Test Report for the Testing of A UHF Base Station to FCC Rule 47CFR 15.247 for Pathtrack

Test Report number 12807TR1

Project number C3881

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Issue	Description						Issue by	Date
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1	11th May 2018	Original issue of test report
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Section 1 Test Location

All testing was performed at;

Eurofins York Ltd	Unit 5
	Speedwell Road
	Castleford
	WF10 5PY
Tested by	M Render, Senior Engineer
Tel:	01977 731173
Website	http://www.yorkemc.co.uk
UKAS Testing No.	1574

1.1 UKAS Accreditation

Tests marked "Not UKAS Accredited" in this report are not included in the UKAS Accreditation Schedule for our laboratory.

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

York EMC Services 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 (formerly York EMC Services), is an Accredited facility recognised by the Federal Communications Commission (FCC) for certification testing. The appropriate FCC Designation Number is number is UK0022, dated 5th September 2017

Section 2 Customer Information

Company name	Pathtrack Ltd
Address	Unit 3
	Chevin Mill
	Leeds Road
	Otley
	LS21 1BT
Tel:	+44 (0) 1943 597977
Contact	Edmund Bryant
Customer Representative(s) present during testing	Edmund Bryant

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	9th April 2018
EUT name:	UHF Base Station
FCCID	2APEJ-PTRX92401
Type/Part no:	#50342
EUT description:	The tag generally remains dormant, taking a GPS positional measurement between once and several times a day and storing the data in on board memory. The user programs how often the tag checks its position and also how often it checks for being in range of a base station. The base station monitors Channel 0 (924.1 MHz) until it detects a valid signal from a tag. It then responds with a handshake signal and connects to the tag. Transmit powers of both tag and base station are << 1W. On receipt of a handshake signal the tag performs a Listen Before Talk (LBT) assessment of the channel it will start to download data on and if clear it begins to download its stored data. It then transmits on that channel for < 400ms. If all the stored data can be transmitted within 400ms the tag then disconnects from the base station, otherwise it hops to the next channel and continues sending data in <400ms sections on different channels until complete. NOTE there are 50 channels available between 924.1 – 927.1 MHz and channel return time is > 20s. Once complete the data is deleted from the tag memory and it resumes GPS data gathering. Should the link with the base station be lost due to range or dropping out due to LBT detecting a blocked channel then the data on the tag is not deleted and will be re-sent at the next connection. The base station returns to its listening state once a tag link is either completed or lost. The only other mode of operation for the tag or base station is in programming mode. In this mode the tag/base-station is connected to a laptop via USB to have its operating parameters programmed (GPS acquisition time steps, base station connection check time steps). During this connection the transmitter/receiver parts of both devices is turned off so no transmissions can be made. Although Pathtrack do not provide a mains charger unit for this equipment, the base-station can be charged if a user connects a USB charger to the USB connector on the unit (Note there is no USB connector on the tag so it cannot be charged this way). Again, with USB charger connected the base station has its transmitter/receiver circuitry turned off.

No of units tested:	Two, one for radiated tests with antenna fitted and one for conducted tests.		
EUT power:	4.2 V	Battery operation	
Highest internal frequency:	927.1MHz		
Highest frequency to test to for emissions (47CFR15.33(a)(i))	10GHz		
Number of channels to test (47CFR1531(m))	2 (operating range <10MHz): One near top channel, one near bottom channel		
Size of EUT (mm)	L:126mm	W: 85mm	H:70mm
Tested as	Table top		
Mode/s of operation	Transmitting continuously at the top channel, 927.1MHz		
	Transmitting continuously at the bottom channel, 924.1MHz		
Transmission method	Frequency hopping spread spectrum (FHSS)		
Modulation	GFSK		
Client modification statement:	Not applicable		
Modifications incorporated during testing:	None		

3.2 EUT Photos

Photographs of the apparatus and test set ups are provided separately.

3.3 Configuration of EUT

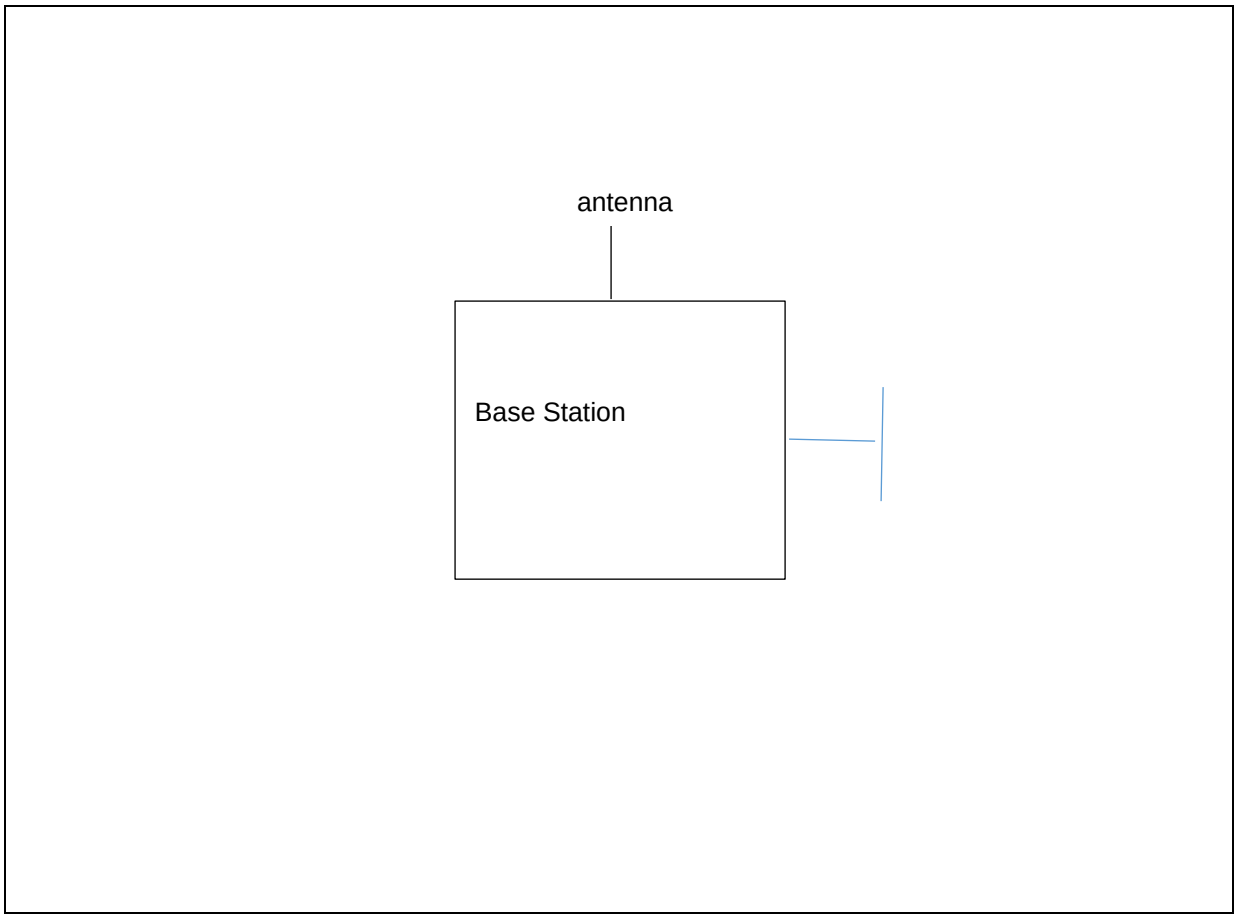

Figure 1: Diagram of EUT

3.4 EUT Monitoring/Auxiliary Equipment

Equipment	Type	Serial no.
Customer laptop for programming the base	-	-

Section 4 Test Specifications

The tests were performed in accordance with York EMC Services Quotation QuC3881

FCC Rule	47 CFR Part 15 Radio Frequency Devices; Subpart C Intentional Radiators
Test standard	ANSIC63.10-2013

Test description	Rule Part	Result Summary
Intentional emission, band occupancy, 20dB bandwidth	47 CFR 15.215(C) 47 CFR 15.247 (a)(1)(i)	Pass
FHSS Requirements	Number of hopping channels 47CFR15.247(a)(1)(i)	Pass
	Channel separation 47CFR15.247(a)(1)(i)	Pass
	Hopping channel occupancy time 47CFR15.247(a)(1)(i)	Pass
	Hopping sequence 47CFR15.247(a)(1)(i)	Pass
Peak power output (conducted)	47 CFR 15.247 b (2)	Pass
Maximum antenna gain	47 CFR 15.247 b(4)	Pass
Radiated spurious emissions* 30MHz to 10GHz	15.247(d)	Pass
Restricted band compliance	47CFR15.247(d) and 45CFR15.205 and 47CFR15.209	Pass
Mains conducted emissions 150kHz to 30MHz Applicable if the apparatus connects to the AC supply directly or via other apparatus.	47 CFR Part 15C Section 15.207 Test standard: ANSI C63.10-2013 Not applicable – battery powered	Not applicable

Note 1 :All testing was carried out at a test distance of 3m and the limits adjusted accordingly. This is a deviation from the standard as Class A limits are specified at 10m test distance.

Note 2: Applies to carrier current systems see reference 47CFR Part 15Clause 15.109(e).

4.1 Knowledge Database References

The following KDBs were referenced during the testing of UHF base station.

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 UHF base station as tested, was shown to meet requirements of the standards listed in Section 4 of this report.

Section 5 Maximum Conducted Output Power

FCC Rule Part	47CFR15.247(b)(2)
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 ±1.5dB

5.1.1 Date of Test

27th April 2018

5.1.2 Test Area

LAB 5 bench area.

