



TEST REPORT

Test Report No. : UL-RPT-RP12649938-116A V3.0

Customer : Grundfos Holding A/S
Model No. : LC 231
FCC ID : OG3-LC231
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: 08 August 2019

Checked by:

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Customer Information

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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	29 May 2019	Initial Version	Ian Watch
2.0	17 July 2019	Inserted additional radiated emission results < 30 MHz at the request of the TCB	Ian Watch
3.0	08 August 2019	Modified Note 5 Page 22 at the request of the TCB	Ian Watch

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1. Attestation of Test Results








1.1. Description of EUT

The EUT was a pump controller with *Bluetooth* Low Energy interface to configure and read out status. It is powered from a single phase mains supply.

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
Test Dates:	19 February 2019 to 16 July 2019

1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
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	
Part 15.207	Transmitter AC Conducted Emissions	
Key to Results  = Complied  = Did not comply		

Note(s):

1. In accordance with Subclause 11.10 of ANSI C63.10, 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:	FCC KDB 558074 D01 DTS Meas Guidance v05r02 April 2, 2019
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247
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
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	490 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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±2.40 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)
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	19 Mar 2019	12
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M2002	Thermohygrometer	Testo	608-H1	45041825	06 Jan 2020	12

Test and Measurement Equipment (continued)**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
M2043	Thermohygrometer	Testo	608-H1	45120017	06 Jan 2020	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	16 Feb 2020	12
K0001	3m RSE Chamber	Rainford	N/A	N/A	04 Oct 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	10 Aug 2019	12
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	08 Aug 2019	12
A2948	Pre-Amplifier	Com-Power	PAM-118A	551087	12 Feb 2020	12
A3165	Magnetic Loop Antenna	ETS-Lindgren	6502	00224383	07 Nov 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	12 Feb 2020	12
A2943	Attenuator	AtlanTecRF	AN18W5-06	208147#2	22 Feb 2019	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	22 Feb 2019	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	12 Feb 2020	12
A3142	Pre Amplifier	Schwarzbeck	BBV 9718 B	00020	12 Feb 2020	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	22 Feb 2019	12
A490	Antenna	Chase	CBL6111A	1590	03 Apr 2019	12
A2148	Attenuator	AtlanTecRF	An18-06	090202-06	N/A	N/A
A3167	Pre-Amplifier	Com Power	PAM-103	18020010	11 Feb 2020	12
A2131	Low Pass Filter	AtlanTecRF	AFL-02000	JFB1004-002	22 Feb 2019	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-717	16 Feb 2020	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721-021	15 Feb 2020	12

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	16 Feb 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	06 Jan 2020	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	20 Sep 2019	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	12 Feb 2020	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	20 Feb 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	12 Feb 2020	12

Test and Measurement Equipment (continued)**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
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
Model Name or Number:	LC 231
Test Sample Serial Number:	00045 (<i>Conducted sample with RF port</i>)
Hardware Version:	R07 with modifications so that it is representative of R08
Software Version:	Application (FE): 99347906V00.00.00.00318 Motor control (BE): V03.06.00 <i>Bluetooth</i> (BLE): 99347928V02.00.00.00001
FCC ID:	OG3-LC231

Brand Name:	Grundfos
Model Name or Number:	LC 231
Test Sample Serial Number:	00044 (<i>Radiated sample</i>)
Hardware Version:	R07 with modifications so that it is representative of R08
Software Version:	Application (FE): 99347906V00.00.00.00318 Motor control (BE): V03.06.00 <i>Bluetooth</i> (BLE): 99347928V02.00.00.00001
FCC ID:	OG3-LC231

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	120 VAC 60 Hz	
Maximum Conducted Output Power:	5.1 dBm		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	37	2402
	Middle	17	2440
	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:	Laptop PC
Brand Name:	HP
Model Name or Number:	ProBook 645 G2
Serial Number:	5CG6083726

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	L450
Serial Number:	PF10T3JS

Description:	USB / RS-485 / RS-232 / TTL communication unit
Brand Name:	Grundfos
Model Name or Number:	PC Tool Link
Serial Number:	05867

Description:	USB 2.0 cable. Type A to Type B. Length 3 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	TTL cable. Length 2 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Operating Modes

