# TEST REPORT

## Test Report No. : UL-RPT-RP12558692-1216A V3.0

| | | |
|---|---|---|
| **Customer** | : | Bio-Medical Research Ltd |
| **Model No.** | : | Type 530 |
| **FCC ID** | : | 2AR5N530 |
| **Technology** | : | *Bluetooth* – Low Energy |
| **Test Standard(s)** | : | FCC Parts 15.207, 15.209(a) & 15.247 |
| **Test Laboratory** | : | UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom |

1. This test report shall not be reproduced except in full, without the written approval of UL VS LTD.
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:** 22 August 2019

**Checked by:**

Ian Watch
Senior Test Engineer, Radio Laboratory

**Company Signatory:**

Ben Mercer
Senior Test Engineer, Radio Laboratory
UL VS LTD

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## Customer Information

| | |
|---|---|
| **Company Name:** | Bio-Medical Research Ltd |
| **Address:** | Parkmore Business Park West<br>Galway<br>H91 NHT7<br>Ireland |

## Report Revision History

| Version Number | Issue Date | Revision Details | Revised By |
|---|---|---|---|
| 1.0 | 07/05/2019 | Initial Version | Ben Mercer |
| 2.0 | 10/05/2019 | Model number, SW & HW version updated | Ben Mercer |
| 3.0 | 22/08/2019 | Inserted AC conducted emissions results | Ian Watch |

# Table of Contents

# 1. Attestation of Test Results

## 1.1. Description of EUT

The EUT was a Wearable EMS device containing a *Bluetooth* Low Energy module.

## 1.2. General Information

| | |
|---|---|
| **Specification Reference:** | 47CFR15.247 |
| **Specification Title:** | Code of Federal Regulations Volume 47 (Telecommunications):<br>Part 15 Subpart C (Intentional Radiators) - Section 15.247 |
| **Specification Reference:** | 47CFR15.207 and 47CFR15.209 |
| **Specification Title:** | Code of Federal Regulations Volume 47 (Telecommunications):<br>Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209 |
| **FCC Test Firm Registration No.:** | 621311 |
| **Test Dates:** | 28 January 2019 to 25 July 2019 |

## 1.3. Summary of Test Results

| FCC Reference (47CFR) | Measurement | Result |
|---|---|---|
| Part 15.247(a)(2) | Transmitter Minimum 6 dB Bandwidth | ✓ |
| Part 15.35(c) | Transmitter Duty Cycle | Note 1 |
| Part 15.247(b)(3) | Transmitter Maximum Peak Output Power | ✓ |
| Part 15.247(e) | Transmitter Power Spectral Density | Note 2 |
| Part 15.247(d)/15.209(a) | Transmitter Radiated Emissions | ✓ |
| Part 15.247(d)/15.209(a) | Transmitter Band Edge Radiated Emissions | ✓ |
| Part 15.207 | Transmitter AC Conducted Emissions | ✓ |
| **Key to Results**<br>✓ = Complied ✗ = Did not comply | | |

**Note(s):**

1. The measurement was performed to assist in the calculation of the level of emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.
2. In accordance with ANSI C63.10 Section 11.10.1, 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 be equal to the measured output power.

## 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 | X |
| Site 2 | - |
| Site 17 | - |

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

| | |
|---|---|
| **Reference:** | ANSI C63.10-2013 |
| **Title:** | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| **Reference:** | KDB 558074 D01 15.247 Meas Guidance v05r02 April 02, 2019 |
| **Title:** | Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules |
| **Reference:** | KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015 |
| **Title:** | 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”.

| 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 |
| AC Conducted Spurious Emissions | 0.15 MHz to 30 MHz | 95% | ±1.96 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 | 6 Jan 2020 | 12 |
| M2036 | Signal Analyser | Rohde & Schwarz | FSV30 | 101791 | 20 Apr 2019 | 12 |
| G0628 | Vector Signal Generator | Rohde & Schwarz | SMBV100A | 261847 | 28 Sep 2020 | 36 |
| A2524 | Attenuator | AtlanTecRF | AN18W5-10 | 832827#2 | 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) |
|---|---|---|---|---|---|---|
| K0001 | 3m RSE Chamber | Rainford | N/A | N/A | 04 Oct 2019 | 12 |
| M1630 | Test Receiver | Rohde & Schwarz | ESU26 | 100233 | 20 Sep 2019 | 12 |
| A3154 | Pre Amplifier | Com-Power | PAM-103 | 18020012 | 14 Sep 2019 | 12 |
| A3155 | Pre Amplifier | Com-Power | PAM-118A | 18040037 | 14 Sep 2019 | 12 |
| A553 | Antenna | Chase | CBL6111A | 1593 | 08 Oct 2019 | 12 |
| A3138 | Antenna | Schwarzbeck | BBHA 9120 B | 00702 | 03 Oct 2019 | 12 |
| A3139 | Antenna | Schwarzbeck | HWRD750 | 00027 | 04 Oct 2019 | 12 |
| A2523 | Attenuator | AtlanTechRF | AN18W5-10 | 832827#1 | 04 Mar 2020 | 12 |
| A3093 | High Pass Filter | AtlanTechRF | AFH-03000 | 18051800077 | 29 Jun 2019 | 12 |
| A3095 | High Pass Filter | AtlanTechRF | AFH-07000 | 18051600012 | 29 Jun 2019 | 12 |
| A3083 | Low Pass Filter | AtlanTechRF | AFL-01000 | 18010900076 | 29 Jun 2019 | 12 |
| A2895 | Antenna | Schwarzbeck | BBHA 9170 | 9170-728 | 08 Feb 2020 | 12 |
| A2896 | Pre Amplifier | Schwarzbeck | BBV 9721 | 9721-023 | 08 Feb 2020 | 12 |

### Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests

| Asset No. | Instrument | Manufacturer | Type No. | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| K0001 | 3m RSE Chamber | Rainford | N/A | N/A | 04 Oct 2019 | 12 |
| M1630 | Test Receiver | Rohde & Schwarz | ESU26 | 100233 | 20 Sep 2020 | 12 |
| A3155 | Pre Amplifier | Com-Power | PAM-118A | 18040037 | 14 Sep 2019 | 12 |
| A3138 | Antenna | Schwarzbeck | BBHA 9120 B | 00702 | 03 Oct 2019 | 12 |
| A2523 | Attenuator | AtlanTechRF | AN18W5-10 | 832827#1 | 04 Mar 2020 | 12 |

