



# TEST REPORT

**Test Report No. : UL-RPT-RP12712934-216C**

**Customer** : Versa Group BV  
**Model No.** : Versa 1  
**FCC ID** : 2ASXO-VERSA1  
**Technology** : *Bluetooth* – Low Energy  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.247  
**Test Laboratory** : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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5. Version 2.0 supersedes all previous versions.

**Date of Issue:** 08 September 2020

**Checked by:**

Ben Mercer  
Senior Test Engineer, Radio Laboratory

**Company Signatory:**

Sarah Williams  
Senior Test Engineer, Radio Laboratory



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**UL International (UK) Ltd**

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

## **Customer Information**

<b>Company Name:</b>	Versa Group BV
<b>Address:</b>	Binckhorstlaan 36 H0.04 The Hague 2516BE Netherlands

## **Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	10/08/2020	Initial Version	Ben Mercer
2.0	08/09/2020	Antenna gain updated	Ben Mercer

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## 1. Attestation of Test Results

### 1.1. Description of EUT

The equipment under test was a luggage tracker device incorporating *Bluetooth Low Energy & 2.4 GHz WLAN*. The EUT also contains a cellular module with FCC ID: RI7UE910GL.

### 1.2. General Information

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.247
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209
<b>Site Registration:</b>	621311
<b>Location of Testing:</b>	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
<b>Test Dates:</b>	03 July 2020 to 11 July 2020

### 1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	✓
Part 15.247(e)	Transmitter Power Spectral Density	✓
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	✓
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	✓
Part 15.207	Transmitter AC Conducted Emissions	✓

**Key to Results**

✓ = Complied    ✘ = Did not comply

#### Note(s):

1. The measurement was performed to assist in the calculation of the level of the emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.

### 1.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

## **2. Summary of Testing**

### **2.1. Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	
Site 2	
Site 17	X

UL International (UK) Ltd is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

### **2.2. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
<b>Title:</b>	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
<b>Reference:</b>	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
<b>Title:</b>	AC Power-Line Conducted Emissions Frequently Asked Questions

## **2.3. Calibration and Uncertainty**

### **Measuring Instrument Calibration**

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

### **Measurement Uncertainty**

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

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

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

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

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Conducted Maximum Peak Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±1.96 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

## **2.4. Test and Measurement Equipment**

### **Test Equipment Used for Transmitter Minimum 6 dB Bandwidth, Duty Cycle, Spectral Power Density & Maximum Peak Output Power Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 2021	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	14 Apr 2021	12
G0615	Signal Generator	Rohde & Schwarz	SMBV100A	260473	19 Mar 2023	36
A2525	Attenuator	AtlanTecRF	AN18W5-10	832827#3	Calibrated before use	-

### **Test Equipment Used for Transmitter Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford	N/A	N/A	01 Aug 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
M1995	Test receiver	Rohde & Schwarz	ESU40	100428	20 Jan 2021	12
A3167	Pre-Amplifier	Com-Power	PAM-103	18020010	14 Aug 2020	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A3224	Pre-Amplifier	Schwarzbeck	BBV 9718 C	00071	24 Apr 2021	12
A2896	Pre-Amplifier	Schwarzbeck	BBV 9721	9721 - 023	13 Feb 2021	12
A3161	Antenna	Teseq	CBL6111D	50859	07 Jan 2021	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	00653	08 Aug 2020	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	08 Aug 2020	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	13 Feb 2021	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	06 Feb 2021	12
A3113	Attenuator	AtlanTecRF	AN18-06	219706#3	07 Jan 2021	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	05 Feb 2021	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	06 Feb 2021	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	06 Feb 2021	12

**Test and Measurement Equipment (continued)****Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford	N/A	N/A	01 Aug 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
M1995	Test receiver	Rohde & Schwarz	ESU40	100428	20 Jan 2021	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	00653	08 Aug 2020	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#2	06 Feb 2021	12

**Test Equipment Used for Transmitter AC Conducted Spurious Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	07 Jan 2021	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	08 Aug 2020	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

**Test Measurement Software/Firmware Used for Transmitter AC Conducted Tests**

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	N/A

### **3. Equipment Under Test (EUT)**

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

<b>Brand Name:</b>	Versa
<b>Model Name or Number:</b>	Versa 1
<b>Test Sample Serial Number:</b>	355000080579080 ( <i>Conducted Sample #1</i> )
<b>Hardware Version:</b>	1.8.0
<b>RF Firmware Version:</b>	1.0.0
<b>FCC ID:</b>	2ASXO-VERSA1

<b>Brand Name:</b>	Versa
<b>Model Name or Number:</b>	Versa 1
<b>Test Sample Serial Number:</b>	355000080506299 ( <i>Radiated Sample #1</i> )
<b>Hardware Version:</b>	1.8.0
<b>RF Firmware Version:</b>	1.0.0
<b>FCC ID:</b>	2ASXO-VERSA1

<b>Brand Name:</b>	Versa
<b>Model Name or Number:</b>	Versa 1
<b>Test Sample Serial Number:</b>	355000081613904 ( <i>Radiated Sample #2</i> )
<b>Hardware Version:</b>	1.8.0
<b>RF Firmware Version:</b>	1.0.0
<b>FCC ID:</b>	2ASXO-VERSA1

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

No modifications were applied to the EUT during testing.

### **3.3. Additional Information Related to Testing**

<b>Technology Tested:</b>	Bluetooth Low Energy (Digital Transmission System)				
<b>Type of Unit:</b>	Transceiver				
<b>Channel Spacing:</b>	2 MHz				
<b>Modulation:</b>	GFSK				
<b>Data Rate:</b>	1 Mbit/s				
<b>Power Supply Requirement(s):</b>	Nominal	3.7 VDC			
<b>Maximum Conducted Output Power:</b>	10.0 dBm				
<b>Transmit Frequency Range:</b>	2402 MHz to 2480 MHz				
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>		
	Bottom	37	2402		
	Middle	17	2440		
	Top	39	2480		

### **3.4. Description of Available Antenna**

The radio utilizes an integrated antenna, with the following maximum gain:

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	1.5

### **3.5. Description of Test Setup**

#### **Support Equipment**

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

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Dell Latitude
<b>Model Name or Number:</b>	E6320
<b>Serial Number:</b>	00115279

<b>Description:</b>	USB Type A to Micro USB Type B Cable. Length 1.8 m.
<b>Brand Name:</b>	Not stated or marked
<b>Model Name or Number:</b>	Not stated or marked
<b>Serial Number:</b>	Not stated or marked

