Eurofins York Castleford
Unit 5, Speedwell Road
Castleford, WF10 5PY
United Kingdom
+44 (0) 1977 731173
enquiryyork@eurofins.com
eurofins.co.uk/york

Test Report for the FCC and ISED Testing of a T2 terminal (WiFi function) for Mitrefinch Ltd

Test Report number: 14098TR3
Project number: C5814

Author: .....
J Beevers MPhys(Hons), PhD
Test Engineer

Checked: .....
M Render BSc(Hons), PhD, MIET
Senior Test Engineer

Approved: .....
M Render BSc(Hons), PhD, MIET
Senior Test Engineer

Issue	Description						Issue by	Date
3	Copy 1		Copy 2		PDF	✓	MR	5th November 2021

Registered Address:
Eurofins York
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

CONTENTS

Test Report Change History

Issue	Date	Modification Details
1	6th May 2021	First Issue
2	14th October 2021	Updated to specify lowest and highest frequencies as defined within KDB 634817D01
3	5th November 2021	Modification HVIN
4		
5		
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 number is UK02013, 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	Mitrefinch Ltd
Address	Mitrefinch House
	Green Lane Trading Estate,
	Clifton
	York
	North Yorkshire
	YO30 5YY
Tel:	01904 693115
Contact	Mr Chris Flynn
Email	Chris.Flynn@mitrefinch.co.uk

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	5th November 2020		
FCC ID	2AZ53-T2		
ISED Certification Number	27361-T2		
Product Marketing Name:	T2 Terminal		
Hardware Version Identification Number	T2 Terminal		
Firmware Version Identification Number	N/A		
EUT description:	Secure Access to a Secure Facility. It is a wall mounted display with: External Mains PSU to 15 to 19VDC Input Raspberry Pie Processor Bio-metric Finger Print Sensor Ethernet Internal Camera Microphone Speaker 4 Relay banks with 12V 2 N/C and 2 N/O connections per relay. So 8 N/C and 8 N/O GPIO Digital 12 V 2 pole. 8 outputs 4 inputs. WIEGAND Serial Port with external PIN for Clock Data 5V Micro USB LED's 14", 7" and 4" Display versions Test 14" for EMC Plastic enclosure (IP66 Rated)		
WiFi module manufacturer	Formike Wireless Technology		
WiFi module description	KWH-8723-BU is a highly integrated single-chip 802.11n Wireless LAN (WLAN) USB 2.0		
WiFi module	Model KWH-8723-BU		
EUT power:	100 -240 V, 50 – 60 Hz mains supply		
Operating frequency band	2400MHz to 2483.5MHz		
Centre frequency of lowest channel	2411.0MHz for widest permitted frequency range		
Centre frequency of highest channel	2463.0MHz for widest permitted frequency range		
Output power setting	Maximum power (Maximum 0.12W measured)		
Transmission system	Digital Transmission System (DTS)		
Modulation scheme(s)	CCK and OFDM		
Bandwidth tested	20 MHz		
Size of EUT (mm)	Width: 125 mm	Depth: 50 mm	Height: 300 mm
Mode/s of operation	Continuous transmit of packetised data at top, middle and bottom channels.		
Modifications incorporated during testing:	None		

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.

3.6 Modifications

None.

Section 4 Test 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
AC power line conducted emissions	FCC § 15.207	Applies	Pass
Band edge compliance	FCC § 15.247(d)	Applies	Pass
Conducted spurious emissions	FCC § 15.247(d)	Applies	Pass
Transmitter radiated spurious emissions	FCC § 15.247(d) FCC § 15.209 FCC § 15.205	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

Requirement	**ISED Ragulation**	**Comments**	**Results Summary**
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
AC power line conducted emissions	ISED RSS-247 § 3.1	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
Receiver radiated spurious emissions	ISED RSS-247 § 3.1	Applies	Pass

4.1 Knowledge Database References

The following KDBs were referenced during the testing of the T2 terminal
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

4.1.3 Frequency Range Listing for Certification Grants

Publication Number	Keyword	Publication Date
634817	Frequency range listings for Certification grants. Part 15 unlicensed transmitters	

4.2 Compliance Statement

The T2 terminal, 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 Restricted Bands Only

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 15.205 Unrestricted Bands

ANSi C63.10-2013 Clause reference:	11.11.2 and 11.11.3
Test software	Keysight Connection Expert

5.3 Radiated Emissions (30MHz to 1GHz)

Radiated electric field emission measurements are applied to the restricted bands only, defined in 47CFR15.205.

5.3.1 Limits at 3m

Frequency (MHz)	Limit (dBµV/m)
	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 15.109 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 Date of Test

19th March 2021

5.3.3 Test Area

LAB 1 (SAC)

5.3.4 Tested by

J Beevers

5.3.5 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.

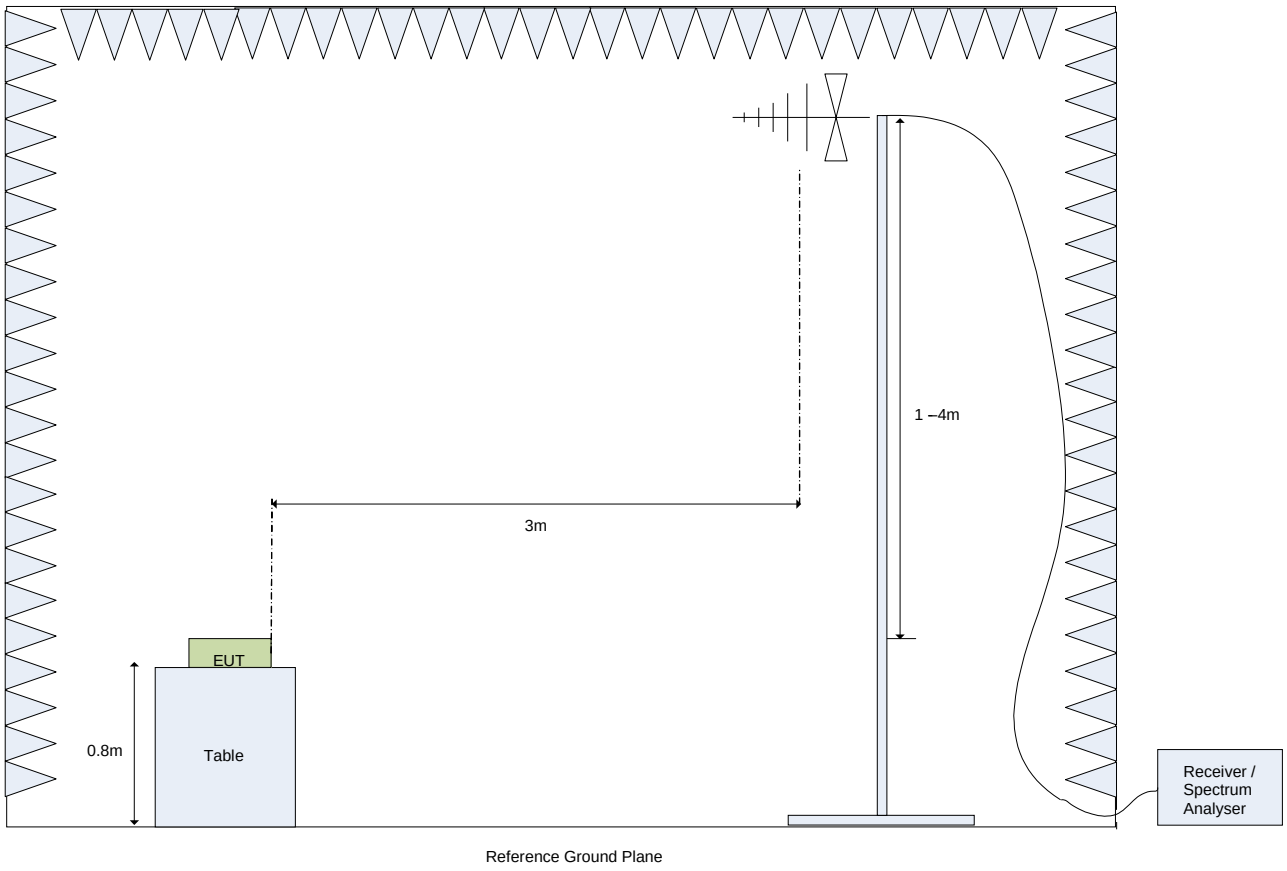


Figure 5.3.5.1: Test Setup for E-Field Measurements from 30MHz to 1GHz

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.

5.3.6 Electric field emissions, 30MHz to 1GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels with both CCK and OFDM modulation. Final measurements were performed with the equipment under test operating on channel 11 with OFDM modulation.

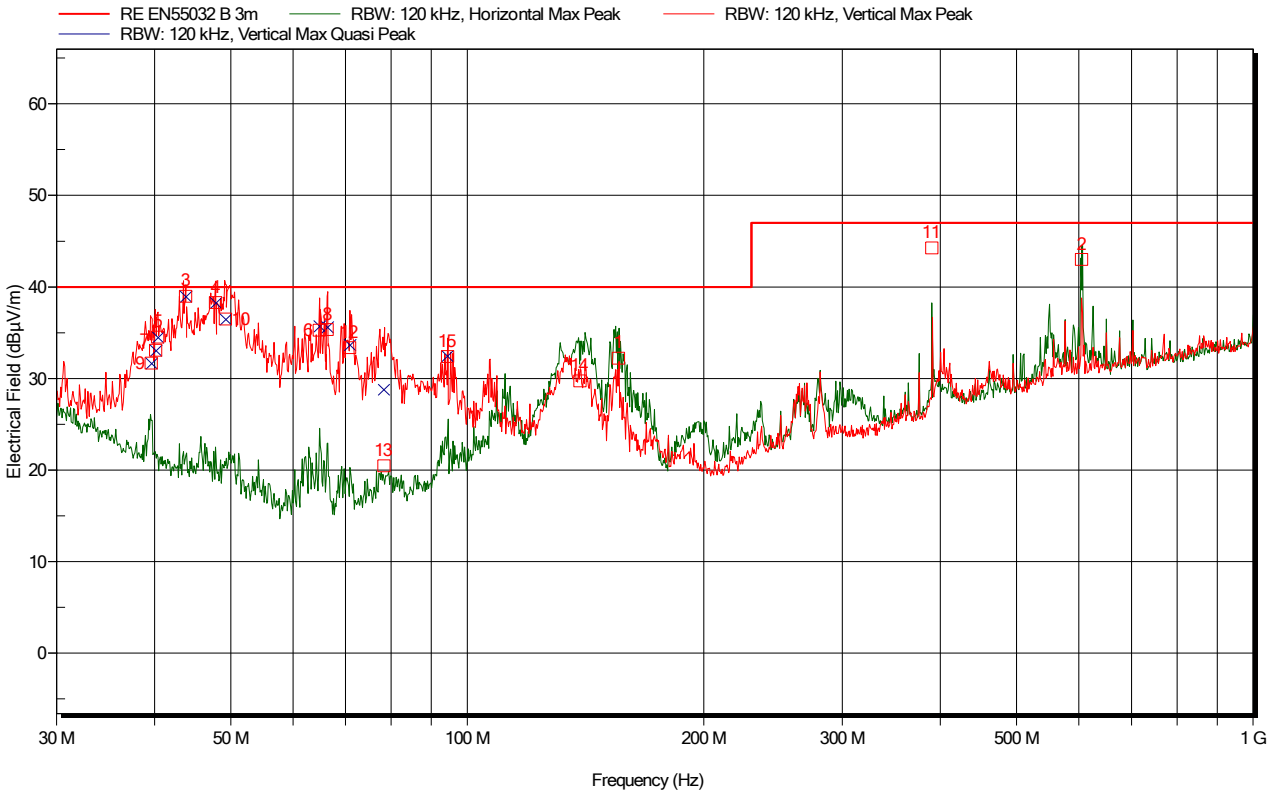


Figure 5.3.6.1: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 11 OFDM modulation

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
155.616	32.2	40	-7.8	Pass	170	1.8	Horizontal
604.920	43.0	47	-4.0	Pass	340	1.4	Horizontal
43.818	39.0	40	-1.0	Pass	250	1.0	Vertical
47.808	38.3	40	-1.7	Pass	240	1.0	Vertical
40.356	34.5	40	-5.5	Pass	180	1.0	Vertical
64.776	35.3	40	-4.7	Pass	225	1.7	Vertical
40.122	33.1	40	-6.9	Pass	44	1.0	Vertical
66.294	35.4	40	-4.6	Pass	124	1.8	Vertical
39.600	31.7	40	-8.3	Pass	90	1.0	Vertical
49.200	36.5	40	-3.5	Pass	65	1.0	Vertical
390.000	44.2	47	-2.8	Pass	195	1.0	Horizontal
70.830	33.4	40	-6.6	Pass	94	2.1	Vertical
78.360	20.5	40	-19.5	Pass	360	3.1	Vertical
139.140	29.8	40	-10.2	Pass	195	2.7	Horizontal
94.392	32.4	40	-7.6	Pass	95	1.0	Vertical

Table 5.3.6.1: Electric Field Emission Peaks, 30MHz to 1GHz, operation on Channel 11 OFDM modulation

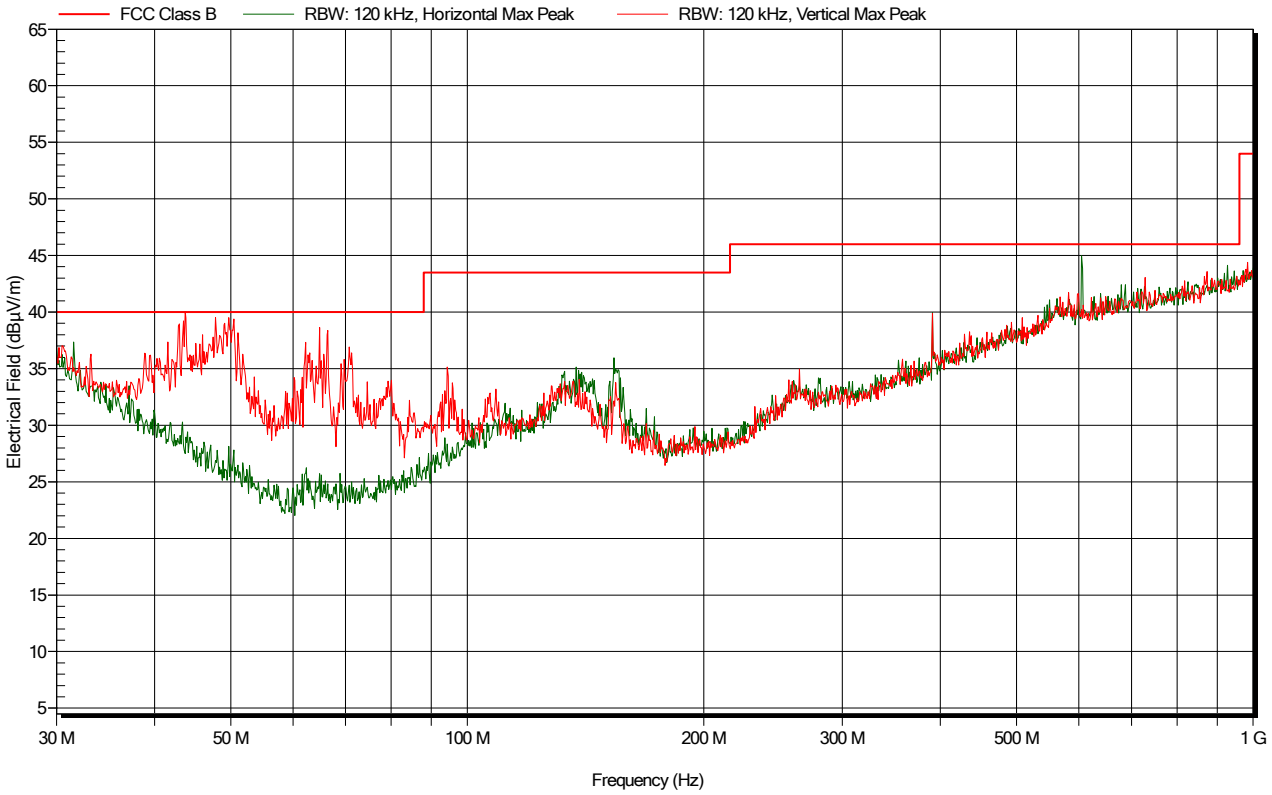


Figure 5.3.6.2: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 11 CCK modulation- Peak detector scan

Figure 5.3.6.3: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 5 OFDM modulation- Peak detector scan

Figure 5.3.6.4: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 5 CCK modulation- Peak detector scan

Figure 5.3.6.5: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 1 OFDM modulation- Peak detector scan

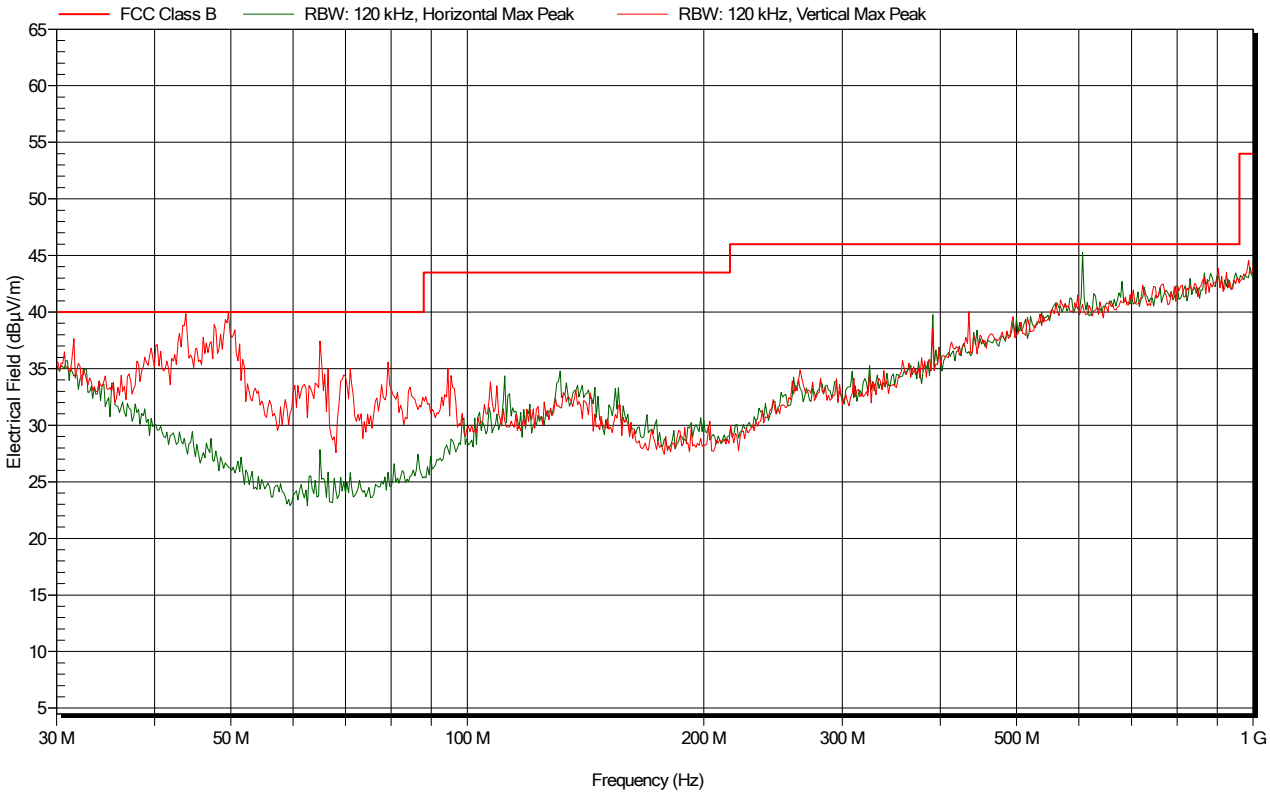


Figure 5.3.6.6: Electric field emissions Plot, 30MHz to 1GHz, operation on Channel 1 CCK modulation- Peak detector scan

5.3.7 Example field strength calculation

Field strength (FS) is calculated as follows:

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

5.3.8 Sample Data

From Figure 5.3.6.1, table 5.3.6.1, the Quasi-Peak level at 155.616 MHz is calculated as follows:

FS (dBµV/m) = 14.6 (dBµV) + 16.3 (dB/m) + 1.3 (dB) = 32.2 dBµV/m

5.4 Radiated Emissions (1GHz to 18GHz)

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	18GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

5.4.3 Date of Test

29th March 2021

5.4.4 Test Area

LAB 1 (SAC)

5.4.5 Tested by

J Beevers

5.4.6 Test Setup

The EUT was configured in the SAC on an 80cm high table Exploratory measurements on the EUT were carried out to identify suspect frequencies and worst case orientations, see Section 5.4.7.

The measurement was then performed with an antenna to EUT separation distance of 1m.

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.

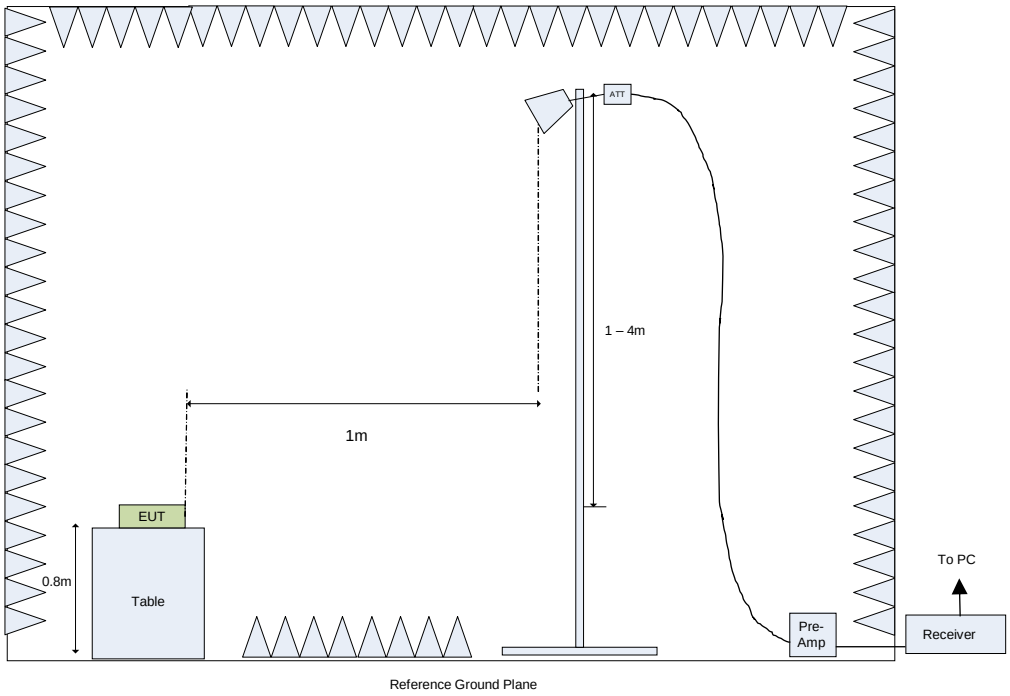


Figure 5.4.6.1: Test Setup for Final E-Field Measurements from 1GHz to 18GHz

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.

5.4.7 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
None	Transmitting on channel 1	-	-	-	-
None	Transmitting on channel 5	-	-	-	-
None	Transmitting on channel 11	-	-	-	-

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°.

5.4.8 Electric field emissions, 1GHz to 18GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels with both CCK and OFDM modulation. Final measurements were performed with the equipment under test operating on channel 11 with OFDM modulation.

