



TEST REPORT

Test Report No. : UL-RPT-RP12105886-916A V2.0

Brand Name : Honeywell
Model No. : Bluetooth module 4.2
FCC ID : HD5-SFPMB
Technology : *Bluetooth* – Basic Rate & EDR
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 2.0 supersedes all previous versions.

Date of Issue: 11 October 2018

Checked by:

Ian Watch
Senior Test Engineer, Radio Laboratory

Company Signatory:

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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

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

2. Summary of Testing

2.1. 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:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	21 February 2018 to 31 May 2018

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	
Part 15.247(a)(1)	Transmitter 20 dB Bandwidth	
Part 15.247(a)(1)	Transmitter Carrier Frequency Separation	
Part 15.247(a)(1)(iii)	Transmitter Number of Hopping Frequencies and Average Time of Occupancy	
Part 15.247(b)(1)	Transmitter Maximum Peak Output Power	
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	
Key to Results  = Complied  = Did not comply		

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	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)

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

Brand Name:	Honeywell
Model Name or Number:	Bluetooth module 4.2
Test Sample Serial Number:	031517470065
Hardware Version:	1.0
Software Version:	1.12
FCC ID:	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

Tested Technology:	Bluetooth		
Power Supply Requirement:	Nominal	3.3 VDC	
Type of Unit:	Transceiver		
Channel Spacing:	1 MHz		
Mode:	Basic Rate	Enhanced Data Rate	
Modulation:	GFSK	$\pi/4$ -DQPSK	8DPSK
Packet Type: (Maximum Payload)	DH5	2DH5	3DH5
Data Rate (Mbit/s):	1	2	3
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	Channel Number	Channel Frequency (MHz)
	Bottom	0	2402
	Middle	39	2441
	Top	78	2480

3.5. Support Equipment

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

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

Description:	Bench Power Supply
Brand Name:	TTi
Model Name or Number:	CPX400S
Serial Number:	436670

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

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

- Continuously transmitting at maximum power on bottom, middle and top channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.
- Continuously transmitting at maximum power in hopping mode on all channels in Basic Rate (DH5 packets) or EDR (2DH5 or 3DH5 packets) as required.

4.2. Configuration and Peripherals

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

- The customer supplied a python script (rftest.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.
- Both EDR/Basic rate modes were compared and tests were performed with the mode that presented the worst-case result. For output power, bandwidth, band edge and channel separation, all modes were tested.
- Transmitter radiated spurious emissions and AC conducted emissions tests were tested with the EUT transmitting using DH5 packet type, as this mode was found to transmit the highest power.
- The EUT was powered with 3.3 V using a bench power supply during conducted tests. A battery pack 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

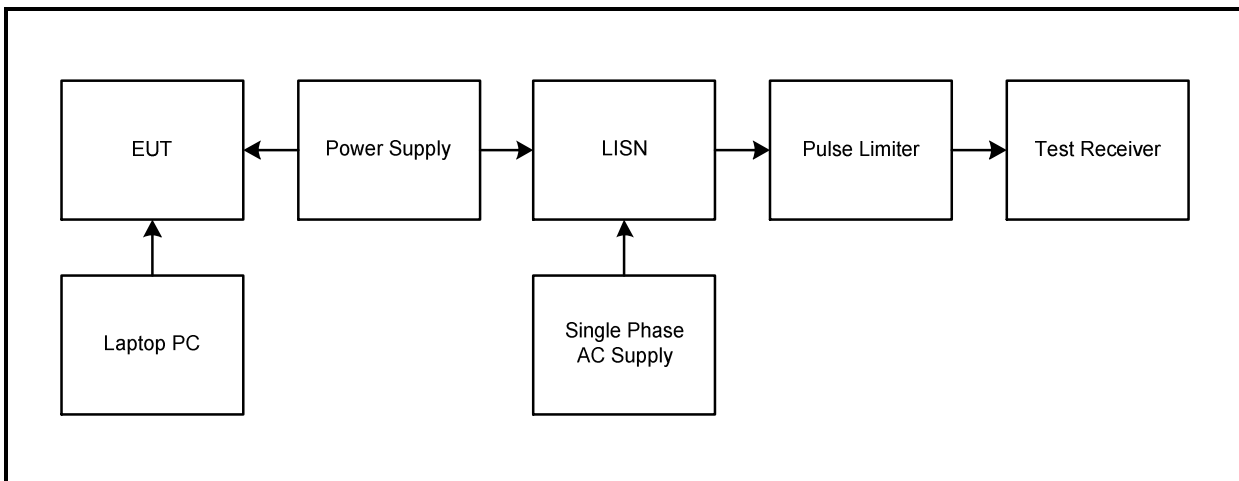
Environmental Conditions:

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
0.236	Live	15.7	62.3	46.6	Complied
0.771	Live	7.9	56.0	48.1	Complied
11.999	Live	24.6	60.0	35.4	Complied
14.321	Live	22.2	60.0	37.8	Complied
17.295	Live	22.4	60.0	37.6	Complied
25.058	Live	23.2	60.0	36.8	Complied

Results: Live / Average / 120 VAC 60 Hz

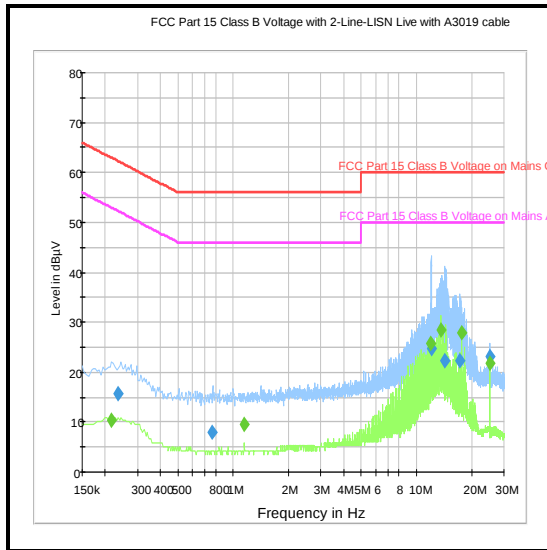
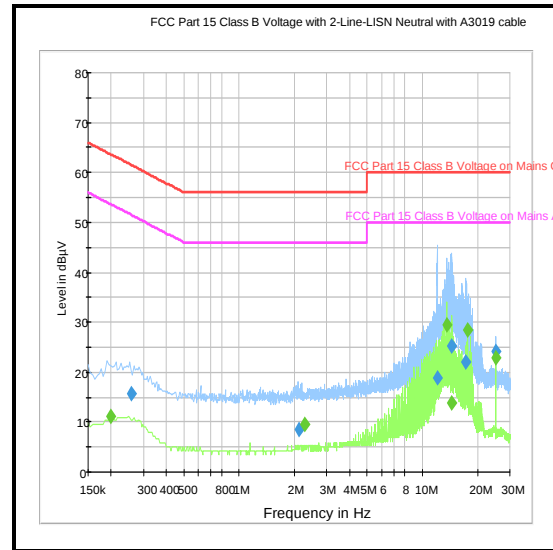
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.218	Live	10.4	52.9	42.5	Complied
1.149	Live	9.4	46.0	36.6	Complied
11.985	Live	25.8	50.0	24.2	Complied
13.560	Live	28.4	50.0	21.6	Complied
17.691	Live	27.9	50.0	22.1	Complied
25.058	Live	21.9	50.0	28.1	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.258	Neutral	15.8	61.5	45.7	Complied
2.117	Neutral	8.5	56.0	47.5	Complied
11.999	Neutral	19.0	60.0	41.0	Complied
14.343	Neutral	25.4	60.0	34.6	Complied
17.295	Neutral	22.0	60.0	38.0	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
2.274	Neutral	9.5	46.0	36.5	Complied
13.560	Neutral	29.5	50.0	20.5	Complied
14.393	Neutral	13.9	50.0	36.1	Complied
17.691	Neutral	28.5	50.0	21.5	Complied
25.058	Neutral	23.0	50.0	27.0	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	19.3	66.0	46.7	Complied
1.154	Live	7.9	56.0	48.1	Complied
11.999	Live	24.2	60.0	35.8	Complied
14.388	Live	25.1	60.0	34.9	Complied
17.295	Live	20.7	60.0	39.3	Complied
25.058	Live	23.3	60.0	36.7	Complied

Results: Live / Average / 240 VAC 60 Hz

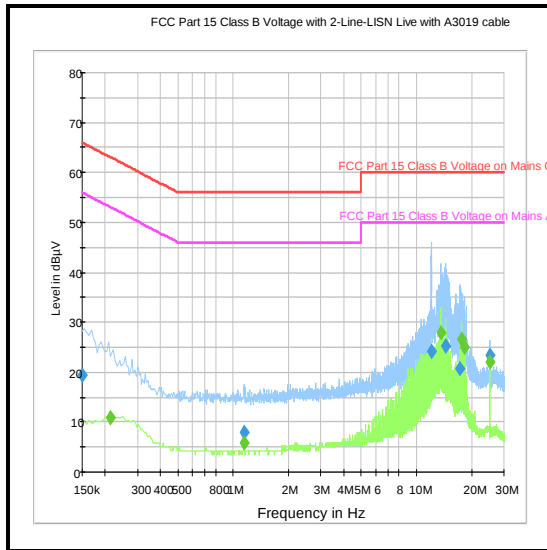
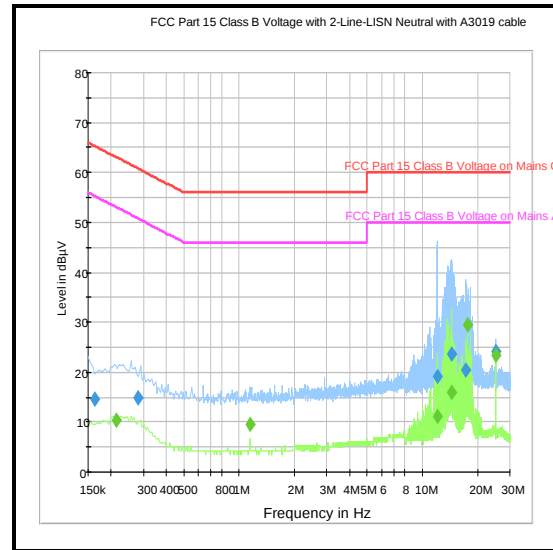
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.213	Live	10.9	53.1	42.2	Complied
1.149	Live	5.9	46.0	40.1	Complied
13.560	Live	28.0	50.0	22.0	Complied
17.696	Live	26.6	50.0	23.4	Complied
18.245	Live	25.0	50.0	25.0	Complied
25.058	Live	22.0	50.0	28.0	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.164	Neutral	14.7	65.3	50.6	Complied
0.281	Neutral	14.8	60.8	46.0	Complied
11.999	Neutral	19.2	60.0	40.8	Complied
14.330	Neutral	23.5	60.0	36.5	Complied
17.295	Neutral	20.6	60.0	39.4	Complied
25.058	Neutral	24.2	60.0	35.8	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.213	Neutral	10.4	53.1	42.7	Complied
1.149	Neutral	9.4	46.0	36.6	Complied
12.003	Neutral	11.1	50.0	38.9	Complied
14.334	Neutral	15.8	50.0	34.2	Complied
17.696	Neutral	29.5	50.0	20.5	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 20 dB Bandwidth**Test Summary:**