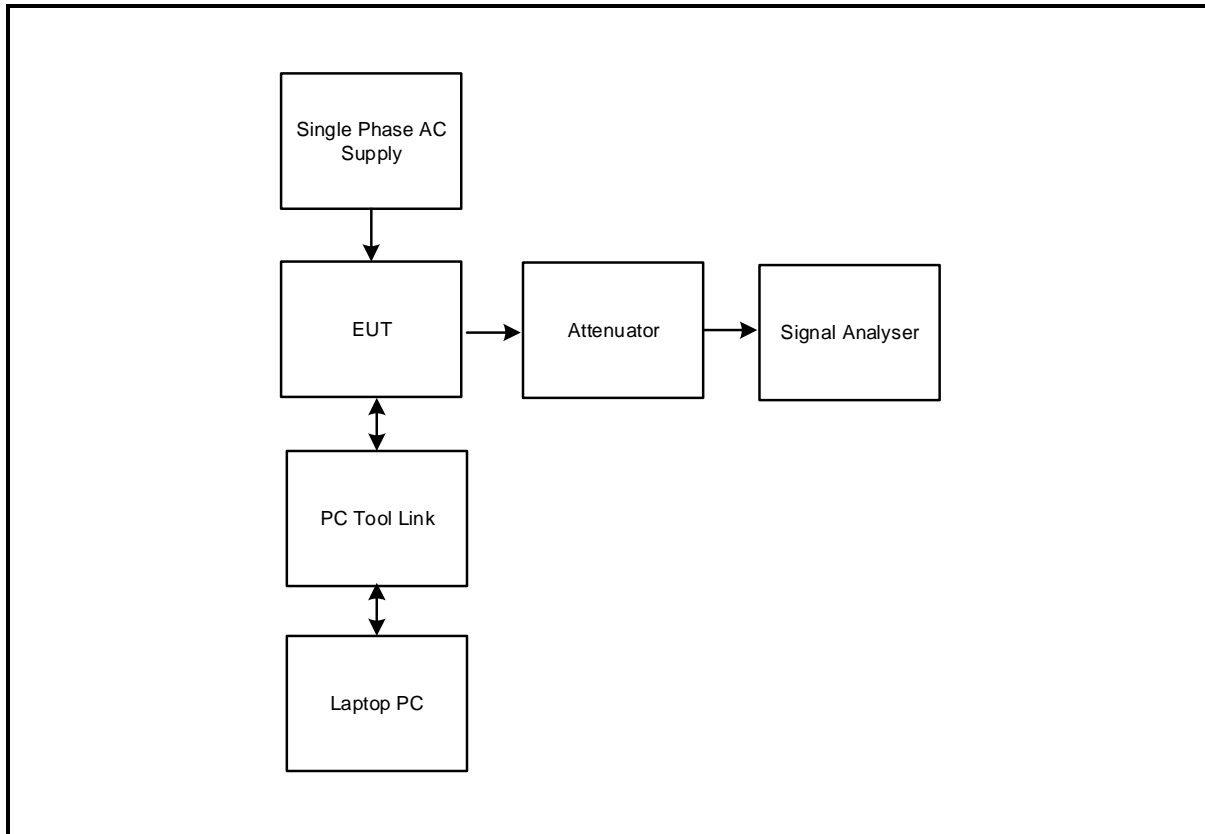
The EUT was tested in the following operating mode(s):

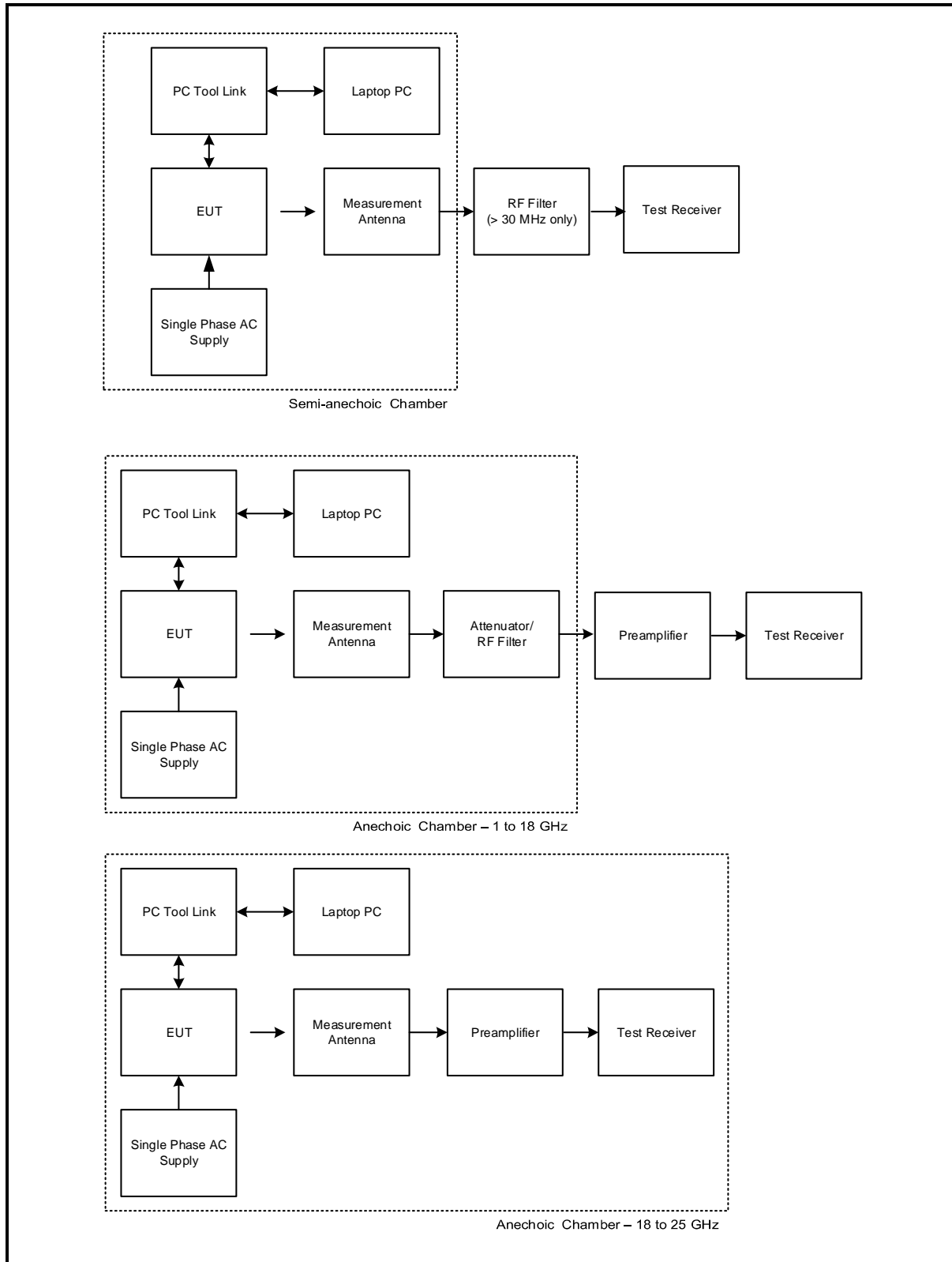
- Transmitting at maximum power in *Bluetooth* LE mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9.

