



TEST REPORT

Test Report No. : UL-RPT-RP11456397JD18E

Manufacturer : Neeo AG
Model No. : 6336-BRAIN
FCC ID : 2AKK7-BR633601
Technology : *Bluetooth* – Basic Rate & EDR
Test Standard(s) : FCC Parts 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: 10 April 2017

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Engineer, Radio Laboratory
UL VS LTD



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UL VS LTD

Pavilion A, Ashwood Park, Ashwood Way, Basingstoke, Hampshire, RG23 8BG, UK
Telephone: +44 (0)1256 312000
Facsimile: +44 (0)1256 312001

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1. Customer Information

Company Name:	Neeo AG
Address:	Ritterquai 8 4500 Solothurn Switzerland

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:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 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:	15 December 2016 to 03 February 2017

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
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

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:	Neeo
Model Name or Number:	6336-BRAIN
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)
Hardware Version:	Hardware Rev. 5
Software Version:	0.23.0
FCC ID:	2AKK7-BR633601

Brand Name:	Neeo
Model Name or Number:	6336-BRAIN
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)
Hardware Version:	Hardware Rev. 5
Software Version:	0.23.0
FCC ID:	2AKK7-BR633601

3.2. Description of EUT

The Equipment Under Test was a base station for home automation. It contains Z-Wave, *Bluetooth* BR/EDR/LE, IEEE 802.15.4 and WLAN transceivers. It is powered from an AC/DC adaptor.

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	5.2 VDC via 120 VAC 60 Hz adaptor	
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 (Mbps):	1	2	3
Maximum Conducted Output Power:	6.0 dBm		
Antenna Gain:	0.5 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:	Dell
Model Name or Number:	E5400
Serial Number:	01160

Description:	USB to TTL Serial Cable. Length 1.8 metres
Brand Name:	FTDI Chip
Model Name or Number:	TTL-232R-3V3-AJ
Serial Number:	Not marked or stated

Description:	AC/DC Adaptor
Brand Name:	Liteon
Model Name or Number:	PA-1100-25
Serial Number:	KPO1003005 6088111EPE03

Description:	HDMI Cable. Length 3 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Now TV Box for HDMI Termination
Brand Name:	Sky
Model Name or Number:	2400SK
Serial Number:	1MM4DE006281

Description:	Infra-Red Sensor
Brand Name:	Neeo
Model Name or Number:	Not marked or stated
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):

- A laptop PC with an open source terminal application Tera Term V4.83 was used to place the EUT into *Bluetooth* test mode. Once in *Bluetooth* mode test mode, a link was established to a *Bluetooth* tester which was then used to control the EUT.
- The procedure to set up and control the EUT was supplied by the customer in a document titled "userManual-Radio.pdf" dated 12/12/2016.
- The EUT was powered from an AC/DC power supply. The power supply input was connected to a 120 VAC 60 Hz single phase supply.
- 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 tests were performed with the EUT transmitting in 3DH5 mode as this mode was found to transmit the highest power.
- Radiated spurious emissions were performed with the EUT in the worst case position for radiated spurious emissions. Tests were performed with the EUT connected to the AC/DC adaptor and USB cable. All other ports were terminated with suitable terminations.
- The EUT radiated sample was used for radiated spurious emissions tests.
- The EUT conducted sample was used for all other tests.

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 20 dB Bandwidth

Test Summary:

Test Engineer:	David Doyle	Test Date:	15 December 2016
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)		

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

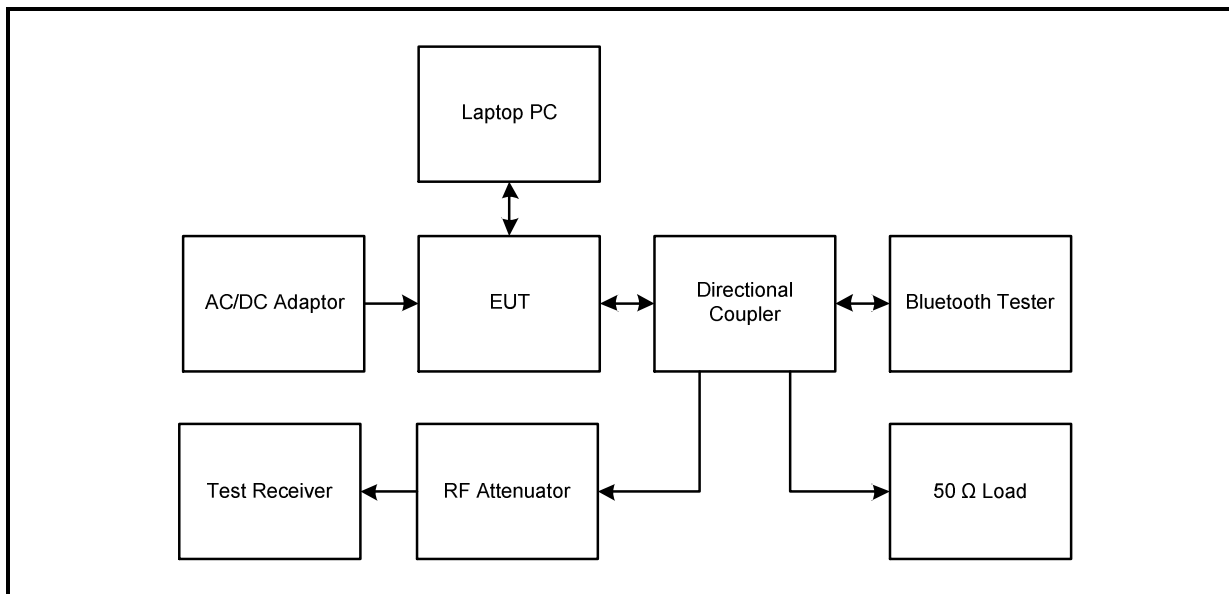
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	44

Note(s):

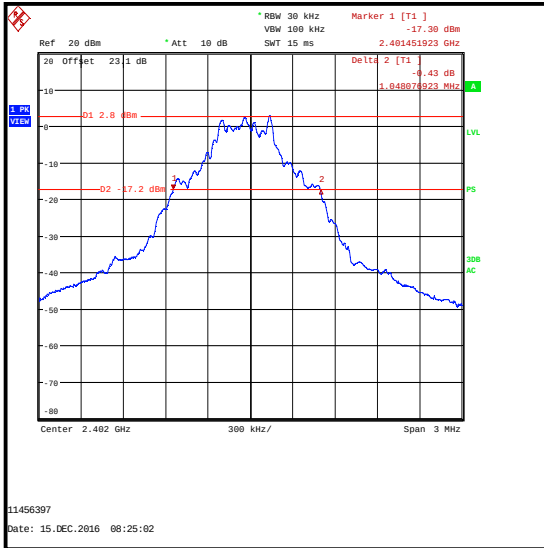
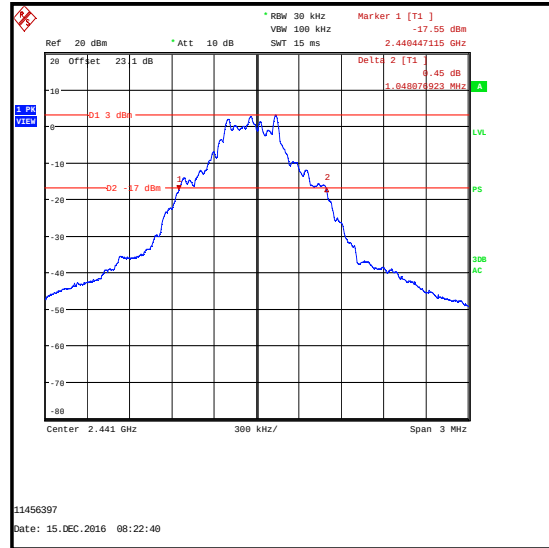
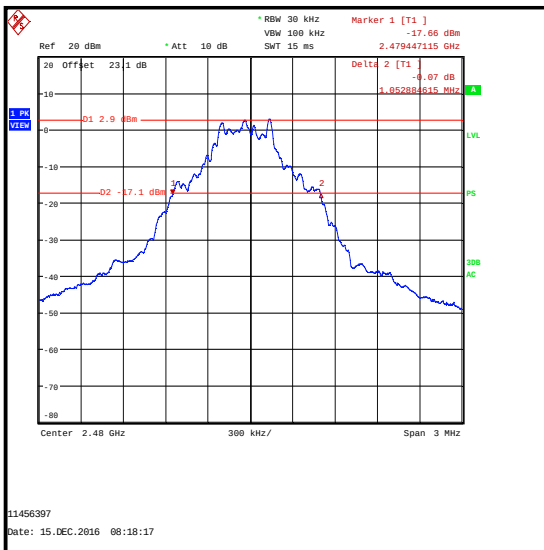
1. The test receiver resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier. These results are recorded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

Test setup:



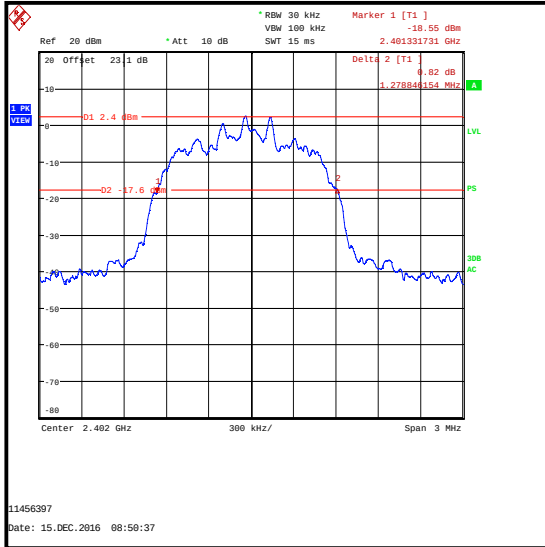
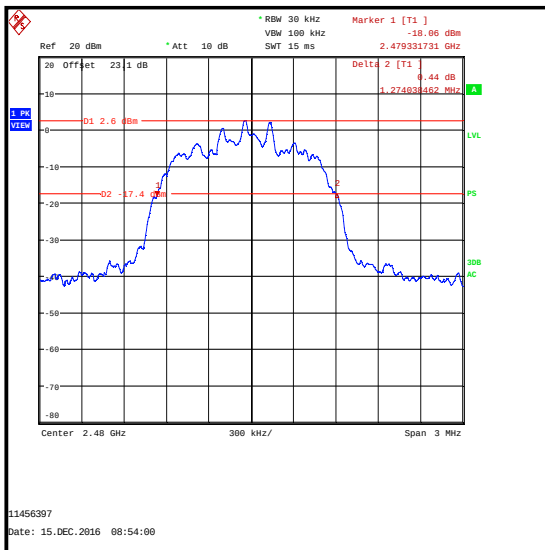
Transmitter 20 dB Bandwidth (continued)**Results DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1048.077
Middle	1048.077
Top	1052.885

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

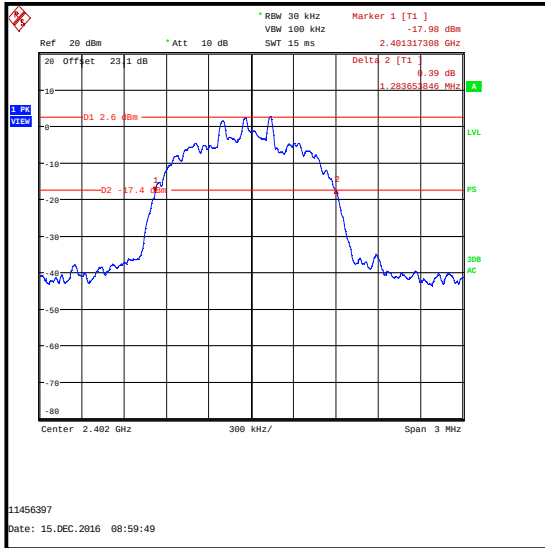
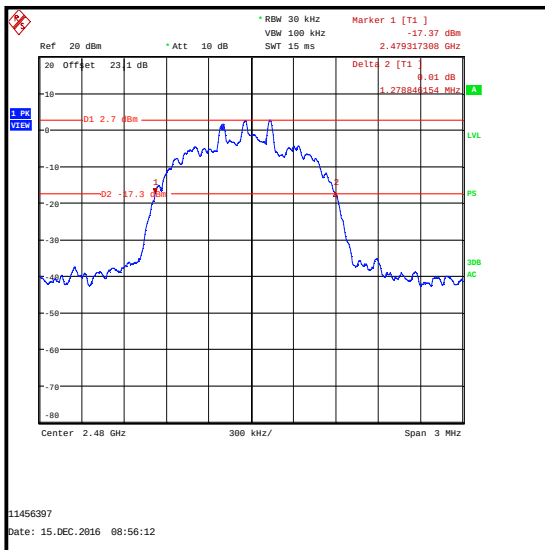
Transmitter 20 dB Bandwidth (continued)**Results 2DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1278.846
Middle	1274.038
Top	1274.038

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

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

Channel	20 dB Bandwidth (kHz)
Bottom	1283.654
Middle	1278.846
Top	1278.846

**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)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	28 Oct 2017	12
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
M1021	Signal Generator	Rohde & Schwarz	SMP02	833286/004	19 May 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.2. Transmitter Carrier Frequency Separation**Test Summary:**

Test Engineer:	David Doyle	Test Date:	15 December 2016
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)		

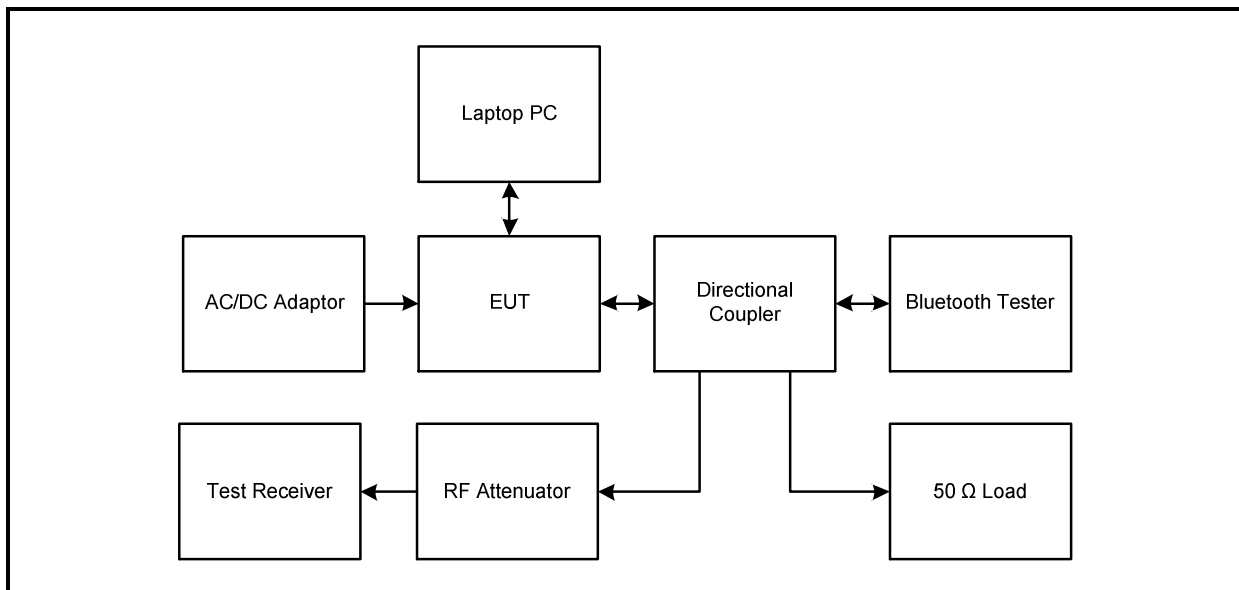
FCC Reference:	Part 15.247(a)(1)
Test Method Used:	ANSI C63.10 Section 7.8.2

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	44

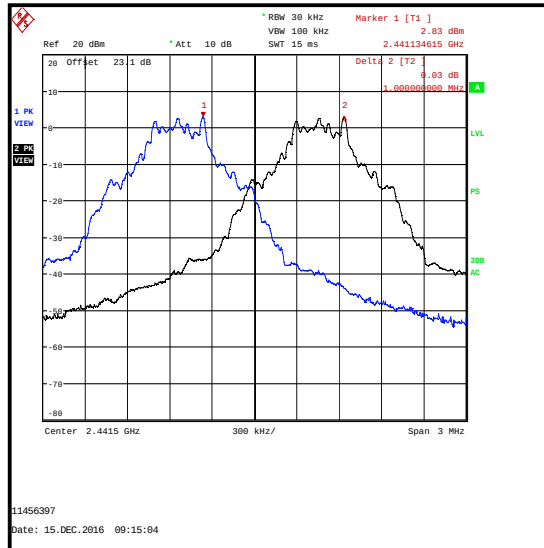
Note(s):

1. The 20 dB bandwidth measured for the middle channel operating at 2441 MHz was used to calculate the limit.
2. The test receiver centre frequency was set at the mid frequency of channels 39 and 40. The 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 3 MHz. A marker was placed on each of the corresponding peaks of the adjacent channels, with the frequency difference recorded in the tables below for each mode of operation.
3. The test receiver was connected to the RF port on the EUT via a directional coupler, suitable attenuation and RF cables.

