TEST REPORT

Test Report No. : UL-RPT-RP13194254-3216A V2.0

Manufacturer	:	Cambium Networks Ltd
Model No.	:	60 GHz cnWave V5000
FCC ID	:	QWP-60V5000
Test Standard(s)	:	FCC Parts 15.207, 15.209, 15.215 & 15.255

1. This test report shall not be reproduced except in full, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 10 November 2020

Checked by:

Sarah Williams
RF Operations Leader, Radio Laboratory

Company Signatory:

Ian Watch
Senior Test Engineer, Radio Laboratory
UL VS LTD

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

UL VS 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

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:	47CFR15.207, 47CFR15.209 and 47CFR15.215
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207, 15.209 & 15.215
Site Registration:	621311
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	01 July 2020 to 28 September 2020

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.255(c)(1)(i)	Transmitter EIRP	✓
Part 15.255(e)	Transmitter Peak Output Power	✓
Part 15.255(e)(1)	Transmitter 6 dB Bandwidth	✓
Part 15.215(c)	Transmitter 20 dB Bandwidth	✓
Part 15.255(d) / 15.209	Transmitter Spurious Emissions	✓
Part 15.255(f)	Transmitter Frequency Stability (Temperature & Voltage Variation)	✓

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
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

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 V5000
Test Sample Serial Number:	V5WA0039PTR5
Hardware Version:	P7
Software Version:	DM Tools 3.2.0.1
Firmware Version:	10.11.1.10448236
FCC ID:	QWP-60V5000

3.2. Description of EUT

The equipment under test was a point to multipoint distribution 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:	2.16 GHz		
Modulation Type:	BPSK, QPSK & 16QAM		
Antenna Type:	Integrated		
Antenna Gain:	22.5 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
Power Supply Requirement:	Nominal	120 VAC via 120 VAC PoE	
	Minimum	85 VAC (PoE)	
	Maximum	276 VAC (PoE)	
Tested Temperature Range:	Minimum	-20°C	
	Maximum	50°C	

3.5. EUT Settings

Channel	Sector	Tx Lineup	RF Lineup	DAC	LO GC	E-Base	Notch
1	27	0	13	42/42	1	0	-
3	27	0	15	42/42	3	0	-
4	27	0	15	42/42	0	0	-

3.6. Support Equipment

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

Description:	PoE
Brand Name:	Cambium Networks
Model Name or Number:	N000000L142A
Serial Number:	2020000773

Description:	Test Laptop
Brand Name:	HP EliteBook
Model Name or Number:	NH121UC#ABU
Serial Number:	2CE00223BK

Description:	Ethernet Cables. Quantity 3. Length 1 m / 3 m / 10 m
Brand Name:	RS Pro
Model Name or Number:	Not marked or stated
Serial Number:	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.
- Testing at voltage extremes was performed with the PoE supply connected to a variable AC power supply.
- The EUT has two pairs of identical patch antenna, two to the left and two to the right, with each pair independently serving different sectors. Only one patch of each pair can transmit at a time. Testing was performed on one patch only.

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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Patrick Jones	**Test Date:**	03 September 2020
Test Sample Serial Number:	V5WA0039PTR5		

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

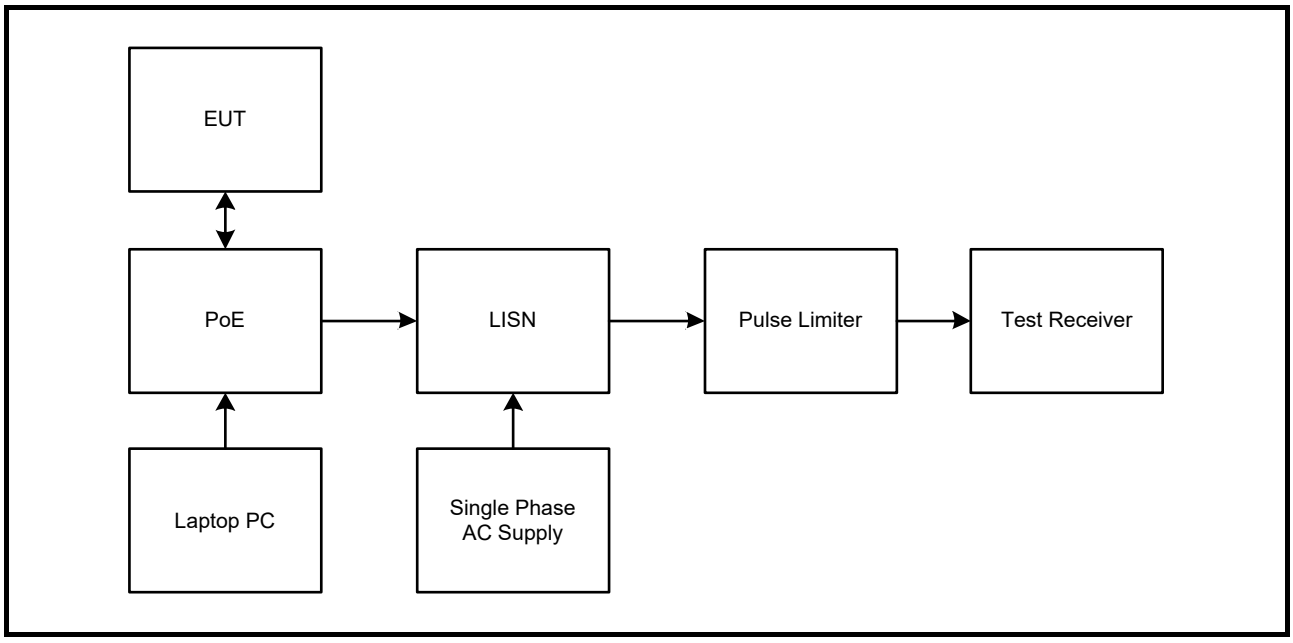
Environmental Conditions:

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

Note(s):

1. The EUT was connected to a PoE adapter via ethernet cable. The PoE adapter was connected to 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 PoE supply.
3. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
4. A pulse limiter was fitted between the LISN and the test receiver.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.155	Live	49.6	65.7	16.1	Complied
0.168	Live	45.6	65.1	19.5	Complied
0.461	Live	43.0	56.7	13.7	Complied
4.758	Live	40.1	56.0	15.9	Complied
5.946	Live	41.0	60.0	19.0	Complied
6.837	Live	39.1	60.0	20.9	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.465	Live	41.2	46.6	5.4	Complied
3.867	Live	34.3	46.0	11.7	Complied
5.055	Live	42.1	50.0	7.9	Complied
5.649	Live	42.5	50.0	7.5	Complied
6.540	Live	41.3	50.0	8.7	Complied
7.431	Live	35.8	50.0	14.2	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

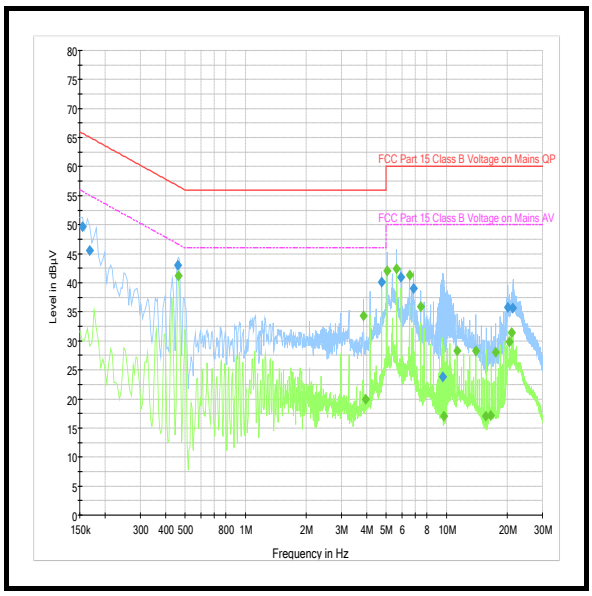
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Neutral	48.9	66.0	17.1	Complied
0.155	Neutral	48.8	65.7	16.9	Complied
0.461	Neutral	43.4	56.7	13.3	Complied
4.758	Neutral	40.5	56.0	15.5	Complied
5.946	Neutral	40.8	60.0	19.2	Complied
21.408	Neutral	36.8	60.0	23.2	Complied

