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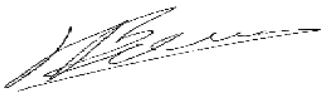
Test Report for the FCC and ISED Testing of a IceQube wireless sensor for IceRobotics Ltd

Test Report number: C14217TR3
Project number: C5985



Author: ....
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Approved: ....
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Laboratory Business Manager

Issue	Description						Issue by	Date
3	Copy 1		Copy 2		PDF	✓	CWG	6th September 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	13th July 2021	First Issue
2	27th August 2021	Second issue – modify set up diagram for radiated emissions 1-10GHz and to add note regarding EUT configuration without lastic case
3	6th September 2021	Additional of further radiated emission results.
4		
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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	IceRobotics Ltd
Address	Bankhead Steading
	Bankhead Road
	South Queensferry
	Midlothian
	EH30 9TF
	United Kingdom
Tel:	+44 131 541 2010
Contact	Mr Gavin Saxby
Email	g.saxby@icerobotics.com

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	12th March 2021		
Product Marketing Name (PMN):	IceQube wireless sensor		
Hardware Version Identification Number (HVIN)	I-QUBE		
FCCID	WWP-I-QUBE		
IC ID	8143A-IQUBE		
EUT description:	Wireless sensors intended to be fitted to the rear leg of cows. The sensors contain an accelerometer to monitor the animal's movements and routines.		
Operating frequency band	902 – 928 MHz		
No of units tested:	Six		
EUT power:	Battery Powered (1 x AA 1.5V battery)		
Highest internal frequency:	928 MHz		
RF module	CC1310 MCU		
RF module manufacturer	Texas Instruments		
RF module description	CC1310 MCU is a ultra-low power Sub 1 GHz RF device		
Transmission system	DTS		
Modulation scheme(s)	WB-DSSS		
Bandwidth	622 kHz		
Number of Channels	38		
Size of EUT (mm)	Width: 77 mm	Depth: 59 mm	Height: 27 mm
Mode/s of operation	Continuous transmit of packetised data at top, middle and bottom channels. RSS-GEN Annex A detail requirements: Test software Version 1.0 • Firmware to send a constant stream of synthetic, realistic data with constant duty cycle on the bottom channel. • Firmware to send a constant stream of synthetic, realistic data with constant duty cycle on the middle channel. • Firmware to send a constant stream of synthetic, realistic data with constant duty cycle on the top channel. • Firmware to send a constant, unmodulated carrier wave on channel 12.		
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. The product was tested without being potted into it send use enclosure.

Note:

The device had to be tested as a bare PCB because of the test modes the FCC required the device to be in to perform the measurements. Once the device is inside the housing and filled with epoxy resin, it is no longer possible to program the firmware (which needs to be done with a JTAG cable) to perform the tests, so the device had to be tested without the plastic enclosure.

The plastic casing was not considered to affect the test results.

3.4 EUT Monitoring/Auxiliary Equipment

None.

3.5 Monitoring Software

None. The channel required was selected and pre-set prior to the testing.

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 47CFR15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5875 MHz 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	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
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

4.1 Knowledge Database References

The following KDBs were referenced during the testing of the IceQube wireless sensor
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 IceQube wireless sensor, 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)
ISED Regulation	ISED RSS-247 § 5.5 and ISED RSS-GEN § 8.9
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

15th March 2021

5.3.3 Test Area

LAB 1 (SAC)

5.3.4 Tested by

M Render

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.

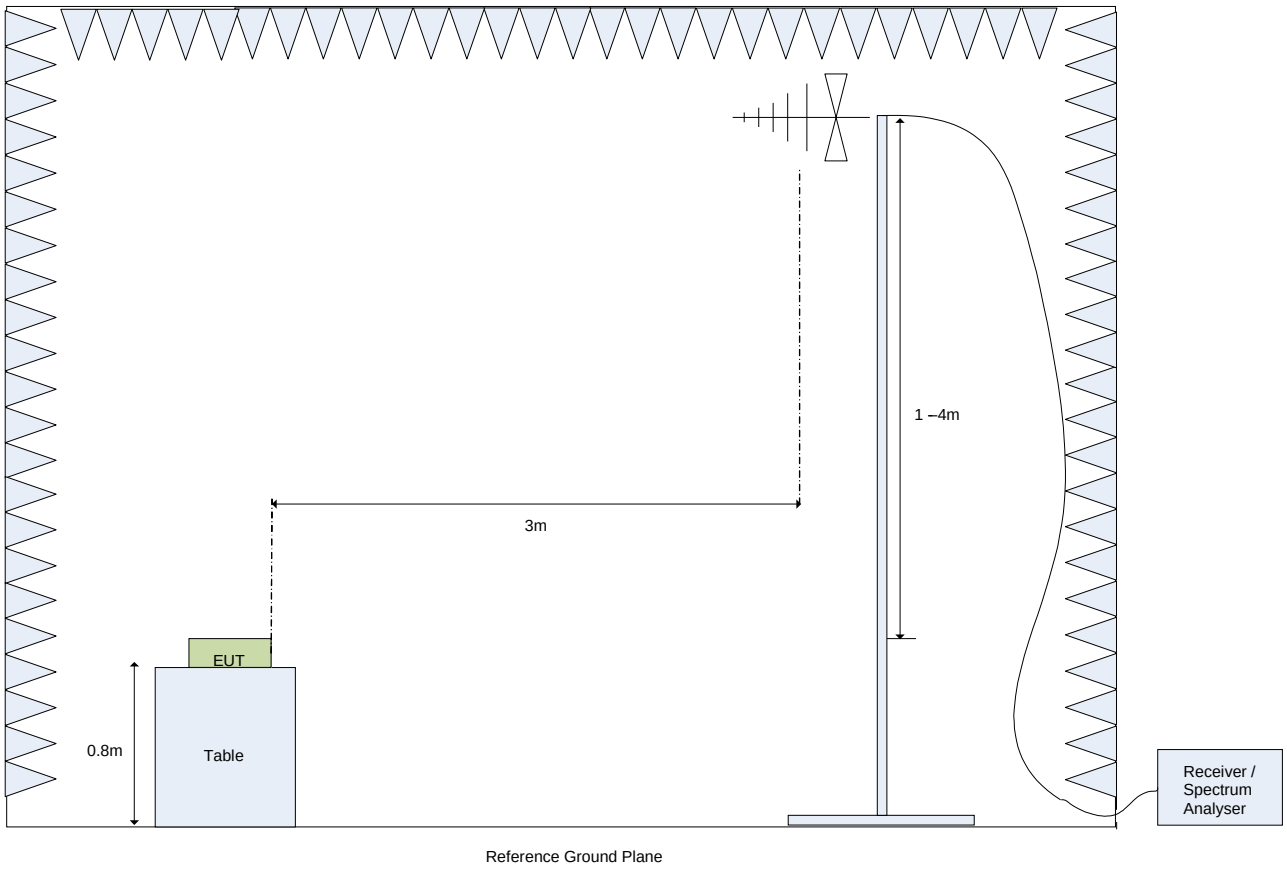


Figure 5.3.5.1: Test Setup for E-Field Measurements from 30MHz to 1GHz

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. Final measurements were performed with the equipment under test operating on the same mode.

Three orientations of the sample were tested using spectrum analyser. No significant difference was observed.

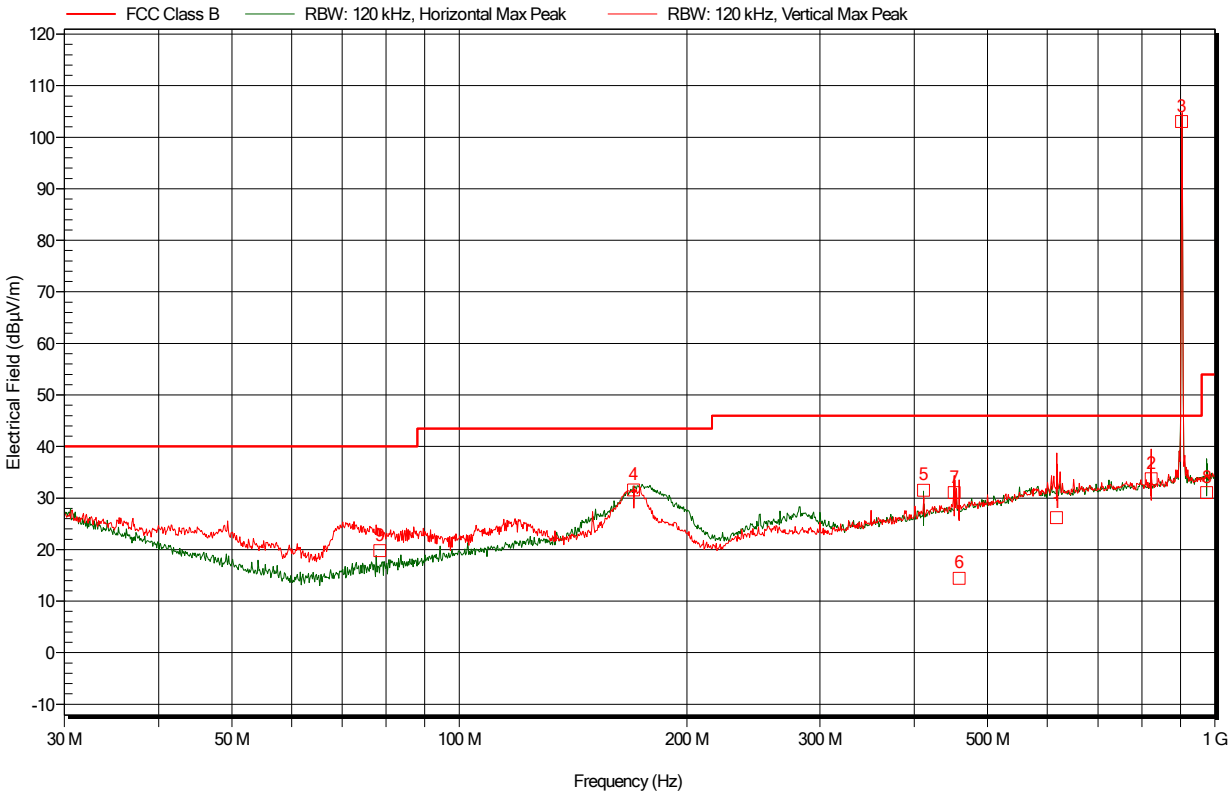


Figure 5.3.6.1: Electric field emissions Plot, 30MHz to 1GHz, operation on Bottom Channel – Peak detector scan

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
617.064	26.2	46.0	-19.8	Pass	285	1.0	Vertical
822.834	33.8	46.0	-12.2	Pass	260	1.4	Vertical
169.980	31.6	43.5	-11.9	Pass	210	1.1	Vertical
411.426	31.5	46.0	-14.5	Pass	140	1.0	Horizontal
458.460	14.4	46.0	-31.6	Pass	130	1.3	Vertical
451.614	31.0	46.0	-15.0	Pass	330	1.2	Vertical
974.946	31.1	54.0	-22.9	Pass	125	1.0	Horizontal
78.480	19.8	40.0	-20.2	Pass	105	1.0	Vertical

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

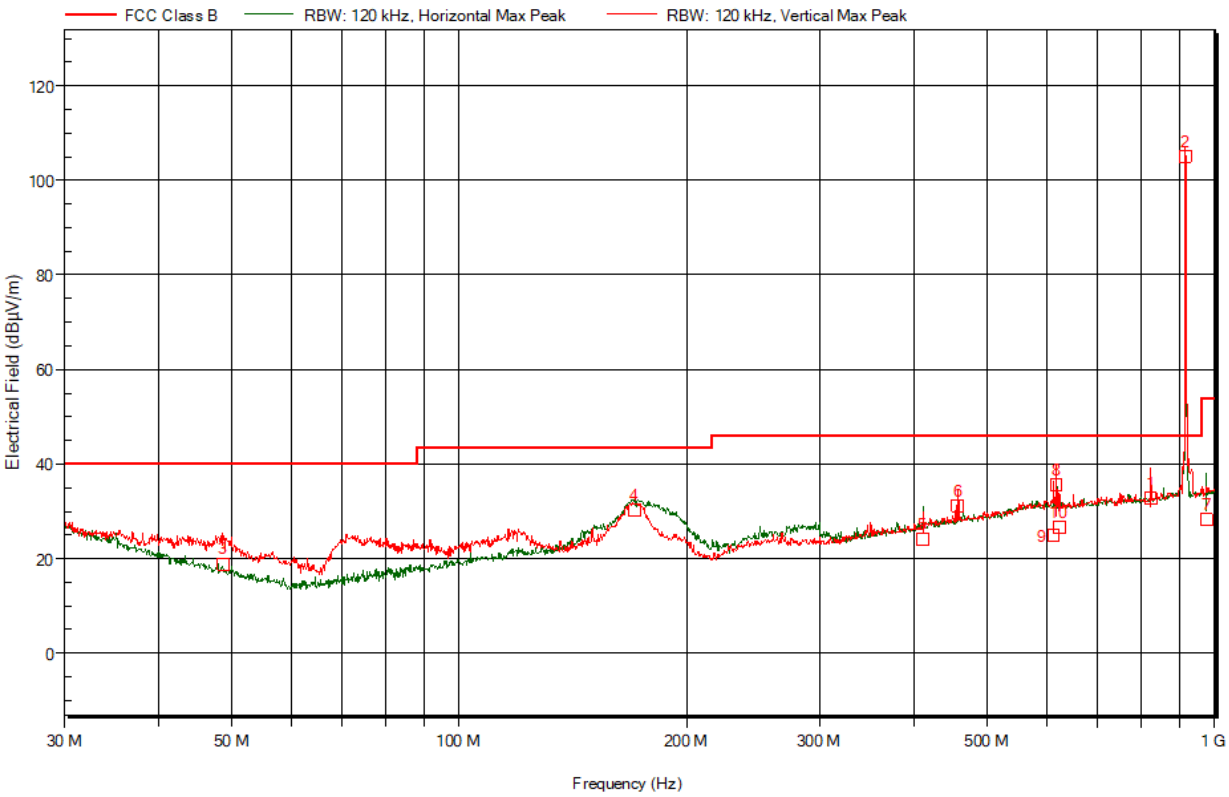


Figure 5.3.6.2: Electric field emissions Plot, 30MHz to 1GHz, operation on Middle Channel - Peak detector scan