<b>Description:</b>	USB Diagnostic Cable and Test Jig
<b>Brand Name:</b>	Not stated or marked
<b>Model Name or Number:</b>	Not stated or marked
<b>Serial Number:</b>	Not stated or marked

<b>Description:</b>	AC to DC USB Charger
<b>Brand Name:</b>	Unifive
<b>Model Name or Number:</b>	UBK310-0520
<b>Serial Number:</b>	F07-3000084

## **Operating Modes**

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

- Transmitting at maximum power in *Bluetooth LE* mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

## **Configuration and Peripherals**

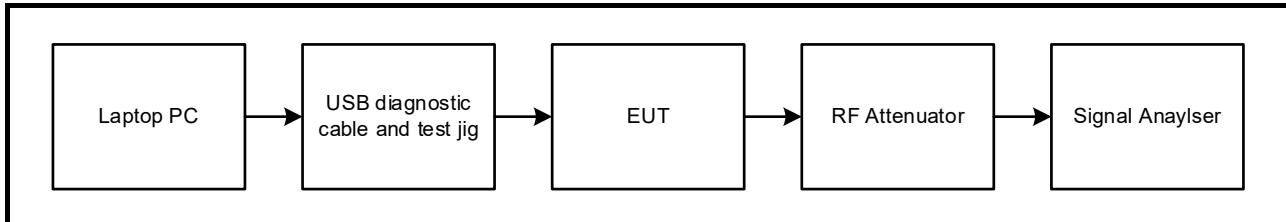
The EUT was tested in the following configuration(s):

- Controlled in test mode using a set of commands entered into a terminal application on the laptop PC supplied by the customer. The commands were used to enable continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions “ESP32\_Certification\_and\_Test\_Guide\_EN.pdf”, dated 20 February 2019. Once in the correct mode for testing, the laptop PC was removed during radiated spurious emissions tests.
- The EUT was powered from a 3.7 VDC internal battery for conducted RF tests.
- AC conducted tests were performed with the AC charger connected and charging the EUT. There were no other ports to terminate.
- Transmitter radiated spurious emissions tests were performed with the AC charger connected to the EUT as this was found to be the worst case during pre-scans. There were no other ports to terminate.
- The conducted RF sample with Serial No. 355000080579080 was supplied with a temporary RF cable and RF connector. This had a declared insertion loss of 0.65 dB.

## Test Setup Diagrams

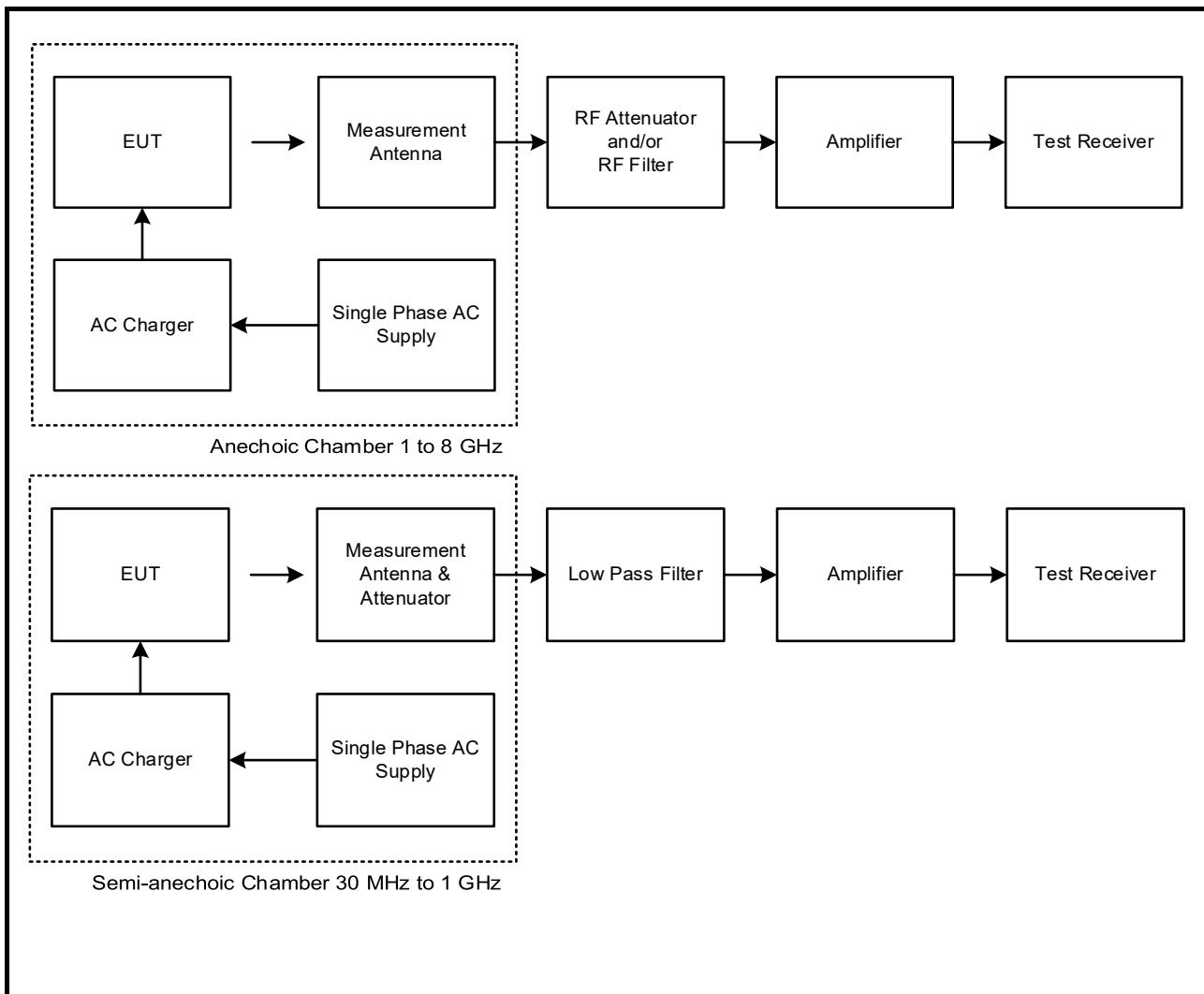
### Conducted Tests:

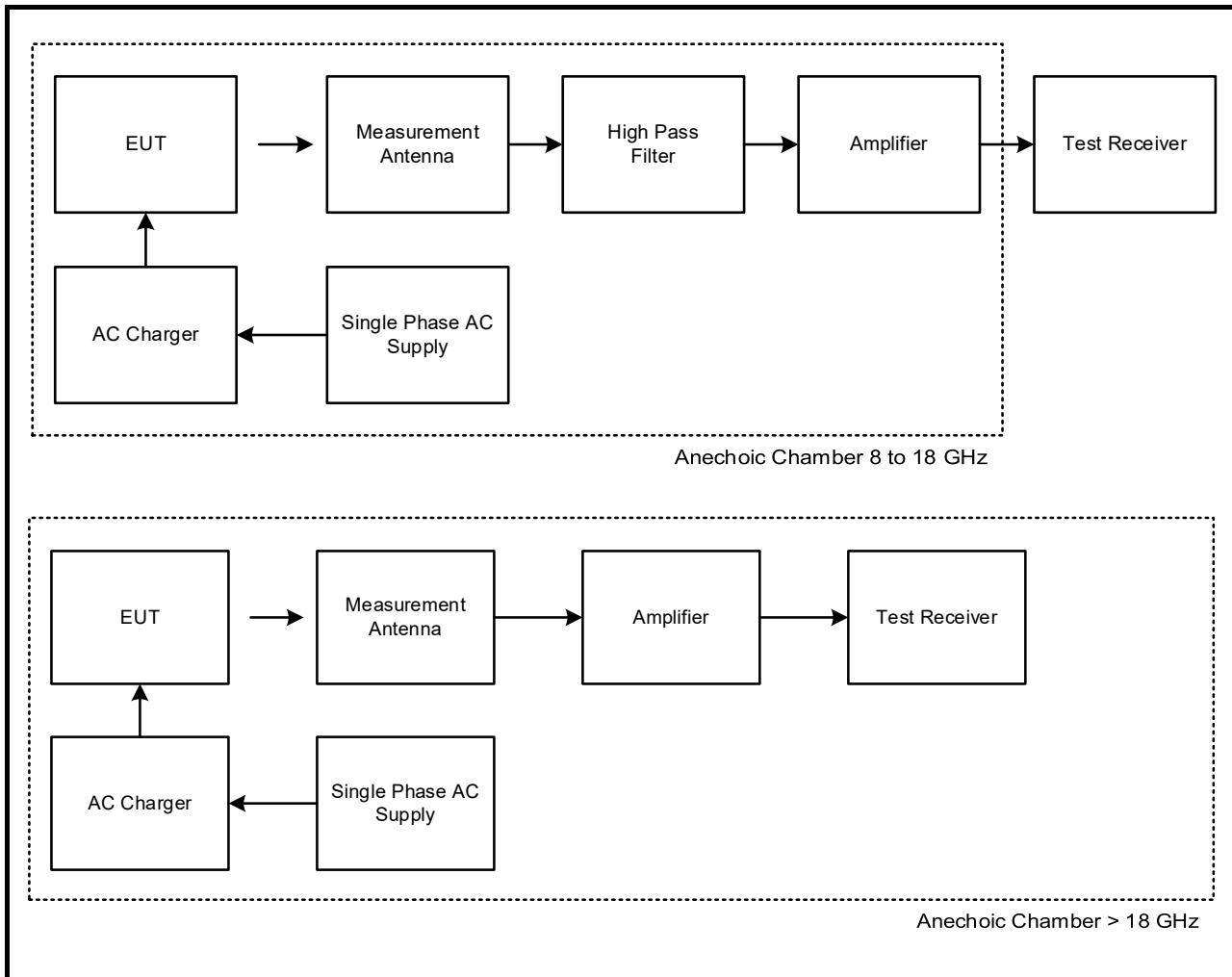
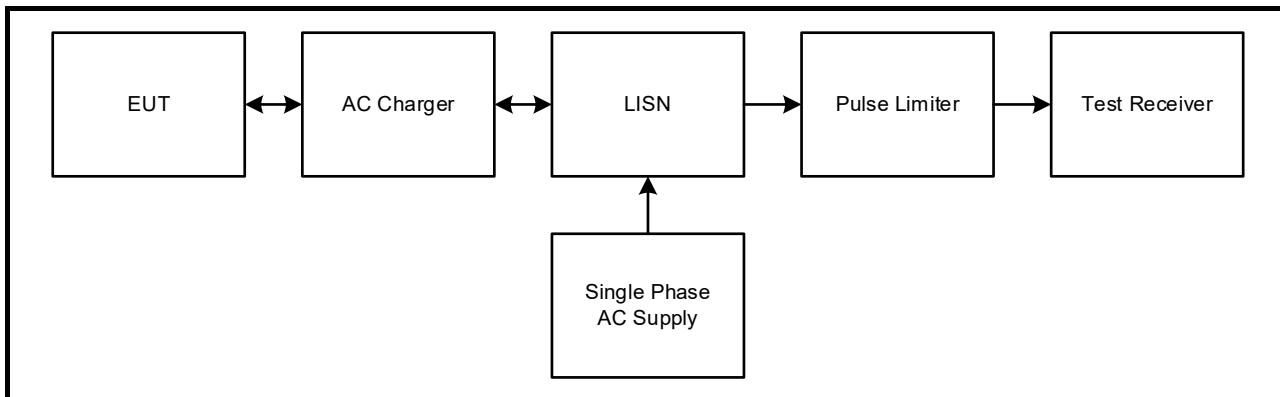
#### Test Setup for Transmitter Duty Cycle, Minimum 6 dB Bandwidth, Spectral Power Density & Maximum Output Power



### Radiated Tests:

#### Test Setup for Transmitter Radiated Emissions



**Test Setup Diagrams (continued)****Test Setup for Transmitter Radiated Emissions****Test Setup for Transmitter AC Conducted Spurious Emissions**

## **4. Antenna Port Test Results**

### **4.1. Transmitter Minimum 6 dB Bandwidth**

#### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	03 July 2020
<b>Test Sample Serial Number:</b>	355000080579080		

