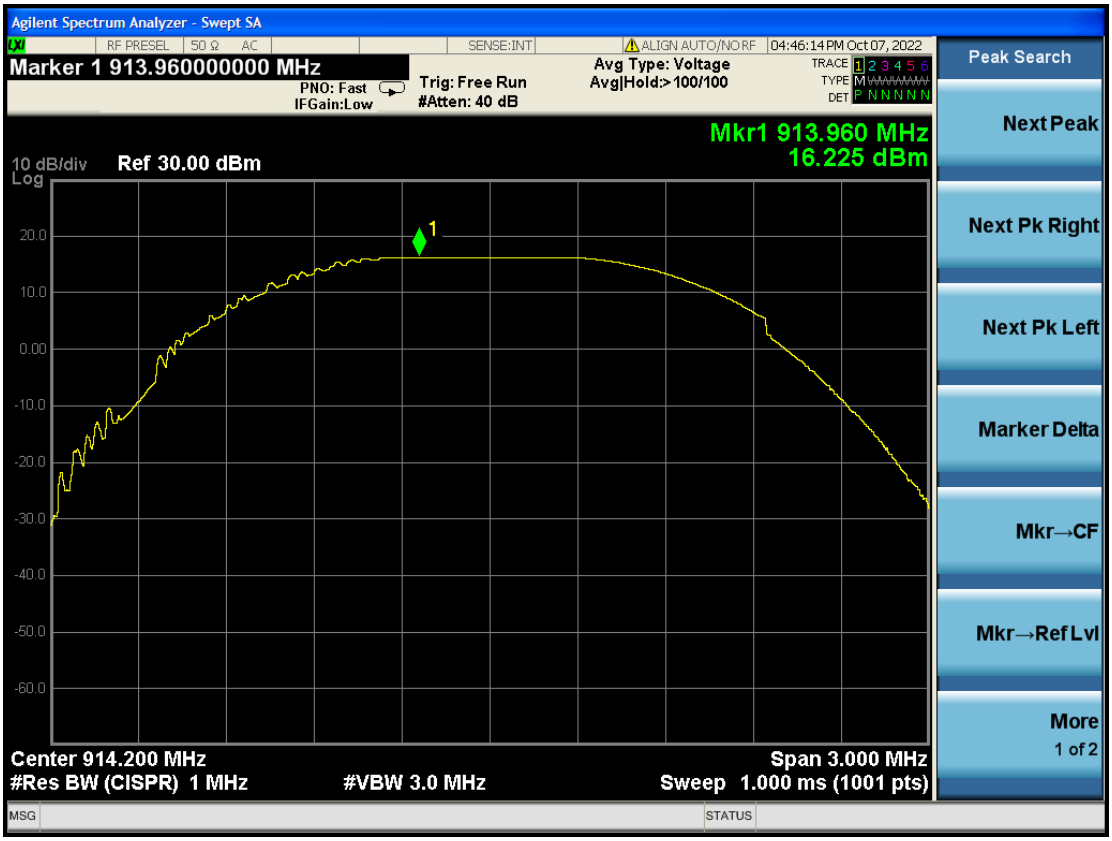


Figure 24 Peak output power, Operation on channel 914.2MHz

Section 8 Power Spectral Density

8.1 Test Specification

FCC Rule Part	46CFR 15.247 (e)
Standard	ANSI C63.10:2013

8.2 Procedure and Test Software Version

Conducted Tests

ANSi C63.10-2013 Clause reference:	Clause 11.10.2
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(e)
	Peak
2400MHz to 2483.5MHz	<8dBm in any 3kHz band during any time interval of complete transmission

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.10.2

Receiver Parameters	Setting
Detector Function	Peak
Span	1.5xDTS bandwidth
Resolution Bandwidth	3kHz ≤RBW ≤100kHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

8.2.1 Emissions measurements

8.2.2 Date of Test

7th October 2022

8.2.3 Test Area

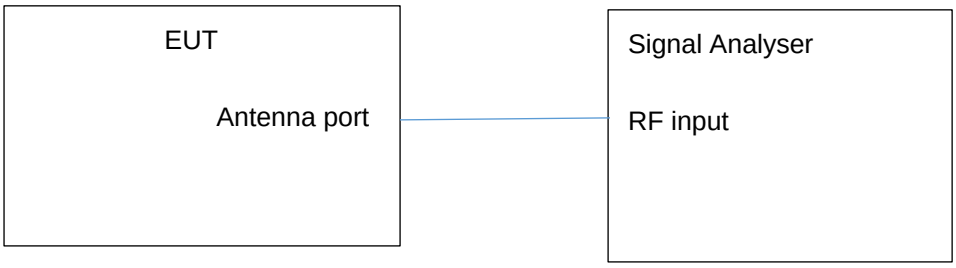
LAB 1

8.2.4 Tested by

J Beevers

8.2.5 Test Setup

The antenna port was connected directly to the signal analyser.



8.2.6 Test Results

The cable loss was determined to be 0.2dB. This was taken into account for the below values.

Channel (MHz)	Power in 3kHz RBW (dBm)	Limit (dBm)	Figure	Result
903.0	7.312	8.0	25	Pass
907.8	6.001	8.0	26	Pass
914.2	6.458	8.0	27	Pass

