FCC and Industry Canada Testing of the Ericsson LAA, Model: RRUS 2205 B46 In accordance with FCC 47 CFR Part 15E and Industry Canada RSS-247

Product Service

Choose certainty.
Add value.

Prepared for: Ericsson AB
Torshamnsgatan 23
Kista
SE-16480
Stockholm
Sweden

FCC ID: TA8AKRC161609-2
IC: 287AB-AS1616092

COMMERCIAL-IN-CONFIDENCE

Document Number: 75944018-01 | Issue: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Maggie Whiting	08 February 2019	
Authorised Signatory	Matthew Russell	08 February 2019	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

ENGINEERING STATEMENT
The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15E and Industry Canada RSS-247. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Simon Bennett	08 February 2019	
Testing	Daniel Bishop	08 February 2019	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC 47 CFR Part 15E: 2017 and Industry Canada RSS-247: Issue 2 (2017-02)

TÜV SÜD Product Service
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD Product Service
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Product Service

Contents

Product Service

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	08 February 2019

Table 1

1.2 Introduction

Applicant	Ericsson
Manufacturer	Ericsson
Model Number(s)	Radio 2205 B46
Serial Number(s)	DB27608630 DB27608621
Hardware Version(s)	R1D
Software Version(s)	CXP9024418/6 R61A97
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15E: 2017 Industry Canada RSS-247: Issue 2 (2017-02)
Date of Receipt of EUT	28-November-2018
Start of Test	21-January-2019
Finish of Test	04-February-2019
Name of Engineer(s)	Simon Bennett Daniel Bishop
Related Document(s)	KDB 662911 D01 v02r01 KDB 905462 D02 v02 KDB 905462 D04 v01 KDB 905462 D06 v02 KDB 789033 D02 v02r01

Product Service

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15E and Industry Canada RSS-247 is shown in the table below.

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	Part 15E	RSS-247			
Configuration and Mode: Master – 20 MHz LTE					
2.2	15.407 (h)(2)	6.3	U-NII Detection Bandwidth	Pass	KDB 905462 D02 v02
2.3	15.407 (h)(2)(ii)	6.3	Initial Channel Availability Check	Pass	KDB 905462 D02 v02
2.4	15.407 (h)(2)(ii)	6.3	Radar Burst at the Beginning of the Channel Availability Check Time	Pass	KDB 905462 D02 v02
2.5	15.407 (h)(2)(ii)	6.3	Radar Burst at the End of the Channel Availability Check Time	Pass	KDB 905462 D02 v02
2.6	15.407 (h)(2)(iii)(iv)	6.3	In-Service Monitoring	Pass	KDB 905462 D02 v02
2.7	15.407 (h)(2)	6.3	Statistical Performance Check	Pass	KDB 905462 D02 v02
2.8	15.407 (h)(2)	6.3	Uniform Spreading	Declaration	KDB 905462 D02 v02

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	Part 15E	RSS-247			
Configuration and Mode: Master – 20 MHz LTE – 2CC –Contiguous Carriers					
2.6	15.407 (h)(2)(iii)(iv)	6.3	In-Service Monitoring (2CC – Lower Portion Of IBW)	Pass	KDB 905462 D02 v02
2.6	15.407 (h)(2)(iii)(iv)	6.3	In-Service Monitoring (2CC – Upper Portion Of IBW)	Pass	KDB 905462 D02 v02

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	Part 15E	RSS-247			
Configuration and Mode: Master – 20 MHz LTE – 2CC – Non Contiguous Carriers					
2.6	15.407 (h)(2)(iii)(iv)	6.3	In-Service Monitoring	Pass	KDB 905462 D02 v02

Section	Specification Clause		Test Description	Result	Comments/Base Standard
	Part 15E	RSS-247			
Configuration and Mode: Master – 20 MHz LTE – 3CC – Contiguous Carriers					
2.6	15.407 (h)(2)(iii)(iv)	6.3	In-Service Monitoring	Pass	KDB 905462 D02 v02

Table 2

Product Service

1.4 Application Form

EQUIPMENT DESCRIPTION	
Model Name/Number	Radio 2205 B46
Part Number	KRC 161 609/2
Hardware Version	R1D
Software Version	CXP9024418/6 R61A97
FCC ID	TA8AKRC161609-2
ISED ID	287AB-AS1616092
Technical Description (Please provide a brief description of the intended use of the equipment)	The equipment is the remote radio part designed for use in 3GPP LTE cellular wireless system with License Assisted Access (LAA).

TYPE OF EQUIPMENT (TICK ALL THAT APPLY)	
☒	Master
☐	Client with Radar Detection
☐	Client without Radar Detection
☐	Wi-Fi Direct Support

TRANSMITTER TECHNICAL CHARACTERISTICS	
FREQUENCY CHARACTERISTICS	
☒	5.150 GHz to 5.250 GHz
☒	5.250 GHz to 5.350 GHz
☒	5.470 GHz to 5.725 GHz
☒	5.725 GHz to 5.825 GHz
☒	EUT can operate in the frequency band 5600 – 5650 MHz
Note: DFS is not required in the ranges 5.15 – 5.25 GHz and 5.725 – 5.825 GHz	

TRANSMITTER RF POWER CHARACTERISTICS		
Maximum rated transmitter output power as stated by manufacturer		
Conducted Power	18 dBm	
Maximum Antenna Gain	12 dBi	
EIRP	30 dBm	
Minimum rated transmitter output power as stated by manufacturer (if applicable)		
Conducted Power	dBm	
Maximum Antenna Gain	dBi	
EIRP	dBm	
Is TPC supported?	☒ Yes	☐ No
If Yes, provide a description of operation.		
The output power of the 2205 B46 radio is controlled by configuration as described in the product operating manuals. The power can be reduced by at least 12dB from the maximum permittable maximum value by operator configuration. The managed object model includes MaxunlicensedTXpower for LAA carrier configuration: maxUnlicensedTxPower = 0 { 0..40000 } Max allowed output power for LAA EARFCN. Below local or county regulations for unlincensed bands and subbands. Unit: 1 mW		

POWER SOURCE					
☒	AC mains supply			State voltage	100-250V
AC supply frequency	45-65	(Hz)	85-275	VAC	
☒	DC supply				
Nominal voltage	-48V DC				

SYSTEM ARCHITECTURE			
☐	Frame Based		
☒	IP Based		
☐	Other	If other please state	
☐	802.11a	Receiver Bandwidth:	MHz
☐	802.11n – 20 MHz	Receiver Bandwidth:	MHz
☐	802.11n – 40 MHz	Receiver Bandwidth:	MHz
☐	802.11ac – 20 MHz	Receiver Bandwidth:	MHz
☐	802.11ac – 40 MHz	Receiver Bandwidth:	MHz
☐	802.11ac – 80 MHz	Receiver Bandwidth:	MHz
☐	802.11ac – 160 MHz	Receiver Bandwidth:	MHz
☐	802.11ax – 20 MHz	Receiver Bandwidth:	MHz
☐	802.11ax – 40 MHz	Receiver Bandwidth:	MHz
☐	802.11ax – 80 MHz	Receiver Bandwidth:	MHz
☐	802.11ax – 160 MHz	Receiver Bandwidth:	MHz
☒	LAA - LTE	Receiver Bandwidth:	20 MHz

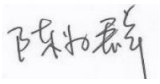
DECLARATION			
No parameter or information relating to the detected radar waveforms is available or accessible to the end user.			
☒	True	☐	False

MISCELLANEOUS (Master Device Only)	
Power-on cycle time*	~123 seconds
* Time from switching on the UUT to the point at which Channel Availability Check (CAC) commences	

UNIFORM SPREADING (Master Device Only)
Describe how the meter provides, on aggregate, uniform channel loading of the spectrum across all channels.
An internal algorithm "Dynamic frequency selection" selects channels for operation from the set of channels across band 46 spectrum based upon RSSI scannning observations of the whole spectrum.This algorithm attempts to select the least occupied channels (based on RSSI measurements) for operation.The algorithm can be executed on each system startup / restart and repeated periodically during operation.

