TEST REPORT

Test Report No. : UL-RPT-RP12901422-416A V2.0

Customer	:	Grundfos Holding A/S
Model No.	:	SCALA1
FCC ID	:	OG3-SCALA1
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 2.0 supersedes all previous versions.

Date of Issue: 27 November 2019

Checked by:

Ian Watch
Senior Test Engineer, Radio Laboratory

Company Signatory:

Ben Mercer
Senior Test Engineer, Radio Laboratory
UL VS LTD

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Customer Information

Company Name:	Grundfos Holding A/S
Address:	Poul Due Jensens vej 7, DK-8850 Bjerringbro, Denmark

Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	02/09/2019	Initial Version	Ben Mercer
2.0	27/11/2019	Page 4. Changed Section 1.1 at the request of the TCB	Ian Watch

Table of Contents

1. Attestation of Test Results

1.1. Description of EUT

The equipment under test was 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:	19 July 2019 to 16 August 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 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 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	9 kHz to 30 MHz	95%	±4.39 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%	±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)
M2005	Thermohygrometer	Testo	608-H1	45046700	06 Jan 2020	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	12 Jun 2020	12
G0607	Vector Signal Generator	Rohde & Schwarz	SMU200A	100943	12 Jun 2022	36
A2946	Attenuator	AlanTechRF	AN18W5-20	208146#1	Calibrate 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	08 May 2020	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
A2890	Antenna	Schwarzbeck	HWRD 750	014	12 Feb 2020	12
A3142	Pre-Amplifier	Schwarzbeck	BBV 9718 B	00020	12 Feb 2020	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	20 Feb 2020	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	04 Oct 2019	12
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
A3165	Magnetic Loop Antenna	ETS-Lindgren	6502	00224383	07 Nov 2019	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842659/016	18 Dec 2019	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	20 Feb 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
A490	Antenna	Chase	CBL6111A	1590	21 May 2020	12
A3167	Pre-Amplifier	Com-Power	PAM-103	18020010	11 Feb 2020	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	13 May 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	08 May 2020	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 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	ESIB 26	100275	18 Dec 2019	12
A3130	Noise Generator	York EMC	CNE V	2646	28 Sep 2019	12
M2037	Thermohygrometer	Testo	608-H1	45124925	06 Jan 2020	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	08 Nov 2019	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	10 Apr 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 A/S
Model Name or Number:	SCALA1
Test Sample Serial Number:	2412289 *(Radiated Sample #1)*
Hardware Version:	MB R05 & MB R06
Software Version:	99545258Vxx.yy.zz.aaaaa
FCC ID:	OG3-SCALA1

Brand Name:	Grundfos Holding A/S
Model Name or Number:	SCALA1
Test Sample Serial Number:	2389160 (*Conducted Sample #1*)
Hardware Version:	MB R05 & MB R06
Software Version:	99545258Vxx.yy.zz.aaaaa
FCC ID:	OG3-SCALA1

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: LE	1 Mbps		
Power Supply Requirement(s):	Nominal	12 VDC	
Maximum Conducted Output Power:	4.5 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	0.0

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:	Lenovo ThinkPad
Model Name or Number:	L480
Serial Number:	PF1EHZQQ

Description:	AC to DC Power Adapter
Brand Name:	Mean Well
Model Name or Number:	GE24I12-P1J
Serial Number:	0F87710849

Description:	USB Hub
Brand Name:	Hama
Model Name or Number:	00078498
Serial Number:	Not Stated

Description:	USB to RS485 Cable
Brand Name:	FTDI Chip
Model Name or Number:	USB-RS485-WE-4500-BT
Serial Number:	Not Stated

Description:	Laptop PC
Brand Name:	Lenovo ThinkPad
Model Name or Number:	L470
Serial Number:	PF10T3HL

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

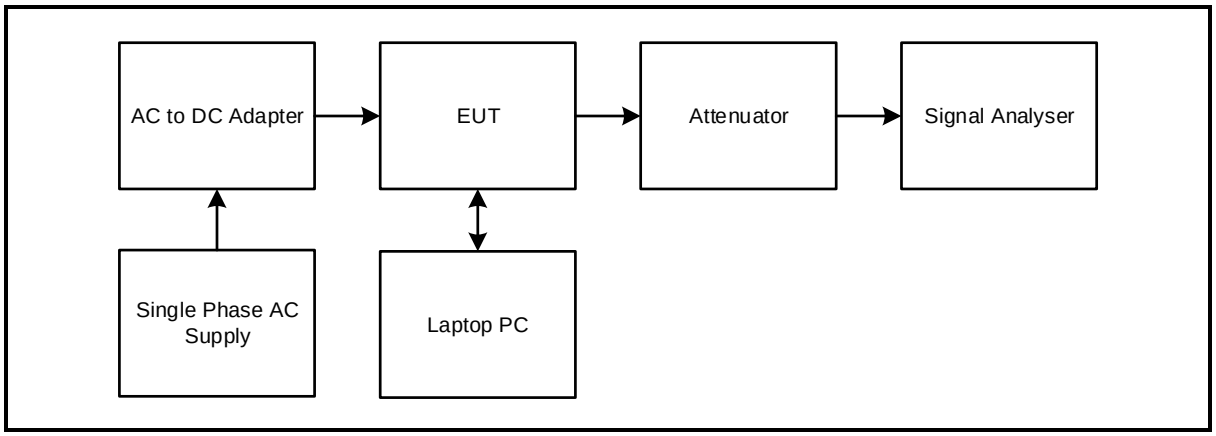
The EUT was tested in the following configuration(s):

