



# TEST REPORT

**Test Report No. : UL-RPT-RP12105886-916C**

**Manufacturer** : Honeywell  
**Model No.** : Bluetooth module 4.2  
**FCC ID** : HD5-SFPMB  
**Technology** : *Bluetooth* – Low Energy  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.247

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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 1.0.

**Date of Issue:** 11 October 2018

**Checked by:**

Ian Watch  
Senior Test Engineer, Radio Laboratory

**Company Signatory:**

Sarah Williams  
Senior Test Engineer, Radio Laboratory  
UL VS LTD



This laboratory is accredited by UKAS.  
The tests reported herein have been  
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**1. Customer Information**









<b>Company Name:</b>	Honeywell, spol. s.r.o. - HTS CZ o.z.
<b>Address:</b>	Tuřanka 1460/106a Brno 627 00 Czech Republic

## **2. Summary of Testing**

### **2.1. General Information**

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
<b>Site Registration:</b>	209735
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	23 February 2018 to 01 June 2018

### **2.2. Summary of Test Results**

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

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

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

**2.3. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 558074 D01 DTS Meas Guidance v04 April 5, 2017
<b>Title:</b>	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247
<b>Reference:</b>	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
<b>Title:</b>	AC Power-Line Conducted Emissions Frequently Asked Questions

**2.4. 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.

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

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

<b>Brand Name:</b>	Honeywell
<b>Model Name or Number:</b>	Bluetooth module 4.2
<b>Test Sample Serial Number:</b>	031517470065
<b>Hardware Version:</b>	1.0
<b>Software Version:</b>	1.12
<b>FCC ID:</b>	HD5-SFPMB

<b>Brand Name:</b>	Honeywell
<b>Model Name or Number:</b>	Bluetooth module 4.2
<b>Test Sample Serial Number:</b>	03151747003
<b>Hardware Version:</b>	1.0
<b>Software Version:</b>	1.12
<b>FCC ID:</b>	HD5-SFPMB

#### **3.2. Description of EUT**

The Equipment Under Test was a wireless module with *Bluetooth* capabilities. The module is powered from a 3.3 VDC supply.

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

No modifications were applied to the EUT during testing.

**3.4. 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	3.3 VDC	
Maximum Conducted Output Power:	8.8 dBm		
Antenna Gain:	1.8 dBi		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	RF Channel	Channel Frequency (MHz)
	Bottom	0	2402
	Middle	19	2440
	Top	39	2480

### **3.5. Support Equipment**

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

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Lenovo
<b>Model Name or Number:</b>	L440
<b>Serial Number:</b>	R9-019EA4 14/04

<b>Description:</b>	Bench Power Supply
<b>Brand Name:</b>	TTi
<b>Model Name or Number:</b>	CPX400S
<b>Serial Number:</b>	436670

<b>Description:</b>	Monopole Antenna
<b>Brand Name:</b>	Taoglas
<b>Model Name or Number:</b>	GW26.0151
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	UART to USB cable. Length 1.8 metres
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	C232HD DDHSP-0
<b>Serial Number:</b>	Not marked or stated

## **4. Operation and Monitoring of the EUT during Testing**

### **4.1. 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.

### **4.2. Configuration and Peripherals**

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

- The customer supplied a python script (rfctest.py Date: 26 February 2018) and instructions (EC3 setup instructions.txt Date: 26 February 2018). The EUT was connected to the laptop PC using a UART to USB cable. The script was used to send HCI commands to enable continuous transmission and to select the test channels as required.
- Transmitter radiated spurious emissions test was performed with the EUT in its worst case orientation. There were no other ports to populate on the EUT.
- The EUT was powered with 3.3 V using a bench power supply; a battery back was used for radiated testing.

## **5. Measurements, Examinations and Derived Results**

### **5.1. General Comments**

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

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.

## 5.2. Test Results

### 5.2.1. Transmitter AC Conducted Spurious Emissions

#### Test Summary:

Test Engineer:	Doug Freegard	Test Date:	15 March 2018
Test Sample Serial Number:	031517470065		

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

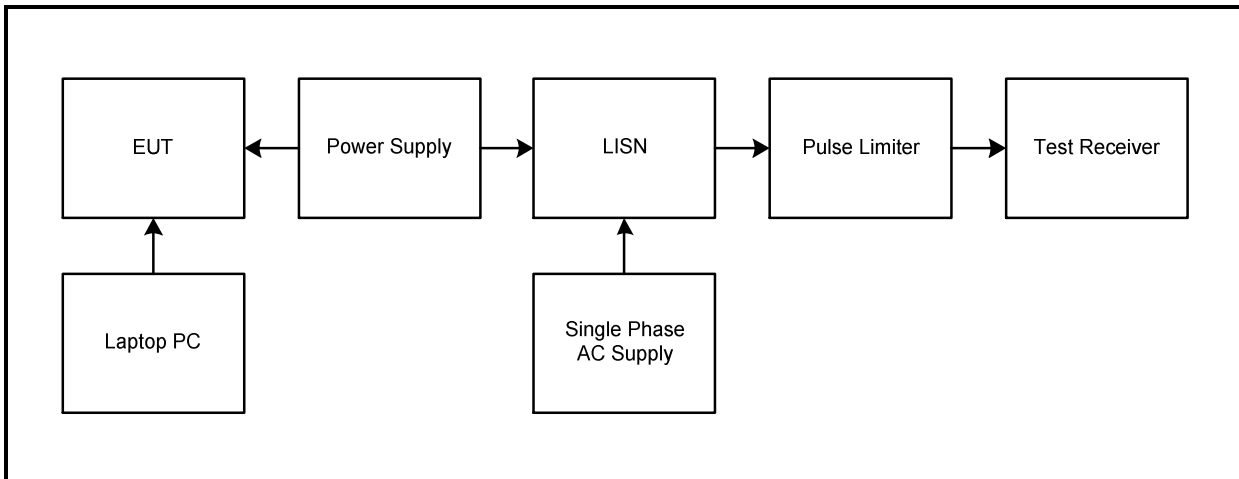
#### Environmental Conditions:

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

#### Note(s):

1. The EUT was connected to the power supply output. The power supply input 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 bench power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.