Test Engineer:	Victor Carmon	Test Date:	23 February 2018
Test Sample Serial Number:	03151747003		

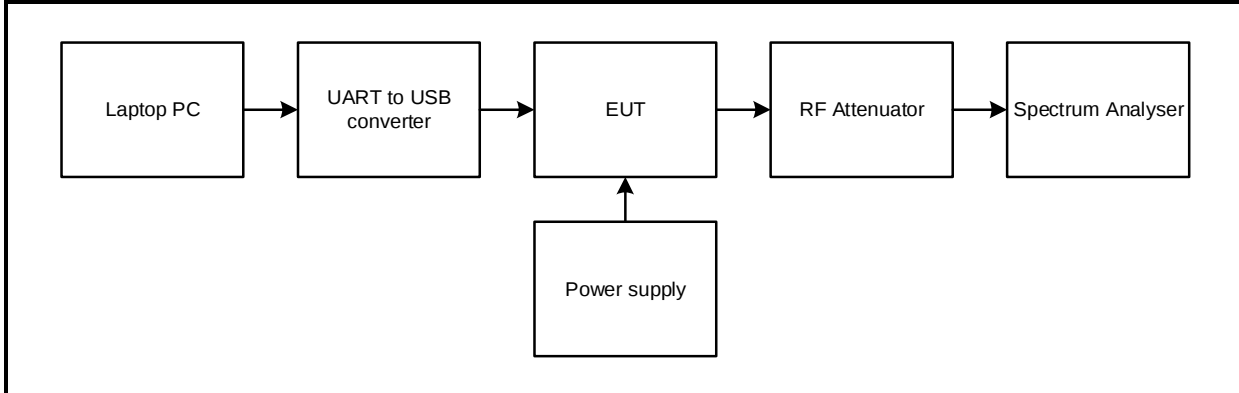
FCC Reference:	Part 15.247(a)(1)
Test Method Used:	ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	30

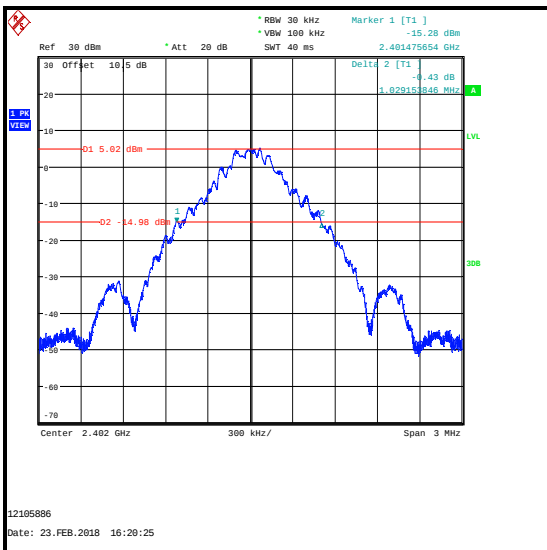
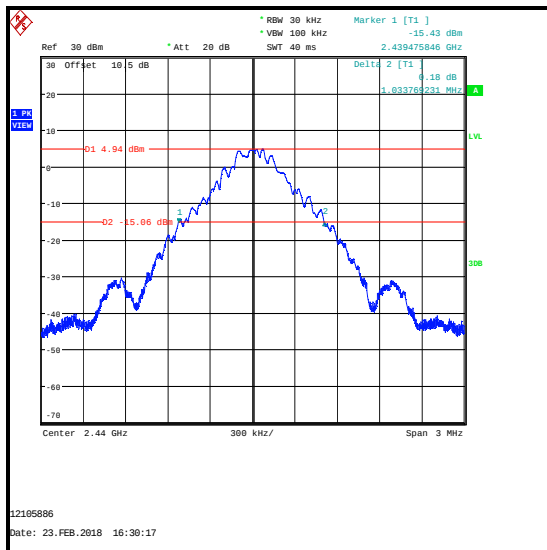
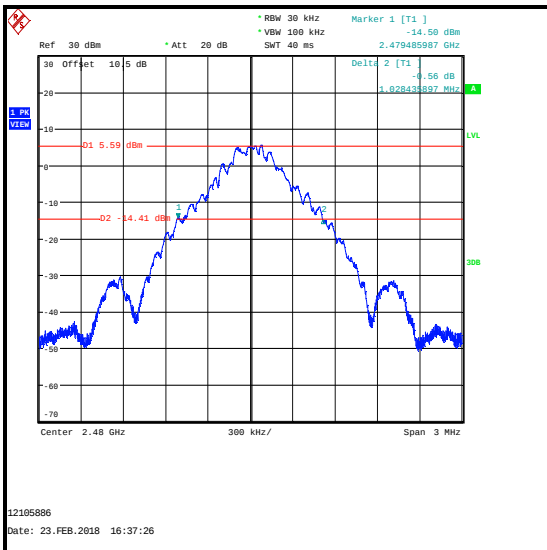
Note(s):

1. The spectrum analyser resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier. These results are recorded in the tables below.
2. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:

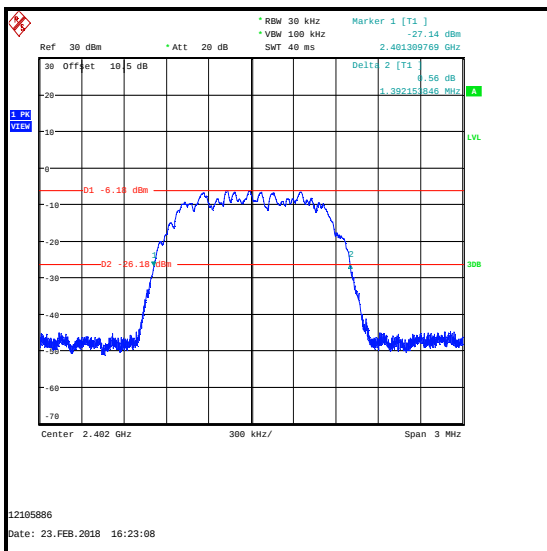
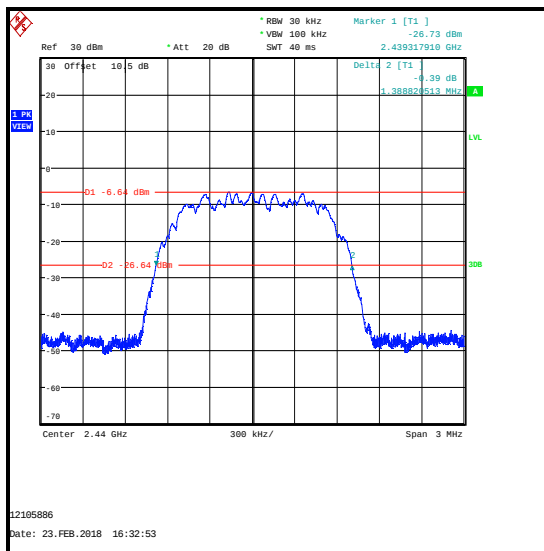
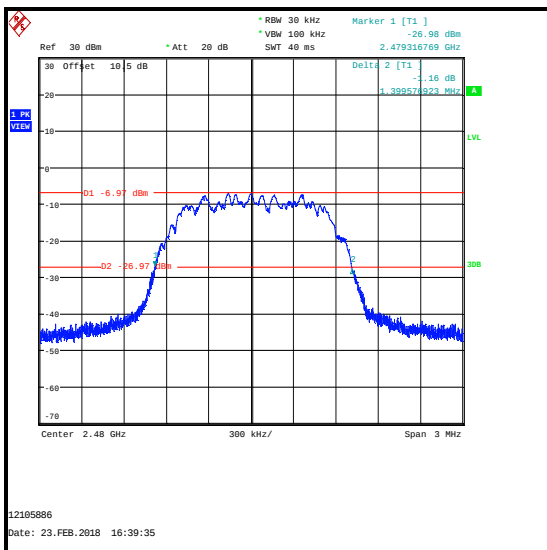
Transmitter 20 dB Bandwidth (continued)**Results DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1029.154
Middle	1033.769
Top	1028.436