Results: Neutral / Average / 120 VAC 60 Hz

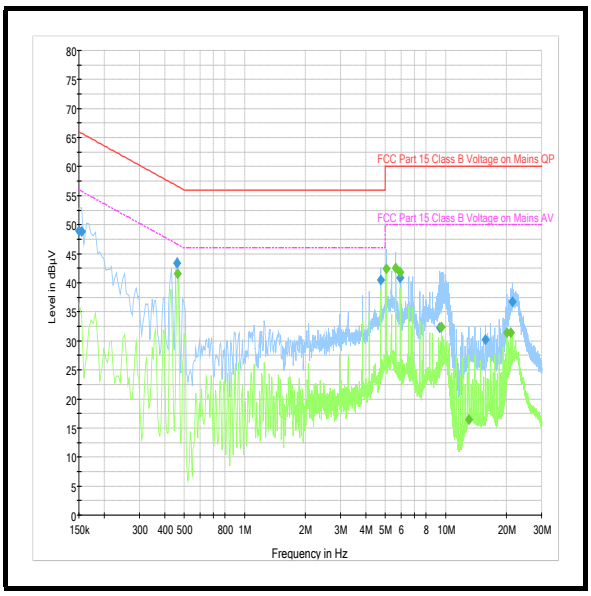
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.465	Neutral	41.6	46.6	5.0	Complied
5.055	Neutral	42.4	50.0	7.6	Complied
5.649	Neutral	42.6	50.0	7.4	Complied
5.946	Neutral	41.8	50.0	8.2	Complied
9.515	Neutral	32.3	50.0	17.7	Complied
20.220	Neutral	31.4	50.0	18.6	Complied

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
0.150	Live	50.2	66.0	15.8	Complied
0.465	Live	43.1	56.6	13.5	Complied
12.989	Live	34.2	60.0	25.8	Complied
13.214	Live	34.4	60.0	25.6	Complied
22.299	Live	41.5	60.0	18.5	Complied
24.081	Live	37.2	60.0	22.8	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.870	Live	32.3	46.0	13.7	Complied
1.275	Live	32.1	46.0	13.9	Complied
1.649	Live	30.4	46.0	15.6	Complied
22.002	Live	35.1	50.0	14.9	Complied
22.893	Live	34.3	50.0	15.7	Complied
27.353	Live	32.7	50.0	17.3	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

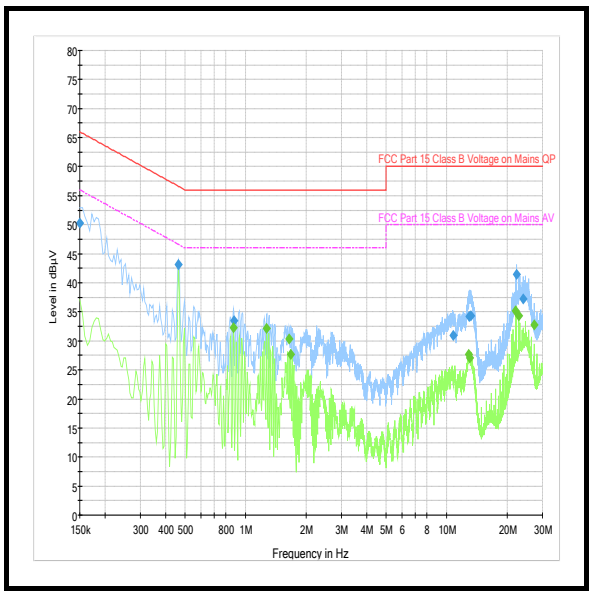
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.155	Neutral	49.9	65.7	15.8	Complied
0.465	Neutral	44.6	56.6	12.0	Complied
13.029	Neutral	34.5	60.0	25.5	Complied
22.295	Neutral	41.0	60.0	19.0	Complied
24.675	Neutral	38.5	60.0	21.5	Complied
25.571	Neutral	35.1	60.0	24.9	Complied

Results: Neutral / Average / 240 VAC 60 Hz

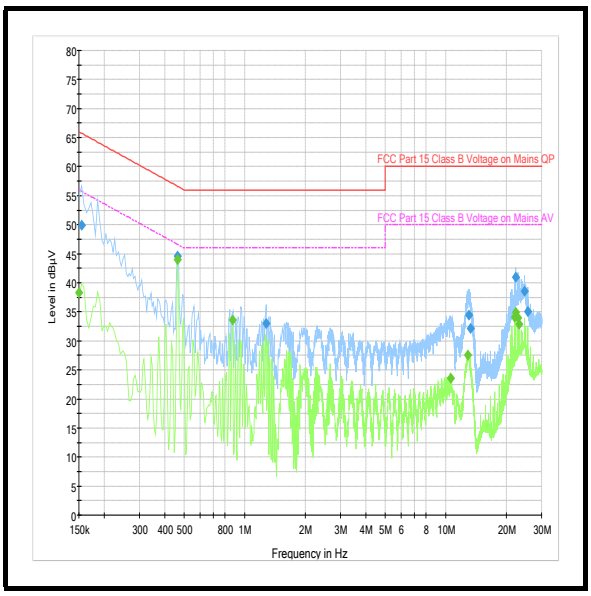
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Neutral	38.3	56.0	17.7	Complied
0.465	Neutral	43.9	46.6	2.7	Complied
0.870	Neutral	33.6	46.0	12.4	Complied
21.998	Neutral	34.1	50.0	15.9	Complied
22.299	Neutral	35.0	50.0	15.0	Complied
22.889	Neutral	34.0	50.0	16.0	Complied

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.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	07 Jan 2021	12
A2086	LISN	Rohde & Schwarz	ESH3-Z5	101033	26 Feb 2021	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	07 Apr 2021	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	03 Dec 2020	12
A2953	Power Supply	Tacima	SC 5467	Not marked or stated	Calibrated before use	-

5.2.2. Transmitter EIRP

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	21 August 2020
Test Sample Serial Number:	V5WA0039PTR5		

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

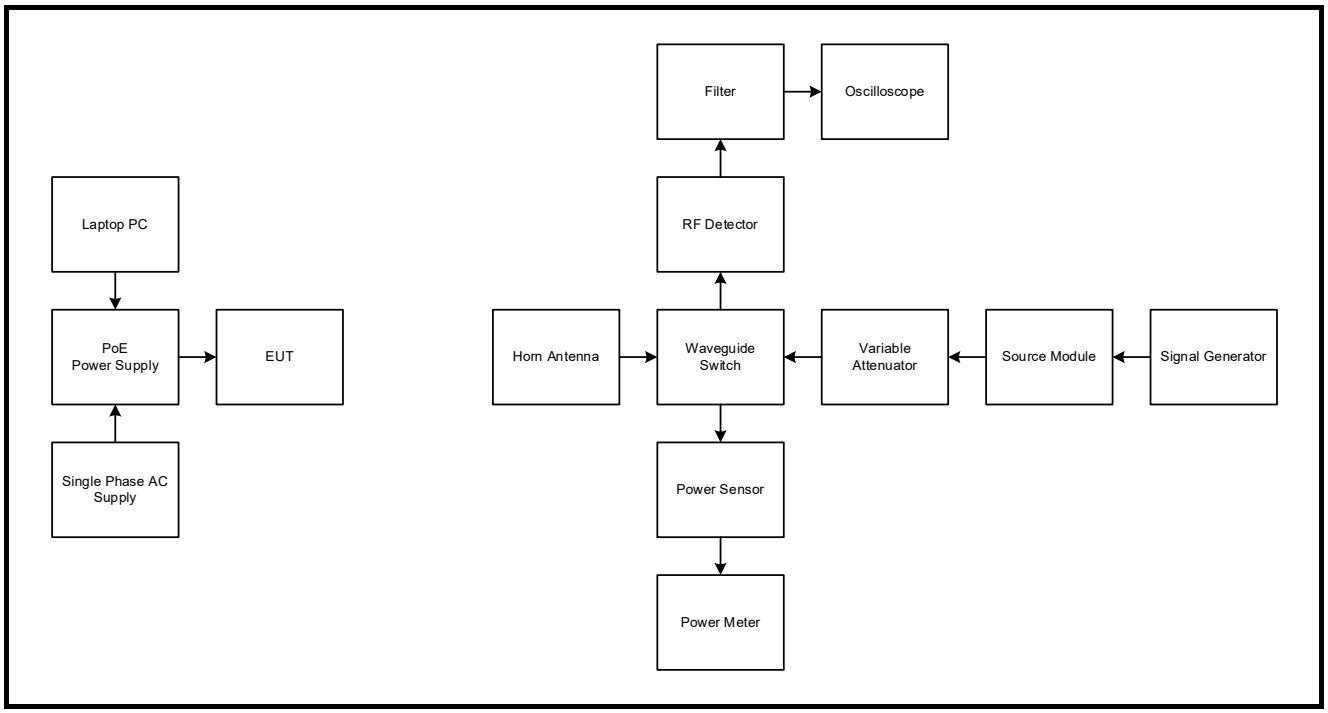
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	64