Test setup:

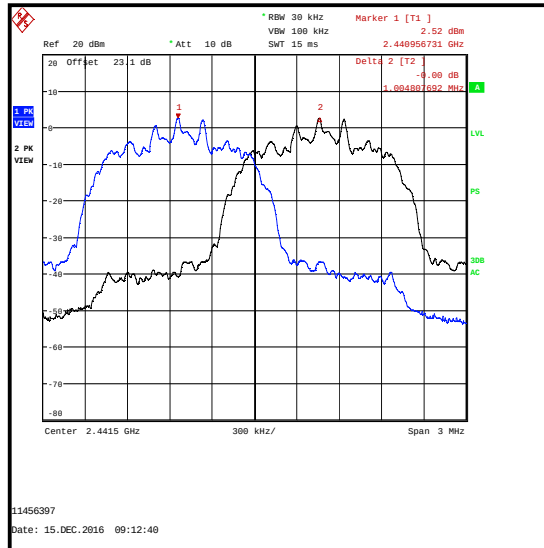
Transmitter Carrier Frequency Separation (continued)**Results: DH5**

Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1000.000	698.718	301.282	Complied



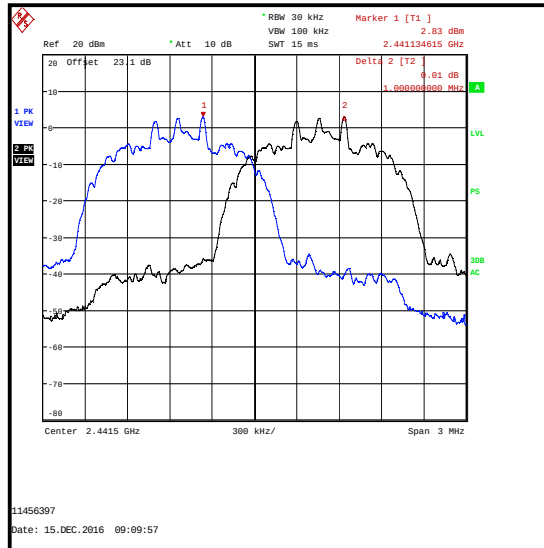
Transmitter Carrier Frequency Separation (continued)**Results: 2DH5**

Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1004.808	849.359	155.449	Complied



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

Carrier Frequency Separation (kHz)	Limit ($2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1000.000	852.564	147.436	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	28 Oct 2017	12
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
M1021	Signal Generator	Rohde & Schwarz	SMP02	833286/004	19 May 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

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

Test Engineer:	David Doyle	Test Date:	15 December 2016
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)		

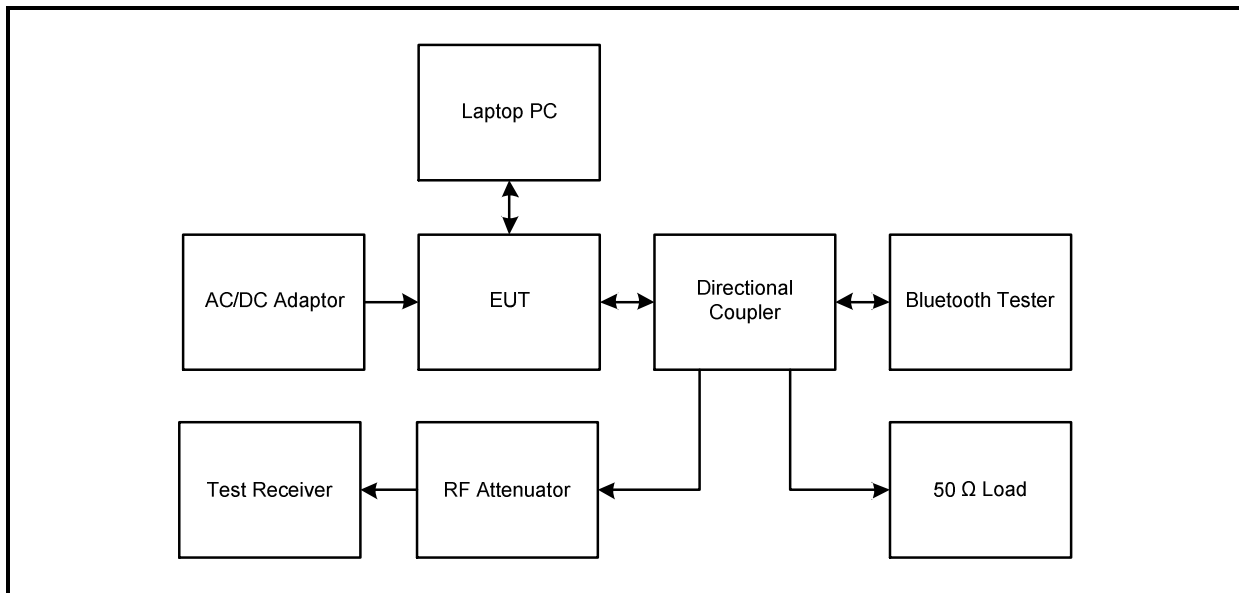
FCC Reference:	Part 15.247(a)(1)(iii)
Test Method Used:	ANSI C63.10 Sections 7.8.3 & 7.8.4

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	44

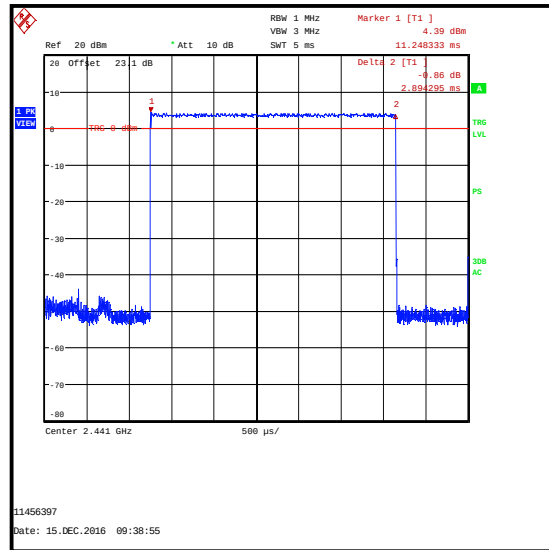
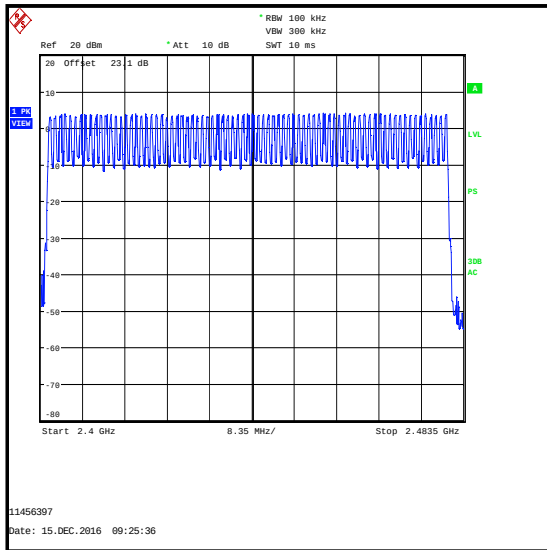
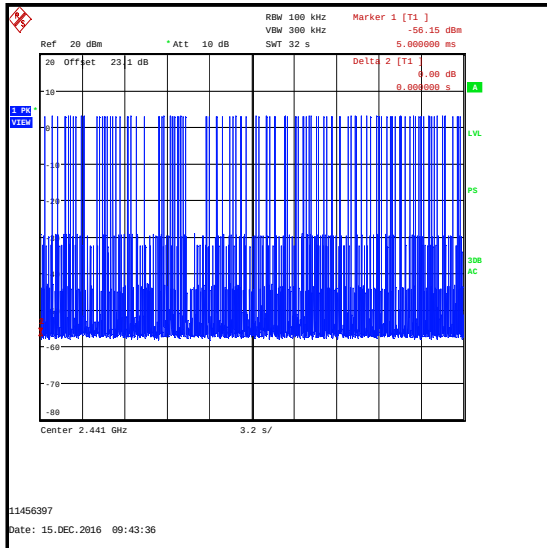
Note(s):

1. Tests were performed to determine the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.
2. Number of Hopping Frequencies test: The test receiver 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 which covers the frequency band of operation. The number of hopping frequencies was recorded.
3. Emission Width test: The test receiver 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. A marker placed at the start of the emission and a delta marked place at the end of the emission. The emission width was recorded.
4. Number of Hops in a 32 second period test: The centre channel was monitored. The test receiver 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. The total number of hops on the centre channel observed in a 32 second period was recorded.
5. The test receiver was connected to the RF port on the EUT via a directional coupler, suitable attenuation and RF cables.

Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)**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
2894.295	111	0.321	0.4	0.079	Compiled

**Number of Hopping Frequencies****Emission Width****Number of Hops in 32 seconds**

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)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	28 Oct 2017	12
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
M1021	Signal Generator	Rohde & Schwarz	SMP02	833286/004	19 May 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

5.2.4. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	David Doyle	Test Date:	15 December 2016
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)		

