



# **TEST REPORT**

**Test Report No. : UL-RPT-RP12173937JD08B**

**Customer** : Apple Inc.  
**Model No.** : A1989  
**FCC ID** : BCGA1989  
**Technology** : *Bluetooth* – Low Energy  
**Test Standard(s)** : FCC Parts 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 1.0.

**Date of Issue:** 20 June 2018

**Checked by:**

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**Customer Information**

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<b>Contact Name:</b>	Stuart Thomas

**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	20/06/2018	Initial Version	Sarah Williams

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

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

The EUT was a Laptop Computer with WLAN and *Bluetooth*.

### **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>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209
<b>Test Dates:</b>	10 April 2018 to 30 April 2018

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

<b>FCC Reference (47CFR)</b>	<b>Measurement</b>	<b>Result</b>
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	Complied
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	Complied
Part 15.247(e)	Transmitter Power Spectral Density	Note 2
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	Complied
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	Complied

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

1. The measurement was performed to assist in the calculation of the level of average radiated emissions at the upper band edge.
2. In accordance with FCC KDB 558074 Section 10.1, PSD measurements are not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured output power.
3. 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	X
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 558074 D01 DTS Meas Guidance v04 April 5, 2017
<b>Title:</b>	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247

## **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".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
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%	±4.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 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 Conducted Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2004	Thermohygrometer	Testo	608-H1	45046425	26 Feb 2019	12
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	11 May 2018	12
A3037	Attenuator	Pasternack	PE7013-10	Not stated	Calibrated before use	-
A3042	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU 200A	100943	10 May 2019	36

### 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	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	20 Feb 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	18 Apr 2019	12
A2148	Attenuator	AtlanTecRF	AN18-06	090202-06	03 Feb 2019	12
A490	Antenna	Chase	CBL6111A	1590	03 Apr 2019	12
A2131	Low Pass Filter	AtlanTecRF	AFL-02000	JFB1004-002	22 Feb 2019	12
M2009	Thermohygrometer	Testo	608-H1	45046699	20 Jun 2018	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	07 Feb 2019	12
M2016	Thermohygrometer	Testo	608-H1	45046428	26 Feb 2019	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	03 Aug 2018	12
A2948	Pre Amplifier	Com-Power Corp	PAM-118A	551087	06 Apr 2019	12
A1818	Antenna	EMCO	3115	00075692	07 Feb 2019	12
A253	Antenna	Flann Microwave	128	12240-20	07 Feb 2019	12
A254	Antenna	Flann Microwave	139	14240-20	07 Feb 2019	12
A255	Antenna	Flann Microwave	519	16240-20	07 Feb 2019	12
A256	Antenna	Flann Microwave	400	18240-20	07 Feb 2019	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	20 Feb 2019	12
A2130	High Pass Filter	AtlanTecRF	AFH-08000	80rJFBD06-002	21 Feb 2019	12
A2973	High Pass Filter	AtlanTecRF	AFH-03000	16080900032	24 Jan 2019	12

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	20 Feb 2019	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	19 Feb 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	18 Apr 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2019	12
A2943	Attenuator	AtlanTecRF	AN18W5-06	208147#2	22 Feb 2019	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>	A1989
<b>Test Sample Serial Number:</b>	C02W6005JTVL ( <i>Conducted sample</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>BT BB Version:</b>	V35
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02W6011JTF2 ( <i>Radiated sample #1</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>BT BB Version:</b>	V35
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02VR00RJH93 ( <i>Radiated sample #2</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>BT BB Version:</b>	V35
<b>FCC ID:</b>	BCGA1989

#### **3.2. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

**3.3. Additional Information Related to Testing**

Technology Tested:	Bluetooth Low Energy (Digital Transmission System)		
Type of Unit:	Transceiver		
Channel Spacing:	2 MHz		
Modulation:	GFSK		
Data Rate: LE	1 Mbps		
Data Rate: LE2M	2 Mbps		
Power Supply Requirement(s):	Nominal	3.8 VDC via 120 VAC 60 Hz AC/DC Adapter	
Maximum Conducted Output Power:	6.5 dBm		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	37	2402
	Middle	17	2440
	Top	39	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	2.3

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

#### **Support Equipment**

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

<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>	USB-C Adapter
<b>Brand Name:</b>	Belkin
<b>Model Name or Number:</b>	F2CU040
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB-C Power Adapter
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1718
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Type C USB 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

