

TEST REPORT

Test Report No. : UL-RPT-RP14002654-316A

Manufacturer* : Cambium Networks Ltd

Model No.* : 60 GHz cnWave V1000

FCC ID* : QWP-60V1000

Test Standard(s) : FCC Parts 15.209, 15.215(c) & 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. All information marked with (*) was provided by the Customer, Applicant or Authorised representative
6. Version 1.0.

Date of Issue:

20 January 2025

Checked by:



Sarah Williams
RF Operations Leader, Radio Laboratory

Company Signatory:



Ben Mercer
Lead Project Engineer, Radio Laboratory



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1. Customer Information

Company Name*:	Cambium Networks Ltd
Address*:	Unit B2 Linhay Business Park Eastern Road Ashburton Devon TQ13 7UP United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.255
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Radio Frequency Devices) – Section 15.255
Specification Reference:	47CFR15.209 and 47CFR15.215
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.209 & 15.215
Site Registration:	685609
Lab. Designation No.:	UK2011
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	13 November 2024 to 19 November 2024

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.255(c)(1)(ii)	Transmitter EIRP	✓
Part 15.255(e)	Transmitter Peak Output Power	✓
Part 15.255(e)(2)	Transmitter 6 dB Bandwidth	✓
Part 15.215(c)	Transmitter 20 dB Bandwidth	✓
Part 15.255(d) / 15.209	Transmitter Spurious Emissions	✓

Key to Results

✓ = Complied ✘ = Did not comply

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of 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)

Brand Name* :	Cambium Networks
Model Name or Number* :	60 GHz cnWave V1000
Test Sample Serial Number* :	V5XL03BN0NQC
Hardware Version* :	P7.4
Software Version* :	1.2.2.1
FCC ID* :	QWP-60V1000
Date of Receipt:	09 June 2023

3.2. Description of EUT

The equipment under test was a point-to-point / point-to-multipoint mid 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		
Channel Spacing:	4.32 GHz		
Modulation Type:	BPSK, QPSK & 16QAM		
Antenna Type*:	Integrated Patch		
Antenna Gain*:	22.5 dBi		
Transmit Frequency Range:	57 GHz to 66 GHz		
Transmit Channels Tested:	Channel ID	Channel No.	Channel Frequency (GHz)
	Bottom	9	59.400
	Middle	10	61.560
	Top	11	63.720
Power Supply Requirement*:	Nominal	56 VDC via 120 VAC PoE	

3.5 EUT Settings

Channel	Sector	TPC	LO GC	Notch
9	29	4	3	-
10	29	4	3	-
11	29	4	3	-

3.6. Support Equipment

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

Customer Supplied*:

Description	Brand Name	Model Name or Number	Serial Number
PoE	Cambium Networks	NET-P15-56IN (N000900L017A)	2028004558
Test Laptop	Dell	Latitude E7440	67QBV32
Ethernet Cables. Quantity 2. Length 1 m / 3 m	RS Pro	Not marked or stated	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 4.32 GHz channel bandwidth.
- Transmitting at maximum output power with beamforming locked to sector 29 (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.

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:

Test Engineer:	Ben Mercer	Test Date:	13 November 2024
Test Sample Serial Number:	V5XL03BN0NQC		

FCC Reference:	Part 15.255(c)(1)(ii)
Test Method Used:	ANSI C63.10 Section 9.11

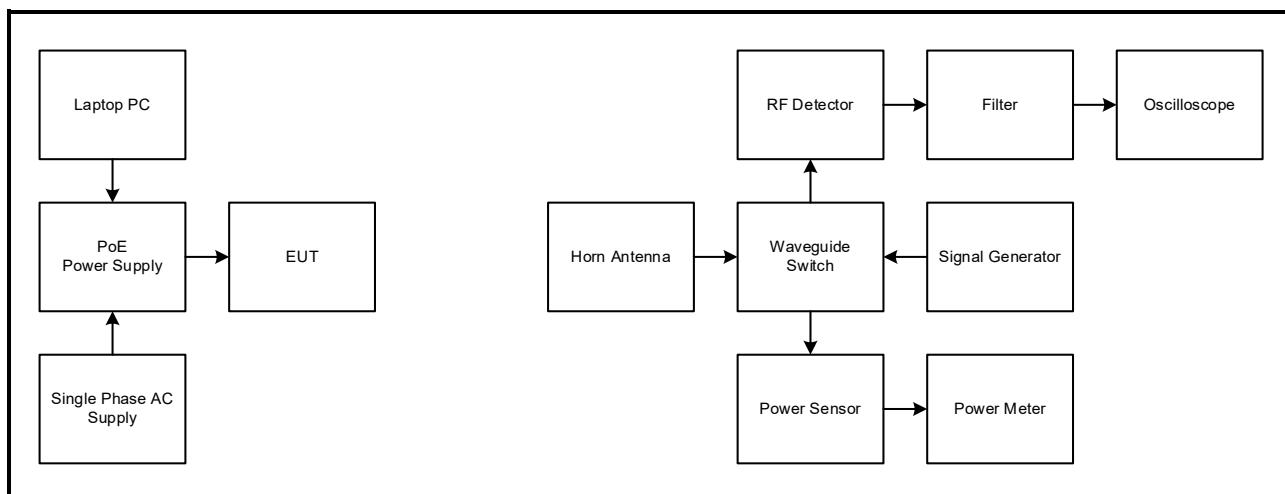
Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	51

