



TEST REPORT

Test Report No. : UL-RPT-RP12643247-116A V3.0

Customer : Grundfos Holding A/S
Model No. : CU 241
FCC ID : OG3-CU241
Technology : *Bluetooth – Low Energy*
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.247

Test Laboratory : UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 3.0 supersedes all previous versions.

Date of Issue: 26 July 2019

Checked by:

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Senior Test Engineer, Radio Laboratory

Company Signatory:

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Senior Test Engineer, Radio Laboratory
UL VS LTD



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The tests reported herein have been
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Customer Information

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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	30/05/2019	Initial Version	Ben Mercer
2.0	31/05/2019	Correction to test dates in section 1.2.	Ben Mercer
3.0	26/07/2019	Measurements below 30 MHz included in section 5.1	Ben Mercer

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1. Attestation of Test Results

1.1. Description of EUT

The equipment under test was a panel mounted user interface for a pump control panel incorporating a *Bluetooth Low Energy* module.

1.2. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.207 and 15.209
Site Registration:	621311
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
Test Dates:	05 March 2019 to 16 July 2019

1.3. Summary of Test Results

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

Key to Results

✓ = Complied ✗ = Did not comply

Note(s):

1. In accordance with ANSI C63.10 Section 11.10.1, PSD measurements are not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured output power.

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	X
Site 2	-
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
Title:	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
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.3. Calibration and Uncertainty

Measuring Instrument Calibration

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

Measurement Uncertainty

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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±2.40 dB
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Conducted Maximum Peak Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±4.39 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±4.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 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 Conducted Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45041825	06 Jan 2020	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	12 Jun 2019	12
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	01 Sep 2020	36
A2508	Attenuator	AtlanTecRF	AN18-10	821846#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)
M2003	Thermohygrometer	Testo	608-H1	45046641	06 Jan 2020	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Feb 2020	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	10 Aug 2019	12
A2948	Pre-Amplifier	Com-Power	PAM-118A	551087	12 Feb 2020	12
A2889	Antenna	Schwarzbeck	BBHA9120B	BBHA 9120 B653	12 Feb 2020	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	20 Feb 2020	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	20 Feb 2020	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	20 Feb 2020	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	12 Feb 2020	12
A3142	Pre-Amplifier	Schwarzbeck	BBV 9718 B	00021	21 Nov 2020	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	16 Feb 2020	12
A2893	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-021	15 Feb 2020	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	20 Sep 2019	12
A2863	Pre-Amplifier	Schwarzbeck	8449B	3008A02100	12 Feb 2020	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	04 Oct 2019	12
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	08 Aug 2019	12
A3165	Loop Antenna	ETS Lindgren	6502	00224383	07 Nov 2019	12
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	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)
M2003	Thermohygrometer	Testo	608-H1	45046641	06 Jan 2020	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Feb 2020	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	10 Aug 2019	12
A2948	Pre-Amplifier	Com-Power	PAM-118A	551087	12 Feb 2020	12
A2889	Antenna	Schwarzbeck	BBHA9120B	BBHA 9120 B653	12 Feb 2020	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	20 Feb 2020	12

Test Equipment Used for Transmitter AC Conducted Spurious Emissions:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	18 Dec 2019	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	23 Aug 2019	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	10 Apr 2020	12
A2953	Power Supply 240 VAC 60 Hz	Tacima	SC 5467	Not stated	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	02 May 2019	12
M2037	Thermohygrometer	Testo	608-H1	45124925	06 Jan 2020	12

Test Measurement Software/Firmware Used

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	2008

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Grundfos Holding AS
Model Name or Number:	CU 241
Test Sample Serial Number:	00061 (<i>Conducted Sample</i>)
Hardware Version:	R06
Software Version:	V08.04.00
FCC ID:	OG3-CU241

Brand Name:	Grundfos Holding AS
Model Name or Number:	CU 241
Test Sample Serial Number:	00076 (<i>Radiated Sample</i>)
Hardware Version:	R06
Software Version:	V08.04.00
FCC ID:	OG3-CU241

3.2. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3. Additional Information Related to Testing

Technology Tested:	Bluetooth Low Energy (Digital Transmission System)				
Type of Unit:	Transceiver				
Channel Spacing:	2 MHz				
Modulation:	GFSK				
Data Rate:	1 Mbit/s				
Power Supply Requirement(s):	Nominal	24.0 VDC			
Maximum Conducted Output Power:	4.4 dBm				
Transmit Frequency Range:	2402 MHz to 2480 MHz				
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)		
	Bottom	37	2402		
	Middle	19	2442		
	Top	39	2480		

3.4. Description of Available Antennas

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

Frequency Range (MHz)	Antenna Gain (dBi)
2400-2480	2.3

3.5. Description of Test Setup

Support Equipment

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

Description:	USB Diagnostic Unit
Brand Name:	Grundfos
Model Name or Number:	PC Tool Link
Serial Number:	05867

Description:	Laptop PC
Brand Name:	Hewlett Packard
Model Name or Number:	ProBook 645 G2
Serial Number:	5CG6083726

Description:	DSL Port Termination
Brand Name:	Netgear
Model Name or Number:	DG834G
Serial Number:	1JX167B008C4A

Description:	USB A Termination
Brand Name:	Hama
Model Name or Number:	00078498
Serial Number:	09825891600

Description:	AC to DC Power Adapter
Brand Name:	Mean Well
Model Name or Number:	HDR-60-24
Serial Number:	Not marked or stated

Description:	IO Module
Brand Name:	Grundfos
Model Name or Number:	IO 242
Serial Number:	00093

