

Report on the Radio Testing

For

SmarDTV (UK) Limited

on

S55

Report no. TRA-031431-00-45-08A

20th April 2017

RF929

Report Number: TRA-031431-00-45-08A
Issue: A

REPORT ON THE RADIO TESTING OF A
SmarDTV (UK) Limited
S55
WITH RESPECT TO SPECIFICATION
DFS requirements of FCC 47CFR15E

TEST DATE: 04/10/2016

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Date: 20th April 2017

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- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF929

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	20th April 2017	Original

2 Summary

TEST REPORT NUMBER:	TRA-031431-00-45-08A
WORKS ORDER NUMBER	TRA-029575-02
PURPOSE OF TEST:	Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION:	47CFR15.407(h)
EQUIPMENT UNDER TEST (EUT):	S55
FCC IDENTIFIER:	DKN-AVAD1 (client)
ISED:	1707A-AVAD1 (client)
FCC IDENTIFIER:	DKN-AVBX1 (Master)
ISED CERTIFICATION NUMBER:	1707A-AVBX1 (Master)
EUT SERIAL NUMBER:	E411006C00066D (Master), E411006C00012D (Client)
MANUFACTURER/AGENT:	SmarDTV (UK) Limited
ADDRESS:	Beckside Design Centre Millennium Business Park Station Rd Steeton Keighley West Yorkshire BD20 6QW United Kingdom
CLIENT CONTACT:	Chris Wordley ☎ 01535 659000 ✉ chris.wordley@smardtv.com
ORDER NUMBER:	POR01251
TEST DATE:	04/10/2016
TESTED BY:	A Longley Element

2.1 Test Summary

Test Method and Description	Requirement Clause	Applicable to this equipment	Result / Note
	47CFR15		
TPC and DFS	15.407(h)	☒	Pass
U-NII detection bandwidth	15.407(h)(2)	☒	Pass
CAC	15.407(h)(2)(ii)	☒	Pass
In-service monitoring	15.407(h)(2)(iii) & 15.407(h)(2)(iv)	☒	Pass
Statistical performance check	-	☒	Pass

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set-up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

1	Revision Record	3
2	Summary	4
2.1	Test Summary	5
3	Contents	6
4	Introduction.....	7
5	Test Specifications	8
5.1	Normative References	8
5.2	Deviations from Test Standards	8
6	Glossary of Terms	9
7	Equipment Under Test.....	10
7.1	EUT Identification	10
7.2	System Equipment.....	10
7.3	EUT Mode of Operation.....	10
7.3.1	Where channel loading is required	10
7.3.2	Where channel loading is not required	10
7.4	EUT Radio Frequency Parameters.....	11
7.4.1	General.....	11
7.4.2	Antennas	11
7.4.3	Product specific declarations	11
7.5	EUT Description.....	12
8	Modifications.....	13
9	EUT Test Setup	14
9.1	Block Diagram	14
9.2	General Set-up Photograph.....	15
10	General Technical Parameters	16
10.1	Normal Conditions	16
10.2	Varying Test Conditions.....	16
11	Dynamic Frequency Selection (DFS).....	17
11.1	General.....	17
11.2	Test Parameters	17
11.3	Test Method.....	20
11.4	Calibration	21
12	In-Service Monitoring.....	22
12.1	Definition.....	22
12.1.1	Channel Closing	22
12.1.2	Non-Occupancy Period.....	22
12.2	Additional Test Parameters	22
12.3	Test Method.....	23
12.4	Test Equipment.....	23
12.5	Test Results.....	24
13	Measurement Uncertainty.....	27

4 Introduction

This report TRA-031431-00-45-08A presents the results of the Radio testing on a SmarDTV (UK) Limited, S55 to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for SmarDTV (UK) Limited by Element, at the address(es) detailed below.

☒	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	☐	Element Skelmersdale Unit 1 Pendle Place Skelmersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

FCC Site Listing:

The test laboratory is accredited for the above sites under the US-EU MRA, Designation number UK0009.

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- FCC KDB Publication 905462 D02 v01r02 – Compliance measurement procedures for unlicensed-national information infrastructure devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating dynamic frequency selection.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

S	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CAC	Channel Availability Check
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DFS	Dynamic Frequency Selection
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada (now ISED)
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
LE-LAN	Licence-Exempt Local Area Network
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
PSD	Power Spectral Density
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
TPC	Transmitter Power Control
Tx	transmitter
UKAS	United Kingdom Accreditation Service
U-NII	Unlicensed-National Information Infrastructure
V	volt
W	watt
Ω	ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: S55
- Serial Number: E411006C00066D (Master), E411006C00012D (Client)
- Model Number: S55
- Software Revision: RF Test Software
- Build Level / Revision Number: Not Applicable

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

A second N63 unit was connected as a Master device during testing, both units were controlled by a Laptop.