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 50Ω 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.

Test Setup:



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

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
59.400	720	36.9	43.0	6.1	Complied

Results: Bottom Channel / Average

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
59.400	632	36.5	40.0	3.5	Complied

Results: Middle Channel / Peak

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
61.560	608	37.3	43.0	5.7	Complied

Results: Middle Channel / Average

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
61.560	520	36.8	40.0	3.2	Complied

Results: Top Channel / Peak

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
63.720	712	38.3	43.0	4.7	Complied

Results: Top Channel / Average

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
63.720	618	37.9	40.0	2.1	Complied

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0010	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	02 Oct 2025	12
M2070	Oscilloscope	Keysight Technologies Inc	DSOX2024A (Opt:001)	MY59125508	28 Feb 2026	24
G0640	Signal Generator	Keysight Technologies Inc	E8257D	US00000055	10 Jan 2025	24
M1145	Power Meter	Hewlett Packard	437B	3737U26557	05 Mar 2025	12
M291	Power Sensor	Hewlett Packard	V8486A	US39010039	01 Feb 2025	24
A3235	Waveguide Switch	Flann Microwave Limited	25333-2	215753	Calibrated before use	-
A3233	RF Detector	Sage Millimeter	SFD-503753-15SF-P1	18199-01	Calibrated before use	-
A2964	Horn Antenna	Link Microtek Ltd.	AM15HA-ULV1	14930	26 Mar 2025	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:

Test Engineer:	Ben Mercer	Test Date:	13 November 2024
Test Sample Serial Number:	V5XL03BN0NQC		

FCC Reference:	Part 15.255(e)
Test Method Used:	ANSI C63.10 Section 9.11

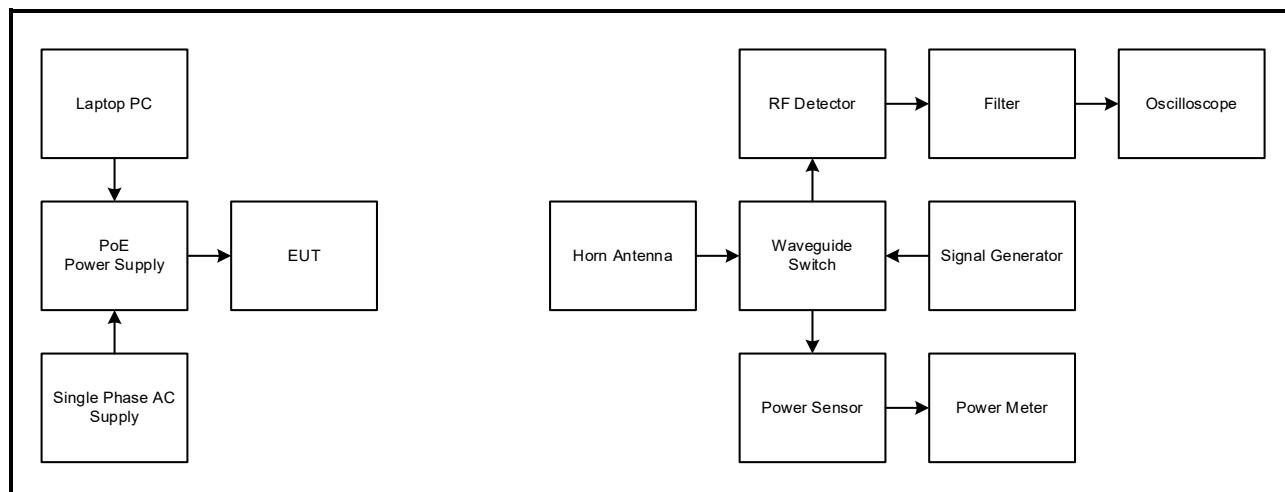
Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	51

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 50Ω 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
36.9	22.5	14.4	27.5	500	472.5	Complied