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

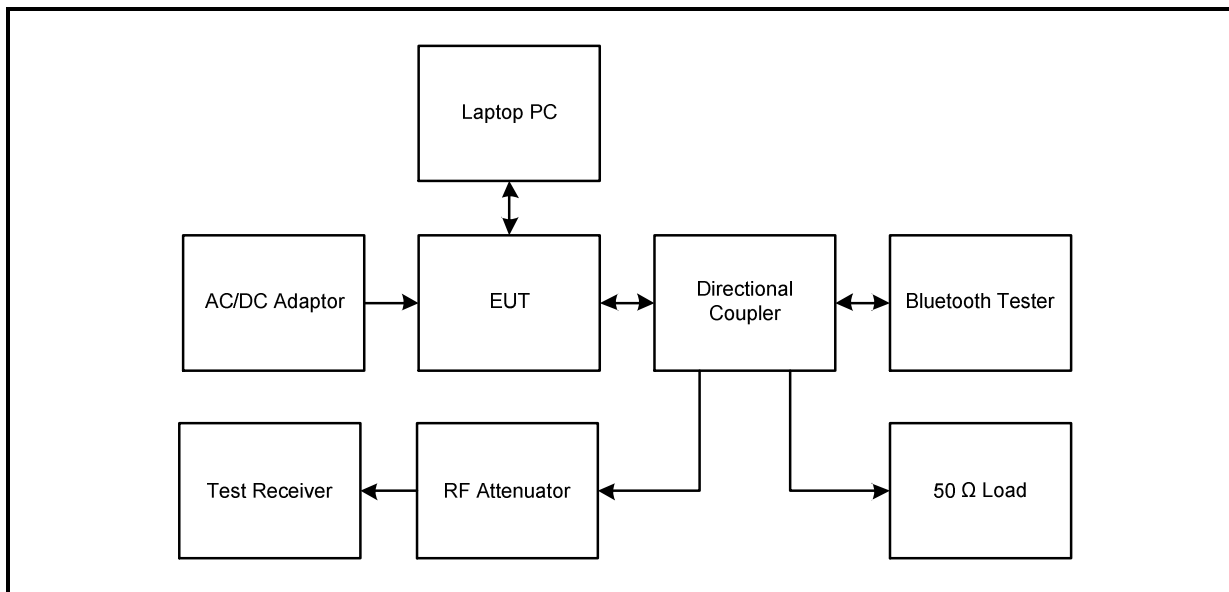
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	44

Note(s):

1. The test receiver resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth 5 MHz ($\geq$ RBW). A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5 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 test receiver was connected to the RF port on the EUT via a directional coupler, suitable attenuation and RF cables.

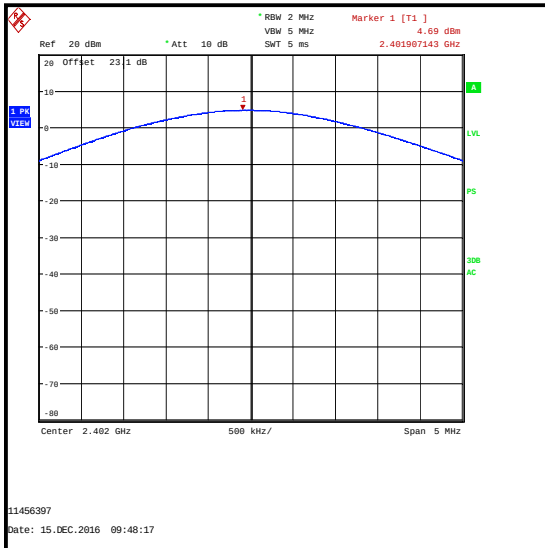
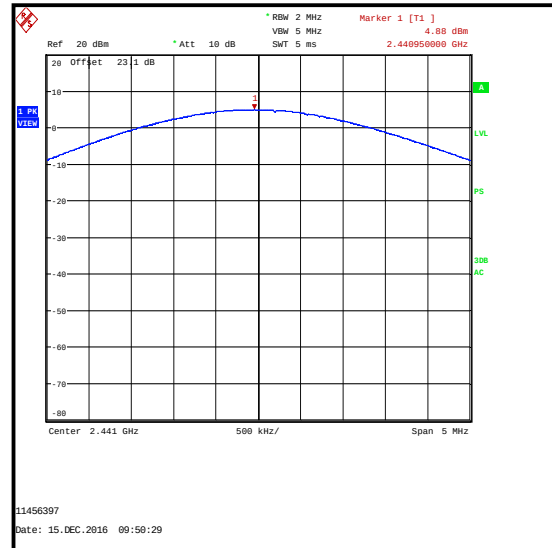
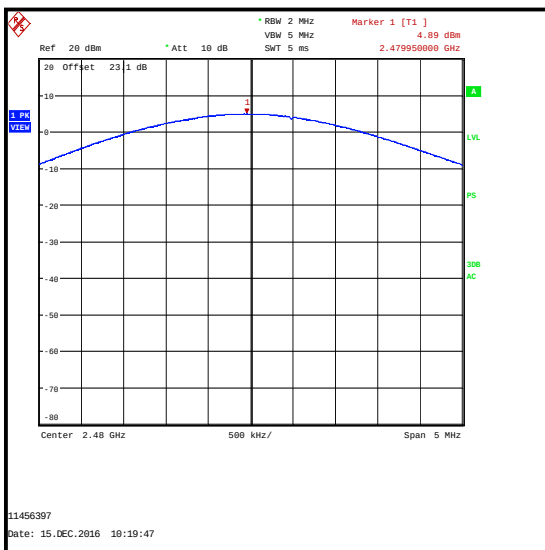
Test setup:



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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	4.7	30.0	25.3	Complied
Middle	4.9	30.0	25.1	Complied
Top	4.9	30.0	25.1	Complied

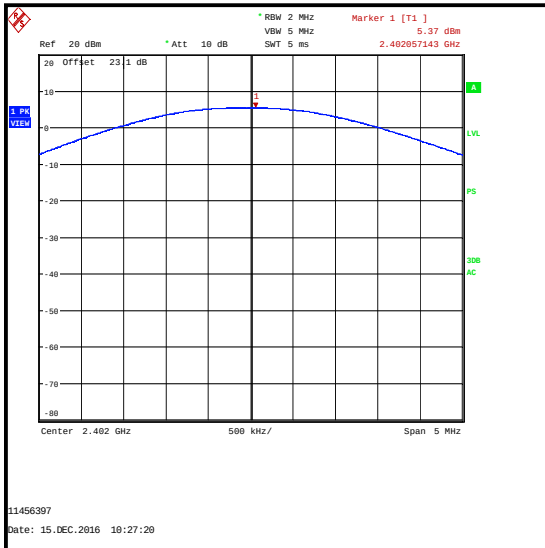
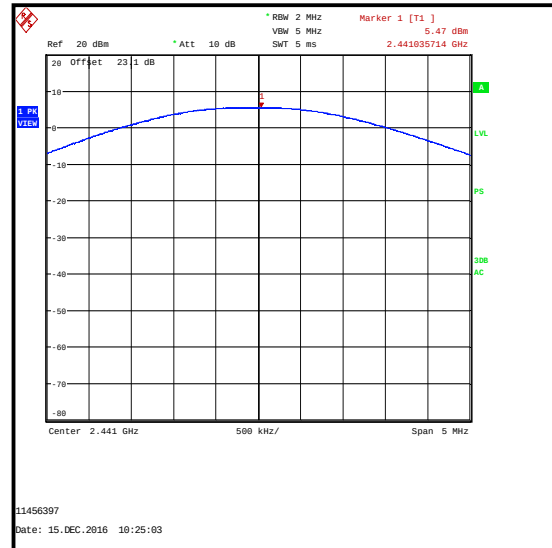
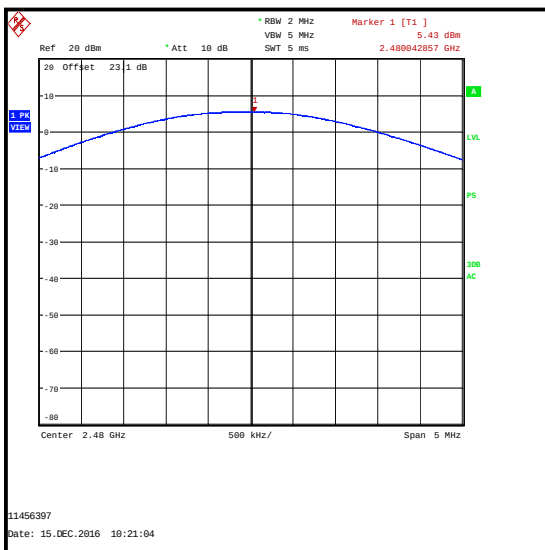
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	4.7	0.5	5.2	36.0	30.8	Complied
Middle	4.9	0.5	5.4	36.0	30.6	Complied
Top	4.9	0.5	5.4	36.0	30.6	Complied

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	5.4	21.0	15.6	Complied
Middle	5.5	21.0	15.5	Complied
Top	5.4	21.0	15.6	Complied

