



# TEST REPORT

**Test Report No. :** UL-RPT-RP10950538JD09A V2.0

**Manufacturer** : Sigma Connectivity AB  
**Model No.** : SSG-002  
**FCC ID** : 2AFCP-002  
**Technology** : *Bluetooth* – Basic Rate & EDR  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.247

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
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:** 25 October 2016

**Checked by:**

Ian Watch  
Senior Engineer, Radio Laboratory

**Company Signatory:**

Steven White  
Service Lead, Radio Laboratory  
UL VS LTD



This laboratory is accredited by UKAS.  
The tests reported herein have been  
performed in accordance with its terms  
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**1. Customer Information**










<b>Company Name:</b>	Sigma Connectivity AB
<b>Address:</b>	Mobilevägen 10 223 62 Lund Sweden

## **2. Summary of Testing**

### **2.1. General Information**

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
<b>Site Registration:</b>	209735
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	17 February 2016 to 11 October 2016

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

<b>FCC Reference (47CFR)</b>	<b>Measurement</b>	<b>Result</b>
Part 15.207	Transmitter AC Conducted Emissions	
Part 15.247(a)(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	
<b>Key to Results</b>  = Complied  = Did not comply		

### **2.3. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

### **2.4. Deviations from the Test Specification**

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

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

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

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	01001B8D ( <i>Conducted sample with RF port</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP-002

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	02001-0354 ( <i>Radiated sample #1</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP-002

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	MC000170 ( <i>Radiated sample #2</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP-002

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

The Equipment Under Test was a gateway in the SENS BY SIGMA system, collecting data from sensors and ensuring that all component parts are continuously under full control. The gateway communicates with the sensors via *Bluetooth* and is transmitting data to the Cloud via WiFi. SensGate is designed to be mounted in the ceiling or on the wall. It contains a battery for backup and is powered via the USB port.

#### **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	3.8 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	8DQPSK
Packet Type: (Maximum Payload)	DH5	2DH5	3DH5
Data Rate (Mbps):	1	2	3
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:

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Hewlett Packard
<b>Model Name or Number:</b>	Compaq 6910p
<b>Serial Number:</b>	HUB7451SGN

<b>Description:</b>	USB Cable
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Switching Power Supply
<b>Brand Name:</b>	Phihong
<b>Model Name or Number:</b>	PSA05E-050Q
<b>Serial Number:</b>	DE29003034A1

## **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):

- Transmit tests: The *Bluetooth* test mode commands were entered into the terminal application on the supplied test laptop. Once in test mode, a *Bluetooth* tester was used to enable continuous transmission and configure the test channels & packet types 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.
- AC conducted emissions and radiated spurious emissions tests were performed with the EUT transmitting on the top channel using DH5 packet type, as this mode was found to transmit the highest power.
- Transmitter radiated spurious emissions tests were performed with the EUT connected to its AC/DC Power Supply and USB cable. The Power supply input was connected to a 120 VAC 60 Hz single phase supply. The EUT was connected to a DC power supply for all conducted tests. A USB diagnostic cable was connected to the EUT to change channels as required.
- The EUT conducted sample was used for 20 dB Bandwidth, Carrier Frequency Separation, Number of Hopping Frequencies, Average Time of Occupancy and Maximum Peak Output Power.
- The EUT radiated samples were used for AC conducted emissions and radiated spurious emissions 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:**

<b>Test Engineer:</b>	Matthew Galbraith	<b>Test Date:</b>	07 October 2016
<b>Test Sample Serial Number:</b>	MC000170		

<b>FCC Reference:</b>	Part 15.207
<b>Test Method Used:</b>	ANSI C63.10 Section 6.2

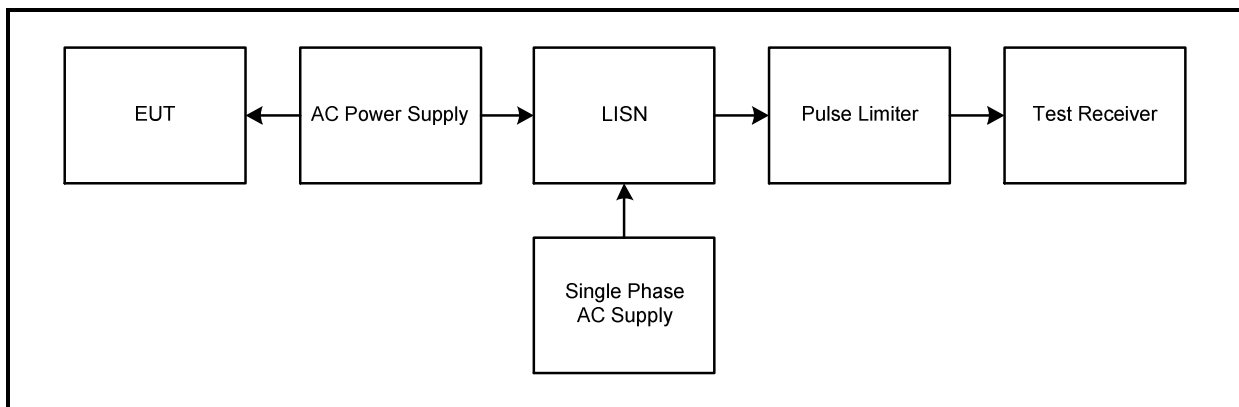
#### **Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	43

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

1. The EUT was connected to an AC/DC power supply via USB cable. The AC/DC power supply input was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were initially performed on all supported technologies/modes and found to produce identical results. Final measurements were therefore only performed on one test case on frequencies that resulted in the highest live/neutral levels and the results entered into the tables below.
3. A pulse limiter was fitted between the LISN and the test receiver.

#### **Test setup:**



**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.190500	Live	47.4	64.0	16.6	Complied
0.235500	Live	44.9	62.3	17.4	Complied
0.289500	Live	38.9	60.5	21.6	Complied
2.566500	Live	34.1	56.0	21.9	Complied
3.588000	Live	36.1	56.0	19.9	Complied
4.434000	Live	36.1	56.0	19.9	Complied

**Results: Live / Average**

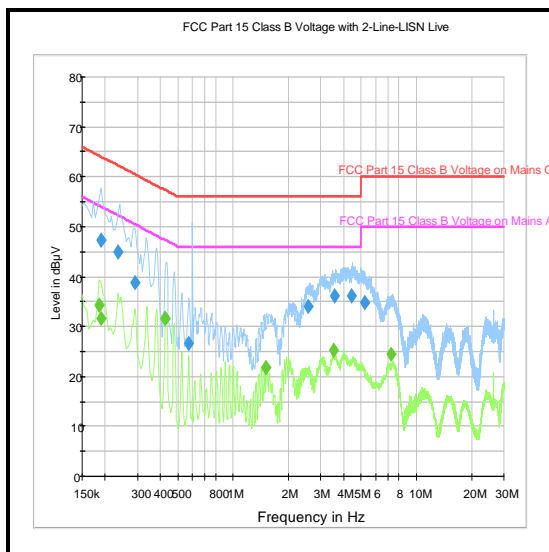
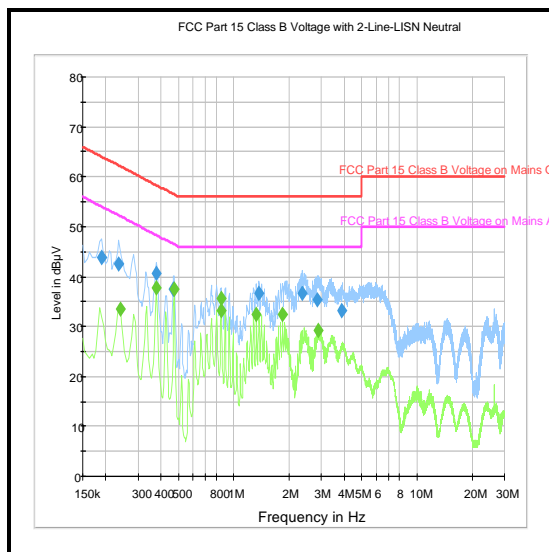
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.186000	Live	34.3	54.2	19.9	Complied
0.190500	Live	31.7	54.0	22.3	Complied
0.424500	Live	31.6	47.4	15.8	Complied
0.424500	Live	31.6	47.4	15.8	Complied
1.513500	Live	21.8	46.0	24.2	Complied
3.507000	Live	25.2	46.0	20.8	Complied

**Results: Neutral / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.190500	Neutral	43.7	64.0	20.3	Complied
0.235500	Neutral	42.6	62.3	19.7	Complied
0.379500	Neutral	40.6	58.3	17.7	Complied
0.469500	Neutral	37.3	56.5	19.2	Complied
1.374000	Neutral	36.6	56.0	19.4	Complied
2.368500	Neutral	36.7	56.0	19.3	Complied

**Results: Neutral / Average**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.379500	Neutral	37.6	48.3	10.7	Complied
0.474000	Neutral	37.4	46.4	9.0	Complied
0.852000	Neutral	35.6	46.0	10.4	Complied
0.852000	Neutral	33.3	46.0	12.7	Complied
1.324500	Neutral	32.5	46.0	13.5	Complied
1.846500	Neutral	32.5	46.0	13.5	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****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)
M2015	Thermohygrometer	Testo	608-H1	45046424	10 Jun 2017	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1379	Test Receiver	Rohde & Schwarz	ESIB7	100330	15 Dec 2016	12

**5.2.2. Transmitter 20 dB Bandwidth****Test Summary:**

Test Engineer:	Stefan Ho	Test Date:	11 October 2016
Test Sample Serial Number:	01001B8D		

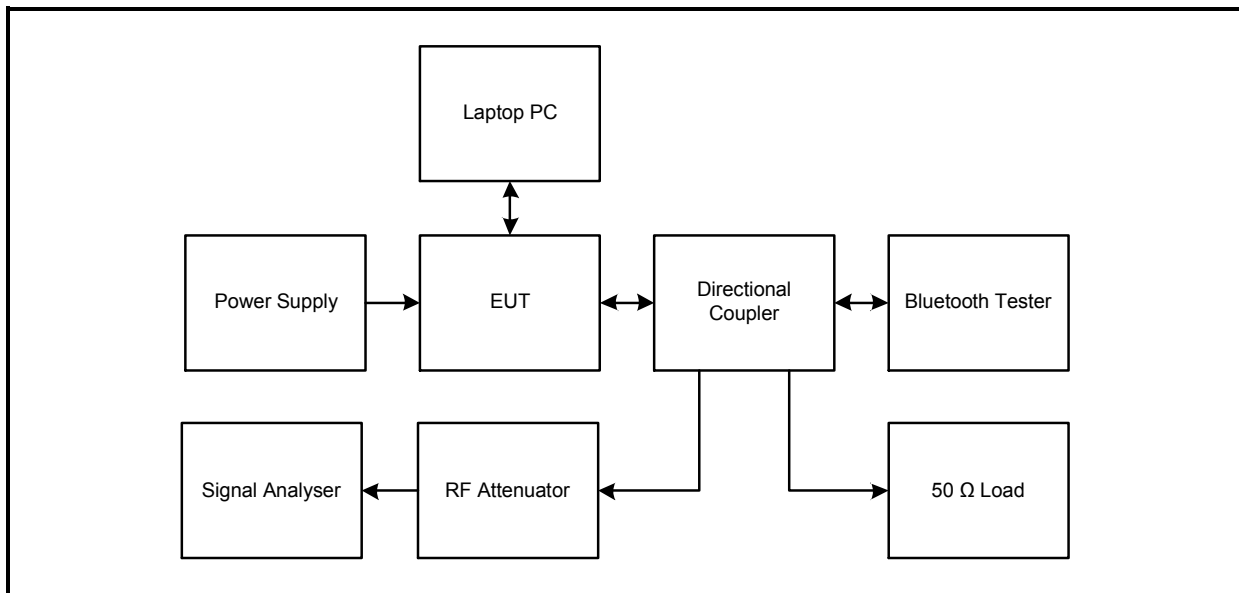
FCC Reference:	Part 15.247(a)(1)
Test Method Used:	ANSI C63.10 Section 6.9.2