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
822.816	32.7	46.0	-13.3	Pass	240	1.4	Vertical
48.780	18.9	40.0	-21.1	Pass	350	1.0	Vertical
171.000	30.2	43.5	-13.3	Pass	320	2.2	Horizontal
411.420	24.1	46.0	-21.9	Pass	190	1.4	Vertical
457.200	31.2	46.0	-14.8	Pass	335	1.2	Vertical
974.988	28.3	54.0	-25.7	Pass	120	1.1	Horizontal
617.118	35.7	46.0	-10.3	Pass	310	1.0	Vertical
611.880	24.9	46.0	-21.1	Pass	295	1.1	Vertical
622.680	26.6	46.0	-19.4	Pass	310	1.0	Vertical

Table 5.3.6.2: Electric Field Emission Peaks, 30MHz to 1GHz, operation on Middle Channel

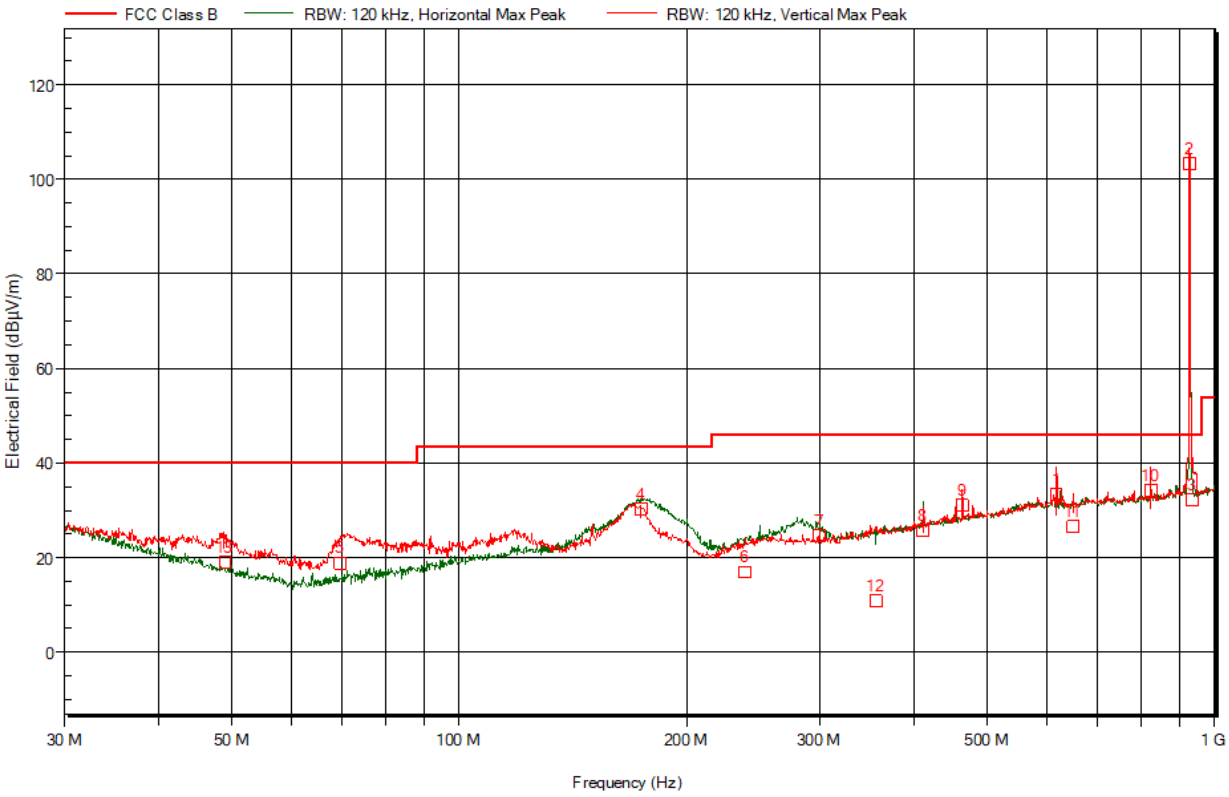


Figure 5.3.6.3: Electric field emissions Plot, 30MHz to 1GHz, operation on Top Channel - Peak detector scan

Frequency	Quasi-Peak	Quasi Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Angle	Height	Polarization
MHz	dBµV/m	dBµV/m	dB		degrees	m	
617.136	33.4	46.0	-12.6	Pass	275	1.7	Vertical
933.840	32.3	46.0	-13.7	Pass	5	1.6	Vertical
174.000	30.3	43.5	-13.2	Pass	200	1.1	Vertical
69.600	18.9	40.0	-21.1	Pass	105	1.0	Vertical
238.860	16.9	46.0	-29.1	Pass	350	1.1	Horizontal
299.988	24.5	46.0	-21.5	Pass	160	1.3	Horizontal
411.420	25.7	46.0	-20.3	Pass	200	1.4	Vertical
463.140	31.1	46.0	-14.9	Pass	325	1.2	Vertical
822.834	34.2	46.0	-11.8	Pass	240	1.4	Vertical
649.998	26.5	46.0	-19.5	Pass	40	1.7	Vertical
356.220	10.8	46.0	-35.2	Pass	225	2.3	Horizontal
49.020	18.9	40.0	-21.1	Pass	265	1.1	Vertical

Table 5.3.6.3: Electric Field Emission Peaks, 30MHz to 1GHz, operation on Top Channel

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 617.064 MHz is calculated as follows:

FS (dBµV/m) = -0.9 (dBµV) + 24.5 (dB/m) + 2.6 (dB) = 26.2 dBµV/m

5.4 Radiated Emissions (1GHz to 10GHz)

5.4.1 Limits

Frequency (GHz)	Limit (dBµV/m)	Limit (dBµV/m)
	Peak	Average
1-10	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 Date of Test

25th March 2021

5.4.4 Test Area

LAB 1 (SAC)

5.4.5 Tested by

M Render

5.4.6 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 5.4.7.

The measurement was then performed with an antenna to EUT separation distance of 1m. The measurements were extrapolated to values at 10m using:

$$\text{Extrapolation} = 1010g_{10}(1/3) = -9.54\text{dB}$$

For operation of the test software, this value was included with the antenna factor.

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.

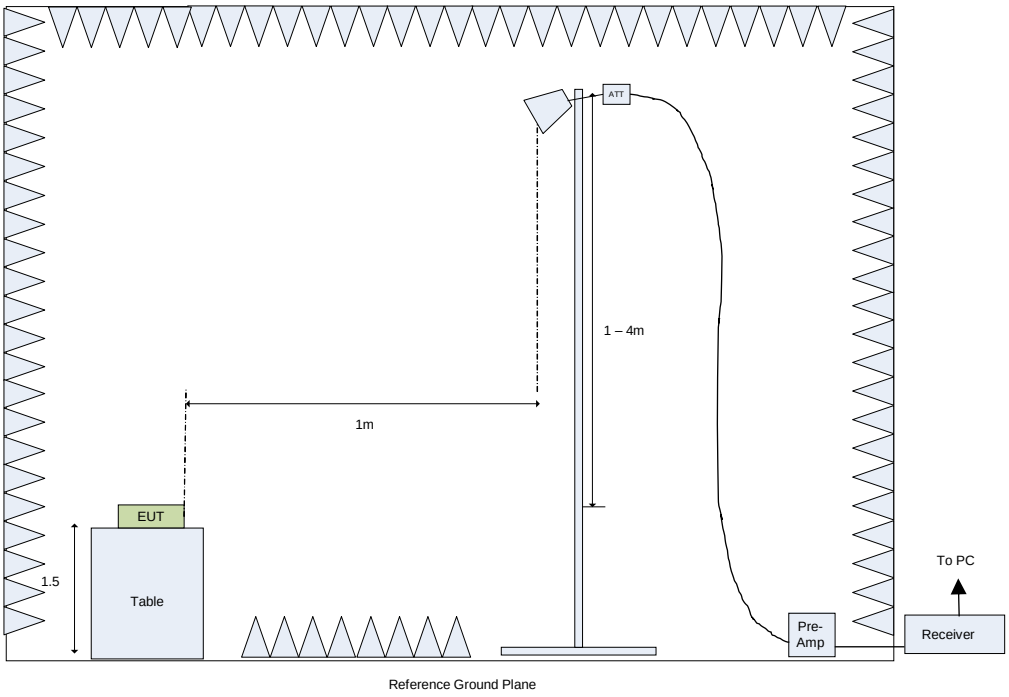


Figure 5.4.6.1: Test Setup for Final E-Field Measurements from 1GHz to 10GHz

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)	EUT face *	Emissions Angle (w.r.t. turntable)	Height	Polarization
4.57	Front	-	-	Vertical
6.40	Front	-	-	Horizontal
2.75	Front	-	-	Horizontal
5.49	Front	-	-	Vertical
1.83	Front	-	-	Vertical

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°.

Note 2: The equipment was operated on all 3 channels. The same frequencies were identified for each channel.

5.4.8 Electric field emissions, 1GHz to 10GHz

The equipment under test was pre-scanned using peak detection when operating on all three channels. Final measurements were performed with the equipment under test operating on the middle channel.

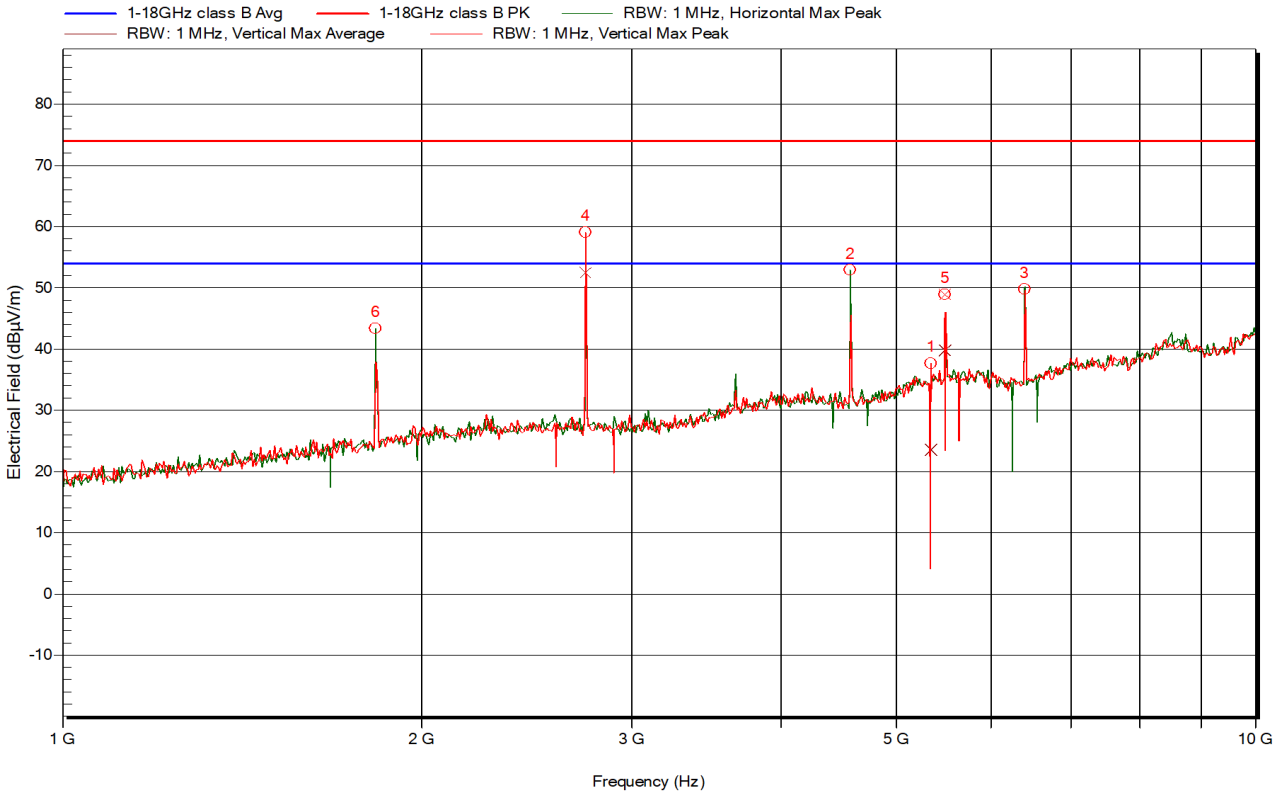


Figure 5.4.8.1: Electric field emissions Plot, 1GHz to 10GHz. Operation on Middle Channel – Peak detector scan

