



TEST REPORT

Test Report No. : UL-RPT-RP11444781JD02A

Manufacturer : PASCE Ltd
Model No. : MRM
FCC ID : 2AD65MRM
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 1.0.

Date of Issue: 14 August 2017

Checked by:

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Senior Test Engineer, Radio Laboratory

Company Signatory:

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Senior Test Engineer, Radio Laboratory
UL VS LTD



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1. Customer Information

Company Name:	PASCE Ltd
Address:	Unit 4 City Business Park Easton Road Bristol BS5 0SP United Kingdom

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:	20 February 2017 to 02 August 2017

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:	Minirig
Model Name or Number:	MRM
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)
Hardware Version:	V2F
Software Version:	6.0.52USB
FCC ID:	2AD65MRM

Brand Name:	Minirig
Model Name or Number:	MRM
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)
Hardware Version:	V2F
Software Version:	6.0.52USB
FCC ID:	2AD65MRM

3.2. Description of EUT

The Equipment Under Test was a portable *Bluetooth* speaker.

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:	<i>Bluetooth</i>				
Power Supply Requirement:	Nominal	5 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 (Mbps):	1	2	3		
Maximum Conducted Output Power:	5.4 dBm				
Antenna Gain:	0.6 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-SPI Converter. Length 2.48 metres
Brand Name:	CSR
Model Name or Number:	1224
Serial Number:	Not marked or stated

Description:	Level Shifter
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Charger/USB Cable
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Switching Power Supply
Brand Name:	Cromecast
Model Name or Number:	5005BBB0500100
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 EUT was powered from a fully charged 5 volt battery.
- Transmit tests: A laptop PC with CSR Bluetest application was used to place the EUT into *Bluetooth* test mode. Operating channels were selected in the test application. For radiated tests, the laptop was disconnected from the EUT once in test mode and prior to testing.
- Radiated spurious emissions were performed with the EUT in the worst case orientation/position. Tests were performed with the EUT connected to its AC adaptor and USB cable. All other ports were terminated with suitable terminations.
- AC conducted emissions tests were performed with the EUT transmitting DH5 packet type, as this mode was found to transmit the highest power. All active ports were terminated.
- Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this mode was found to transmit the highest power.
- The EUT radiated sample was used for AC conducted emissions and 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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	David Doyle	Test Date:	06 March 2017
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)		

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

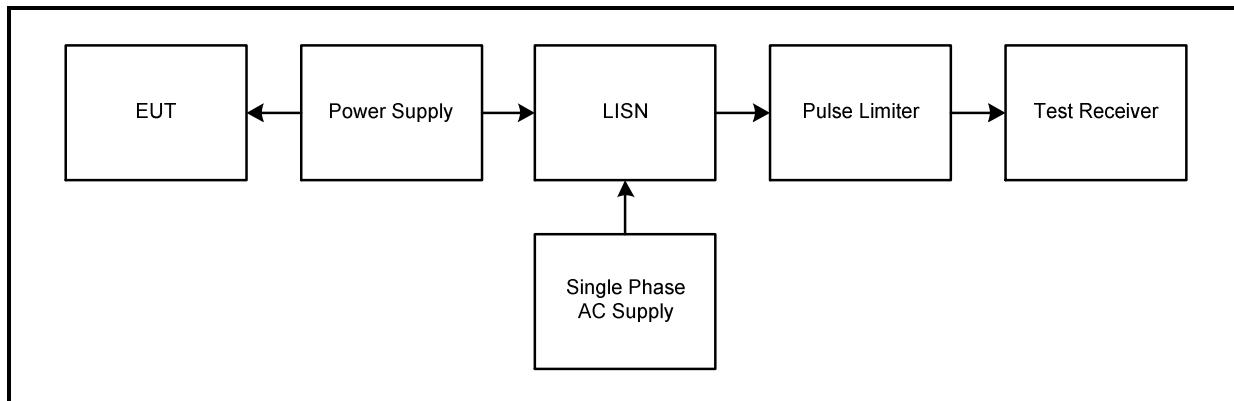
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	42

Note(s):

1. The EUT was connected to an AC charger via a USB cable. The AC charger was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the AC 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 (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.429	Live	46.4	57.3	10.9	Complied
0.438	Live	44.7	57.1	12.4	Complied
0.848	Live	42.0	56.0	14.0	Complied
1.230	Live	43.5	56.0	12.5	Complied
1.289	Live	43.9	56.0	12.1	Complied
2.427	Live	38.8	56.0	17.2	Complied

Results: Live / Average / 120 VAC 60 Hz

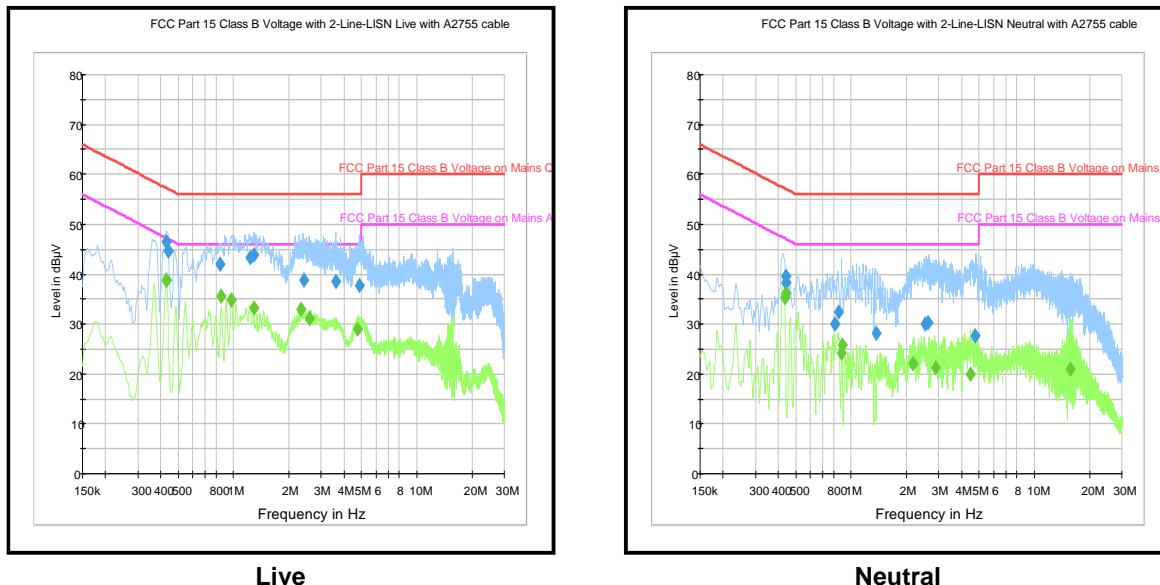
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.429	Live	38.7	47.3	8.6	Complied
0.857	Live	35.5	46.0	10.5	Complied
0.974	Live	34.9	46.0	11.1	Complied
1.289	Live	33.3	46.0	12.7	Complied
2.328	Live	32.9	46.0	13.1	Complied
2.589	Live	31.1	46.0	14.9	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.438	Neutral	38.2	57.1	18.9	Complied
0.443	Neutral	39.6	57.0	17.4	Complied
0.816	Neutral	30.0	56.0	26.0	Complied
0.857	Neutral	32.4	56.0	23.6	Complied
2.522	Neutral	30.0	56.0	26.0	Complied
2.634	Neutral	30.2	56.0	25.8	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.434	Neutral	35.4	47.2	11.8	Complied
0.438	Neutral	36.2	47.1	10.9	Complied
0.879	Neutral	24.1	46.0	21.9	Complied
0.893	Neutral	25.7	46.0	20.3	Complied
2.180	Neutral	22.0	46.0	24.0	Complied
2.882	Neutral	21.3	46.0	24.7	Complied

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

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

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.366	Live	47.8	58.6	10.8	Complied
0.479	Live	46.6	56.4	9.8	Complied
0.825	Live	47.5	56.0	8.5	Complied
0.897	Live	47.8	56.0	8.2	Complied
1.334	Live	46.1	56.0	9.9	Complied
2.711	Live	45.7	56.0	10.3	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.362	Live	40.5	48.7	8.2	Complied
0.479	Live	39.6	46.4	6.8	Complied
0.843	Live	38.8	46.0	7.2	Complied
0.897	Live	38.5	46.0	7.5	Complied
1.379	Live	38.0	46.0	8.0	Complied
2.391	Live	36.0	46.0	10.0	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