**Environmental Conditions:**

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

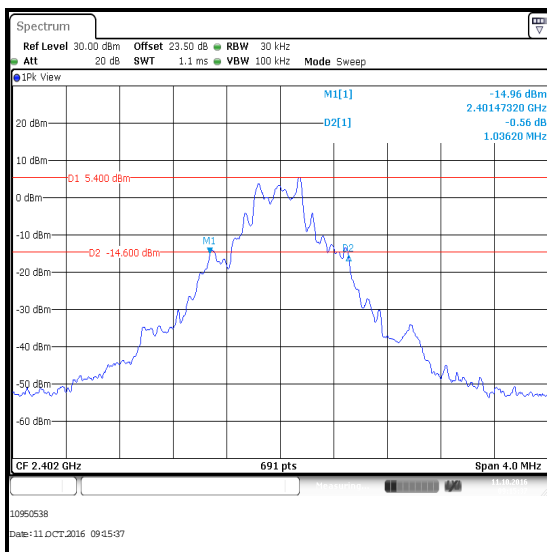
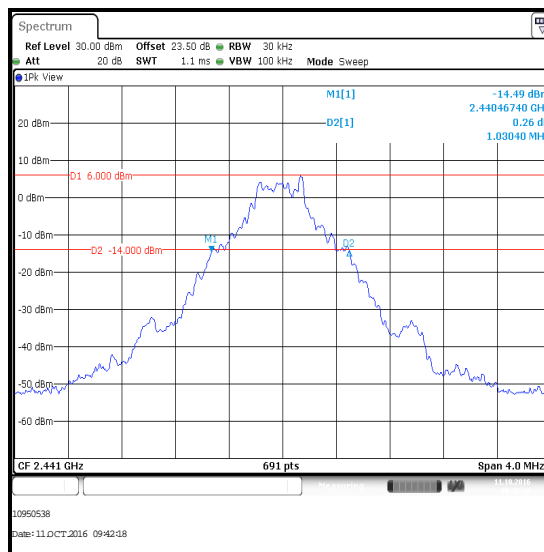
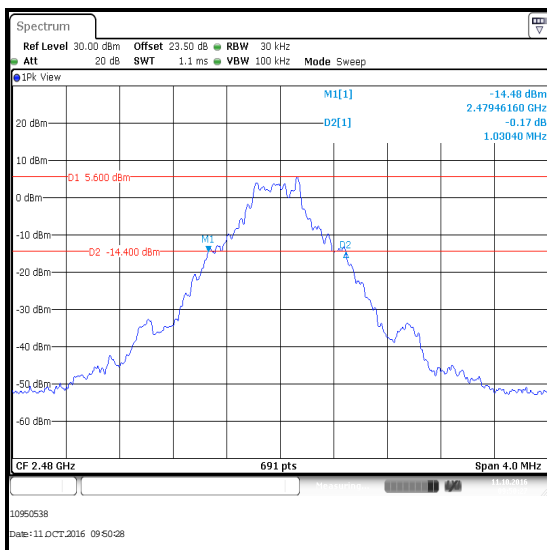
**Note(s):**

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 4 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier.
2. The signal analyser was connected to the EUT's RF port via a directional coupler using suitable attenuation and RF cable. An RF offset level was entered on the signal analyser to compensate for the loss of the coupler, attenuator and RF cable.

**Test setup:**

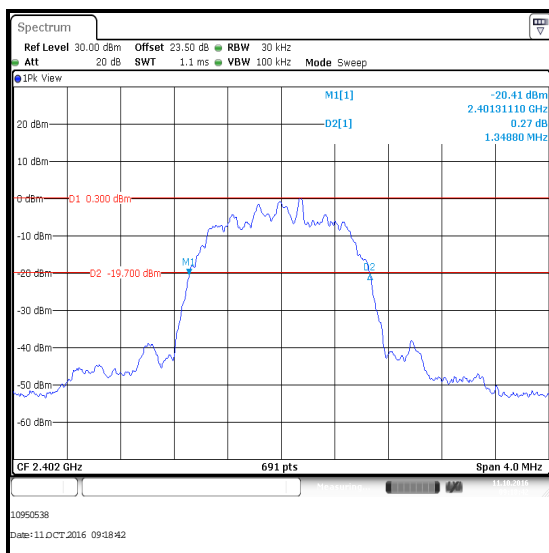
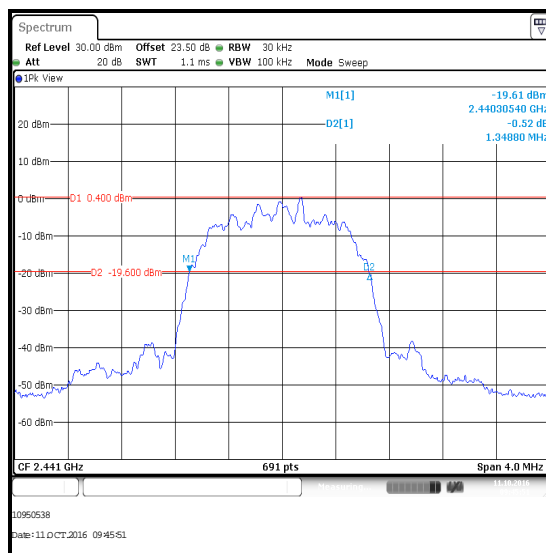
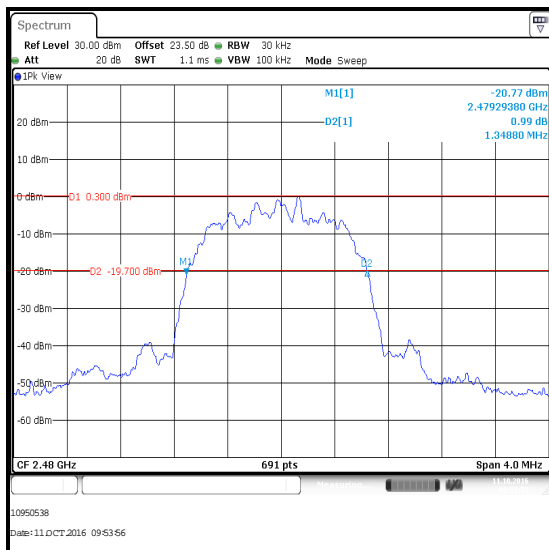
**Transmitter 20 dB Bandwidth (continued)****Results DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1036.200
Middle	1030.400
Top	1030.400

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

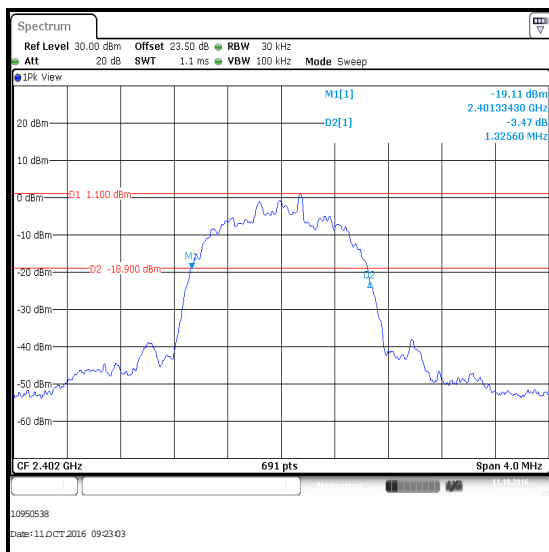
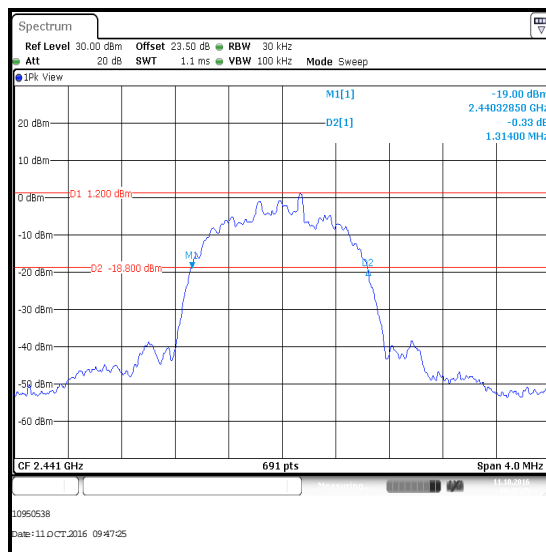
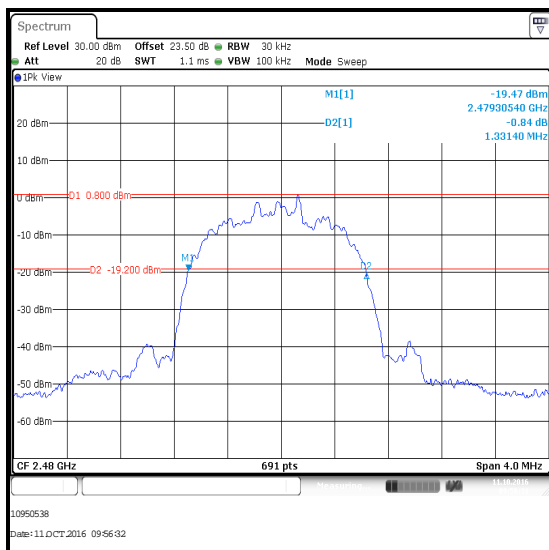
**Transmitter 20 dB Bandwidth (continued)****Results 2DH5:**

Channel	20 dB Bandwidth (kHz)
Bottom	1348.800
Middle	1348.800
Top	1348.800

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

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

Channel	20 dB Bandwidth (kHz)
Bottom	1325.600
Middle	1314.000
Top	1331.400

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



**Transmitter 20 dB Bandwidth (continued)****Test Equipment Used:**

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	27 Jun 2017	12
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
S021	DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12

### **5.2.3. Transmitter Carrier Frequency Separation**

#### **Test Summary:**

<b>Test Engineer:</b>	Stefan Ho	<b>Test Date:</b>	11 October 2016
<b>Test Sample Serial Number:</b>	01001B8D		