Frequency	Peak Det.	Peak Limit	Peak Difference	Peak Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
5.341	37.61	74.0	-36.39	Pass	10	1.7	Vertical
4.571	52.91	74.0	-21.09	Pass	25	2.1	Horizontal
6.402	49.74	74.0	-24.26	Pass	20	1.0	Horizontal
2.744	59.06	74.0	-14.94	Pass	335	1.5	Vertical
5.488	48.91	74.0	-25.09	Pass	30	2.3	Vertical
1.828	43.32	74.0	-30.68	Pass	290	1.8	Horizontal

Table 5.4.8.1: Electric Field Emissions Peaks, 1GHz to 10GHz – Operation on Middle Channel

Frequency	Average Det.	Average Limit	Average Difference	Average Status	Angle	Height	Polarization
GHz	dBµV/m	dBµV/m	dB		degrees	m	
5.341	23.56	54.0	-30.44 dB	Pass	10	1.7	Vertical
4.571	44.76	54.0	-9.24 dB	Pass	25	2.1	Horizontal
6.402	39.12	54.0	-14.88 dB	Pass	20	1.0	Horizontal
2.744	52.47	54.0	-1.53 dB	Pass	335	1.5	Vertical
5.488	39.78	54.0	-14.22 dB	Pass	30	2.3	Vertical
1.828	36.38	54.0	-17.62 dB	Pass	290	1.8	Horizontal

Table 5.4.8.2: Electric Field Emissions Average Detector, 1GHz to 10GHz – Operation on Middle Channel

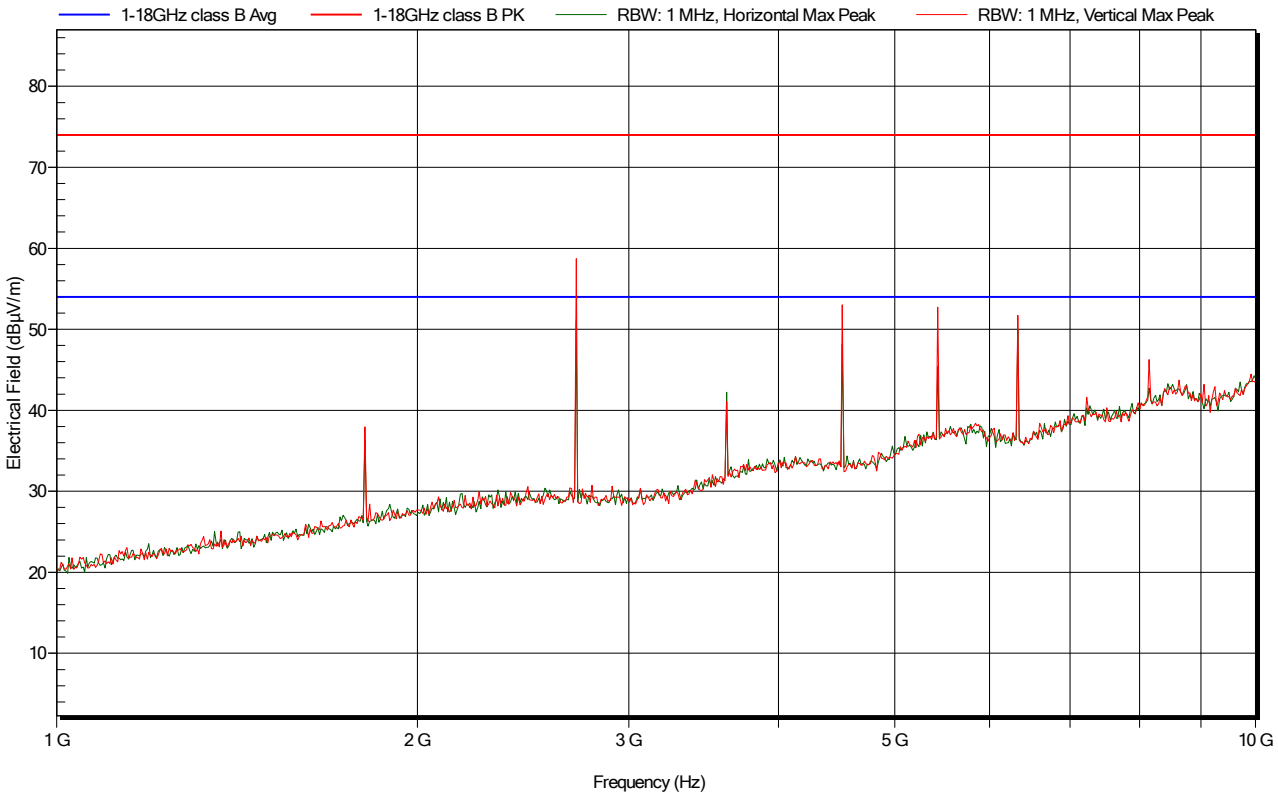


Figure 5.4.8.2: Electric field emissions Plot, 1GHz to 10GHz, Operation on Bottom Channel - Peak detector scan

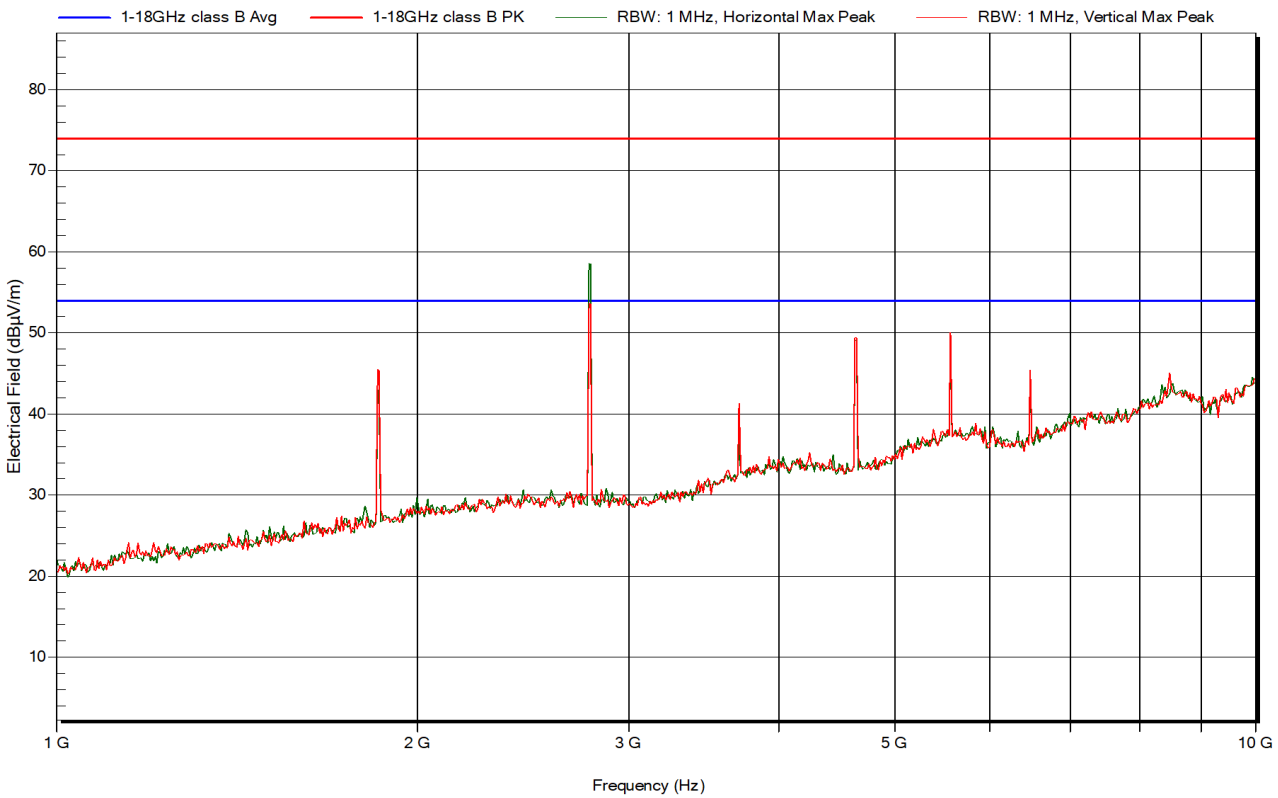


Figure 5.4.8.3: Electric field emissions Plot, 1GHz to 10GHz, Operation on Top Channel – Peak detector scan

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);, Cable loss (CL) and 1-3m distance extrapolation (combined with the antenna factor in the test software).

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 5.4.8.1 and table 5.4.8.1, The Average level at 5.341GHz is calculated as follows:

FS (dBµV/m) = 44.10 (dBµV) -50.84 (dB) +36.30 (dB/m) +8.05 (dB) = 37.61 dBµV/m

5.5 Conducted Spurious Emissions 30MHz to 10GHz

5.5.1 Limits

Frequency (MHz)	Limit, 47CFR 15.247(d)
	Peak
30 – 10000	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	10000MHz
Resolution Bandwidth	100kHz
Video Bandwidth	300kHz
Sweep rate	Auto couple
Trace mode	Max hold

5.5.2 Date of Test

15th March 2021

5.5.3 Test Area

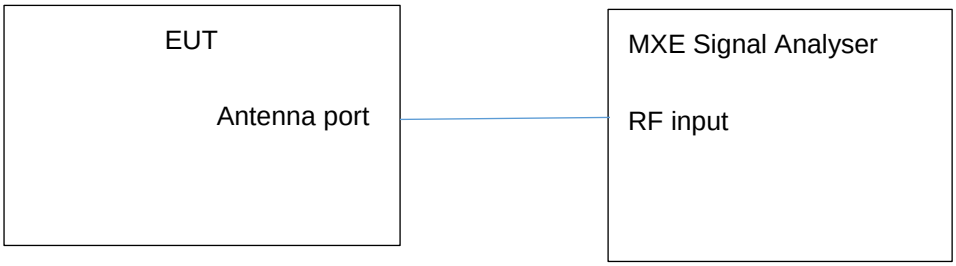
LAB 7

5.5.4 Tested by

M Render

5.5.5 Test Setup

The antenna port was connected directly to the signal analyser.

