TEST REPORT

Test Report No. : UL-RPT-RP86779JD03B V2.0

Manufacturer	:	connectBlue
Model No.	:	cB-0926-02 & cB-0926-03
FCC ID	:	PVH0926
IC Certification No.	:	5325A-0926
Test Standard(s)	:	FCC Parts 15.407(h)(2)(iii), 15.407(h)(2)(iv) & Industry Canada RSS-210 A9.3(b)(iii)(iv), A9.3(b)(v)

1. This test report shall not be reproduced in full or partial, without the written approval of RFI Global Services Ltd trading as UL.
2. The results in this report apply only to the sample(s) tested.
3. This 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: 22 May 2013

Checked by:

Sarah Williams
WiSE Laboratory Engineer

Issued by :

pp

John Newell
Group Quality Manager, WiSE
Basingstoke,
UL Verification Services

0644

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

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Table of Contents

1. Customer Information

Company Name:	connectBlue AB
Address:	Norra Vallgatan 64 3V SE-221 22 Malmo Sweden

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.407
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications) 2012: Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) - Section 15.407
Specification Reference:	Industry Canada RSS-210 Issue 8 December 2010
Specification Title:	Low-power Licence-exempt Radio communication Devices (All Frequency Bands): Category I Equipment.
Site Registration:	FCC: 209735; Industry Canada: 3245B-2
Location of Testing:	RFI Global Services Ltd trading as UL, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	25 October 2012 to 26 October 2012

2.2. Summary of Test Results

FCC Reference (47CFR)	IC Reference	Measurement	Result
Part 15.407(h)(2)(iii)	RSS-210 A9.3(b)(iii)(iv)	Channel Closing Transmission Time and Channel Move Time	✓
Part 15.407(h)(2)(iv)	RSS-210 A9.3(b)(v)	Non-occupancy Period	✓

Key to Results

✓ = Complied ✗ = Did not comply

Note(s):

1. The Manufacturer confirms that information regarding the parameters of the radar waveforms is not available to the end user.

2.3. Methods and Procedures

Reference:	FCC 06-96
Title:	Compliance Measurement Procedures for Unlicensed-National Information Infrastructure Devices Operating in the 5250-5350 MHz and 5470-5725 MHz Bands Incorporating Dynamic Frequency Selection

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:	connectBlue
Model Name or Number:	cB-0926-02 (SPI interface & external antenna connections)
Serial Number:	0216-01-001506
Hardware Version Number:	2.10
Software Version Number:	2.10
FCC ID:	PVH0926
Industry Canada Certification Number:	5325A-0926

3.2. Description of EUT

The module with the model family name cB-0926 is a small size WLAN module intended for OEM integration. The module provides a wireless communication link using IEEE802.11a/b/g/n WLAN.

WLAN is a short-range radio link intended to transmit and receive information between portable and/or fixed electronic devices.

The WLAN module conforms to the standards IEEE 802.11a/b/g/ and 802.11n single stream.

The modules can be operated on 5 frequency bands:

- ISM Band (2412 – 2462 MHz), 11 channels with a separation of 5 MHz
- U-NII band-1 (5180 – 5240 MHz), 4 channels with a separation of 20 MHz
- U-NII band-2 (5260 -5320 MHz), 4 channels with a separation of 20 MHz
- U-NII band-2e (5500 – 5700 MHz), 11 channels with a separation of 20 MHz
- U-NII band-3 (5745 – 5850 MHz), 5 channels with a separation of 20 MHz

The channel bit rate is between 1 Mbps and 65 Mbps depending on which modulation scheme is selected.

It is restricted to function as a DFS client without radar detection in U-NII Bands 2 and 2e.

The module has two antenna ports, one transmit/receive and one receive, or alternatively can be fitted with a PCB antenna. The antenna connectors are not mounted on versions with PCB antenna.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	IEEE 802.11a/b/g/n		
Type of Unit:	Transceiver		
Modulation:	CCK, BPSK, QPSK, 16QAM, 64QAM		
Data rates:	802.11a	6, 9, 12, 18, 24, 36 ,48 & 54 Mbps	
	802.11n HT20	6.5, 13, 19.5, 26, 39, 52, 58.5 & 65 Mbps	
Power Supply Requirement(s):	5.0 VDC nominal		
Channel Spacing:	20 MHz		
Transmit / Receive Frequency Range:	5250 to 5350 MHz & 5470 to 5725 MHz		
Transmit / Receive Channels Tested:	**Test**	**Channel ID**	**Channel Frequency (MHz)**
	Channel Move Time	108	5540
	Channel Non-Occupancy	140	5700

Intended antennas for use with the Client device.

Antenna Model:	Min Antenna Gain:	Max Antenna Gain:
Fractus FR05-S1-N-0-104	+3dBi	+3dBi
ProAnt Inside-WLAN (with 10 cm RF cable)	+3dBi	+3dBi
ProAnt InSide-EPA (5 GHz)	+3dBi	+3dBi
Proant Ex-IT WLAN RP-SMA	+3dBi	+3dBi

Note: Antenna Impedances is 50Ohms.