<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8.1

#### **Environmental Conditions:**

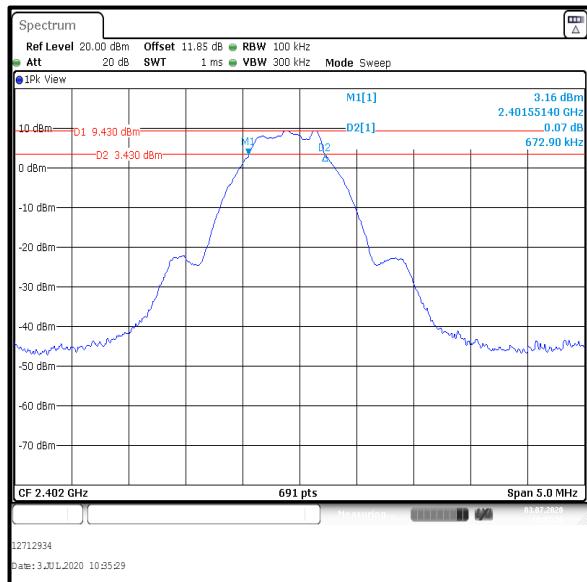
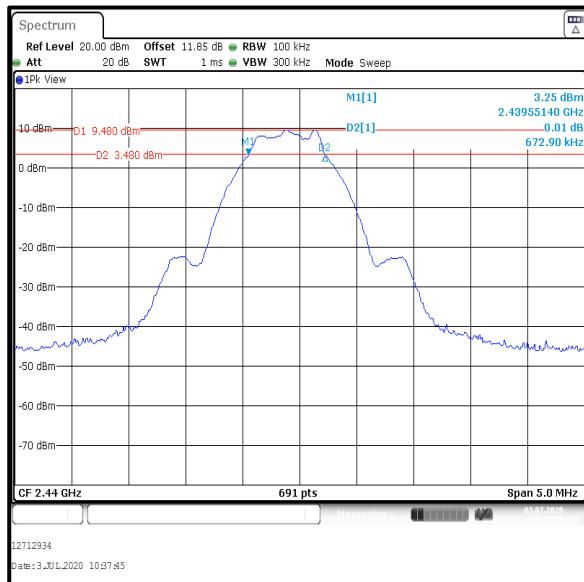
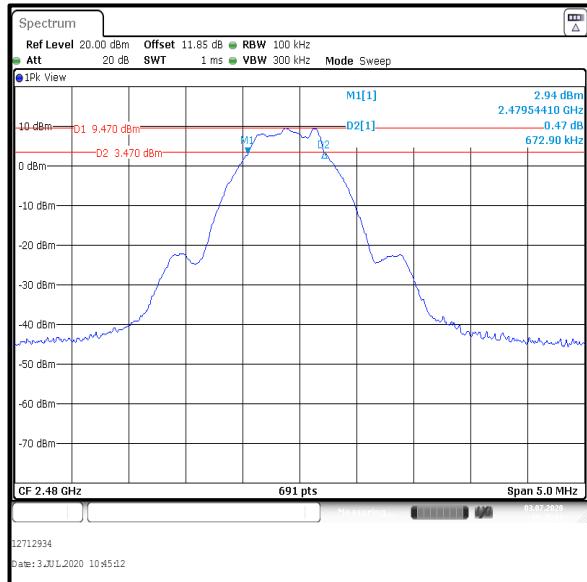
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	58

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

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.8.1 Option 1 measurement procedure. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

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

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	672.900	≥500	172.900	Complied
Middle	672.900	≥500	172.900	Complied
Top	672.900	≥500	172.900	Complied

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

## 4.2. Transmitter Duty Cycle

### Test Summary:

Test Engineer:	Matthew Botfield	Test Date:	03 July 2020
Test Sample Serial Number:	355000080579080		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6 referencing ANSI C63.10 Section 11.6

### Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	58

### Note(s):

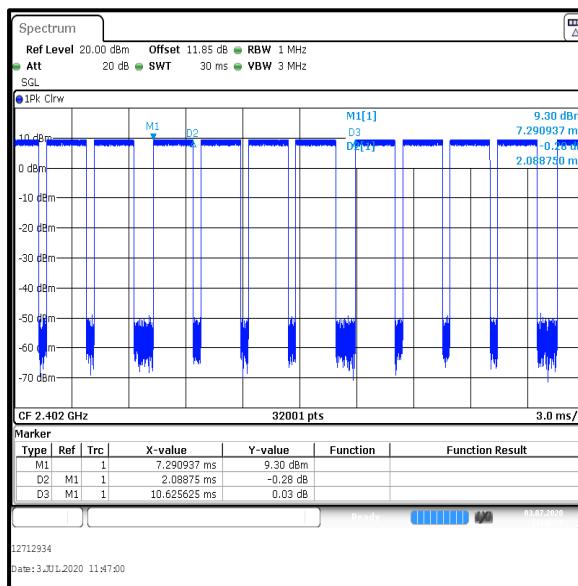
1. In order to assist with the determination of the average level of spurious emissions, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a signal analyser in the time domain and calculated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

$$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])).$$

$$\text{Duty cycle: } 10 \log (1 / (8355.000 \mu\text{s} / 10625.625 \mu\text{s})) = 1.0 \text{ dB}$$

### Results:

Pulse Duration ( $\mu\text{s}$ )	Period ( $\mu\text{s}$ )	Duty Cycle (dB)
8355.000	10625.625	1.0



### **4.3. Transmitter Maximum Peak Output Power**

#### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	03 July 2020
<b>Test Sample Serial Number:</b>	355000080579080		

<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.3.1.1 referencing ANSI C63.10 Section 11.9.1.1 and Notes below

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	58

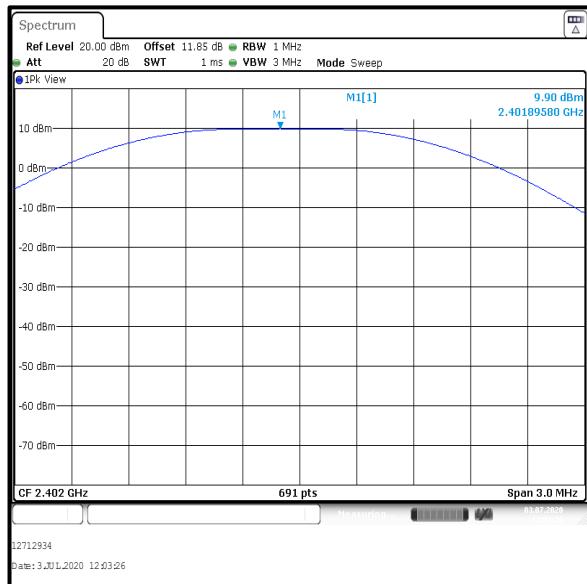
#### **Note(s):**

1. Conducted power tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 with the  $RBW \geq DTS$  bandwidth procedure.
2. The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth of 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 MHz. A marker was placed at the peak of the signal and the results recorded in the tables below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cables.
4. The conducted power was added to the declared antenna gain to obtain the EIRP.

