




# TEST REPORT


**Test Report No. : UL-RPT-RP11838557JD08A V3.0**

**Customer** : Apple Inc.  
**Model No.** : A1862  
**FCC ID** : BCGA1862  
**Technology** : *Bluetooth* – Basic Rate & EDR  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.247  
**Test Laboratory** : UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 3.0 supersedes all previous versions.

**Date of Issue:** 01 December 2017

**Checked by:**   
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Senior Test Engineer, Radio Laboratory

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**Customer Information**

<b>Company Name:</b>	Apple Inc.
<b>Address:</b>	1 Infinite Loop Cupertino, CA 95014 U.S.A.

**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	20/11/2017	Initial Version	Sarah Williams
2.0	23/11/2017	Section 4.4 updated	Sarah Williams
3.0	01/12/2017	AC Conducted Emissions results added, Sections 1.2, 1.3, 2.2, 2.3, 2.4, 3.5, 4.4 updated	Sarah Williams

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## **1. Attestation of Test Results**

### **1.1. Description of EUT**

The Apple iMac Pro is a desktop computer, with 27-inch Retina display, storage media, multimedia functions, IEEE 802.11a/b/g/n/ac radio and Bluetooth radio.

### **1.2. General Information**

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209
<b>Test Dates:</b>	19 August 2017 to 30 November 2017

### **1.3. Summary of Test Results**

<b>FCC Reference (47CFR)</b>	<b>Measurement</b>	<b>Result</b>
Part 15.247(a)(1)	Transmitter 20 dB Bandwidth	Complied
Part 15.247(a)(1)	Transmitter Carrier Frequency Separation	Complied
Part 15.247(a)(1)(iii)	Transmitter Number of Hopping Frequencies and Average Time of Occupancy	Complied
Part 15.247(b)(1)	Transmitter Maximum Peak Output Power	Complied
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	Complied
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	Complied
Part 15.207	Transmitter AC Conducted Emissions	Complied

#### **Note(s):**

- There are two vendors of the WiFi/*Bluetooth* radio modules, Vendor 1 and Vendor 2.
- The WiFi/*Bluetooth* radio modules have the same mechanical outline (i.e. the same packaging dimension and pin layout), use the same on-board antenna matching circuit, have an identical antenna structure and are built and tested to conform to the same specification and to operate within the same tolerances.  
Baseline testing was performed on the two vendors to determine the worst case.

### **1.4. Deviations from the Test Specification**

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

## **2. Summary of Testing**

### **2.1. Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	
Site 2	
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

### **2.2. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
<b>Title:</b>	AC Power-Line Conducted Emissions Frequently Asked Questions

## **2.3. Calibration and Uncertainty**

### **Measuring Instrument Calibration**

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

### **Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value measured (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
20 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Carrier Frequency Separation	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Average Time of Occupancy	2.4 GHz to 2.4835 GHz	95%	±3.53 ns
Conducted Maximum Peak Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

## 2.4. Test and Measurement Equipment

### Test Equipment Used for Transmitter Conducted Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	22 Feb 2018	12
M1804	Signal Generator	Rohde & Schwarz	SMP22	100026	03 Feb 2018	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU26	100027	28 Feb 2019	24
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	22 Nov 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24
A2521	Attenuator	AtlanTecRF	AN18-20	832797#2	Calibrated before use	-
A2520	Attenuator	AtlanTecRF	AN18-20	832797#1	Calibrated before use	-

### Test Equipment Used for Transmitter Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	22 Feb 2018	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	14 Apr 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	11 Apr 2018	12
A2891	Preamplifier	Schwarzbeck	BBV 9718	9718-306	11 Apr 2018	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	11 Apr 2018	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	11 Apr 2018	12
A2893	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-021	11 Apr 2018	12
A2888	Antenna	Schwarzbeck	VULB 9163	9163-941	25 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	06 Mar 2018	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	160190001	06 Mar 2018	12
A2131	Low Pass Filter	AtlanTecRF	AFL-02000	JFB1004-002	27 Feb 2018	12

**Test and Measurement Equipment (continued)****Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	22 Feb 2018	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	14 Apr 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	11 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12

**Test Equipment Used for Transmitter AC Conducted Spurious Emissions**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2013	Thermohygrometer	Testo	608-H1	45046424	20 Jun 2018	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2018	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	09 May 2018	12
M1379	Test Receiver	Rohde & Schwarz	ESIB7	100330	08 Dec 2017	12
A2953	Power Supply	Tacima	SC 5467	Not stated	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	12 May 2018	12



### 3. Equipment Under Test (EUT)

#### 3.1. Identification of Equipment Under Test (EUT)

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1862
<b>Test Sample Serial Number:</b>	C02V4002J61N ( <i>Conducted &amp; Radiated Sample</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17B2022
<b>BT BB Version:</b>	v253
<b>FCC ID:</b>	BCGA1862

#### 3.2. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

#### 3.3. Additional Information Related to Testing

<b>Tested Technology:</b>	<i>Bluetooth</i>		
<b>Power Supply Requirement:</b>	Nominal	120 VAC 60 Hz	
<b>Type of Unit:</b>	Transceiver		
<b>Channel Spacing:</b>	1 MHz		
<b>Mode:</b>	Basic Rate	Enhanced Data Rate	
<b>Modulation:</b>	GFSK	$\pi/4$ -DQPSK	8DPSK
<b>Packet Type: (Maximum Payload)</b>	DH5	2DH5	3DH5
<b>Data Rate (Mbps):</b>	1	2	3
<b>Maximum Conducted Output Power:</b>	11.4 dBm		
<b>Transmit Frequency Range:</b>	2402 MHz to 2480 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	0	2402
	Middle	39	2441
	Top	78	2480

#### 3.4. Description of Available Antennas

The radio utilizes an integrated antenna, with the following maximum gain:

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	6.0

### **3.5. Description of Test Setup**

#### **Support Equipment**

The following support equipment was used to exercise the EUT during testing:

<b>Description:</b>	USB-C VGA Multiport Adaptor.
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	MJ1L2ZM/A
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Keyboard
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1243
<b>Serial Number:</b>	DG7515613M4DPQWA2

<b>Description:</b>	USB Keyboard
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1243
<b>Serial Number:</b>	DG763550FGGGV6GAP

<b>Description:</b>	USB Mouse
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1152
<b>Serial Number:</b>	CC2446203JDNYPAN

<b>Description:</b>	USB Mouse
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1152
<b>Serial Number:</b>	CC2650501N3GW86AL

<b>Description:</b>	PHF
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	Apple EarPods
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Ethernet cable. Length 2.0 metres
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

**Support Equipment (continued)**

<b>Description:</b>	5 port Ethernet switch
<b>Brand Name:</b>	Netgear
<b>Model Name or Number:</b>	GS605 v3
<b>Serial Number:</b>	1YG19430021A1

**Operating Modes**

The EUT was tested in the following operating mode(s):

- Continuously transmitting at maximum power on bottom, middle and top channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.
- Continuously transmitting at maximum power in hopping mode on all channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.

**Configuration and Peripherals**

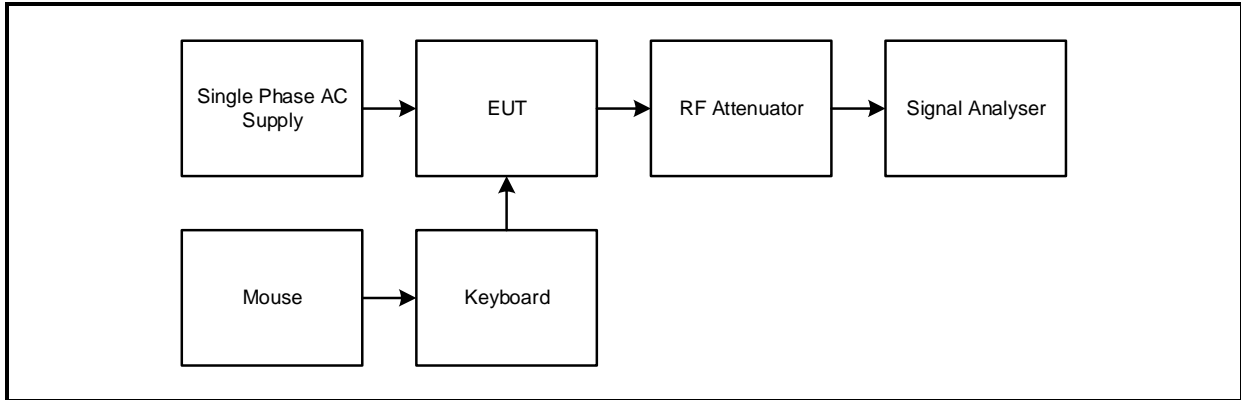
The EUT was tested in the following configuration(s):

- Controlled in test mode using a software application on the EUT. The application was used to enable a continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions 'EUT\_BT\_SOP\_v1.3.pdf'.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply.
- AC conducted emissions test was tested with the EUT transmitting on the middle channel using DH5 packet type, as this mode was found to transmit the highest power.
- Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this mode was found to transmit the highest power.
- For radiated testing all active ports were terminated using the appropriate termination.
- The radiated sample was converted to a conducted sample by disconnecting the internal antenna and replacing with a cable and RF connector in its place.