Table 6 Peak Spectral Density Measurements

Figure 25 Power spectral density, Operation on channel 903.0MHz

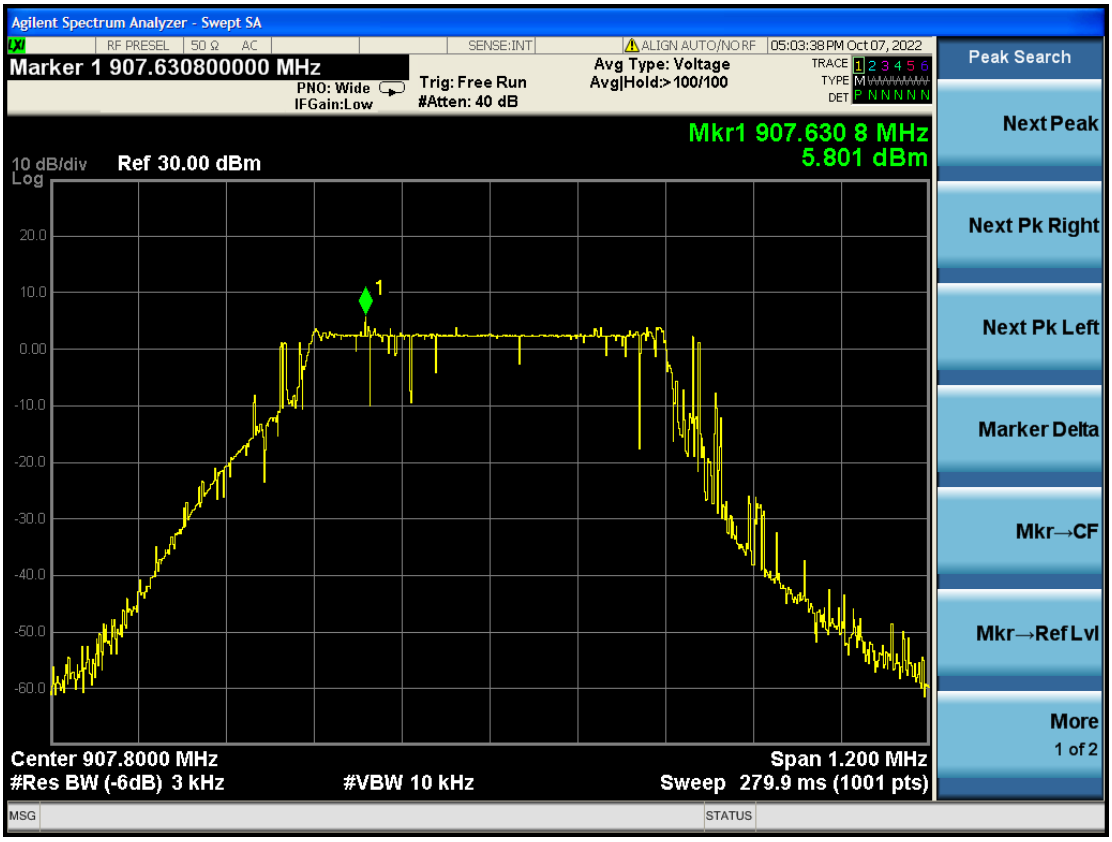


Figure 26 Power spectral density, Operation on channel 907.8MHz

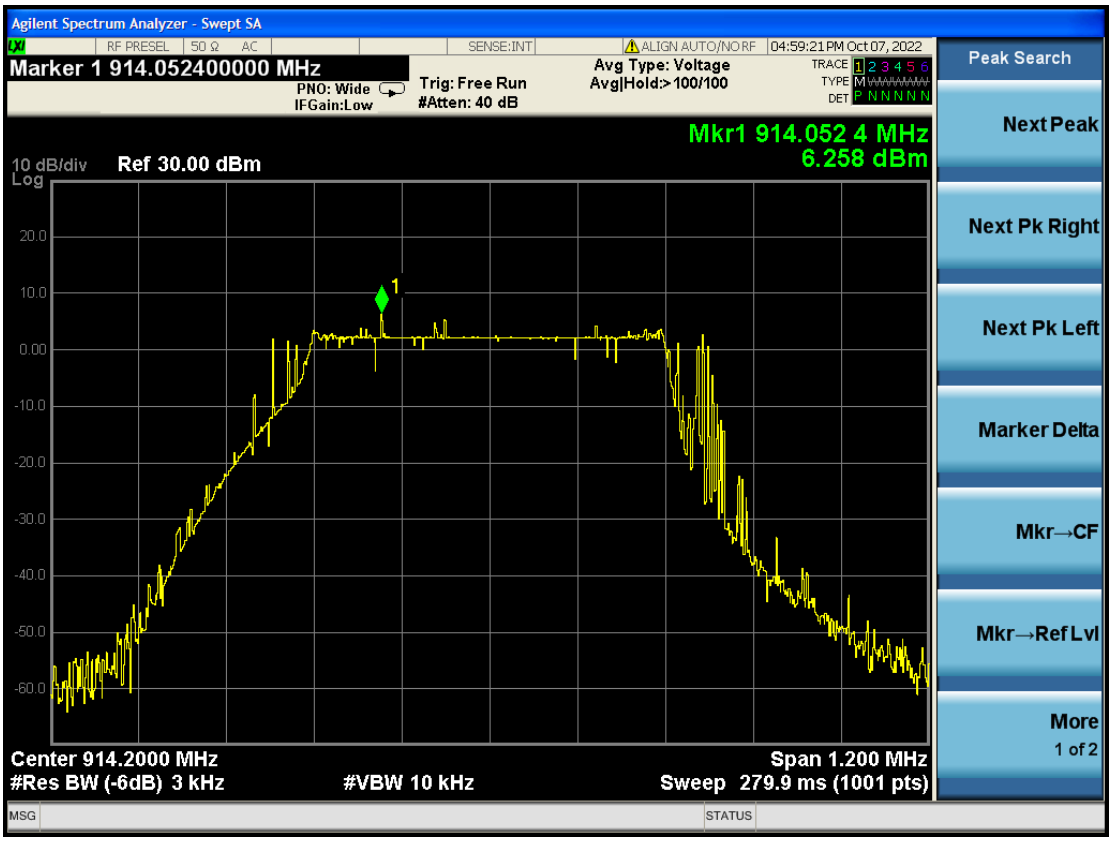


Figure 27 Power spectral density, Operation on channel 914.2MHz

Section 9 Band Edge Compliance

9.1 Test Specification

FCC Rule Part	47CFR15.247(d)
ISED	RSS-247 Issue 2 Sections 3.3 and 5.5 RSS-Gen Issue 5 Section 8.10
Standard	ANSI C63.10:2013

9.2 Procedure and Test Software Version

Conducted Tests

ANSi C63.10-2013 Clause reference:	Clause 6.10.4 Authorised band-edge measurements
Test software	N/A

Frequency (MHz)	Limit, 47CFR 15.247(d)
	Peak
902MHz to 928MHz	For a 902MHz to 928MHz device, there are no restricted bands adjacent to the band edge. In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Spectrum analyser settings as specified in ANSI C63.10-2013 Clause 6.10.4 “Authorised Band Edge Measurements”

Receiver Parameters	Setting
Detector Function	Peak
Span	As necessary
Resolution Bandwidth	100kHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

9.2.1 Emissions measurements

9.2.2 Date of Test

12th October 2022

9.2.3 Test Area

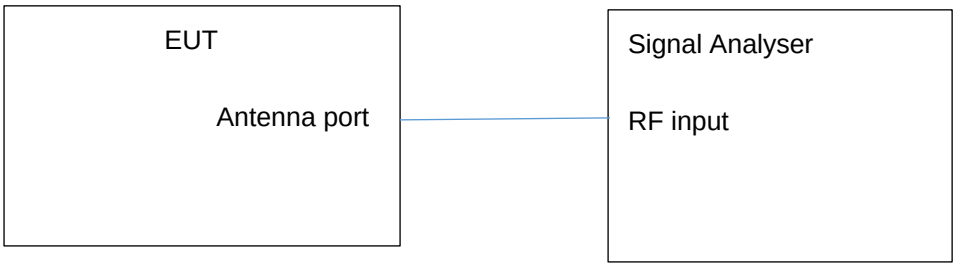
LAB 1

9.2.4 Tested by

J Beevers

9.2.5 Test Setup

The antenna port was connected directly to the signal analyser.



9.2.6 Test Results

The plots below demonstrate that at the band edge the power is more than 20 dB below the carrier power in the 100kHz bandwidth. Therefore, this demonstrates compliance.

