

Report on the Radio Testing

For

Pace plc

on

Xi5

Report no. TRA-029286-02-45-04A

20th May 2016

Report Number: TRA-029286-02-45-04A
Issue: A

REPORT ON THE RADIO TESTING OF A
Pace plc
Xi5
WITH RESPECT TO SPECIFICATION
DFS requirements of FCC 47CFR15E

TEST DATE: 09th - 10th May 2016

Written by: A Tosif

A Tosif - K Anderson
Radio Test Engineers

Approved by: **John Charters**
Date: 20th May 2016

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Disclaimers:

- [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

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	20th May 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-029286-02-45-04A
WORKS ORDER NUMBER:	TRA-029286-02
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15.407 (h)
EQUIPMENT UNDER TEST (EUT):	Xi5
FCC IDENTIFIER:	NQ8PX051AEI
EUT SERIAL NUMBER:	PAW400000782
MANUFACTURER/AGENT:	Pace plc
ADDRESS:	Victoria Road Saltaire Shipley West Yorkshire BD18 3LF United Kingdom
CLIENT CONTACT:	James Humphrey ☎ 01274 537259 ✉ James.Humphrey1@pace.com
ORDER NUMBER:	5185322
TEST DATE:	09th - 10th May 2016
TESTED BY:	A Tosif - K Anderson 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)	☐	N/A*
CAC	15.407(h)(2)(ii)	☐	N/A*
In-service monitoring	15.407(h)(2)(iii) & 15.407(h)(2)(iv)	☒	Pass
Statistical performance check	-	☐	N/A*

* Not required for slave devices without radar detection

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).

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4 Introduction

This report TRA-029286-02-45-04A presents the results of the Radio testing on a Pace plc, Xi5 to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Pace plc 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.

IC 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
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: Xi5
- Serial Number: PAW400000782
- Model Number: PX051AEI
- Software Revision: Not Applicable
- Build Level / Revision Number: DV

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.

Cisco WAP371 Access Point (Master device)
 EPS-2 (AC Adapter)
 2 Dell Latitude Laptops
 2 Dell AC/DC Adapters

7.3 EUT Mode of Operation

EUT was in communication with the master device with channel loading of 28.8 % and 31.7 % at Channels 58 and 106 respectively.

7.4 EUT Radio Frequency Parameters

7.4.1 General

Frequency of operation:	5.15 GHz – 5.35 GHz; 5.47 GHz – 5.725 GHz; 5.725GHz – 5.85 GHz
Modulation type(s):	OFDM
Occupied channel bandwidth(s):	20 MHz / 40 MHz / 80 MHz
Declared output power(s):	+25dBm
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	110 Vac
Location of notice for license exempt use:	Label / user manual / both.

7.4.2 Product specific declarations

Multiple antenna configuration(s), e.g. MIMO:	MIMO
Fixed pt-pt operations (yes/no):	No
Installation manual advice on pt-pt operational restrictions (yes/no):	Not Applicable
Fixed pt-mpt operations (yes/no):	Not Applicable
Simultaneous tx (yes/no):	Yes

7.4.3 Dfs Parameters

Antenna port impedance:	50 ohms
Channel loading:	28.8 %for Ch 58 31.7 % for Ch 106
Clients: Radar detection Master U-NII Device FCC ID	N89-WAP371

7.5 EUT Description

The EUT is a set top box with one HDMI output for connection to a television. The EUT can accept inputs from Wi-Fi, HDMI and Ethernet. The EUT is controlled by remote control over RF4CE and/or Bluetooth. EUT is a Wi-Fi Client device.

8 Modifications

No modifications were performed during this assessment.

9 General Technical Parameters

9.1 *Normal Conditions*

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 110 Vac from the mains.

9.2 *Varying Test Conditions*

No varying test conditions were used during these tests.

10 Dynamic Frequency Selection (DFS)

10.1 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*.