7.3 EUT Mode of Operation

7.3.1 Where channel loading is required

The mode of operation for tests was as follows...

Script files load_stbap.sh and START_TRAFFIC.sh contained parameters for data block sizes and distribution to give a channel loading of >17% (channel loading measurements indicated between 19% and 20% for all bandwidths, each bandwidth tested had a different set of parameters set by the script files). The EUT was associated with the Master device during testing.

The files and settings were supplied by the client by email on 27/09/2016, all tests reported here that required channel loading were performed after this date.

7.3.2 Where channel loading is not required

The mode of operation for tests was as follows...

The EUT was associated with the Master device during testing, the Master was set to vacate the channel when a radar pulse had been successfully detected.

7.4 EUT Radio Frequency Parameters

7.4.1 General

Frequency of operation:	5180 to 5825 MHz
Modulation type(s):	802.11a/n/ac
Occupied channel bandwidth(s):	20MHz, 40MHz and 80MHz
Channel spacing:	By bandwidth
Warning against use of alternative antennas in user manual (yes/no):	Yes
Nominal Supply Voltage:	12V dc from power supply
Location of notice for license exempt use:	Label / user manual / both.
Method of prevention of use on non-US frequencies:	Frequency list programmed into EUT, see also Software Security.

7.4.2 Antennas

Type:	PCB
Frequency range:	5150 to 5850 MHz
Impedance:	50 Ω
Gain:	U-NII-2A: 4.2 dBi at channel tested U-NII-2C: 3.5 dBi at channel tested
Polarisation:	Linear
Connector type:	UFL
Length:	18mm
Mounting:	Fixed within EUT enclosure

7.4.3 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	4 antennas mounted orthogonally within EUT enclosure
Fixed pt-pt operations (yes/no):	No
Software security description:	Detailed in file "Software Security Description S60.pdf" stored in Element job folder
TDWR interference information in users manual (yes/no):	Yes

DFS Parameters:	
Highest and lowest EIRP:	U-NII-2A 91.15 mW U-NII-2C 95.29 mW
Antenna used for testing:	All 4 antennas were connected to the DFS test set using a suitable combiner
Antenna port impedance:	50 ohms
Channel loading / test file:	START_TRAFFIC.sh
TPC description:	None
System architectures, data rates, U-NII channel bandwidths:	20MHz : 1.1M L:65000 40MHz : 2.3M L:60000 80MHz : 5M L:60000
Power up cycle time:	To start of CAC: 20.8s To command prompt: 25.5s
Clients: Radar detection Master U-NII Device FCC ID	The EUT was a Client device without radar detection. The Master module is reported separately

7.5 EUT Description

The EUT is a Multimedia Transcoder containing a dual band Wi-Fi router with Bluetooth. The radios are contained in two separate modules. The module covered by this report is a DFS Client device.

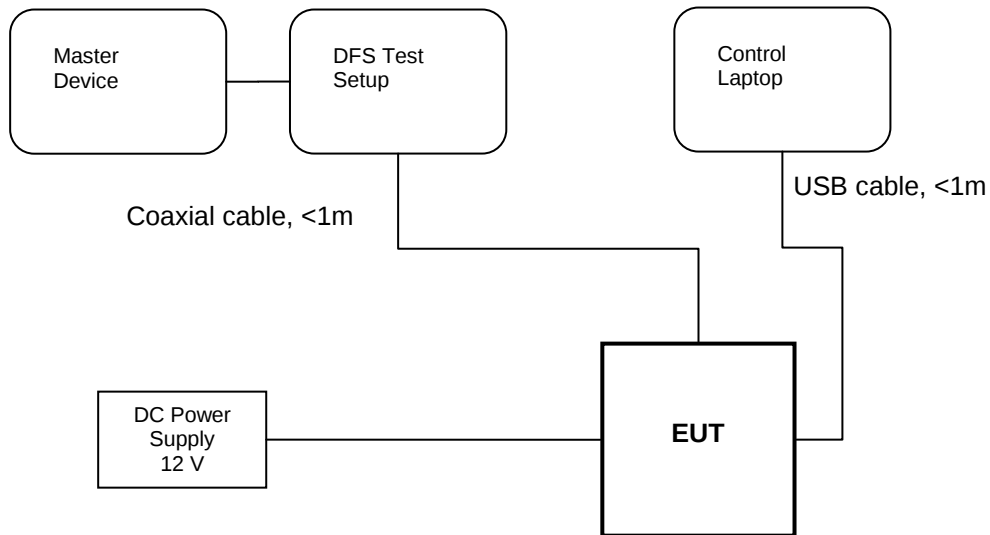
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:

Photographs are withheld in accordance with client's FCC confidentiality request.