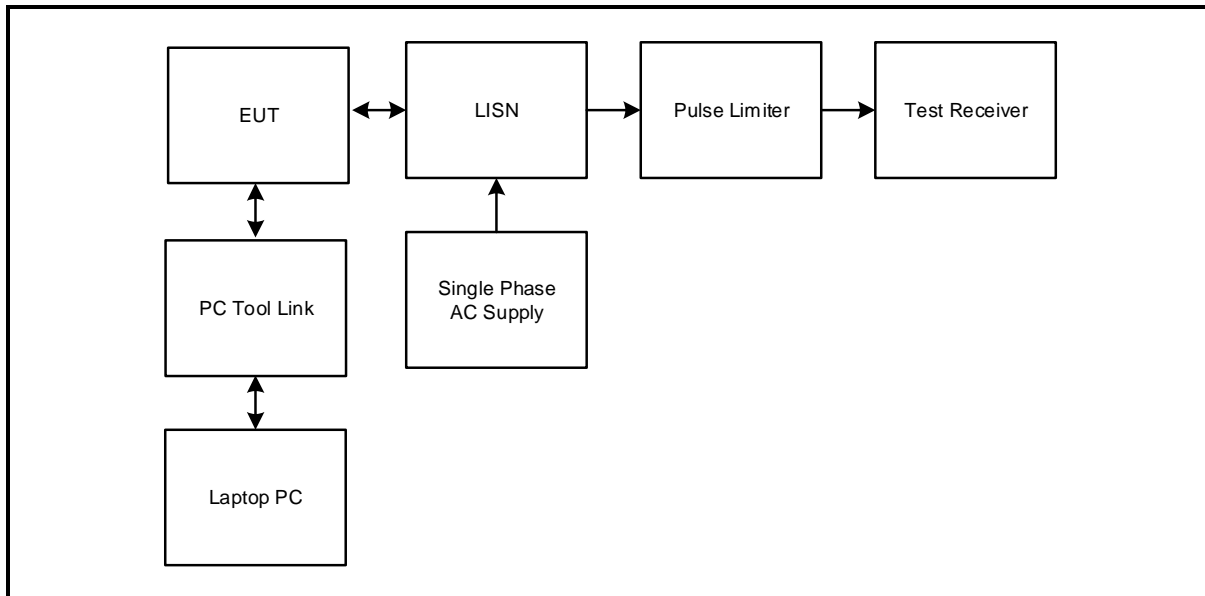
Configuration and Peripherals

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

- Controlled in test mode using software application 'GF_BLE_tool.exe' (date: 18-02-2019) on the laptop PC supplied by the customer. The application was used to enable a continuous transmission and to select the test channels as required. The EUT was connected to the laptop PC via the PC Tool Link and associated cables during all tests.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply.
- Transmitter radiated spurious emissions tests were performed with the EUT in the position / orientation (control panel at the top and facing upwards) 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 AC Conducted Spurious Emissions

4. Antenna Port Test Results

4.1. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Stefan Ho	Test Date:	19 February 2019
Test Sample Serial Number:	00045		

FCC Reference:	Part 15.247(a)(2)
Test Method Used:	FCC KDB 558074 Section 8.2 referencing Subclause 11.8 of ANSI C63.10

Environmental Conditions:

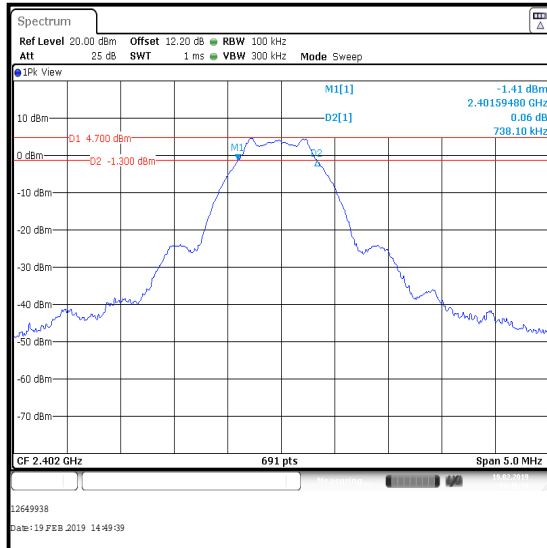
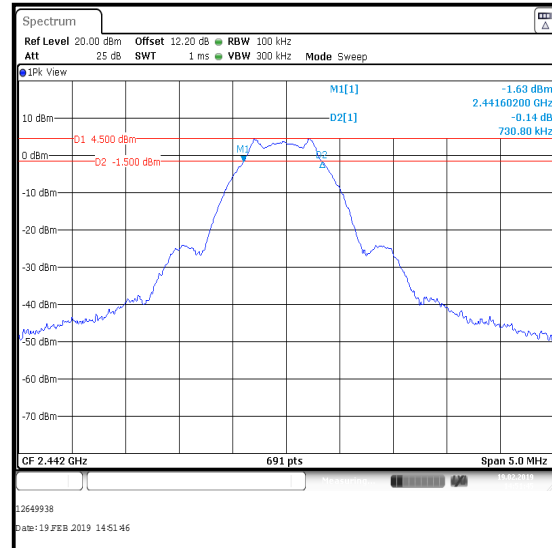
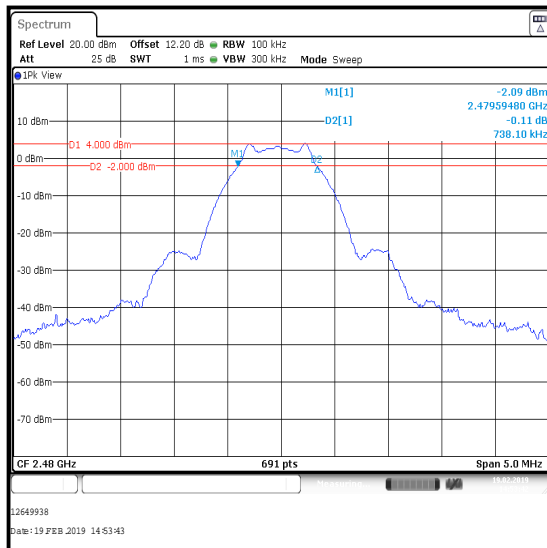
Temperature (°C):	23
Relative Humidity (%):	31

Note(s):

1. 6 dB DTS bandwidth tests were performed using a signal analyser in accordance with Subclause 11.8 of ANSI C63.10 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	738.100	≥500	238.100	Complied
Middle	730.800	≥500	230.800	Complied
Top	738.100	≥500	238.100	Complied

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

4.2. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Stefan Ho	Test Date:	19 February 2019
Test Sample Serial Number:	00045		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 8.3.1 referencing Subclause 11.9.1.1 of ANSI C63.10

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	31

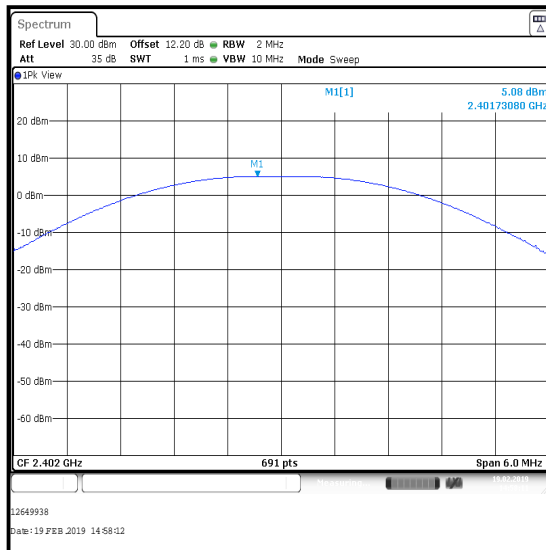
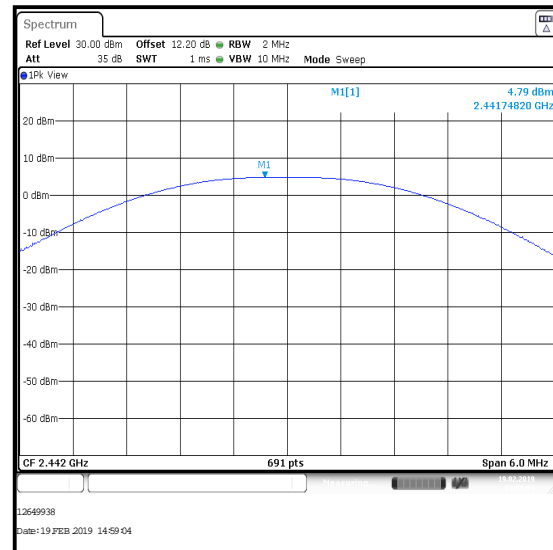
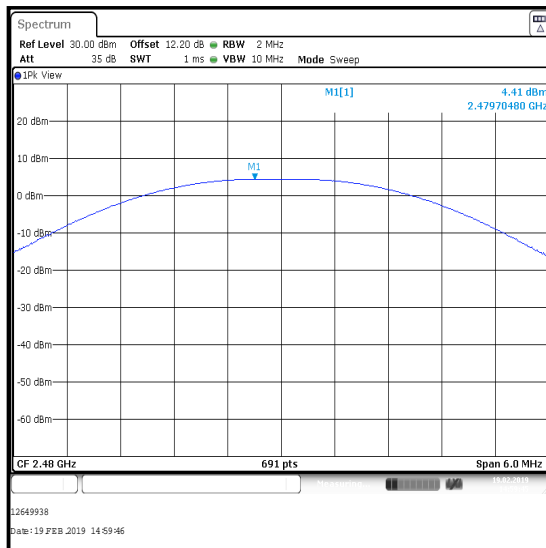
Note(s):