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 Ω 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 (V)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
58.320	25.3	38.1	43.0	4.9	Complied

Results: Bottom Channel / Average

Frequency (GHz)	Level (V)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
58.320	20.8	37.5	40.0	2.5	Complied

Results: Middle Channel / Peak

Frequency (GHz)	Level (V)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
62.640	19.3	36.6	43.0	6.4	Complied

Results: Middle Channel / Average

Frequency (GHz)	Level (V)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
62.640	15.9	36.1	40.0	3.9	Complied

Results: Top Channel / Peak

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
64.800	15.5	35.9	43.0	7.1	Complied

Results: Top Channel / Average

Frequency (GHz)	Level (mV)	Substituted EIRP Level (dBm)	Limit (dBm)	Margin (dB)	Result
64.800	11.5	35.1	40.0	4.9	Complied

Transmitter EIRP (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 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	-
M281	Power Meter	Hewlett Packard	E4418A	GB37170210-01	05 May 2021	12
M291	Waveguide Power Sensor	Hewlett Packard	V8486A	US39010039	11 Dec 2020	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
G094	Source Module	Hewlett Packard	83557A	2948A00475	Calibrated before use	-
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 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 Peak Conducted Output Power

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	21 August 2020
Test Sample Serial Number:	V5WA0039PTR5		

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

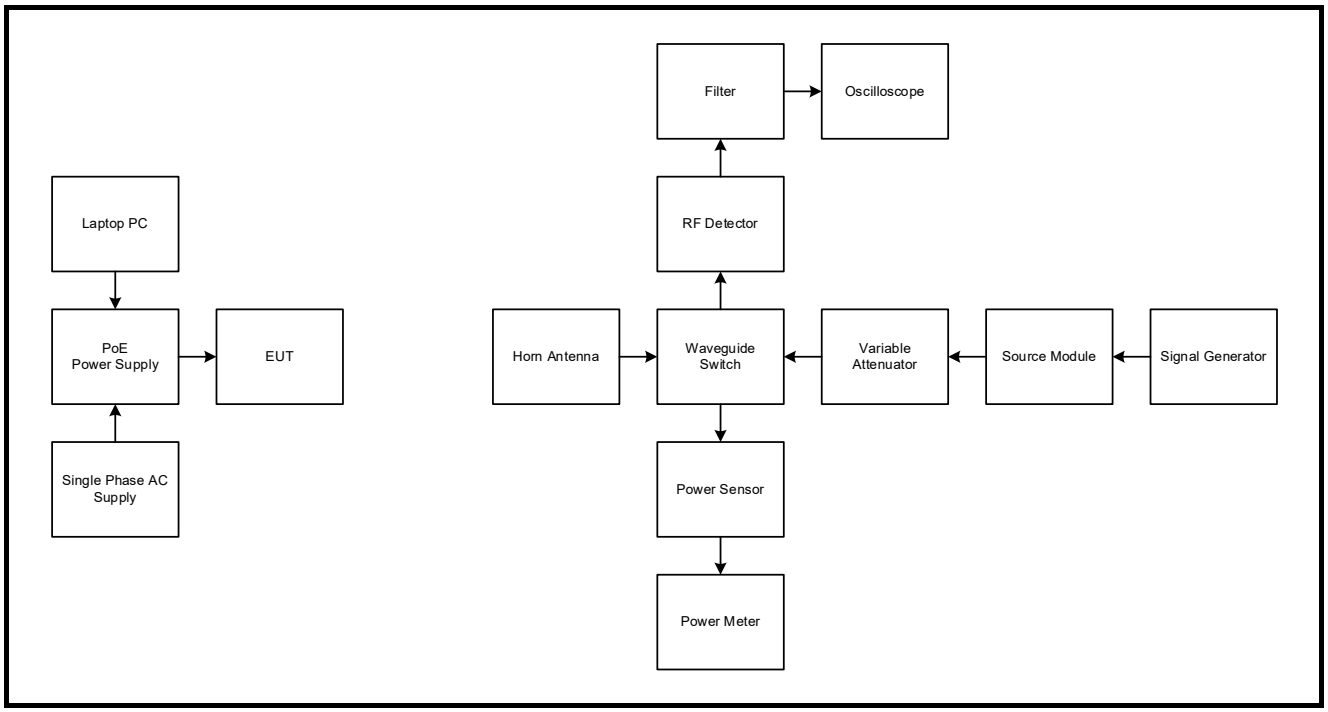
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	64

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 Ω 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
38.1	22.5	15.6	36.3	500	463.7	Complied

Results: Middle Channel

EIRP Level (dBm)	Antenna Gain (dBi)	Conducted Level (dBm)	Conducted Level (mW)	Limit (mW)	Margin (mW)	Result
36.6	22.5	14.1	25.7	500	474.3	Complied

Results: Top Channel

EIRP Level (dBm)	Antenna Gain (dBi)	Conducted Level (dBm)	Conducted Level (mW)	Limit (mW)	Margin (mW)	Result
35.9	22.5	13.4	21.9	500	478.1	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 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	-
M281	Power Meter	Hewlett Packard	E4418A	GB37170210-01	05 May 2021	12
M291	Waveguide Power Sensor	Hewlett Packard	V8486A	US39010039	11 Dec 2020	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
G094	Source Module	Hewlett Packard	83557A	2948A00475	Calibrated before use	-
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 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	-

5.2.4. Transmitter 6 dB Bandwidth

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	24 August 2020
Test Sample Serial Number:	V5WA0039PTR5		

FCC Reference:	Part 15.255(e)(1)
Test Method Used:	ANSI C63.10 Section 9.3

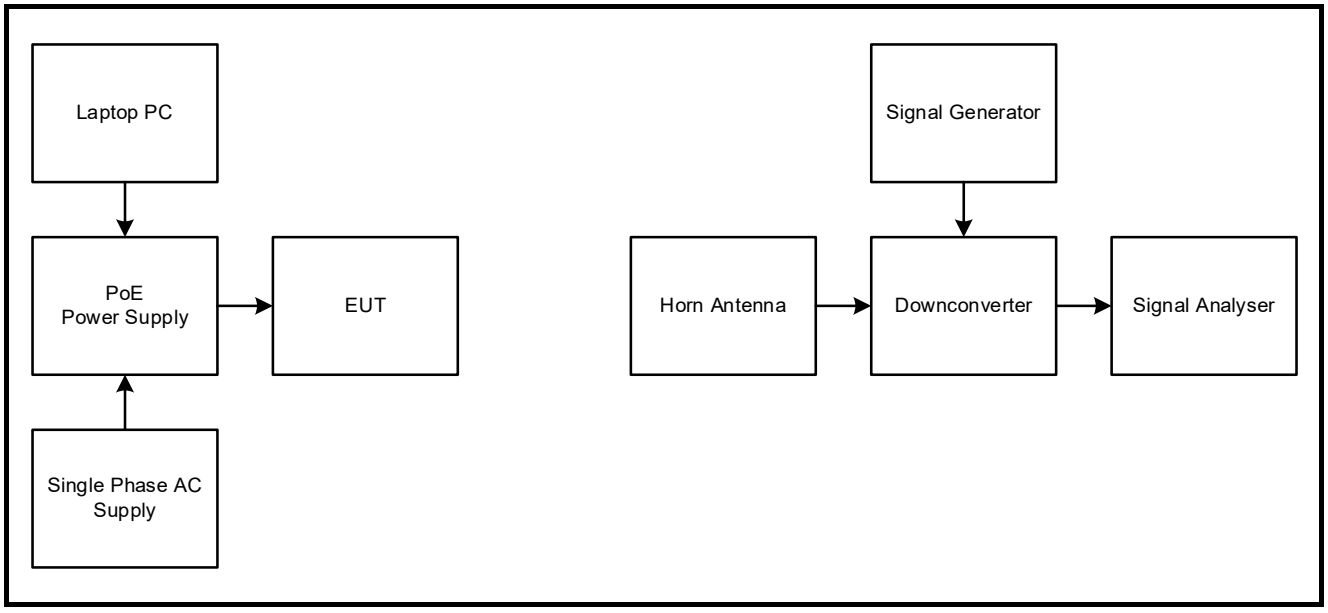
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	50

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	1480.000
Middle	100	300	1770.000
Top	100	300	1835.000

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)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 2021	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	06 Mar 2022	24
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2021	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 2021	12

5.2.5. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	24 August 2020
Test Sample Serial Number:	V5WA0039PTR5		