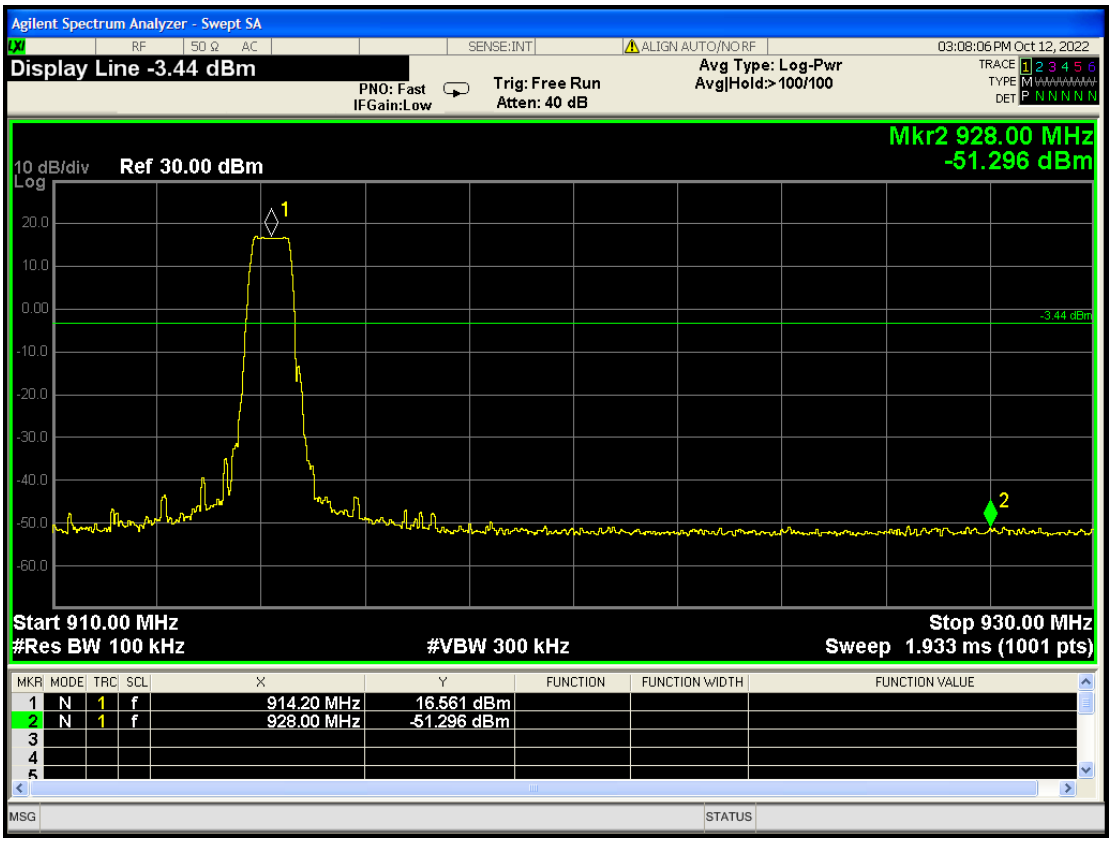


Figure 28 Band Edge Measurement – upper band edge

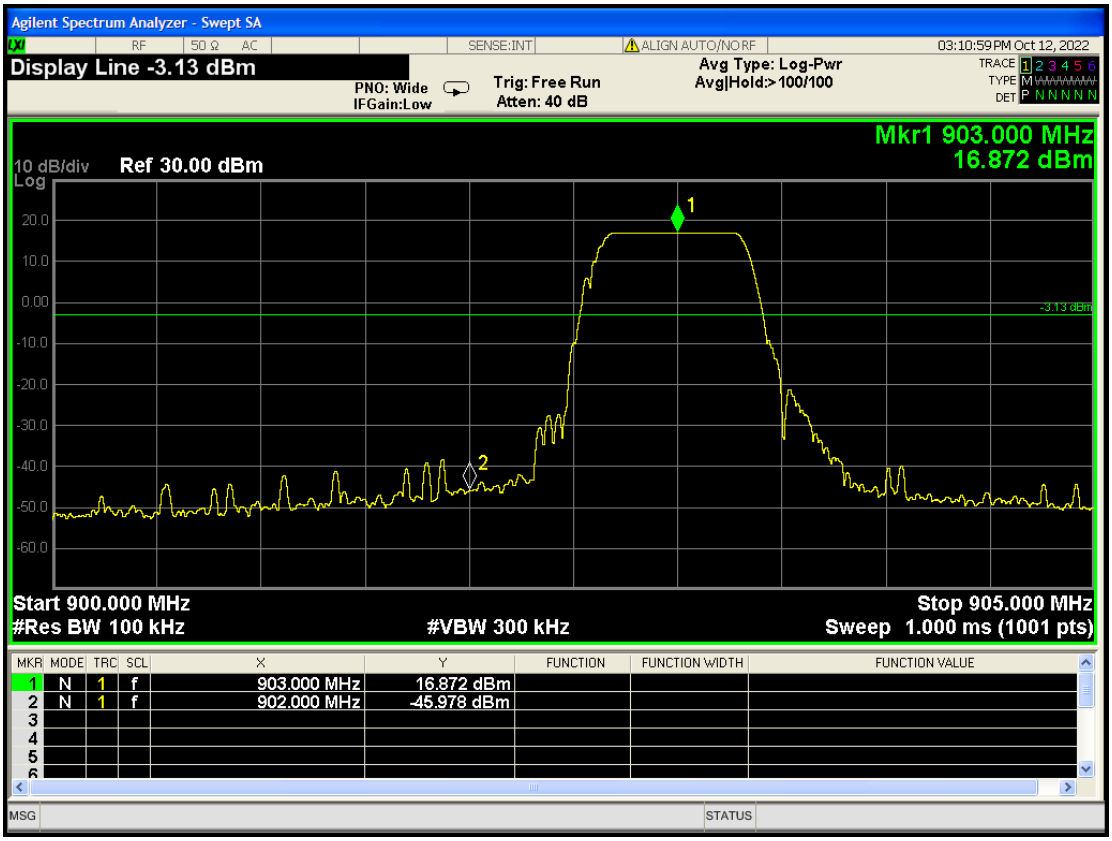


Figure 29 Band Edge Measurement – lower band edge

Section 10 AC Mains Conducted Emissions

10.1 Test Specification

Standard	ANSI C63.10:2013
Measurement Uncertainty	The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 % is +/- 3.45dB

10.2 Power Line Emission Limits

Frequency (MHz)	Class B (dBµV)	
	Quasi Peak	Average
0.15 – 0.5	66 – 56*	56 – 46*
0.5 – 5.0	56.0	46.0
5.0 - 30	60.0	50.0

Note: * The limit decreases linearly with the logarithm of the frequency in the range

10.3 Receiver Settings

Receiver Parameters	Setting
Detector Function	Quasi Peak and Average
Start Frequency	150kHz
Stop Frequency	30MHz
Resolution Bandwidth	10kHz
Video Bandwidth	Auto

10.4 Procedure and Test Software Version

Eurofins York test procedure	CEP19 Issue 5
Test software	RadiMation Version 2016.1.6