Results: Middle Channel

EIRP Level (dBm)	Antenna Gain (dBi)	Conducted Level (dBm)	Conducted Level (mW)	Limit (mW)	Margin (mW)	Result
37.3	22.5	14.8	30.2	500	469.8	Complied

Results: Top Channel

EIRP Level (dBm)	Antenna Gain (dBi)	Conducted Level (dBm)	Conducted Level (mW)	Limit (mW)	Margin (mW)	Result
38.3	22.5	15.8	38.0	500	462.0	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0010	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	02 Oct 2025	12
M2070	Oscilloscope	Keysight Technologies Inc	DSOX2024A (Opt:001)	MY59125508	28 Feb 2026	24
G0640	Signal Generator	Keysight Technologies Inc	E8257D	US00000055	10 Jan 2025	24
M1145	Power Meter	Hewlett Packard	437B	3737U26557	05 Mar 2025	12
M291	Power Sensor	Hewlett Packard	V8486A	US39010039	01 Feb 2025	24
A3235	Waveguide Switch	Flann Microwave Limited	25333-2	215753	Calibrated before use	-
A3233	RF Detector	Sage Millimeter	SFD-503753-15SF-P1	18199-01	Calibrated before use	-
A2964	Horn Antenna	Link Microtek Ltd.	AM15HA-ULV1	14930	26 Mar 2025	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 6 dB Bandwidth

Test Summary:

Test Engineer:	Ben Mercer	Test Date:	13 November 2024
Test Sample Serial Number:	V5XL03BN0NQC		

FCC Reference:	Part 15.255(e)(2)
Test Method Used:	ANSI C63.10 Section 9.3

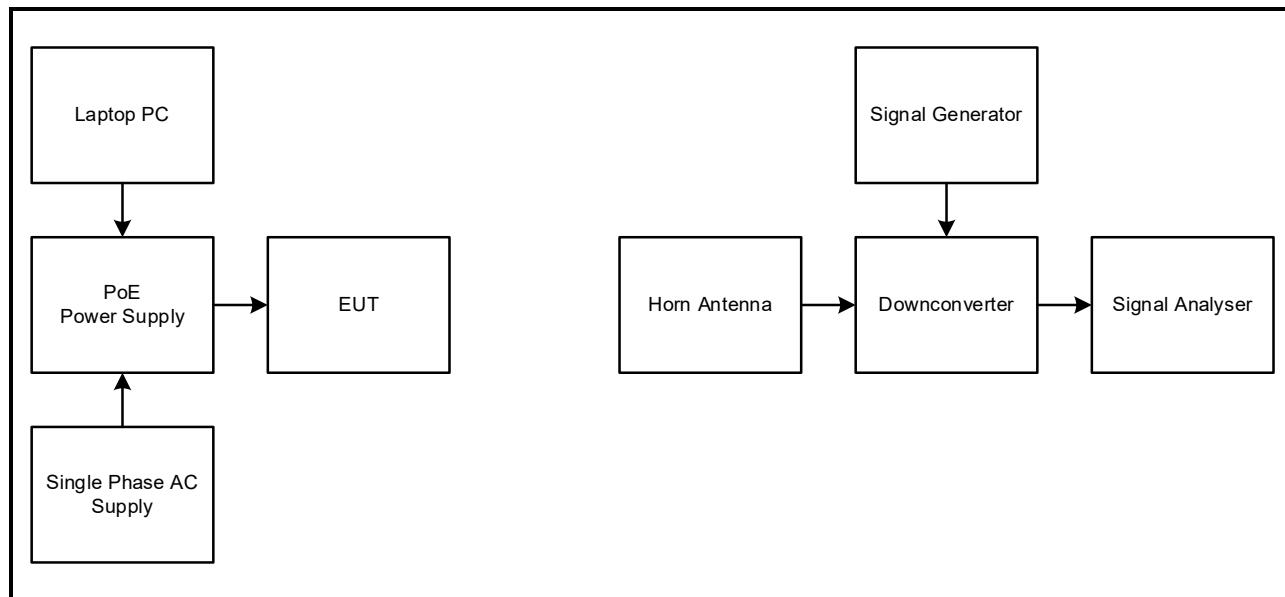
Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	51

Note(s):