**Test Setup Diagrams**

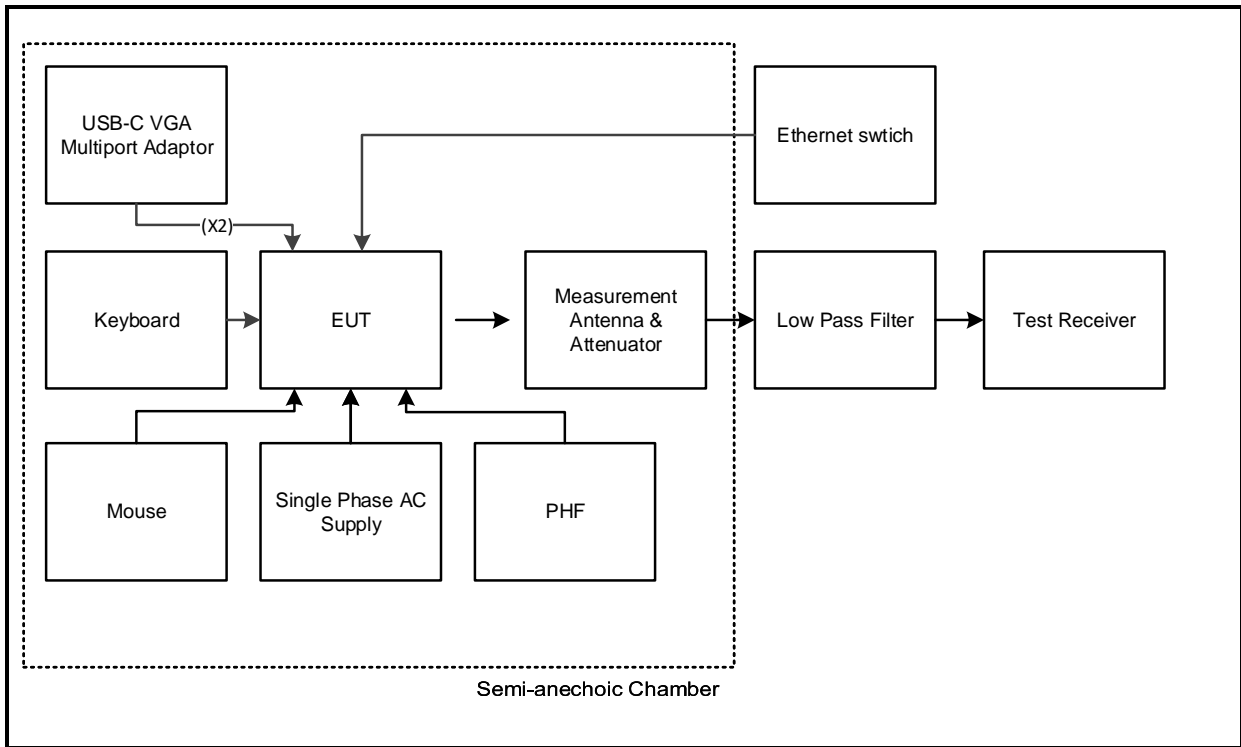
**Conducted Tests:**

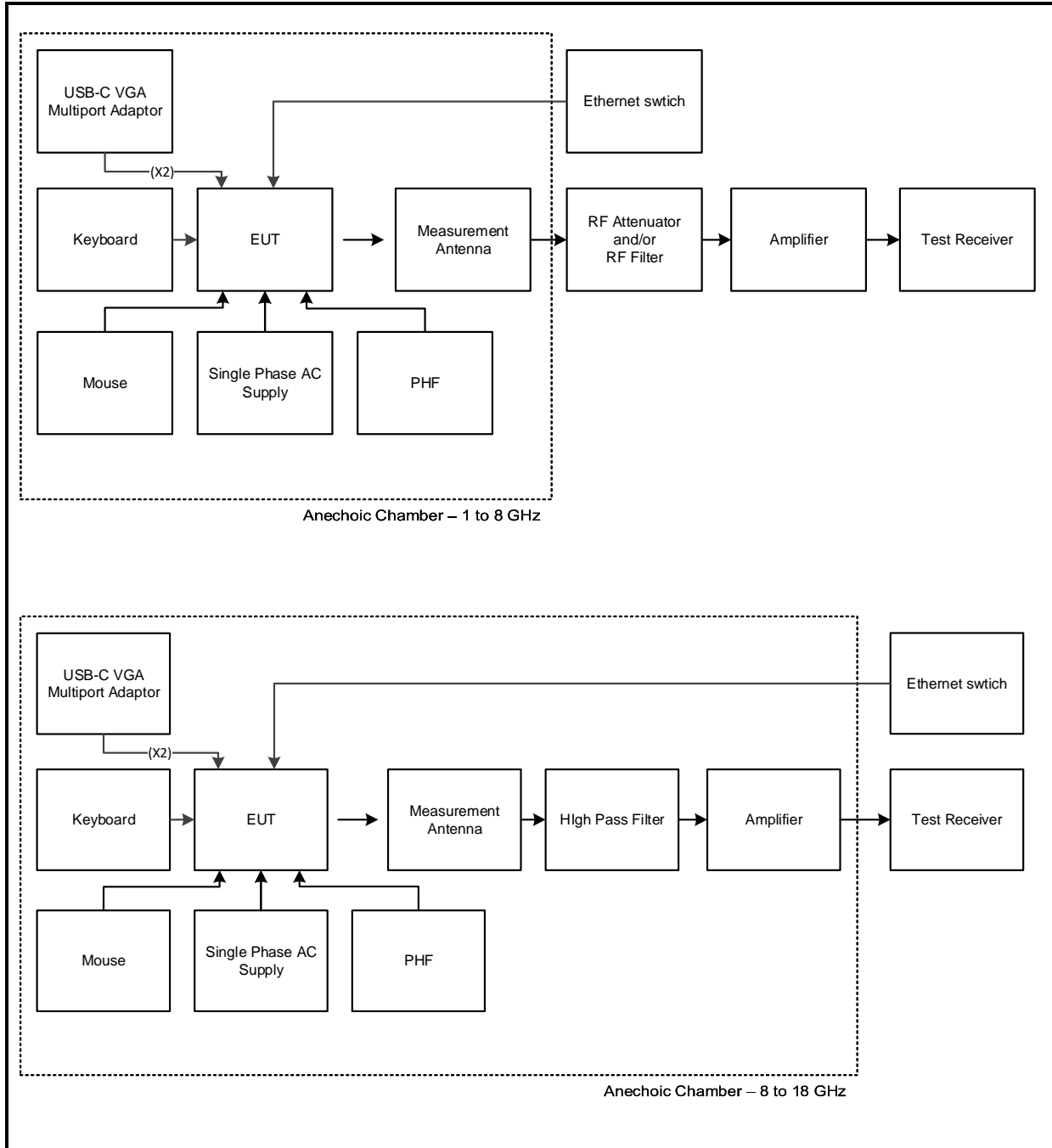
**Setup for Transmitter 20 dB Bandwidth, Carrier Frequency Separation, Number of Hopping Frequencies, Average Time of Occupancy & Maximum Peak Output Power**



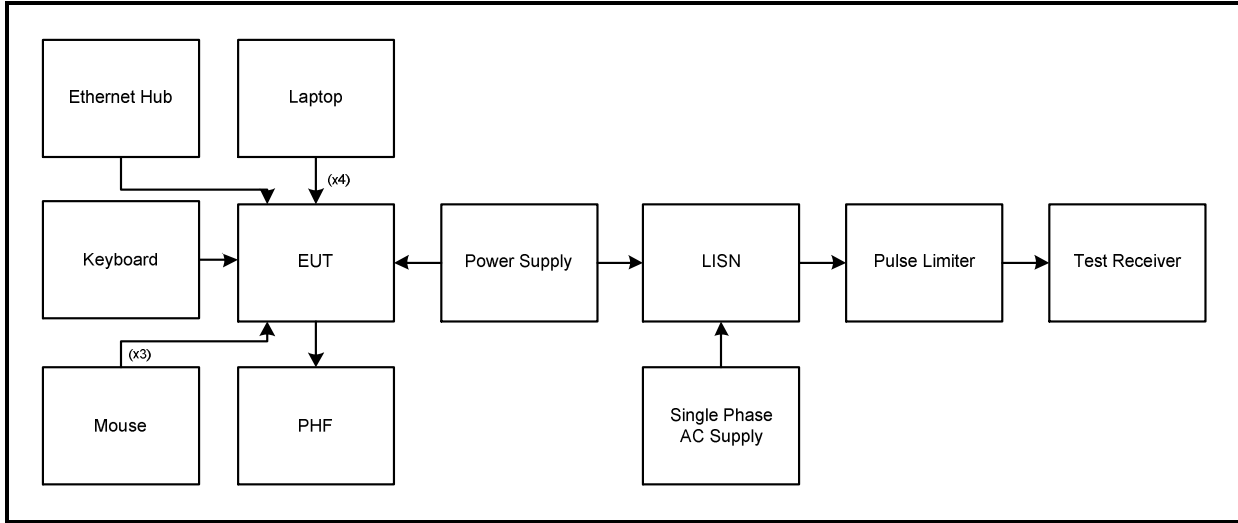
**Radiated Tests:**

**Test Setup for Transmitter Radiated Emissions**





**Test Setup for Transmitter AC Conducted Spurious Emissions**



## **4. Antenna Port Test Results**

### **4.1. Transmitter 20 dB Bandwidth**

#### **Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Date:</b>	09 October 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Part 15.247(a)(1)
<b>Test Method Used:</b>	ANSI C63.10 Section 6.9.2

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	41

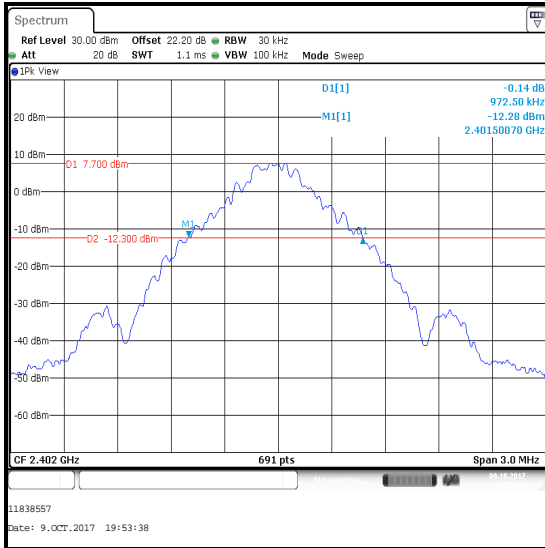
#### **Note(s):**

1. The signal analyser resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3.0 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

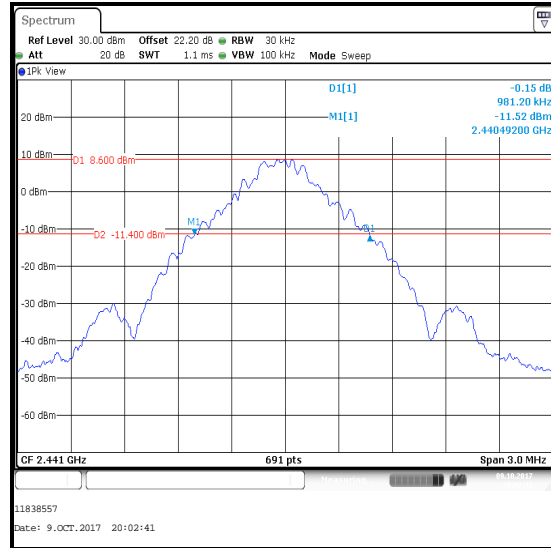
**Transmitter 20 dB Bandwidth (continued)**