1. Conducted power tests were performed using a signal analyser in accordance with Subclause 11.9.1.1 of ANSI C63.10.
2. The signal analyser resolution bandwidth was set to 2 MHz and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 6 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	5.1	30.0	24.9	Complied
Middle	4.8	30.0	25.2	Complied
Top	4.4	30.0	25.6	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.1	2.3	7.4	36.0	28.6	Complied
Middle	4.8	2.3	7.1	36.0	28.9	Complied
Top	4.4	2.3	6.7	36.0	29.3	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:	Marco Zunarelli & Nick Tye	Test Dates:	22 February 2019 & 16 July 2019
Test Sample Serial Number:	00044		

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:

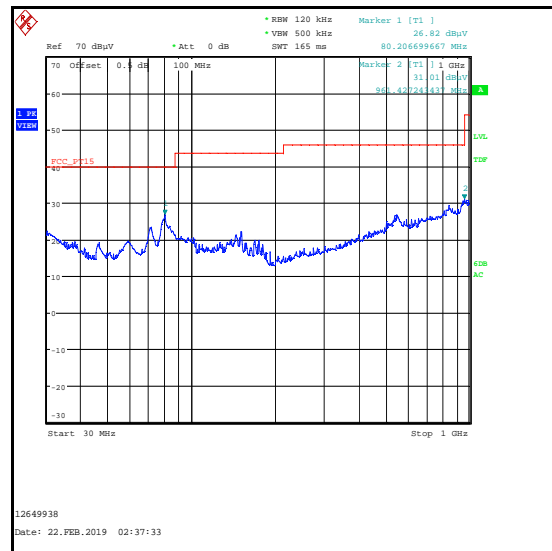
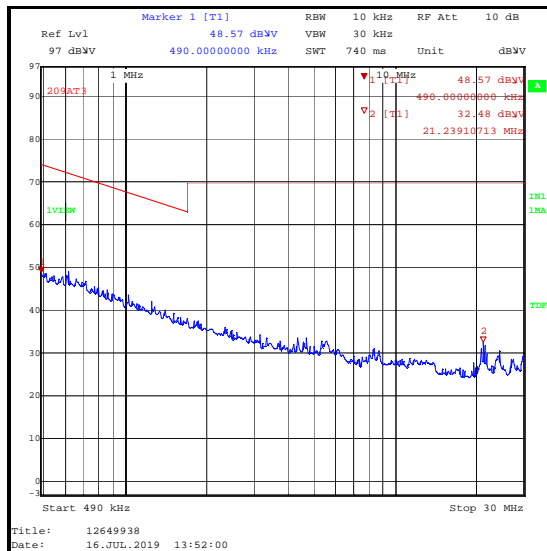
Temperature (°C):	23 to 25
Relative Humidity (%):	38 to 46

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
3. 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.
4. 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.
5. Measurements between 490 kHz and 30 MHz were performed in a semi-anechoic chamber (Asset Number K0001) 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. 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. Part 15.209 limits at 30 metres have been extrapolated to a measurement distance of 3 metres using 40 dB/decade. Correlation data between the semi-anechoic chamber and an open area test site is available upon request.

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

Frequency (MHz)	Antenna Orientation	Level (dB μ V/m)	Limit (dB μ V/m at 3 metres)	Margin (dB)	Result
0.490	Tip 90 degrees from EUT	48.6	73.8	25.2	Complied



5.2. Transmitter Radiated Emissions >1 GHz**Test Summary:**

Test Engineer:	Marco Zunarelli	Test Dates:	21 February 2019 & 22 February 2019
Test Sample Serial Number:	00044		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Subclause 11.11 & 11.12. ANSI C63.10 Subclauses 6.3 & 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	38

Note(s):

