TEST REPORT

Test Report No. : UL-RPT-RP-11836681-216FCC

Manufacturer	:	Harman Becker Automotive System GmbH
Model No.	:	AUS4 BASIC
Technology	:	Bluetooth – Basic Rate & EDR
Test Standard(s)	:	FCC Parts 15.209(a) & 15.247

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. Test Report Version 1.2 – Supersede Version 1.1
5. Result of the tested sample: **PASS**

Prepared by: Abdoufataou, Salifou
Title: Laboratory Engineer
Date: 26.09.2018

Approved by: Jakob, Reschke
Title: Test Engineer
Date: 26.09.2018

ilac-MRA

DAkkS Deutsche Akkreditierungsstelle D-PL-19381-02-00

This laboratory is accredited by DAkkS.
The tests reported herein have been performed in accordance with its' terms of accreditation.

UL INTERNATIONAL GERMANY GMBH
Hedelfinger Str. 61
70327 Stuttgart, Germany
STU.CTECHLab@ul.com

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1. Customer Information

Company Name:	Harman Becker Automotive System GmbH
Company Address:	Becker-Göring-str.16, 67307- Karlsbad, Germany
Contact Person:	Ouajdi Ochi / Stefan Blaschek
Contact E-Mail Address:	ouajdi.ochi@harman.com / stefan.blaschek@harman.com
Contact Phone No.:	+49 7248715407 / +49 7248713382

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart B (Unintentional Radiators) –15.109
Site Registration:	22511-1

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany

Date information

Order Date:	23 June 2017
EUT arrived:	03 May 2017
Test Dates:	29 August 2017 to 11 October 2017
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement	Complied	Did not comply	Not performed	Not applicable
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	☒	☐	☐	☐

Note:
Device is an in car/vehicle device. No connection to AC mains. Due to this fact Part 15.207 is not applicable (AC conducted measurements)

2.3. Methods and Procedures

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

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	SCANIA
Model Name or Number:	AUS4 BASIC
Test Sample Serial Number:	A558CT0H2513013 and A558CQ0H2513001*(Radiated samples)*
Hardware Version Number:	H32
Software Version Number:	SCANIA_J5_R32.0.016313A
FCC ID:	T8GAUS4BASIC

Brand Name:	SCANIA
Model Name or Number:	AUS4 BASIC
Test Sample Serial Number:	A558CROH2513020 *(Conducted sample)*
Hardware Version Number:	H32
Software Version Number:	SCANIA_J5_R32.0.016313A
FCC ID:	T8GAUS4BASIC

3.2. Description of EUT

The equipment under test was a head unit with Bluetooth capability.

Device is mounted in a car/vehicle and powered over the car battery. No AC mains supply/connection possible.

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	12 VDC	
Type of Unit:	Transceiver		
Channel Spacing:	1 MHz		
Mode:	Basic Rate	Enhanced Data Rate	
Modulation:	GFSK	π/4-DQPSK	8DPSK
Packet Type: (Maximum Payload)	DH5	2DH5	3DH5
Data Rate (Mbps):	1	2	3
Maximum Conducted Output Power:	5.9 dBm		
Antenna Gain:	4.5 dBi		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	1	2402
	Middle	39	2441
	Top	79	2480

3.5. Support Equipment

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

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Laptop PC with software application Tera Term	Lenovo	20F1-001YGE	MP-16X71T 16/11
2	Power supply wires (Length 2 metres)	Not marked or stated	Not marked or stated	Not marked or stated
3	Edge connector	HARMAN BECKER	45/16 MOS	Not marked or stated
4	USB-Adapter	BECKER	40/16 MOS	Not marked or stated
5	USB cable (Length 2 metres)	Not marked or stated	Not marked or stated	Not marked or stated
6	Laboratory Power Supply	Conrad Electronic Germany	PS-2403D	Not marked or stated
7	2 USB	Kingston	DTR3.0 G2	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):

- Controlled using a terminal application on the laptop PC along with instructions provided by the customer. The document was called “How to configure named MAN-Scania-Testsetup_170116 v06.pdf” dated 16/01/17.
- Both EDR/Basic rate modes were compared and tests were performed with the mode that presented the worst case result. For output power, bandwidth, band edge and channel separation, all modes were tested.
- Transmitter radiated spurious emissions tests were performed with the EUT transmitting in DH5 mode as this mode was found to transmit the highest power.
- The EUT was powered via a 12 V power supply for both conducted and radiated tests.
- For Transmit tests: A test computer with the above mentioned software application was used to place the EUT into *Bluetooth* modes.
- The EUT conducted sample was used for peak output power, Bandwidth, transmitter number of hopping frequencies, average time of occupancy and transmitter carrier frequency separation measurement.
- The EUT radiated sample was used for transmitter band edge radiated emissions and radiated spurious emissions tests.
- Software EMC32 V10.1.0

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 DAkkS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	05 October 2017
Test Sample Serial Number:	A558CROH2513020 *(Conducted sample with RF port)*		
Test Site Identification	SR 9		

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

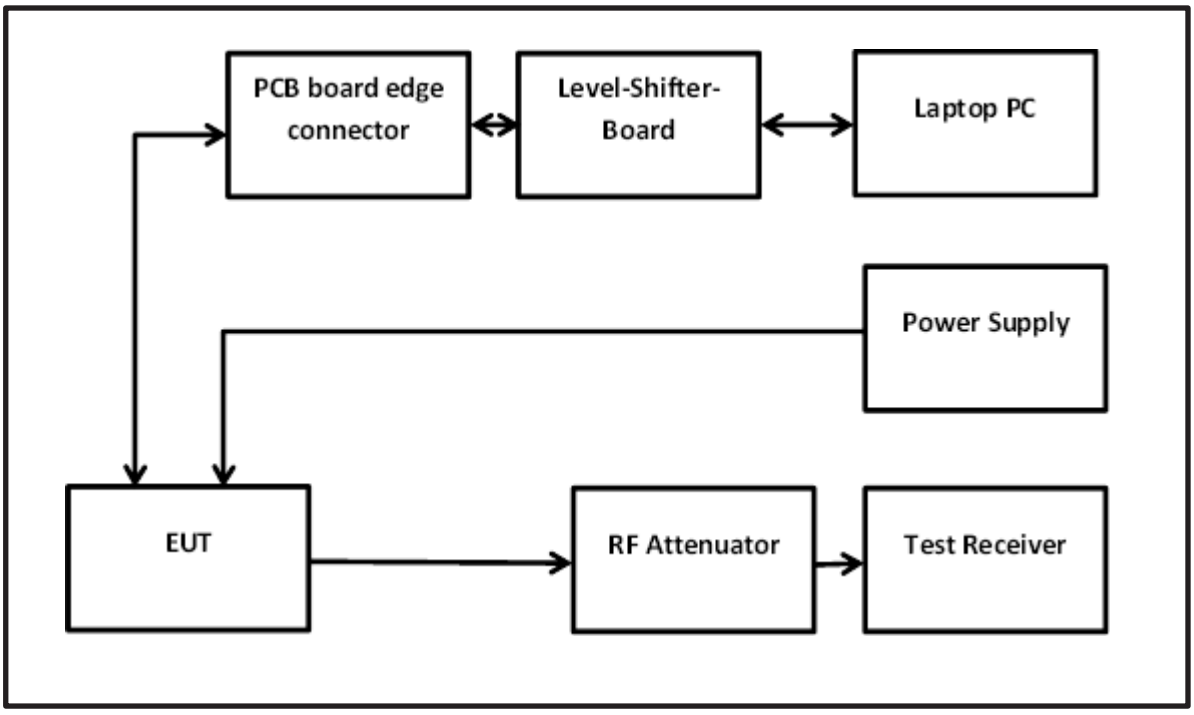
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	48

Note(s):

1. The test receiver resolution bandwidth was set to 30 kHz and video bandwidth 100 kHz. A MaxPeak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 3.0 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 test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

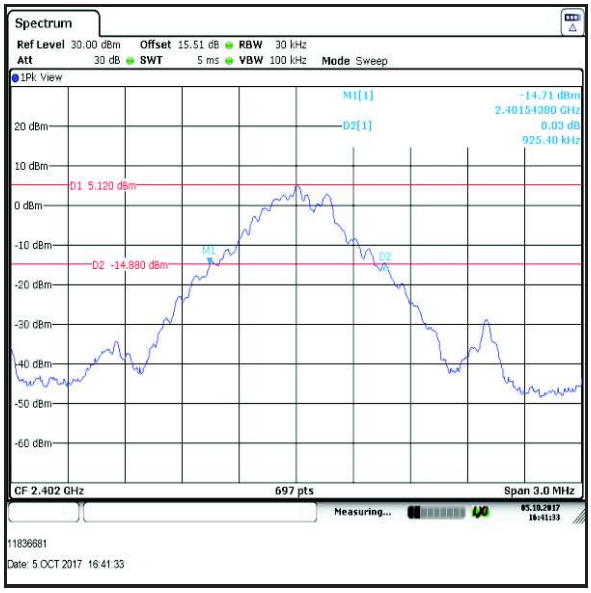
Test setup:



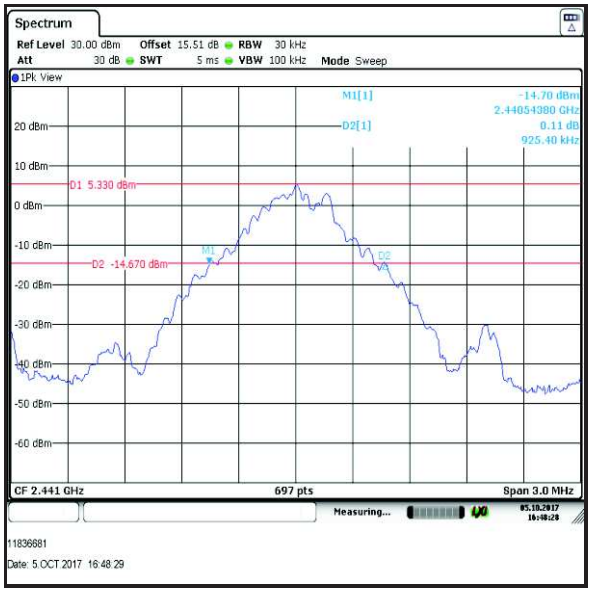
Transmitter 20 dB Bandwidth (continued)

Results DH5:

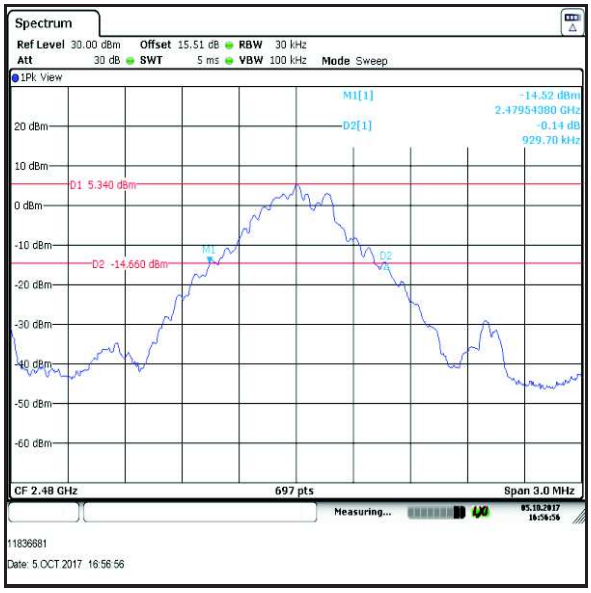
Channel	20 dB Bandwidth (kHz)
Bottom	925.400
Middle	925.400
Top	929.700



