



# TEST REPORT

**Test Report No. : UL-RPT-RP11373196JD01A V2.0**

**Manufacturer** : ALBRECHT JUNG GmbH & CO. KG  
**Model No.** : ZLLHS4-01  
**FCC ID** : 2AJR7ZLLHS401  
**Technology** : Zigbee (IEEE 802.15.4)  
**Test Standard(s)** : FCC Parts 15.209(a) & 15.247

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2. The results in this report apply only to the sample(s) tested.
3. This 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 2.0 supersedes all previous versions.

**Date of Issue:** 04 January 2017

**Checked by:**

Ian Watch  
Senior Engineer, Radio Laboratory

**Company Signatory:**

Sarah Williams  
Senior Engineer, Radio Laboratory  
UL VS LTD



This laboratory is accredited by UKAS.  
The tests reported herein have been  
performed in accordance with its terms  
of accreditation.

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## UL VS LTD

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**1. Customer Information**

|                      |                                                     |
|----------------------|-----------------------------------------------------|
| <b>Company Name:</b> | ALBRECHT JUNG GmbH & CO. KG                         |
| <b>Address:</b>      | Volmestrasse 1<br>Schalksmuehle<br>58579<br>Germany |

## **2. Summary of Testing**

### **2.1. General Information**

|                                 |                                                                                                                           |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>Specification Reference:</b> | 47CFR15.247                                                                                                               |
| <b>Specification Title:</b>     | Code of Federal Regulations Volume 47 (Telecommunications):<br>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):<br>Part 15 Subpart C (Intentional Radiators) – Section 15.209 |
| <b>Site Registration:</b>       | 209735                                                                                                                    |
| <b>Location of Testing:</b>     | UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park,<br>Basingstoke, Hampshire, RG24 8AH, United Kingdom        |
| <b>Test Dates:</b>              | 25 October 2016 to 13 November 2016                                                                                       |

### **2.2. 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       |    |
| Part 15.247(e)                                                                                                                                                                                                               | Transmitter Power Spectral Density       | Note 1                                                                                |
| Part 15.247(b)(3)                                                                                                                                                                                                            | Transmitter Maximum Peak Output Power    |  |
| Part 15.247(d)/15.209(a)                                                                                                                                                                                                     | Transmitter Radiated Emissions           |  |
| Part 15.247(d)/15.209(a)                                                                                                                                                                                                     | Transmitter Band Edge Radiated Emissions |  |
| <b>Key to Results</b><br> = Complied  = Did not comply |                                          |                                                                                       |

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

1. 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 equal to the measured total output power.

### **2.3. Methods and Procedures**

|                   |                                                                                                                  |
|-------------------|------------------------------------------------------------------------------------------------------------------|
| <b>Reference:</b> | ANSI C63.10-2013                                                                                                 |
| <b>Title:</b>     | American National Standard of Procedures for Compliance Testing of<br>Unlicensed Wireless Devices                |
| <b>Reference:</b> | KDB 558074 D01 DTS Meas Guidance v03r05 April 8, 2016                                                            |
| <b>Title:</b>     | Guidance for Performing Compliance Measurements on Digital Transmission<br>Systems (DTS) Operating Under §15.247 |

### **2.4. 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.

### **3. Equipment Under Test (EUT)**

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

|                                   |                                            |
|-----------------------------------|--------------------------------------------|
| <b>Brand Name:</b>                | Radio Hand-held Transmitter                |
| <b>Model Name or Number:</b>      | ZLLHS4-01                                  |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Radiated Sample</i> ) |
| <b>Hardware Version:</b>          | V00                                        |
| <b>Software Version:</b>          | V00                                        |
| <b>FCC ID:</b>                    | 2AJR7ZLLHS401                              |

|                                   |                                                |
|-----------------------------------|------------------------------------------------|
| <b>Brand Name:</b>                | Radio Hand-held Transmitter                    |
| <b>Model Name or Number:</b>      | ZLLHS4-01                                      |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Conducted RF Sample</i> ) |
| <b>Hardware Version:</b>          | V00                                            |
| <b>Software Version:</b>          | V00                                            |
| <b>FCC ID:</b>                    | 2AJR7ZLLHS401                                  |

#### **3.2. Description of EUT**

The Equipment Under Test was a hand-held remote control for control of lighting using ZigBee Light Link. The EUT contains 2.4 GHz Zigbee with an integral antenna. It is powered from a lithium CR2450N battery.

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

No modifications were applied to the EUT during testing.

### **3.4. Additional Information Related to Testing**

|                              |                                             |                |                         |
|------------------------------|---------------------------------------------|----------------|-------------------------|
| Technology Tested:           | IEEE 802.15.4 (Digital Transmission System) |                |                         |
| Type of Unit:                | Transceiver                                 |                |                         |
| Modulation:                  | O-QPSK                                      |                |                         |
| Data Rate:                   | 250 kbit/s                                  |                |                         |
| Power Supply Requirement(s): | Nominal                                     | 3 VDC          |                         |
| Antenna Gain:                | 2.2 dBi                                     |                |                         |
| Transmit Frequency Range:    | 2405 MHz to 2480 MHz                        |                |                         |
| Transmit Channels Tested:    | Channel ID                                  | Channel Number | Channel Frequency (MHz) |
|                              | Bottom                                      | 11             | 2405                    |
|                              | Middle                                      | 18             | 2440                    |
|                              | Top                                         | 26             | 2480                    |