ANTENNA OPTIONS	
Antenna 1	
Antenna Description:	Integrated panel antenna
Antenna Model:	KRE 105259/1
Antenna Maximum Gain:	9.5dBi +/- 1dB
Antenna Frequency Range:	5155 - 5875 MHz
Antenna 2	
Antenna Description:	Galtronics Outdoor Omni Canister Antenna
Antenna Model:	Extent P6480i
Antenna Maximum Gain:	6dBi
Antenna Frequency Range:	5150-5950MHz
Antenna 3	
Antenna Description:	Integrated Dual Directional Antenna 6513
Antenna Model:	KRE 101 2350/2
Antenna Maximum Gain:	12dBi
Antenna Frequency Range:	5150-5925MHz
Antenna 4	
Antenna Description:	
Antenna Model:	
Antenna Maximum Gain:	
Antenna Frequency Range:	
Antenna 5	
Antenna Description:	
Antenna Model:	
Antenna Maximum Gain:	
Antenna Frequency Range:	

I hereby declare that that the information supplied is correct and complete.

Name: Weiqun Chen  Position held: Regulatory Approval Engineer

Date: 2019-02-08

Product Service

1.5 Product Information

1.5.1 Description

The equipment is the remote radio part designed for use in 3GPP LTE cellular wireless system with License Assisted Access (LAA). Each LTE LAA carrier operates as a 20 MHz carrier associated with a licensed carrier using 3GPP Release-10 Carrier Aggregation procedures.

This product supports multiple LAA carrier operation, each LAA carrier maintains its own independent listen before talk process (LBT), control channels, MAC scheduler and PHY encoder/decoder. Each LAA carrier is independent of any others that the equipment may radiate.

Additional channels are utilized as needed, e.g. when total payload reaches a certain threshold. Furthermore, if radar is detected in one of the 20 MHz LAA channels then the transmissions will be stopped in that channel for the non-occupancy period. The DFS availability and in-service monitoring procedures are performed by each 20 MHz carrier independently.

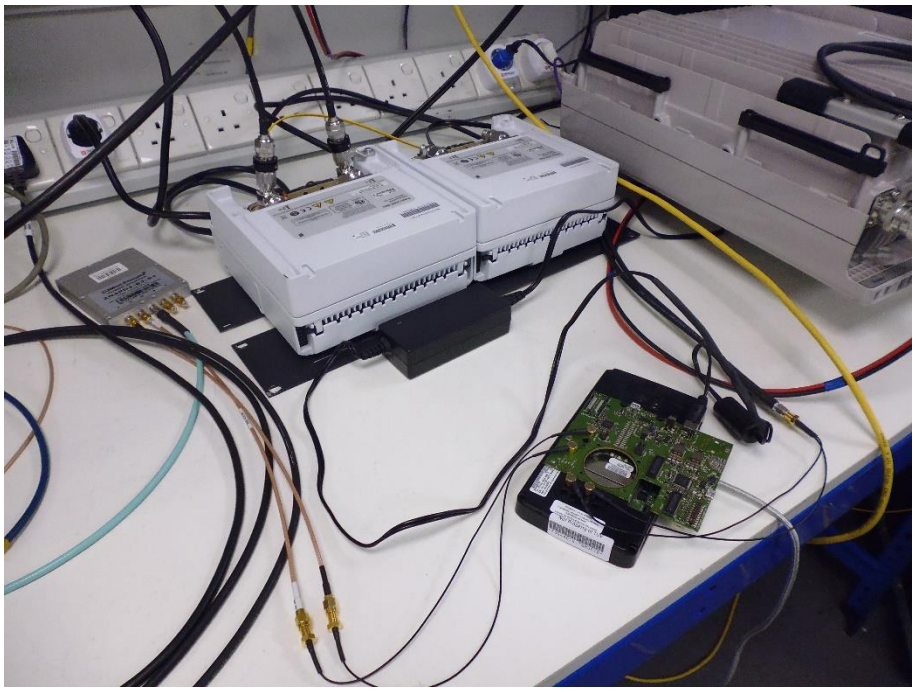


Figure 1 – Test Setup Photo

1.5.2 Antenna Configuration

DFS testing was performed conducted using the lowest gain antenna which is 0 dBi (worst case scenario).

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

Product Service

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: Not Stated			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

TÜV SÜD Product Service conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Master – 20 MHz LTE		
U-NII Detection Bandwidth	Simon Bennett Daniel Bishop	UKAS
Initial Channel Availability Check	Simon Bennett Daniel Bishop	UKAS
Radar Burst at the Beginning of the Channel Availability Check Time	Simon Bennett Daniel Bishop	UKAS
Radar Burst at the End of the Channel Availability Check Time	Simon Bennett Daniel Bishop	UKAS
In-Service Monitoring	Simon Bennett Daniel Bishop	UKAS
Statistical Performance Check	Simon Bennett Daniel Bishop	UKAS
Configuration and Mode: Master – 20 MHz LTE – 2CC		
In-Service Monitoring	Simon Bennett Daniel Bishop	UKAS
Configuration and Mode: Master – 20 MHz LTE – 3CC		
In-Service Monitoring	Simon Bennett Daniel Bishop	UKAS

Table 4

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

Product Service

2 Test Details

2.1 Calibration of Test Setup

2.1.1 Specification Reference

FCC 47 CFR Part 15E
Industry Canada RSS-247

2.1.2 Equipment Under Test and Modification State

Master Device:
Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.1.3 Date of Test

21-January-2019 to 04-February-2019

2.1.4 Environmental Conditions

Ambient Temperature	22.2 °C
Relative Humidity	33.5 % to 47.6 %

2.1.5 Test Results

DFS Measurement Instrumentation

The Aeroflex Dynamic Frequency Selection Radar Simulation and Analyser Test Suite was utilised. This test system consists of hardware and software; which comprises of a radar test signal generator and a test signal analyser.

The DFS test system utilises a PXI chassis with PXI instruments populating this chassis; which allows all instrumentation to communicate on a common bus. The following PXI instruments are populated in the PXI chassis; PC with a dual core processor, Frequency References, Vector Signal Generator and a Digitiser.

The test signal and analysis software is run on the PC and controls all of the instruments such that the required test signals are generated and analysed using test sequences in the test software application. The specific test utilisation of this system is described within applicable measurement procedures.

Test Signal Generator

The PXI Vector Signal Generator is capable of generating all test signals required by the relevant test specification and is driven using the Aeroflex DFS Simulation and Analyser Test Suite on the PXI PC. An external trigger is also provided at the SMB output of the signal generator which is employed when an external spectrum analyser is utilised for DFS measurements instead of the Aeroflex Digitiser.

Test Signal Analyser

The PXI Digitiser is used for channel monitoring during DFS testing and is capable of capturing measurement sweeps with sample rates of 5 M samples/s and 2.5 M samples/s with sweep times of 12 s and 24 s respectively.

Various markers are contained within the generated test signals. The markers are used to trigger the Signal Analyser at the correct points. Once a measurement sweep has completed, the signal analyser software evaluates the data according to the relevant test requirement.

Test Channel, Channel Bandwidth and Data Rate Selection

DFS support activation and identification of band 46 channels which are subject to DFS is automatic (software logic) and based on MCC (Mobile Country Code). Value determined from configured PLMN ID attribute on eNodeB. PLMN ID uniquely identifies geographical area in which an eNodeB is operational. MCC (Mobile Country Code) is fetched from PLMN ID, and mapped to table in source code which contains all allowed frequencies as per FCC regulatory guidelines.

For CANADA, MCC (302), table containing allowed frequencies excludes frequencies in the range 5600 – 5650 MHz.