- Controlled in test mode using a software application 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 customer supplied a document containing the setup instructions ‘Test BLE radio for Grundfos SCALA1 NAMREG.pdf’. The laptop PC was connected to the EUT via a USB to RS485 cable.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply via a 12 V AC to DC adapter.
- Transmitter radiated spurious emissions tests were performed with the EUT in the position / orientation that produced the worst case with respect to emissions. Once in the correct mode, the laptop PC was removed and the USB connector was terminated. There were no other active ports on the EUT to populate.

Test Setup Diagrams

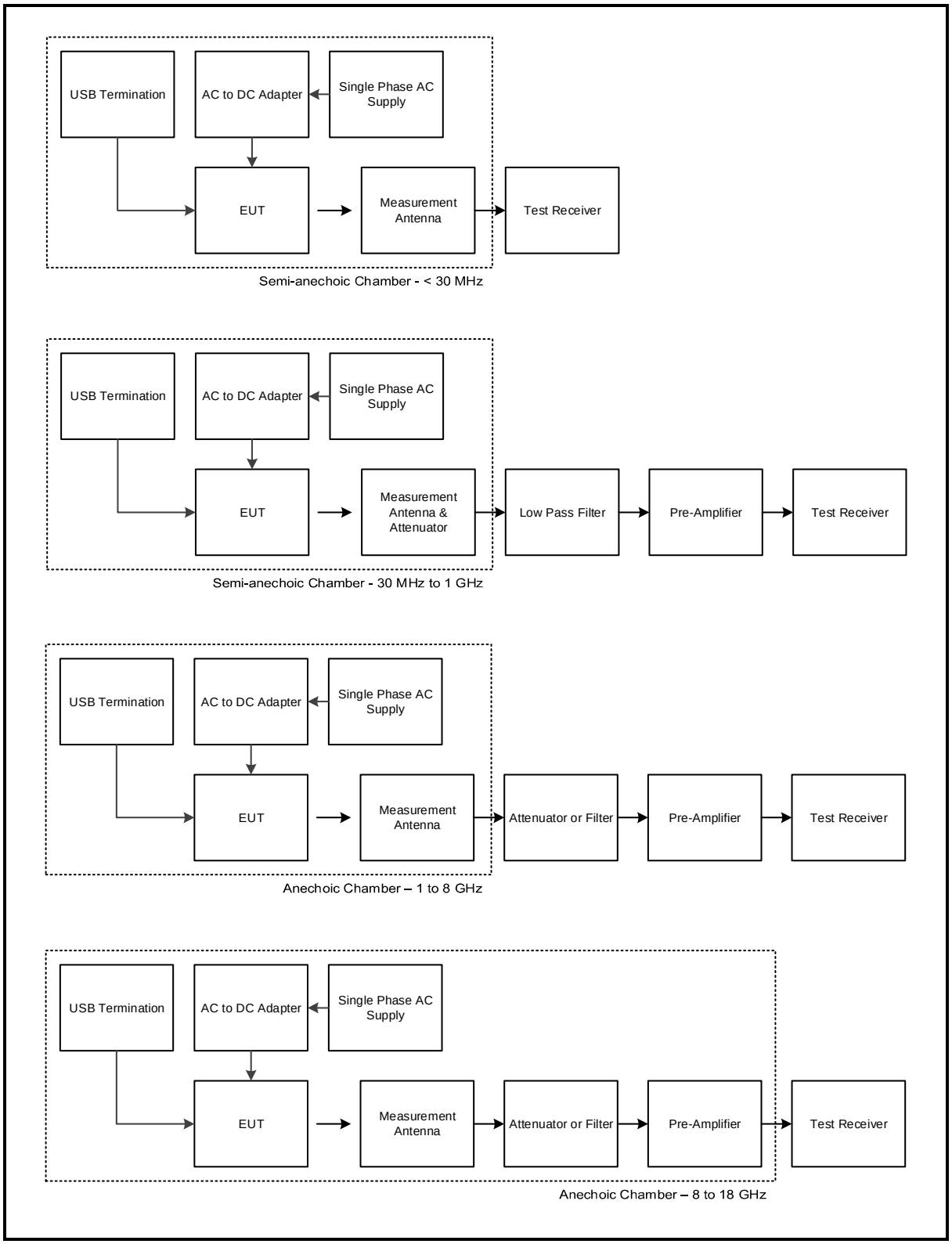
Conducted Tests:

Test Setup for Transmitter Minimum 6 dB Bandwidth & Maximum Peak Output Power

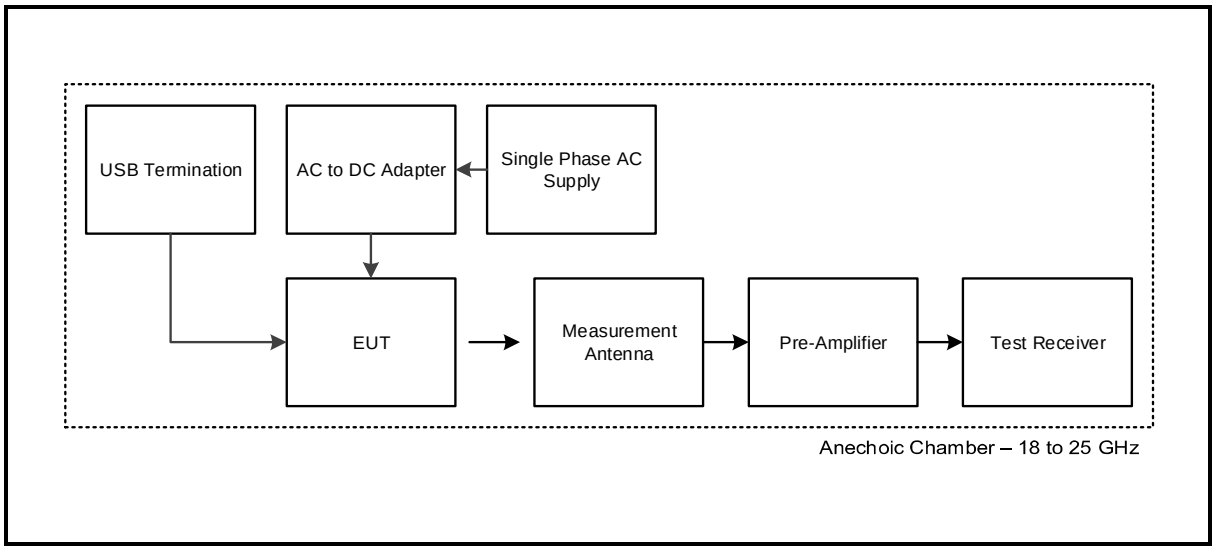


Radiated Tests:

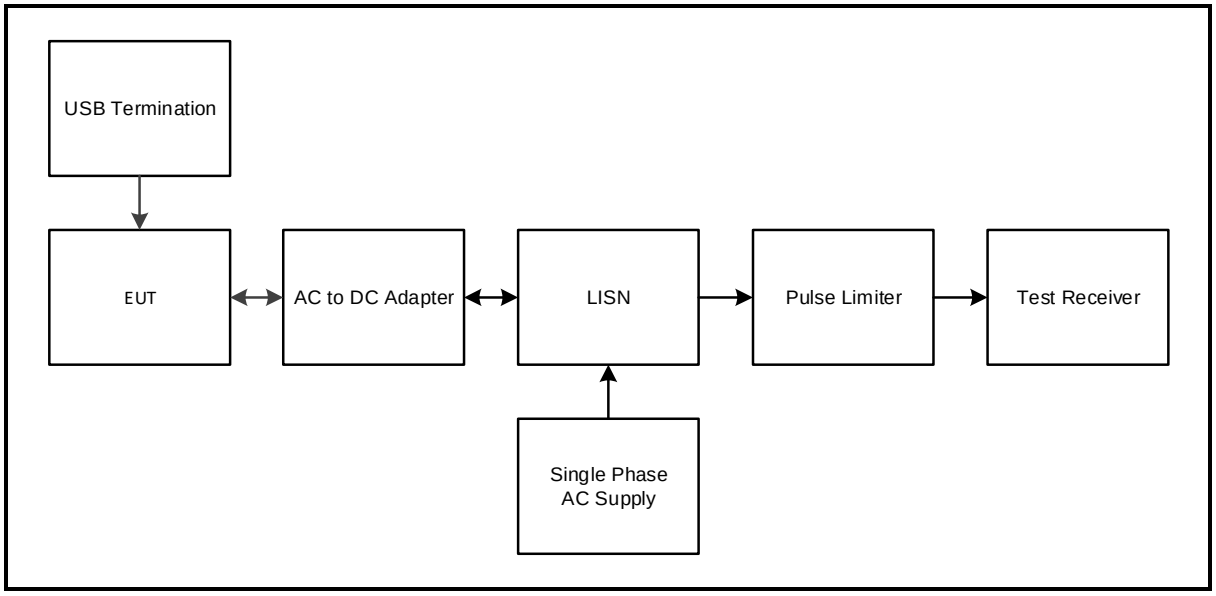
Test Setup for Transmitter Radiated Emissions



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 Engineer:	Stefan Ho & Alison Johnston	**Test Date:**	08 August 2019
Test Sample Serial Number:	2389160		