10.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	KDB 905462 D02, Clause 7.8
EUT Tested Channel Bandwidths:	80 MHz
EUT Test Channel Loading:	Internal data pattern repeated every 2ms, 20% duty.
EUT Output Power Setting:	Max.
EUT Tested Modes:	Client
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 23 °C	Usually: +15 °C to +35 °C
Humidity: 35 %RH	Usually: 20%RH to 75%RH
Supply: 110 Vac	

Test Limits

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

Table 3: Interference threshold values

Maximum Transmit Power	Value (see notes 1, 2 and 3)
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

Parameter	Value
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: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.	
NOTE 2: The Channel Closing Transmission Time is comprised of 200 ms starting at the beginning of the Channel Move Time 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 U-NII Detection Bandwidth 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.	

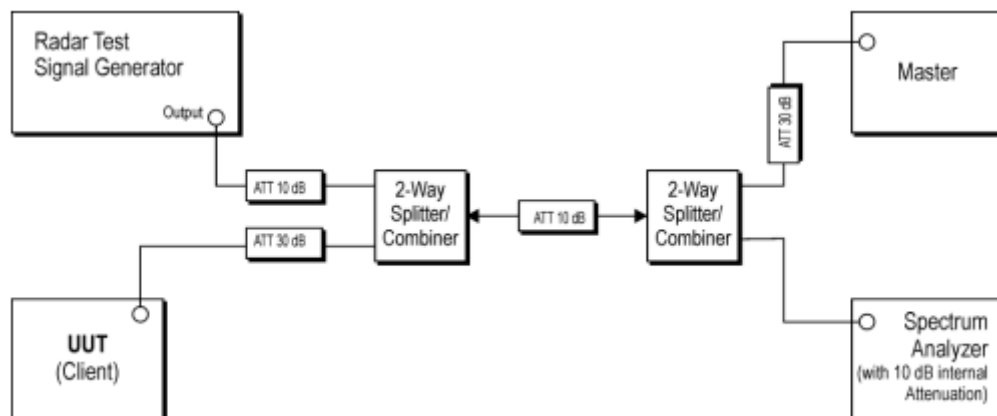
Table 5: Short pulse radar test signals

Radar type	Pulse width (μs)	PRI (μs)	Number of pulses	Min. % of successful detection	Min. number of trials
0	1	1428	18	See Note 1	See Note 1
NOTE 1: Short pulse radar type 0 should be used for detection bandwidth test, channel move time and channel closing time tests.					

10.3 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.

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.

Figure i Test Setup



Calibration

DFS Radar Waveforms

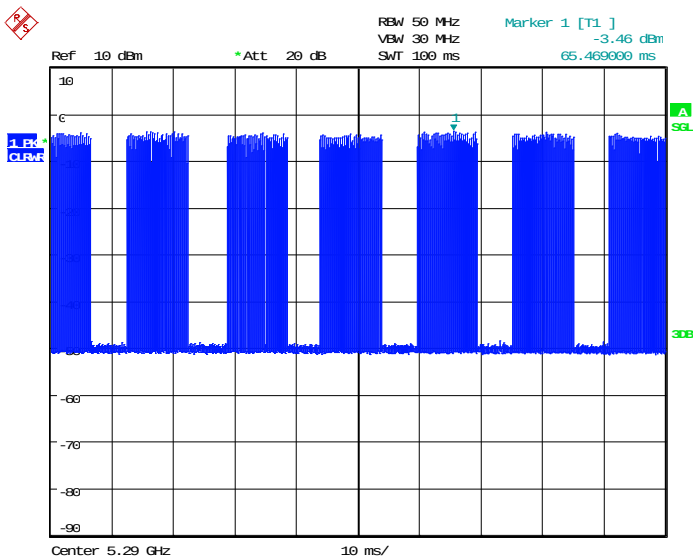
The RF attenuator nearest the EUT was set to provide sufficient attenuation not to overload the analyser whilst the EUT was at maximum power. The RF attenuator nearest the support radio was then set by increasing to the point where the EUT could no longer receive the signal (receiver threshold), then 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 was set to the centre of the test channel, Ch_r . 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, 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.

