



TEST REPORT

Test Report No. : UL-RPT-RP13232099-616A V2.0

Customer : Grundfos Holding A/S
Model No. : GiM CIU
FCC ID : OG3-GIM1A
Technology : *Bluetooth – Low Energy*
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.247
Test Laboratory : UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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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: 08 February 2021

Checked by:

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Operations Leader, Radio Laboratory



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Customer Information

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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	25/01/2021	Initial Version	Ian Watch
2.0	08/02/2021	Changed FCC ID Pages 1 & 9 Changed antenna gain page 20 Inserted <30 MHz radiated emissions test results, test equipment & block diagram, updated notes	Ian Watch

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1. Attestation of Test Results

1.1. Description of EUT

The Equipment Under Test was an iSolution monitor containing a Bluetooth Low Energy module (FCC ID:OG3-GIM10).

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
Location of Testing:	UL International (UK) Ltd, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
FCC Test Laboratory Designation No.:	UK2011
Test Dates:	28 April 2020 to 28 January 2021

1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	✓
Part 15.247(e)	Transmitter Power Spectral Density	Note 2
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	✓
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	✓
Part 15.207	Transmitter AC Conducted Emissions	✓
Key to Results		
✓ = Complied	✗ = Did not comply	

Note(s):

1. The measurement was performed to assist in the calculation of the level of the emissions.
2. 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 17	X

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

2.2. Methods and Procedures

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. Measurement Uncertainty & Decision Rule

Overview

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

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

Decision Rule

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

Measurement Uncertainty

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

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
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%	±5.32 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±1.96 dB

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

2.4. Test and Measurement Equipment

Test Equipment Used for Transmitter Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	05 Jan 2021	12
M2835	Signal Analyser	Rohde & Schwarz	FSV 30	103050	14 Apr 2021	12
G0615	Vector Signal Generator	Rohde & Schwarz	SMBV100A	260473	19 Mar 2023	36
M1818	Multimeter	Fluke	79 Series III	71811580	09 Apr 2021	12
A2525	Attenuator	AtlanTecRF	AN18W5-10	832827#3	Calibrated before use	-
S0564	Power Supply	Thurlby Thandar	PL330P	062941	Calibrated before use	-

Test Equipment Used for Transmitter Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Oct 2021	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
M2040	Thermohygrometer	Testo	608-H1	45124934	10 Dec 2021	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	20 Jan 2021	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	09 Apr 2021	12
A3155	Pre-Amplifier	Com-Power	PAM-118A	18040037	04 Oct 2020	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A3142	Pre-Amplifier	Schwarzbeck	BBV 9718 B	00020	08 Aug 2020	12
A3198	Magnetic Loop Antenna	ETS-Lindgren	6502	00221887	01 Apr 2021	12
A553	Antenna	Chase	CBL6111A	1593	14 Oct 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	08 Aug 2020	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	08 Aug 2020	12
A2943	Attenuator	AtlanTecRF	AN18W5-06	208147#2	06 Jan 2021	12
A3085	Low Pass Filter	AtlanTecRF	AFL-02000	18051600014	20 Feb 2021	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	06 Feb 2021	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	06 Feb 2021	12

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	20 Jan 2021	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B 653	BBHA 9120 B 653	08 Aug 2020	12
A2943	Attenuator	AtlanTecRF	AN18W5-06	208147#2	06 Jan 2021	12

Test Equipment Used for Transmitter AC Conducted Spurious Emissions:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	07 Jan 2021	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	08 Aug 2020	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	07 Apr 2021	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	03 Dec 2020	12

Test Measurement Software/Firmware Used:

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:	GiM CIU
Test Sample Serial Number:	0375
Hardware Version:	R03
Software Version:	V03.00.03.00001
FCC ID:	OG3-GIM1A

Brand Name:	Grundfos Holding A/S
Model Name or Number:	GiM CIU
Test Sample Serial Number:	0744
Hardware Version:	R03
Software Version:	V03.00.03.00001
FCC ID:	OG3-GIM1A

Brand Name:	Grundfos Holding A/S
Model Name or Number:	GiM CIU
Test Sample Serial Number:	0358
Hardware Version:	R03
Software Version:	V03.00.03.00001
FCC ID:	OG3-GIM1A

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:	<i>Bluetooth Low Energy (Digital Transmission System)</i>				
Type of Unit:	Transceiver				
Channel Spacing:	2 MHz				
Modulation:	GFSK				
Data Rate:	1 Mbps				
Power Supply Requirement(s):	Nominal	120 VAC 60 Hz			
Maximum Conducted Output Power:	4.7 dBm				
Transmit Frequency Range:	2402 MHz to 2480 MHz				
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)		
	Bottom	37	2402		
	Middle	18	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	2.0

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
Model Name or Number:	ThinkPad L480
Serial Number:	PF1EHZQ0

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	ThinkPad L480
Serial Number:	PF10T3HL

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	ThinkPad L440
Serial Number:	R9-019EA1

Description:	BLE Companion box
Brand Name:	Grundfos
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	PC Link to USB cable
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Operating Modes