In cases where the fundamental emission channel bandwidth exceeds DFS band edges and where it is not possible to select a channel that has the entire emission bandwidth within the DFS band, specific requirements and procedures are detailed further in the relevant test sections.

Product Service

Test Signal Selection and Calibration

The test signal calibration was completed using the calibration procedure as described in KDB 905462 D02, clause 7.5.

The EUT can be configured as a master mode device employing a radar detection with the following power and antenna assembly characteristics. Other antennas are supplied by the manufacturer with the product but were not selected for testing. Details of all antennas can be found in section 1.5.2.

Note that the maximum EIRP is based on the highest antenna gain. In the cases of MIMO devices, the maximum EIRP has been obtained according to KDB 662911 D01.

Noise Floor Characterisation

The noise floor of the spectrum analyser was characterised for comparative use with Availability Check, initial radar bursts, In-Service Monitoring, and 30 minute Non-Occupancy Period tests to determine whether any observed transmissions were from the EUT.

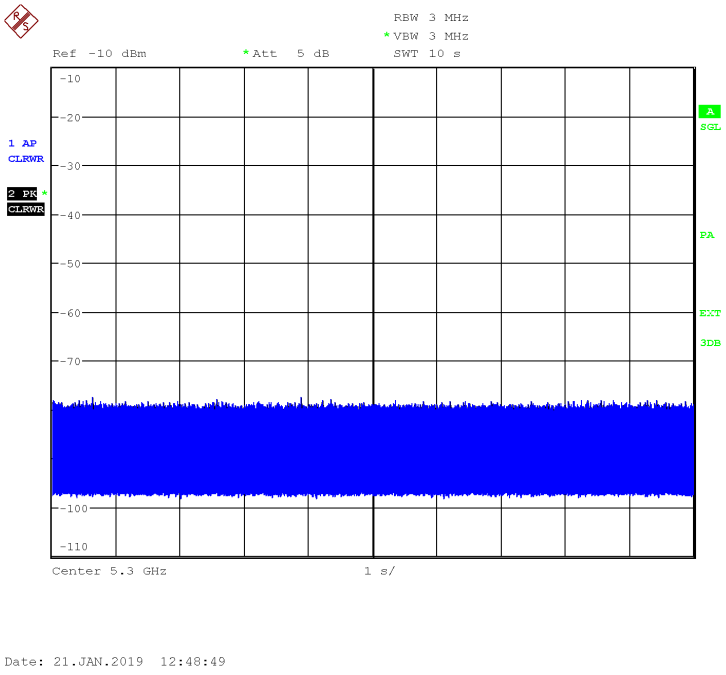


Figure 2 - Noise Floor Characterisation Plot

Master - LTE

The test was performed in the conducted test configuration as shown in the diagram below and that specified in KDB 905462, clause 7.2.1.

The client device used during test was a Snapdragon 845 Development Toolkit, S/N: DB27608621.

The system was configured with a random ping command that was configured from a PC connected to the EUT via ethernet interface. Channel loading of at least 17% remained a requirement for in-service monitoring.

To verify the radar type 0 signal used during testing, the master device was replaced with a spectrum analyser. The level was then adjusted to a level of -63 dBm and the number of pulses was verified as 18.

The channel loading was determined using the methods described in KDB 789033 D02 General UNII Test Procedures, Clause II.B. A spectrum analyser in zero-span mode was employed, a sweep duration of 100 milliseconds was used. An average detector was utilized with 3 MHz resolution and video bandwidths. The measurement sweep trace showing transmissions on the channel frequency was exported to a data file and then analyzed. An amplitude threshold was applied to the trace data in the file, such that the total number of sweep points that exceeded this threshold was determined. The duration of each sweep point was calculated by dividing the sweep time by the number of sweep points. The channel loading was calculated by multiplying this total number of sweep points by the time duration of each sweep point.

The path loss to each antenna port was measured. The path loss with the least loss was used to calibrate the radar pulses. This ensures worst case across both ports. This port was referred to as Port A which has been used for the radar level measurements shown below.

Maximum Transmit Power	Value (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.	

Table 5 - DFS Detection Thresholds for Master Devices and Client Devices with Radar Detection