**Results DH5:**

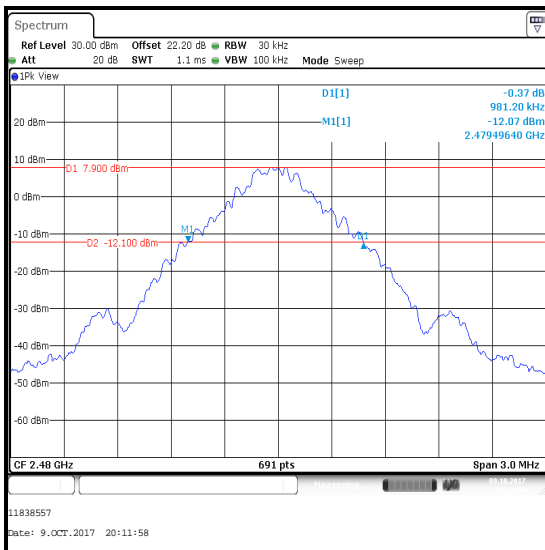
Channel	20 dB Bandwidth (kHz)
Bottom	972.500
Middle	981.200
Top	981.200



**Bottom Channel**



**Middle Channel**



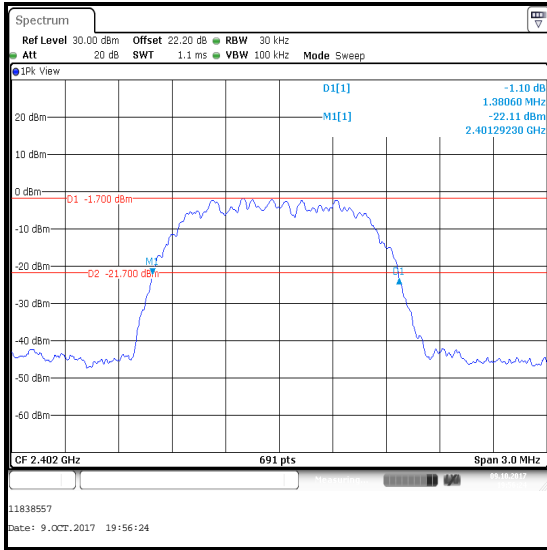
**Top Channel**



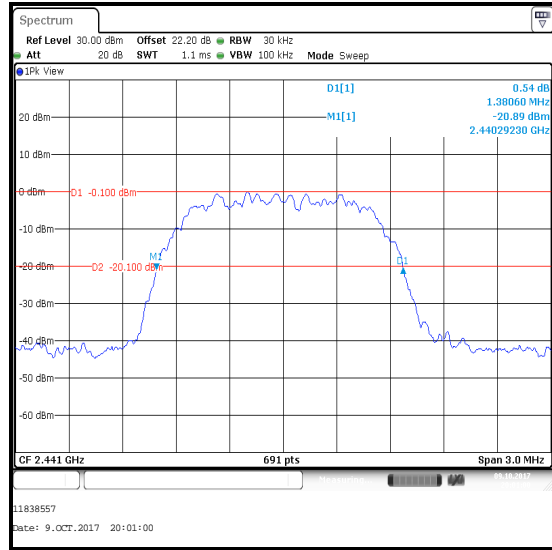
**Transmitter 20 dB Bandwidth (continued)**

**Results 2DH5:**

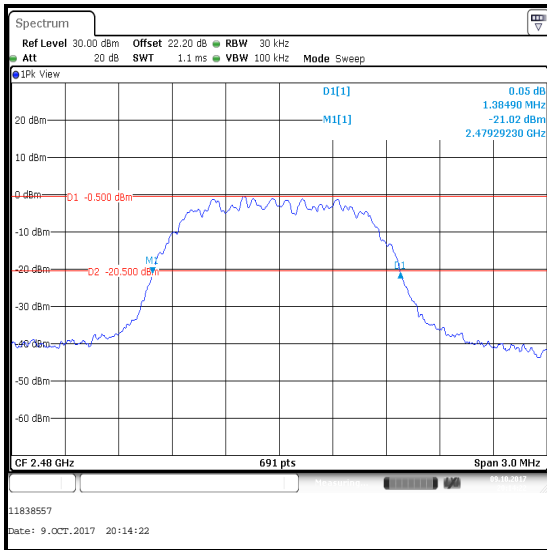
Channel	20 dB Bandwidth (kHz)
Bottom	1380.600
Middle	1380.600
Top	1384.900



**Bottom Channel**



**Middle Channel**

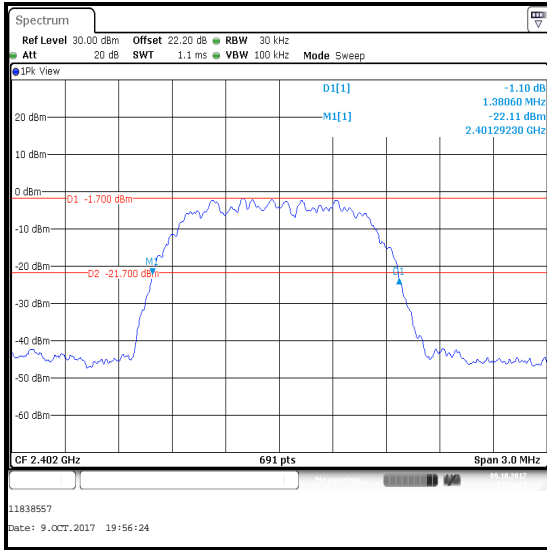


**Top Channel**

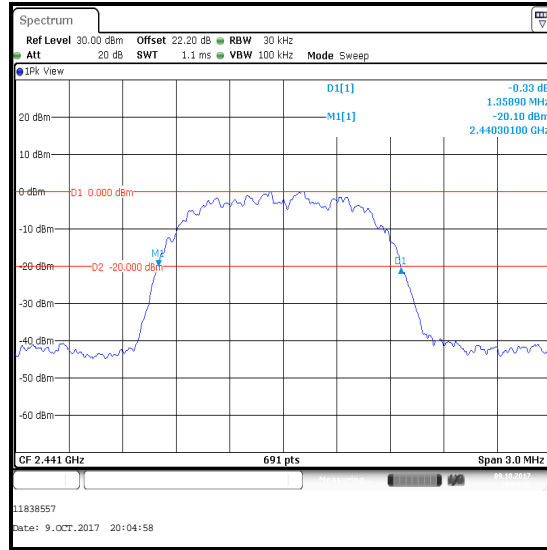
**Transmitter 20 dB Bandwidth (continued)**

**Results 3DH5:**

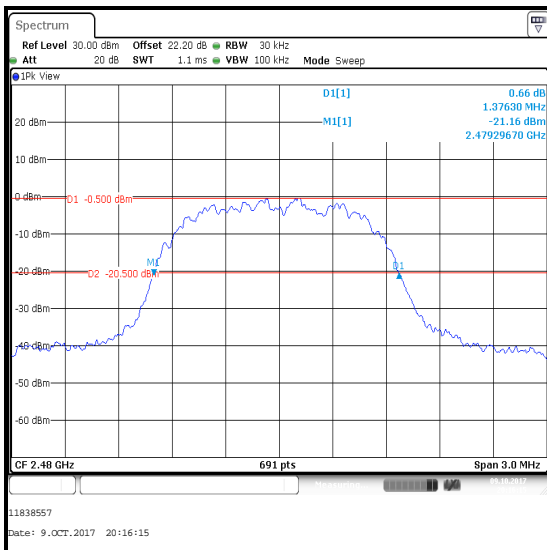
Channel	20 dB Bandwidth (kHz)
Bottom	1380.600
Middle	1358.900
Top	1376.300



**Bottom Channel**



**Middle Channel**



**Top Channel**

**4.2. Transmitter Carrier Frequency Separation****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	19 September 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Part 15.247(a)(1)
<b>Test Method Used:</b>	ANSI C63.10 Section 7.8.2

**Environmental Conditions:**

<b>Temperature (°C):</b>	26
<b>Relative Humidity (%):</b>	38

**Note(s):**

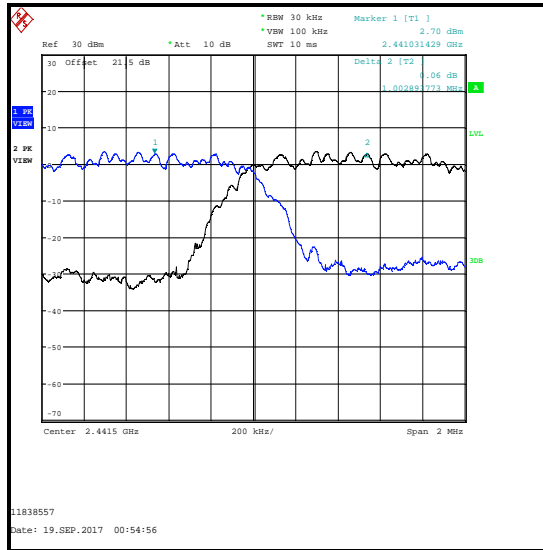
1. The 20 dB bandwidth measured for the middle channel operating at 2441 MHz was used to calculate the limit.