**Transmitter Maximum Peak Output Power (continued)****Results:**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	9.9	30.0	20.1	Complied
Middle	9.9	30.0	20.1	Complied
Top	10.0	30.0	20.0	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	9.9	1.5	11.4	36.0	24.6	Complied
Middle	9.9	1.5	11.4	36.0	24.6	Complied
Top	10.0	1.5	11.5	36.0	24.5	Complied

**Transmitter Maximum Peak Output Power (continued)****Results:****Bottom Channel****Middle Channel****Top Channel**

#### **4.4. Transmitter Power Spectral Density**

##### **Test Summary:**

<b>Test Engineer:</b>	Matthew Botfield	<b>Test Date:</b>	03 July 2020
<b>Test Sample Serial Number:</b>	355000080579080		

<b>FCC Reference:</b>	Part 15.247(e)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.4 referencing ANSI C63.10 Section 11.10.2

##### **Environmental Conditions:**

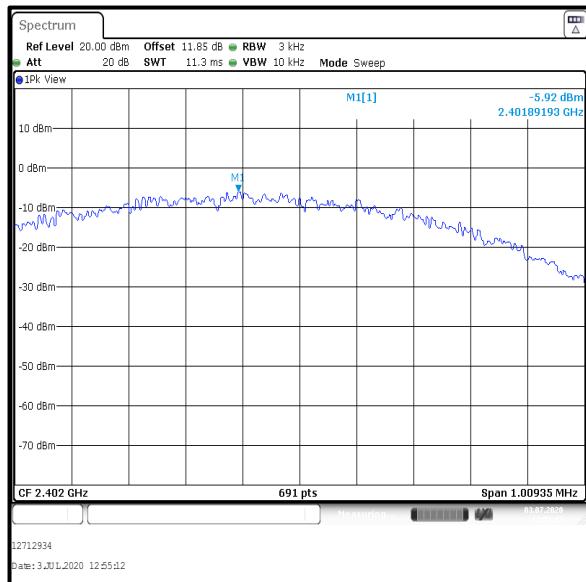
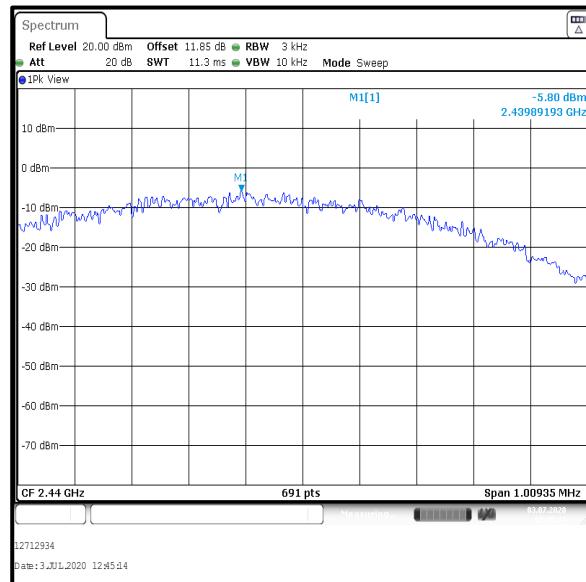
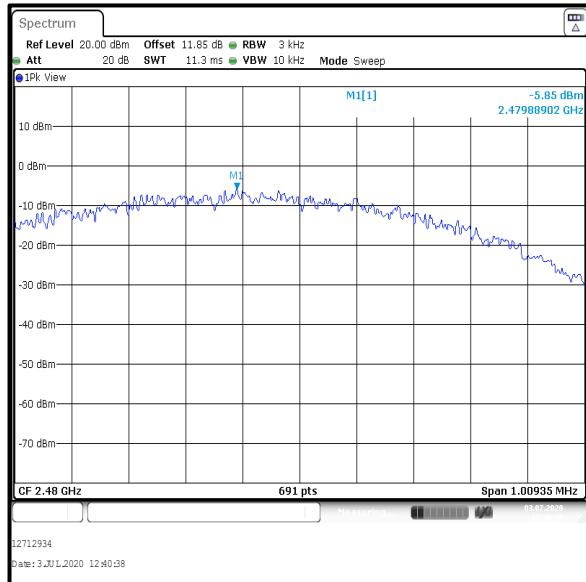
<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	58

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

1. Transmitter Power Spectral Density tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.10.2.
2. The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth 10 kHz. A Peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 1.5 times the measured DTS bandwidth. A marker was placed at the peak of the signal and the results recorded in the table below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

**Transmitter Power Spectral Density (continued)****Results:**

Channel	Output Power (dBm / 3 kHz)	Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-5.9	8.0	13.9	Complied
Middle	-5.8	8.0	13.8	Complied
Top	-5.8	8.0	13.8	Complied

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

## **5. Radiated Test Results**

### **5.1. Transmitter Radiated Emissions <1 GHz**

#### **Test Summary:**

<b>Test Engineer:</b>	Mark Perry	<b>Test Date:</b>	11 July 2020
<b>Test Sample Serial Number:</b>	355000080506299		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

#### **Environmental Conditions:**

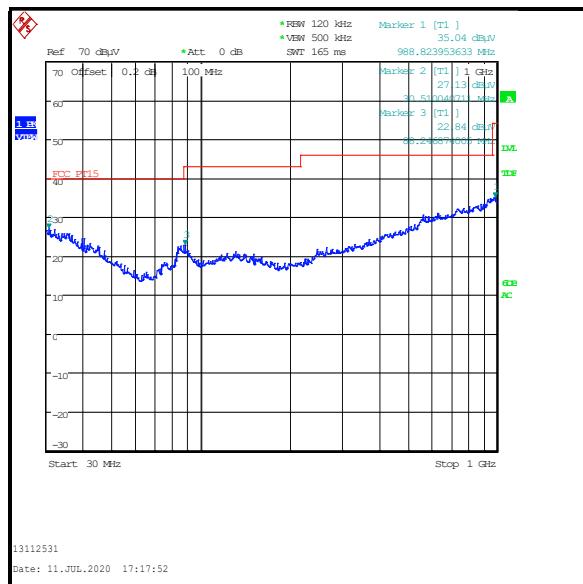
<b>Temperature (°C):</b>	24 to 25
<b>Relative Humidity (%):</b>	37 to 42

#### **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 were performed with the EUT set to the middle channel only.
3. All other emissions shown on the pre-scan plots were investigated and found to be ambient, >20 dB below the applicable limit or below the measurement system noise floor.
4. Measurements below 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.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
31.677	Vertical	21.1	40.0	18.9	Complied
75.311	Vertical	19.5	40.0	20.5	Complied