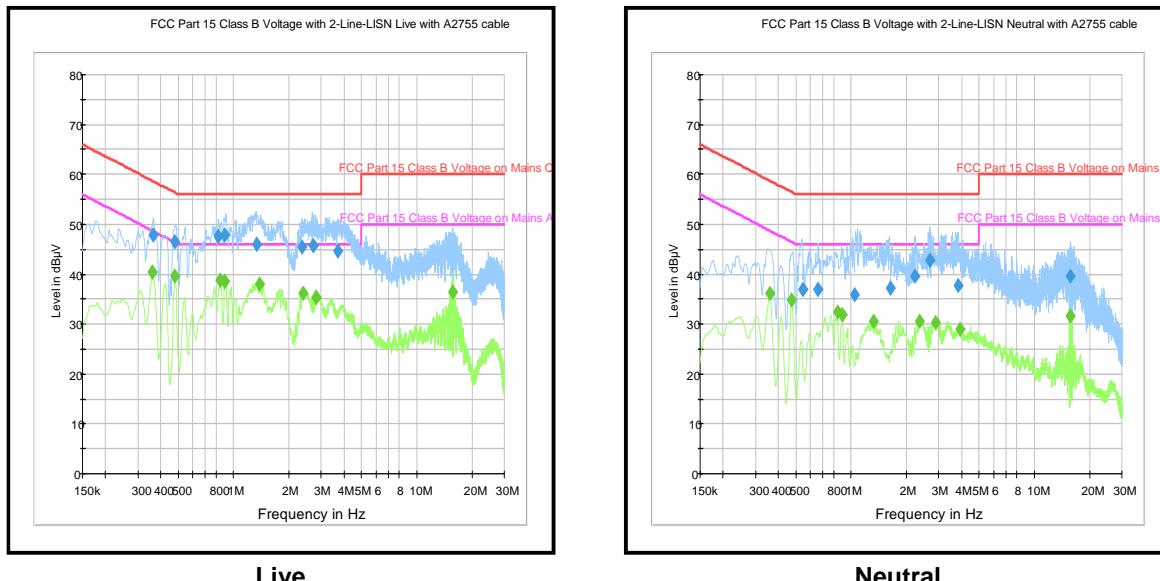
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.542	Neutral	36.9	56.0	19.1	Complied
0.659	Neutral	37.0	56.0	19.0	Complied
1.626	Neutral	37.1	56.0	18.9	Complied
2.216	Neutral	39.7	56.0	16.3	Complied
2.693	Neutral	42.9	56.0	13.1	Complied
3.845	Neutral	37.9	56.0	18.1	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.362	Neutral	36.0	48.7	12.7	Complied
0.474	Neutral	34.7	46.4	11.7	Complied
0.839	Neutral	32.3	46.0	13.7	Complied
0.897	Neutral	31.9	46.0	14.1	Complied
1.320	Neutral	30.6	46.0	15.4	Complied
2.346	Neutral	30.6	46.0	15.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 240 VAC 60 Hz



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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2013	Thermohygrometer	Testo	608-H1	45046419	10 Jun 2017	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	20 Jul 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1263	Test Receiver	Rohde & Schwarz	ESIB-7	100265	07 Nov 2017	12
M1818	Multimeter	Fluke	79 Series II	71811580	27 Apr 2017	12

5.2.2. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	David Doyle	Test Date:	20 February 2017
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

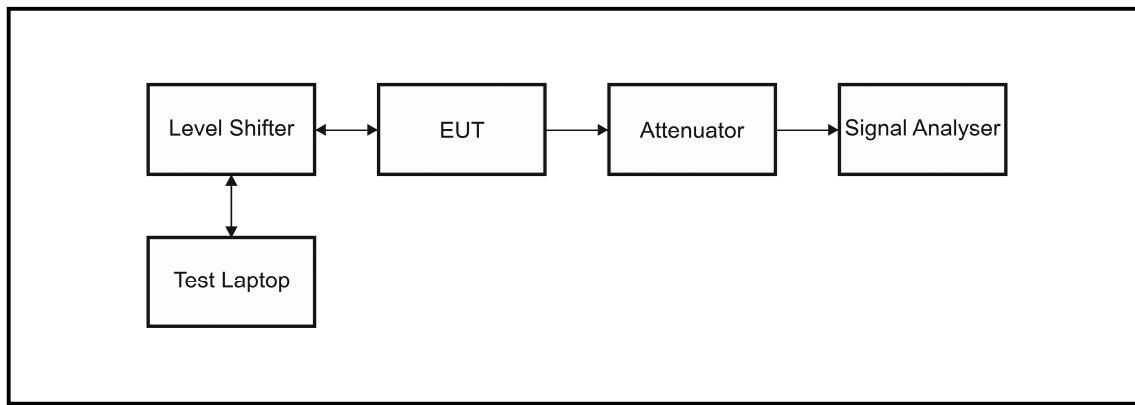
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	36

Note(s):

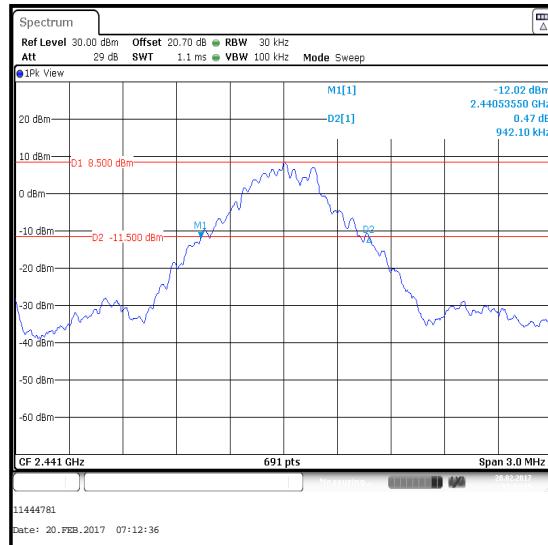
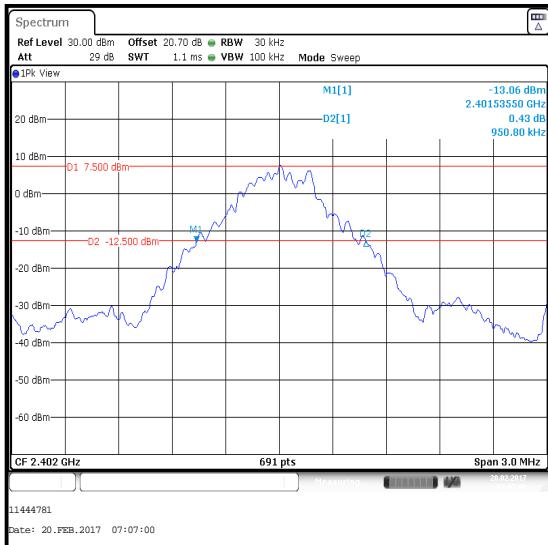
1. The signal analyser resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier. These results are documented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

Test setup:



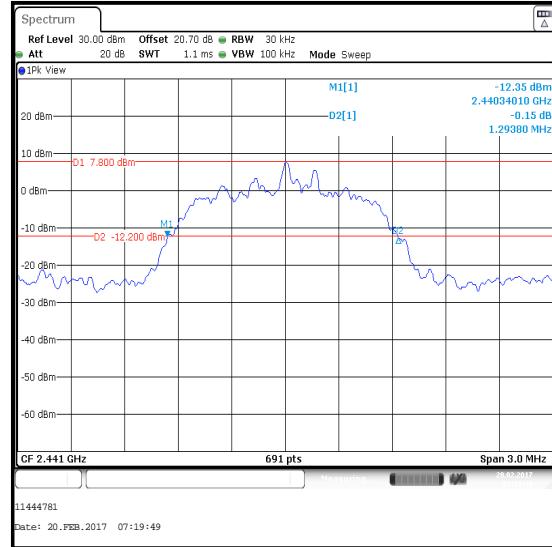
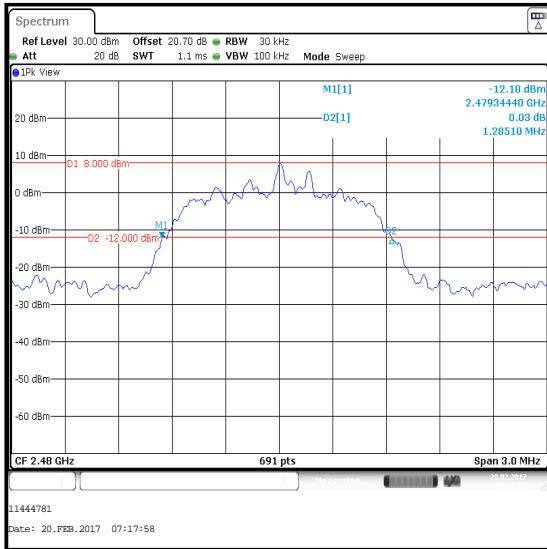
Transmitter 20 dB Bandwidth (continued)**Results DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	950.800
Middle	942.100
Top	946.500