**Transmitter Carrier Frequency Separation (continued)**

**Results: 2DH5**

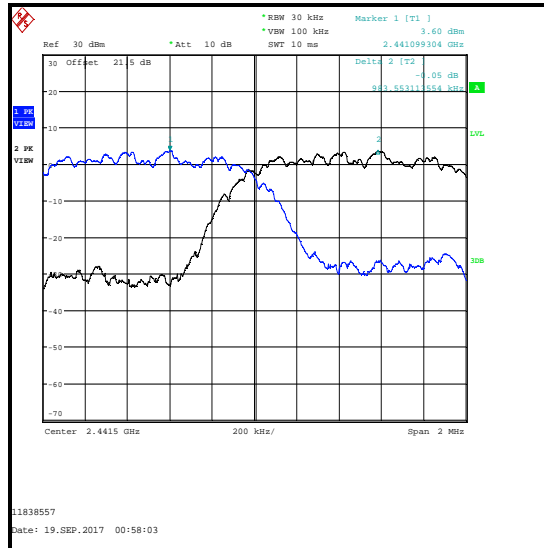
Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1002.894	920.400	82.494	Complied



**Transmitter Carrier Frequency Separation (continued)**

**Results: 3DH5**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
983.553	905.933	77.620	Complied



**4.3. Transmitter Number of Hopping Frequencies and Average Time of Occupancy****Test Summary:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	19 September 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Part 15.247(a)(1)(iii)
<b>Test Method Used:</b>	ANSI C63.10 Sections 7.8.3 & 7.8.4

**Environmental Conditions:**

<b>Temperature (°C):</b>	26
<b>Relative Humidity (%):</b>	38

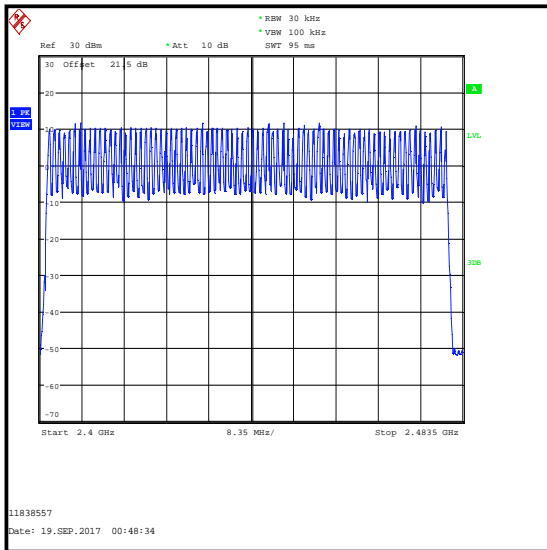
**Note(s):**

1. Tests were performed to identify the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.
2. The spectrum analyser was set up for the Number of Hopping Frequencies measurement as follows: the resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 83.5 MHz.
3. The spectrum analyser was set up for the Emission Width measurement as follows: the resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used and sweep time was set to auto with a span of zero Hz. The spectrum analyser was set to trigger at 0.5 ms, with a marker placed at the start of the emission and a delta marked place at the end of the emission. The emission width is recorded in the table below.
4. The spectrum analyser was set up for the Number of Hopping Frequencies in 32 seconds measurement as follows: the resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used and sweep time was set to 32 seconds. The EUT was set to transmit in a hopping frequency mode with zero span. The total number of hopping frequencies was recorded in the table below.
5. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

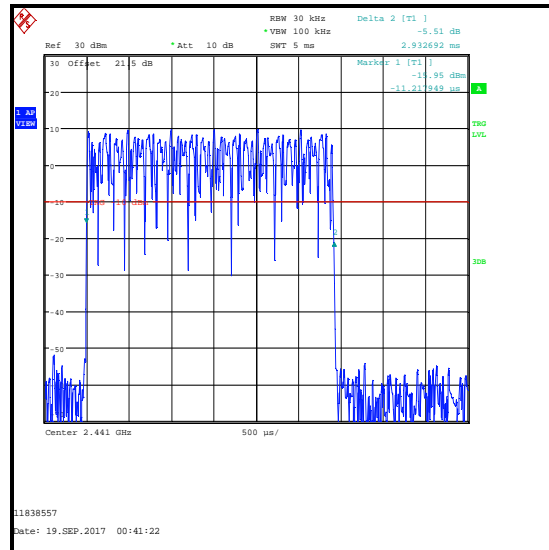
**Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)**

**Results:**

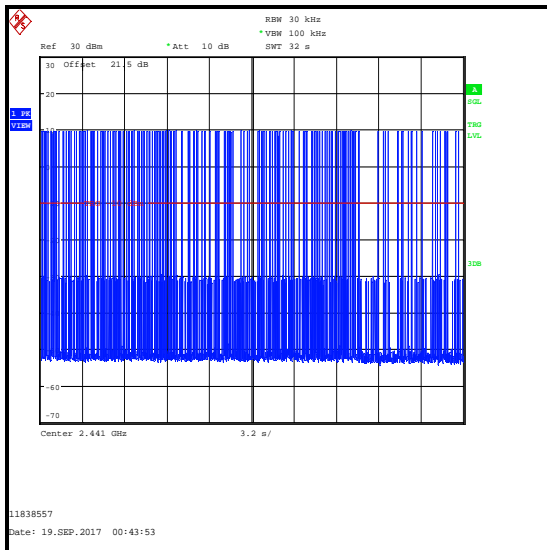
Emission Width ( $\mu$ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2932.692	131	0.384	0.4	0.016	Complied



**Number of Hopping Frequencies**



**Emission Width**



**Number of Hopping Frequencies in 32 s**



#### **4.4. Transmitter Maximum Peak Output Power**

##### **Test Summary:**

<b>Test Engineer:</b>	Andrew Edwards	<b>Test Date:</b>	09 October 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Part 15.247(b)(1)
<b>Test Method Used:</b>	ANSI C63.10 Section 7.8.5

##### **Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	41

##### **Note(s):**

1. The spectrum analyser resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5.0 MHz (approximately five times the 20 dB bandwidth). A marker was placed at the peak of the signal and the results recorded in the tables below.
2. The declared antenna gain was added to the conducted peak power to obtain the EIRP.
3. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the spectrum analyser to compensate for the loss of the attenuator and RF cable.

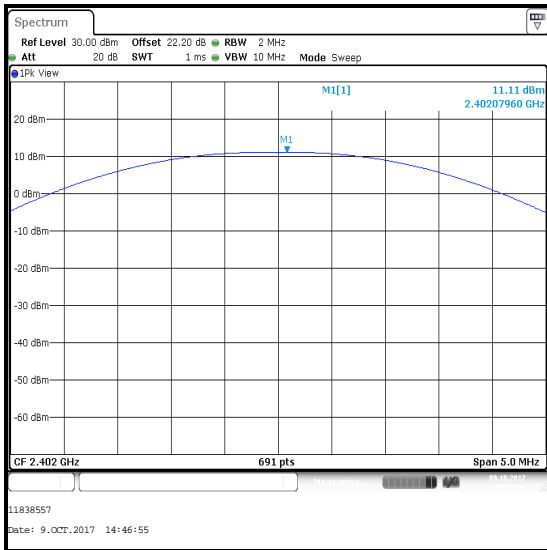
**Transmitter Maximum Peak Output Power (continued)****Results: DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	11.1	30.0	18.9	Complied
Middle	11.4	30.0	18.6	Complied
Top	10.8	30.0	19.2	Complied

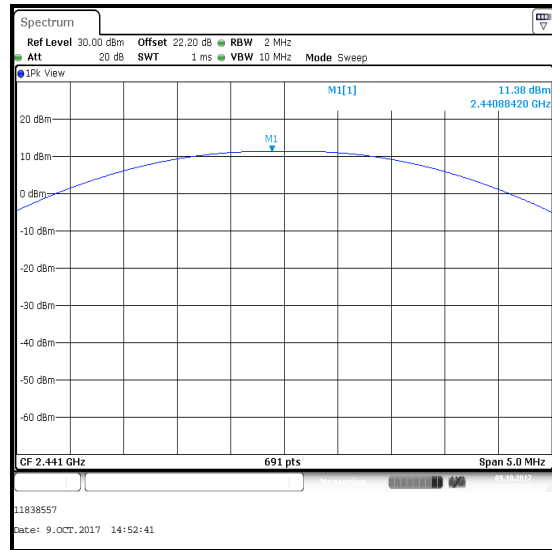
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	11.1	6.0	17.1	36.0	18.9	Complied
Middle	11.4	6.0	17.4	36.0	18.6	Complied
Top	10.8	6.0	16.8	36.0	19.2	Complied

### Transmitter Maximum Peak Output Power (continued)

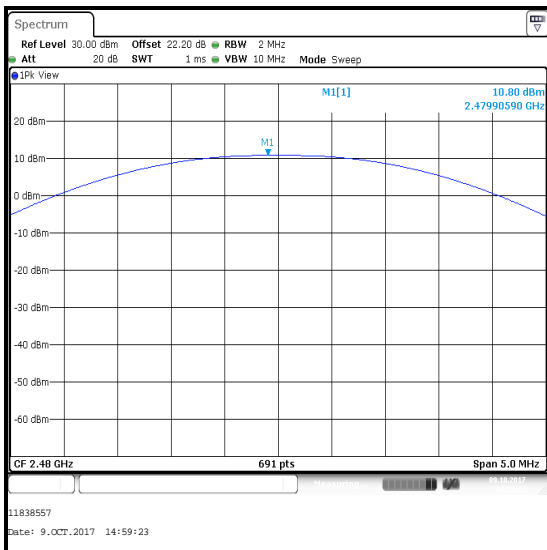
#### Results: DH5



Bottom Channel



Middle Channel



Top Channel

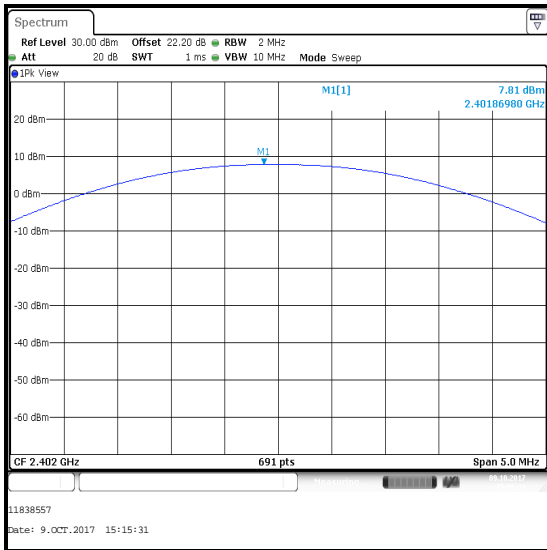
**Transmitter Maximum Peak Output Power (continued)****Results: 2DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	7.8	21.0	13.2	Complied
Middle	8.3	21.0	12.7	Complied
Top	7.8	21.0	13.2	Complied