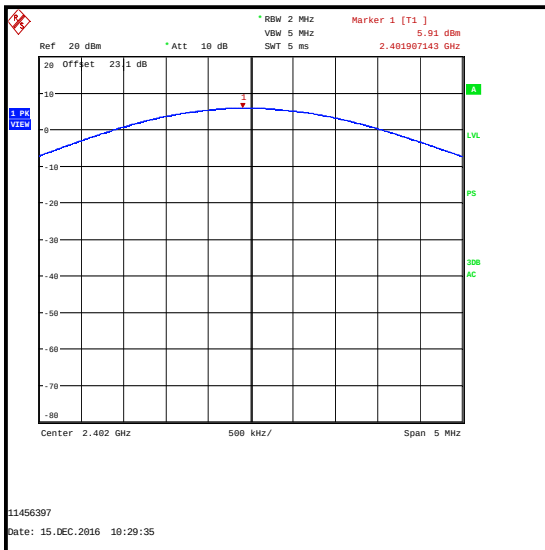
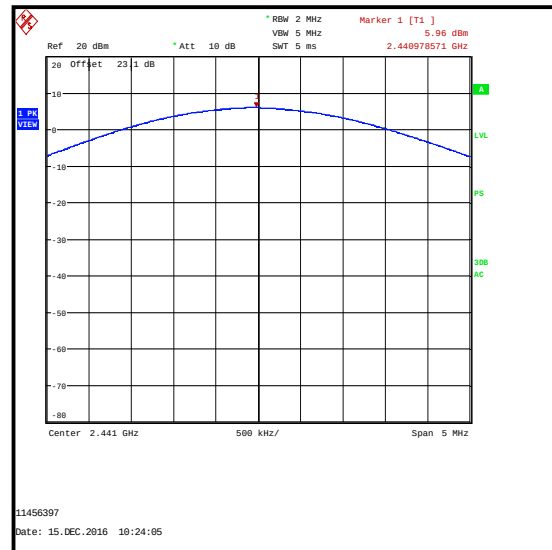
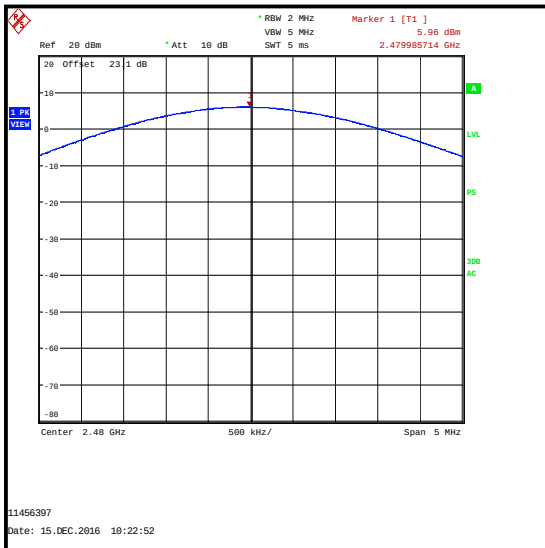
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.4	0.5	5.9	27.0	21.1	Complied
Middle	5.5	0.5	6.0	27.0	21.0	Complied
Top	5.4	0.5	5.9	27.0	21.1	Complied

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	5.9	21.0	15.1	Complied
Middle	6.0	21.0	15.0	Complied
Top	6.0	21.0	15.0	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.9	0.5	6.4	27.0	20.6	Complied
Middle	6.0	0.5	6.5	27.0	20.5	Complied
Top	6.0	0.5	6.5	27.0	20.5	Complied

Transmitter Maximum Peak Output Power (continued)**Results: 3DH5****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)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	28 Oct 2017	12
A2524	Attenuator	AtlanTecRF	AN18W5-10	832827#2	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
M1021	Signal Generator	Rohde & Schwarz	SMP02	833286/004	19 May 2017	12
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24

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

Test Engineer:	David Doyle	Test Date:	03 February 2017
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)		

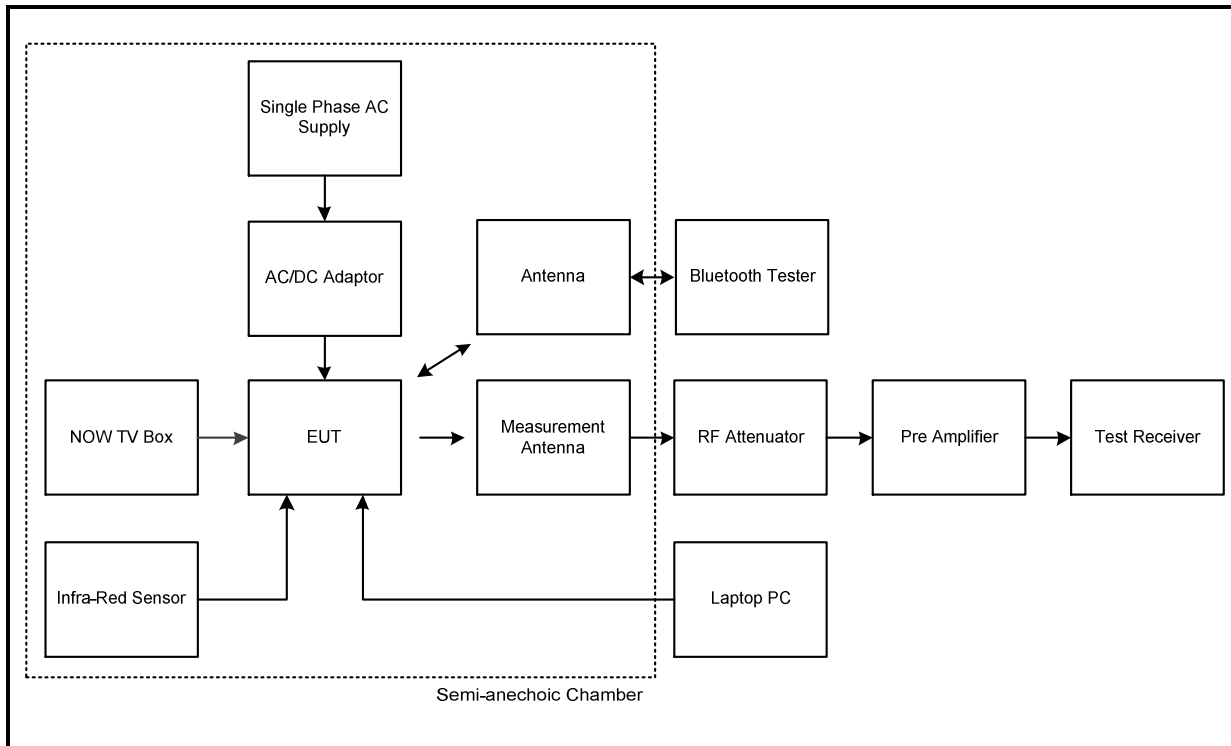
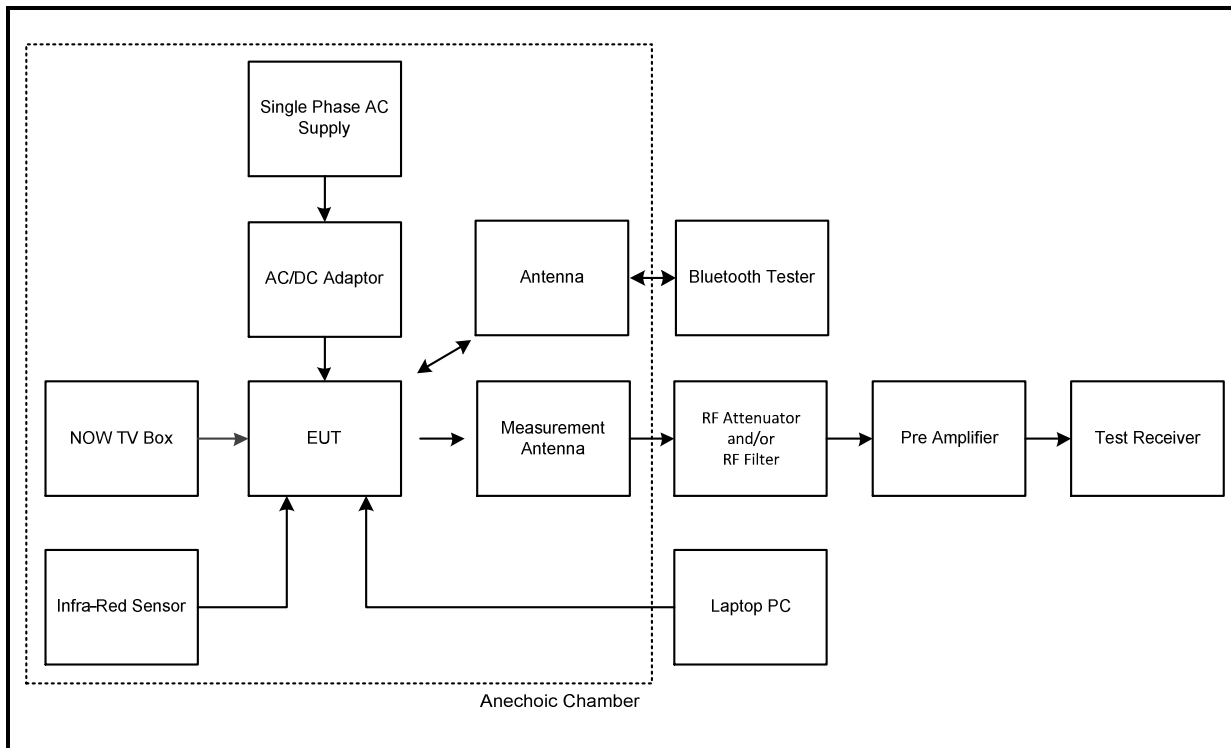
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	39

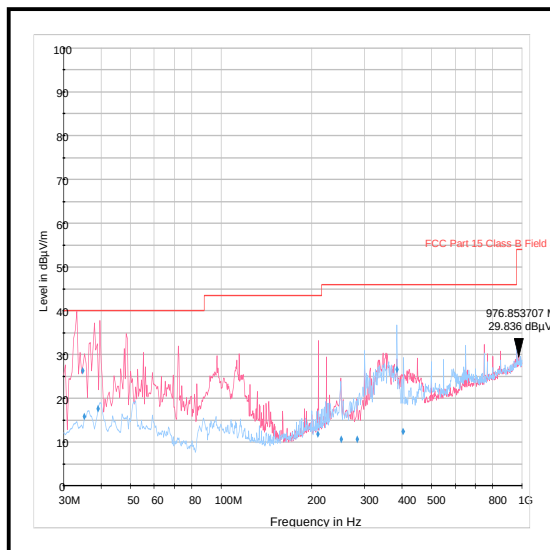
Note(s):