## Test Equipment Used for Transmitter AC Conducted Emissions

| Asset No. | Instrument | Manufacturer | Type No. | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| M2037 | Thermohygrometer | Testo | 608-H1 | 45124925 | 06 Jan 2020 | 12 |
| A067 | LISN | Rohde & Schwarz | ESH3-Z5 | 890603/002 | 08 Nov 2019 | 12 |
| A1830 | Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 100668 | 10 Apr 2020 | 12 |
| M1273 | Test Receiver | Rohde & Schwarz | ESIB 26 | 100275 | 18 Dec 2019 | 12 |

## Test Measurement Software/Firmware Used:

| Name | Version | Release Date |
|---|---|---|
| Rohde & Schwarz EMC32 | 6.30.0 | 2008 |

# 3. Equipment Under Test (EUT)

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

| | |
|---|---|
| **Brand Name:** | Slendertone |
| **Model Name or Number:** | Type 530 |
| **Test Sample Serial Number:** | X8231281 *(Conducted sample)* |
| **Hardware Version:** | 1000-0100, rev.D |
| **Software Version:** | 00.02.00 |
| **FCC ID:** | 2AR5N530 |

| | |
|---|---|
| **Brand Name:** | Slendertone |
| **Model Name or Number:** | Type 530 |
| **Test Sample Serial Number:** | X8231222 *(Radiated sample #1)* |
| **Hardware Version:** | 1000-0100, rev.D |
| **Software Version:** | 00.02.00 |
| **FCC ID:** | 2AR5N530 |

| | |
|---|---|
| **Brand Name:** | Slendertone |
| **Model Name or Number:** | Type 530 |
| **Test Sample Serial Number:** | X8231081 *(Radiated sample #2)* |
| **Hardware Version:** | 1000-0100, rev.D |
| **Software Version:** | 00.02.00 |
| **FCC ID:** | 2AR5N530 |

## 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:** | 1 Mbps | | |
| **Power Supply Requirement(s):** | Nominal | 4.1 VDC (battery) &<br>5 VDC via 120 VAC 60 Hz adaptor | |
| **Maximum Conducted Output Power:** | 1.3 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 | 0.5 |

## 3.5. Description of Test Setup

### Support Equipment

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

| | |
|---|---|
| **Description:** | Laptop PC |
| **Brand Name:** | Dell |
| **Model Name or Number:** | E5400 |
| **Serial Number:** | 01150 |

| | |
|---|---|
| **Description:** | RS232 to Serial Converter |
| **Brand Name:** | MikroElektronika |
| **Model Name or Number:** | mikroBUS |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | USB to Serial Converter |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | Holster PCB |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | iPhone |
| **Brand Name:** | Apple |
| **Model Name or Number:** | MLXN2B/A |
| **Serial Number:** | F17RHST8H2XX |

| | |
|---|---|
| **Description:** | USB cable. Length 145 mm ± 15 mm |
| **Brand Name:** | Slendertone |
| **Model Name or Number:** | 4700-0021 |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | I.T.E. Power supply<br>Input 100 VAC to 240 VAC 60 Hz / Output +5 VDC |
| **Brand Name:** | Ideal Power |
| **Model Name or Number:** | HK-AP-050A120-CP |
| **Serial Number:** | 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.
- During AC conducted emissions tests, frequency hopping across the operating band at full power while charging.

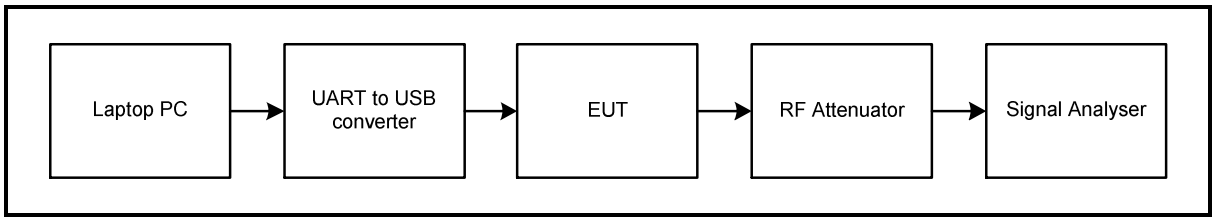
## Configuration and Peripherals

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

- Transmit tests: The EUT was placed into *Bluetooth* LE test mode using a laptop PC and application *nRFgo Studio* (version 1.21.0.2) by Nordic Semiconductor ASA. *Bluetooth* Direct Test Mode was selected, Mode was set to Transmit, Payload Model was PRBS9 and Payload Length was 37 bytes. The EUT Channel was set to Single and the test channel number set as required. For radiated testing, once in the correct mode the computer was disconnected.
- The EUT was powered from its internal battery.
- Radiated spurious emissions were performed with the EUT in the position that produced worst case with respect to emissions. The Holster PCB was attached, electrodes placed in a saline solution and excited.
- AC conducted emissions tests: Connected via radio link to an iPhone as used in an end-user application following the customer's procedure in 'Video4 – App & Pairing.mp4' dated 02 January 2019. Connected to an I.T.E. power supply via USB cable. The I.T.E. power supply was connected to a single phase supply via a LISN. The EUT was powered from a 120 VAC 60 Hz single phase mains supply unless otherwise stated.