3.5. Support Equipment

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

Description:	DFS Enabled Wireless Access Point
Brand Name:	Cisco
Model Name or Number:	AIR-AP1252AG-A-K9
Software Version:	12.4(10b)JDA3
FCC ID:	LDK102061
Industry Canada ID:	2461B-102061
Serial Number:	FTX143490WE

Description:	EUT Module Host Computer
Brand Name:	BeagleBoard
Model Name or Number:	xM
Serial Number:	Not marked or stated

Description:	OEM Adaptor Board
Brand Name:	connectBlue
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Laptop
Brand Name:	Acer
Model Name or Number:	Aspire One
Serial Number:	LUS750B02191210D892500

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated:

- Operating on the channel selected by the Master device in UNII Band III.
- The EUT operated on both 20 MHz and 40 MHz channel bandwidths. The EUT was only tested on the narrowest bandwidth in accordance with clause 8.3) 18) of FCC 06-96.
- The Master device was set with a maximum power level of 20 dBm (100 mW).
- The Master device was set to 802.11a / 12 Mbps.
- The Master device used a channel bandwidth of 20 MHz and defined the channel the EUT (Client) operated at during testing.
- The DFS detection threshold of -63 dBm was used at the Master device antenna port. The Master has a maximum EIRP of 20 dBm with 0 dBi gain.

FCC 06-96 Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

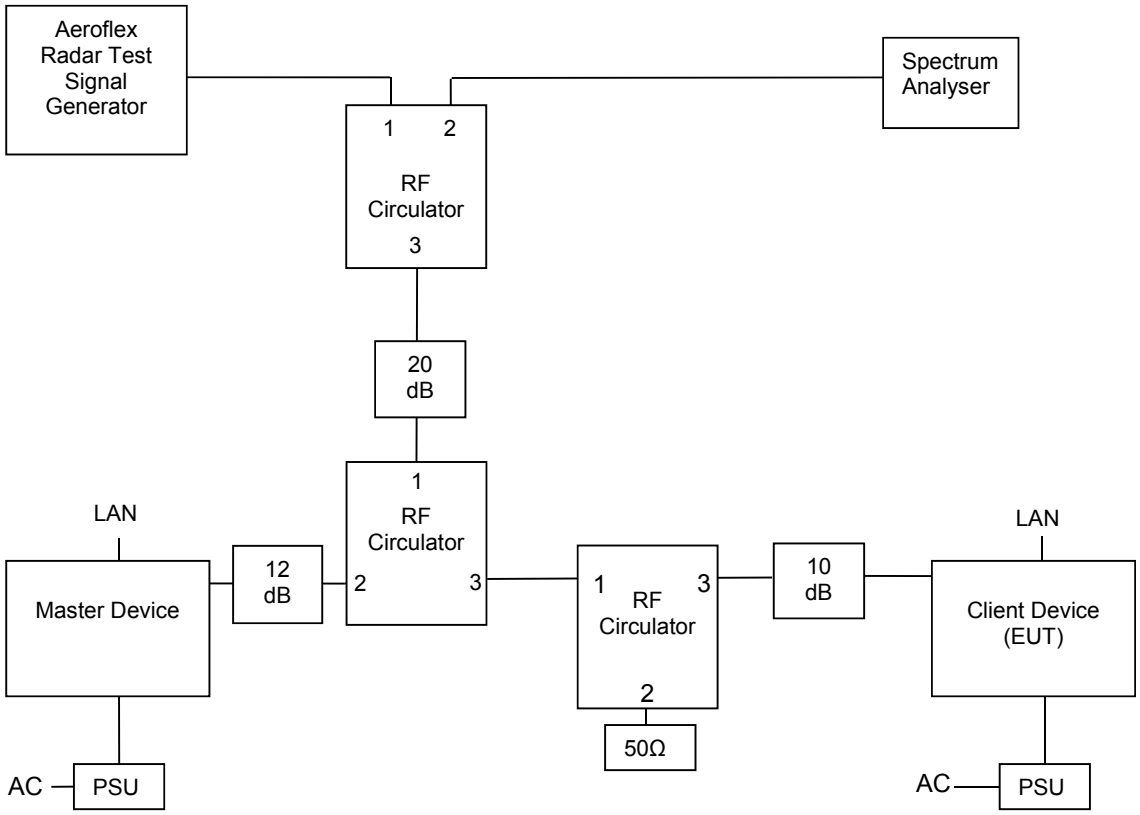
Maximum Transmit Power	**Value (See Notes 1 and 2)**
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

4.2. Configuration and Peripherals

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

- The EUT is a DFS Client without Radar Detection capability. It was tested in combination with a FCC approved Cisco DFS enabled router (FCC ID: LDK102061, IC ID: 2461B-102061) being used as the Master. Due to the full compliance of the Master, radar pulse type 1 was injected to test the Client channel move behaviour.
- All measurements were made using a conducted link. The EUT has one transmit external antenna port, one transmit chain and one receive chain, MIMO is not supported. System losses for the interconnecting hardware were measured and taken into consideration.
- For the required channel loading, the test MPEG video file was downloaded from the website http://ntiacsd.ntia.doc.gov/dfs/. The test file was then streamed in full motion at 30 frames per second from a laptop PC, via the Master device to the Client Device (EUT).
- The Radar test platform used was the Aeroflex DFS Radar 110105 Simulator which has been verified and accepted by Andrew Leimer of the FCC/NTIA on the 23rd of September 2011. Refer to Appendix 4 of this Test Report for the original confirmation email.
- The plots were captured using a Rohde & Schwarz ESU set to the maximum sampling rate of 30001 data points. These were then exported as delimited ASCII files so the data could be analysed in greater detail than available on the analyser screen.
- The Channel Move Time was the time taken from the end of the radar waveform to the time the Client ceased transmission. Any additional pulses were taken as control signals of which the aggregate time was also recorded for the Channel Closing Transmission Time.