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 (%):	54

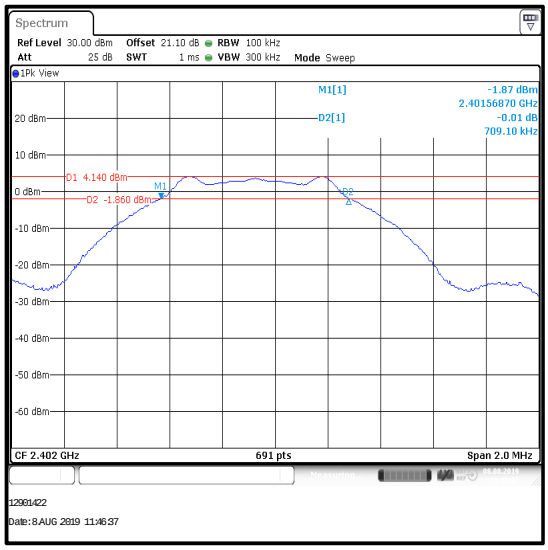
Note(s):

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.

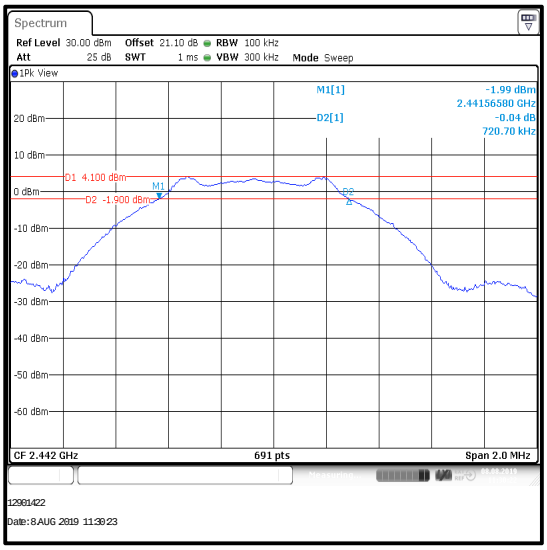
Transmitter Minimum 6 dB Bandwidth (continued)

Results:

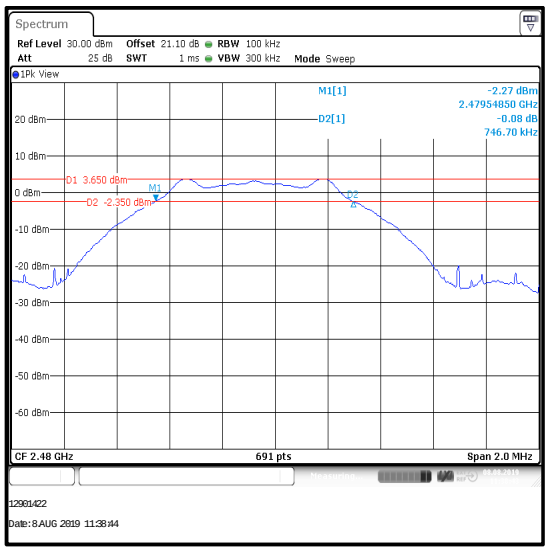
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	709.100	≥500	209.100	Complied
Middle	720.700	≥500	220.700	Complied
Top	746.700	≥500	246.700	Complied



Bottom Channel



Middle Channel



Top Channel

4.2. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineers:	Stefan Ho & Alison Johnston	**Test Date:**	08 August 2019
Test Sample Serial Number:	2389160		

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 (%):	60

Note(s):

1. Tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 with the RBW ≥ 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)

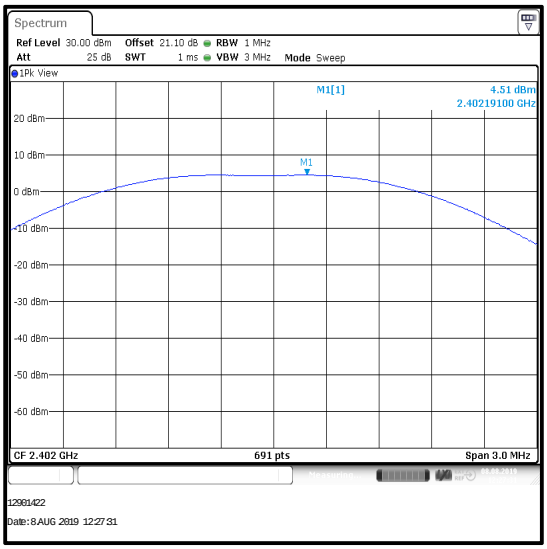
Results:

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	4.5	30.0	25.5	Complied
Middle	4.4	30.0	25.6	Complied
Top	4.1	30.0	25.9	Complied