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

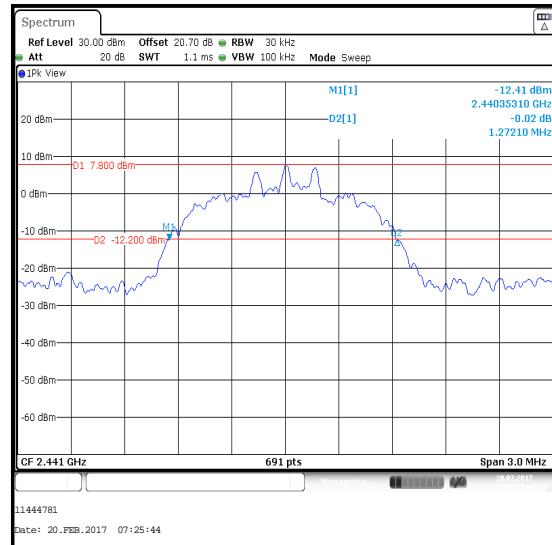
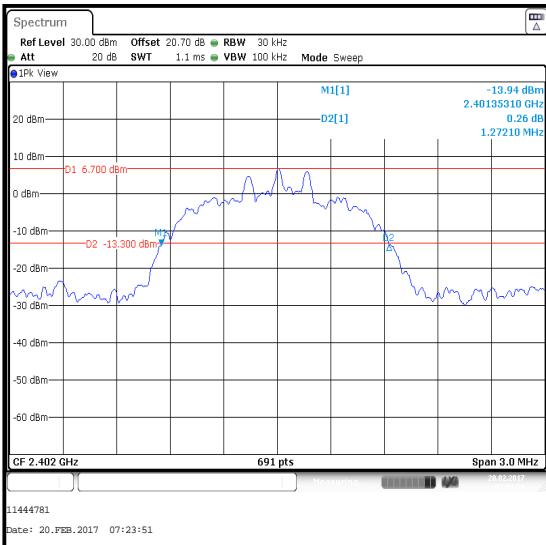
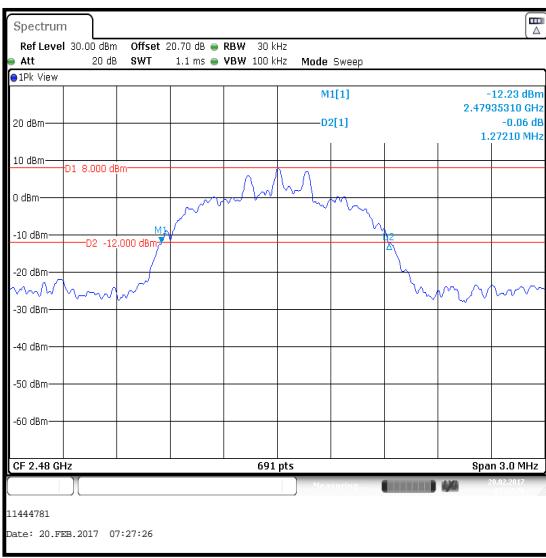
Transmitter 20 dB Bandwidth (continued)**Results 2DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1280.800
Middle	1293.800
Top	1285.100

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

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

Channel	20 dB Bandwidth (kHz)
Bottom	1272.100
Middle	1272.100
Top	1272.100

**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 Handelpunkt	30.5015.13	Not stated	02 Apr 2017	12
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	22 Nov 2017	12
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	09 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 Carrier Frequency Separation

Test Summary:

Test Engineer:	David Doyle	Test Date:	20 February 2017
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

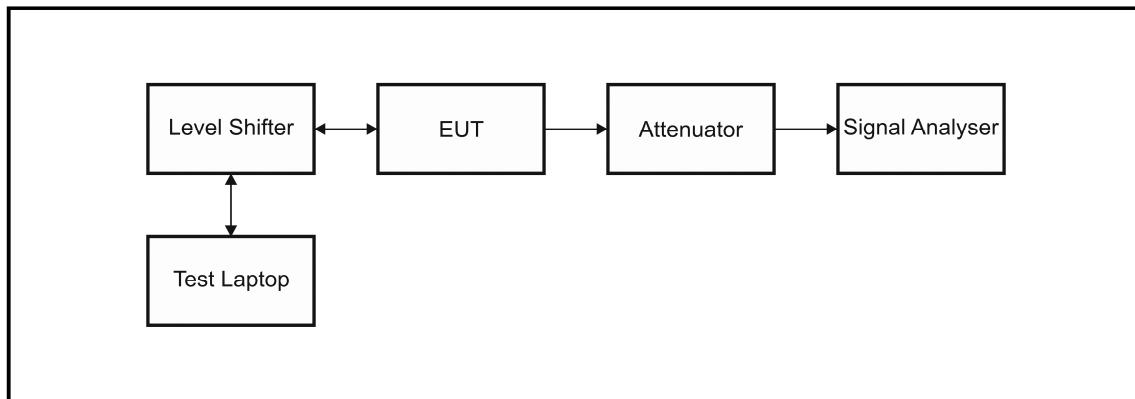
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	36

Note(s):

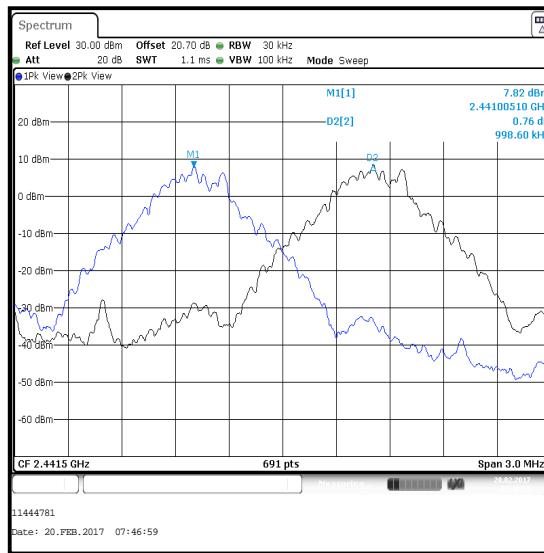
1. The 20 dB bandwidth measured for the middle channel operating at 2440 MHz was used to calculate the limit.
2. The signal analyser centre frequency was set at the mid frequency of channels 39 and 40. In order to identify the centre of adjacent channels, the signal analyser resolution bandwidth was set to 30 kHz and video bandwidth set to 100 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was wide enough to capture the peaks of two adjacent channels. A marker was placed at the peak on the first channel and a delta marker was placed at the peak of the adjacent channel. The delta between the two markers was recorded for each mode of operation.
3. The signal 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 $\frac{2}{3}$ of 20 dB BW (kHz)	Margin (kHz)	Result
998.600	628.067	370.533	Complied



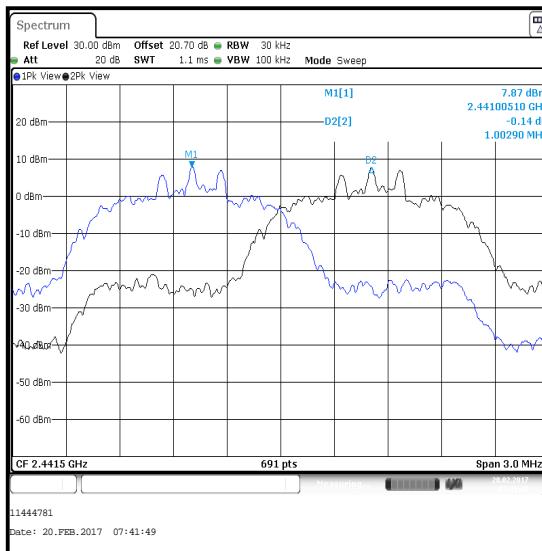
Transmitter Carrier Frequency Separation (continued)**Results: 2DH5**

Carrier Frequency Separation (kHz)	Limit $\frac{2}{3}$ of 20 dB BW (kHz)	Margin (kHz)	Result
1002.900	862.533	140.367	Complied



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

Carrier Frequency Separation (kHz)	Limit $\frac{2}{3}$ of 20 dB BW (kHz)	Margin (kHz)	Result
1002.900	848.067	154.833	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	02 Apr 2017	12
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	22 Nov 2017	12
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	09 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 Number of Hopping Frequencies and Average Time of Occupancy**Test Summary:**

Test Engineer:	David Doyle	Test Date:	20 February 2017
Test Sample Serial Number:	Not marked or stated (<i>Conducted sample with RF port</i>)		

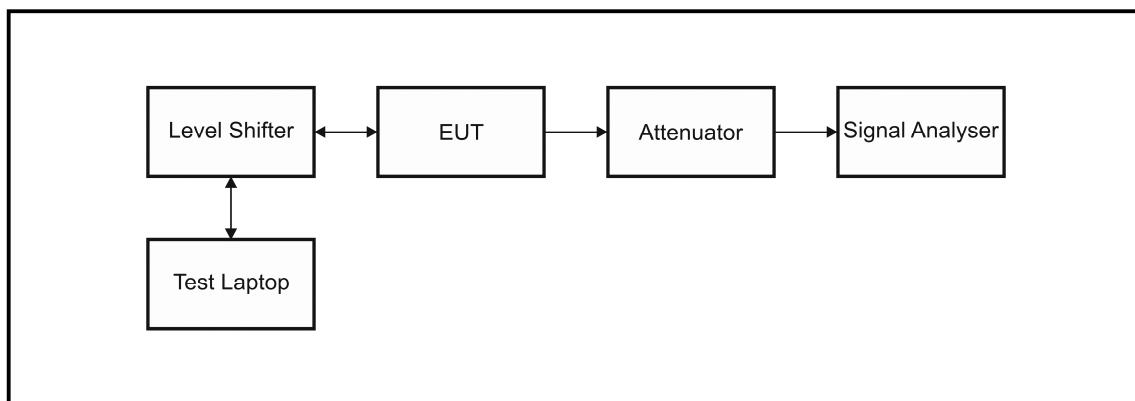
FCC Reference:	Part 15.247(a)(1)(iii)
Test Method Used:	ANSI C63.10 Sections 7.8.3 & 7.8.4