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

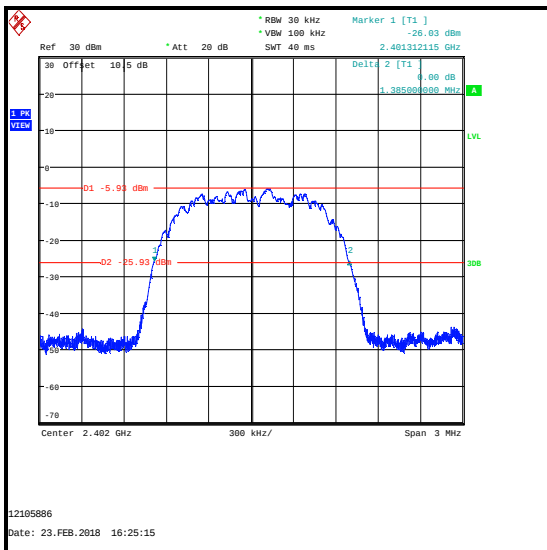
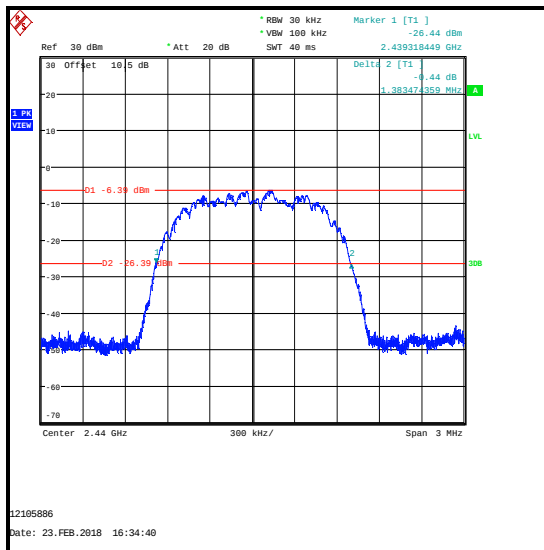
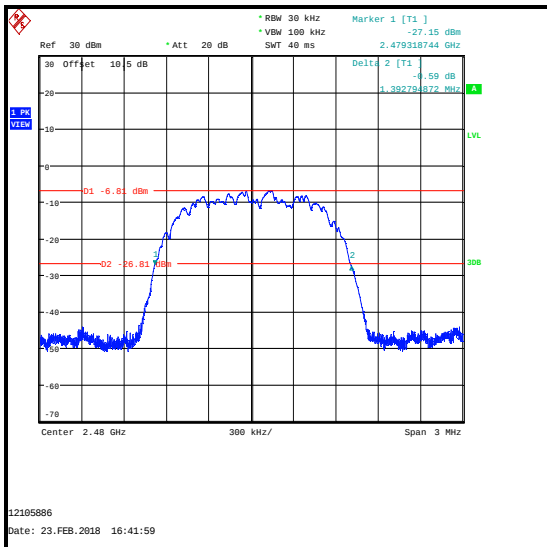
Transmitter 20 dB Bandwidth (continued)**Results 2DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1392.154
Middle	1388.205
Top	1399.577

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

Transmitter 20 dB Bandwidth (continued)**Results 3DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1385.000
Middle	1383.474
Top	1392.795

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

Transmitter 20 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 Carrier Frequency Separation**Test Summary:**

Test Engineer:	Victor Carmon	Test Date:	28 February 2018
Test Sample Serial Number:	03151747003		

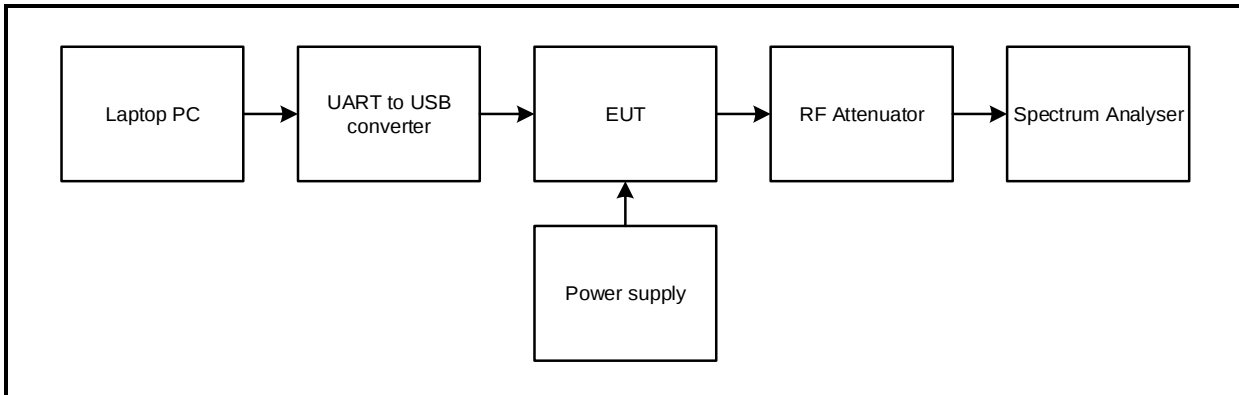
FCC Reference:	Part 15.247(a)(1)
Test Method Used:	ANSI C63.10 Section 7.8.2

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	30

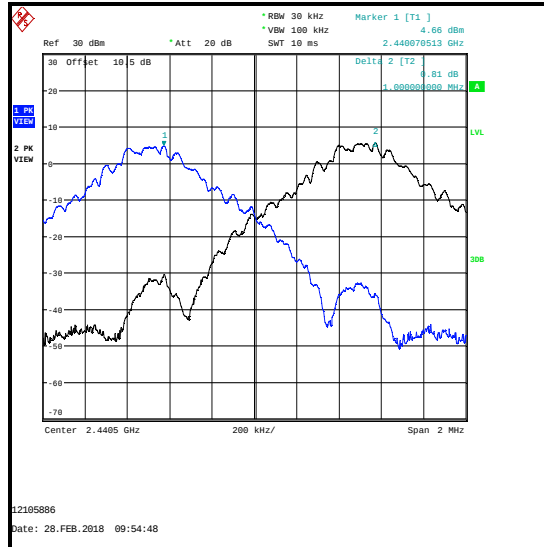
Note(s):

1. The 20 dB bandwidth measured for the middle channel operating at 2441 MHz was used to calculate the limit.
2. The spectrum analyser resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 2 MHz. A marker was placed at the centre of one signal and then a delta marker was placed in the same place on the second signal, the results are recorded in the table below.
3. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:

Transmitter Carrier Frequency Separation (continued)**Results: DH5**

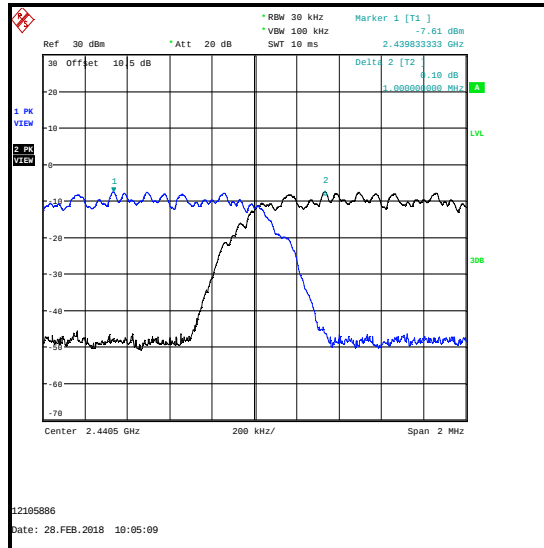
Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1000.000	689.179	310.821	Complied



Transmitter Carrier Frequency Separation (continued)

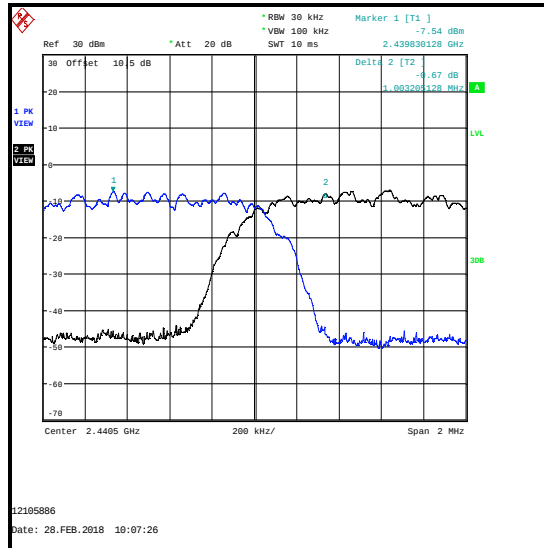
Results: 2DH5

Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1000.000	925.470	74.53	Complied



Transmitter Carrier Frequency Separation (continued)**Results: 3DH5**

Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1003.205	922.316	80.889	Complied

**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	-

5.2.4. Transmitter Number of Hopping Frequencies and Average Time of Occupancy**Test Summary:**

Test Engineer:	Victor Carmon	Test Dates:	28 February 2018 & 05 March 2018
Test Sample Serial Number:	03151747003		

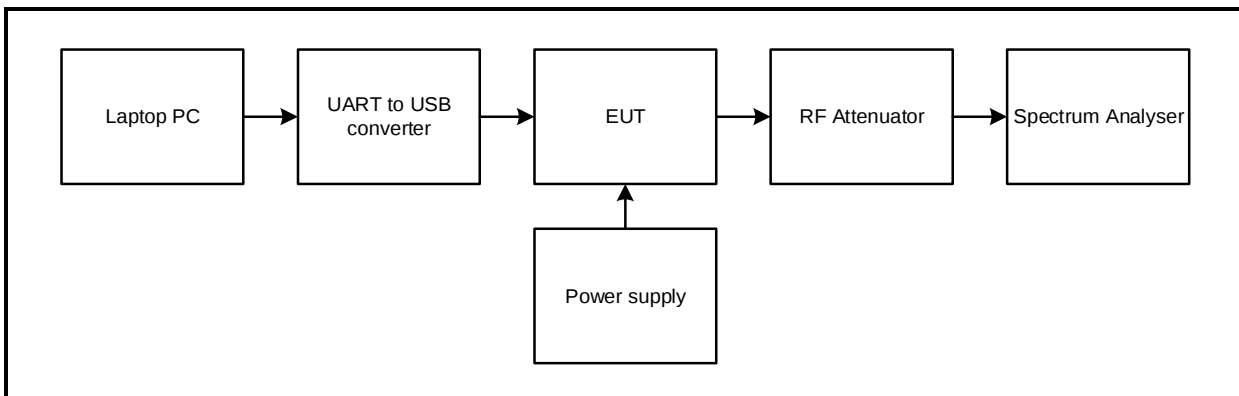
FCC Reference:	Part 15.247(a)(1)(iii)
Test Method Used:	ANSI C63.10 Sections 7.8.3 & 7.8.4

Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	26

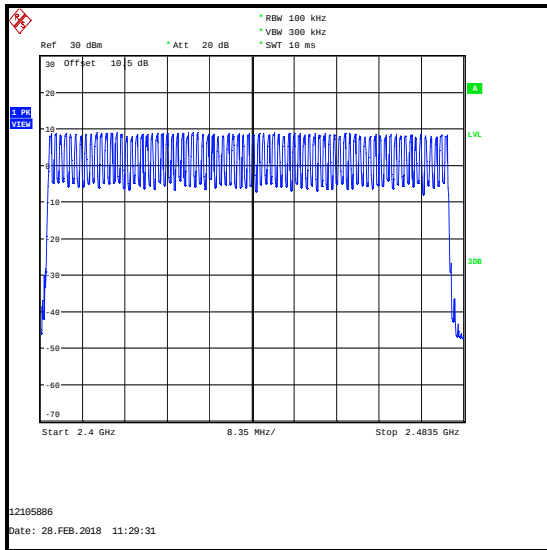
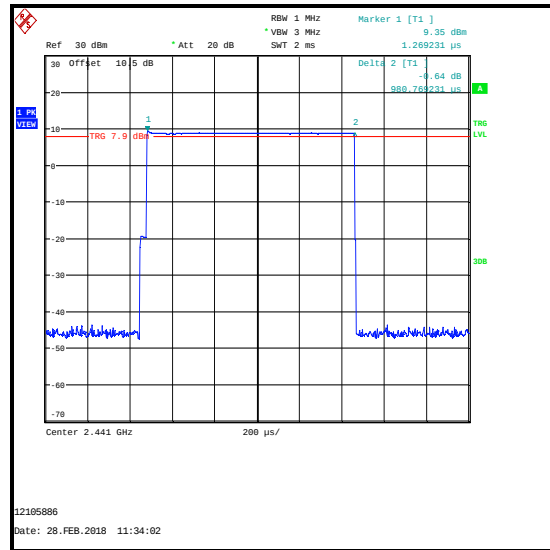
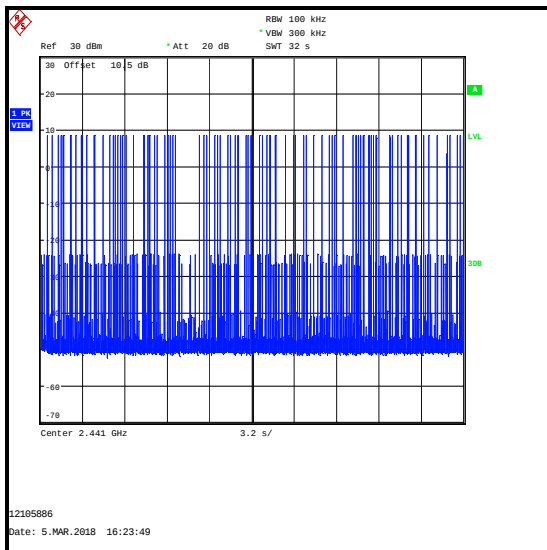
Note(s):

1. Tests were performed to identify the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.
2. The spectrum analyser was set up for the Number of Hopping Frequencies measurement as follows: the resolution bandwidth was set to 100 kHz and video bandwidth of 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 83.5 MHz.
3. The spectrum analyser was set up for the Emission Width measurement as follows: the resolution bandwidth was set to 1 MHz and video bandwidth of 3 MHz. A peak detector was used and sweep time was set to auto with a span of zero Hz. The spectrum analyser was set to trigger at 1 ms, with a marker placed at the start of the emission and a delta marked place at the end of the emission. The emission width is recorded in the table below
4. The spectrum analyser was set up for the Number of Hopping Frequencies in 32 seconds measurement as follows: the resolution bandwidth was set to 100 kHz and video bandwidth of 300 kHz. A peak detector was used and sweep time was set to 32 seconds. The EUT was set to transmit in a hopping frequency mode with zero span. The total number of hopping frequencies were recorded in the table below.
5. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:

Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)**Results:**

Emission Width (μ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
980.769	107	0.105	0.4	0.295	Complied

**Number of Hopping Frequencies****Emission Width****Number of Hopping Frequencies in 32 s**

Transmitter Number of Hopping Frequencies and Average Time of Occupancy (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	-

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

Test Engineer:	Victor Carmon	Test Date:	28 February 2018
Test Sample Serial Number:	03151747003		

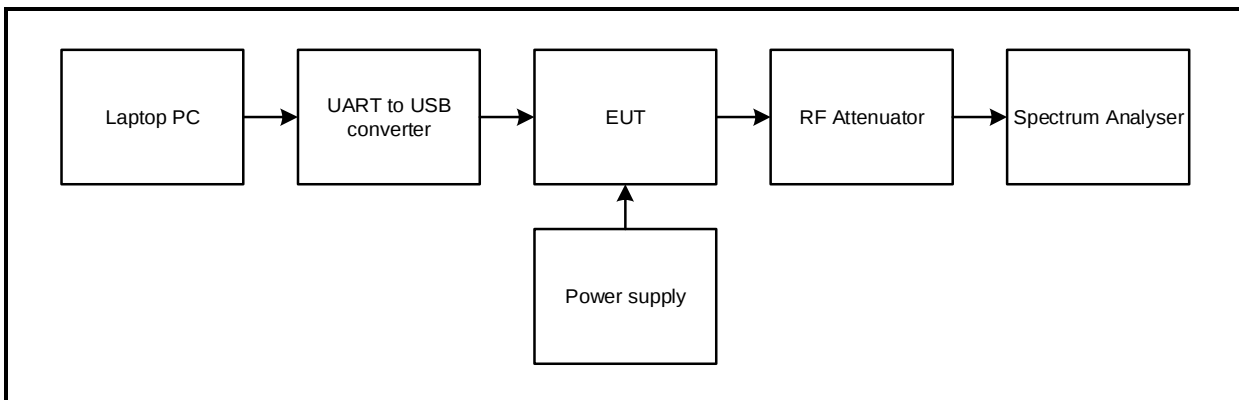
FCC Reference:	Part 15.247(b)(1)
Test Method Used:	ANSI C63.10 Section 7.8.5

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	30

Note(s):

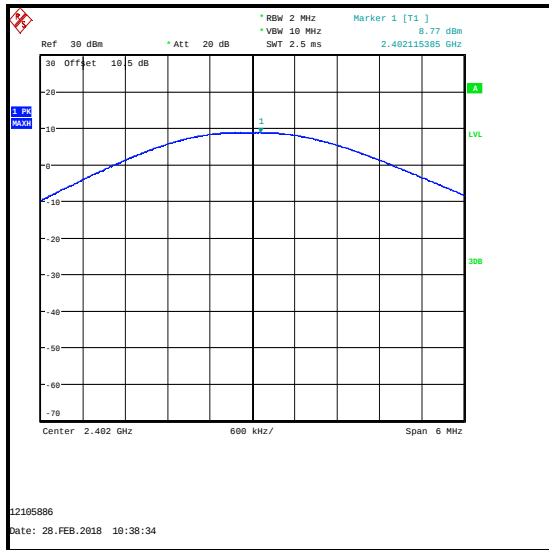
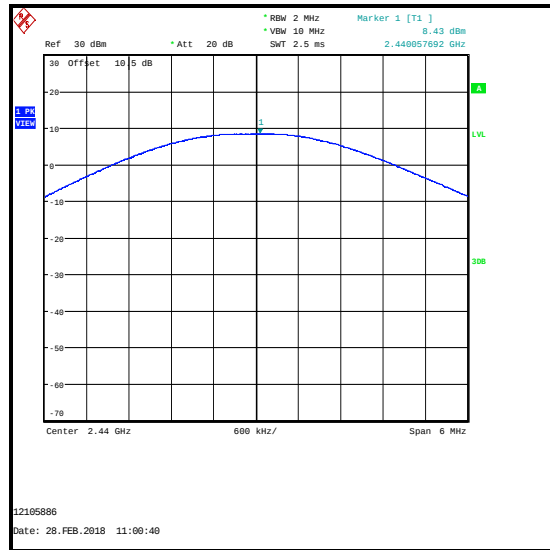
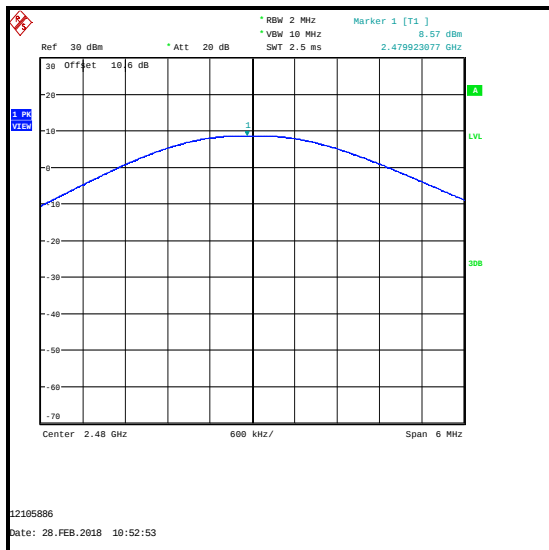
1. The spectrum analyser resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 6 MHz (approximately five times the 20 dB bandwidth). A marker was placed at the peak of the signal and the results recorded in the tables below.
2. The declared antenna gain was added to the conducted peak power to obtain the EIRP.
3. The spectrum analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the spectrum analyser to compensate for the loss of the attenuator and RF cable.