#### **Operating Modes**

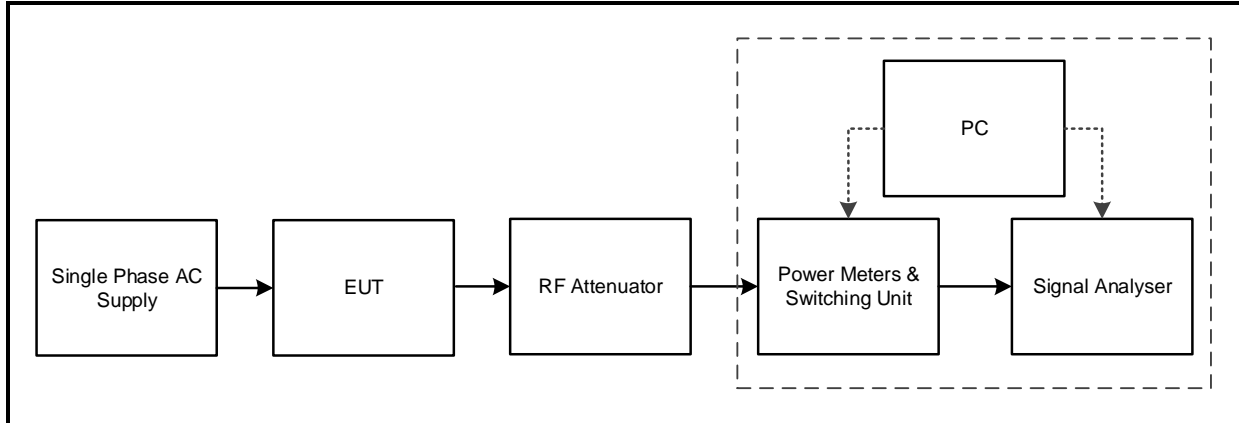
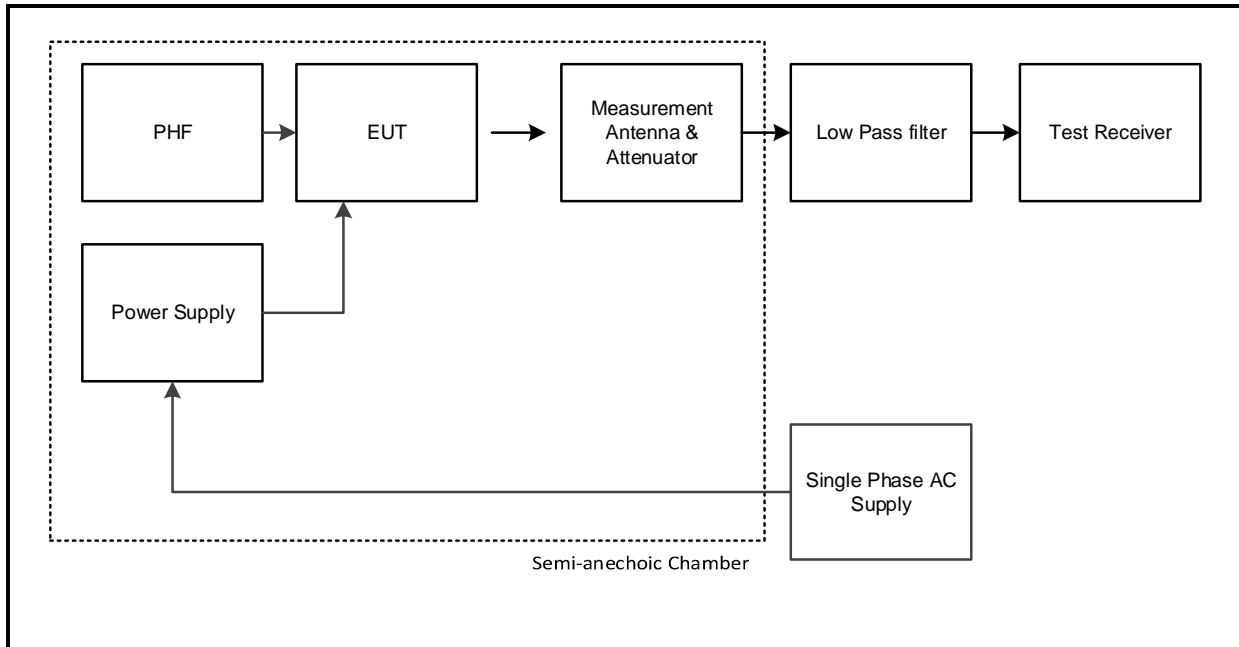
The EUT was tested in the following operating mode(s):

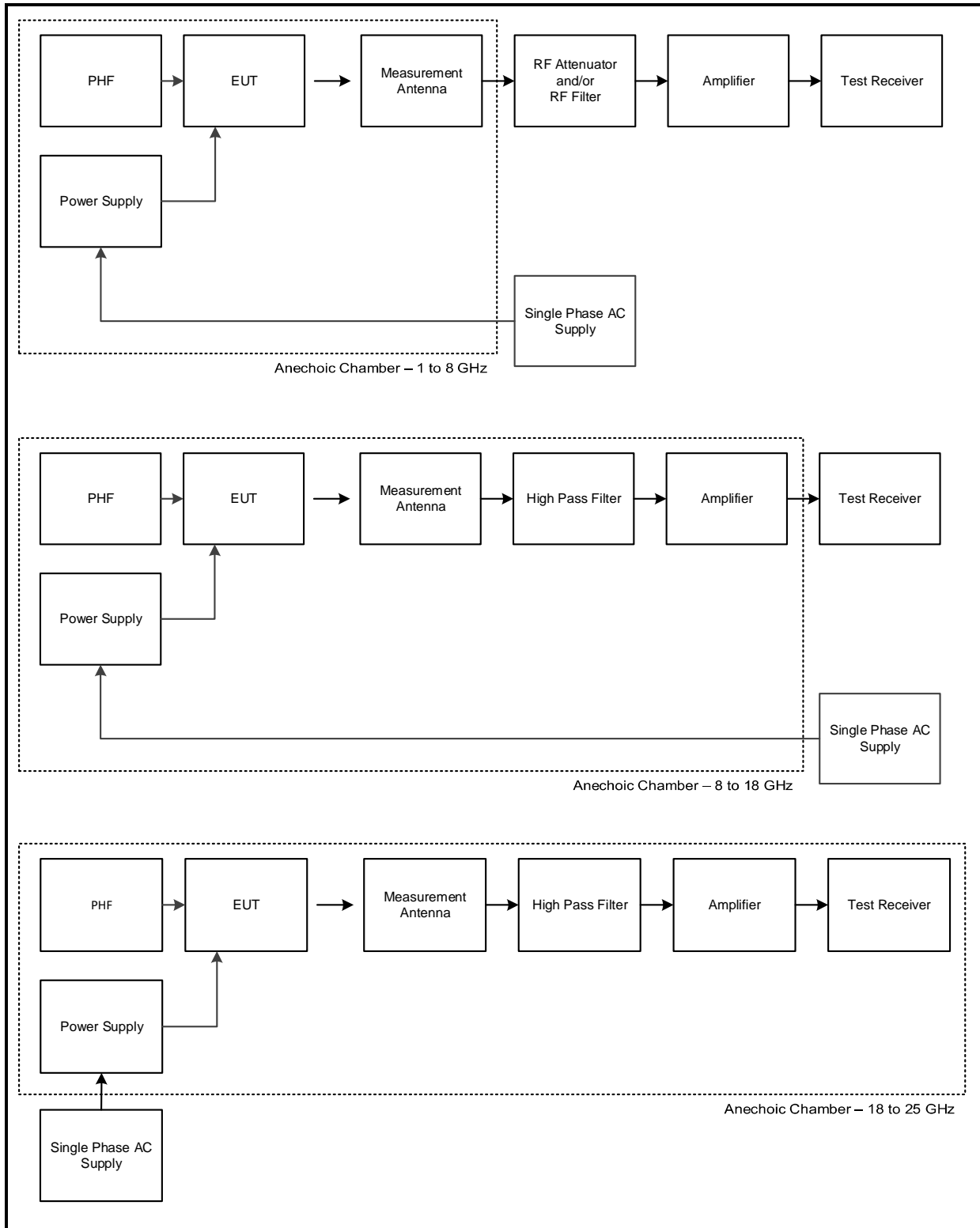
- Transmitting at maximum power in *Bluetooth* LE mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.
- Transmitting at maximum power in *Bluetooth* LE2M mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