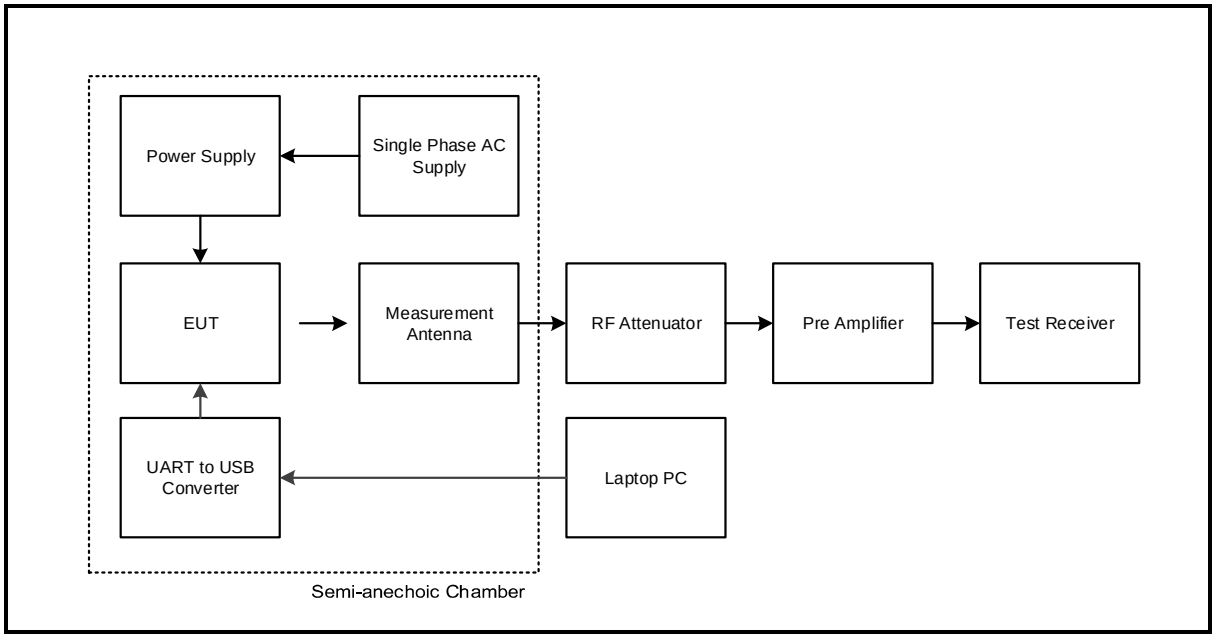
## Test Setup Diagrams

### Conducted Tests:

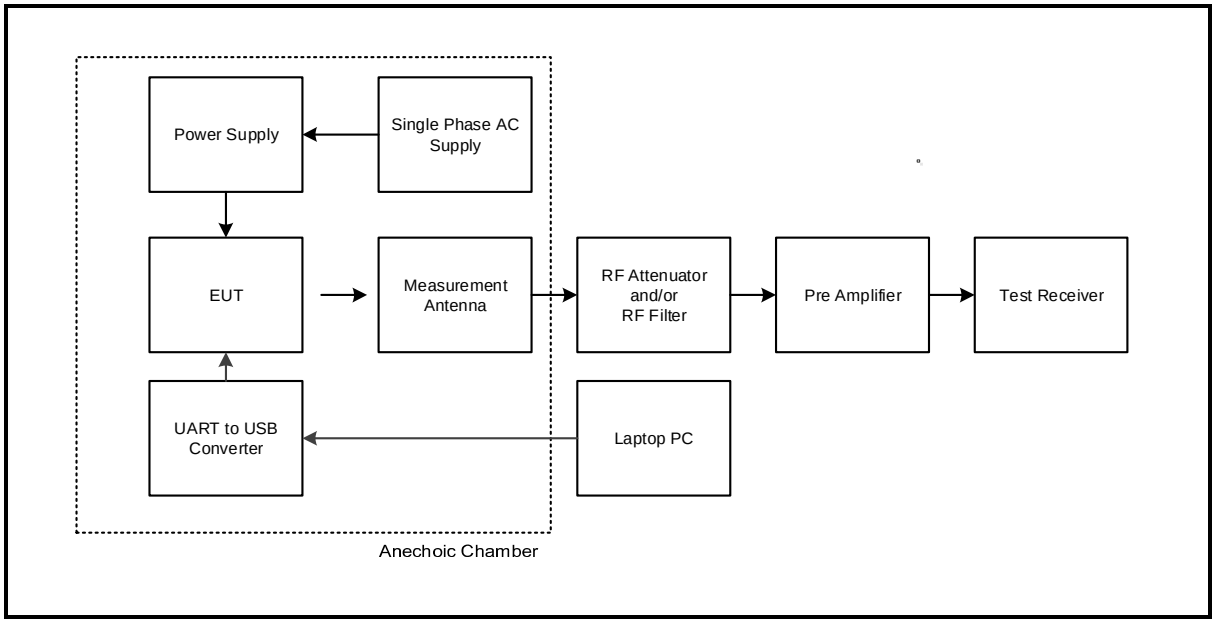



### Radiated Tests:

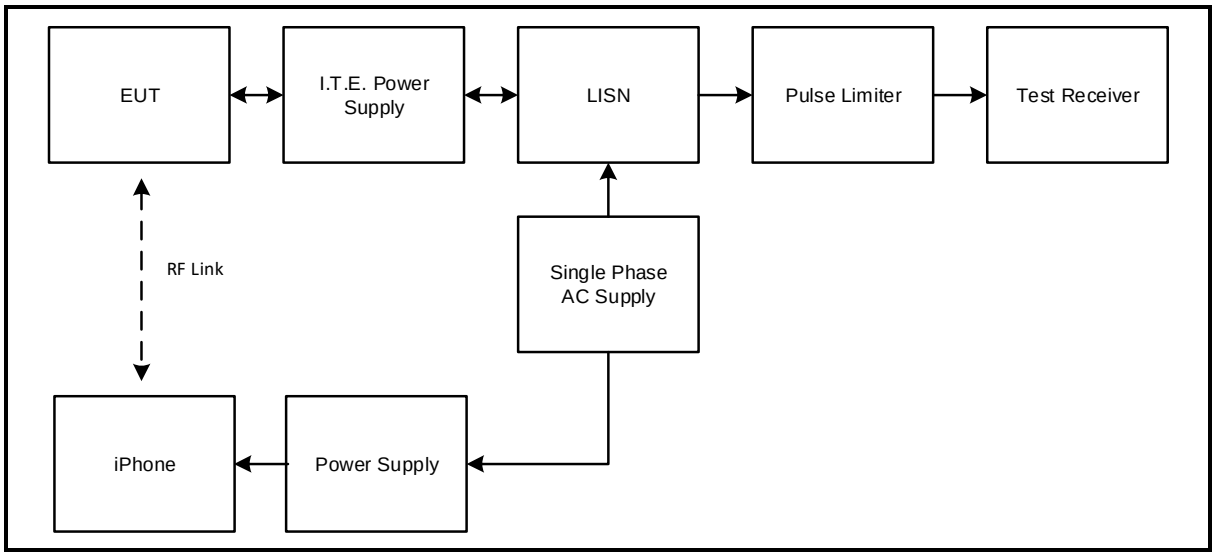
### Semi-anechoic chamber




### Anechoic chamber



## Test Setup for Transmitter AC Conducted Emissions



# 4. Antenna Port Test Results

## 4.1. Transmitter Minimum 6 dB Bandwidth

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Stefan Ho | **Test Date:** | 31 January 2019 |
| **Test Sample Serial Number:** | X8231281 | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.247(a)(2) |
| **Test Method Used:** | FCC KDB 558074 Section 8.2 referencing<br>ANSI C63.10 Section 11.8.1 Option 1 |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 21 |
| **Relative Humidity (%):** | 34 |