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

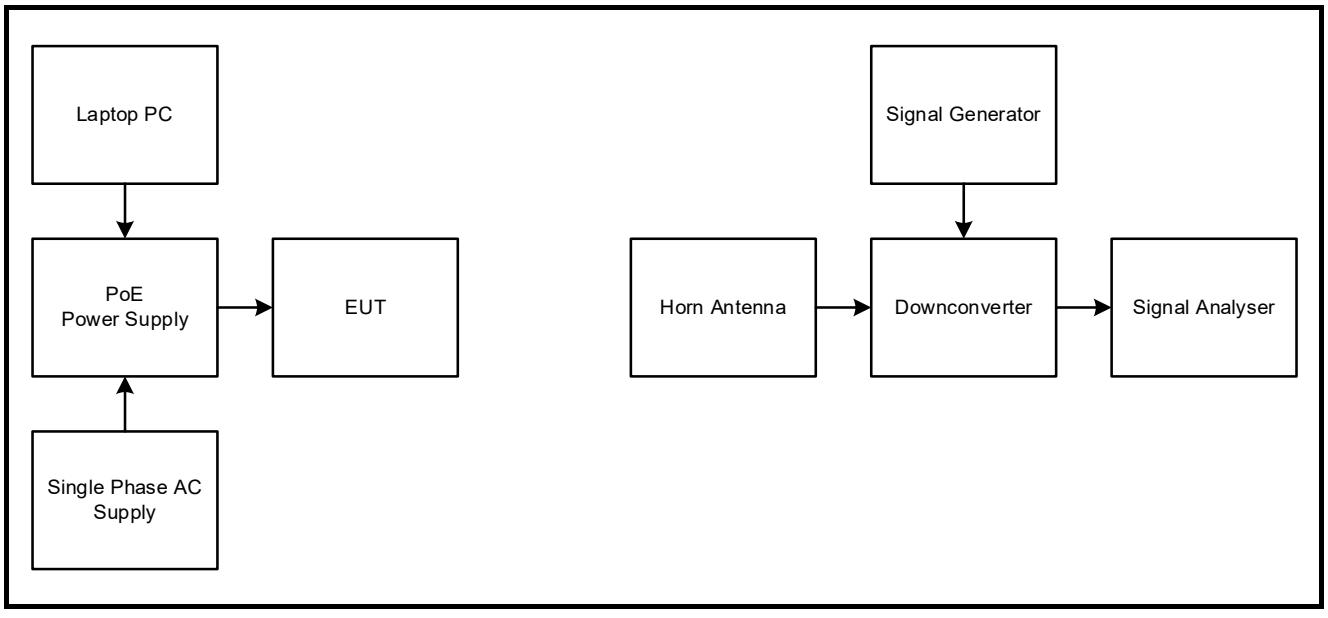
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	50

Note(s):

1. The signal analyser resolution bandwidth was set to 3 MHz and the video bandwidth to 50 MHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 5 GHz. 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.
2. Due to limitations of the downconverter setup it was not possible to increase the signal analyser span above 5 GHz.

Test setup:

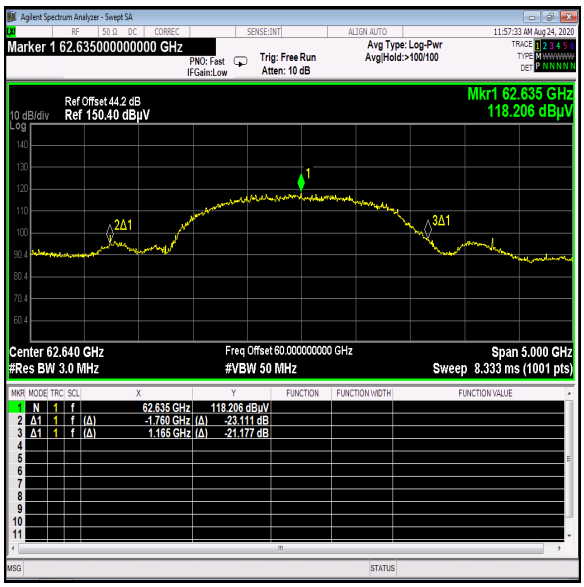


Transmitter 20 dB Bandwidth (continued)

Results:

Channel	20 dB Bandwidth (MHz)
Bottom	2245.000
Middle	2925.000
Top	2255.000

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)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 2021	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	06 Mar 2022	24
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2021	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 2021	12

5.2.6. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineers:	Patrick Jones & Nick Tye	**Test Dates:**	01 July 2020 & 28 September 2020
Test Sample Serial Number:	V5WA0039PTR5		

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

Environmental Conditions:

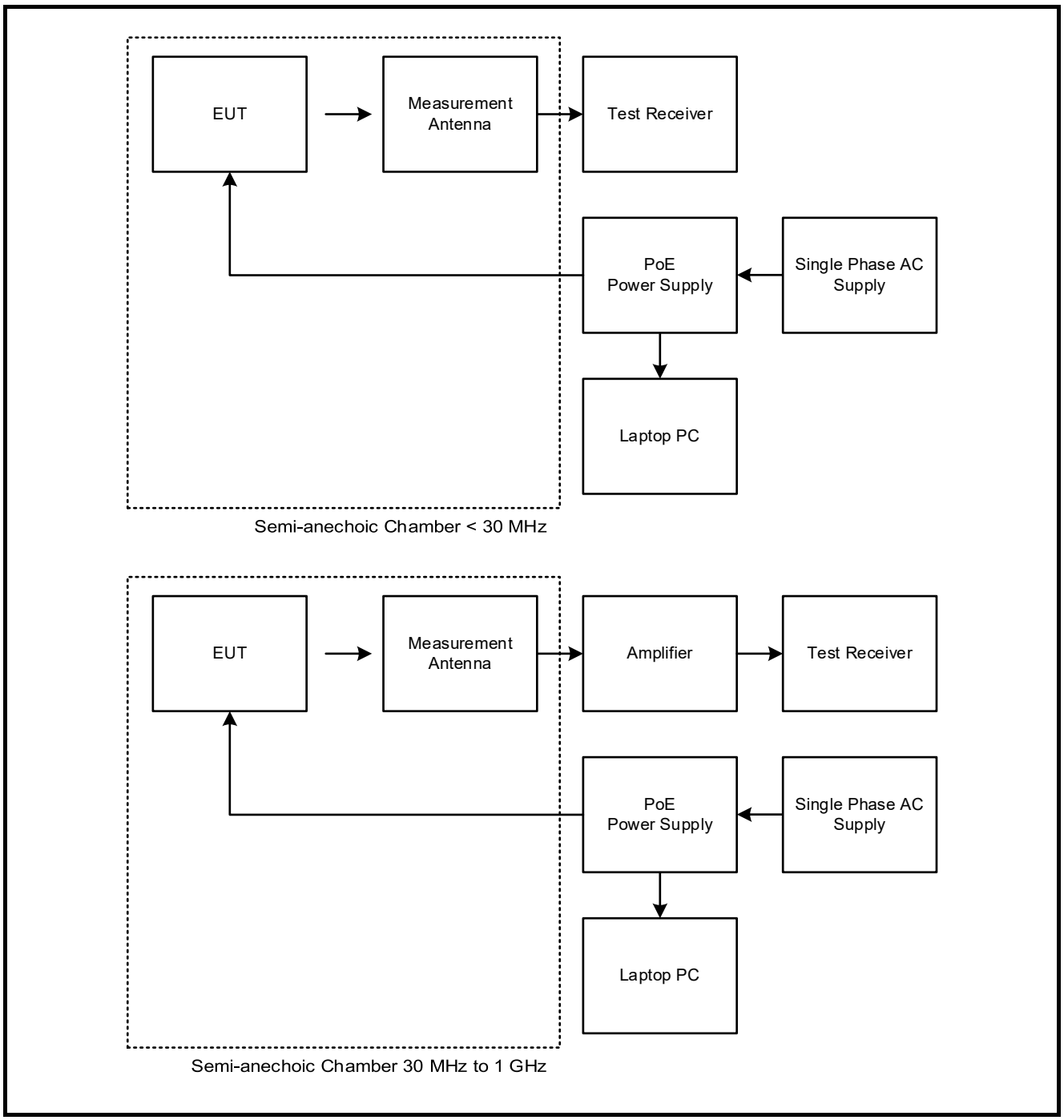
Temperature (°C):	21 to 23
Relative Humidity (%):	40 to 46

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. 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)