Operating Modes

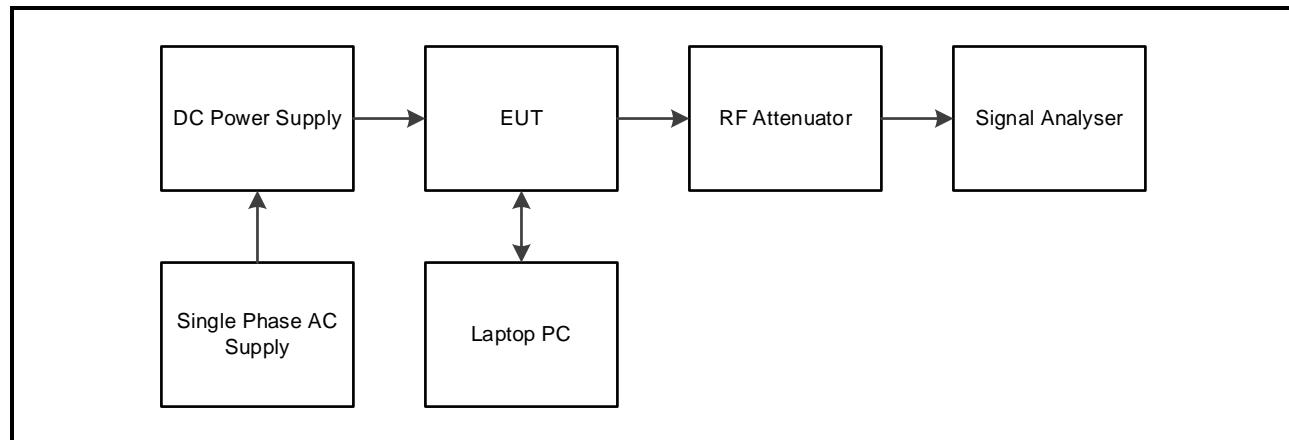
The EUT was tested in the following operating mode(s):

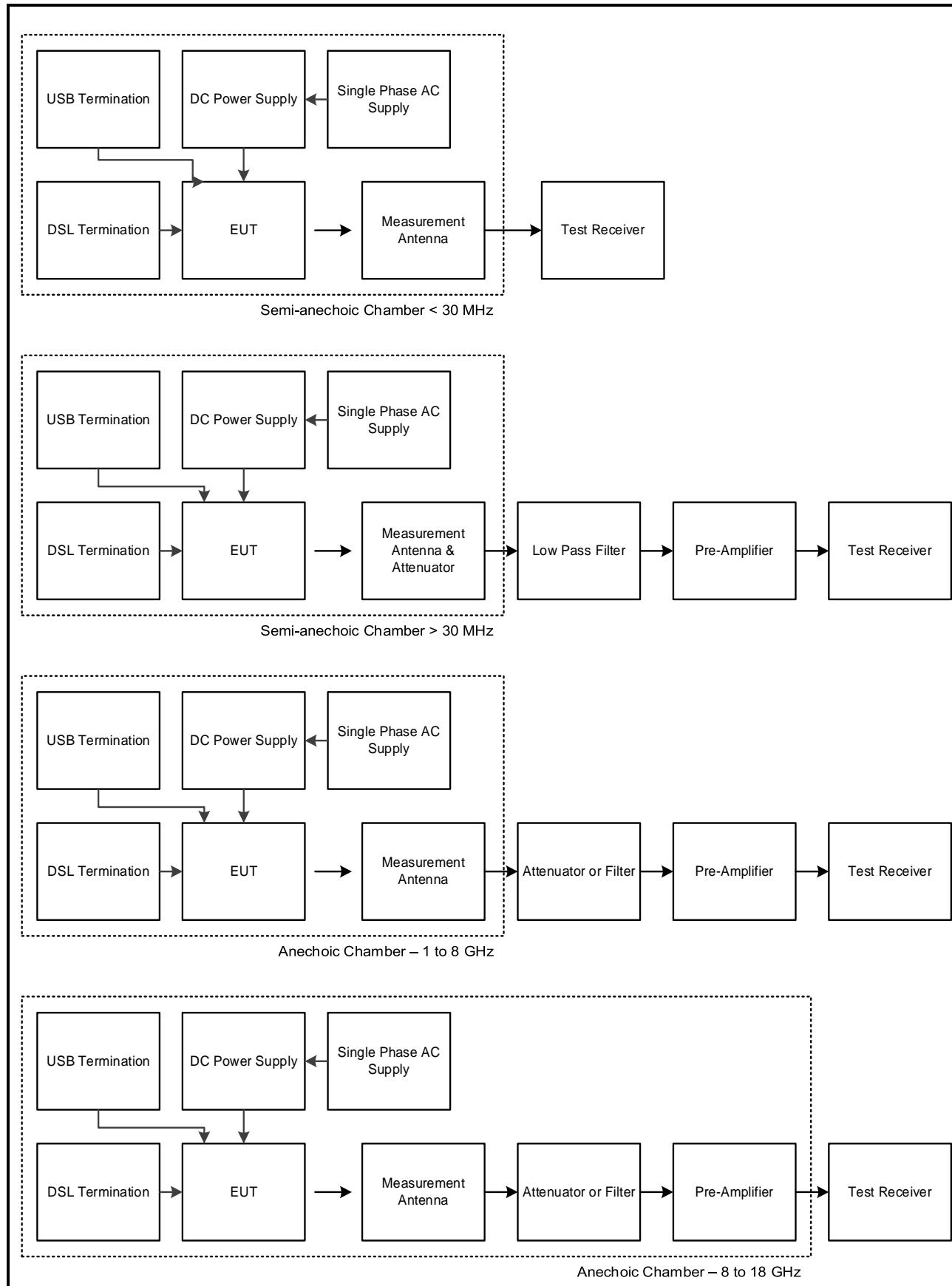
- Transmitting at maximum power in *Bluetooth LE* mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