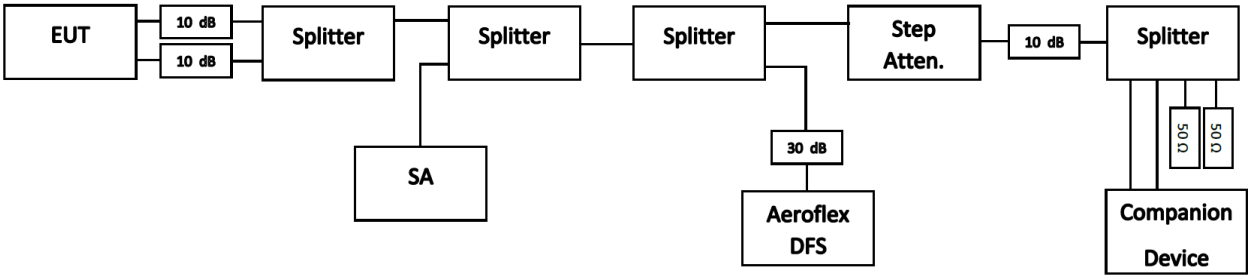


Figure 3 - Test Equipment Setup for Master with Injection at the Master

Radar Type	Pulse Width (µs)	PRI (µs)	Number of Pulses
0	1	1428	18

Table 6 - Radar Pulse Type 0 Characteristics

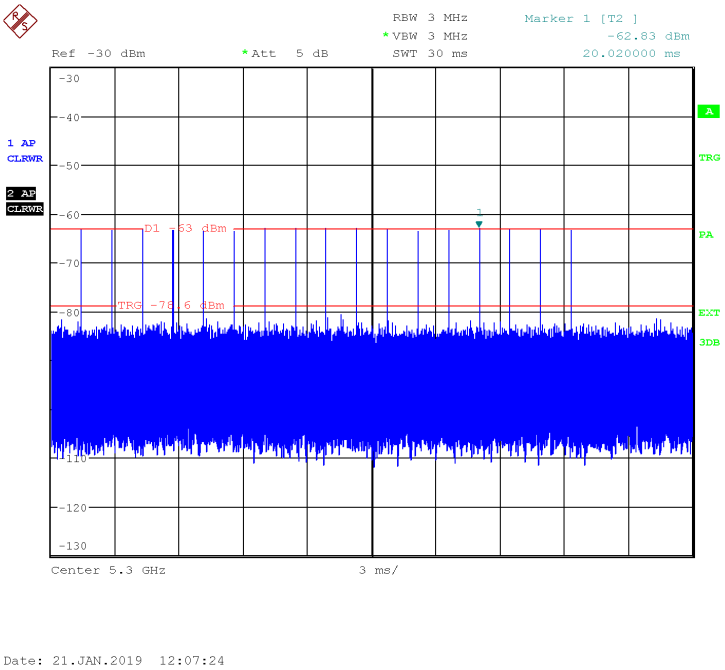


Figure 4 - Verification of Radar Type 0

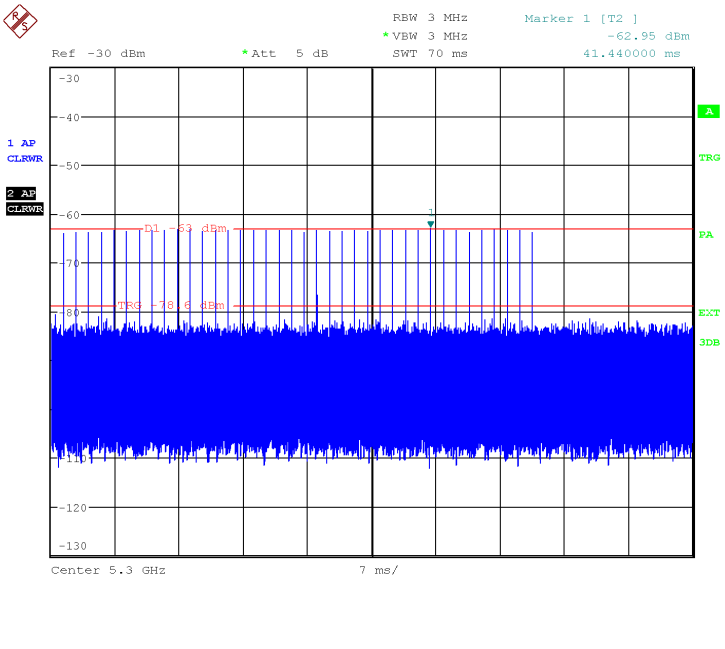


Figure 5 - Verification of Radar Type 1

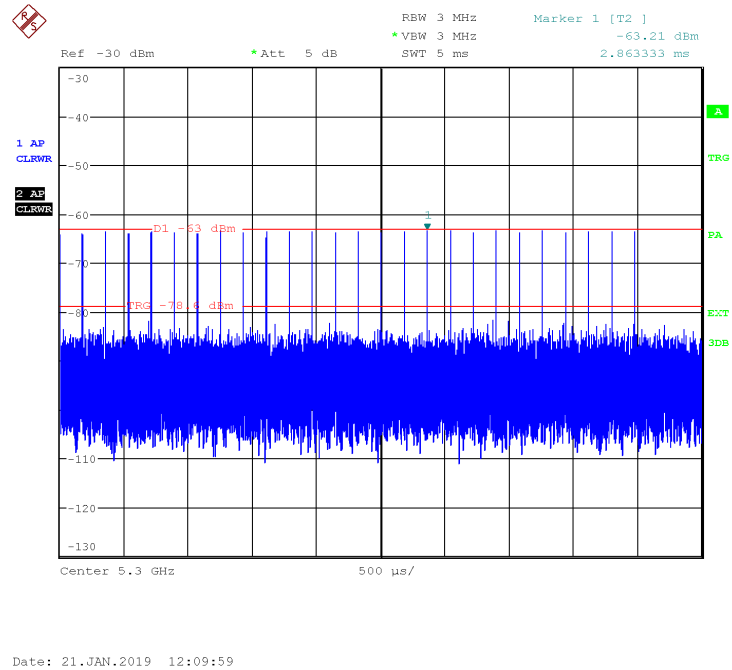


Figure 6 - Verification of Radar Type 2

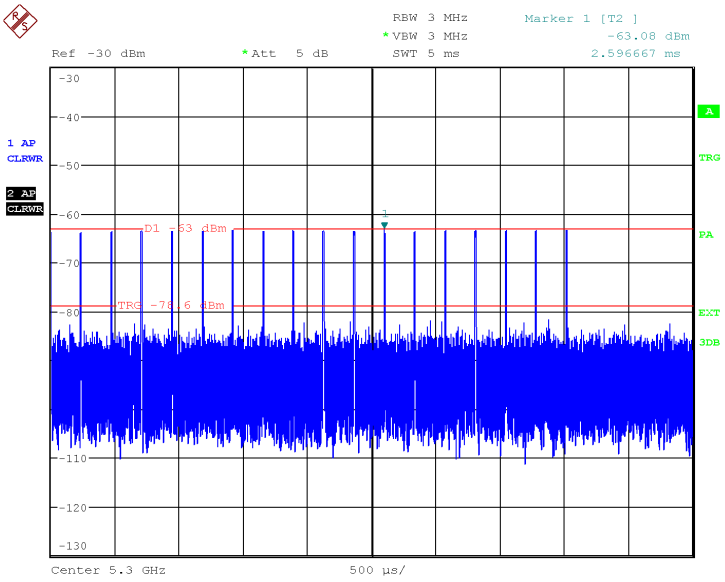


Figure 7 - Verification of Radar Type 3

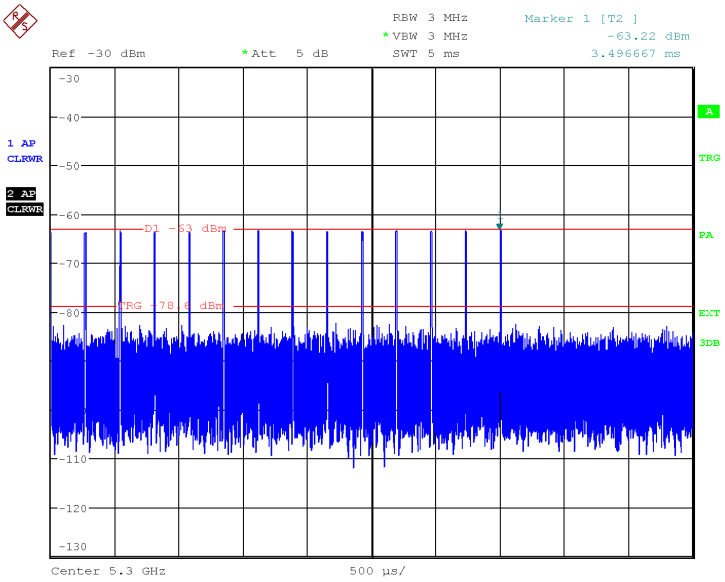


Figure 8 - Verification of Radar Type 4

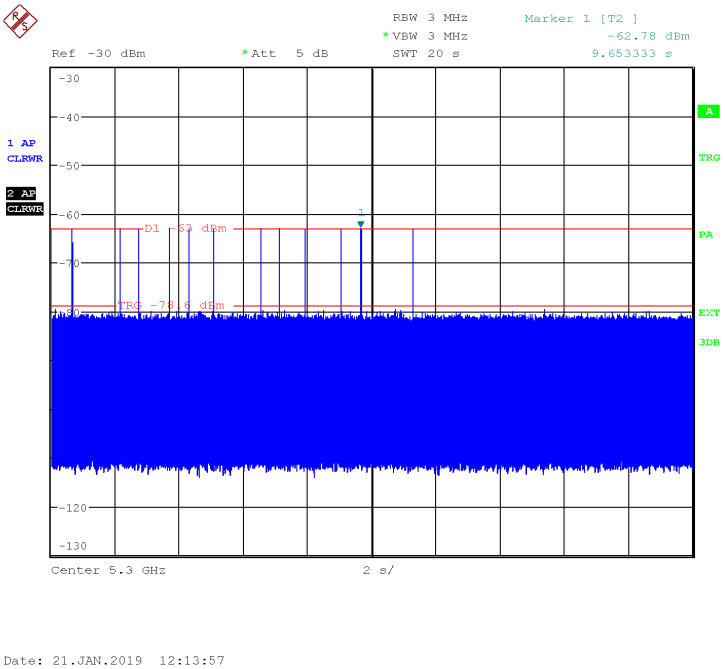


Figure 9 - Verification of Radar Type 5

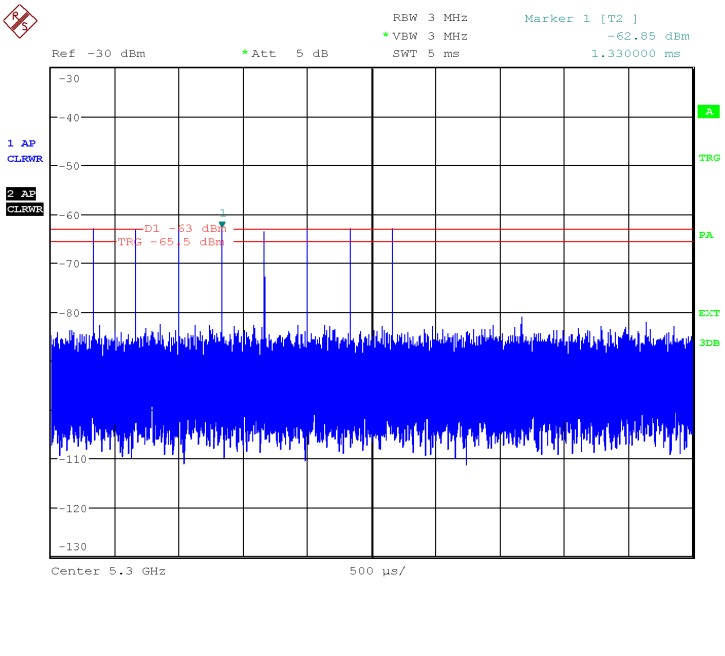


Figure 10 - Verification of Radar Type 6