10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 12 V dc from the adaptor.

10.2 Varying Test Conditions

No varying test conditions were used during these tests.

11 Dynamic Frequency Selection (DFS)

11.1 General

An U-NII network will employ a Dynamic Frequency Selection (DFS) function to detect interference from radar systems (radar detection) and to avoid co-channel operation with these systems.

Within the context of the operation of the DFS function, a U-NII device will operate in either Master Mode or Client Mode. U-NII devices operating in Client Mode can only operate in a network controlled by a U-NII device operating in Master Mode.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Lab 4
Test Standard and Clause:	KDB 905462 D02, Clause 7.8
EUT Tested Channel Bandwidths:	20 MHz, 40 MHz & 80 MHz
EUT Test Channel Loading:	Duty cycle >17%
EUT Output Power Setting:	Max.
EUT Tested Modes:	Client
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 23 °C	Usually: +15 °C to +35 °C
Humidity: 45 %RH	Usually: 20%RH to 75%RH

Test Limits

Refer to individual tests for applicable tables, as defined below.

Table 3: Interference threshold values

<i>Maximum Transmit Power</i>	<i>Value (see notes 1, 2 and 3)</i>
EIRP $\geq$ 200 mW	-64 dBm
EIRP < 200 mW and PSD < 10 dBm/MHz	-62 dBm
EIRP < 200 mW that do not meet the PSD requirement	-64 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.
NOTE 2:	EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 4: DFS requirement values

<i>Parameter</i>	<i>Value</i>
Non-Occupancy Period	Min. 30 minutes
Channel Availability Check Time	60 s
Channel Move Time	10 s (see note 1).
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 s period (see notes 1 & 2).
U-NII Detection Bandwidth	Min. 100 % of the U-NII 99% transmission power bandwidth (see note 3).
Maximum Off-Channel CAC Time	4 hours (see note 2)
NOTE 1:	<i>Channel Move Time</i> and the <i>Channel Closing Transmission Time</i> should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.
NOTE 2:	The <i>Channel Closing Transmission Time</i> is comprised of 200 ms starting at the beginning of the <i>Channel Move Time</i> plus any additional intermittent control signals required to facilitate a channel move (an aggregate of 60 ms) during the remainder of the 10 s period. The aggregate duration of control signals will not count quiet periods in-between transmissions.
NOTE 3:	During the <i>U-NII Detection Bandwidth</i> detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 %. Measurements are performed with no data traffic.

Table 5: Short pulse radar test signals

<i>Radar type</i>	<i>Pulse width (μs)</i>	<i>PRI (μs)</i>	<i>Number of pulses</i>	<i>Min. % of successful detection</i>	<i>Min. number of trials</i>
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a Test B: 15 unique PRI values randomly selected within the range of 518-3066 μs, with a minimum increment of 1 μs, excluding PRI values selected in Test A	Roundup: $1/360 \times 19.10^6 / \text{PRI}$	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
NOTE 1: Short pulse radar type 0 should be used for detection bandwidth test, channel move time and channel closing time tests.					

Table 5a: Pulse repetition intervals for test A

<i>Pulse repetition frequency number</i>	<i>Pulse repetition frequency (pulses / s)</i>	<i>Pulse repetition interval (μs)</i>
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

Table 6: Long pulse radar test signal

<i>Radar type</i>	<i>Pulse width (μs)</i>	<i>Chirp width (MHz)</i>	<i>PRI (μs)</i>	<i>Number of pulses per burst</i>	<i>Number of bursts</i>	<i>Min. % of successful detection</i>	<i>Min. number of trials</i>
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7: Frequency hopping radar test signal

<i>Radar type</i>	<i>Pulse width (μs)</i>	<i>PRI (μs)</i>	<i>Pulses per hop</i>	<i>Hopping rate (kHz)</i>	<i>Hopping sequence length (ms)</i>	<i>Min. % of successful detection</i>	<i>Min. number of trials</i>
6	1	333	9	0.333	300	70%	30

11.3 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the wanted signal (Gen A) was set to establish a reliable link (approx. 10 dB above receiver threshold). The interfering signal (Gen B) was then introduced at the specified Radar Detection Threshold level, plus 1dB.

