# TEST REPORT

## Test Report No. : UL-RPT-RP14614879JD06A

| | | |
|---|---|---|
| **Customer** | : | Apple Inc. |
| **Model No. / HVIN** | : | A2992 |
| **PMN** | : | MacBook Pro |
| **FCC ID** | : | BCGA2992 |
| **ISED Certification No.** | : | IC: 579C-A2992 |
| **Technology** | : | *Bluetooth, Bluetooth* Low Energy, *Bluetooth* HDR, *Thread*, NB-FHSS |
| **Test Standard(s)** | : | FCC Part 15.207<br>Innovation, Science and Economic Development Canada<br>RSS-Gen Issue 5 February 2021 |
| **Test Laboratory** | : | UL International (UK) 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:** 29 September 2023

**Checked by:**

Ben Mercer
Lead Project Engineer, Radio Laboratory

Ben Mercer
Digitally signed by Ben Mercer
Date: 2023.09.29 15:01:39 +01'00'

**Company Signatory:**

Sarah Williams
RF Operations Leader, Radio Laboratory

Sarah Williams
Digitally signed by Sarah Williams
Date: 2023.09.29 15:02:00 +01'00'

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## Customer Information

| | |
|---|---|
| **Company Name:** | Apple Inc. |
| **Address:** | One Apple Park Way<br>Cupertino, California 95014<br>U.S.A. |
| **Contact Name:** | Stuart Thomas |

## Report Revision History

| Version Number | Issue Date | Revision Details | Revised By |
|---|---|---|---|
| 1.0 | 29/09/2023 | Initial Version | Ben Mercer |

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# 1 Attestation of Test Results

## 1.1 Description of EUT

The equipment under test (EUT) was a portable laptop computer.

## 1.2 General Information

| | |
|---|---|
| **Specification Reference:** | 47CFR15.207 |
| **Specification Title:** | Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.207 |
| **Specification Reference:** | RSS-Gen Issue 5 February 2021 |
| **Specification Title:** | General Requirements for Compliance of Radio Apparatus |
| **Site Registration:** | FCC: 685609, ISEDC: 20903 |
| **FCC Lab. Designation No.:** | UK2011 |
| **ISEDC CABID:** | UK0001 |
| **Location of Testing:** | Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom |
| **Test Dates:** | 06 September 2023 to 07 September 2023 |

## 1.3 Summary of Test Results

| FCC Reference (47CFR) | ISED Canada Reference | Measurement | Result |
|---|---|---|---|
| Part 15.207 | RSS-Gen 8.8 | Transmitter AC Conducted Emissions | Complied |

## 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.

UL International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. 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 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 & Decision Rule

#### Overview

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.

#### Decision Rule

Measurement system instrumentation shall be used with an accuracy specification meeting the accuracy specification limits according to IEC/IECEE OD-5014.

As applicable, unless specified otherwise in this report, the compliance “Decision Rule” is based on Simple Acceptance. If the measured value is on the limit, the result is defined as a pass. In this case the risk of a false positive is 50%. For further information regarding risk assessment refer to ILAC G8:09/2019.

#### Measurement Uncertainty

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 |
|---|---|---|---|
| AC Conducted Spurious Emissions | 0.15 MHz to 30 MHz | 95% | ±2.42 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

| Asset No. | Instrument | Manufacturer | Type No. | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| M2037 | Thermohygrometer | Testo | 608-H1 | 45124925 | 08 Dec 2023 | 12 |
| A649 | LISN | Rohde & Schwarz | ESH3-Z5 | 825562/008 | 23 Aug 2024 | 12 |
| A1830 | Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 100668 | 01 Jun 2024 | 12 |
| M1124 | Test Receiver | Rohde & Schwarz | ESIB 26 | 100046 | 06 Oct 2023 | 12 |

### Test Measurement Software/Firmware Used:

| Name | Version | Release Date |
|---|---|---|
| Rohde & Schwarz EMC32 | 6.30.0 | 2018 |