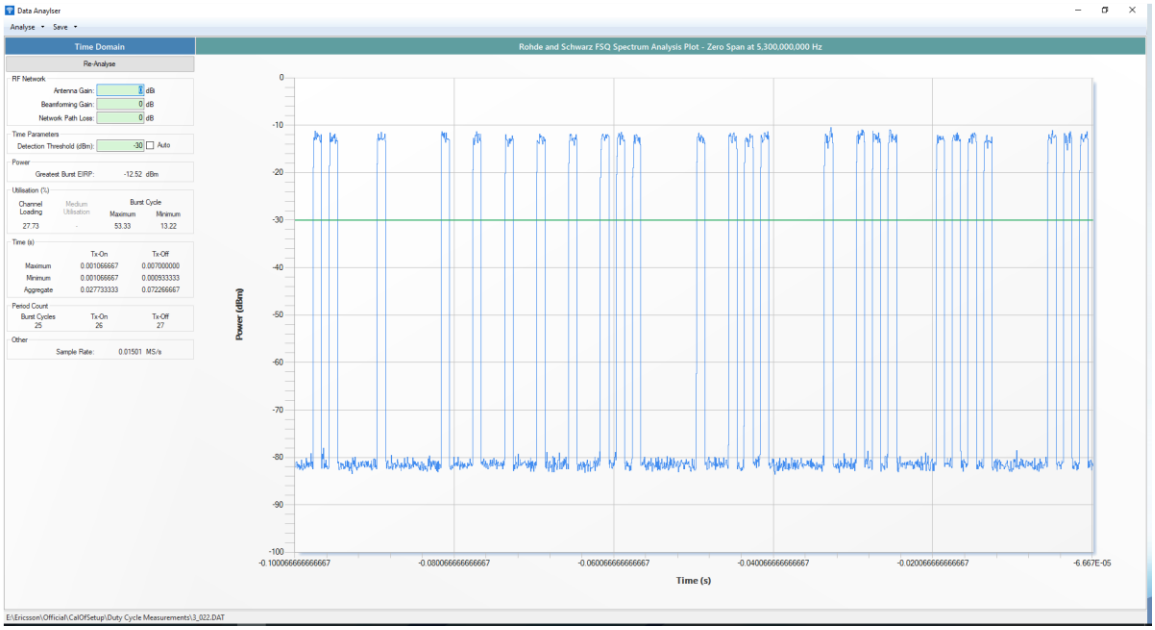


Figure 11 - Channel Loading

The channel loading was measured as 27.73% In order to achieve this channel loading a data rate of approximately 2 - 3 Mbps was used.

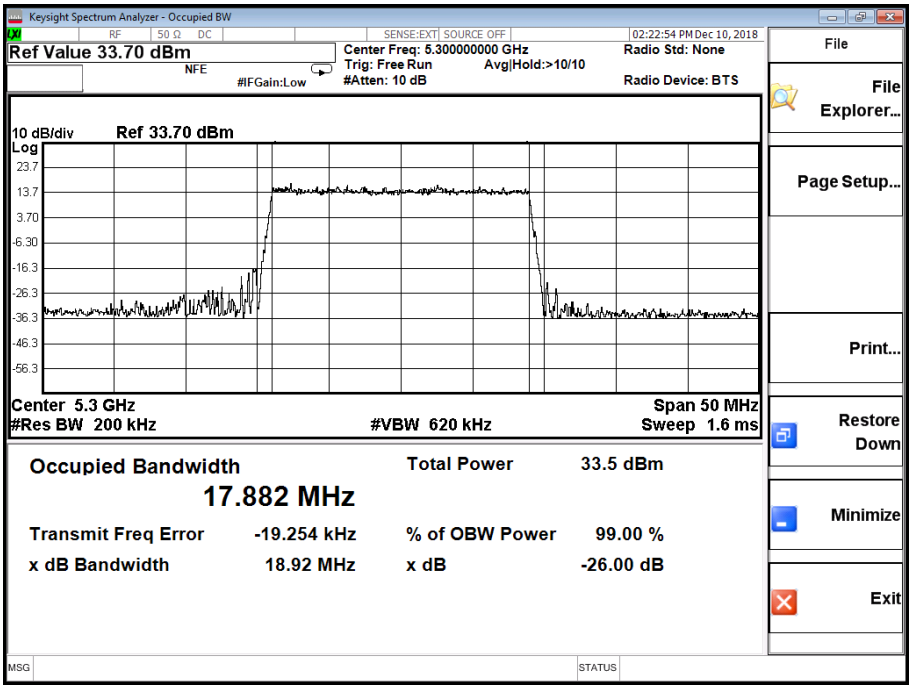


Figure 12 - Occupied Bandwidth

The Occupied Bandwidth was measured in order to determine the pass/fail criterion of the U-NII Detection Bandwidth. In addition to this the points F_{OBL} and F_{OBH} were determined in order to calculate the point F_{C5} for use with the statistical performance check for Radar Type 5.

Occupied Bandwidth	17.882 MHz
F_{OBL}	5291.059 MHz
F_{OBH}	5308.941 MHz

Table 7 - Occupied Bandwidth Results

Product Service

Master - LTE 2CC & 3CC Bandwidth

The 26 dB Bandwidth has been measured to demonstrate that each channel is individual.