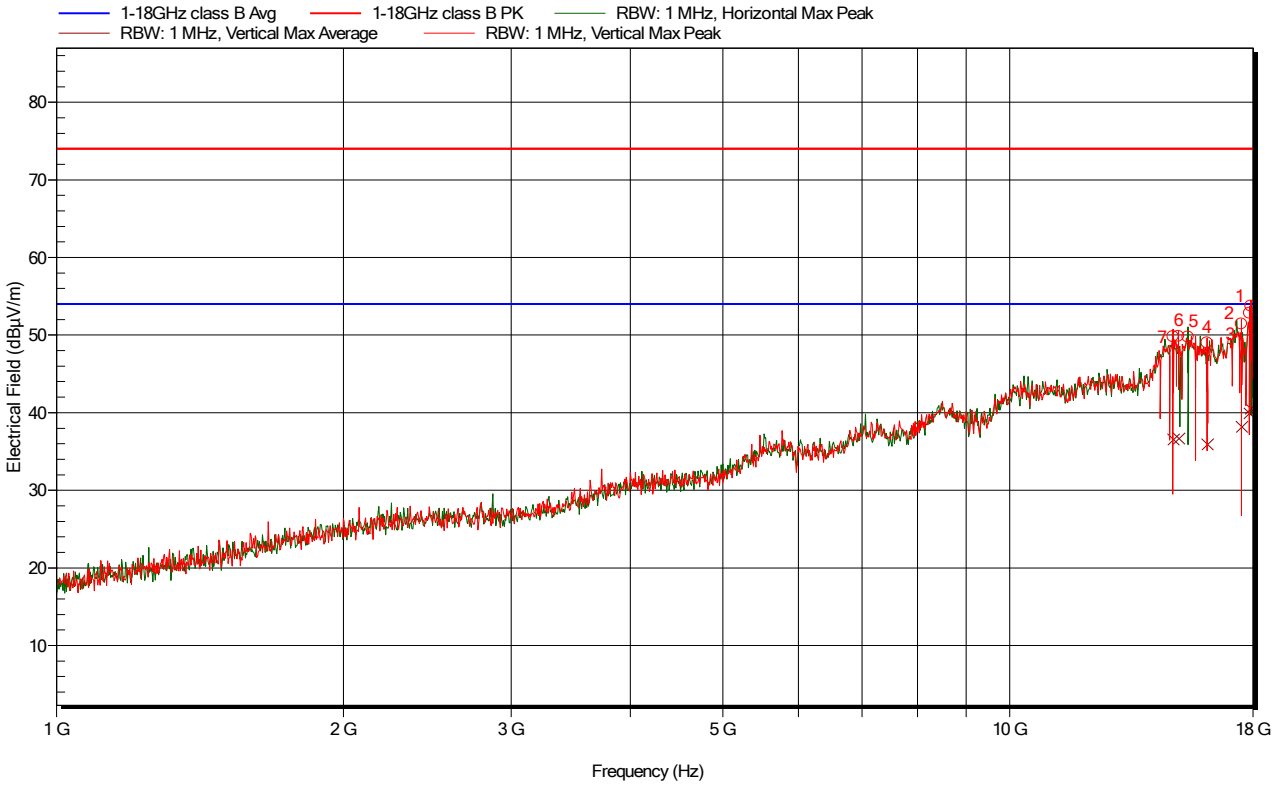


Figure 5.4.8.1: Electric field emissions Plot, 1GHz to 18GHz. Operation on Channel 11 OFDM modulation

Frequency	Average	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
17.905	40.50	54	-13.50	Pass	50	3.6	Vertical
17.845	39.92	54	-14.08	Pass	205	2.6	Vertical
17.498	38.24	54	-15.76	Pass	340	3.1	Vertical
16.108	35.96	54	-18.04	Pass	305	4.0	Vertical
15.376	37.09	54	-16.91	Pass	325	2.6	Horizontal
15.035	36.70	54	-17.30	Pass	160	3.2	Vertical
14.832	36.60	54	-17.40	Pass	25	1.0	Vertical

Table 5.4.8.1: Electric Field Emissions Peaks, 1GHz to 18GHz – Operation on Channel 11 OFDM modulation

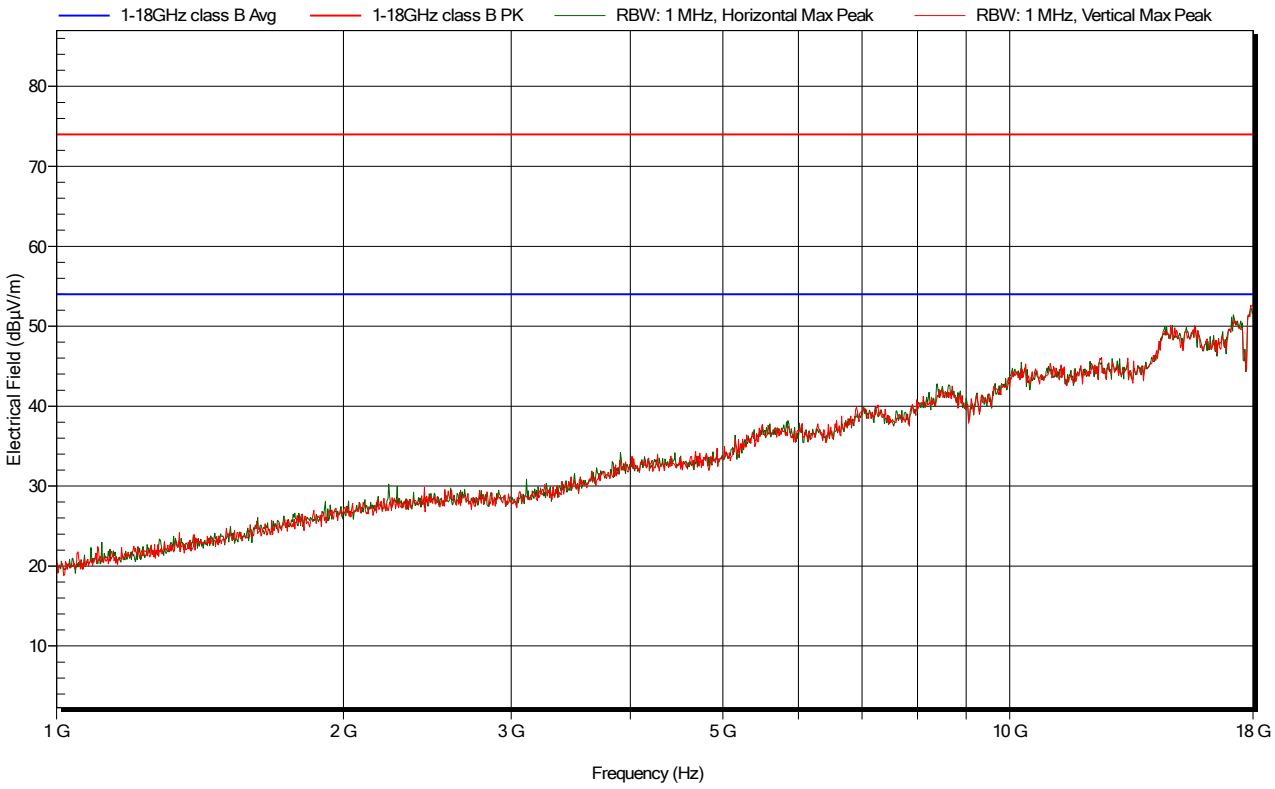


Figure 5.4.8.2: Electric field emissions Plot, 1GHz to 18GHz, Operation on channel 11 CCK modulation - Peak detector scan

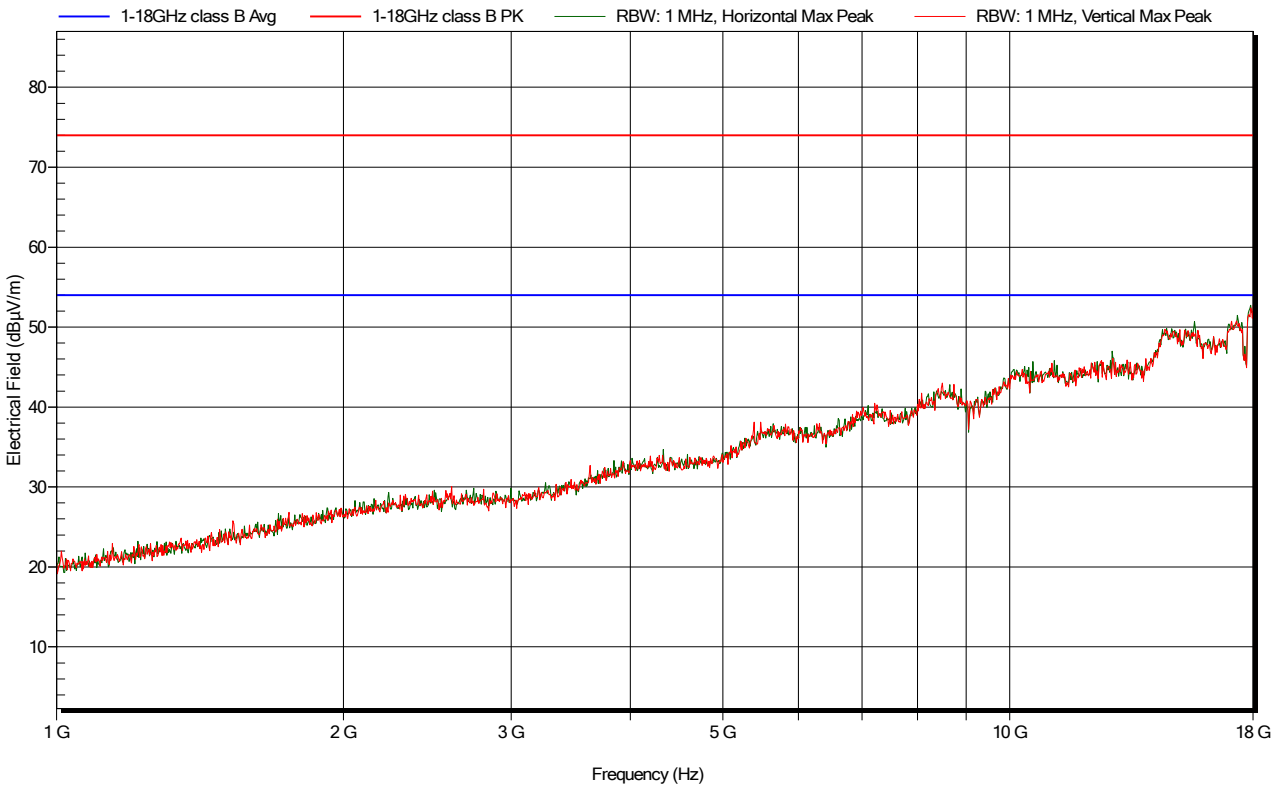


Figure 5.4.8.3: Electric field emissions Plot, 1GHz to 18GHz, Operation on Channel 5 OFDM modulation – Peak detector scan

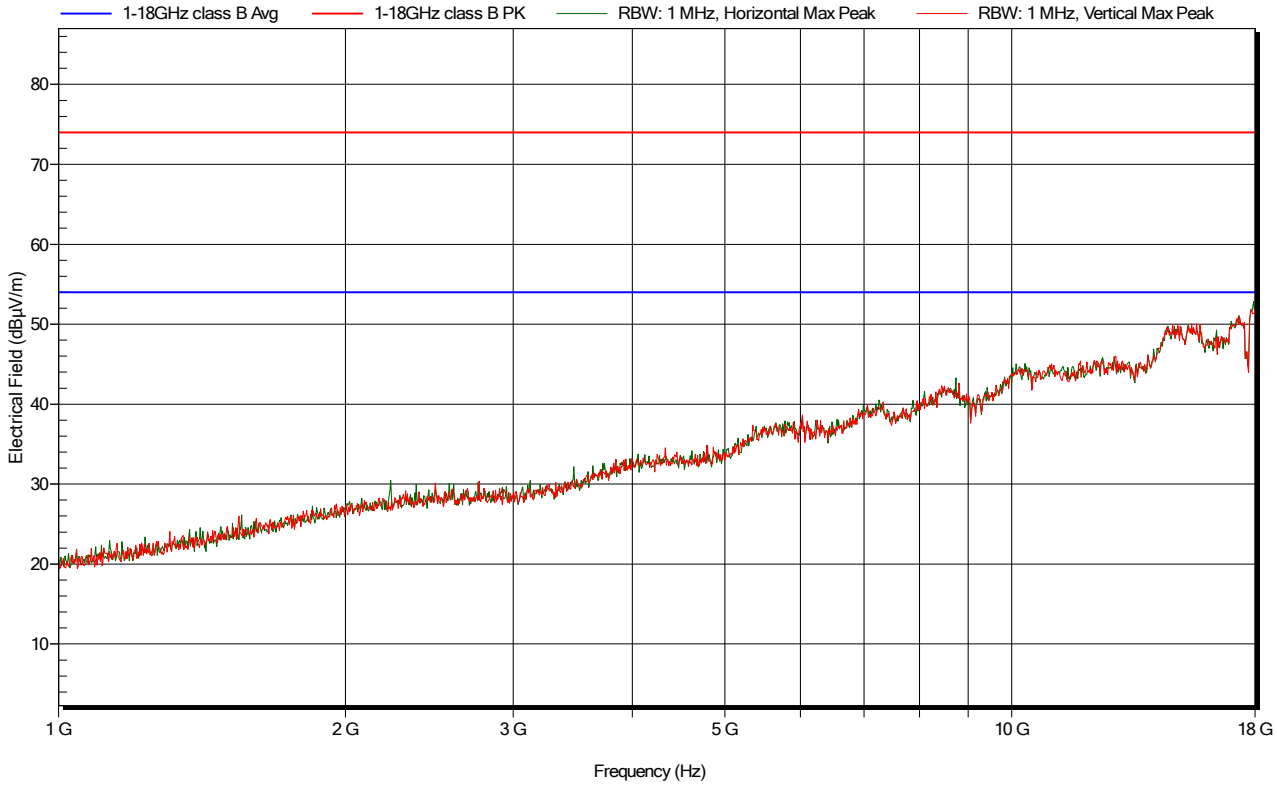


Figure 5.4.8.4: Electric field emissions Plot, 1GHz to 18GHz, Operation on Channel 5 CCK modulation – Peak detector scan

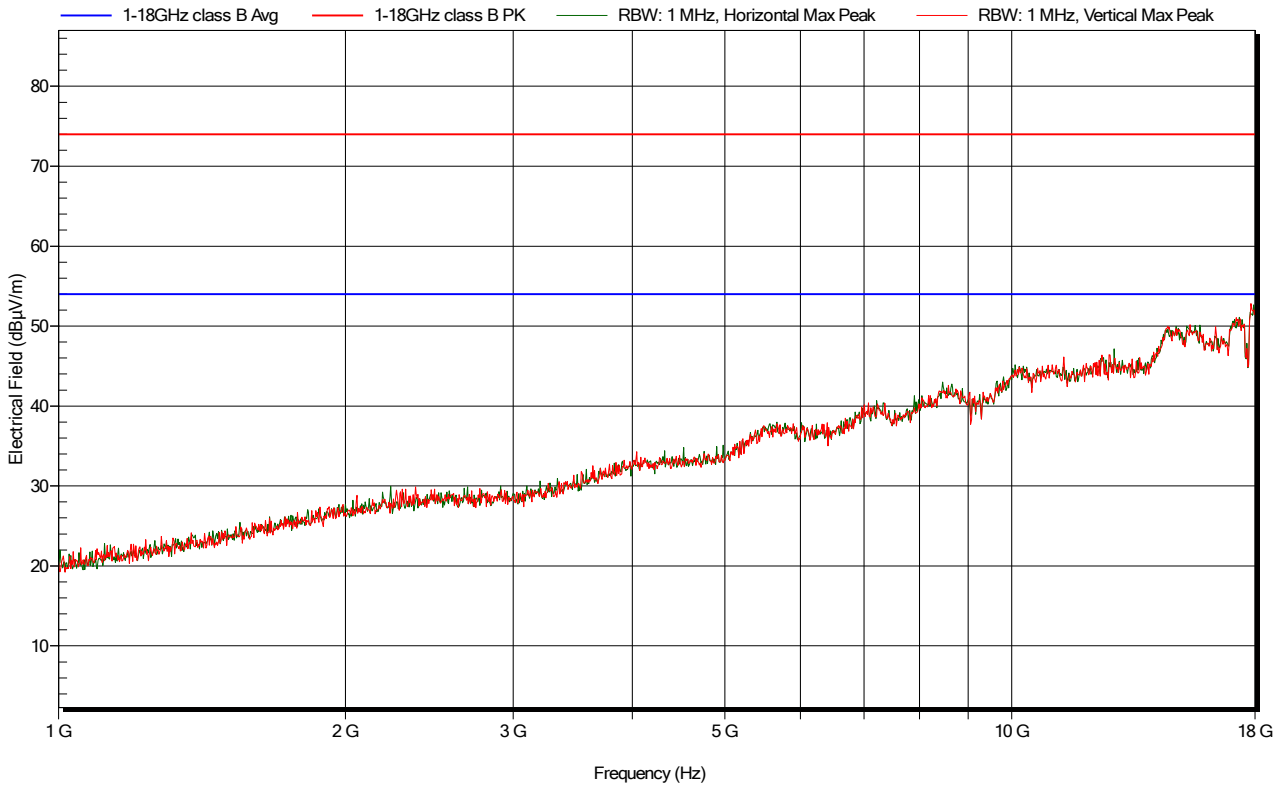


Figure 5.4.8.5: Electric field emissions Plot, 1GHz to 18GHz, Operation on Channel 1 OFDM modulation – Peak detector scan

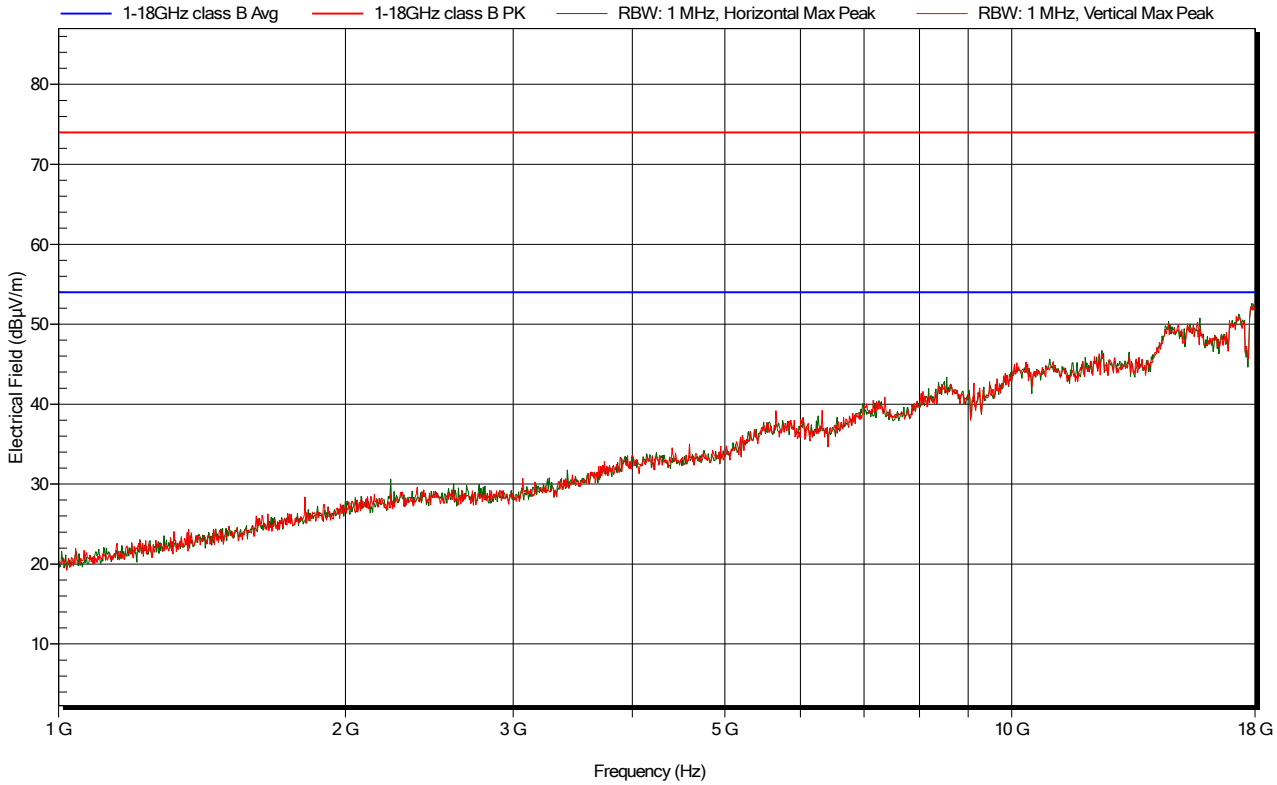


Figure 5.4.8.6: Electric field emissions Plot, 1GHz to 18GHz, Operation on Channel 1 CCK modulation – Peak detector scan

5.4.9 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); Attenuator loss (AL) and Cable loss (CL).

Field strength (FS) is calculated as follows:

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

5.4.10 Sample Data

From Figure 54.9.1 and table 5.4.9.1, The Average level at 17.905GHz is calculated as follows:

FS (dBµV/m) = 21.37(dBµV) -49.67(dB) +47.70(dB/m) +21.10 (dB) = 40.50 dBµV/m

5.5 Radiated Emissions (18GHz to 26GHz)

5.5.1 Limits

Frequency (GHz)	Limit (dBµV/m)	Limit (dBµV/m)
	Peak	Average
18-26	74.0	54.0

5.5.2 Receiver Settings

Receiver Parameters	Setting
Detector Function	Average and Peak
Start Frequency	1GHz
Stop Frequency	18GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

5.5.3 Date of Test

30th March 2021

5.5.4 Test Area

LAB 1 (SAC)

5.5.5 Tested by

J Beevers

5.5.6 Test Setup

This is the same as for the 1-18GHz range for final measurements.

5.5.7 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
None	Transmitting on channel 1	-	-	-	-
None	Transmitting on channel 5	-	-	-	-
None	Transmitting on channel 11	-	-	-	-

Table 5.5.7.1: Frequencies identified during Exploratory Radiated Emission maximization

Note 2 : The front face of the EUT is deemed to be 0°, which is then turned in a clockwise direction through 360°.

5.5.8 Electric field emissions, 18GHz to 26GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels with both CCK and OFDM modulation. No spurious emissions were detected above the measurement noise floor.

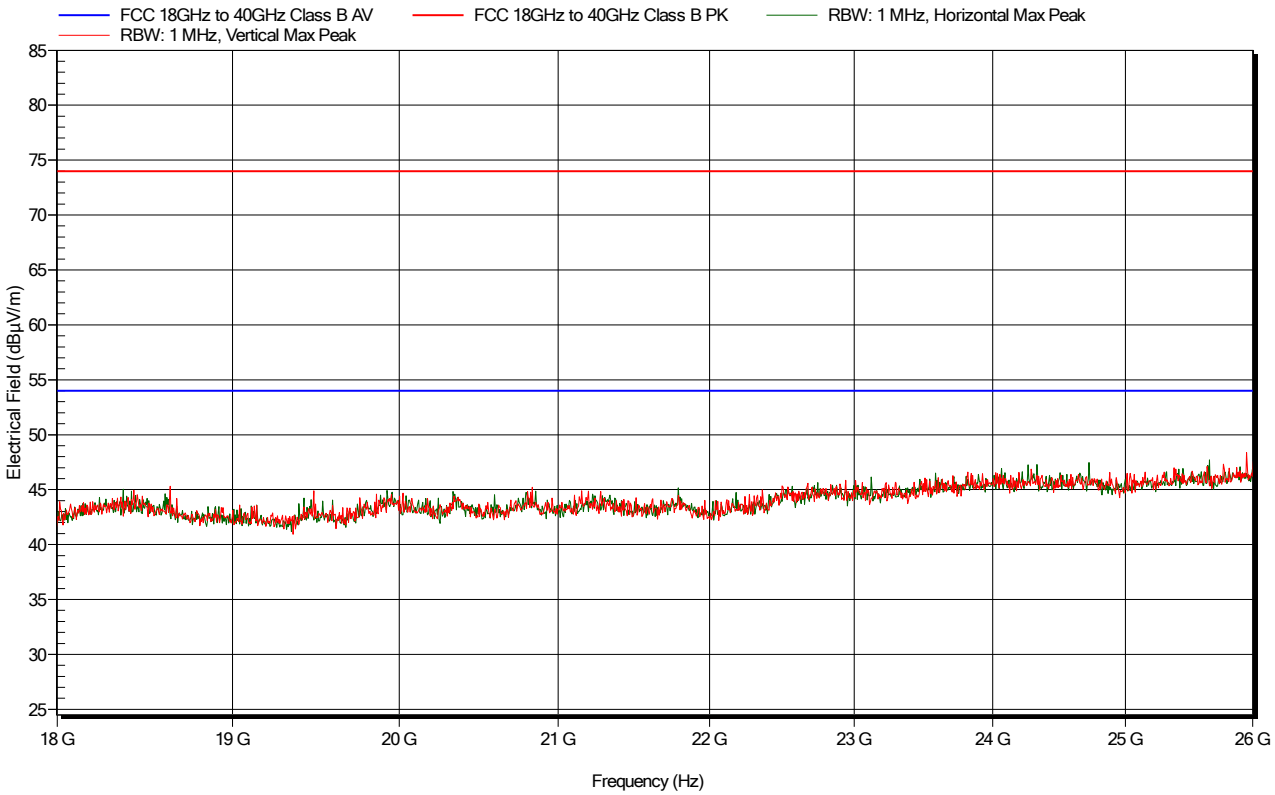


Figure 5.5.8.1: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 11 OFDM modulation – Peak detector scan

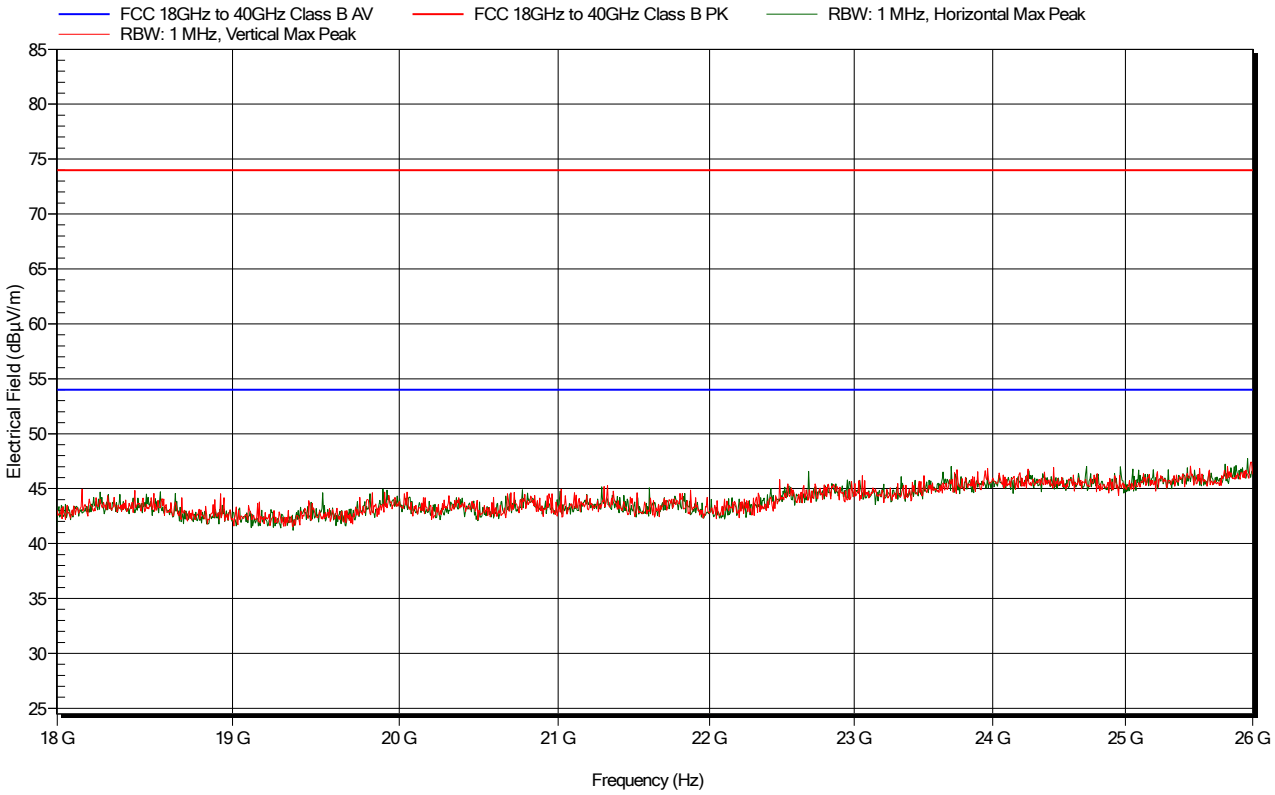


Figure 5.5.8.2: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 11 CCK modulation – Peak detector scan

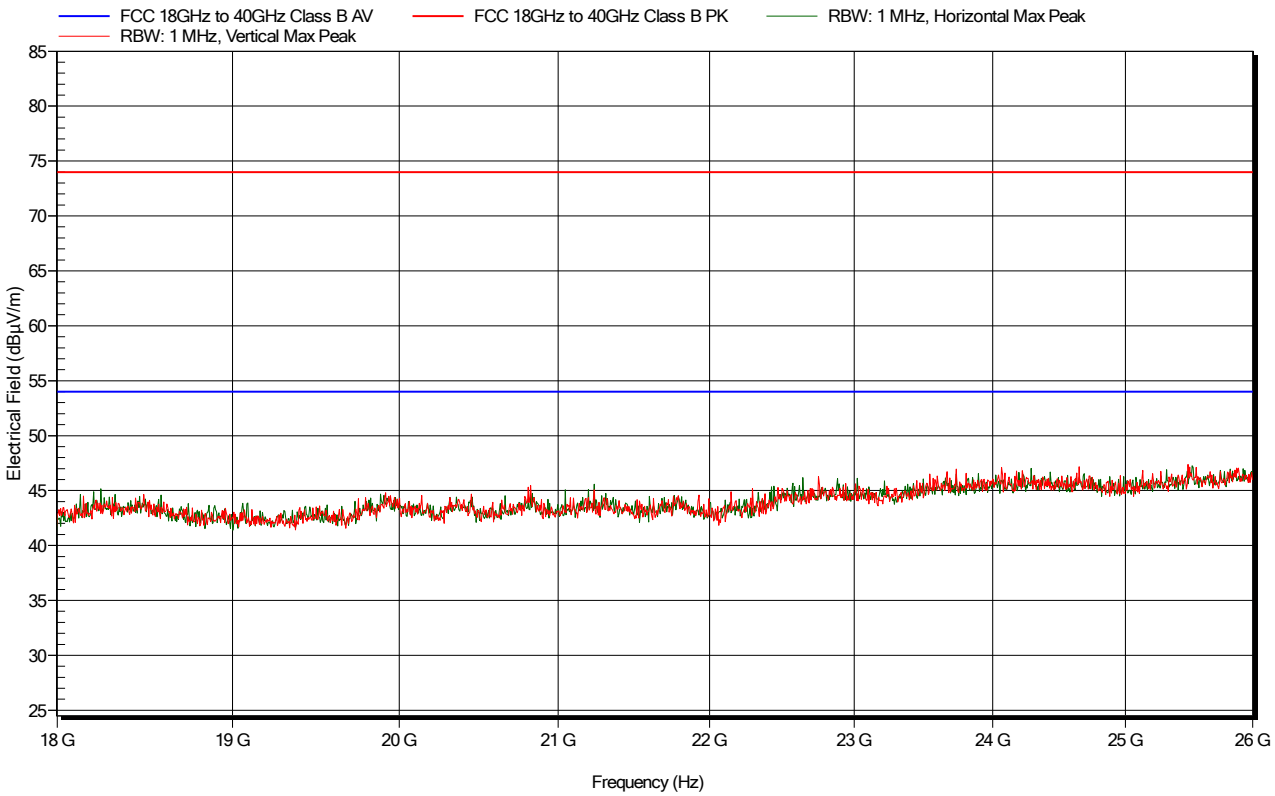


Figure 5.5.8.3: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 5 OFDM modulation – Peak detector scan