5.1.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short ()

5.1.4 Maximum Peak Conducted Power Limit

47CFR15.247(b)(2)

For frequency hopping systems operating in the 902-928 MHz band: 1 Watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Since 50 channels are used the limit is 1Watt = 1000mW = 30dBm

5.1.5 Test Results

Frequency (MHz)	Measured Power (mW)	Measured Power (dBm)	Cable loss (dB)	Conducted power (dBm)	Limit (dBm)	Margin (dB)	Result Summary
924.100	3.052	4.8	1.0	5.8	30.0	-24.2	Pass
927.100	2.929	4.7	1.0	5.7	30.0	-24.3	Pass

Note:

10dBm = 0.01W

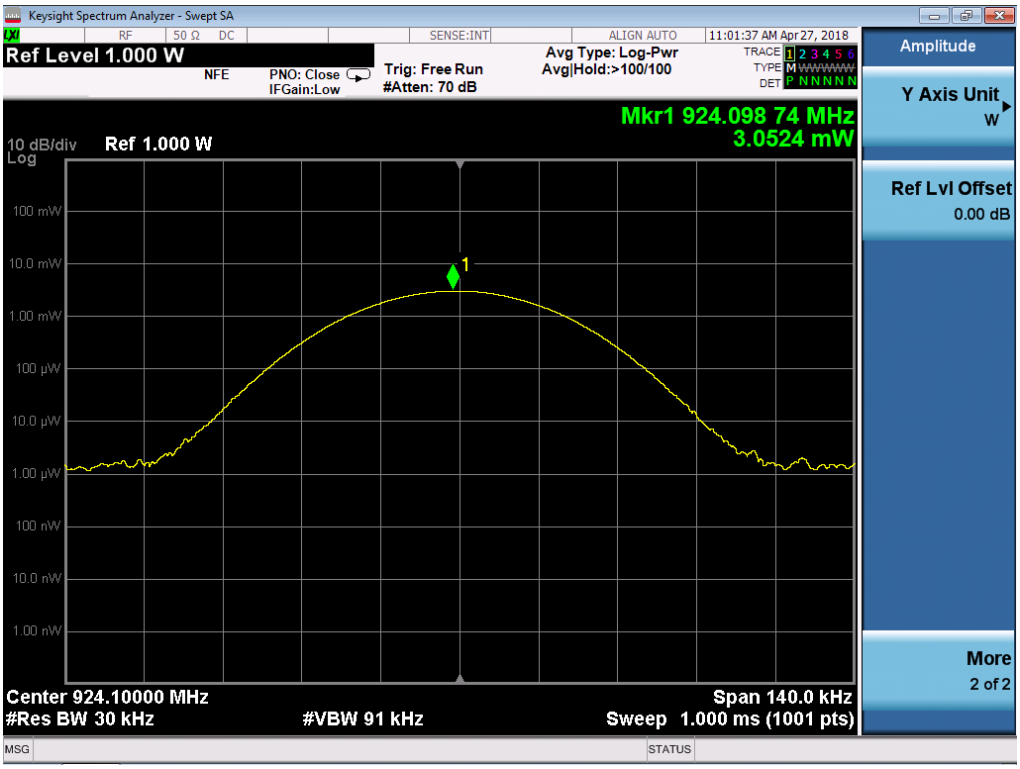

Figure 2: Peak output power – Bottom Channel 924.1MHz

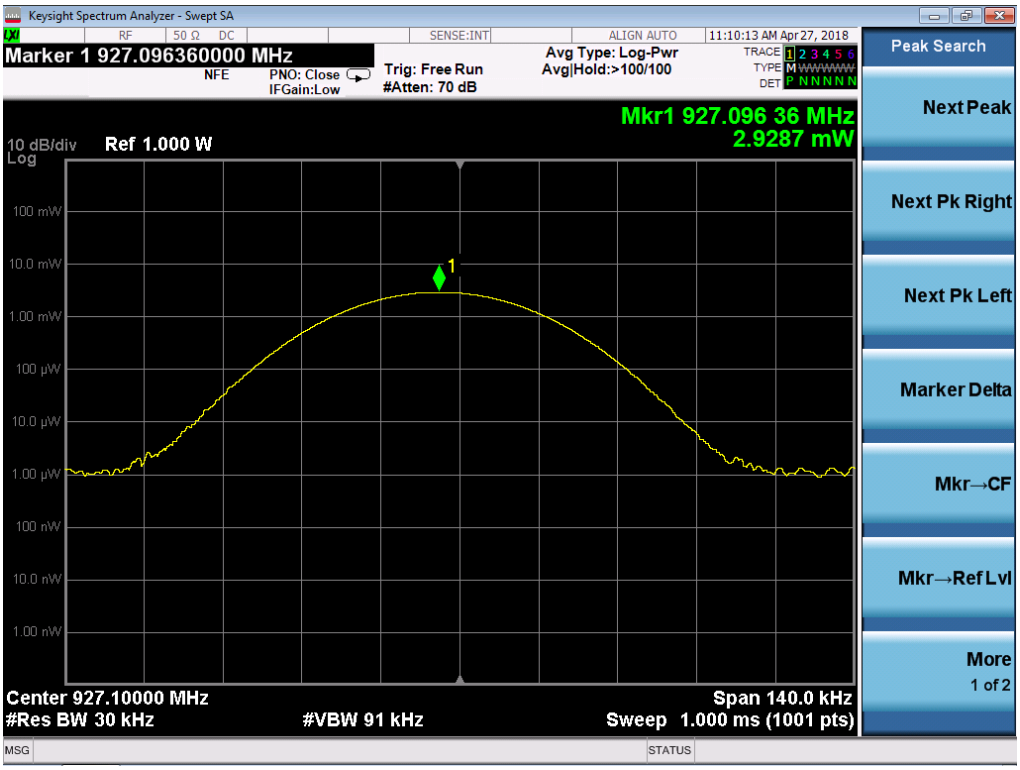

Figure 3: Peak output power – Top Channel 927.1MHz

Section 6 Conducted Spurious Emission Results

FCC Rule Part	47CFR15.247(d)
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 ±1.5dB

6.1.1 Date of Test

27th April 2018

6.1.2 Test Area

LAB 5 bench area.

6.1.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm) low loss coaxial cable

6.1.4 Maximum Peak Conducted Power Limit

47CFR15.247(d)

The unwanted 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

Emissions within the restricted bands must comply with the radiated emission limits of 47CFR 15.209.

6.1.5 Test Results

The measurements were taken with the equipment transmitting on the top and bottom channels.

In the spectrum analyser displays the green display line is positioned 20dB below the peak carrier. All disturbances are greater than 20dB below the carrier in all cases.

Disturbance within the restricted bands were measured radiated.