# 3 Equipment Under Test (EUT)

## 3.1 Identification of Equipment Under Test (EUT)

| | |
|---|---|
| **Brand Name:** | Apple |
| **Model Name or Number / HVIN:** | A2992 |
| **PMN:** | MacBook Pro |
| **Test Sample Serial Number:** | DCXLFPVWQL |
| **Hardware Version:** | REV 1.0 |
| **Software Version:** | 23A32391n |
| **FCC ID:** | BCGA2992 |
| **ISED Canada Certification Number:** | IC: 579C-A2992 |
| **Date of Receipt:** | 10 August 2023 |

## 3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

## 3.3 Additional Information Related to Testing

| | | | |
|---|---|---|---|
| **Category of Equipment:** | *Bluetooth* | | |
| **Power Supply Requirement(s):** | Nominal | 12 VDC via 120 VAC 60 Hz adaptor | |
| **Channel Spacing:** | 1 MHz | | |
| **Mode:** | Basic Rate | | |
| **Modulation:** | GFSK | | |
| **Packet Type (Maximum Payload):** | DH5 | | |
| **Data Rate (Mbps):** | 1 | | |
| **Transmit Frequency Range:** | 2402 MHz to 2480 MHz | | |
| **Transmit Channels Tested:** | **Mode** | **Hopping Frequency Range (MHz)** | |
| | Hopping | 2402 to 2480 | |

| | | | |
|---|---|---|---|
| **Technology Tested:** | *Bluetooth* Low Energy (Digital Transmission System) | | |
| **Type of Unit:** | Transceiver | | |
| **Channel Spacing:** | 2 MHz | | |
| **Modulation:** | GFSK | | |
| **Data Rate: LE1M** | 1 Mbps | | |
| **Power Supply Requirement(s):** | Nominal | 12 VDC via 120 VAC 60 Hz adaptor | |
| **Transmit Frequency Range:** | 2402 MHz to 2480 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Middle | 17 | 2440 |

| | | | |
|---|---|---|---|
| **Technology Tested:** | *Bluetooth* (Digital Transmission System) | | |
| **Type of Unit:** | Transceiver | | |
| **Channel Spacing:** | 1 MHz | | |
| **Mode** | High Data Rate | | |
| **Modulation:** | π/4-DQPSK | | |
| **Packet Type (Maximum Payload):** | 4DH5 | | |
| **Data Rate (Mbps):** | 4 | | |
| **Power Supply Requirement(s):** | Nominal | 12 VDC via 120 VAC 60 Hz adaptor | |
| **Transmit Frequency Range:** | 2404 MHz to 2476 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Middle | 39 | 2441 |

## Additional Information Related to Testing (continued)

| | | | |
|---|---|---|---|
| **Technology Tested:** | *Thread* (Digital Transmission System) | | |
| **Type of Unit:** | Transceiver | | |
| **Channel Spacing:** | 5 MHz | | |
| **Modulation:** | OQPSK | | |
| **Data Rate (kbps):** | 250 | | |
| **Power Supply Requirement(s):** | Nominal | 12 VDC via 120 VAC 60 Hz adaptor | |
| **Transmit Frequency Range:** | 2404 MHz to 2478 MHz | | |
| **Transmit Channels Tested:** | **Channel ID** | **Channel Number** | **Channel Frequency (MHz)** |
| | Middle | 18 | 2440 |