Bottom Channel



Middle Channel

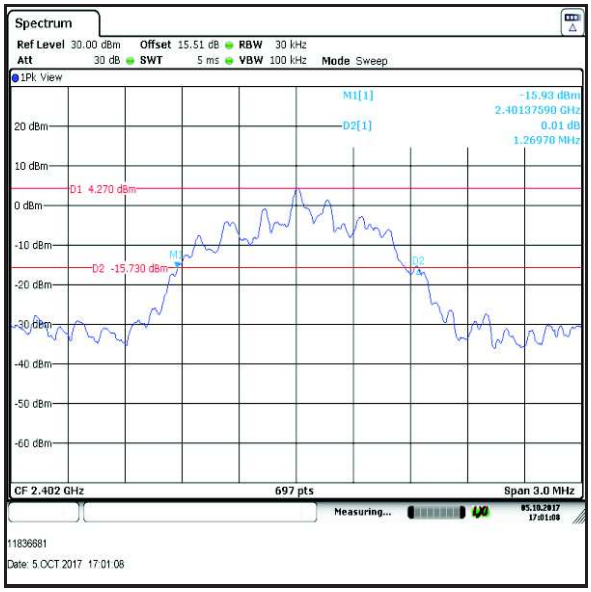


Top Channel

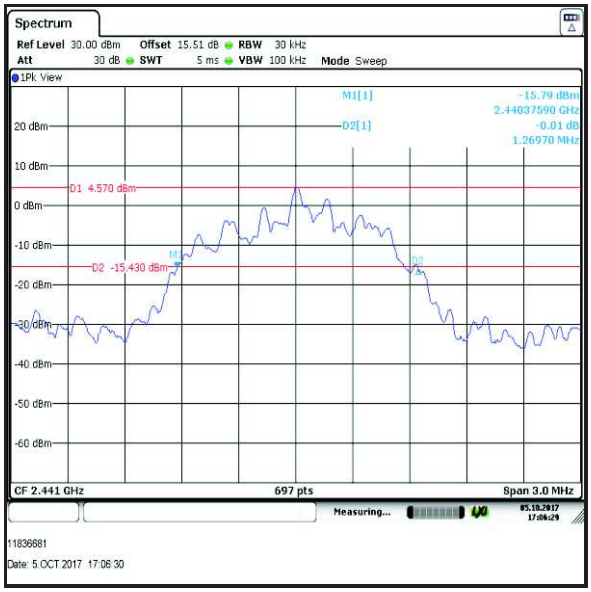
Result: Pass

Results 2DH5:

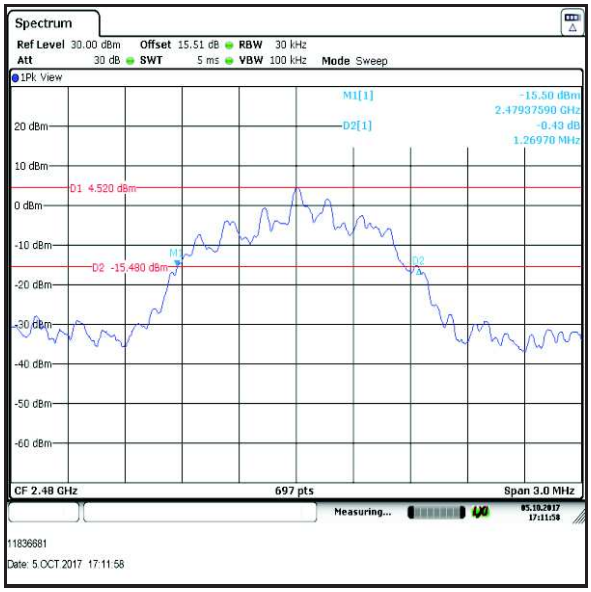
Channel	20 dB Bandwidth (kHz)
Bottom	1269.700
Middle	1269.700
Top	1269.700



Bottom Channel



Middle Channel

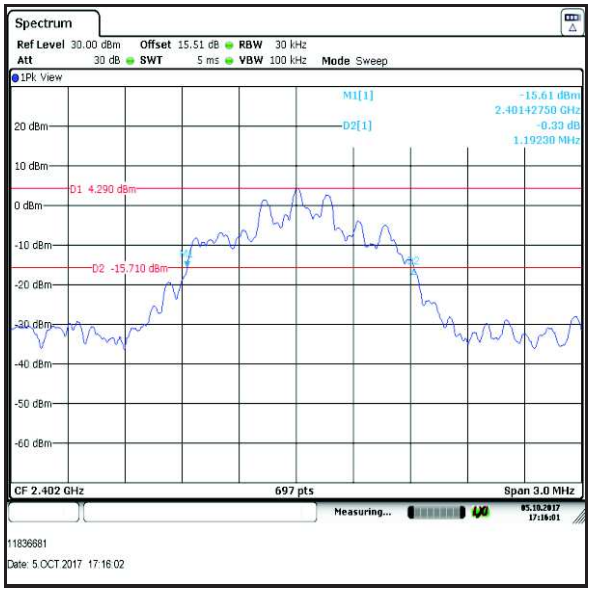


Top Channel

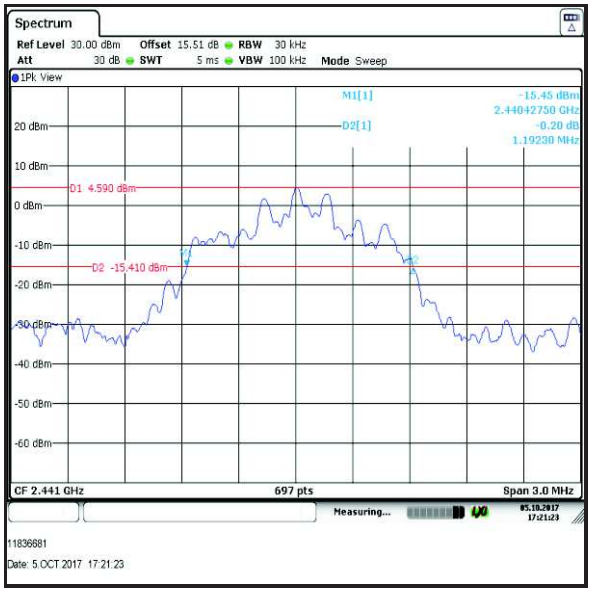
Result: Pass

Results 3DH5:

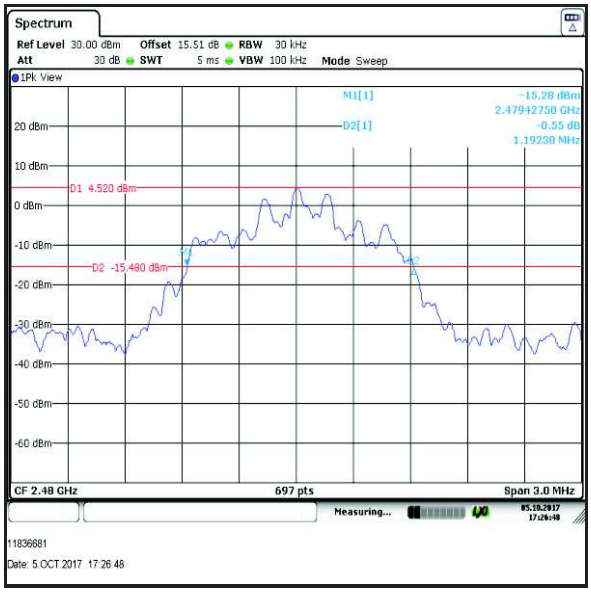
Channel	20 dB Bandwidth (kHz)
Bottom	1192.300
Middle	1192.300
Top	1192.300



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.2. Transmitter Carrier Frequency Separation

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	05 October 2017
Test Sample Serial Number:	A558CROH2513020 *(Conducted sample with RF port)*		
Test Site Identification	SR 9		

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

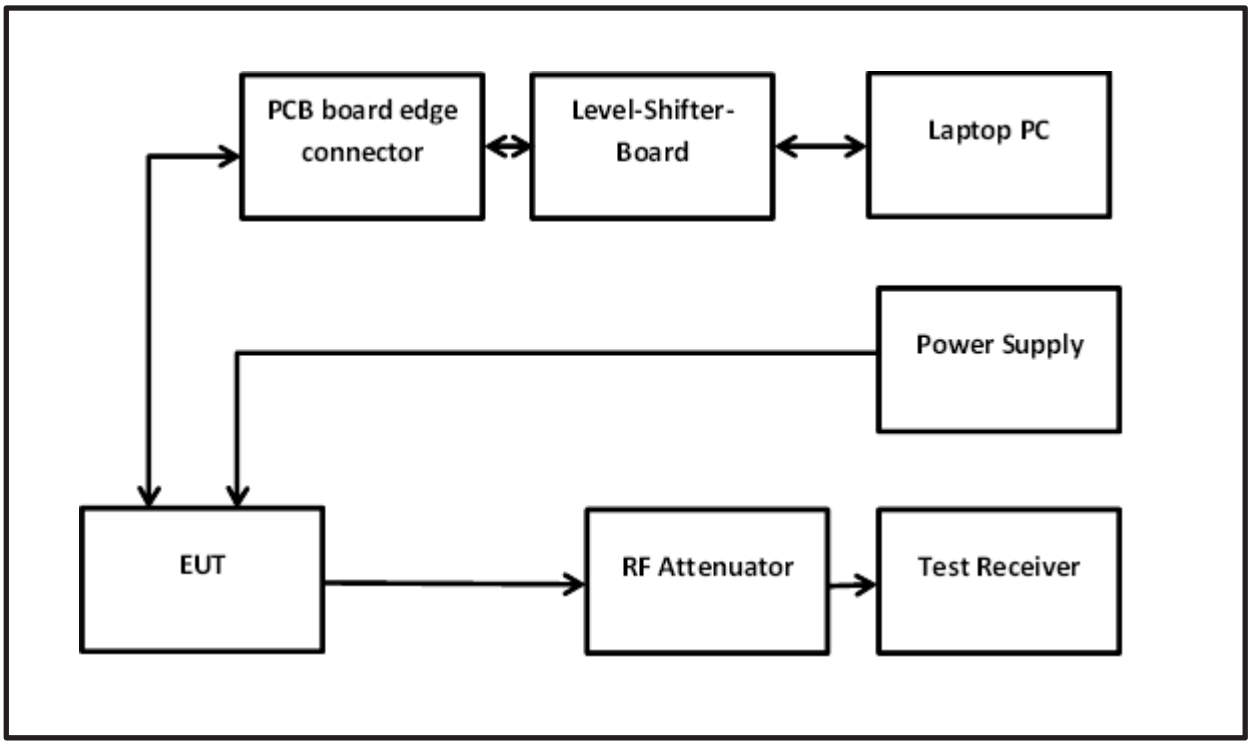
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	48

Note(s):

1. The 20 dB bandwidth measured for the middle channel operating at 2441 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 test receiver 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 3MHz. A marker was placed at the centre of one signal and then a delta marker was placed in the same place on the second signal, the results are recorded in the table below.
3. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

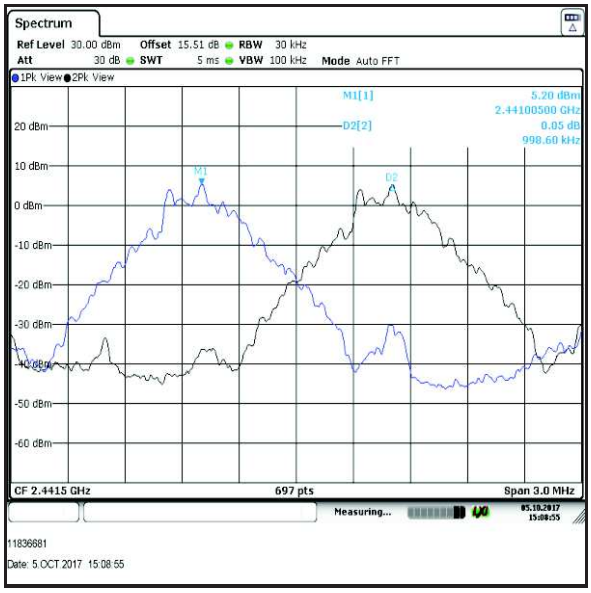
Test setup:



Transmitter Carrier Frequency Separation (continued)

Results: DH5

Carrier Frequency Separation (kHz)	Limit ($^2/_3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	616.933	381.667	Complied

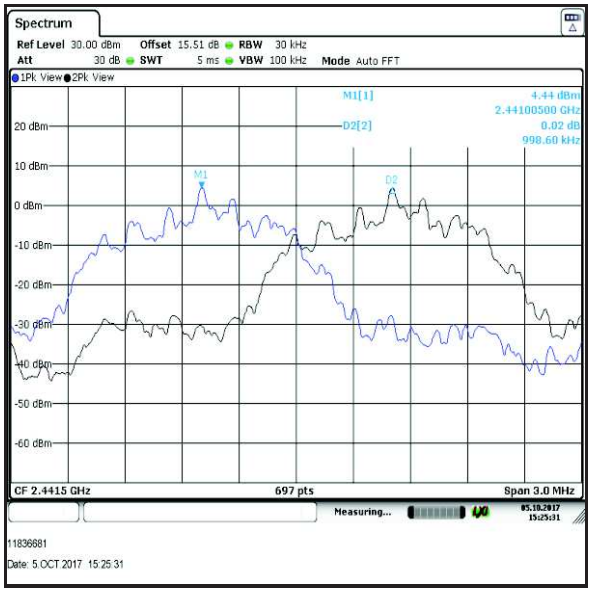


Result: Pass

Transmitter Carrier Frequency Separation (continued)

Results: 2DH5

Carrier Frequency Separation (kHz)	Limit ($^2/_3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	846.467	152.133	Complied

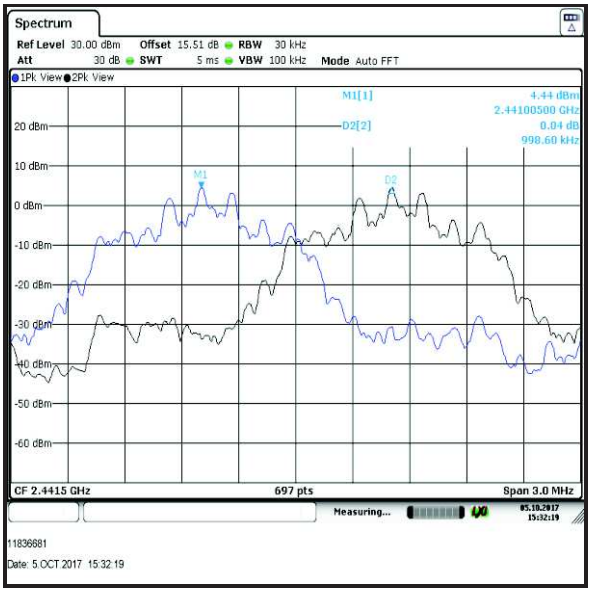


Result: Pass

Transmitter Carrier Frequency Separation (continued)

Results: 3DH5

Carrier Frequency Separation (kHz)	Limit ($^2/_3$ of 20 dB BW) (kHz)	Margin (kHz)	Result
998.600	794.867	203.734	complied



Result: Pass

5.2.3. Transmitter Number of Hopping Frequencies and Average Time of Occupancy

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	05 October 2017
Test Sample Serial Number:	A558CROH2513020 *(Conducted sample with RF port)*		
Test Site Identification	SR 9		

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

Environmental Conditions:

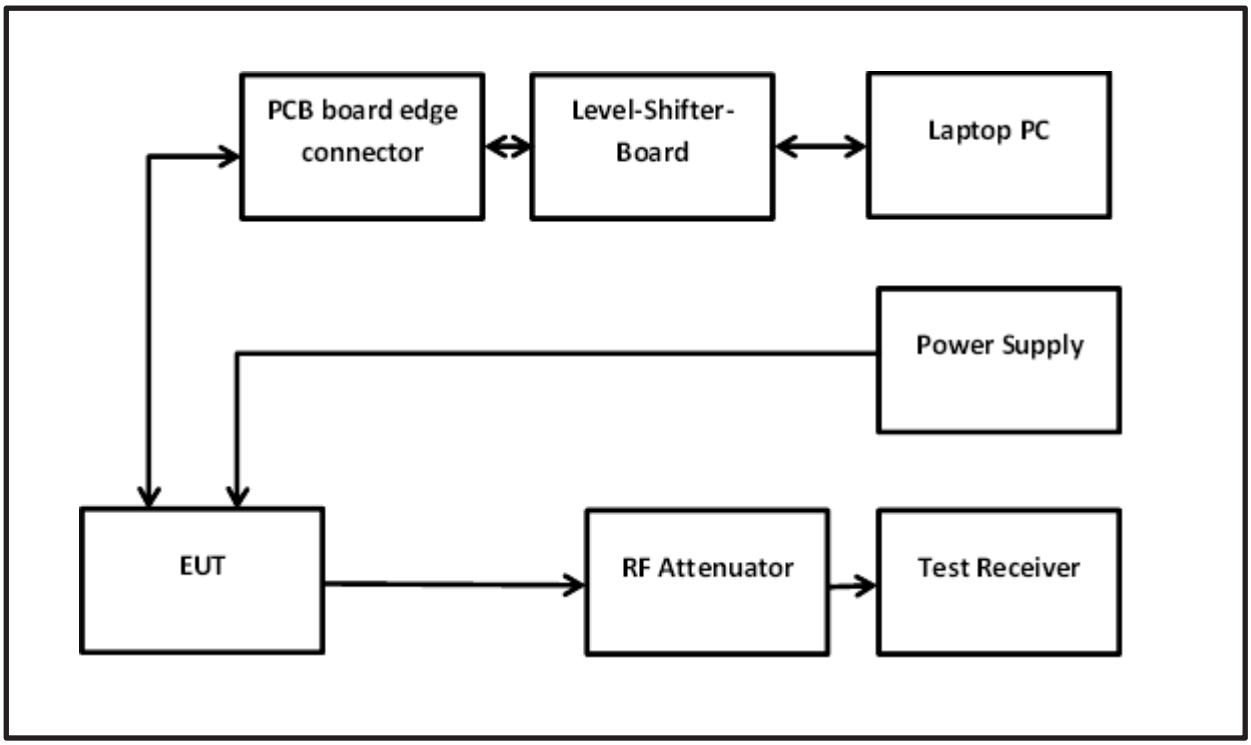
Temperature (°C):	24
Relative Humidity (%):	48

Note(s):

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

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

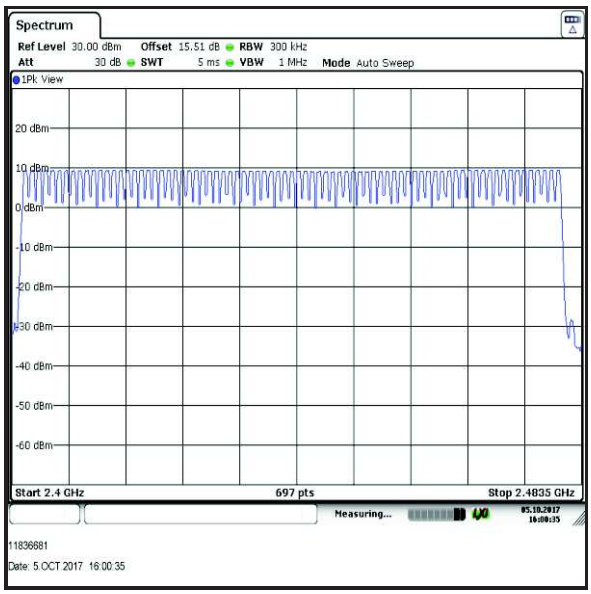
Test setup:



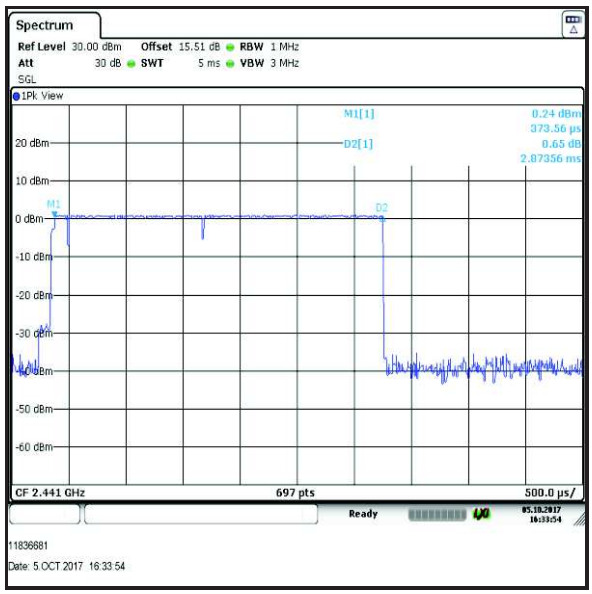
Transmitter Number of Hopping Frequencies and Average Time of Occupancy(continued)

Results:

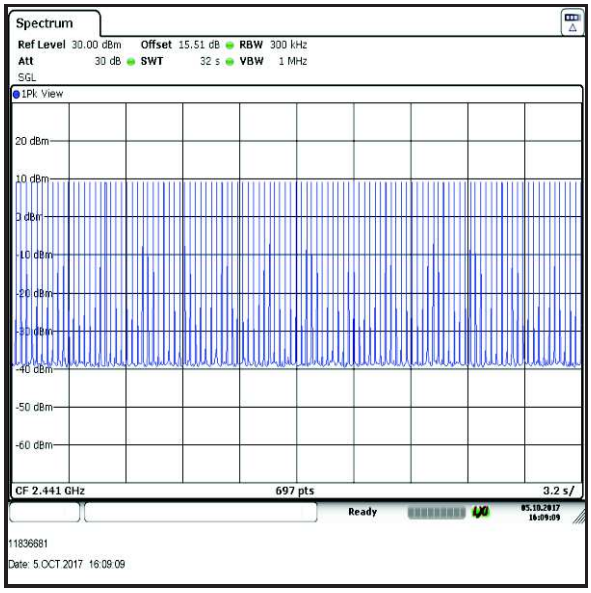
Emission Width (µs)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2873.560	79	0.227	0.4	0.173	Complied



Number of Hopping Frequencies



Emission width



Number of Hopping Frequencies in 32 s

5.2.4. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	05 October 2017
Test Sample Serial Number:	A558CROH2513020 *(Conducted sample with RF port)*		
Test Site Identification	SR 1/2		