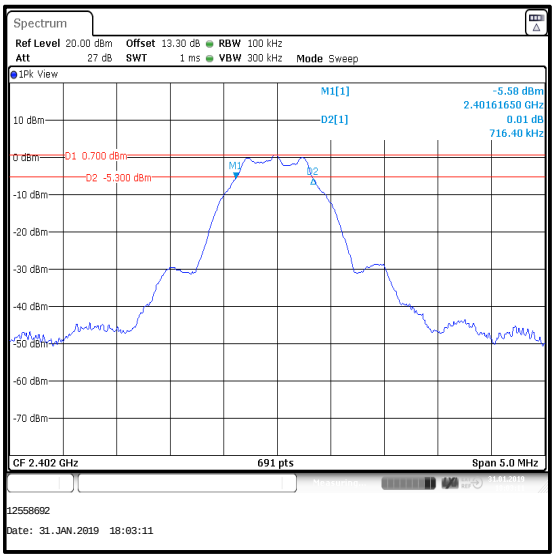
### Note(s):

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth to 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.

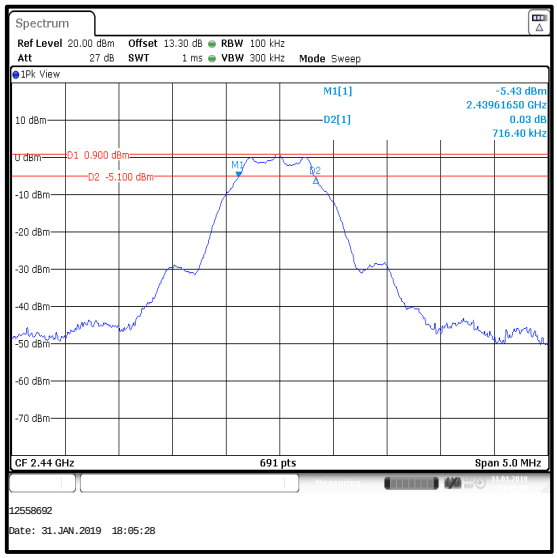
## Transmitter Minimum 6 dB Bandwidth (continued)

## Results:

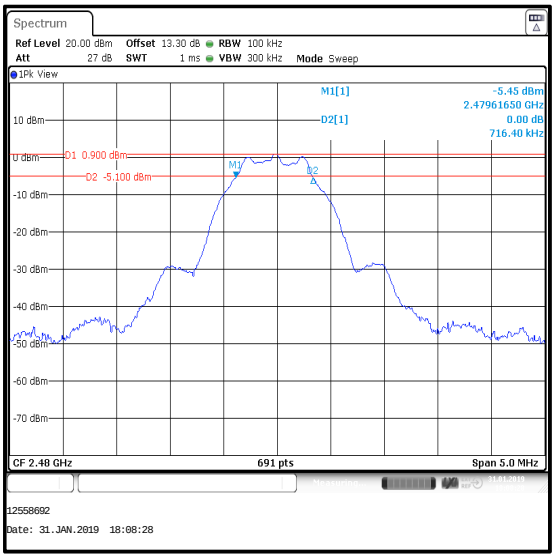
| Channel | 6 dB Bandwidth (kHz) | Limit (kHz) | Margin (kHz) | Result |
|---|---|---|---|---|
| Bottom | 716.400 | ≥500 | 216.400 | Complied |
| Middle | 716.400 | ≥500 | 216.400 | Complied |
| Top | 716.400 | ≥500 | 216.400 | Complied |




**Bottom Channel**




**Middle Channel**




**Top Channel**

## 4.2. Transmitter Duty Cycle

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Stefan Ho | **Test Date:** | 28 January 2019 |
| **Test Sample Serial Number:** | X8231281 | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.35(c) |
| **Test Method Used:** | FCC KDB 558074 Section 6.0 |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 21 |
| **Relative Humidity (%):** | 34 |

### Note(s):

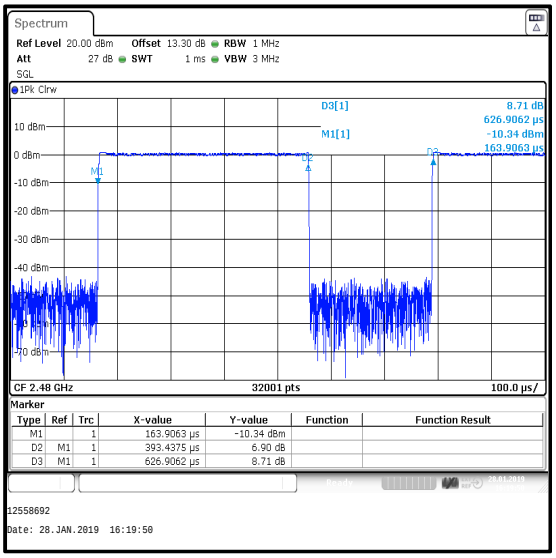
1. In order to assist with the determination of the average level of spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time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

*10 log (1 / (On Time / [Period or 100 ms whichever is the lesser])).*

*10 log (1 / (393.438 µs / 626.906 µs)) = 2.0 dB*

### Results:

| Pulse Duration (µs) | Period (µs) | Duty Cycle (dB) |
|---|---|---|
| 393.438 | 626.906 | 2.0 |



## 4.3. Transmitter Maximum Peak Output Power

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Stefan Ho | **Test Date:** | 28 January 2019 |
| **Test Sample Serial Number:** | X8231281 | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.247(b)(3) |
| **Test Method Used:** | FCC KDB 558074 Section 8.3.1.1 referencing<br>ANSI C63.10 Section 11.9.1.1 |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 21 |
| **Relative Humidity (%):** | 34 |

### Note(s):

1. Conducted power tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 RBW > DTS bandwidth procedure.
2. The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth to 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5 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)