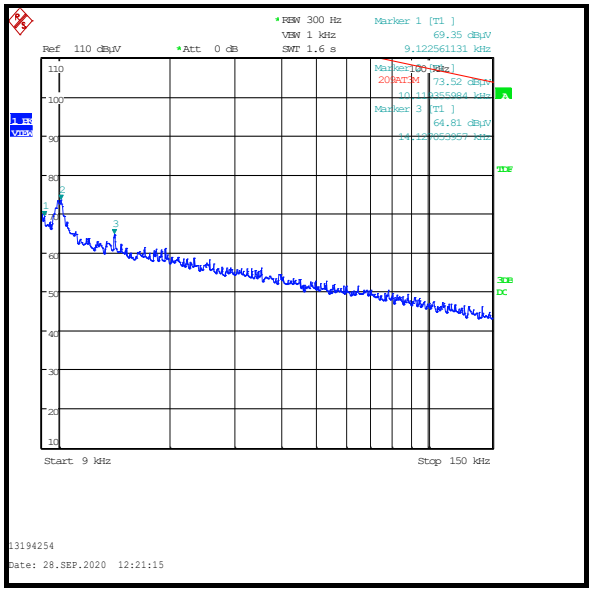
Test setup:

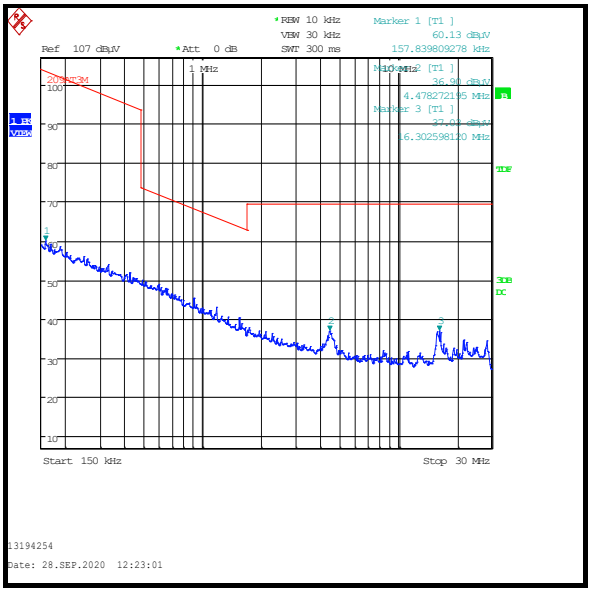


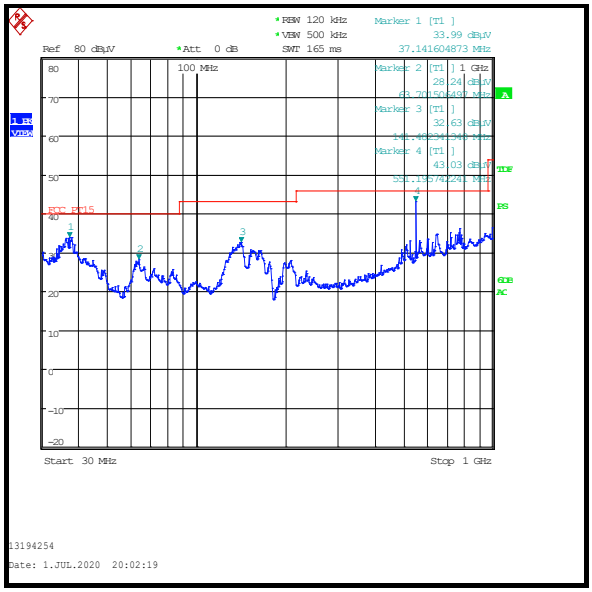
Transmitter Radiated Spurious Emissions (continued)

Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
30.162718	Horizontal	24.3	40.0	15.7	Complied
37.143667	Vertical	31.3	40.0	8.7	Complied
62.470603	Vertical	21.1	40.0	18.9	Complied
139.735879	Vertical	31.5	43.0	11.5	Complied
550.045858	Vertical	41.8	46.0	4.2	Complied
773.038359	Horizontal	31.7	46.0	14.3	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	07 Jan 2021	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Nov 2020	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	15 May 2021	12
A3167	Amplifier	Com-Power	PAM-103	18020010	01 Nov 2020	12
A259	Antenna	Chase	CBL6111A	1513	13 Jul 2021	12
M2040	Thermohygrometer	Testo	608-H1	451224934	07 Jan 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	16 Oct 2020	12

Transmitter Radiated Spurious Emissions (continued)

Test Summary:

Test Engineers:	Patrick Jones & Ben Mercer	**Test Dates:**	22 August 2020 to 04 September 2020
Test Sample Serial Numbers:	V5WA0039PTR5		

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 GHz to 200 GHz

Environmental Conditions:

Temperature (°C):	20 to 24
Relative Humidity (%):	51 to 60

Note(s):

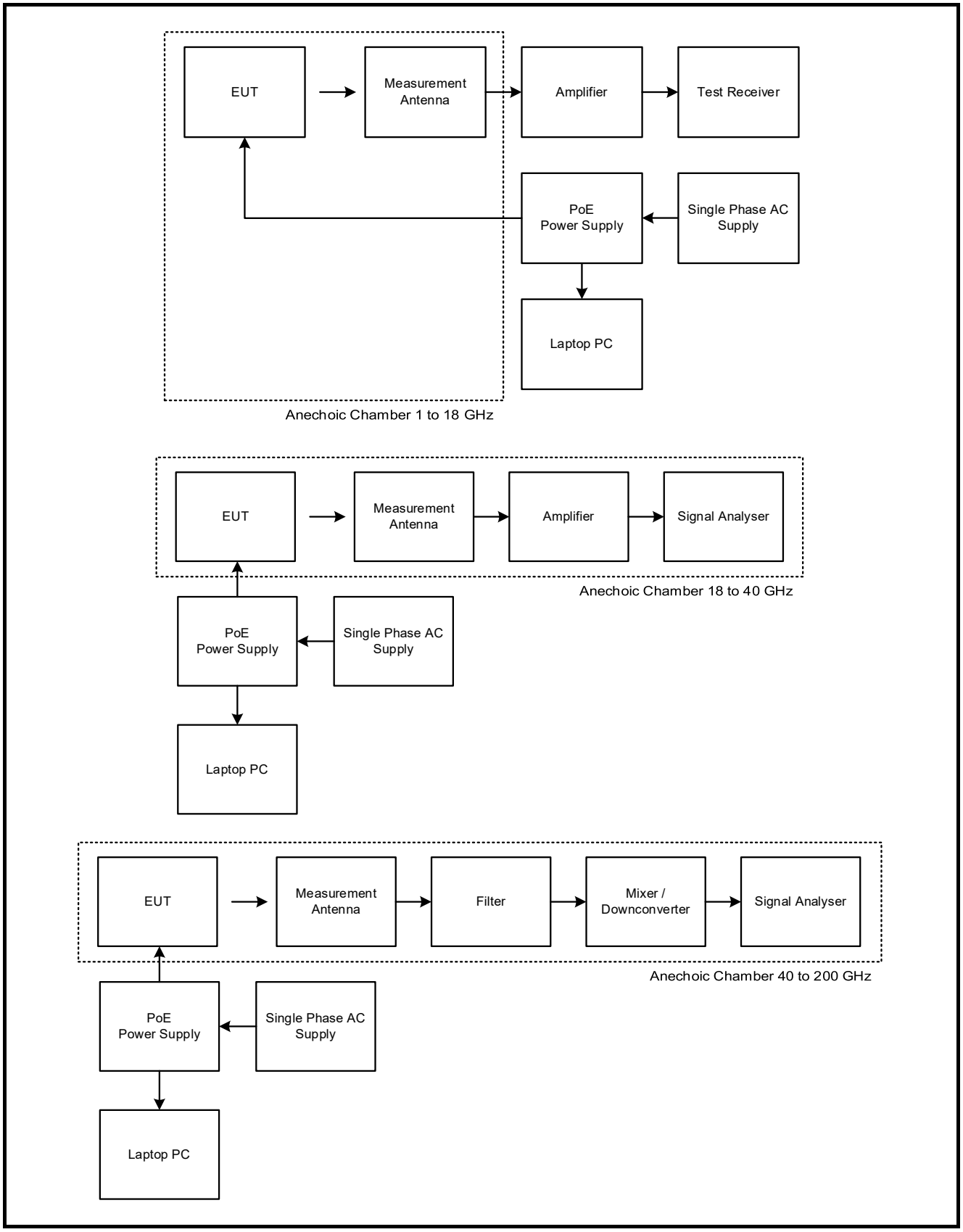
1. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
2. Final measurements above 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height 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.
3. The emission identified by a marker 2 on the 57 - 71 GHz plot is the fundamental.
4. Part 15.255(d)(3) defines a power density limit of 90 pW/cm^2 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.
5. 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 – 2 metres
   170 GHz to 200 GHz – 1 metre

6. 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.
7. 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 (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
7290.000	Horizontal	57.2	74.0	16.8	Complied

Results: Bottom Channel / Average

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
7290.000	Horizontal	53.8	54.0	0.2	Complied
115759.490	Vertical	78.0	85.3	7.3	Complied
117519.460	Vertical	80.7	85.3	4.6	Complied