#### **Configuration and Peripherals**

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

- Controlled in test mode using a set of commands entered into a terminal application on the EUT. The commands were 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\_BTLE\_CPM\_SOP v1.0.docx'.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply.
- Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LE2M mode as this was found to transmit the highest power.
- Transmitter radiated spurious emissions tests were performed with the AC Charger and PHF connected to the EUT.

**Test Setup Diagrams****Conducted Tests:****Test Setup for Transmitter Minimum 6 dB Bandwidth, Duty Cycle & Maximum Peak Output Power****Radiated Tests:****Test Setup for Transmitter Radiated Emissions**

**Test Setup Diagrams (continued)****Test Setup for Transmitter Radiated Emissions (continued)**

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

### **4.1. Transmitter Minimum 6 dB Bandwidth**

#### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Victor Carmon	<b>Test Date:</b>	10 April 2018
<b>Test Sample Serial Number:</b>	C02W6005JTVL		

<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.1 Option 1

#### **Environmental Conditions:**

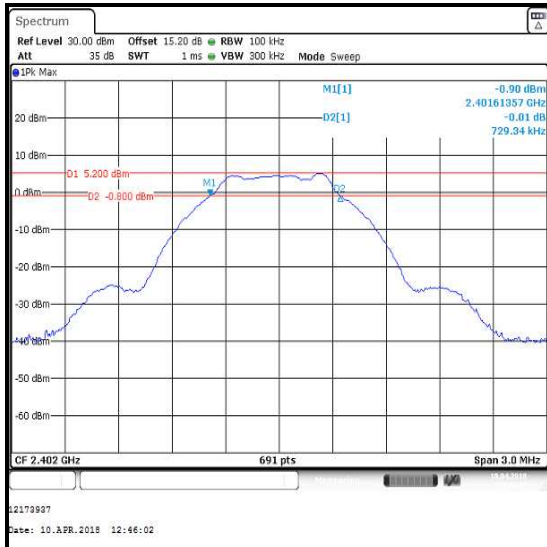
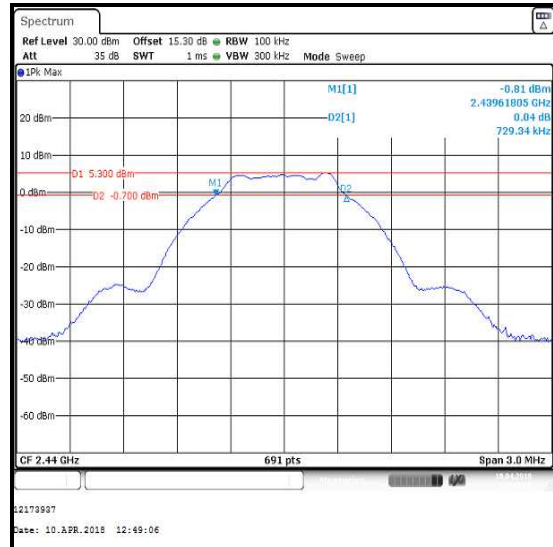
<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	40

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

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with FCC KDB 558074 Section 8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

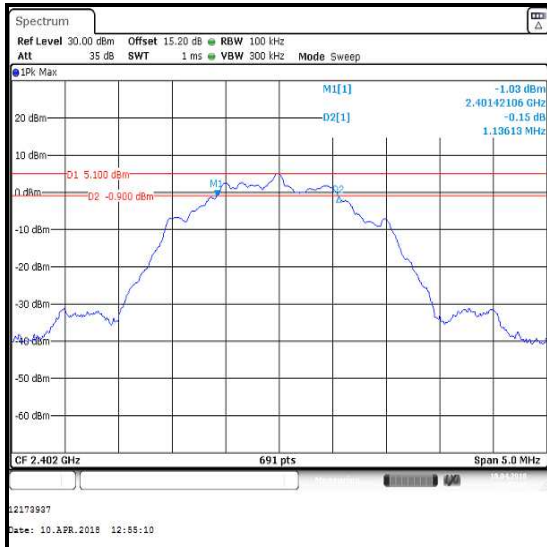
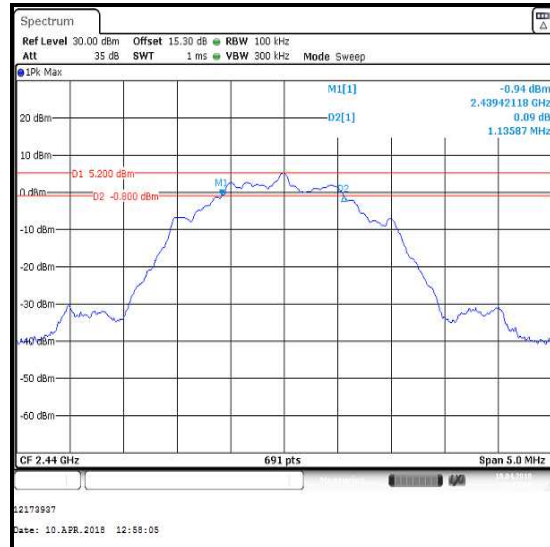
**Transmitter Minimum 6 dB Bandwidth (continued)****Results: LE**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	729.344	≥500	229.344	Complied
Middle	729.344	≥500	229.344	Complied
Top	733.696	≥500	233.696	Complied