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

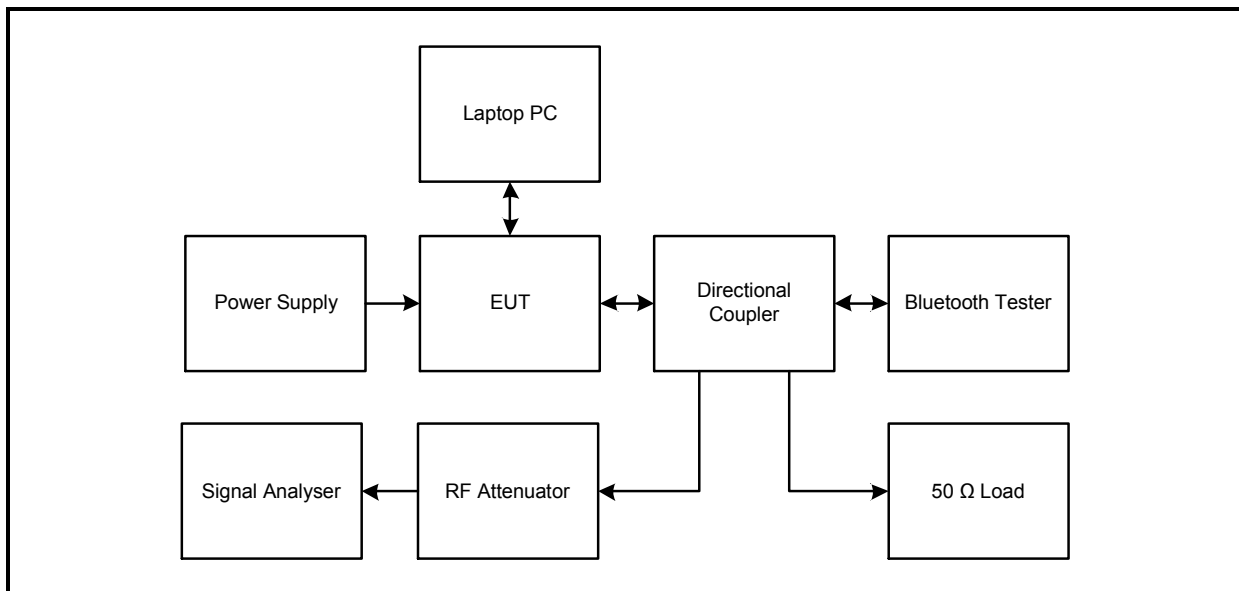
#### **Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	36

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

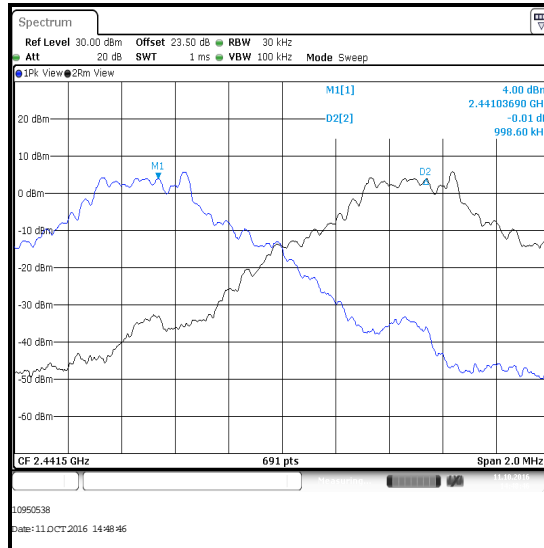
1. In order to identify the centre of adjacent channels, the signal analyser resolution bandwidth was set to 30 kHz and video bandwidth of 100 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 2 MHz. A marker was placed at the peak on the first channel and then a delta marker was placed on the same peak of the adjacent channel. The delta between the two markers was recorded for each mode of operation.
2. The 20 dB bandwidth measured for the middle channel operating at 2441 MHz was used to calculate the limit.
3. The signal analyser was connected to the RF port via a directional coupler 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:**



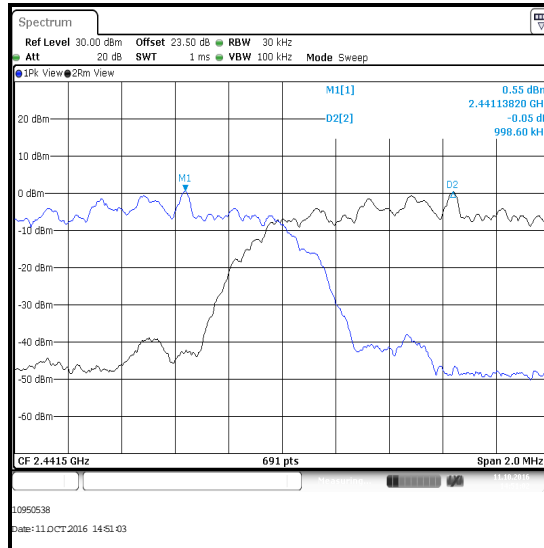
**Transmitter Carrier Frequency Separation (continued)****Results: DH5**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	686.933	311.667	Complied



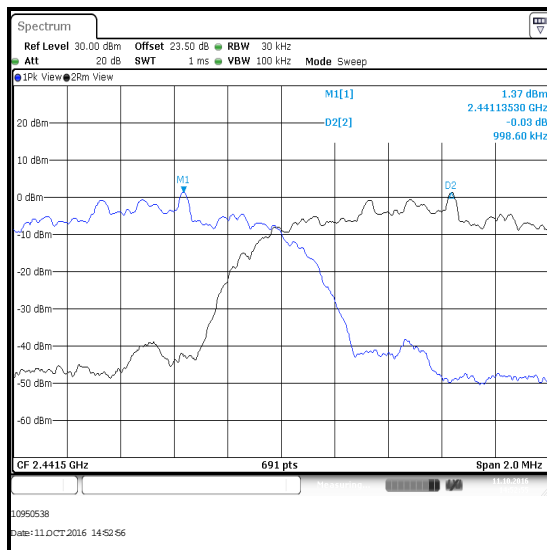
**Transmitter Carrier Frequency Separation (continued)****Results: 2DH5**

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	899.200	99.400	Complied



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

Carrier Frequency Separation (kHz)	Limit ( $2/3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	876.000	122.600	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	27 Jun 2017	12
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
S021	DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12

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

<b>Test Engineer:</b>	Stefan Ho	<b>Test Date:</b>	11 October 2016
<b>Test Sample Serial Number:</b>	01001B8D		

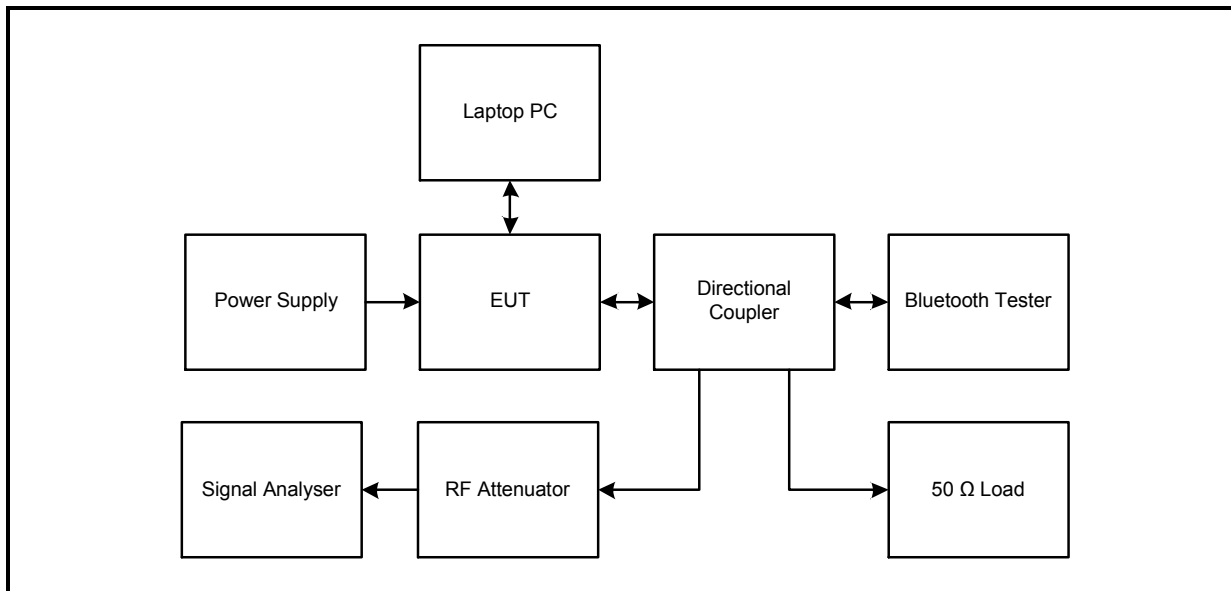
<b>FCC Reference:</b>	Part 15.247(a)(1)(iii)
<b>Test Method Used:</b>	ANSI C63.10 Sections 7.8.3 & 7.8.4

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	36

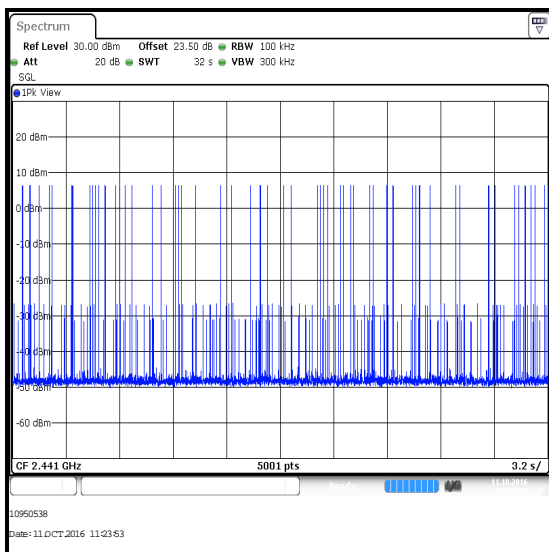
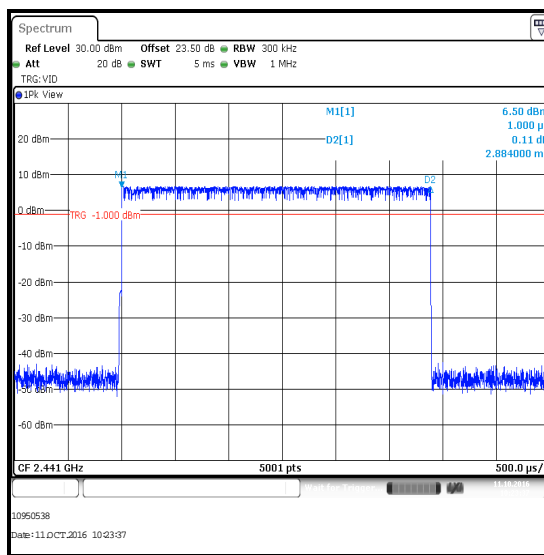
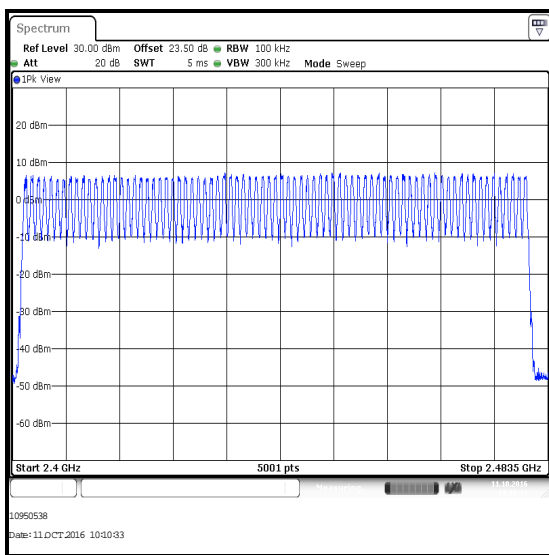
**Note(s):**

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. 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 300 kHz and video bandwidth of 1 MHz. A peak detector was used and sweep time was set to auto with a span of zero Hz. The signal 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 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 with zero span. 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 via a directional coupler 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.