Results: Middle Channel / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
7829.973	Horizontal	55.6	74.0	18.4	Complied

Results: Middle Channel / Average

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
7829.973	Horizontal	52.7	54.0	1.3	Complied
124399.500	Vertical	77.9	85.3	7.4	Complied
126159.360	Vertical	74.9	85.3	10.4	Complied

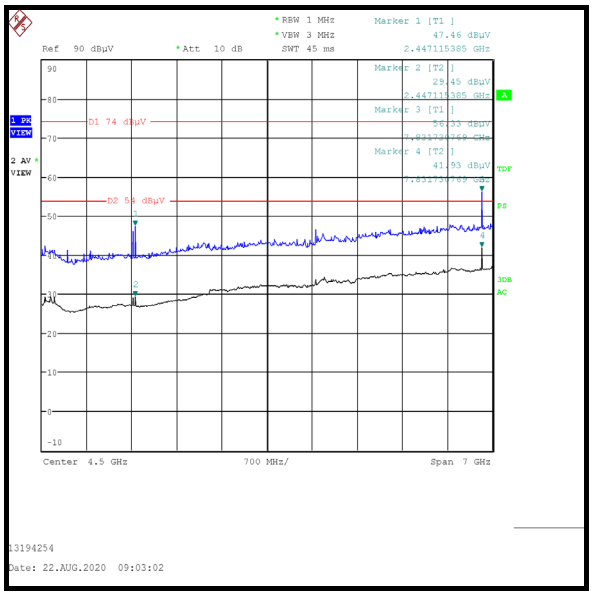
Results: Top Channel / Peak

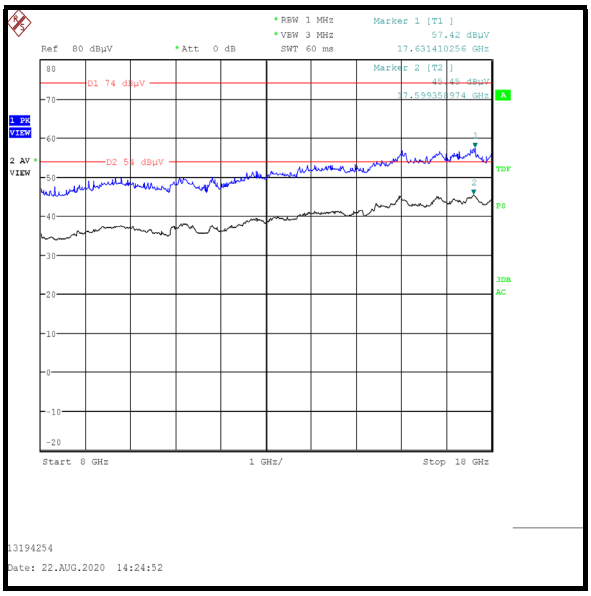
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
8099.968	Horizontal	52.4	74.0	21.6	Complied

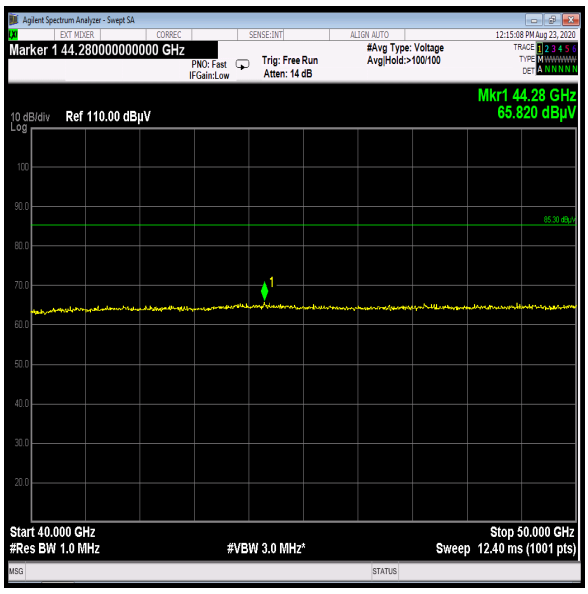
Results: Top Channel / Average

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
8100.016	Horizontal	48.4	54.0	5.6	Complied
128719.500	Vertical	77.8	85.3	7.5	Complied
130479.520	Vertical	75.9	85.3	9.4	Complied

Transmitter Radiated Spurious Emissions (continued)

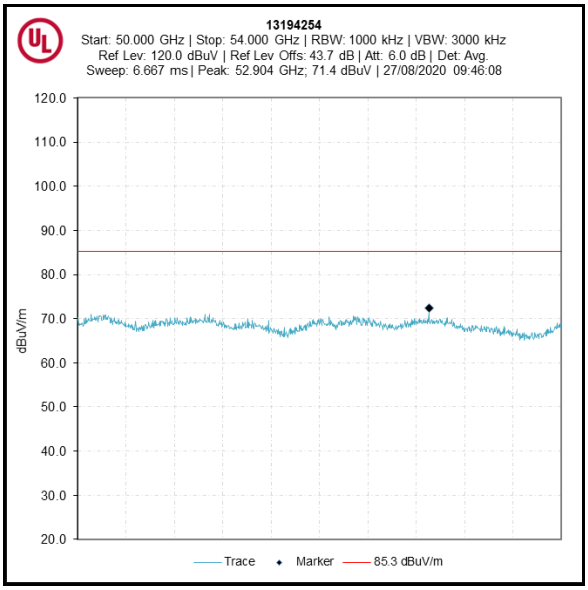


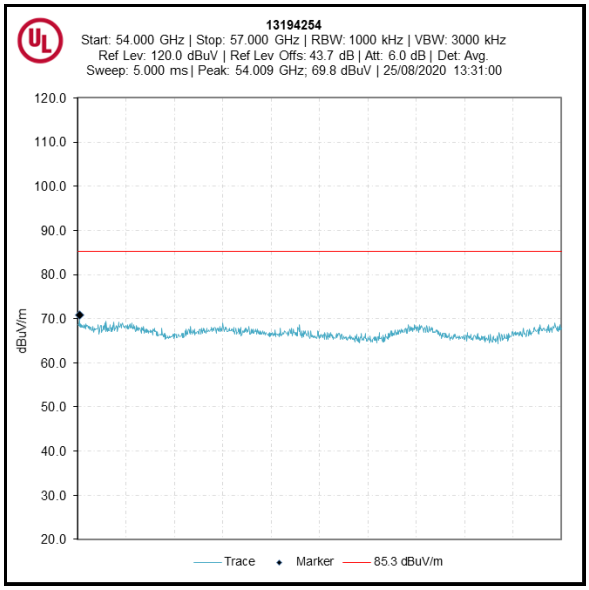


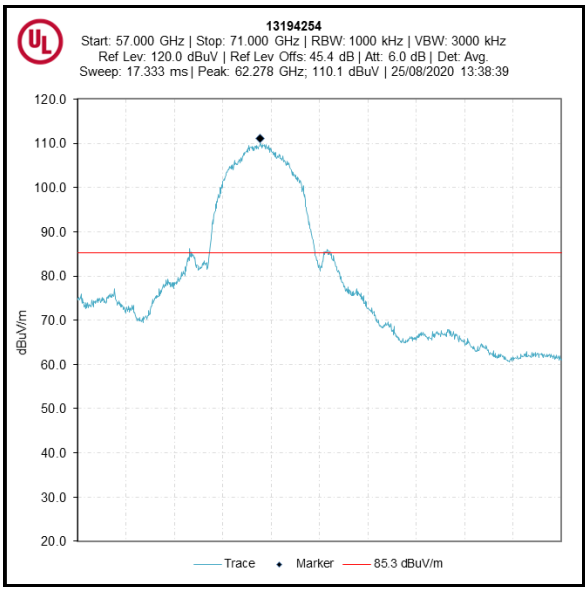


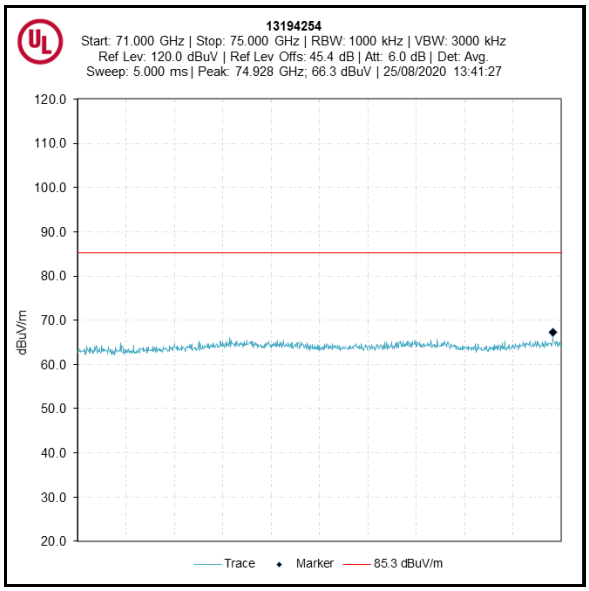
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Radiated Spurious Emissions (continued)