Configuration and Peripherals

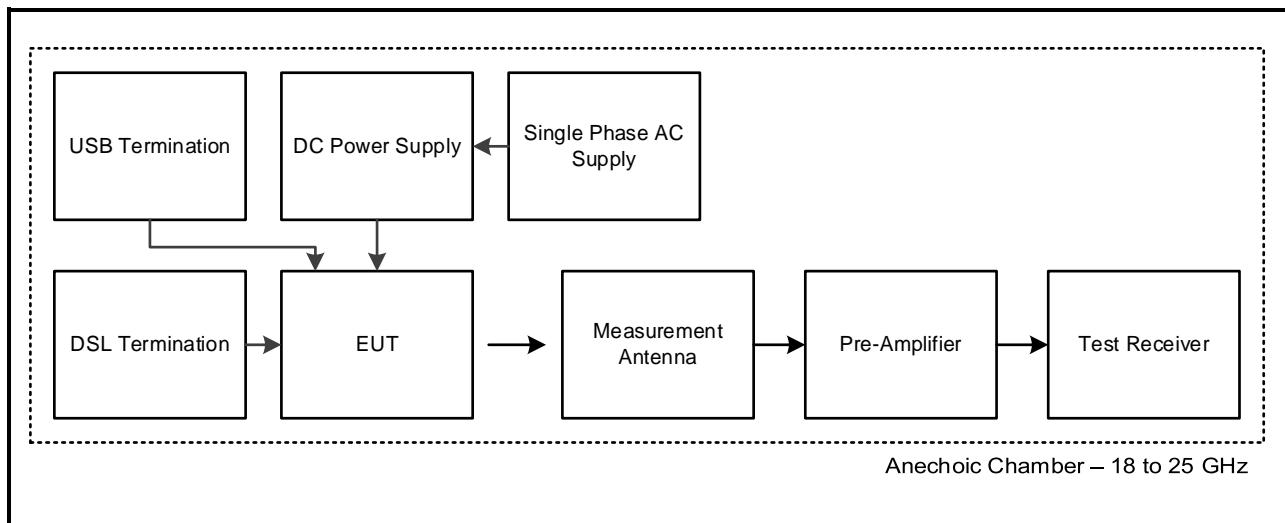
The EUT was tested in the following configuration(s):

- Controlled in test mode using the software application BLE Service Tool on the laptop PC supplied by the customer. The application was used to enable continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions 'BLE tool short.docx'. The laptop PC was connected to the EUT via a PC Tool Link adaptor and a TTL cable.
- For conducted and radiated tests, the EUT was powered from a bench top DC power supply.
- For AC conducted tests, the EUT was powered by a Mean Well HDR-60-24 AC to DC adapter supplied with the EUT.
- Transmitter radiated spurious emissions tests were performed with the EUT in the position / orientation that produced the worst case with respect to emissions. All active ports were terminated using appropriate terminations.

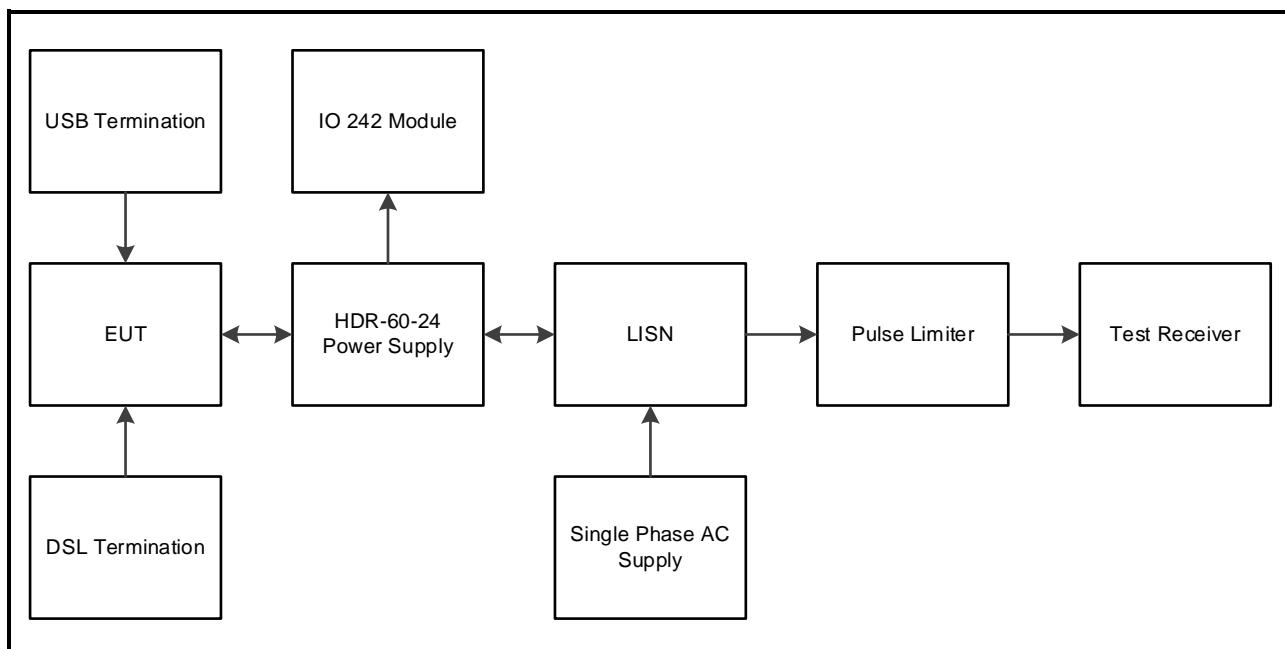
Test Setup Diagrams**Conducted Tests:****Test Setup for Transmitter Minimum 6 dB Bandwidth & Maximum Peak Output Power**

Radiated Tests:**Test Setup for Transmitter Radiated Emissions**

Test Setup for Transmitter Radiated Emissions (continued)