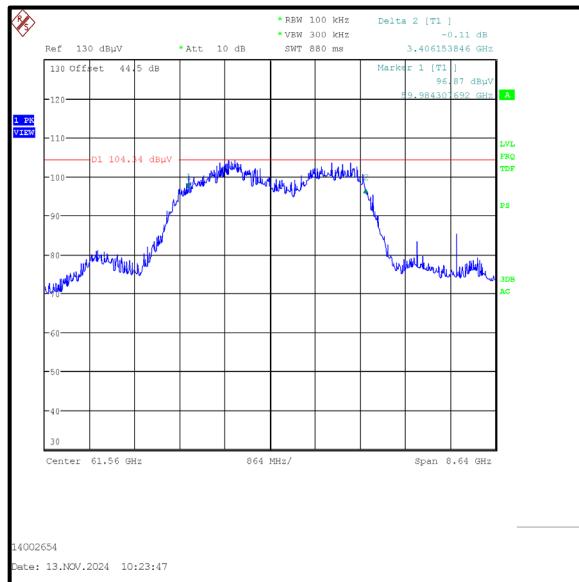
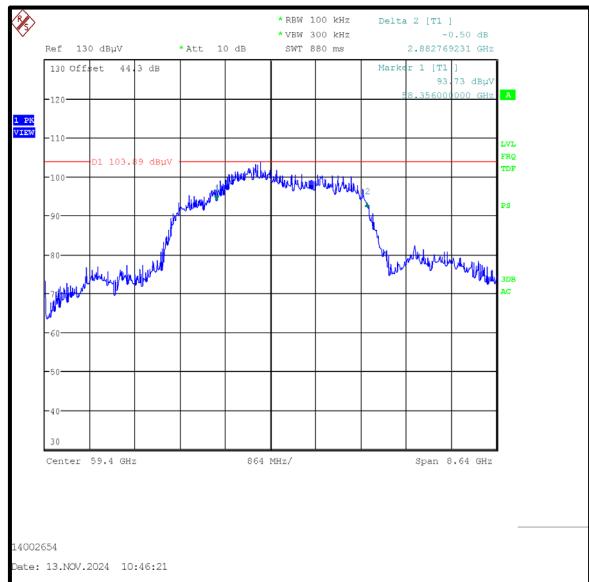
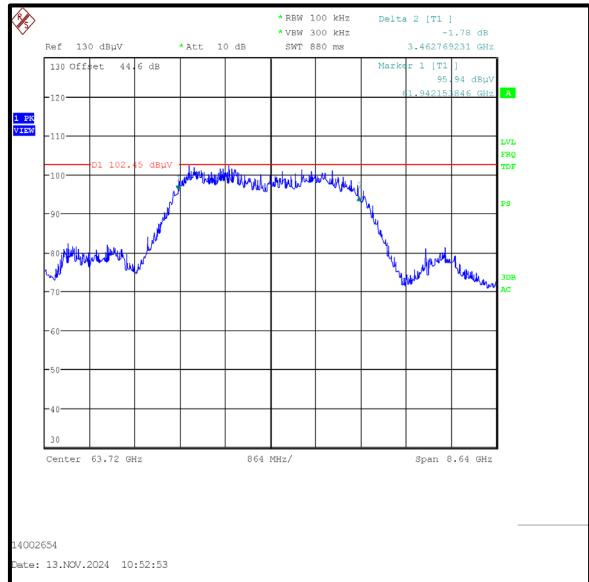
1. The analyser span was set to between two and three times the emission bandwidth. The RBW was set to 100 kHz, and the VBW was set to three times the RBW. The marker delta function was used to measure 6 dB down from the peak on both sides of the emission. The resulting frequency delta between the two markers was recorded as the emission bandwidth.

Test Setup:



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

Channel	RBW (kHz)	VBW (kHz)	Emission Bandwidth (MHz)
Bottom	100	300	2882.769
Middle	100	300	3406.154
Top	100	300	3462.769

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

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2041	Thermohygrometer	Testo	608-H1	45119912	27 Dec 2024	12
K0010	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	02 Oct 2025	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	09 Aug 2025	12
G0640	Signal Generator	Keysight Technologies Inc	E8257D	US00000055	10 Jan 2025	24
M2069	Downconverter	Virginia Diodes, Inc.	WR15SAX	SAX 394	12 Oct 2025	24
A2964	Horn Antenna	Link Microtek Ltd.	AM15HA-ULV1	14930	26 Mar 2025	12

5.2.4. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Ben Mercer	Test Date:	13 November 2024
Test Sample Serial Number:	V5XL03BN0NQC		