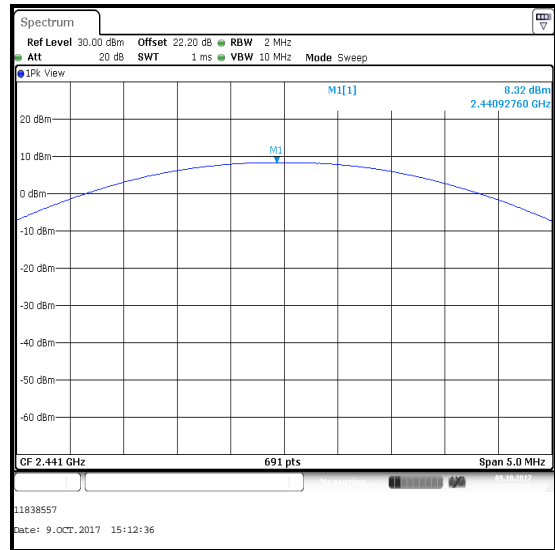
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	7.8	6.0	13.8	27.0	13.2	Complied
Middle	8.3	6.0	14.3	27.0	12.7	Complied
Top	7.8	6.0	13.8	27.0	13.2	Complied

**Transmitter Maximum Peak Output Power (continued)**

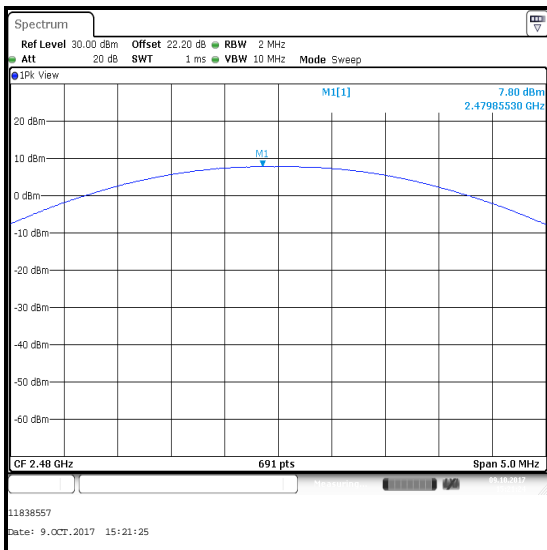
**Results: 2DH5**



**Bottom Channel**



**Middle Channel**



**Top Channel**

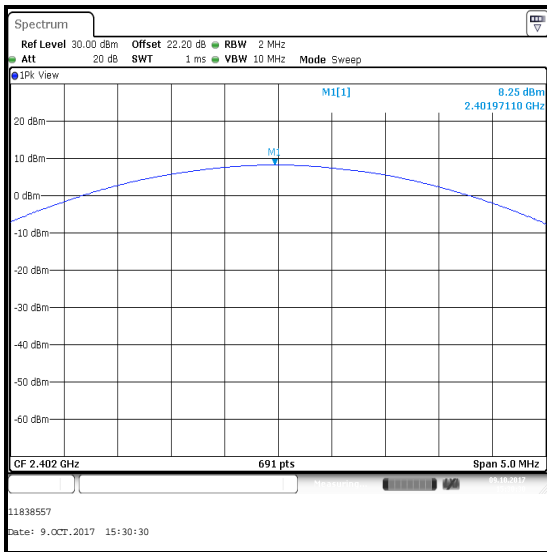
**Transmitter Maximum Peak Output Power (continued)****Results: 3DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	8.3	21.0	12.7	Complied
Middle	8.7	21.0	12.3	Complied
Top	8.3	21.0	12.7	Complied

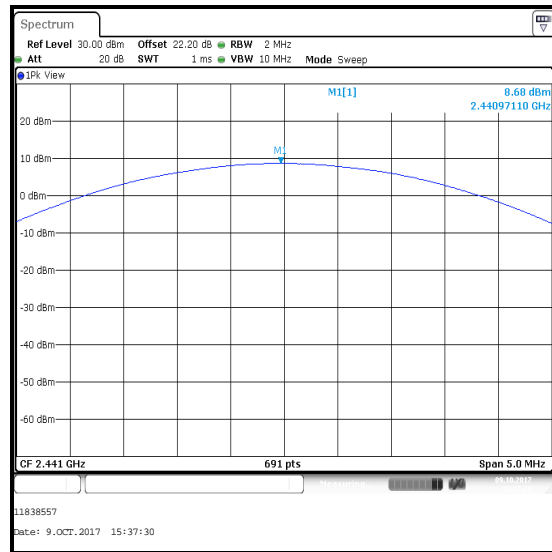
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	8.3	6.0	14.3	27.0	12.7	Complied
Middle	8.7	6.0	14.7	27.0	12.3	Complied
Top	8.3	6.0	14.3	27.0	12.7	Complied

**Transmitter Maximum Peak Output Power (continued)**

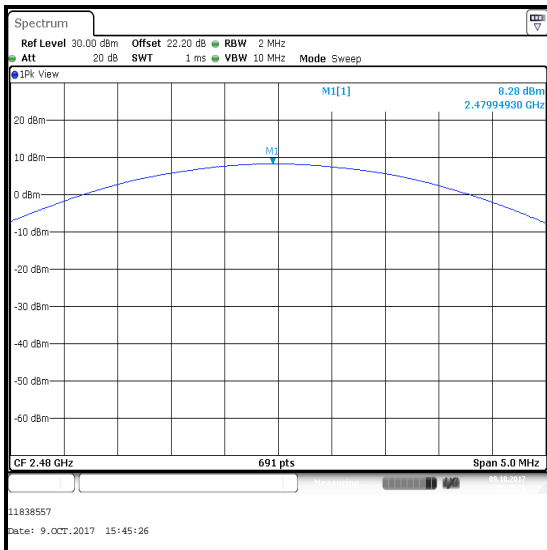
**Results: 3DH5**



**Bottom Channel**



**Middle Channel**



**Top Channel**

## **5. Radiated Test Results**

### **5.1. Transmitter Radiated Emissions <1 GHz**

#### **Test Summary:**

<b>Test Engineers:</b>	Mark Perry & Stuart Martin	<b>Test Date:</b>	01 September 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	49

#### **Note(s):**

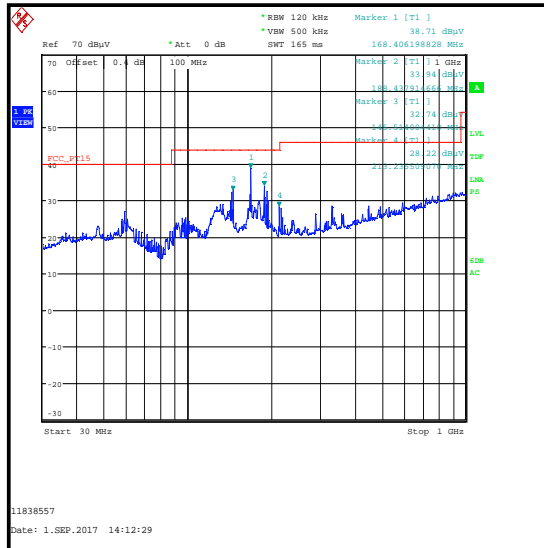
1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this was found to transmit the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
4. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
5. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
7. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span big enough to see the whole emission.



**Transmitter Radiated Emissions (continued)**

**Results: Quasi-Peak / DH5**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
168.135	Horizontal	35.1	43.5	8.4	Complied



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

**5.2. Transmitter Radiated Emissions >1 GHz****Test Summary:**

<b>Test Engineer:</b>	Stuart Martin	<b>Test Dates:</b>	20 August 2017 & 26 August 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 25 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	21 to 25
<b>Relative Humidity (%):</b>	47 to 50

**Note(s):**

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this was found to transmit the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental at 2441 MHz.
4. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded as shown in the tables below.
5. Pre-scans above 1 GHz were performed in fully anechoic chamber (Assets Number K0017) and at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
6. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.

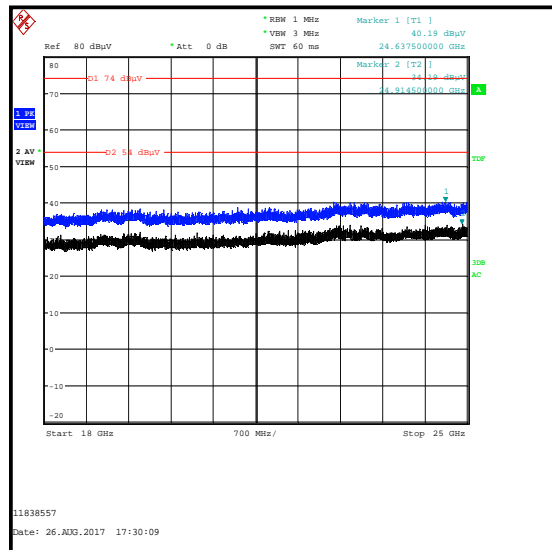
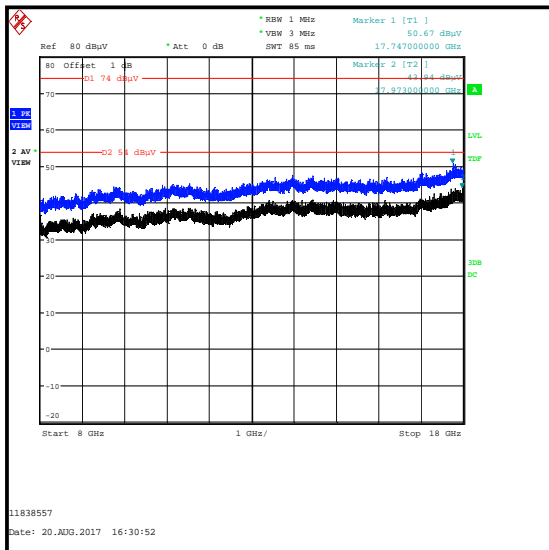
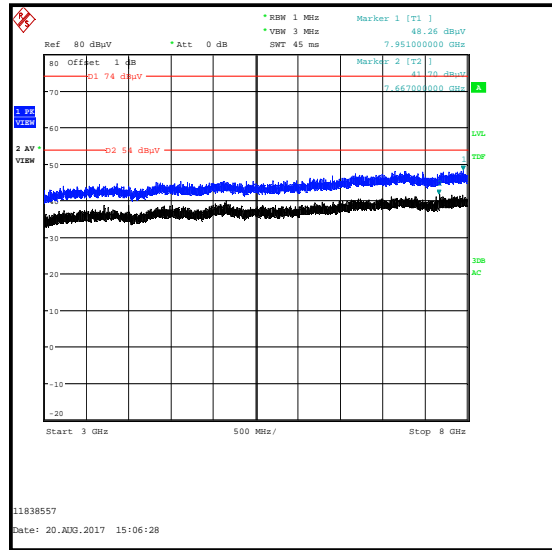
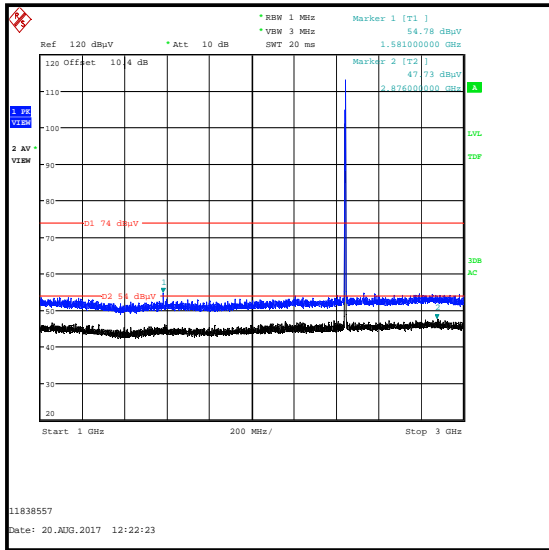
**Results: Peak / Middle Channel / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
1581.000	Vertical	54.8	74.0	19.2	Complied