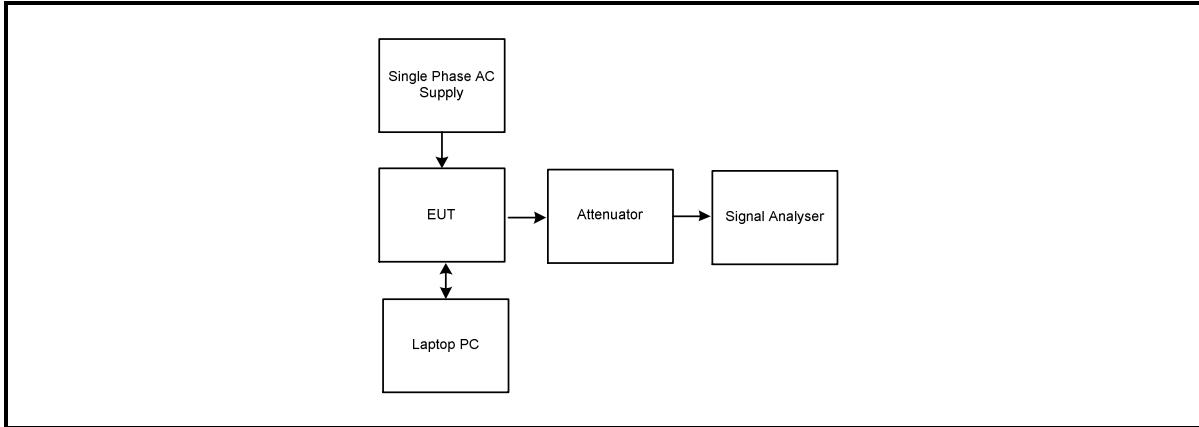
The EUT was tested in the following operating mode(s):

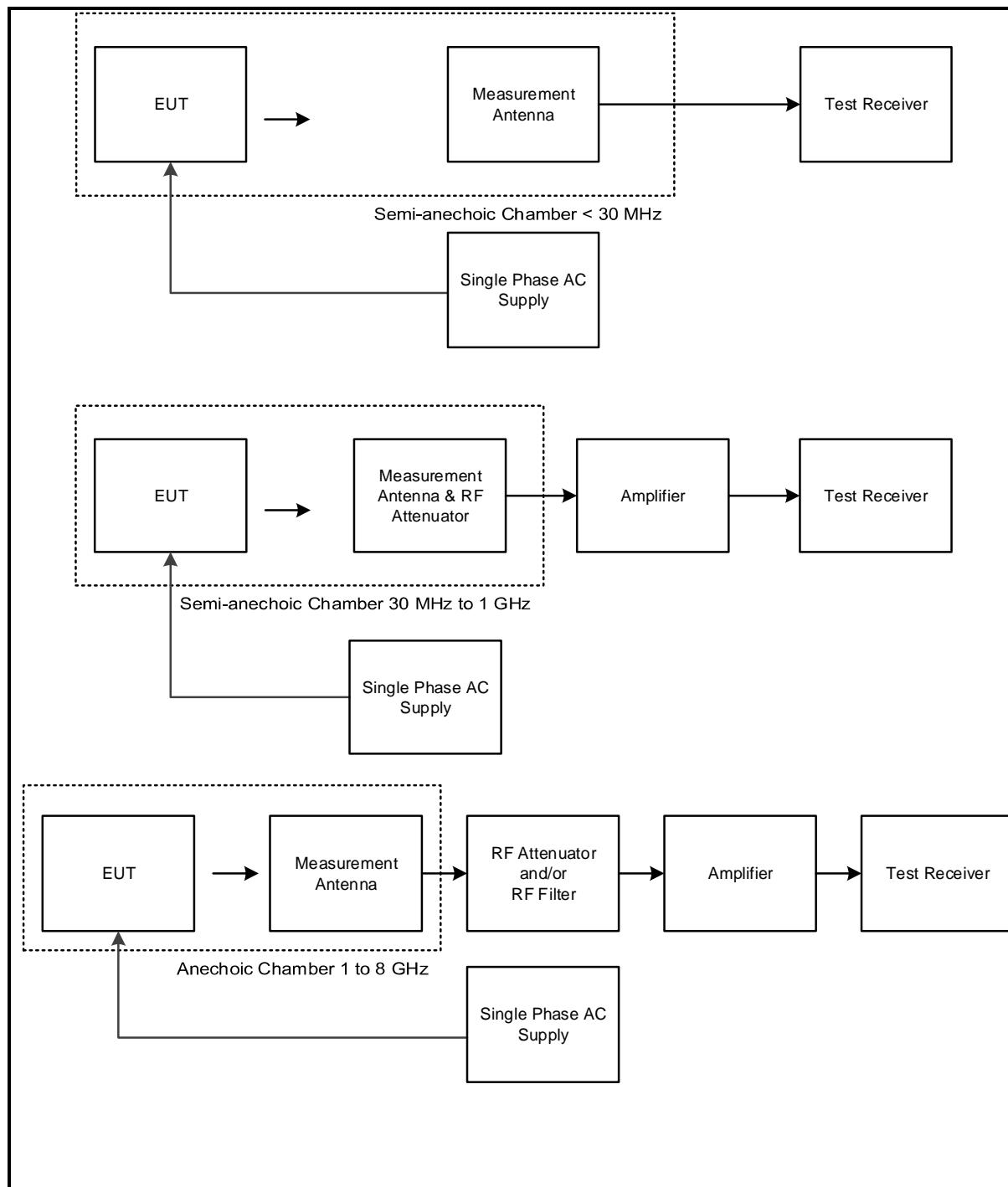
- Transmitting on bottom, middle or top channel with a modulated carrier at maximum power in *Bluetooth LE* mode.