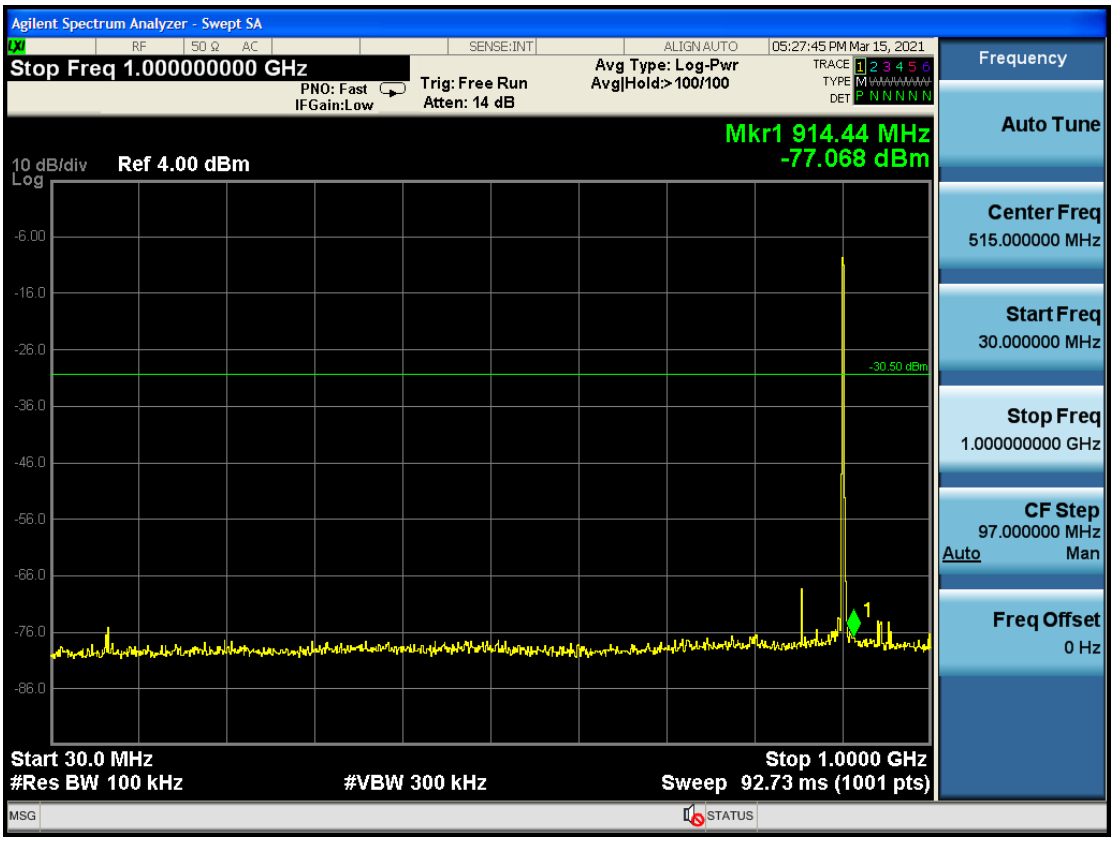


5.5.6 Test Results

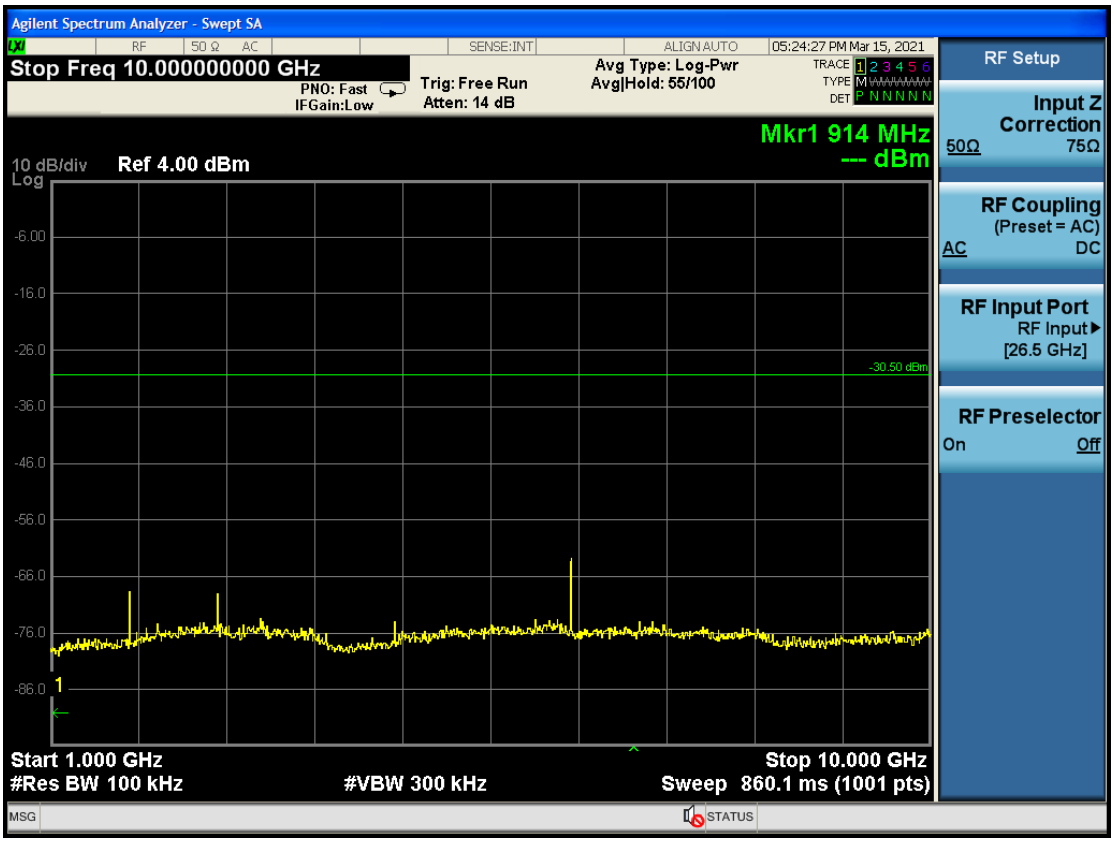
The results of the conducted spurious emissions are stated below and by the signal analyser images.

All disturbances detected were > 20dB below the carrier.

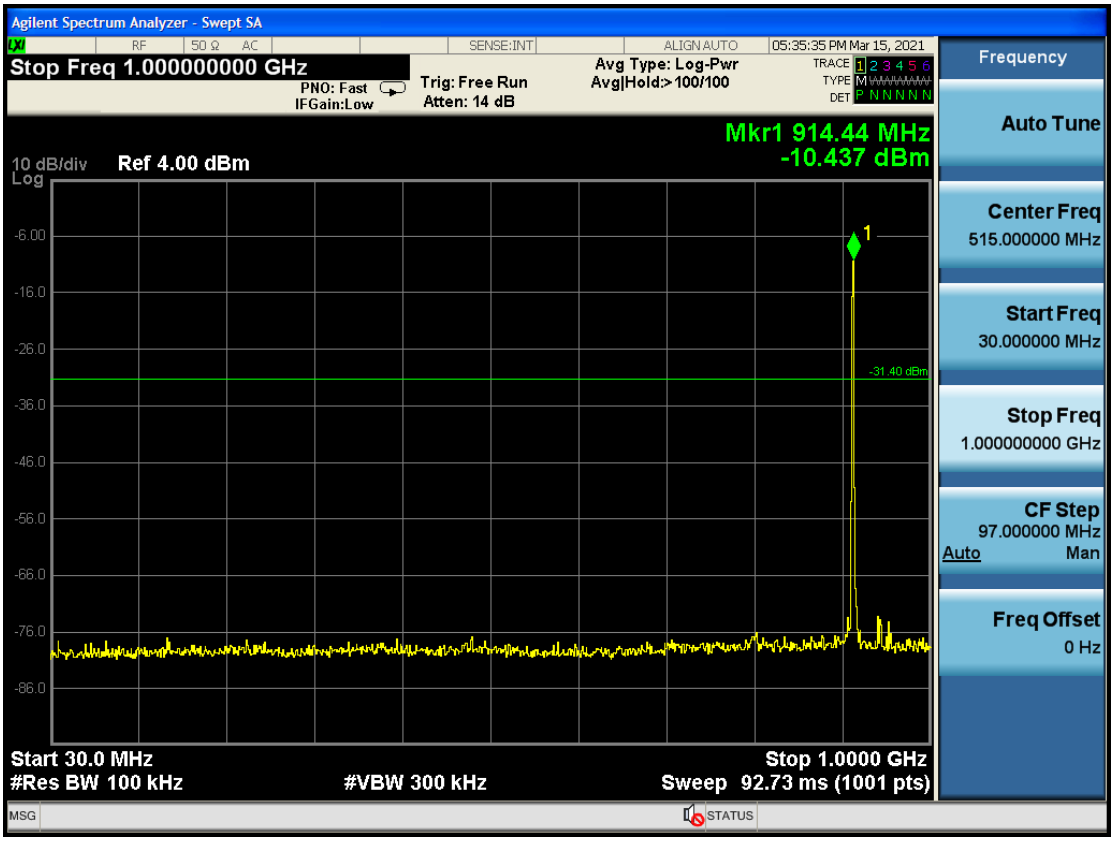
Antenna port conducted emissions 30MHz to 10GHz



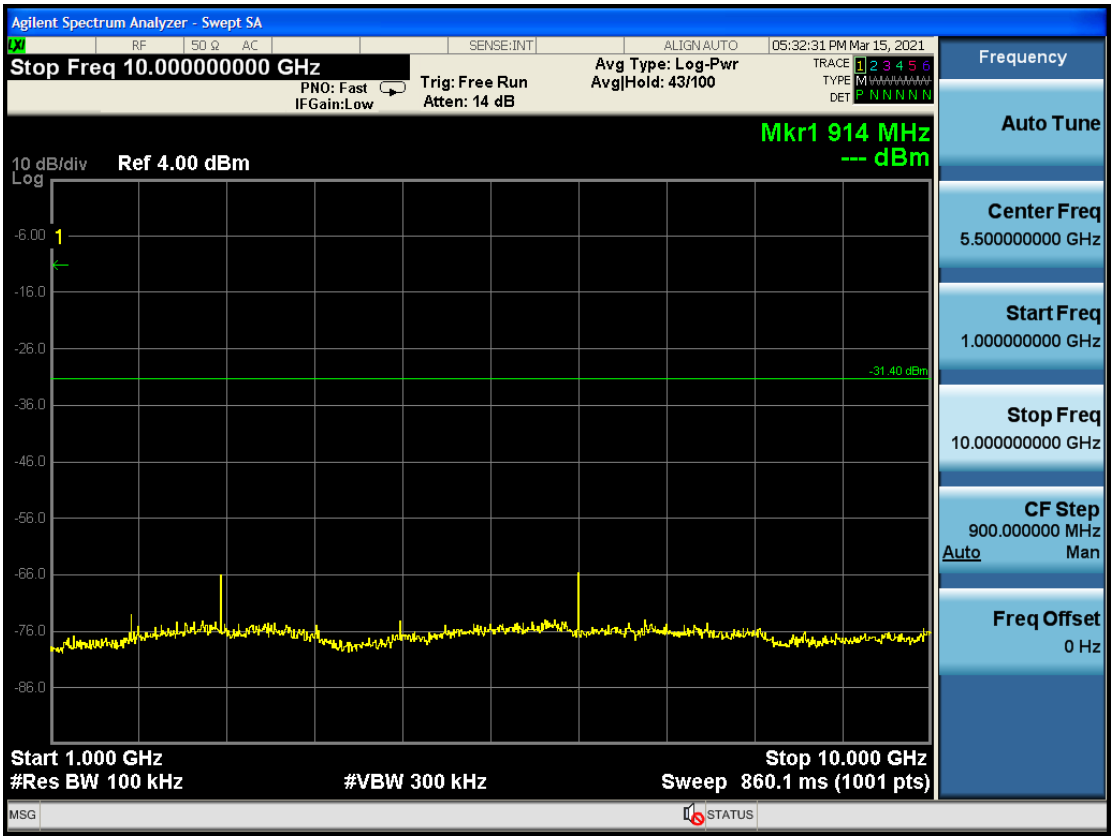
Conducted emissions 30MHz to 1GHz. Operation on Bottom channel.



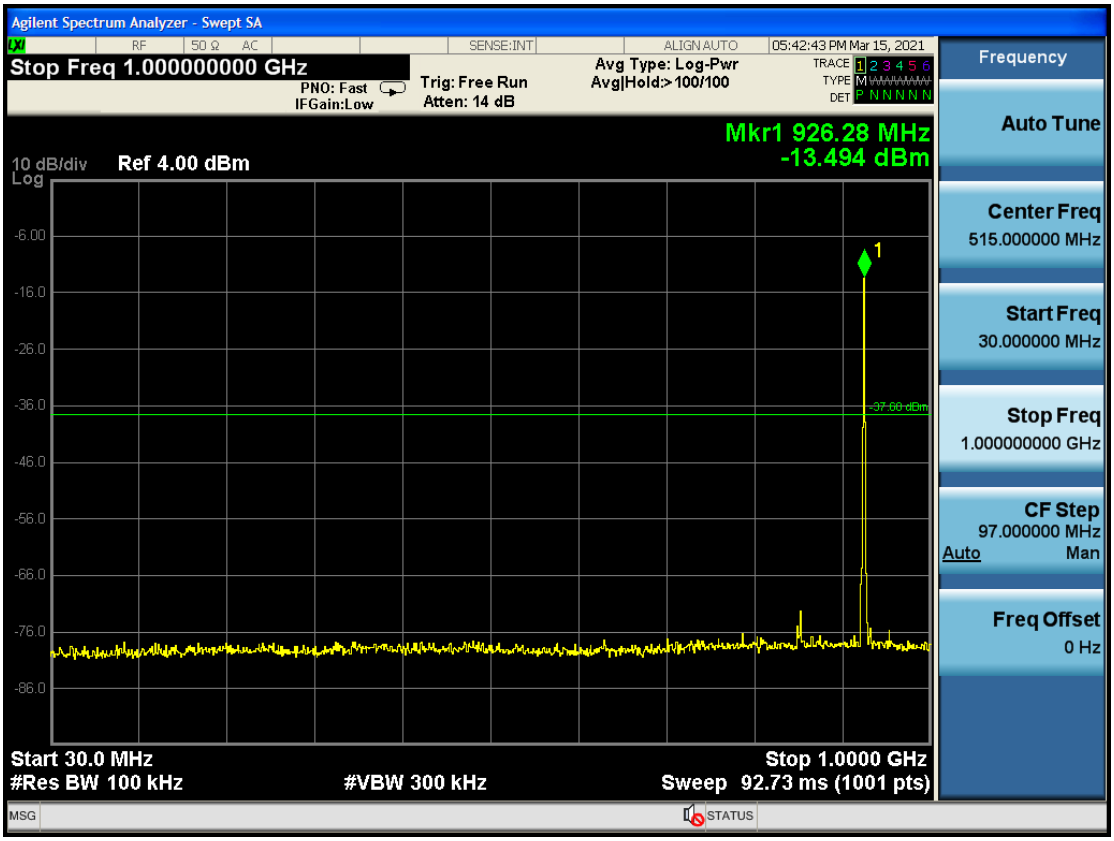
Conducted emissions 1GHz to 10GHz. Operation on Bottom channel.