### **3.5. Support Equipment**

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

|                              |                                          |
|------------------------------|------------------------------------------|
| <b>Description:</b>          | IPDA development board with ribbon cable |
| <b>Brand Name:</b>           | Insta Elektro GmbH                       |
| <b>Model Name or Number:</b> | INSTA programming and debug adapter      |
| <b>Serial Number:</b>        | Not marked or stated                     |

|                              |                              |
|------------------------------|------------------------------|
| <b>Description:</b>          | Laptop Computer              |
| <b>Brand Name:</b>           | Dell                         |
| <b>Model Name or Number:</b> | Latitude E5410               |
| <b>Serial Number:</b>        | UL VS LTD Asset Number 00763 |

|                              |                                             |
|------------------------------|---------------------------------------------|
| <b>Description:</b>          | USB type A to Micro B cable, length 1 metre |
| <b>Brand Name:</b>           | Motorola                                    |
| <b>Model Name or Number:</b> | Not marked or stated                        |
| <b>Serial Number:</b>        | Not marked or stated                        |

## **4. Operation and Monitoring of the EUT during Testing**

### **4.1. Operating Modes**

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

- Continuously transmitting at maximum power on the bottom, middle and top channels with >98% duty cycle.

### **4.2. Configuration and Peripherals**

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

- Controlled using an Atmel Studio 6.2.121.0 application installed on a laptop PC. The application was used to enable continuous transmission mode and to select the test channels following instructions provided by the customer in 'Start-up guide.PDF' dated 08 August 2016.
- In order for the EUT to communicate to the Atmel test tool, an IPDA development board was connected via a ribbon cable. The development board was connected to the laptop via a USB cable. Once the EUT had been configured, the ribbon cable was disconnected and the EUT continued to transmit in test mode.
- The EUT was powered by a 3.0 Volt CR2450N battery. The voltage was monitored with a calibrated digital voltmeter.
- Radiated spurious emissions were performed with the EUT in its worst case orientation/position and with the EUT in its normal configuration with no ancillaries attached.
- The EUT conducted sample was used for 6 dB bandwidth and maximum peak output power tests.
- The EUT radiated sample was used for all other tests.

## **5. Measurements, Examinations and Derived Results**

### **5.1. General Comments**

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

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.

## **5.2. Test Results**

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

#### **Test Summary:**

|                            |                                                |            |                 |
|----------------------------|------------------------------------------------|------------|-----------------|
| Test Engineer:             | Andrew Edwards                                 | Test Date: | 25 October 2016 |
| Test Sample Serial Number: | 100500452 26/16 ( <i>Conducted RF Sample</i> ) |            |                 |

|                   |                                     |
|-------------------|-------------------------------------|
| FCC Reference:    | Part 15.247(a)(2)                   |
| Test Method Used: | FCC KDB 558074 Section 8.1 Option 1 |

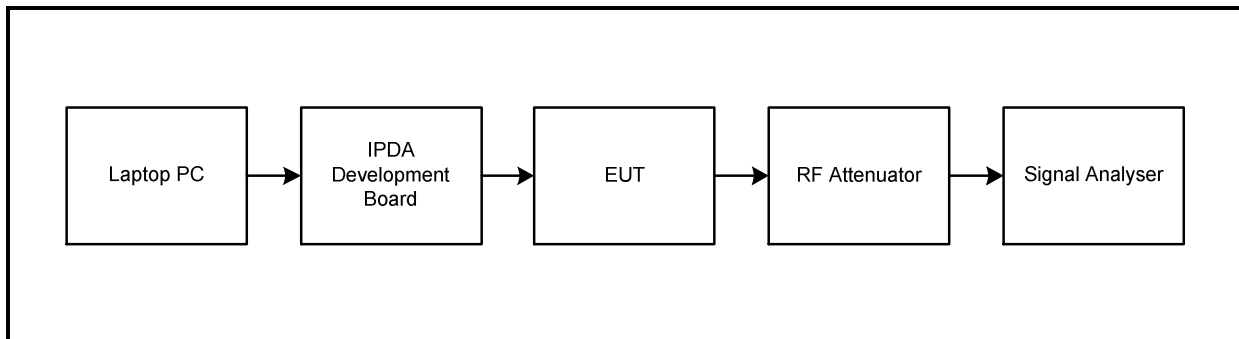
#### **Environmental Conditions:**

|                        |    |
|------------------------|----|
| Temperature (°C):      | 22 |
| Relative Humidity (%): | 48 |