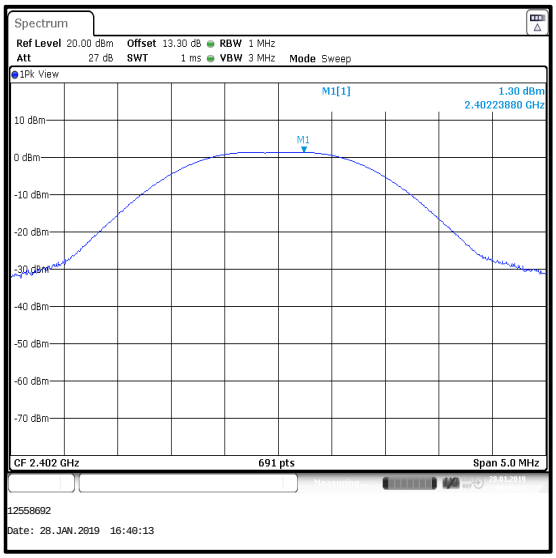
## Results:

| Channel | Conducted Peak Power (dBm) | Conducted Peak Power Limit (dBm) | Margin (dB) | Result |
|---|---|---|---|---|
| Bottom | 1.3 | 30.0 | 28.7 | Complied |
| Middle | 1.3 | 30.0 | 28.7 | Complied |
| Top | 0.9 | 30.0 | 29.1 | Complied |

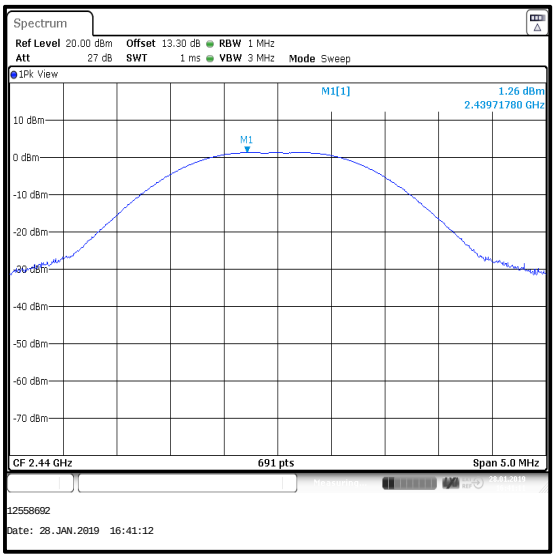
| Channel | Conducted Peak Power (dBm) | Declared Antenna Gain (dBi) | EIRP (dBm) | De Facto EIRP Limit (dBm) | Margin (dB) | Result |
|---|---|---|---|---|---|---|
| Bottom | 1.3 | 0.5 | 1.8 | 36.0 | 34.2 | Complied |
| Middle | 1.3 | 0.5 | 1.8 | 36.0 | 34.2 | Complied |
| Top | 0.9 | 0.5 | 1.4 | 36.0 | 34.6 | Complied |

## Transmitter Maximum Peak Output Power (continued)

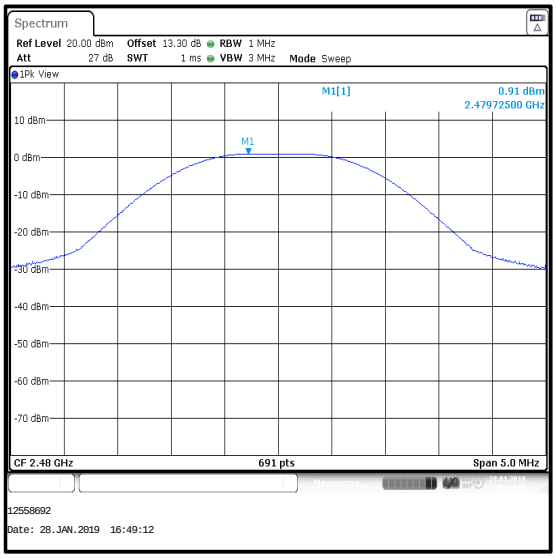
## Results: LE




**Bottom Channel**




**Middle Channel**




**Top Channel**

# 5. Radiated Test Results

## 5.1. Transmitter Radiated Emissions <1 GHz

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineers:** | John Ferdinand | **Test Date:** | 05 April 2019 |
| **Test Sample Serial Number:** | X8231222 | | |

| | |
|---|---|
| **FCC Reference:** | Parts 15.247(d) & 15.209(a) |
| **Test Method Used:** | ANSI C63.10 Sections 6.3, 6.5, 11.11 & 11.12 |
| **Frequency Range** | 30 MHz to 1000 MHz |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 18 |
| **Relative Humidity (%):** | 36 |

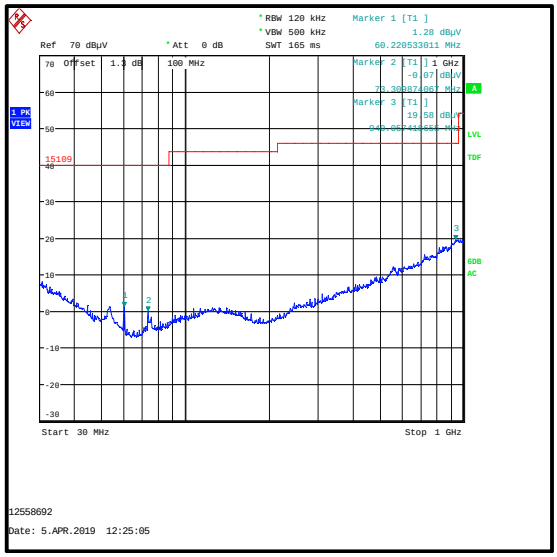
### Note(s):

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, > 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. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) 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.
4. 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 to 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
5. 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

| Frequency (MHz) | Antenna Polarity | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 940.057 | Horizontal | 19.6 | 46.0 | 26.4 | Complied |



## 5.2. Transmitter Radiated Emissions >1 GHz

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineers:** | John Ferdinand | **Test Dates:** | 05 April 2019 |
| **Test Sample Serial Number:** | X8231222 | | |

| | |
|---|---|
| **FCC Reference:** | Parts 15.247(d) & 15.209(a) |
| **Test Method Used:** | ANSI C63.10 Sections 6.3, 6.6, 11.11 & 11.12 |
| **Frequency Range** | 1 GHz to 25 GHz |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 18 |
| **Relative Humidity (%):** | 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. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
3. All other emissions shown on the pre-scans were investigated and found to be ambient, > 20 dB below the appropriate limit or below the noise floor of the measurement system.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0001) 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 to 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their respective detectors during the pre-scan measurements.
6. *In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.