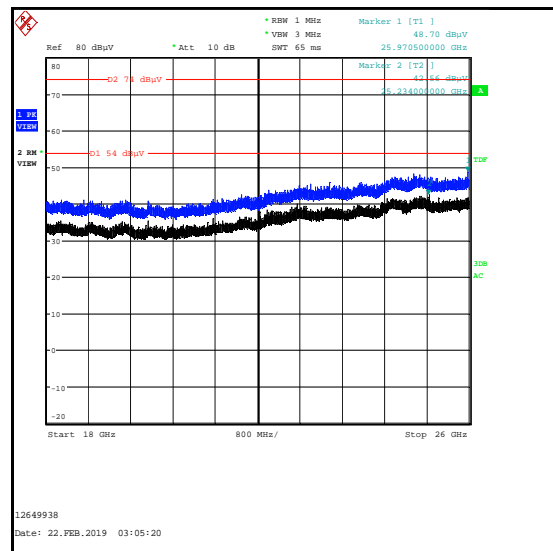
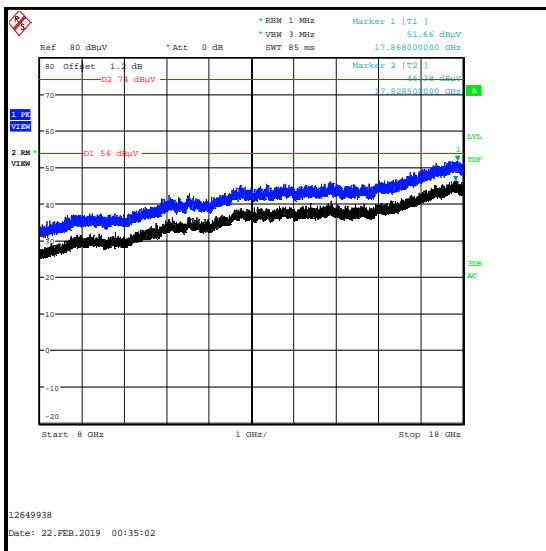
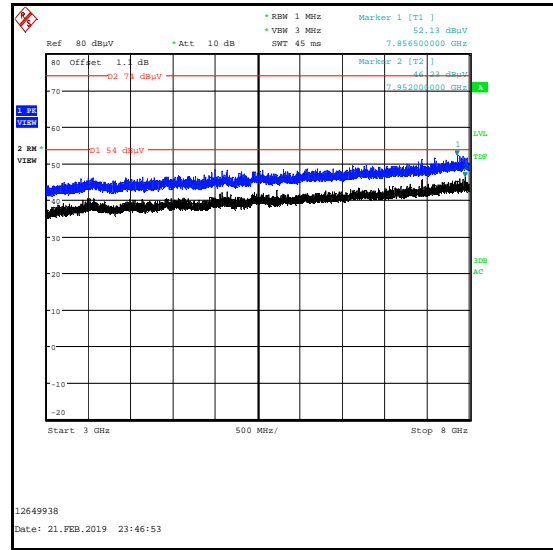
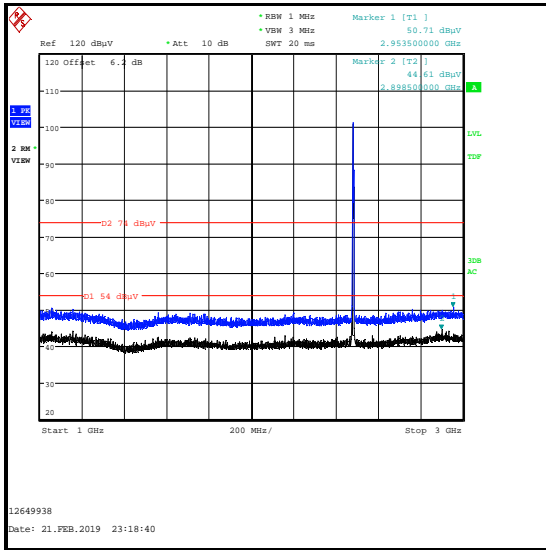
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The emission shown on the 1 GHz to 4 GHz plot is the EUT fundamental.
3. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded in the tables below.
4. 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.
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 (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
7856.500	Horizontal	52.1	74.0	21.9	Complied

Results: Average / Middle Channel

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
17828.500	Horizontal	46.4	54.0	7.6	Complied

Transmitter Radiated Emissions (continued)

5.3. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Marco Zunarelli	Test Date:	08 May 2019
Test Sample Serial Number:	00044		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Subclause 11.11 & 11.12. ANSI C63.10 Subclause 6.10.4 & 6.10.5.2

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	38

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, 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 an peak detector, an out-of-band limit line was placed 20 dB (ANSI C63.10 Subclause 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.