10.4.1 Date of Test

17th October 2022

10.4.2 Test Area

LAB 2

10.4.3 Tested by

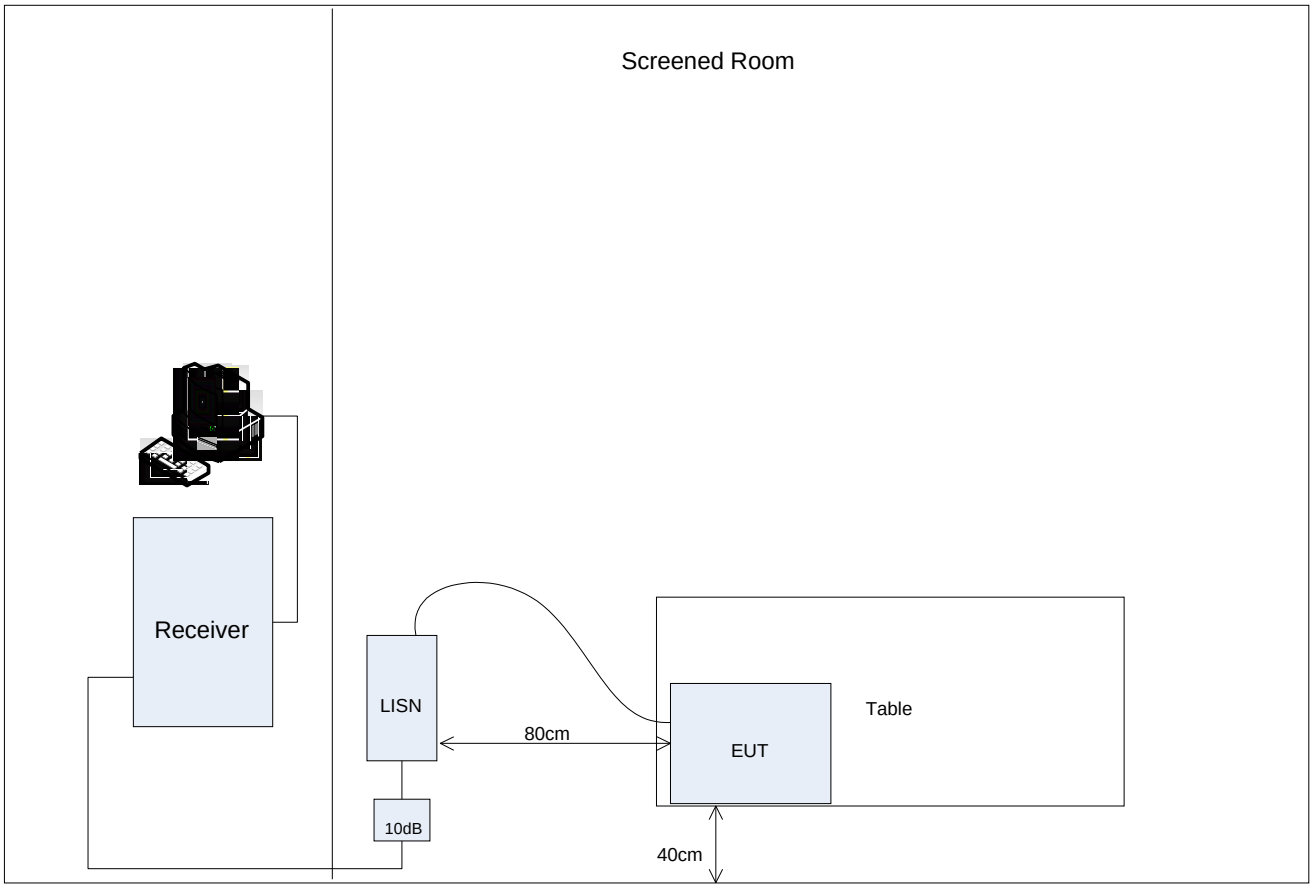
J Beevers

10.4.4 Test Setup

This test was applied to the EUT's Live and Neutral lines. The EUT was configured in the screened room on an 80cm high table was positioned 40cm from the room wall.

A calibrated mains extension lead was used to ensure a known impedance was presented to the EUT

The EUT was then powered from the mains supply via a Line Impedance Stabilisation Network (LISN).



10.5 Test Results

This section contains graphical and tabulated data. The following data is presented

Mode of Operation	Conductor	Result summary
903.0 MHz transmission	Live	Pass
903.0 MHz transmission	Neutral	Pass
907.8 MHz transmission	Live	Pass
907.8 MHz transmission	Neutral	Pass
914.2 MHz transmission	Live	Pass
914.2 MHz transmission	Neutral	Pass

