



# TEST REPORT

**Test Report No. : UL-RPT-RP13678390-116A V2.0**

**Manufacturer** : Cambium Networks Ltd  
**Model No.** : 60 GHz cnWave V3000  
**FCC ID** : QWP-60V3000  
**Test Standard(s)** : FCC Parts 15.209, 15.215 & 15.255(c), (d) & (e)

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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 2.0 supersedes all previous versions.

**Date of Issue:** 12 April 2021

**Checked by:**

Sarah Williams  
RF Operations Leader, Radio Laboratory

**Company Signatory:**

Ben Mercer  
Lead Project Engineer, Radio Laboratory



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**UL International (UK) Ltd**

Unit 1-3 Horizon, Kingsland Business Park, Wade Road, Basingstoke, Hampshire, RG24 8AH, UK  
Telephone: +44 (0)1256 312000  
Facsimile: +44 (0)1256 312001

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**1. Customer Information**

|                      |                                                                                                     |
|----------------------|-----------------------------------------------------------------------------------------------------|
| <b>Company Name:</b> | Cambium Networks Ltd                                                                                |
| <b>Address:</b>      | Unit B2<br>Linhay Business Park<br>Eastern Road<br>Ashburton<br>Devon<br>TQ13 7UP<br>United Kingdom |

## **2. Summary of Testing**

### **2.1. General Information**

|                                  |                                                                                                                                     |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>Specification Reference:</b>  | 47CFR15.255                                                                                                                         |
| <b>Specification Title:</b>      | Code of Federal Regulations Volume 47 (Telecommunications):<br>Part 15 Subpart C (Radio Frequency Devices) – Section 15.255         |
| <b>Specification Reference:</b>  | 47CFR15.209 and 47CFR15.215                                                                                                         |
| <b>Specification Title:</b>      | Code of Federal Regulations Volume 47 (Telecommunications):<br>Part 15 Subpart C (Intentional Radiators) – Sections 15.209 & 15.215 |
| <b>Site Registration:</b>        | 621311                                                                                                                              |
| <b>FCC Lab. Designation No.:</b> | UK2011                                                                                                                              |
| <b>Location of Testing:</b>      | Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke,<br>Hampshire, RG24 8AH, United Kingdom                             |
| <b>Test Dates:</b>               | 07 February 2021 to 22 March 2021                                                                                                   |

### **2.2. Summary of Test Results**

| <b>FCC Reference (47CFR)</b>                                                                                                                                                                                                 | <b>Measurement</b>             | <b>Result</b>                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------|
| Part 15.255(c)(1)(ii)                                                                                                                                                                                                        | Transmitter EIRP               |   |
| Part 15.255(e)                                                                                                                                                                                                               | Transmitter Peak Output Power  |  |
| Part 15.255(d) / 15.209                                                                                                                                                                                                      | Transmitter Spurious Emissions |  |
| <b>Key to Results</b><br> = Complied  = Did not comply |                                |                                                                                       |

### **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 |

### **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>                | Cambium Networks                           |
| <b>Model Name or Number:</b>      | 60 GHz cnWave V3000                        |
| <b>Test Sample Serial Number:</b> | V5WM01QL295N ( <i>Radiated sample #1</i> ) |
| <b>Hardware Version:</b>          | P7.0                                       |
| <b>Software Version:</b>          | DM Tools 3.9.0.3                           |
| <b>Firmware Version:</b>          | 10.11.1.83                                 |
| <b>FCC ID:</b>                    | QWP-60V3000                                |

|                                   |                                            |
|-----------------------------------|--------------------------------------------|
| <b>Brand Name:</b>                | Cambium Networks                           |
| <b>Model Name or Number:</b>      | 60 GHz cnWave V3000                        |
| <b>Test Sample Serial Number:</b> | V5WM01QFN8PR ( <i>Radiated sample #2</i> ) |
| <b>Hardware Version:</b>          | P7.0                                       |
| <b>Software Version:</b>          | DM Tools 3.9.0.3                           |
| <b>Firmware Version:</b>          | 10.11.1.83                                 |
| <b>FCC ID:</b>                    | QWP-60V3000                                |

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

The equipment under test was a point-to-point / point-to-multipoint high gain client node operating in the 57-71 GHz band.

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

No modifications were applied to the EUT during testing.

### 3.4. Additional Information Related to Testing

|                           |                                                               |                         |
|---------------------------|---------------------------------------------------------------|-------------------------|
| Category of Equipment:    | Transceiver                                                   |                         |
| Power Supply Requirement: | Nominal                                                       | 56 VDC via 120 VAC PoE  |
| Channel Spacing:          | 2.16 GHz                                                      |                         |
| Modulation Type:          | BPSK, QPSK & 16QAM                                            |                         |
| Antenna Type:             | Integrated Patch & Parabolic Reflector                        |                         |
| Antenna Gain:             | 20.1 dBi (patch)<br>20.4 dB (reflector)<br>Combined: 40.5 dBi |                         |
| Transmit Frequency Range: | 57 GHz to 66 GHz                                              |                         |
| Transmit Channels Tested: | Channel ID                                                    | Channel Frequency (GHz) |
|                           | Bottom                                                        | 58.320                  |
|                           | Middle                                                        | 62.640                  |
|                           | Top                                                           | 64.800                  |

### 3.5. EUT Settings

| Channel | Sector | Tx Lineup | RF Lineup | DAC     | LO GC | E-Base | Notch |
|---------|--------|-----------|-----------|---------|-------|--------|-------|
| 1       | 32     | N/A       | N/A       | 110/110 | 1     | N/A    | N/A   |
| 3       | 32     | N/A       | N/A       | 119/119 | 1     | N/A    | N/A   |
| 4       | 32     | N/A       | N/A       | 192/192 | 1     | N/A    | N/A   |

### **3.6. Support Equipment**

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

|                              |                  |
|------------------------------|------------------|
| <b>Description:</b>          | PoE              |
| <b>Brand Name:</b>           | Cambium Networks |
| <b>Model Name or Number:</b> | N000000L142A     |
| <b>Serial Number:</b>        | 2020000773       |

|                              |              |
|------------------------------|--------------|
| <b>Description:</b>          | Test Laptop  |
| <b>Brand Name:</b>           | HP EliteBook |
| <b>Model Name or Number:</b> | NH121UC#ABU  |
| <b>Serial Number:</b>        | 2CE00223BK   |

|                              |                                                      |
|------------------------------|------------------------------------------------------|
| <b>Description:</b>          | Ethernet Cables. Quantity 3. Length 1 m / 3 m / 10 m |
| <b>Brand Name:</b>           | RS Pro                                               |
| <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):

- Transmitting with BPSK MCS5 modulation, which was found to be the worst case mode after preliminary investigation.
- Operating on bottom, middle and top channels with a 2.16 GHz channel bandwidth.
- Transmitting at maximum output power with beamforming locked to sector 27 (straight ahead), which was found to be the direction of highest EIRP during preliminary investigation.

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

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

- A laptop PC with Qualcomm DMTools and QRCT software was used to configure the EUT during the testing. Telnet commands were used to set the channel and modulation. The laptop was connected to the EUT via Ethernet.
- The EUT was powered by a PoE supply connected to 120 VAC mains.
- Due to the large dimensions of the 22 dB reflector, the far field measurement distance is in excess of 100 m. For in-band tests, the reflector was removed to expose the smaller 20.1 dBi patch, allowing measurements to be made in the far field at 3 m. The 20.4 dB reflector gain was added to the measured results. An inquiry was made to the FCC OET and this method was deemed acceptable.
- Transmitter radiated spurious emissions tests were performed with the 20.4 dB reflector fitted. All measurements were performed in the far field of the measurement antenna.