Setup of DFS Client without Radar Detection



Rationale

The setup shown above ensures the waveforms indicated on the spectrum analyser are in order of magnitude. The circulators have approximately 18 dB attenuation in the reverse direction. The lower left-hand circulator directs the radar towards the master, ensuring there is not an overly large radar pulse into the Client (EUT), even though there is less attenuation between the Client and the radar generator. The radar signal should be approximately 44 dB smaller at the Client than the Master. The lower right-hand circulator is to give the same path loss between Master and Client in both directions.

The Radar signal is most predominant on the spectrum analyser, coming straight through the top circulator. The Client is 2nd largest, being attenuated by the 10 dB and 20 dB attenuators and 18 dB from the top circulator. The smallest signal is the Master, being attenuated by 32 dB from the two attenuators and approximately 36 dB from the two circulators. This means the EUT will be attenuated approximately 20 dB less than the Master. The EUT transmits at approximately 10 dB less power than the Master and therefore will appear approximately 10 dB higher than it.

Setup of DFS Client without Radar Detection (continued)

Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (without radar detection)	Client (with radar detection)
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required

Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master	Client (without DFS)	Client (with DFS)
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	**Yes**	Yes
Channel Move Time	Yes	**Yes**	Yes

Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see note)
≥ 200 milliwatt	**-64 dBm**
< 200 milliwatt	-62 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.

DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
Channel Closing Transmission Time	200 milliseconds + 60 milliseconds over remaining 10 second period

The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows: For the Short pulse radar Test Signals this instant is the end of the Burst. For the Frequency Hopping radar Test Signal, this instant is the end of the last radar burst generated. For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission. The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate channel changes (an aggregate of approximately 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Setup of DFS Client without Radar Detection (continued)

Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (Microseconds)	PRI (Microseconds)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	**1**	**1428**	**18**	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)			80%	120	

Long Pulse Radar Test Signal

Radar Waveform	Bursts	Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	80%	30

Frequency Hopping Radar Test Signal

Radar Waveform	Pulse Width (µsec)	PRI (µsec)	Burst Length (ms)	Pulses per Hop	Hopping Rate (kHz)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	300	9	.333	70%	30

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. Channel Closing Transmission Time and Channel Move Time

Test Summary:

Test Engineer:	Philip Harrison	**Test Date:**	26 October 2012
Test Sample Serial Number:	0216-01-001506		

FCC Reference:	Part 15.407(h)(2)(iii)
Industry Canada Reference:	RSS-210 A9.3(b)(iii)(iv)
Test Method Used:	FCC 06-96 Section 7.8.3

Environmental Conditions:

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

Note(s):

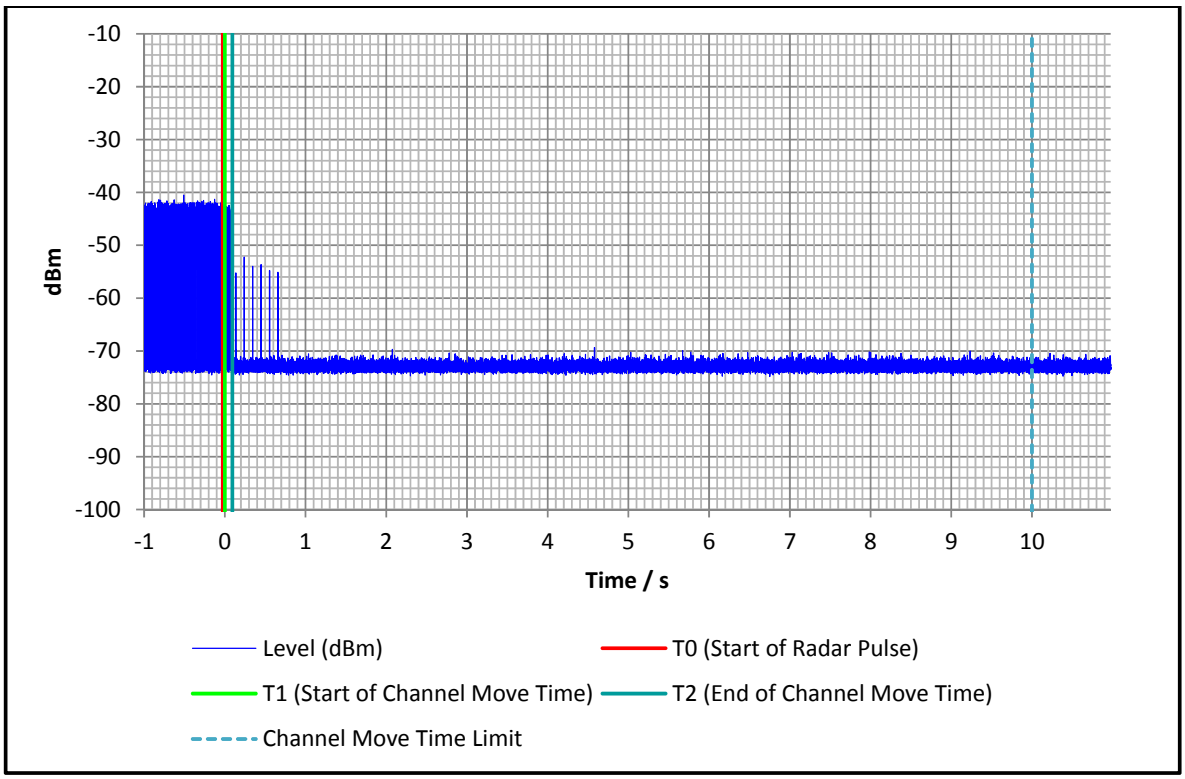
1. The channel move time is the time taken from the end of the radar burst to the ceasing of transmissions of the EUT. The smaller transmissions seen in the first plot that are less than -45 dBm, come from the Master device and not from the Client, these transmissions can be ignored.