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	36

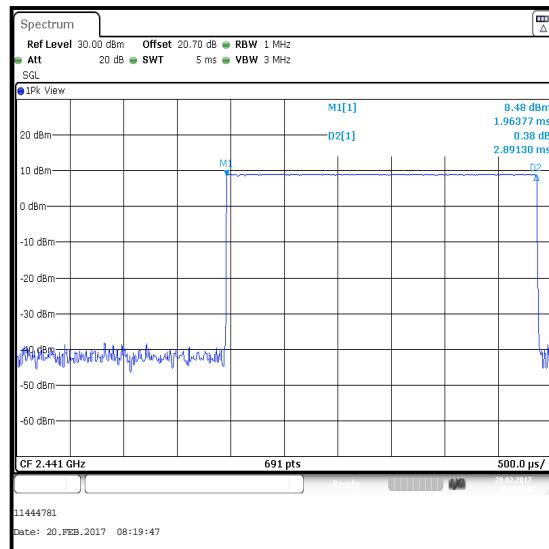
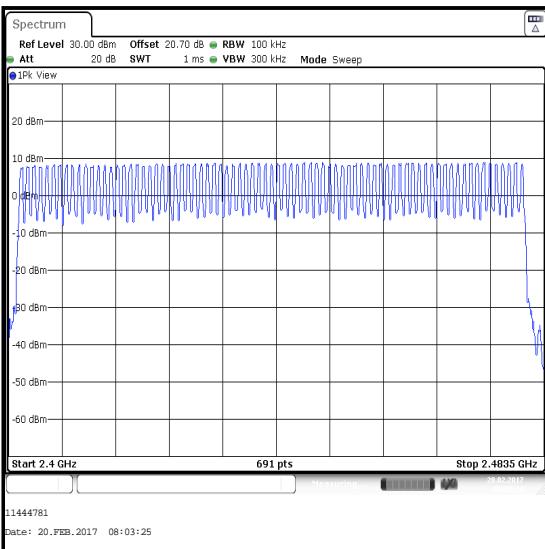
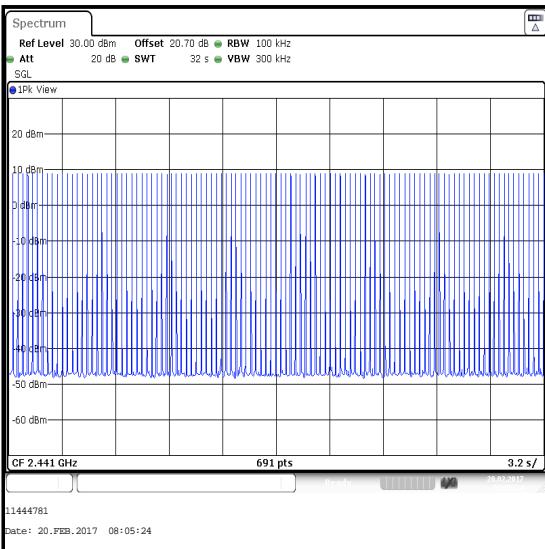
Note(s):

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 signal analyser 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 signal analyser 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 signal analyser 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 signal 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 (μs)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2891.300	106	0.306	0.4	0.094	Compiled

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

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 Handelpunkt	30.5015.13	Not stated	02 Apr 2017	12
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	22 Nov 2017	12
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-
M260	Signal Generator	Rohde & Schwarz	SMP02	829076/008	09 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 Maximum Peak Output Power

Test Summary:

Test Engineer:	Stefan Ho	Test Date:	02 August 2017
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

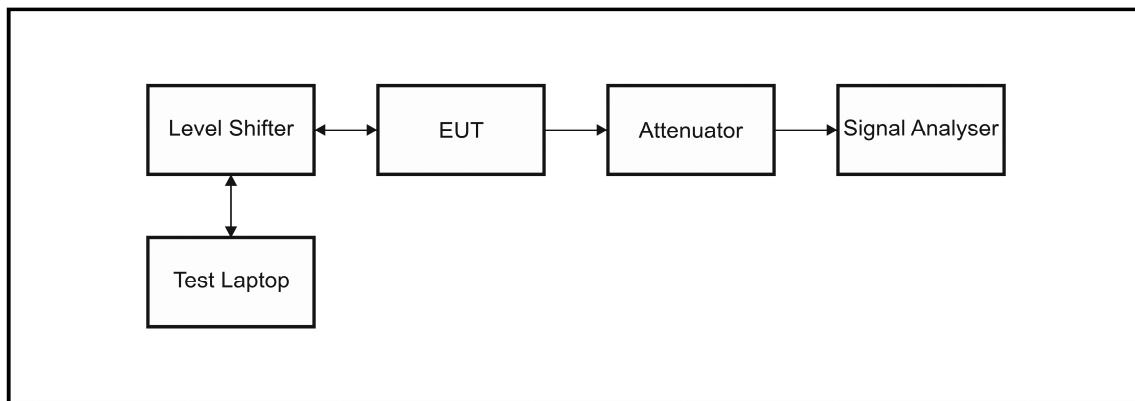
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	38

Note(s):

1. The signal analyser resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth of 5 MHz. 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 signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

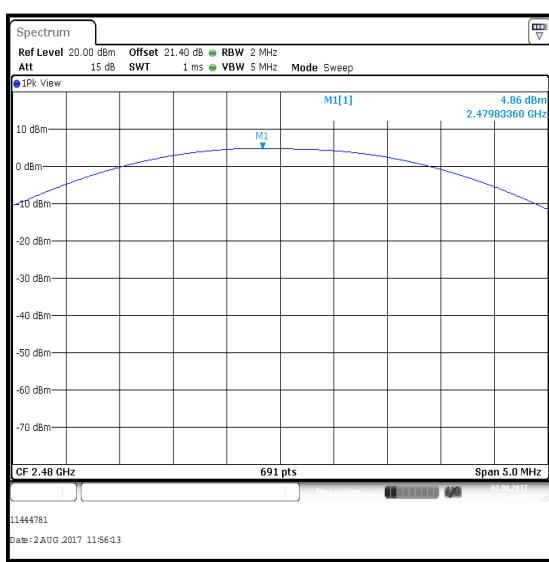
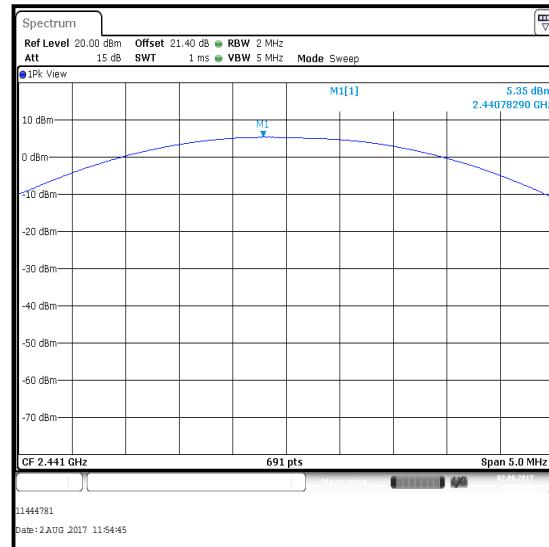
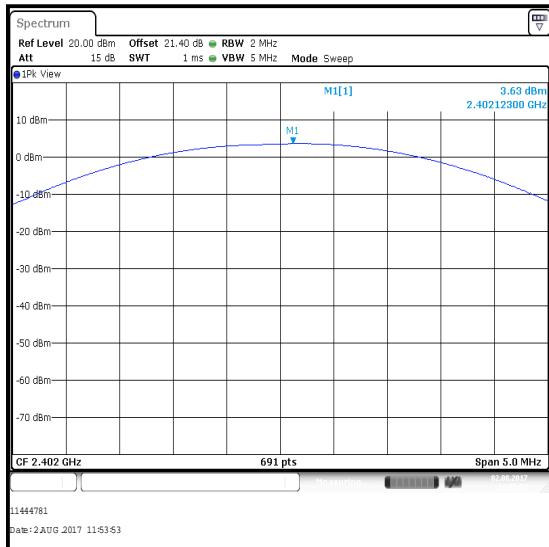
Test setup:



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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	3.6	30.0	26.4	Complied
Middle	5.4	30.0	24.6	Complied
Top	4.9	30.0	25.1	Complied