#### Test setup:



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

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.200	Live	16.2	63.6	47.4	Complied
0.249	Live	15.7	61.8	46.1	Complied
11.999	Live	24.6	60.0	35.4	Complied
14.334	Live	24.1	60.0	35.9	Complied
17.259	Live	18.1	60.0	41.9	Complied
25.058	Live	23.0	60.0	37.0	Complied

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

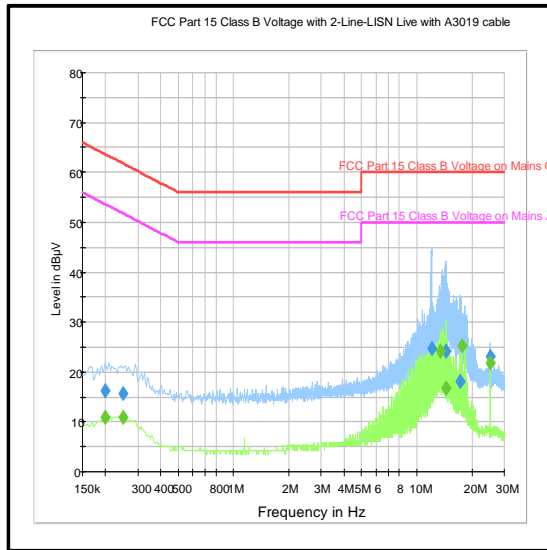
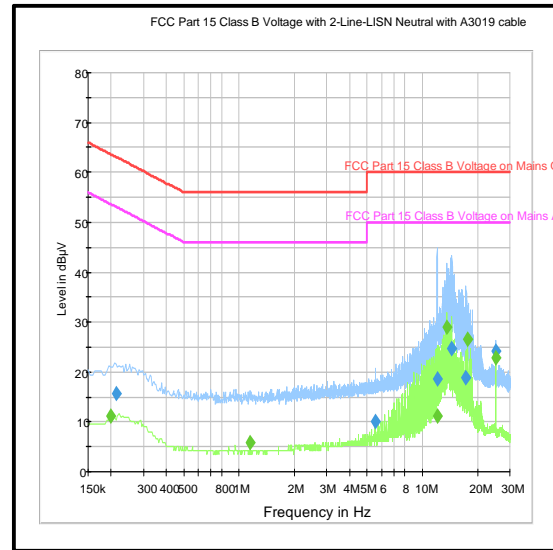
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.200	Live	10.9	53.6	42.7	Complied
0.249	Live	10.8	51.8	41.0	Complied
13.412	Live	24.3	50.0	25.7	Complied
14.330	Live	16.8	50.0	33.2	Complied
17.696	Live	25.4	50.0	24.6	Complied
25.058	Live	21.9	50.0	28.1	Complied

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

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.213	Neutral	15.8	63.1	47.3	Complied
5.501	Neutral	10.1	60.0	49.9	Complied
11.999	Neutral	18.5	60.0	41.5	Complied
14.352	Neutral	24.7	60.0	35.3	Complied
17.295	Neutral	18.8	60.0	41.2	Complied
25.058	Neutral	24.1	60.0	35.9	Complied

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

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.200	Neutral	11.3	53.6	42.3	Complied
1.149	Neutral	5.9	46.0	40.1	Complied
11.999	Neutral	11.1	50.0	38.9	Complied
13.560	Neutral	29.0	50.0	21.0	Complied
17.696	Neutral	26.5	50.0	23.5	Complied
25.058	Neutral	22.8	50.0	27.2	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
0.155	Live	22.7	65.8	43.1	Complied
0.299	Live	15.7	60.3	44.6	Complied
11.999	Live	24.3	60.0	35.7	Complied
14.343	Live	25.1	60.0	34.9	Complied
17.295	Live	21.1	60.0	38.9	Complied
25.058	Live	23.2	60.0	36.8	Complied

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

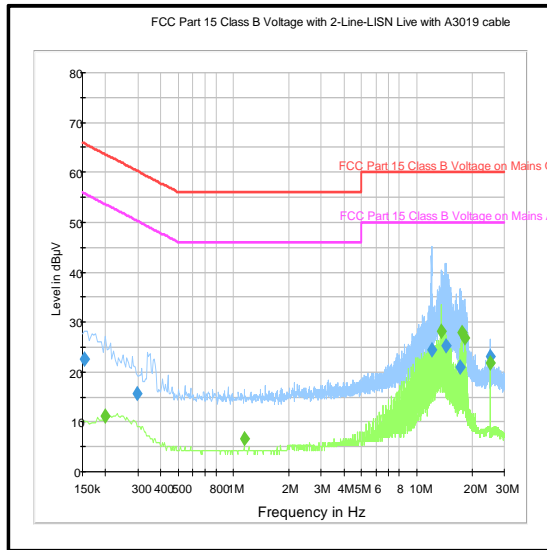
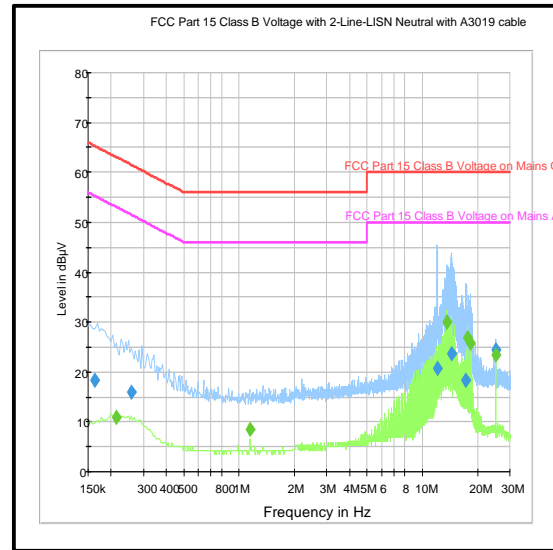
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.200	Live	11.3	53.6	42.3	Complied
1.149	Live	6.6	46.0	39.4	Complied
13.560	Live	28.2	50.0	21.8	Complied
17.696	Live	28.0	50.0	22.0	Complied
18.245	Live	26.8	50.0	23.2	Complied
25.058	Live	21.9	50.0	28.1	Complied

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

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.164	Neutral	18.4	65.3	46.9	Complied
0.258	Neutral	16.0	61.5	45.5	Complied
11.999	Neutral	20.7	60.0	39.3	Complied
14.330	Neutral	23.7	60.0	36.3	Complied
17.295	Neutral	18.2	60.0	41.8	Complied
25.058	Neutral	24.3	60.0	35.7	Complied

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

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.213	Neutral	10.9	53.1	42.2	Complied
1.149	Neutral	8.4	46.0	37.6	Complied
13.560	Neutral	30.1	50.0	19.9	Complied
17.696	Neutral	27.0	50.0	23.0	Complied
18.245	Neutral	25.9	50.0	24.1	Complied
25.058	Neutral	23.3	50.0	26.7	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.