Results: 20 MHz / 5470 – 5725 MHz band

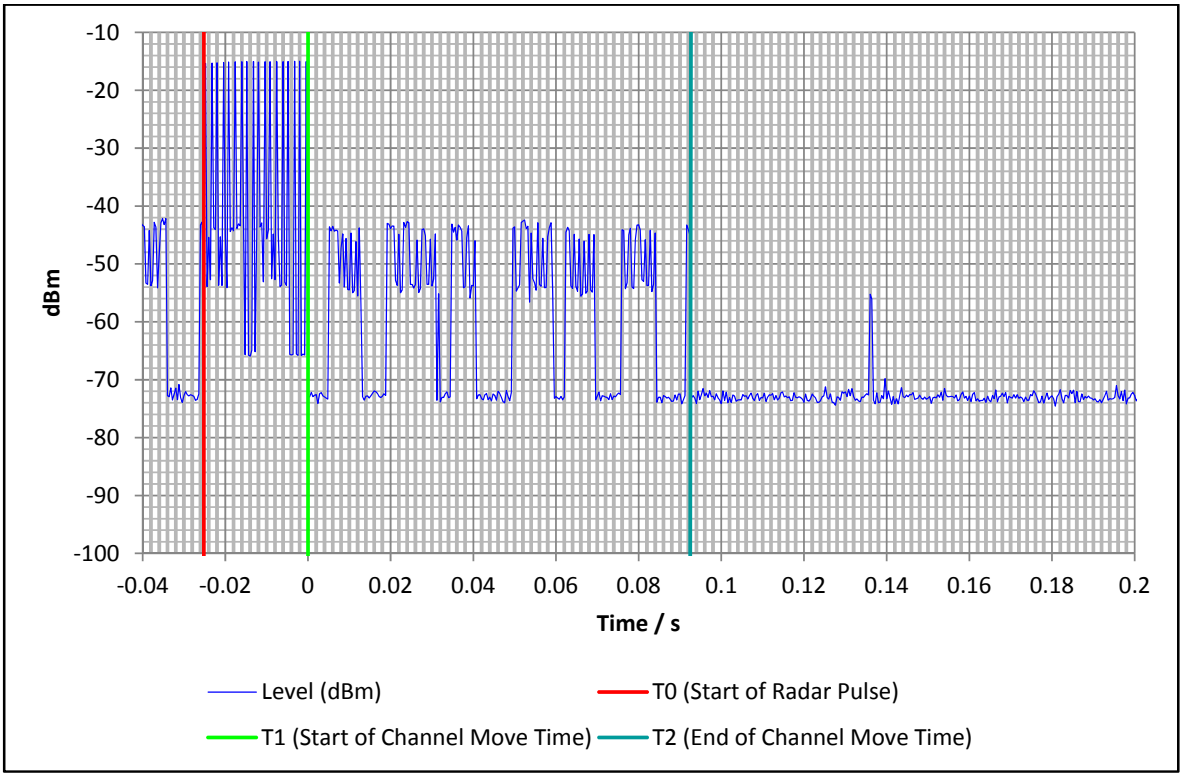
Radar #	Channel Frequency (MHz)	Channel Move Time (ms)	Total Transmission Aggregate Time after the first 200 ms of the radar end (ms)	Limit (ms)	Margin (ms)	Status
1	5540	92.4	-	10000	9907.6	Complied
1	5540	-	0	60	60	Complied

Radar burst type 1 was detected and channel move occurred in 92.4 ms, all of which was within the first 200 ms after the end of the radar pulse.