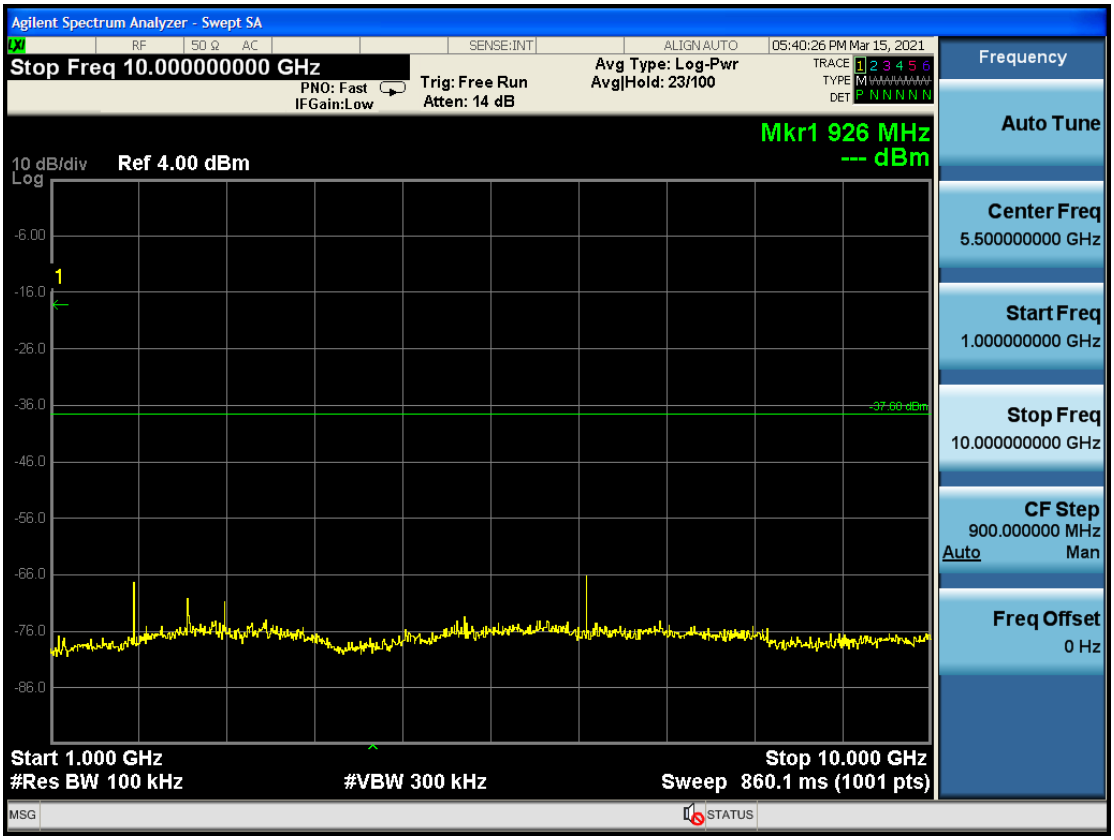
Conducted emissions 30MHz to 1GHz. Operation on Middle channel.



Conducted emissions 1GHz to 10GHz. Operation on Middle channel.



Conducted emissions 30MHz to 1GHz. Operation on Top channel.



Conducted emissions 1GHz to 10GHz. Operation on Top channel.

Section 6 6dB Bandwidth and 99% Occupied Bandwidth

6.1 Test Specification

FCC Rule Part	47CFR 15.247 (a)(2)
ISED Regulation	ISED RSS-247 § 5.2 and RSS-Gen 6.6
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

15th March 2021

6.2.2 Test Area

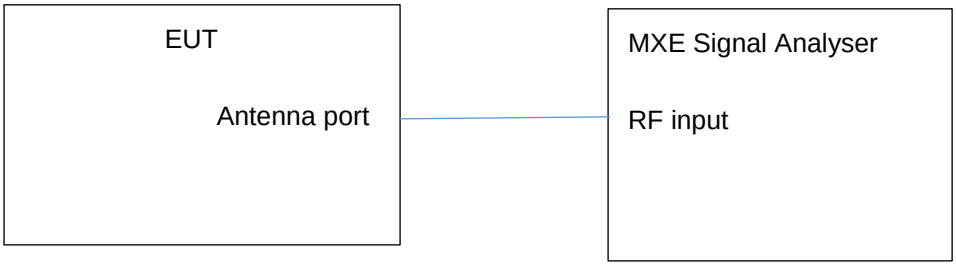
LAB 7

6.2.3 Tested by

M Render

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 (kHz)	Minimum requirement (kHz)	99% Occupied bandwidth (kHz)	Figure	Result
903.2	WB-DSSS	559.1	500.0	792.91	6.3.1	Pass
914.4	WB-DSSS	563.1	500.0	817.06	6.3.2	Pass
926.3	WB-DSSS	552.1	500.0	752.84	6.3.3	Pass

6dB and 99% Bandwidth Measurements

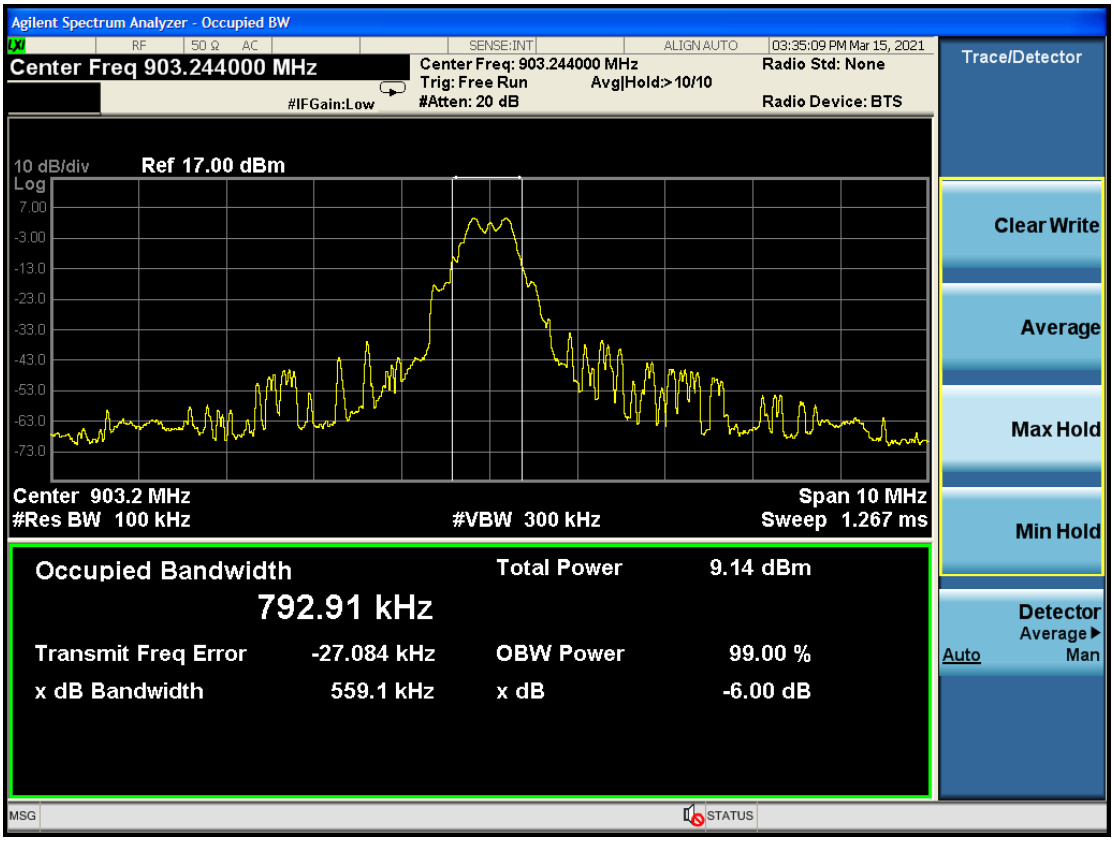


Figure 6.3.1 Bandwidth at 6dB Point. Operation on Bottom Channel

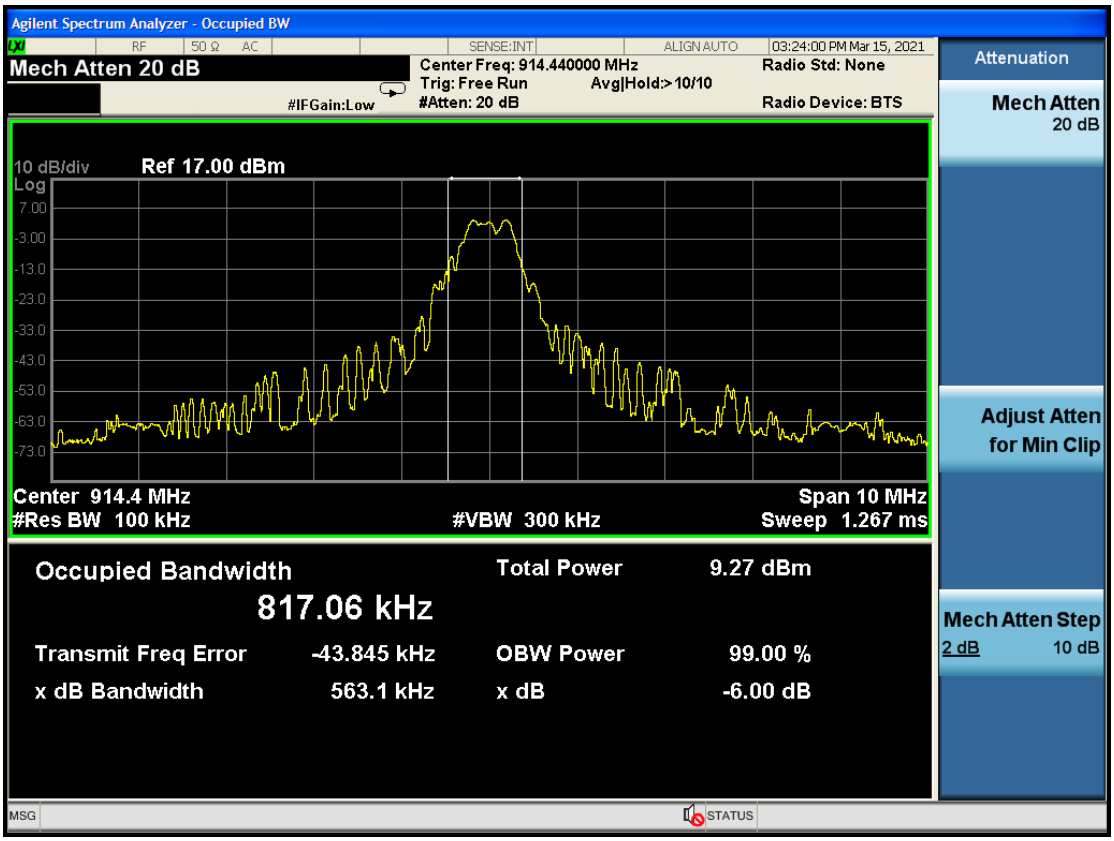


Figure 6.3.2 Bandwidth at 6dB Point. Operation on Middle Channel

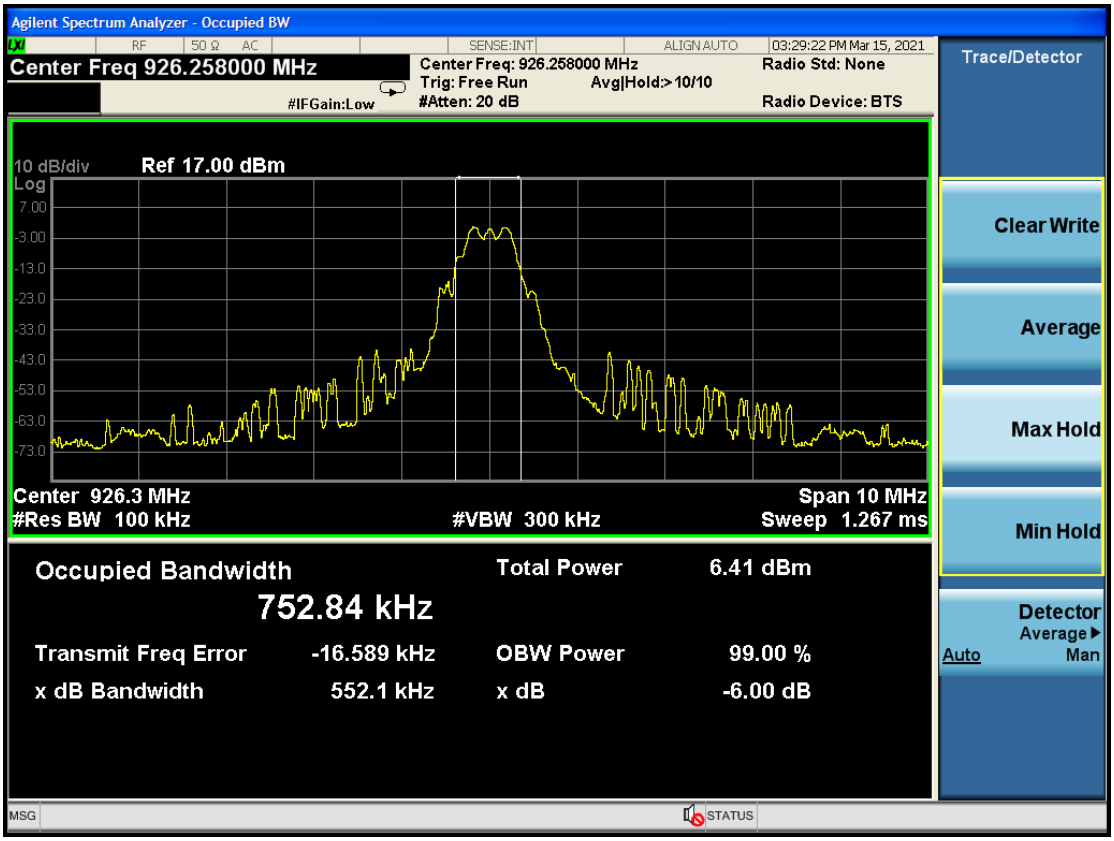


Figure 6.3.3 Bandwidth at 6dB Point. Operation on Top Channel

Section 7 Peak Output Power

7.1 Test Specification

FCC Rule Part	47CFR 15.247 (b)(3)
ISED Regulation	ISED RSS-247 § 5.4
Standard	ANSI C63.10:2013