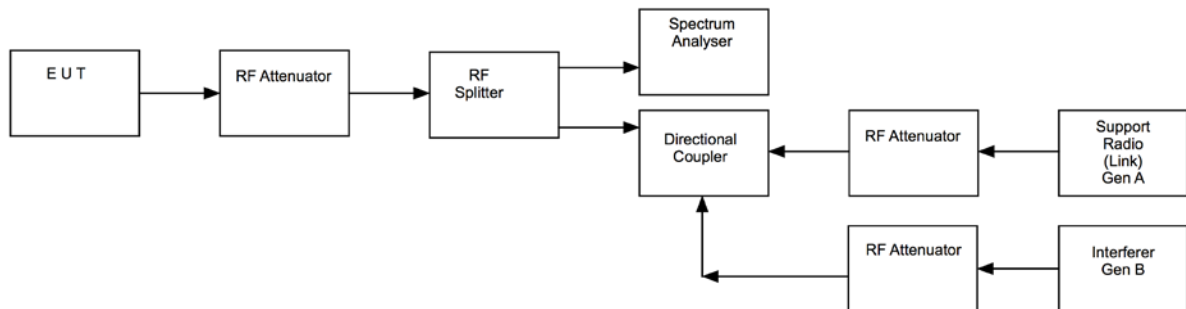
[1] Conducted method

Received power was measured at the antenna port. For multiple port devices, equal splitting was employed to ensure the same level was received at each antenna port.

[2] Radiated method

Received power was measured at the centre of the EUT.

Figure i Test Setup



EUT and setup photos are withheld due to confidentiality request.

11.4 Calibration

The test generator level setting was made at the Master to which the EUT was associated during the test. The EUT itself does not have radar detection

Antenna Gain

The test generator level setting was adjusted to take account of the worst case antenna gain for the frequencies tested in each band.

For U-NII-2A the antenna gain as specified by the client was: 4.2 dBi

For U-NII-2C the antenna gain as specified by the client was: 3.5 dBi

DFS Radar Waveforms

The RF attenuator nearest the EUT was set to provide sufficient attenuation not to overload the analyser whilst the EUT was at maximum power. The RF attenuator nearest the support radio was then set by increasing to the point where the EUT could no longer receive the signal (receiver threshold), then backing off 10dB. The RF attenuator nearest the signal generator was then set to provide sufficient isolation between the generator and the support radio.

The interferer (Gen B) was set to the centre of the test channel, Ch_r , in CW mode. The EUT was replaced with the spectrum analyser, whilst the analyser was replaced with a 50 ohm load. The level of the generator was adjusted to find the appropriate DFS threshold +1dB, adjusted for min. antenna gain (see above), measured on the spectrum analyser. The analyser and EUT were then returned to position and an offset added to the analyser to read the same level as measured at the EUT.

Each radar signal required was then observed on the spectrum analyser in a 3MHz RBW with peak detector.

12 In-Service Monitoring

12.1 Definition

12.1.1 Channel Closing

The *Channel Closing* is defined as the process initiated by the U-NII device on an *Operating Channel* after a radar signal has been detected during the *In-Service Monitoring* on that channel.

The master device shall instruct all associated slave devices to stop transmitting on this channel, which they shall do within the *Channel Move Time*.

Slave devices with a Radar Interference Detection function, shall stop their own transmissions on an *Operating Channel* within the *Channel Move Time* upon detecting a radar signal within this channel.

The aggregate duration of all transmissions of the U-NII device on this channel during the *Channel Move Time* shall be limited to the *Channel Closing Transmission Time*. The aggregate duration of all transmissions shall not include quiet periods in-between transmissions.

For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, only the channel(s) containing the frequency on which radar was detected is subject to the *Channel Closing* requirement. The equipment is allowed to continue transmissions on other *Operating Channels*.

12.1.2 Non-Occupancy Period

The *Non-Occupancy Period* is defined as the time during which the U-NII device shall not make any transmissions on a channel after a radar signal was detected on that channel.

For equipment having simultaneous transmissions on multiple (adjacent or non-adjacent) operating channels, only the channel(s) containing the frequency on which radar was detected is subject to the *Non-Occupancy Period* requirement. The equipment is allowed to continue transmissions on other *Operating Channels*.