Channel Closing Transmission Time and Channel Move Time (continued)



10 second plot of Channel Move Time



Zoomed Plot of Channel Move Time and first 200 ms of Channel Shutdown

5.2.2. Non-Occupancy Period

Test Summary:

Test Engineer:	Philip Harrison	**Test Date:**	25 October 2012
Test Sample Serial Number:	0216-01-001506		

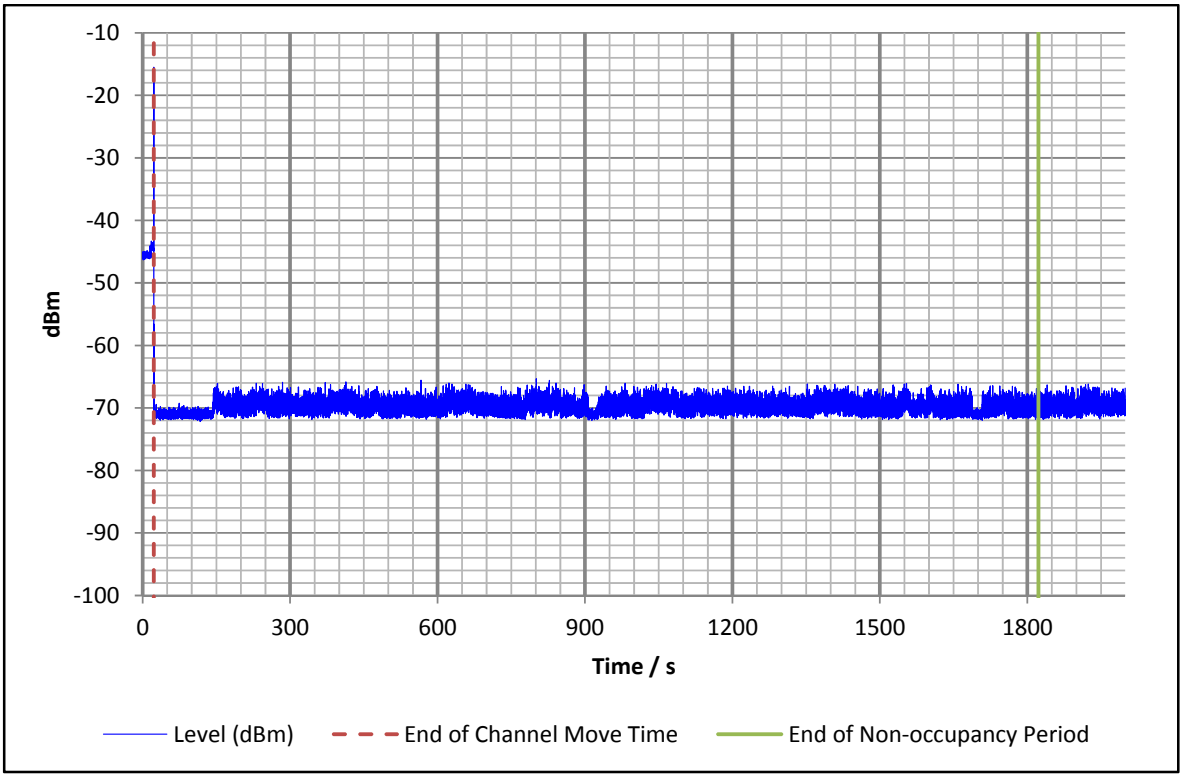
FCC Reference:	Part 15.407(h)(iv)
Industry Canada Reference:	RSS-210 A9.3(b)(v)
Test Method Used:	FCC 06-96 Section 7.8.3

Environmental Conditions:

Temperature (°C):	20
Relative Humidity (%):	56

Results: 20 MHz

Radar burst type 1 detected and channel was vacated for >30 minutes.



Non-Occupancy on Channel 5700

Note(s):

1. After 30 seconds (CAC) a slight increase in noise floor can be seen when the master and EUT restart transmitting on another channel in the same band.

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”.

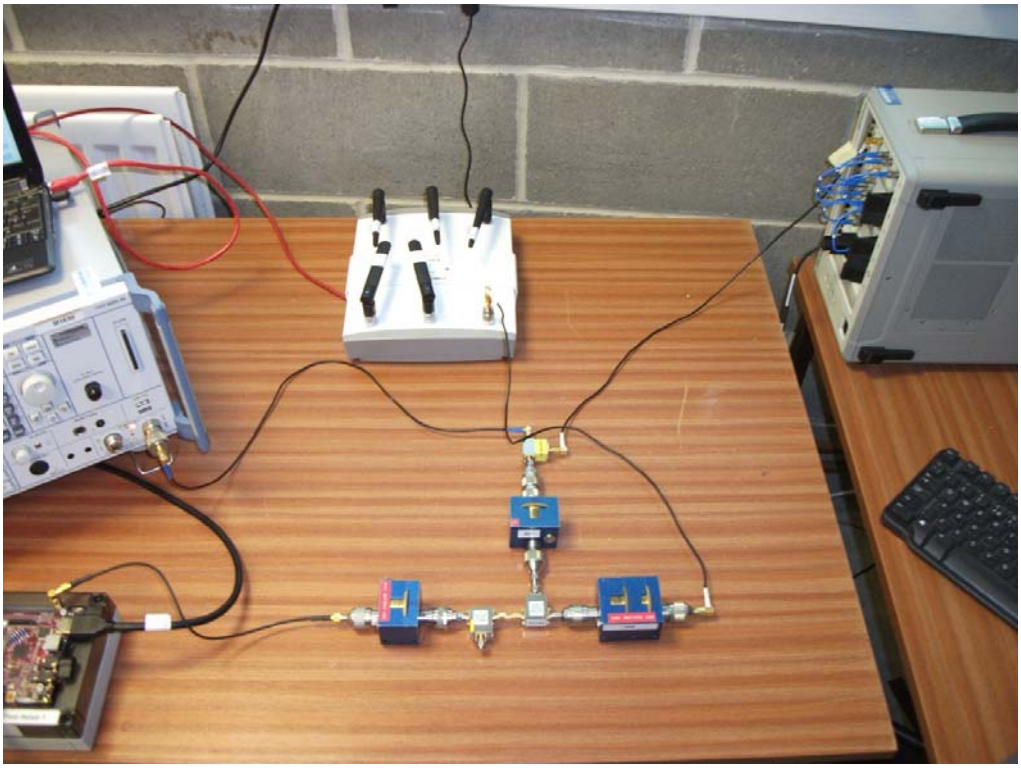
Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Channel Move Time	5.15 GHz to 5.825 GHz	95%	0.8 ms (2 samples)
Channel Close Time	5.15 GHz to 5.825 GHz	95%	0.8 ms (2 samples)
Non-Occupancy Period	5.15 GHz to 5.825 GHz	95%	132 ms (2 samples)
DFS Threshold (Conducted)	5.15 GHz to 5.825 GHz	95%	0.28 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.