Test Setup for Transmitter AC Conducted Spurious Emissions



4. Antenna Port Test Results

4.1. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineers:	Stefan Ho & Max Passell	Test Date:	05 March 2019
Test Sample Serial Number:	00061		

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

Environmental Conditions:

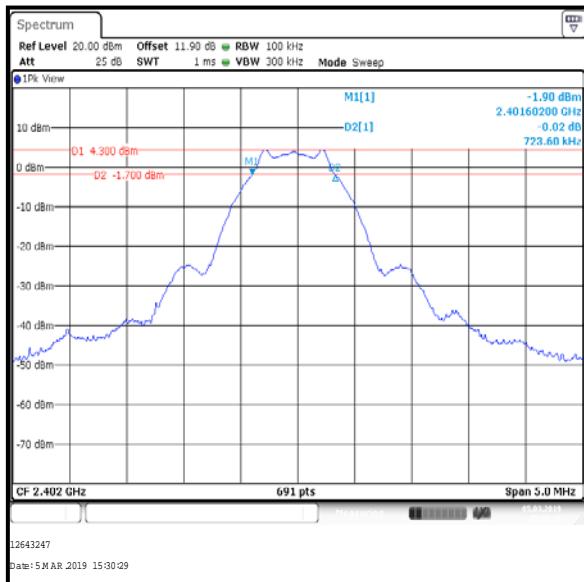
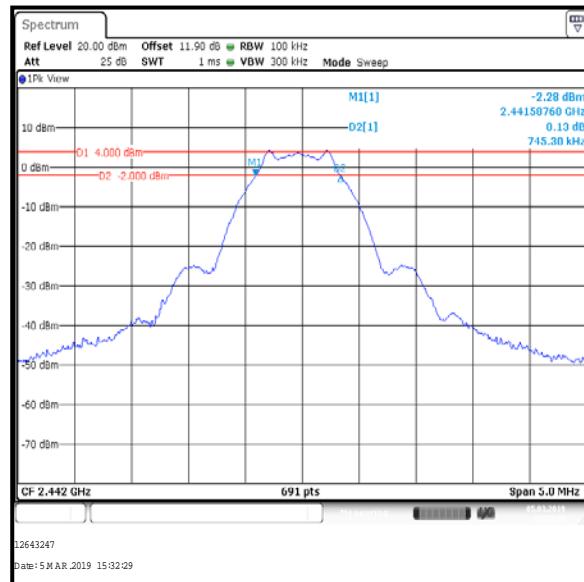
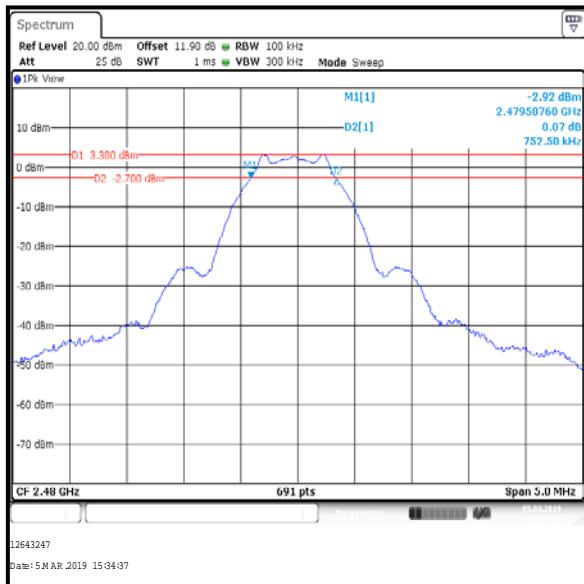
Temperature (°C):	24
Relative Humidity (%):	35

Note(s):

1. 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	723.600	≥500	223.600	Complied
Middle	745.300	≥500	245.300	Complied
Top	752.500	≥500	252.500	Complied

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

4.2. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineers:	Stefan Ho & Max Passell	Test Date:	05 March 2019
Test Sample Serial Number:	00061		

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

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	35

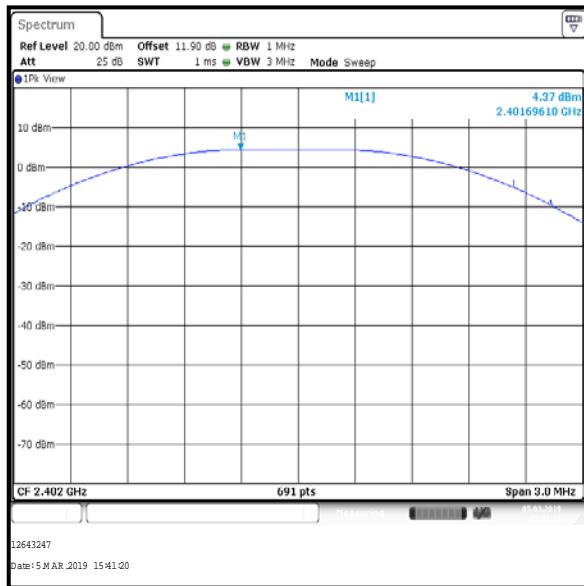
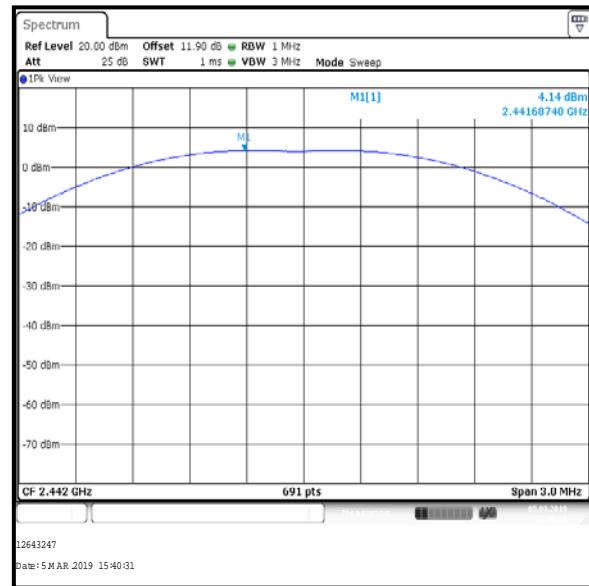
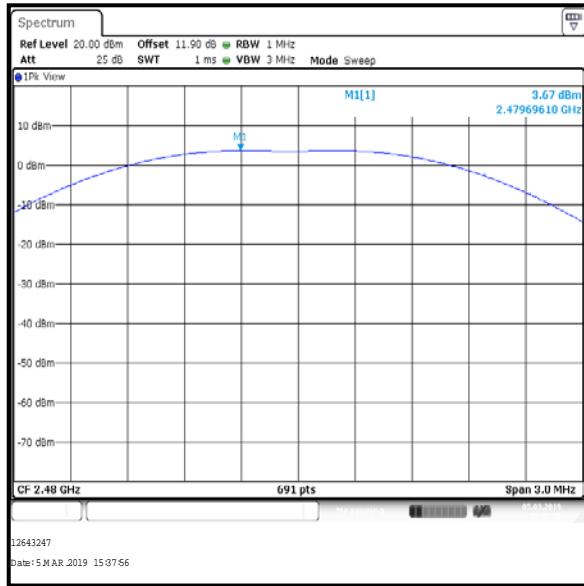
Note(s):

1. Tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 with the $\text{RBW} \geq \text{DTS}$ bandwidth procedure.
2. The signal analyser resolution bandwidth was set to 1.0 MHz and video bandwidth of 3.0 MHz. A peak detector was used, sweep time was set to Auto and trace mode was set to Max Hold. The span was set to 3.0 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 cable.
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	4.4	30.0	25.6	Complied
Middle	4.1	30.0	25.9	Complied
Top	3.7	30.0	26.3	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	4.4	2.3	6.7	36.0	29.3	Complied
Middle	4.1	2.3	6.4	36.0	29.6	Complied
Top	3.7	2.3	6.0	36.0	30.0	Complied

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

5. Radiated Test Results

5.1. Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineers:	Tom Sleigh & Ian Watch	Test Dates:	19 March 2019 & 16 July 2019
Test Sample Serial Number:	00076		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5
Frequency Range	490 kHz to 1000 MHz

Environmental Conditions:

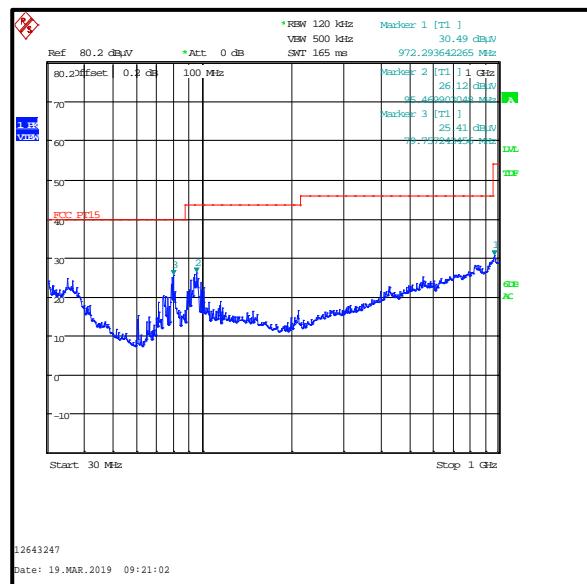
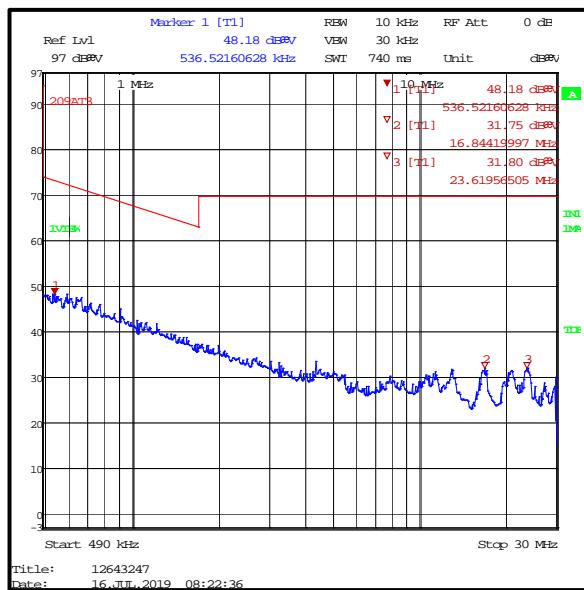
Temperature (°C):	22 to 23
Relative Humidity (%):	42 to 46

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 were performed with the EUT set to the middle channel only.
3. Measurements below 30 MHz were performed in a semi-anechoic chamber (Asset Number K0001) at 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.
4. Pre-scans were performed, and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to Auto and trace mode was Max Hold.
5. Measurements between 30 MHz and 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) at 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.
6. 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.
7. Final measurements were performed on the marker frequencies and the results were 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: Peak / Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
80.006	Vertical	23.2	43.5	20.2	Compiled
94.048	Vertical	21.3	46.0	24.7	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:

Test Engineers:	Tom Sleigh & Marco Zunarelli	Test Dates:	11 March 2019 to 09 May 2019
Test Sample Serial Number:	00076		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	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
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	20 to 24
Relative Humidity (%):	38 to 44

Note(s):