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter Minimum 6 dB Bandwidth (continued)****Results: LE2M**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	1136.128	≥500	636.128	Complied
Middle	1135.872	≥500	635.872	Complied
Top	1136.128	≥500	636.128	Complied

**Bottom Channel****Middle Channel****Top Channel**

**4.2. Transmitter Duty Cycle****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Victor Carmon	<b>Test Date:</b>	10 April 2018
<b>Test Sample Serial Number:</b>	C02W6005JTVL		

<b>FCC Reference:</b>	Part 15.35(c)
<b>Test Method Used:</b>	FCC KDB 558074 Section 6.0

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	40

**Note(s):**

- In order to assist with the determination of the average level of spurious emissions field strength in LE2M mode, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

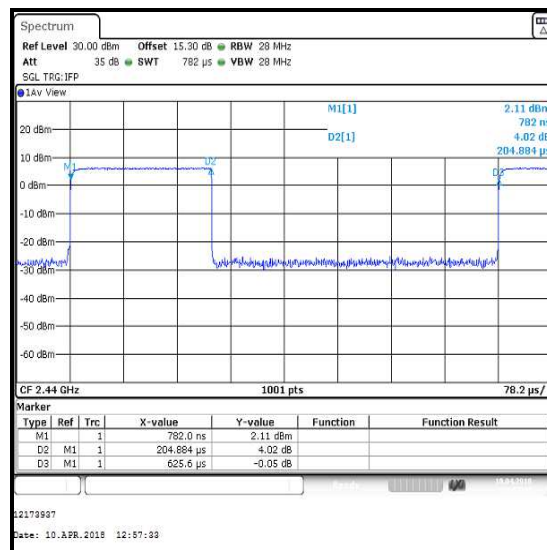
$$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])).$$

$$\text{LE2M duty cycle: } 10 \log (1 / (204.884 \mu\text{s} / 625.600 \mu\text{s})) = 4.8 \text{ dB}$$

- The LE mode duty cycle was measured and found to be greater than 98%. No duty cycle correction is required.

**Results: LE2M**

Pulse Duration ( $\mu\text{s}$ )	Period ( $\mu\text{s}$ )	Duty Cycle (dB)
204.884	625.600	4.8



**4.3. Transmitter Maximum Peak Output Power****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Victor Carmon	<b>Test Date:</b>	10 April 2018
<b>Test Sample Serial Number:</b>	C02W6005JTVL		

<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>Test Method Used:</b>	FCC KDB 558074 Section 9.1.1 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	40

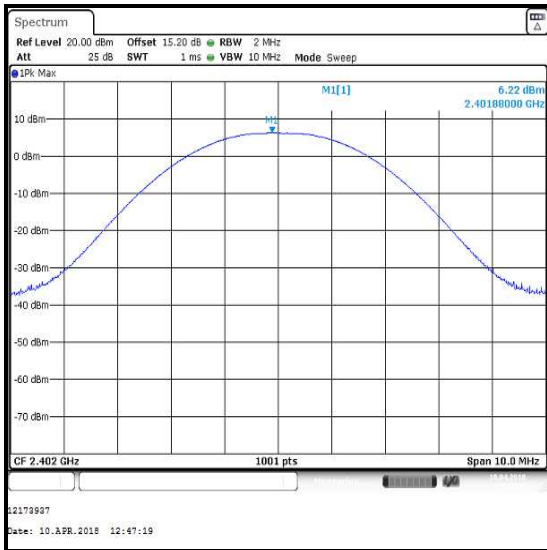
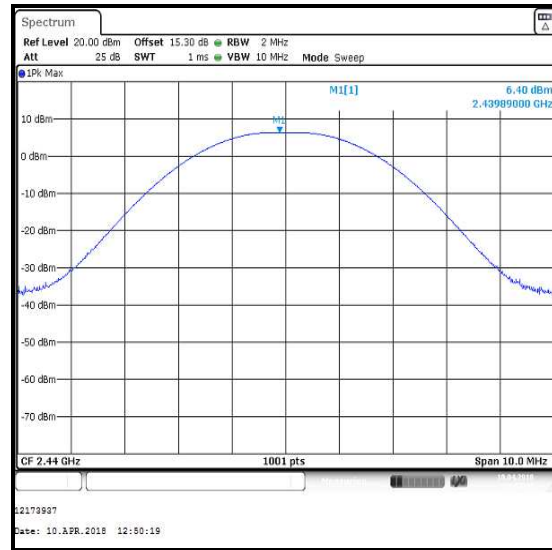
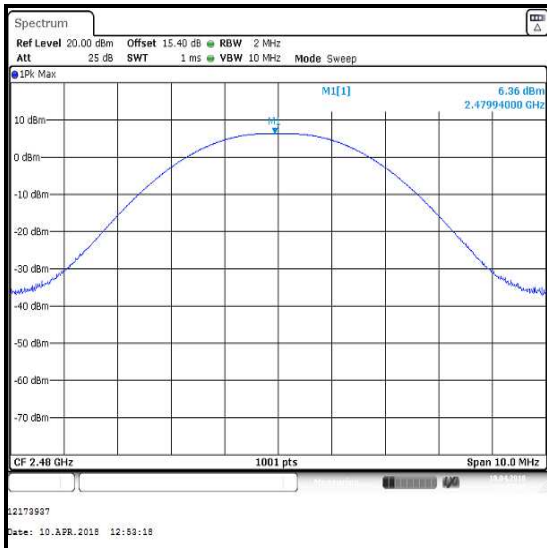
**Note(s):**