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2013	Thermohygrometer	Testo	608-H1	45046424	20 Jun 2018	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2018	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	09 May 2018	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	13 Nov 2018	12
S0537	Variable DC Power Supply	TTI	EL302D	249928	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	12 May 2018	12

**Test Measurement Software/Firmware Used:**

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

**5.2.2. Transmitter Minimum 6 dB Bandwidth****Test Summary:**

<b>Test Engineer:</b>	Victor Carmon	<b>Test Date:</b>	23 February 2018
<b>Test Sample Serial Number:</b>	03151747003		

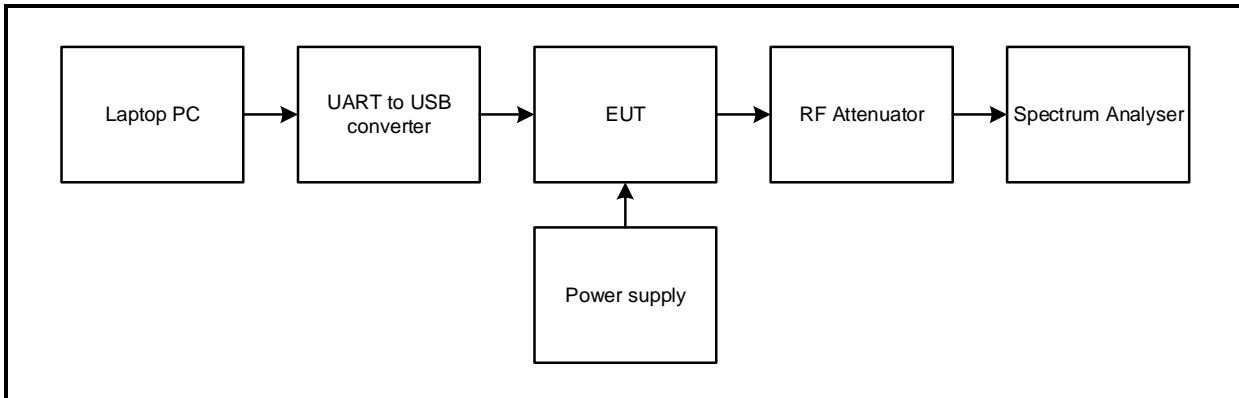
<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.1 Option 1

**Environmental Conditions:**

<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	32

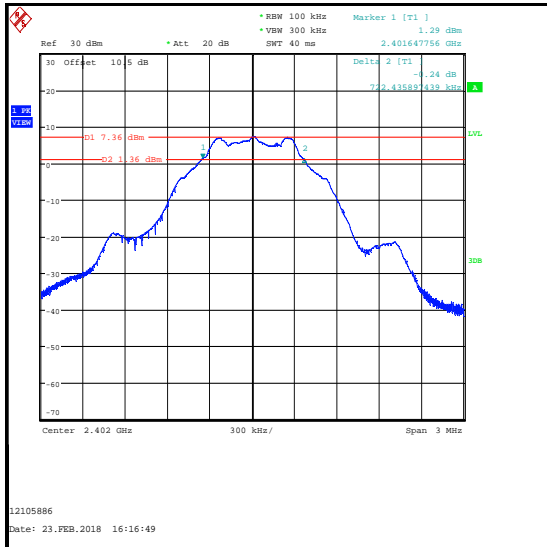
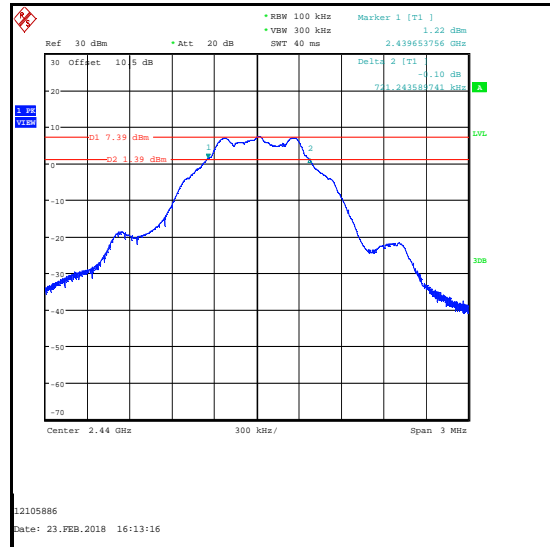
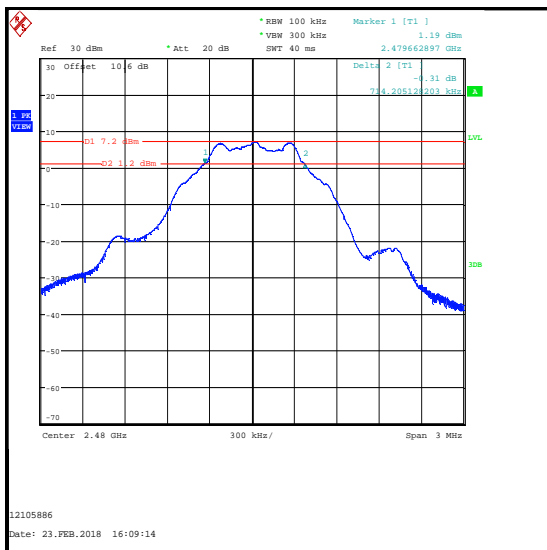
**Note(s):**

1. 6 dB DTS bandwidth tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.1 Option 1 measurement procedure. The spectrum 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 spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

**Test setup:**

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

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	722.436	≥500	222.436	Complied
Middle	721.244	≥500	221.244	Complied
Top	714.205	≥500	214.205	Complied

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

**Transmitter Minimum 6 dB Bandwidth (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45046425	28 Feb 2019	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU26	100027	28 Feb 2019	24
A2508	Attenuator	AtlanTecRF	AN18-10	821846#3	Calibrated before use	-

**5.2.3. Transmitter Power Spectral Density****Test Summary:**

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	01 June 2018
<b>Test Sample Serial Number:</b>	031517470065		