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

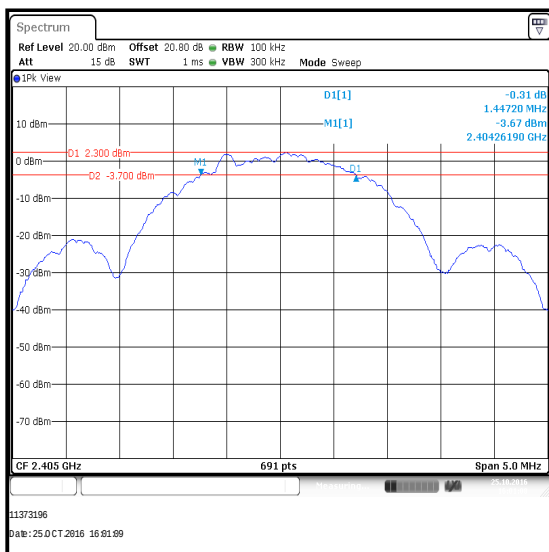
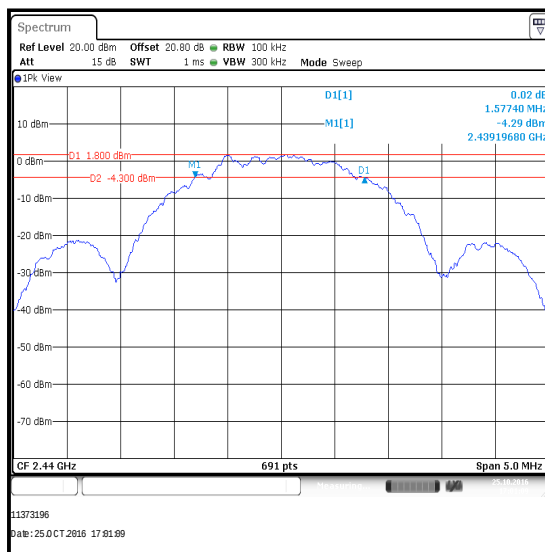
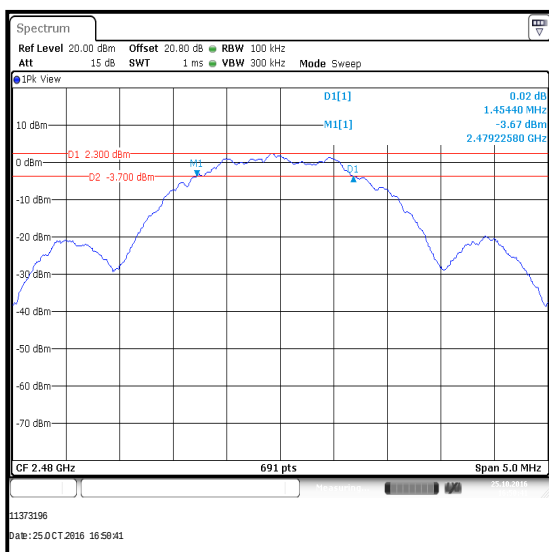
1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with FCC KDB 558074 Section 8.1 Option 1 measurement procedure. The spectrum analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace 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.

#### **Test setup:**



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

| Channel | 6 dB Bandwidth (kHz) | Limit (kHz) | Margin (kHz) | Result   |
|---------|----------------------|-------------|--------------|----------|
| Bottom  | 1447.200             | ≥500        | 947.200      | Complied |
| Middle  | 1577.400             | ≥500        | 1077.400     | Complied |
| Top     | 1454.400             | ≥500        | 954.400      | Complied |

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

**Transmitter Minimum 6 dB Bandwidth (continued)****Test Equipment Used:**

| Asset No. | Instrument       | Manufacturer    | Type No.  | Serial No. | Date Calibration Due  | Cal. Interval (Months) |
|-----------|------------------|-----------------|-----------|------------|-----------------------|------------------------|
| M2001     | Thermohygrometer | Testo           | 608-H1    | 45041824   | 02 Apr 2017           | 12                     |
| M1873     | Signal Analyser  | Rohde & Schwarz | FSV30     | 103074     | 27 Jun 2017           | 12                     |
| A2526     | Attenuator       | AtlanTecRF      | AN18W5-20 | 832828#1   | Calibrated before use | -                      |
| M199      | Power Meter      | Rohde & Schwarz | NRVS      | 827023/075 | 11 Apr 2018           | 24                     |
| M1267     | Power Sensor     | Rohde & Schwarz | NRV-Z52   | 100155     | 15 Apr 2018           | 24                     |

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

|                                   |                                                |                   |                 |
|-----------------------------------|------------------------------------------------|-------------------|-----------------|
| <b>Test Engineer:</b>             | Andrew Edwards                                 | <b>Test Date:</b> | 25 October 2016 |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Conducted RF Sample</i> ) |                   |                 |

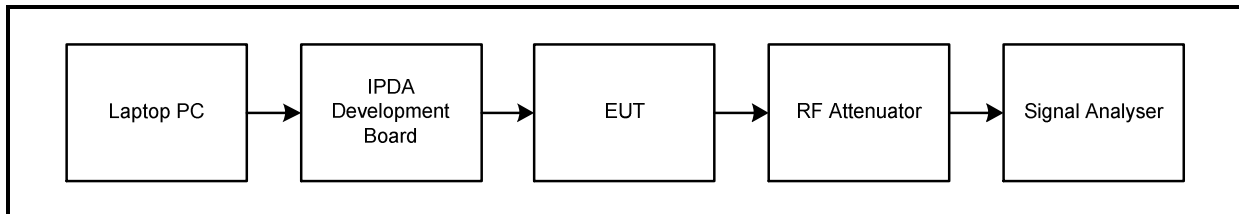
|                          |                              |
|--------------------------|------------------------------|
| <b>FCC Reference:</b>    | Part 15.247(b)(3)            |
| <b>Test Method Used:</b> | FCC KDB 558074 Section 9.1.1 |

**Environmental Conditions:**

|                               |    |
|-------------------------------|----|
| <b>Temperature (°C):</b>      | 22 |
| <b>Relative Humidity (%):</b> | 50 |