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

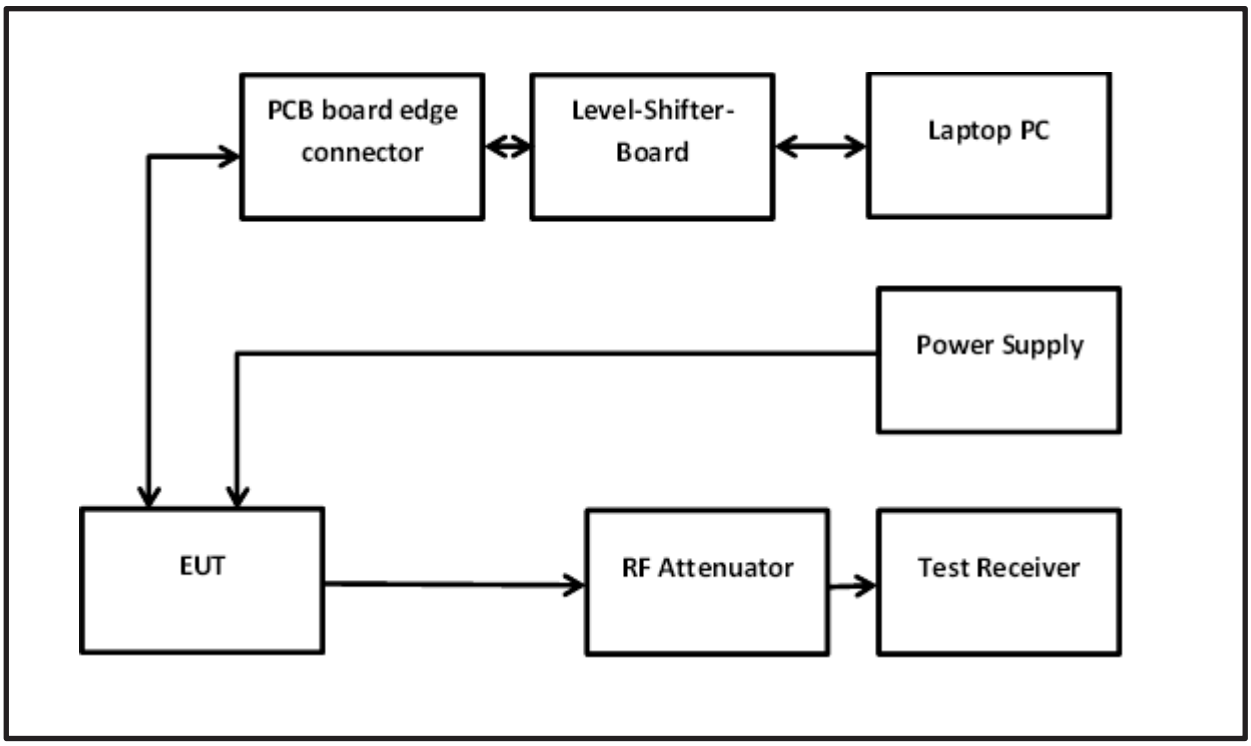
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	44

Note(s):

1. These tests were performed conducted; therefore the EUT antenna gain is encompassed in the final result and not measurable.
2. The test receiver resolution bandwidth was set to 2 MHz (>20 dB bandwidth) and video bandwidth of 5MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 5.0 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.
3. The declared antenna gain was added to the conducted peak power to obtain the EIRP.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF offset level was entered on the test receiver to compensate for the loss of the attenuator and RF cable.

Test setup:



Transmitter Maximum Peak Output Power (continued)

Results: DH5

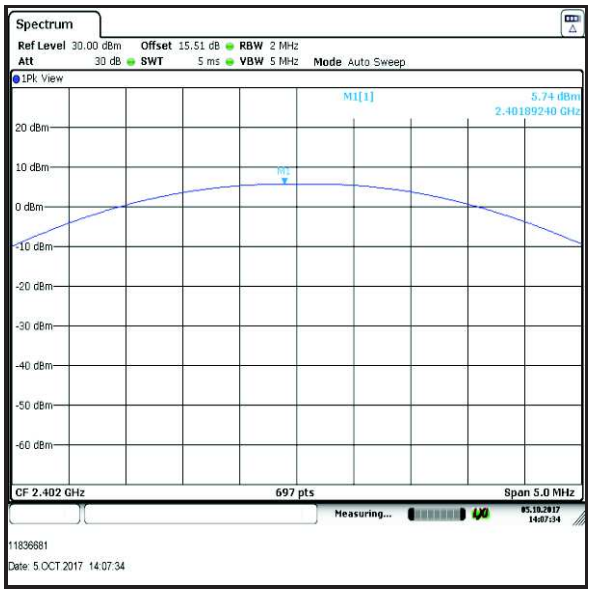
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.7	30.0	24.3	Complied
Middle	5.9	30.0	24.1	Complied
Top	5.9	30.0	24.1	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.7	4.5	10.2	36.0	25.8	Complied
Middle	5.9	4.5	10.4	36.0	25.6	Complied
Top	5.9	4.5	10.2	36.0	25.6	Complied

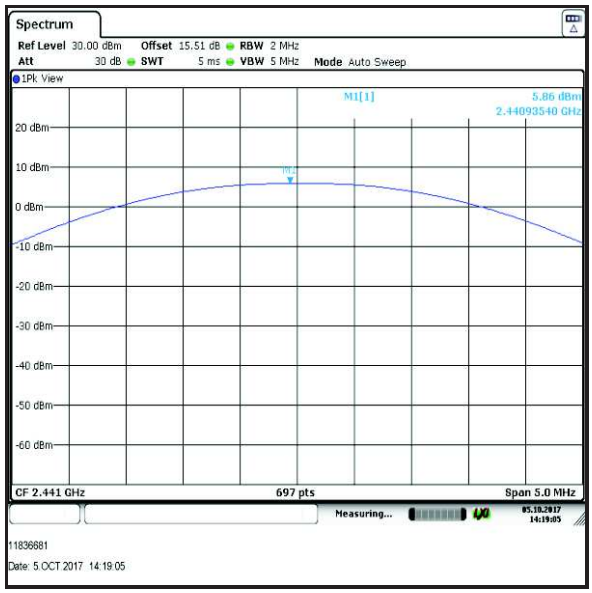
Result: Pass

Transmitter Maximum Peak Output Power (continued)

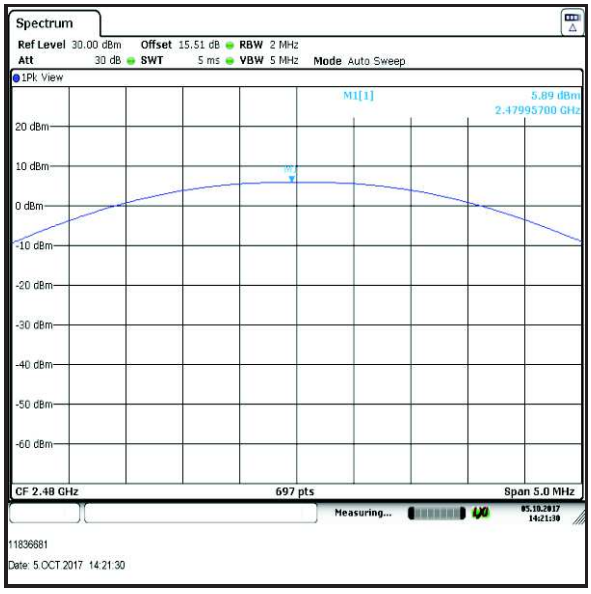
Results: DH5



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Peak Output Power (continued)

Results: 2DH5

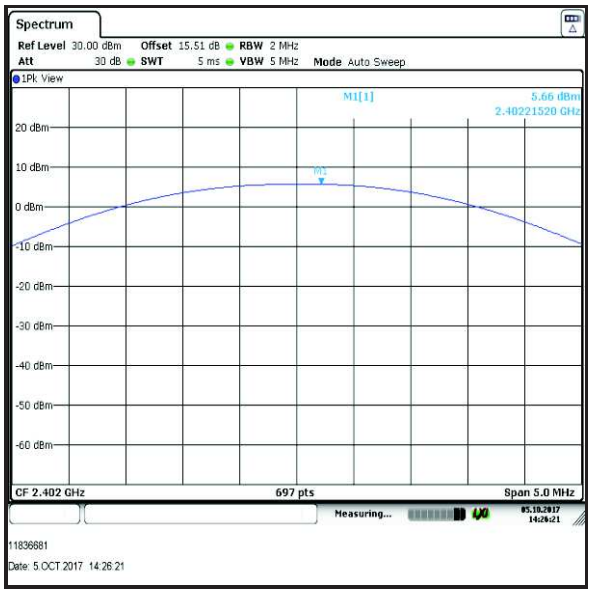
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.7	21.0	15.3	Complied
Middle	5.8	21.0	15.2	Complied
Top	5.8	21.0	15.2	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.7	4.5	10.2	27.0	16.8	Complied
Middle	5.8	4.5	10.3	27.0	16.7	Complied
Top	5.8	4.5	10.3	27.0	16.7	Complied

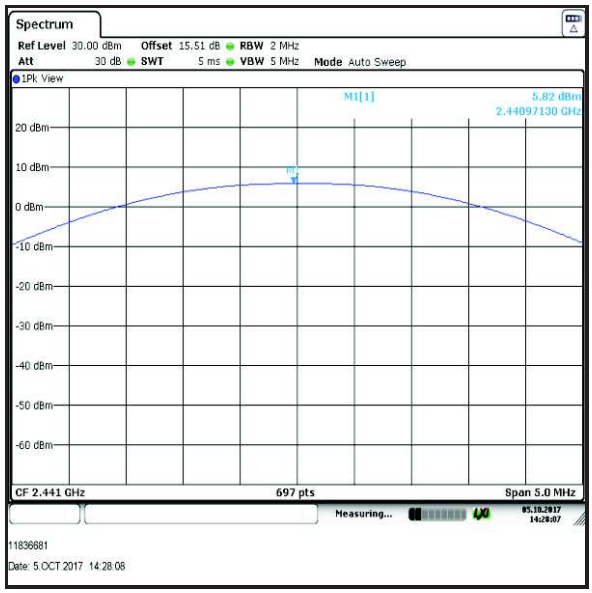
Result: Pass

Transmitter Maximum Peak Output Power (continued)

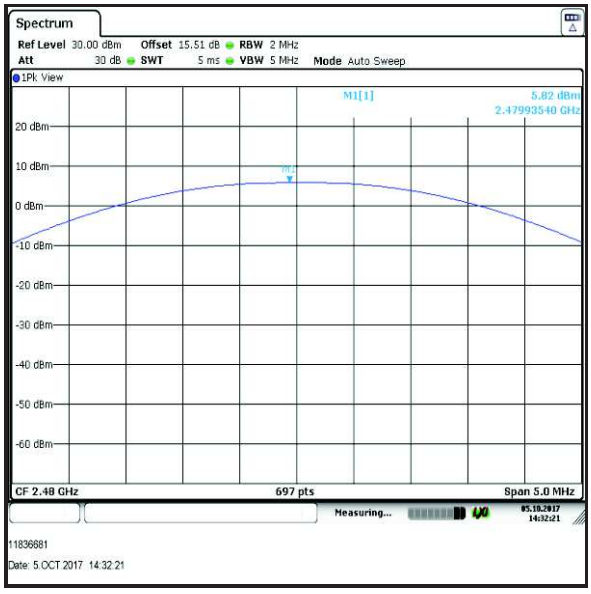
Results:2DH5



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Peak Output Power (continued)

Results: 3DH5

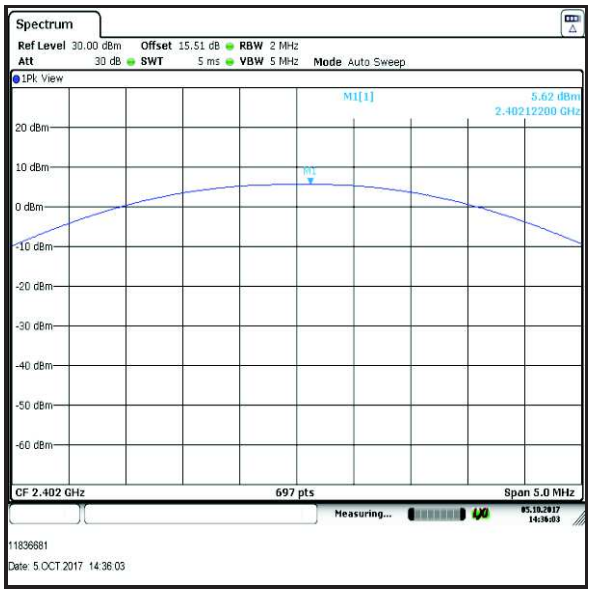
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.6	21.0	15.4	Complied
Middle	5.8	21.0	15.2	Complied
Top	5.8	21.0	15.2	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.6	4.5	10.1	27.0	16.9	Complied
Middle	5.8	4.5	10.3	27.0	16.7	Complied
Top	5.8	4.5	10.3	27.0	16.7	Complied