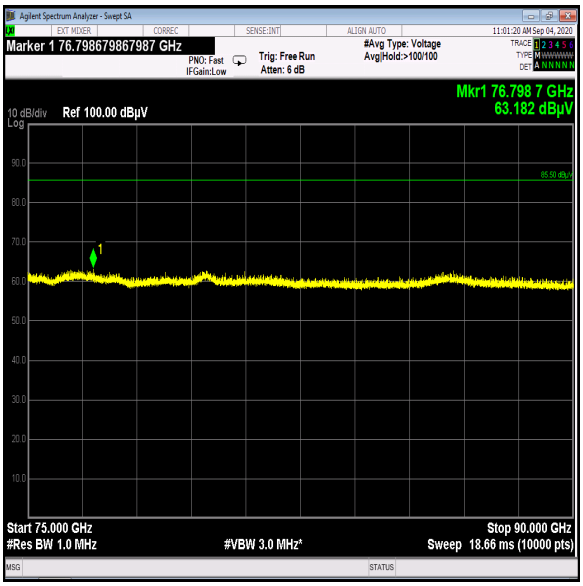


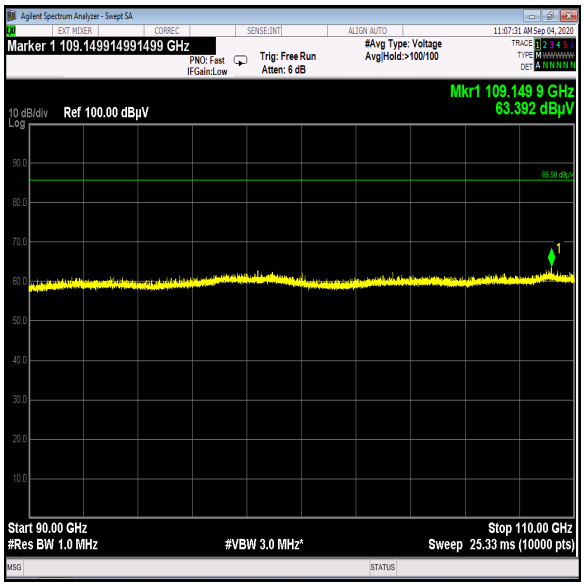


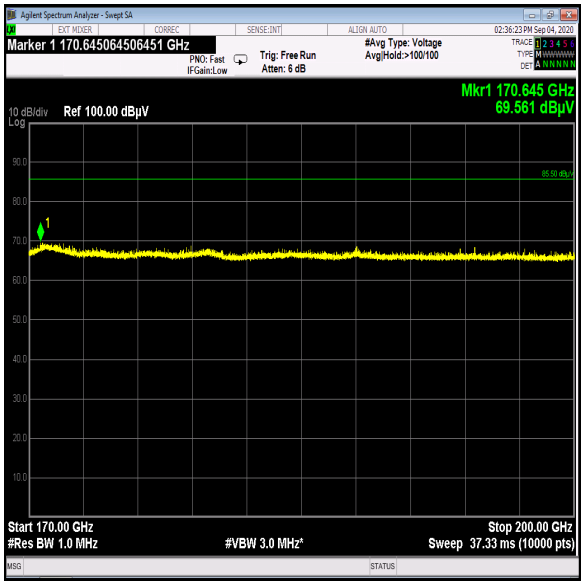


Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	09 Apr 2021	12
A3155	Pre Amplifier	Com-Power	PAM-118A	18040037	04 Oct 2020	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	702	04 Oct 2020	12
A3139	Antenna	Schwarzbeck	HWRD750	27	07 Oct 2020	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	13 Feb 2021	12
A2896	Pre Amplifier	Schwarzbeck	BBV 9721	9721 - 023	13 Feb 2021	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	06 Mar 2022	24
M197	Harmonic Mixer	Hewlett Packard	11970U	2332A00782	26 Oct 2020	36
M2064	Downconverter	Virginia Diodes	WR12SAX	SAX 325	07 Jan 2021	24
M2065	Downconverter	Virginia Diodes	WR10SAX	SAX 393	11 Jul 2021	24
M2066	Downconverter	Virginia Diodes	WR6.5SAX	SAX 392	24 Jul 2021	24
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2021	24
A2963	Horn Antenna	Link Microtek	AM19HA-ULV1	14929	16 Jan 2021	12
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 2021	12
A2967	Horn Antenna	Link Microtek	AM10HA-ULV1	14933	16 Jan 2021	12
A2968	Horn Antenna	Link Microtek	AM7HA-ULV1	14934	16 Jan 2021	12
A3212	Low Pass Filter	Sage Millimeter	SWF-50354340-22-L1	B10754-01	26 Feb 2021	12
A3213	High Pass Filter	Sage Millimeter	SWF-75370340-10-H1	18199-01	26 Feb 2021	12

5.2.7. Transmitter Frequency Stability (Temperature Variation)

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	14 September 2020
Test Sample Serial Number:	V5WA0039PTR5		

FCC Reference:	Part 15.255(f)
Test Method Used:	ANSI C63.10 Section 9.14

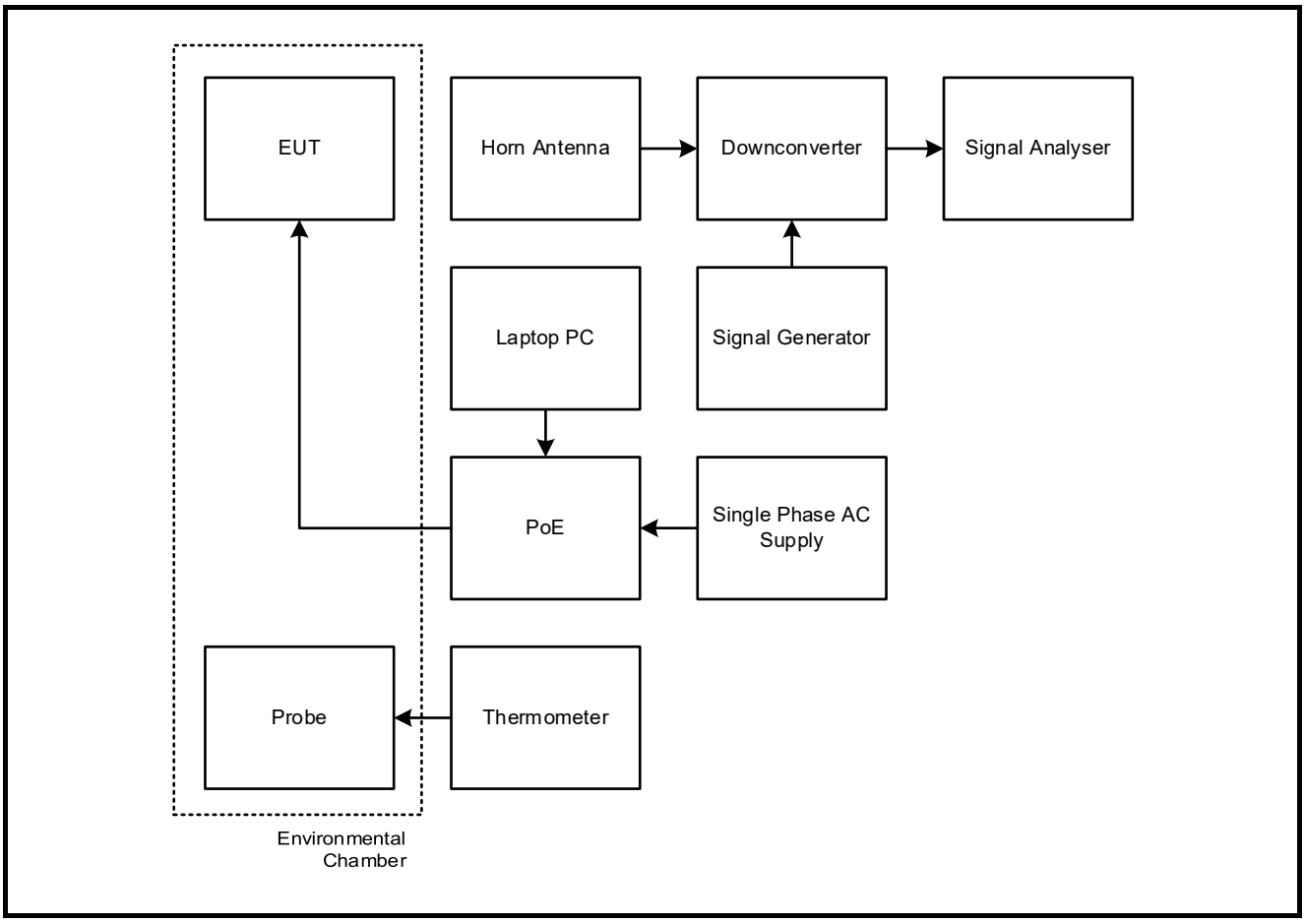
Environmental Conditions:

Ambient Temperature (°C):	23
Ambient Relative Humidity (%):	42

Note(s):

1. The 20 dB emission bandwidth was recorded on a signal analyser at bottom and top channel, and compared to the lower and upper emission edges respectively.
2. Temperature was monitored throughout the test with a calibrated digital thermometer.