**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 (DH5):**

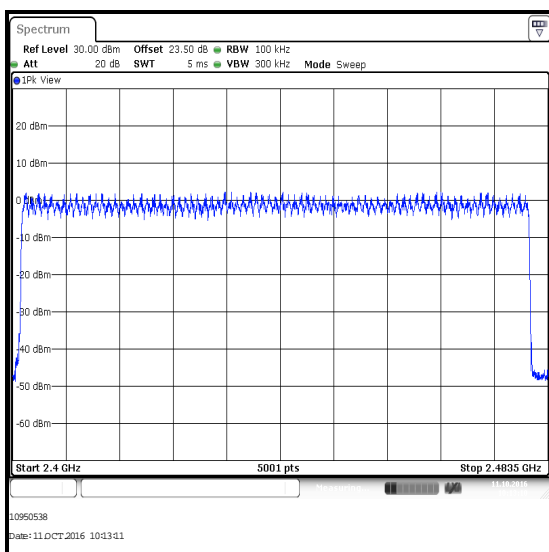
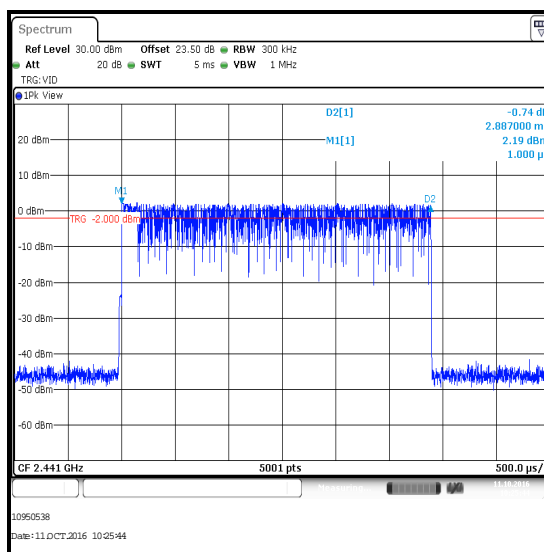
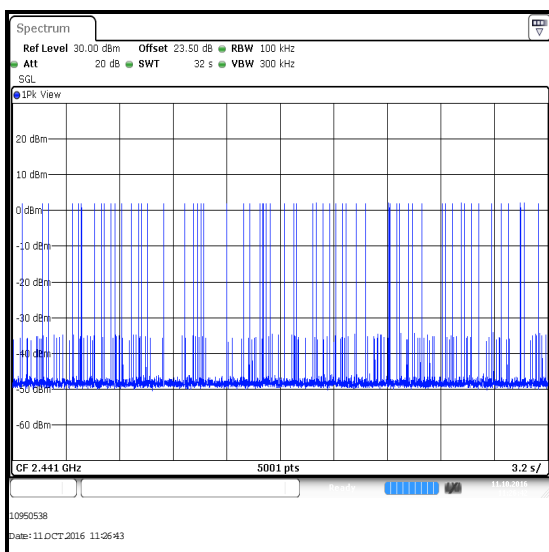
Emission Width ( $\mu$ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2884.000	64	0.185	0.4	0.215	Complied





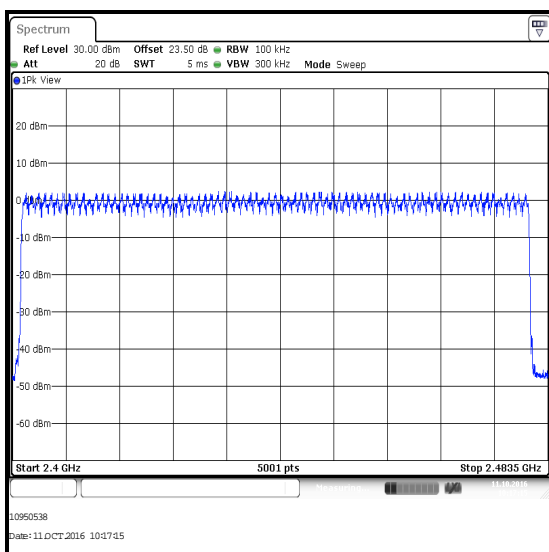
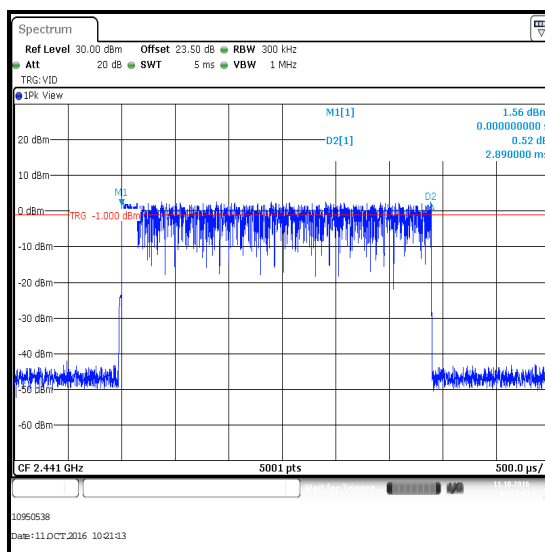
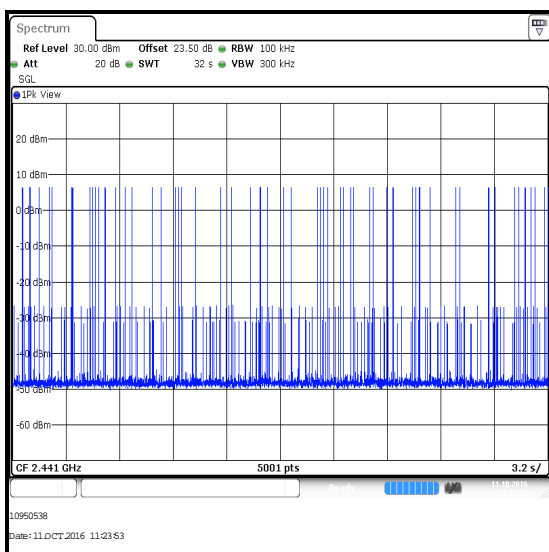
**Transmitter Number of Hopping Frequencies and Average Time of Occupancy (continued)****Results (2DH5):**

Emission Width ( $\mu$ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2887.000	65	0.188	0.4	0.212	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)****Results (3DH5):**

Emission Width ( $\mu$ s)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2890.000	68	0.197	0.4	0.203	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)
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	27 Jun 2017	12
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
S021	DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12

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

Test Engineer:	Stefan Ho	Test Date:	10 October 2016
Test Sample Serial Number:	01001B8D		

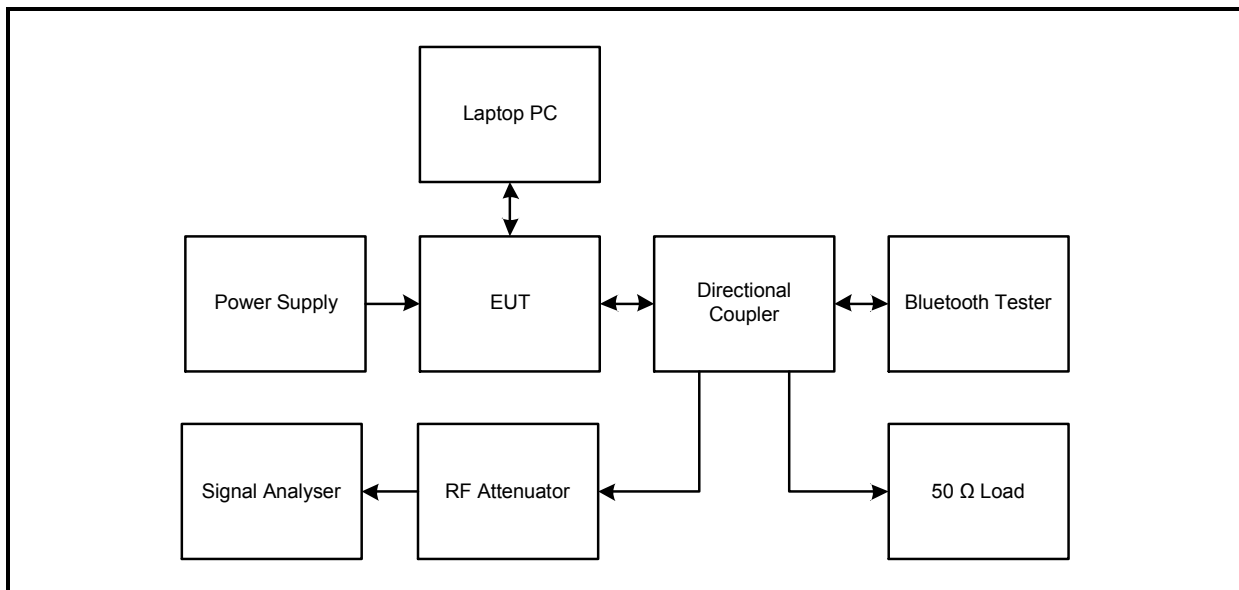
FCC Reference:	Part 15.247(b)(1)
Test Method Used:	ANSI C63.10 Section 7.8.5

**Environmental Conditions:**

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

**Note(s):**

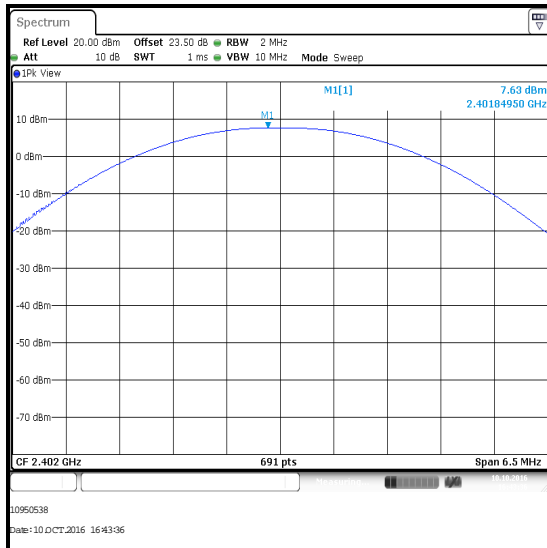
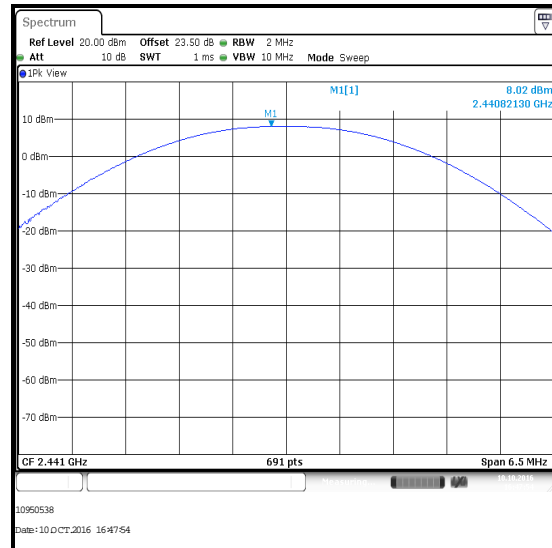
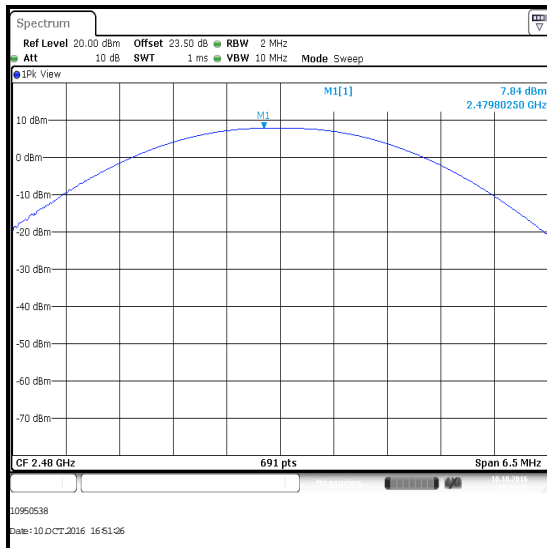
1. The signal analyser resolution bandwidth was set to 2 MHz (greater than the 20 dB bandwidth) and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 6.5 MHz (approximately five times the 20 dB bandwidth). A marker was placed at the peak of the signal and the results recorded in the tables below.
2. The signal analyser was connected to the EUT's RF port via a directional coupler using suitable attenuation and RF cable. An RF offset level was entered on the signal analyser to compensate for the loss of the coupler, attenuator and RF cable.
3. The declared antenna gain was added to the conducted peak power to obtain the EIRP.