## Transmitter Radiated Emissions (continued)

### Results: Peak Bottom Channel

| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 4804.146 | Horizontal | 49.5 | 54.0* | 4.5 | Complied |

| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 7206.666 | Horizontal | 53.1 | 54.0* | 0.9 | Complied |

### Results: Peak Middle Channel

| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 4880.050 | Horizontal | 50.6 | 54.0* | 3.4 | Complied |

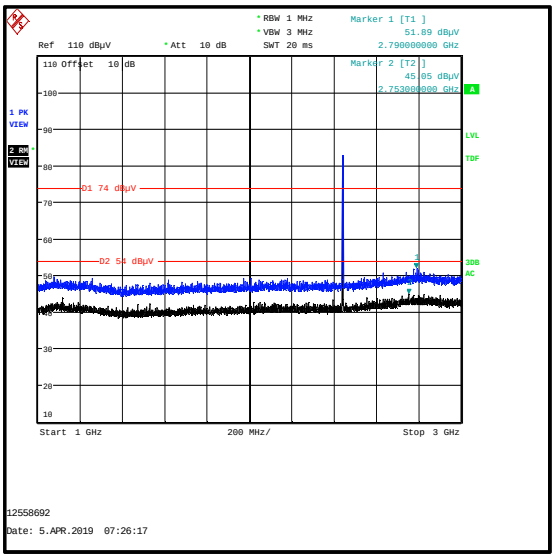
| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 7319.044 | Horizontal | 51.6 | 54.0* | 2.4 | Complied |

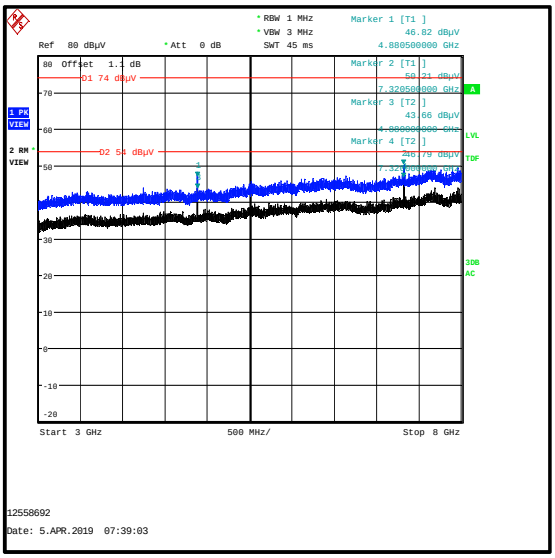
### Results: Peak Top Channel

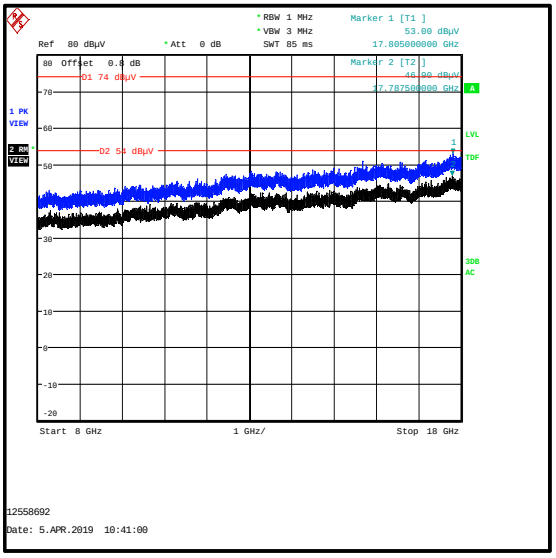
| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 4960.140 | Horizontal | 51.5 | 54.0* | 2.5 | Complied |

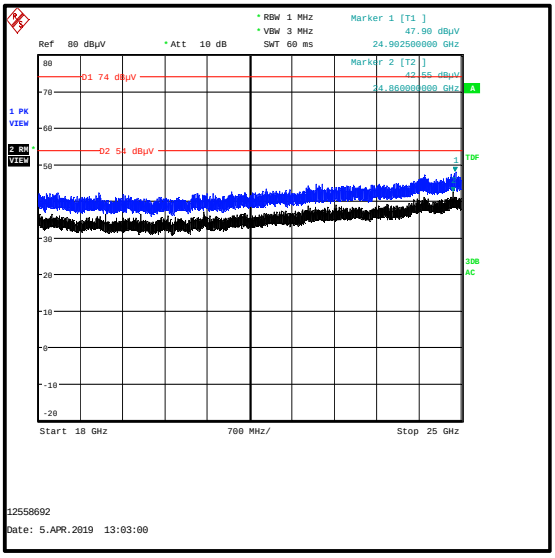
| Frequency (MHz) | Antenna Polarity | Peak Level (dBµV/m) | Average Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 7439.774 | Horizontal | 52.4 | 54.0* | 1.6 | Complied |

## Transmitter Radiated Emissions (continued)



## 5.3. Transmitter Band Edge Radiated Emissions

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | John Ferdinand | **Test Date:** | 04 April 2019 |
| **Test Sample Serial Number:** | X8231222 | | |

| | |
|---|---|
| **FCC Reference:** | Parts 15.247(d) & 15.209(a) |
| **Test Method Used:** | ANSI C63.10 Sections 11.11, 11.12, 11.13 & Notes below |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 18 |
| **Relative Humidity (%):** | 37 |

### 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 ANSI C63.10 Section 11.11.1(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 ANSI C63.10 Section 11.11.1. The test method in Section 11.11.3 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 ANSI C63.10 Section 11.9.1.1 an out-of-band limit line was placed 20 dB (ANSI C63.10 Section 11.11.1(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 upper band edge average result. The corrected level is shown below:

*Upper Band Average result + duty cycle = Corrected band edge level*

*Corrected band edge level at 2483.5 MHz : 38.0 + 2.0 = 40.0 dBµV/m*

## Transmitter Band Edge Radiated Emissions (continued)

### Results: Peak

| Frequency (MHz) | Antenna Polarity | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 2383.253 | Horizontal | 38.5 | 61.9* | 23.4 | Complied |
| 2400.000 | Horizontal | 36.5 | 61.9* | 25.4 | Complied |
| 2484.782 | Horizontal | 48.9 | 74.0 | 25.1 | Complied |