| | | |
|---|---|---|
| **Technology Tested:** | NarrowBand FHSS | |
| **Type of Unit:** | Transceiver | |
| **Mode:** | Basic Rate | |
| **Modulation:** | GFSK | |
| **Packet Type (Maximum Payload):** | DH5 | |
| **Data Rate (Mbps):** | 1 | |
| **Power Supply Requirement:** | Nominal | 12 VDC via 120 VAC 60 Hz adaptor |
| **Channel Bandwidth(s):** | 1 MHz | |
| **Transmit Frequency Range:** | 5150 MHz to 5250 MHz | |
| **Transmit Channels Tested:** | **Mode** | **Hopping Frequency Range (MHz)** |
| | Hopping | 5152 to 5230 |
| **Transmit Frequency Range:** | 5725 MHz to 5850 MHz | |
| **Transmit Channels Tested:** | **Mode** | **Hopping Frequency Range (MHz)** |
| | Hopping | 5727 to 5805 |
| **Transmit Frequency Range:** | 5925 MHz to 6015 MHz | |
| **Transmit Channels Tested:** | **Mode** | **Hopping Frequency Range (MHz)** |
| | Hopping | 5927 to 6005 |
| **Transmit Frequency Range:** | 6300 MHz to 6385 MHz | |
| **Transmit Channels Tested:** | **Mode** | **Hopping Frequency Range (MHz)** |
| | Hopping | 6301 to 6379 |

## 3.4 Description of Available Antennas

The radio utilises three integrated antennas, with the following maximum gain:

| Antenna Port | Frequency Range (MHz) | Antenna Gain (dBi) |
|---|---|---|
| Core 0 | 2400 to 2483.5 | 5.4 |
| | 5150 to 5250 | 8.4 |
| | 5725 to 5850 | 4.5 |
| | 5925 to 6015 | 5.6 |
| | 6300 to 6385 | 5.2 |
| Core 1 | 2400 to 2483.5 | 5.4 |
| | 5150 to 5250 | 5.5 |
| | 5725 to 5850 | 4.1 |
| | 5925 to 6015 | 4.5 |
| | 6300 to 6385 | 2.4 |
| Dedicated Core | 2400 to 2480 | 6.1 |

## 3.5 Description of Test Setup

### Support Equipment

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

| | |
|---|---|
| **Description:** | Test Laptop |
| **Brand Name:** | Apple |
| **Model Name or Number:** | MacBook Pro |
| **Serial Number:** | C02CF02XP3XY |

| | |
|---|---|
| **Description:** | USB Diagnostic Cable |
| **Brand Name:** | Apple |
| **Model Name or Number:** | Chimp |
| **Serial Number:** | 427A65 |

| | |
|---|---|
| **Description:** | USB Flash Drive. Quantity 2 |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Numbers:** | Not marked or stated |

| | |
|---|---|
| **Description:** | USB-A to USB-C Adapter. Quantity 2. |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | HDMI Cable. Length 2 m. |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | USB/HDMI Termination Hub |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | Personal Hands Free (PHF) |
| **Brand Name:** | Not marked or stated |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

## Support Equipment (continued)

| | |
|---|---|
| **Description:** | Micro SD Card |
| **Brand Name:** | SanDisk edge |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | Micro SD Card Adaptor |
| **Brand Name:** | SanDisk edge |
| **Model Name or Number:** | Not marked or stated |
| **Serial Number:** | Not marked or stated |

| | |
|---|---|
| **Description:** | AC to DC Power Adaptor |
| **Brand Name:** | Apple |
| **Model Name or Number:** | A2166 |
| **Serial Number:** | Not marked or stated |