Test setup:

Transmitter Maximum Peak Output Power (continued)**Results: DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	8.8	30.0	21.2	Complied
Middle	8.4	30.0	21.6	Complied
Top	8.6	30.0	21.4	Complied

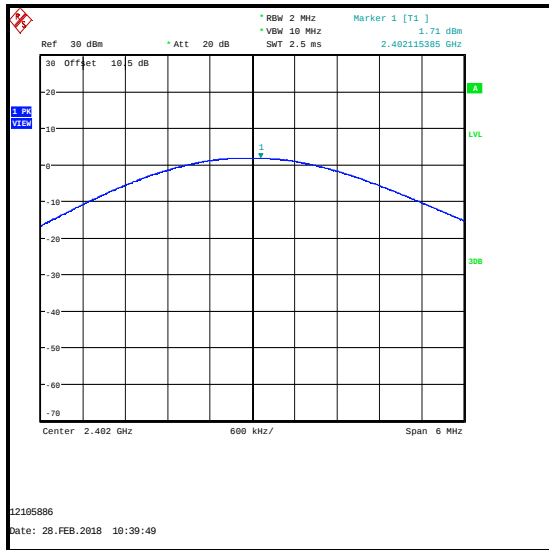
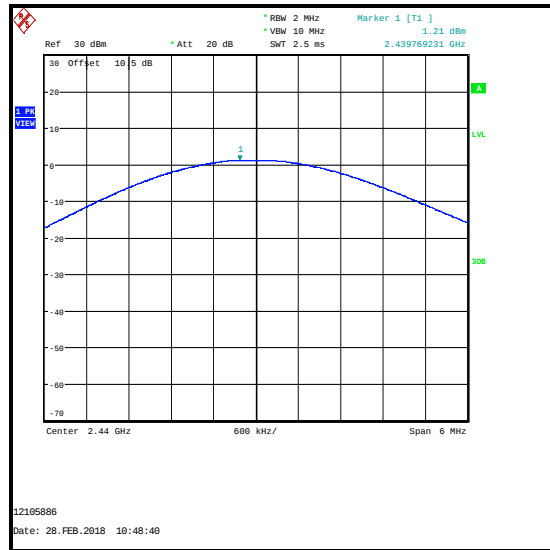
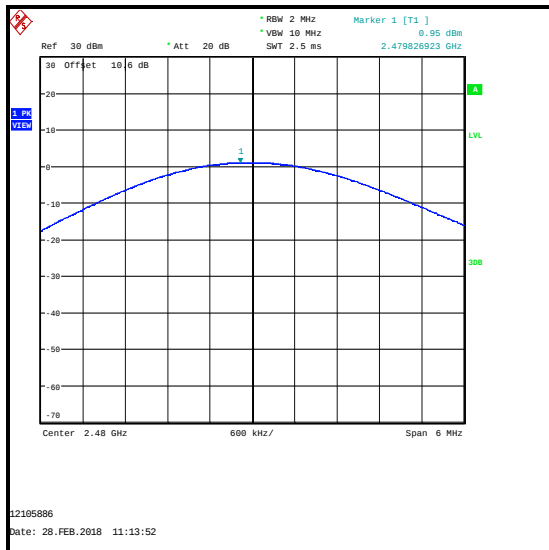
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	8.8	1.8	10.6	36.0	25.4	Complied
Middle	8.4	1.8	10.2	36.0	25.8	Complied
Top	8.6	1.8	10.4	36.0	25.6	Complied

Transmitter Maximum Peak Output Power (continued)**Results: DH5****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum Peak Output Power (continued)**Results: 2DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	1.7	21.0	19.3	Complied
Middle	1.2	21.0	19.8	Complied
Top	1.0	21.0	20.0	Complied

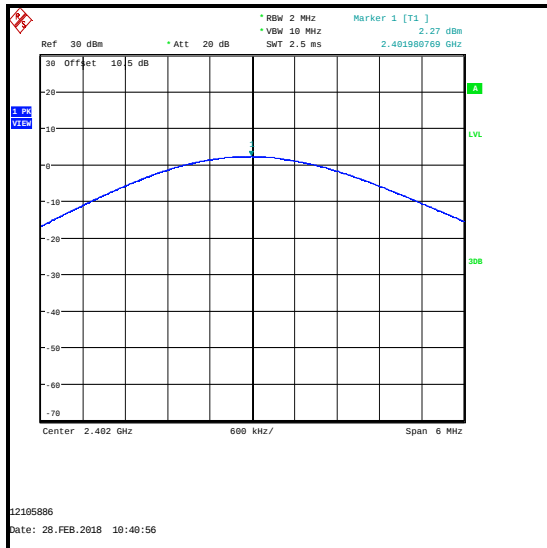
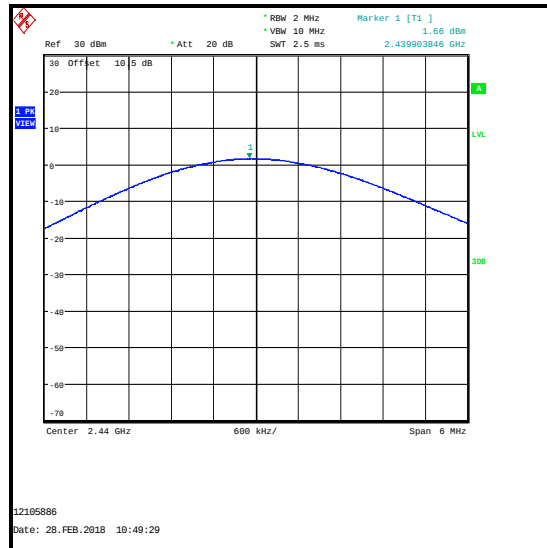
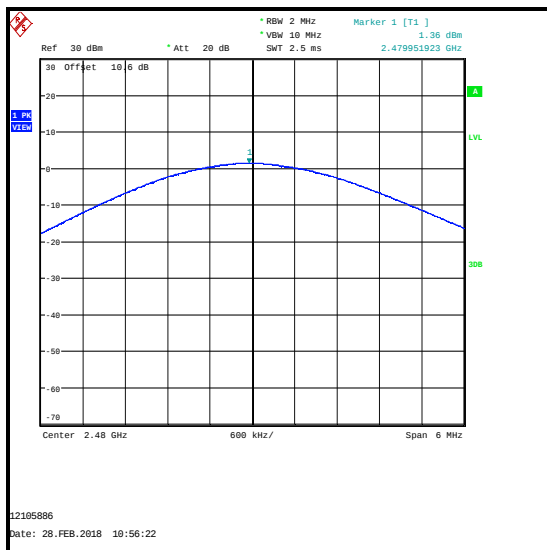
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	1.7	1.8	3.5	27.0	23.5	Complied
Middle	1.2	1.8	3.0	27.0	24.0	Complied
Top	1.0	1.8	2.8	27.0	24.2	Complied

Transmitter Maximum Peak Output Power (continued)**Results: 2DH5****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum Peak Output Power (continued)**Results: 3DH5**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	2.3	21.0	18.7	Complied
Middle	1.7	21.0	19.3	Complied
Top	1.4	21.0	19.6	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	2.3	1.8	4.1	27.0	22.9	Complied
Middle	1.7	1.8	3.5	27.0	23.5	Complied
Top	1.4	1.8	3.2	27.0	23.8	Complied

Transmitter Maximum Peak Output Power (continued)**Results: 3DH5****Bottom Channel****Middle Channel****Top Channel****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:**

Test Engineer:	David Doyle	Test Date:	17 May 2018
Test Sample Serial Number:	03151747065		

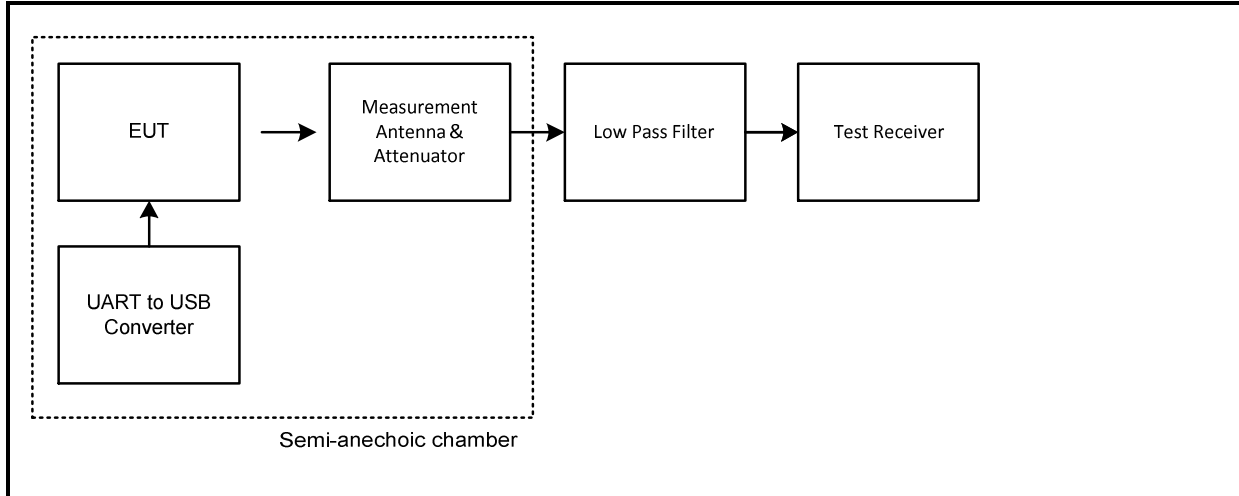
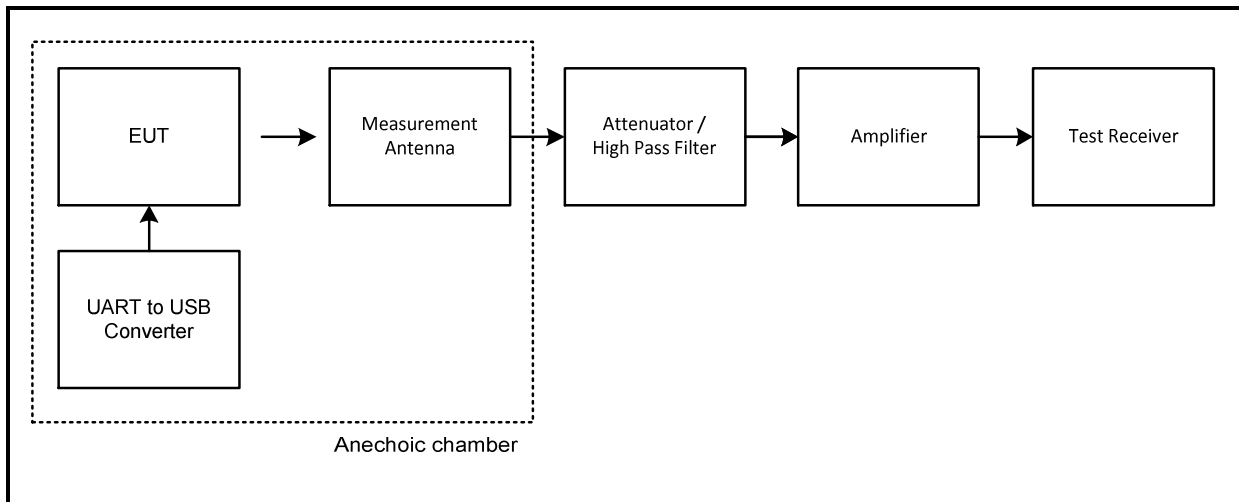
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	37