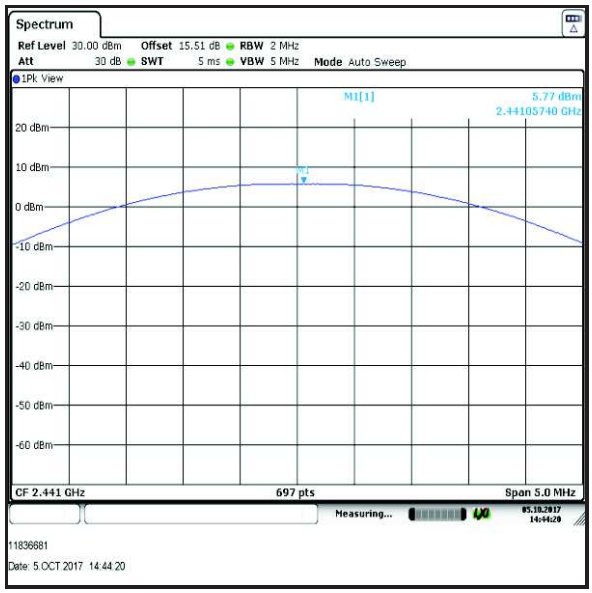
Result: Pass

Transmitter Maximum Peak Output Power (continued)

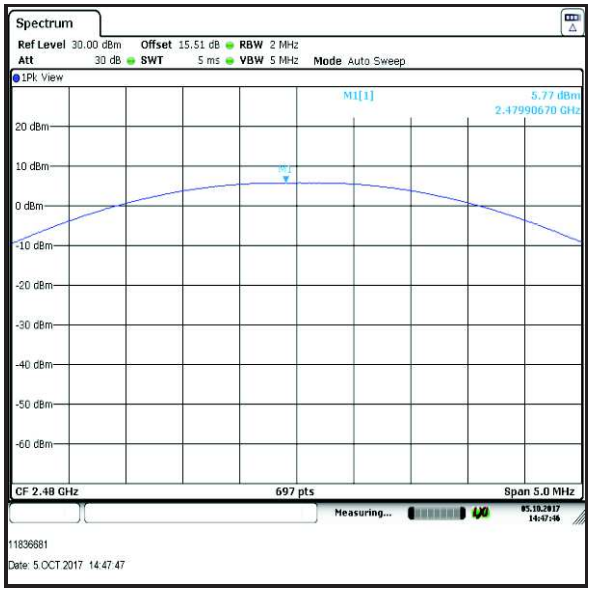
Results: 3DH5



Bottom Channel



Middle Channel



Top Channel

5.2.5. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	06 September 2017
Test Sample Serial Number:	A558CQ0H2513001 *(Radiated sample)*		
Test Site Identification	SR 1/2		

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

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	51

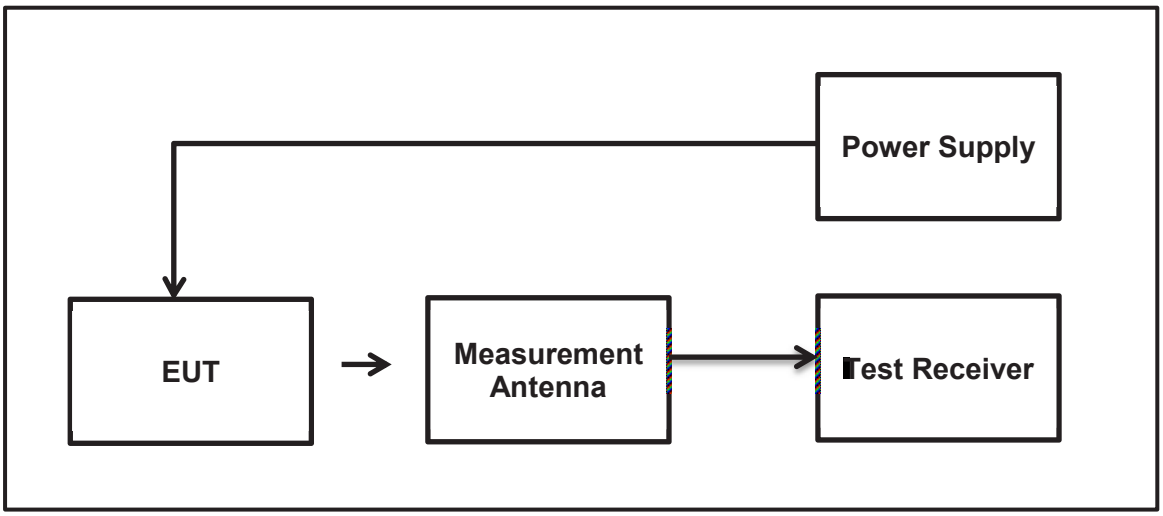
Note(s):

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 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 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:

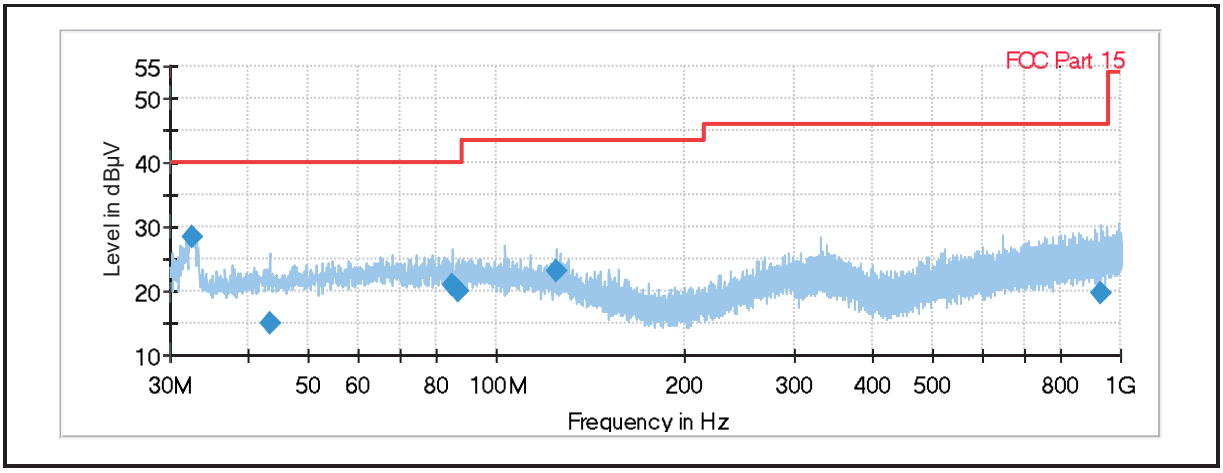
Semi-anechoic chamber



Transmitter Radiated Emissions (continued)

Results: middle channel

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
32.625	Vertical	28.4	40	11.6	Complied



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Result: Pass

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	29 August 2017 10 October 2017
Test Sample Serial Number:	A558CT0H2513013 *(Radiated sample)*		
Test Site Identification	SR 1/2		

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):	24
Relative Humidity (%):	51

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.
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. Pre-scans above 1 GHz were performed in a semi anechoic chamber with absorber on the floor 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. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
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 their own appropriate detectors during the pre-scan measurements.

Transmitter Radiated Emissions (continued)

Results: Peak / Bottom Channel / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
4803.667	Vertical	46.8	54.0	7.2	Complied
12673.917	Vertical	50.8	54.0	3.2	Complied

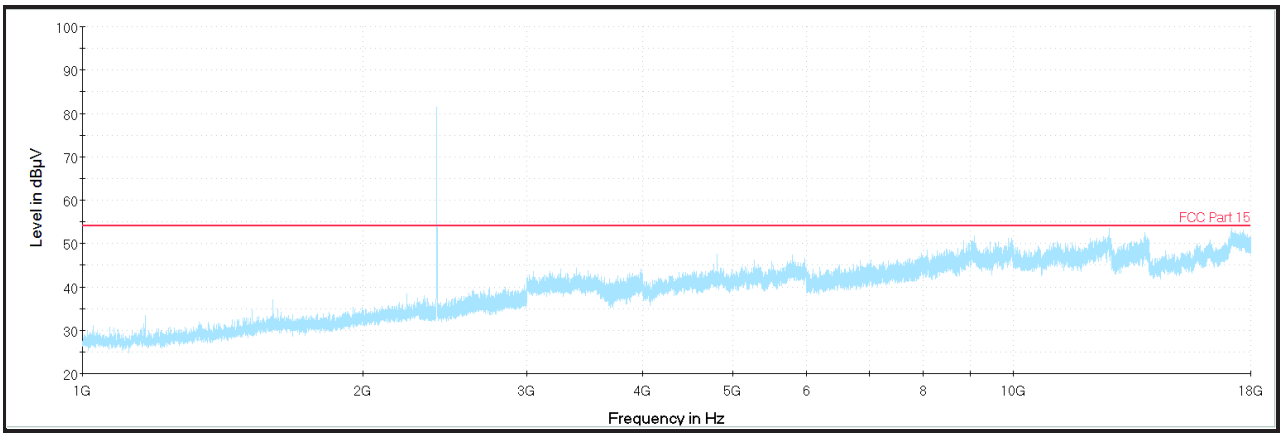
Results: Peak / Middle Channel / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
4882.000	Horizontal	45.8	54.0	8.2	Complied
7484.000	Horizontal	43.4	54.0	10.6	Complied
9991.333	Horizontal	50.7	54.0	3.3	Complied

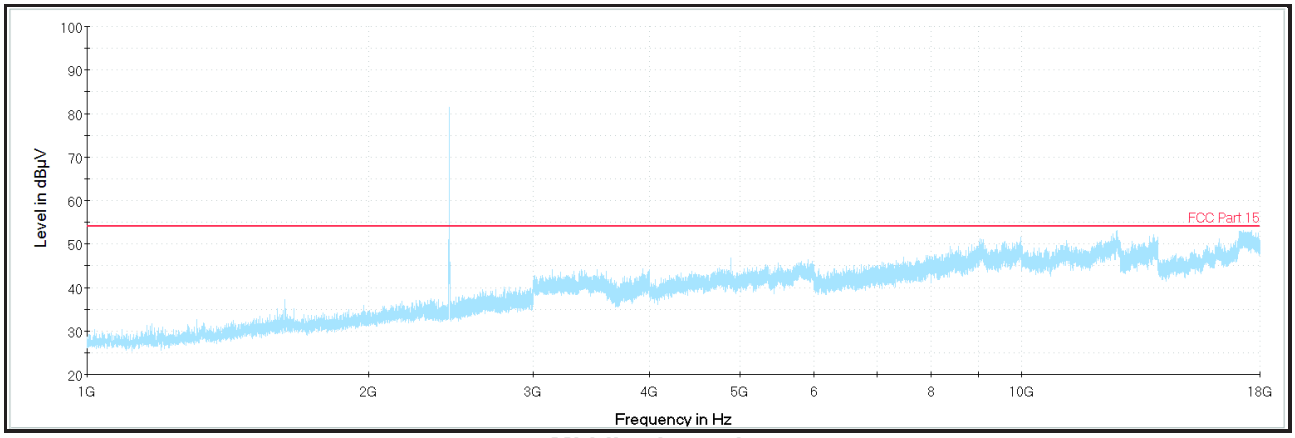
Results: Peak / Top Channel / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
4960.000	Horizontal	45.2	54.0	8.8	Complied
7026.667	Horizontal	44.7	54.0	9.3	Complied