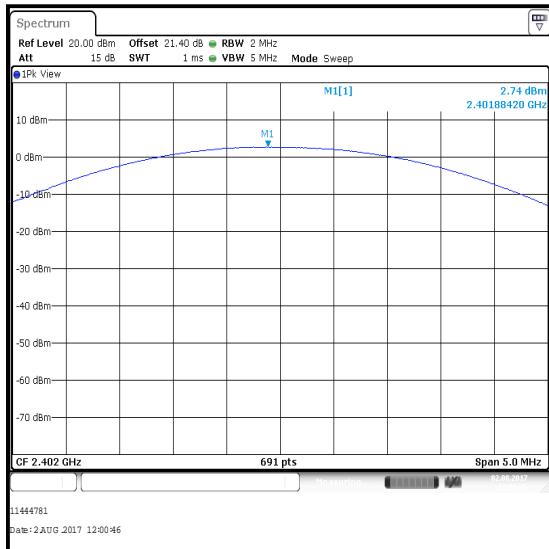
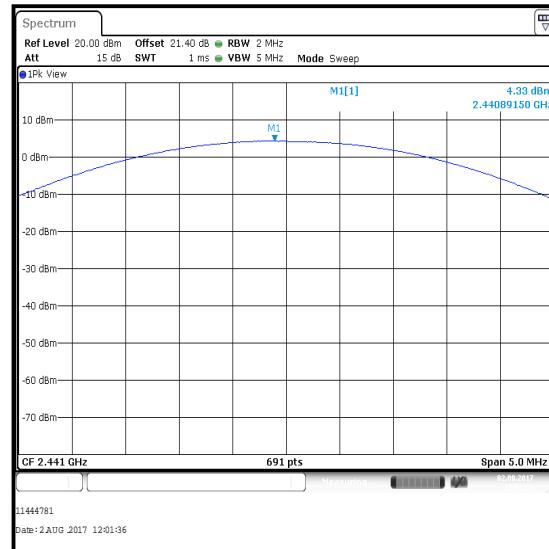
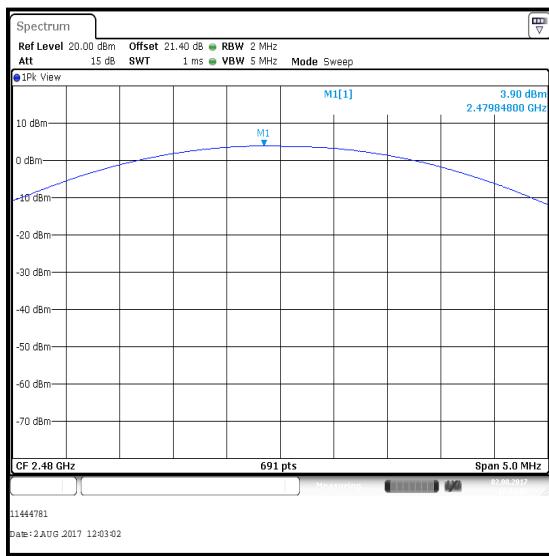
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	3.6	0.6	4.2	36.0	31.8	Complied
Middle	5.4	0.6	6.0	36.0	30.0	Complied
Top	4.9	0.6	5.5	36.0	30.5	Complied

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

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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	2.7	21.0	18.3	Complied
Middle	4.3	21.0	16.7	Complied
Top	3.9	21.0	17.1	Complied

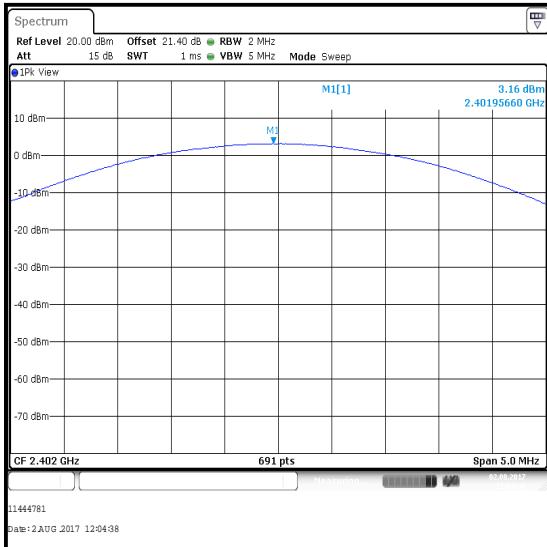
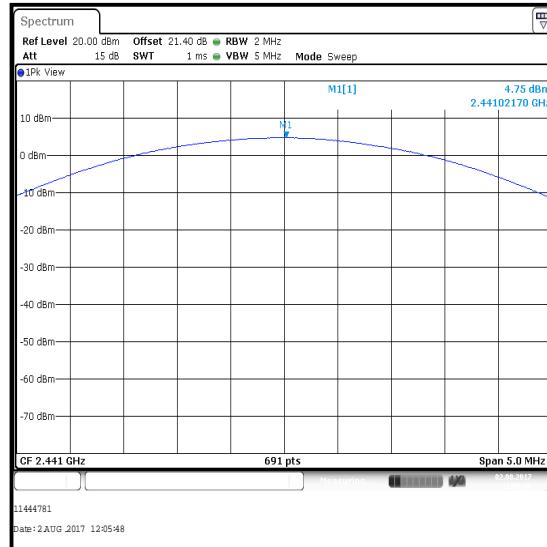
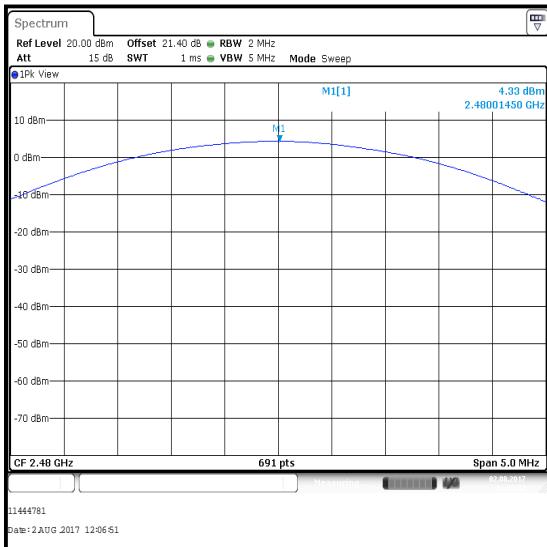
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	2.7	0.6	3.3	27.0	23.7	Complied
Middle	4.3	0.6	4.9	27.0	22.1	Complied
Top	3.9	0.6	4.5	27.0	22.5	Complied

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	3.2	21.0	17.8	Complied
Middle	4.8	21.0	16.2	Complied
Top	4.3	21.0	16.7	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	3.2	0.6	3.8	27.0	23.2	Complied
Middle	4.8	0.6	5.4	27.0	21.6	Complied
Top	4.3	0.6	4.9	27.0	22.1	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)
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	06 Jun 2018	12
A2505	Directional Coupler	AtlanTecRF	CDC-003060-20	1101230	Calibrated before use	-
G0614	Signal Generator	Rohde & Schwarz	SMB100A	177687	08 May 2020	36
M2002	Thermohygrometer	Testo	608-H1	45041825	22 Feb 2018	12

5.2.6. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	Test Date:	28 February 2017
Test Sample Serial Number:	Not marked or stated (<i>Radiated sample</i>)		

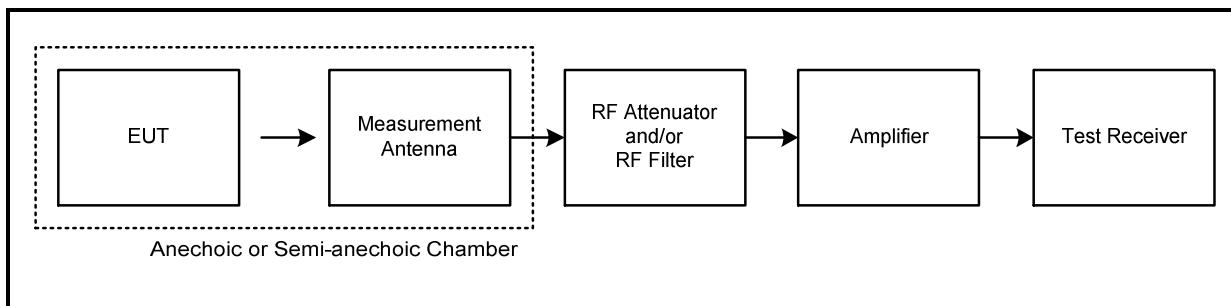
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	35

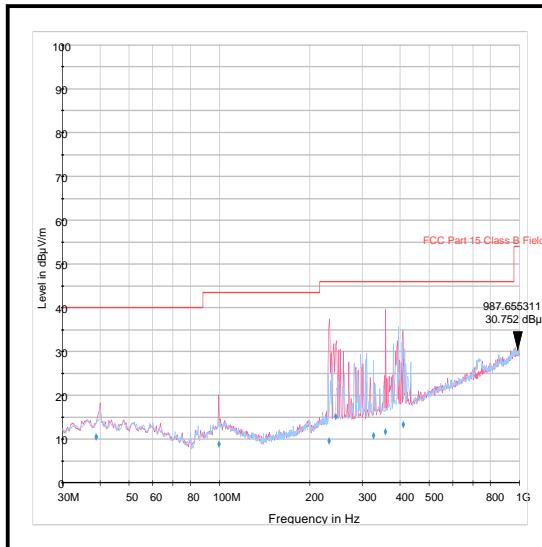
Note(s):

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this was found to transmit the highest power and therefore deemed worst case.
2. The final measured value in the table below incorporates the calibrated antenna factor and cable loss.
3. 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.
4. 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.
5. 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.
6. 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:**

Transmitter Radiated Emissions (continued)**Results: Middle Channel**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
987.655	Vertical	30.8	54.0	23.2	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 Dates:	22 February 2017 & 23 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 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	23 to 26
Relative Humidity (%):	42 to 44

Note(s):

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 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. The emission shown on the 1 GHz to 4 GHz plot is the EUT fundamental at 2441 MHz.
4. 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.
5. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
6. Measurements above 1 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.
7. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto. Peak and average measurements were performed with their own appropriate detectors during the pre-scan measurements.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4803.571	Vertical	46.8	54.0	7.2	Complied
12009.768	Horizontal	44.8	54.0	9.2	Complied