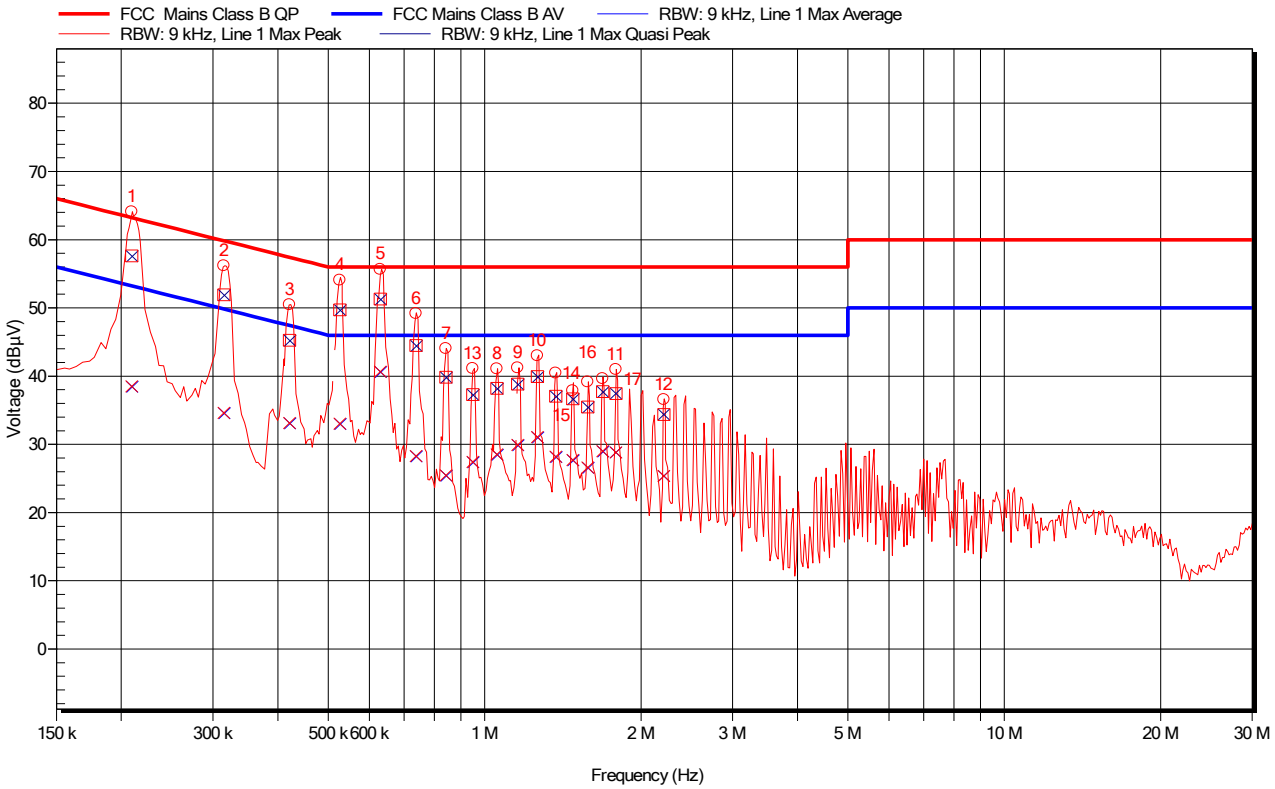


Figure 30: AC mains conducted emissions. Operation on channel 903.0MHz – Live

Frequency (MHz)	Average (dBµV)	Average Limit (dBµV)	Average Difference (dB)	Average Status	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.209	38.5	53.2	-14.73	Pass	57.6	63.2	-5.59	Pass
0.315	34.6	49.8	-15.23	Pass	51.9	59.8	-7.93	Pass
0.421	33.1	47.4	-14.32	Pass	45.3	57.4	-12.14	Pass
0.527	33.0	46.0	-12.96	Pass	49.7	56.0	-6.27	Pass
0.630	40.7	46.0	-5.34	Pass	51.3	56.0	-4.72	Pass
0.738	28.3	46.0	-17.71	Pass	44.5	56.0	-11.51	Pass
0.843	25.5	46.0	-20.53	Pass	39.8	56.0	-16.16	Pass
1.056	28.5	46.0	-17.48	Pass	38.2	56.0	-17.77	Pass
1.158	29.9	46.0	-16.1	Pass	38.8	56.0	-17.15	Pass
1.264	31.1	46.0	-14.93	Pass	39.9	56.0	-16.06	Pass
1.789	28.8	46.0	-17.21	Pass	37.5	56.0	-18.54	Pass
2.214	25.4	46.0	-20.62	Pass	34.4	56.0	-21.61	Pass
0.949	27.4	46.0	-18.56	Pass	37.3	56.0	-18.69	Pass
1.370	28.2	46.0	-17.8	Pass	37	56.0	-18.96	Pass
1.477	27.7	46.0	-18.29	Pass	36.7	56.0	-19.34	Pass
1.579	26.6	46.0	-19.37	Pass	35.5	56.0	-20.5	Pass
1.687	29.0	46.0	-16.97	Pass	37.8	56.0	-18.25	Pass

Table 7: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 903.0MHz - Live

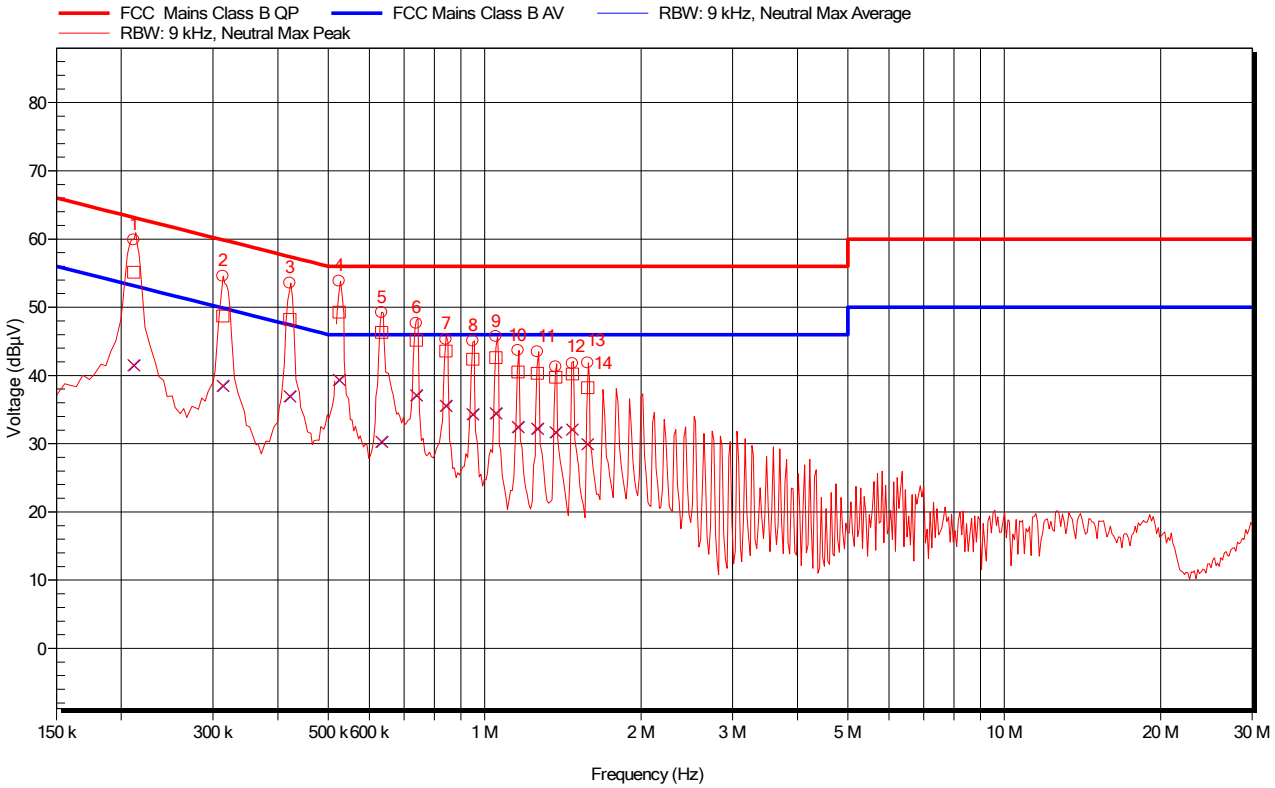


Figure 31: AC mains conducted emissions. Operation on channel 903.0MHz – Neutral

Frequency (MHz)	Average (dBµV)	Average Limit (dBµV)	Average Difference (dB)	Average Status	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.211	41.5	53.2	-11.62	Pass	55.1	63.2	-8.03	Pass
0.313	38.5	49.9	-11.38	Pass	48.7	59.9	-11.15	Pass
0.422	37.0	47.4	-10.43	Pass	48.2	57.4	-9.17	Pass
0.525	39.4	46.0	-6.62	Pass	49.3	56.0	-6.73	Pass
0.633	30.3	46.0	-15.68	Pass	46.3	56.0	-9.69	Pass
0.739	37.1	46.0	-8.88	Pass	45.2	56.0	-10.83	Pass
0.843	35.6	46.0	-10.43	Pass	43.6	56.0	-12.41	Pass
0.949	34.3	46.0	-11.66	Pass	42.4	56.0	-13.64	Pass
1.051	34.5	46.0	-11.53	Pass	42.6	56.0	-13.40	Pass
1.160	32.5	46.0	-13.53	Pass	40.5	56.0	-15.47	Pass
1.263	32.2	46.0	-13.80	Pass	40.3	56.0	-15.67	Pass
1.371	31.7	46.0	-14.33	Pass	39.7	56.0	-16.28	Pass
1.476	32.1	46.0	-13.91	Pass	40.2	56.0	-15.78	Pass
1.578	29.9	46.0	-16.08	Pass	38.2	56.0	-17.81	Pass