After the *Non-Occupancy Period*, the channel needs to be identified again as an *Available Channel* before the U-NII device may start transmitting again on this channel.

12.2 Additional Test Parameters

EUT Test Channels, Ch _r .	Mid low band / Mid high band
EUT Operating Channels / Bandwidths:	Ch58/80MHz & Ch106/80MHz
Master Uniform Spreading:	Disabled

Test Limits

The *Channel Move Time* shall not exceed the limit defined in table 4.

The *Channel Closing Transmission Time* shall not exceed the limit defined in table 4.

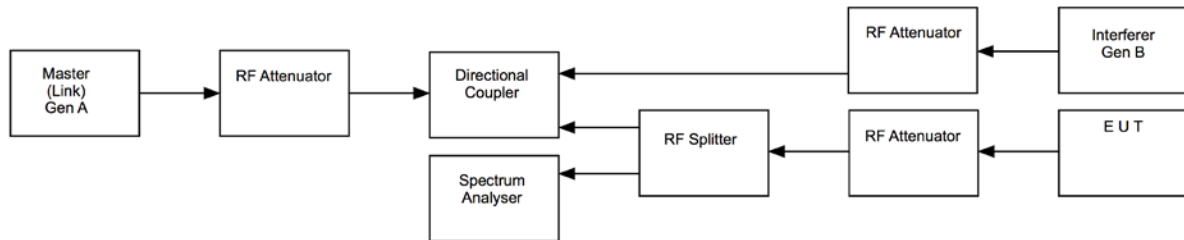
The *Non-Occupancy Period* shall not be less than the value defined in table 4.

12.3 Test Method

The EUT channel for both data and control signals, Ch_r , was selected, then transmissions to the paired device commenced. The interferer (Gen B) was set to the same frequency, Ch_r , and a radar test signal of table 5 (to appear at the Master at the threshold level + 1dB) then muted. The spectrum analyser was set to time domain (zero span) with sufficient bandwidth to capture all intentional emissions from the EUT. The analyser was then synchronised to the switching of the interferer – the interferer (Gen B) level was unmuted for a single burst. Transmissions from the EUT were observed for 12 seconds, it is not required to perform a 30 minute observation on a Client device without radar detection.

Note, the set-up of figure ii was required to test slave mode, where the master is not the EUT.