## Operating Modes

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

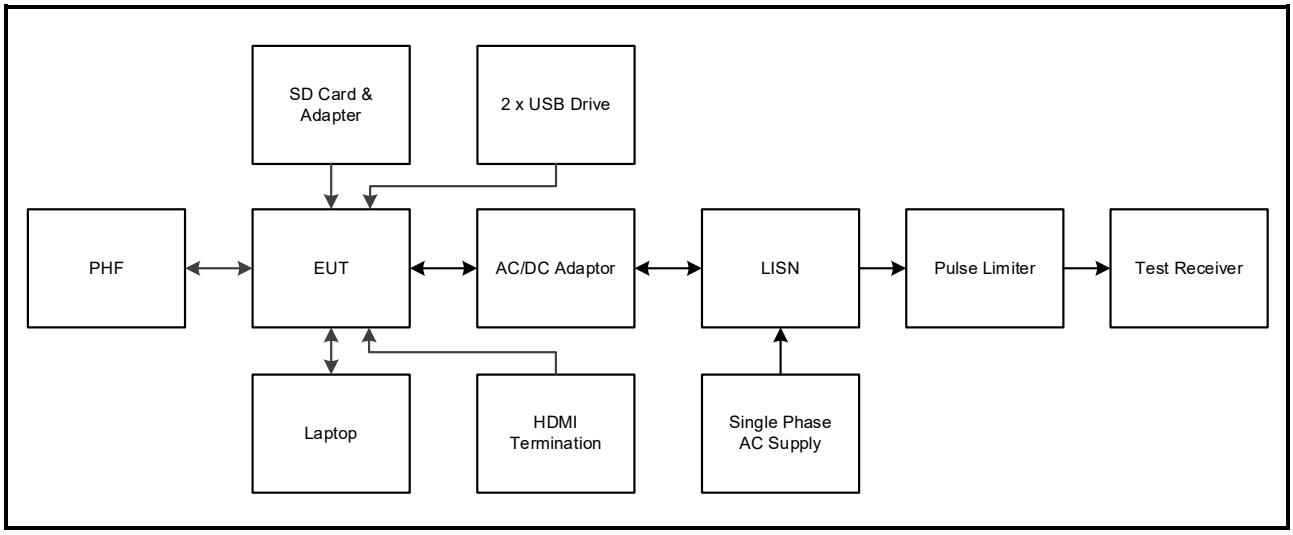
- Continuously transmitting at maximum power on the middle channels / in hopping mode as required.
- The EUT was tested in the following operating mode(s): Pre-scans were performed with the EUT transmitting in *Bluetooth* BDR, *Bluetooth* LE, *Thread* and NB-FHSS UNII-1, UNII-3 & UNII-5 modes individually. The worst-case mode was found to be *Bluetooth* BDR using DH5 packets. Final measurements were performed in this configuration.

## Configuration and Peripherals

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

- Controlled in test mode using a desktop application on the test laptop supplied by the customer. The commands were used to enable a continuous transmission and to select the test channels as required on the EUT.
- Pre-scan plots for all configurations are archived on the UL IT server and available for inspection if required.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply unless otherwise stated.
- All ports were populated with suitable terminations.

## Test Setup Diagrams



# 4 AC Power Line Conducted Emissions Test Results

## 4.1 Transmitter AC Conducted Spurious Emissions

### Test Summary:

| | | | |
|---|---|---|---|
| **Test Engineer:** | Alison Johnston | **Test Dates:** | 06 September 2023 & 07 September 2023 |
| **Test Sample Serial Number:** | DCXLFPVWQL | | |

| | |
|---|---|
| **FCC Reference:** | Part 15.207 |
| **ISED Canada Reference:** | RSS-Gen 8.8 |
| **Test Method Used:** | ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below |

### Environmental Conditions:

| | |
|---|---|
| **Temperature (°C):** | 23 |
| **Relative Humidity (%):** | 65 |

### Note(s):

1. The EUT was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the USB-C Power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.

## Transmitter AC Conducted Spurious Emissions (continued)

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

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.177000 | Live | 48.4 | 64.6 | 16.2 | Complied |
| 0.294000 | Live | 37.1 | 60.4 | 23.3 | Complied |
| 0.447000 | Live | 34.8 | 56.9 | 22.1 | Complied |
| 2.080500 | Live | 31.5 | 56.0 | 24.5 | Complied |
| 4.123500 | Live | 35.9 | 56.0 | 20.1 | Complied |
| 18.019500 | Live | 26.1 | 60.0 | 33.9 | Complied |

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

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.465000 | Live | 22.4 | 46.6 | 24.2 | Complied |
| 0.784500 | Live | 20.5 | 46.0 | 25.5 | Complied |
| 1.099500 | Live | 15.8 | 46.0 | 30.2 | Complied |
| 4.123500 | Live | 22.4 | 46.0 | 23.6 | Complied |
| 8.088000 | Live | 22.5 | 50.0 | 27.5 | Complied |
| 17.605500 | Live | 23.3 | 50.0 | 26.7 | Complied |