## **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 Uncertainties* 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 EIRP**

#### **Test Summary:**

|                                   |              |                   |                  |
|-----------------------------------|--------------|-------------------|------------------|
| <b>Test Engineer:</b>             | Ben Mercer   | <b>Test Date:</b> | 07 February 2021 |
| <b>Test Sample Serial Number:</b> | V5WM01QL295N |                   |                  |

|                          |                          |
|--------------------------|--------------------------|
| <b>FCC Reference:</b>    | Part 15.255(c)(1)(ii)    |
| <b>Test Method Used:</b> | ANSI C63.10 Section 9.11 |

#### **Environmental Conditions:**

|                               |    |
|-------------------------------|----|
| <b>Temperature (°C):</b>      | 21 |
| <b>Relative Humidity (%):</b> | 33 |

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

1. The measurement antenna was connected to an RF detector via a 4 way waveguide switch. A CW signal generator and wideband thermocouple power sensor were connected to the remaining two ports.
2. The RF detector was connected to the 50  $\Omega$  input of a digital storage oscilloscope via a 10 MHz low pass filter.
3. The EUT peak and average voltages were measured on the oscilloscope. The waveguide switch was then rotated to connect the signal generator to the RF detector, and the signal generator output was adjusted to match the previously measured voltages. The waveguide switch was then rotated to connect the signal generator output to the thermocouple power sensor, and the signal generator output power was measured.
4. The substituted levels recorded below include the calibrated path loss of the waveguide switch.
5. In accordance with Part 15.255(c)(1)(ii), the peak and average EIRP limits shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The combined gain of the patch antenna and reflector is 40.5 dBi. The limit reduction was calculated as follows:

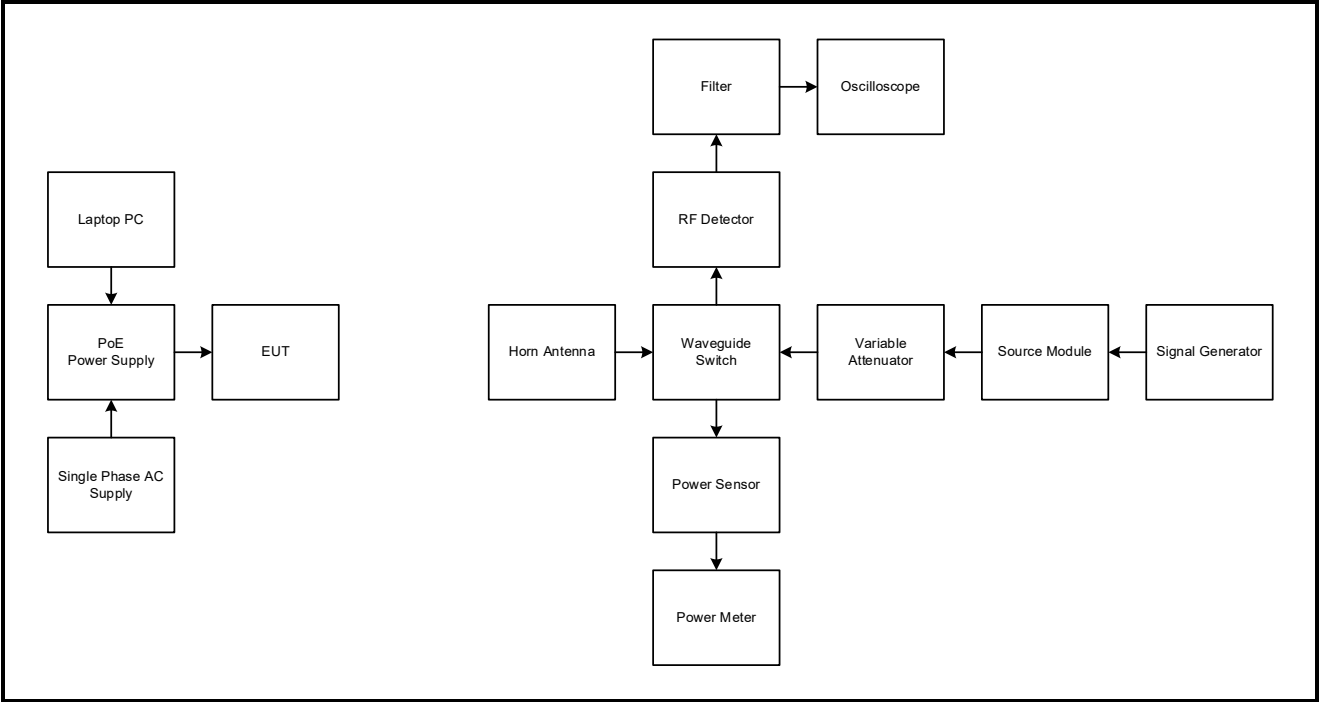
$$2 \times (51 \text{ dBi} - 40.5 \text{ dBi}) = 21.0 \text{ dB}$$

$$\text{Peak EIRP Limit: } 85 \text{ dBm} - 21.0 \text{ dB} = 64.0 \text{ dBm}$$

$$\text{Average EIRP Limit: } 82 \text{ dBm} - 21.0 \text{ dB} = 61.0 \text{ dBm}$$

**Transmitter EIRP (continued)**

**Test setup:**



**Transmitter EIRP (continued)****Results: Bottom Channel / Peak**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 58.320          | 3.3       | 33.6                         | 20.4                | 54.0                       | 64.0        | 10.0        | Complied |

**Results: Bottom Channel / Average**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 58.320          | 2.4       | 32.9                         | 20.4                | 53.3                       | 61.0        | 7.7         | Complied |

**Results: Middle Channel / Peak**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 62.640          | 3.3       | 34.0                         | 20.4                | 54.4                       | 64.0        | 9.6         | Complied |

**Results: Middle Channel / Average**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 62.640          | 2.7       | 33.6                         | 20.4                | 54.0                       | 61.0        | 7.0         | Complied |

**Results: Top Channel / Peak**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 64.800          | 1.9       | 32.3                         | 20.4                | 52.7                       | 64.0        | 11.3        | Complied |

**Results: Top Channel / Average**

| Frequency (GHz) | Level (V) | Substituted EIRP Level (dBm) | Reflector Gain (dB) | Corrected EIRP Level (dBm) | Limit (dBm) | Margin (dB) | Result   |
|-----------------|-----------|------------------------------|---------------------|----------------------------|-------------|-------------|----------|
| 64.800          | 1.5       | 31.9                         | 20.4                | 52.3                       | 61.0        | 8.7         | Complied |

**Transmitter EIRP (continued)****Test Equipment Used:**

| Asset No. | Instrument             | Manufacturer    | Type No.           | Serial No.  | Date Calibration Due  | Cal. Interval (Months) |
|-----------|------------------------|-----------------|--------------------|-------------|-----------------------|------------------------|
| M2016     | Thermohygrometer       | Testo           | 608-H1             | 45046428    | 10 Dec 2021           | 12                     |
| M2070     | Oscilloscope           | Keysight        | DSOX2024A          | MY59125508  | 28 Aug 2021           | 24                     |
| A3233     | Waveguide RF Detector  | Sage Millimeter | SFD-503753-15SF-P1 | 18199-01    | Calibrated before use | -                      |
| A3235     | Waveguide Switch       | Flann           | 25333-2            | 215753      | Calibrated before use | -                      |
| M1145     | Power Meter            | Hewlett Packard | 437B               | 3737U26557  | 18 Nov 2021           | 12                     |
| M291      | Waveguide Power Sensor | Hewlett Packard | V8486A             | US39010039  | 30 Nov 2022           | 24                     |
| M1252     | Signal Generator       | Hewlett Packard | 83640A             | 3119A00489  | 25 Jan 2022           | 24                     |
| G094      | Source Module          | Hewlett Packard | 83557A             | 2948A00475  | Calibrated before use | -                      |
| A3211     | Horn Antenna           | Sage Millimeter | SAZ-2410-15-S1     | 18199-01    | 31 Dec 2021           | 12                     |
| A3251     | Video Amplifier        | Femto           | HVA-200M-40B       | 05-01-354   | Calibrated before use | -                      |
| A3252     | Low Pass Filter        | Mini-Circuits   | BLP-10.7+          | YUU54901833 | Calibrated before use | -                      |