**Test setup:**

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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	7.6	30.0	22.4	Complied
Middle	8.0	30.0	22.0	Complied
Top	7.8	30.0	22.2	Complied

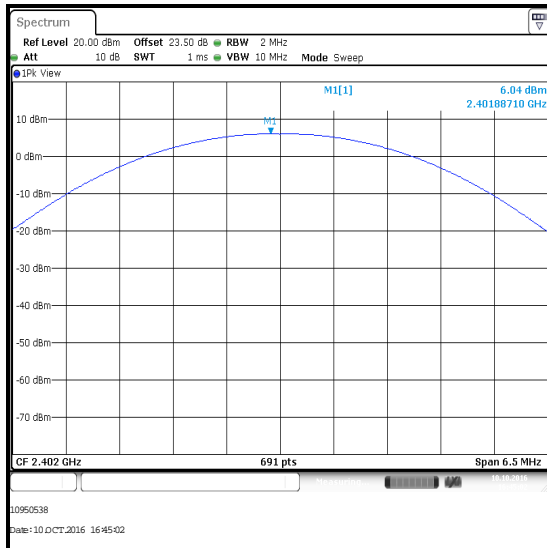
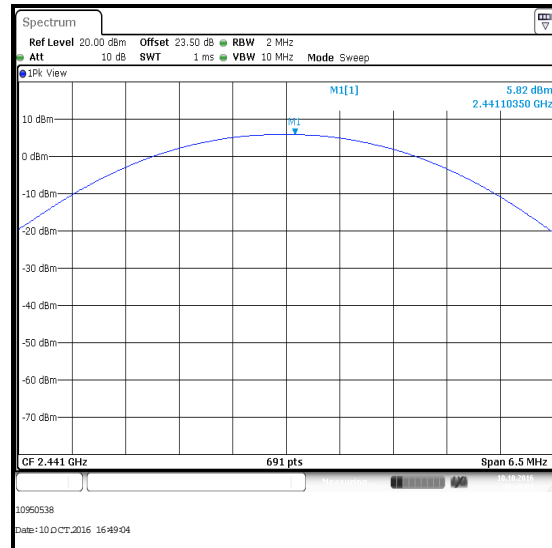
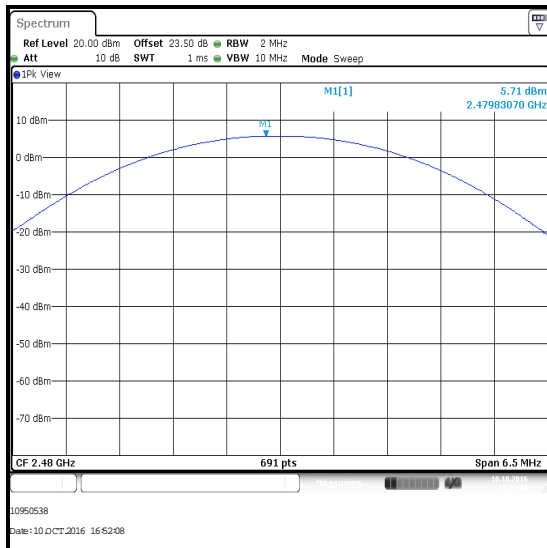
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	7.6	2.0	9.6	36.0	26.4	Complied
Middle	8.0	2.0	10.0	36.0	26.0	Complied
Top	7.8	2.0	9.8	36.0	26.2	Complied

**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	6.0	21.0	15.0	Complied
Middle	5.8	21.0	15.2	Complied
Top	5.7	21.0	15.3	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.0	2.0	8.0	27.0	19.0	Complied
Middle	5.8	2.0	7.8	27.0	19.2	Complied
Top	5.7	2.0	7.7	27.0	19.3	Complied

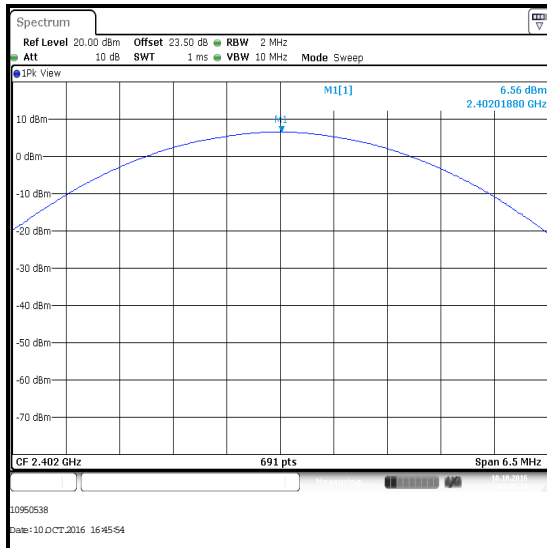
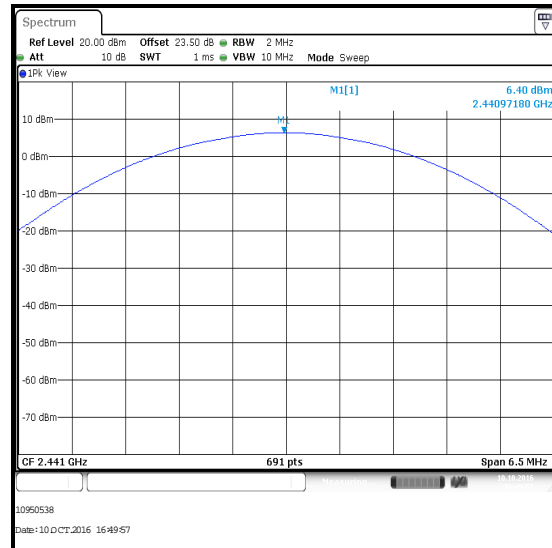
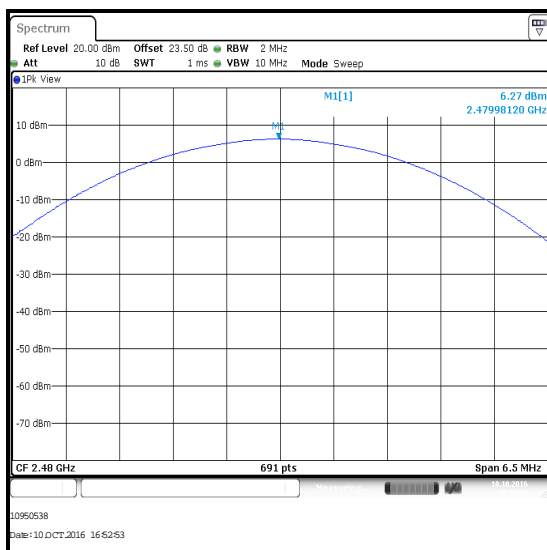
**Transmitter Maximum Peak Output Power (continued)****Results: 2DH5****Bottom Channel****Middle Channel****Top Channel**



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

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.6	21.0	14.4	Complied
Middle	6.4	21.0	14.6	Complied
Top	6.3	21.0	14.7	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.6	2.0	8.6	27.0	18.4	Complied
Middle	6.4	2.0	8.4	27.0	18.6	Complied
Top	6.3	2.0	8.3	27.0	18.7	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)
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	27 Jun 2017	12
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	11 Apr 2018	24
M1267	Thermal Power Sensor	Rohde & Schwarz	NRV-Z52	100155	15 Apr 2018	24
S021	DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12

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

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	10 March 2016
<b>Test Sample Serial Number:</b>	02001-0354		

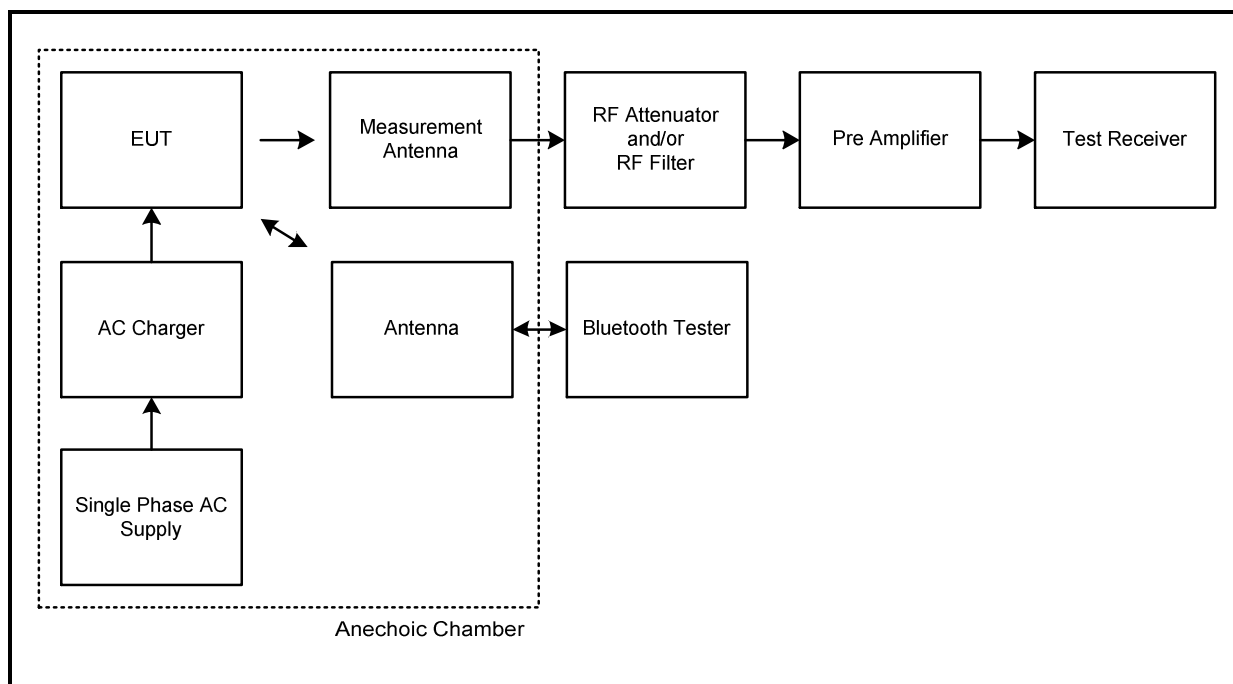
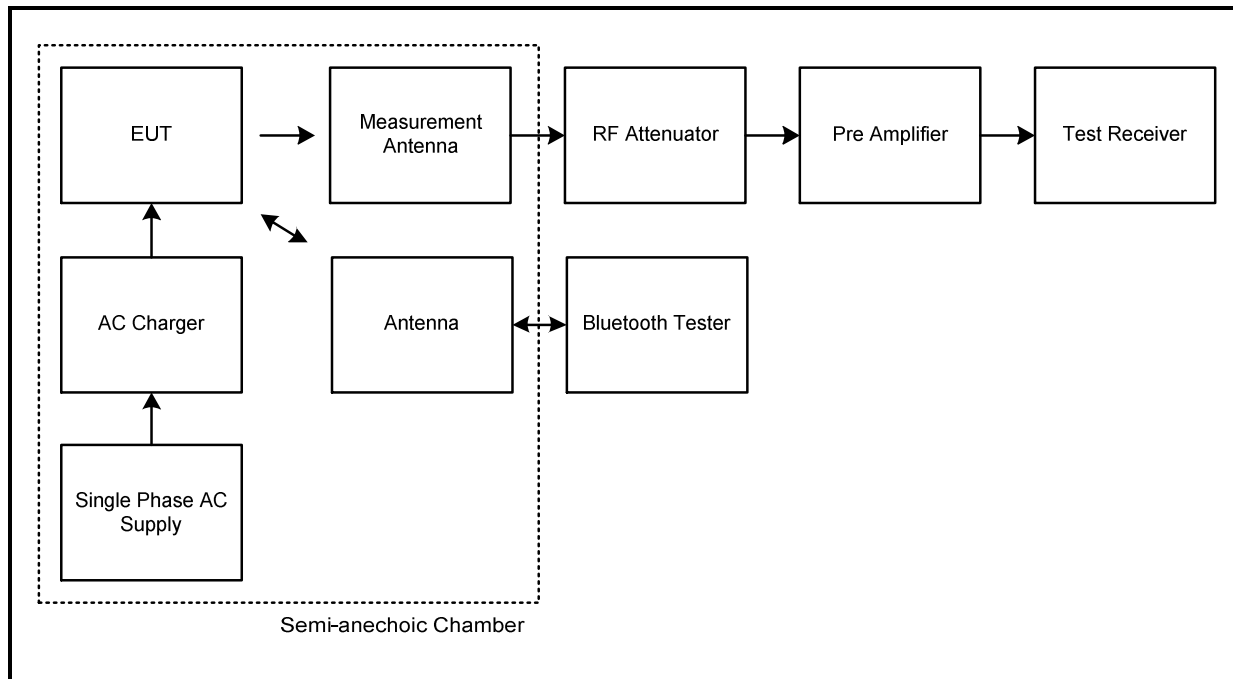
<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	31