**Note(s):**

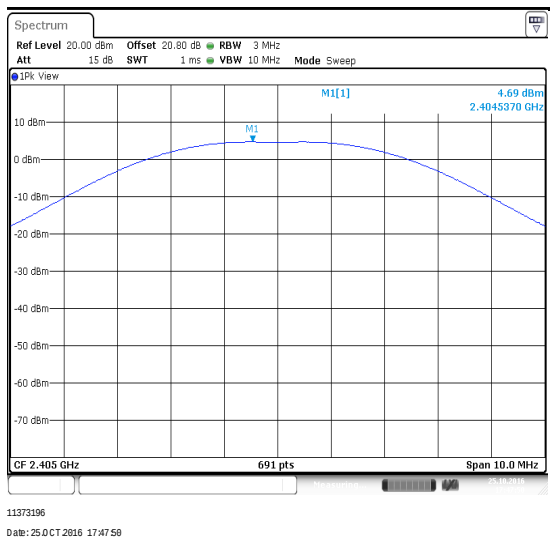
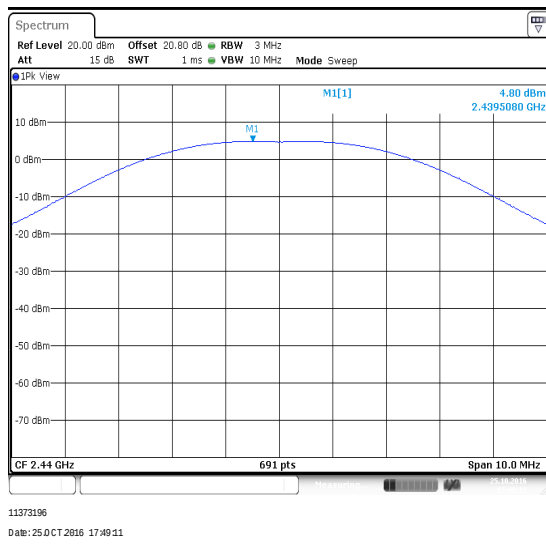
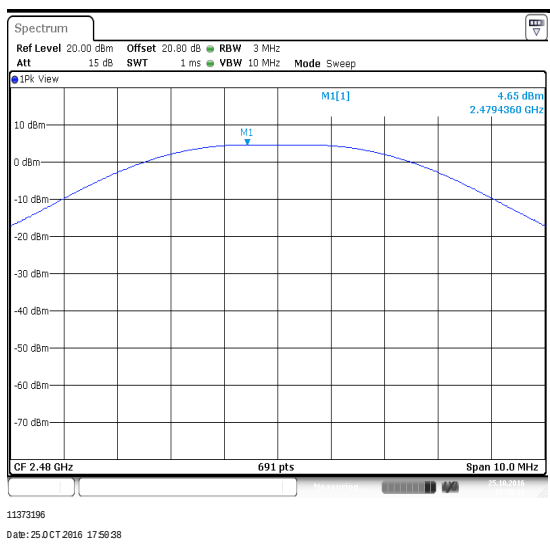
1. Conducted power tests were performed using a signal analyser in accordance with FCC KDB 558074 Section 9.1.1 Measurement Procedure.
2. The signal analyser resolution bandwidth was set to 3 MHz and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 10 MHz. A marker was placed at the peak of the signal and the results recorded in the table 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 spectrum analyser to compensate for the loss of the attenuator and RF cable.
4. The conducted power was added to the maximum declared antenna gain to obtain the EIRP.

**Test setup:**

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

| Channel | Conducted Peak Power (dBm) | Conducted Peak Power Limit (dBm) | Margin (dB) | Result   |
|---------|----------------------------|----------------------------------|-------------|----------|
| Bottom  | 4.7                        | 30.0                             | 25.3        | Complied |
| Middle  | 4.8                        | 30.0                             | 25.2        | Complied |
| Top     | 4.7                        | 30.0                             | 25.3        | Complied |

| Channel | Conducted Peak Power (dBm) | Declared Antenna Gain (dBi) | EIRP (dBm) | De Facto EIRP Limit (dBm) | Margin (dB) | Result   |
|---------|----------------------------|-----------------------------|------------|---------------------------|-------------|----------|
| Bottom  | 4.7                        | 2.2                         | 6.9        | 36.0                      | 29.1        | Complied |
| Middle  | 4.8                        | 2.2                         | 7.0        | 36.0                      | 29.0        | Complied |
| Top     | 4.7                        | 2.2                         | 6.9        | 36.0                      | 29.1        | Complied |

**Transmitter Maximum Peak Output Power (continued)****Bottom Channel****Middle Channel****Top Channel****Test Equipment Used:**

| Asset No. | Instrument       | Manufacturer    | Type No.  | Serial No. | Date Calibration Due  | Cal. Interval (Months) |
|-----------|------------------|-----------------|-----------|------------|-----------------------|------------------------|
| M2001     | Thermohygrometer | Testo           | 608-H1    | 45041824   | 02 Apr 2017           | 12                     |
| M1873     | Signal Analyser  | Rohde & Schwarz | FSV30     | 103074     | 27 Jun 2017           | 12                     |
| A2526     | Attenuator       | AtlanTecRF      | AN18W5-20 | 832828#1   | Calibrated before use | -                      |
| M199      | Power Meter      | Rohde & Schwarz | NRVS      | 827023/075 | 11 Apr 2018           | 24                     |
| M1267     | Power Sensor     | Rohde & Schwarz | NRV-Z52   | 100155     | 15 Apr 2018           | 24                     |
| G0607     | Signal Generator | Rohde & Schwarz | SMU200A   | 100943     | 10 May 2019           | 36                     |

**5.2.3. Transmitter Radiated Emissions****Test Summary:**

|                                   |                                            |                   |                  |
|-----------------------------------|--------------------------------------------|-------------------|------------------|
| <b>Test Engineer:</b>             | Mark Perry                                 | <b>Test Date:</b> | 13 November 2016 |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Radiated Sample</i> ) |                   |                  |