**Results: Average / Middle Channel / DH5**

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
2876.000	Vertical	47.7	54.0	6.3	Complied

### Transmitter Radiated Emissions (continued)



### **5.3. Transmitter Band Edge Radiated Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Stuart Martin	<b>Test Dates:</b>	19 August 2017 to 26 August 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Section 6.10

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 25
<b>Relative Humidity (%):</b>	39 to 50

#### **Note(s):**

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The lower band edge is adjacent to a non-restricted band. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
3. The upper band edge is adjacent to a restricted band. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak and average measurements were performed with their respective detectors, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
4. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.
5. \* -20 dBc limit.

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.920	Vertical	49.0	90.8*	41.8	Complied
2400.000	Vertical	48.2	90.8*	42.6	Complied
2483.500	Vertical	53.8	74.0	20.2	Complied
2483.740	Vertical	55.8	74.0	18.2	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	48.5	54.0	5.5	Complied
2484.141	Vertical	50.2	54.0	3.8	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

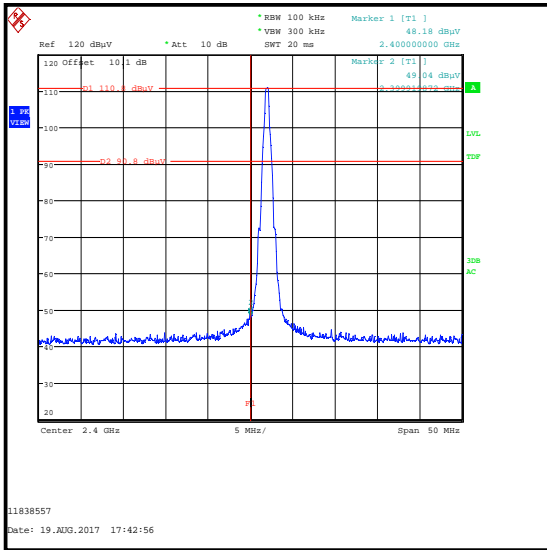
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2339.615	Vertical	52.8	74.0	21.2	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

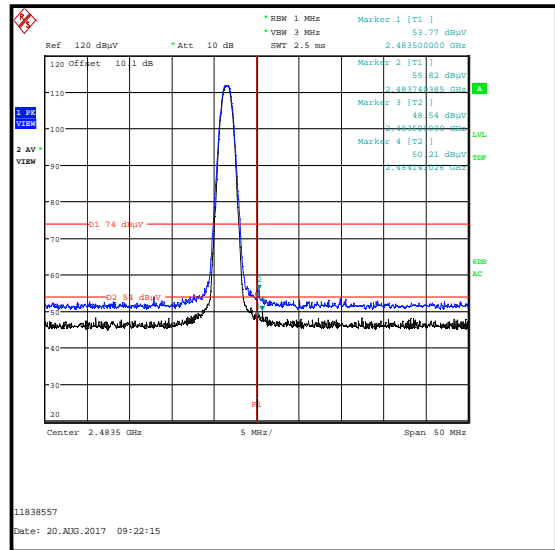
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2320.897	Vertical	47.1	54.0	6.9	Complied

### Transmitter Band Edge Radiated Emissions (continued)

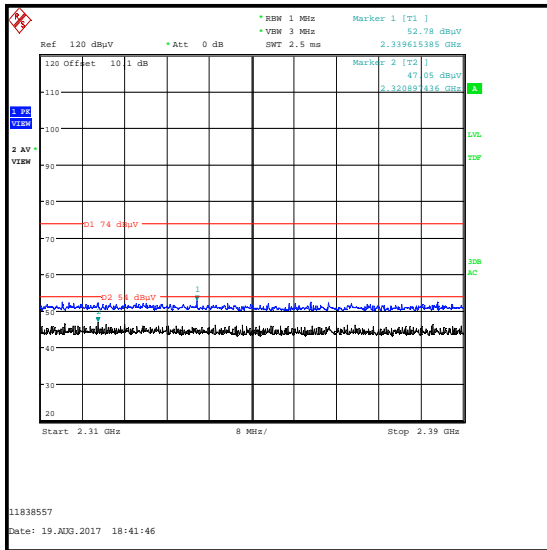
#### Results: Static Mode / DH5



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.000	Vertical	46.0	92.3*	46.3	Complied
2483.500	Vertical	50.9	74.0	23.1	Complied
2483.901	Vertical	54.0	74.0	20.0	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	46.6	54.0	7.4	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

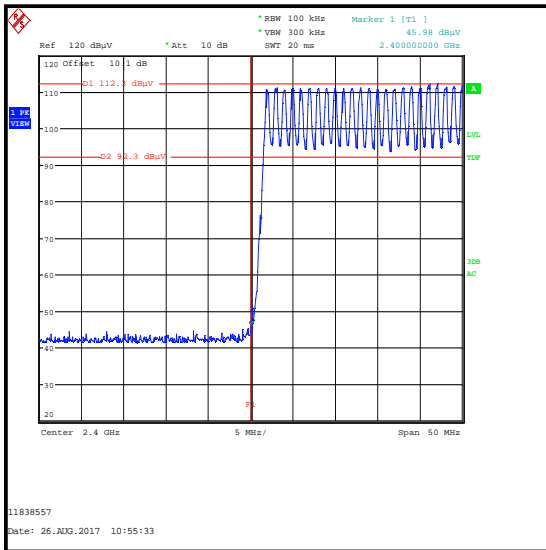
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2319.487	Vertical	53.2	74.0	20.8	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

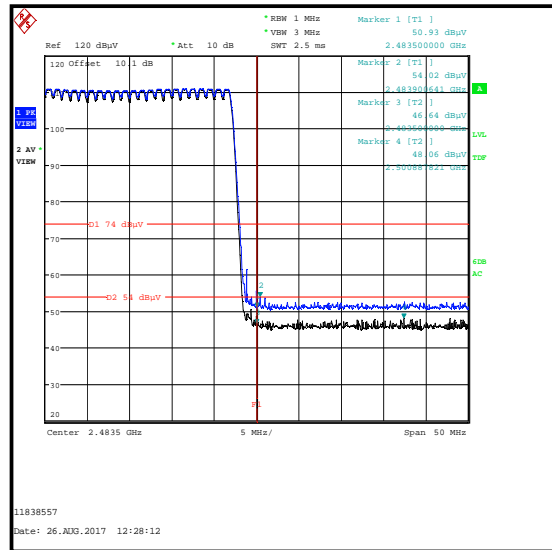
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2333.077	Vertical	46.3	54.0	7.7	Complied

### Transmitter Band Edge Radiated Emissions (continued)

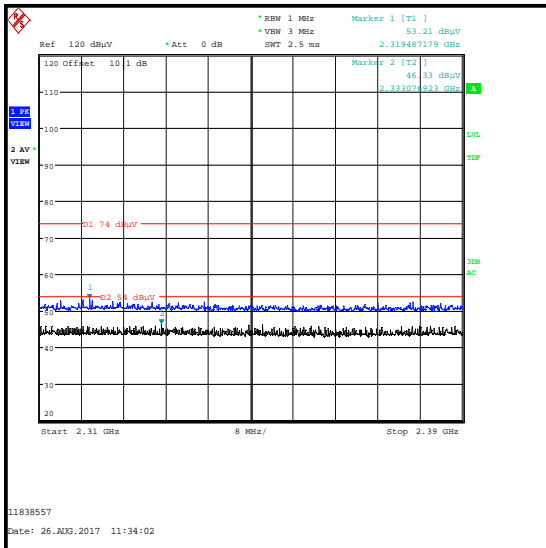
#### Results: Hopping Mode / DH5



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band



**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 2DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.000	Vertical	49.6	85.2*	35.6	Complied
2483.500	Vertical	56.4	74.0	17.6	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	48.9	54.0	5.1	Complied
2484.141	Vertical	49.1	54.0	4.9	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

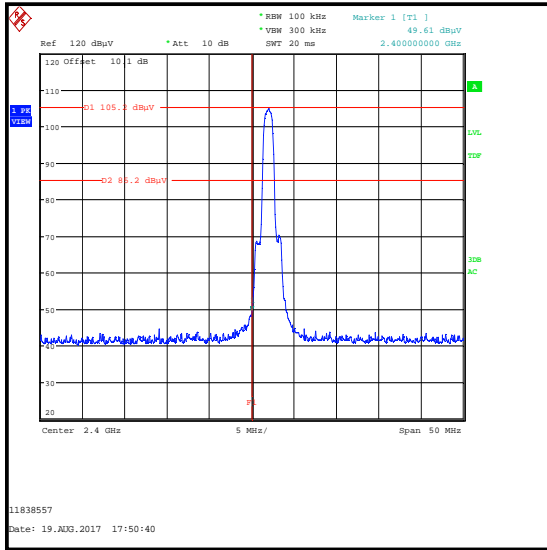
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2346.410	Vertical	52.4	74.0	21.6	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