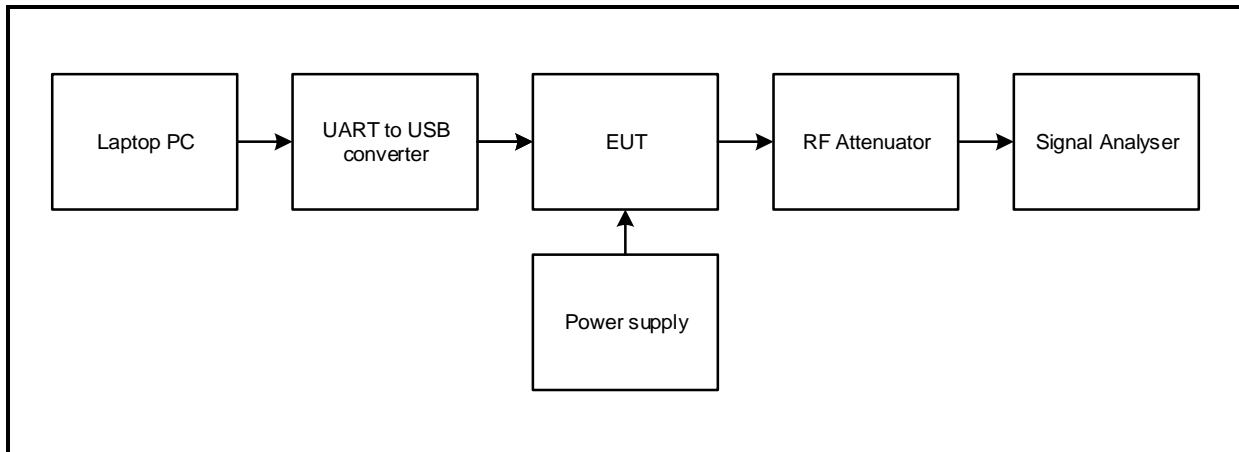
<b>FCC Reference:</b>	Part 15.247(e)
<b>Test Method Used:</b>	FCC KDB 558074 Section 10.2

**Environmental Conditions:**

<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	53

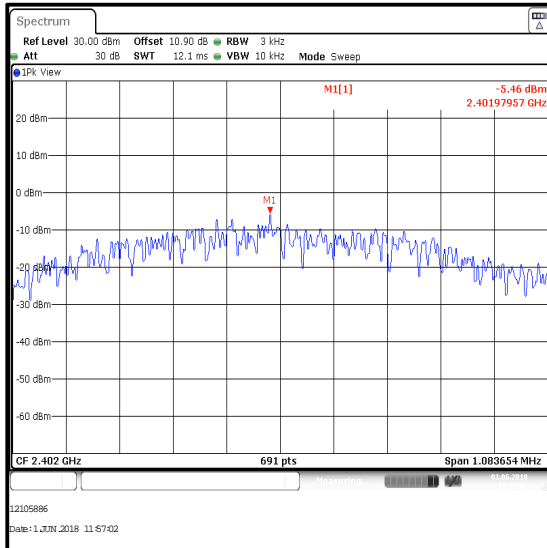
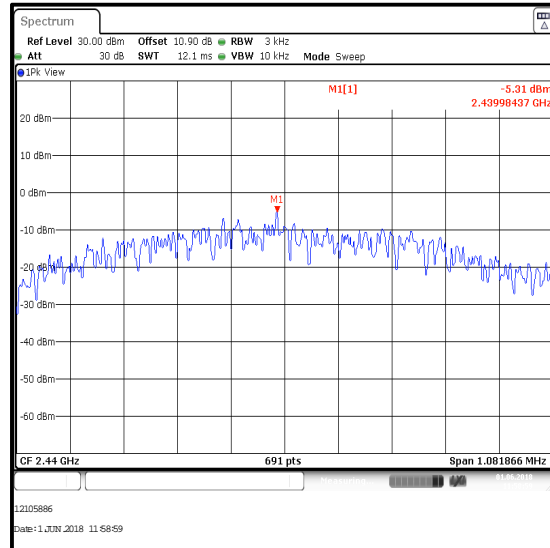
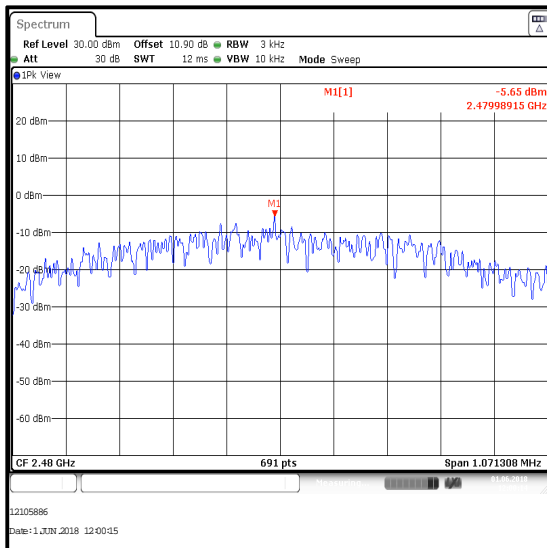
**Note(s):**

1. Transmitter Power Spectral Density tests in all bands were performed using a signal analyser in accordance with FCC KDB 558074 Section 10.2.
2. The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth of 10 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 1.5 times the measured DTS bandwidth. A marker was placed at the peak of the signal and the results recorded in the table below.
3. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

**Test setup:**

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

Channel	Output Power (dBm / 3 kHz)	Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-5.5	8.0	13.5	Complied
Middle	-5.3	8.0	13.3	Complied
Top	-5.6	8.0	13.6	Complied

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

**Transmitter Power Spectral Density (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	27 Mar 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	13 Jun 2018	12
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	20 Apr 2020	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	20 Apr 2020	24

**5.2.4. Transmitter Maximum Peak Output Power****Test Summary:**

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	01 June 2018
<b>Test Sample Serial Number:</b>	031517470065		