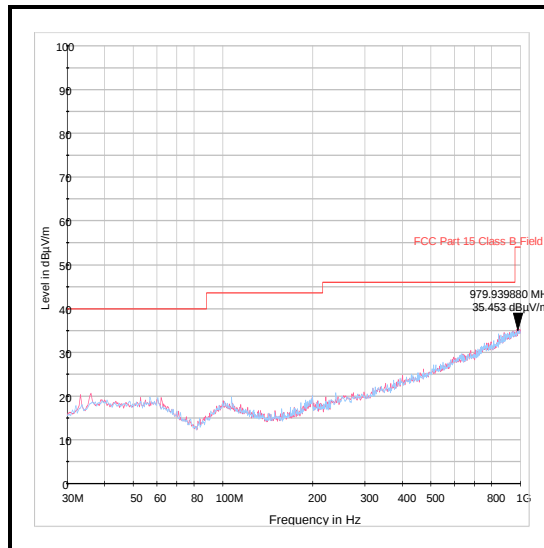
Note(s):

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 (continued)**Test setup for radiated measurements:****Semi-anechoic chamber****Anechoic chamber**

Transmitter Radiated Emissions (continued)**Results: Peak / DH5**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
979.940	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 (continued)**Test Summary:**

Test Engineers:	James O'Reilly & David Doyle	Test Dates:	21 April 2018, 15 May 2018 & 31 May 2018
Test Sample Serial Number:	03151747065		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	44 to 51

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 2441 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 / DH5**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4804.314	Horizontal	54.3	74.0	19.7	Complied

Results: Average / Bottom Channel / DH5

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4803.707	Horizontal	50.5	54.0	3.5	Complied

Results: Peak / Middle Channel / DH5

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4879.893	Horizontal	54.5	74.0	19.5	Complied

Results: Average / Middle Channel / DH5

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4879.764	Horizontal	51.3	54.0	2.7	Complied

Results: Top Channel / DH5

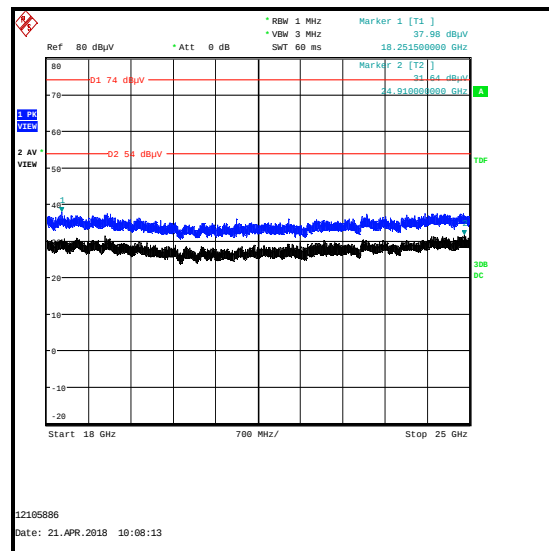
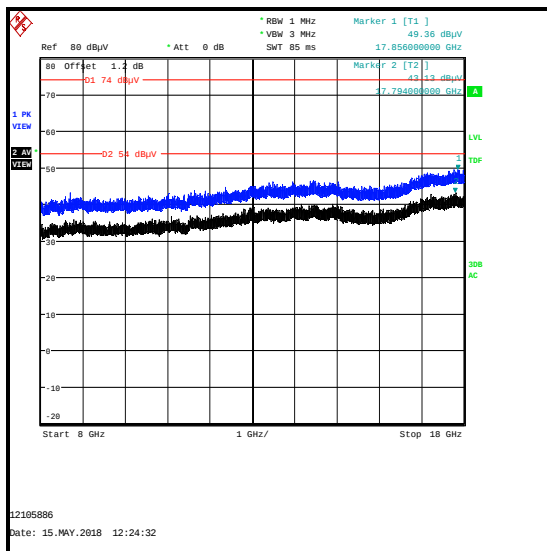
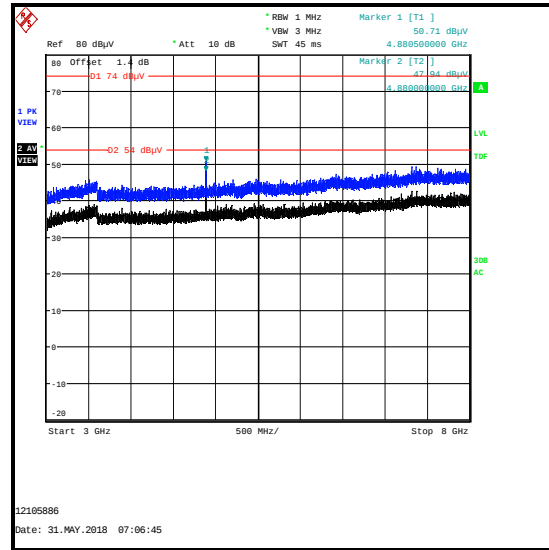
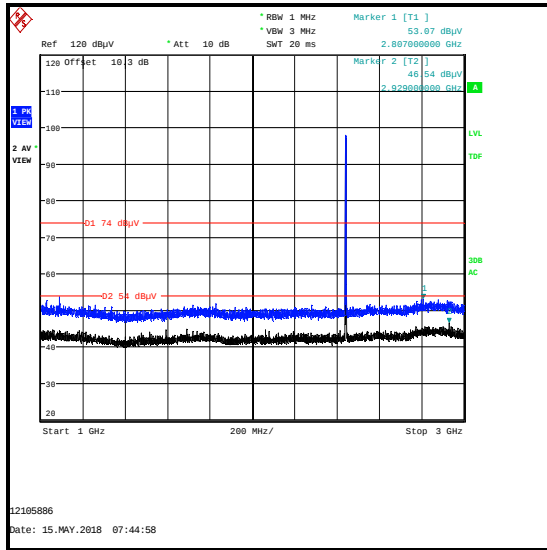
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4959.614	Horizontal	52.1	54.0*	1.9	Complied

Results: Peak / Hopping Mode / DH5

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4878.200	Horizontal	55.7	74.0	18.3	Complied

Results: Average / Hopping Mode / DH5

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
4862.171	Horizontal	53.7	54.0	0.3	Complied

Transmitter Radiated Emissions (continued)

Note: These 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	Rhode & 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

All test equipment was within the current calibration period on the date of testing

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

Test Engineer:	David Doyle	Test Date:	27 February 2018
Test Sample Serial Number:	03151747003		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	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 lower band edge is adjacent to a non-restricted band. 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. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent band (where a higher level emission was present). Marker frequencies and levels were recorded.
3. The upper band edge is adjacent to a restricted band. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak and average measurements were performed with their respective detectors, 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 frequencies and a second marker placed on the highest emission level in the adjacent band (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 their respective detectors. Markers were placed on the highest point on each trace.
5. * -20 dBc limit.

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400.000	Horizontal	46.0	79.3*	33.3	Complied
2483.500	Horizontal	50.9	74.0	23.1	Complied
2483.580	Horizontal	51.9	74.0	22.1	Complied