Results: Peak / Middle Channel / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4882.271	Vertical	45.6	54.0	8.4	Complied
7322.519	Horizontal	48.4	54.0	5.6	Complied
12204.151	Vertical	45.7	54.0	8.3	Complied

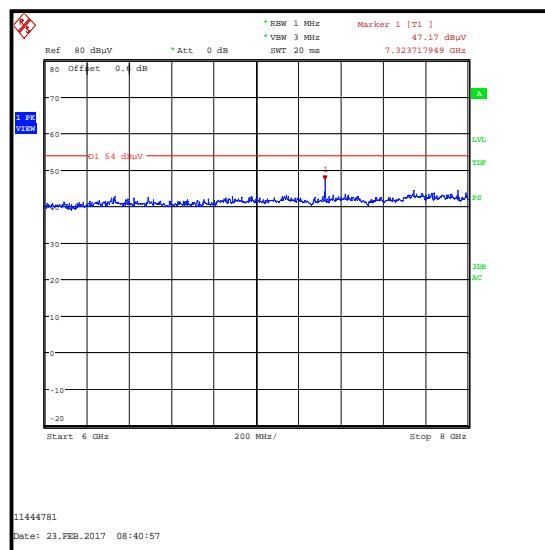
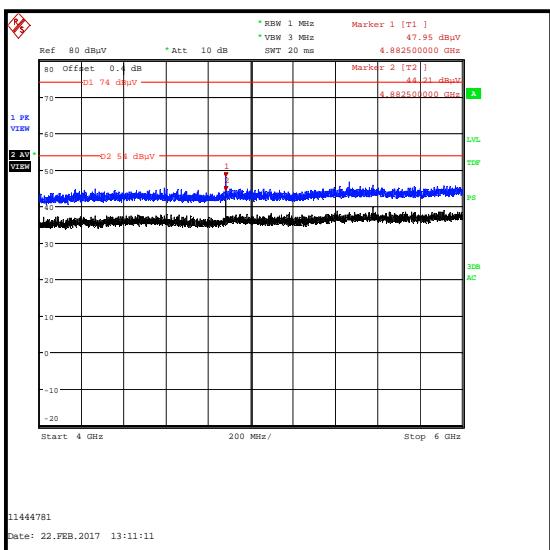
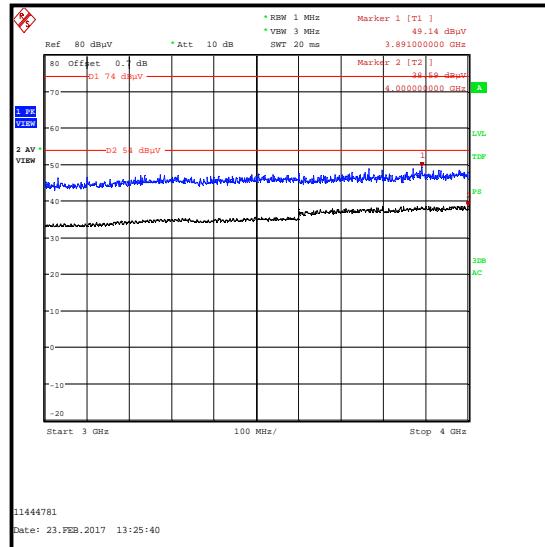
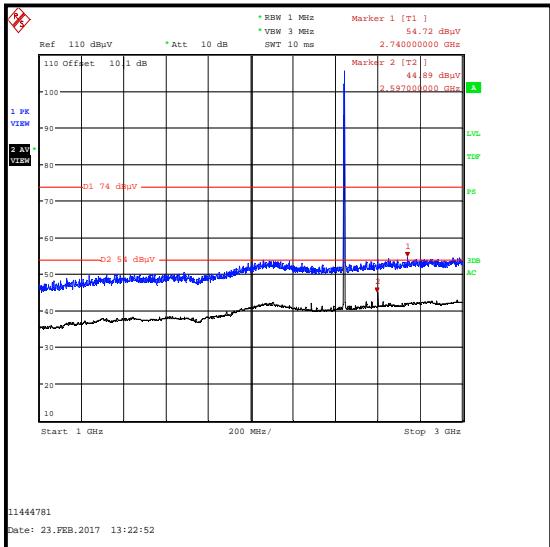
Results: Peak / Top Channel / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4960.286	Vertical	45.6	54.0	8.4	Complied
7440.280	Horizontal	47.7	54.0	6.3	Complied
12400.601	Vertical	45.5	54.0	8.5	Complied

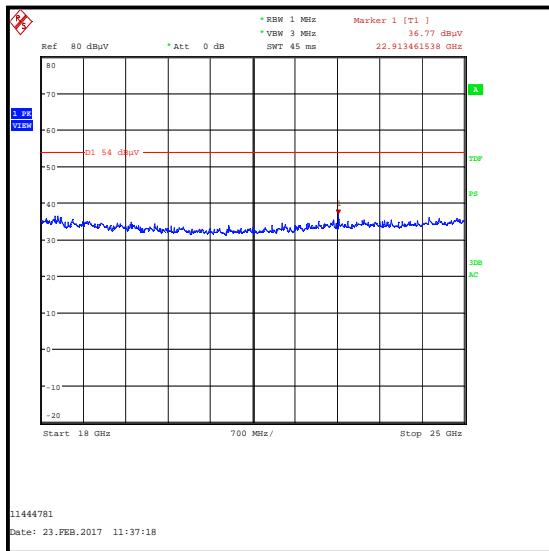
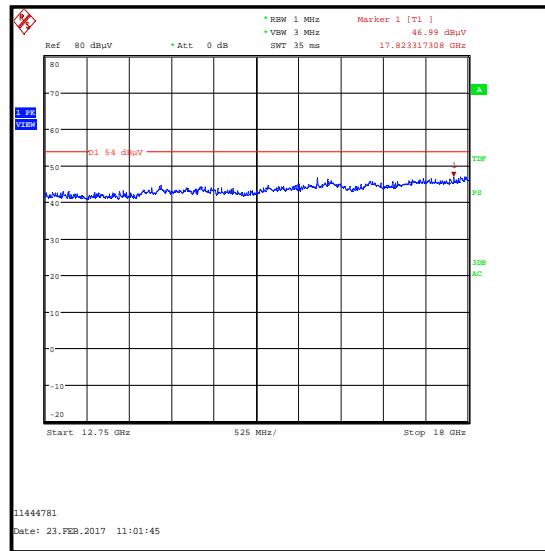
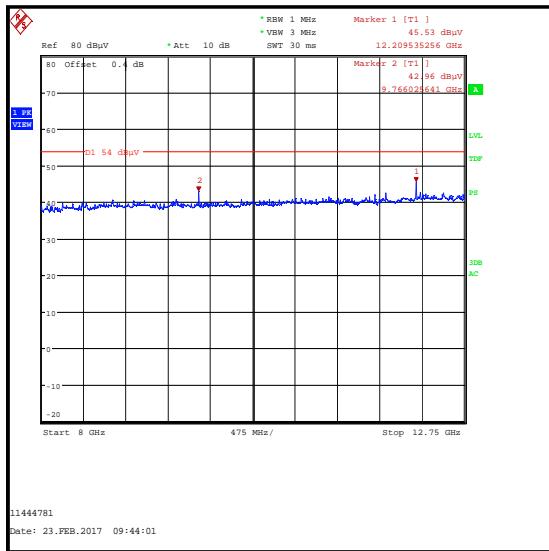
Results: Peak / Hopping Mode / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
4819.551	Vertical	50.2	54.0	3.8	Complied
7334.776	Horizontal	46.8	54.0	7.2	Complied
12035.673	Vertical	45.5	54.0	8.5	Complied

Transmitter Radiated Emissions (continued)



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)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Nov 2017	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	09 Nov 2017	12
A1818	Antenna	EMCO	3115	00075692	08 Nov 2017	12
A253	Antenna	Flann Microwave	12240-20	128	08 Nov 2017	12
A254	Antenna	Flann Microwave	14240-20	139	08 Nov 2017	12
A255	Antenna	Flann Microwave	16240-20	519	08 Nov 2017	12
A256	Antenna	Flann Microwave	18240-20	400	08 Nov 2017	12
A2896	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-023	09 Nov 2017	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	07 Apr 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	26 Apr 2017	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	26 Apr 2017	12

5.2.7. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	David Doyle	Test Dates:	21 February 2017 & 20 March 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 6.10.4 & 6.10.5