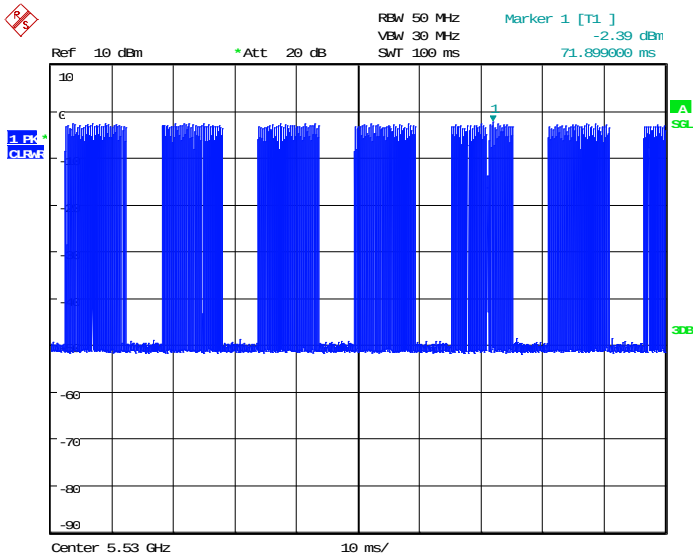
Channel Loading

Chanel	Channel Loading (%)
58	28.5
106	31.7



Date: 10.MAY.2016 09:45:34

Timing Plot - CH 58



Date: 10.MAY.2016 09:48:04

Timing Plot - CH 106

11 In-Service Monitoring

11.1 Definition

11.1.1 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*.

11.1.2 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.

11.2 Additional Test Parameters

EUT Test Channels, Ch _r .	5280 MHz & 5500 MHz
EUT Operating Channels / Bandwidths:	Ch 58 & Ch 106 / 80 MHz
Master Uniform Spreading:	N/A

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.

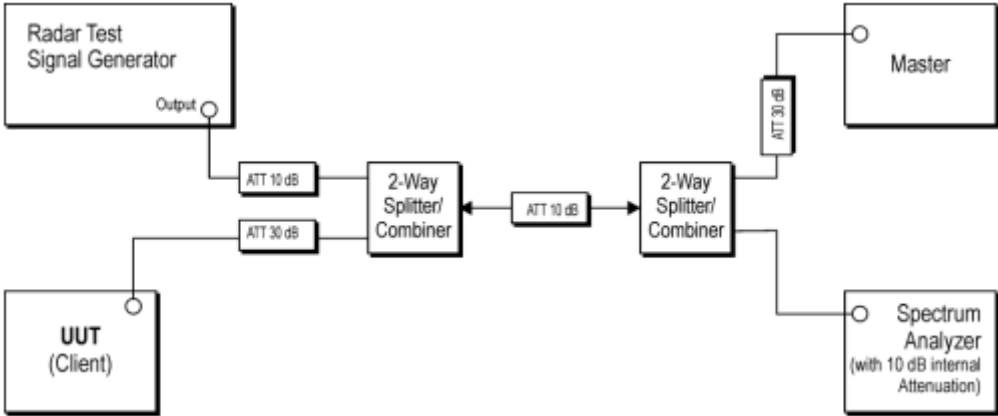
The *Non-Occupancy Period* shall not be less than the value defined in table 4.

11.3 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 continued to be observed for a further 30 min.