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	Horizontal	51.2	78.8*	27.6	Complied
2399.920	Horizontal	51.4	78.8*	27.4	Complied
2483.500	Horizontal	57.8	74.0	16.2	Complied

Results: Average

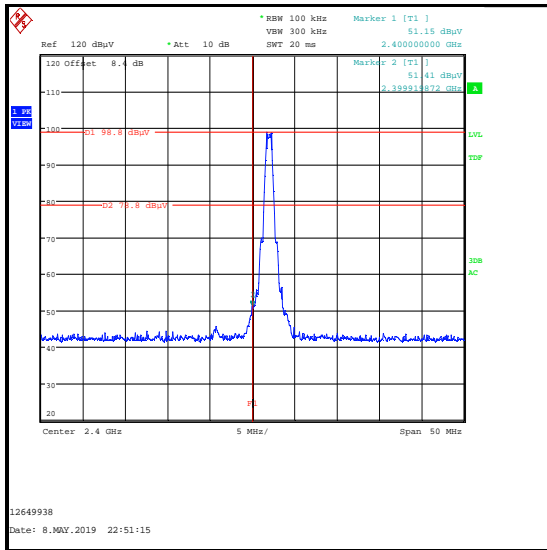
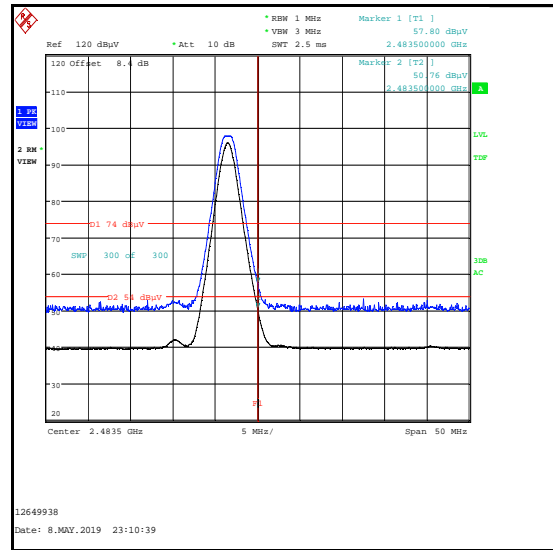
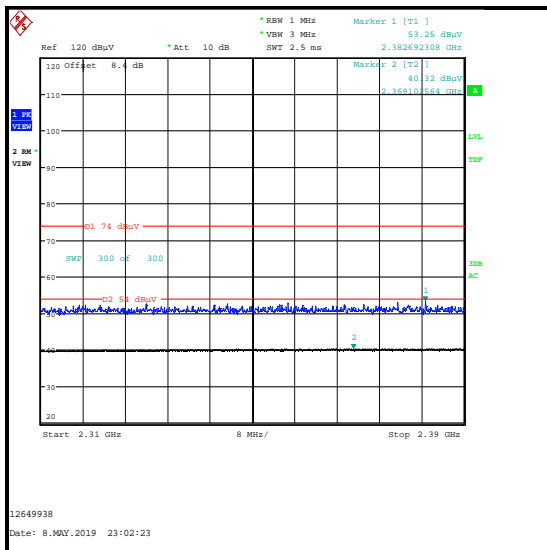
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	50.8	54.0	3.2	Complied

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
2382.692	Horizontal	53.3	74.0	20.7	Complied

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
2369.103	Horizontal	40.3	54.0	13.7	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:

Test Engineer:	Stefan Ho	Test Date:	22 February 2019
Test Sample Serial Number:	00044		

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 (%):	40

Note(s):

1. The EUT 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 supported by the EUT.
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 (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.154500	Live	42.5	65.8	23.3	Complied
0.627000	Live	39.2	56.0	16.8	Complied
4.254000	Live	26.5	56.0	29.5	Complied
8.812500	Live	36.1	60.0	23.9	Complied
13.564500	Live	32.9	60.0	27.1	Complied
26.614500	Live	32.5	60.0	27.5	Complied