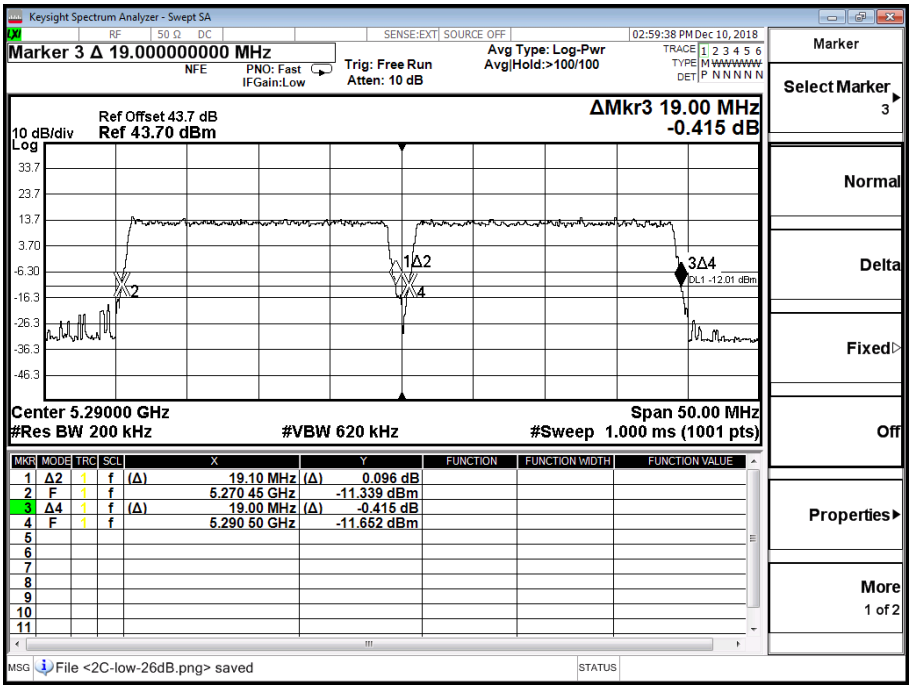


Figure 13 - 2CC - Contiguous Carriers - Lower IBW

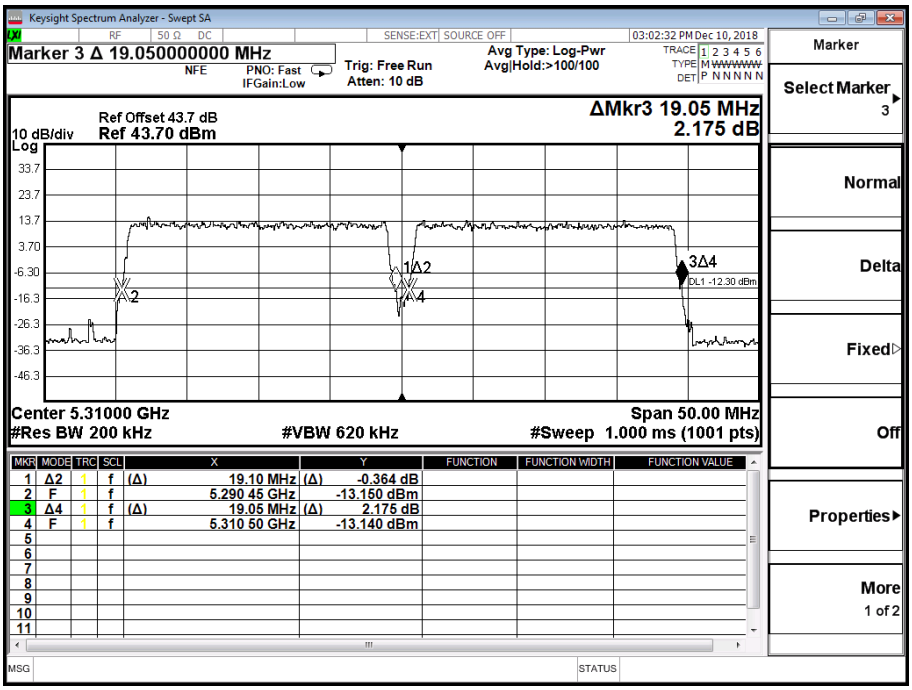


Figure 14 - 2CC - Contiguous Carriers - Upper IBW

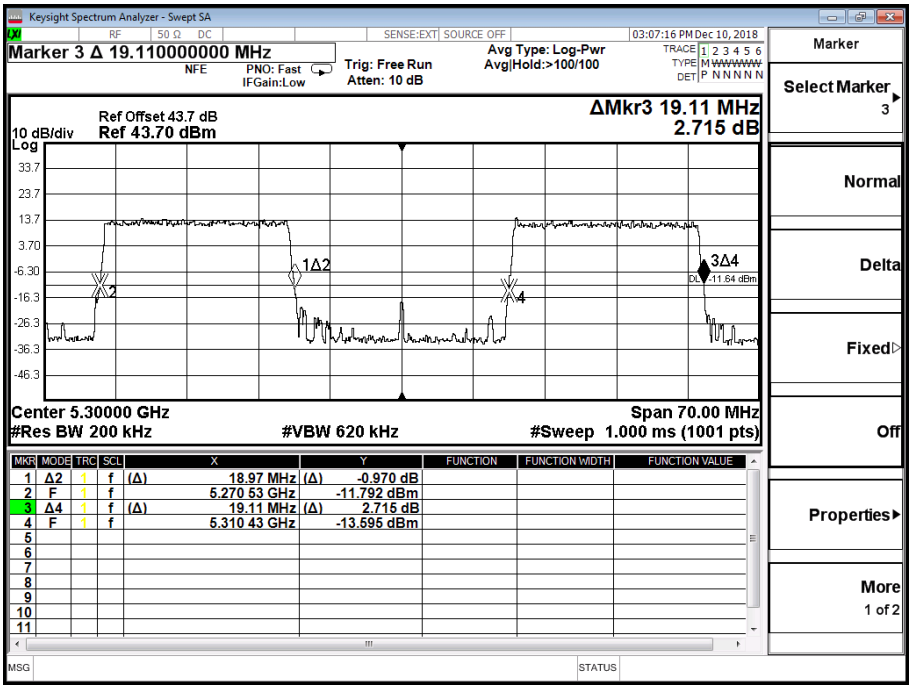


Figure 15 - 2C - Split Carriers

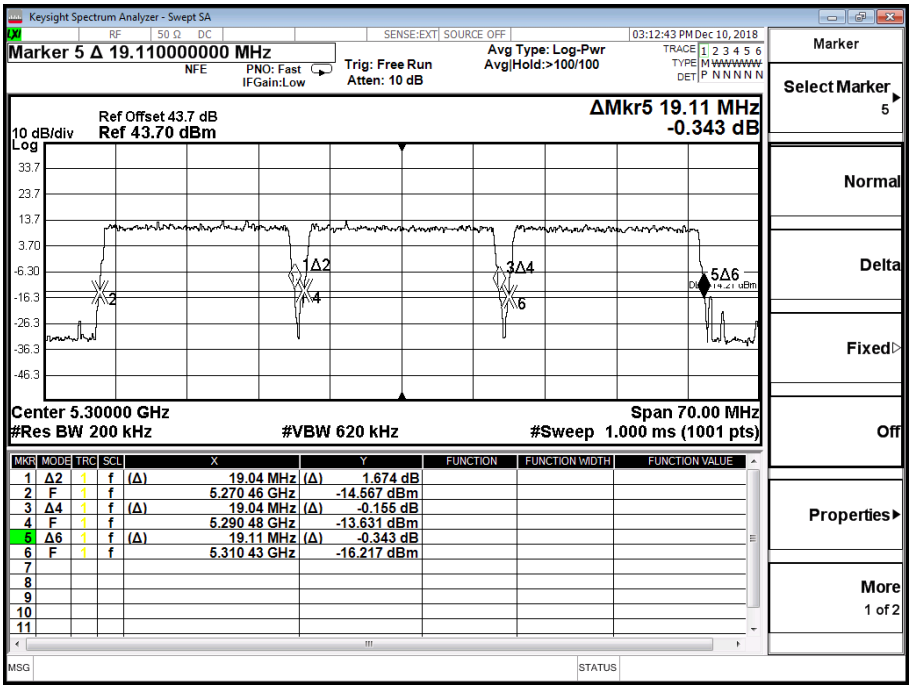


Figure 16 - 3CC - Contiguous Carriers

Product Service

2.2 U-NII Detection Bandwidth

2.2.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(iii)(iv)
Industry Canada RSS-247, Clause 6.3.

2.2.2 Equipment Under Test and Modification State

Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.2.3 Date of Test

02-February-2019

2.2.4 Test Method

To determine the required detection bandwidth, the 99% occupied bandwidth was measured in accordance with the occupied bandwidth measurement method described in KDB 789033 D02 as shown in the Calibration of Test Setup section of this report.

The U-NII Detection Bandwidth was measured according to the method described in KDB 905462 D02, clause 7.8.1.

Separate test software was provided that overrides the non-occupancy mechanism for the purpose of increasing time efficiency during testing.

The EUT was configured as a standalone device with no associations with any other devices and with no channel loading. Starting at the centre frequency of the EUT operating channel, a single radar burst of a short pulse radar test signal (Type 0) was produced with a level of the required DFS detection threshold, at the antenna port of the EUT. The EUT response from this radar test signal was noted.

This procedure was repeated for a minimum of 10 trials, while adjusting the radar test signal frequency in ±5 MHz steps until the detection rate fell below the U-NII Detection Bandwidth criterion. At this point the previous procedure was repeated in 1 MHz steps until the highest and lowest frequencies were determined by the points at which detection was greater than or equal to the U-NII Detection Bandwidth criterion.