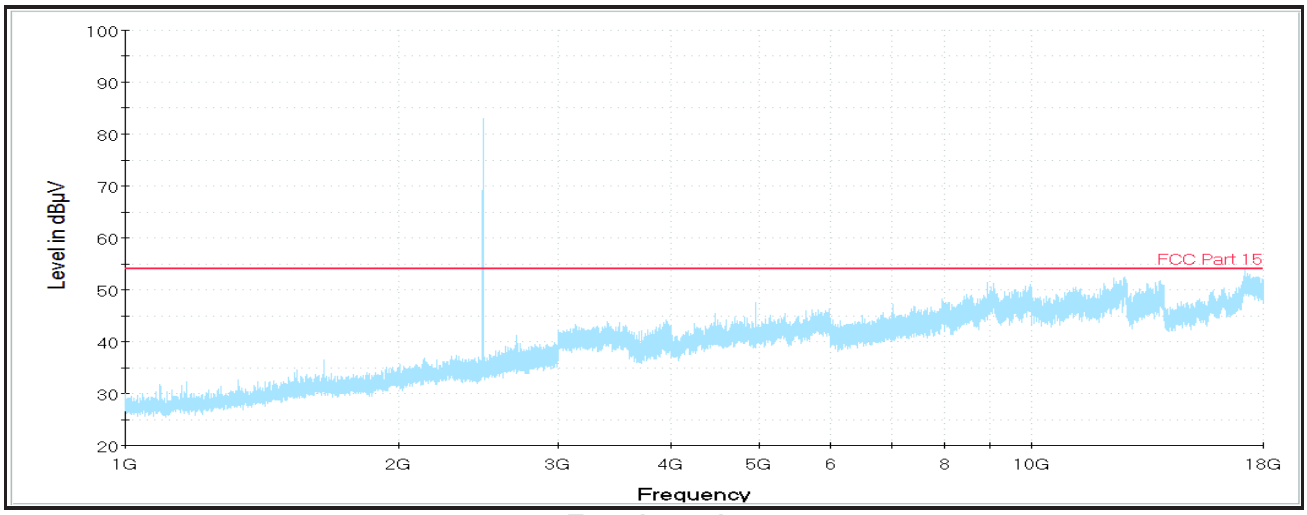
Transmitter Radiated Emissions (continued)



Bottom channel

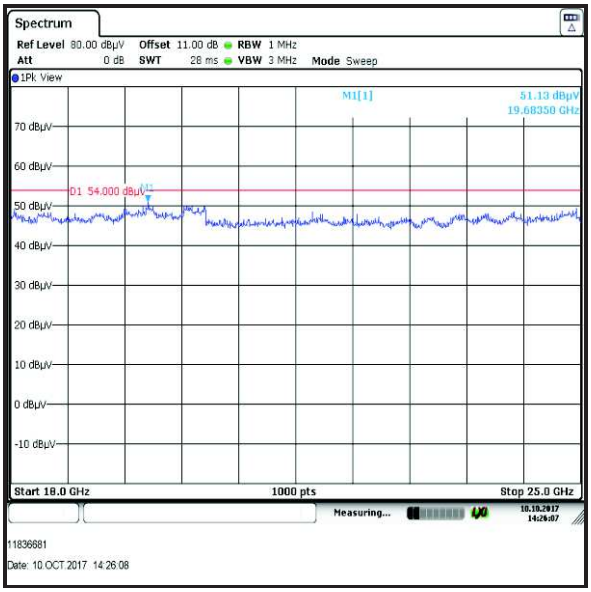


Middle channel



Top channel

Transmitter Radiated Emissions (continued)



From 18 GHz to 25 GHz

Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Result: Pass

5.2.6. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Abdoufataou Salifou	**Test Date:**	27 September 2017 to 11 October 2017
Test Sample Serial Number:	A558CQ0H2513001 *(Radiated sample)*		
Test Site Identification	SR 1/2		

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):	24
Relative Humidity (%):	40

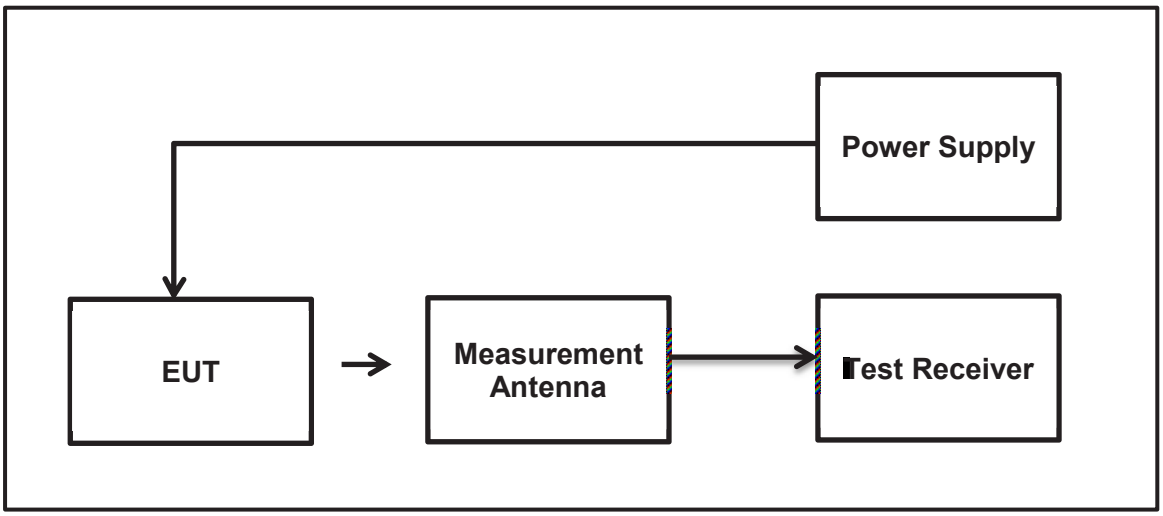
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. As the lower band edge is adjacent to a non-restricted band, only peak measurements are required. In accordance with FCC KDB 558074 Section 11.1, the test method in Section 11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum conducted (average) output power was measured using an RMS detector in accordance with FCC KDB 558074 Section 9.2.2.4 an out-of-band limit line was placed 20 dB (FCC KDB 558074 Section 11.1(b)) below the peak level. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent non-restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
3. As the upper band edge is adjacent to a restricted band both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was trace averaging over 300 sweeps. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
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)

Test setup for Transmitter Band Edge Radiated Emissions:

Semi-anechoic chamber

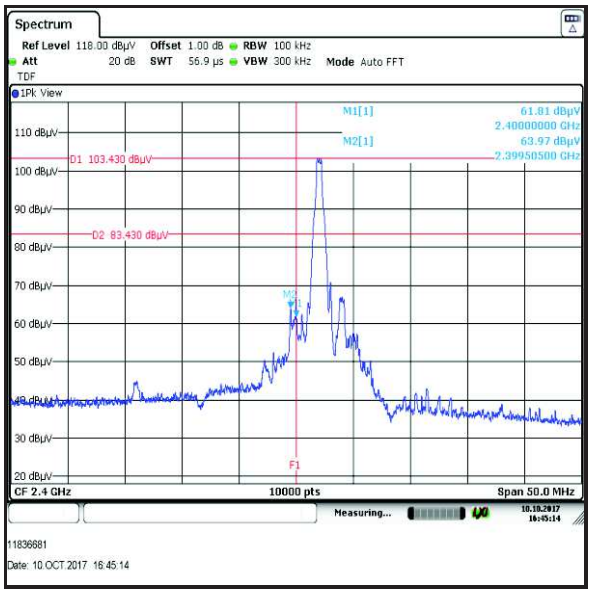


Transmitter Band Edge Radiated Emissions (continued)

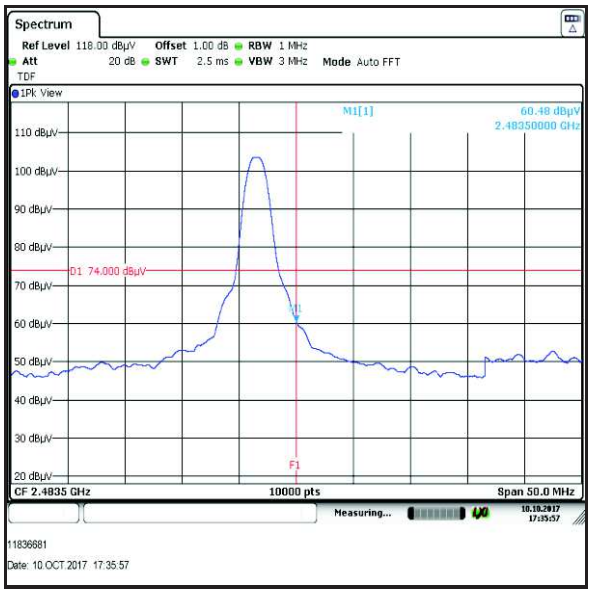
Results: Static Mode / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.505	Vertical	64.0	83.4	19.4	Complied
2400.0	Vertical	61.8	83.4	21.6	Complied
2483.5	Vertical	60.5	74.0	13.5	Complied

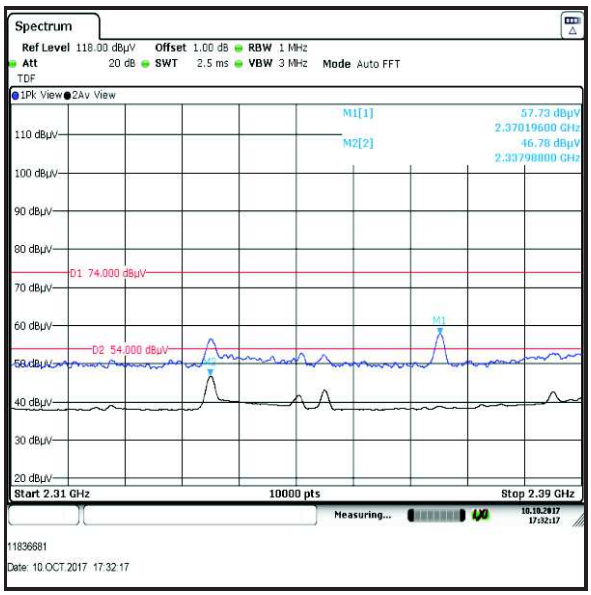
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Horizontal	37.6	54.0	19.4	Complied