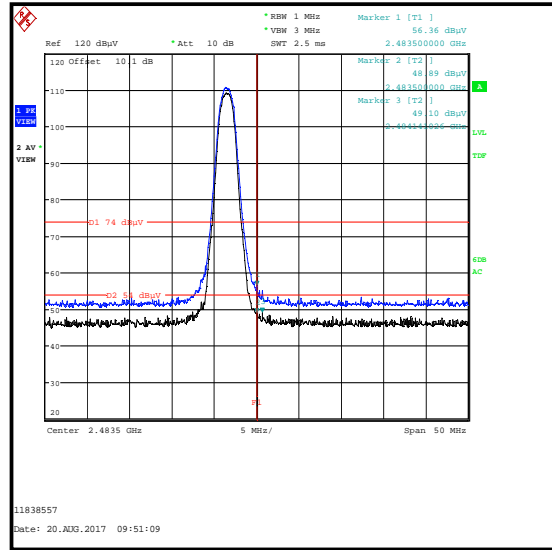
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2364.615	Vertical	47.0	54.0	7.0	Complied

### Transmitter Band Edge Radiated Emissions (continued)

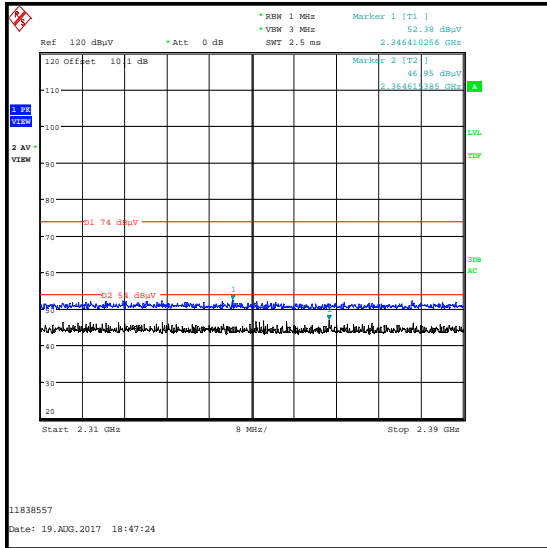
#### Results: Static Mode / 2DH5



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 2DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.519	Vertical	59.9	90.3*	30.4	Complied
2400.000	Vertical	56.1	90.3*	34.2	Complied
2483.500	Vertical	51.4	74.0	22.6	Complied
2484.782	Vertical	56.0	74.0	18.0	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	46.0	54.0	8.0	Complied
2487.747	Vertical	49.2	54.0	4.8	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

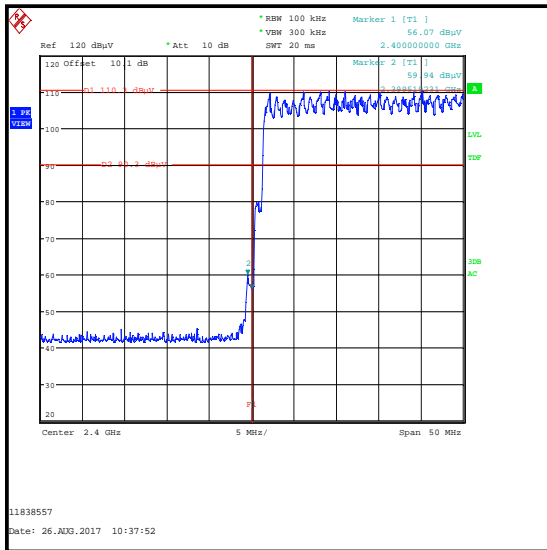
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2380.128	Vertical	53.0	74.0	21.0	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

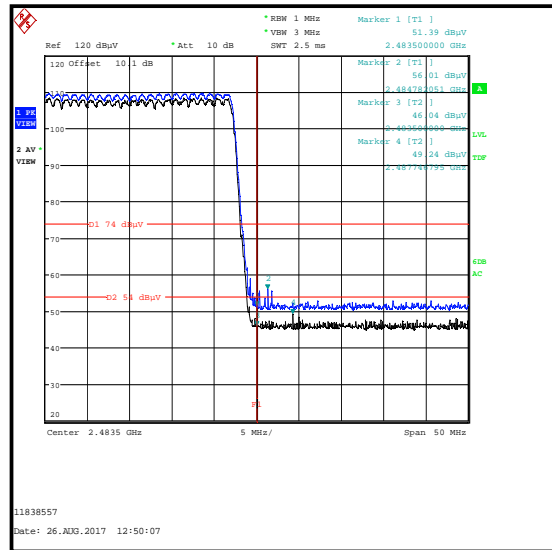
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2376.410	Vertical	46.3	54.0	7.7	Complied

### Transmitter Band Edge Radiated Emissions (continued)

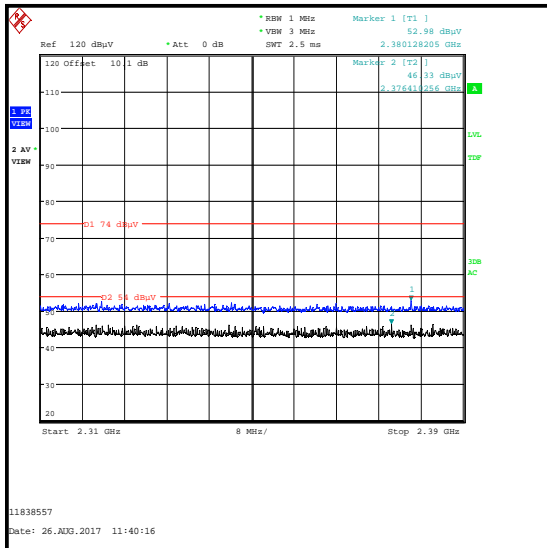
#### Results: Hopping Mode / 2DH5



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

**Transmitter Band Edge Radiated Emissions (continued)****Results: Static Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.679	Vertical	47.4	85.2*	37.8	Complied
2400.000	Vertical	46.7	85.2*	38.5	Complied
2483.500	Vertical	56.1	74.0	17.9	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	50.2	54.0	3.8	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

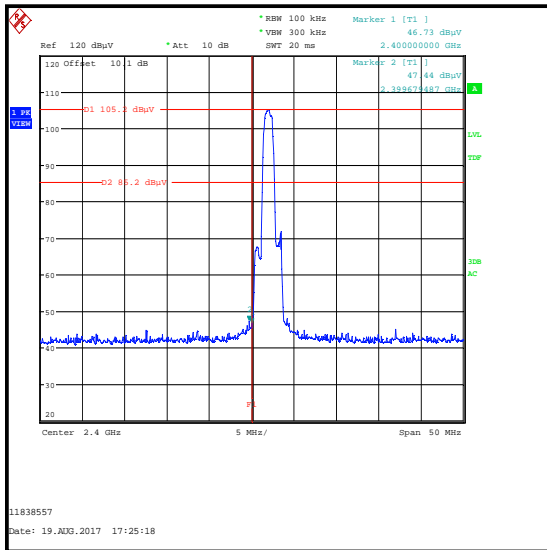
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2363.333	Vertical	52.5	74.0	21.5	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

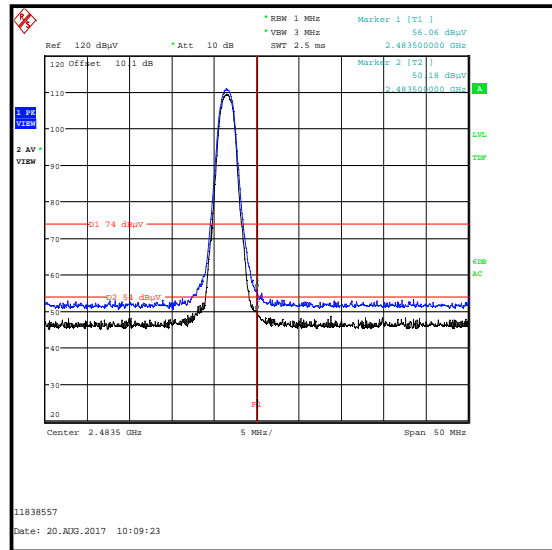
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2356.795	Vertical	47.7	54.0	6.3	Complied

### Transmitter Band Edge Radiated Emissions (continued)

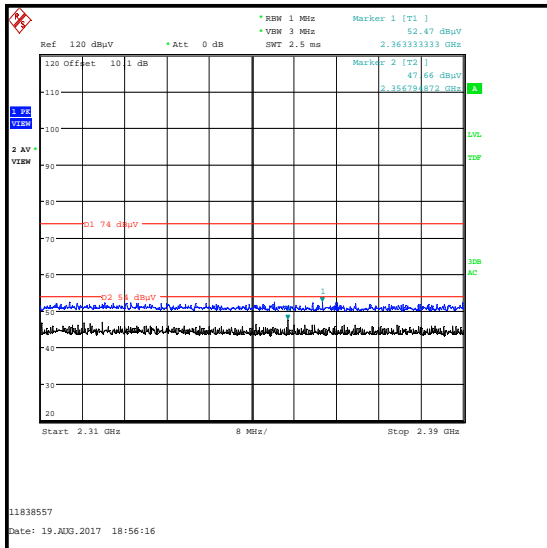
#### Results: Static Mode / 3DH5



Lower Band Edge Peak



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

**Transmitter Band Edge Radiated Emissions (continued)****Results: Hopping Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.519	Vertical	62.1	90.3*	28.2	Complied
2400.000	Vertical	56.8	90.3*	33.5	Complied
2483.500	Vertical	54.1	74.0	19.9	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	48.0	54.0	6.0	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak**

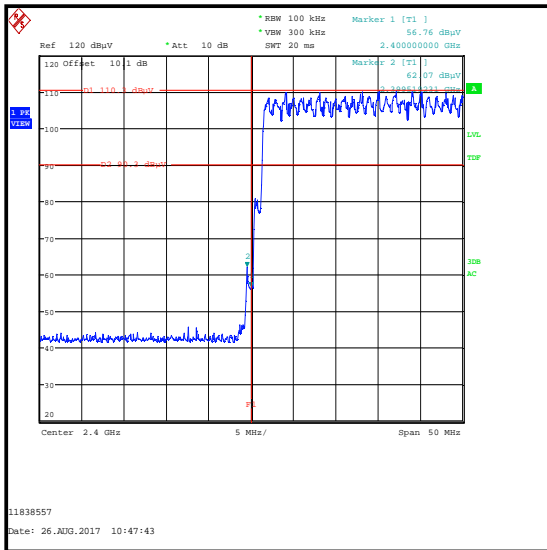
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2331.795	Vertical	52.5	74.0	21.5	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average**