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

|                                   |              |                   |                  |
|-----------------------------------|--------------|-------------------|------------------|
| <b>Test Engineer:</b>             | Ben Mercer   | <b>Test Date:</b> | 07 February 2021 |
| <b>Test Sample Serial Number:</b> | V5WM01QL295N |                   |                  |

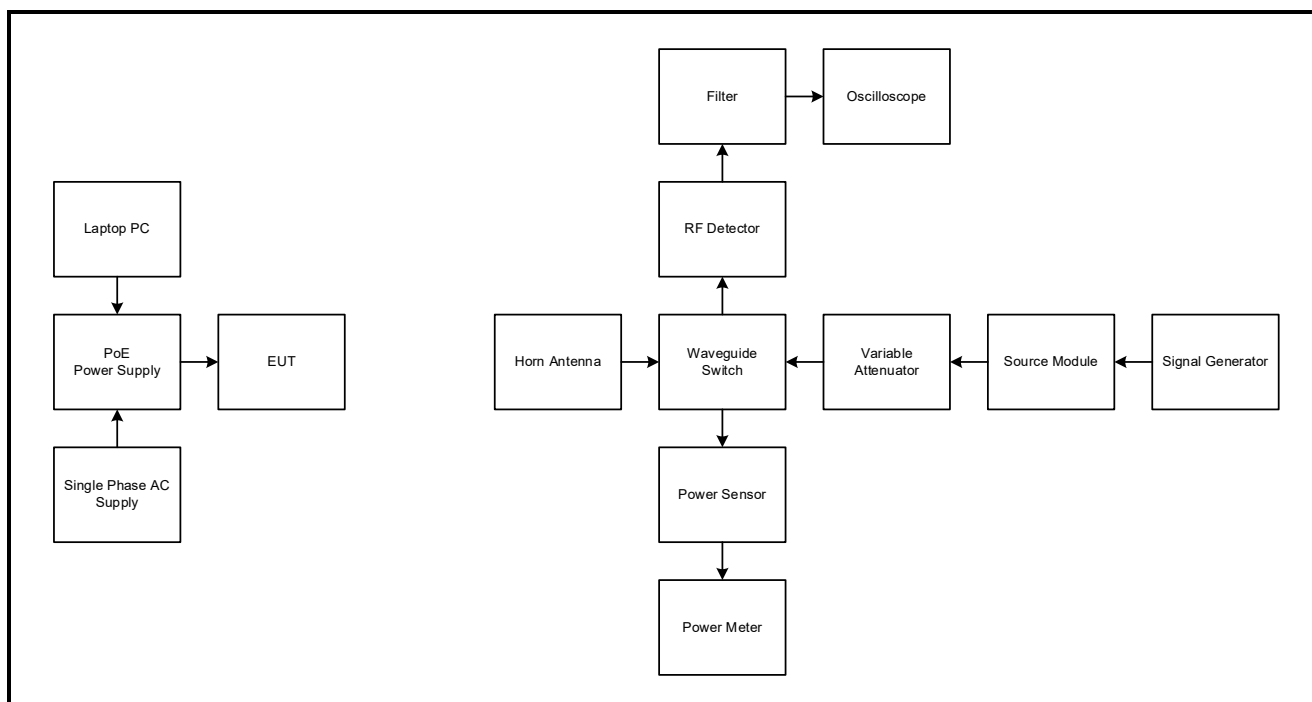
|                          |                          |
|--------------------------|--------------------------|
| <b>FCC Reference:</b>    | Part 15.255(e)           |
| <b>Test Method Used:</b> | ANSI C63.10 Section 9.11 |

**Environmental Conditions:**

|                               |    |
|-------------------------------|----|
| <b>Temperature (°C):</b>      | 21 |
| <b>Relative Humidity (%):</b> | 33 |

**Note(s):**

1. The measurement antenna was connected to an RF detector via a 4 way waveguide switch. A CW signal generator and wideband thermocouple power sensor were connected to the remaining two ports.
2. The RF detector was connected to the 50  $\Omega$  input of a digital storage oscilloscope via a 10 MHz low pass filter.
3. The EUT peak and average voltages were measured on the oscilloscope. The waveguide switch was then rotated to connect the signal generator to the RF detector, and the signal generator output was adjusted to match the previously measured voltages. The waveguide switch was then rotated to connect the signal generator output to the thermocouple power sensor, and the signal generator output power was measured.
4. The stated antenna gain was subtracted from the measured EIRP to obtain the conducted power.
5. The substituted levels recorded below include the calibrated path loss of the waveguide switch.

**Test setup:**

**Transmitter Peak Conducted Output Power (continued)****Results: Bottom Channel**

| EIRP Level (dBm) | Antenna Gain (dBi) | Conducted Level (dBm) | Conducted Level (mW) | Limit (mW) | Margin (mW) | Result   |
|------------------|--------------------|-----------------------|----------------------|------------|-------------|----------|
| 54.0             | 40.5               | 13.5                  | 22.4                 | 500        | 477.6       | Complied |

**Results: Middle Channel**

| EIRP Level (dBm) | Antenna Gain (dBi) | Conducted Level (dBm) | Conducted Level (mW) | Limit (mW) | Margin (mW) | Result   |
|------------------|--------------------|-----------------------|----------------------|------------|-------------|----------|
| 54.4             | 40.5               | 13.9                  | 24.5                 | 500        | 475.5       | Complied |

**Results: Top Channel**

| EIRP Level (dBm) | Antenna Gain (dBi) | Conducted Level (dBm) | Conducted Level (mW) | Limit (mW) | Margin (mW) | Result   |
|------------------|--------------------|-----------------------|----------------------|------------|-------------|----------|
| 52.7             | 40.5               | 12.2                  | 16.6                 | 500        | 483.4       | Complied |

**Test Equipment Used:**

| Asset No. | Instrument             | Manufacturer    | Type No.           | Serial No.  | Date Calibration Due  | Cal. Interval (Months) |
|-----------|------------------------|-----------------|--------------------|-------------|-----------------------|------------------------|
| M2016     | Thermohygrometer       | Testo           | 608-H1             | 45046428    | 10 Dec 2021           | 12                     |
| M2070     | Oscilloscope           | Keysight        | DSOX2024A          | MY59125508  | 28 Aug 2021           | 24                     |
| A3233     | Waveguide RF Detector  | Sage Millimeter | SFD-503753-15SF-P1 | 18199-01    | Calibrated before use | -                      |
| A3235     | Waveguide Switch       | Flann           | 25333-2            | 215753      | Calibrated before use | -                      |
| M1145     | Power Meter            | Hewlett Packard | 437B               | 3737U26557  | 18 Nov 2021           | 12                     |
| M291      | Waveguide Power Sensor | Hewlett Packard | V8486A             | US39010039  | 30 Nov 2022           | 24                     |
| M1252     | Signal Generator       | Hewlett Packard | 83640A             | 3119A00489  | 25 Jan 2022           | 24                     |
| G094      | Source Module          | Hewlett Packard | 83557A             | 2948A00475  | Calibrated before use | -                      |
| A3211     | Horn Antenna           | Sage Millimeter | SAZ-2410-15-S1     | 18199-01    | 31 Dec 2021           | 12                     |
| A3251     | Video Amplifier        | Femto           | HVA-200M-40B       | 05-01-354   | Calibrated before use | -                      |
| A3252     | Low Pass Filter        | Mini-Circuits   | BLP-10.7+          | YUU54901833 | Calibrated before use | -                      |