2.2.5 Environmental Conditions

Ambient Temperature	24.3 °C
Relative Humidity	37.5 %

2.2.6 Test Results

The specific parameters of the waveforms used during these measurements are detailed in Appendix A of this report.

LTE – 20 MHz

The highest detection frequency is 5309 MHz and the lowest detection frequency is 5291 MHz, yielding a Detection Bandwidth of 18 MHz. The specific measurements are detailed below.

Radar Waveform	Radar Frequency (MHz)	Number of Detections	Number of Non-detections	Detection Rate (%)
FCC Short Pulse Radar (Type 0)	5290	0	10	0
	5291	10	0	100
	5292	10	0	100
	5293	10	0	100
	5294	10	0	100
	5295	10	0	100
	5300	10	0	100
	5305	10	0	100
	5306	10	0	100
	5307	10	0	100
	5308	10	0	100
	5309	10	0	100
	5310	0	10	0

Figure 17 - U-NII Detection Bandwidth Results

FCC Part 15E Limit Clause 15.407(h)(2)

The device must sense for radar signals at 100 percent of its emissions bandwidth.

Industry Canada RSS-247, Limit Clause 6.3.1

The device must detect radar signals within its entire emissions bandwidth.

KDB 905462 D02, Limit Clause 5.3

Minimum 100% of the U-NII 99% transmission power bandwidth.

Product Service

2.2.7 Test Location

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
PXA Signal Analyser	Keysight	N9030A	4654	12	08-Oct-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 8

O/P Mon - Output Monitored using calibrated equipment

Product Service

2.3 Initial Channel Availability Check

2.3.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(ii)
Industry Canada RSS-247, Clause 6.3.

2.3.2 Equipment Under Test and Modification State

Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.3.3 Date of Test

04-February-2019

2.3.4 Test Method

This test was performed in accordance with KDB 905462 D02, clause 7.8.2.1. This test does not use any Radar Waveforms and was only performed once for each mode and test frequency.

A spectrum analyser was used for measurements. The spectrum analyser centre frequency was set to the intended test frequency and utilised a peak detector with resolution and video bandwidths of 3 MHz. During the channel availability testing a measurement sweep duration of 2.5 minutes was set. The spectrum analyser sweep was started at the same time as the EUT monitoring software indicated the CAC time had begun.

It was not possible to accurately measure the power on sequence time of the EUT because the time elapsed during node restart was an arbitrary value. To measure the CAC time, a real time message appeared on the EUT monitoring software to indicate the beginning of the period.

When performing channel availability check measurements, the EUT was pre-configured to operate in each mode and set to operate on the test frequency before commencing the Channel Availability Check. Upon the EUT CAC being started, the spectrum analyser sweep was triggered whereby the channel activity was monitored. Using delta markers on the measurement sweep, the channel availability check time was determined as shown by the delta markers on the plots below. The start of sweep, (0 seconds), was the beginning of the EUT CAC time.

The spectrum analyser nominal noise floor was characterised with a 10 second sweep time before testing, using the same resolution and video bandwidths utilised during testing. During this process, there were no transmissions by the EUT or companion devices.

2.3.5 Environmental Conditions

Ambient Temperature	20.6 °C
Relative Humidity	40.5 %

2.3.6 Test Results

LTE – 20 MHz

The initial channel availability check time was at least 60 seconds.

Product Service

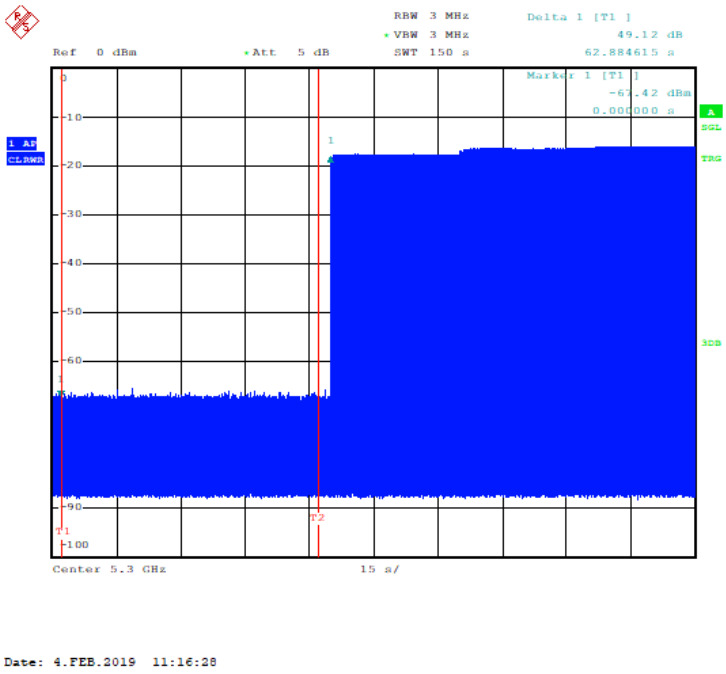


Figure 18 - Initial Channel Availability Check Time

Note: Time display line T1 is centred at 0 seconds, and T2 is centred at 60 seconds. The marker delta shows the CAC period is over 60 seconds (62.9 seconds).

FCC Part 15E, Limit Clause 15.407(h)(2)(ii)

The U–NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of the test specification, is detected within 60 seconds.

Industry Canada RSS-247, Limit Clause 6.3 (2)(b)

The device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in Section 6.3.1 of the specification is detected within 60 seconds.

KDB 905462 D02, Limit Clause 5.3

The channel availability check shall be performed for a minimum of 60 seconds.

Product Service

2.3.7 Test Location

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 9

TU - Traceability Unscheduled
O/P Mon - Output Monitored using calibrated equipment

Product Service

2.4 Radar Burst at the Beginning of the Channel Availability Check Time

2.4.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(ii)
Industry Canada RSS-247, Clause 6.3.

2.4.2 Equipment Under Test and Modification State

Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.4.3 Date of Test

04-February-2019

2.4.4 Test Method

This test was performed in accordance with KDB 905462 D02, clause 7.8.2.2.

A spectrum analyser was used for measurements. The spectrum analyser centre frequency was set to the intended test frequency and utilised a peak detector with resolution and video bandwidths of 3 MHz.

When performing channel availability check measurements, the EUT was pre-configured to operate in each mode and set to operate on the test frequency before commencing the Channel Availability Check. Upon the EUT CAC being started, the spectrum analyser sweep was triggered whereby the channel activity was monitored. Using delta markers on the measurement sweep, the Radar signal injection time was indicated. The start of sweep, (0 seconds), was the beginning of the EUT CAC time. The EUT CAC period is shown by the time lines on the plots below.

A single short pulse radar type 0 was applied to the EUT receiver within 6 seconds of the beginning of the channel availability check time, at a level equal to the detection threshold level + 1 dB, accounting for equipment variation/errors.

The measurement observation period was no less than 2.5 minutes proceeding the time at which the radar test signal was generated. It was verified that no EUT transmissions occurred on the test channel during this 2.5 minutes measurement period.

2.4.5 Environmental Conditions

Ambient Temperature	23.8 °C
Relative Humidity	39.1 %

2.4.6 Test Results

LTE – 20 MHz

It was verified that the radar was detected during the CAC time and no transmissions were produced from the EUT on the test channel.