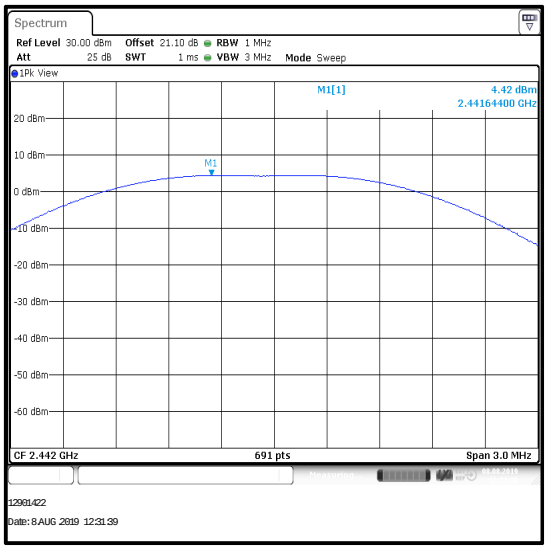
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	4.5	0.0	4.5	36.0	31.5	Complied
Middle	4.4	0.0	4.4	36.0	31.6	Complied
Top	4.1	0.0	4.1	36.0	31.9	Complied

Transmitter Maximum Peak Output Power (continued)

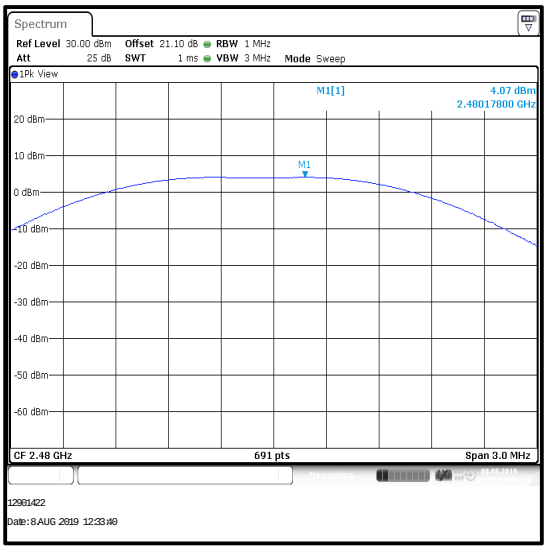
Results:



Bottom Channel



Middle Channel



Top Channel

5. Radiated Test Results

5.1. Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineers:	Mark Perry & Nick Tye	**Test Dates:**	20 July 2019 & 16 August 2019
Test Sample Serial Number:	2412289		

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):	24
Relative Humidity (%):	47 to 48

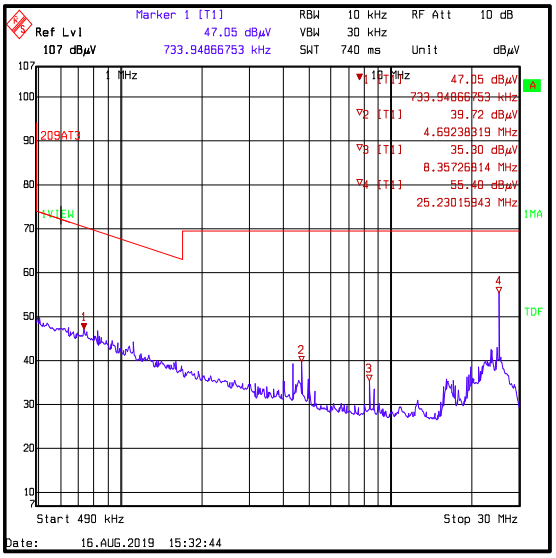
Note(s):

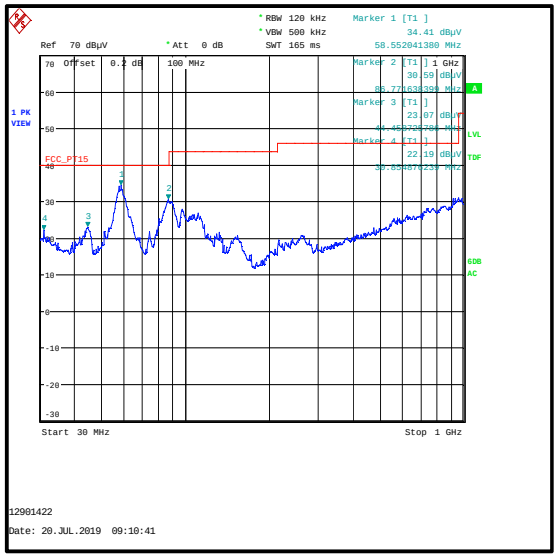
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore, final radiated emissions measurements were performed with the 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 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.
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.
8. All other 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.

Transmitter Radiated Spurious Emissions (continued)

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
58.552	Vertical	34.4	40.0	5.6	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 Engineer:	Mark Perry	**Test Date:**	19 July 2019
Test Sample Serial Number:	2412289		

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):	24
Relative Humidity (%):	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 3 GHz plot is the EUT fundamental.
3. 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.
4. All other emissions were at least 20 dB below the appropriate limit or below the noise floor of the measurement system.
5. 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.
6. 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.