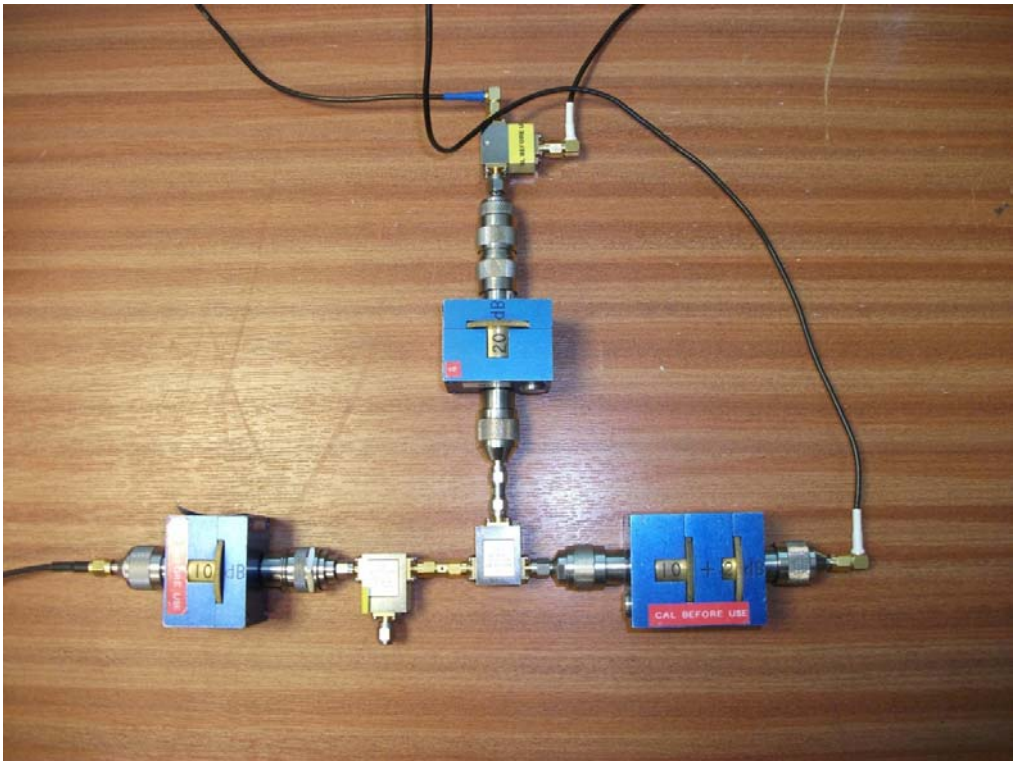
Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
A248	Step Attenuator	Narda	743-60	01411	Calibrated Before Use	-
A030	Step Attenuator	Narda	745-69	01544	Calibrated Before Use	-
A163	Step Attenuator	Narda	743-80	01344	Calibrated Before Use	-
A2182	RF Circulator	AtlanTec RF	ACC-20130 SF-SF-SF	120409231	Calibrated Before Use	-
A2183	RF Circulator	AtlanTec RF	ACC-20130 SF-SF-SF	120409232	Calibrated Before Use	-
A2179	RF Circulator	AtlanTec RF	ACC-20130 SF-SF-SF	120409230	Calibrated Before Use	-
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	06 Feb 2013	12
M1361	DFS Radar Simulator and Analyser	Aeroflex	110105	300110/291	11 Feb 2013	12