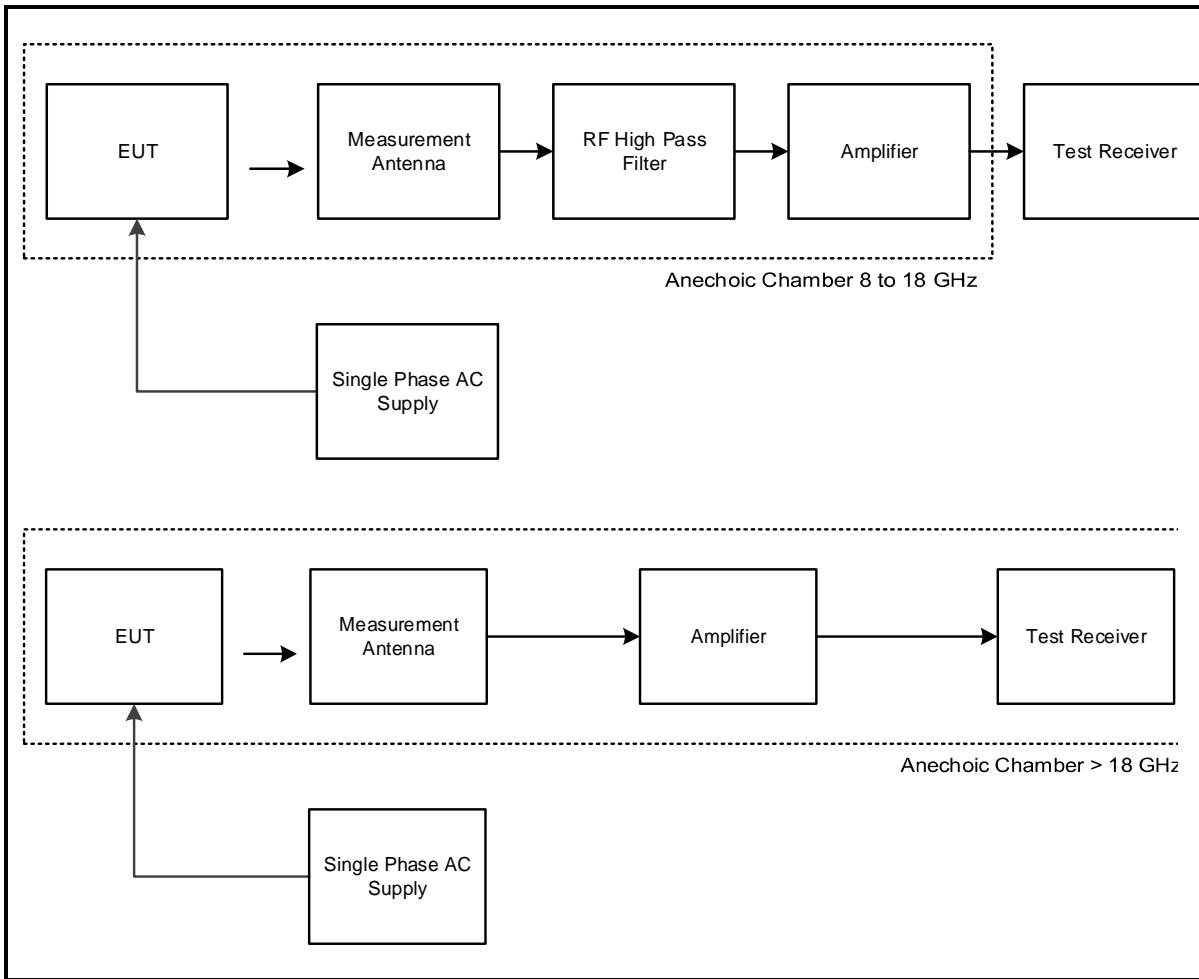
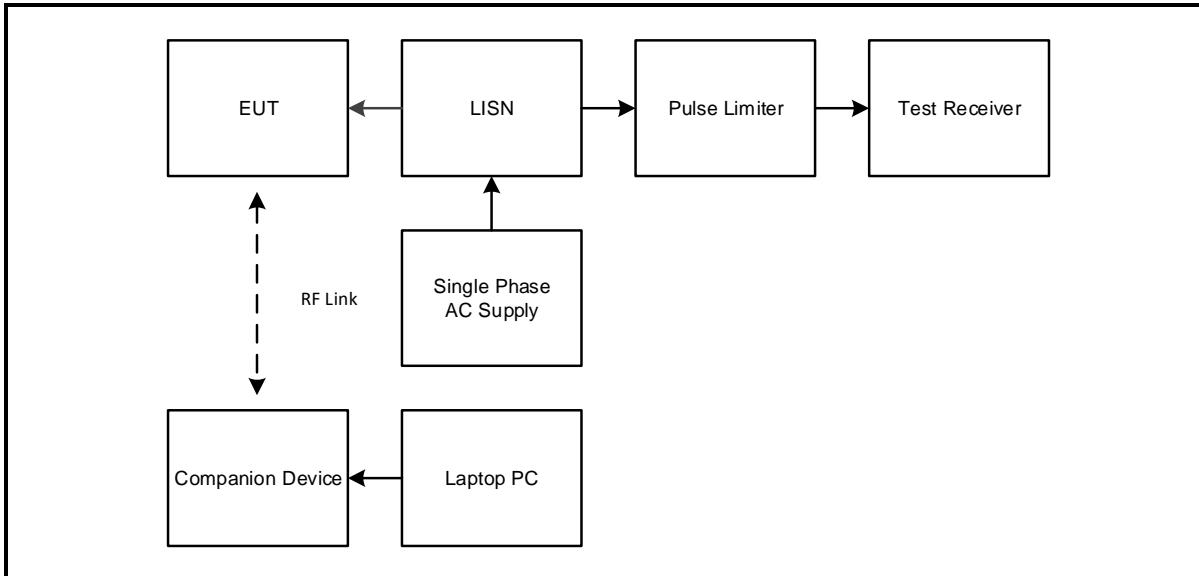
Configuration and Peripherals

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

- Controlled in test mode using a software application supplied by the customer on the laptop PC. 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 'Connect GiM to BLE.pdf', Date: 22 April 2020. The laptop PC was connected to the EUT via a USB to serial port cable.
- Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LE mode. PSD was not measured as the output power is less than 10 dBm.
- All active ports were terminated using the appropriate terminations during radiated emissions testing.