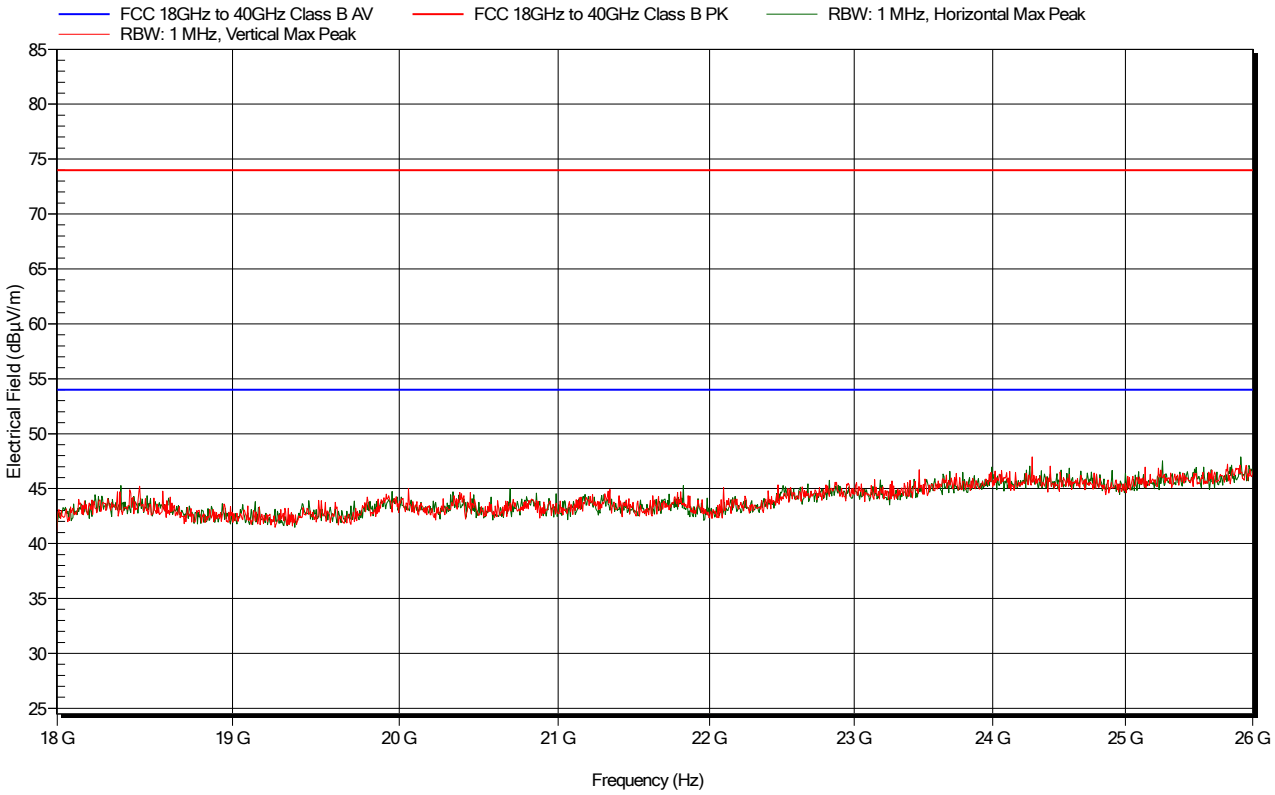


Figure 5.5.8.4: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 5 CCK modulation – Peak detector scan

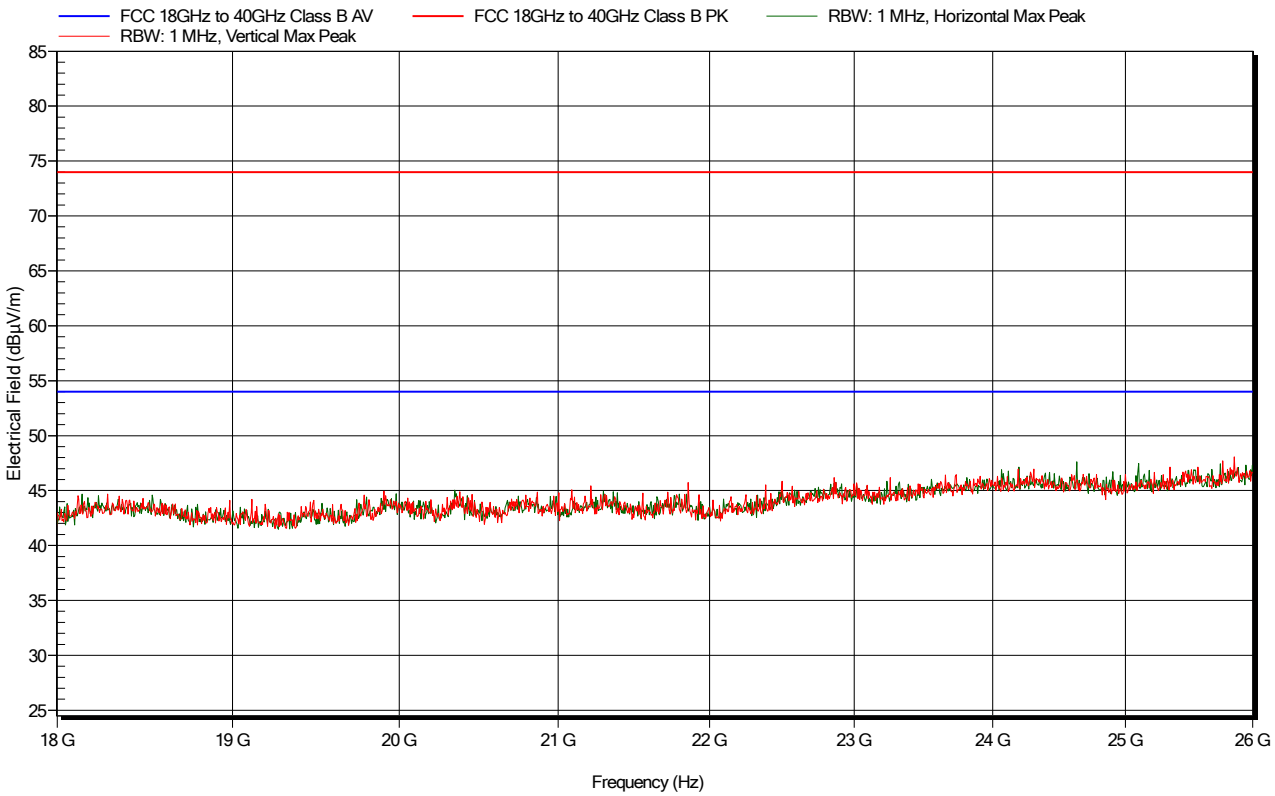


Figure 5.5.8.5: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 1 OFDM modulation – Peak detector scan

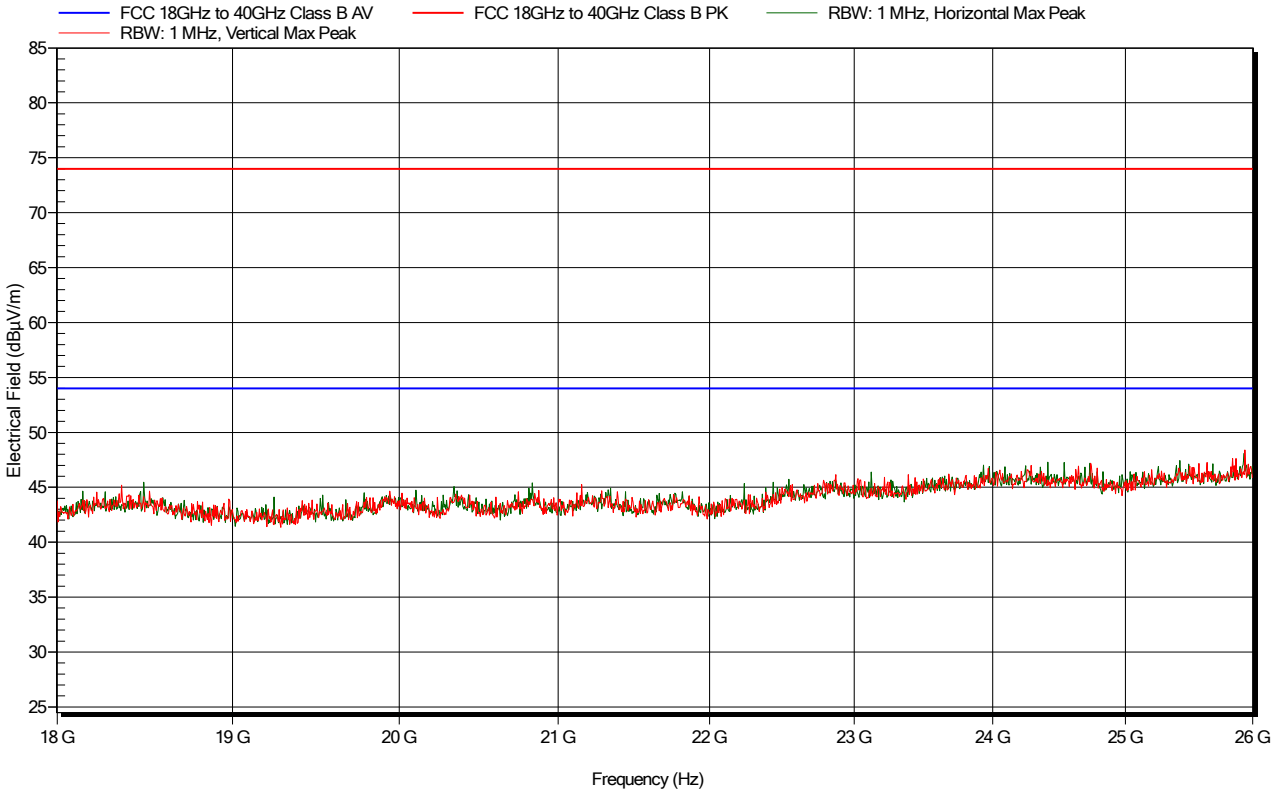


Figure 5.5.8.6: Electric field emissions Plot, 18GHz to 26GHz. Operation on Channel 1 CCK modulation – Peak detector scan

5.6 Conducted Spurious Emissions 30MHz to 26GHz

5.6.1 Limits

Frequency (MHz)	Limit, 47CFR 15.247(d)
	Peak
30 – 26000	20dBc

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

Receiver Parameters	Setting
Detector Function	Peak
Start Frequency A	30MHz
Stop Frequency A	1000MHz
Start Frequency B	1000MHz
Stop Frequency B	26000MHz
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

5.6.2 Date of Test

6th April 2021

5.6.3 Test Area

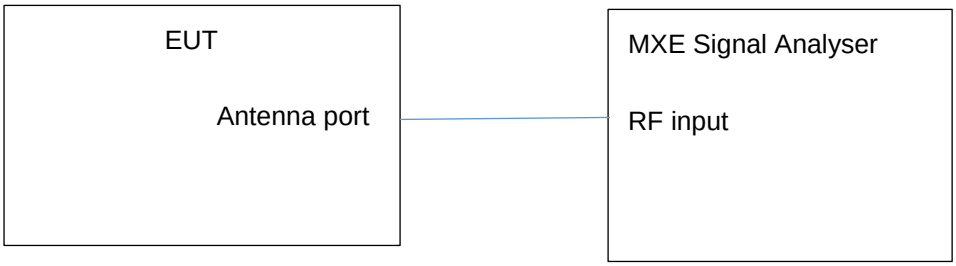
LAB 7

5.6.4 Tested by

J Beevers

5.6.5 Test Setup

The antenna port was connected directly to the signal analyser.

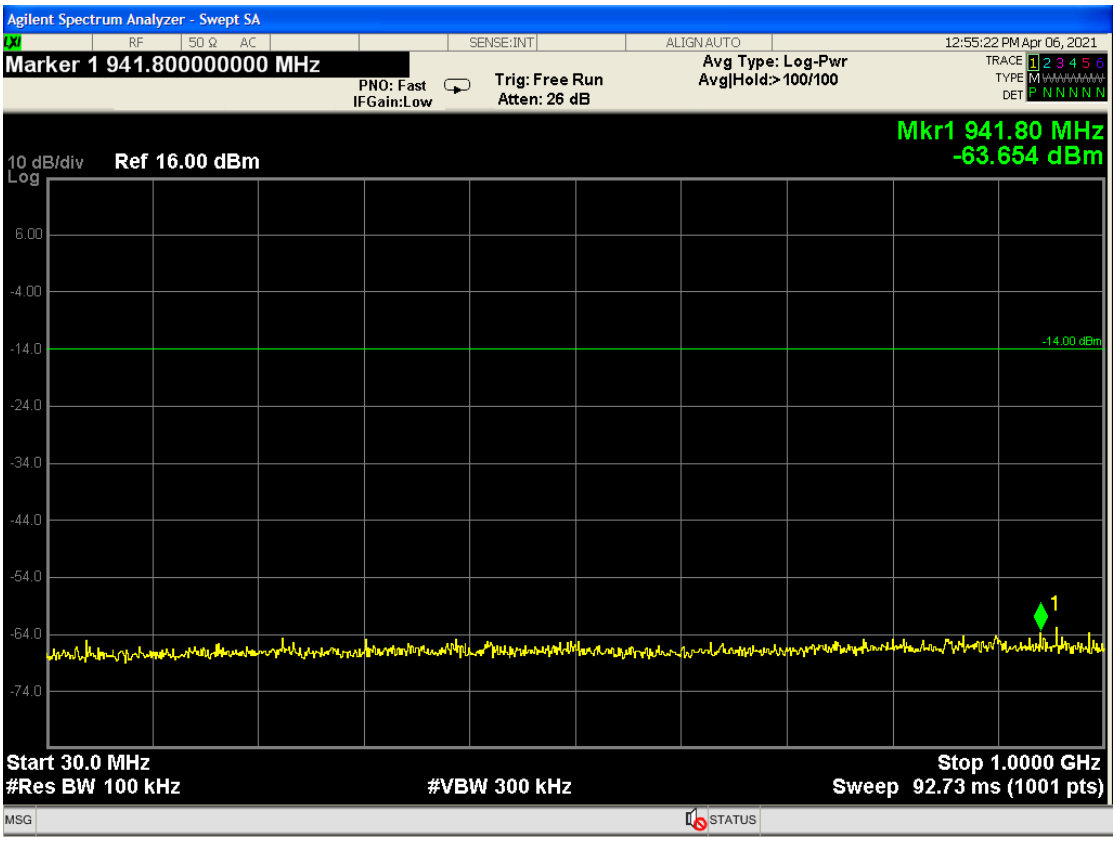


5.6.6 Test Results

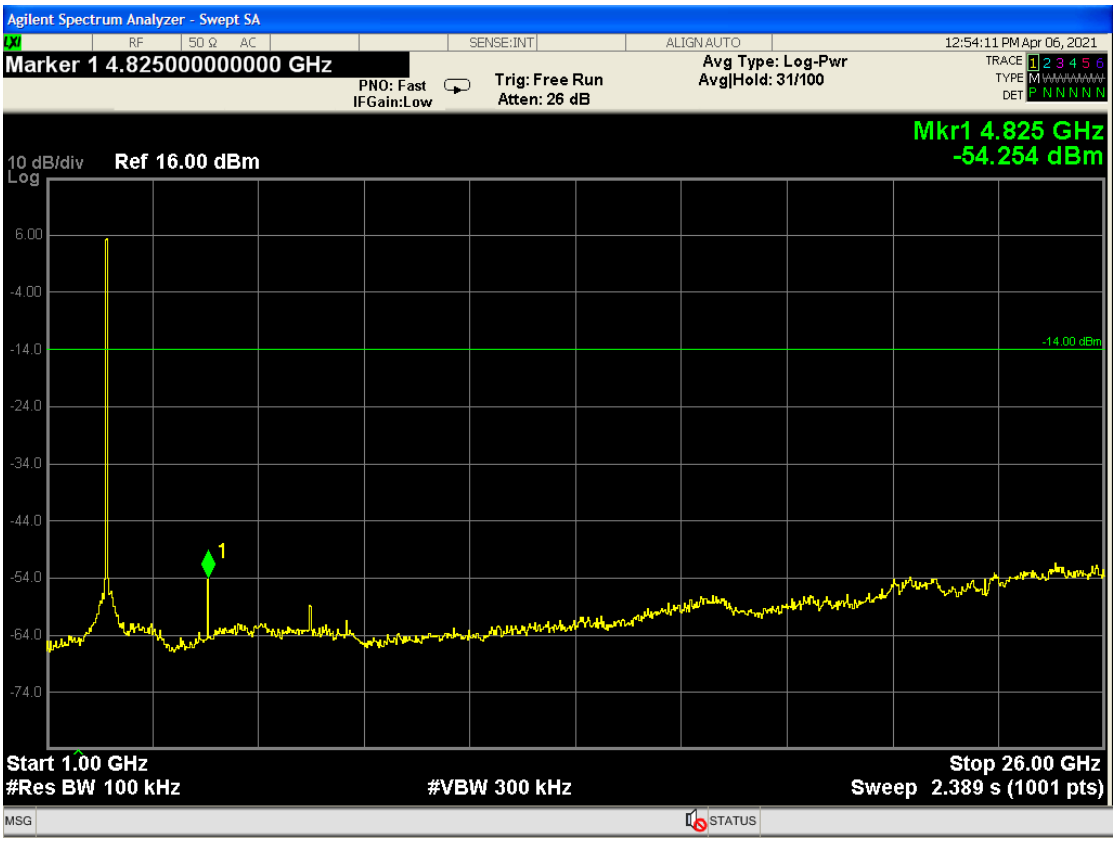
The results of the conducted spurious emissions are stated below and by the signal analyser images.

All disturbances detected were > 20dB below the carrier.

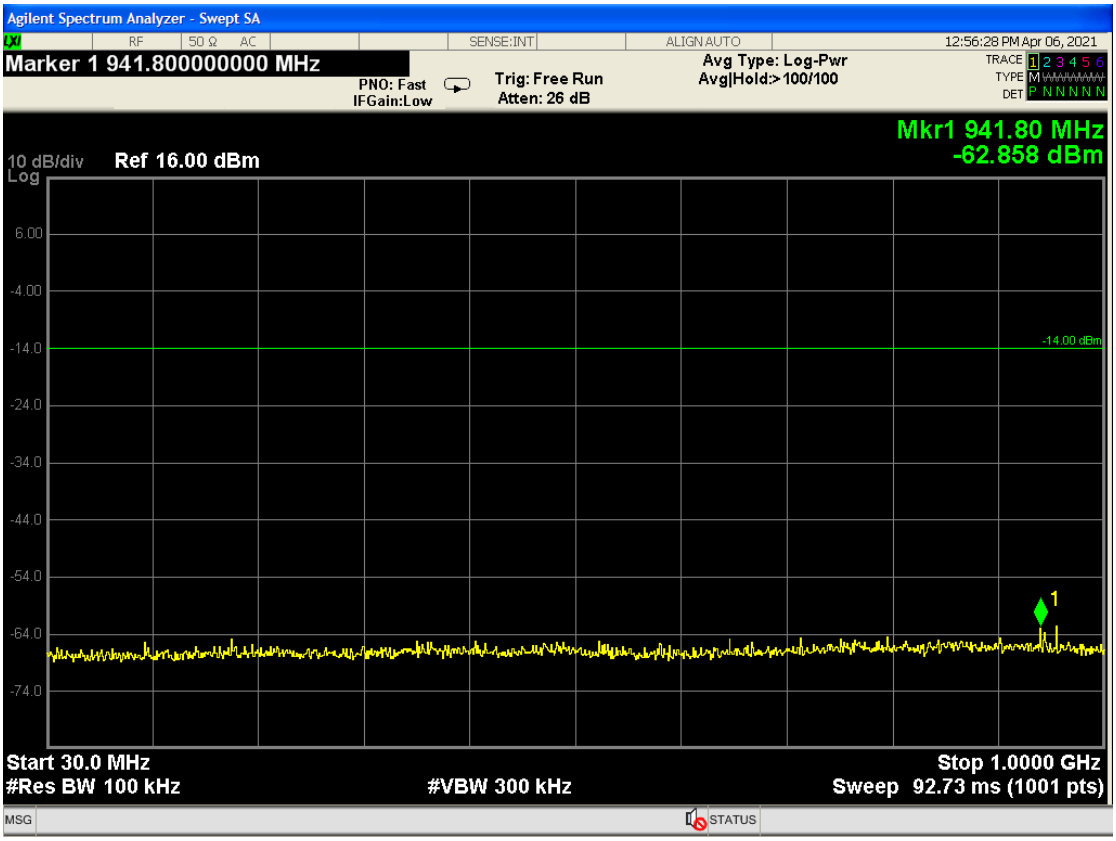
Antenna port conducted emissions 30MHz to 26GHz



Conducted emissions 30MHz to 1GHz. Operation on channel 1 CCK modulation.

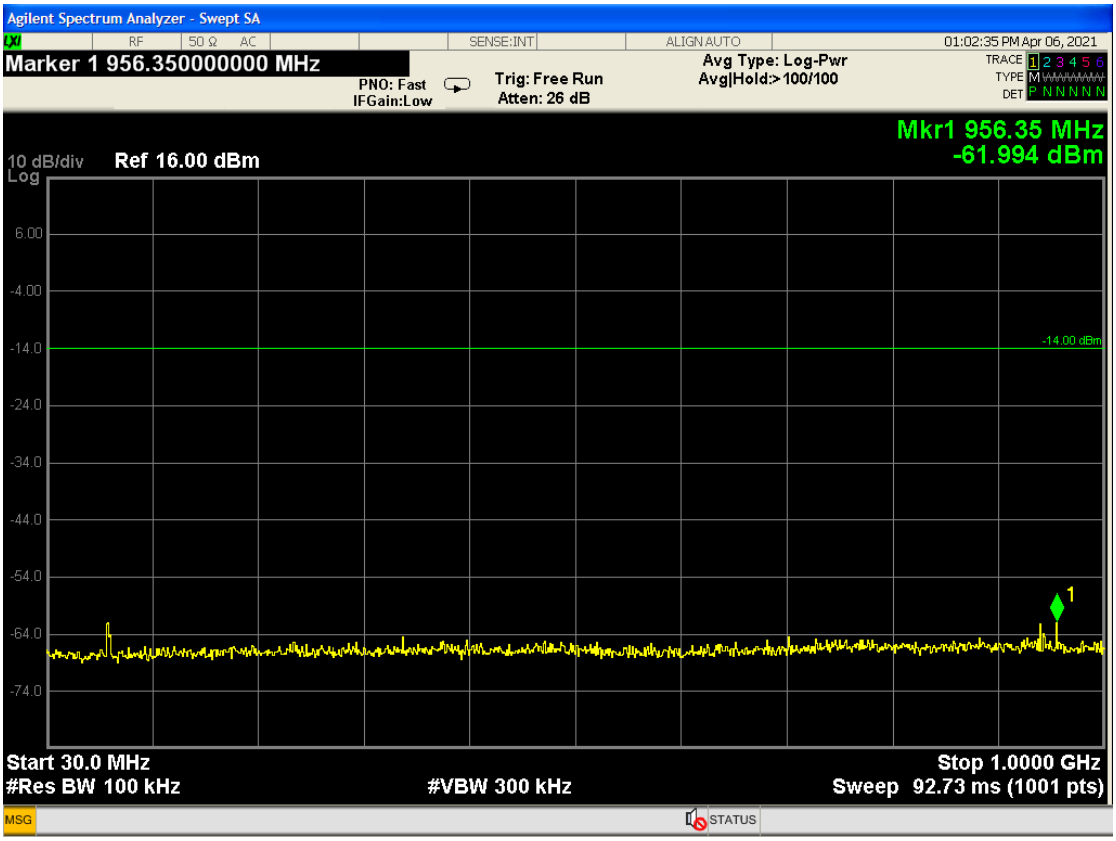


Conducted emissions 1GHz to 26GHz. Operation on channel 1 CCK modulation.



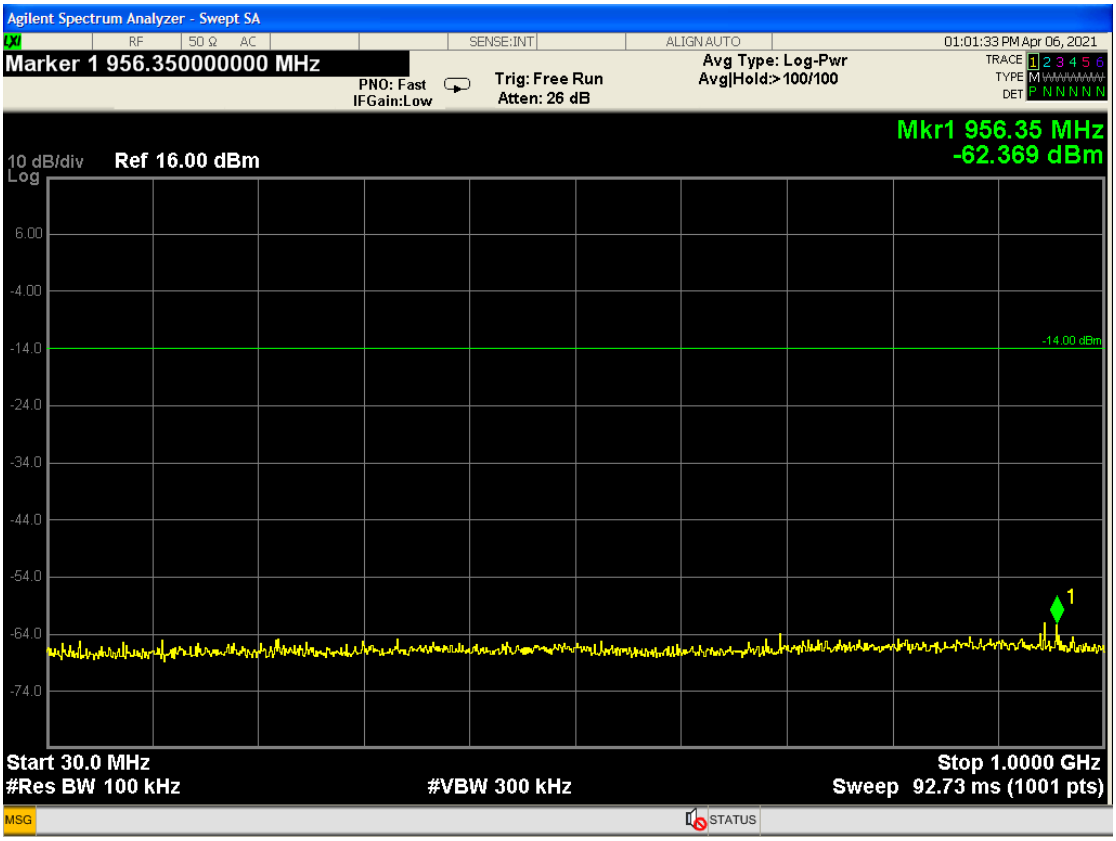
Conducted emissions 30MHz to 1GHz. Operation on channel 1 OFDM modulation.