Appendix 2. Test Setup Photos



DFS Test Set-up



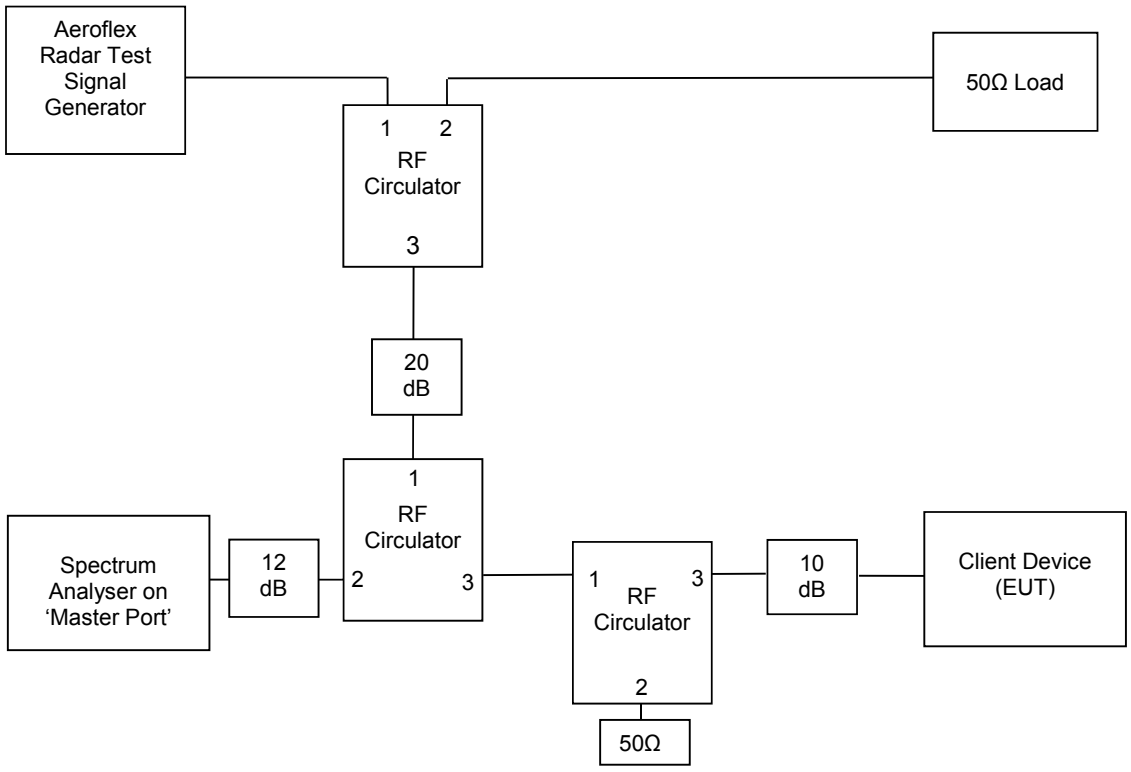
DFS Test Network

Appendix 3. Radar Calibration and Verification Data

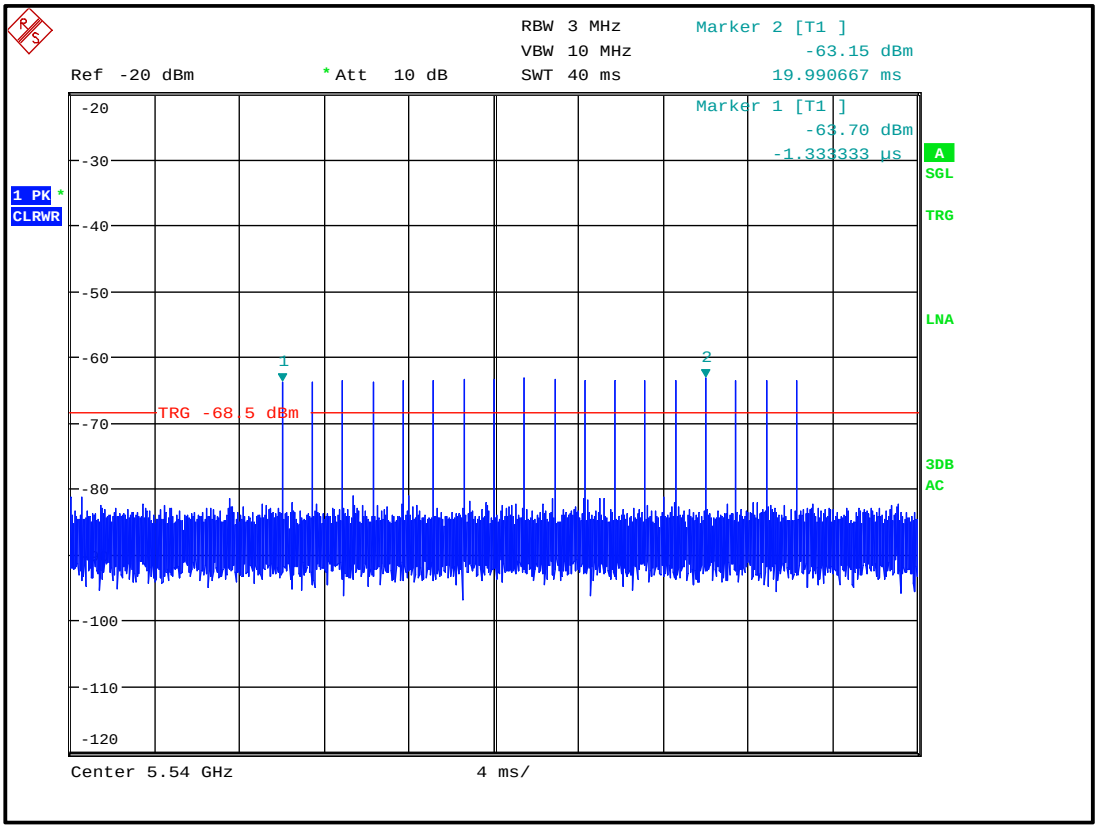
Radar calibration procedure.