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

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

Radiated Tests:**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:	Matthew Botfield	Test Date:	29 April 2020
Test Sample Serial Number:	0375		

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:

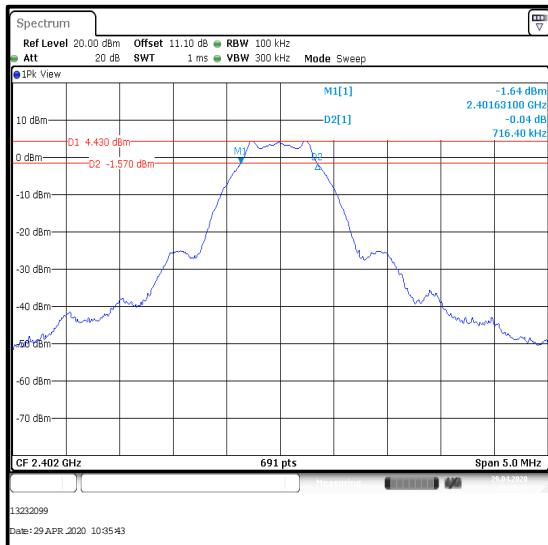
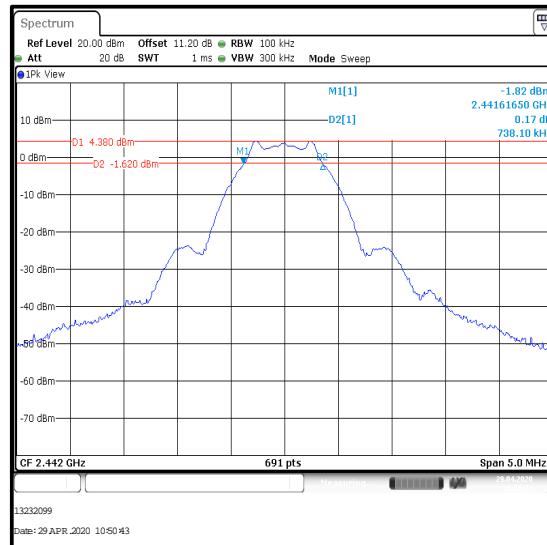
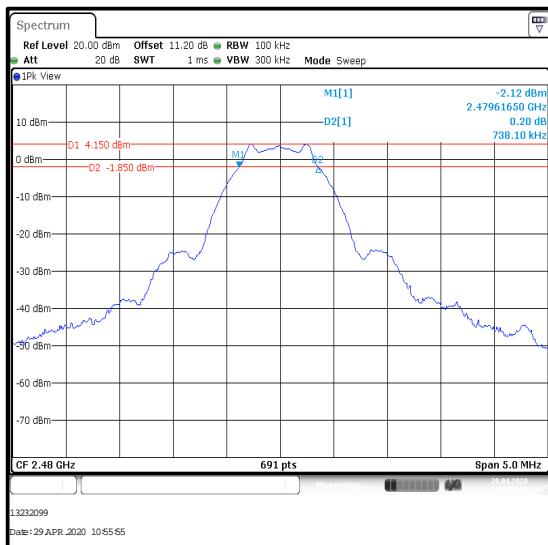
Temperature (°C):	22
Relative Humidity (%):	45

Note(s):

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

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

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	716.400	≥500	216.400	Complied
Middle	738.100	≥500	238.100	Complied
Top	738.100	≥500	238.100	Complied

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

4.2. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Matthew Botfield	Test Date:	29 April 2020
Test Sample Serial Number:	0375		

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

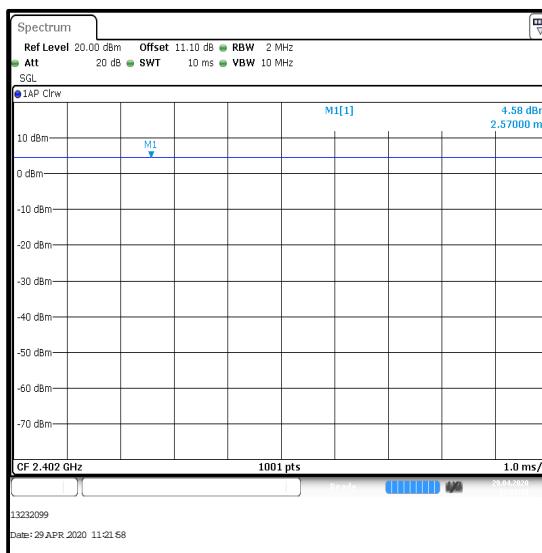
Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	44

Note(s):

1. The LE mode duty cycle was measured and found to be greater than 98%. No duty cycle correction is required.

Results:



4.3. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Matthew Botfield	Test Date:	29 April 2020
Test Sample Serial Number:	0375		

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):	21
Relative Humidity (%):	44