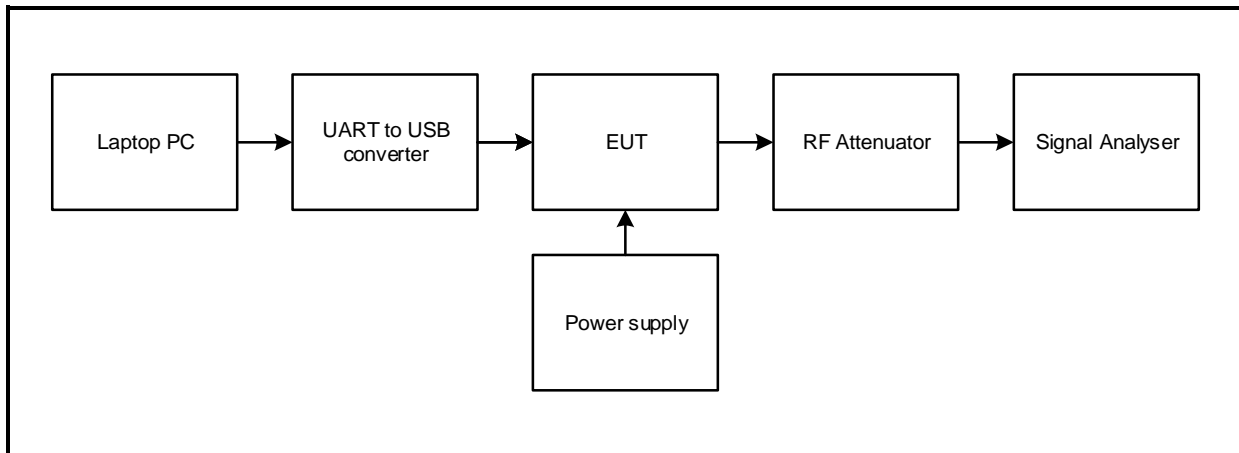
<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>Test Method Used:</b>	FCC KDB 558074 Section 9.1.1 and Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	53

**Note(s):**

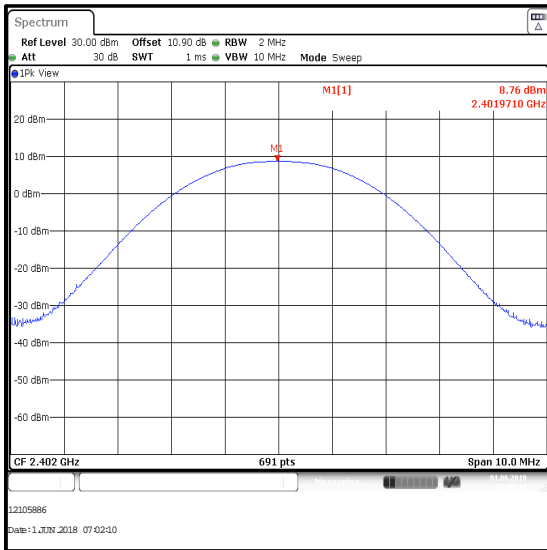
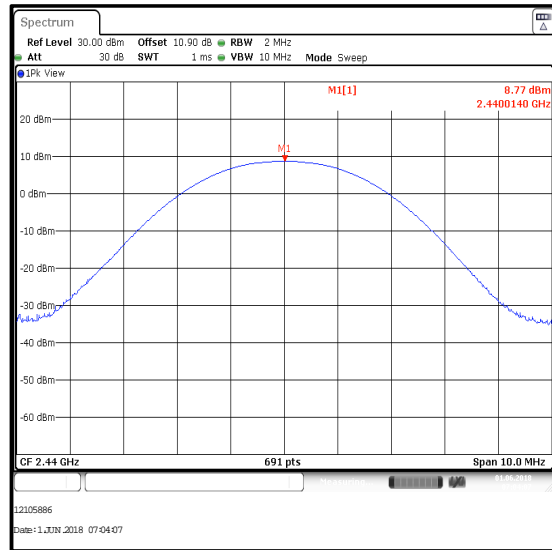
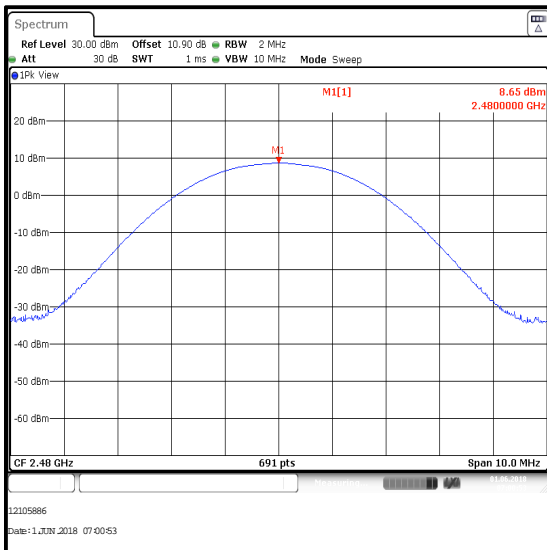
1. Conducted power tests were performed using a signal analyser in accordance with FCC KDB 558074 Section 9.1.1 with the RBW > *DTS bandwidth* procedure.
2. The signal analyser resolution bandwidth was set to 2 MHz and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 10 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 spectrum 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.

**Test setup:**

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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	8.8	30.0	21.2	Complied
Middle	8.8	30.0	21.2	Complied
Top	8.7	30.0	21.3	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	8.8	1.8	10.6	36.0	25.4	Complied
Middle	8.8	1.8	10.6	36.0	25.4	Complied
Top	8.7	1.8	10.5	36.0	25.5	Complied

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

**Transmitter Maximum Peak Output Power (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	27 Mar 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	13 Jun 2018	12
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	20 Apr 2020	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	20 Apr 2020	24

**5.2.5. Transmitter Duty Cycle****Test Summary:**

<b>Test Engineer:</b>	Victor Carmon	<b>Test Date:</b>	26 February 2018
<b>Test Sample Serial Number:</b>	03151747003		

<b>FCC Reference:</b>	Part 15.35(c)
<b>Test Method Used:</b>	FCC KDB 558074 Section 6.0