Conducted emissions 1GHz to 26GHz. Operation on channel 1 OFDM modulation.



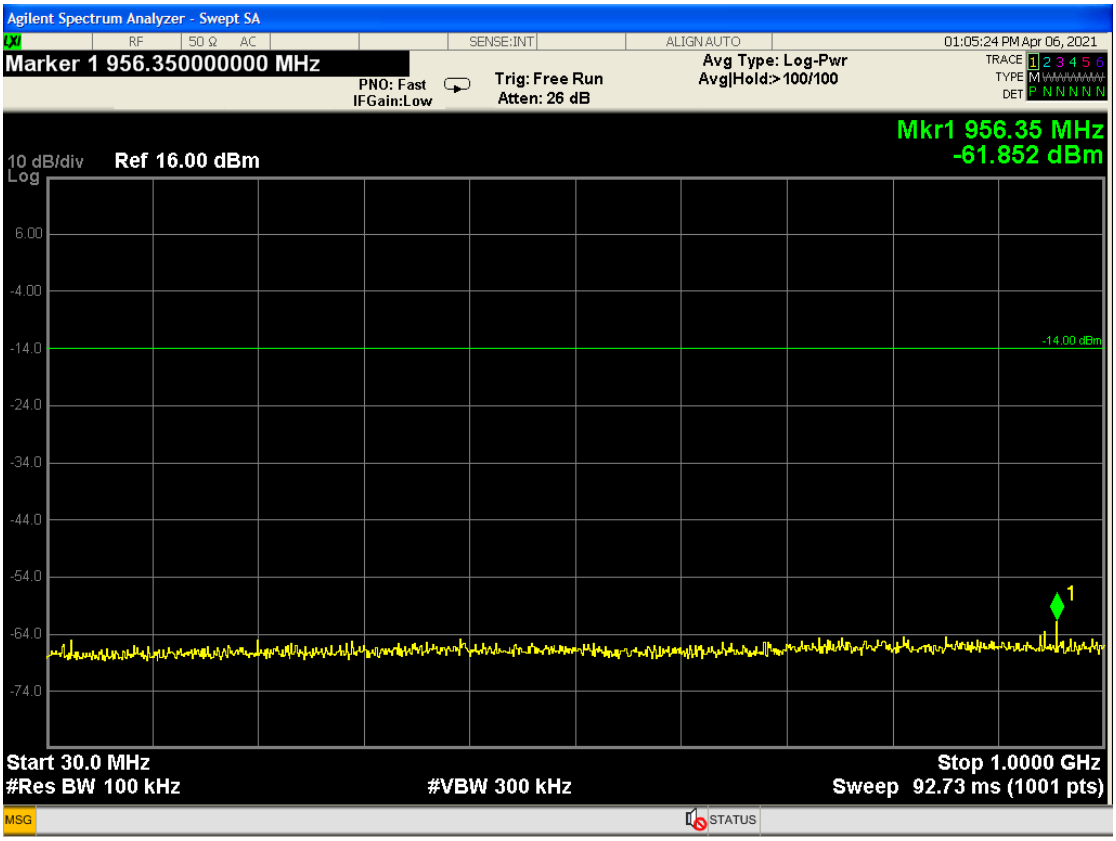
Conducted emissions 30MHz to 1GHz. Operation on channel 5 CCK modulation.

Conducted emissions 1GHz to 26GHz. Operation on channel 5 CCK modulation



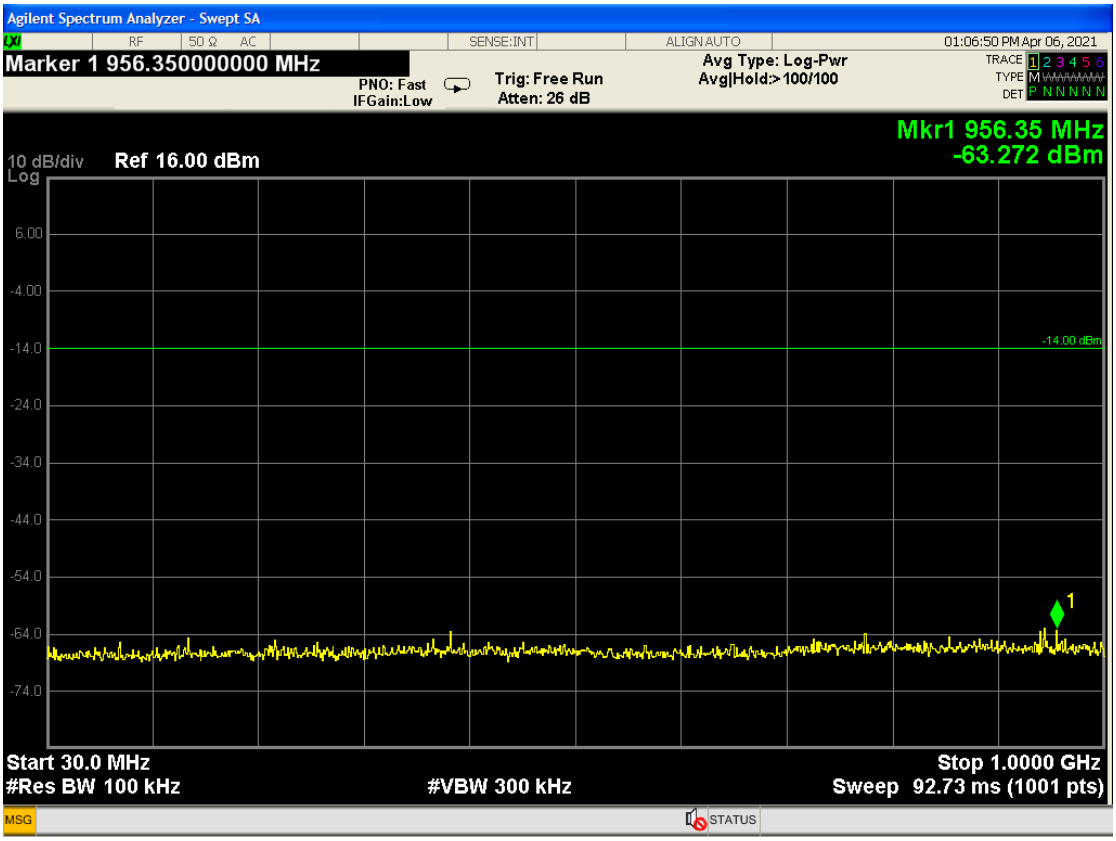
Conducted emissions 30MHz to 1GHz. Operation on channel 5 OFDM modulation.

Conducted emissions 1GHz to 26GHz. Operation on channel 5 OFDM modulation



Conducted emissions 30MHz to 1GHz. Operation on channel 11 CCK modulation.

Conducted emissions 1GHz to 26GHz. Operation on channel 11 CCK modulation



Conducted emissions 30MHz to 1GHz. Operation on channel 11 OFDM modulation.

Conducted emissions 1GHz to 26GHz. Operation on channel 11 OFDM modulation

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	Keysight Connection Expert

Frequency (MHz)	Limit, 47CFR 15.247(a)(2)
	Peak
2400MHz to 2483.5MHz	At least 500kHz

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

Receiver Parameters	Setting
Detector Function	Peak
Span	3 x RBW
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

6.2.1 Date of Test

1st April 2021

6.2.2 Test Area

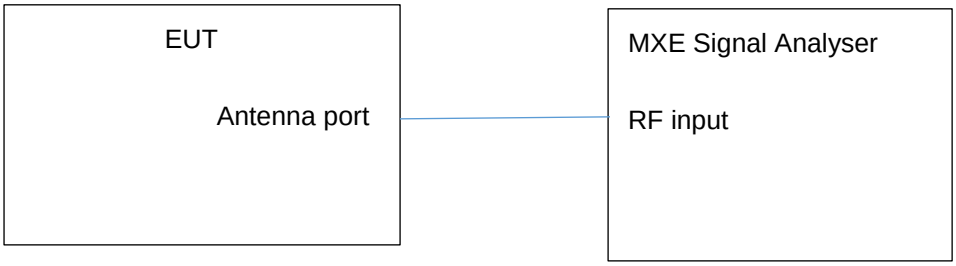
LAB 7

6.2.3 Tested by

J Beevers

6.2.4 Test Setup

The antenna port was connected directly to the signal analyser.



6.3 Test Results

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

Channel (MHz)	Modulation scheme	Measured 6dB bandwidth (MHz)	Minimum requirement (kHz)	99% Occupied bandwidth (MHz)	Figure	Result
2411.0	CCK	10.11	500.0	15.210	6.3.1	Pass
2411.0	OFDM	16.58	500.0	16.505	6.3.2	Pass
2432.0	CCK	10.11	500.0	15.224	6.3.3	Pass
2432.0	OFDM	16.58	500.0	16.502	6.3.4	Pass
2463.0	CCK	10.12	500.0	15.222	6.3.5	Pass
2463.0	OFDM	16.60	500.0	16.507	6.3.6	Pass

6dB and 99% Bandwidth Measurements

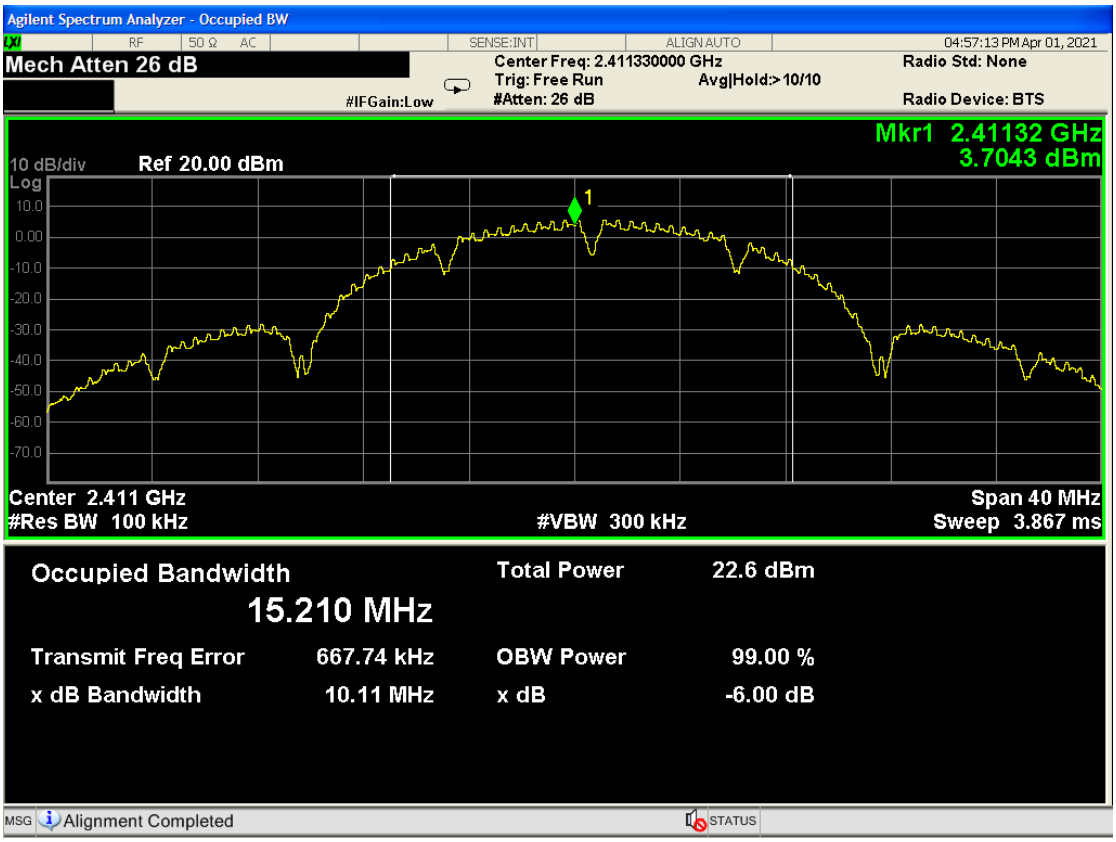


Figure 6.3.1 Bandwidth at 6dB Point. Operation on Channel 1 CCK modulation

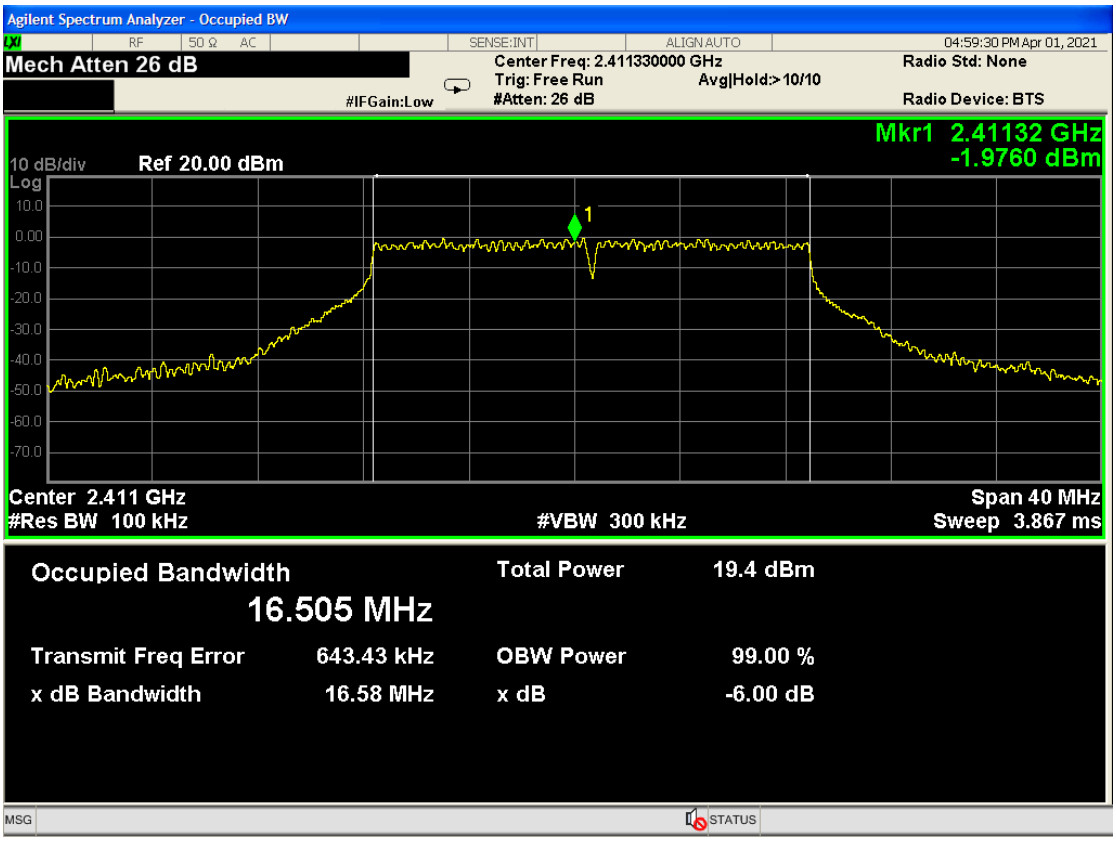


Figure 6.3.2 Bandwidth at 6dB Point. Operation on Channel 1 OFDM modulation

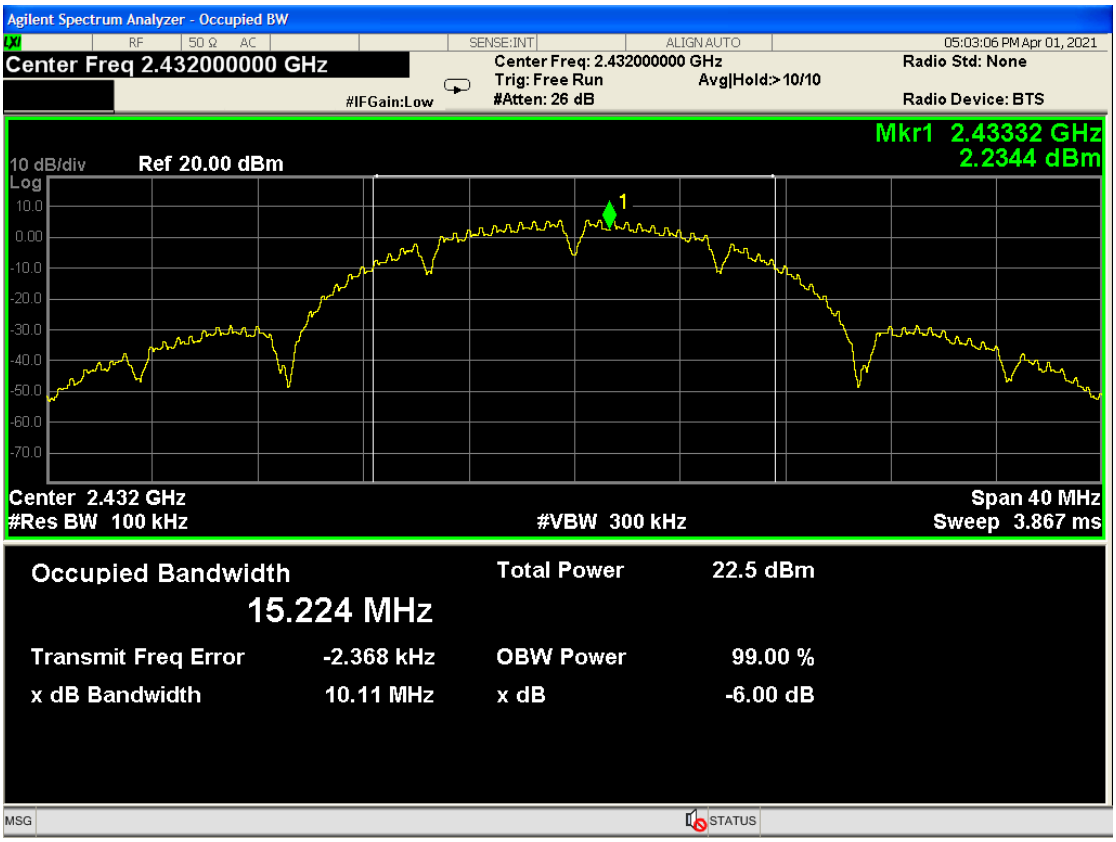


Figure 6.3.3 Bandwidth at 6dB Point. Operation on Channel 5 CCK modulation

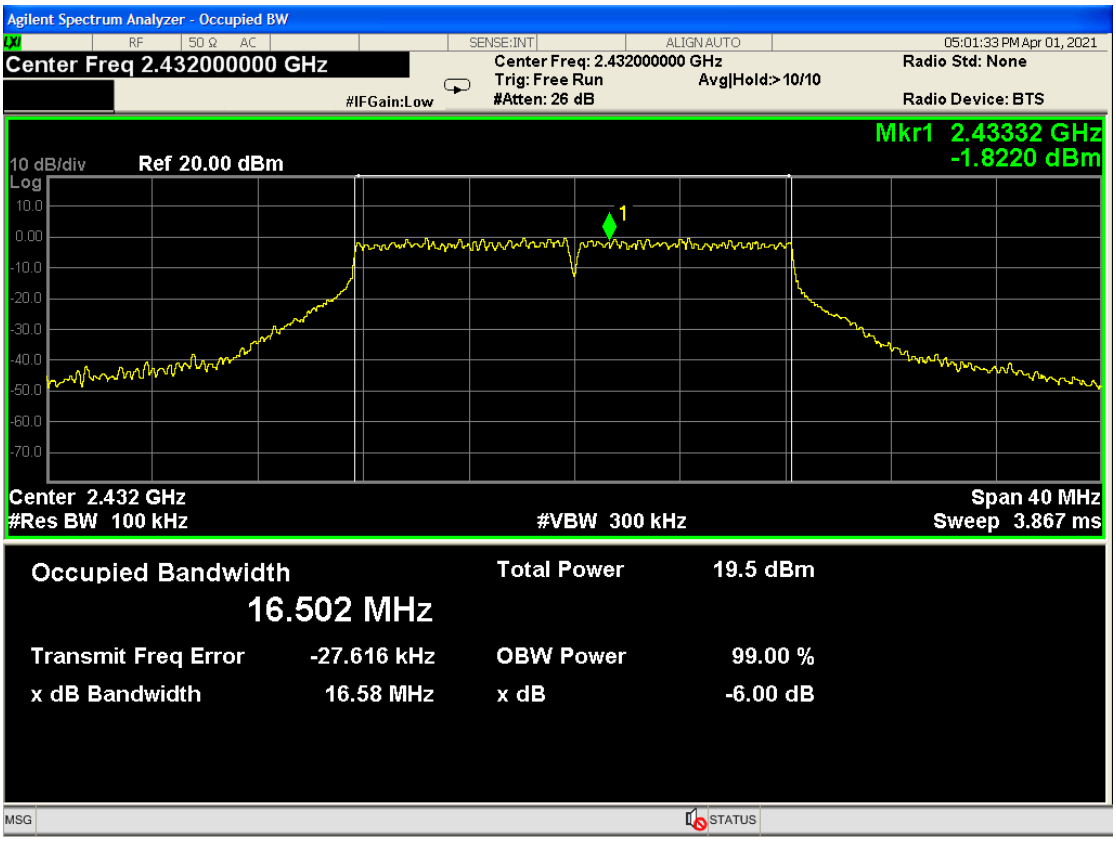


Figure 6.3.4 Bandwidth at 6dB Point. Operation on Channel 5 OFDM modulation

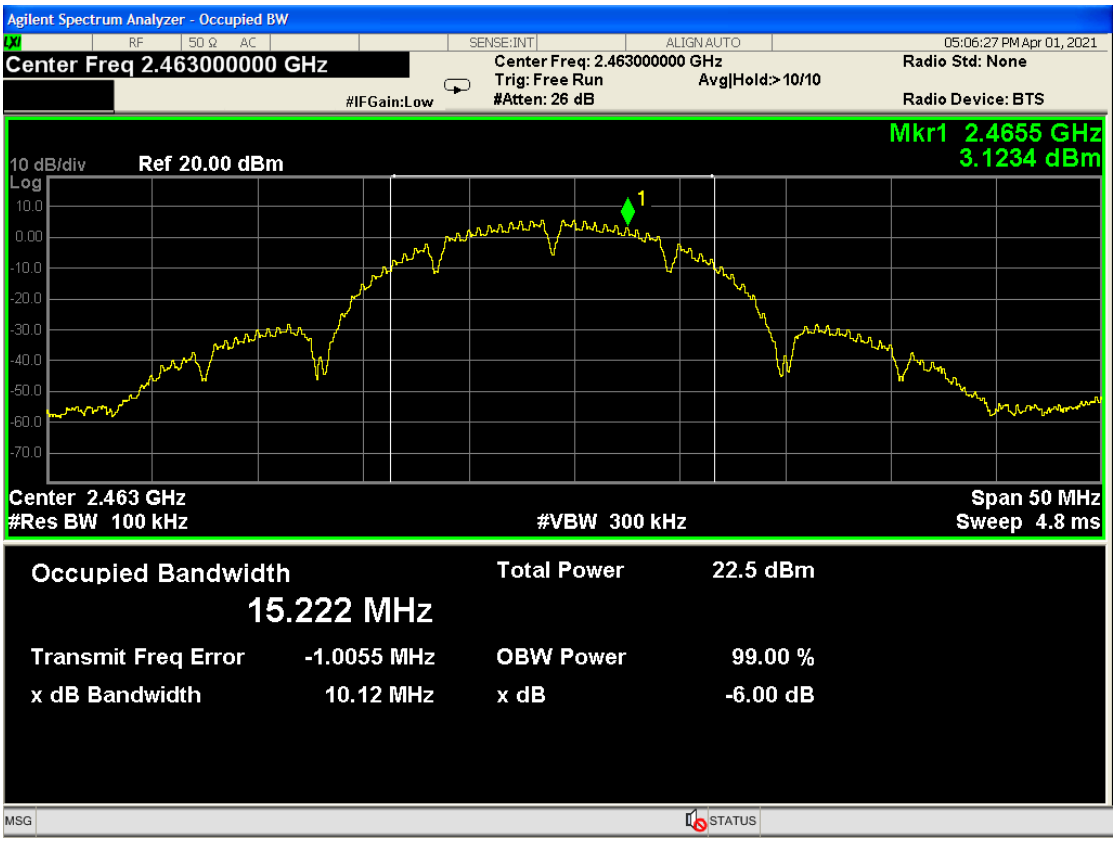


Figure 6.3.5 Bandwidth at 6dB Point. Operation on Channel 11 CCK modulation

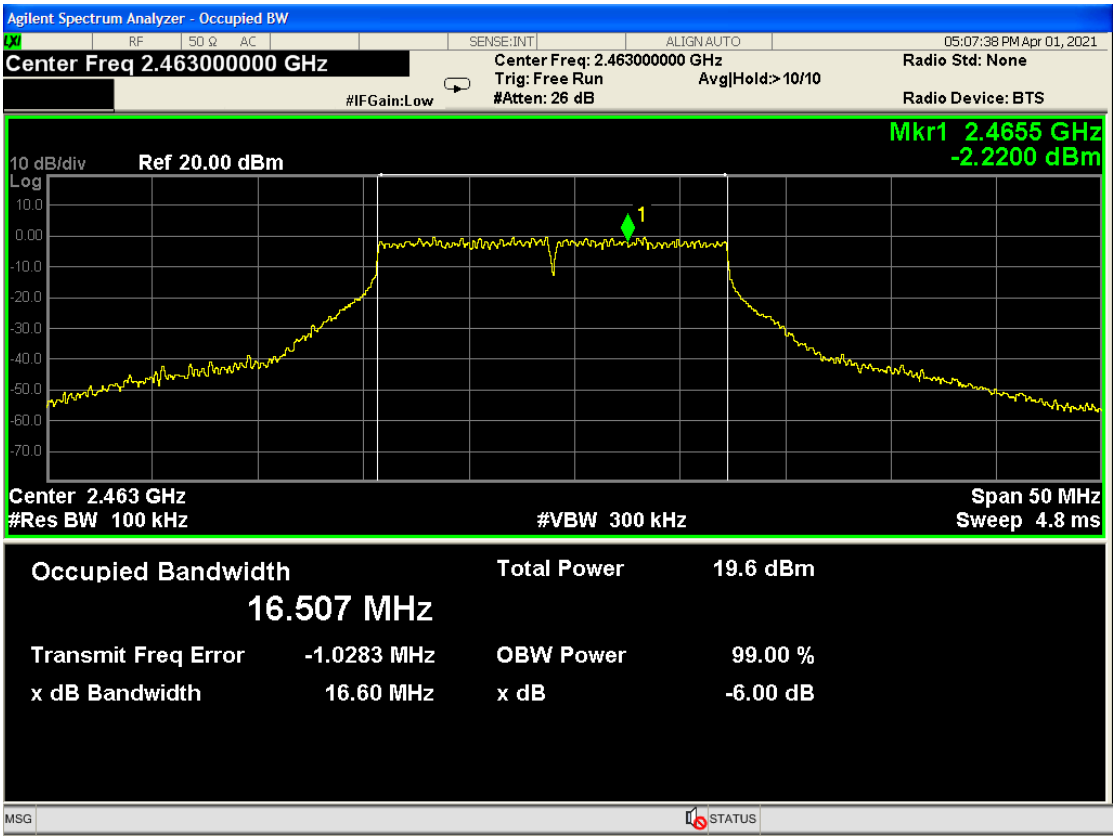


Figure 6.3.6 Bandwidth at 6dB Point. Operation on Channel 11 OFDM modulation

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:	11.9.1.2 (Integrated band power method)
Test software	Keysight Connection Expert

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 11.9.1.2

Receiver Parameters	Setting
Detector Function	Peak
Span	[1.5 x DTS bandwidth]
Resolution Bandwidth	1MHz
Video Bandwidth	3MHz
Sweep rate	Auto couple
Trace mode	Max hold
Integration Bandwidth	[DTS bandwidth]

7.2.1 Date of Test

6th April 2021

7.2.2 Test Area

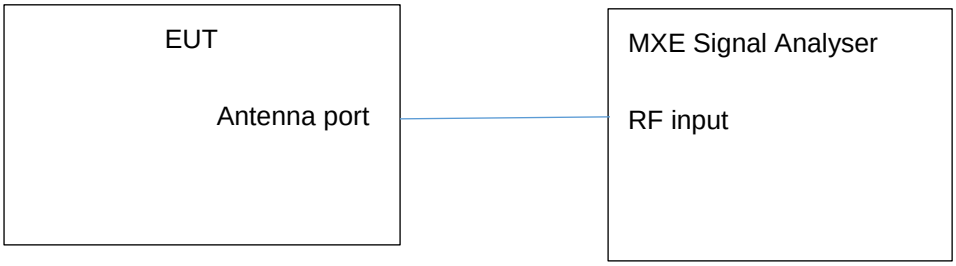
LAB 7

7.2.3 Tested by

J Beevers

7.2.4 Test Setup

The antenna port was connected directly to the signal analyser.