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

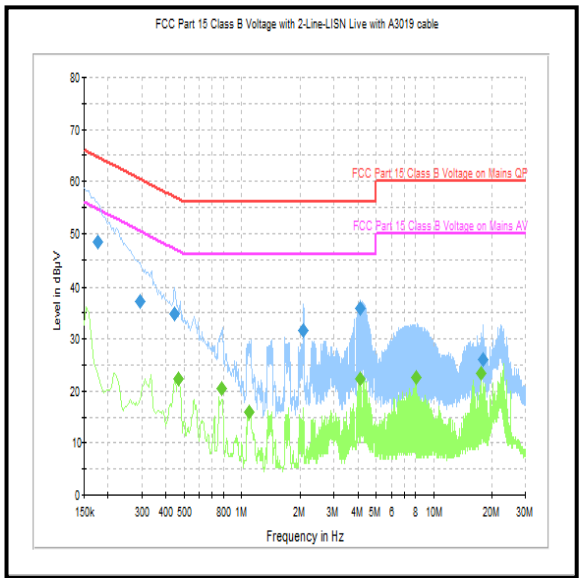
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.177000 | Neutral | 48.4 | 64.6 | 16.2 | Complied |
| 0.289500 | Neutral | 37.5 | 60.5 | 23.0 | Complied |
| 0.447000 | Neutral | 34.9 | 56.9 | 22.0 | Complied |
| 2.080500 | Neutral | 31.1 | 56.0 | 24.9 | Complied |
| 4.164000 | Neutral | 35.5 | 56.0 | 20.5 | Complied |
| 17.605500 | Neutral | 30.6 | 60.0 | 29.4 | Complied |

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

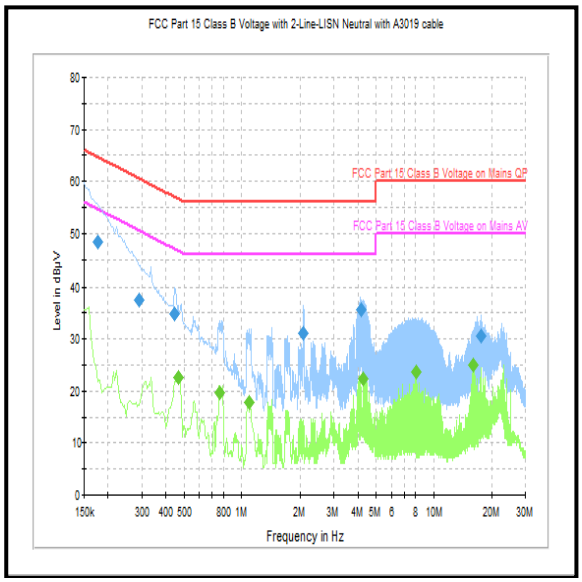
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.469500 | Neutral | 22.6 | 46.5 | 23.9 | Complied |
| 0.771000 | Neutral | 19.6 | 46.0 | 26.4 | Complied |
| 1.099500 | Neutral | 17.7 | 46.0 | 28.3 | Complied |
| 4.272000 | Neutral | 22.2 | 46.0 | 23.8 | Complied |
| 8.088000 | Neutral | 23.8 | 50.0 | 26.2 | Complied |
| 16.021500 | Neutral | 25.1 | 50.0 | 24.9 | 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 |
|---|---|---|---|---|---|
| 0.199500 | Live | 43.9 | 63.6 | 19.7 | Complied |
| 0.312000 | Live | 33.7 | 59.9 | 26.2 | Complied |
| 0.406500 | Live | 28.2 | 57.7 | 29.5 | Complied |
| 2.080500 | Live | 31.5 | 56.0 | 24.5 | Complied |
| 4.164000 | Live | 35.3 | 56.0 | 20.7 | Complied |
| 22.209000 | Live | 26.5 | 60.0 | 33.5 | Complied |