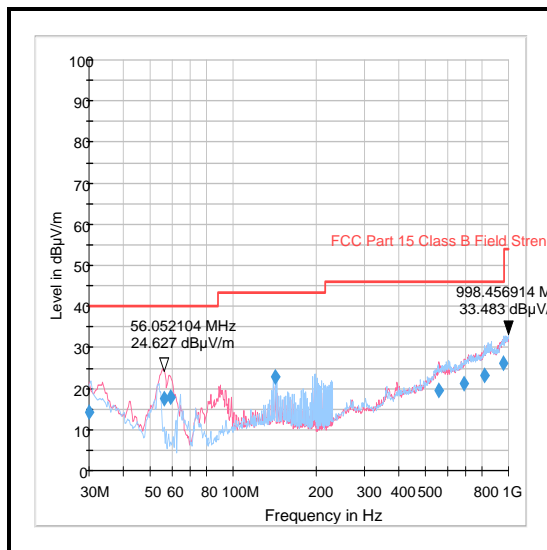
**Note(s):**

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 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 level of noise floor has been recorded.
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.

**Transmitter Radiated Emissions (continued)****Test set up for radiated measurements:**

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
998.457	Horizontal	33.5	54.0	20.5	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1627	Thermohygrometer	JM Handelspunkt	30.5015.10	Not stated	11 Jan 2017	12
K0001	5 m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	19 Mar 2016	12
A259	Antenna	Chase	CBL6111A	1513	09 Apr 2016	12
G0543	Amplifier	Sonoma	310N	230801	28 Feb 2017	12
A1834	Attenuator	Hewlett Packard	8491B	10444	28 Feb 2017	12

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

<b>Test Engineer:</b>	David Doyle	<b>Test Dates:</b>	17 February 2016 & 18 February 2016
<b>Test Sample Serial Number:</b>	02001-0354		

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

**Environmental Conditions:**

<b>Temperature (°C):</b>	22 to 23
<b>Relative Humidity (%):</b>	31 to 33

**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. 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.
5. \*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.
6. Pre-scans 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. 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 appropriate detectors during the pre-scan measurements.

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4803.639	Horizontal	46.0	54.0*	8.0	Complied

**Results: Middle Channel / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4882.024	Horizontal	47.5	54.0*	6.5	Complied

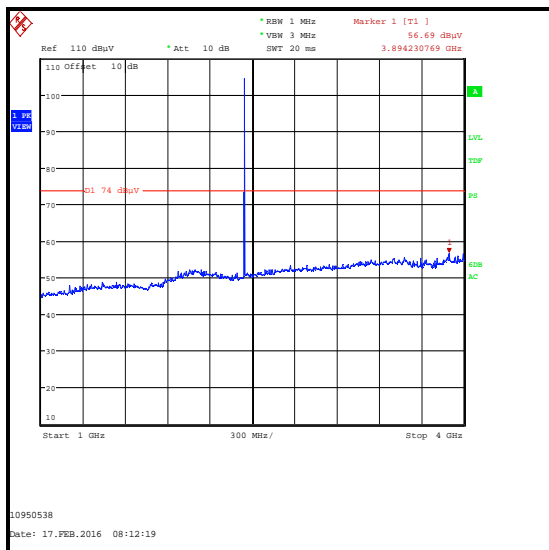
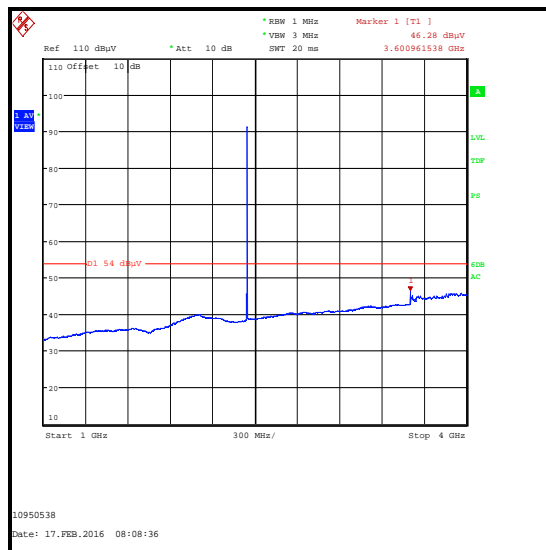
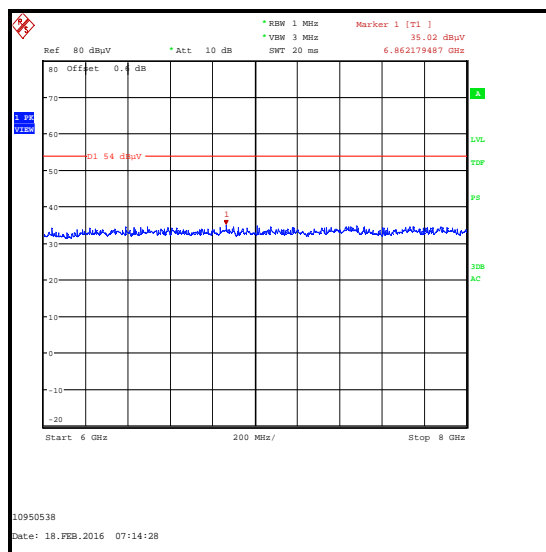
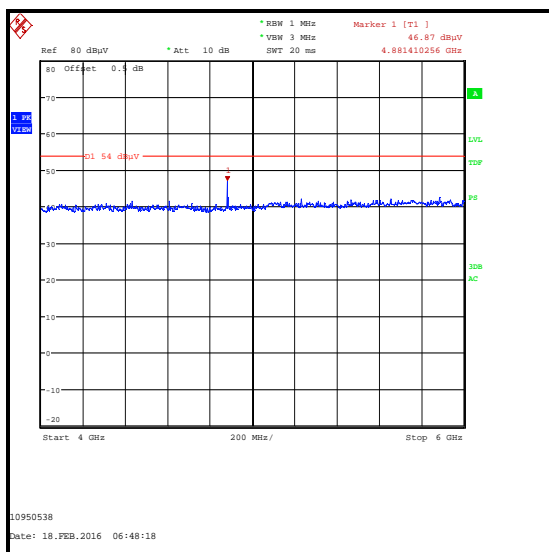
**Results: Top Channel / DH5**

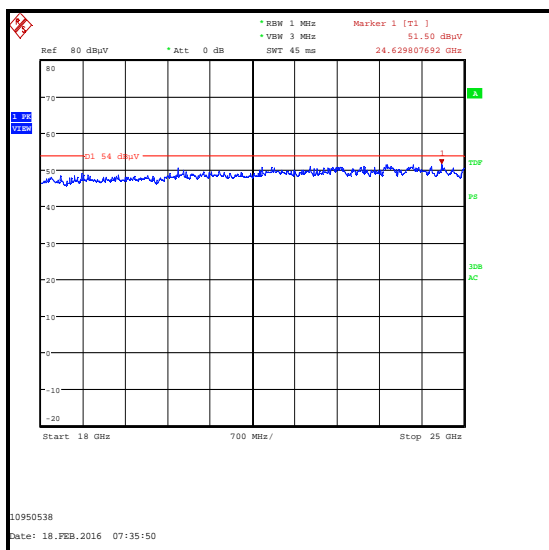
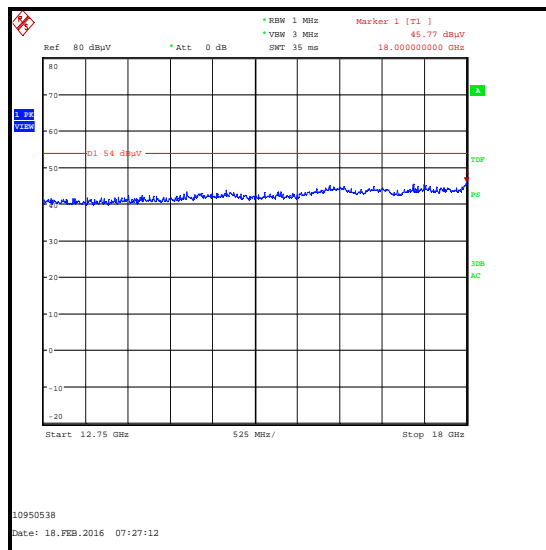
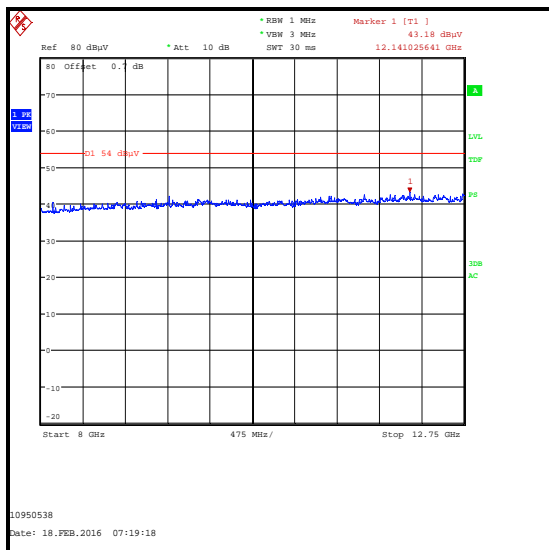
Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4959.984	Horizontal	47.7	54.0*	6.3	Complied