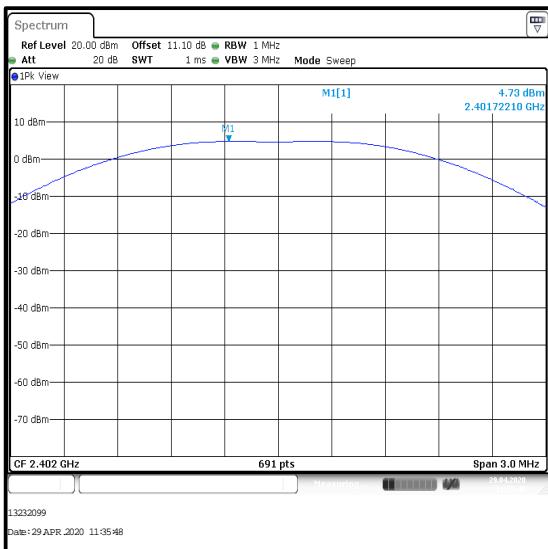
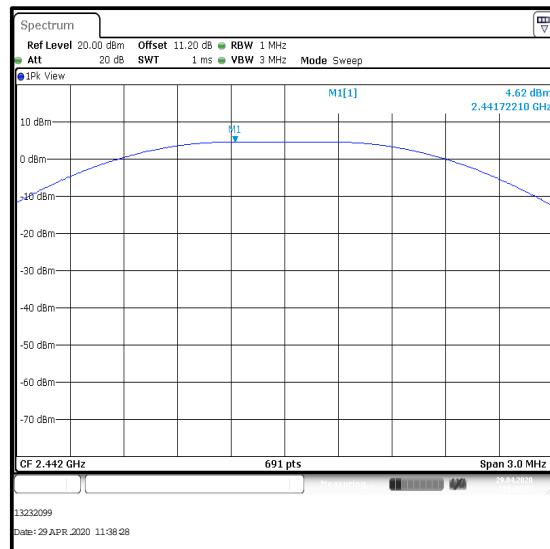
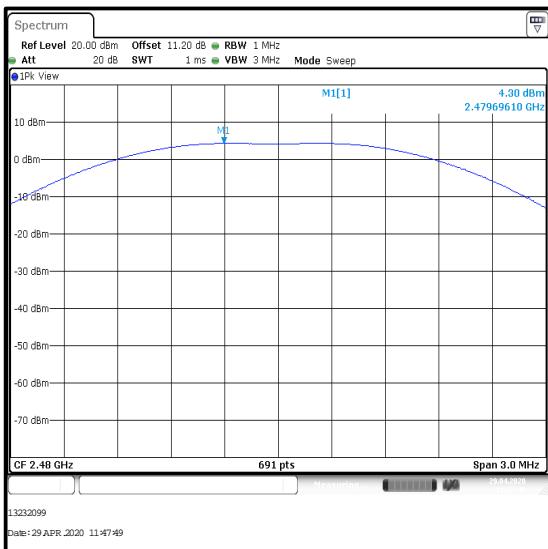
Note(s):

1. Conducted power tests were performed using a signal analyser in accordance with ANSI C63.10 Section 11.9.1.1 with the $RBW \geq DTS$ bandwidth procedure.
2. The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth of 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 MHz. A marker was placed at the peak of the signal and the results recorded in the tables below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF 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	4.7	30.0	25.3	Complied
Middle	4.6	30.0	25.4	Complied
Top	4.3	30.0	25.7	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	4.7	2.0	6.7	36.0	29.3	Complied
Middle	4.6	2.0	6.6	36.0	29.4	Complied
Top	4.3	2.0	6.3	36.0	29.7	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 & Andrew Edwards	Test Dates:	30 April 2020 & 28 January 2021
Test Sample Serial Number:	0358		

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	9 kHz to 1000 MHz

Environmental Conditions:

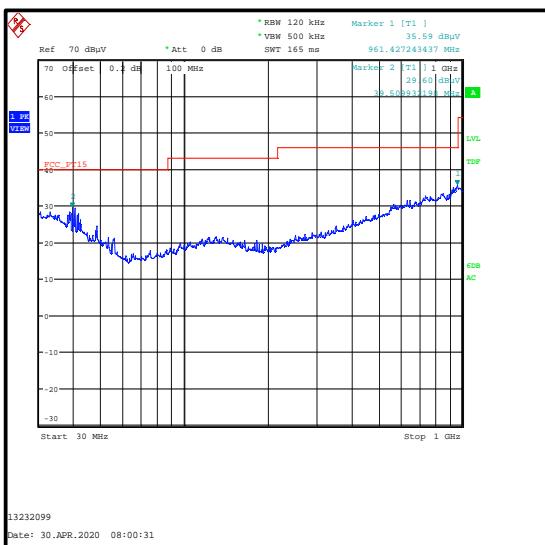
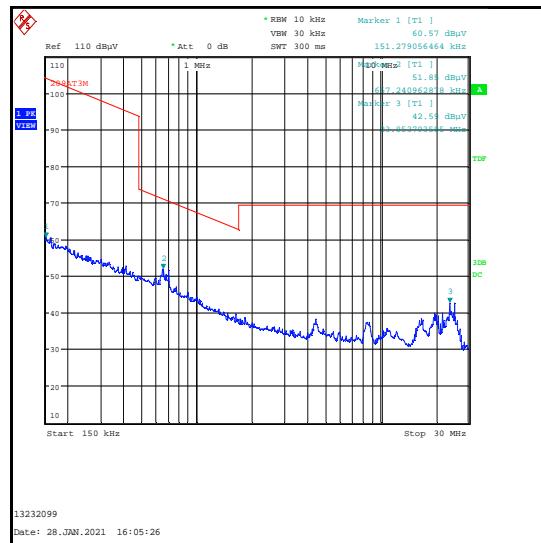
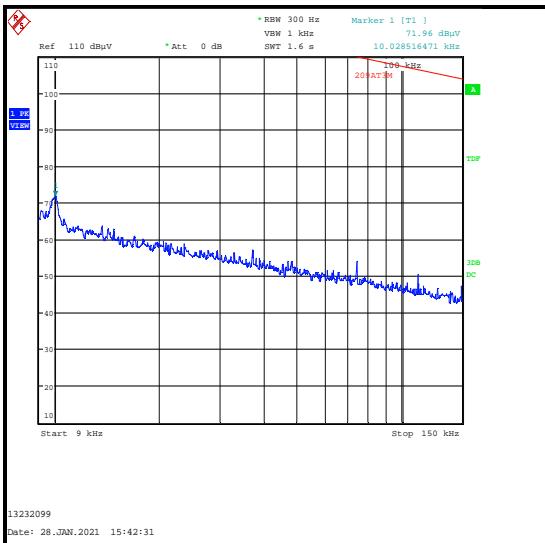
Temperature (°C):	21 to 22
Relative Humidity (%):	40 to 41

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
3. All emissions shown on the pre-scan plots were investigated and found to be ambient, or >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest peak noise floor reading of the measuring receiver in the 30 MHz to 1 GHz range was recorded in the table below
4. 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.
5. Measurements from 30 MHz to 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 was configured as follows: During 9 kHz to 150 kHz measurements, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz, trace mode was Max Hold. During 30 MHz to 1 GHz measurements, the 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.