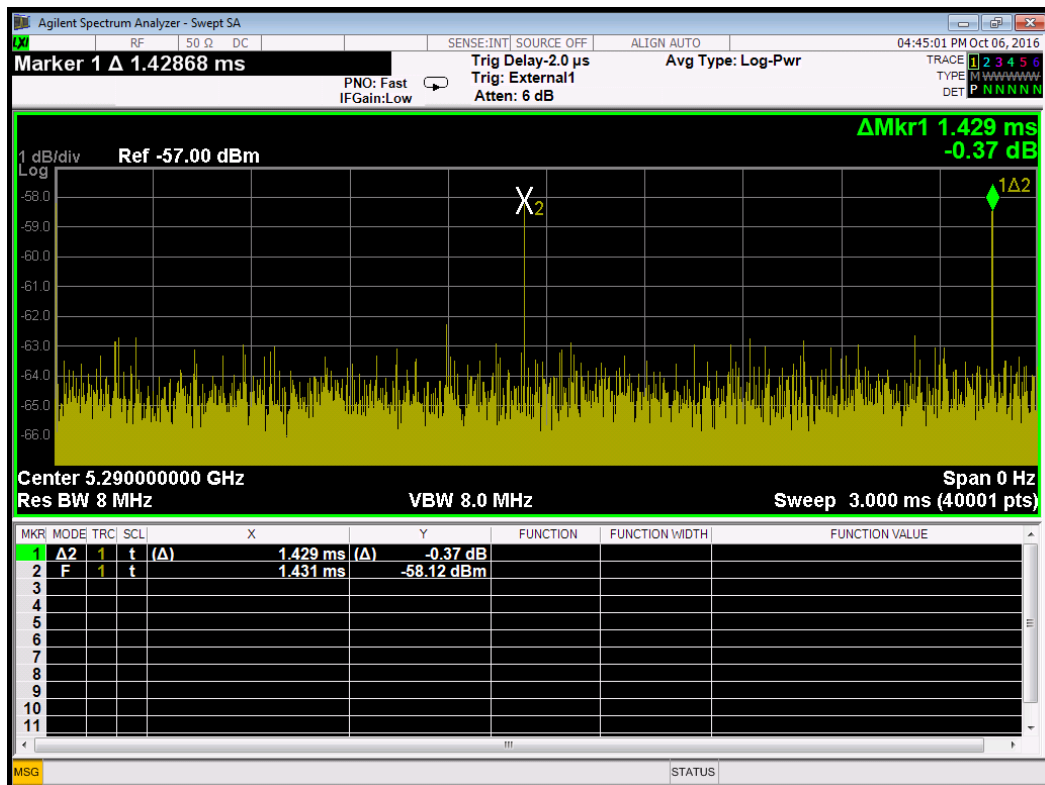
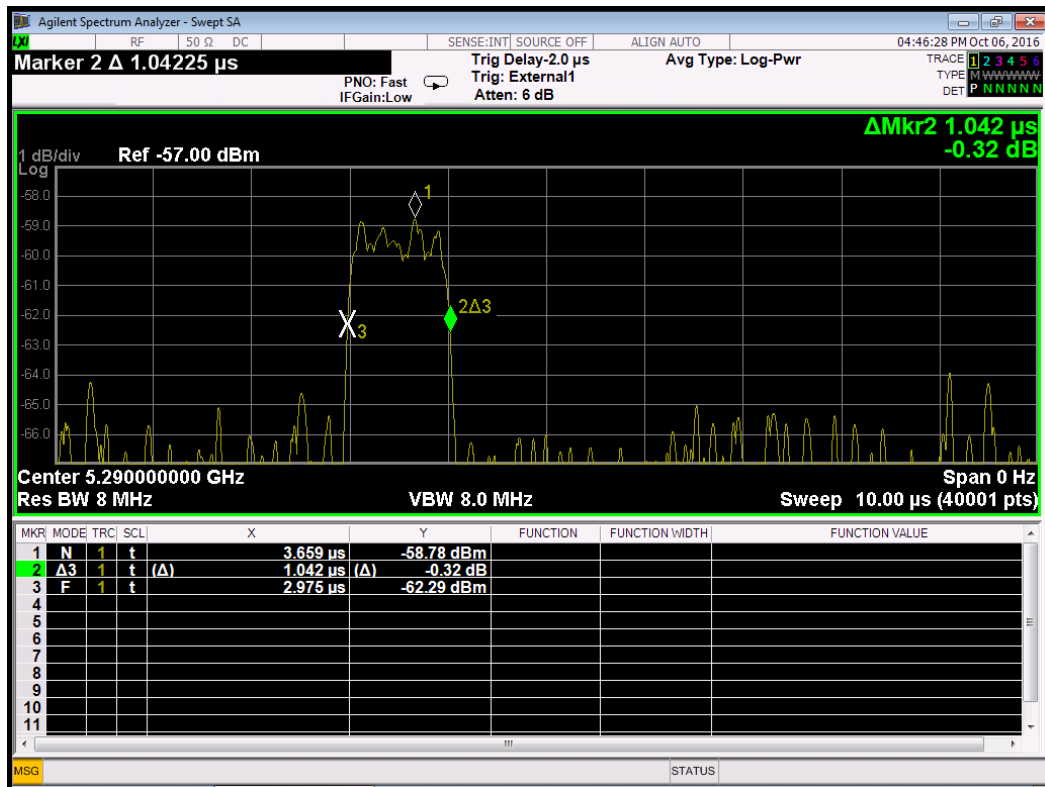
Figure ii Test Setup



12.4 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
DFS Test System	Aeroflex	PXI-1042	REF2152	05/07/2016	12	05/07/2017
Spectrum Analyser	Agilent	N9030A	REF2167	13/10/2015	12	13/10/2016

12.5 Test Results



Bandwidth: 80 MHz					
Channel (MHz)	Interference level (dBm)	Channel move time (s)	Channel Closing Transmission Time (ms)	Transmissions during non-occupancy period	Result
5290	-58.8	0.05742	18.028	None	PASS



Bandwidth: 80 MHz					
Channel (MHz)	Interference level (dBm)	Channel move time (s)	Channel Closing Transmission Time (ms)	Transmissions during non-occupancy period	Result
5530	-59.5	0.091466	8.799	None	PASS



13 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence:

[1] DFS Parameters

Test type	Quantity	Quantity frequency range	Uncertainty
DFS Parameters	Amplitude	9kHz to 26.5GHz	±0.9 dB
	Time	9kHz to 26.5GHz	0.1%
	Frequency	9kHz to 26.5GHz	3.611kHz