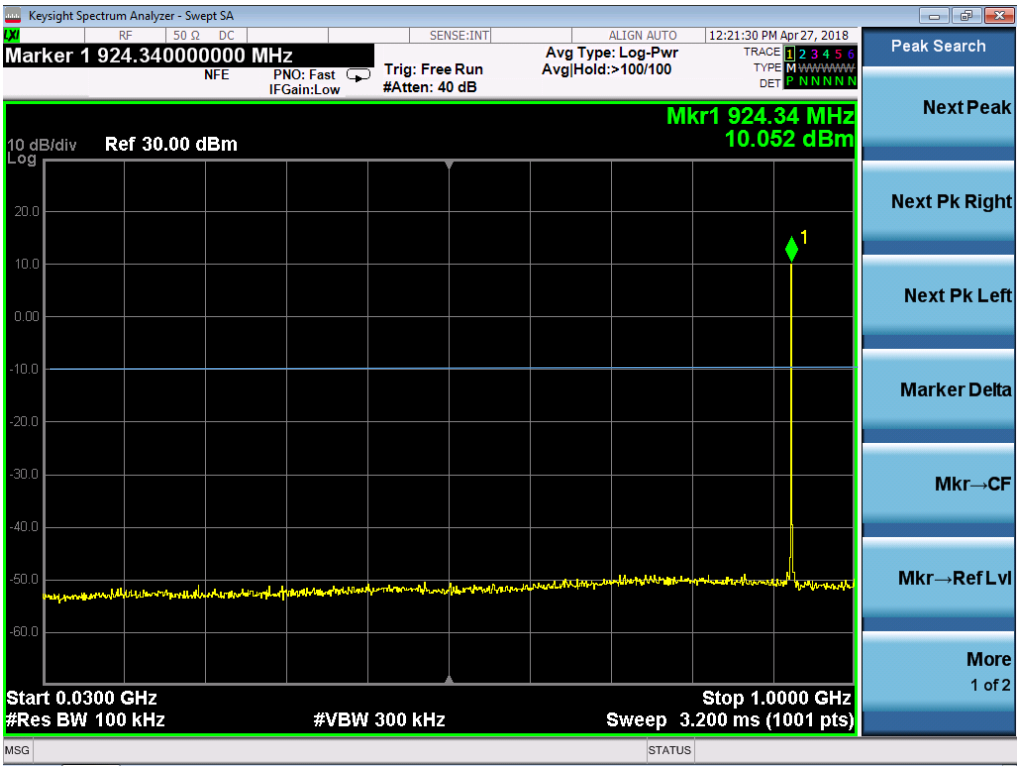

Figure 4: Conducted emissions bottom channel 30MHz to 1GHz

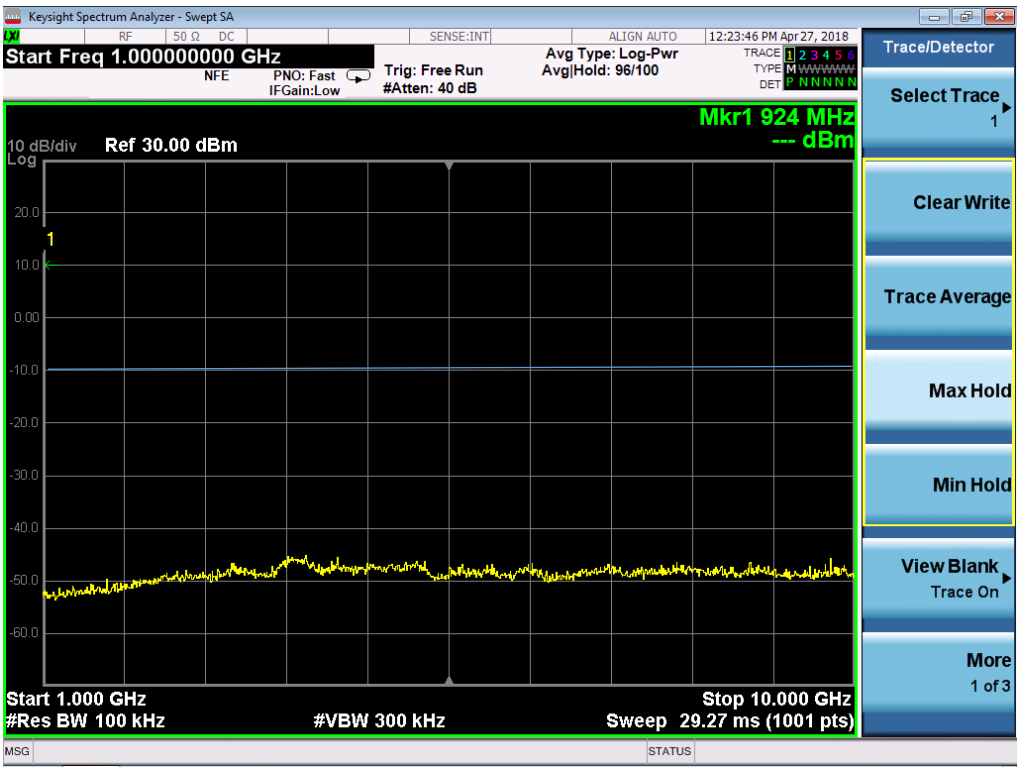

Figure 5: Conducted emissions bottom channel 1GHz to 10GHz

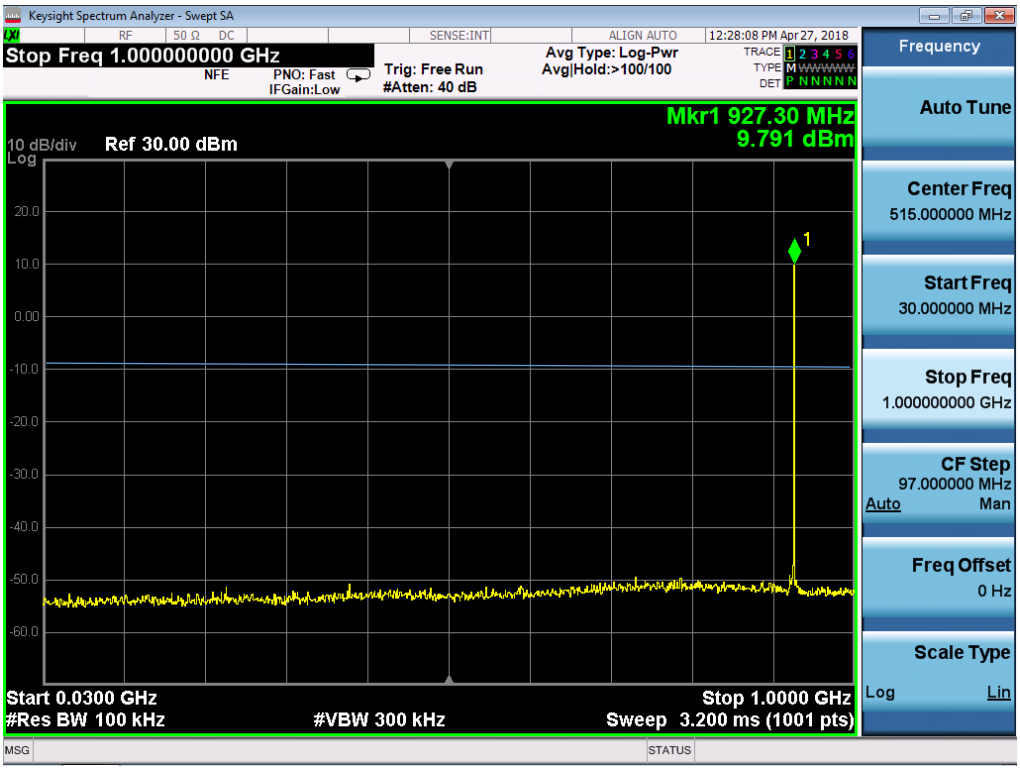

Figure 6: Conducted emissions top Channel 30MHz to 1GHz

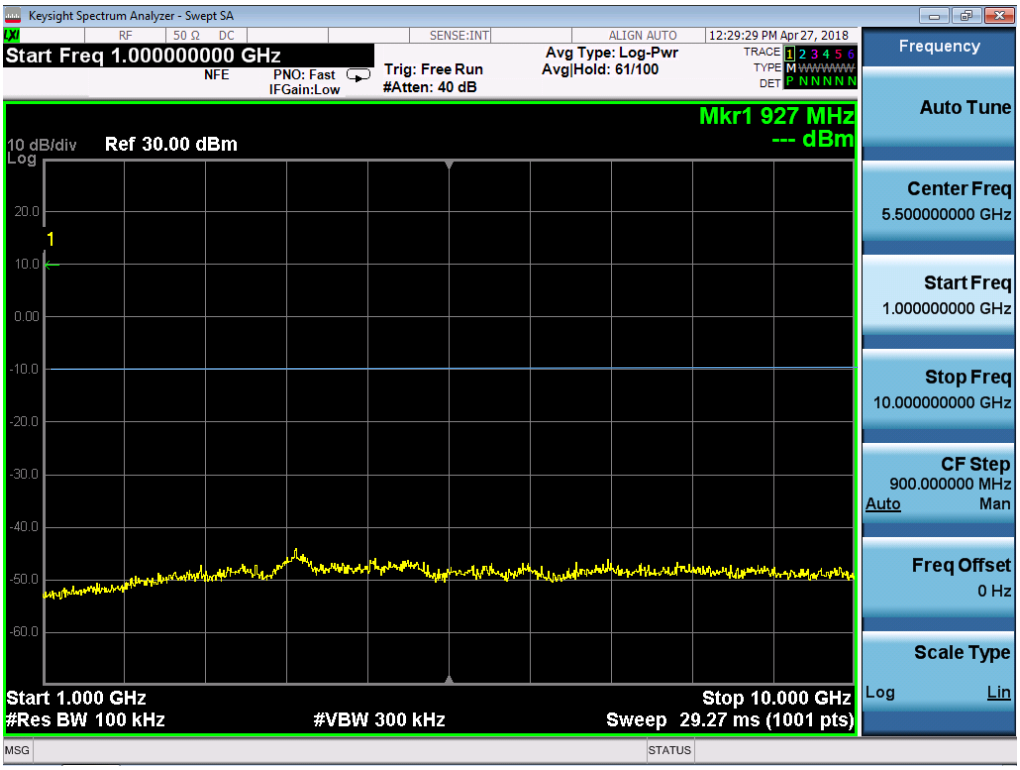

Figure 7: Conducted emissions top channel 30MH 1GHz to 10GHz

Section 7 Radiated Emission Results

7.1 Test Specification

FCC Rule Part	47CFR15.247(d)
Standard	ANSI C63.4:2014
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 +/- 4.27dB for the frequency range from 9kHz to 30MHz +/- 5.81dB 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 +/- 4.77dB for the frequency range from 18GHz to 40GHz

7.2 Procedure and Test Software Version

Eurofins York Test procedure (9kHz to 30MHz)	CEP22 Issue 2
Eurofins York test procedure (30MHz to 1GHz)	CEP23b Issue 2
Eurofins York test procedure (1GHz to 40GHz)	CEP64b Issue 2
Test software	Radimation Version

7.2.1 Electric Field Strength Limits

The electric field strength limits are defined in 47CFR15.209. The radiated limits apply to any disturbance within the restricted bands defined section 47CFR15.205. All other emissions must comply with the conducted emission requirement of 47CFR15.247(d).

Frequency (MHz)	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 specifies test limits at 3m.

7.2.2 Receiver Settings

Receiver Parameters	Setting
Detector Function for spectrum analyser swept measurements	Peak hold
Detector Function for final measurements	Quasi Peak
Start Frequency	30MHz
Stop Frequency	1000MHz
Resolution Bandwidth	120kHz
Video Bandwidth	Auto

7.2.3 Emissions measurements

7.2.4 Date of Test

26th April 2018

7.2.5 Test Area

LAB 1 (SAC)

7.2.6 Test Setup

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

The measurement was performed with an antenna to EUT separation distance of 3m. The Quasi peak limits are therefore increased by 10dB (from the 10m values), to allow for the reduction in the measurement distance.

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

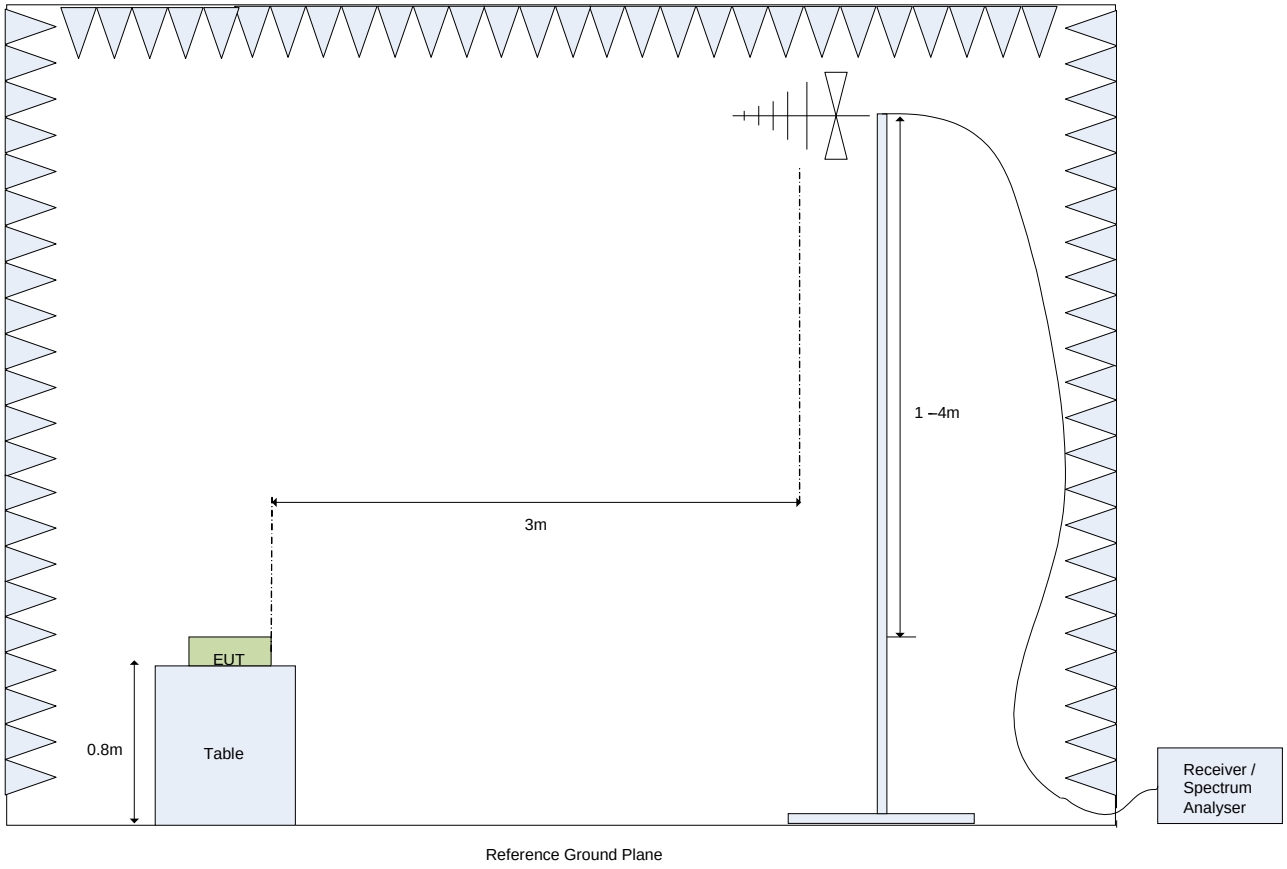

Figure 8: Arrangement for radiated electric field emissions 30MHz to 1GHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.4-2014 Clause 5.1.3.

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.