The system was configured as shown in the diagram below, with all ports terminated into their respective loads. The EUT was substituted with the spectrum analyser and the output level was adjusted so that the required DFS threshold was observed. The EUT was then re-connected.

Radar Calibration Setup Block Diagram



Radar Type 1 Verification



Radar Pulse

Appendix 4. Aeroflex Test Platform Approval email

From: Andrew Leimer [mailto:Andrew.Leimer@fcc.gov]
Sent: Friday, September 23, 2011 4:24 PM
To: Chisham, Steve
Cc: Carey, Tim; Hack, Barry; Rashmi Doshi; Joe Dichoso
Subject: RE: Certification for Aeroflex DFS solution

Hello Steve,

The Aeroflex "DXI based DFS test solution" system used for DFS alternative radar signal generation has been approved by the FCC and NTIA.

This approval permits the system to be used by labs in the testing of DFS devices for equipment authorization Certification. It is recommended that applicants that use your system for testing include a statement in the Test Report or a Letter Exhibit stating that the system has FCC and NTIA approval. This E-mail is your record of this approval.
Note that the appropriate term for your system is Approved as the term Certification is reserved for devices gaining equipment authorization through the FCC or a TCB.

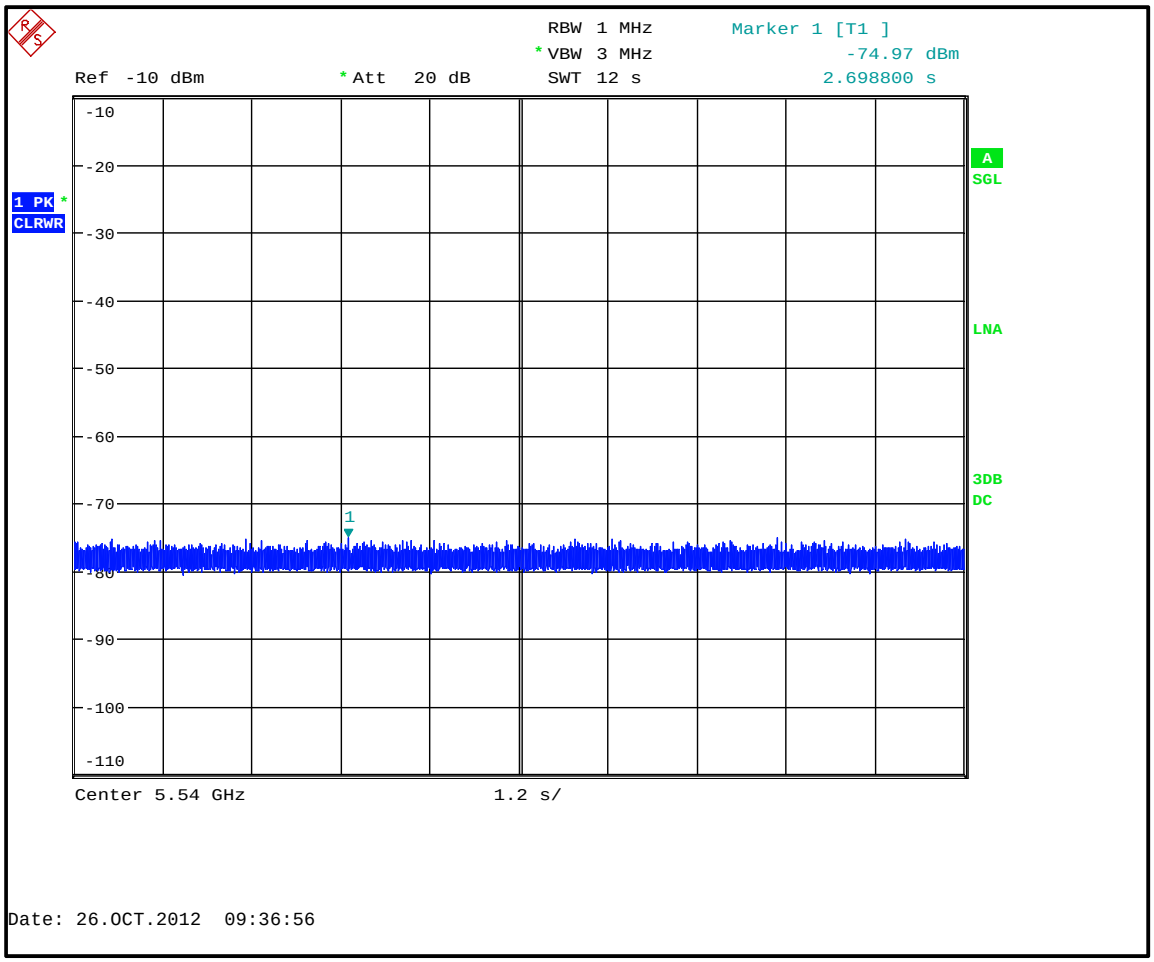
Regards,

Andy Leimer

FCC/OET/EACB

Appendix 5. System Noise Floor Reference Plot

As required by Section 8.3.18(iii) of FCC 06-96, the following plot shows the reference noise floor of the system used during measurement.



Noise Floor of Spectrum Analyser