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
961.427	Vertical	35.6	54.0	18.4	Complied



5.2. Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineer:	Tom Sleigh	Test Dates:	28 Apr 2020 to 01 May 2020
Test Sample Serial Number:	0358		

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):	21 to 22
Relative Humidity (%):	36 to 40

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 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.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. Final measurements above 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 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
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 the appropriate detectors during the pre-scan measurements.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
4803.776	Vertical	47.0	74.0	27.0	Complied
12008.702	Horizontal	49.7	74.0	24.3	Complied

Results: Average / Bottom Channel

Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4804.048	Vertical	36.2	54.0	17.8	Complied
12011.042	Horizontal	41.2	54.0	12.8	Complied

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
4883.343	Vertical	49.2	74.0	24.8	Complied
7326.591	Vertical	55.5	74.0	18.5	Complied
12211.154	Horizontal	49.7	74.0	24.3	Complied

Results: Average / Middle Channel

Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4883.968	Vertical	39.0	54.0	15.0	Complied
7326.463	Vertical	46.7	54.0	7.3	Complied
12211.106	Horizontal	41.4	54.0	12.6	Complied

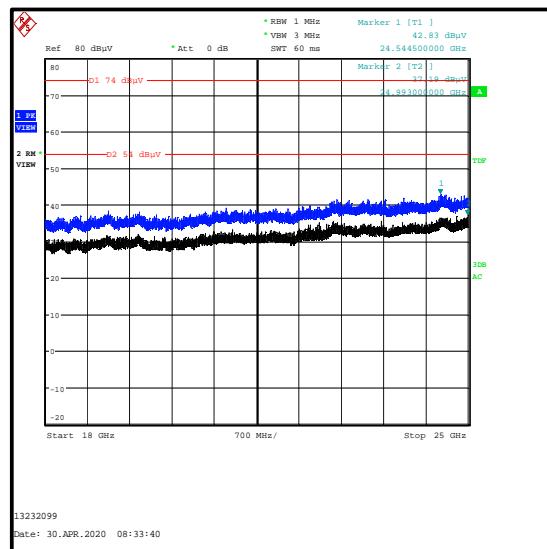
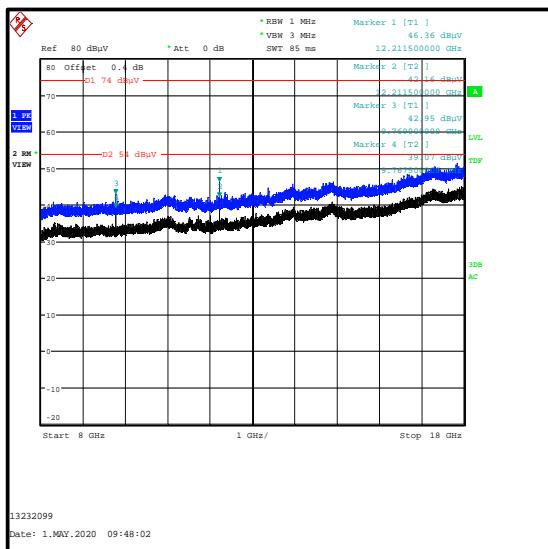
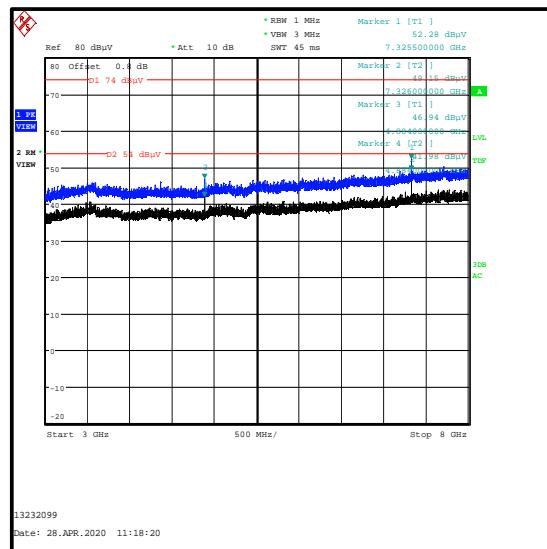
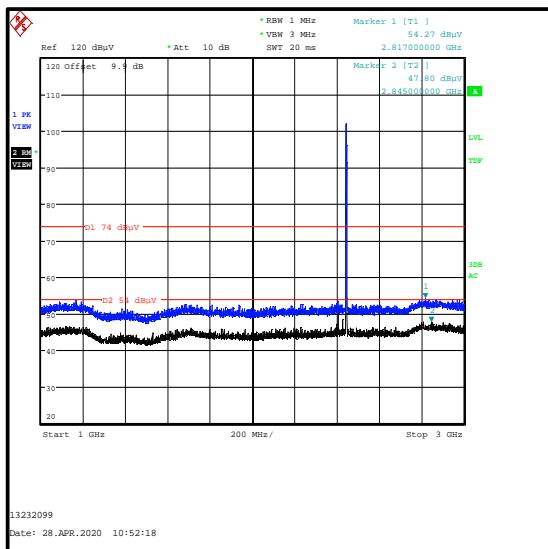
Results: Peak / Top Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
4959.423	Vertical	43.7	74.0	30.3	Complied
7439.038	Vertical	52.0	74.0	22.0	Complied
12398.798	Horizontal	50.6	74.0	23.4	Complied