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

|                                   |                  |                    |                                  |
|-----------------------------------|------------------|--------------------|----------------------------------|
| <b>Test Engineer:</b>             | Mohamed Toubella | <b>Test Dates:</b> | 19 March 2021 &<br>20 March 2021 |
| <b>Test Sample Serial Number:</b> | V5WM01QFN8PR     |                    |                                  |

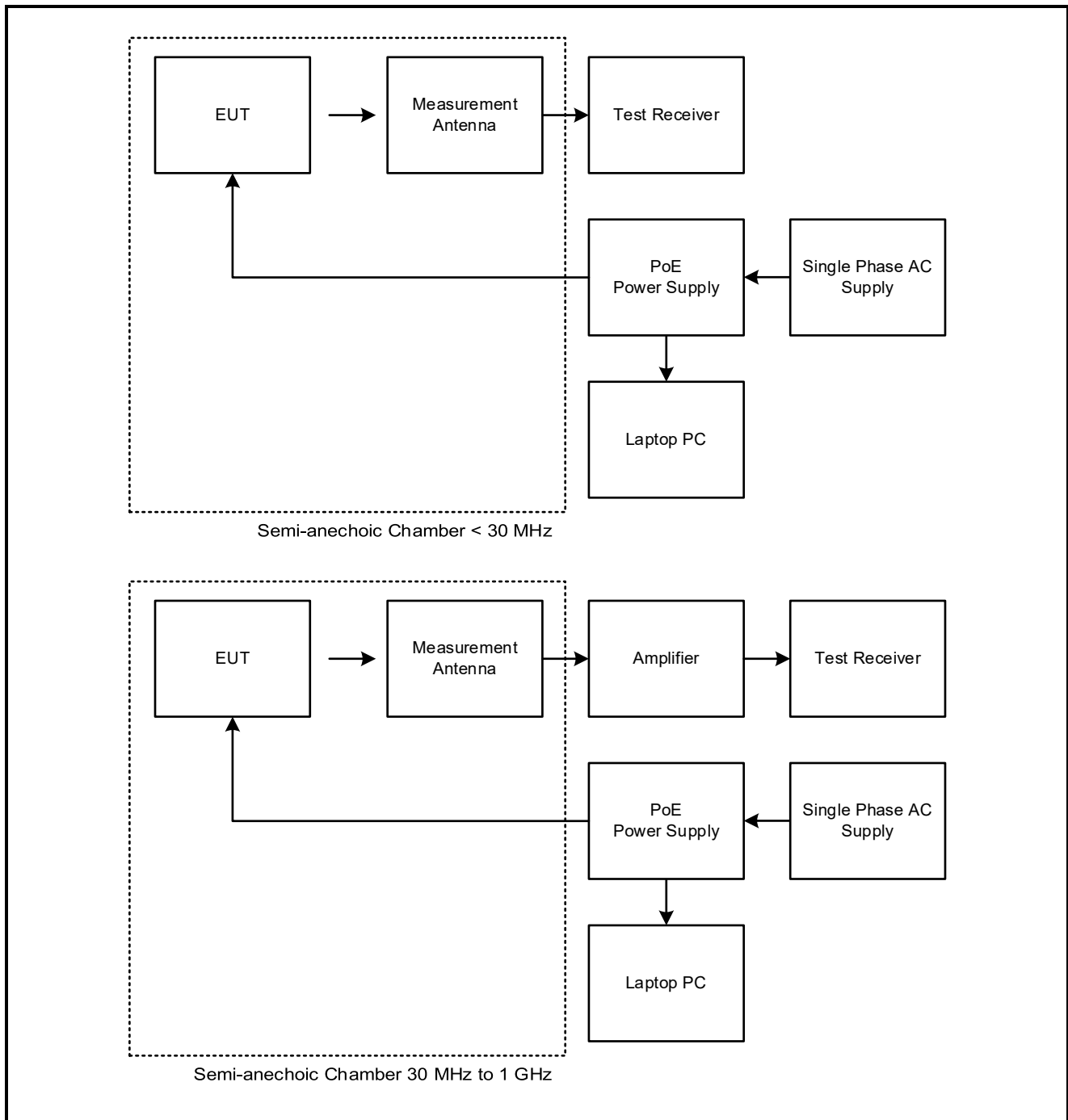
|                          |                                           |
|--------------------------|-------------------------------------------|
| <b>FCC Reference:</b>    | Part 15.255(d) / 15.209                   |
| <b>Test Method Used:</b> | ANSI C63.10 Sections 6.3, 6.4, 6.5 & 9.13 |
| <b>Frequency Range:</b>  | 9 kHz to 1000 MHz                         |

**Environmental Conditions:**

|                               |          |
|-------------------------------|----------|
| <b>Temperature (°C):</b>      | 22 to 23 |
| <b>Relative Humidity (%):</b> | 35       |

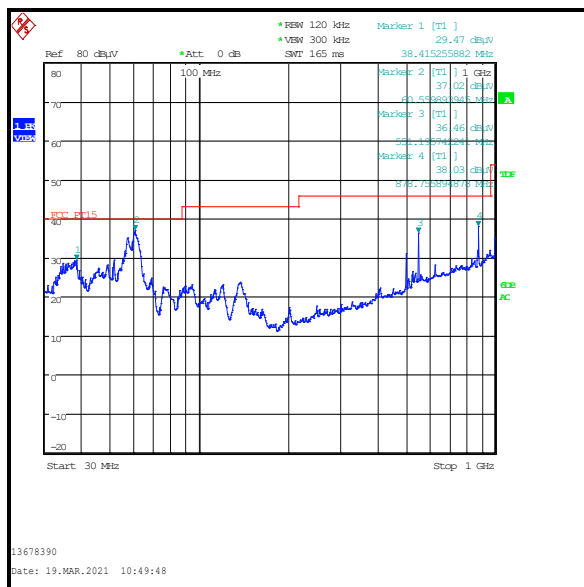
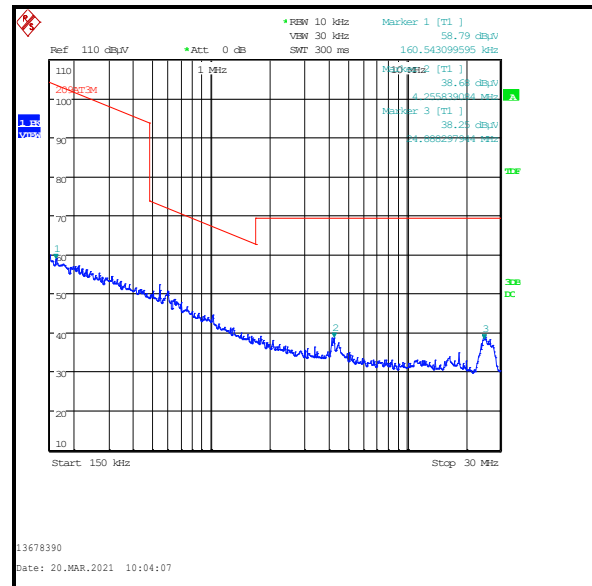
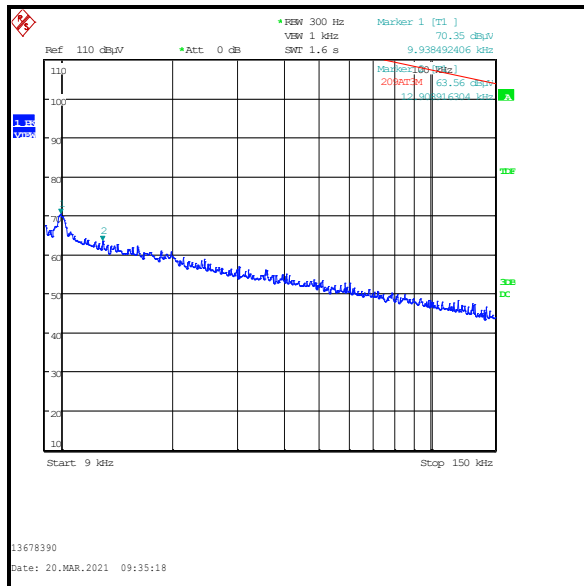
**Note(s):**