Table 8: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 903.0MHz - Neutral

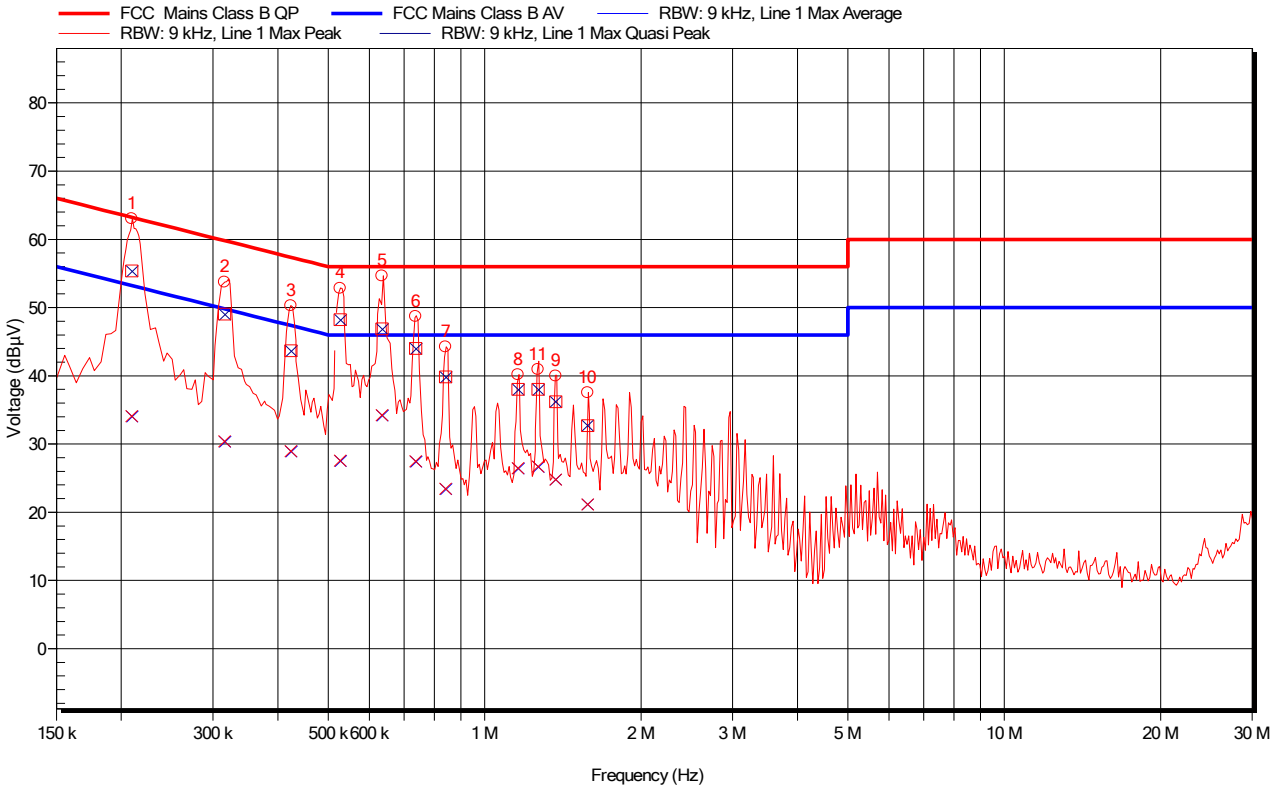


Figure 32: AC mains conducted emissions. Operation on channel 907.8MHz – Live

Frequency (MHz)	Average (dBµV)	Average Limit (dBµV)	Average Difference (dB)	Average Status	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.209	34.1	53.2	-19.16	Pass	55.4	63.2	-7.88	Pass
0.316	30.4	49.8	-19.42	Pass	49.1	59.8	-10.75	Pass
0.424	29.0	47.4	-18.41	Pass	43.7	57.4	-13.71	Pass
0.528	27.6	46.0	-18.41	Pass	48.2	56.0	-7.79	Pass
0.635	34.2	46.0	-11.77	Pass	46.9	56.0	-9.11	Pass
0.736	27.5	46.0	-18.52	Pass	44.0	56.0	-11.97	Pass
0.842	23.5	46.0	-22.54	Pass	39.9	56.0	-16.14	Pass
1.159	26.5	46.0	-19.52	Pass	38.0	56.0	-18.00	Pass
1.371	24.8	46.0	-21.23	Pass	36.2	56.0	-19.80	Pass
1.580	21.2	46.0	-24.85	Pass	32.7	56.0	-23.32	Pass
1.267	26.7	46.0	-19.29	Pass	38.0	56.0	-17.97	Pass