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

## **5.2. Transmitter Radiated Emissions >1 GHz**

### **Test Summary:**

<b>Test Engineer:</b>	Mark Perry	<b>Test Date:</b>	11 July 2020
<b>Test Sample Serial Number:</b>	355000080506299		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 8.1 c)3), 8.5 & 8.6 referencing ANSI C63.10 Sections 6.3, 6.6, 11.11 & 11.12
<b>Frequency Range</b>	1 GHz to 25 GHz

### **Environmental Conditions:**

<b>Temperature (°C):</b>	24 to 25
<b>Relative Humidity (%):</b>	37 to 42

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

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
3. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements were performed in a fully anechoic chamber (Asset Number K0017) 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.
4. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their respective detectors during the pre-scan measurements.
5. All other emissions shown on the pre-scans were investigated and found to be ambient, >20 dB below the applicable limit or below the noise floor of the measurement system.
6. \*In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
3202.276	Horizontal	47.2	80.9	33.7	Complied

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4803.614	Vertical	50.3*	54.0	3.7	Complied

**Results: Peak / Middle Channel**

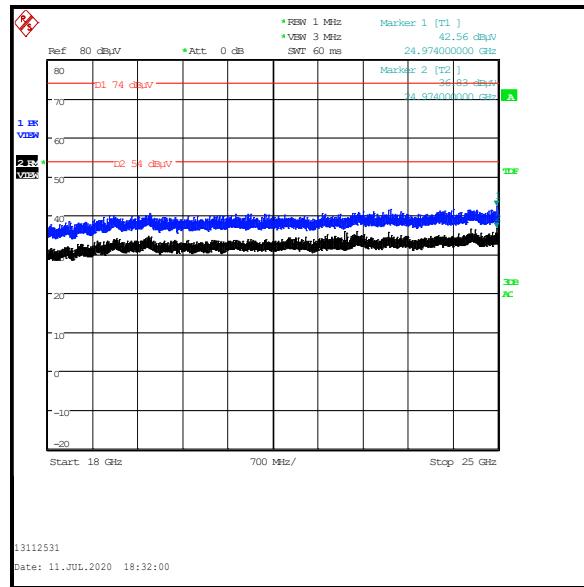
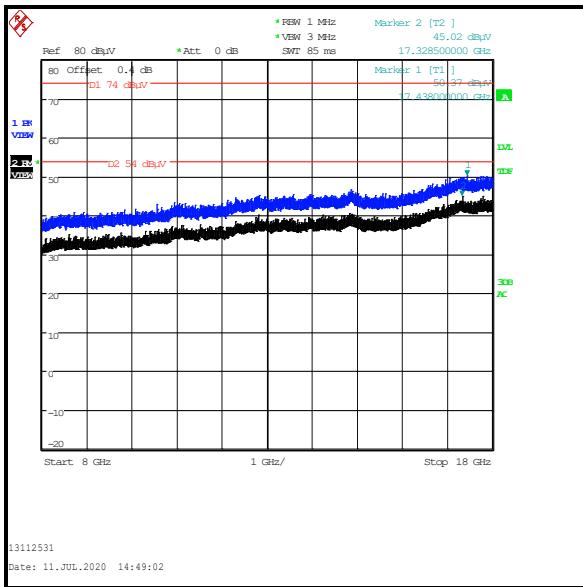
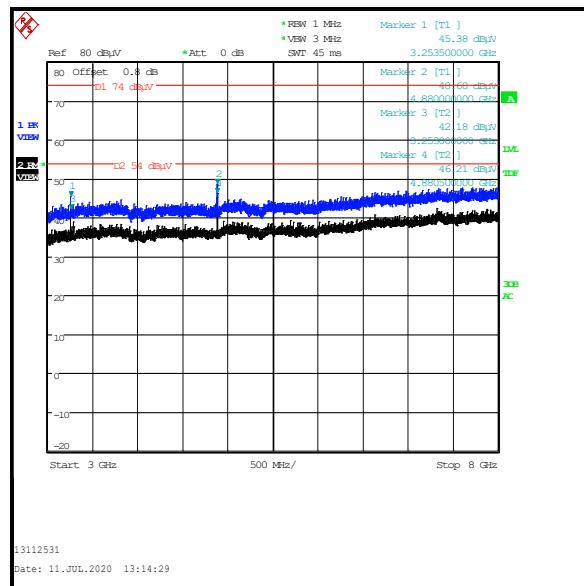
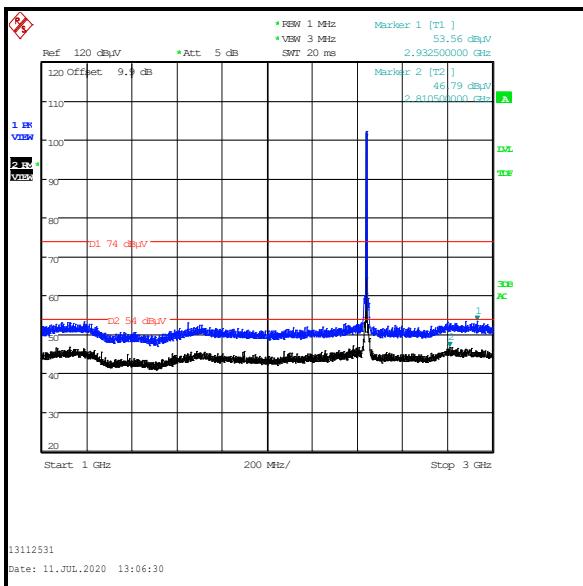
Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
3253.340	Horizontal	48.2	80.9	32.7	Complied

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4880.112	Vertical	50.9*	54.0	3.1	Complied

**Results: Peak / Top Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
3306.657	Horizontal	48.4	80.9	32.5	Complied

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4960.080	Vertical	53.2*	54.0	0.8	Complied

**Transmitter Radiated Emissions (continued)**

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

### **5.3. Transmitter Band Edge Radiated Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Mark Perry	<b>Test Date:</b>	11 July 2020
<b>Test Sample Serial Number:</b>	355000080506299		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	KDB 558074 Section 8.7 referencing ANSI C63.10 Sections 11.11, 11.12 & 11.13

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	24 to 25
<b>Relative Humidity (%):</b>	37 to 42