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 below 1 GHz were performed with the EUT set to the middle channel only.
3. All other emissions were at least 20 dB below the appropriate limit or below the noise floor of the measurement system.
4. There are ambient emissions seen between 2 to 30 MHz on the pre-scan plot for 150 kHz to 30 MHz. A background scan is stored on the company server and is available for inspection upon request.
5. Measurements below 30 MHz were performed in a semi-anechoic chamber (asset number K0001) as 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. The limit was extrapolated to 3 metres in accordance with ANSI C63.10 Section 6.4.4.2. Correlation data between the semi-anechoic chamber and an open-field test site is available upon request.
6. Measurements between 30 MHz and 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.
7. Final measurements were performed 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 a span wide enough to include the entire emission.

**Transmitter Radiated Spurious Emissions (continued)****Test setup:**

**Transmitter Radiated Spurious Emissions (continued)****Results: Quasi Peak**

| Frequency (MHz) | Antenna Polarity | Level (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|----------------------|----------------------|-------------|----------|
| 57.573          | Horizontal       | 30.3                 | 40.0                 | 9.7         | Complied |
| 60.560          | Horizontal       | 31.7                 | 40.0                 | 8.3         | Complied |



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

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

| Asset No. | Instrument       | Manufacturer    | Type No. | Serial No. | Date Calibration Due | Cal. Interval (Months) |
|-----------|------------------|-----------------|----------|------------|----------------------|------------------------|
| M2041     | Thermohygrometer | Testo           | 608-H1   | 45119912   | 10 Dec 2021          | 12                     |
| K0017     | 3m RSE Chamber   | Rainford EMC    | N/A      | N/A        | 21 Oct 2021          | 12                     |
| M1886     | Test Receiver    | Rohde & Schwarz | ESU26    | 100554     | 15 May 2021          | 12                     |
| A3167     | Amplifier        | Com-Power       | PAM-103  | 18020010   | 21 Oct 2021          | 12                     |
| A259      | Antenna          | Chase           | CBL6111A | 1513       | 13 Jul 2021          | 12                     |
| M2040     | Thermohygrometer | Testo           | 608-H1   | 451224934  | 10 Dec 2021          | 12                     |
| M2044     | Test Receiver    | Rohde & Schwarz | ESU26    | 100122     | 03 Sep 2021          | 12                     |
| A3198     | Loop Antenna     | ETS Lindgren    | 6502     | 00221887   | 01 Apr 2021          | 12                     |
| K0001     | 3m RSE Chamber   | Rainford EMC    | N/A      | N/A        | 14 Oct 2021          | 12                     |

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

|                                    |                               |                    |                                   |
|------------------------------------|-------------------------------|--------------------|-----------------------------------|
| <b>Test Engineers:</b>             | Mohamed Toubella & Ben Mercer | <b>Test Dates:</b> | 24 February 2021 to 22 March 2021 |
| <b>Test Sample Serial Numbers:</b> | V5WM01QL295N & V5WM01QFN8PR   |                    |                                   |

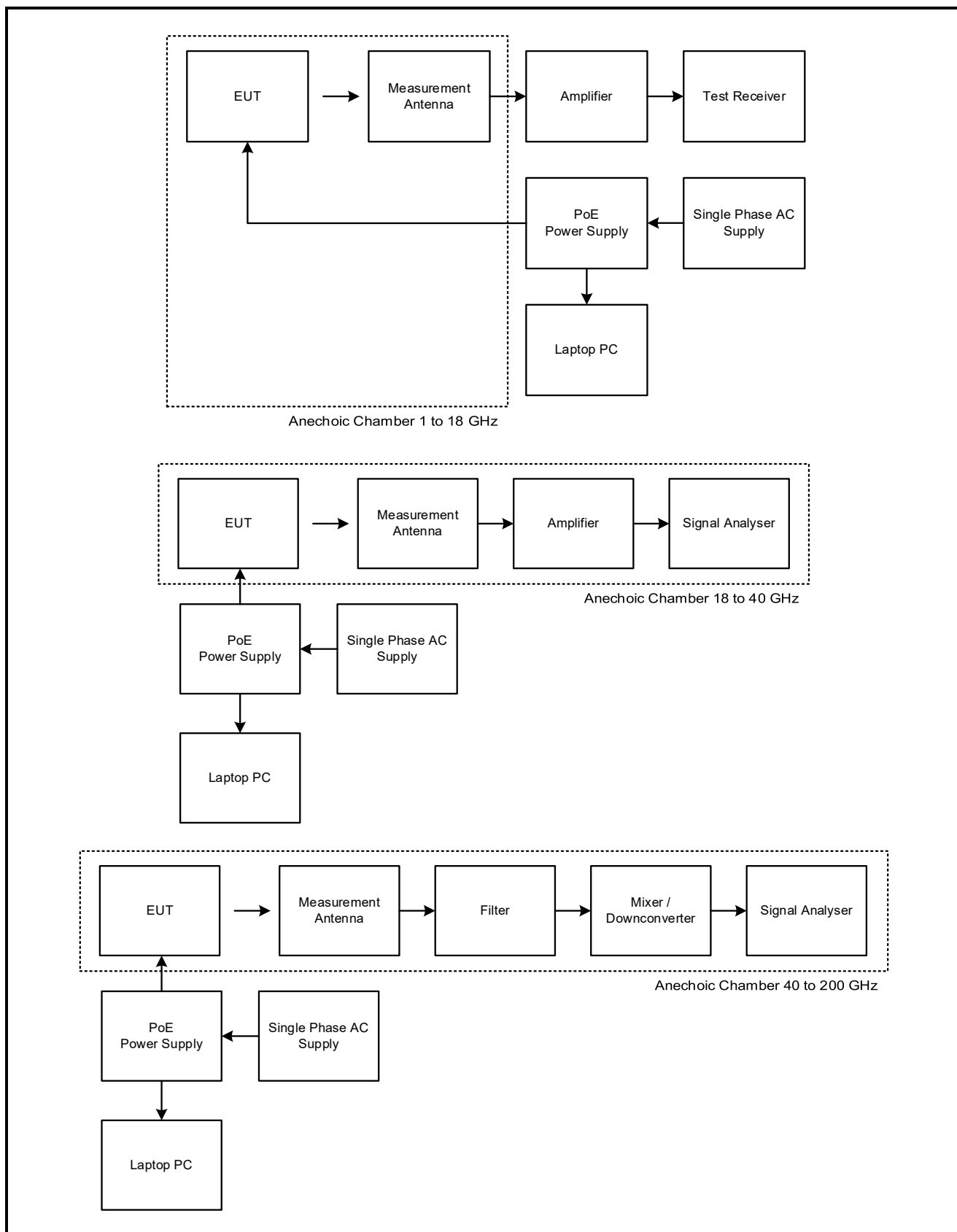
|                          |                                                      |
|--------------------------|------------------------------------------------------|
| <b>FCC Reference:</b>    | Part 15.255(d) / 15.209                              |
| <b>Test Method Used:</b> | ANSI C63.10 Sections 6.3, 6.6, 9.8, 9.9, 9.12 & 9.13 |
| <b>Frequency Range:</b>  | 1 GHz to 200 GHz                                     |