7.2.7 Radiated Electric field emissions, 30MHz to 1GHz

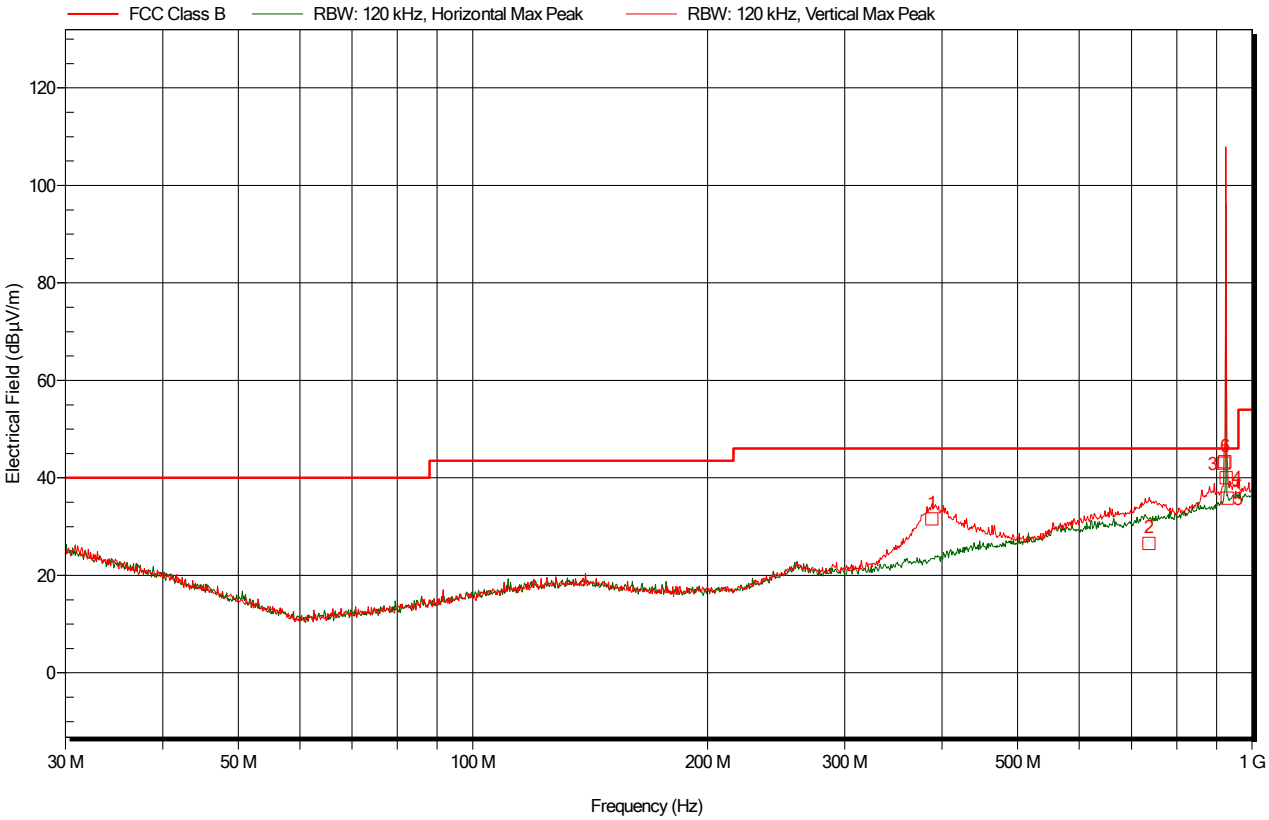

Figure 9: Radiated electric field emissions bottom channel MODE 1

Frequency (MHz)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)	Quasi-Peak Correction (dB/m)	Quasi-Peak Status	Angle	Height	Polarization
387.9	31.6	46	-14.4	23	Pass	170	1.2	Vertical
737.1	26.6	46	-19.4	30.7	Pass	5	1.5	Vertical
919.68	43	46	-3	33.8	Pass	120	1	Vertical
926.28	40	46	-6	34.1	Pass	115	1	Vertical
928.56	35.8	46	-10.2	34.2	Pass	135	1.5	Vertical
921.9	43.3	46	-2.7	33.9	Pass	120	1	Vertical

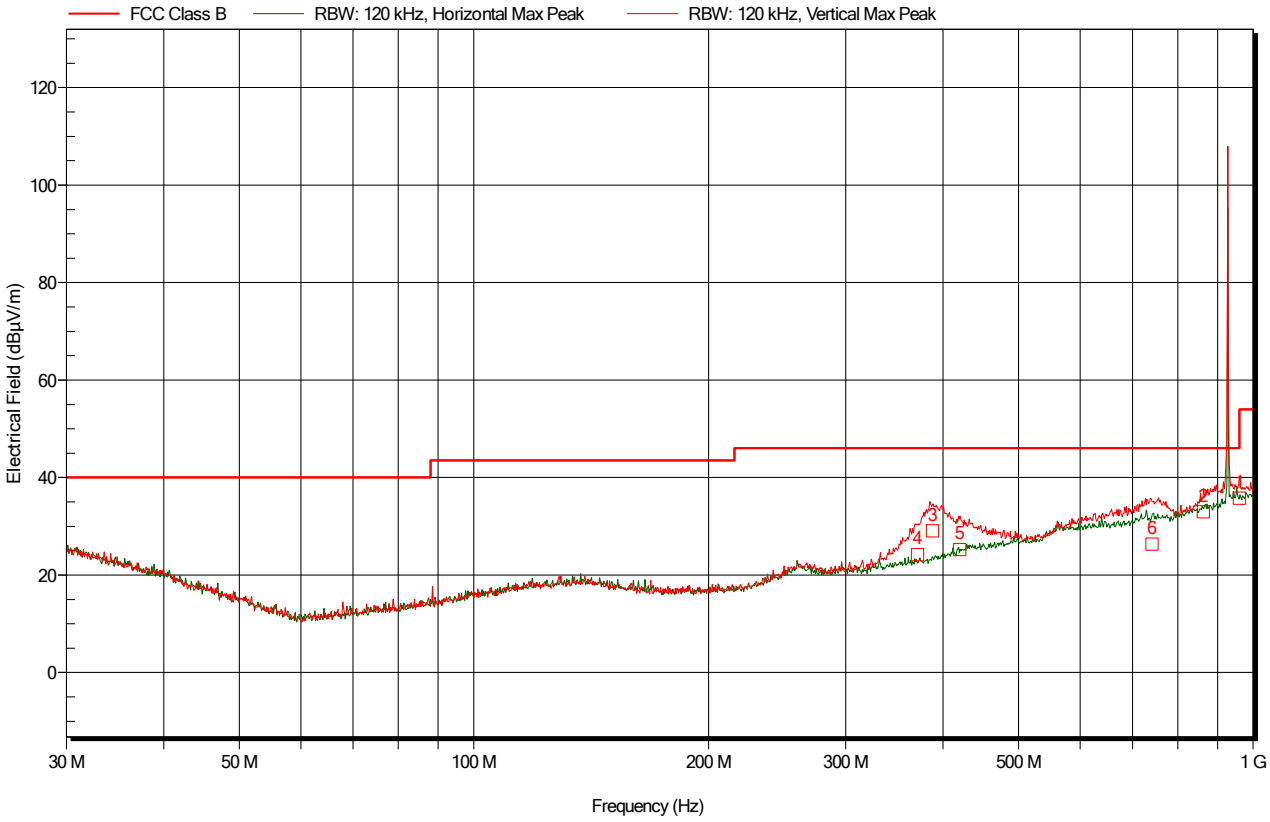

Figure 10: Radiated electric field emissions top channel

Frequency (MHz)	Quasi-Peak (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Difference (dB)	Quasi-Peak Correction (dB/m)	Quasi-Peak Status	Angle	Height	Polarization
960	35.8	46	-10.2	34.9	Pass	69	1	Vertical
863.1	33	46	-13	32.6	Pass	170	1	Vertical
387.66	29.1	46	-16.9	23	Pass	180	1.2	Vertical
371.1	24.2	46	-21.8	22.7	Pass	175	1.3	Vertical
420.24	25.2	46	-20.8	24.5	Pass	39	1.2	Vertical
741.36	26.4	46	-19.6	30.8	Pass	5	1.5	Vertical

7.2.8 Quasi Peak correction factors

The quasi peak correction is 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) + AF (dB/m) + CL (dB)

7.2.9 Sample Data

The Quasi-Peak level at 387.90MHz

FS (dBµV/m) = 8.8dBµV + 21.3dB/m + 1.5dB = 31.6dBµV/m

7.3 Radiated electric field emissions 1GHz to 10GHz

7.3.1 Limits

Frequency (GHz)	Average (dBμV/m)	Peak (dBμV/m)
1-10	54	74

7.3.2 Receiver Settings

Receiver Parameters	Setting
Detector Function for spectrum analyser swept measurements	Peak hold
Detector Function for final measurements	Average
Start Frequency	1GHz
Stop Frequency	10GHz
Resolution Bandwidth	1MHz
Video Bandwidth	Auto

7.3.3 Emissions measurements

7.3.4 Date of Test

13th April 2018

7.3.5 Test Area

LAB 1 (SAC)

7.3.6 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 7.3.7.

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.

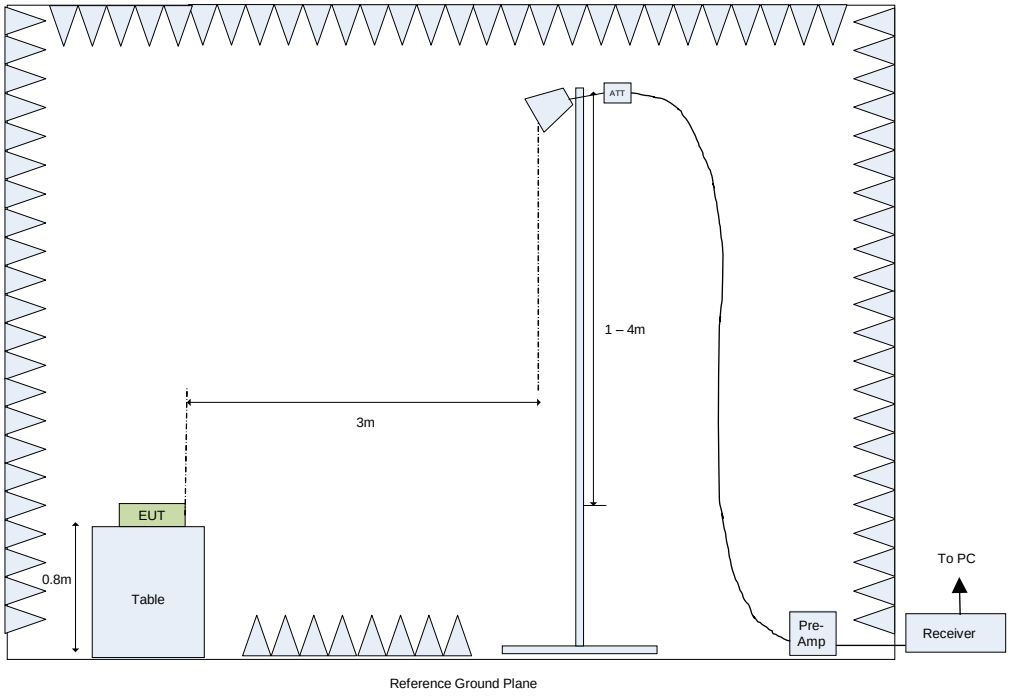

Figure 11: Test Setup for Final E-Field Measurements from 1GHz to 10GHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.4-2014 Clause 5.1.3.

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.

7.3.7 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.

No additional signals were investigated during investigative measurements.