**Results: Hopping Mode / DH5**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
4810.372	Horizontal	47.0	54.0*	7.0	Complied



**Transmitter Radiated Emissions (continued)****Peak Detector****Average Detector**

**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 Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 May 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	00075692	17 Dec 2016	12
A253	Antenna	Flann Microwave	12240-20	128	17 Dec 2016	12
A254	Antenna	Flann Microwave	14240-20	139	17 Dec 2016	12
A255	Antenna	Flann Microwave	16240-20	519	17 Dec 2016	12
A256	Antenna	Flann Microwave	18240-20	400	17 Dec 2016	12
A436	Antenna	Flann Microwave	20240-20	330	19 Dec 2016	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12

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

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	17 February 2016
<b>Test Sample Serial Number:</b>	02001-0354		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.10.4 & 6.10.5

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	31

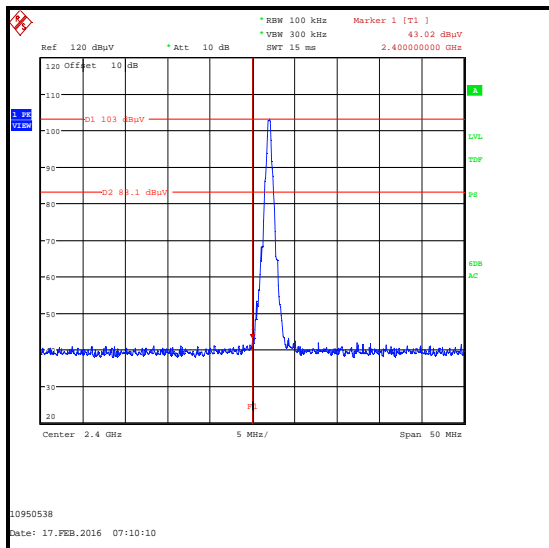
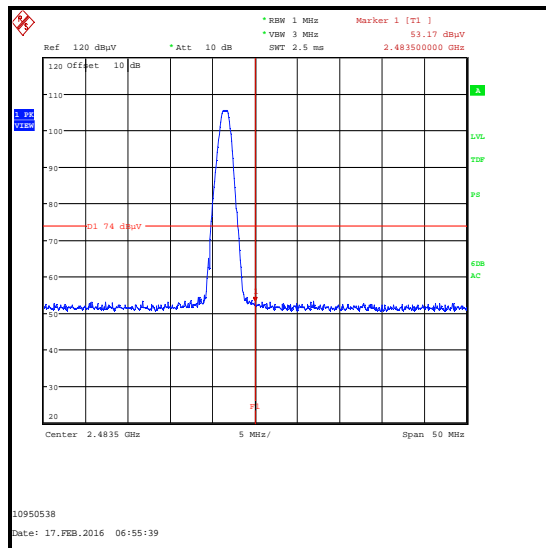
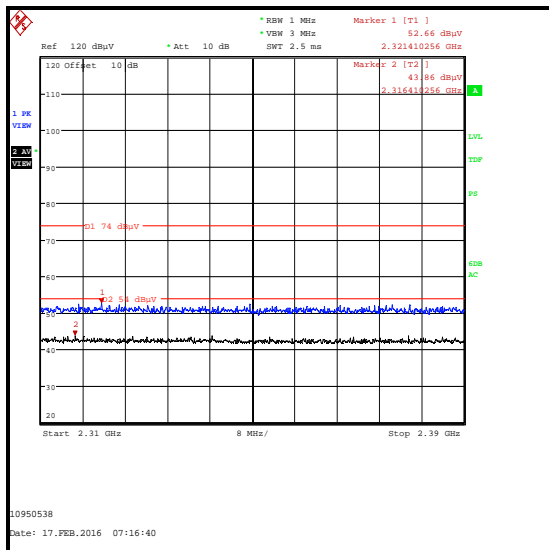
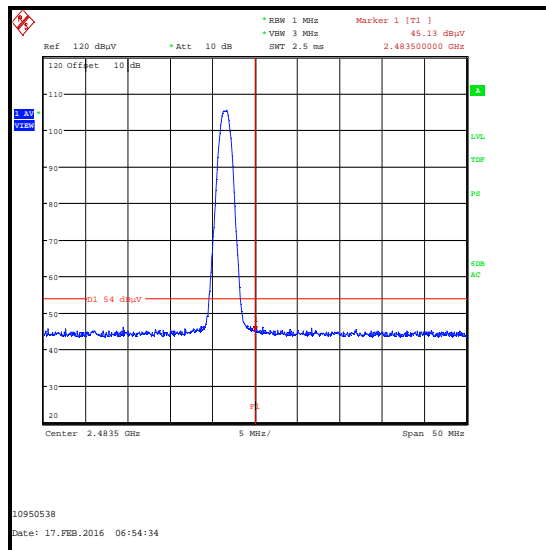
**Note(s):**

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 falls within 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 within 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 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 $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2321.410	Horizontal	52.7	74.0	21.3	Complied
2400.000	Horizontal	43.0	83.1*	40.1	Complied
2483.500	Horizontal	53.2	74.0	20.8	Complied

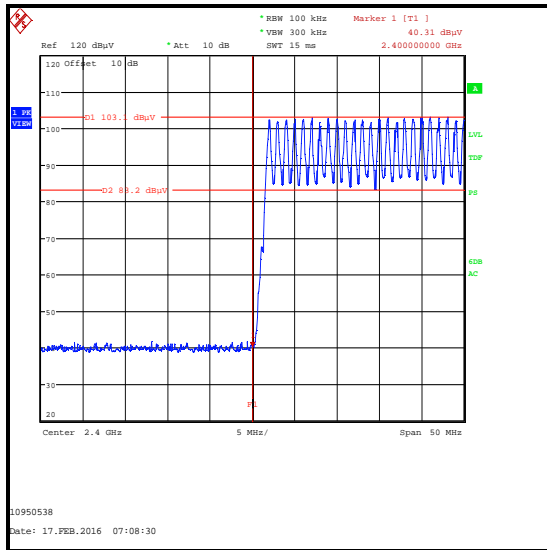
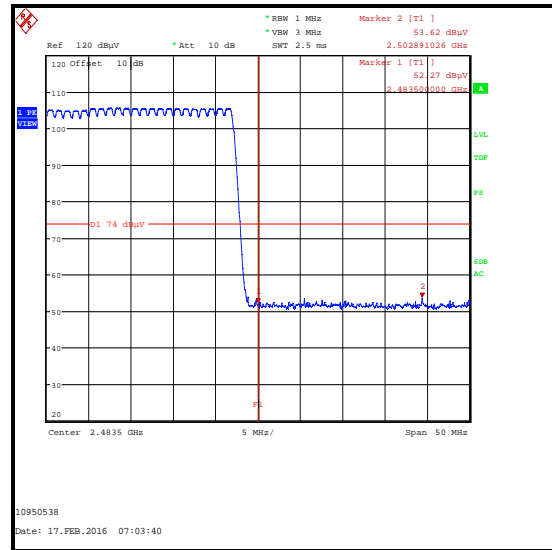
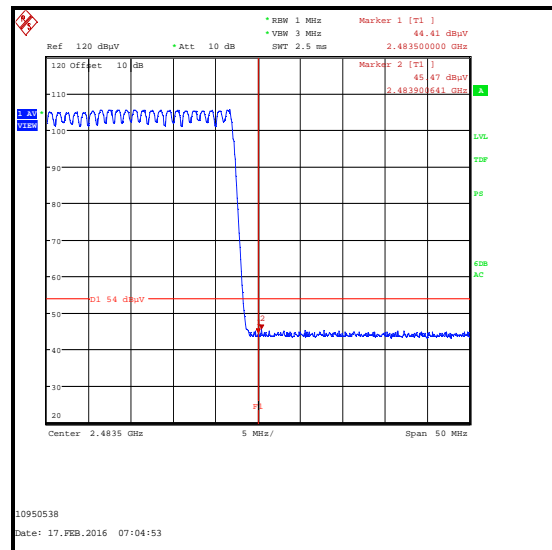
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
2316.410	Horizontal	43.9	54.0	10.1	Complied
2483.500	Horizontal	45.1	54.0	8.9	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Lower Band Edge Peak Static****Upper Band Edge Peak Static****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 $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.000	Horizontal	40.3	83.2*	42.9	Complied
2483.500	Horizontal	52.3	74.0	21.7	Complied
2502.891	Horizontal	53.6	74.0	20.4	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Horizontal	44.1	54.0	9.9	Complied
2483.901	Horizontal	45.5	54.0	8.5	Complied

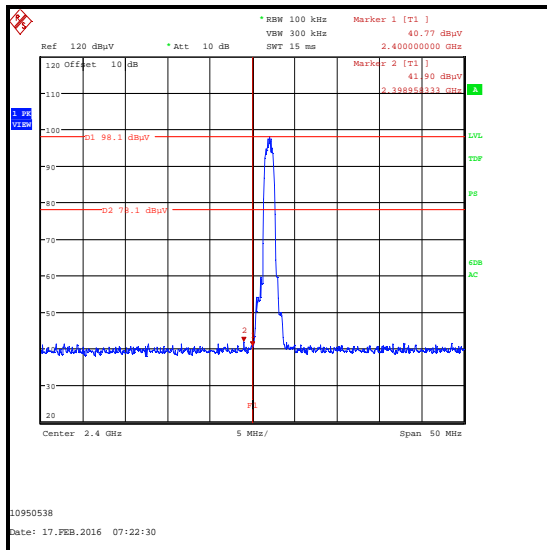
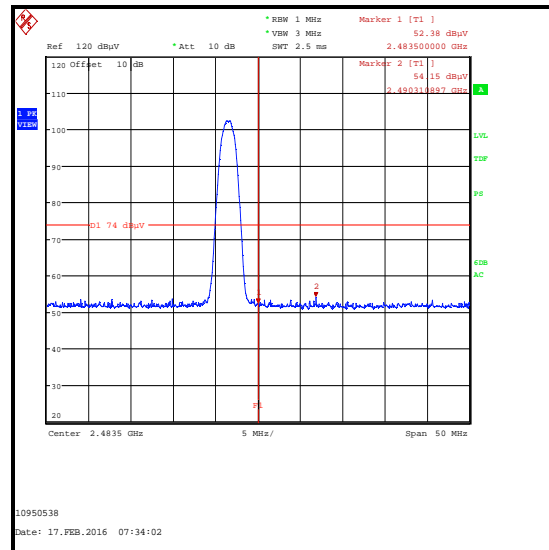
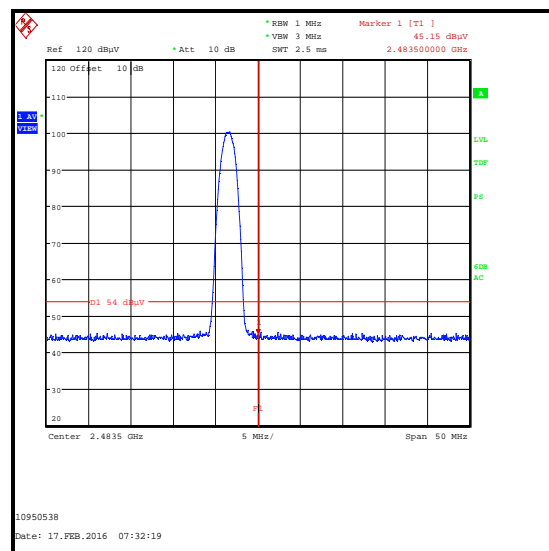
**Transmitter Band Edge Radiated Emissions (continued)****Lower Band Edge Peak Hopping****Upper Band Edge Peak Hopping****Upper Band Edge Average Hopping**