**Environmental Conditions:**

|                               |          |
|-------------------------------|----------|
| <b>Temperature (°C):</b>      | 20 to 23 |
| <b>Relative Humidity (%):</b> | 38 to 42 |

**Note(s):**

- The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
- Final measurements above 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 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.
- The emission identified by a marker on the 57 – 71 GHz plot is the fundamental.
- Part 15.255(d)(3) defines a power density limit of 90 pW/cm<sup>2</sup> at 3 metres for spurious emissions between 40 GHz and 200 GHz. This was converted to a field strength limit of 85.31 dBuV/m using the equations provided in section 9.6 of ANSI C63.10.
- Measurements distances above 40 GHz were determined using the procedure defined in section 9.8 of ANSI C63.10. Measurements were made at the following distances:
  - 40 GHz to 50 GHz – 1 metre
  - 50 GHz to 75 GHz – 3 metres
  - 75 GHz to 110 GHz – 1 metre
  - 110 GHz to 170 GHz – 1 metre
  - 170 GHz to 200 GHz – 1 metre
- Where measurements were performed at a distance other than that specified by the limit, a correction factor was calculated using the equation provided in section 9.4 of ANSI C63.10. This correction factor was included in the transducer factor entered on the signal analyser.
- All other emissions were at least 20 dB below the appropriate limit or below the noise floor of the measurement system.

**Transmitter Radiated Spurious Emissions (continued)****Test setup:**

**Transmitter Radiated Spurious Emissions (continued)****Results: Bottom Channel / Peak**

| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Peak Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|---------------------------|-------------|----------|
| 7290.016        | Horizontal       | 55.0                      | 74.0                      | 19.0        | Complied |

**Results: Bottom Channel / Average**

| Frequency (MHz) | Antenna Polarity | Average Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|------------------------------|------------------------------|-------------|----------|
| 7289.952        | Horizontal       | 50.7                         | 54.0                         | 3.3         | Complied |

**Results: Middle Channel / Peak**

| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Peak Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|---------------------------|-------------|----------|
| 7829.936        | Horizontal       | 56.0                      | 74.0                      | 18.0        | Complied |
| 15536.250       | Horizontal       | 58.3                      | 74.0                      | 15.7        | Complied |

**Results: Middle Channel / Average**

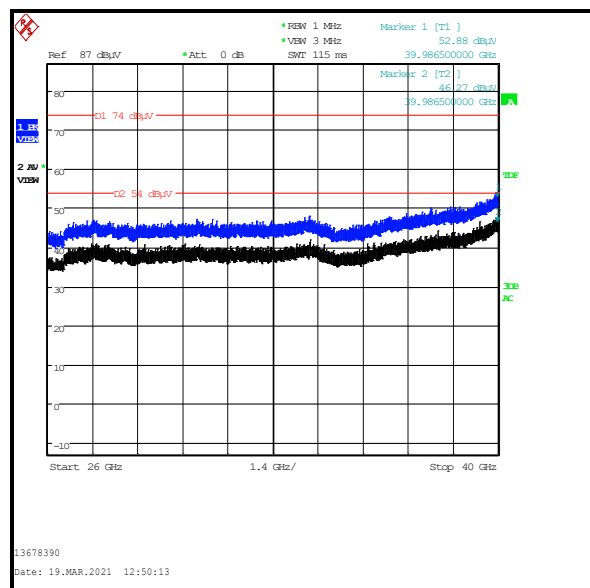
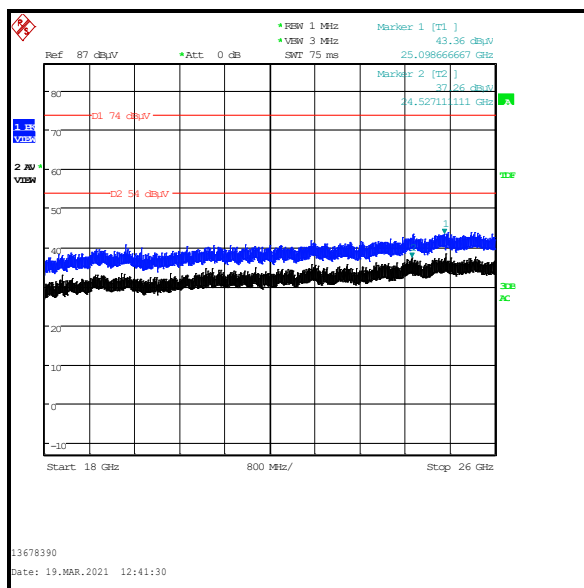
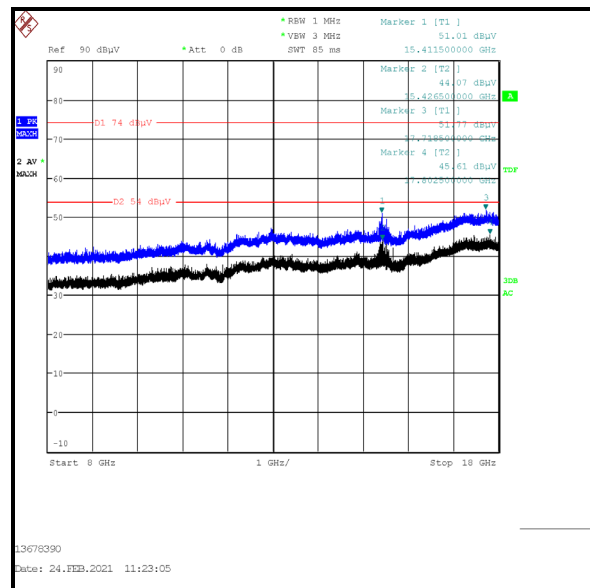
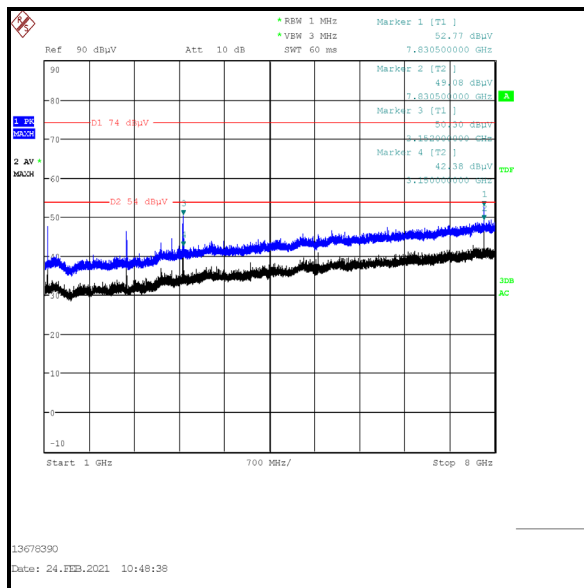
| Frequency (MHz) | Antenna Polarity | Average Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|------------------------------|------------------------------|-------------|----------|
| 7829.888        | Horizontal       | 52.0                         | 54.0                         | 2.0         | Complied |
| 15429.4         | Horizontal       | 50.8                         | 54.0                         | 3.2         | Complied |