Transmitter Radiated Emissions (continued)

Results: Bottom Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
12008.392	Horizontal	48.8	54.0	5.2	Complied

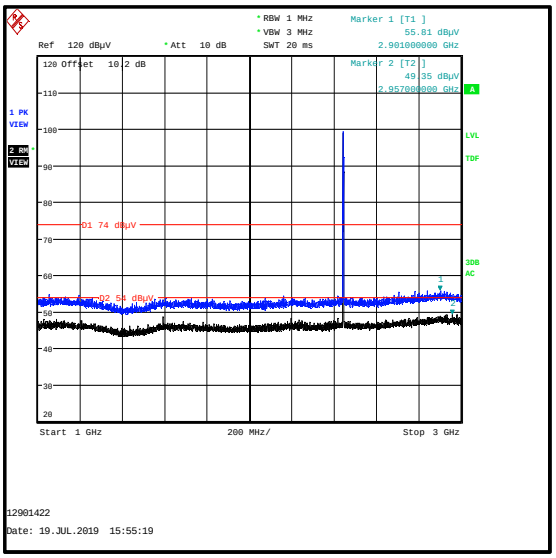
Results: Middle Channel

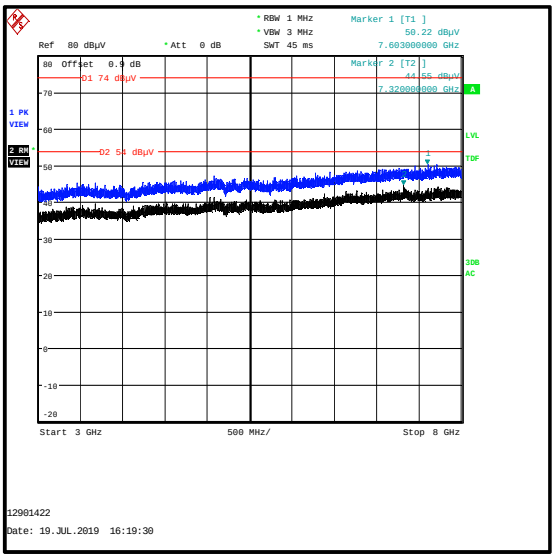
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
12210.912	Horizontal	48.7	54.0	5.3	Complied

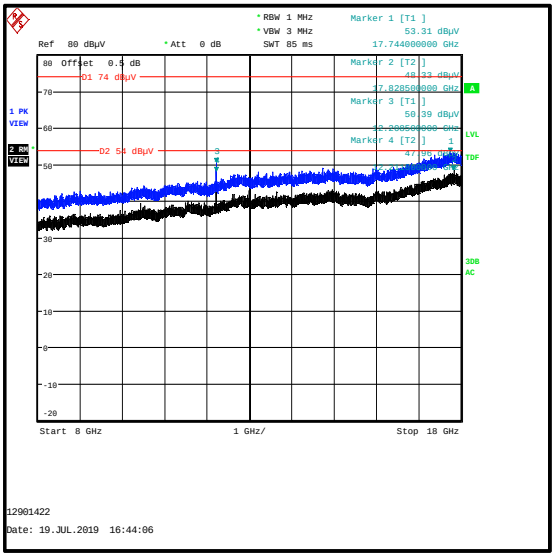
Results: Top Channel

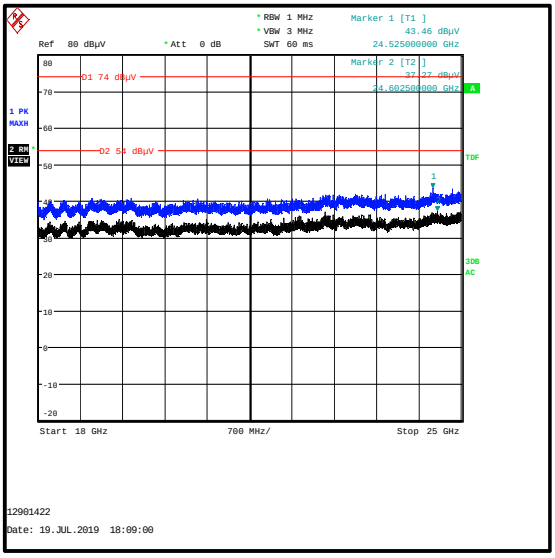
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
12400.975	Horizontal	50.9	54.0	3.1	Complied

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:

Test Engineer:	Mark Perry	**Test Date:**	19 July 2019
Test Sample Serial Number:	2412289		

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

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	44

Transmitter Band Edge Radiated Emissions (continued)

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 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.
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 (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2400.000	Horizontal	51.7	78.7*	27.0	Complied
2483.500	Horizontal	58.2	74.0	15.8	Complied

Results: Average

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	Horizontal	51.8	54.0	2.2	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