Test setup:



Transmitter Frequency Stability (Temperature Variation) (continued)

Results: Bottom Channel / Lower Band Edge

Temperature (°C)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Margin (MHz)	Result
-20	57000.000	57188.160	188.160	Complied
-10	57000.000	57179.520	179.520	Complied
0	57000.000	57179.520	179.520	Complied
10	57000.000	57188.160	188.160	Complied
20	57000.000	57209.760	209.760	Complied
30	57000.000	57252.960	252.960	Complied
40	57000.000	57252.960	252.960	Complied
50	57000.000	57339.360	339.360	Complied

Results: Top Channel / Upper Band Edge

Temperature (°C)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Margin (MHz)	Result
-20	71000.000	65880.000	5120.000	Complied
-10	71000.000	65881.760	5118.240	Complied
0	71000.000	65907.680	5092.320	Complied
10	71000.000	65918.880	5081.120	Complied
20	71000.000	66566.880	4433.120	Complied
30	71000.000	66566.880	4433.120	Complied
40	71000.000	66566.880	4433.120	Complied
50	71000.000	66566.880	4433.120	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2038	Thermohygrometer	Testo	608-H1	45124919	07 Jan 2021	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	06 Mar 2022	24
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2021	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 2021	12
E0518	Environmental Chamber	TAS	LTCL 1200	24000107	Calibrated before use	-
M1642	Thermometer	Fluke	52II	18890119	04 May 2021	12

5.2.8. Transmitter Frequency Stability (Voltage Variation)

Test Summary:

Test Engineer:	Ben Mercer	**Test Date:**	18 September 2020
Test Sample Serial Number:	V5WA0039PTR5		

FCC Reference:	Part 15.255(f)
Test Method Used:	ANSI C63.10 Section 9.14

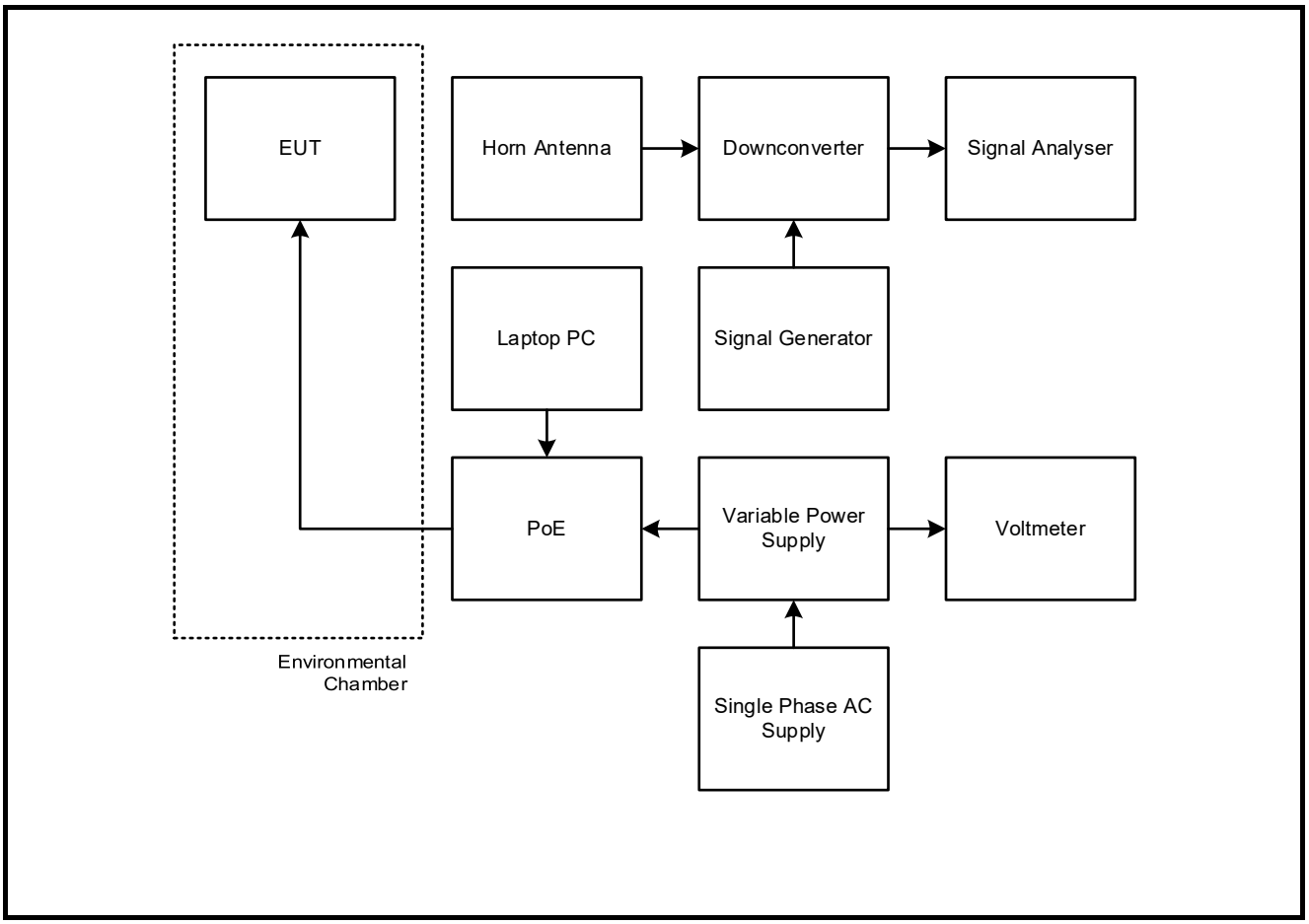
Environmental Conditions:

Ambient Temperature (°C):	21
Ambient Relative Humidity (%):	41

Note(s):

1. The 20 dB emission bandwidth was recorded on a signal analyser at bottom and top channel, and compared to the lower and upper emission edges respectively.
2. The PoE input voltage was set to 85% and 115% of the stated input voltage range of 100-240 V.
3. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Test setup:



Transmitter Frequency Stability (Voltage Variation) (continued)

Results: Bottom Channel / Lower Band Edge

Supply Voltage (VAC)	Lower Band Edge Frequency (MHz)	Lower Emission Bandwidth Frequency (MHz)	Margin (MHz)	Result
85.0	57000.000	57179.520	179.520	Complied
276.0	57000.000	57179.520	179.520	Complied

Results: Top Channel / Upper Band Edge

Supply Voltage (VAC)	Upper Band Edge Frequency (MHz)	Upper Emission Bandwidth Frequency (MHz)	Margin (MHz)	Result
85.0	71000.000	65858.400	5141.600	Complied
276.0	71000.000	65914.560	5085.440	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2038	Thermohygrometer	Testo	608-H1	45124919	07 Jan 2021	12
M1832	Signal Analyser	Agilent	N9010A	MY53470303	06 Mar 2022	24
M2069	Downconverter	Virginia Diodes	WR15SAX	SAX 394	09 Jul 2021	24
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	25 Jan 2022	24
A2964	Horn Antenna	Link Microtek	AM15HA-ULV1	14930	17 Jan 2021	12
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	-
M1251	Digital Voltmeter	Fluke	175	89170179	09 Apr 2021	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Transmitter EIRP	57 to 71 GHz	95%	± 5.36 dB
Transmitter Peak Output Power	57 to 71 GHz	95%	± 5.36 dB
Transmitter 6 dB Bandwidth	57 to 71 GHz	95%	±4.59 %
Transmitter 20 dB Bandwidth	57 to 71 GHz	95%	±4.59 %
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
Transmitter Frequency Stability	57 to 71 GHz	95%	±4.59 %

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	27	5.2.6	Corrected frequency range

--- END OF REPORT ---