**Results: Top Channel / Peak**

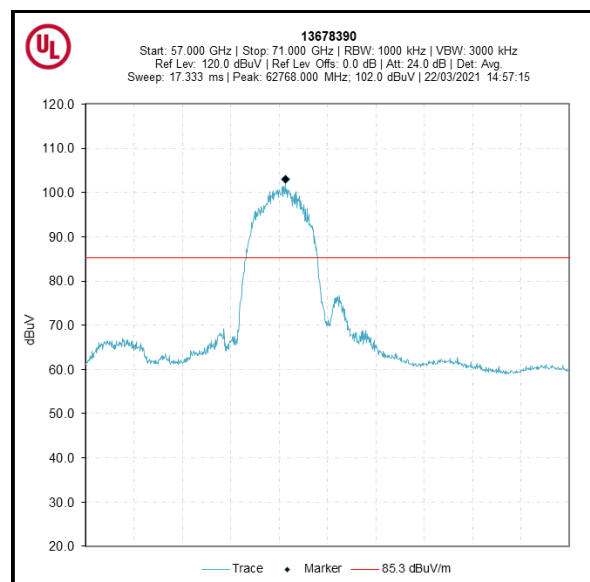
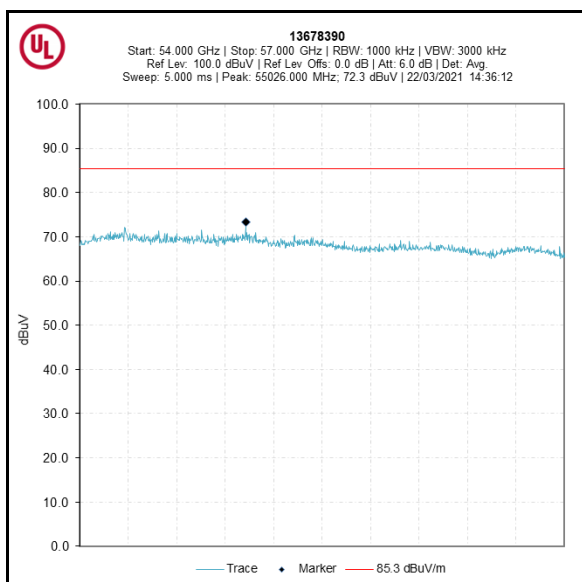
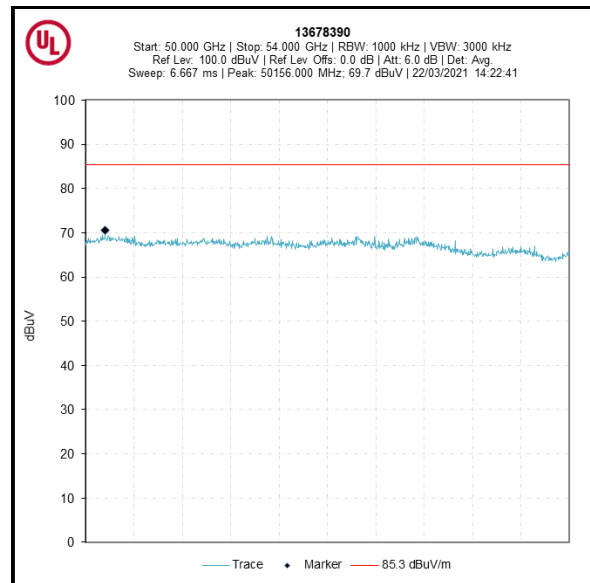
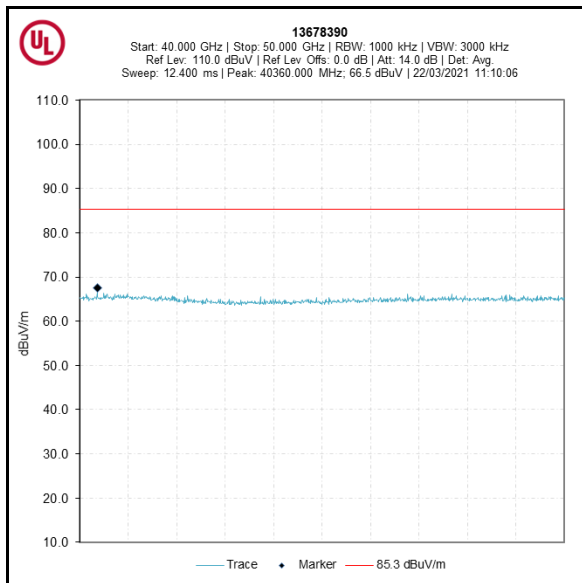
| Frequency (MHz) | Antenna Polarity | Peak Level (dB $\mu$ V/m) | Peak Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|---------------------------|---------------------------|-------------|----------|
| 8099.904        | Horizontal       | 54.8                      | 74.0                      | 19.2        | Complied |