1. Conducted power tests were performed using a signal analyser in accordance with FCC KDB 558074 Section 9.1.1 with the RBW > *DTS bandwidth* procedure.
2. The signal analyser resolution bandwidth was set to 2 MHz (LE) or 3 MHz (LE2M) 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 10 MHz. A marker was placed at the peak of the signal and the results recorded in the tables below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
4. The conducted power was added to the declared antenna gain to obtain the EIRP.

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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.2	30.0	23.8	Complied
Middle	6.4	30.0	23.6	Complied
Top	6.4	30.0	23.6	Complied

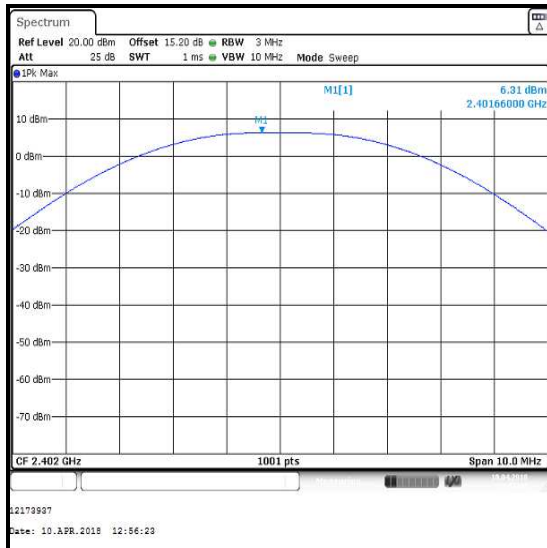
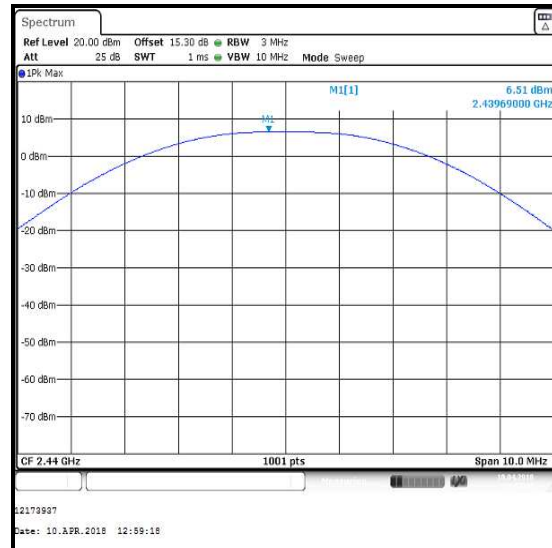
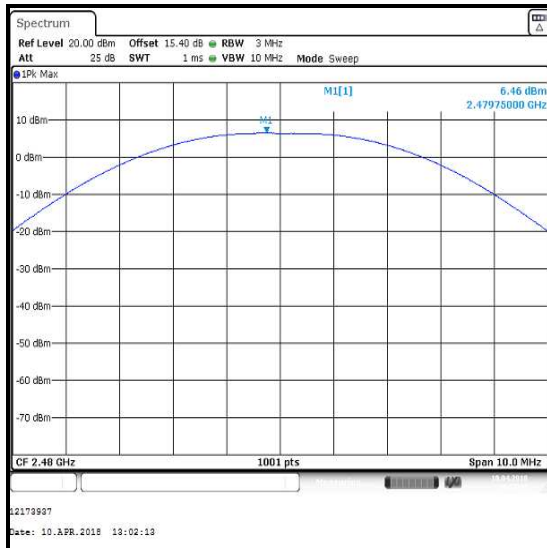
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.2	2.3	8.5	36.0	27.5	Complied
Middle	6.4	2.3	8.7	36.0	27.3	Complied
Top	6.4	2.3	8.7	36.0	27.3	Complied

**Transmitter Maximum Peak Output Power (continued)****Results: LE****Bottom Channel****Middle Channel****Top Channel**

**Transmitter Maximum Peak Output Power (continued)****Results: LE2M**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.3	30.0	23.7	Complied
Middle	6.5	30.0	23.5	Complied
Top	6.5	30.0	23.5	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.3	2.3	8.6	36.0	27.4	Complied
Middle	6.5	2.3	8.8	36.0	27.2	Complied
Top	6.5	2.3	8.8	36.0	27.2	Complied

**Transmitter Maximum Peak Output Power (continued)****Results: LE2M****Bottom Channel****Middle Channel****Top Channel**

## **5. Radiated Test Results**

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

#### **Test Summary:**

<b>Test Engineer:</b>	John Ferdinand	<b>Test Date:</b>	30 April 2018
<b>Test Sample Serial Number:</b>	C02VR00RJH93		

<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>	22
<b>Relative Humidity (%):</b>	36

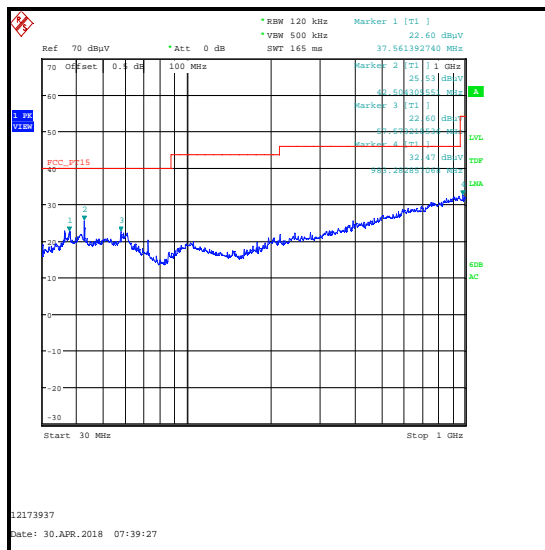
#### **Note(s):**

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All 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. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
3. 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.
4. 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.
5. 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.
6. 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 wide enough to see the whole emission.