**Environmental Conditions:**

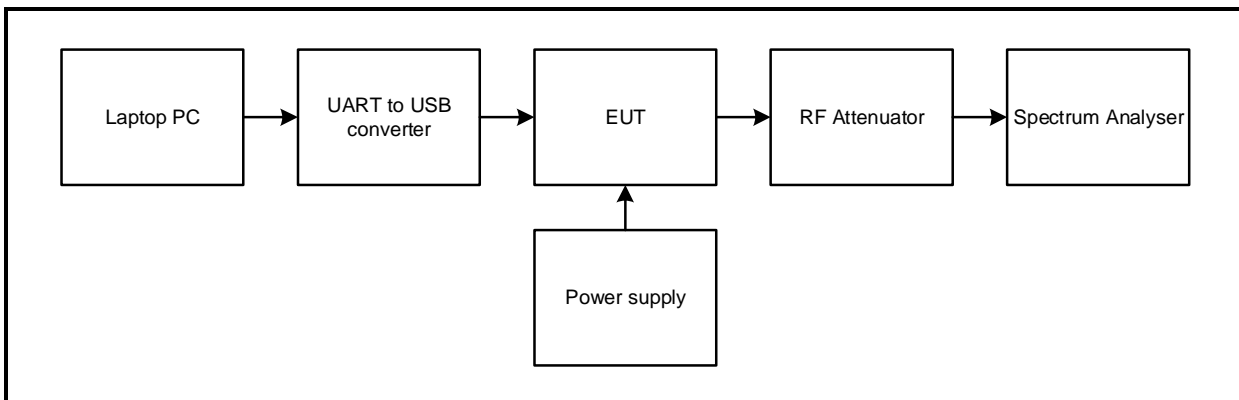
<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	32

**Note(s):**

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

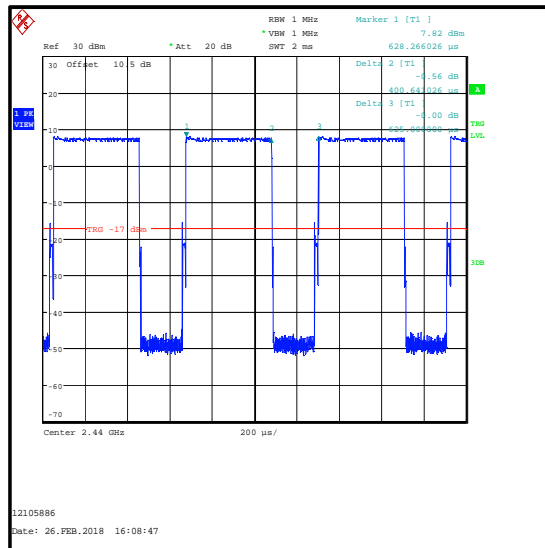
$$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])).$$

$$10 \log (1 / (400.641 / 625.000)) = 1.9 \text{ dB}$$

**Test setup:**

**Transmitter Duty Cycle (continued)****Results:**

Pulse Duration ( $\mu$ s)	Period ( $\mu$ s)	Duty Cycle (dB)
400.641	625.000	1.9

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45046425	28 Feb 2019	12
M1794	Spectrum Analyser	Rohde & Schwarz	FSU26	100027	28 Feb 2019	24
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
A2508	Attenuator	AtlanTecRF	AN18-10	821846#3	Calibrated before use	-

**5.2.6. Transmitter Radiated Emissions****Test Summary:**

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	17 May 2018
<b>Test Sample Serial Number:</b>	031517470065		

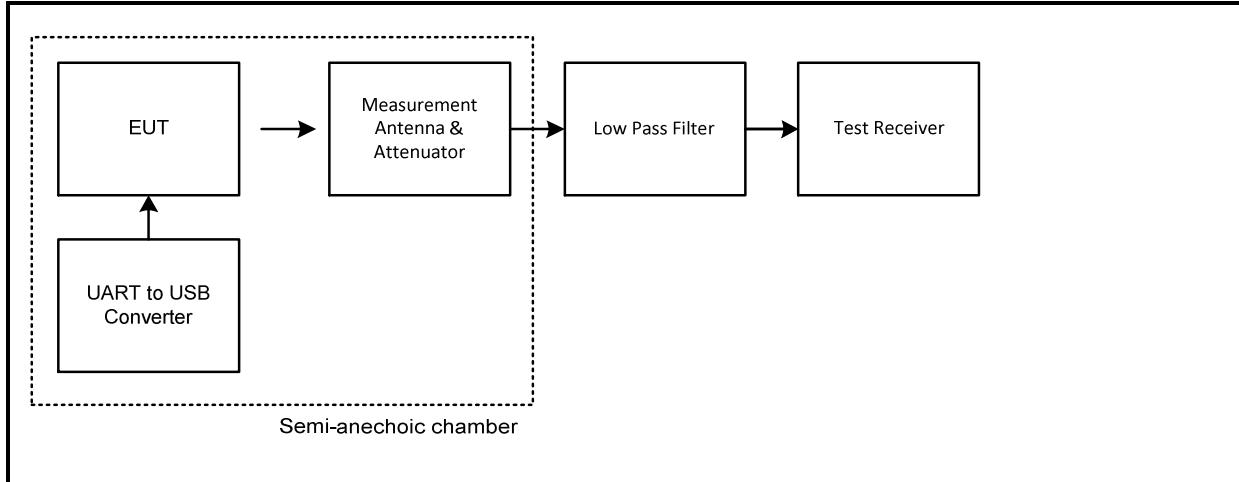
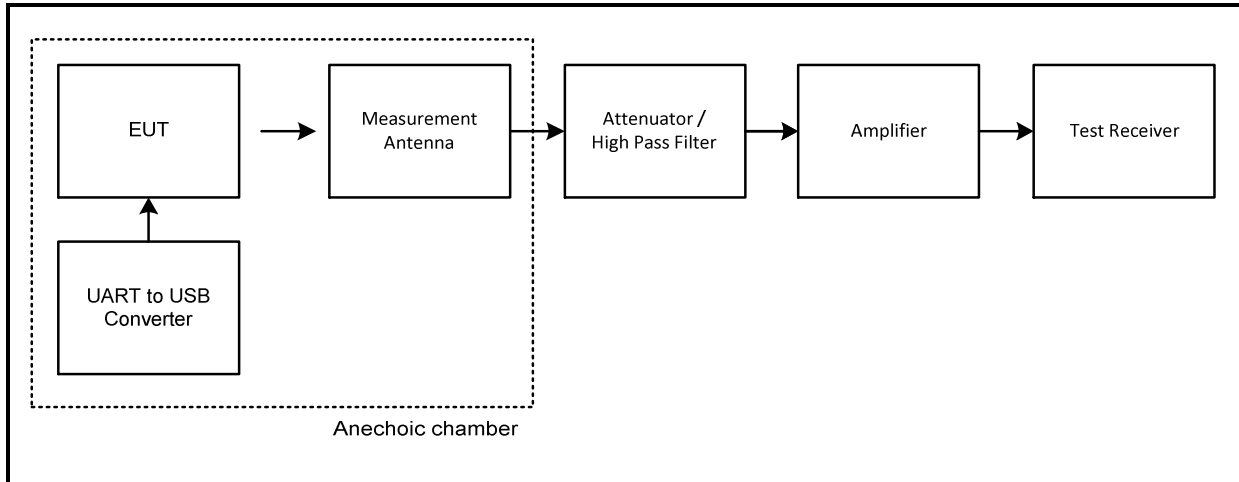
<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