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 3DH5 mode as this was found to transmit the highest power and therefore deemed worst case.
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 plot 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 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. The sweep time was set to auto. 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: Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
976.854	Vertical	29.8	54.0	24.2	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
K0001	5 m RSE Chamber	Rainford EMC	N/A	N/A	07 Dec 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	11 Apr 2017	12
A2959	Antenna	Schwarzbeck	VULB 9163	9163-967	08 Sep 2017	12
G0543	Amplifier	Sonoma	310N	230801	09 Jun 2017	6
A1834	Attenuator	Hewlett Packard	8491B	10444	30 Mar 2017	12

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	David Doyle	Test Date:	04 January 2017
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)		

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:

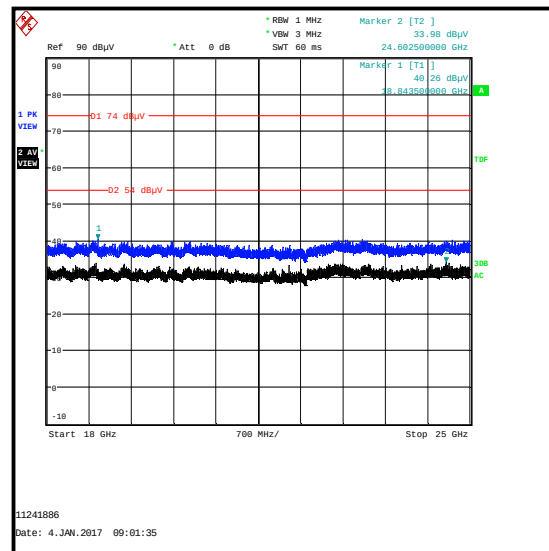
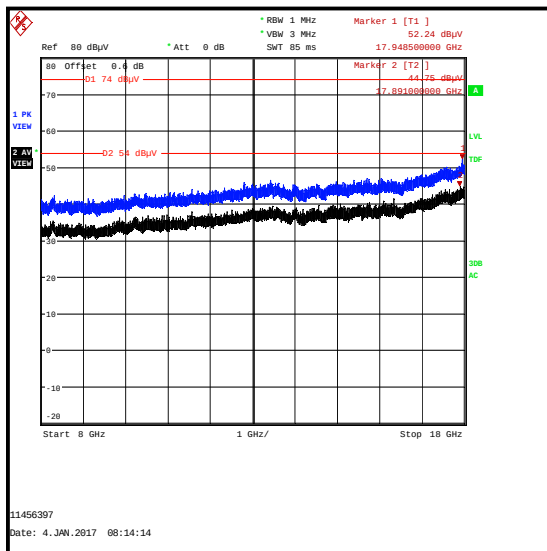
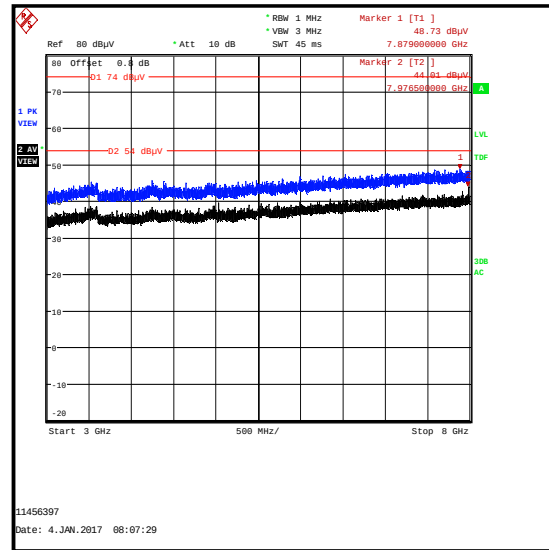
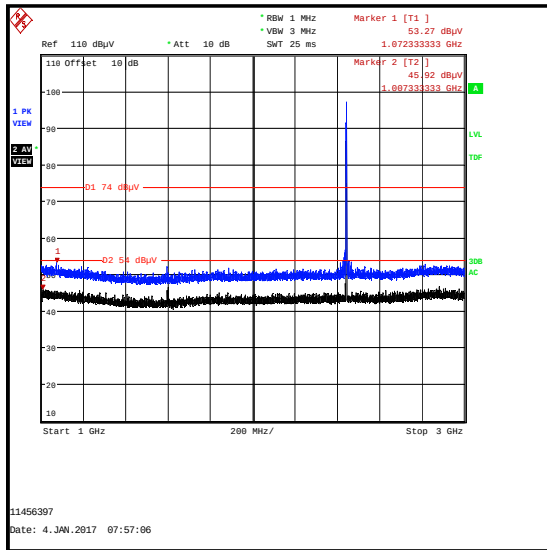
Temperature (°C):	21
Relative Humidity (%):	37

Note(s):

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 3DH5 mode as this was found to transmit the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak noise floor reading of the measuring receiver was recorded as shown in the table below. The peak level was compared to the average limit as opposed to being compared to the peak limit because this is the more onerous limit.
4. The emission shown on the 1 GHz to 3 GHz plot is the EUT fundamental at 2441 MHz.
5. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the 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 a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.

Results: 3DH5 / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
1072.333	Horizontal	53.3	54.0	0.7	Complied

Transmitter Radiated Emissions (continued)

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	22 Apr 2017	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	17 May 2017	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	21 Mar 2017	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	07 Apr 2017	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	06 May 2017	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	07 Apr 2017	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	07 Apr 2017	12
A2891	Pre-Amplifier	Schwarzbeck	BBV 9718	9718-306	07 Apr 2017	12
A2893	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-021	07 Apr 2017	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	19 May 2017	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	01 Jun 2017	12
A2916	Attenuator	AtlanTecRF	AN185W-10	832827#1	19 May 2017	12

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

Test Engineer:	David Doyle	Test Date:	04 January 2017
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)		

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

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	37

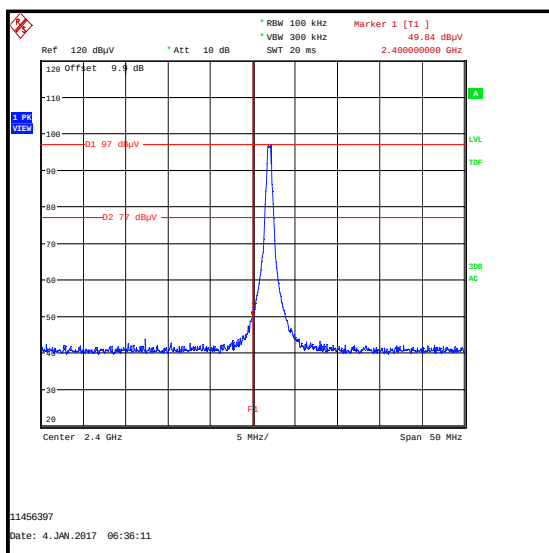
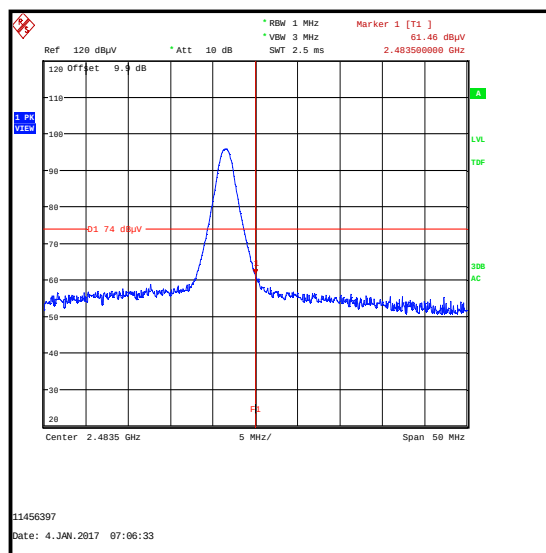
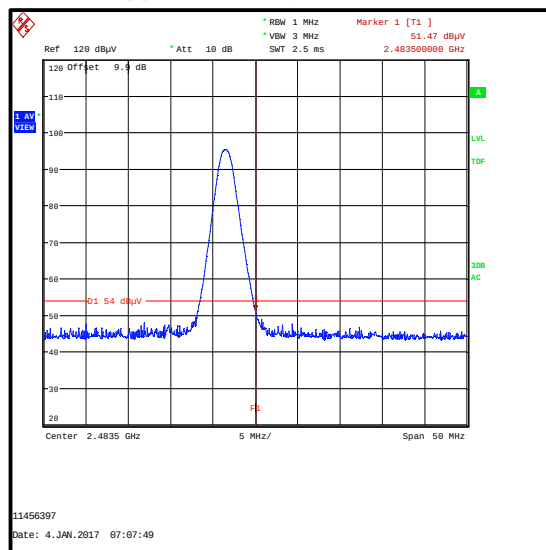
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The 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 falls 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. The restricted band plot for 2310 MHz to 2390 MHz can be found under the results for 3DH5 static as this mode had the highest output power and was therefore deemed worst case.
6. * -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	49.8	77.0*	27.2	Complied
2483.500	Horizontal	61.5	74.0	12.5	Complied