### Transmitter Radiated Emissions (continued)

### Results: Peak / Middle Channel / LE2M

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
983.283	Vertical	32.5	54.0	21.5	Complied



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

<b>Test Engineer:</b>	Marco Zunarelli	<b>Test Dates:</b>	19 April 2018 & 20 April 2018
<b>Test Sample Serial Number:</b>	C02W6011JTF2		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 11 & 12 referencing ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 25 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	25 to 26
<b>Relative Humidity (%):</b>	43 to 45

**Note(s):**

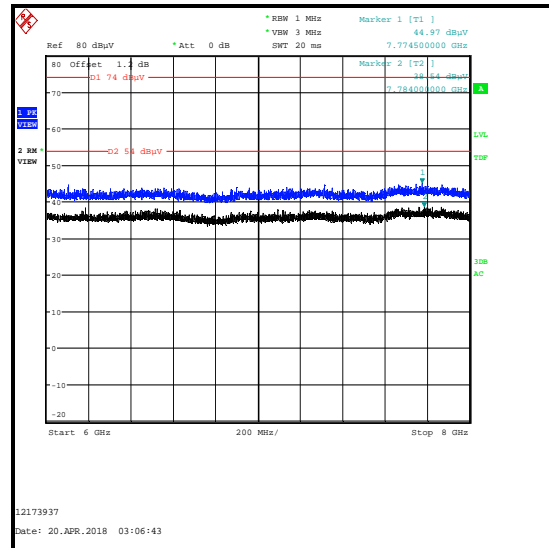
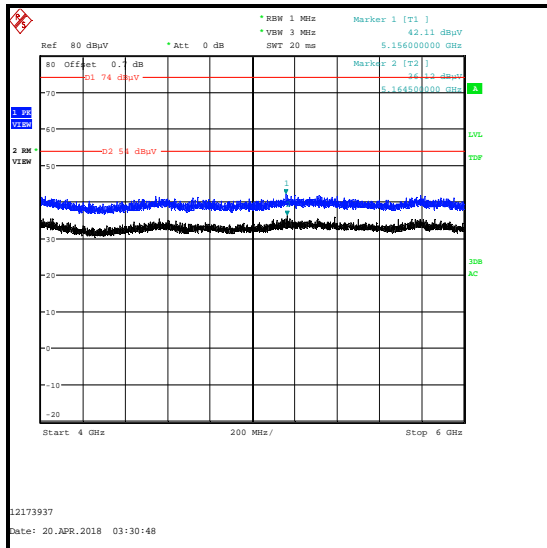
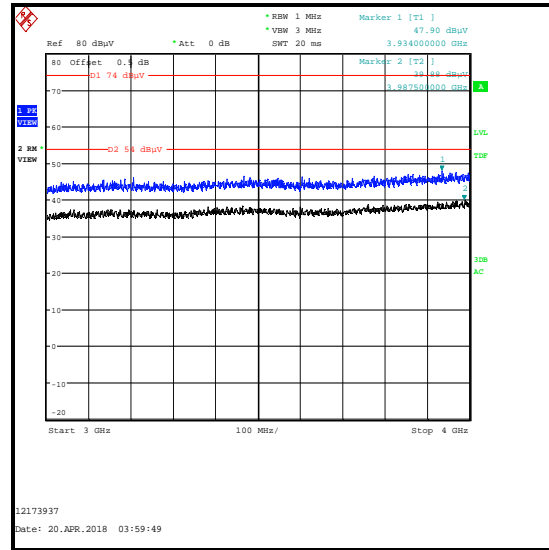
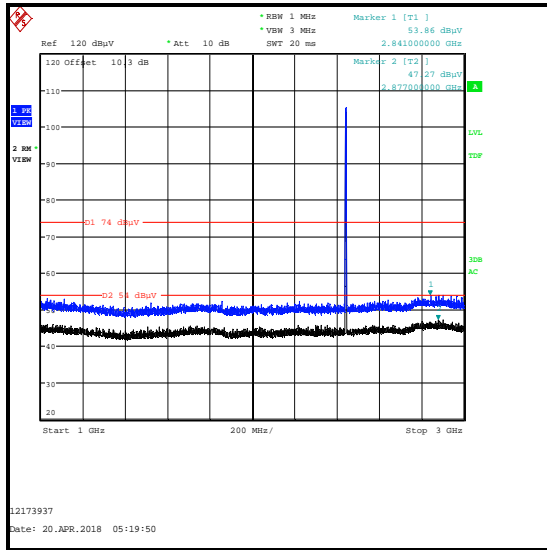
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
3. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded as shown in the tables below.
4. Pre-scans above 1 GHz were performed in a semi anechoic chamber (Asset Number K0002) 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.
5. 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.