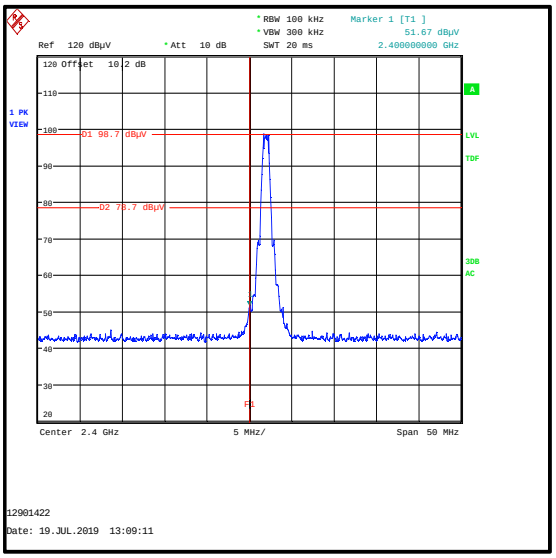
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2345.897	Horizontal	54.2	74.0	19.8	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

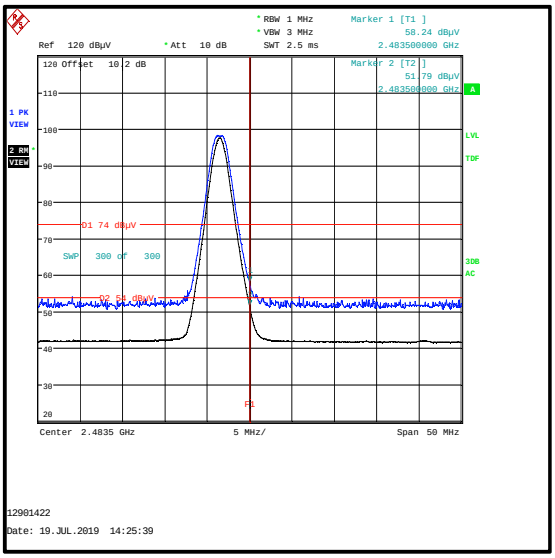
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2388.333	Horizontal	42.2	54.0	11.8	Complied

Transmitter Band Edge Radiated Emissions (continued)

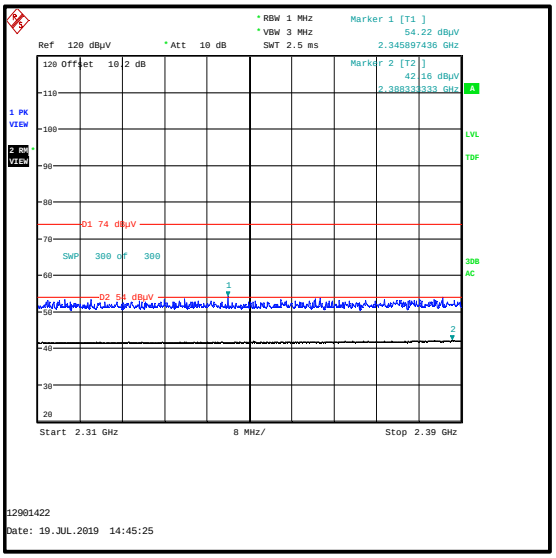
Results:



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:	Mark Perry	**Test Date:**	21 July 2019
Test Sample Serial Number:	2412289		

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

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	61

Note(s):

1. The EUT was connected to its AC to DC adapter, 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 performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the AC to DC adapter.
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
0.150	Live	36.3	66.0	29.7	Complied
0.326	Live	27.6	59.6	32.0	Complied
0.614	Live	30.6	56.0	25.4	Complied
1.649	Live	17.2	56.0	38.8	Complied
2.135	Live	15.9	56.0	40.1	Complied
12.062	Live	20.0	60.0	40.0	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.177	Live	21.1	54.6	33.5	Complied
0.348	Live	16.1	49.0	32.9	Complied
0.614	Live	19.8	46.0	26.2	Complied
2.126	Live	8.9	46.0	37.1	Complied
7.913	Live	7.6	50.0	42.4	Complied
12.075	Live	11.7	50.0	38.3	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

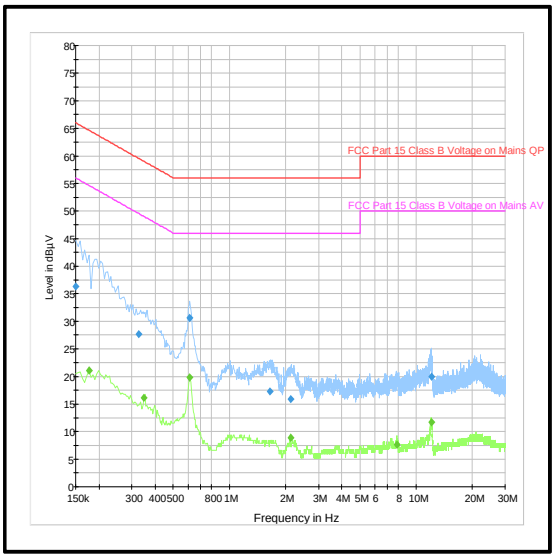
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.164	Neutral	35.3	65.3	30.0	Complied
0.303	Neutral	33.1	60.2	27.1	Complied
0.609	Neutral	37.9	56.0	18.1	Complied
0.789	Neutral	24.4	56.0	31.6	Complied
1.473	Neutral	18.3	56.0	37.7	Complied
12.120	Neutral	22.7	60.0	37.3	Complied