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

7.3.8 Electric field emissions, 1GHz to 18GHz

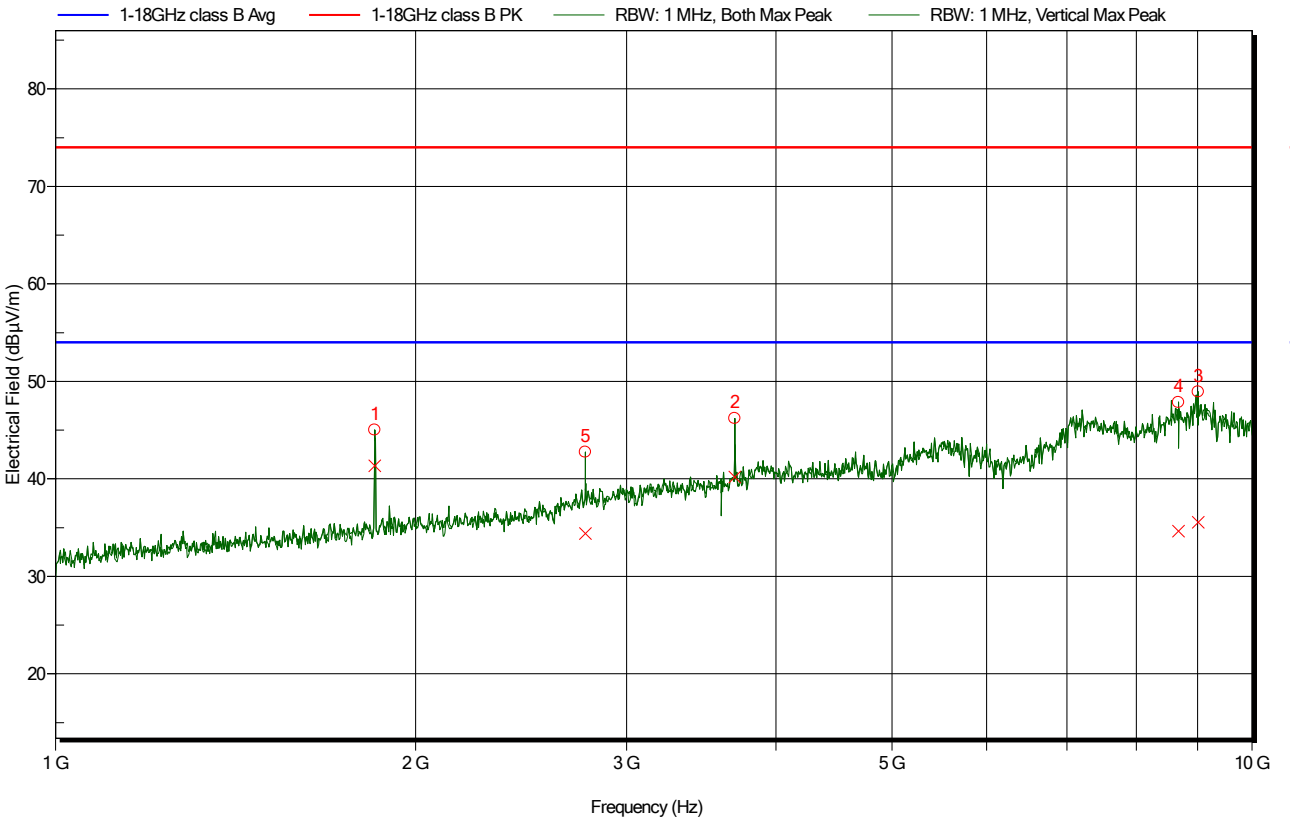

Figure 12: Electric field emissions bottom channel, 1GHz to 10GHz

Frequency (GHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	-Peak Difference (dB)	-Peak Correction (dB/m)	-Peak Status	Angle	Height	Polarization
3.696	46.2	74	-27.8	-13.2	Pass	55	1	Vertical
9.012	48.9	74	-25.1	-4	Pass	260	3.5	Vertical
8.678	47.83	74	-26.17	-4.3	Pass	10	3.5	Vertical
2.772	42.73	74	-31.27	-15.9	Pass	170	1.4	Vertical

Frequency (GHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Difference (dB)	-Average Correction (dB/m)	Average Status	Angle	Height	Polarization
1.848	41.33	54	-12.67	-19.3	Pass	135	1.1	Vertical
3.696	40.19	54	-13.81	-13.2	Pass	55	1	Vertical
9.012	35.56	54	-18.44	-4	Pass	260	3.5	Vertical
8.678	34.65	54	-19.35	-4.3	Pass	10	3.5	Vertical
2.772	34.41	54	-19.59	-15.9	Pass	170	1.4	Vertical

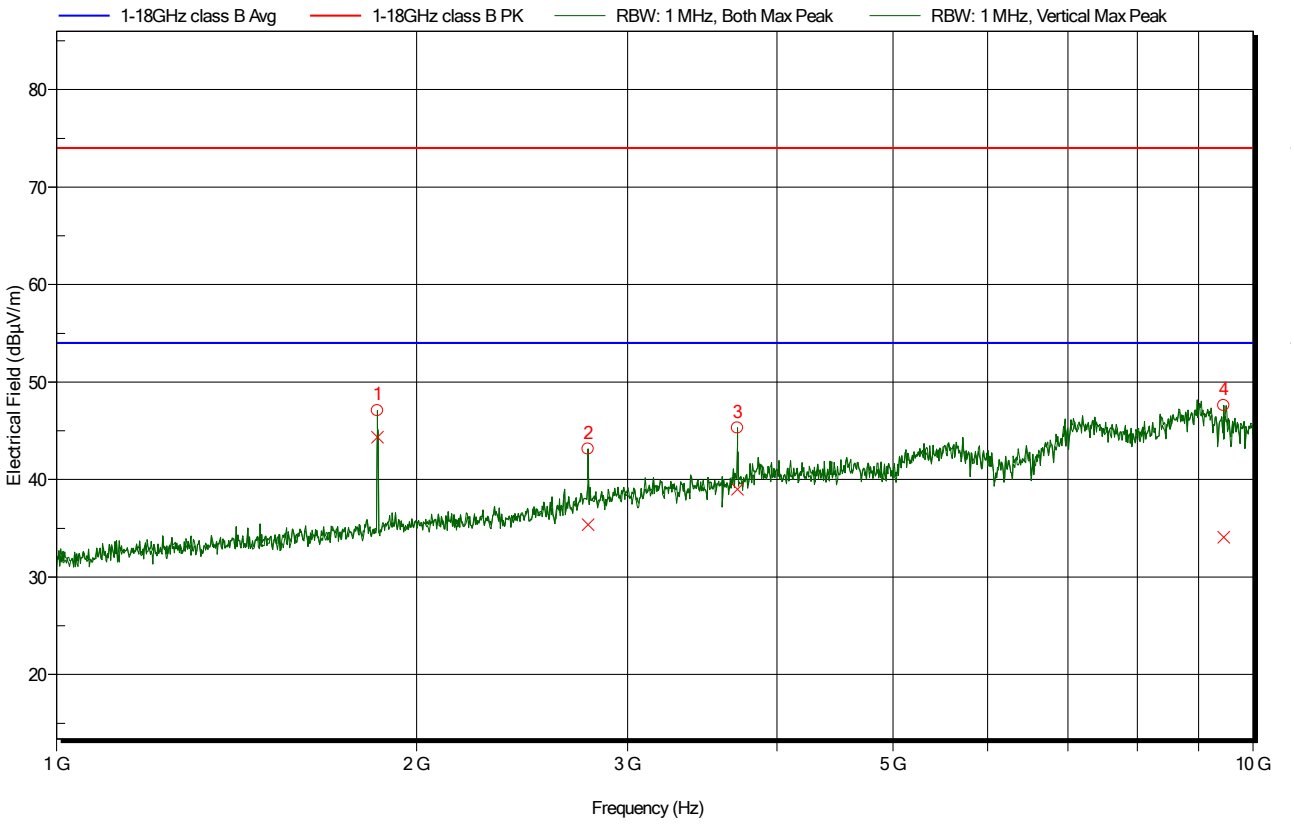

Figure 13: Electric field emissions top channel 1GHz to 10GHz

Frequency (GHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	-Peak Difference (dB)	-Peak Correction (dB/m)	-Peak Status	Angle	Height	Polarization
1.854	47.08	74	-26.92	-19.2	Pass	60	1.4	Vertical
2.781	43.13	74	-30.87	-15.8	Pass	170	4	Vertical
3.708	45.27	74	-28.73	-13.2	Pass	60	1.1	Vertical
9.451	47.59	74	-26.41	-3.2	Pass	180	2.3	Vertical

Frequency (GHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Difference (dB)	-Average Correction (dB/m)	Average Status	Angle	Height	Polarization
1.854	44.33	54	-9.67	-19.2	Pass	60	1.4	Vertical
2.781	35.37	54	-18.63	-15.8	Pass	170	4	Vertical
3.708	39.02	54	-14.98	-13.2	Pass	60	1.1	Vertical
9.451	34.09	54	-19.91	-3.2	Pass	180	2.3	Vertical

7.3.9 Contributing calibration factors

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).

Field strength (FS) is calculated as follows:

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

7.3.10 Sample Data

The Average level at 9.451GHz

FS (dBµV/m) = 51.7dBµV – 52.0dB +37.98.6dB + 9.86dB

= 45.5 dBµV/m

Section 8 20dB Bandwidth

FCC Rule Part	47CFR15.247(a)(1)(i)
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 Frequency: $\pm 10^{-8}$

8.1.1 Date of Test

10th April 2018

8.1.2 Test Area

LAB 5 bench area.

8.1.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm)

8.1.4 20dB Bandwidth Requirement

8.1.5 Test Results

Channel Frequency (MHz)	Measured 20dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result Summary
924.100	19.12	250	-230.88	Pass
927.100	19.2	250	-230.8	Pass