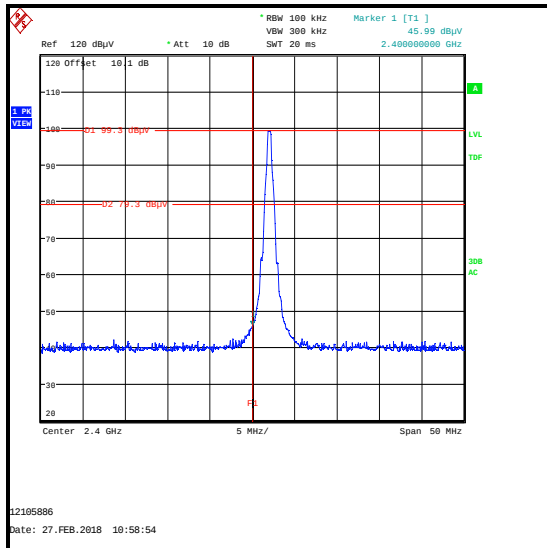
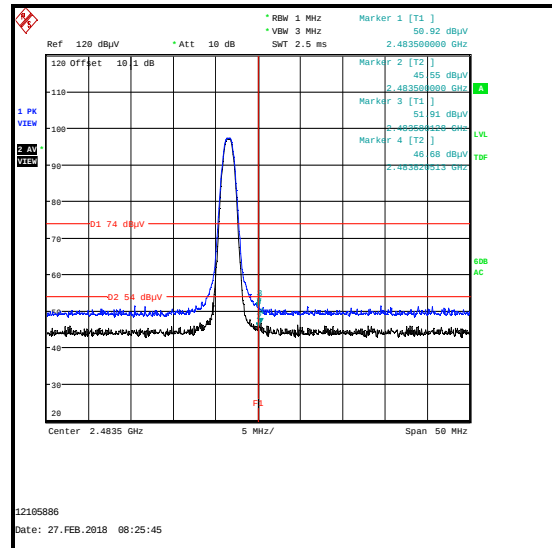
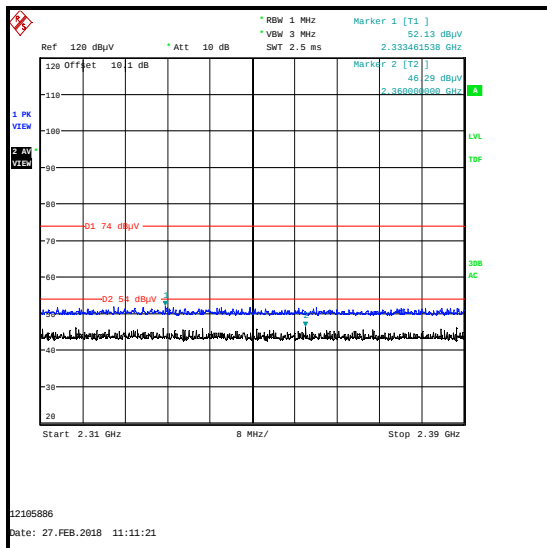
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	45.6	54.0	8.4	Complied
2483.821	Horizontal	46.7	54.0	7.3	Complied

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
2333.462	Horizontal	52.1	74.0	21.9	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
2360.000	Horizontal	46.3	54.0	7.7	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / DH5****Lower Band Edge Static****Upper Band Edge Static****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400.000	Horizontal	51.7	80.4*	28.7	Complied
2483.500	Horizontal	49.0	74.0	25.0	Complied
2484.141	Horizontal	57.4	74.0	16.6	Complied

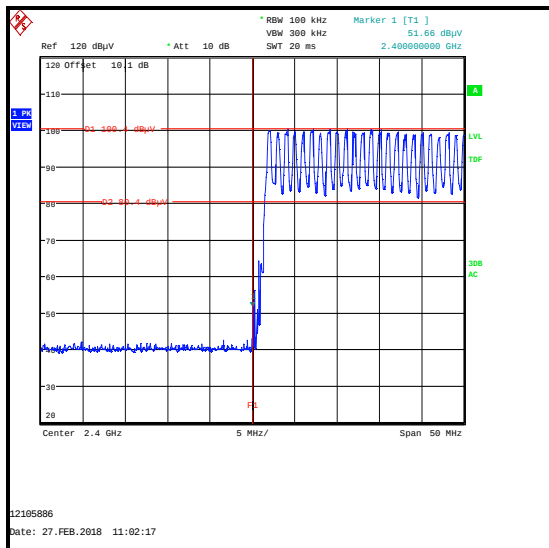
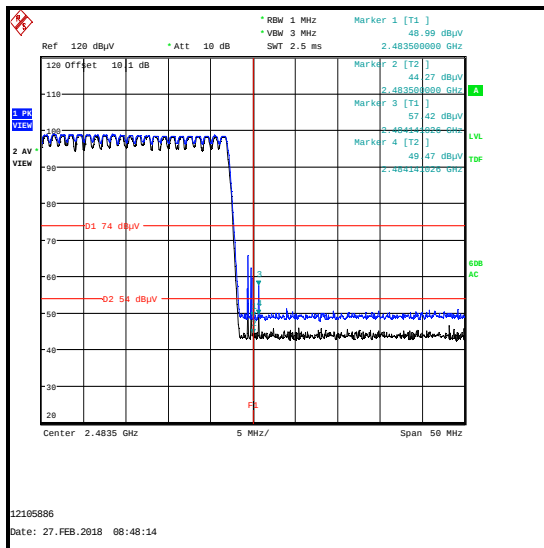
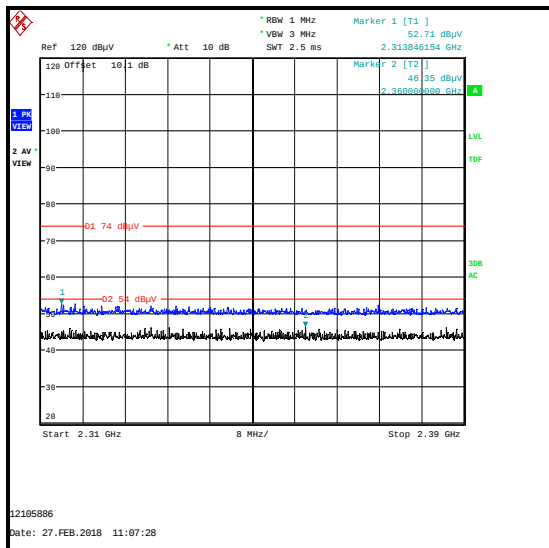
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	44.3	54.0	9.7	Complied
2484.141	Horizontal	49.5	54.0	4.5	Complied

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
2313.846	Horizontal	52.7	74.0	21.3	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
2360.000	Horizontal	46.4	54.0	7.6	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / DH5****Lower Band Edge Hopping****Upper Band Edge Hopping****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 2DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2400.000	Horizontal	44.4	71.1*	26.7	Complied
2483.500	Horizontal	52.2	74.0	21.8	Complied
2483.580	Horizontal	52.4	74.0	21.6	Complied

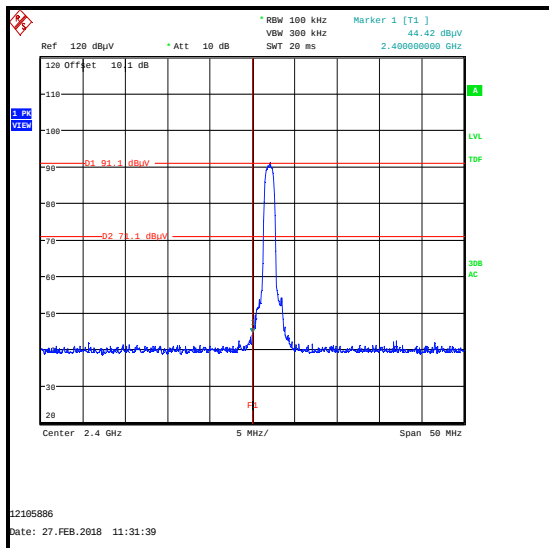
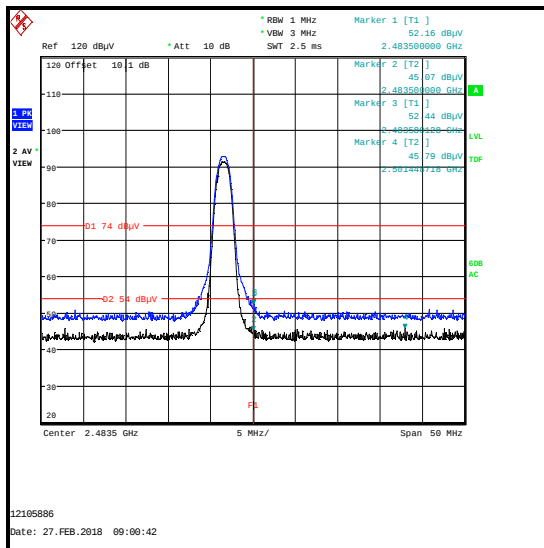
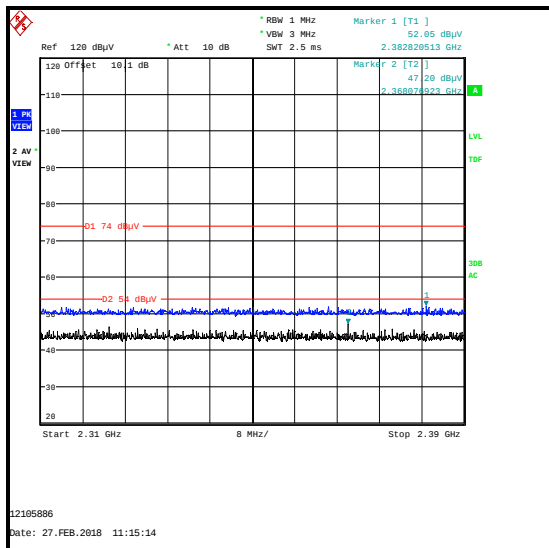
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	45.1	54.0	8.9	Complied
2501.449	Horizontal	45.8	54.0	8.2	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2382.821	Horizontal	52.1	74.0	21.9	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
2368.077	Horizontal	47.2	54.0	6.8	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 2DH5****Lower Band Edge Static****Upper Band Edge Static****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / 2DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.519	Horizontal	53.0	77.0*	24.0	Complied
2400.000	Horizontal	48.1	77.0*	28.9	Complied
2483.500	Horizontal	53.4	74.0	20.6	Complied
2483.580	Horizontal	57.6	74.0	16.4	Complied