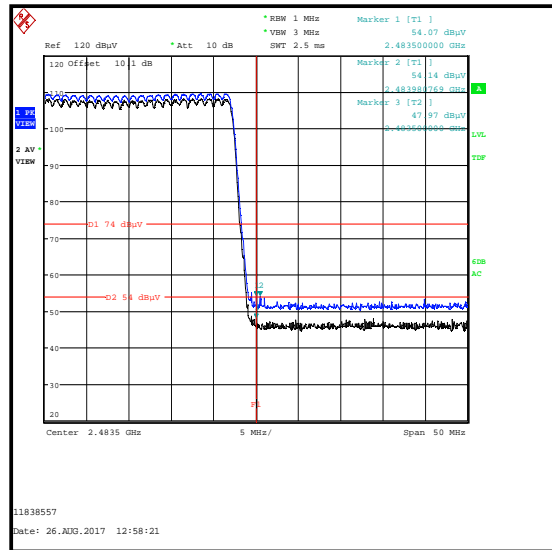
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2362.821	Vertical	46.9	54.0	7.1	Complied

### Transmitter Band Edge Radiated Emissions (continued)

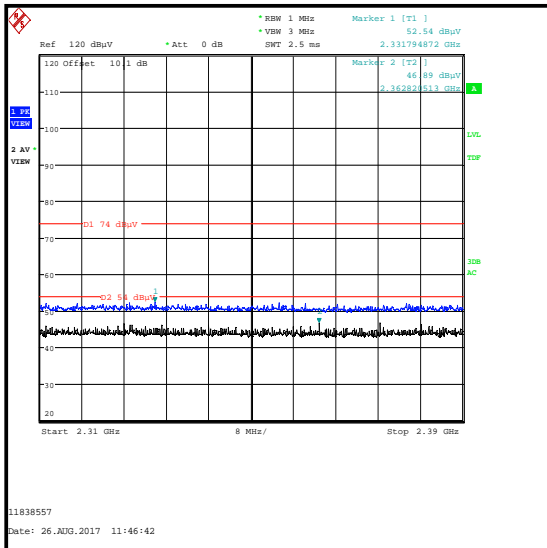
#### Results: Hopping Mode / 3DH5



Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band



## **6. AC Power Line Conducted Emissions Test Results**

### **6.1. Transmitter AC Conducted Spurious Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Doug Freegard	<b>Test Date:</b>	30 November 2017
<b>Test Sample Serial Number:</b>	C02V4002J61N		

<b>FCC Reference:</b>	Part 15.207
<b>Test Method Used:</b>	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	33

#### **Note(s):**

1. The EUT was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Live	54.5	65.5	11.0	Complied
0.236	Live	43.3	62.3	19.0	Complied
0.389	Live	31.5	58.1	26.6	Complied
10.838	Live	25.4	60.0	34.6	Complied
11.999	Live	28.9	60.0	31.1	Complied
13.565	Live	20.9	60.0	39.1	Complied

**Results: Live / Average / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Live	39.4	55.5	16.1	Complied
0.240	Live	40.7	52.1	11.4	Complied
0.398	Live	29.0	47.9	18.9	Complied
10.838	Live	20.2	50.0	29.8	Complied
11.994	Live	18.9	50.0	31.1	Complied
13.556	Live	12.8	50.0	37.2	Complied

**Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

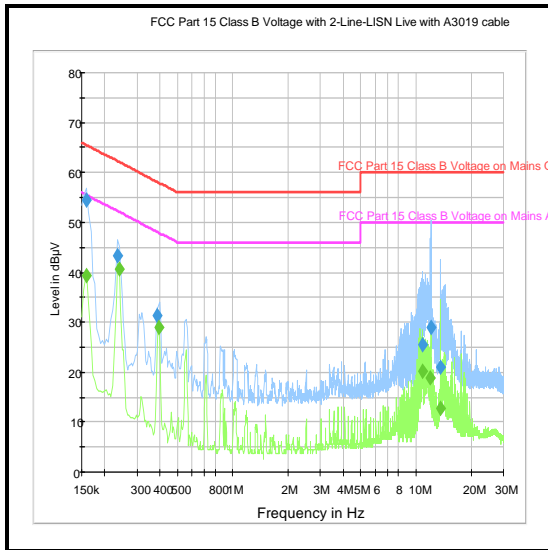
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Neutral	54.5	65.5	11.0	Complied
0.236	Neutral	42.0	62.3	20.3	Complied
0.555	Neutral	29.4	56.0	26.6	Complied
11.270	Neutral	36.6	60.0	23.4	Complied
11.999	Neutral	25.0	60.0	35.0	Complied
13.560	Neutral	27.5	60.0	32.5	Complied

**Results: Neutral / Average / 120 VAC 60 Hz**

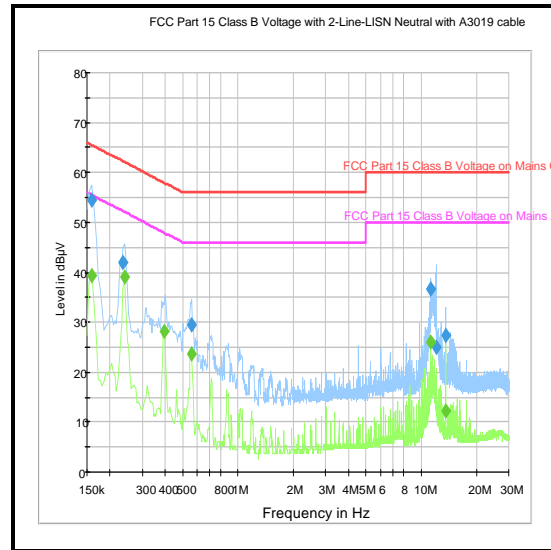
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Neutral	39.4	55.5	16.1	Complied
0.240	Neutral	39.2	52.1	12.9	Complied
0.398	Neutral	28.2	47.9	19.7	Complied
0.555	Neutral	23.6	46.0	22.4	Complied
11.243	Neutral	26.2	50.0	23.8	Complied
13.565	Neutral	12.4	50.0	37.6	Complied

**Transmitter AC Conducted Spurious Emissions (continued)**

**Results: 120 VAC 60 Hz**



**Live**



**Neutral**

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Live	55.4	65.5	10.1	Complied
0.240	Live	43.9	62.1	18.2	Complied
0.398	Live	31.8	57.9	26.1	Complied
0.555	Live	27.9	56.0	28.1	Complied
11.270	Live	34.5	60.0	25.5	Complied
12.012	Live	29.1	60.0	30.9	Complied

**Results: Live / Average / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Live	40.2	55.5	15.3	Complied
0.236	Live	41.3	52.3	11.0	Complied
0.393	Live	28.7	48.0	19.3	Complied
0.551	Live	27.0	46.0	19.0	Complied
10.482	Live	23.9	50.0	26.1	Complied
11.549	Live	28.8	50.0	21.2	Complied

**Results: Neutral / Quasi Peak / 240 VAC 60 Hz**

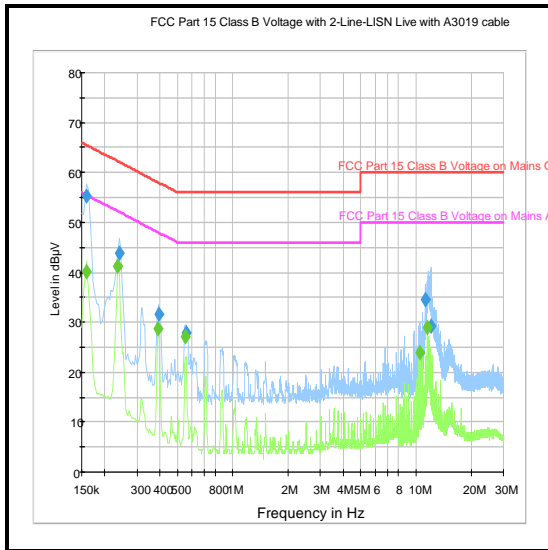
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Neutral	56.1	65.5	9.4	Complied
0.240	Neutral	44.0	62.1	18.1	Complied
0.398	Neutral	32.2	57.9	25.7	Complied
0.560	Neutral	27.8	56.0	28.2	Complied
11.729	Neutral	30.7	60.0	29.3	Complied
12.003	Neutral	25.2	60.0	34.8	Complied

**Results: Neutral / Average / 240 VAC 60 Hz**

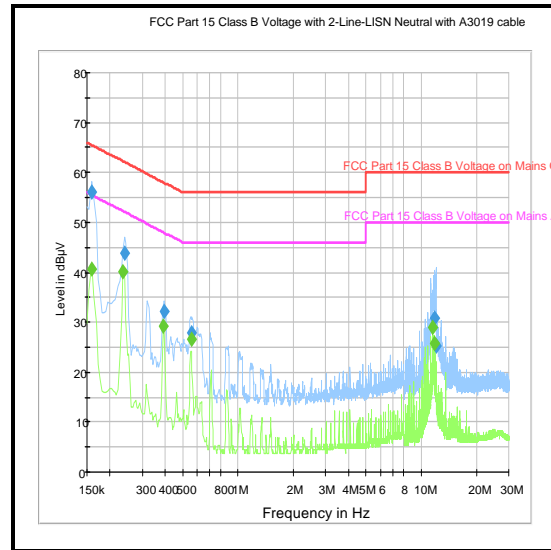
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.159	Neutral	40.7	55.5	14.8	Complied
0.236	Neutral	40.1	52.3	12.2	Complied
0.393	Neutral	29.1	48.0	18.9	Complied
0.555	Neutral	26.7	46.0	19.3	Complied
11.549	Neutral	29.1	50.0	20.9	Complied
11.724	Neutral	25.7	50.0	24.3	Complied

**Transmitter AC Conducted Spurious Emissions (continued)**

**Results: 240 VAC 60 Hz**



**Live**



**Neutral**

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**--- END OF REPORT ---**