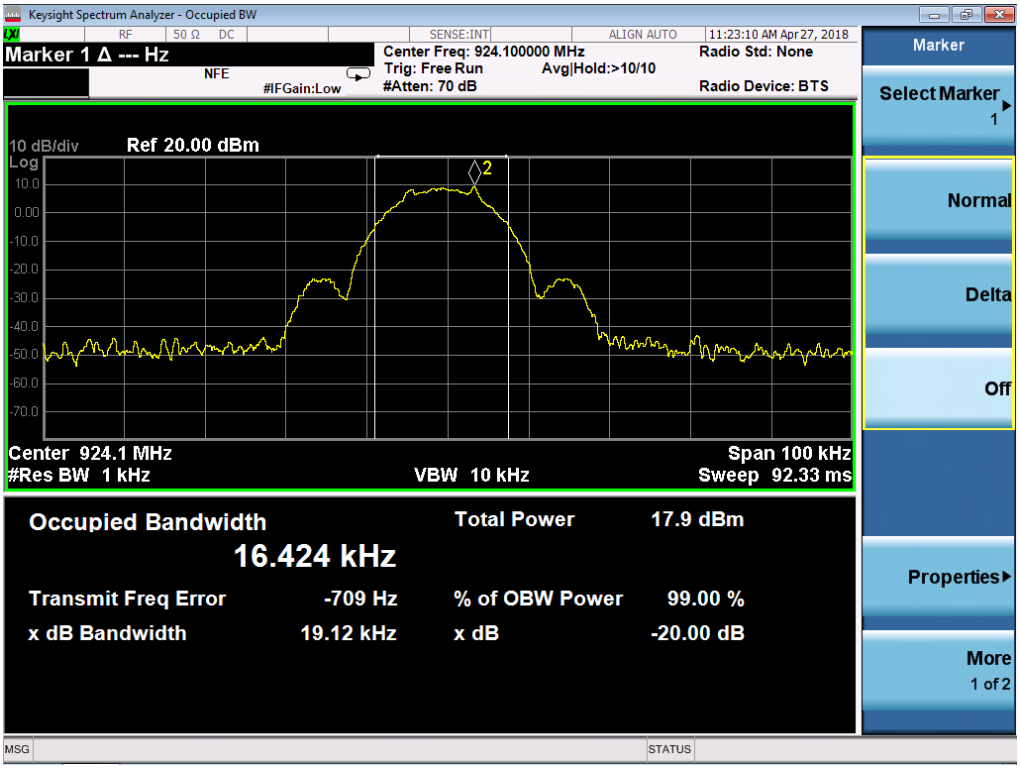

Figure 14: 20dB Bandwidth bottom channel 924.1MHz

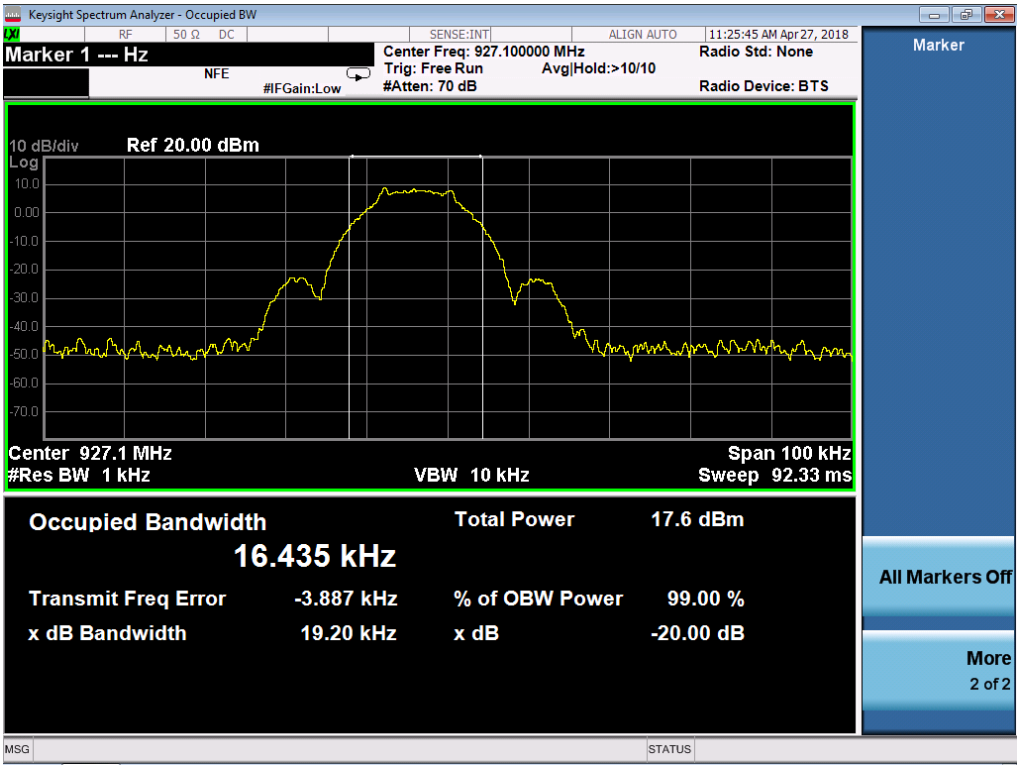

Figure 15: 20dB Bandwidth Top channel 927.1MHz

Section 9 Frequency Hopping Spread Spectrum Requirements

9.1 Number of Hopping Frequencies

FCC Rule Part	47CFR15.247(a)(1)(i)
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 Not applicable

9.1.1 Date of Test

27th April 2018

9.1.2 Test Area

LAB 5 bench area.

9.1.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm)

9.1.4 Requirement

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

9.1.5 Procedure

The procedure described in ANSI C63.10-2013 Clause 7.8.3 was followed.

9.1.6 Test Results

The results show that 50 hopping channels were utilised. The analyser screen displays show the 50 hopping channels, split into two subranges:

924.0MHz to 925.57MHz showing channels 1 -25

And

925.57MHz to 927.1MHz showing channels 26-50

Overall requirement of at least 50 channels was met.

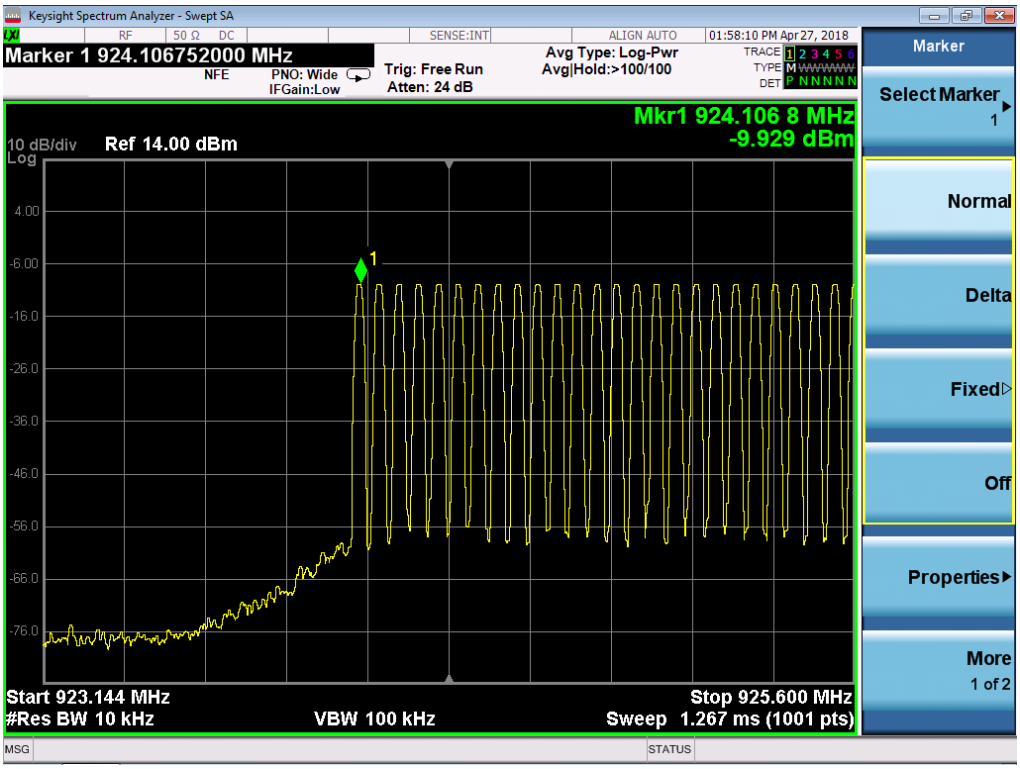

Figure 16: Number of hopping frequencies Channels 1-25

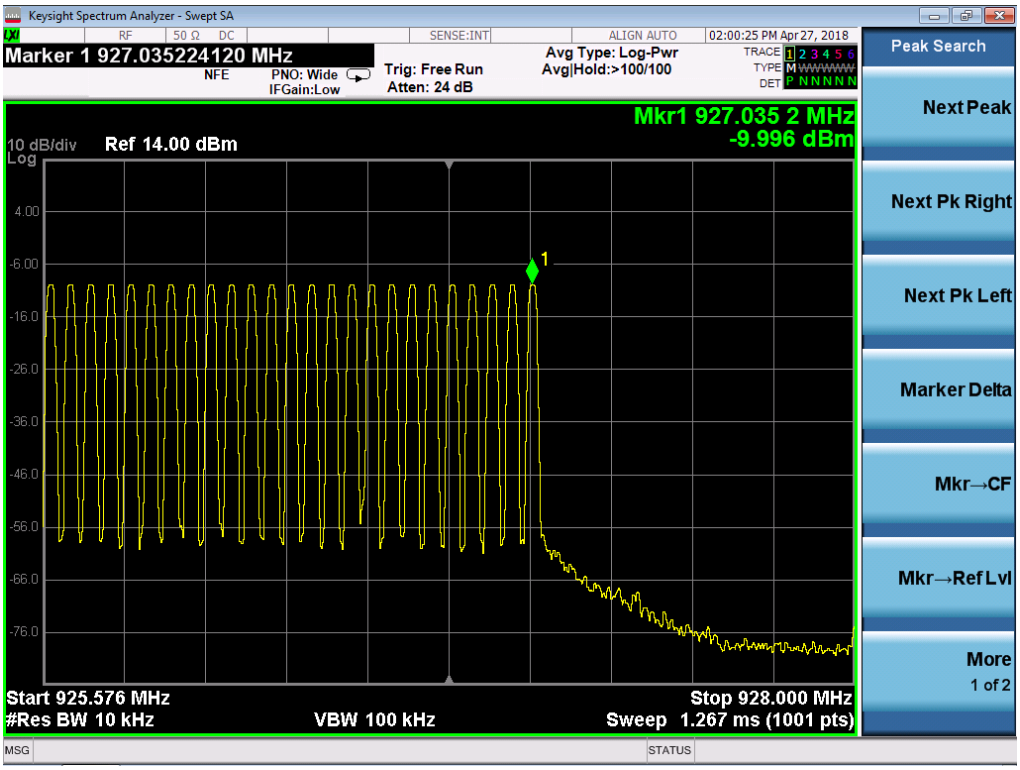

Figure 17: Number of hopping frequencies Channels 26-50

9.2 Frequency Hopping Channel Separation

FCC Rule Part	47CFR15.247(a)(1)
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 Frequency: $\pm 10^{-8}$

9.2.1 Date of Test

27th April 2018

9.2.2 Test Area

LAB 5 bench area.

9.2.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm) coaxial cable.

9.2.4 Requirement 47CFR15.247(a)(1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Since 25kHz is greater than the measured 20dB bandwidth, the carrier frequency separation shall be > 25kHz.

9.2.5 Procedure

The procedure described in ANSI C63.10-2013 Clause 7.8.2 was followed.

9.2.6 Test Results

Between any two adjacent channels the carrier separation was measured to be 52.14kHz, compliant with the requirement.

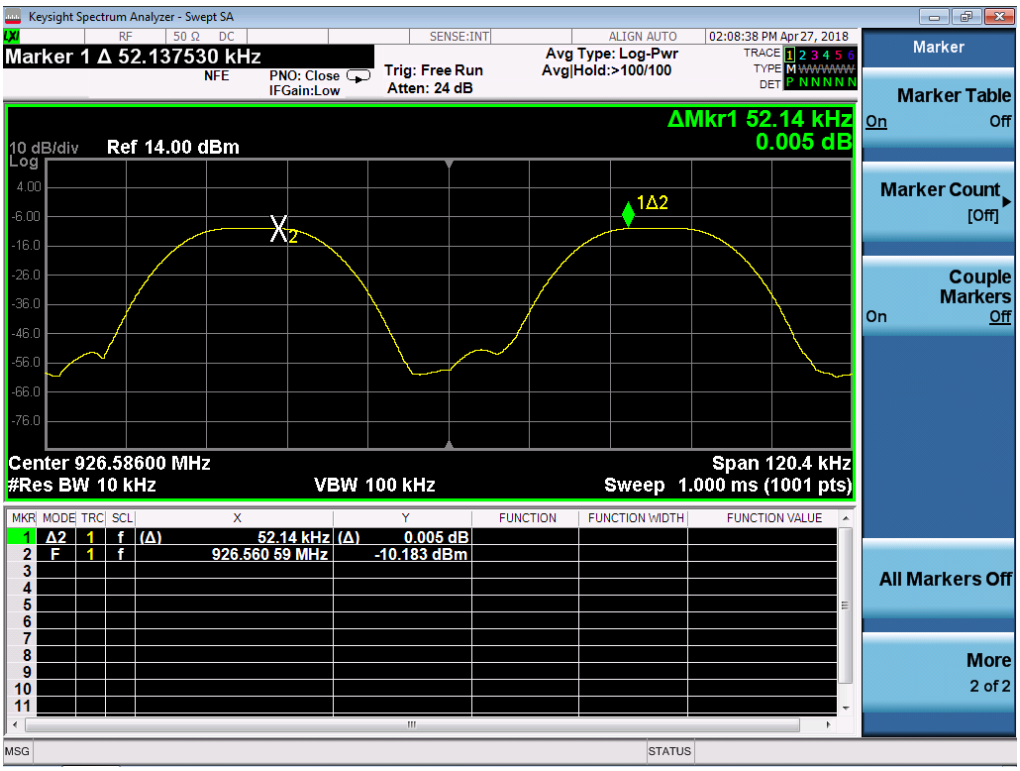

Figure 18: Carrier frequency separation

9.3 Hopping Channel Occupancy Time

FCC Rule Part	47CFR15.247(a)(1)(i)
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 Frequency: $\pm 10^{-8}$

9.3.1 Date of Test

27th April 2018

9.3.2 Test Area

LAB 5 bench area.