Results: Average / Top Channel

Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4960.000	Vertical	33.7	54.0	20.3	Complied
7439.343	Vertical	42.8	54.0	11.2	Complied
12401.041	Horizontal	42.4	54.0	11.6	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:	Tom Sleigh	Test Dates:	29 April 2020 & 30 April 2020
Test Sample Serial Number:	0358		

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):	21
Relative Humidity (%):	38 to 40

Note(s):

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

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	54.8	79.5*	24.7	Complied
2483.500	Vertical	57.0	74.0	17.0	Complied

Results: Average

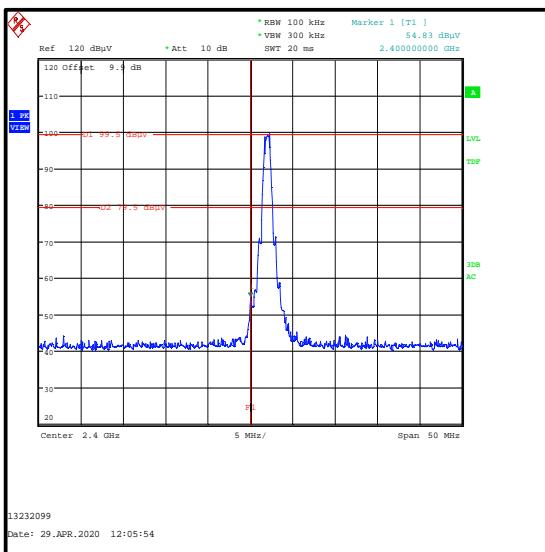
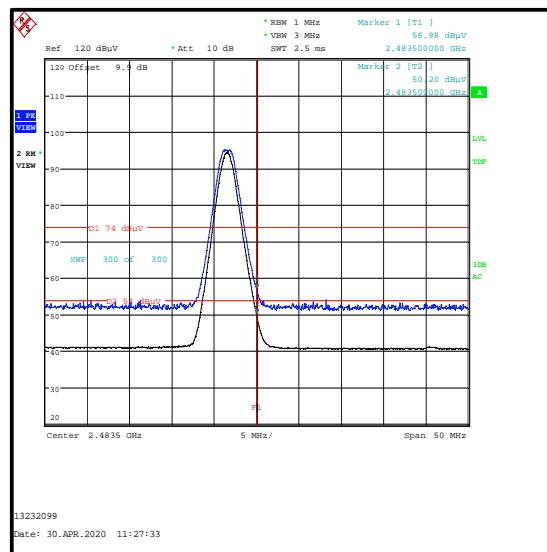
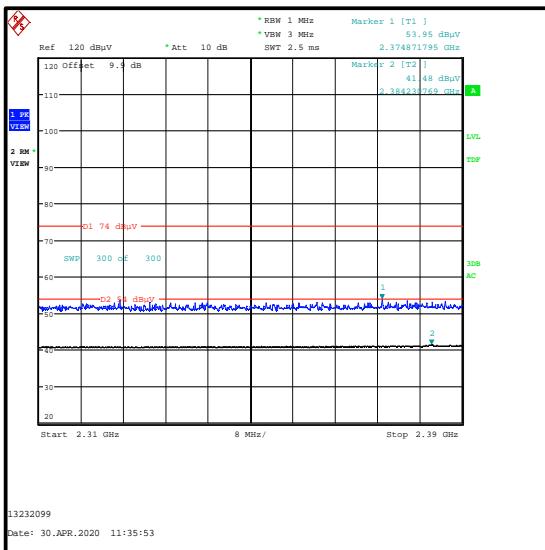
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Vertical	50.2	54.0	3.8	Complied

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
2374.872	Vertical	54.0	74.0	20.0	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
2384.231	Vertical	41.5	54.0	12.5	Complied

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

6. AC Power Line Conducted Emissions Test Results

6.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Alison Johnston	Test Date:	04 May 2020
Test Sample Serial Number:	0744		

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 (%):	41

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 stated by the customer.
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
0.172500	Live	18.9	64.8	45.9	Complied
0.204000	Live	19.4	63.4	44.0	Complied
0.280500	Live	14.9	60.8	45.9	Complied
14.001000	Live	9.7	60.0	50.3	Complied
15.009000	Live	11.2	60.0	48.8	Complied
28.315500	Live	10.7	60.0	49.3	Complied