### Results: Average

| Frequency (MHz) | Antenna Polarity | Level (dBµV/m) | Duty cycle correction (dB) | Corrected Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|---|---|
| 2483.500 | Horizontal | 38.0 | 2.3 | 40.3** | 54.0 | 13.7 | Complied |

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

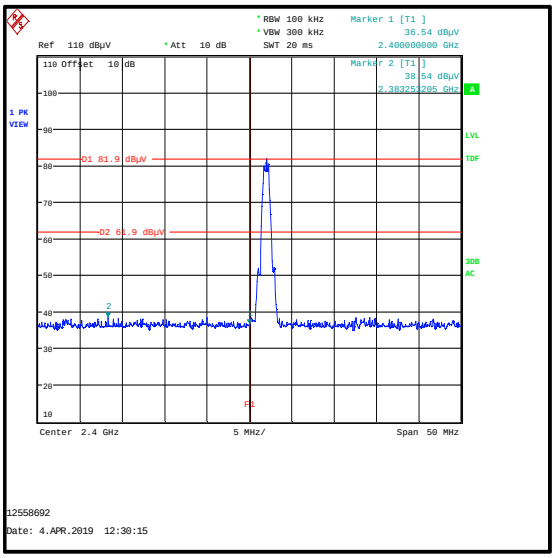
| Frequency (MHz) | Antenna Polarity | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 2341.026 | Horizontal | 50.1 | 74.0 | 23.9 | Complied |

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

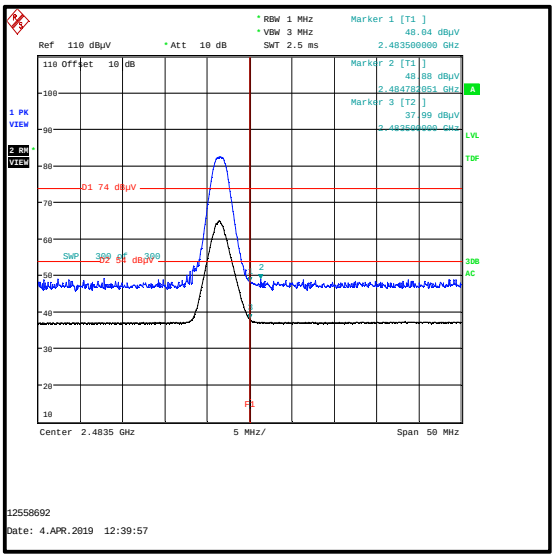
| Frequency (MHz) | Antenna Polarity | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 2347.692 | Horizontal | 37.1 | 54.0 | 16.9 | Complied |

## Transmitter Band Edge Radiated Emissions (continued)

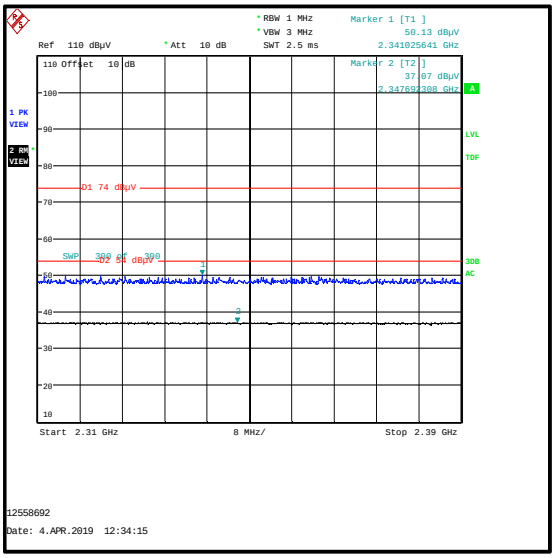
## Results:




**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:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Alison Johnston | **Test Dates:** | 23 July 2019 & 25 July 2019 |
| **Test Sample Serial Number:** | X8231081 | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.207 |
| **Test Method Used:** | ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 24 |
| **Relative Humidity (%):** | 52 to 61 |

### Note(s):

1. The EUT was connected to an I.T.E. power supply via USB cable. The I.T.E. power supply was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. A pulse limiter was fitted between the LISN and the test receiver.
3. 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 marked on the power supply.
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 (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.402000 | Live | 35.7 | 57.8 | 22.1 | Complied |
| 0.555000 | Live | 25.1 | 56.0 | 30.9 | Complied |
| 0.789000 | Live | 20.9 | 56.0 | 35.1 | Complied |
| 0.910500 | Live | 24.5 | 56.0 | 31.5 | Complied |
| 1.693500 | Live | 24.4 | 56.0 | 31.6 | Complied |
| 2.467500 | Live | 23.9 | 56.0 | 32.1 | Complied |

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

| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.249000 | Live | 19.4 | 51.8 | 32.4 | Complied |
| 0.402000 | Live | 30.4 | 47.8 | 17.4 | Complied |
| 0.541500 | Live | 20.6 | 46.0 | 25.4 | Complied |
| 0.910500 | Live | 19.4 | 46.0 | 26.6 | Complied |
| 1.734000 | Live | 19.3 | 46.0 | 26.7 | Complied |
| 2.485500 | Live | 18.5 | 46.0 | 27.5 | Complied |

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

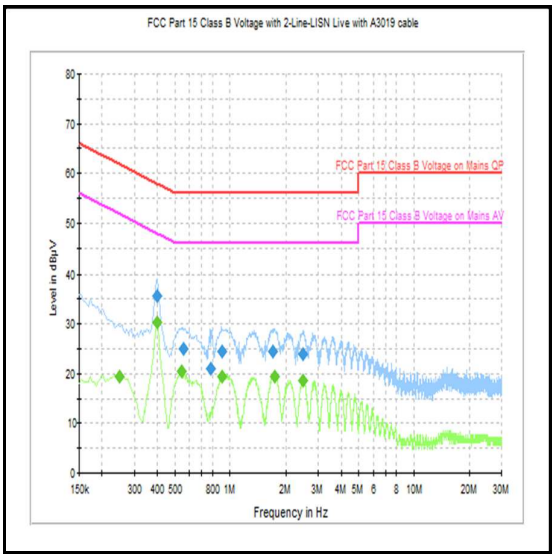
| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.208500 | Neutral | 25.7 | 63.3 | 37.6 | Complied |
| 0.402000 | Neutral | 33.8 | 57.8 | 24.0 | Complied |
| 0.793500 | Neutral | 19.1 | 56.0 | 36.9 | Complied |
| 0.901500 | Neutral | 22.3 | 56.0 | 33.7 | Complied |
| 1.306500 | Neutral | 21.4 | 56.0 | 34.6 | Complied |
| 2.040000 | Neutral | 20.9 | 56.0 | 35.1 | Complied |