FCC Reference:	Part 15.215(c)
Test Method Used:	ANSI C63.10 Section 6.9.2

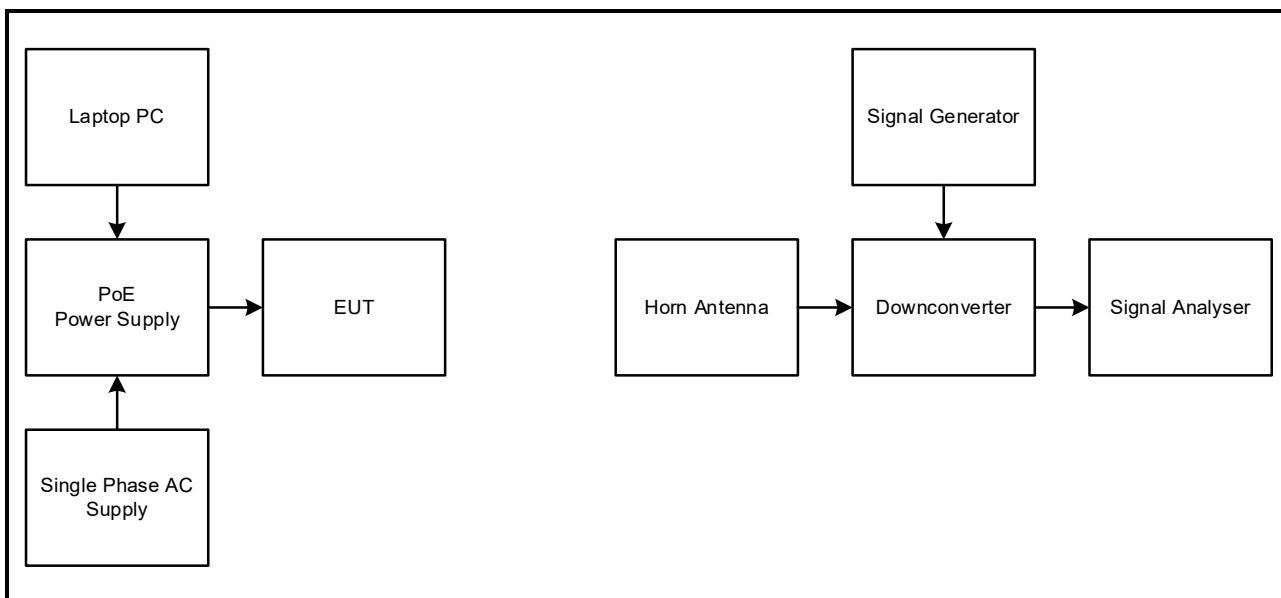
Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	51

Note(s):

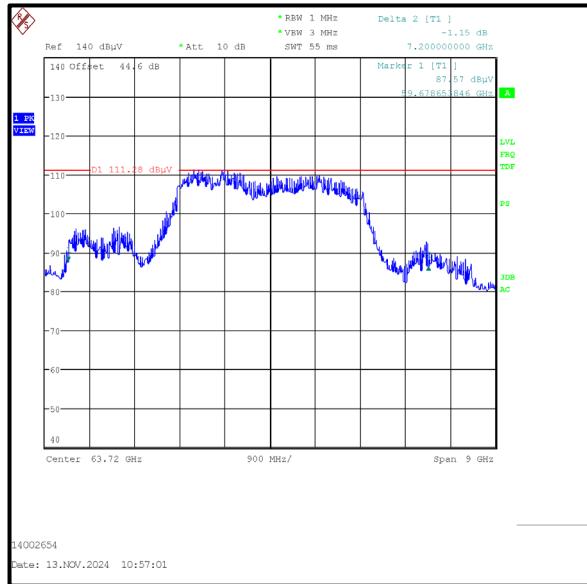
1. The signal analyser resolution bandwidth was set to 1 MHz and the video bandwidth to 3 MHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set wide enough to capture all modulation products. The marker delta function was used to measure 20 dB down from the peak on both sides of the emission. The resulting frequency delta between the two markers was recorded as the 20 dB bandwidth.

Test Setup:



Transmitter 20 dB Bandwidth (continued)**Results:**

Channel	20 dB Bandwidth (MHz)
Bottom	6172.615
Middle	7050.462
Top	7200.000

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

Transmitter 20 dB Bandwidth (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2041	Thermohygrometer	Testo	608-H1	45119912	27 Dec 2024	12
K0010	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	02 Oct 2025	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	09 Aug 2025	12
G0640	Signal Generator	Keysight Technologies Inc	E8257D	US00000055	10 Jan 2025	24
M2069	Downconverter	Virginia Diodes, Inc.	WR15SAX	SAX 394	12 Oct 2025	24
A2964	Horn Antenna	Link Microtek Ltd.	AM15HA-ULV1	14930	26 Mar 2025	12

5.2.5. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineers:	Ben Mercer & John Ferdinand	Test Dates:	15 November 2024 & 19 November 2024
Test Sample Serial Number:	V5XL03BN0NQC		

FCC Reference:	Part 15.255(d) / 15.209
Test Method Used:	ANSI C63.10 Sections 6.3, 6.6, 9.8, 9.9, 9.12 & 9.13
Frequency Range:	1 to 8 GHz, 110 to 140 GHz