Table 9: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 907.8MHz - Live

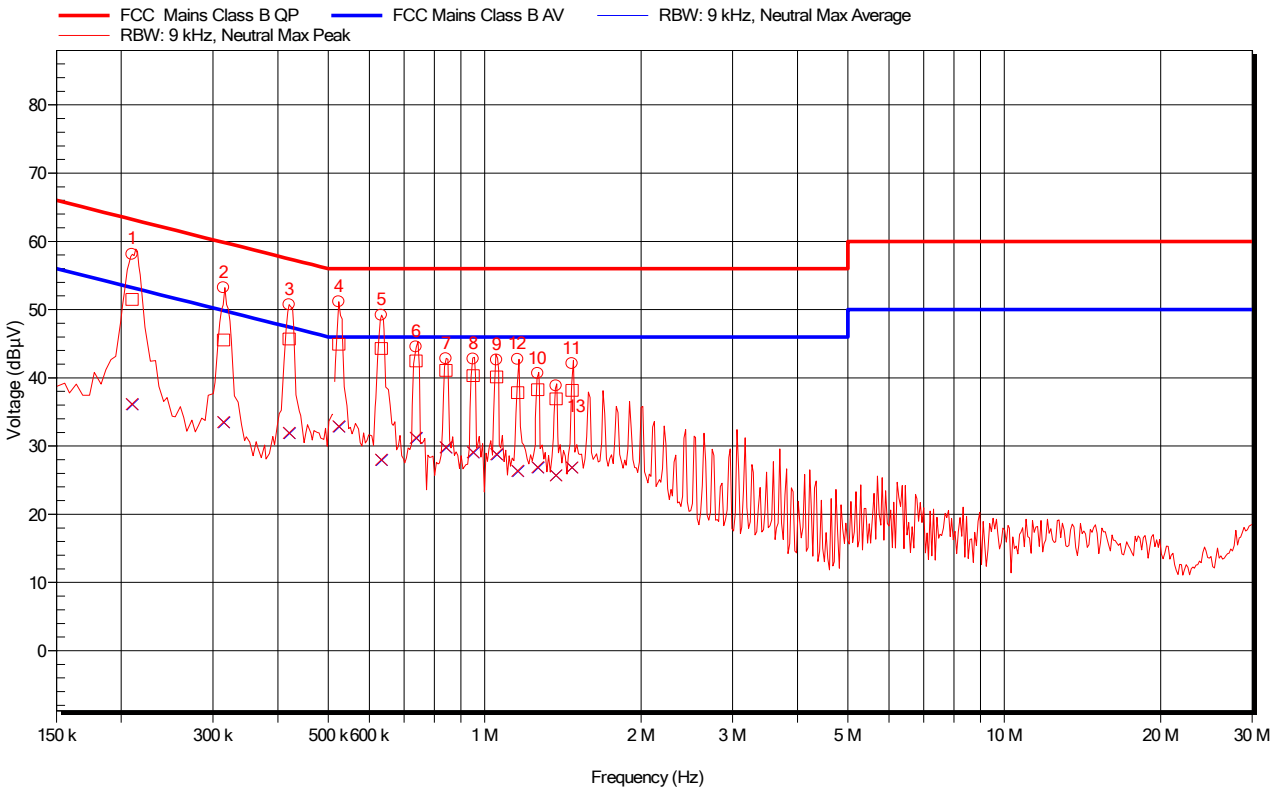


Figure 33: AC mains conducted emissions. Operation on channel 907.8MHz – Neutral

Frequency (MHz)	Average (dBuV)	Average Limit (dBuV)	Average Difference (dB)	Average Status	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.210	36.1	53.2	-17.08	Pass	51.5	63.2	-11.72	Pass
0.315	33.5	49.8	-16.33	Pass	45.5	59.8	-14.32	Pass
0.421	31.9	47.4	-15.50	Pass	45.7	57.4	-11.76	Pass
0.524	32.9	46.0	-13.13	Pass	44.9	56.0	-11.08	Pass
0.632	28.0	46.0	-18.01	Pass	44.3	56.0	-11.71	Pass
0.738	31.2	46.0	-14.77	Pass	42.5	56.0	-13.55	Pass
0.843	29.8	46.0	-16.16	Pass	41.1	56.0	-14.90	Pass
0.950	29.1	46.0	-16.89	Pass	40.3	56.0	-15.68	Pass
1.054	28.8	46.0	-17.20	Pass	40.1	56.0	-15.89	Pass
1.265	26.9	46.0	-19.08	Pass	38.3	56.0	-17.74	Pass
1.474	26.8	46.0	-19.17	Pass	38.2	56.0	-17.85	Pass
1.158	26.4	46.0	-19.61	Pass	37.8	56.0	-18.16	Pass
1.372	25.7	46.0	-20.32	Pass	36.9	56.0	-19.1	Pass

Table 10: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 907.8MHz - Neutral

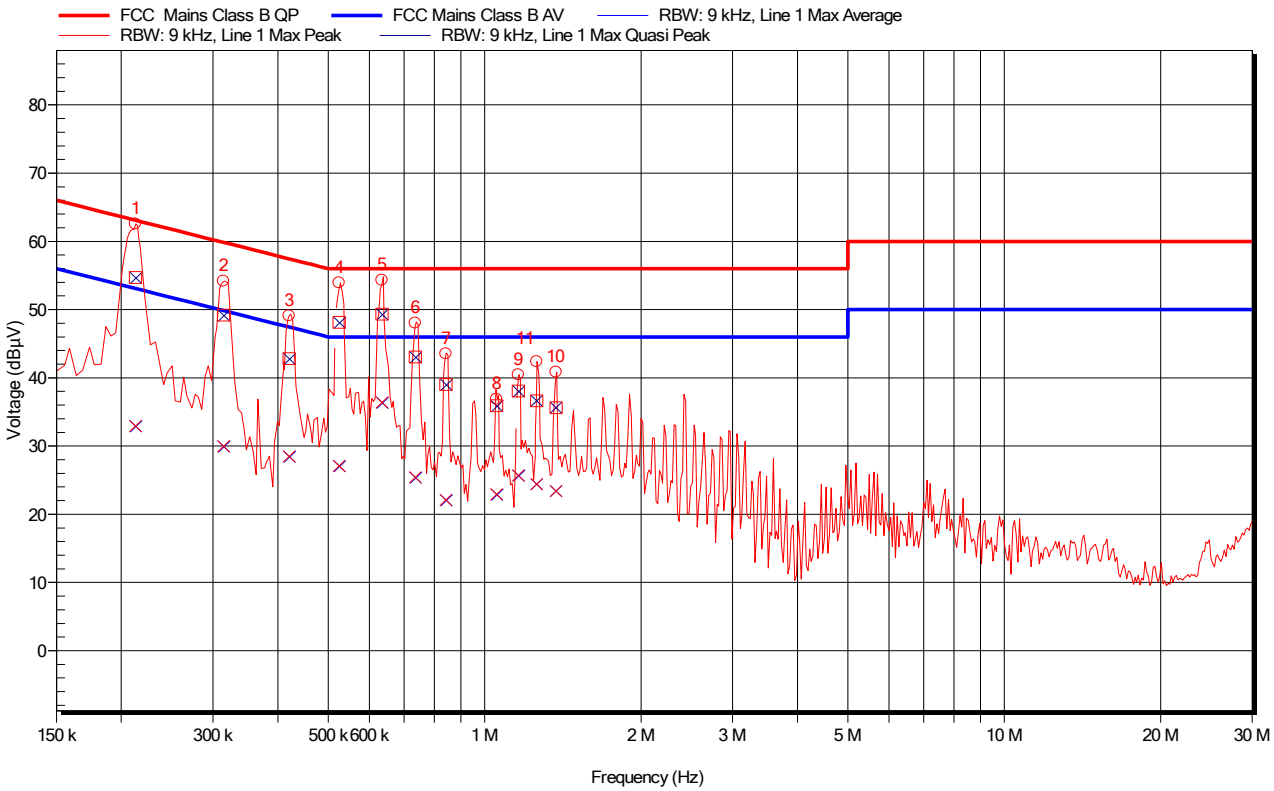


Figure 34: AC mains conducted emissions. Operation on channel 914.2MHz – Live

Frequency (MHz)	Average (dBuV)	Average Limit (dBuV)	Average Difference (dB)	Average Status	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.213	32.9	53.1	-20.14	Pass	54.7	63.1	-8.38	Pass
0.315	29.9	49.8	-19.90	Pass	49.2	59.8	-10.65	Pass
0.420	28.5	47.4	-18.97	Pass	42.8	57.4	-14.61	Pass
0.525	27.1	46.0	-18.92	Pass	48.1	56.0	-7.89	Pass
0.634	36.4	46.0	-9.61	Pass	49.3	56.0	-6.67	Pass
0.736	25.4	46.0	-20.60	Pass	43.1	56.0	-12.93	Pass
0.842	22.1	46.0	-23.90	Pass	39.0	56.0	-16.98	Pass
1.055	22.9	46.0	-23.09	Pass	35.9	56.0	-20.10	Pass
1.161	25.7	46.0	-20.31	Pass	38.0	56.0	-17.95	Pass
1.372	23.4	46.0	-22.59	Pass	35.6	56.0	-20.36	Pass
1.260	24.4	46.0	-21.62	Pass	36.6	56.0	-19.37	Pass