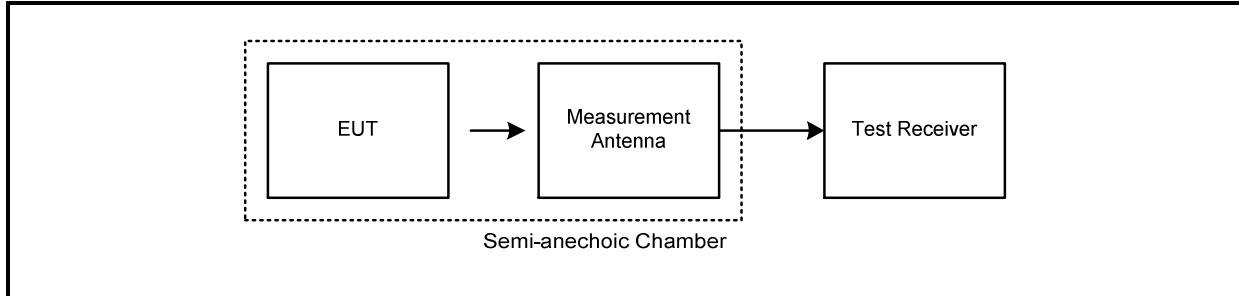
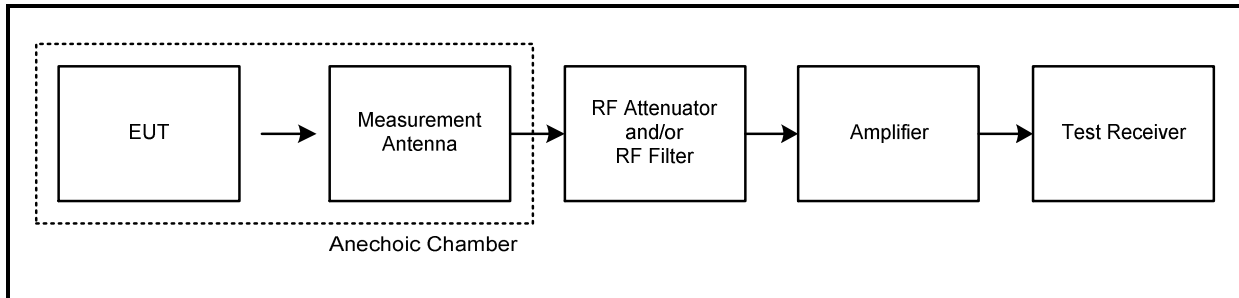
|                          |                                  |
|--------------------------|----------------------------------|
| <b>FCC Reference:</b>    | Parts 15.247(d) & 15.209(a)      |
| <b>Test Method Used:</b> | ANSI C63.10 Sections 6.3 and 6.5 |
| <b>Frequency Range</b>   | 30 MHz to 1000 MHz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

**Environmental Conditions:**

|                               |    |
|-------------------------------|----|
| <b>Temperature (°C):</b>      | 24 |
| <b>Relative Humidity (%):</b> | 38 |

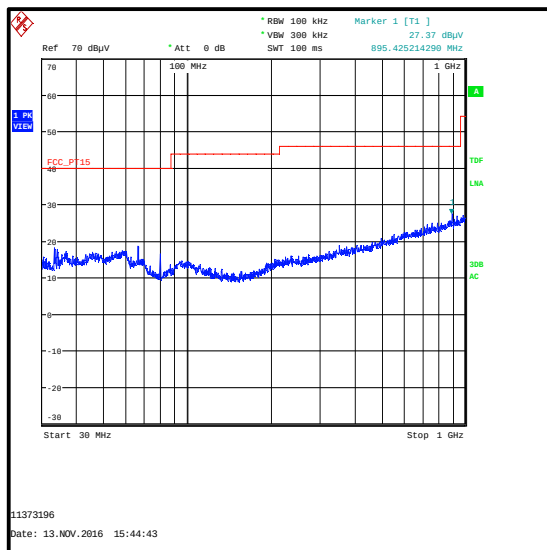
**Note(s):**

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The 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.
3. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak noise floor reading of the measuring receiver was recorded as shown in the table below.
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 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

**Transmitter Radiated Emissions (continued)****Test setup for radiated measurements:****Radiated Measurements < 1GHz****Radiated Measurements > 1GHz**

**Transmitter Radiated Emissions (continued)****Results: Middle Channel**

| Frequency (MHz) | Antenna Polarity | Level (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|----------------------|----------------------|-------------|----------|
| 895.425         | Vertical         | 27.4                 | 46.0                 | 18.6        | Complied |

**Test Equipment Used:**

| Asset No. | Instrument       | Manufacturer    | Type No.  | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|-----------|------------------|-----------------|-----------|------------|----------------------|------------------------|
| M2003     | Thermohygrometer | Testo           | 608-H1    | 45046641   | 22 Apr 2017          | 12                     |
| K0017     | 3m RSE Chamber   | Rainford EMC    | N/A       | N/A        | 17 May 2017          | 12                     |
| M1995     | Test Receiver    | Rohde & Schwarz | ESU40     | 100428     | 21 Mar 2017          | 12                     |
| A2888     | Antenna          | Schwarzbeck     | VULB 9163 | 9163-941   | 06 May 2017          | 12                     |

**Transmitter Radiated Emissions (continued)****Test Summary:**

|                                   |                                            |                    |                                      |
|-----------------------------------|--------------------------------------------|--------------------|--------------------------------------|
| <b>Test Engineers:</b>            | David Doyle &<br>Andrew Edwards            | <b>Test Dates:</b> | 27 October 2016 &<br>31 October 2016 |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Radiated Sample</i> ) |                    |                                      |

|                          |                                                                                 |
|--------------------------|---------------------------------------------------------------------------------|
| <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<br>Sections 6.3 and 6.6 |
| <b>Frequency Range</b>   | 1 GHz to 25 GHz                                                                 |

**Environmental Conditions:**

|                               |          |
|-------------------------------|----------|
| <b>Temperature (°C):</b>      | 23 to 24 |
| <b>Relative Humidity (%):</b> | 45 to 46 |

**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 other emissions shown on the pre-scan plots were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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. Final measurements above 1 GHz were performed at a distance of 3 metres. The EUT was placed at a height of 1.5 m 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. \*Emissions in restricted bands: In accordance with C63.10 Section 6.6.4.3, Note 1, where the peak detected amplitude was shown to comply with the average limit, an average measurement was not performed.