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	37 to 43

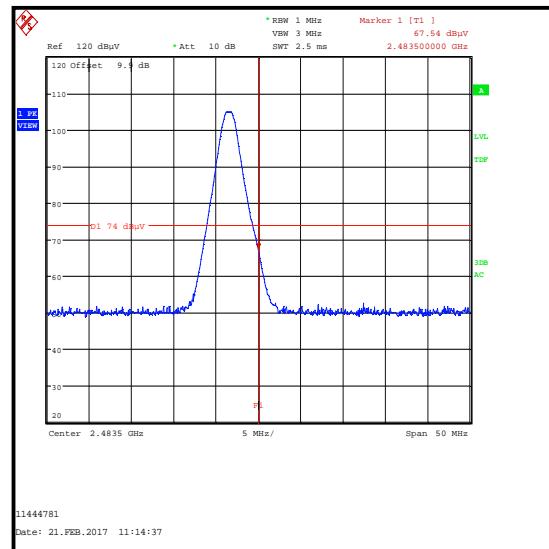
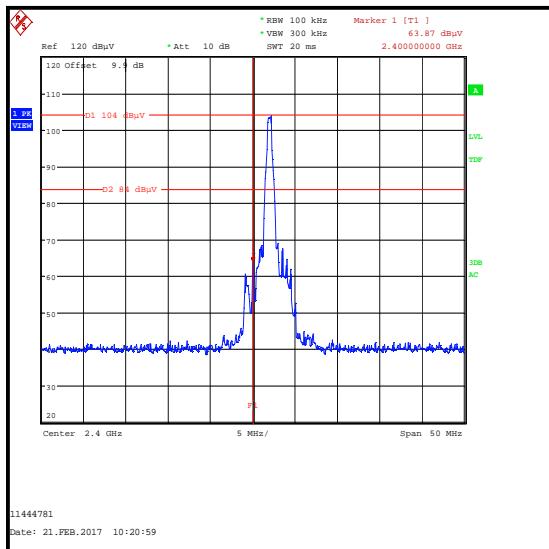
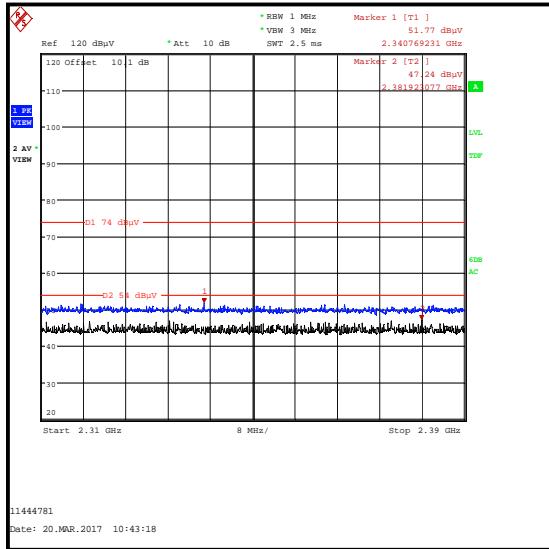
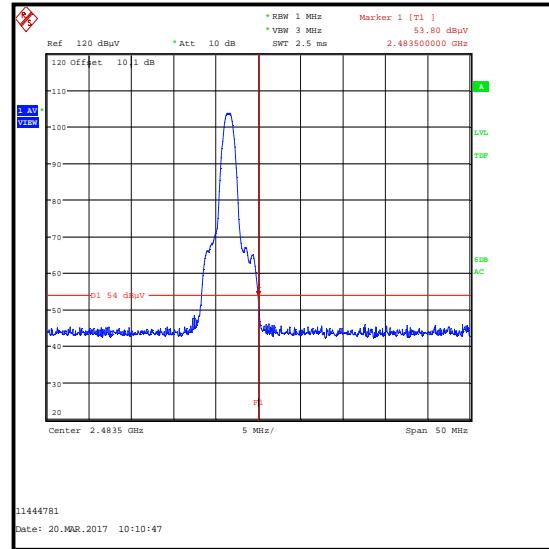
Note(s):

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 and 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 DH5 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
2340.769	Horizontal	51.8	74.0	22.2	Complied
2400.0	Horizontal	63.9	84.0*	20.1	Complied
2483.5	Horizontal	67.5	74.0	6.5	Complied

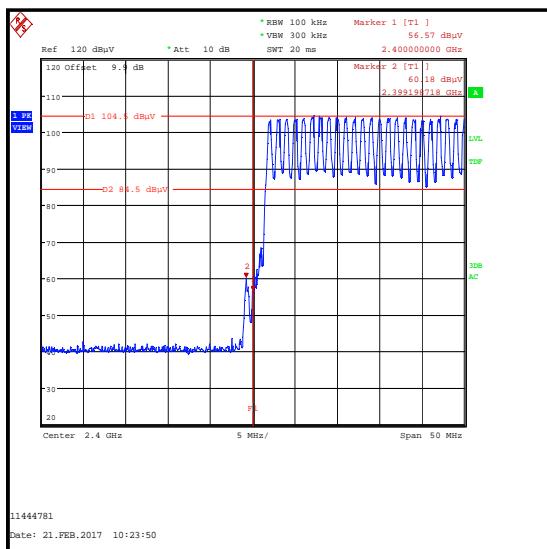
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2381.923	Horizontal	47.2	54.0	6.8	Complied
2483.5	Horizontal	53.8	54.0	0.2	Complied

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

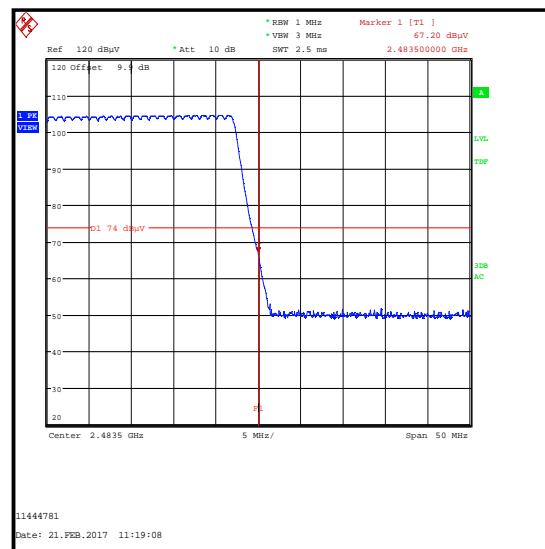
Transmitter Band Edge Radiated Emissions (continued)**Results: Hopping Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.199	Horizontal	60.2	84.5*	24.3	Complied
2400.0	Horizontal	56.6	84.5*	27.9	Complied
2483.5	Horizontal	67.2	74.0	6.8	Complied

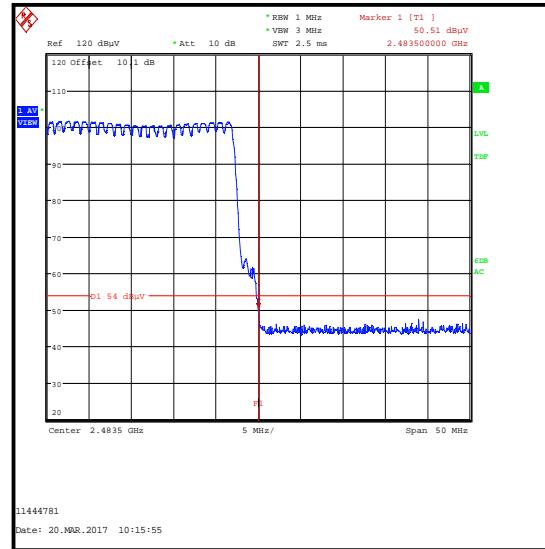
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	50.5	54.0	3.5	Complied



Lower Band Edge



Upper Band Edge

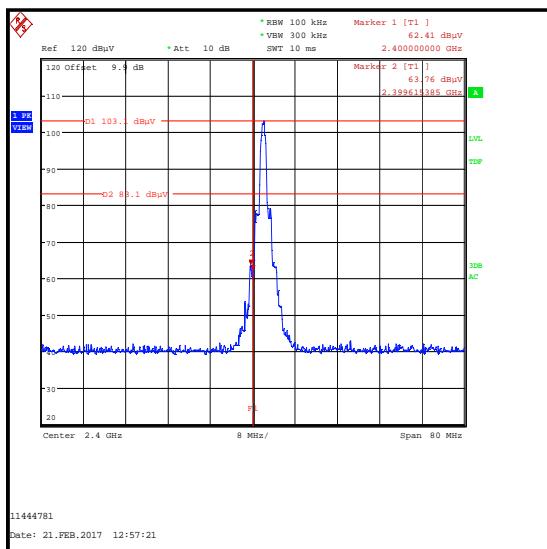


Upper Band Edge

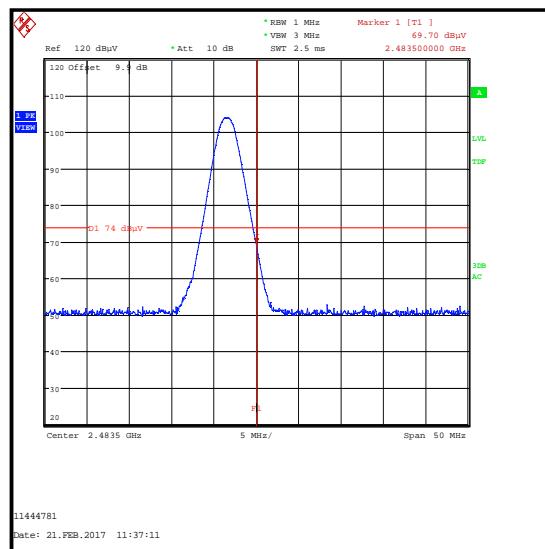
Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 2DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.615	Horizontal	63.8	83.1*	19.3	Complied
2400.0	Horizontal	62.4	83.1*	20.7	Complied
2483.5	Horizontal	69.7	74.0	4.3	Complied