7.2 Procedure and Test Software Version

Conducted Tests

ANSi C63.10-2013 Clause reference:	11.9.1.1 (RBW ≥ DTS bandwidth method)
Test software	Keysight Connection Expert

Frequency (MHz)	**Limit, 47CFR 15.247(b)(2)**
	Peak
902 MHz to 928 MHz	1 Watt

Spectrum analyser settings as specified by ANSI C63.10-2013 Clause 11.9.1.1

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

7.2.1 Date of Test

15th March 2021

7.2.2 Test Area

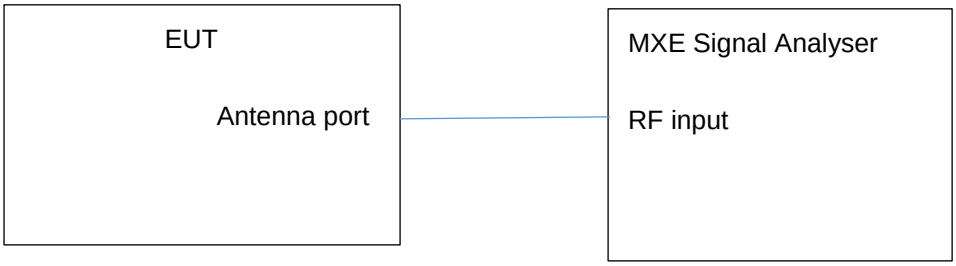
LAB 7

7.2.3 Tested by

M Render

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 (mW)	Limit (Watts)	Figure
903.2	WB-DSSS	0.081	1.0	7.3.1
914.4	WB-DSSS	0.065	1.0	7.3.2
926.3	WB-DSSS	0.024	1.0	7.3.3

Peak Output Power Measurement

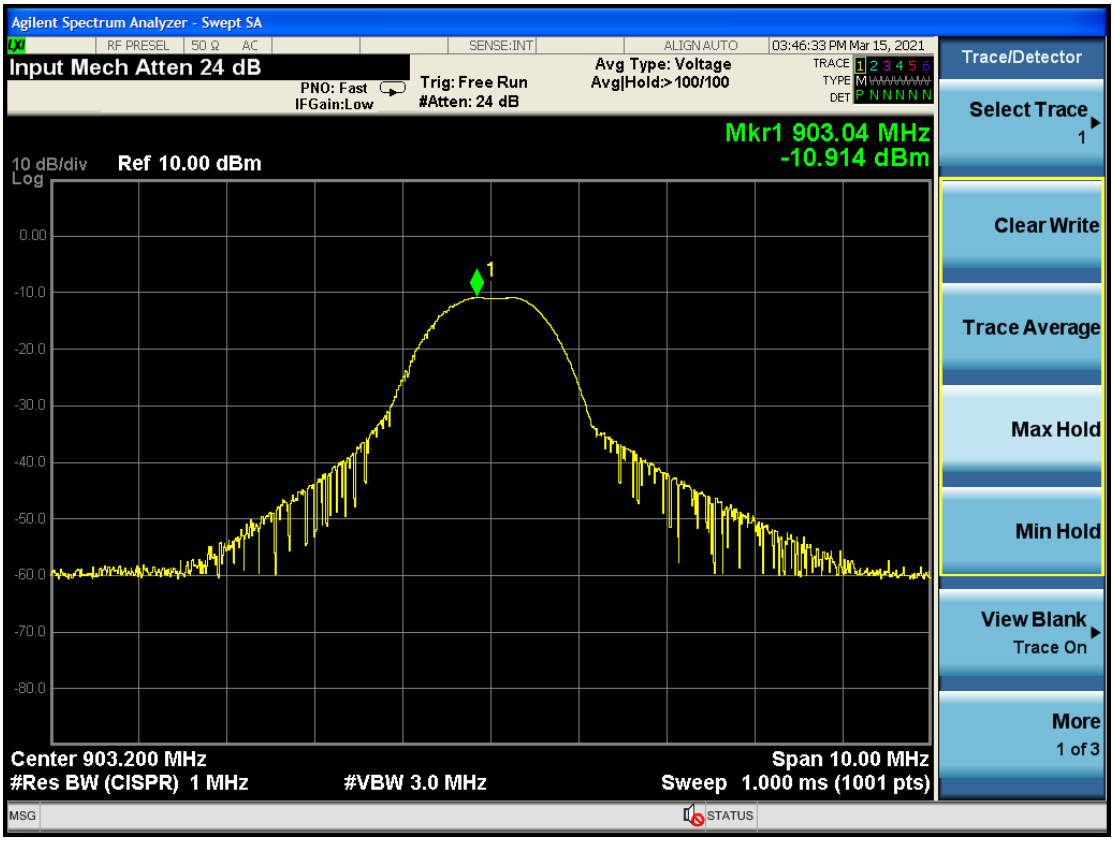


Figure 7.3.1 Peak output power. Operation on Bottom channel

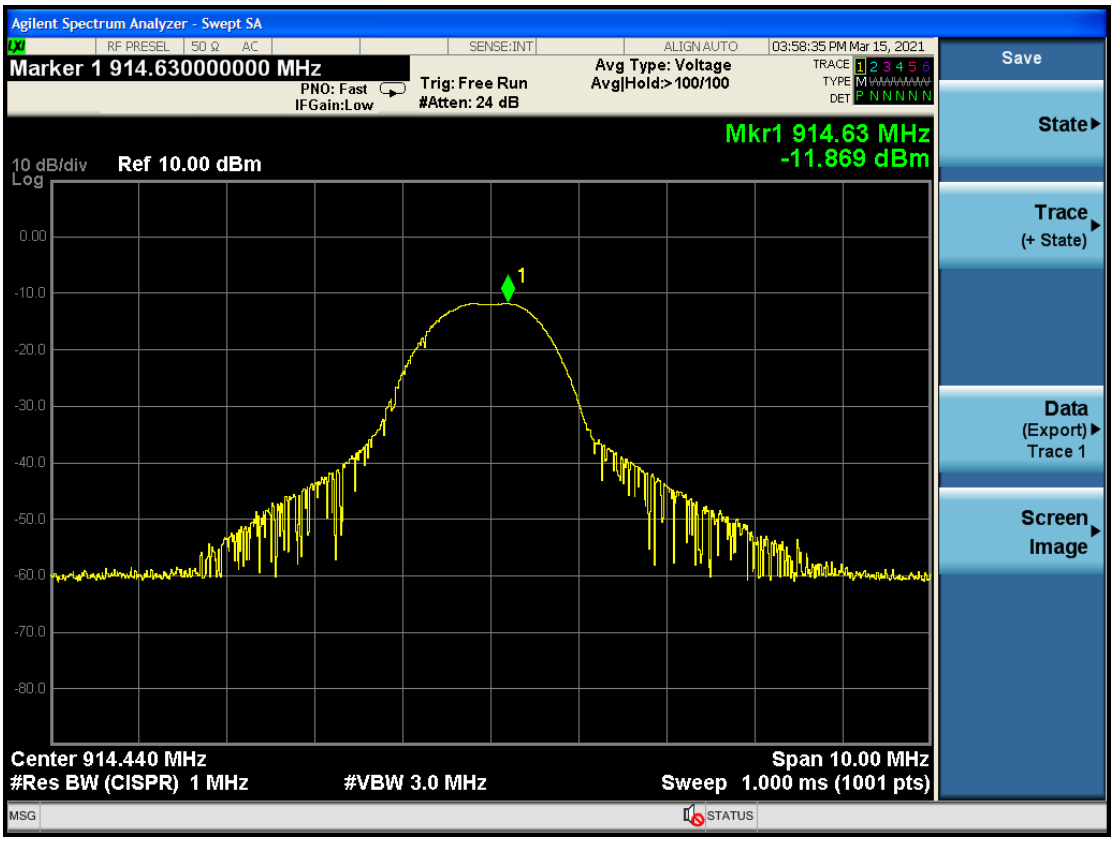


Figure 7.3.2 Peak output power. Operation on Middle channel

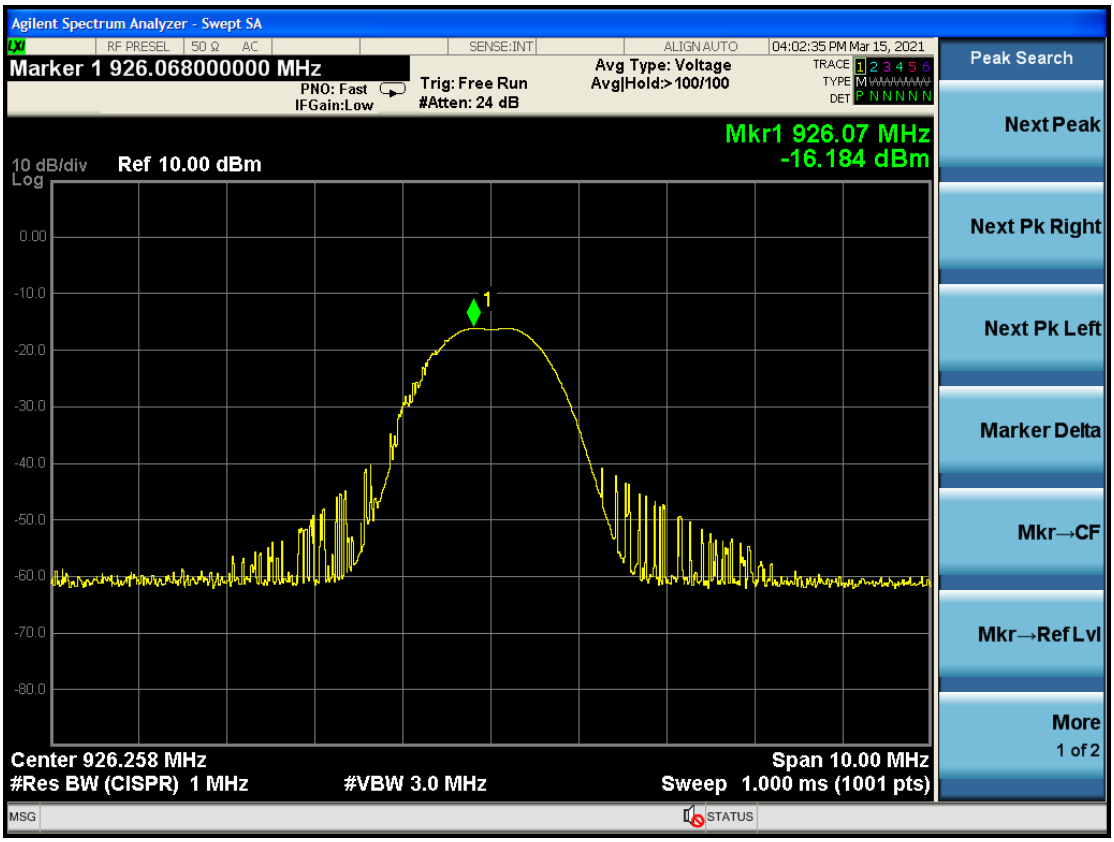


Figure 7.3.3 Peak output power. Operation on Top channel

Section 8 Power Spectral Density

8.1 Test Specification

FCC Rule Part	47CFR 15.247 (e)
ISED Regulation	ISED RSS-247 § 5.2
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
902 MHz to 928 MHz	<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