**Environmental Conditions:**

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

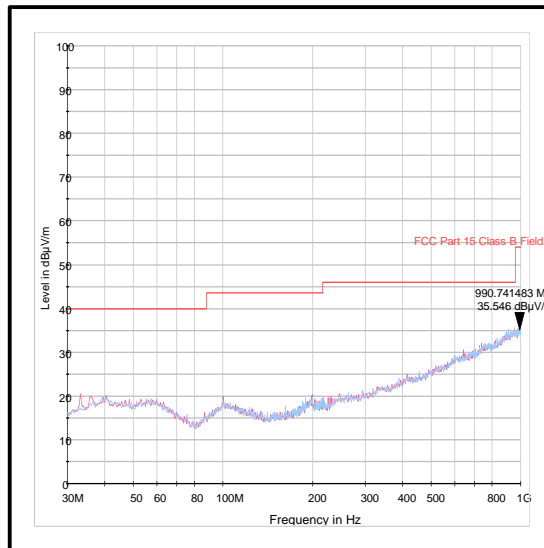
**Note(s):**

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.
3. No spurious emissions were observed during prescans, therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. Measurements below 1 GHz 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

**Transmitter Radiated Emissions****Test setup for radiated measurements:****Semi-anechoic chamber****Anechoic chamber**

**Transmitter Radiated Emissions****Results: Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
990.741	Vertical	35.5	54.0	18.5	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2014	Thermohygrometer	Testo	608-H1	45046246	20 Jun 2018	12
K0001	RSE Chamber	Rainford EMC	N/A	N/A	12 Mar 2019	12
G0543	Amplifier	Sonoma	310N	230801	15 Jun 2018	12
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	13 Jul 2018	12
A2959	Antenna	Schwarzbeck	VULB 9163	9163-967	16 Nov 2018	12
A1834	Attenuator	Hewlett Packard	8491B	10444	14 Mar 2019	12

**Test Measurement Software/Firmware Used:**

Name	Version	Release Date
Rohde & Schwarz EMC32	8.53.0	N/A

**Transmitter Radiated Emissions****Test Summary:**

<b>Test Engineers:</b>	James O'Reilly & David Doyle	<b>Test Dates:</b>	27 February 2018 & 21 April 2018
<b>Test Sample Serial Number:</b>	031517470065		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 11 & 12 referencing ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 25 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	44 to 45

**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-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
3. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental at 2440 MHz.
4. Pre-scans between 1 GHz and 18 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. Pre-scans above 18 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements 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.
6. \*In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4804.479	Vertical	51.7	54.0*	2.3	Complied

**Results: Peak / Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4880.093	Vertical	54.9	74.0	19.1	Complied

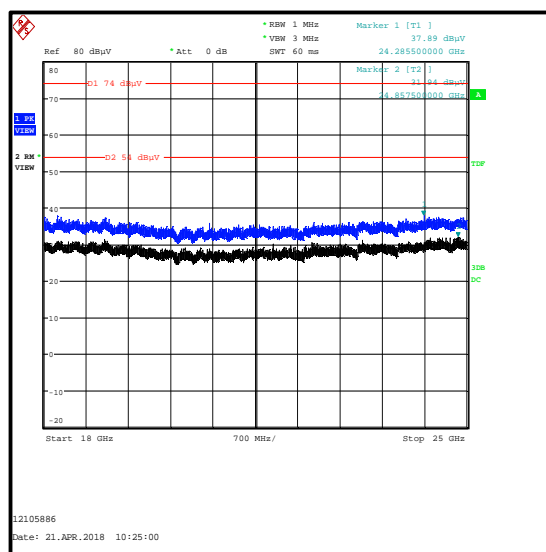
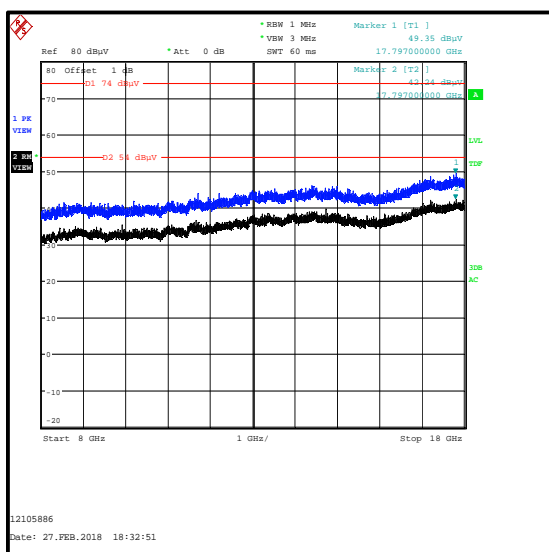
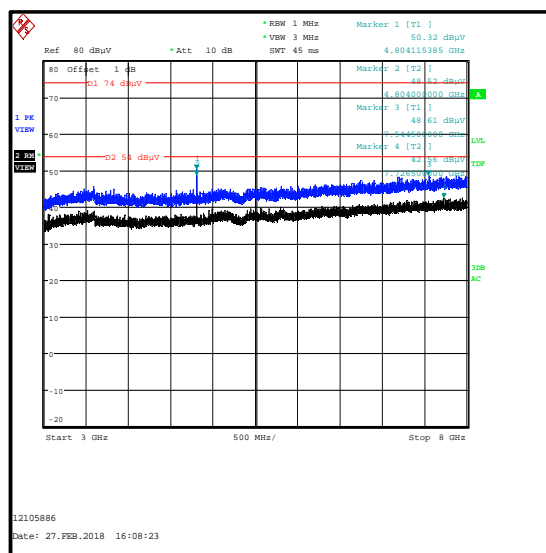
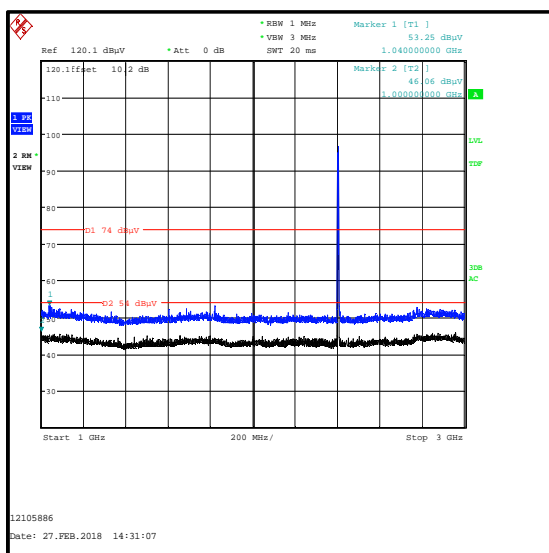
**Results: Average / Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Correction Factor (dB)	Corrected Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4879.936	Vertical	48.2	1.9	50.1	54.0	3.9	Complied