7.3 Test Result

The results of the peak output power measurements are stated in the table below and by the signal analyser images.

Channel (MHz)	Modulation scheme	Peak output power (Watts)*	Limit (Watts)	Figure
2411.0	CCK	0.0657	1	7.3.1
2411.0	OFDM	0.1165	1	7.3.2
2432.0	CCK	0.0676	1	7.3.3
2432.0	OFDM	0.1200	1	7.3.4
2463.0	CCK	0.0698	1	7.3.5
2463.0	OFDM	0.1263	1	7.3.6

Peak Output Power Measurement

*note: this is the power measured in the DTS bandwidth.

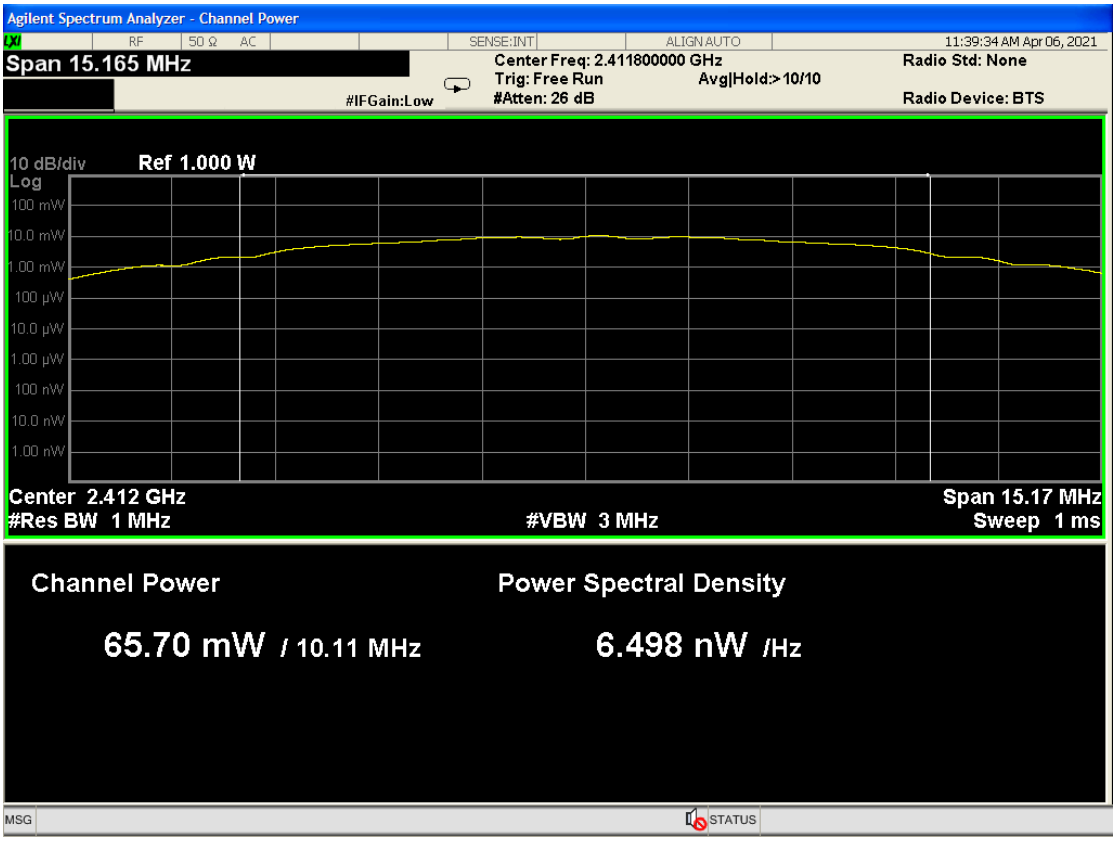


Figure 7.3.1 Peak output power. Operation on channel 1 CCK modulation

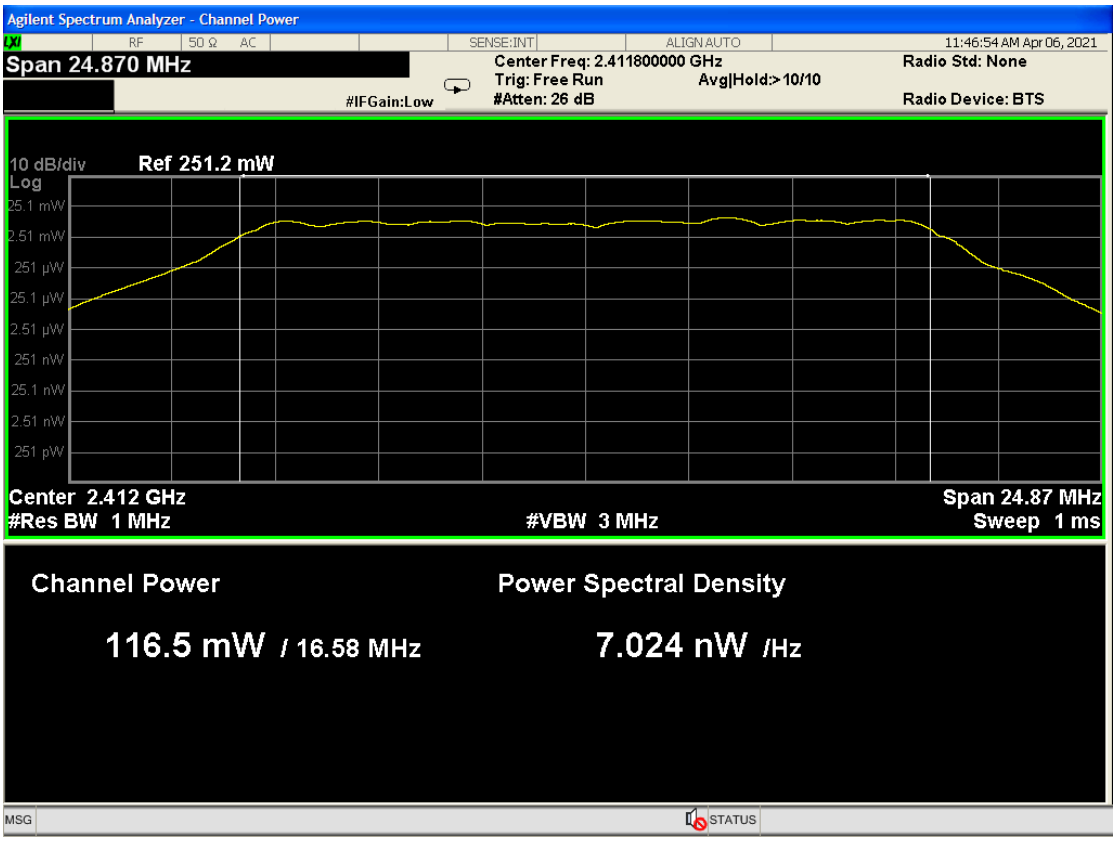


Figure 7.3.2 Peak output power. Operation on channel 1 OFDM modulation

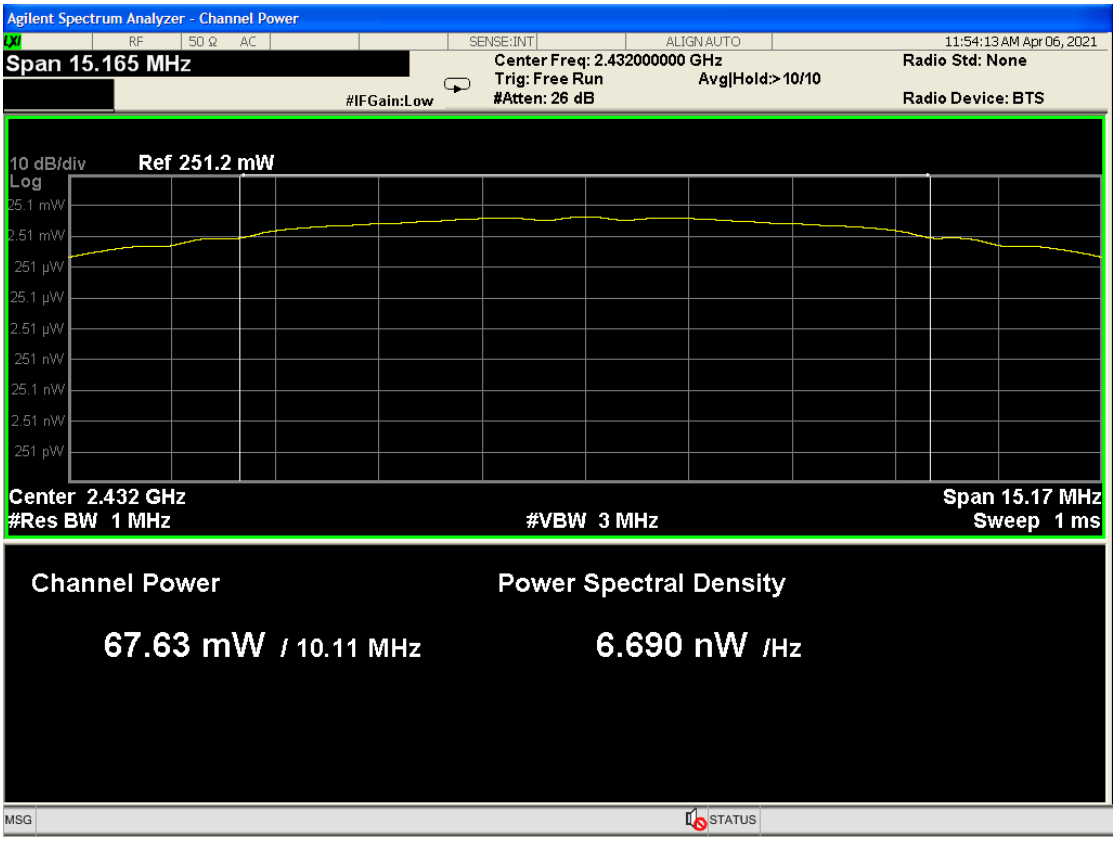


Figure 7.3.3 Peak output power. Operation on channel 5 CCK modulation

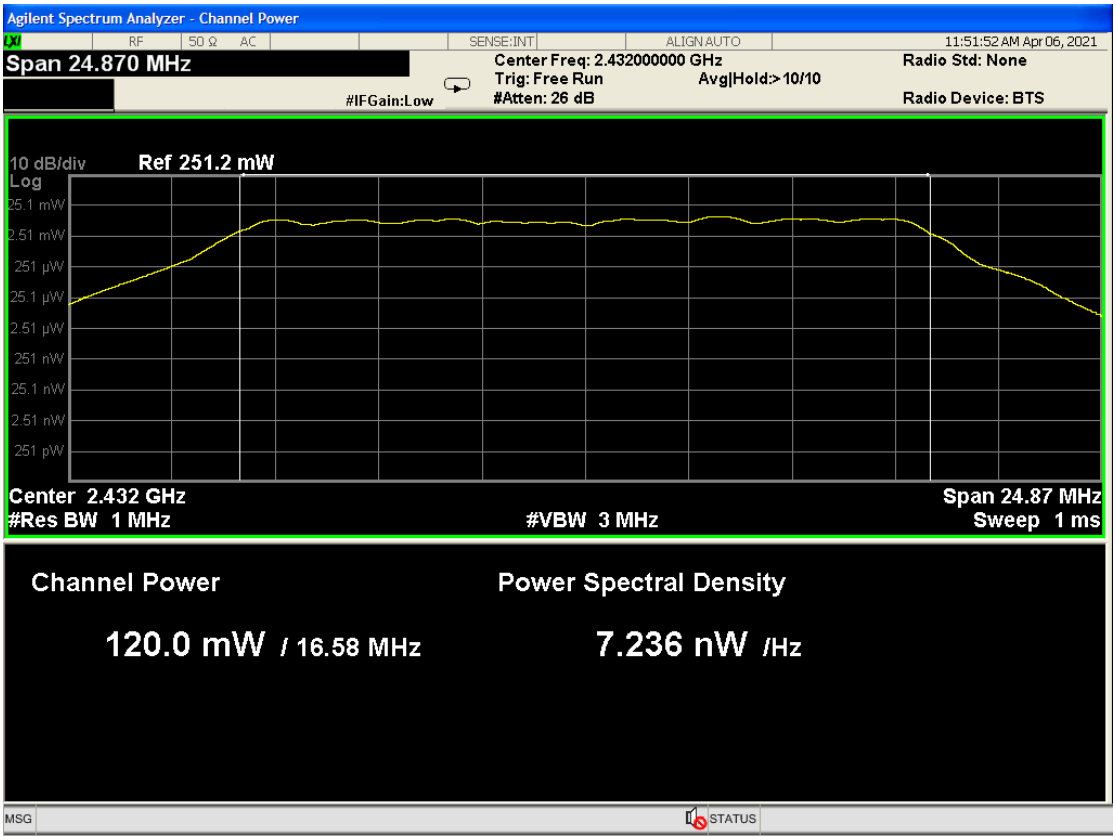


Figure 7.3.4 Peak output power. Operation on channel 5 OFDM modulation

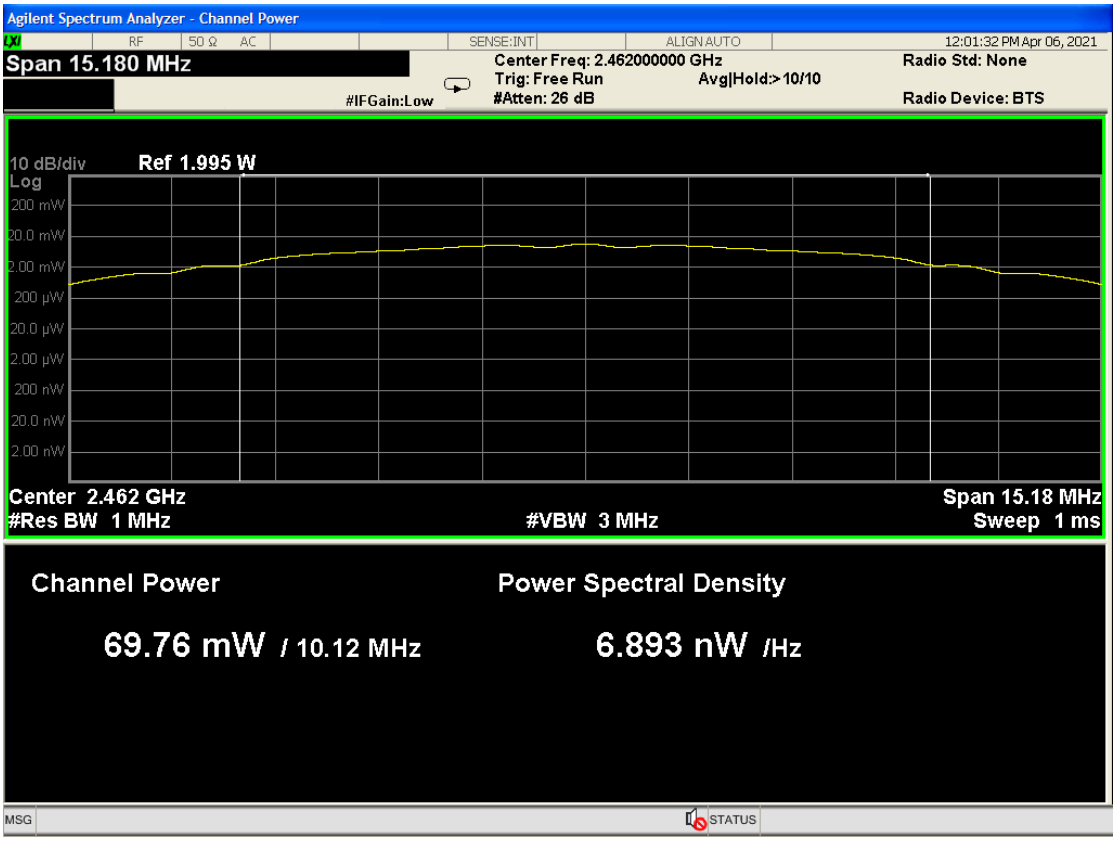


Figure 7.3.5 Peak output power. Operation on channel 11 CCK modulation

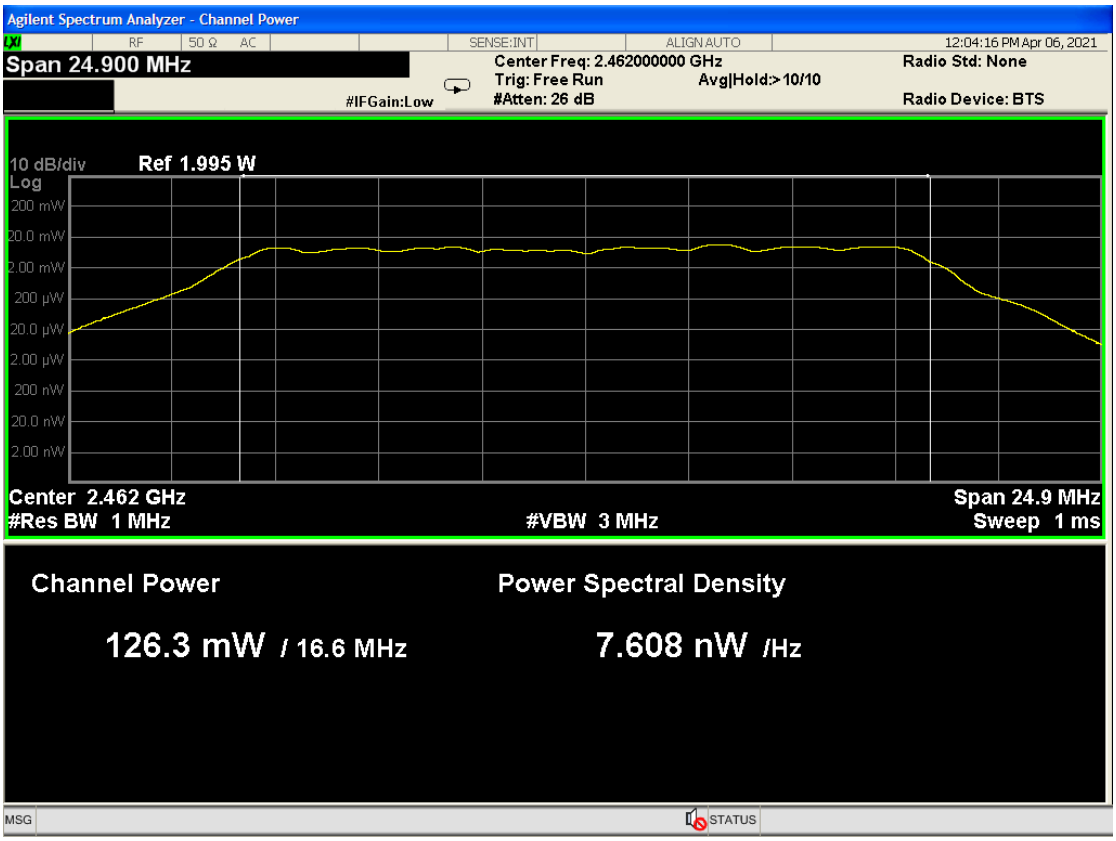


Figure 7.3.6 Peak output power. Operation on channel 11 OFDM modulation

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	Keysight Connection Expert

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 Date of Test

6th April 2021

8.2.2 Test Area

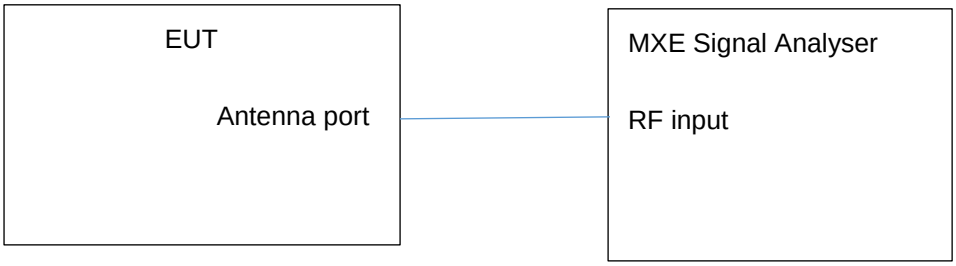
LAB 7

8.2.3 Tested by

J Beevers

8.2.4 Test Setup

The antenna port was connected directly to the signal analyser.



8.3 Test Results

Channel (MHz)	Modulation scheme	Power in 3kHz RBW (dBm)	Limit (dBm)	Figure	Result
2411.0	CCK	5.798	8.0	8.3.1	Pass
2411.0	OFDM	-0.137	8.0	8.3.2	Pass
2432.0	CCK	5.865	8.0	8.3.3	Pass
2432.0	OFDM	0.039	8.0	8.3.4	Pass
2463.0	CCK	5.999	8.0	8.3.5	Pass
2463.0	OFDM	0.269	8.0	8.3.6	Pass