9.3.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm) coaxial cable.

9.3.4 Requirement 47CFR15.247(a)(1)(i)

The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period

9.3.5 Procedure

The procedure described in ANSI C63.10-2013 Clause 7.8.4 was followed.

9.3.6 Test Results

Channe1 (MHz)	Measured transmit time per hop (ms)	Limit (ms)	Result summary	No of hops in the period specified in the requirements	Average time of occupancy (ms)	limit (ms)	Result summary
924.1	386.0	400	Pass	1	386.0	400	Pass
927.1	388.0	400	Pass	1	388.0	400	Pass

Figure 19: Bottom channel, 924.1MHz transmit time per hop

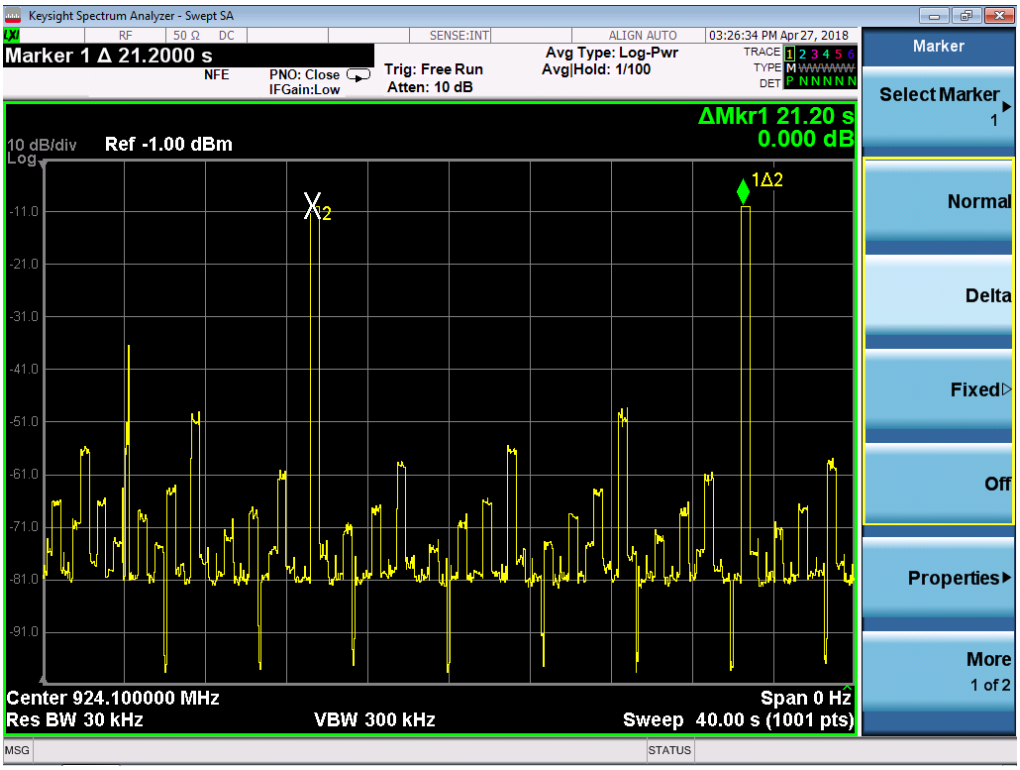

Figure 20: Bottom channel, 924.1MHz number of hops in specified period

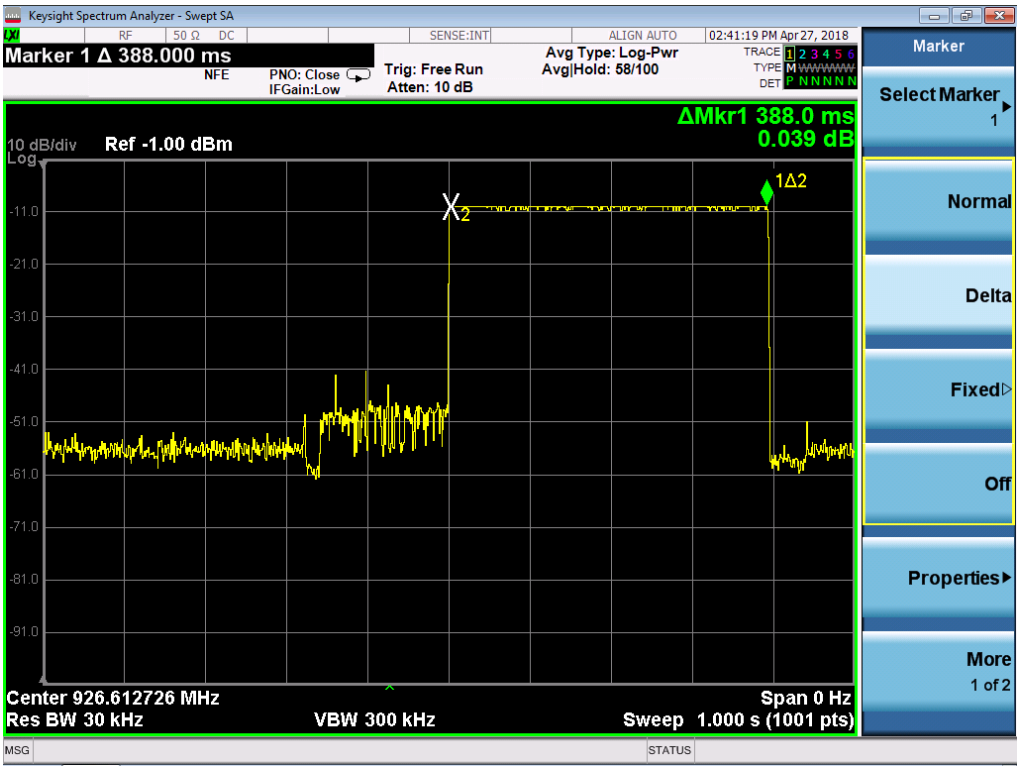

Figure 21: Top channel, 927.1MHz, transmit time per hop

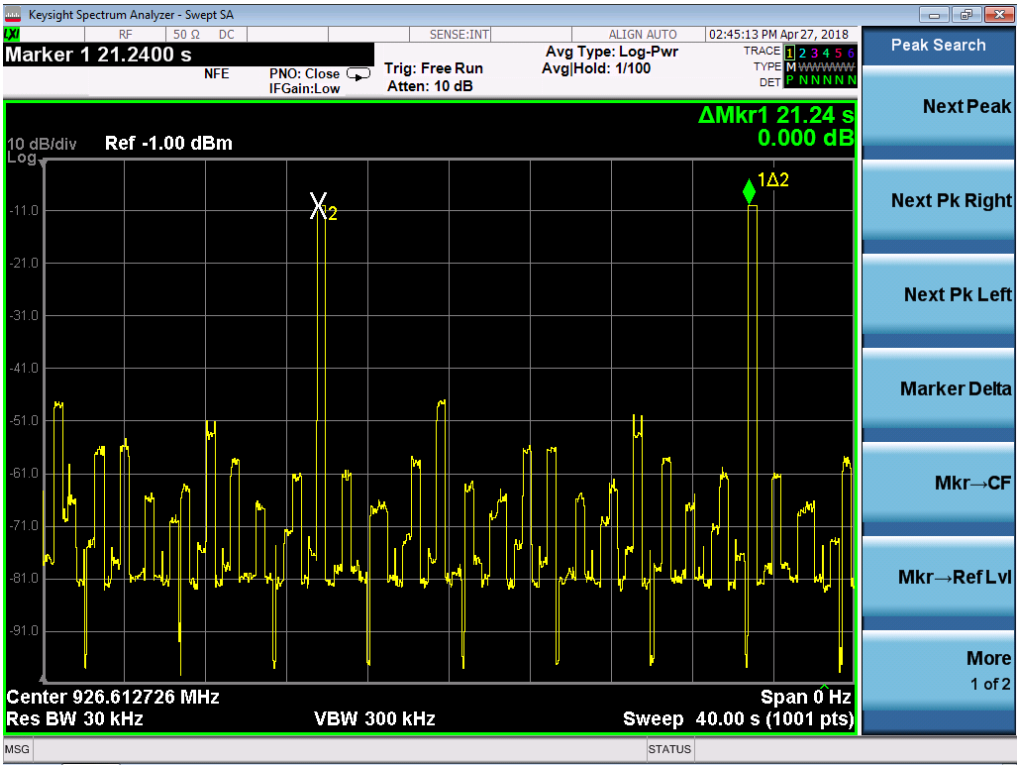

Figure 22: Top channel, 927.1MHz number of hops in specified period

Section 10 Band Edge Compliance

FCC Rule Part	47CFR15.247(a)(1)
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 Frequency: $\pm 10^{-8}$

10.1.1 Date of Test

27th April 2018

10.1.2 Test Area

LAB 5 bench area.

10.1.3 Test Setup

The equipment under test was provided with an SMA antenna connector and connected directly to the spectrum analyser using a short (30cm) coaxial cable.

10.1.4 Requirement 47CFR15.

For a 902MHz to 928MHz device, there are not any restricted bands at 902 MHz or 928 MHz. The authorised band-edge measurements according to the procedures of ANSI C63.10-2013 Clause 6.10.4 were performed.