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

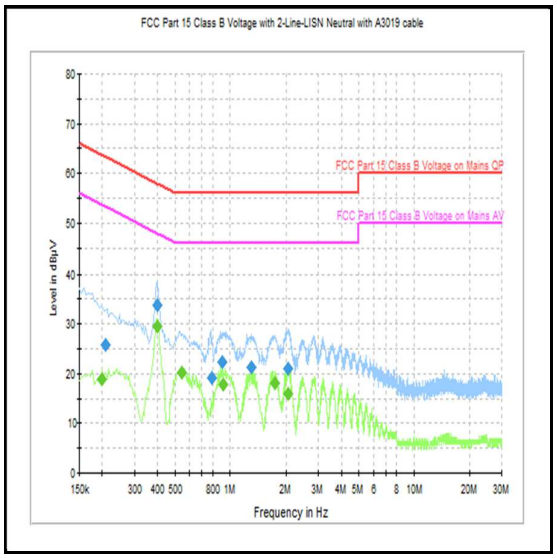
| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.199500 | Neutral | 18.9 | 53.6 | 34.7 | Complied |
| 0.402000 | Neutral | 29.6 | 47.8 | 18.2 | Complied |
| 0.541500 | Neutral | 20.2 | 46.0 | 25.8 | Complied |
| 0.919500 | Neutral | 17.9 | 46.0 | 28.1 | Complied |
| 1.729500 | Neutral | 18.0 | 46.0 | 28.0 | Complied |
| 2.035500 | Neutral | 15.9 | 46.0 | 30.1 | 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 (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.397500 | Live | 37.9 | 57.9 | 20.0 | Complied |
| 0.487500 | Live | 29.3 | 56.2 | 26.9 | Complied |
| 1.135500 | Live | 28.5 | 56.0 | 27.5 | Complied |
| 1.855500 | Live | 27.9 | 56.0 | 28.1 | Complied |
| 2.571000 | Live | 26.1 | 56.0 | 29.9 | Complied |
| 3.381000 | Live | 23.5 | 56.0 | 32.5 | Complied |

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

| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.402000 | Live | 31.8 | 47.8 | 16.0 | Complied |
| 0.478500 | Live | 22.9 | 46.4 | 23.5 | Complied |
| 1.117500 | Live | 22.5 | 46.0 | 23.5 | Complied |
| 1.792500 | Live | 21.6 | 46.0 | 24.4 | Complied |
| 2.602500 | Live | 19.8 | 46.0 | 26.2 | Complied |
| 3.331500 | Live | 17.5 | 46.0 | 28.5 | Complied |

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

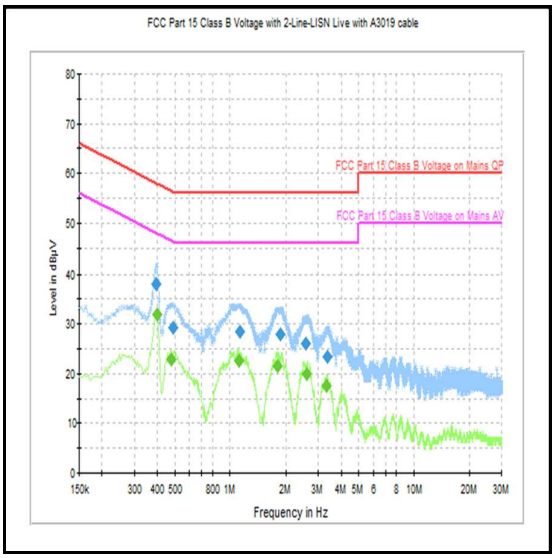
| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.397500 | Neutral | 35.3 | 57.9 | 22.6 | Complied |
| 0.487500 | Neutral | 26.3 | 56.2 | 29.9 | Complied |
| 0.766500 | Neutral | 18.9 | 56.0 | 37.1 | Complied |
| 1.153500 | Neutral | 40.2 | 56.0 | 15.8 | Complied |
| 1.855500 | Neutral | 41.7 | 56.0 | 14.3 | Complied |
| 2.580000 | Neutral | 23.4 | 56.0 | 32.6 | Complied |

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

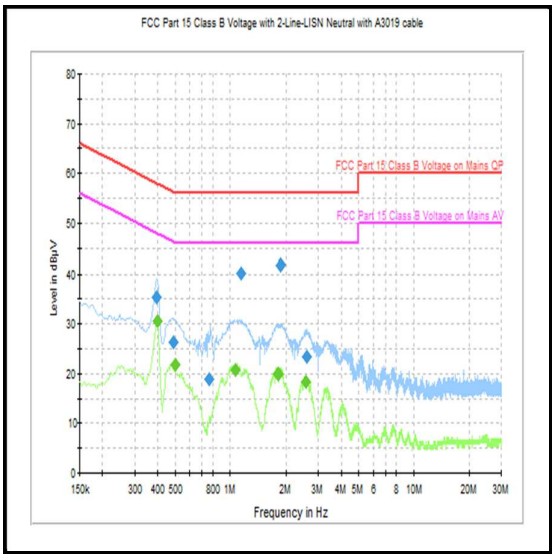
| Frequency (MHz) | Line | Level (dBµV) | Limit (dBµV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.402000 | Neutral | 30.6 | 47.8 | 17.2 | Complied |
| 0.501000 | Neutral | 21.8 | 46.0 | 24.2 | Complied |
| 1.068000 | Neutral | 20.7 | 46.0 | 25.3 | Complied |
| 1.797000 | Neutral | 19.9 | 46.0 | 26.1 | Complied |
| 1.828500 | Neutral | 19.9 | 46.0 | 26.1 | Complied |
| 2.553000 | Neutral | 18.4 | 46.0 | 27.6 | 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 ---**