Peak Spectral Density Measurements

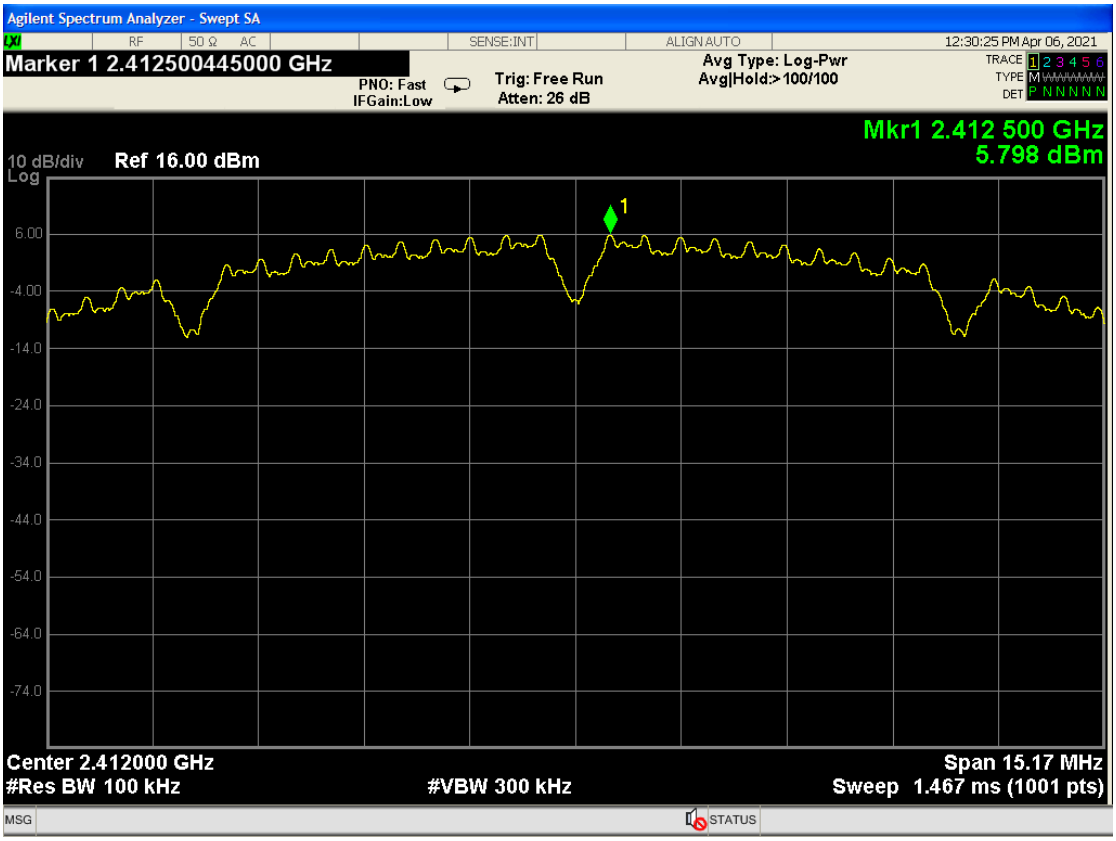


Figure 8.3.1 Power spectral density. Operation on channel 1 CCK modulation

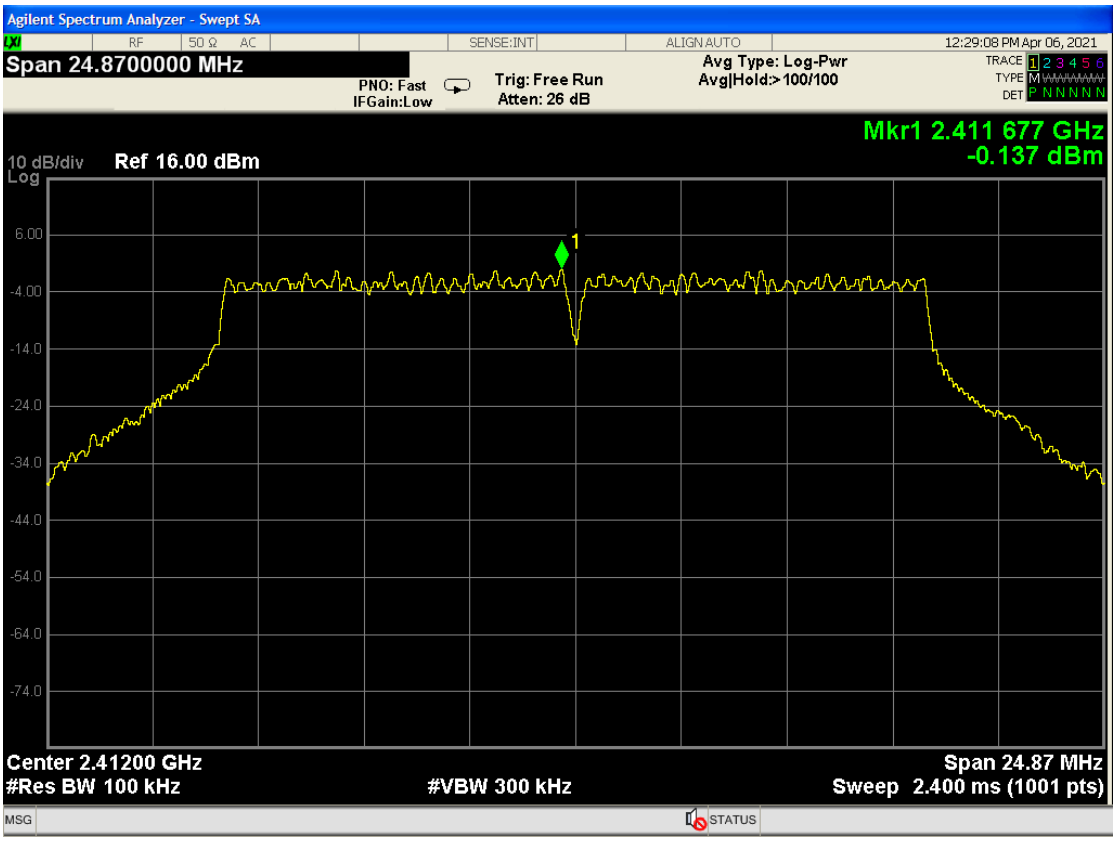


Figure 8.3.2 Power spectral density. Operation on channel 1 OFDM modulation

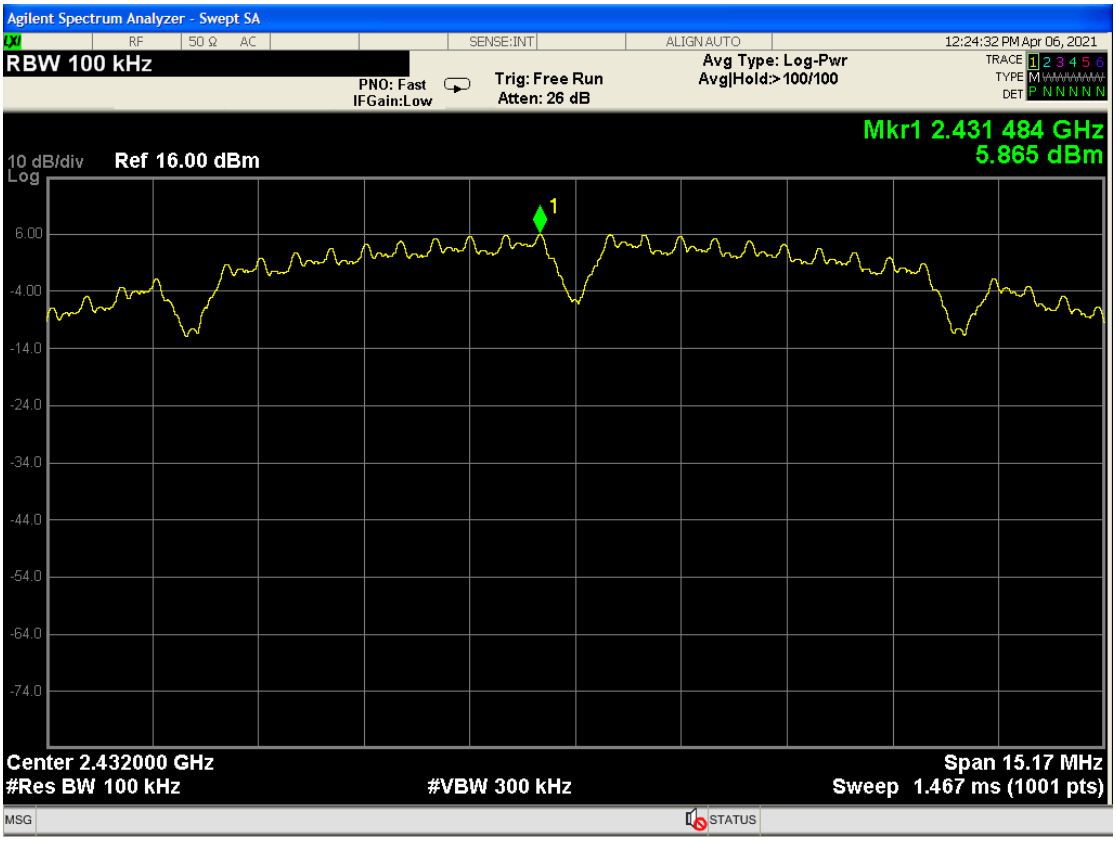


Figure 8.3.3 Power spectral density. Operation on channel 5 CCK modulation

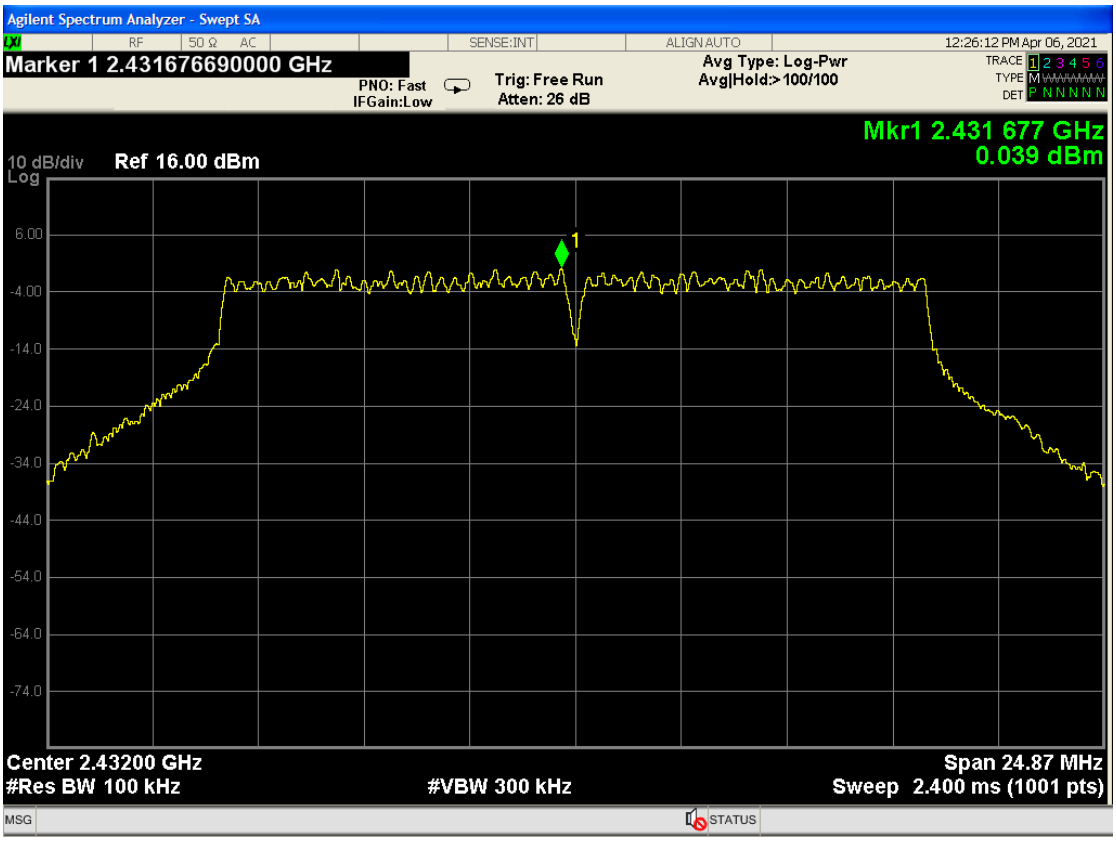


Figure 8.3.4 Power spectral density. Operation on channel 5 OFDM modulation

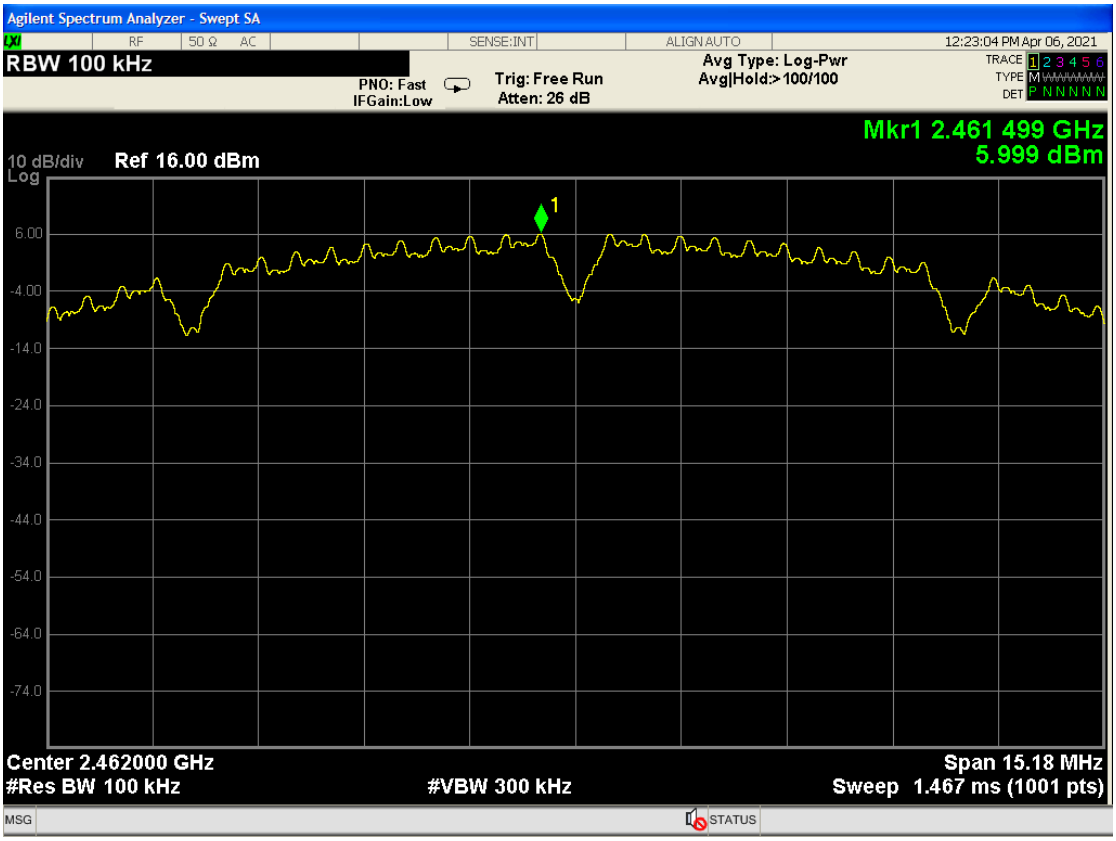


Figure 8.3.5 Power spectral density. Operation on channel 11 CCK modulation

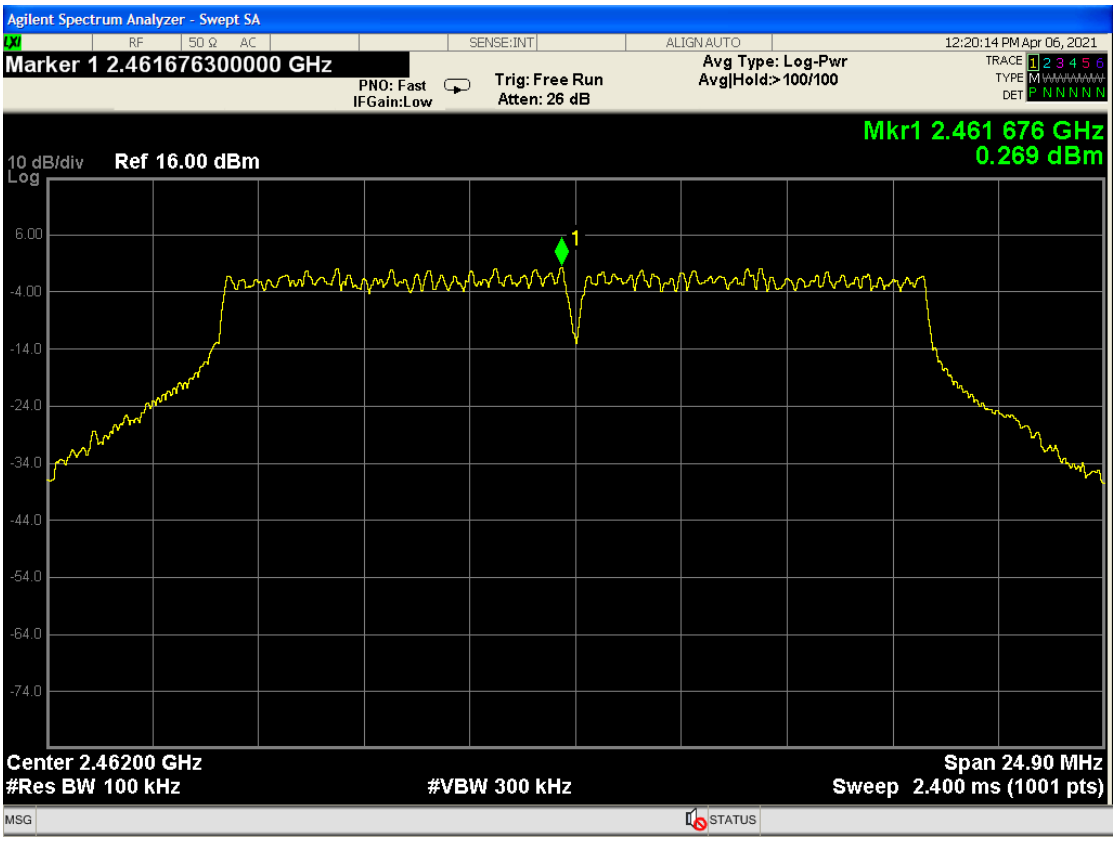


Figure 8.3.6 Power spectral density. Operation on channel 11 OFDM modulation

Section 9 Band Edge Compliance

9.1 Test Specification

FCC Rule Part	46CFR 15.205
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	Keysight Connection Expert

Frequency (MHz)	Limit, 47CFR 15.247(e)
	Peak
2400MHz to 2483.5MHz	Measured signal at the band edge must below the radiated emission limits of 47CFR15.209

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 6.10.5 “Restricted band-edge measurements”

Receiver Parameters	Setting
Detector Function	Peak
Span	As necessary
Resolution Bandwidth	1MHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

9.2.1 Date of Test

30th March 2021

9.2.2 Test Area

LAB 1 (SAC)

9.2.3 Tested by

J Beevers

9.2.4 Test Setup

The test setup was identical to radiated emissions testing 1-18GHz. The measuring antenna was positioned at 1m from the sample. The limits were adjusted to reflect a 1m measurement distance, assuming an increase of 10dB per decade.

9.3 Test Results

Results are presented in two formats:

Tabular results of measurements at the band edges. Manual measurements were performed to measure the maximum value of signal at the band edge. The tabular data includes the following:

1. Polarity of the measurement antenna
2. Modulation scheme
3. Frequency at the band edge
4. Amplitude of signal at the input of the test receiver
5. Pre-amplifier gain
6. Cable loss
7. Antenna factor
8. Resultant Electric field strength = 3-4+5+6

Spectrum analyser screen displays are also included. Please note that the screen displays do not include losses or antenna factor.

Tabular Data

The following radiated measurements were made at the band edges:

Upper band edge

Polarity	Frequency (MHz)	Modu-lation	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Limit at 1m (dBuV/m)	Margin (dB)
H	2483.5	CCK	59.84	50.99	4.77	29.89	43.51	83.54	-40.03
V	2483.5	CCK	72.12	50.99	4.77	29.89	55.79	83.54	-27.75
H	2483.5	OFDM	66.48	50.99	4.77	29.89	50.15	83.54	-33.39
V	2483.5	OFDM	88.78	50.99	4.77	29.89	72.45	83.54	-11.09

Operation on Channel 11, Peak detector measurements

Polarity	Frequency (MHz)	Modu-lation	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2483.5	CCK	48.95	50.99	4.77	29.89	32.62	63.54	-30.92
V	2483.5	CCK	62.29	50.99	4.77	29.89	45.96	63.54	-17.58
H	2483.5	OFDM	52.75	50.99	4.77	29.89	36.42	63.54	-27.12
V	2483.5	OFDM	75.55	50.99	4.77	29.89	59.22	63.54	-4.32

Operation on Channel 11, average detector measurements

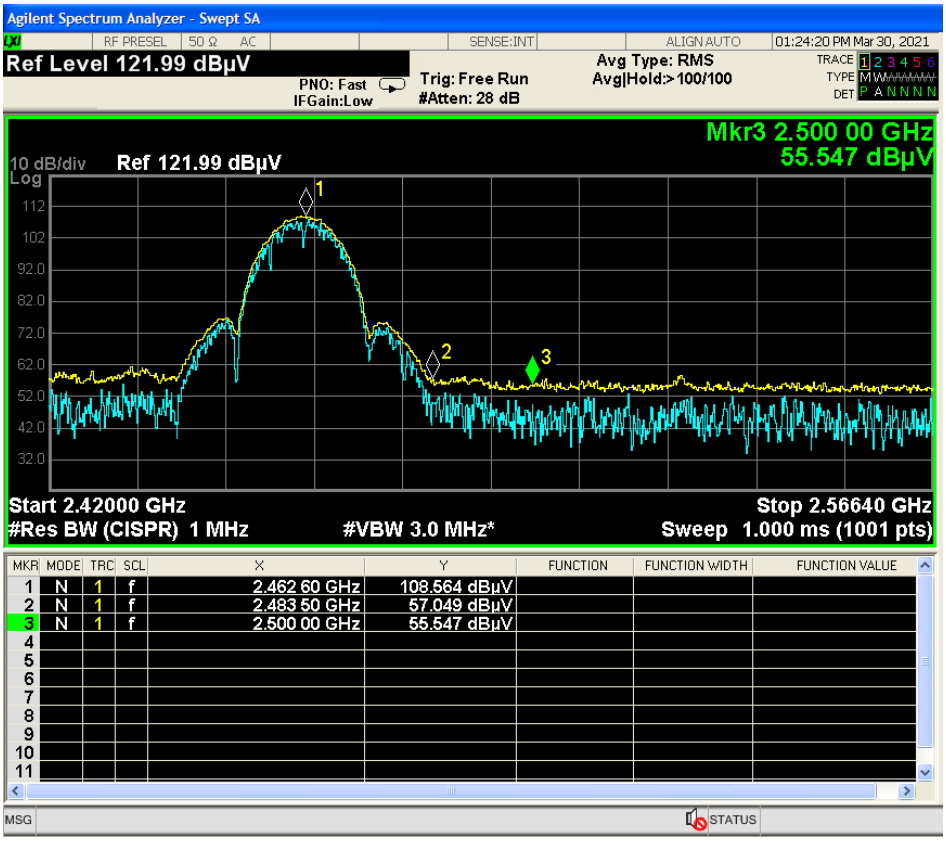
Lower band edge

Polarity	Frequency (MHz)	Modu-lation	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	CCK	81.36	50.97	4.64	29.67	64.7	83.54	-18.84
V	2400	CCK	78.00	50.97	4.64	29.67	61.34	83.54	-22.20
H	2400	OFDM	89.90	50.97	4.64	29.67	73.24	83.54	-10.30
V	2400	OFDM	85.81	50.97	4.64	29.67	69.15	83.54	-14.39

Operation on Channel 1 Peak detector measurements

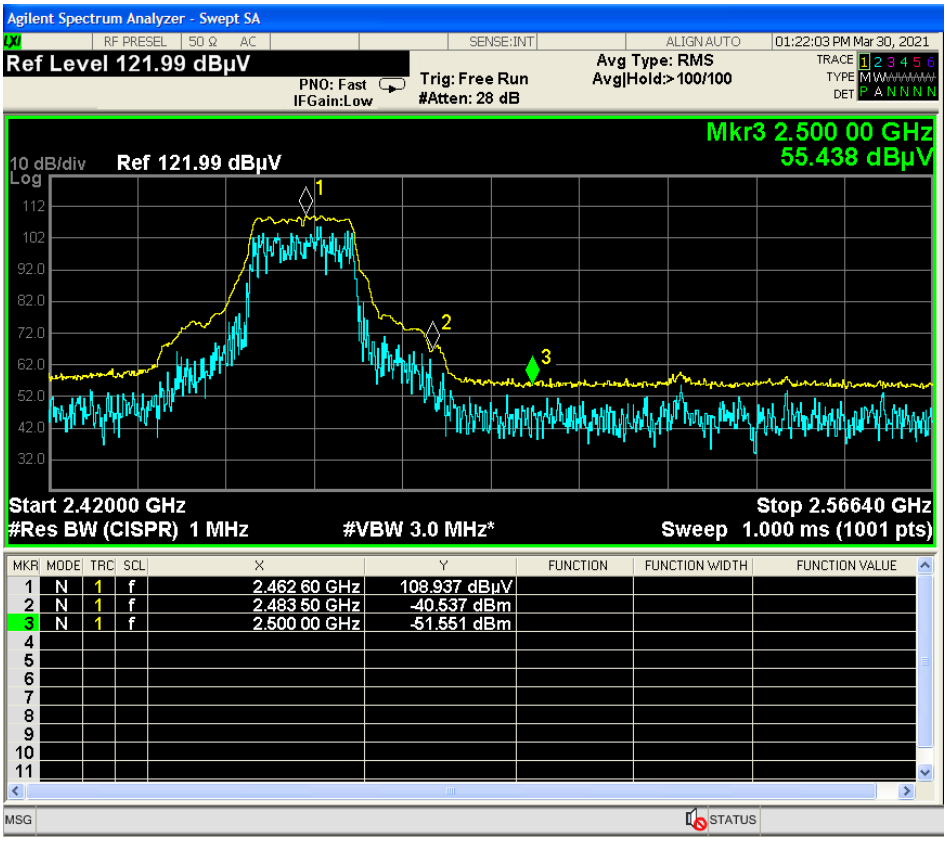
Polarity	Frequency (MHz)	Modu-lation	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	2400	CCK	77.81	50.97	4.64	29.67	61.15	63.54	-2.39
V	2400	CCK	74.05	50.97	4.64	29.67	57.39	63.54	-6.15
H	2400	OFDM	76.27	50.97	4.64	29.67	59.61	63.54	-3.93
V	2400	OFDM	69.32	50.97	4.64	29.67	52.66	63.54	-10.88

Operation on Channel 1 average detector measurements

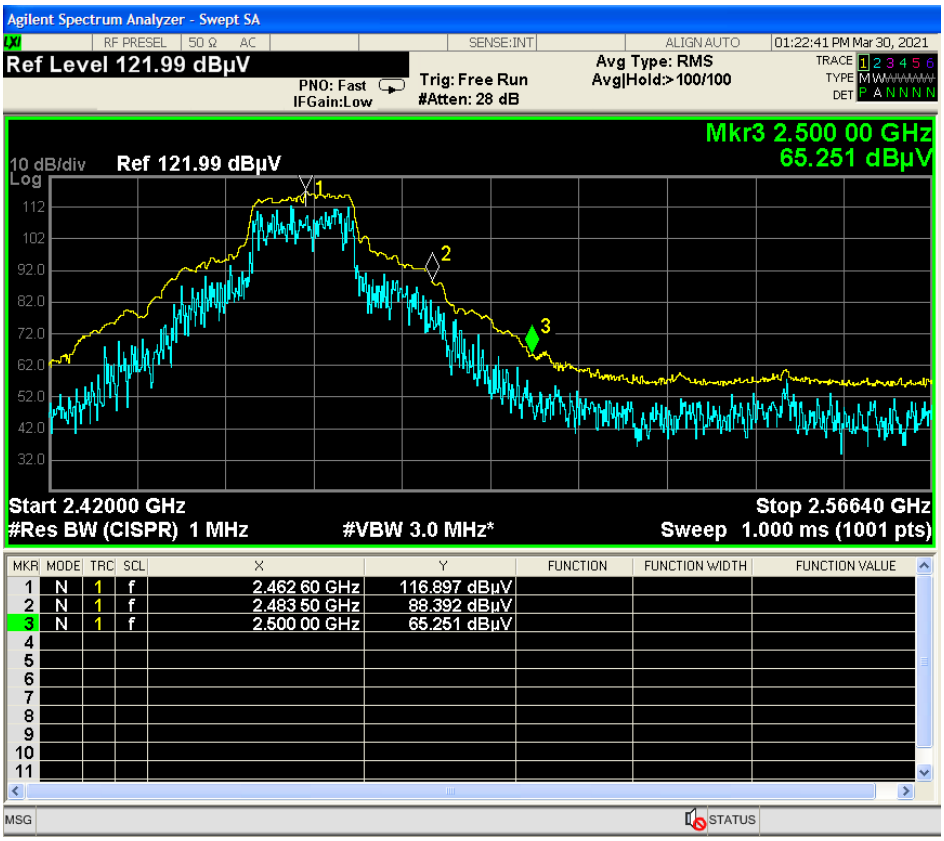


Band Edge Measurement – upper band edge – CCK modulation - horizontal polarity

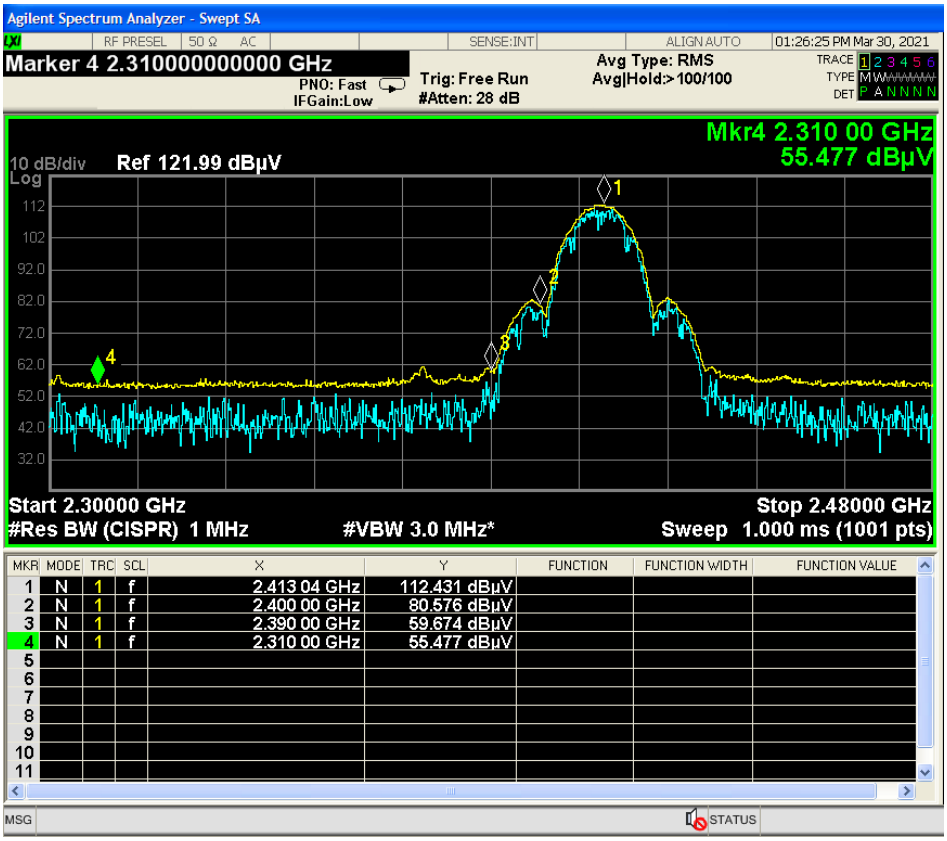
Band Edge Measurement – upper band edge – CCK modulation - vertical polarity