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

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The maximum peak conducted output power was previously measured. In accordance with ANSI C63.10 Section 11.11.1(a), the lower band edge measurement was performed with a peak detector and the -20 dBc limit applied.
3. As the lower band edge is adjacent to a non-restricted band, only peak measurements are required. In accordance with ANSI C63.10 Section 11.11.1, the test method in Section 11.11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum peak conducted output power was measured using a peak detector in accordance with ANSI C63.10 Section 11.9.1.1 an out-of-band limit line was placed 20 dB (ANSI C63.10 Section 11.11.1(a)) below the peak level. A marker was placed on the band edge spot frequencies. Marker frequency and levels were recorded.
4. As the upper band edge is adjacent to a restricted band, both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was trace averaging over 300 sweeps. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
5. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with peak and RMS detectors respectively. Markers were placed on the highest point on each trace.
6. \* -20 dBc limit.
7. For the upper band edge average result, the EUT had a duty cycle <98%. The duty cycle correction factor has been applied and the corrected level is shown below:

$$\text{Upper Band Average result} + \text{duty cycle} = \text{Corrected band edge level}$$

$$\text{Corrected band edge level at 2483.5 MHz: } 51.9 + 1.0 = 52.9 \text{ dB}\mu\text{V/m}$$

**Transmitter Band Edge Radiated Emissions (continued)****Results: Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2393.349	Horizontal	50.2	80.9*	30.7	Complied
2400.000	Horizontal	47.8	80.9*	33.1	Complied
2483.500	Horizontal	59.9	74.0	14.1	Complied

**Results: Average**

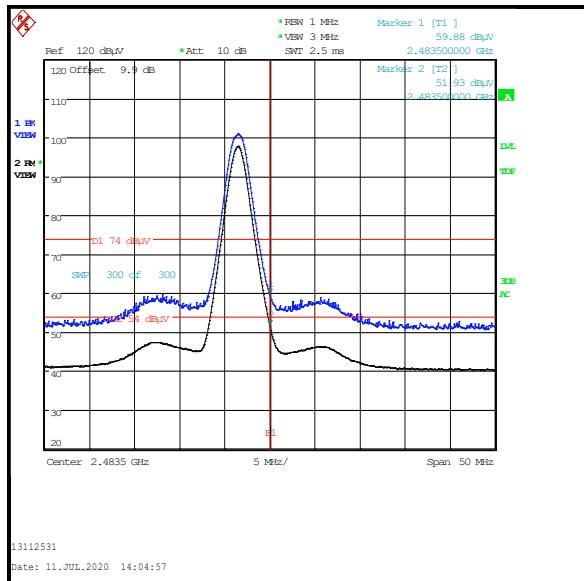
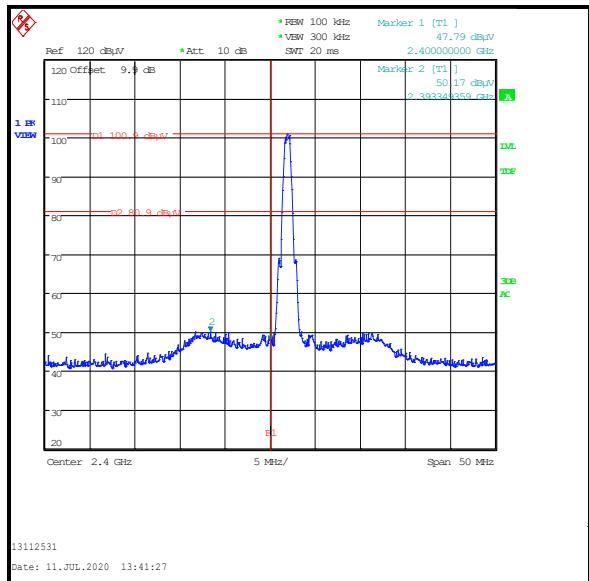
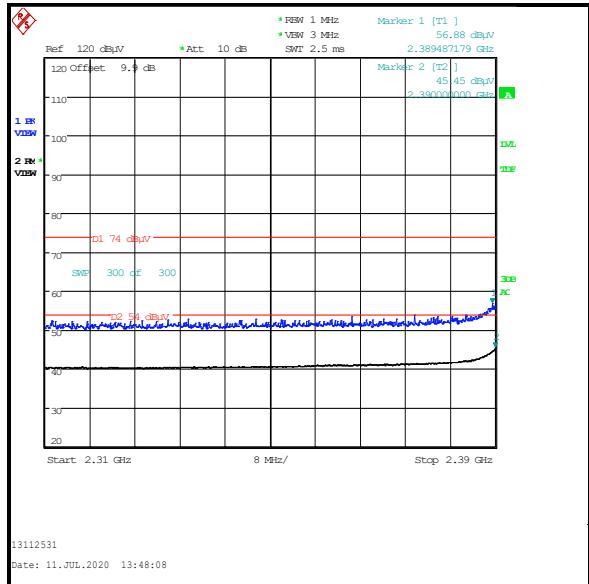
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Duty cycle correction (dB)	Corrected Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Horizontal	51.9	1.0	52.9	54.0	1.1	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.487	Horizontal	56.9	74.0	17.1	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	Horizontal	45.5	54.0	8.5	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results:****Lower Band Edge****Upper Band Edge****2310 MHz to 2390 MHz Restricted Band**

## **6. AC Power Line Conducted Emissions Test Results**

### **6.1. Transmitter AC Conducted Spurious Emissions**

#### **Test Summary:**

<b>Test Engineer:</b>	Alison Johnston & Raghavendra Katti	<b>Test Date:</b>	7 July 2020
<b>Test Sample Serial Number:</b>	355000081613904		

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

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	27
<b>Relative Humidity (%):</b>	37

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

1. The EUT was connected to its USB AC charger. The AC charger was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were also performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the EUT power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.465000	Live	34.9	56.6	21.7	Complied
0.595500	Live	37.7	56.0	18.3	Complied
0.730500	Live	30.4	56.0	25.6	Complied
1.099500	Live	28.9	56.0	27.1	Complied
2.422500	Live	28.5	56.0	27.5	Complied
24.252000	Live	11.0	60.0	49.0	Complied