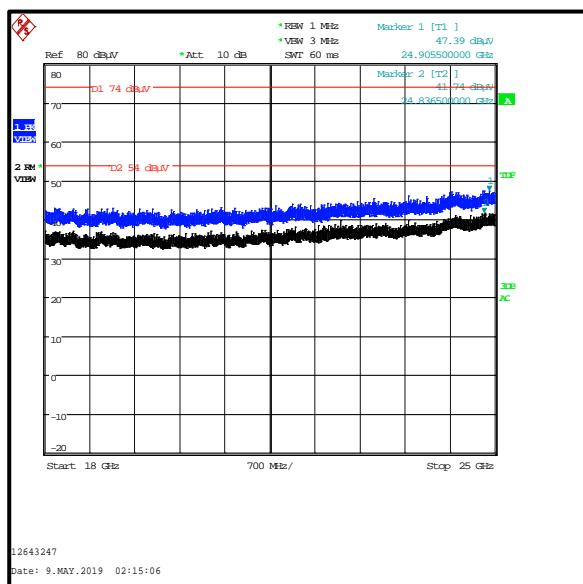
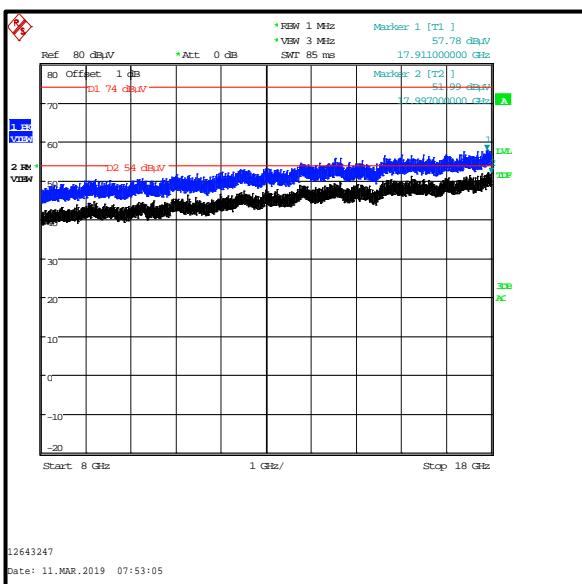
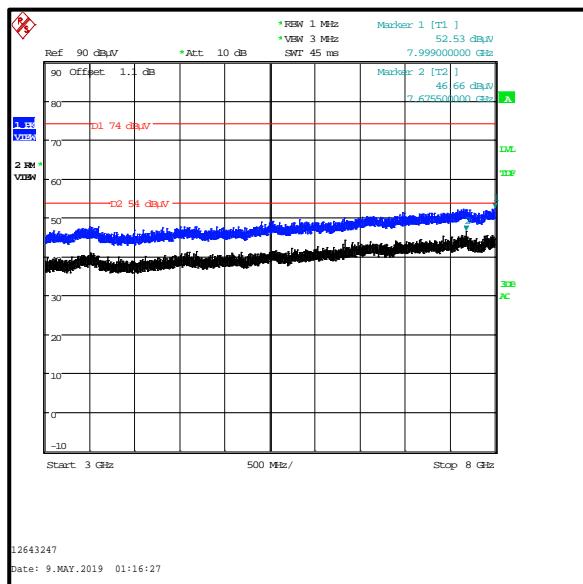
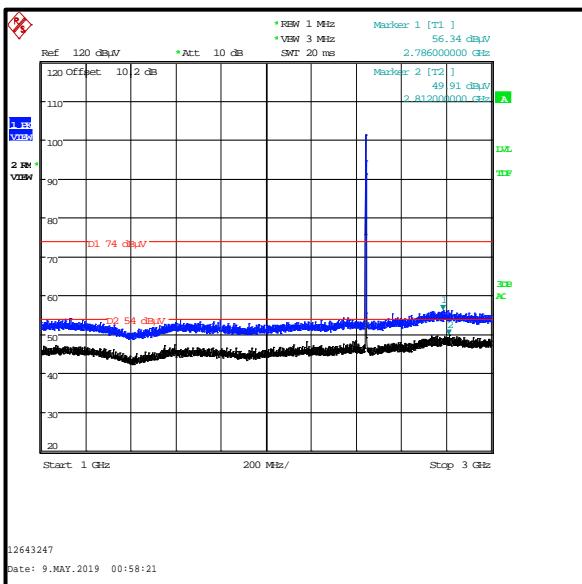
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The emission shown on the 1 GHz to 4 GHz plot is the EUT fundamental.
3. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded as shown in the tables below.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at 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.
5. 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 own appropriate detectors during the pre-scan measurements.

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
17911.000	Vertical	57.8	74.0	6.2	Complied

Results: Average / Middle Channel

Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
17997.000	Vertical	52.0	54.0	2.0	Complied

Transmitter Radiated Emissions (continued)

5.3. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Tom Sleigh	Test Dates:	06 March 2019 to 19 March 2019
Test Sample Serial Number:	00076		

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

Environmental Conditions:

Temperature (°C):	20 to 21
Relative Humidity (%):	41 to 44

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. 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 enough time 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.
3. 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.
4. 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.
5. * -20 dBc limit.
6. ** Lower Band Edge plot incorrectly shows the out-of-band limit line at -30 dBc.