**Results: Top Channel / Average**

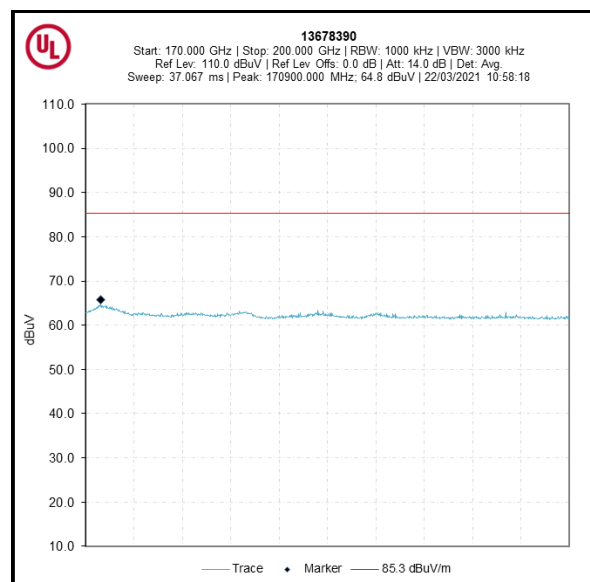
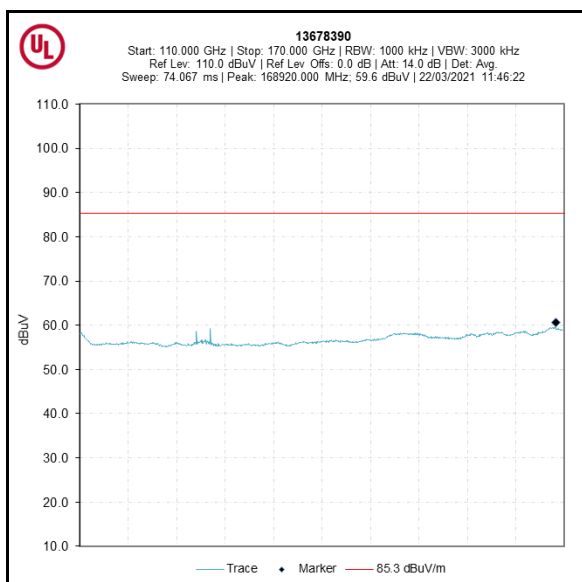
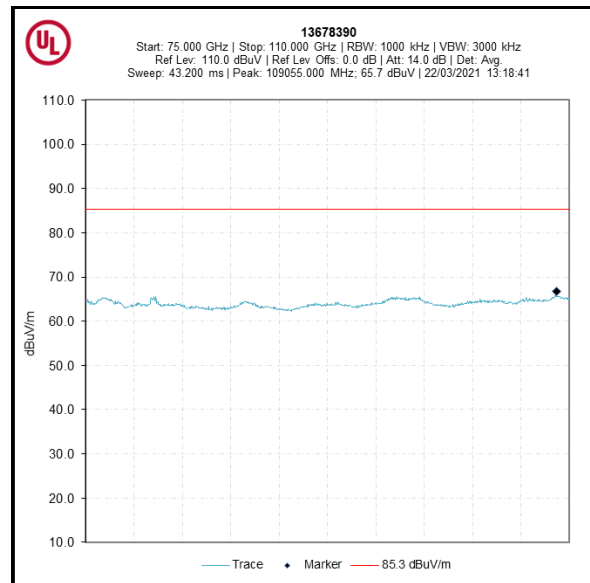
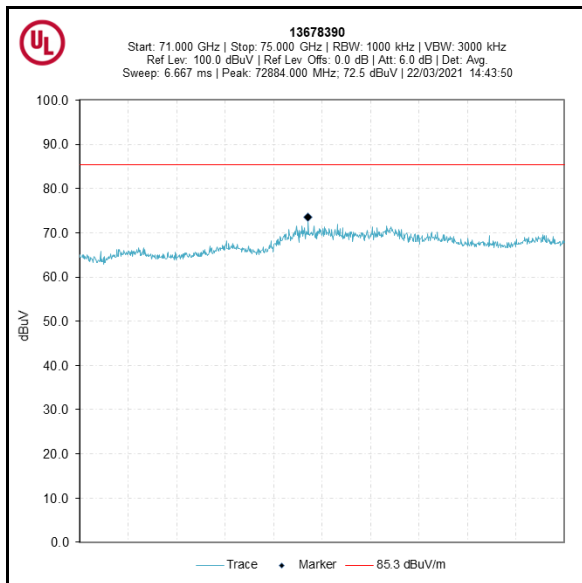
| Frequency (MHz) | Antenna Polarity | Average Level (dB $\mu$ V/m) | Average Limit (dB $\mu$ V/m) | Margin (dB) | Result   |
|-----------------|------------------|------------------------------|------------------------------|-------------|----------|
| 8099.904        | Horizontal       | 53.9                         | 54.0                         | 0.1         | Complied |

**Transmitter Radiated Spurious Emissions (continued)**

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

**Transmitter Radiated Spurious Emissions (continued)**

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

**Transmitter Radiated Spurious Emissions (continued)**

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

**Transmitter Radiated Spurious 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   | 10 Dec 2021           | 12                     |
| K0017     | 3m RSE Chamber   | Rainford EMC    | N/A                | N/A        | 21 Oct 2021           | 12                     |
| M1995     | Test Receiver    | Rohde & Schwarz | ESU40              | 100428     | 07 Dec 2021           | 12                     |
| A2948     | Pre Amplifier    | Com-Power       | PAM-118A           | 551087     | 21 Oct 2021           | 12                     |
| A2863     | Pre Amplifier    | Keysight        | 8449B              | 3008A02100 | 21 Oct 2021           | 12                     |
| A2889     | Antenna          | Schwarzbeck     | BBHA 9120 B        | 00653      | 23 Oct 2021           | 12                     |
| A2890     | Antenna          | Schwarzbeck     | HWRD 750           | 014        | 26 Oct 2021           | 12                     |
| M2040     | Thermohygrometer | Testo           | 608-H1             | 45124934   | 10 Dec 2021           | 12                     |
| K0001     | 3m RSE Chamber   | Rainford EMC    | N/A                | N/A        | 14 Oct 2021           | 12                     |
| M2044     | Test Receiver    | Rohde & Schwarz | ESU26              | 100122     | 03 Sep 2021           | 12                     |
| A3154     | Pre-Amplifier    | Com-Power       | PAM-103            | 18020012   | 29 Sep 2021           | 12                     |
| A2896     | Pre Amplifier    | Schwarzbeck     | BBV 9721           | 9721-023   | 16 Feb 2022           | 12                     |
| A553      | Antenna          | Chase           | CBL6111A           | 1593       | 21 Sep 2021           | 12                     |
| A2895     | Antenna          | Schwarzbeck     | BBHA 9170          | 9170-728   | 16 Feb 2022           | 12                     |
| M1832     | Signal Analyser  | Agilent         | N9010A             | MY53470303 | 06 Mar 2022           | 24                     |
| M1621     | Harmonic Mixer   | Hewlett Packard | 11970U             | 3003A01631 | 30 Apr 2021           | 36                     |
| M2065     | Downconverter    | Virginia Diodes | WR10SAX            | SAX 393    | 11 Jul 2021           | 24                     |
| M2066     | Downconverter    | Virginia Diodes | WR6.5SAX           | SAX 392    | 24 Jul 2021           | 24                     |
| M2067     | Downconverter    | Virginia Diodes | WR4.3SAX           | SAX 391    | 18 Jun 2021           | 24                     |
| M2069     | Downconverter    | Virginia Diodes | WR15SAX            | SAX 394    | 09 Jul 2021           | 24                     |
| A2963     | Horn Antenna     | Link Microtek   | AM19HA-ULV1        | 14929      | 31 Dec 2021           | 12                     |
| A2964     | Horn Antenna     | Link Microtek   | AM15HA-ULV1        | 14930      | 31 Dec 2021           | 12                     |
| A2967     | Horn Antenna     | Link Microtek   | AM10HA-ULV1        | 14933      | 31 Dec 2021           | 12                     |
| A2968     | Horn Antenna     | Link Microtek   | AM7HA-ULV1         | 14934      | 31 Dec 2021           | 12                     |
| A3212     | Low Pass Filter  | Sage Millimeter | SWF-50354340-22-L1 | B10754-01  | Calibrated before use | -                      |
| A3213     | High Pass Filter | Sage Millimeter | SWF-75370340-10-H1 | 18199-01   | Calibrated before use | -                      |
| M1252     | Signal Generator | Hewlett Packard | 83640A             | 3119A00489 | 25 Jan 2022           | 24                     |
| G0554     | Source Module    | Hewlett Packard | 83556A             | 2616A00428 | Calibrated before use | -                      |
| G0555     | Source Module    | Hewlett Packard | 83558A             | 2948A00189 | Calibrated before use | -                      |

## **6. 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**

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

### **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 |
|--------------------------------|-------------------|----------------------|------------------------|
| Transmitter EIRP               | 57 to 71 GHz      | 95%                  | ± 5.36 dB              |
| Transmitter Peak Output Power  | 57 to 71 GHz      | 95%                  | ± 5.36 dB              |
| Transmitter Radiated Emissions | 9 kHz to 30 MHz   | 95%                  | ±5.32 dB               |
| Transmitter Radiated Emissions | 30 MHz to 1 GHz   | 95%                  | ±3.30 dB               |
| Transmitter Radiated Emissions | 1 GHz to 40 GHz   | 95%                  | ±2.94 dB               |
| Transmitter Radiated Emissions | 40 GHz to 200 GHz | 95%                  | ±5.10 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                | 3.1    | Address TCB requests |

--- END OF REPORT ---