**Transmitter Radiated Emissions (continued)****Results: Bottom Channel**

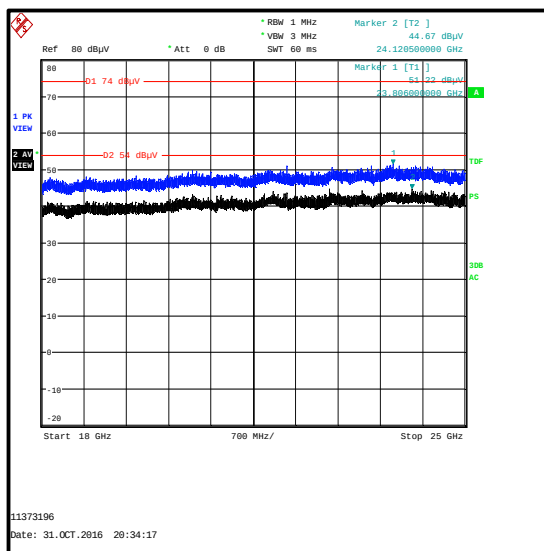
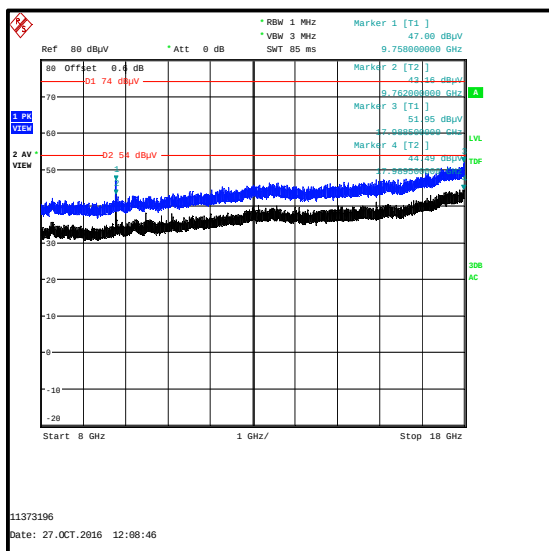
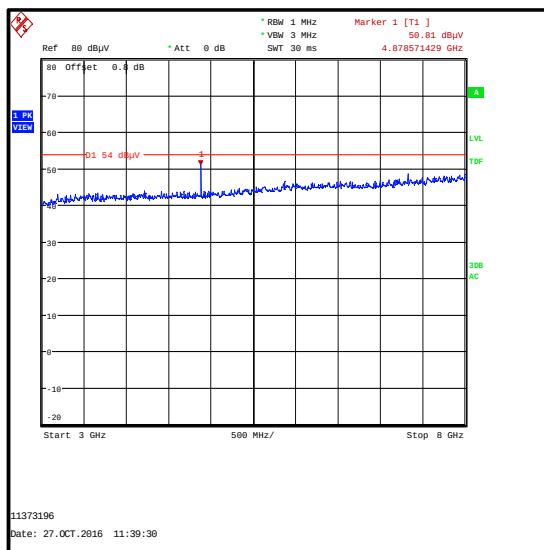
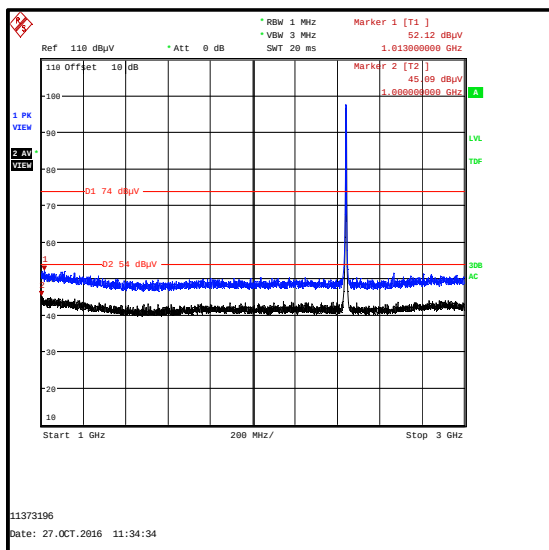
| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|------------------------------|-------------|----------|
| 4810.857        | Horizontal       | 50.8*                     | 54.0                         | 3.2         | Complied |

**Results: Middle Channel**

| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|------------------------------|-------------|----------|
| 4881.106        | Horizontal       | 51.8*                     | 54.0                         | 2.2         | Complied |

**Results: Top Channel**

| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|------------------------------|-------------|----------|
| 4960.993        | Horizontal       | 52.5*                     | 54.0                         | 1.5         | Complied |