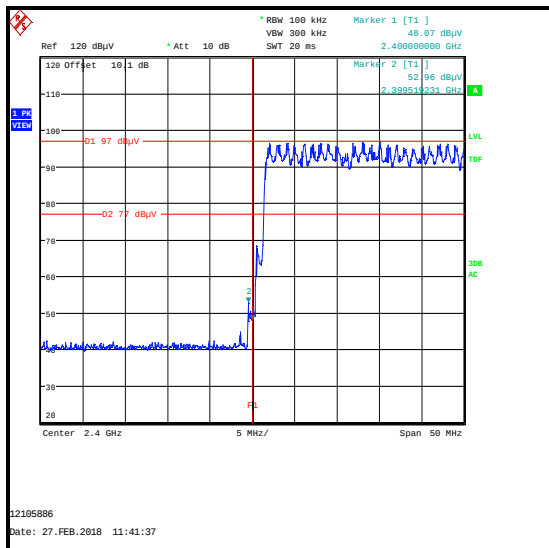
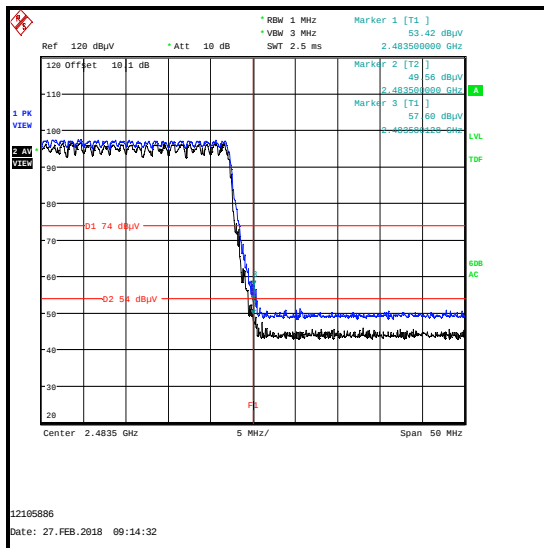
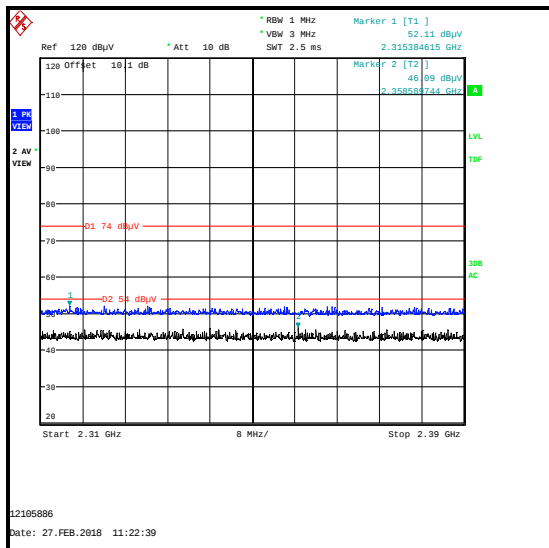
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	49.6	54.0	4.4	Complied

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
2315.385	Horizontal	52.1	74.0	21.9	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
2358.590	Horizontal	46.1	54.0	7.9	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / 2DH5****Lower Band Edge Hopping****Upper Band Edge Hopping****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.439	Horizontal	41.8	71.0*	29.2	Complied
2400.000	Horizontal	39.9	71.0*	31.1	Complied
2483.500	Horizontal	51.4	74.0	22.6	Complied
2497.122	Horizontal	51.5	74.0	22.5	Complied

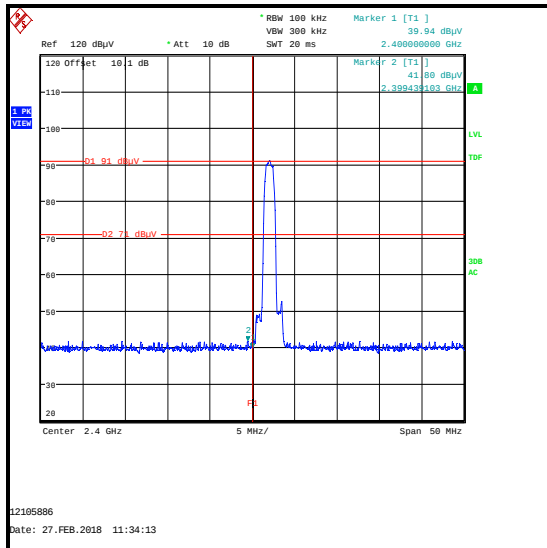
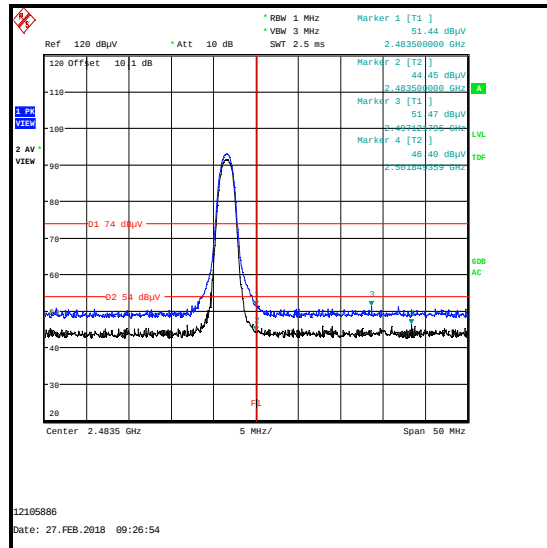
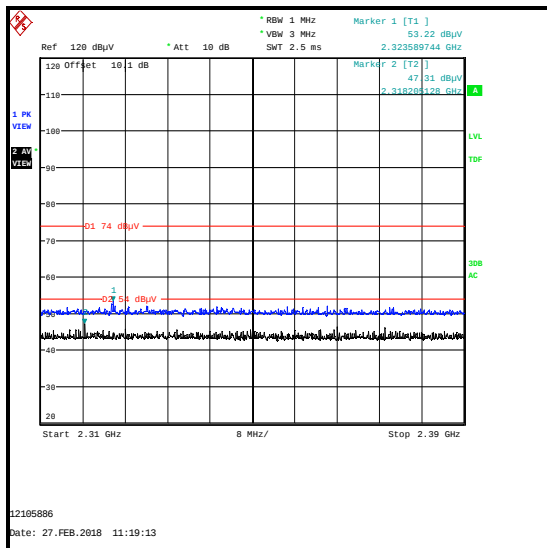
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	44.5	54.0	9.5	Complied
2501.849	Horizontal	46.4	54.0	7.6	Complied

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
2323.590	Horizontal	53.2	74.0	20.8	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
2318.205	Horizontal	47.3	54.0	6.7	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 3DH5****Lower Band Edge Static****Upper Band Edge Static****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.519	Horizontal	54.3	77.0*	22.7	Complied
2400.000	Horizontal	48.1	77.0*	28.9	Complied
2483.500	Horizontal	52.5	74.0	21.5	Complied
2483.740	Horizontal	56.6	74.0	17.4	Complied

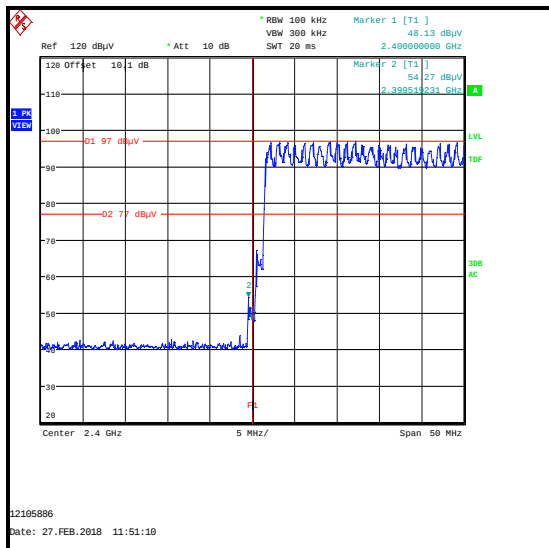
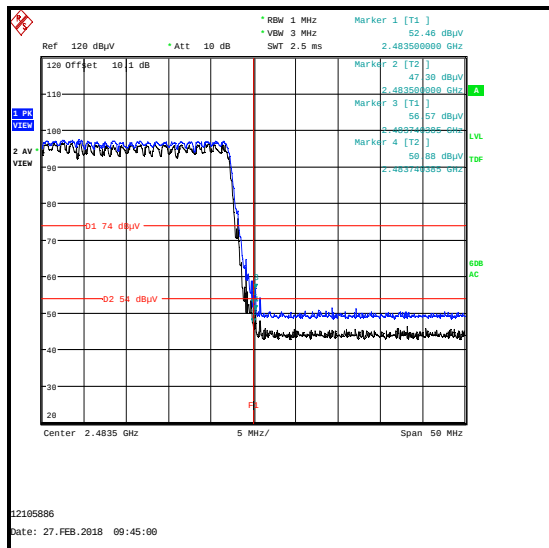
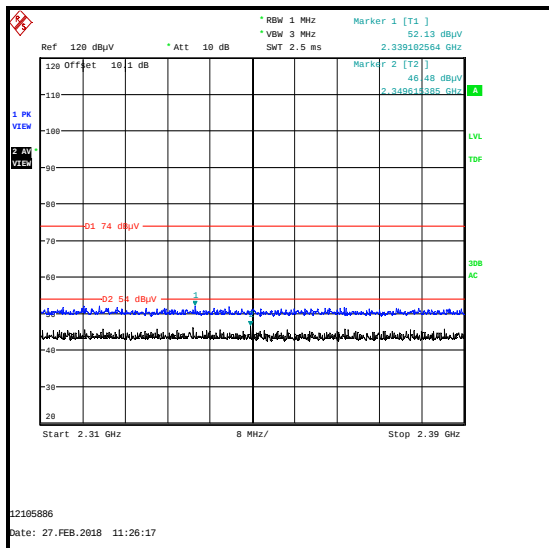
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	47.3	54.0	6.7	Complied
2483.740	Horizontal	50.9	54.0	3.1	Complied

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
2339.103	Horizontal	52.1	74.0	21.9	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
2349.615	Horizontal	46.5	54.0	7.5	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / 3DH5****Lower Band Edge Hopping****Upper Band Edge Hopping****2310 MHz to 2390 MHz Restricted Band**

Transmitter Band Edge 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	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 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.

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
Carrier Frequency Separation	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Average Time of Occupancy	2.4 GHz to 2.4835 GHz	95%	±3.53 ns
20 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
2.0	16	-	Corrected test date

--- END OF REPORT ---