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

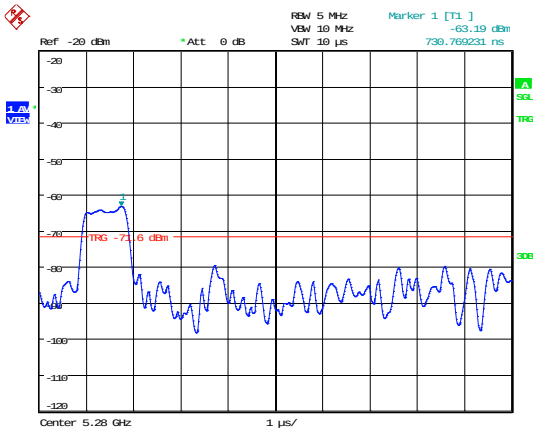
Figure ii Test Setup



11.4 Test Equipment

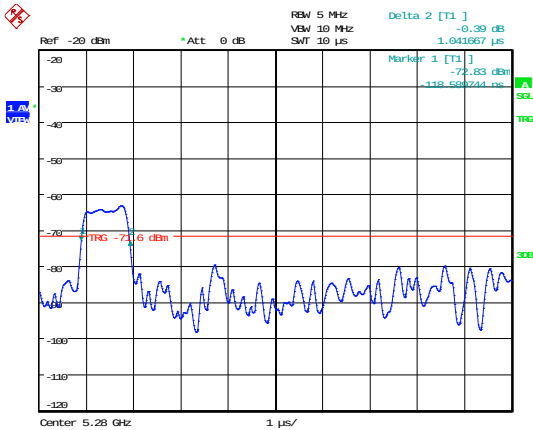
Equipment Description	Manufacturer	Equipment Type	Element No	Last Cal Calibration	Calibration Period	Due For Calibration
Spectrum Analyser	R&S	FSU26	U405	11/05/2015	12	11/05/2016
Signal Generator	Aeroflex	NI PXI 1042	REF2152	Cal before use		