**Transmitter Radiated Emissions (continued)**

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

**Transmitter Radiated Emissions (continued)****Test Equipment Used:**

| Asset No. | Instrument       | Manufacturer    | Type No.    | Serial No.      | Date Calibration Due | Cal. Interval (Months) |
|-----------|------------------|-----------------|-------------|-----------------|----------------------|------------------------|
| M1656     | Thermohygrometer | JM Handelspunkt | 30.5015.13  | Not stated      | 02 Apr 2017          | 12                     |
| K0002     | 3m RSE Chamber   | Rainford EMC    | N/A         | N/A             | 21 Dec 2016          | 12                     |
| M1886     | Test Receiver    | Rohde & Schwarz | ESU26       | 100554          | 21 Mar 2017          | 12                     |
| A1534     | Pre Amplifier    | Hewlett Packard | 8449B       | 3008A00405      | 19 Dec 2016          | 12                     |
| A436      | Antenna          | Flann Microwave | 20240-20    | 330             | 19 Dec 2016          | 12                     |
| M1995     | Test Receiver    | Rohde & Schwarz | ESU40       | 100428          | 21 Mar 2017          | 12                     |
| A2863     | Pre Amplifier    | Agilent         | 8449B       | 3008A02100      | 07 Jan 2017          | 12                     |
| A2889     | Antenna          | Schwarzbeck     | BBHA 9120 B | BBHA 9120 B 653 | 07 Apr 2017          | 12                     |
| A2890     | Antenna          | Schwarzbeck     | HWRD 750    | 014             | 06 May 2017          | 12                     |
| A2891     | Pre Amplifier    | Schwarzbeck     | BBV 9718    | 9718-306        | 07 Apr 2017          | 12                     |
| A2914     | High Pass Filter | AtlanTecRF      | AFH-03000   | 2155            | 19 May 2017          | 12                     |
| A2947     | High Pass Filter | AtlanTecRF      | AFH-07000   | 1601900001      | 01 Jun 2017          | 12                     |
| A2916     | Attenuator       | AtlanTecRF      | AN18W5-10   | 832827#1        | 19 May 2017          | 12                     |
| M2003     | Thermohygrometer | Testo           | 608-H1      | 45046641        | 22 Apr 2017          | 12                     |
| K0017     | 3m RSE Chamber   | Rainford EMC    | N/A         | N/A             | 17 May 2017          | 12                     |

**5.2.4. Transmitter Band Edge Radiated Emissions****Test Summary:**

|                                   |                                            |                   |                 |
|-----------------------------------|--------------------------------------------|-------------------|-----------------|
| <b>Test Engineer:</b>             | David Doyle                                | <b>Test Date:</b> | 27 October 2016 |
| <b>Test Sample Serial Number:</b> | 100500452 26/16 ( <i>Radiated Sample</i> ) |                   |                 |

|                          |                                                                 |
|--------------------------|-----------------------------------------------------------------|
| <b>FCC Reference:</b>    | Parts 15.247(d) & 15.209(a)                                     |
| <b>Test Method Used:</b> | ANSI C63.10 Section 6.10.4, 6.10.5 & KDB 558074 Section 11 & 13 |

**Environmental Conditions:**

|                               |    |
|-------------------------------|----|
| <b>Temperature (°C):</b>      | 24 |
| <b>Relative Humidity (%):</b> | 43 |

**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 edges fall within non-restricted bands, 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 a peak detector in accordance with FCC KDB 558074 Section 9.1.1 an out-of-band limit line was placed 20 dB below the peak level (FCC KDB 558074 Section 11.1(a)). A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent non-restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
4. As the upper band edge falls within 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 average 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 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 their respective detectors. Markers were placed on the highest point on each trace.
6. \*Emissions in restricted bands: In accordance with C63.10 Section 6.6.4.3, Note 1, where the peak detected amplitude was shown to comply with the average limit, an average measurement was not performed.
7. \*\*The final upper band edge average measurement was performed using the integration method stated in FCC KDB 558074 Section 13.3.1 and the result was compliant.

**Transmitter Band Edge Radiated Emissions (continued)****Results: Lower Band Edge**

| Frequency (MHz) | Level (dB $\mu$ V/m) | -20 dBc Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|----------------------|------------------------------|-------------|----------|
| 2399.920        | 54.1                 | 73.6                         | 19.5        | Complied |
| 2400.000        | 53.6                 | 73.6                         | 20.0        | Complied |