Table 11: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 914.2MHz - Live

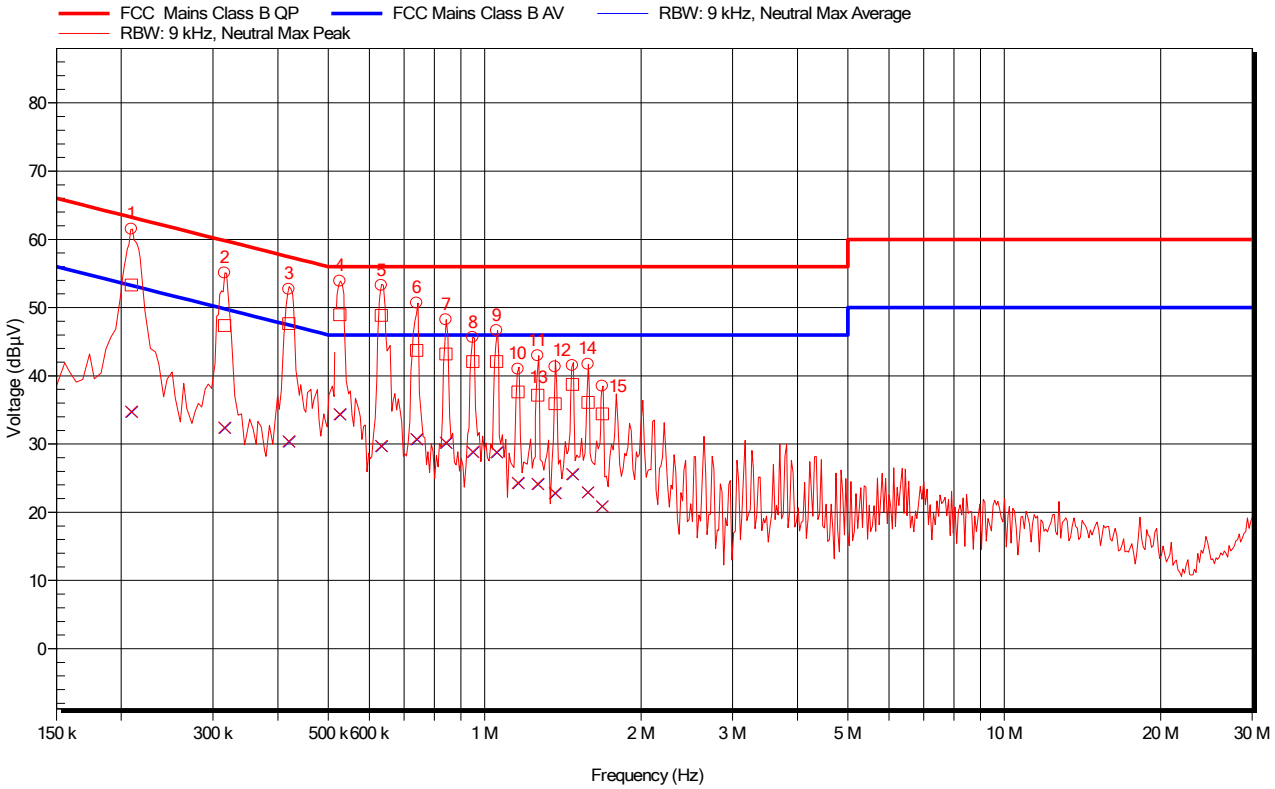


Figure 35: AC mains conducted emissions. Operation on channel 914.2MHz – Neutral

Frequency (MHz)	Average (dBuV)	Average Limit (dBuV)	Average Difference (dB)	Average Status	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.209	34.8	53.2	-18.48	Pass	53.3	63.2	-9.93	Pass
0.316	32.4	49.8	-17.42	Pass	47.4	59.8	-12.45	Pass
0.420	30.4	47.4	-17.08	Pass	47.6	57.4	-9.81	Pass
0.526	34.4	46.0	-11.63	Pass	48.9	56.0	-7.07	Pass
0.633	29.7	46.0	-16.27	Pass	48.8	56.0	-7.17	Pass
0.740	30.7	46.0	-15.29	Pass	43.7	56.0	-12.28	Pass
0.843	30.2	46.0	-15.80	Pass	43.2	56.0	-12.79	Pass
0.948	28.8	46.0	-17.16	Pass	42.1	56.0	-13.89	Pass
1.054	28.8	46.0	-17.19	Pass	42.1	56.0	-13.92	Pass
1.16	24.3	46.0	-21.69	Pass	37.6	56.0	-18.38	Pass
1.266	24.2	46.0	-21.82	Pass	37.2	56.0	-18.83	Pass
1.475	25.6	46.0	-20.42	Pass	38.7	56.0	-17.29	Pass
1.367	22.8	46.0	-23.18	Pass	35.9	56.0	-20.08	Pass
1.581	22.9	46.0	-23.09	Pass	36.1	56.0	-19.88	Pass
1.684	20.9	46.0	-25.14	Pass	34.4	56.0	-21.57	Pass

Table 12: Electric Field Emissions Peaks, 150kHz to 30MHz – Operation on channel 914.2MHz - Neutral

10.5.1 Example calculation

This correction factors required consists of LISN Insertion loss (IL), Cable loss (CL) and Transient Limiter Loss (TL)

The Actual Signal Level (ASL) is calculated as follows:

ASL (dBµV) = Indicated Signal Level (dBµV) + IL (dB) + CL (dB) + TL (dB)

10.5.2 Sample Data

The Quasi-Peak level at 1.684 MHz

ASL (dBµV) = 20.9dBµV = 10.8BµV + 0.2dB + 0.0dB + 9.9dB

Appendix A EUT Test Photos

Test set up photographs are supplied separately.

Appendix B Test Equipment List

Conducted Emissions from Antenna Port

Item	Serial No.	Last Calibration Date	Calibration Interval
RF Cable	Cable 21	January 2022	12 Months
Agilent MXE EMI Receiver	C0339	25th January 2022	12 Months
Kikusui PCR2000M power supply	-	-	-

Radiated Emissions Equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Laboratory 1 Semi-Anechoic Chamber	Lab 1	28th January 2020	36 Months
ETS Lindgren 2017B Mast (1 – 4m) with tilting mechanism	--	N/A	N/A
R & S ESR26	C0502	10th November 2021	12 Months
Teseq CBL 6112D Bilog antenna	C0506	*15th July 2021*	*36 Months*
6dB Attenuator (For use with Bilog Antenna)	C0506B	15th July 2021	36 Months
HF26 Cable	HF26	17th January 2022	12 Months
HF35 Cable	HF35	17th January 2022	12 Months
HF27 Cable	HF27	17th January 2022	12 Months
Schwarzbeck D-69250 Antenna 1-18GHz	C0626	23rd December 2021	24 Months
2.4GHz Microtronics BRM50702 notch filter	C0473	11th January 2022	12 Months
BONN BLMA 0118-M Preamplifier	G0327	6th January 2022	12 Months
Kikusui PCR2000M power supply	-	-	-

AC Mains conducted emissions equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Rohde & Schwarz ESR7 Test receiver	C0449	30th January 2022	12 Months
Cables J7, J9 and LF3	-	11th January 2022	12 Months
Rohde & Schwarz ESH3-Z5 LISN 78119	78119	17th January 2022	12 Months
Teseq CFL 9206A transient limiter 10dB 9kHz - 30MHz	C0282	11th January 2022	12 Months
Kikusui PCR2000M power supply	-	-	-