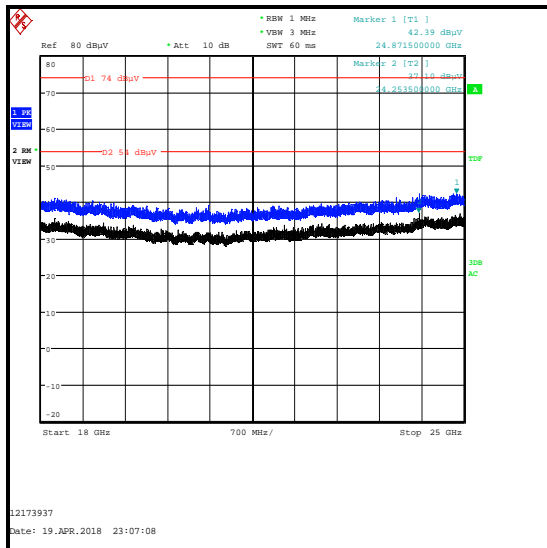
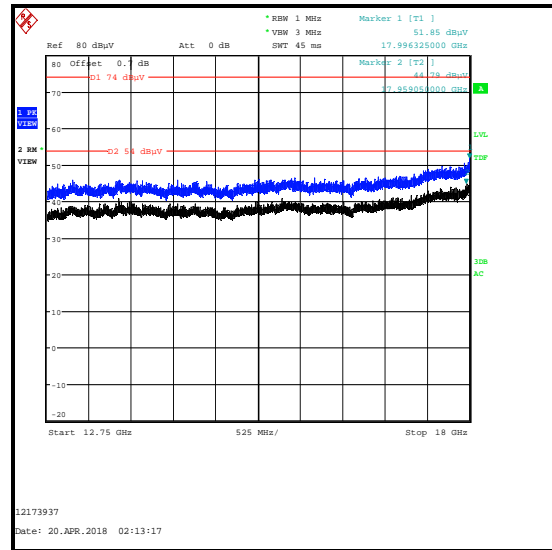
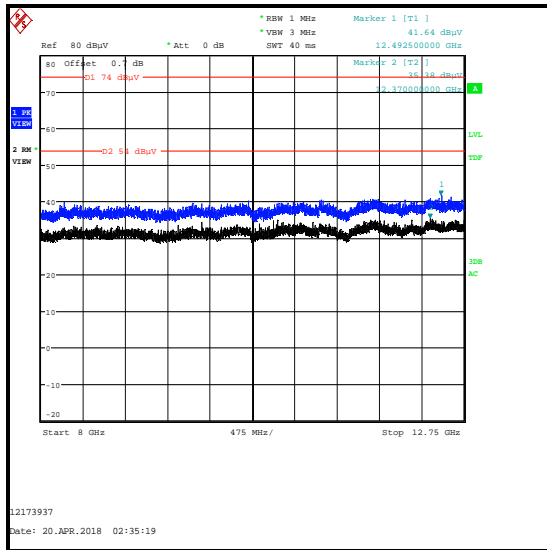
**Results: Peak / Middle Channel / LE2M**

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2841.000	Vertical	53.9	74.0	20.1	Complied

**Results: Average / Middle Channel / LE2M**

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2877.000	Vertical	47.3	54.0	6.7	Complied

**Transmitter Radiated Emissions (continued)**

**Transmitter Radiated Emissions (continued)**

### 5.3. Transmitter Band Edge Radiated Emissions

#### Test Summary:

Test Engineer:	James O'Reilly	Test Date:	27 April 2018
Test Sample Serial Number:	C02VR00RJH93		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	KDB 558074 Section 11, 12 & Notes below

#### Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	47

#### 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 maximum peak conducted output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(a), the lower band edge measurement was performed with a peak detector and the -20 dBc limit applied.
3. As the lower band edge is adjacent to a non-restricted band, only peak measurements are required. In accordance with FCC KDB 558074 Section 11.1, the test method in Section 11.3 was followed: 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. As the maximum peak conducted output power was measured using an peak detector in accordance with FCC KDB 558074 Section 9.1.1 an out-of-band limit line was placed 20 dB (FCC KDB 558074 Section 11.1(a)) below the peak level. A marker was placed on the band edge spot frequencies. Marker frequency and levels were recorded.
4. As the upper band edge is adjacent to a restricted band, both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was trace averaging over 300 sweeps. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
5. 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 peak and RMS detectors respectively. Markers were placed on the highest point on each trace.
6. \* -20 dBc limit.
7. \*\*As the EUT had a duty cycle < 98% the duty cycle correction factor has been applied to the LE2M upper band edge average result. The corrected level is shown below:

$$\text{Upper Band Average result} + \text{duty cycle} = \text{Corrected band edge level}$$

$$\text{Corrected band edge level at 2483.5 MHz : } 43.9 + 4.8 = 48.7 \text{ dB}\mu\text{V/m}$$

**Transmitter Band Edge Radiated Emissions (continued)****Results: Peak / LE**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.0	Vertical	45.2	86.8*	41.6	Complied
2483.5	Vertical	51.1	74.0	22.9	Complied
2483.786	Vertical	51.5	74.0	22.5	Complied