Results: Live / Average / 120 VAC 60 Hz

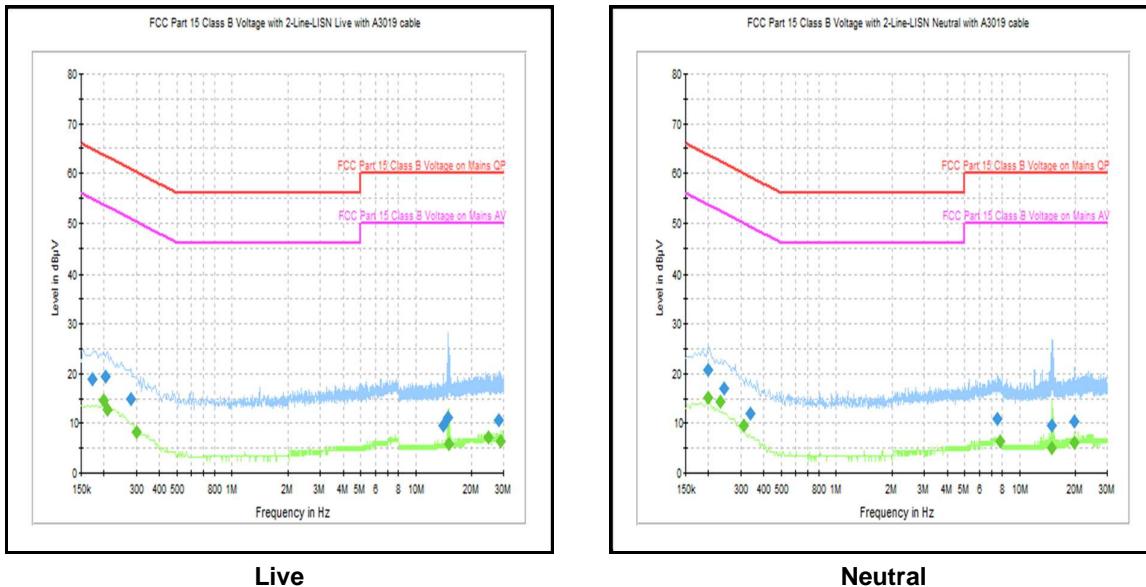
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.199500	Live	14.7	53.6	38.9	Complied
0.208500	Live	12.8	53.3	40.5	Complied
0.303000	Live	8.3	50.2	41.9	Complied
15.036000	Live	6.0	50.0	44.0	Complied
24.819000	Live	7.1	50.0	42.9	Complied
28.833000	Live	6.4	50.0	43.6	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.199500	Neutral	20.7	63.6	42.9	Complied
0.244500	Neutral	17.0	61.9	44.9	Complied
0.339000	Neutral	11.9	59.2	47.3	Complied
7.485000	Neutral	10.8	60.0	49.2	Complied
14.964000	Neutral	9.6	60.0	50.4	Complied
19.932000	Neutral	10.3	60.0	49.7	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.199500	Neutral	15.1	53.6	38.5	Complied
0.231000	Neutral	14.4	52.4	38.0	Complied
0.312000	Neutral	9.4	49.9	40.5	Complied
7.822500	Neutral	6.3	50.0	43.7	Complied
14.932500	Neutral	5.0	50.0	45.0	Complied
19.864500	Neutral	6.0	50.0	44.0	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: 120 VAC 60 Hz**

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
0.168000	Live	20.0	65.1	45.1	Complied
0.172500	Live	19.8	64.8	45.0	Complied
0.235500	Live	17.5	62.3	44.8	Complied
7.908000	Live	11.6	60.0	48.4	Complied
15.004500	Live	9.7	60.0	50.3	Complied
29.485500	Live	13.5	60.0	46.5	Complied

Results: Live / Average / 240 VAC 60 Hz

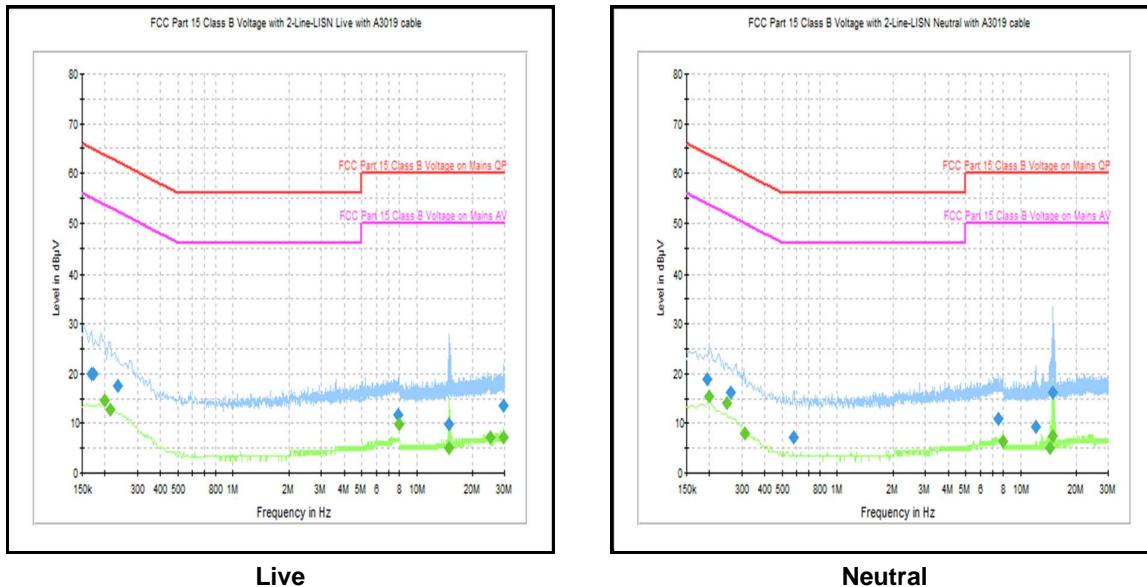
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.199500	Live	14.7	53.6	38.9	Complied
0.213000	Live	12.8	53.1	40.3	Complied
8.020500	Live	9.9	50.0	40.1	Complied
14.977500	Live	5.1	50.0	44.9	Complied
25.021500	Live	7.1	50.0	42.9	Complied
29.805000	Live	7.1	50.0	42.9	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.195000	Neutral	19.0	63.8	44.8	Complied
0.262500	Neutral	16.2	61.4	45.2	Complied
0.577500	Neutral	7.3	56.0	48.7	Complied
7.512000	Neutral	10.8	60.0	49.2	Complied
11.998500	Neutral	9.4	60.0	50.6	Complied
15.009000	Neutral	16.2	60.0	43.8	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.199500	Neutral	15.4	53.6	38.2	Complied
0.249000	Neutral	14.2	51.8	37.6	Complied
0.312000	Neutral	7.9	49.9	42.0	Complied
8.011500	Neutral	6.4	50.0	43.6	Complied
14.437500	Neutral	5.0	50.0	45.0	Complied
14.982000	Neutral	7.3	50.0	42.7	Complied

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

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

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