Environmental Conditions:

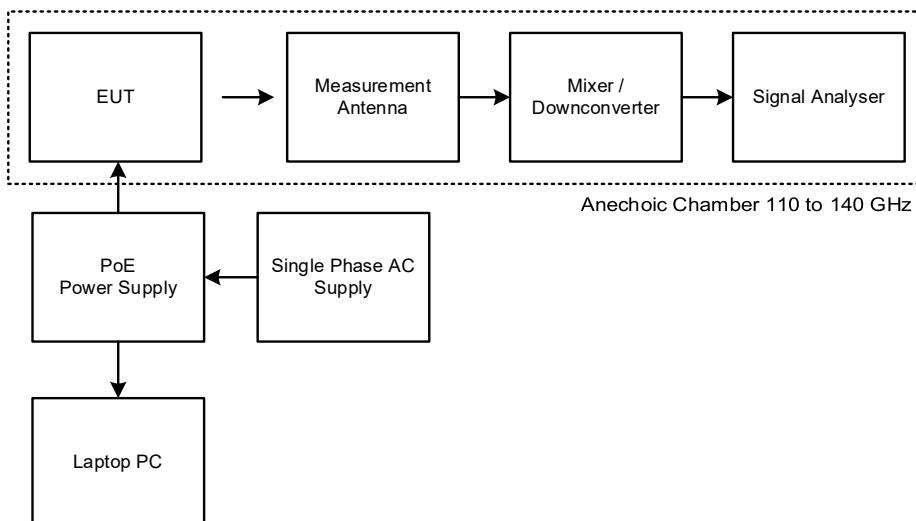
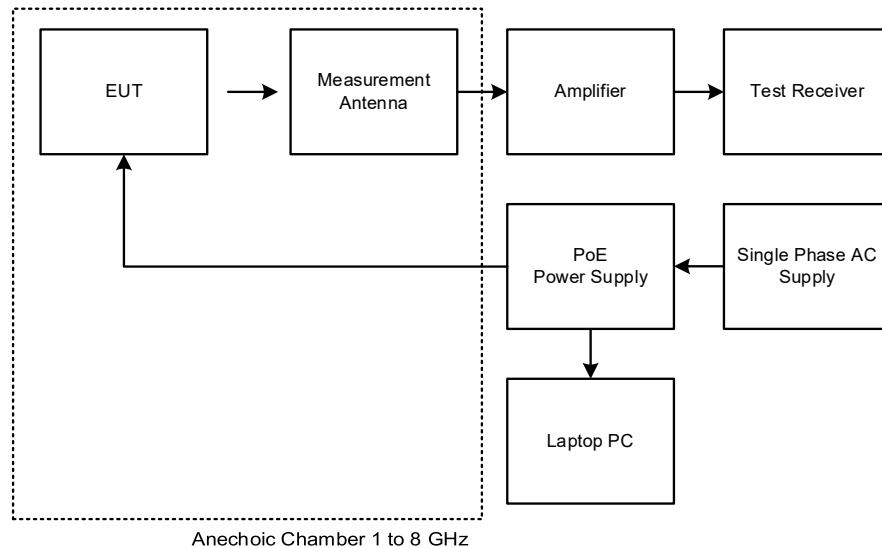
Temperature (°C):	19 to 20
Relative Humidity (%):	47 to 51

Note(s):

1. Full range spurious emissions testing was performed using a 2.16 GHz channel bandwidth under test report UL-RPT-RP13194254-616A. Testing in this report has been reduced to known emission frequencies from the 2.16 GHz testing.
2. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss. Only the 6 highest emissions were recorded in the tables below in accordance with ANSI C63.10 Section 6.6.4.3.
3. All other emissions were >20 dB below the applicable limit or below the noise floor of the measurement system.
4. 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.
5. Part 15.255(d)(3) defines a power density limit of 90 pW/cm² 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.
6. 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:

110 GHz to 140 GHz – 1 metre

7. 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.
8. *In accordance with ANSI C63.10 Section 6.6.4.3 Note 1, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

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

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

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1032.157	Vertical	50.7	54.0*	3.3	Complied
2349.420	Horizontal	47.7	54.0*	6.3	Complied
2687.999	Vertical	49.1	54.0*	4.9	Complied
3027.500	Vertical	50.4	54.0*	3.6	Complied
3696.090	Vertical	52.0	54.0*	2.0	Complied
4023.500	Vertical	50.1	54.0*	3.9	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
117039.670	Horizontal	76.1	85.3	9.2	Complied
120559.640	Horizontal	77.3	85.3	8.0	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1032.157	Vertical	50.7	54.0*	3.3	Complied
2349.420	Horizontal	47.7	54.0*	6.3	Complied
2687.999	Vertical	49.1	54.0*	4.9	Complied
3027.500	Vertical	50.4	54.0*	3.6	Complied
3696.090	Vertical	52.0	54.0*	2.0	Complied
4023.500	Vertical	50.1	54.0*	3.9	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
121359.640	Horizontal	76.1	85.3	9.2	Complied
124879.630	Horizontal	73.2	85.3	12.1	Complied