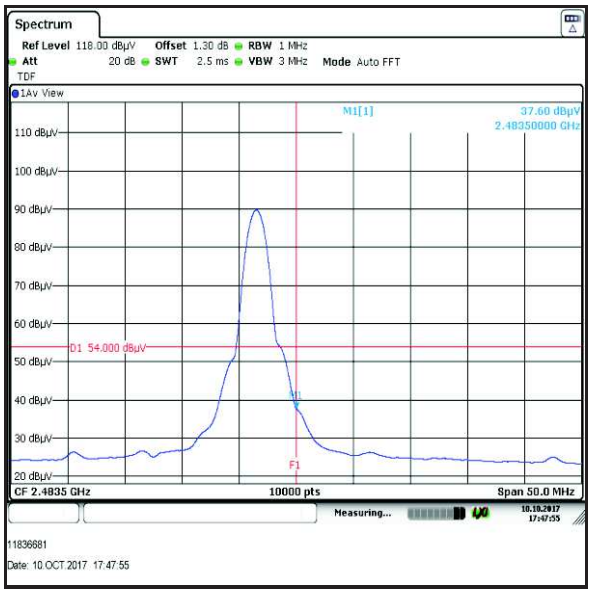
Lower Band Edge Peak Static



Upper Band Edge Peak Static



2310 MHz to 2390 MHz Restricted Band Plot



Upper Band Edge Average Static

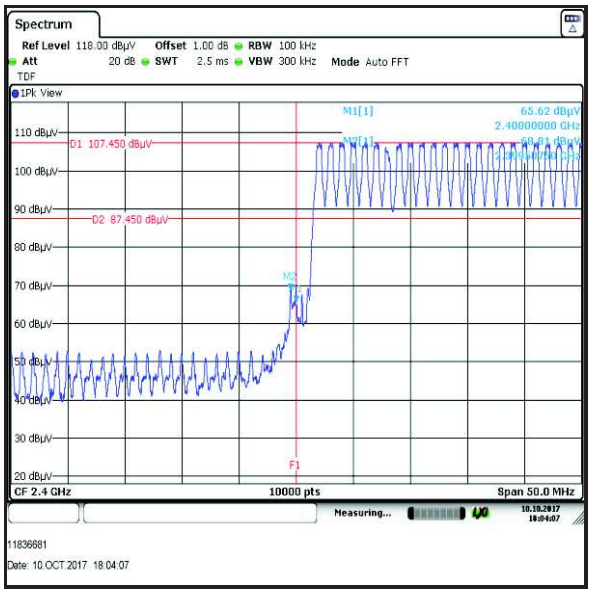
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

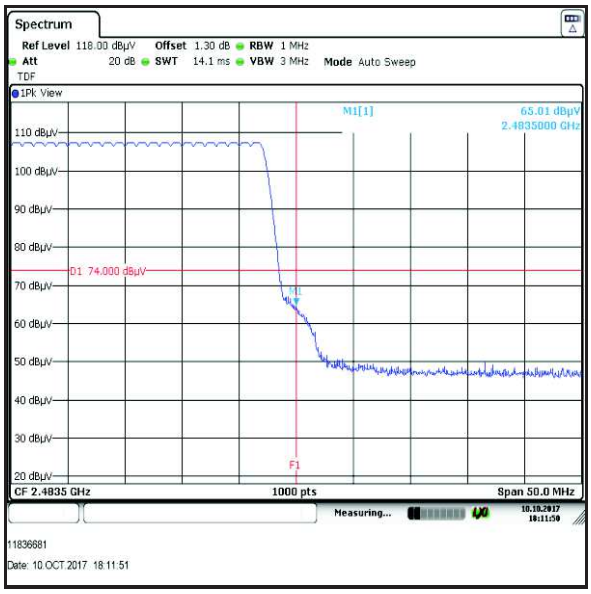
Results: Hopping Mode / DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.507	Vertical	68.8	87.5	18.7	Complied
2400.0	Vertical	65.7	87.5	21.8	Complied
2483.5	Vertical	65.0	74.0	9.0	Complied

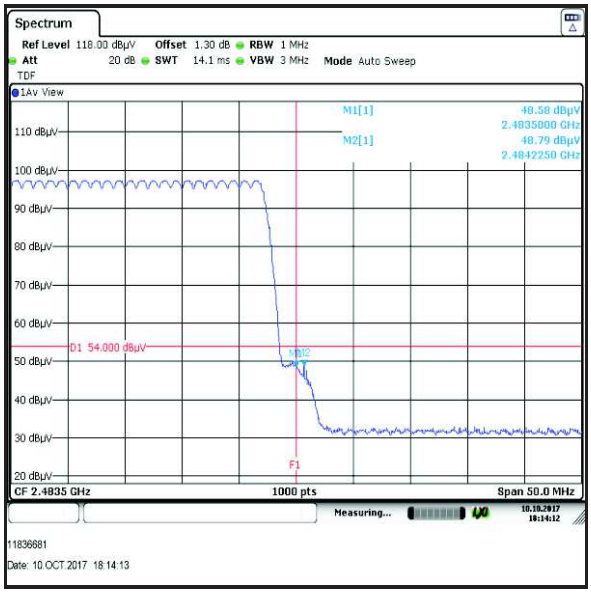
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Vertical	48.6	54.0	5.4	Complied
2484.225	Vertical	48.8	54.0	5.2	



Lower Band Edge Peak Hopping



Upper Band Edge Peak Hopping



Upper Band Edge Average Hopping

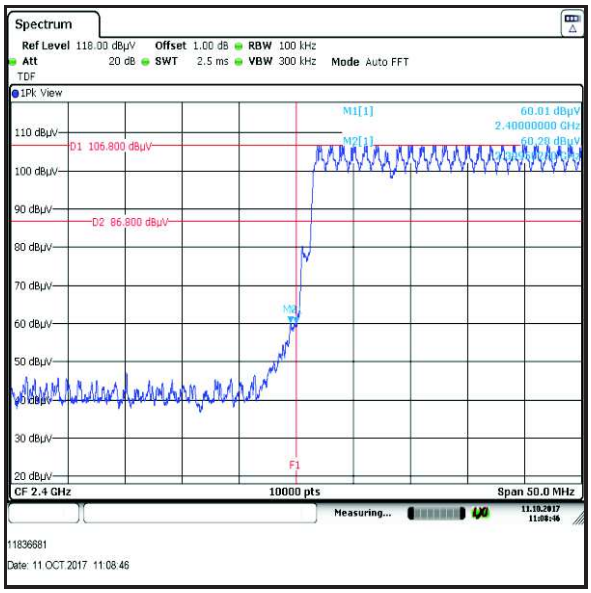
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

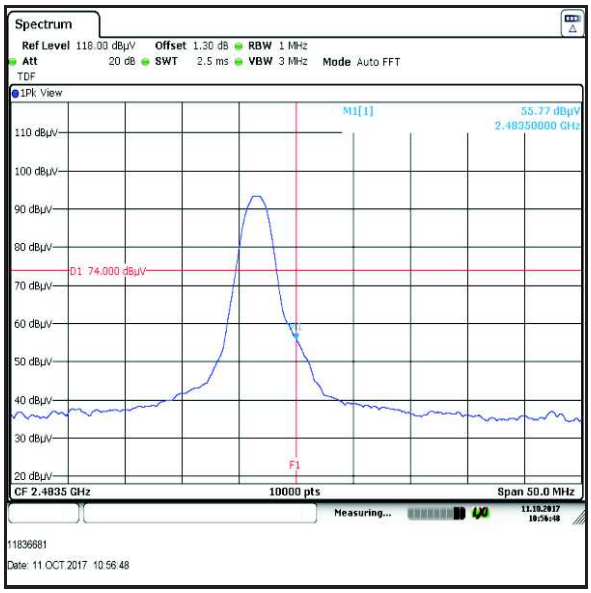
Results: Static Mode / 2DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.502	Horizontal	60	80.6	25.1	Complied
2400.0	Horizontal	54.2	80.6	26.4	Complied
2483.5	Horizontal	55.8	74.0	18.2	Complied

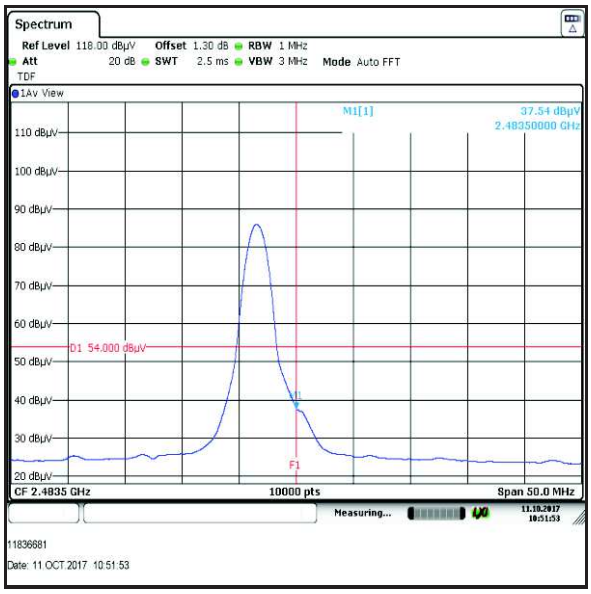
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Horizontal	37.5	54.0	16.5	Complied



Lower Band Edge Peak Static



Upper Band Edge Peak Static



Upper Band Edge Average Static

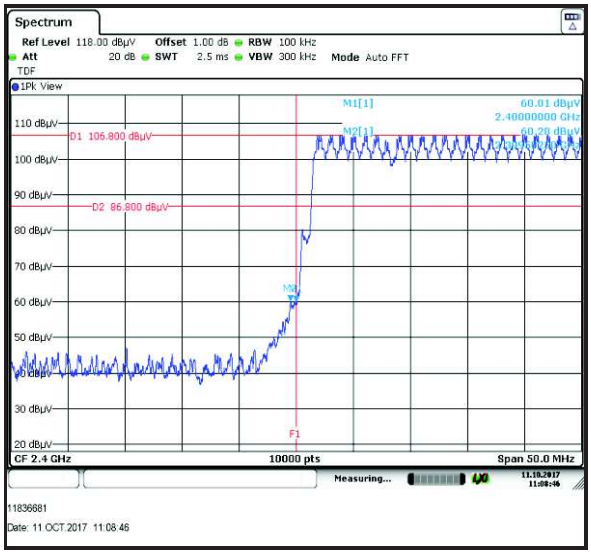
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

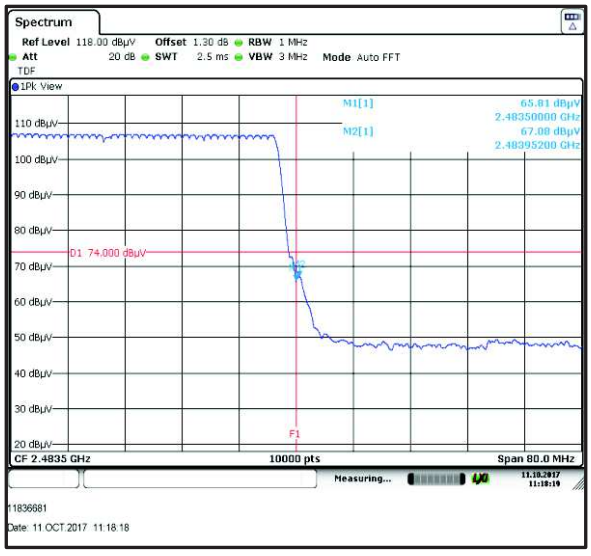
Results: Hopping Mode / 2DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.502	Horizontal	60.3	86.8	26.5	Complied
2400.0	Horizontal	60.0	86.8	26.8	Complied
2483.5	Horizontal	65.8	74.0	8.2	Complied
2483.952	Horizontal	67.1	74.0	6.9	Complied

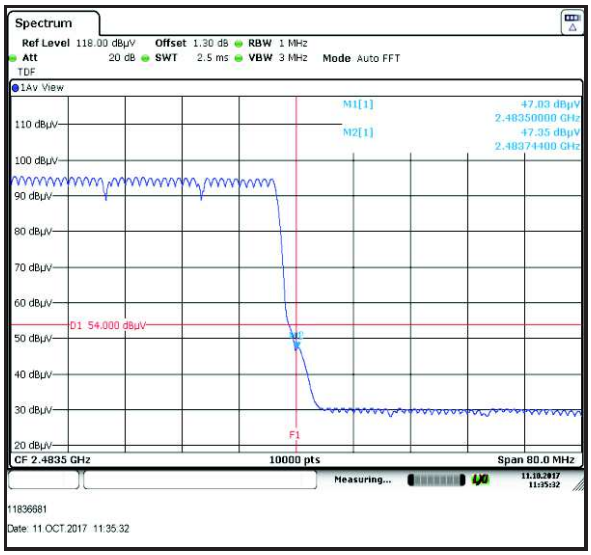
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Horizontal	47.0	54.0	7.0	Complied
2483.744	Horizontal	47.4	54.0	6.6	Complied