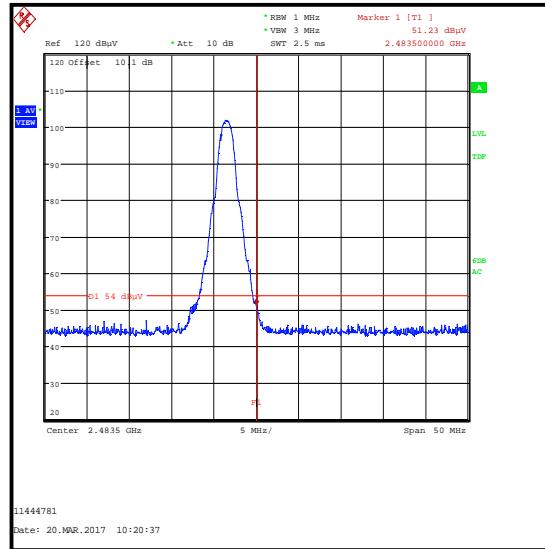
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	51.2	54.0	2.8	Complied



Lower Band Edge



Upper Band Edge

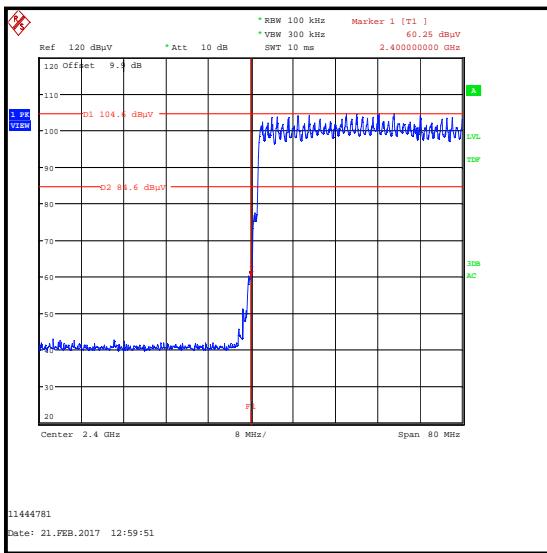
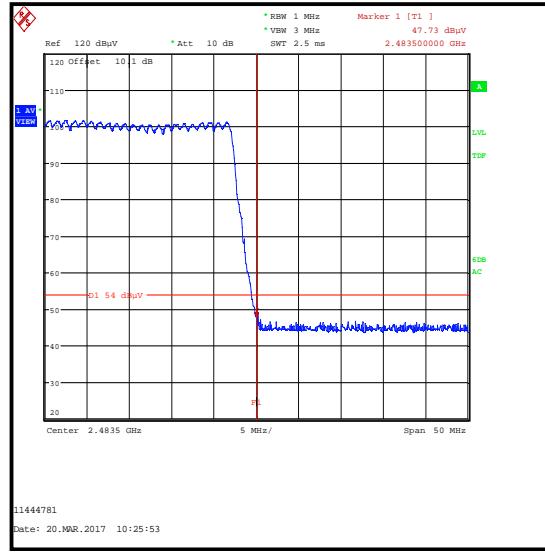


Upper Band Edge

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
2400.0	Horizontal	60.3	84.6*	24.3	Complied
2483.5	Horizontal	68.7	74.0	5.3	Complied

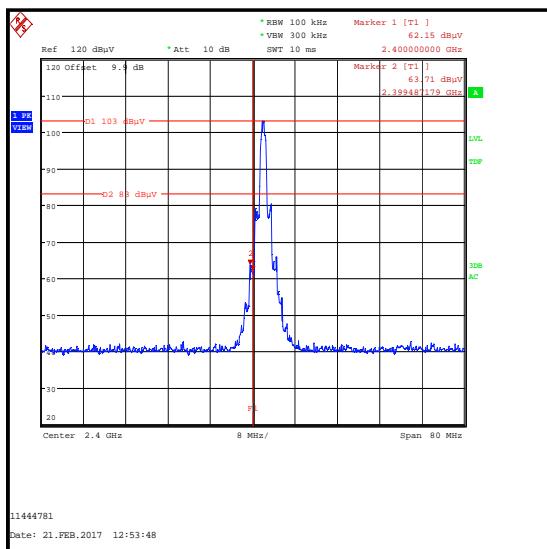
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	47.7	54.0	6.3	Complied

**Lower Band Edge****Upper Band Edge****Upper Band Edge**

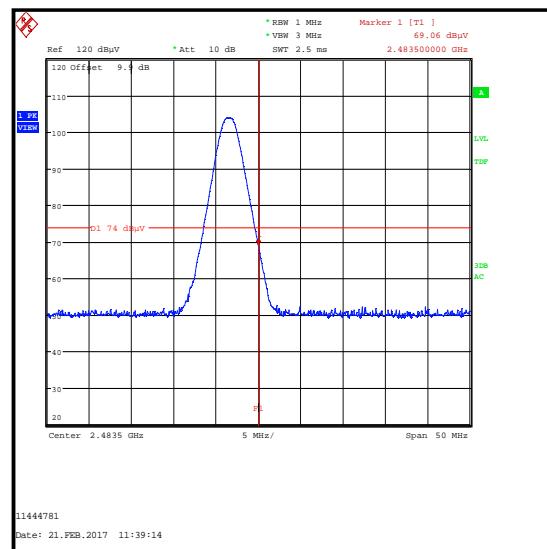
Transmitter Band Edge Radiated Emissions (continued)**Results: Static Mode / 3DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2399.487	Horizontal	63.7	83.0*	19.3	Complied
2400.0	Horizontal	62.2	83.0*	20.8	Complied
2483.5	Horizontal	69.1	74.0	4.9	Complied

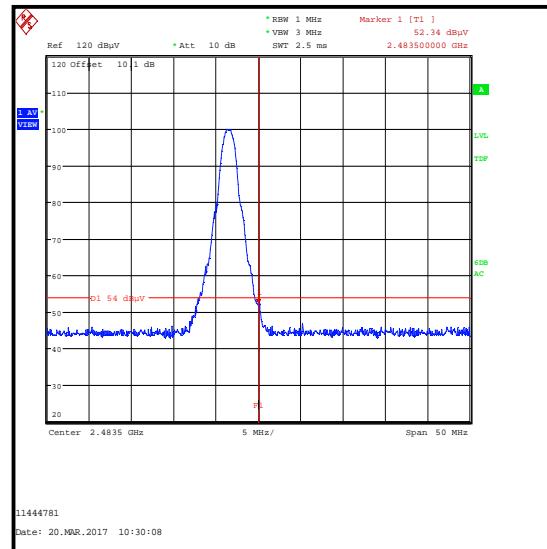
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	52.3	54.0	1.7	Complied



Lower Band Edge



Upper Band Edge

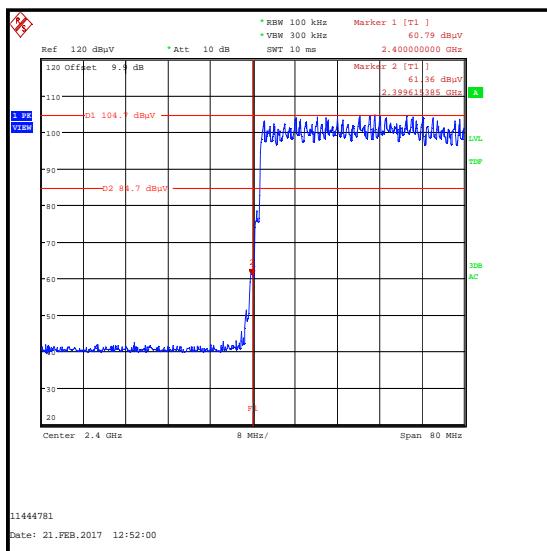


Upper Band Edge

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
2399.615	Horizontal	61.4	84.7*	23.3	Complied
2400.0	Horizontal	60.8	84.7*	23.9	Complied
2483.5	Horizontal	68.9	74.0	5.1	Complied

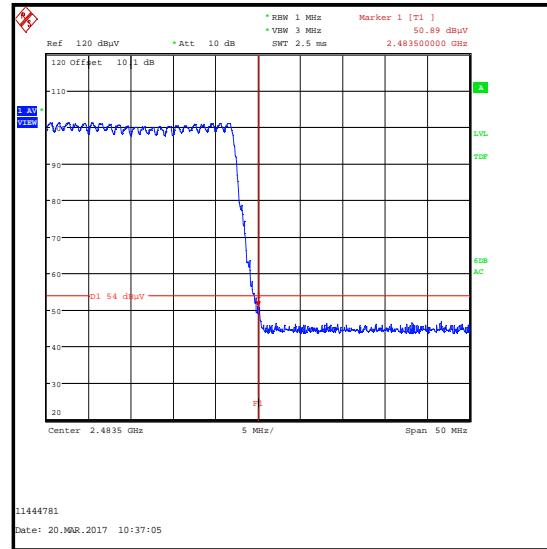
Frequency (MHz)	Antenna Polarity	Average Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	Horizontal	50.9	54.0	3.1	Complied



Lower Band Edge



Upper Band Edge



Upper Band Edge

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	Not stated	02 Apr 2017	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Nov 2017	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	09 Nov 2017	12
A1818	Antenna	EMCO	3115	00075692	08 Nov 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	26 Apr 2017	12
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	BBHA9120B	BBHA9120B653	07 Apr 2017	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832837#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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 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%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 26.5 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 ---