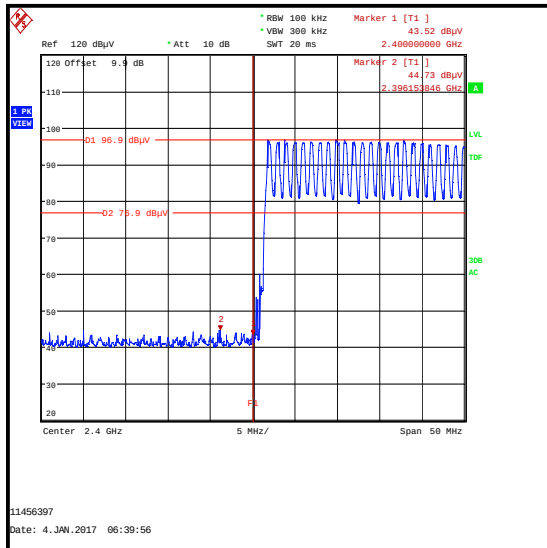
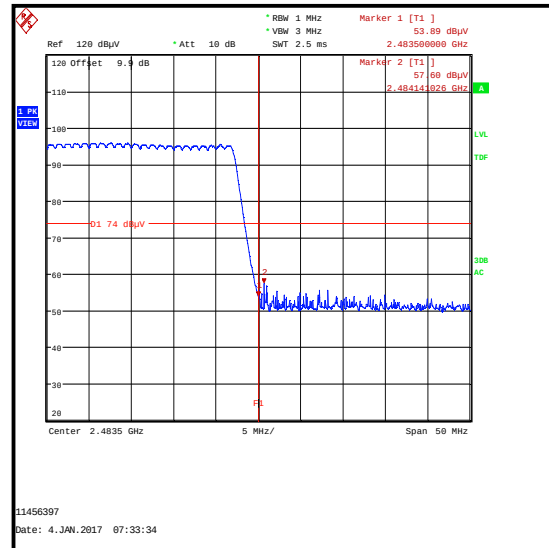
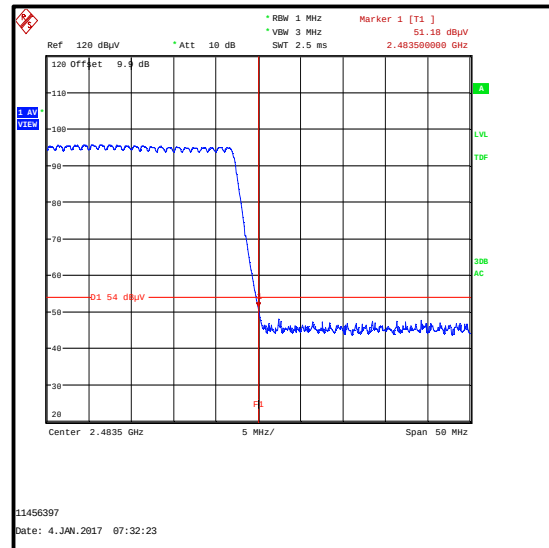
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	51.5	54.0	2.5	Complied

**Lower Band Edge Peak Static****Upper Band Edge Peak Static****Upper Band Edge Average Static**

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

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2396.154	Horizontal	44.7	76.9*	32.2	Complied
2400.000	Horizontal	43.5	76.9*	33.4	Complied
2483.500	Horizontal	53.9	74.0	20.1	Complied
2484.141	Horizontal	57.6	74.0	16.4	Complied

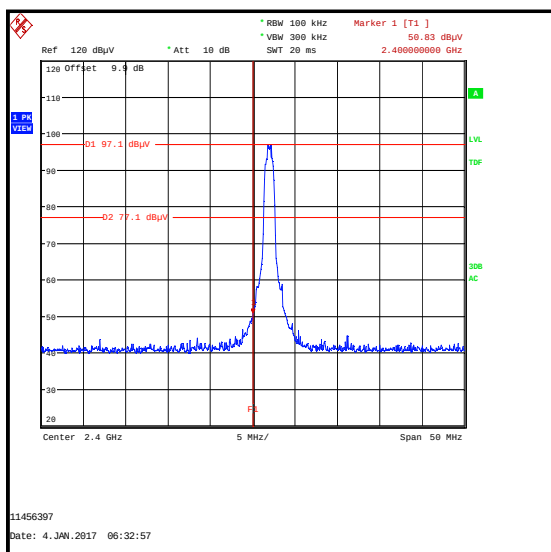
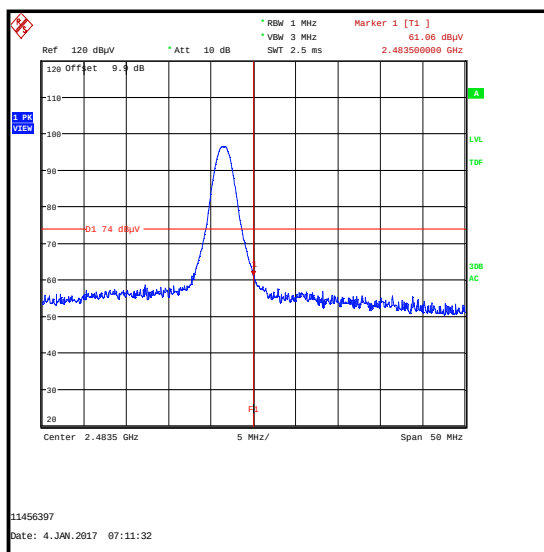
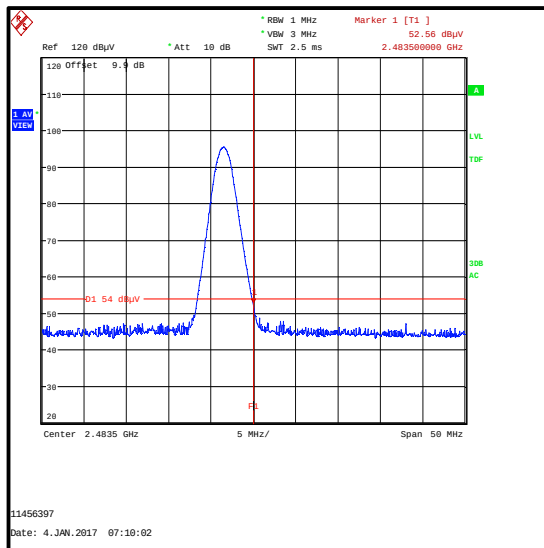
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	Horizontal	51.2	54.0	2.8	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / DH5****Lower Band Edge Peak Hopping****Upper Band Edge Peak Hopping****Upper Band Edge Average Hopping**

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	50.8	77.1*	26.3	Complied
2483.500	Horizontal	61.1	74.0	12.9	Complied

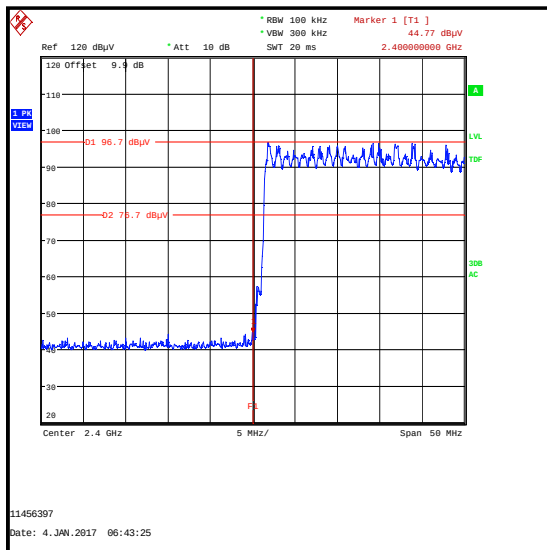
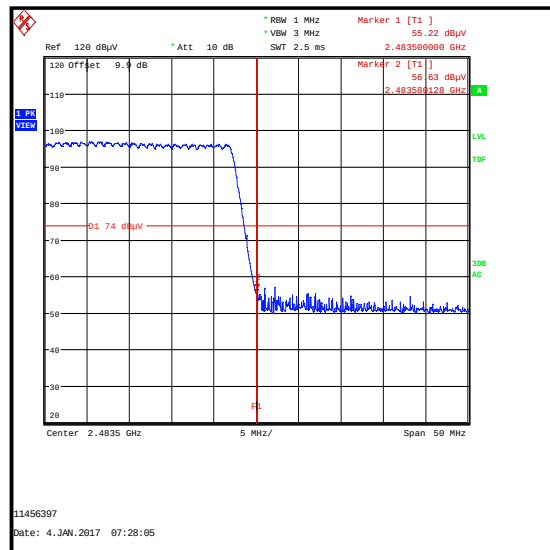
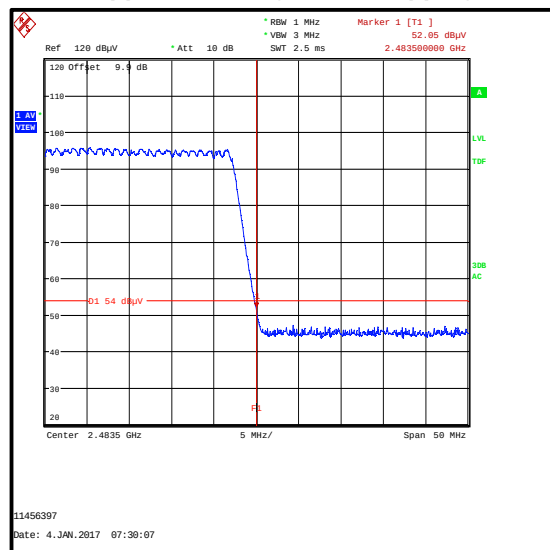
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	52.6	54.0	1.4	Complied