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

| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.465000 | Live | 20.9 | 46.6 | 25.7 | Complied |
| 0.555000 | Live | 22.0 | 46.0 | 24.0 | Complied |
| 0.780000 | Live | 16.5 | 46.0 | 29.5 | Complied |
| 4.272000 | Live | 22.1 | 46.0 | 23.9 | Complied |
| 8.088000 | Live | 22.2 | 50.0 | 27.8 | Complied |
| 17.605500 | Live | 22.8 | 50.0 | 27.2 | Complied |

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

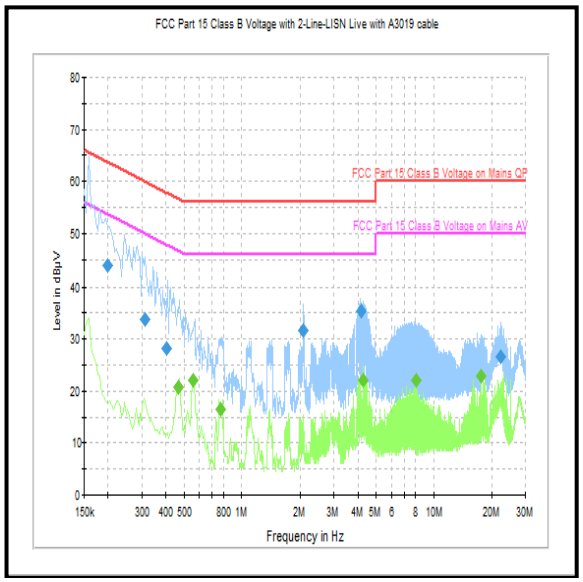
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.190500 | Neutral | 44.9 | 64.0 | 19.1 | Complied |
| 0.280500 | Neutral | 36.1 | 60.8 | 24.7 | Complied |
| 0.442500 | Neutral | 26.9 | 57.0 | 30.1 | Complied |
| 2.080500 | Neutral | 31.8 | 56.0 | 24.2 | Complied |
| 4.272000 | Neutral | 36.3 | 56.0 | 19.7 | Complied |
| 16.800000 | Neutral | 30.8 | 60.0 | 29.2 | Complied |

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

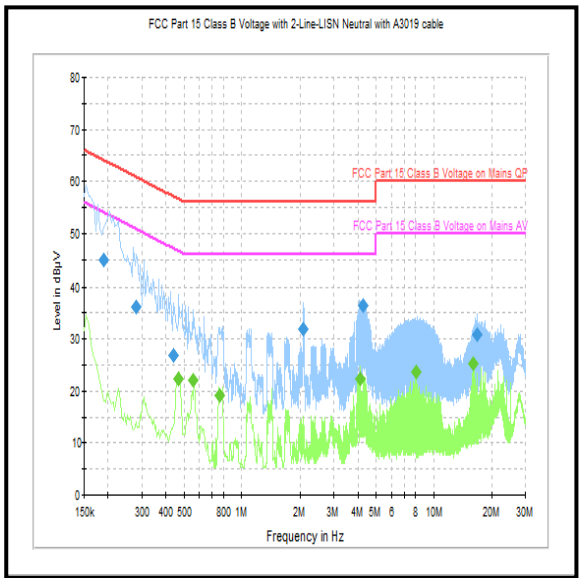
| Frequency (MHz) | Line | Level (dBμV) | Limit (dBμV) | Margin (dB) | Result |
|---|---|---|---|---|---|
| 0.469500 | Neutral | 22.4 | 46.5 | 24.1 | Complied |
| 0.555000 | Neutral | 22.2 | 46.0 | 23.8 | Complied |
| 0.771000 | Neutral | 19.1 | 46.0 | 26.9 | Complied |
| 4.123500 | Neutral | 22.4 | 46.0 | 23.6 | Complied |
| 8.088000 | Neutral | 23.8 | 50.0 | 26.2 | Complied |
| 16.021500 | Neutral | 25.4 | 50.0 | 24.6 | 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 ---**