Lower Band Edge Peak Hopping



Upper Band Edge Peak Hopping



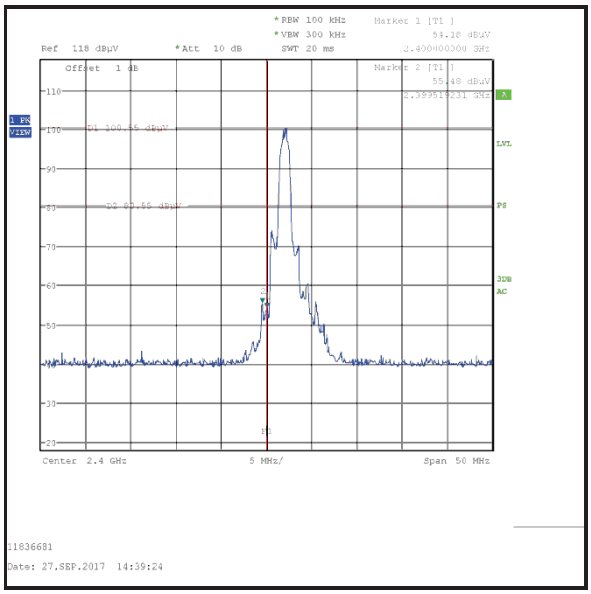
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

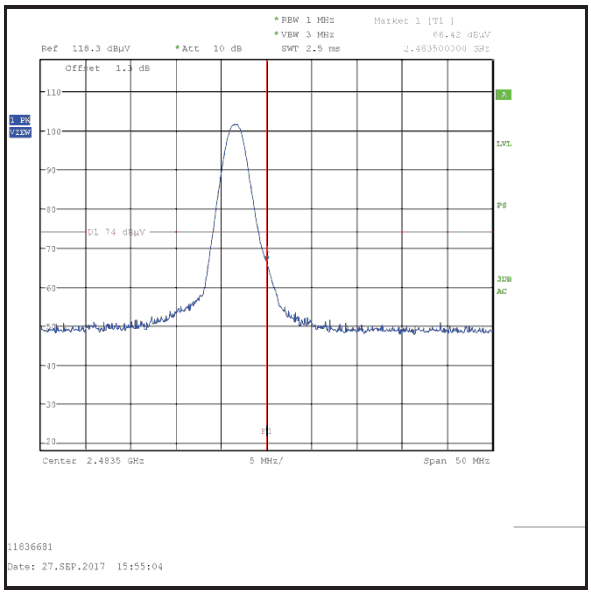
Results: Static Mode / 3DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.52	Vertical	55.5	80.6	25.1	Complied
2400.0	Vertical	54.2	80.6	26.4	Complied
2483.5	Vertical	66.4	74	7.6	Complied

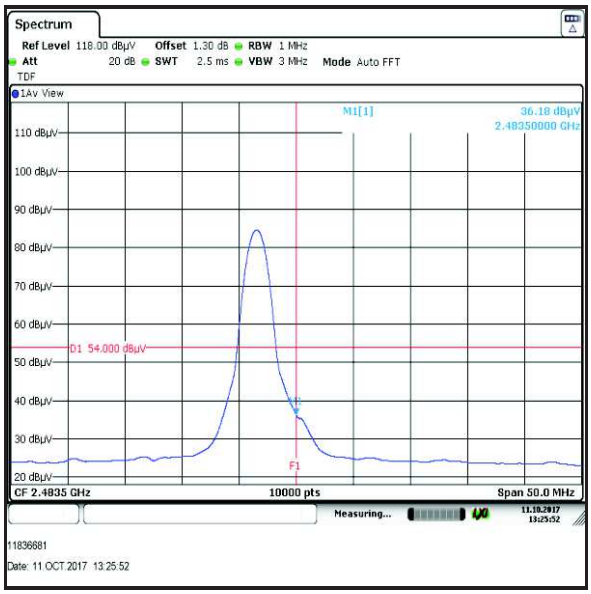
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Vertical	36.2	54.0	7.8	Complied



Lower Band Edge Peak Static



Upper Band Edge Peak Static



Upper Band Edge Average Static

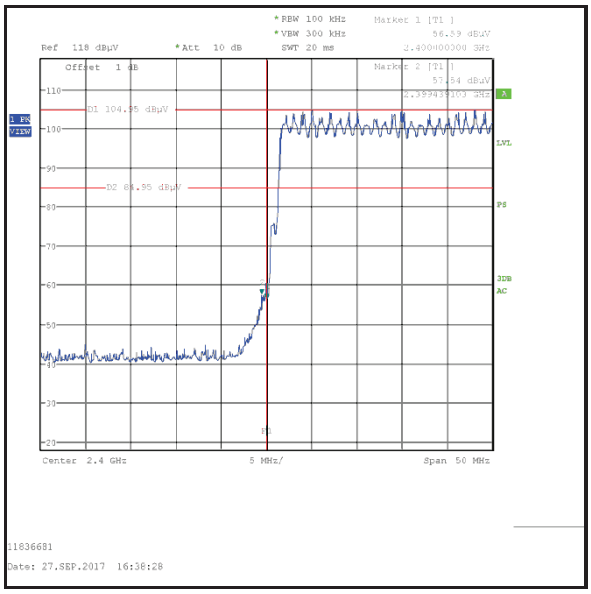
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

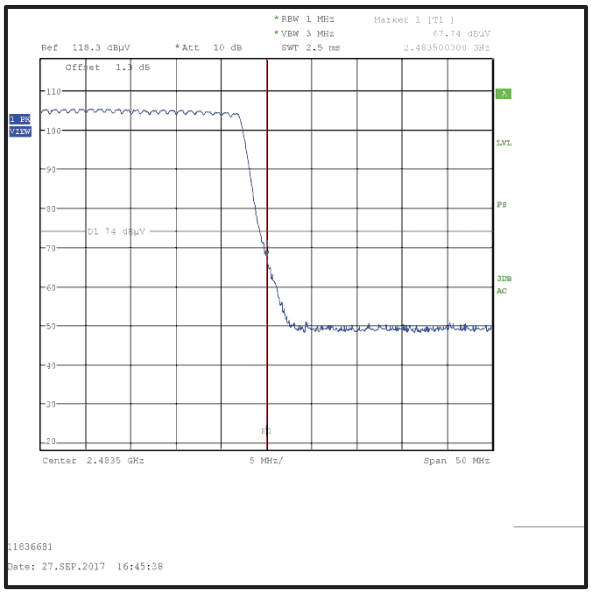
Results: Hopping Mode / 3DH5

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2399.43	Vertical	57.5	85.0	27.5	Complied
2400.0	Vertical	56.6	85.0	28.4	Complied
2483.5	Vertical	67.7	74	6.3	Complied

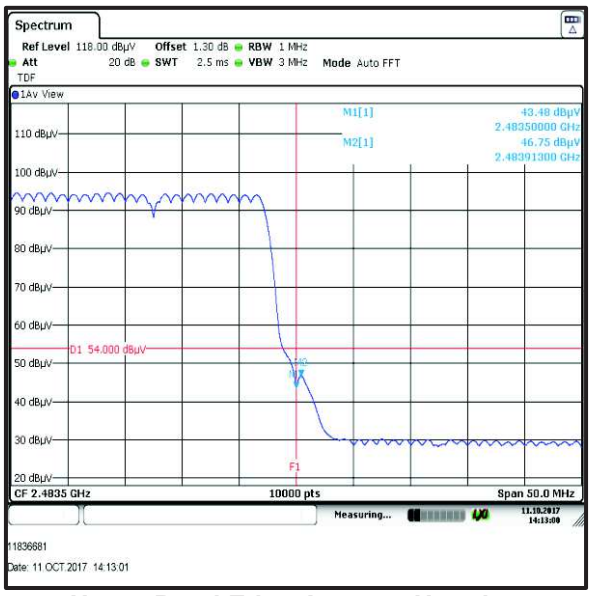
Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	Vertical	43.5	54.0	10.5	Complied
2483.913	Vertical	46.8	54.0	7.2	Complied



Lower Band Edge Peak Hopping



Upper Band Edge Peak Hopping



Upper Band Edge Average Hopping

Result: Pass

6. Measurement Uncertainty

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
Carrier Frequency Separation	2.4 GHz to 2.4835 GHz	95%	±0.89 %
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%	±0.89 %
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±2.53 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.53 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. Used equipment

Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	8/5/2016	36
103	EMCO	Antenna, Horn	3115	9008/3485	7/20/2016	36
104	EMCO	Antenna, Horn	3115	9008/3486	7/20/2016	36
156	Rohde & Schwarz	V-Network	ESH3-Z6	843864/004	7/12/2017	12
350	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/014	7/13/2017	12
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	7/11/2017	12
383	Rohde & Schwarz	Antenna, Rod	HFH2-Z1	890151/11	7/14/2017	24
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	055929	7/12/2017	12
424	EMCO	Antenna, Horn	EMCO 3116	00046537	7/28/2016	24
425	Agilent	Generator, CW Signal	E8247C	MY43320849	7/19/2016	24
426	Agilent	Spectrum Analyzer	E4446A	US44020316	7/20/2016	24
460	Deisl	Turntable	DT 4250 S		n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	8/8/2016	36
474	Agilent	Analyzer, ENA Network	E5071C	MY46100912	7/20/2016	24
495	Rohde & Schwarz	Antenna, Log.- Periodical	HL050	100296	7/20/2016	24
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	7/20/2016	24
497	Schwarzbeck	Antenna, Biconical	VHBB 9124	423	7/7/2016	36
499	Schwarzbeck	Antenna, log.-per	VUSLP 9111	317	8/2/2016	36
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	7/12/2017	12
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	7/28/2016	24
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	4/8/2014	60
363	Wainwright	Notch Filter GSM900	WW-NF9	100002	Lab verification	n/a
611	Wainwright Instruments	Band Reject Filter DL LTE	WRCGV8-	1	Lab verification	n/a
612	Wainwright Instruments	Band Reject Filter UL LTE	WRCGV8-	1	Lab verification	n/a
613	Wainwright Instruments	Band Reject Filter WLAN/ BT	WRCTF12-	1	Lab verification	n/a
614	Wainwright Instruments	Highpass Filter 3GHz	WHKX10-	1	Lab verification	n/a
615	Wainwright Instruments	Highpass Filter 1GHz	WHKX12-	3	Lab verification	n/a
620	Bonn Elektronik	pre-amplifier	BLNA 0110-01N	1510111	7/12/2017	24
624	Wainwright	6 GHz high-pass filter	WHKX10-5850-6500-18000-40SS	5	9/6/2016	60
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippeinrichtung	KE 2.5-R-M	MAT002	n/a	n/a

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ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
424	EMCO	Antenna, Horn	EMCO 3116	00046537	7/28/2016	24
472	Rohde & Schwarz	Generator, Vektorsignal	SMU200A	102409	7/11/2017	12
592	Rohde & Schwarz	Wideband Radio Communication tester	CMW 500	119593	8/15/2017	12
622	Rohde & Schwarz	Step Attenuator	RSC	101904	7/13/2017	12
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	Verification - only relative measurements	n/a
626	Rohde & Schwarz	Bluetooth Tester	CBT	100481	9/1/2016	24
634	Rohde & Schwarz	Wireless Devices Test System	TS8997		7/11/2017	12
635	Rohde & Schwarz	Signal generator	SMB100A	179875	7/11/2017	12
636	Rohde & Schwarz	switching unit	OSP120	101698	7/14/2017	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	7/11/2017	12

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0		-	Initial Version
1.1	7	3	Changed FCC ID
1.2	32 & 36	5.2.5 & 5.2.6	Test Dates Corrected

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