**Lower Band Edge Peak Static****Upper Band Edge Peak Static****Upper Band Edge Average Static**

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
2400.000	Horizontal	44.8	76.7*	31.9	Complied
2483.500	Horizontal	55.2	74.0	18.8	Complied
2483.580	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	52.1	54.0	1.9	Complied

**Lower Band Edge Peak Hopping****Upper Band Edge Peak Hopping****Upper Band Edge Average Hopping**

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
2400.000	Horizontal	50.0	77.1*	27.1	Complied
2483.500	Horizontal	61.8	74.0	12.2	Complied

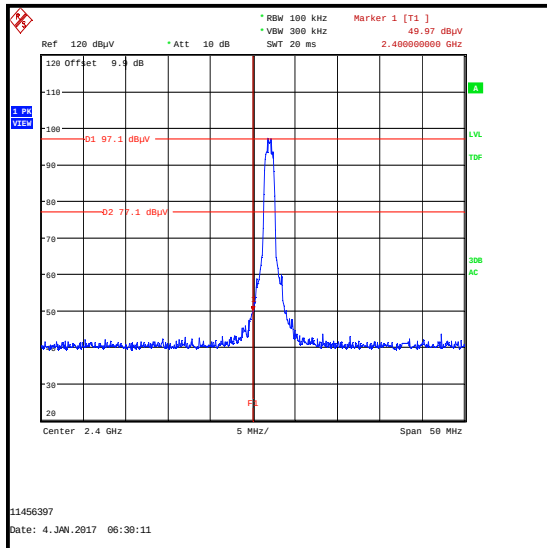
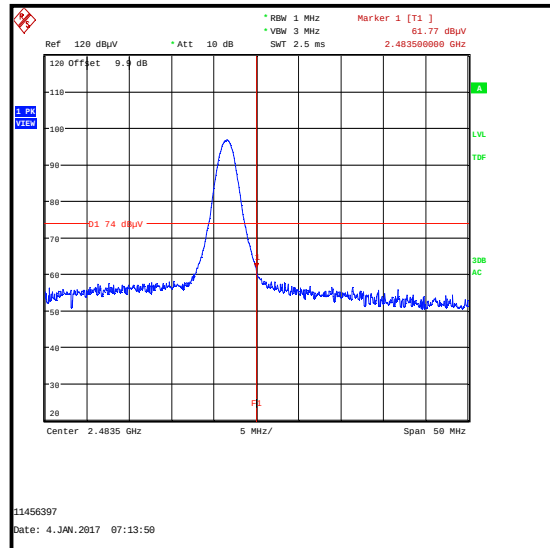
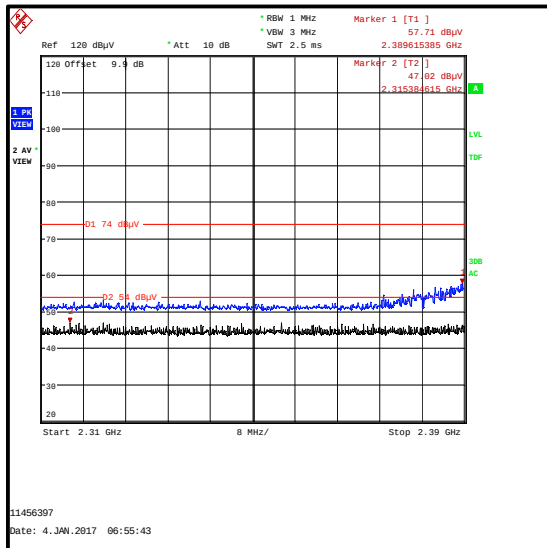
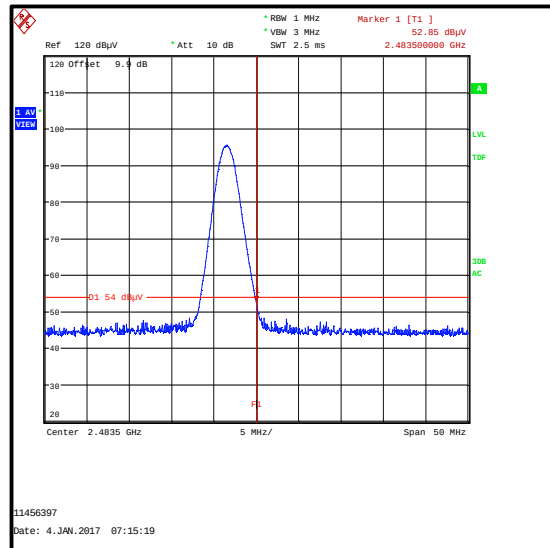
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.500	Horizontal	52.9	54.0	1.1	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2389.615	Horizontal	57.7	74.0	16.3	Complied

Results: 2310 MHz to 2390 MHz Restricted Band / Average

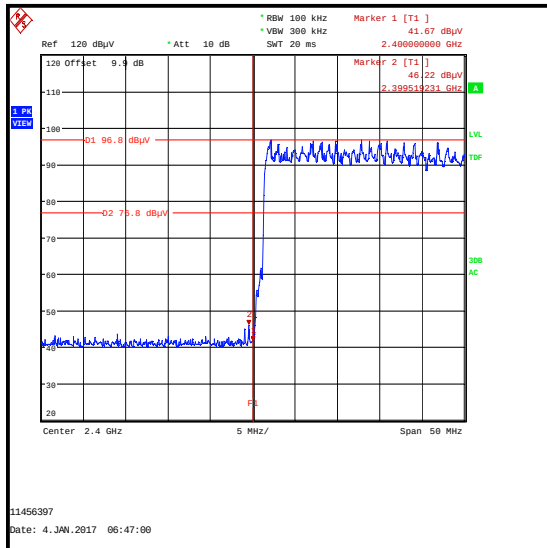
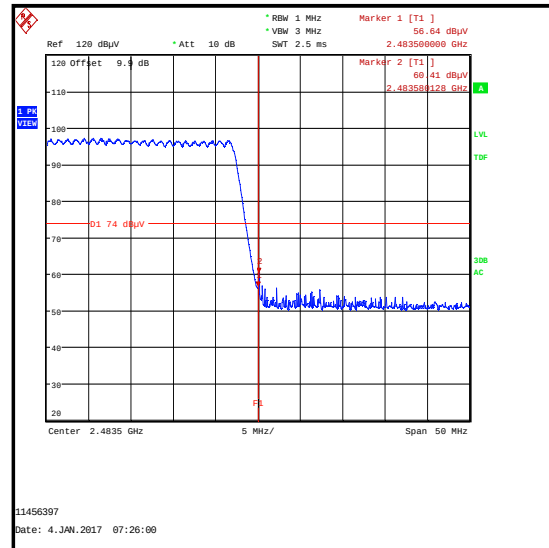
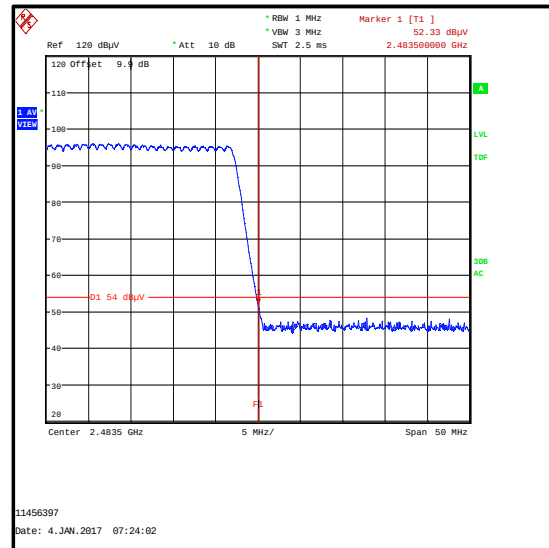
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2315.385	Horizontal	47.0	54.0	7.0	Complied

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

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

Frequency (MHz)	Antenna Polarity	Peak Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2399.519	Horizontal	46.2	76.8*	30.6	Complied
2400.000	Horizontal	41.7	76.8*	35.1	Complied
2483.500	Horizontal	56.6	74.0	17.4	Complied
2483.580	Horizontal	60.4	74.0	13.6	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2483.500	Horizontal	52.3	54.0	1.7	Complied

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

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	22 Apr 2017	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	17 May 2017	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	21 Mar 2017	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	07 Apr 2017	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	07 Apr 2017	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	19 May 2017	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
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%	±5.65 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 ---