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

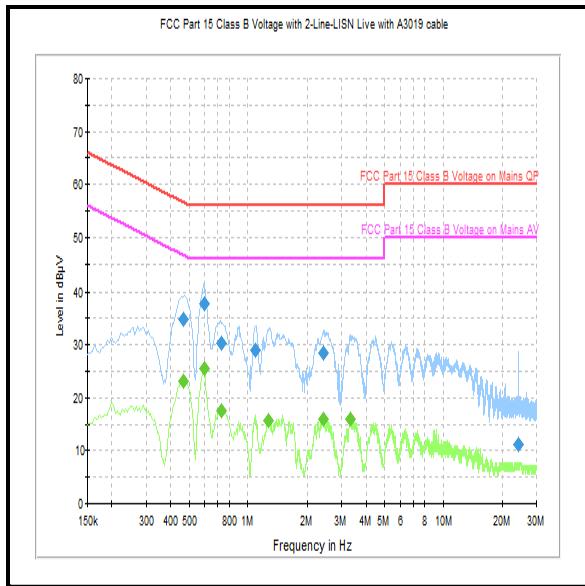
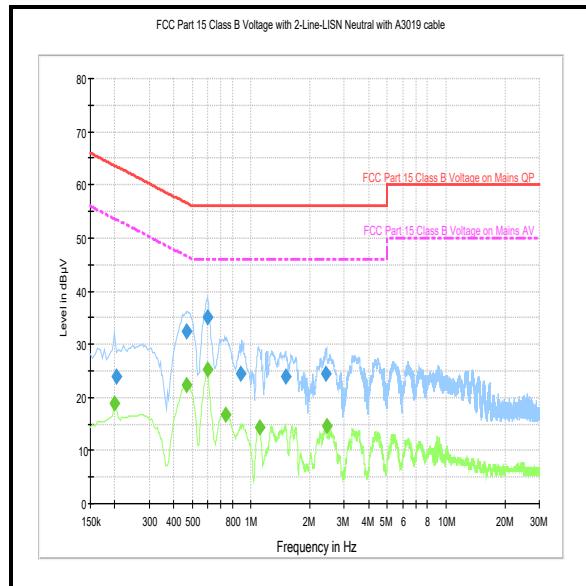
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.469500	Live	23.1	46.5	23.4	Complied
0.595500	Live	25.5	46.0	20.5	Complied
0.735000	Live	17.5	46.0	28.5	Complied
1.279500	Live	15.8	46.0	30.2	Complied
2.413500	Live	15.8	46.0	30.2	Complied
3.313500	Live	15.9	46.0	30.1	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.204000	Neutral	24.0	63.4	39.4	Complied
0.469500	Neutral	32.4	56.5	24.1	Complied
0.595500	Neutral	35.2	56.0	20.8	Complied
0.888000	Neutral	24.4	56.0	31.6	Complied
1.500000	Neutral	23.9	56.0	32.1	Complied
2.418000	Neutral	24.6	56.0	31.4	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.199500	Neutral	18.8	53.6	34.8	Complied
0.465000	Neutral	22.3	46.6	24.3	Complied
0.600000	Neutral	25.2	46.0	20.8	Complied
0.744000	Neutral	16.8	46.0	29.2	Complied
1.104000	Neutral	14.5	46.0	31.5	Complied
2.431500	Neutral	14.6	46.0	31.4	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 (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.442500	Live	35.3	57.0	21.7	Complied
0.577500	Live	36.3	56.0	19.7	Complied
0.640500	Live	41.5	56.0	14.5	Complied
0.856500	Live	35.8	56.0	20.2	Complied
2.130000	Live	32.7	56.0	23.3	Complied
3.790500	Live	31.9	56.0	24.1	Complied

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

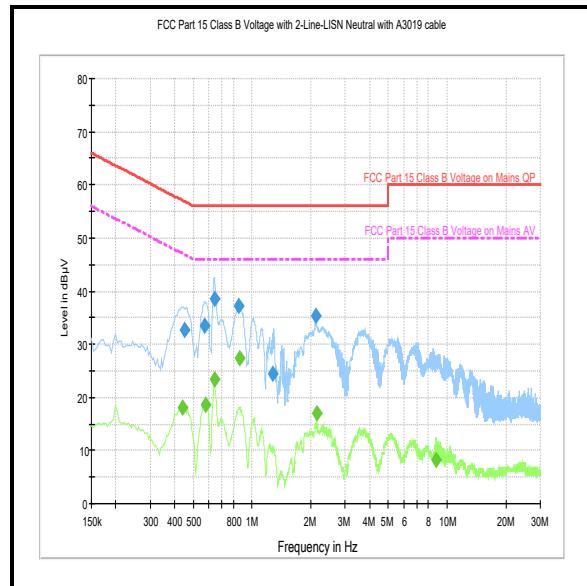
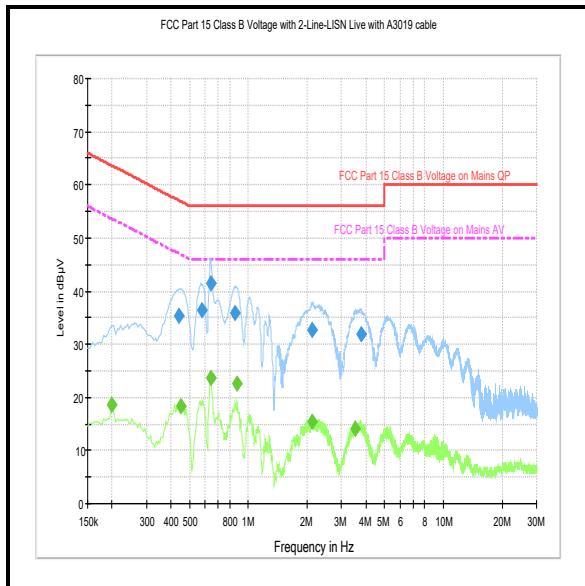
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.199500	Live	18.5	53.6	35.1	Complied
0.451500	Live	18.2	46.8	28.6	Complied
0.640500	Live	23.6	46.0	22.4	Complied
0.870000	Live	22.7	46.0	23.3	Complied
2.125500	Live	15.3	46.0	30.7	Complied
3.507000	Live	14.1	46.0	31.9	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.451500	Neutral	32.7	56.8	24.1	Complied
0.573000	Neutral	33.4	56.0	22.6	Complied
0.640500	Neutral	38.5	56.0	17.5	Complied
0.856500	Neutral	37.3	56.0	18.7	Complied
1.275000	Neutral	24.6	56.0	31.4	Complied
2.112000	Neutral	35.4	56.0	20.6	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.442500	Neutral	18.0	47.0	29.0	Complied
0.577500	Neutral	18.7	46.0	27.3	Complied
0.640500	Neutral	23.3	46.0	22.7	Complied
0.865500	Neutral	27.5	46.0	18.5	Complied
2.134500	Neutral	16.9	46.0	29.1	Complied
8.794500	Neutral	8.3	50.0	41.7	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 240 VAC 60 Hz**

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

**--- END OF REPORT ---**