**Results: Average / LE**

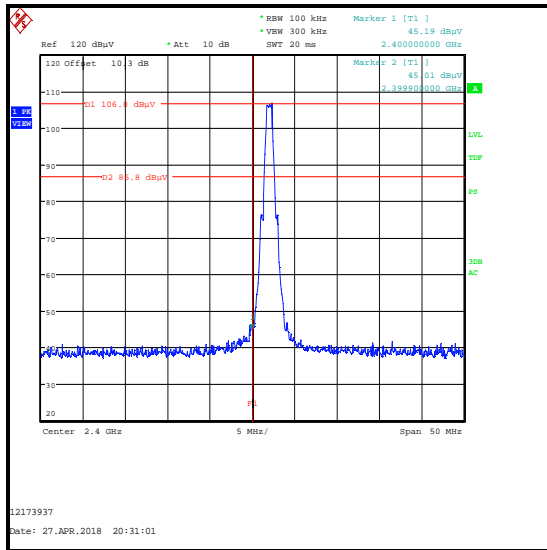
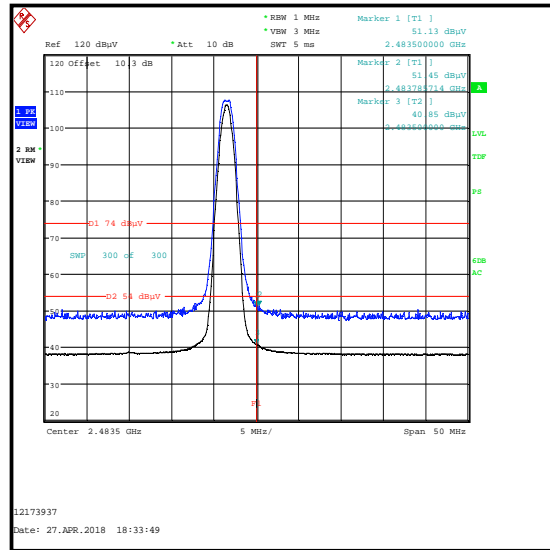
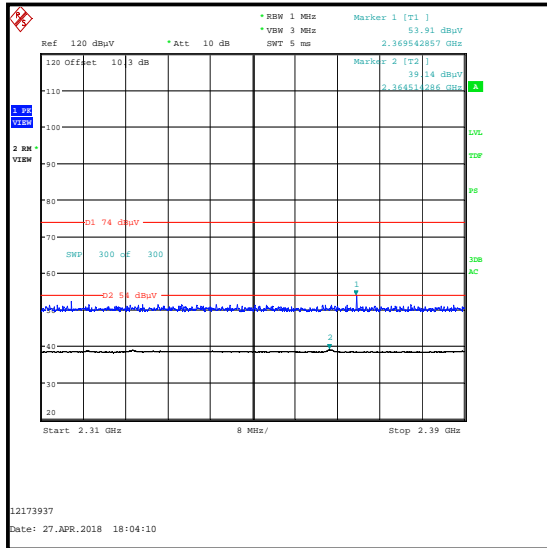
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	Vertical	40.9	54.0	13.1	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2369.543	Vertical	53.9	74.0	20.1	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2364.514	Vertical	39.1	54.0	14.9	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: LE****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Peak / LE2M**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.0	Vertical	71.7	85.7*	14.0	Complied
2483.5	Vertical	56.5	74.0	17.5	Complied

**Results: Average / LE2M**

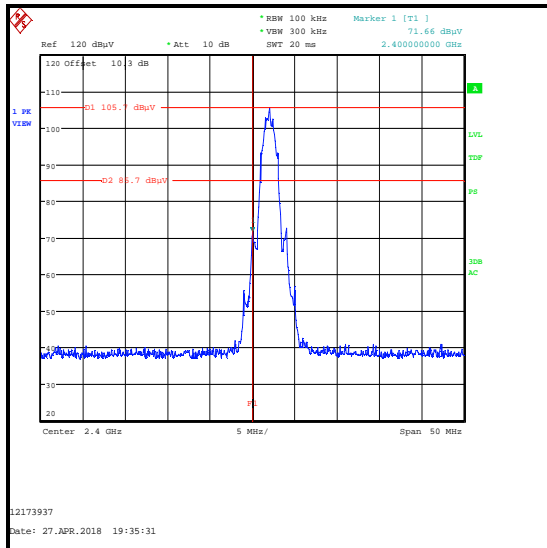
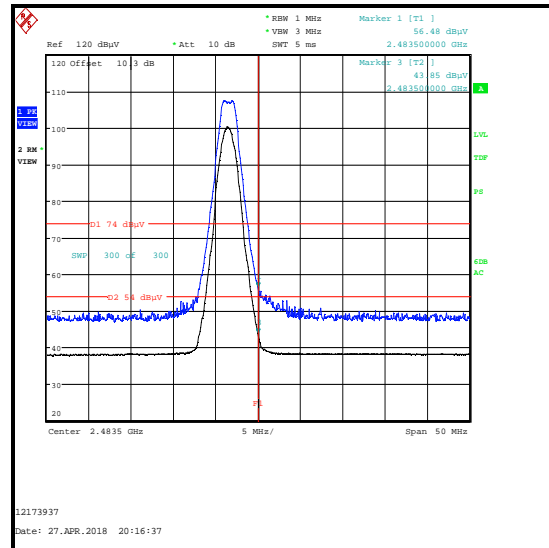
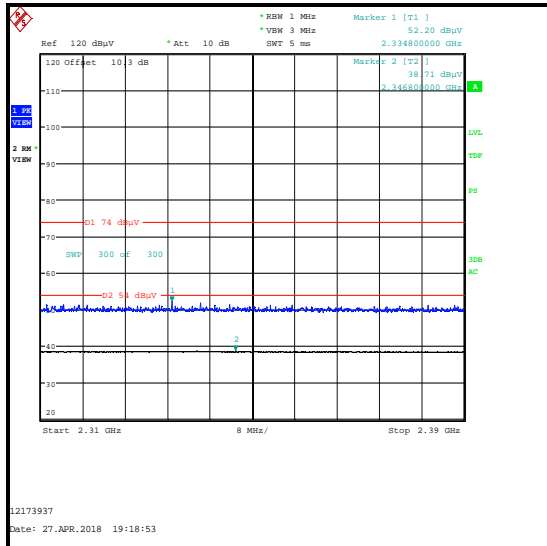
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Duty cycle correction (dB)	Corrected Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Vertical	43.9	4.8**	48.7	54.0	5.3	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Peak / LE2M**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2334.800	Vertical	52.2	74.0	21.8	Complied

**Results: 2310 MHz to 2390 MHz Restricted Band / Average / LE2M**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2346.800	Vertical	38.7	54.0	15.3	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: LE2M****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band****--- END OF REPORT ---**