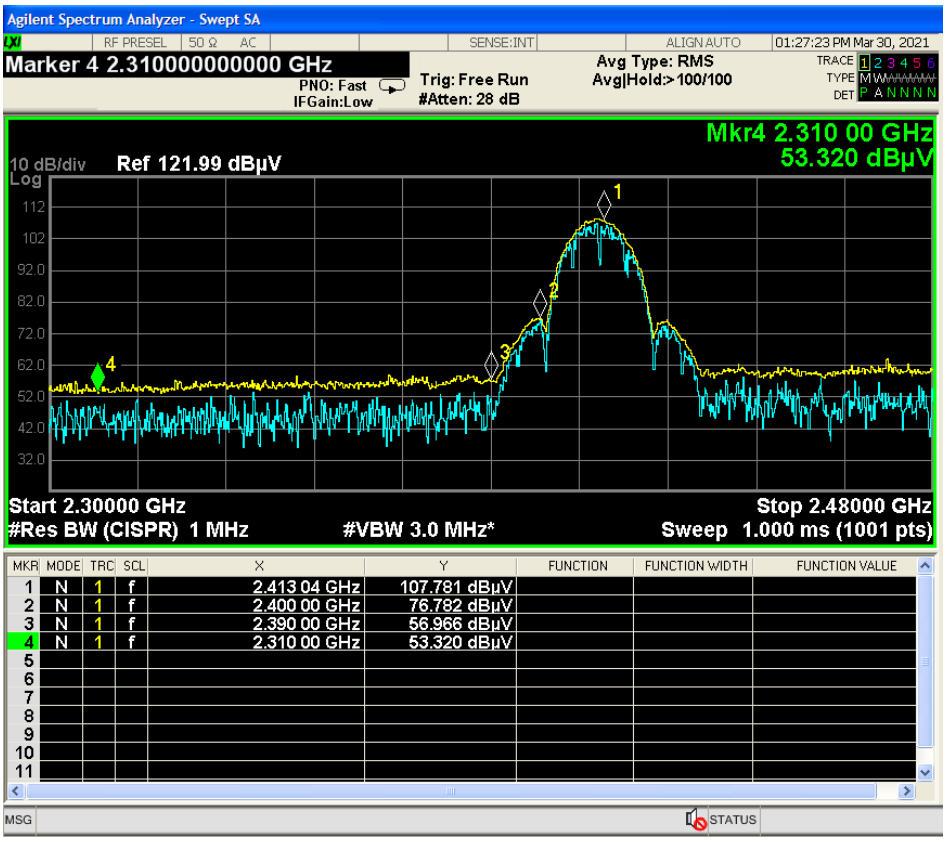
Band Edge Measurement – upper band edge – OFDM modulation - horizontal polarity



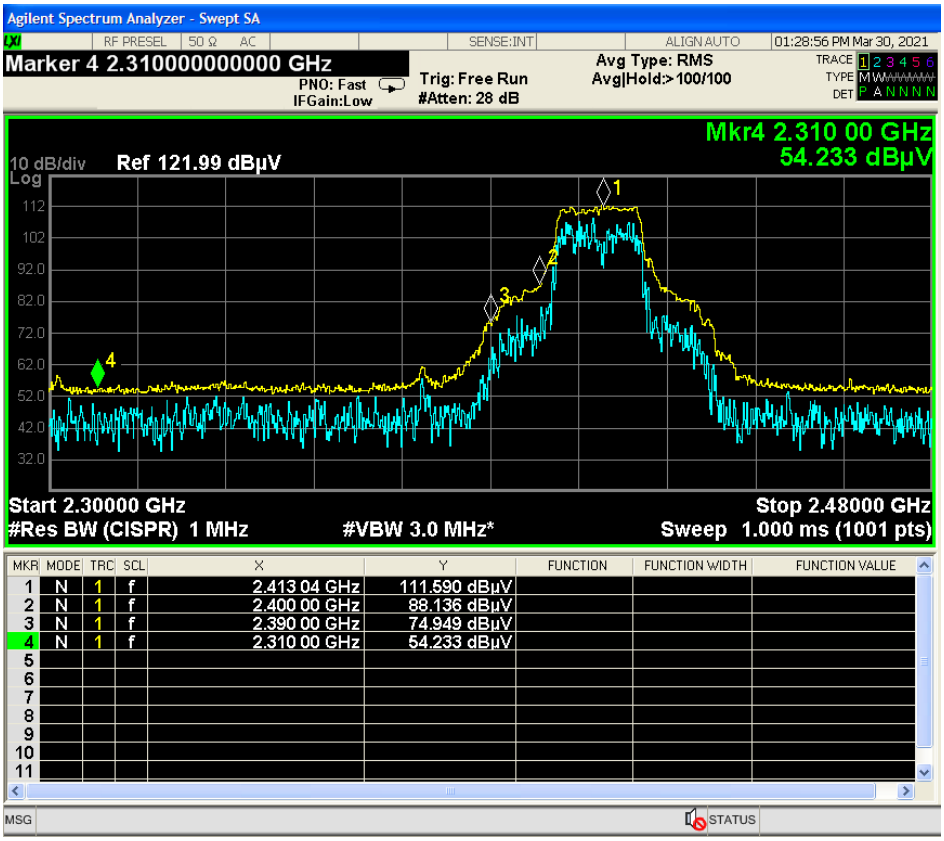
Band Edge Measurement – upper band edge – OFDM modulation - vertical polarity



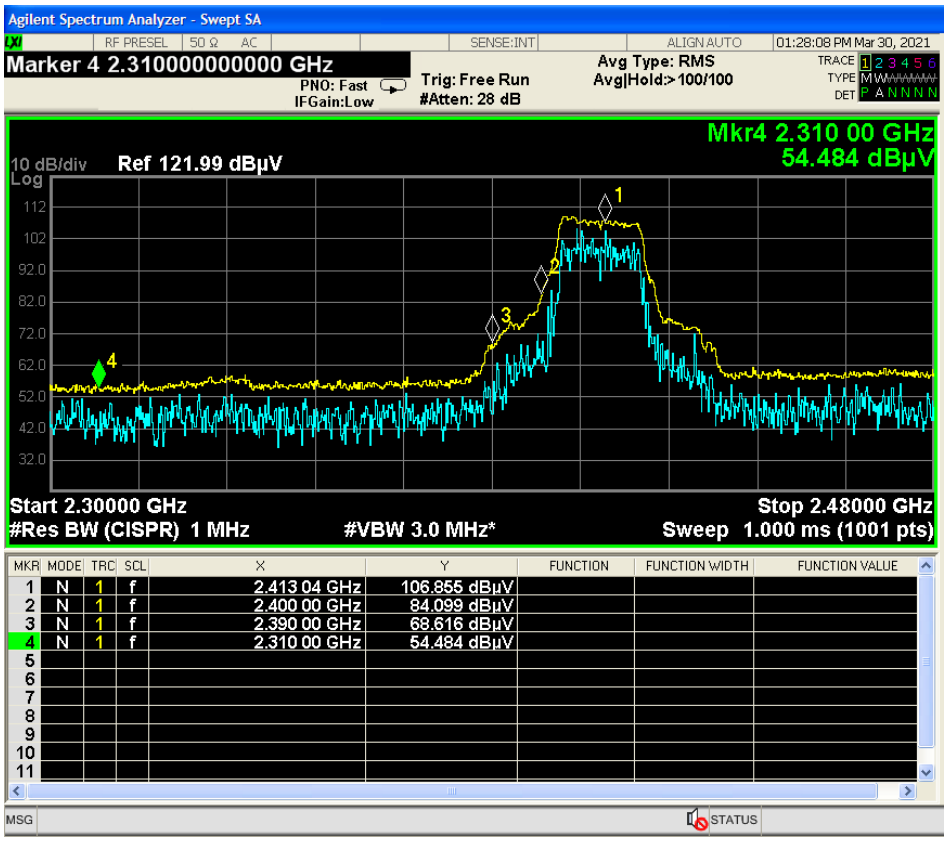
Band Edge Measurement – lower band edge – CCK modulation - horizontal polarity



Band Edge Measurement – lower band edge – CCK modulation - vertical polarity



Band Edge Measurement – lower band edge – OFDM modulation - horizontal polarity



Band Edge Measurement – lower band edge – OFDM modulation - vertical polarity

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 A (dBµV)		Class B (dBµV)	
	Quasi Peak	Average	Quasi Peak	Average
0.15 – 0.5	79.0	66.0	66 – 56*	56 – 46*
0.5 – 5.0	73.0	60.0	56.0	46.0
5.0 - 30	73.0	60.0	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

6th April 2021

10.4.2 Test Area

LAB 2

10.4.3 Tested by

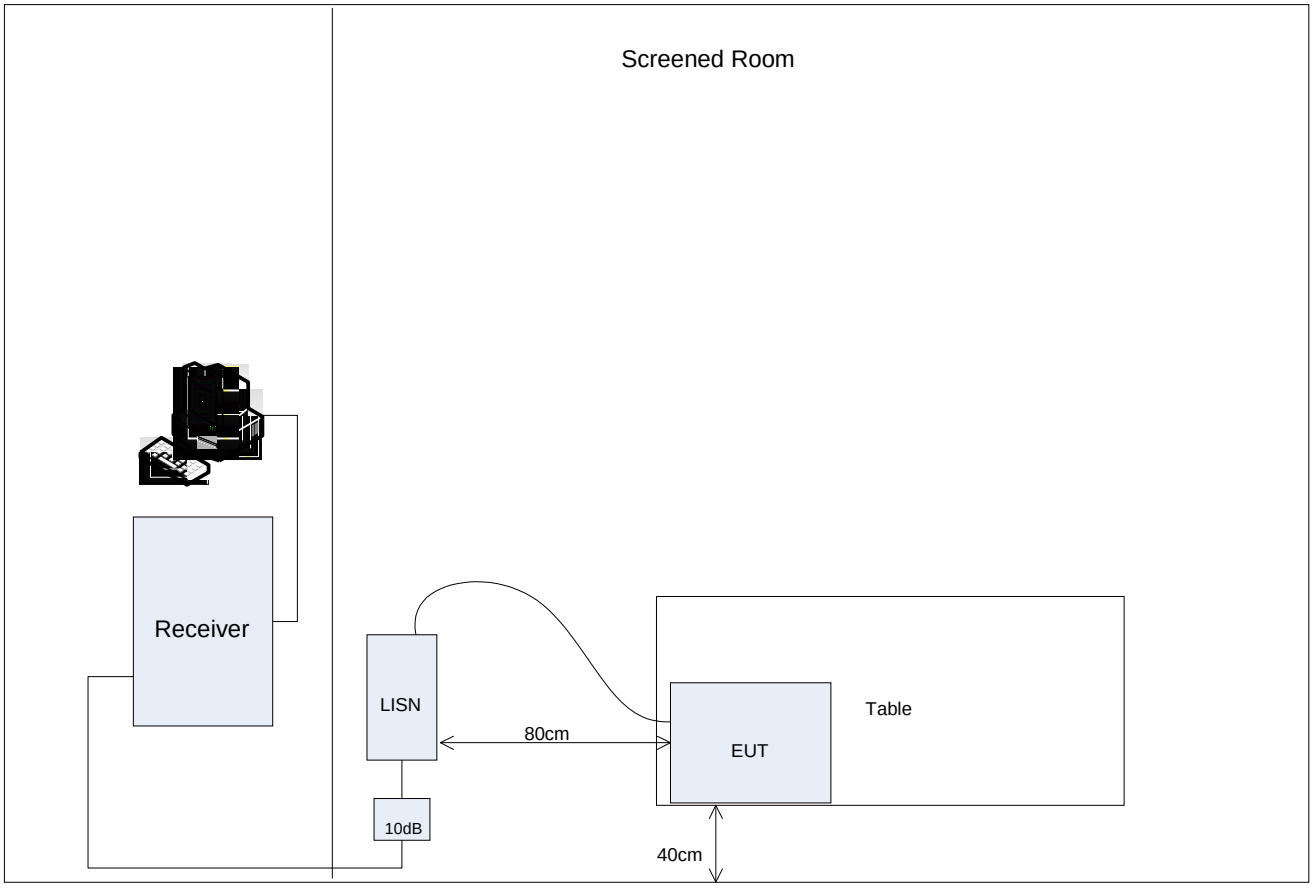
J Beevers

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).

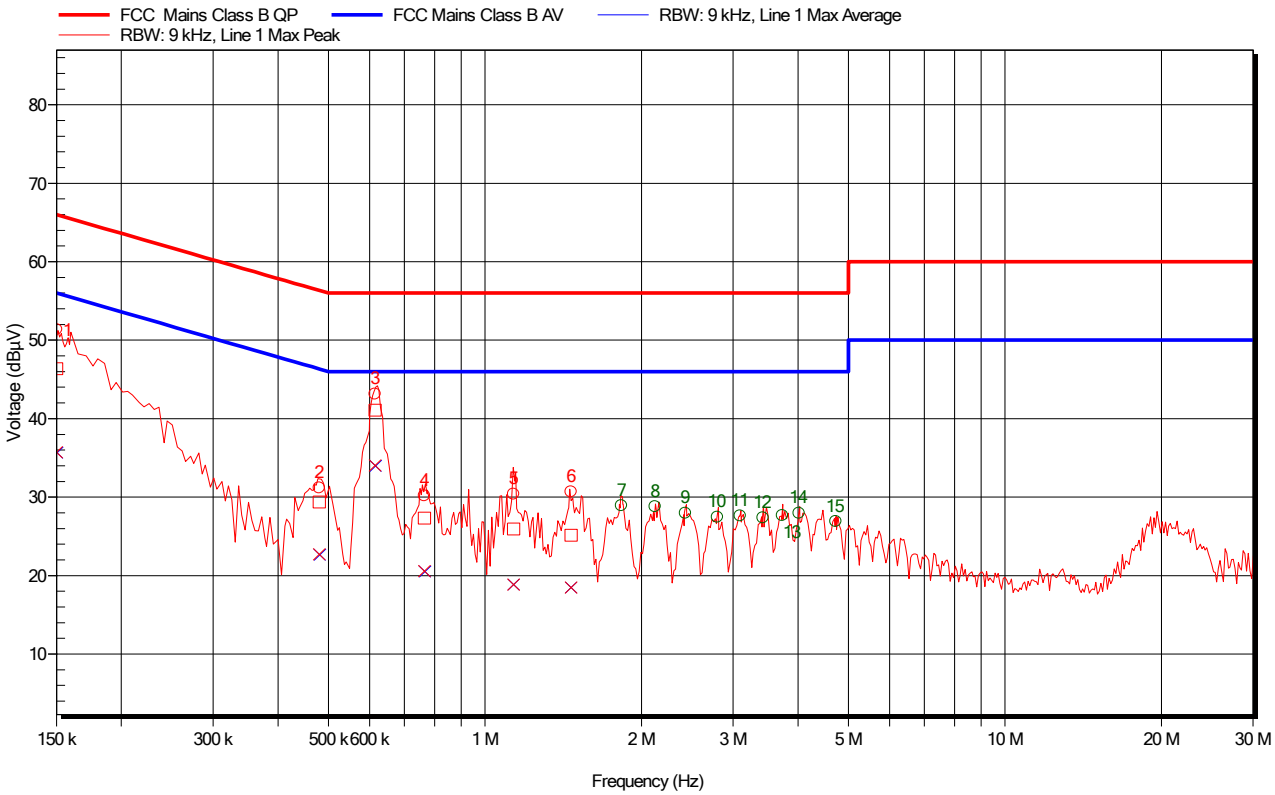


10.5 Test Results

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

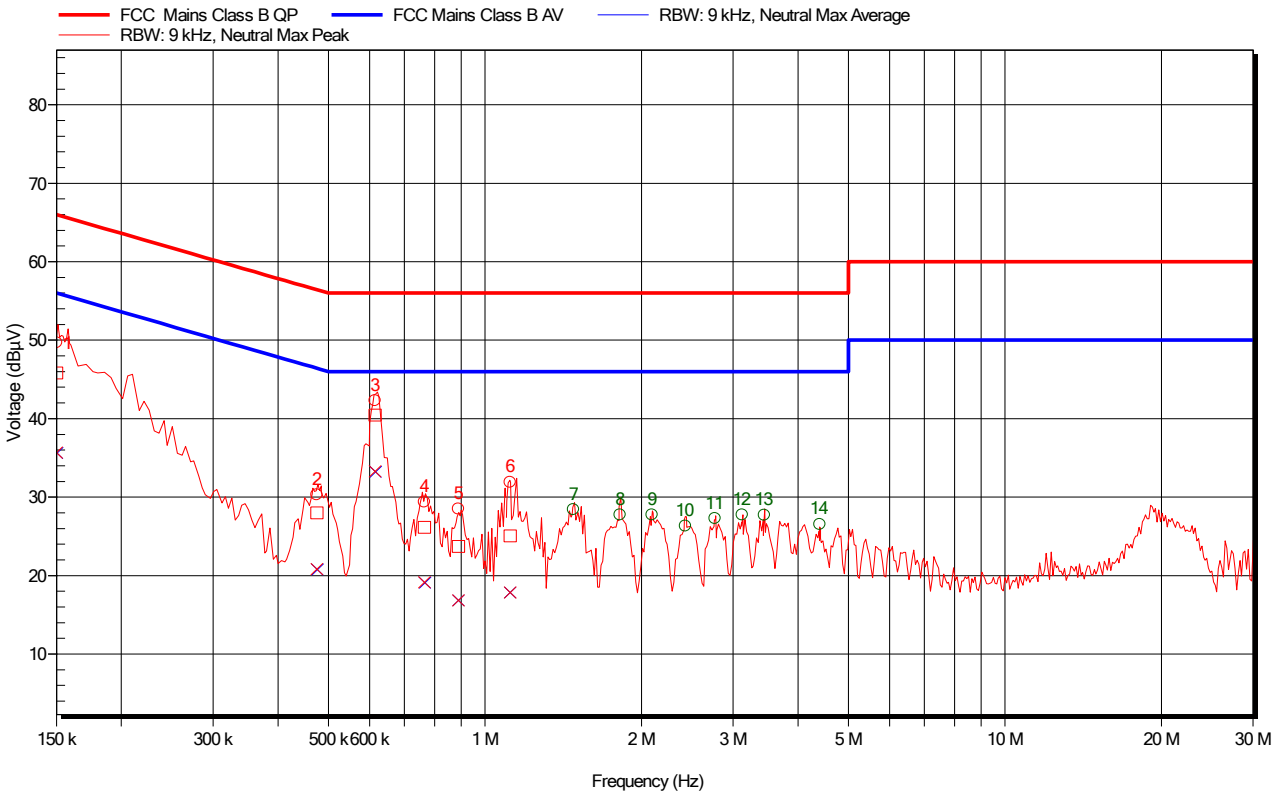
Modulation scheme	Channel	Conductor	Result summary
CCK	1	Live	Pass
CCK	1	Neutral	Pass
OFDM	1	Live	Pass
OFDM	1	Neutral	Pass
CCK	5	Live	Pass
CCK	5	Neutral	Pass
OFDM	5	Live	Pass
OFDM	5	Neutral	Pass
CCK	11	Live	Pass
CCK	11	Neutral	Pass
OFDM	11	Live	Pass
OFDM	11	Neutral	Pass

The equipment under test was pre-scanned using peak detection when operating on all three channels with both CCK and OFDM modulation. Final measurements were performed with the equipment under test operating on channel 1 with CCK modulation.



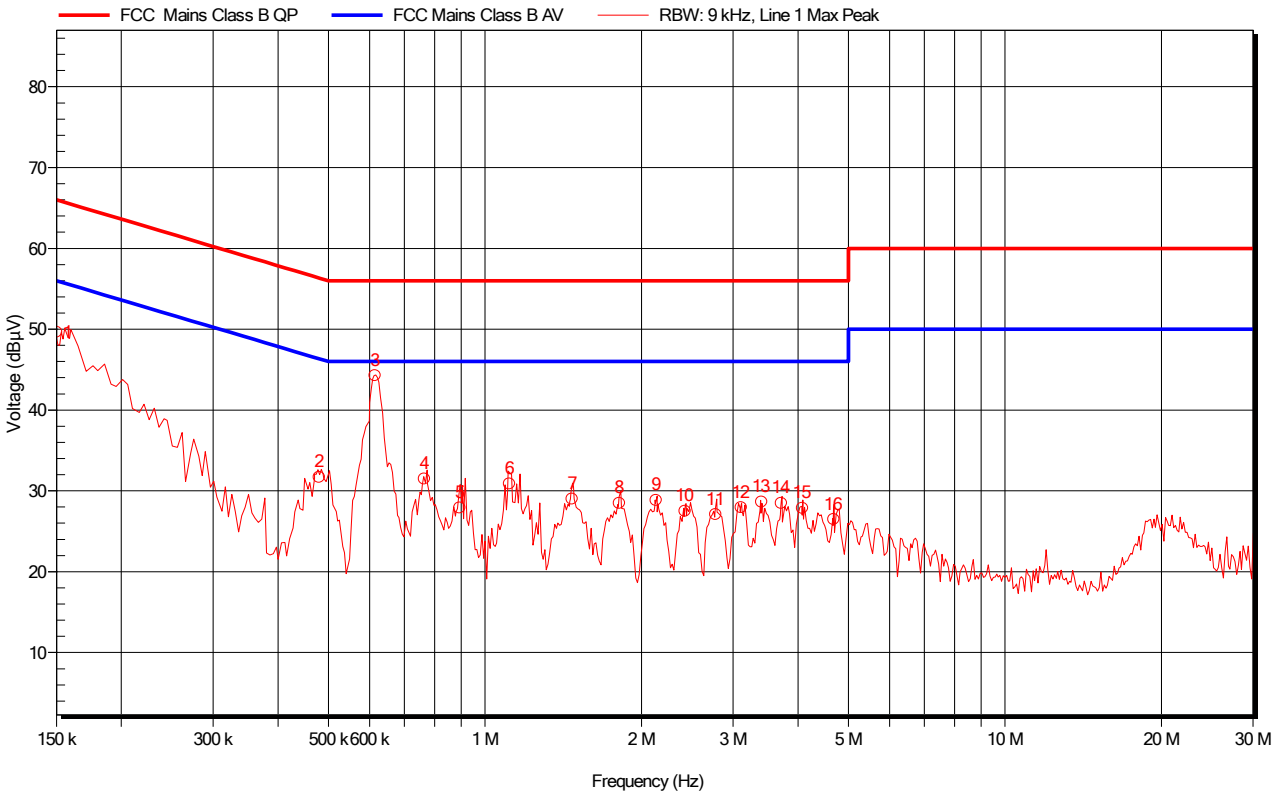
AC mains conducted emissions. Operating on channel 1 CCK modulation – Live

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
0.150	35.7	56.0	-20.28	Pass	46.4	66.0	-19.61	Pass
0.480	22.7	46.3	-23.61	Pass	29.4	56.3	-26.96	Pass
0.615	34.0	46.0	-11.98	Pass	41.1	56.0	-14.93	Pass
0.765	20.6	46.0	-25.43	Pass	27.3	56.0	-28.69	Pass
1.135	18.9	46.0	-27.14	Pass	25.9	56.0	-30.07	Pass
1.465	18.5	46.0	-27.53	Pass	25.1	56.0	-30.85	Pass

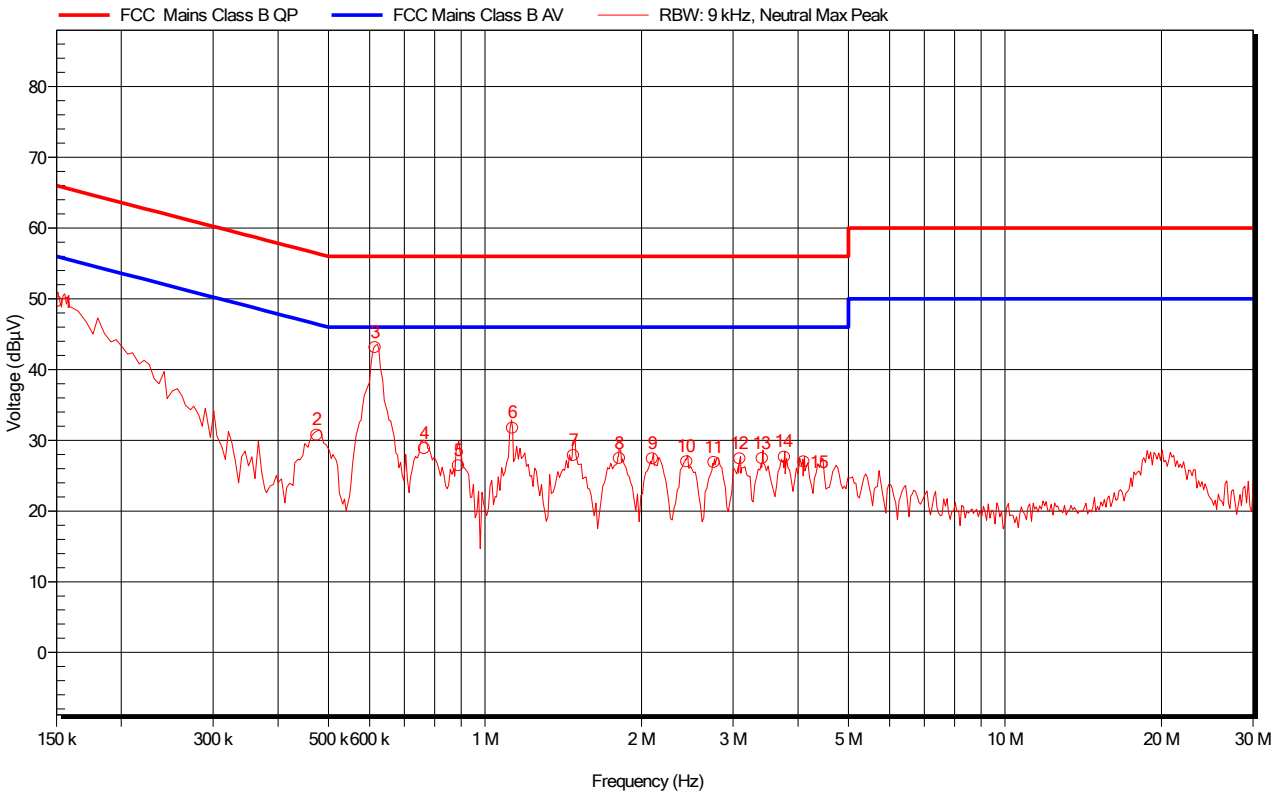


AC mains conducted emissions. Operating on channel 1 CCK modulation – Neutral

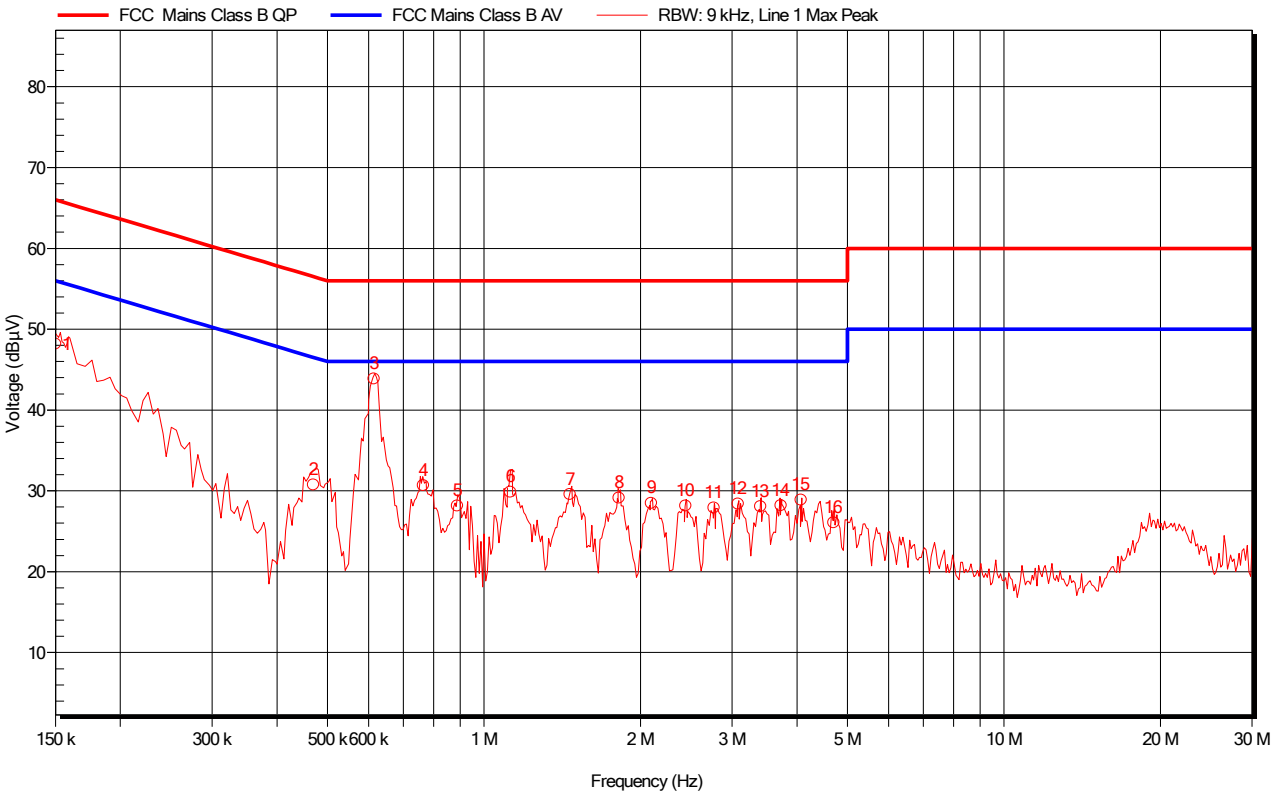
Frequency (MHz)	Average (dBµV)	Average Limit (dBµV)	Average Difference (dB)	Average Status	Quasi-Peak (dBµV)	Quasi-Peak Limit (dBµV	Quasi-Peak Difference (dB)	Quasi-Peak Status
0.150	35.7	56.0	-20.35	Pass	45.8	66.0	-20.19	Pass
0.475	20.8	46.4	-25.60	Pass	28.0	56.4	-28.45	Pass
0.615	33.3	46.0	-12.71	Pass	40.4	56.0	-15.56	Pass
0.765	19.1	46.0	-26.86	Pass	26.2	56.0	-29.83	Pass
0.890	16.8	46.0	-29.18	Pass	23.7	56.0	-32.27	Pass
1.118	17.8	46.0	-28.16	Pass	25.1	56.0	-30.92	Pass