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

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400.000	Vertical	52.5	82.2*	29.7	Compiled
2483.740	Vertical	51.7	74.0	22.3	Complied

Results: Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Vertical	41.3	54.0	12.7	Compiled

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

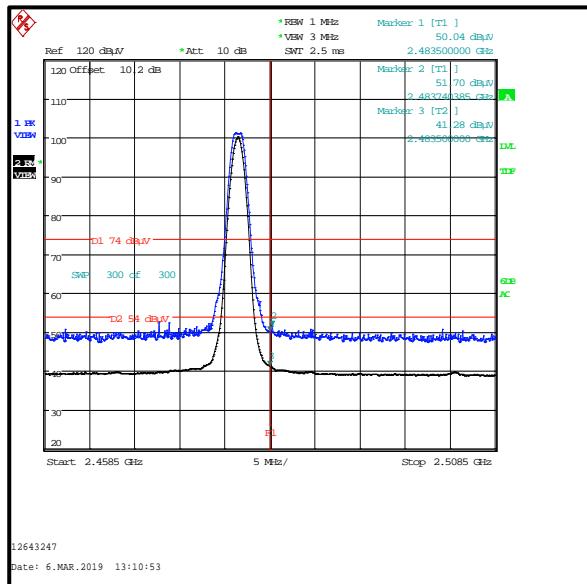
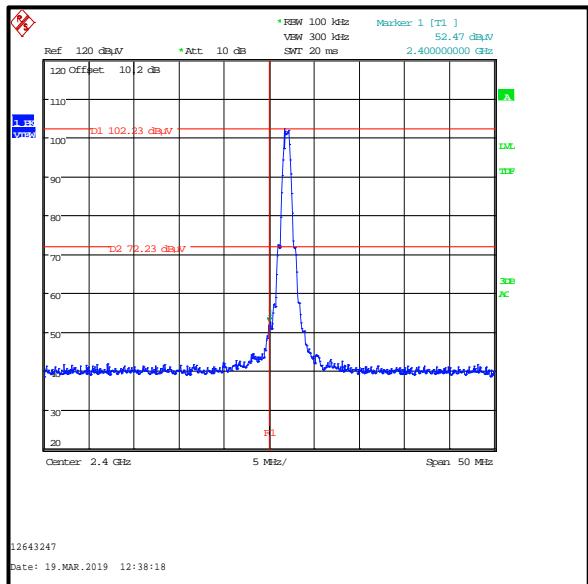
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2362.436	Vertical	48.6	74.0	25.4	Compiled

Results: 2310 MHz to 2390 MHz Restricted Band / Average

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2388.718	Vertical	36.9	54.0	17.1	Compiled

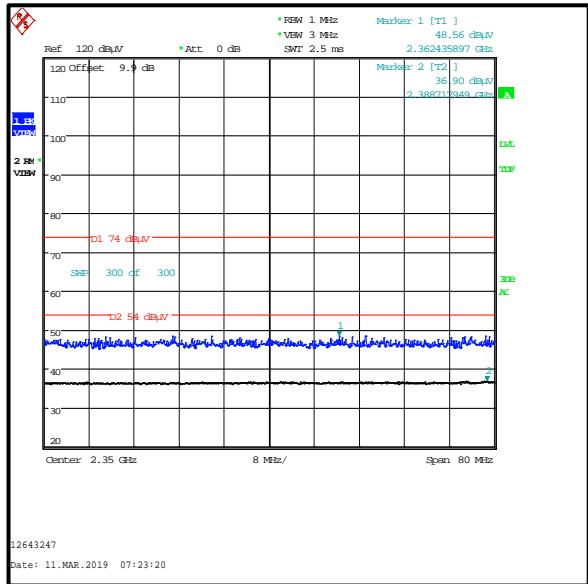
Transmitter Band Edge Radiated Emissions (continued)

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:

Test Engineer:	Stefan Ho	Test Date:	26 April 2019
Test Sample Serial Number:	00076		

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

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	43

Note(s):

1. The EUT was connected to its power supply, which 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 μ V)	Limit (dB μ V)	Margin (dB)	Result
0.150000	Live	48.0	66.0	18.0	Complied
0.199500	Live	41.7	63.6	21.9	Complied
0.388500	Live	35.1	58.1	23.0	Complied
14.667000	Live	40.7	60.0	19.3	Complied
18.370500	Live	46.5	60.0	13.5	Complied
21.075000	Live	40.5	60.0	19.5	Complied