Results: Neutral / Average / 120 VAC 60 Hz

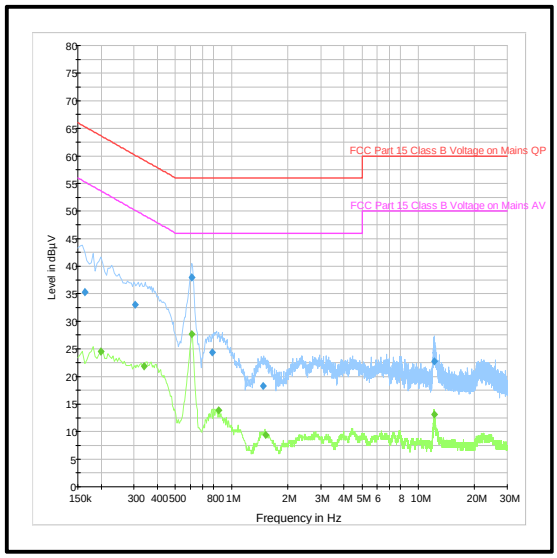
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.200	Neutral	24.5	53.6	29.1	Complied
0.339	Neutral	21.9	49.2	27.3	Complied
0.614	Neutral	27.7	46.0	18.3	Complied
0.852	Neutral	13.8	46.0	32.2	Complied
1.523	Neutral	9.4	46.0	36.6	Complied
12.143	Neutral	13.1	50.0	36.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 120 VAC 60 Hz



Live



Neutral

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

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150	Live	34.1	66.0	31.9	Complied
0.465	Live	24.0	56.6	32.6	Complied
0.632	Live	28.3	56.0	27.7	Complied
1.410	Live	20.3	56.0	35.7	Complied
2.427	Live	17.8	56.0	38.2	Complied
12.044	Live	15.7	60.0	44.3	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.177	Live	20.8	54.6	33.8	Complied
0.285	Live	18.4	50.7	32.3	Complied
0.632	Live	16.7	46.0	29.3	Complied
1.347	Live	10.8	46.0	35.2	Complied
2.423	Live	9.5	46.0	36.5	Complied
3.633	Live	8.0	46.0	38.0	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

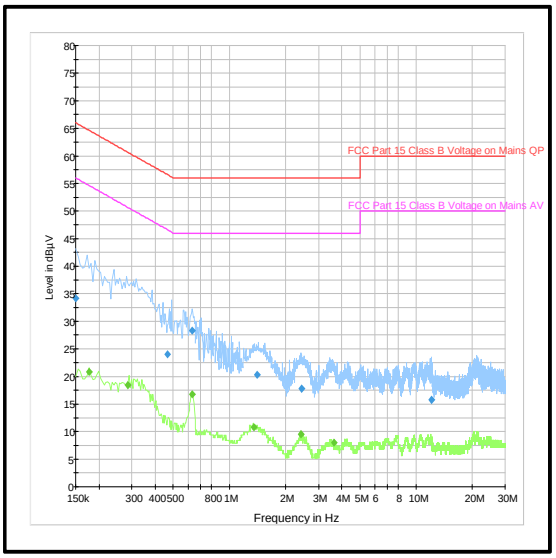
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.182	Neutral	35.9	64.4	28.5	Complied
0.218	Neutral	35.2	62.9	27.7	Complied
0.348	Neutral	35.9	59.0	23.1	Complied
0.641	Neutral	35.9	56.0	20.1	Complied
1.563	Neutral	22.5	56.0	33.5	Complied
21.359	Neutral	17.1	60.0	42.9	Complied

Results: Neutral / Average / 240 VAC 60 Hz

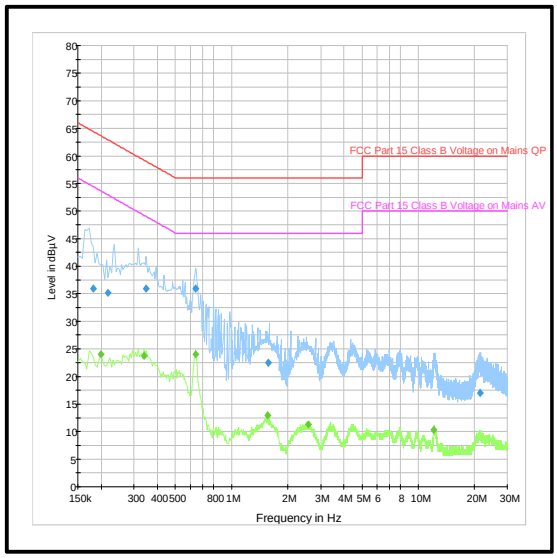
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.200	Neutral	23.9	53.6	29.7	Complied
0.339	Neutral	23.8	49.2	25.4	Complied
0.641	Neutral	24.0	46.0	22.0	Complied
1.554	Neutral	13.0	46.0	33.0	Complied
2.562	Neutral	11.3	46.0	34.7	Complied
12.102	Neutral	10.3	50.0	39.7	Complied

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.

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