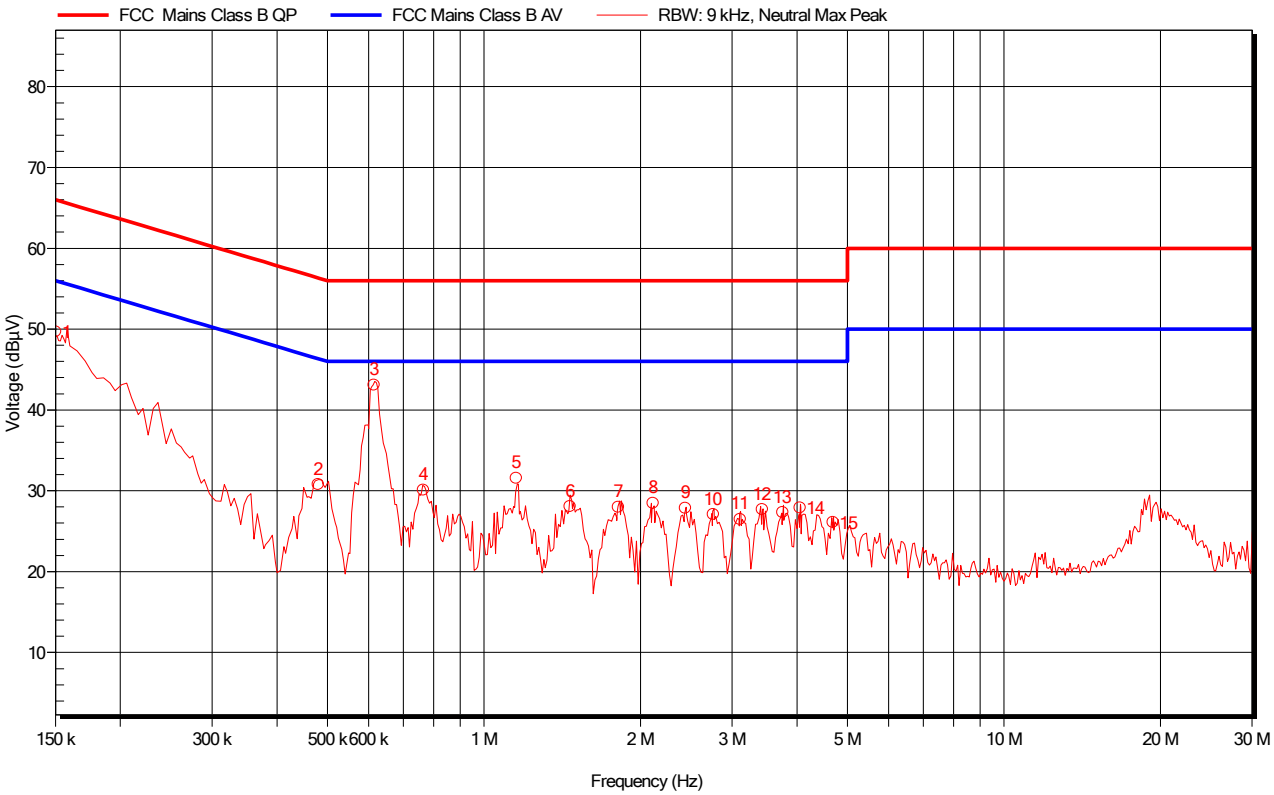
AC mains conducted emissions – Peak detector scan. Operating on channel 1 OFDM modulation – Live



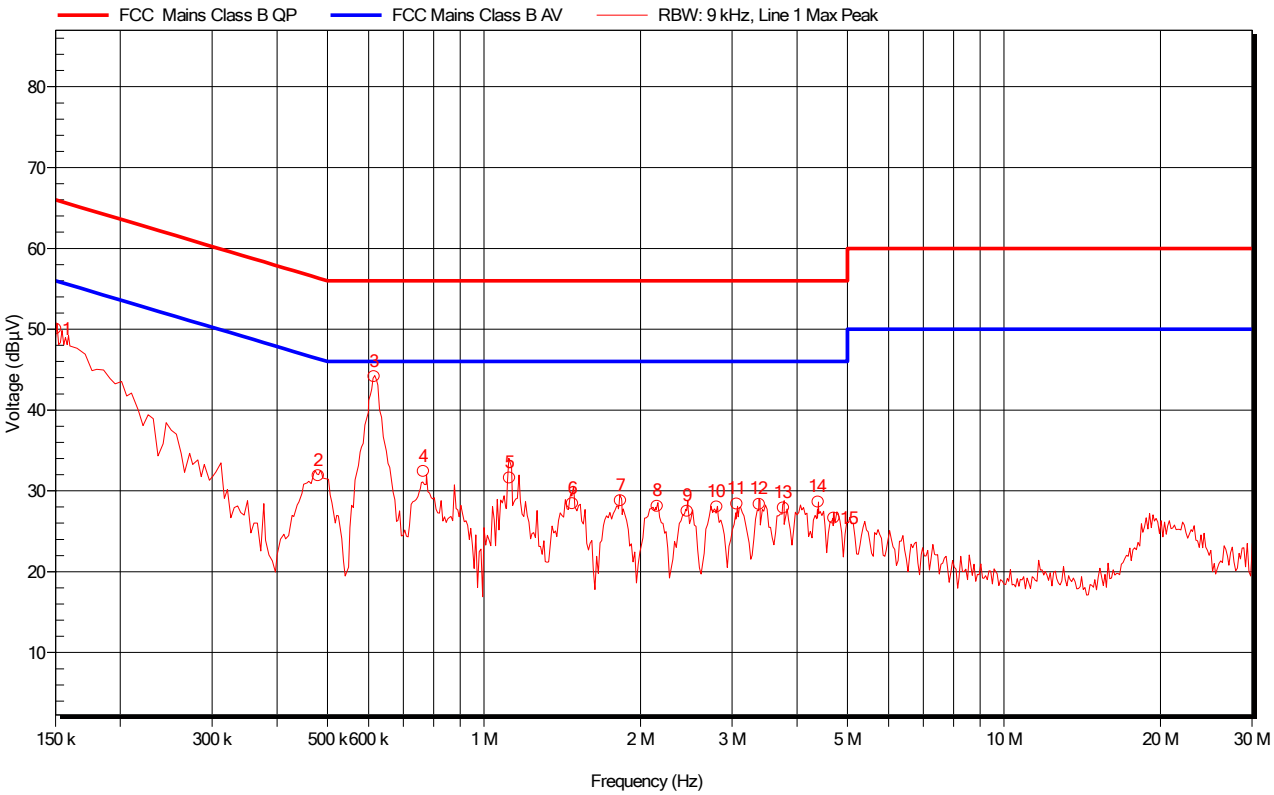
AC mains conducted emissions – Peak detector scan. Operating on channel 1 OFDM modulation – Neutral



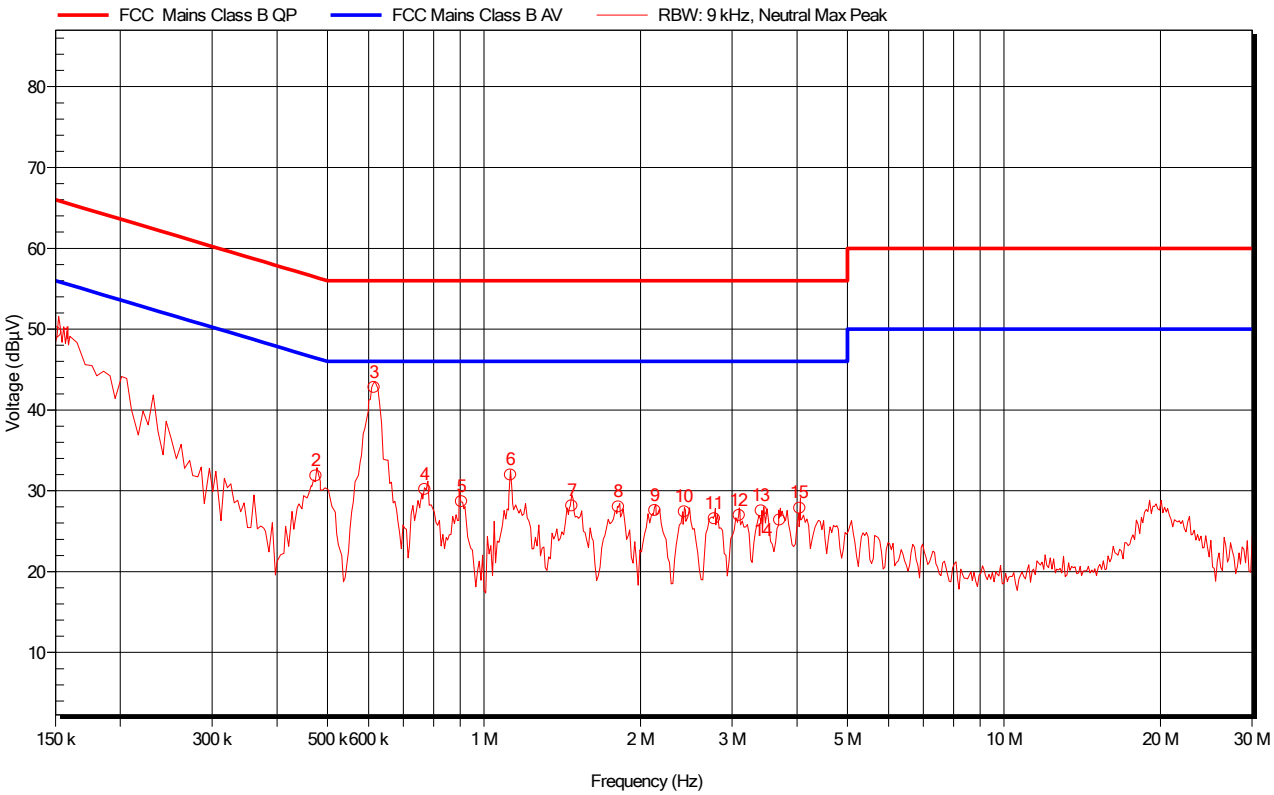
AC mains conducted emissions – Peak detector scan. Operating on channel 5 CCK modulation – Live



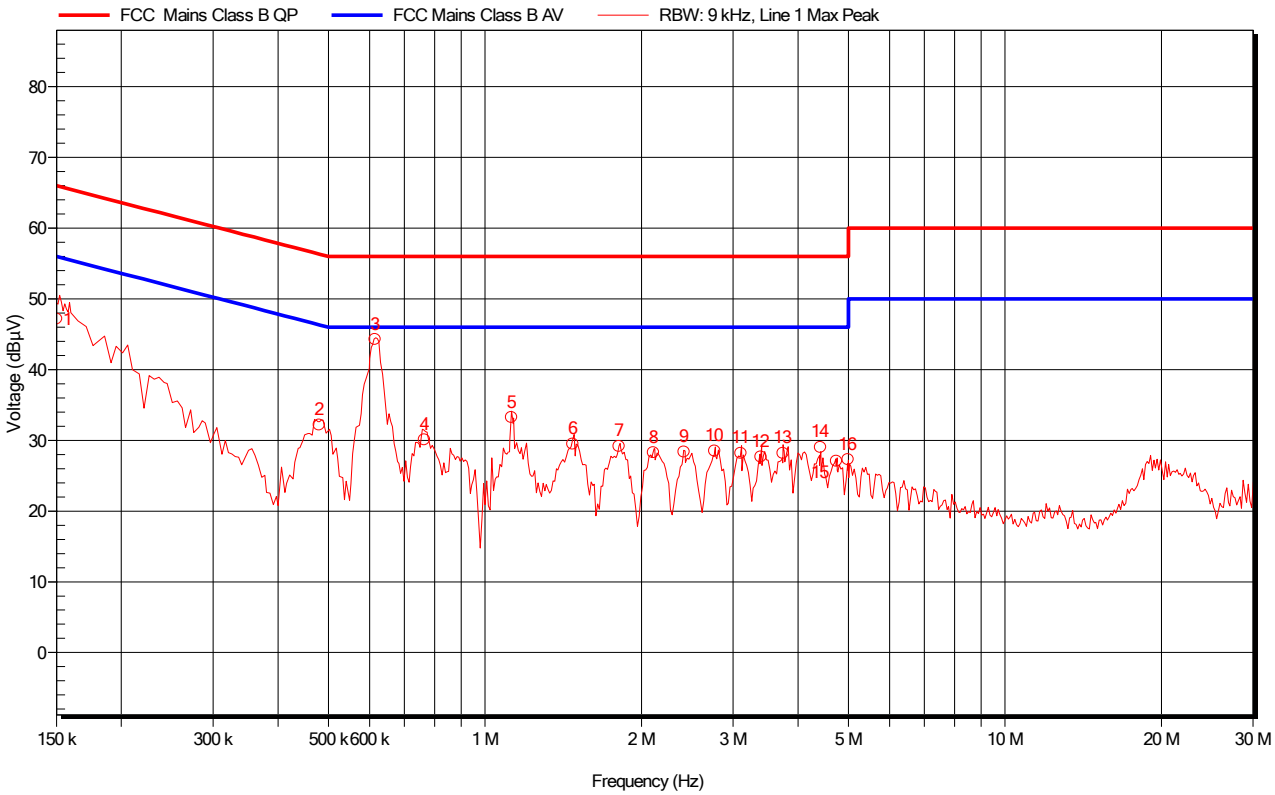
AC mains conducted emissions – Peak detector scan. Operating on channel 5 CCK modulation – Neutral



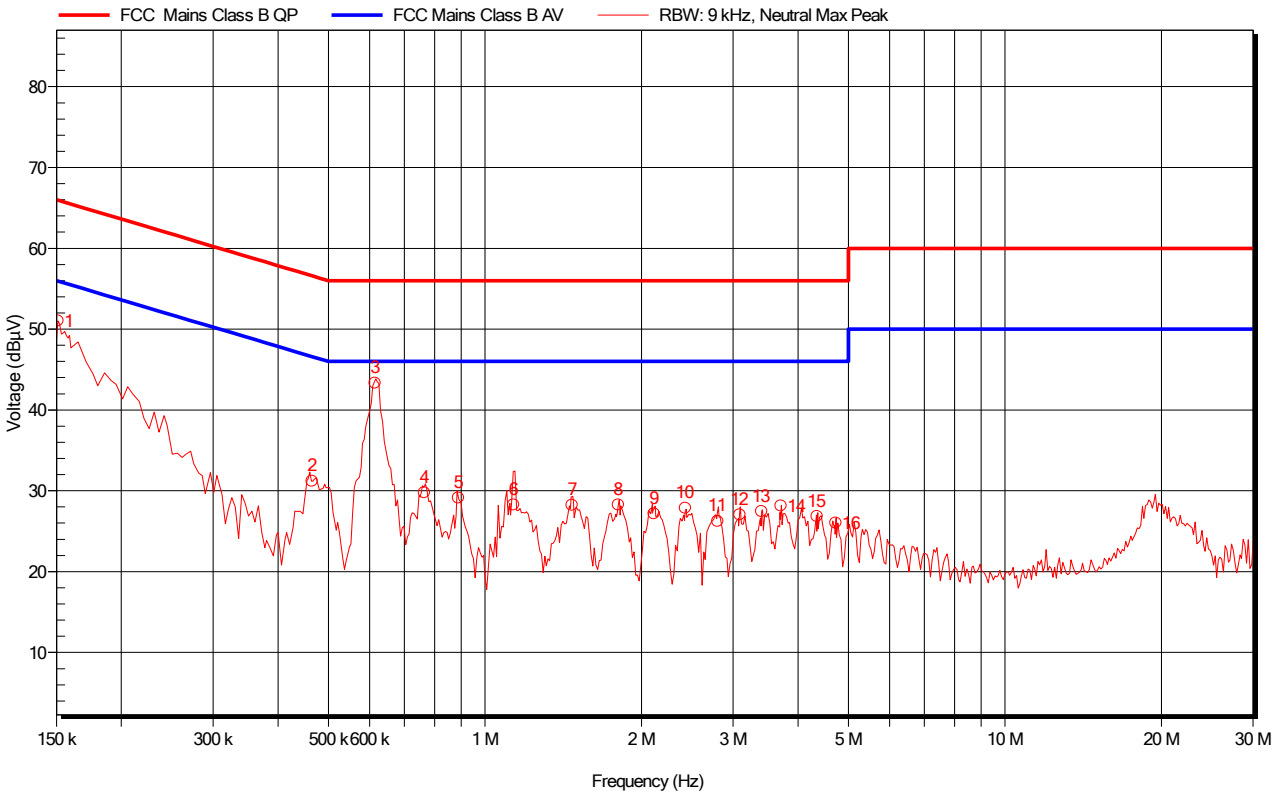
AC mains conducted emissions – Peak detector scan. Operating on channel 5 OFDM modulation – Live



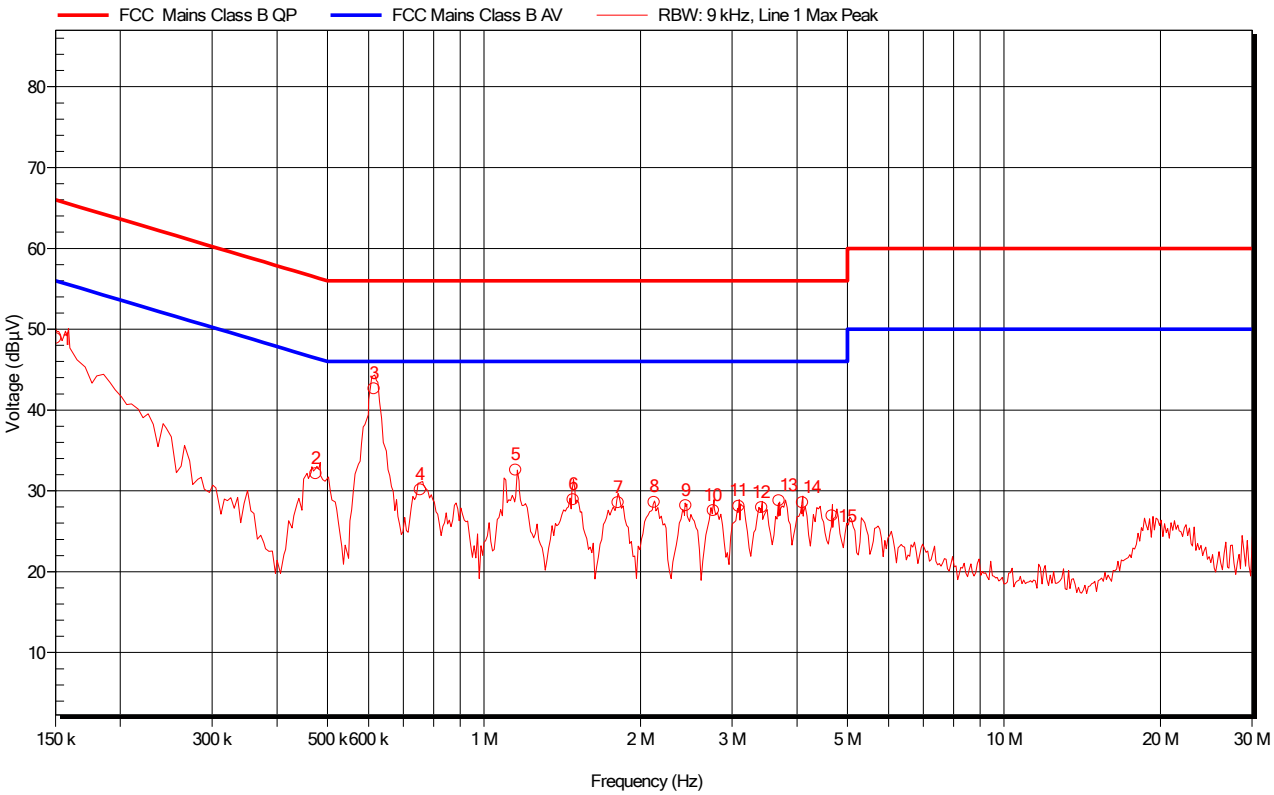
AC mains conducted emissions – Peak detector scan. Operating on channel 5 OFDM modulation – Neutral



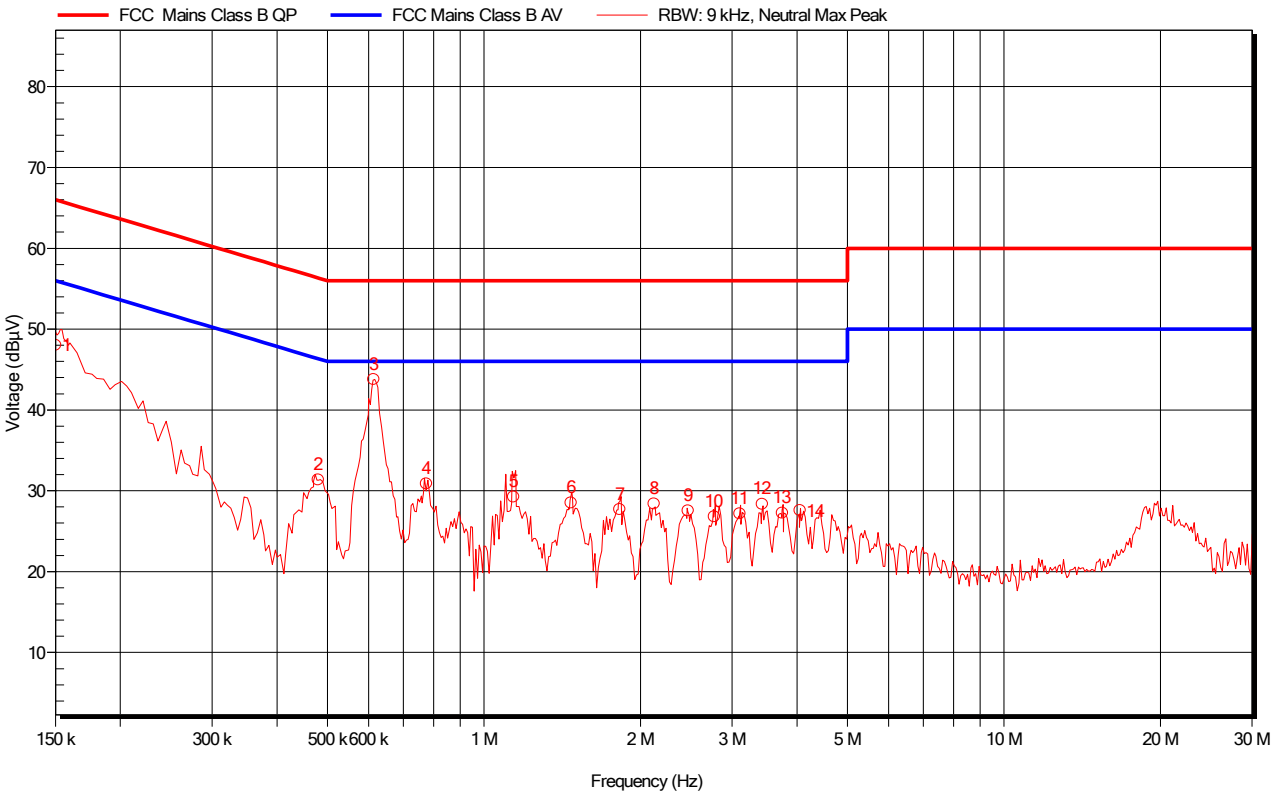
AC mains conducted emissions – Peak detector scan. Operating on channel 11 CCK modulation – Live



AC mains conducted emissions – Peak detector scan. Operating on channel 11 CCK modulation – Neutral



AC mains conducted emissions – Peak detector scan. Operating on channel 11 OFDM modulation – Live



AC mains conducted emissions – Peak detector scan. Operating on channel 11 OFDM modulation – 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 1.135 MHz

ASL (dBµV) = 25.90dBµV = 15.46BµV + 0.44dB + 0.10dB + 9.90dB

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 9	January 2021	12 Months
Keysight MXE EMI Receiver	MY51210185	19th October 2020	12 Months

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 ESR	C0499	26th January 2021	12 Months
Chase CBL6112B Bilog Antenna, 78167	1503	13th December 2019	36 Months
6dB Attenuator (For use with Bilog Antenna)	78708B	13th December 2019	36 Months
HF26 Cable	167003-001	14th February 2020	12 Months
HF17 Cable	167002-001	14th February 2020	12 Months
HF27 Cable	-	14th February 2020	12 Months
EMCO 3115 Horn Antenna 78347	9712-5380	25th May 2020	24 Months
BONN BLMA 0118-5A Preamplifier	149759	3rd March 2020	12 Months

AC Mains conducted emissions equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Rohde & Schwarz ESR7 Test receiver	-	26th January 2021	12 Months
Cables J7, J9 and LF3	-	January 2021	12 Months
Rohde & Schwarz ESH3-Z5 LISN 78119	-	25th January 2021	12 Months
Teseq CFL 9206A transient limiter 10dB 9kHz - 30MHz	-	6th January 2021	12 Months
Kikusui PCR2000M power supply	-	-	-