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

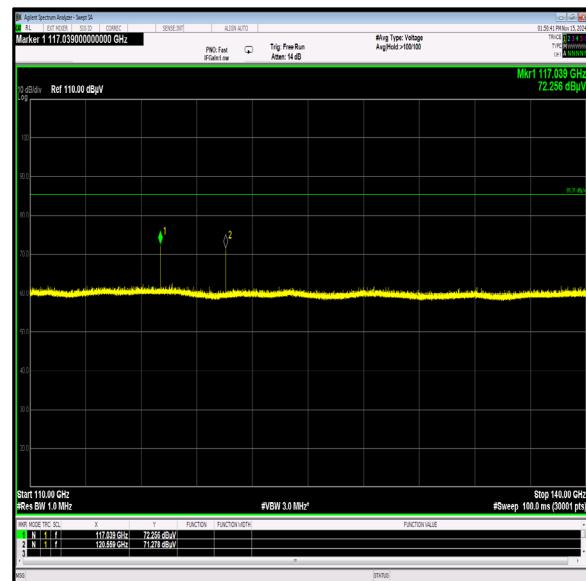
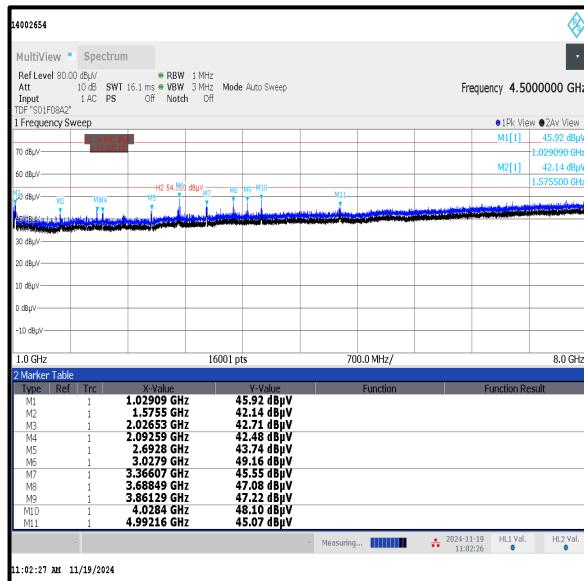
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1032.157	Vertical	50.7	54.0*	3.3	Complied
2687.999	Vertical	49.1	54.0*	4.9	Complied
3027.500	Vertical	50.4	54.0*	3.6	Complied
3696.090	Vertical	52.0	54.0*	2.0	Complied
4023.500	Vertical	50.1	54.0*	3.9	Complied
7965.080	Vertical	50.4	54.0*	3.6	Complied

Results: Top Channel / Average

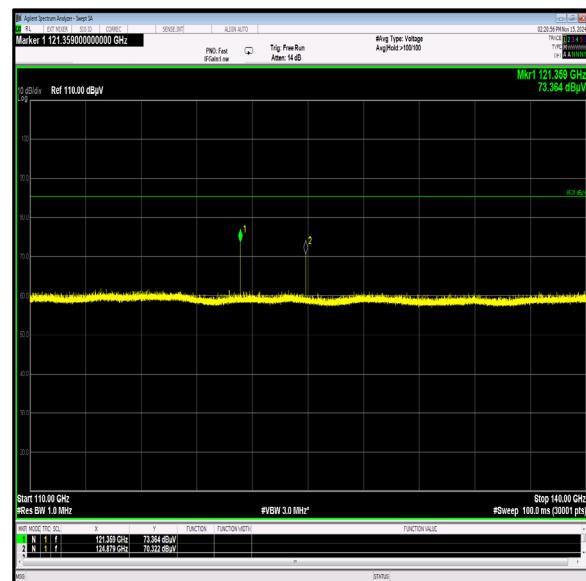
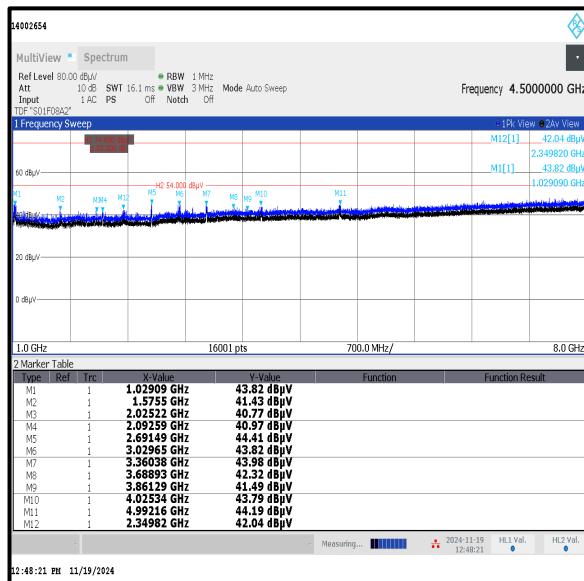
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
125679.650	Horizontal	80.8	85.3	4.5	Complied
129199.630	Horizontal	80.8	85.3	4.5	Compiled