**Results: Peak / Top Channel**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
4960.021	Vertical	51.6	54.0*	2.4	Complied

### **Transmitter Radiated Emissions (continued)**



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

**Transmitter Radiated Emissions (continued)****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	RSE Chamber	Rainford EMC	N/A	N/A	20 Feb 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	18 Apr 2019	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	19 Feb 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	19 Feb 2019	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	21 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	19 Feb 2019	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	22 Feb 2019	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	22 Feb 2019	12
M1269	Multimeter	Fluke	179	90250210	02 May 2018	12
K0002	RSE Chamber	Rainford EMC	N/A	N/A	07 Feb 2019	12
M1630	Test Receiver	Rohde & Schwarz	ESU 40	100233	03 Aug 2018	12
M2016	Thermohygrometer	Testo	608-H1	45046428	26 Feb 2019	12
A2896	Pre-Amplifier	Schwarzbeck	BBV 9721	9721 - 023	20 Feb 2019	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	20 Feb 2019	12

**5.2.7. Transmitter Band Edge Radiated Emissions****Test Summary:**

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	27 February 2018
<b>Test Sample Serial Number:</b>	03151747003		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	KDB 558074 Section 11 & 12 & Notes below

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	32

**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 FCC KDB 558074 Section 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 FCC KDB 558074 Section 11.1, the test method in Section 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 was placed on the band edge spot frequency. Marker frequencies 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. The reference level was set to 120 dBµV in order to achieve sufficient headroom.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.000	Horizontal	46.7	79.4*	32.7	Complied
2483.500	Horizontal	61.3	74.0	12.7	Complied

**Results: Average**

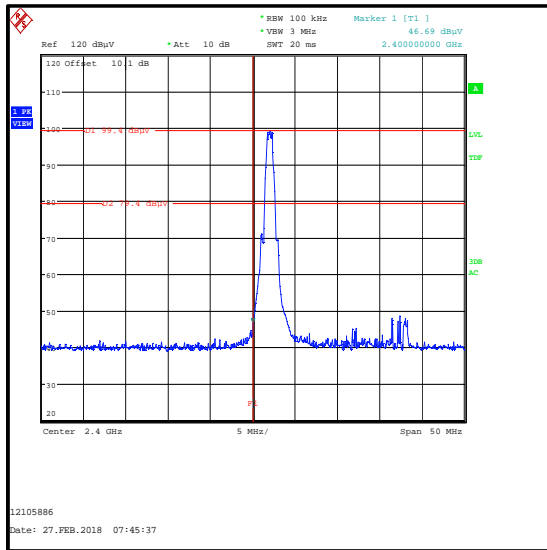
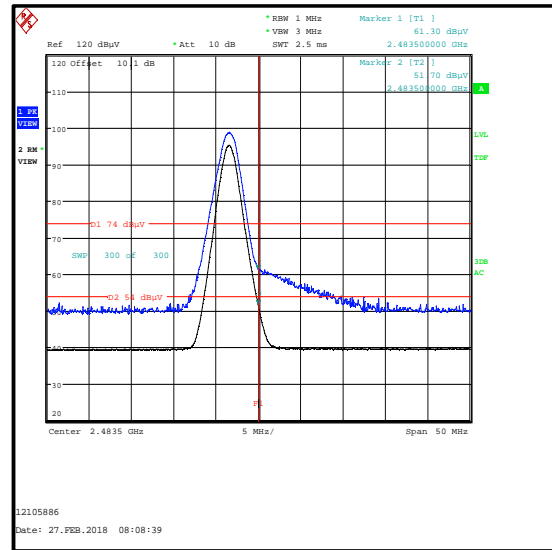
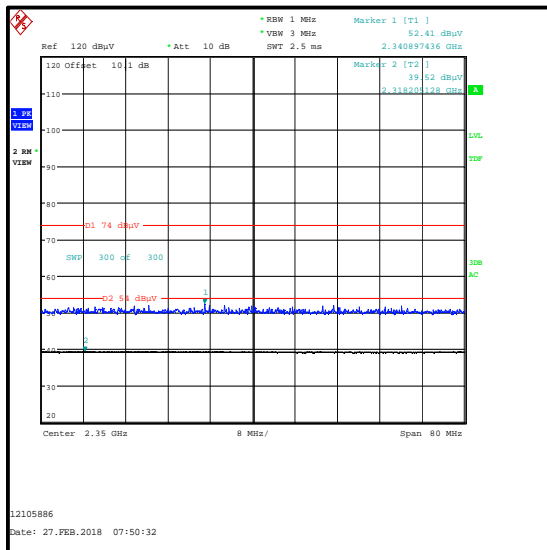
Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Duty Cycle Correction Factor (dB)	Corrected Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Horizontal	51.7	1.9	53.6	54.0	0.4	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2340.897	Horizontal	52.4	74.0	21.6	Complied

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2318.205	Horizontal	39.5	54.0	14.5	Complied

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	RSE Chamber	Rainford EMC	N/A	N/A	14 Apr 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	11 Apr 2018	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12

## 6. Measurement Uncertainty

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

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

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

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

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±2.40 dB
Conducted Maximum Peak Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±4.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB

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

**7. Report Revision History**

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

--- END OF REPORT ---