**Results: Upper Band Edge / Peak**

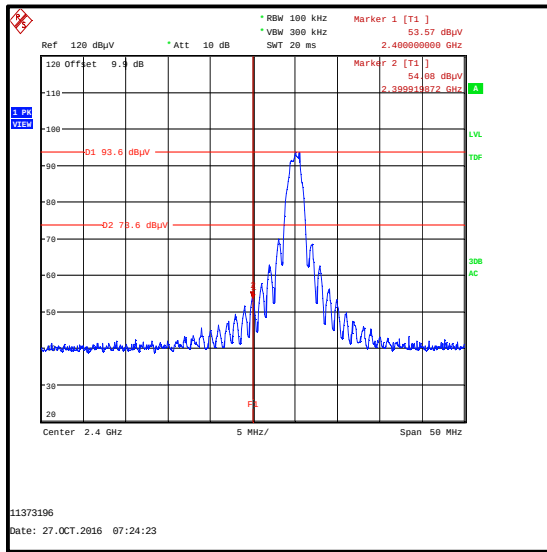
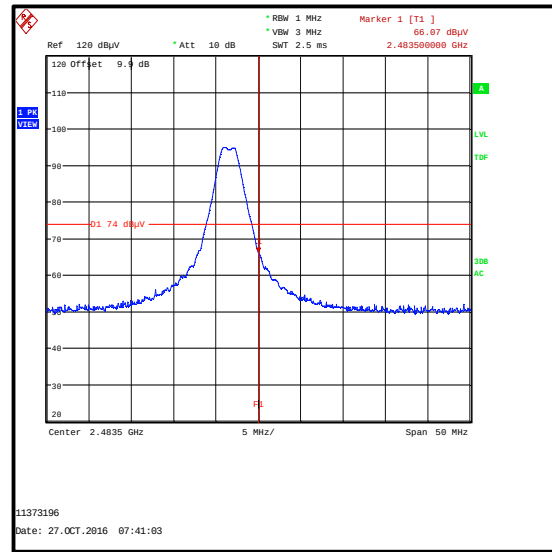
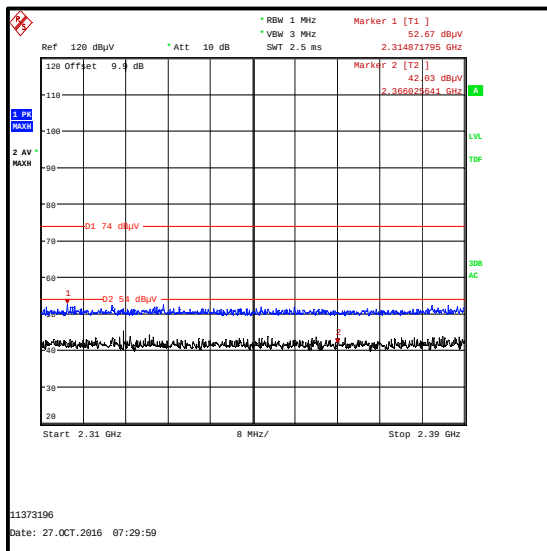
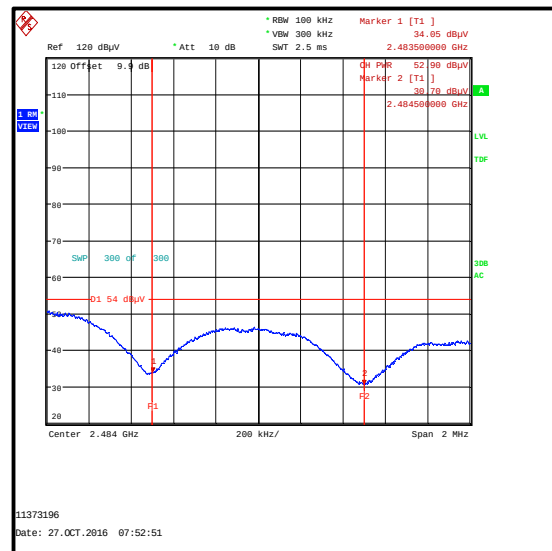
| Frequency (MHz) | Level (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|----------------------|----------------------|-------------|----------|
| 2483.500        | 66.1                 | 74.0                 | 7.9         | Complied |

**Results: Upper Band Edge / Average**

| Frequency (MHz) | Level (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|----------------------|----------------------|-------------|----------|
| 2483.500        | 52.9**               | 54.0                 | 1.1         | Complied |

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

| Frequency (MHz) | Peak Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|---------------------------|------------------------------|-------------|----------|
| 2314.872        | 52.7*                     | 54.0                         | 1.3         | Complied |

**Transmitter Band Edge Radiated Emissions (continued)****Lower Band Edge Peak Measurement****Upper Band Edge Peak Measurement****2310 MHz to 2390 MHz Restricted Band****Upper Band Edge Average / Integrated**

**Transmitter Band Edge Radiated Emissions (continued)****Test Equipment Used:**

| Asset No. | Instrument       | Manufacturer    | Type No.    | Serial No.      | Date Calibration Due | Cal. Interval (Months) |
|-----------|------------------|-----------------|-------------|-----------------|----------------------|------------------------|
| M2003     | Thermohygrometer | Testo           | 608-H1      | 45046641        | 22 Apr 2017          | 12                     |
| K0017     | 3m RSE Chamber   | Rainford EMC    | N/A         | N/A             | 17 May 2017          | 12                     |
| M1995     | Test Receiver    | Rohde & Schwarz | ESU40       | 100428          | 21 Mar 2017          | 12                     |
| A2889     | Antenna          | Schwarzbeck     | BBHA 9120 B | BBHA 9120 B 653 | 07 Apr 2017          | 12                     |
| A2863     | Pre-Amplifier    | Agilent         | 8449B       | 3008A02100      | 07 Jan 2017          | 12                     |
| A2916     | Attenuator       | AtlanTecRF      | AN18W5-10   | 832827#1        | 19 May 2017          | 12                     |

## **6. 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 of the measurand (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 |
|-------------------------------------|-----------------------|----------------------|------------------------|
| Conducted Maximum Peak Output Power | 2.4 GHz to 2.4835 GHz | 95%                  | ±1.13 dB               |
| Minimum 6 dB Bandwidth              | 2.4 GHz to 2.4835 GHz | 95%                  | ±4.59 %                |
| Radiated Spurious Emissions         | 30 MHz to 1 GHz       | 95%                  | ±5.65 dB               |
| Radiated Spurious Emissions         | 1 GHz to 26.5 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.

**7. Report Revision History**

| Version Number | Revision Details |        |                                                                                                                                  |
|----------------|------------------|--------|----------------------------------------------------------------------------------------------------------------------------------|
|                | Page No(s)       | Clause | Details                                                                                                                          |
| 1.0            | -                | -      | Initial Version                                                                                                                  |
| 2.0            | 6<br>23<br>25    | -      | Changed EUT description in Section 3.2<br>Changed wording of Note 7 and Test Method Used<br>Removed upper band edge average plot |

--- END OF REPORT ---