Transmitter Radiated Spurious Emissions (continued)

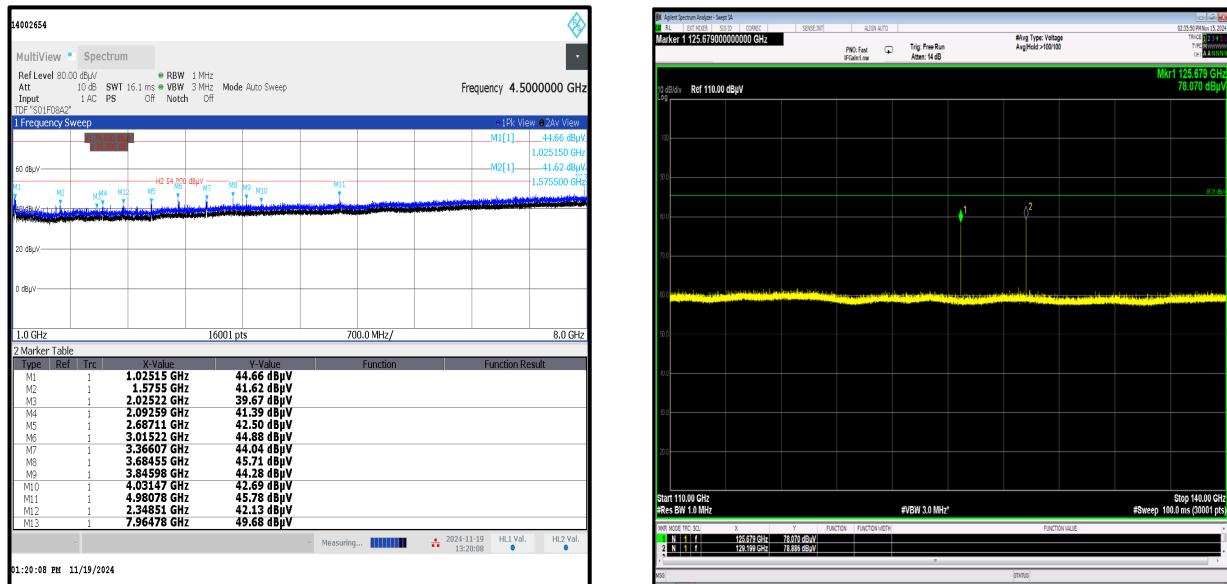
Bottom Channel



Middle Channel



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

Transmitter Radiated Spurious Emissions (continued)**Top Channel**

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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2041	Thermohygrometer	Testo	608-H1	45119912	27 Dec 2024	12
K0010	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	02 Oct 2025	12
M1832	Signal Analyser	Keysight Technologies Inc	N9010A	MY53470303	03 Jul 2026	24
M2066	Downconverter	Virginia Diodes, Inc.	WR6.5SAX	SAX 392	02 Sep 2026	24
A2968	Horn Antenna	Link Microtek Ltd.	AM7HA-ULV1	14934	26 Mar 2025	12
K0001	3m RSE Chamber	MVG Industries UK Ltd.	N/A	N/A	11 Sep 2025	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	30 Aug 2025	12
M236226	Test Receiver	Rohde & Schwarz	ESW26	103134	06 May 2025	12
M2040	Thermohygrometer	Testo	608-H1	45124934	27 Dec 2024	12

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%	±2.70 dB
Transmitter Peak Output Power	57 to 71 GHz	95%	±2.70 dB
Transmitter 6 dB Bandwidth	57 to 71 GHz	95%	±3.27 %
Transmitter 20 dB Bandwidth	57 to 71 GHz	95%	±3.27 %
Transmitter Radiated Emissions	1 GHz to 40 GHz	95%	±3.64 dB
Transmitter Radiated Emissions	40 GHz to 200 GHz	95%	±5.12 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

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