15th March 2021

8.2.2 Test Area

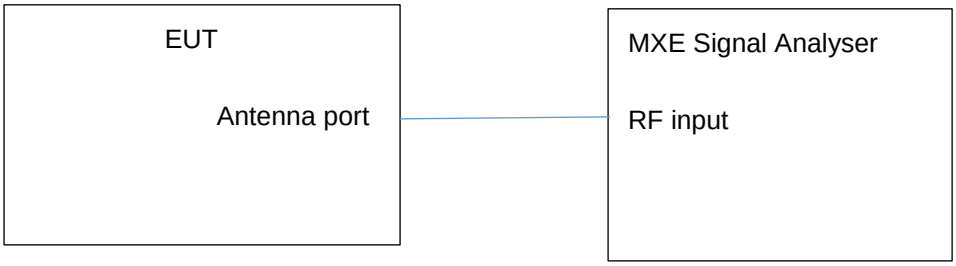
LAB 7

8.2.3 Tested by

M Render

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
903.2	WB-DSSS	-20.659	8.0	8.3.1	Pass
914.4	WB-DSSS	-17.962	8.0	8.3.2	Pass
926.3	WB-DSSS	-21.351	8.0	8.3.3	Pass

Peak Spectral Density Measurements

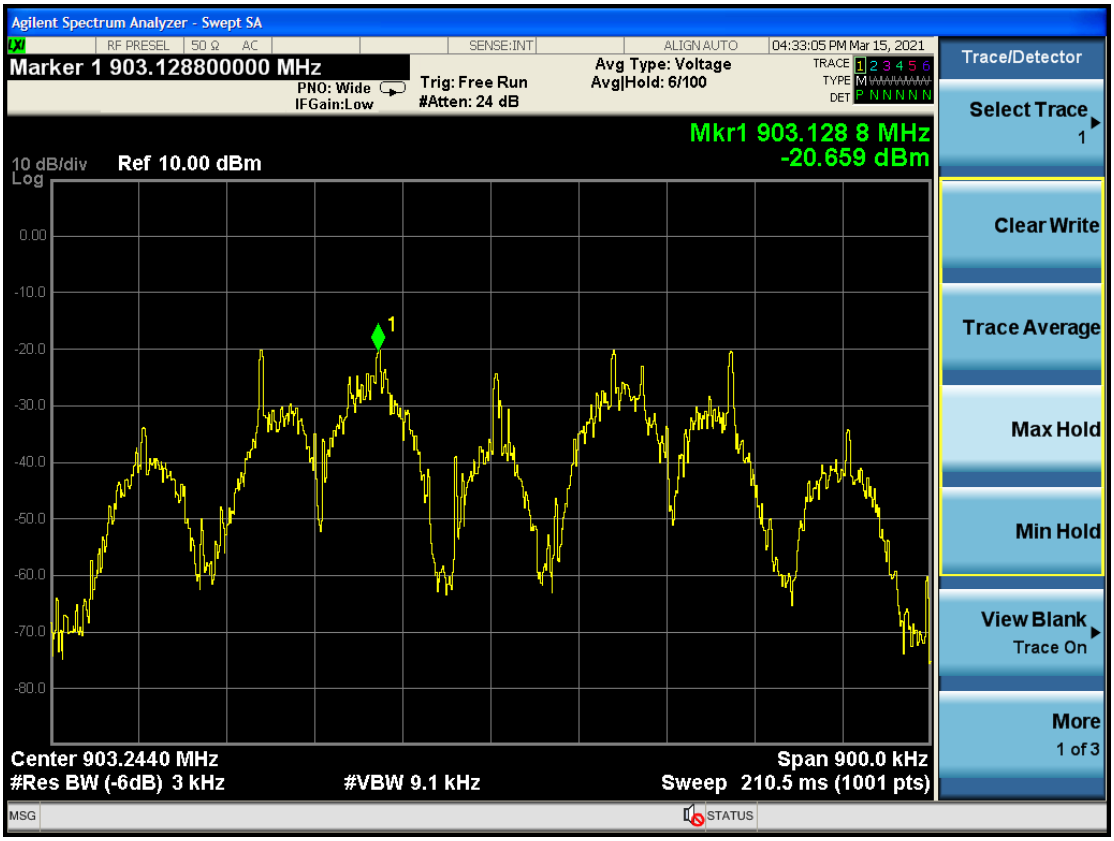


Figure 8.3.1 Power spectral density. Operation on Bottom channel

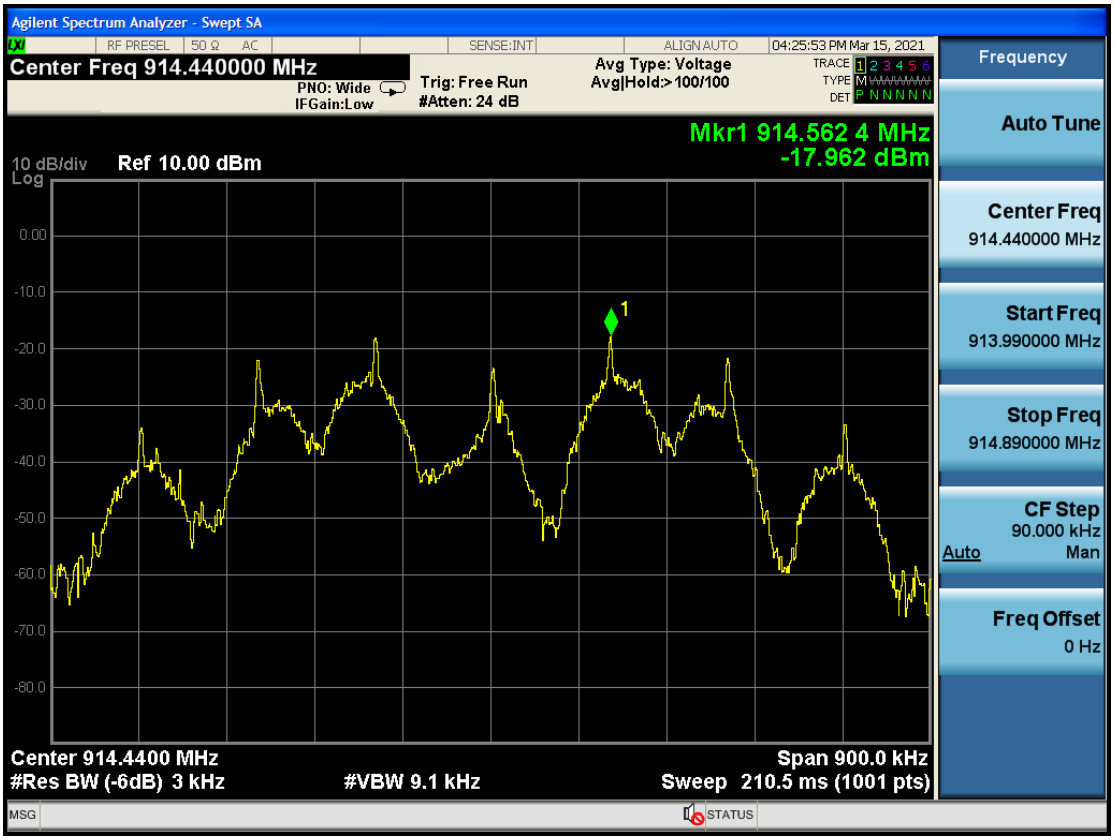


Figure 8.3.2 Power spectral density. Operation on Middle channel

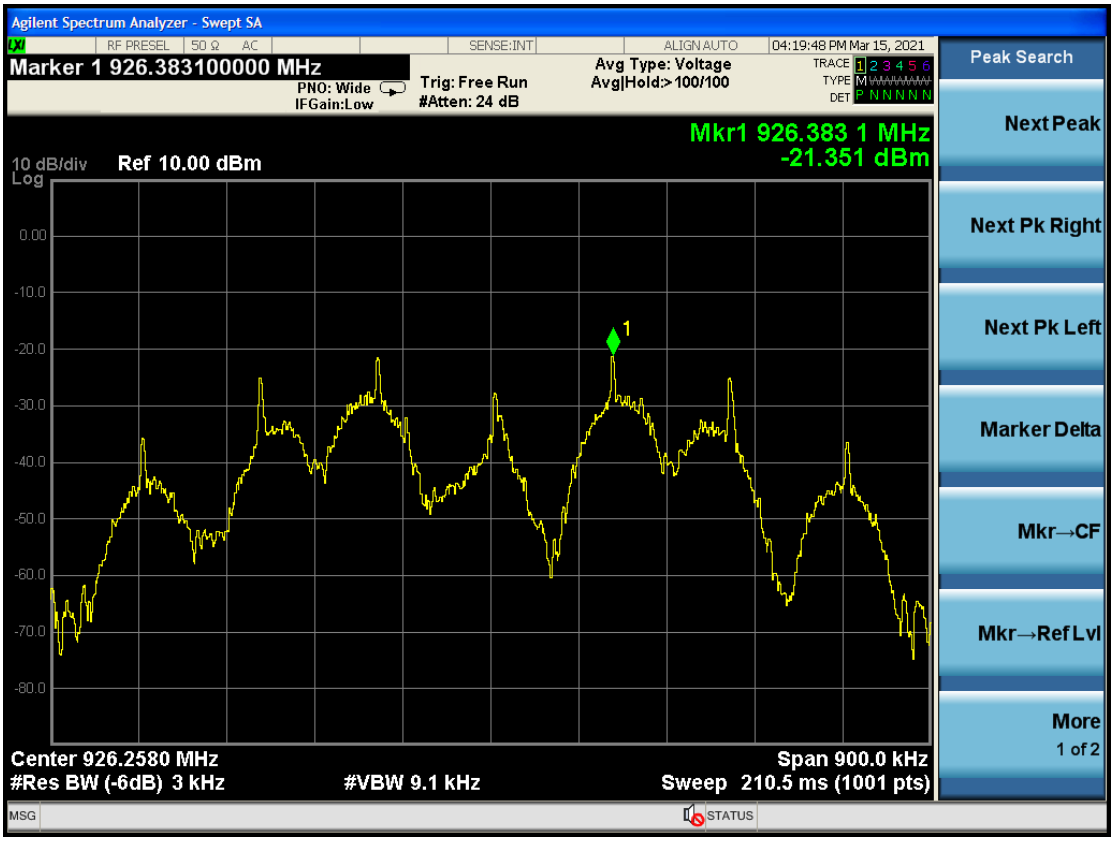


Figure 8.3.3 Power spectral density. Operation on Top channel

Section 9 Band Edge Compliance

9.1 Test Specification

FCC Rule Part	47CFR 15.247(d)
ISED Regulation	ISED RSS-247 § 3.3 and 5.5
Standard	ANSI C63.10:2013

No restricted bands as specified by 47CFR 15.205 and RSS Gen 8.10 are adjacent to the band edges of the 902 – 928MHz band.

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
902 MHz to 928 MHz	Measured signal at the band edge must 20 dB below the carrier 47CFR15.247 (d)

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	120 kHz
Video Bandwidth	3 x RBW
Sweep rate	Auto couple
Trace mode	Max hold

9.2.1 Date of Test

20th May 2021

9.2.2 Test Area

LAB 1 (SAC)

9.2.3 Tested by

M Render

9.2.4 Test Setup

The test setup was identical to radiated emissions testing 30MHz-1GHz (section 5.3.5).