Results: Live / Average / 120 VAC 60 Hz

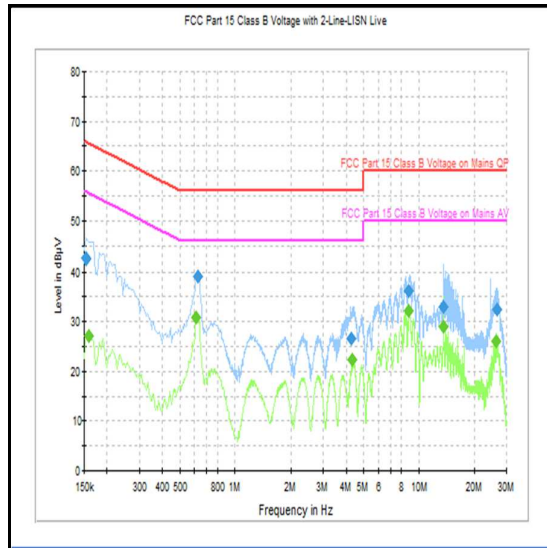
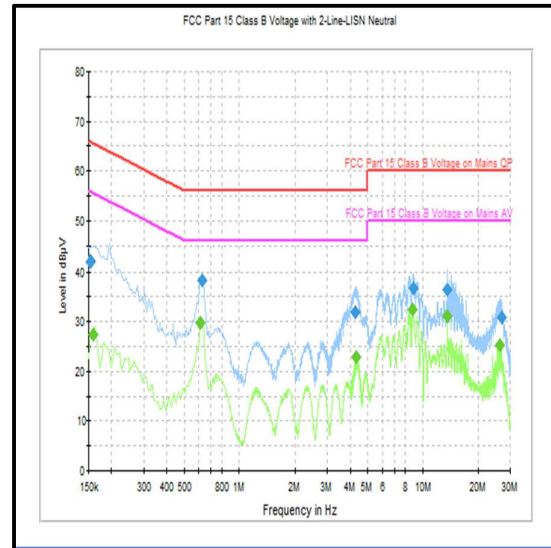
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159000	Live	27.1	55.5	28.4	Complied
0.613500	Live	30.8	46.0	15.2	Complied
4.330500	Live	22.3	46.0	23.7	Complied
8.803500	Live	32.1	50.0	17.9	Complied
13.560000	Live	28.9	50.0	21.1	Complied
26.371500	Live	25.9	50.0	24.1	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.154500	Neutral	42.0	65.8	23.8	Complied
0.627000	Neutral	38.3	56.0	17.7	Complied
4.281000	Neutral	31.9	56.0	24.1	Complied
8.848500	Neutral	36.6	60.0	23.4	Complied
13.560000	Neutral	36.3	60.0	23.7	Complied
26.853000	Neutral	30.9	60.0	29.1	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159000	Neutral	27.4	55.5	28.1	Complied
0.613500	Neutral	29.9	46.0	16.1	Complied
4.303500	Neutral	22.8	46.0	23.2	Complied
8.808000	Neutral	32.3	50.0	17.7	Complied
13.560000	Neutral	31.0	50.0	19.0	Complied
26.416500	Neutral	25.4	50.0	24.6	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
0.154500	Live	38.1	65.8	27.7	Complied
0.654000	Live	38.8	56.0	17.2	Complied
4.047000	Live	28.7	56.0	27.3	Complied
9.213000	Live	38.3	60.0	21.7	Complied
14.338500	Live	35.5	60.0	24.5	Complied
25.552500	Live	32.8	60.0	27.2	Complied

Results: Live / Average / 240 VAC 60 Hz

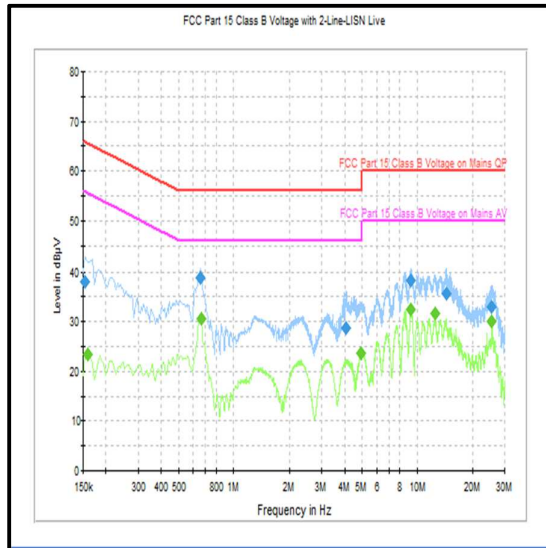
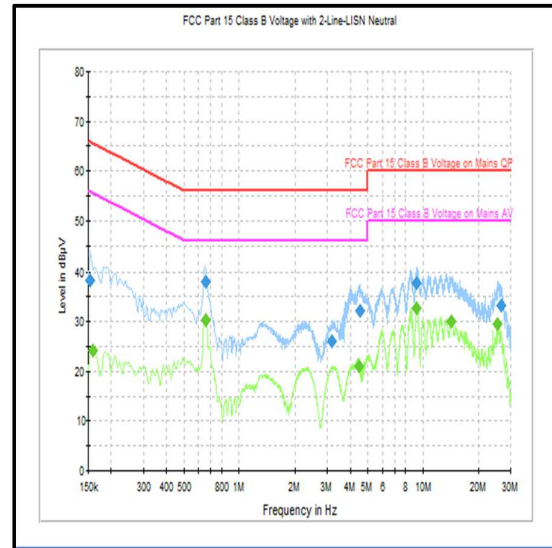
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159000	Live	23.4	55.5	32.1	Complied
0.663000	Live	30.7	46.0	15.3	Complied
4.929000	Live	23.7	46.0	22.3	Complied
9.235500	Live	32.3	50.0	17.7	Complied
12.462000	Live	31.7	50.0	18.3	Complied
25.561500	Live	30.1	50.0	19.9	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.154500	Neutral	38.2	65.8	27.6	Complied
0.654000	Neutral	38.1	56.0	17.9	Complied
3.187500	Neutral	26.2	56.0	29.8	Complied
4.510500	Neutral	32.2	56.0	23.8	Complied
9.190500	Neutral	37.8	60.0	22.2	Complied
26.736000	Neutral	33.2	60.0	26.8	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159000	Neutral	24.2	55.5	31.3	Complied
0.658500	Neutral	30.4	46.0	15.6	Complied
4.443000	Neutral	21.0	46.0	25.0	Complied
9.231000	Neutral	32.8	50.0	17.2	Complied
14.298000	Neutral	29.9	50.0	20.1	Complied
25.498500	Neutral	29.4	50.0	20.6	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.

--- END OF REPORT ---