Results: Live / Average / 120 VAC 60 Hz

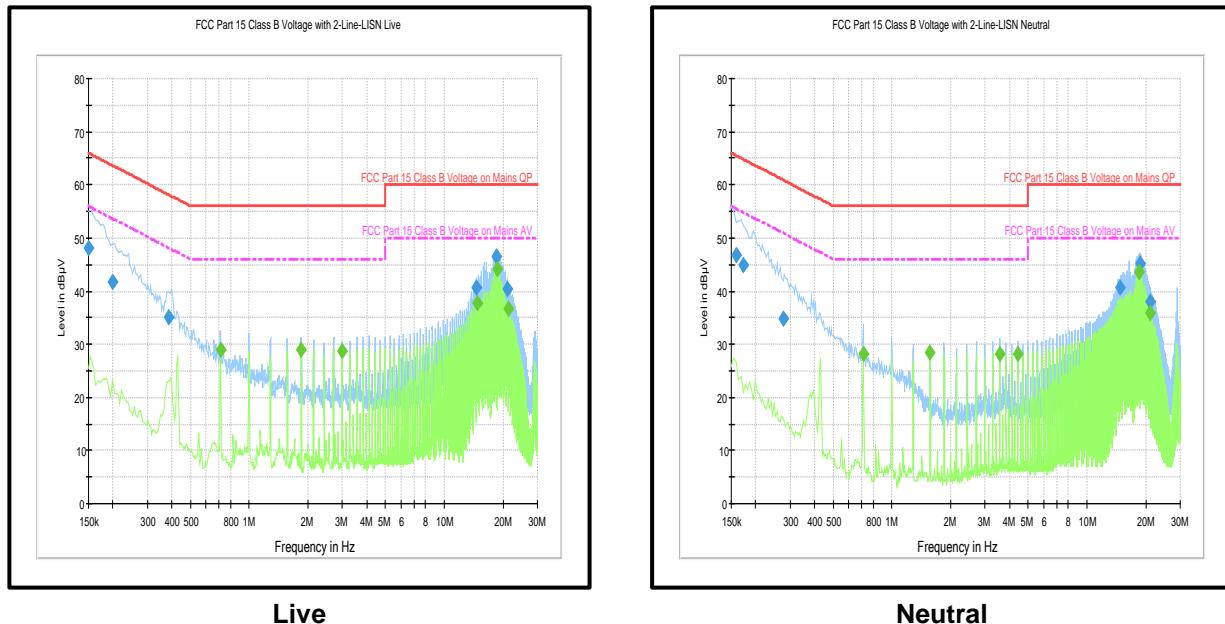
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.712500	Live	28.8	46.0	17.2	Complied
1.851000	Live	29.1	46.0	16.9	Complied
2.989500	Live	28.7	46.0	17.3	Complied
14.671500	Live	37.7	50.0	12.3	Complied
18.658500	Live	44.1	50.0	5.9	Complied
21.363000	Live	36.7	50.0	13.3	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.159000	Neutral	46.8	65.5	18.7	Complied
0.172500	Neutral	44.9	64.8	19.9	Complied
0.276000	Neutral	34.8	60.9	26.1	Complied
14.676000	Neutral	40.6	60.0	19.4	Complied
18.676500	Neutral	45.2	60.0	14.8	Complied
21.084000	Neutral	37.9	60.0	22.1	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.712500	Neutral	28.2	46.0	17.8	Complied
1.567500	Neutral	28.4	46.0	17.6	Complied
3.561000	Neutral	28.1	46.0	17.9	Complied
4.416000	Neutral	28.1	46.0	17.9	Complied
18.384000	Neutral	43.5	50.0	6.5	Complied
21.088500	Neutral	35.9	50.0	14.1	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 μ V)	Limit (dB μ V)	Margin (dB)	Result
0.163500	Live	39.6	65.3	25.7	Complied
0.379500	Live	31.9	58.3	26.4	Complied
1.851000	Live	28.9	56.0	27.1	Complied
14.401500	Live	40.1	60.0	19.9	Complied
18.393000	Live	46.8	60.0	13.2	Complied
21.097500	Live	40.3	60.0	19.7	Complied

Results: Live / Average / 240 VAC 60 Hz

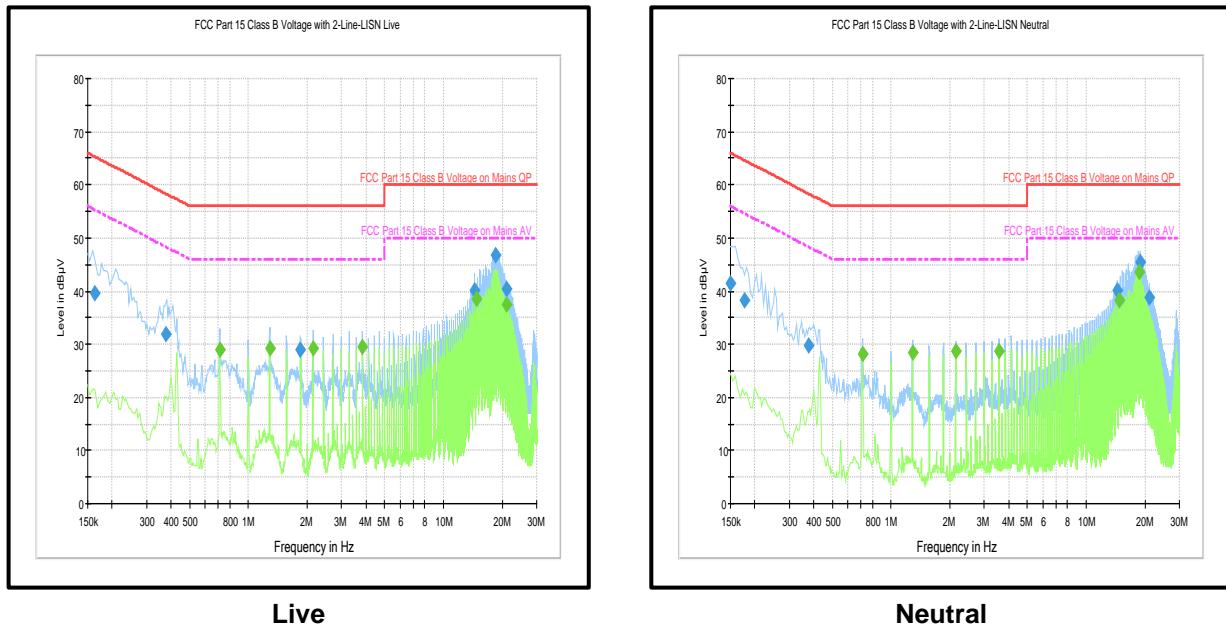
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.712500	Live	29.0	46.0	17.0	Complied
1.284000	Live	29.2	46.0	16.8	Complied
2.139000	Live	29.3	46.0	16.7	Complied
3.849000	Live	29.4	46.0	16.6	Complied
14.685000	Live	38.7	50.0	11.3	Complied
21.102000	Live	37.5	50.0	12.5	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.150000	Neutral	41.4	66.0	24.6	Complied
0.177000	Neutral	38.3	64.6	26.3	Complied
0.379500	Neutral	29.7	58.3	28.6	Complied
14.401500	Neutral	40.2	60.0	19.8	Complied
18.969000	Neutral	45.4	60.0	14.6	Complied
21.115500	Neutral	38.9	60.0	21.1	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.712500	Neutral	28.3	46.0	17.7	Complied
1.284000	Neutral	28.5	46.0	17.5	Complied
2.139000	Neutral	28.7	46.0	17.3	Complied
3.565500	Neutral	28.8	46.0	17.2	Complied
14.689500	Neutral	38.4	50.0	11.6	Complied
18.681000	Neutral	43.7	50.0	6.3	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.

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