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. Frequency at the band edge
3. Amplitude of signal at the input of the test receiver
4. Pre-amplifier gain
5. Cable loss
6. Antenna factor
7. Resultant Electric field strength = 3-4+5+6
8. The measured carrier Electric filed strength
9. The band edge limit
10. The margin of result

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)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Carrier E (dBuV/m)*	Limit (dBuV/m)	Margin (dB)
H	928.0	44.31	25.72	3.06	26.40	48.05	90.17	70.17	-22.12
V	928.0	38.80	25.72	3.06	26.40	42.54	102.14	82.14	-39.60

Operation on Top Channel, Band edge measurements

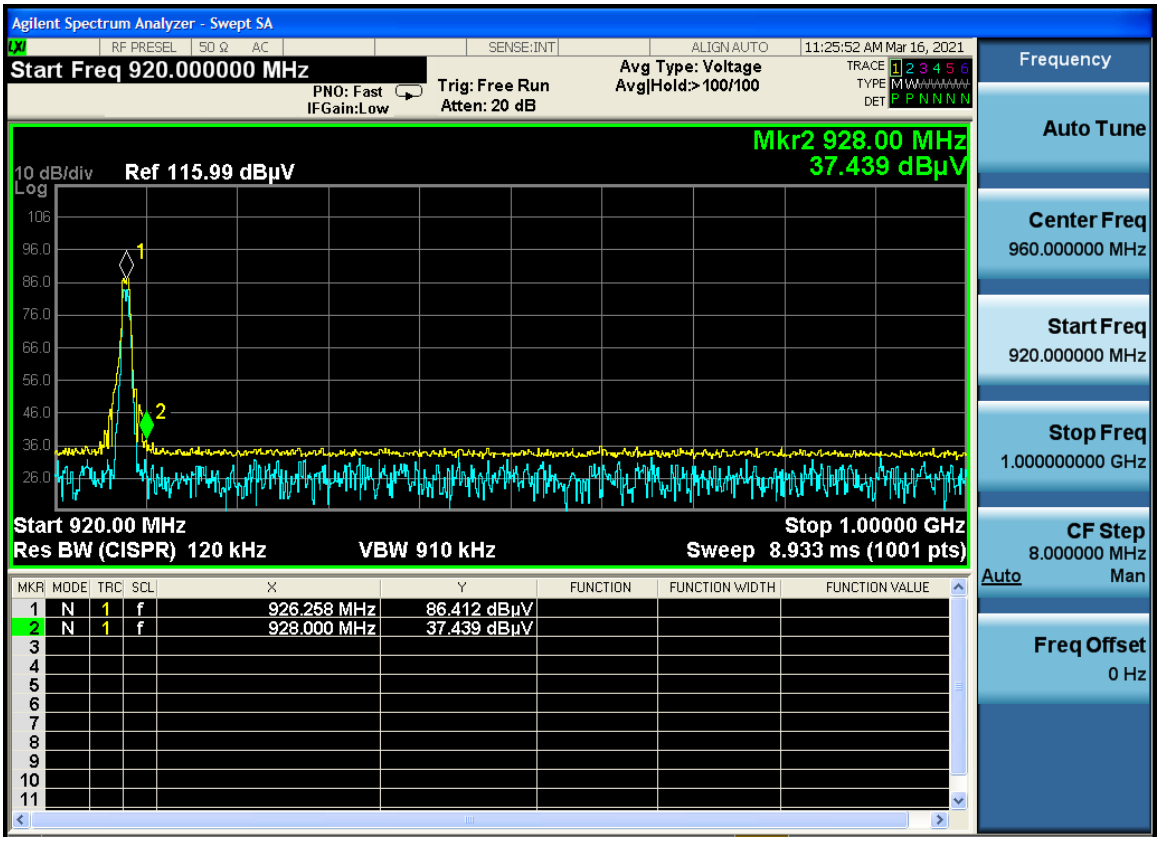
Lower band edge

Polarity	Frequency (MHz)	Amplitude (dBuV)	Preamp (dB)	Cable loss (dB)	AF (dB/m)	E (dBuV/m)	Carrier E (dBuV/m)*	Limit (dBuV/m)	Margin (dB)
H	902.0	22.40	25.60	3.01	26.58	26.39	70.03	50.03	-23.64
V	902.0	47.37	25.60	3.01	26.58	51.36	102.47	82.47	-31.11

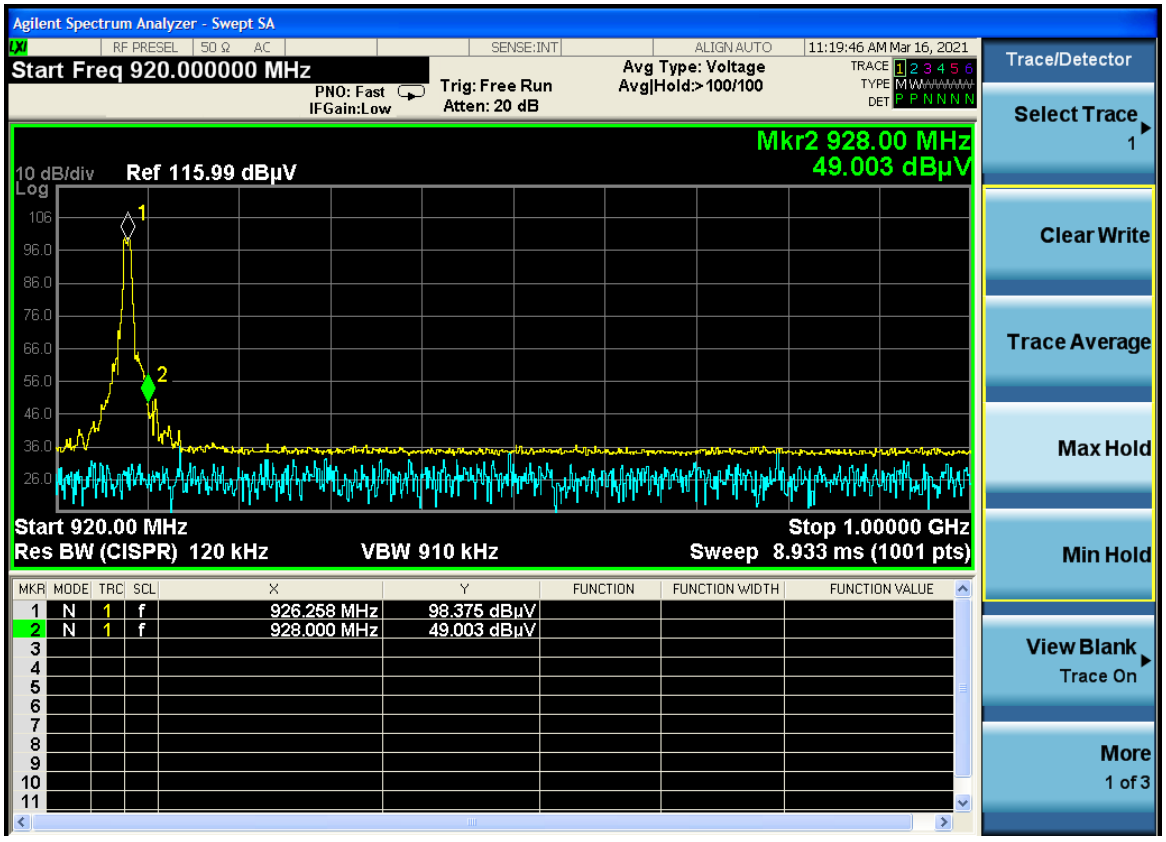
Operation on Bottom Channel, Band edge measurements

* The carrier field strength was measured to determine the band edge limit (20dBc) as per clause 15.247(d).

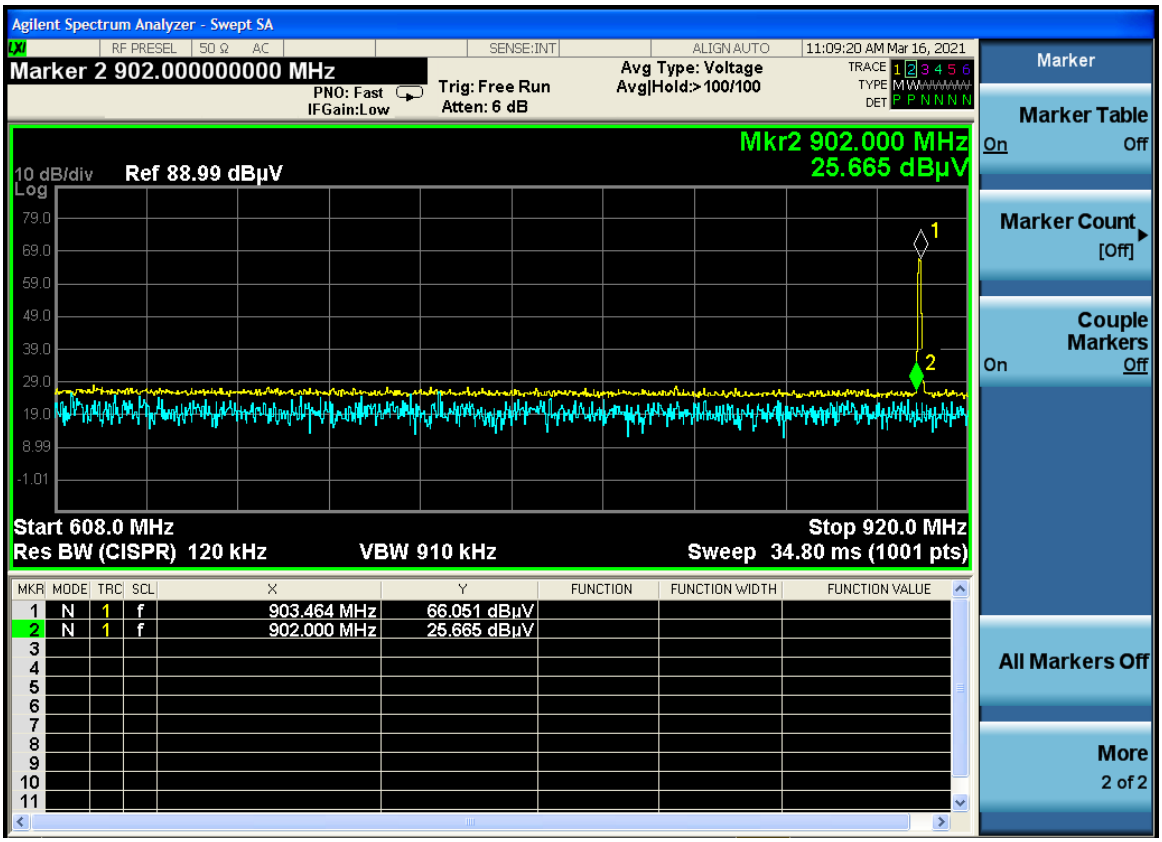
Spectrum analyser displays



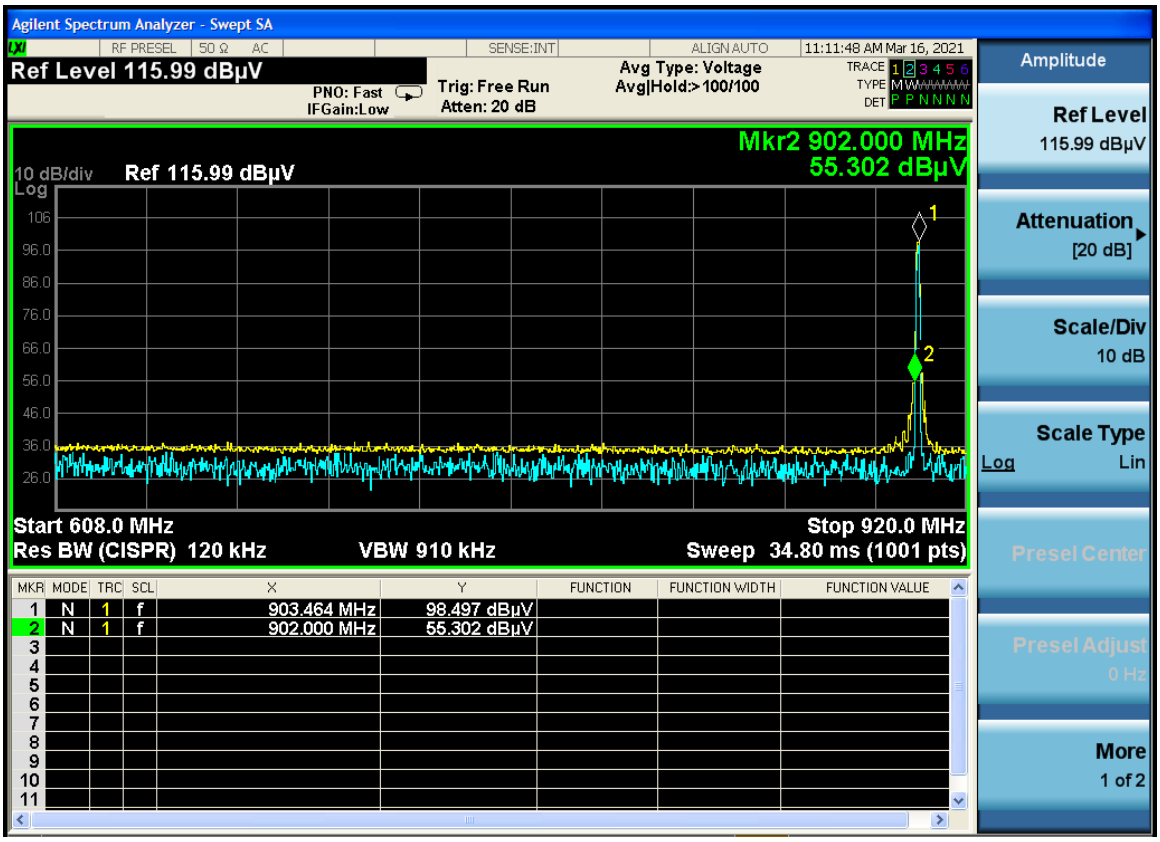
Band Edge Measurement – upper band edge - horizontal polarity



Band Edge Measurement – upper band edge - vertical polarity



Band Edge Measurement – lower band edge - horizontal polarity



Band Edge Measurement – lower band edge - vertical polarity

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	5th January 2021	12 Months
HF17 Cable	167002-001	5th January 2021	12 Months
HF27 Cable	-	5th January 2021	12 Months
STLP9148 SCHWARZBECK Antenna 1-18GHz stacked LogPeriodic	C0626	13th November 2020	12 Months
BONN BLMA 0118-5A Preamplifier	149759	9th March 2021	12 Months