For FHSS apparatus, the measurements shall be performed twice:

- Frequency hopping turned off
- Frequency hopping enabled

10.1.5 Procedure

The procedure described in ANSI C63.10-2013 Clause 6.10.4

10.1.6 Results

Band edge frequency (MHz)	Transmit frequency (MHz)	FHSS Status	Figure	dBc band edge value	Summary
902	924.1	OFF	30	44.0	Pass
	924.1	ON	31	42.97	Pass
928	927.1	OFF	32	44.47	Pass
	927.1	ON	33	43.53	Pass

10.1.7 Analyser Displays

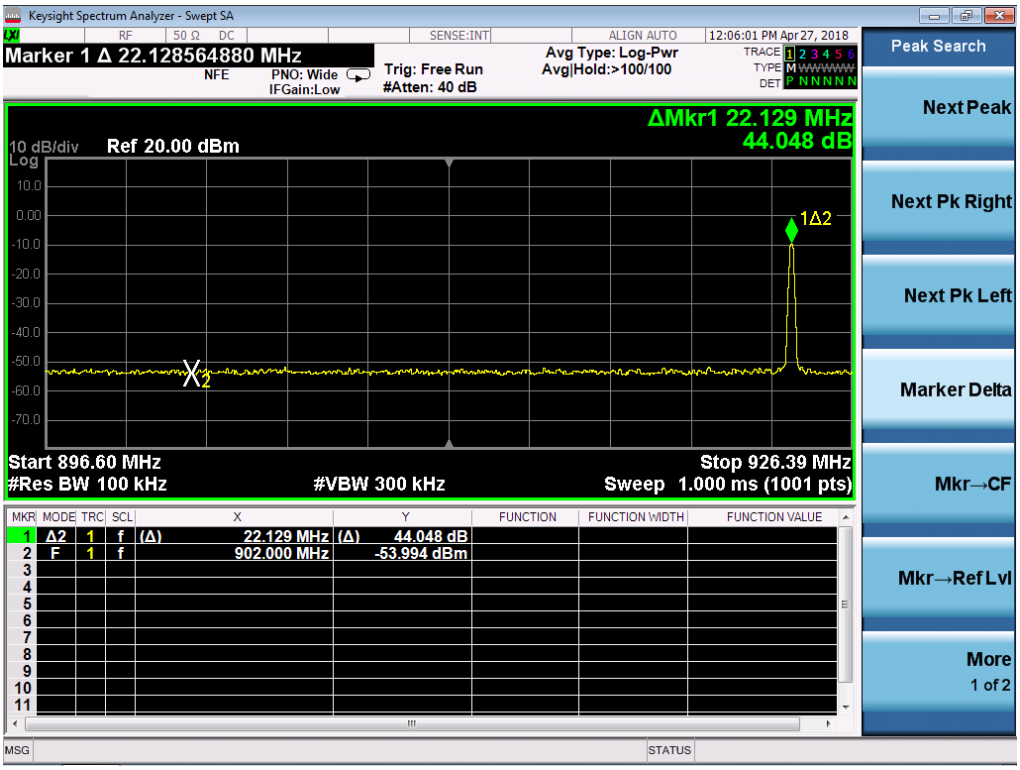

Figure 23: Lower band edge – FHSS turned off

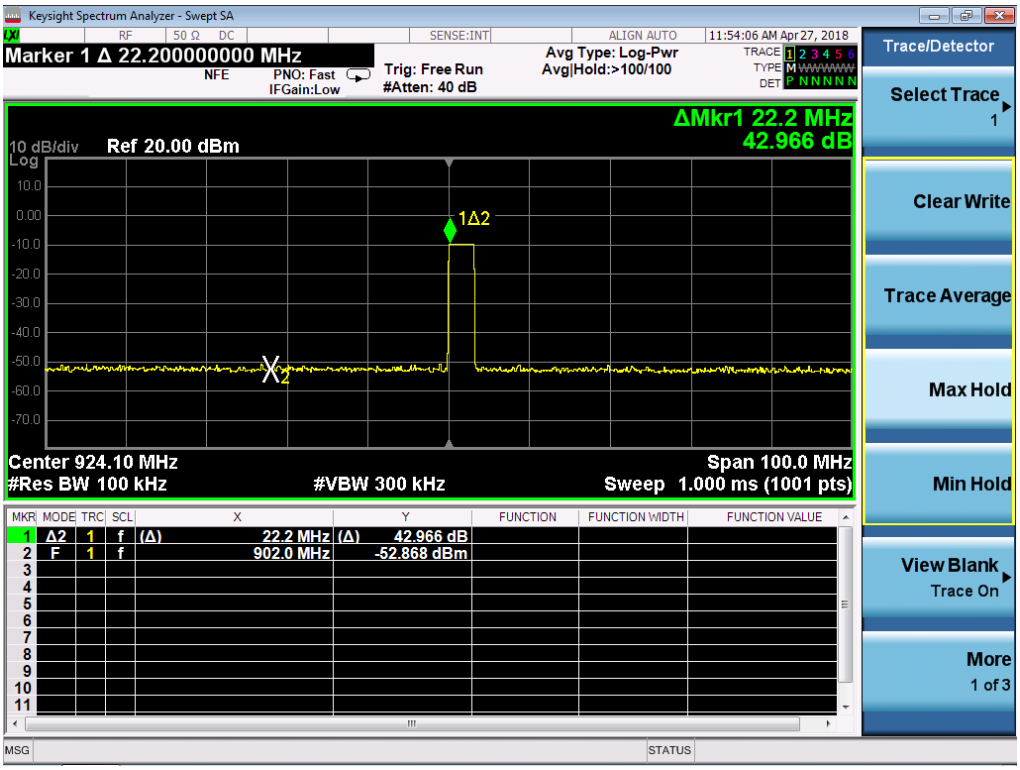

Figure 24: Upper band edge – FHSS Turned on

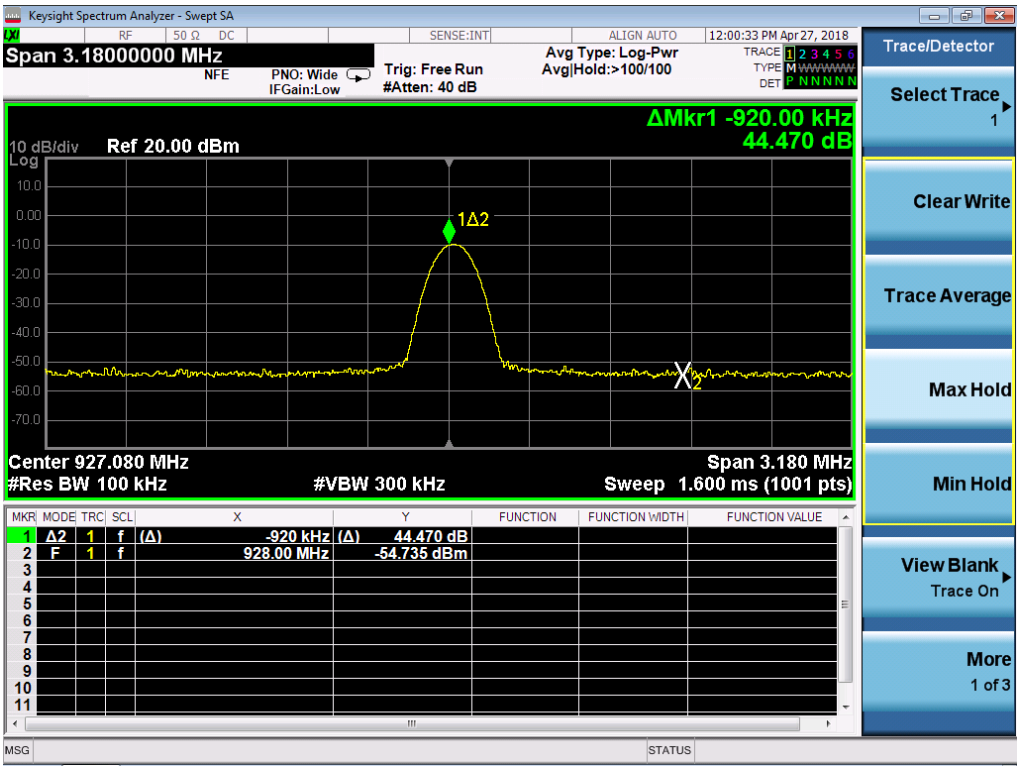

Figure 25: Upper band edge FHSS turned off

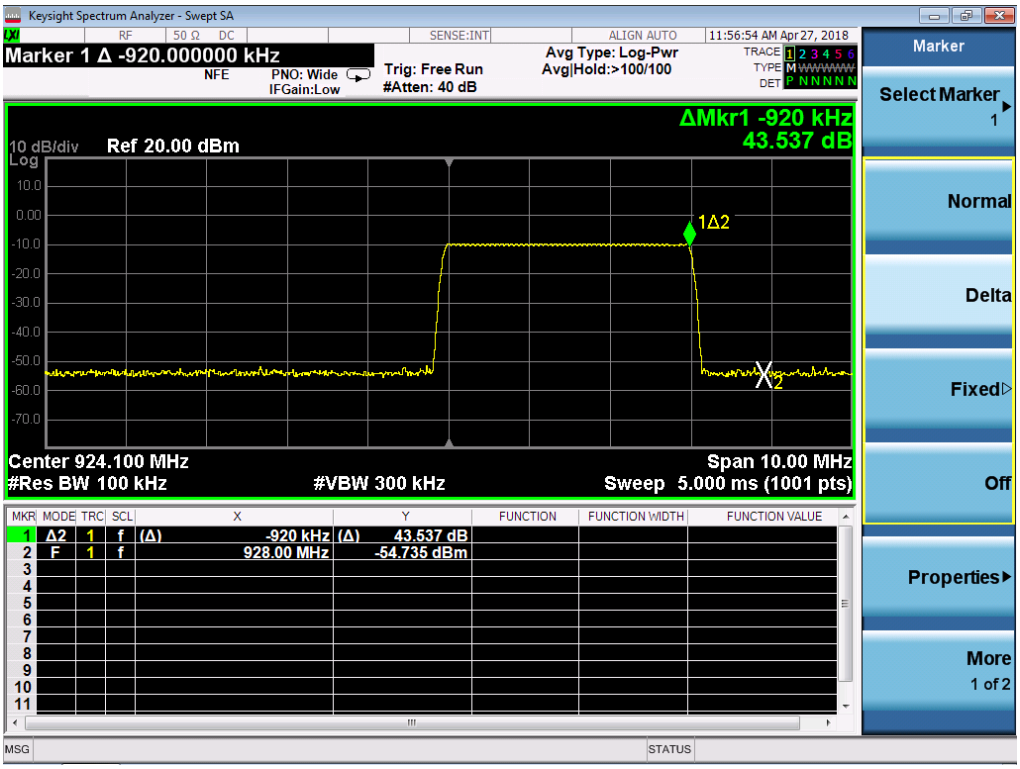

Figure 26: Upper band edge FHSS turned on

Appendix A EUT Test Photos

Photographs are supplied separately.

Appendix B Test Equipment List

Radiated and conducted antenna port emissions Equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Laboratory 1 Semi-Anechoic Chamber	Lab 1	07/12/2016	24 Months
ETS Lindgren 2017B Mast (1 – 4m) with tilting mechanism	--	N/A	N/A
Chase CPA9231 Pre amplifier	1434	09/02/2018	12 Months
HF18 Cable (For use from 9kHz to 18GHz)	167004-001	15/05/2017	12 Months
Keysight PXA Signal Analyser	MY54170531	07/09/2016	24 Months
Chase CBL6112B Bilog Antenna and 6dB attenuator 78708B	2763	21/02/2017	15 Months
HF14 Cable (For use from 9kHz to 18GHz)	167003-001	15/05/2017	12 Months
HF17 Cable (For use from 9kHz to 18GHz)	167002-001	15/05/2017	12 Months
EMCO 3115 Horn Antenna	9002-6058	03/08/2016	24 Months
BONN BLMA 0118-5A Preamplifier	149759	02/01/2018	12 Months
Cable (For use from 18GHz to 40GHz)	HF19	14/05/2017	12 Months