11.5 Test Results



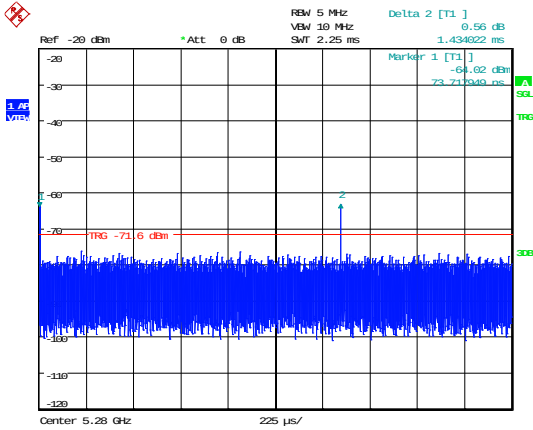
Date: 9.MAY.2016 11:31:28

Test Signal Amplitude – 5280 MHz



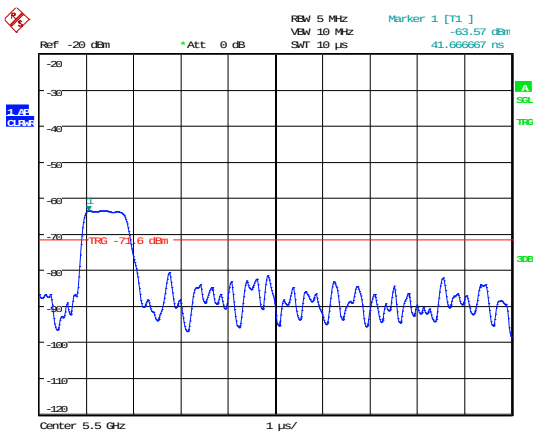
Date: 9.MAY.2016 11:33:31

Test Signal Width – 5280 MHz



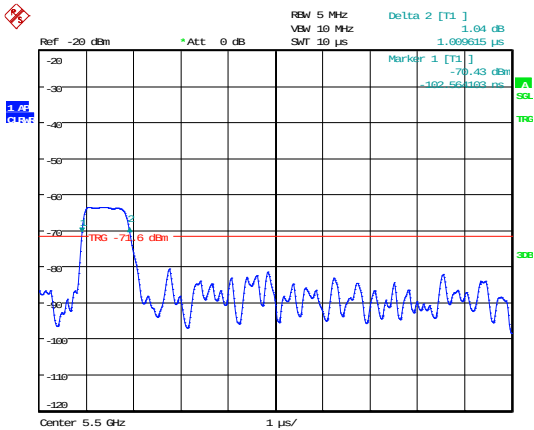
Date: 9.MAY.2016 11:39:14

Test Signal Repetition – 5280 MHz



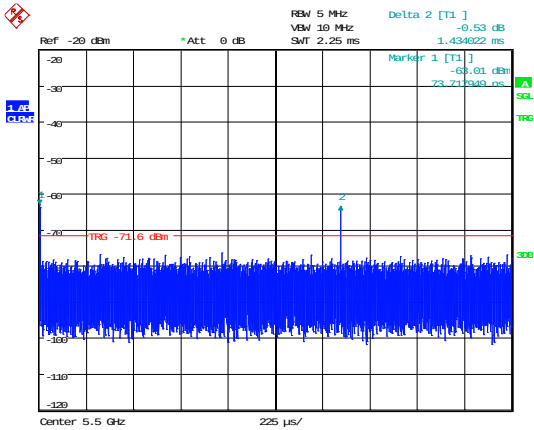
Date: 9.MAY.2016 11:45:24

Test Signal Amplitude – 5500 MHz



Date: 9.MAY.2016 11:45:03

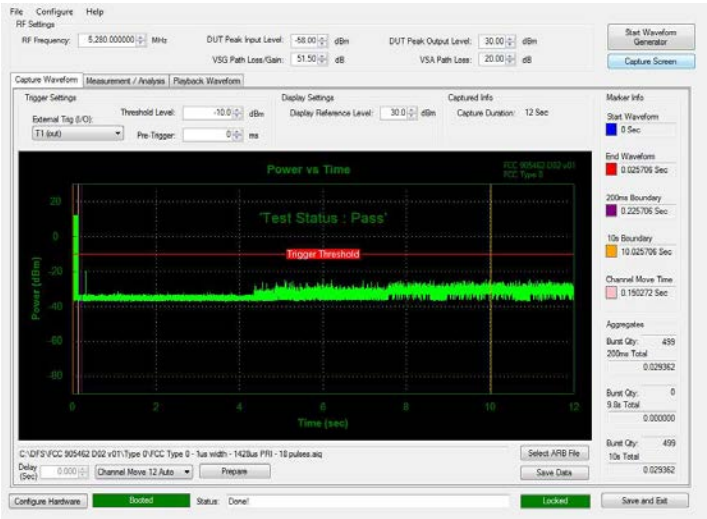
Test Signal Width– 5500 MHz



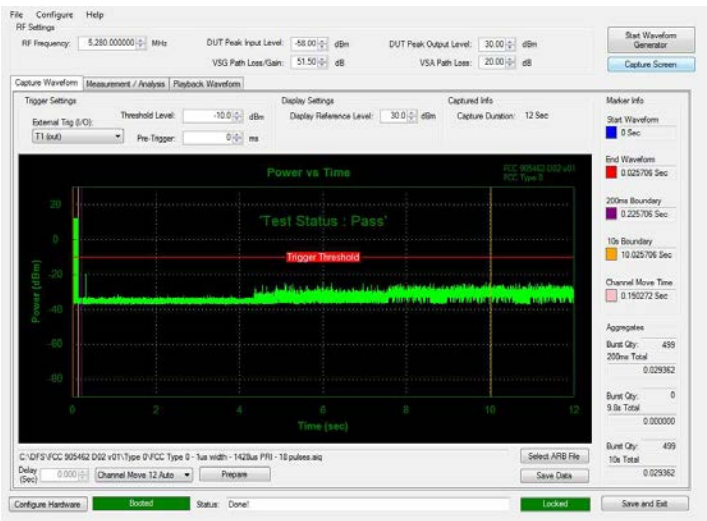
Date: 9.MAY.2016 11:44:08

Test Signal Repetition– 5500 MHz

Bandwidth: 80 MHz					
Channel	Interference level (dBm)	Channel move time (s)	Channel Closing Transmission Time (ms)	Transmissions during non-occupancy period	Result
58	-63.19	29.362	0	None	PASS
106	-63.57	28.408	0.424	None	PASS



Timing Plot – CH 58



Timing Plot – CH 106

12 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] Radiated spurious emissions

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[2] AC power line conducted emissions

Uncertainty in test result = **3.4dB**

[3] Occupied bandwidth

Uncertainty in test result = **15.5%**

[4] Conducted carrier power

Uncertainty in test result (Power Meter) = **1.08dB**

[5] Conducted / radiated RF power out-of-band

Uncertainty in test result – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[6] Power spectral density

Uncertainty in test result (Spectrum Analyser) = **2.48dB**