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

Frequency (MHz)	Antenna Polarity	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Result
2398.958	Horizontal	41.9	78.1*	36.2	Complied
2400.000	Horizontal	40.8	78.1*	37.3	Complied
2483.500	Horizontal	52.4	74.0	21.6	Complied
2490.311	Horizontal	54.2	74.0	19.8	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
2483.500	Horizontal	45.2	54.0	8.8	Complied

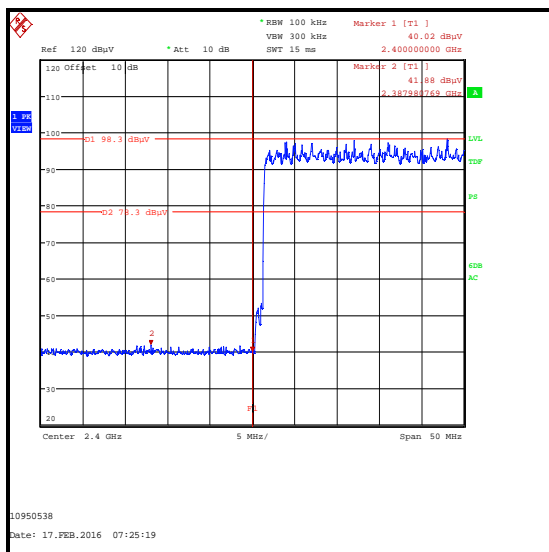
**Transmitter Band Edge Radiated Emissions (continued)****Lower Band Edge Peak Static****Upper Band Edge Peak Static****Upper Band Edge Average Static**

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

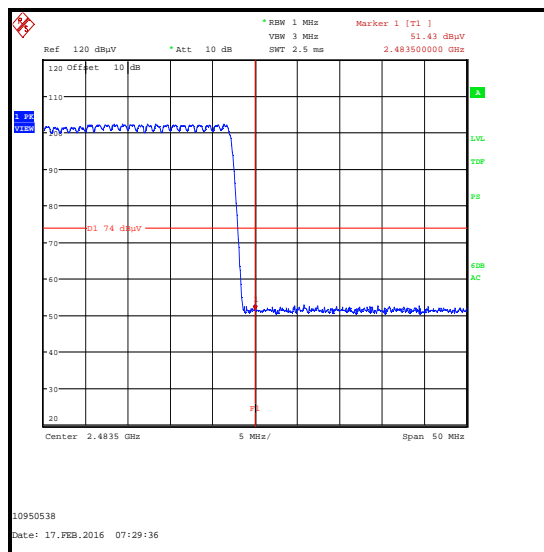
### Results: Hopping Mode / 2DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Result
2387.981	Horizontal	41.9	78.3*	36.4	Complied
2400.000	Horizontal	40.0	78.3*	38.3	Complied
2483.500	Horizontal	51.4	74.0	22.6	Complied

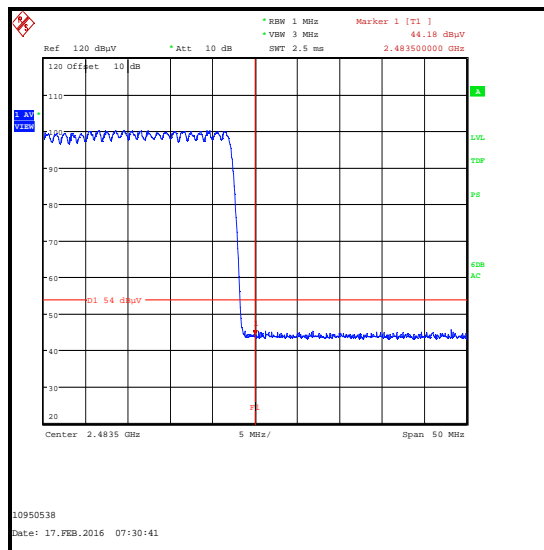
Frequency (MHz)	Antenna Polarity	Average Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
2483.500	Horizontal	44.2	54.0	9.8	Complied



### Lower Band Edge Peak Hopping



### Upper Band Edge Peak Hopping

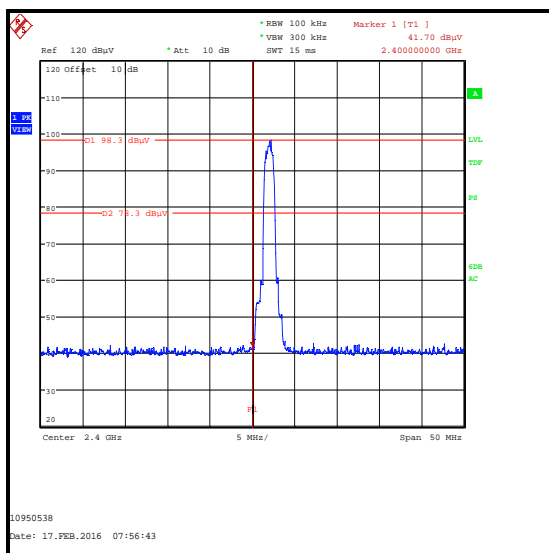
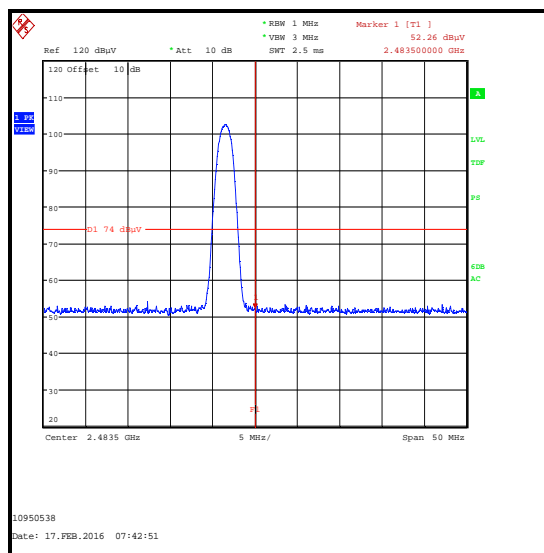
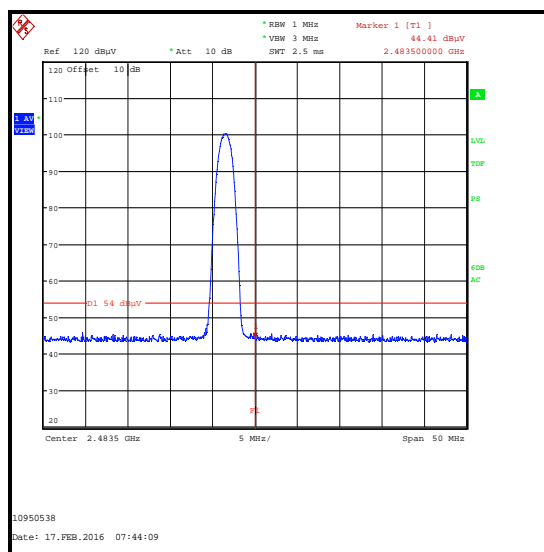


### Upper Band Edge Average Hopping

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400.000	Horizontal	41.7	78.3*	36.6	Complied
2483.500	Horizontal	52.3	74.0	21.7	Complied

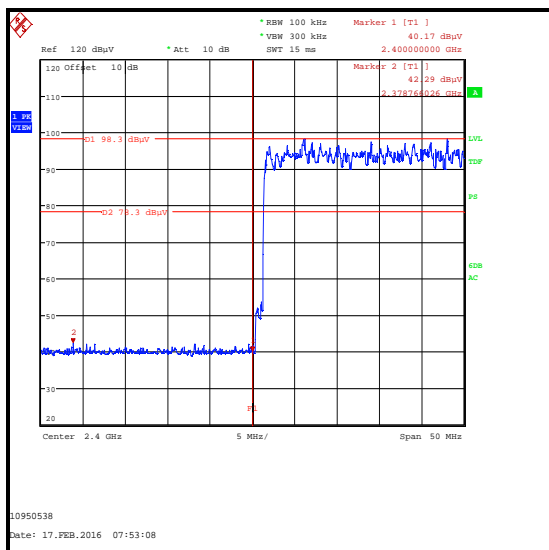
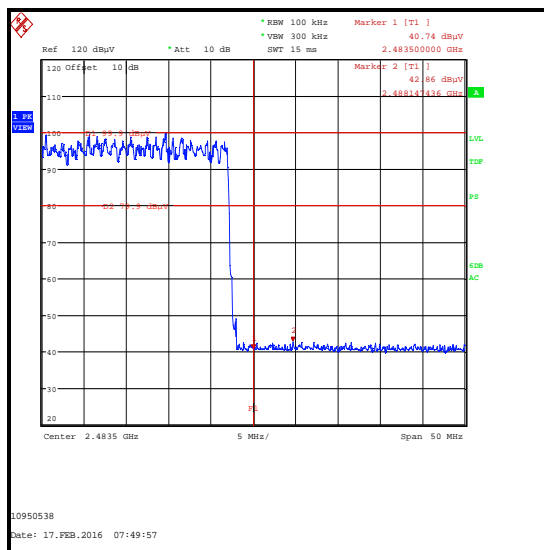
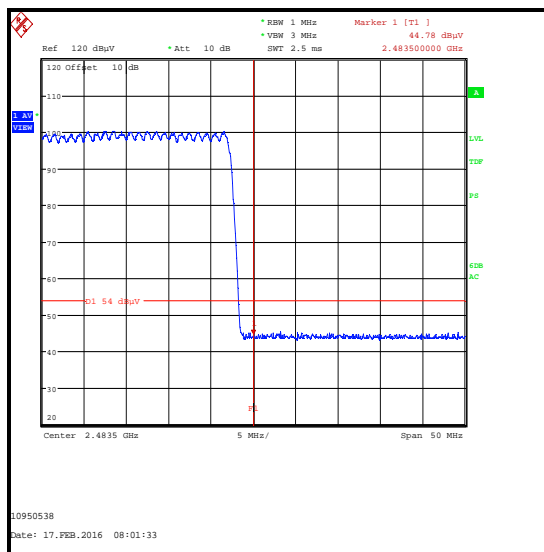
Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Horizontal	44.4	54.0	9.6	Complied

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

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

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2378.766	Horizontal	42.3	78.3*	36.0	Complied
2400.000	Horizontal	40.2	78.3*	38.1	Complied
2483.500	Horizontal	40.7	74.0	33.3	Complied
2488.147	Horizontal	42.9	74.0	31.1	Complied

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.500	Horizontal	44.8	54.0	9.2	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Lower Band Edge Peak Hopping****Upper Band Edge Peak Hopping****Upper Band Edge Average Hopping**

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

<b>Asset No.</b>	<b>Instrument</b>	<b>Manufacturer</b>	<b>Type No.</b>	<b>Serial No.</b>	<b>Date Calibration Due</b>	<b>Cal. Interval (Months)</b>
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 May 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	00075692	17 Dec 2016	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	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 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	55	-	Corrected calibration due date for Asset No. A1534

--- END OF REPORT ---