Product Service

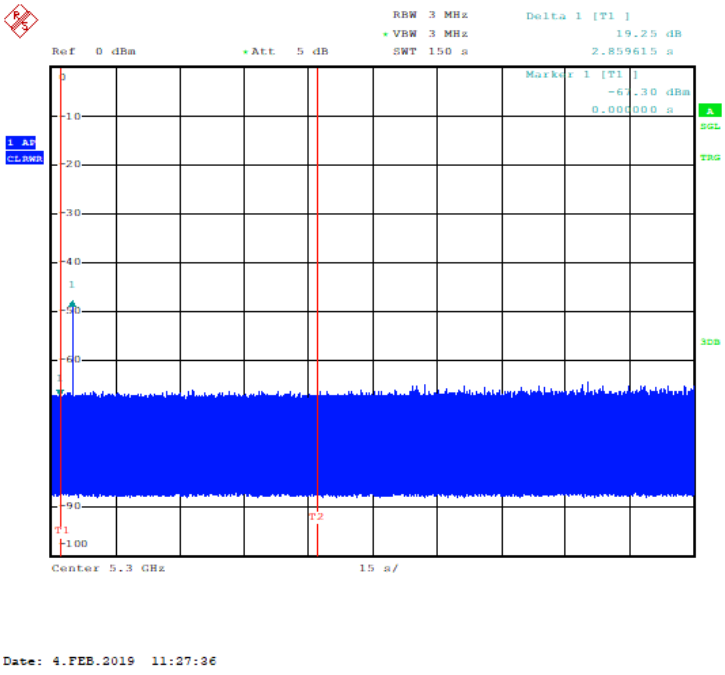


Figure 19 - Radar Injected at the Beginning of the Channel Availability Check

Note: Time display lines T1 denotes start of 60 second CAC period and T2 denotes the end of the 60 second CAC period. The marker delta shows the time at which the radar burst was injected. This was within 6 seconds of the beginning of the EUT's CAC period.

FCC Part 15E, Limit Clause 15.407(h)(2)(ii)

The U–NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of the test specification, is detected within 60 seconds.

Industry Canada RSS-247, Limit Clause 6.3 (2)(b)

The device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in Section 6.3(1) above is detected within 60 seconds.

KDB 905462 D02, Limit Clause 5.3

The channel availability check shall be performed for a minimum of 60 seconds.

Product Service

2.4.7 Test Location

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 10

O/P Mon - Output Monitored using calibrated equipment

Product Service

2.5 Radar Burst at the End of the Channel Availability Check Time

2.5.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(iii)(iv)
Industry Canada RSS-247, Clause 6.3.

2.5.2 Equipment Under Test and Modification State

Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.5.3 Date of Test

04-February-2019

2.5.4 Test Method

This test was performed in accordance with KDB 905462 D02, clause 7.8.2.3.

A spectrum analyser was used for measurements. The spectrum analyser centre frequency was set to the intended test frequency and utilised a peak detector with resolution and video bandwidths of 3 MHz.

When performing channel availability check measurements, the EUT was pre-configured to operate in each mode and set to operate on the test frequency before commencing the Channel Availability Check. Upon the EUT CAC being started, the spectrum analyser sweep was triggered whereby the channel activity was monitored. Using delta markers on the measurement sweep, the Radar signal injection time was indicated. The start of sweep, (0 seconds), was the start of the EUT CAC time.

A single short pulse radar type 0 was applied to the EUT receiver within 6 seconds of the end of the channel availability check time, at a level equal to the detection threshold level + 1 dB, accounting for equipment variation/errors.

The measurement observation period was no less than 2.5 minutes proceeding the time at which the radar test signal was generated. It was verified that no EUT transmissions occurred on the test channel during this 2.5 minutes measurement period.

2.5.5 Environmental Conditions

Ambient Temperature	21.1 °C
Relative Humidity	40.1 %

2.5.6 Test Results

<u>LTE – 20 MHz</u>

It was verified that the radar was detected during the CAC time and no transmissions were produced from the EUT on the test channel.

Product Service

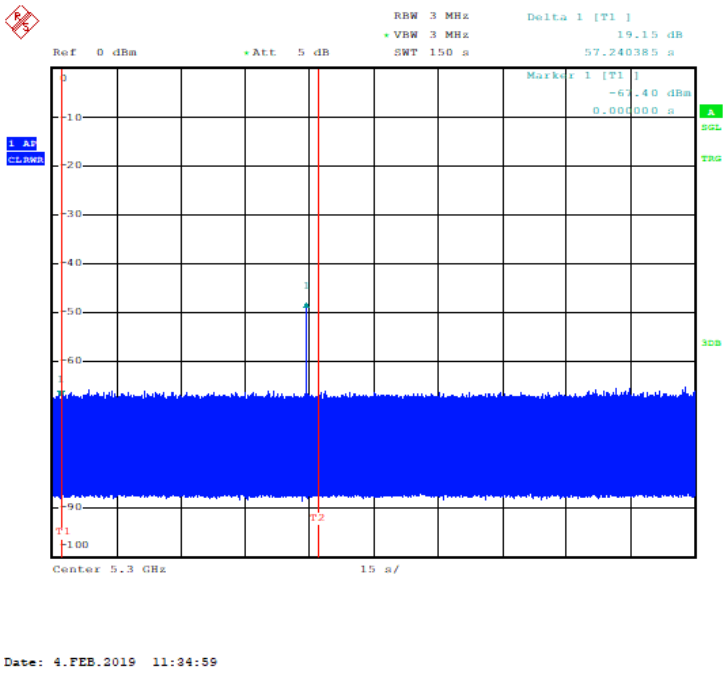


Figure 20 - Radar Injected at the end of the Channel Availability Check

Note: Time display lines T1 denotes start of 60 second CAC period and T2 denotes the end of the 60 second CAC period. The marker shows the time at which the radar burst was injected. This was within 6 seconds of the end of the EUT's CAC period.

FCC Part 15E, Limit Clause 15.407(h)(2)(ii)

The U–NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of the test specification, is detected within 60 seconds.

Industry Canada RSS-247, Limit Clause 6.3 (2)(ii)

The device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in Section 6.3(1) above is detected within 60 seconds.

KDB 905462 D02, Limit Clause 5.3

The channel availability check shall be performed for a minimum of 60 seconds.

Product Service

2.5.7 Test Location

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 11

O/P Mon - Output Monitored using calibrated equipment

Product Service

2.6 In-Service Monitoring

2.6.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(iii)(iv)
Industry Canada RSS-247, Clause 6.3

2.6.2 Equipment Under Test and Modification State

Master Device:
Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.6.3 Date of Test

04-February-2019

2.6.4 Test Method

This test was performed in accordance with FCC KDB 905462 D02, clause 7.8.3.

Radar Pulse Type 0 was transmitted, and the spectrum monitored. The transmissions from the UUT were observed for a period of 12 seconds after the final injected Radar Pulse.

During in-service monitoring, the system was configured with a random ping command from the master device (EUT) to the client device.

It was checked that all transmissions stopped within the 10 second period defined from the point of the end of the final Radar pulse + 10 seconds. In addition, the aggregate on time during the first 200ms and the following 9.8 seconds of the Channel Move Time was computed by the Aeroflex DFS Software.

The markers on the trace data correspond to the following time periods:

Red - End of Radar Burst, (T0)

Purple - End of 200ms Period, (T0 + 200 ms)

Orange - End of Channel Move Time, (T0 + 10 seconds)

To verify the non-occupancy period, the PXI digitiser was replaced with a Spectrum Analyser. The external trigger from the Aeroflex DFS test system was used to trigger a 30 minute sweep from the moment the radar burst sequence was injected. It was verified that no transmissions occurred on the test channel during this time period.

2.6.5 Environmental Conditions

Ambient Temperature	23.4 °C
Relative Humidity	41.2 %

2.6.6 Test Results

Master – LTE – 20 MHz

Test Parameter	Type 0	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Channel Move Time	4.19 ms	3.79 ms	3.09 ms	3.58 ms	2.33 ms	1.19 s	74.7 ms
Channel Closing Time (Aggregate Time During 200 ms)	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms
Channel Closing Time (Aggregate Time During 10 s)	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms	0 ms
Transmission Observed During Non-Occupancy Period	None	None	None	None	None	None	None

Table 12 - In-Service Monitoring Test Results

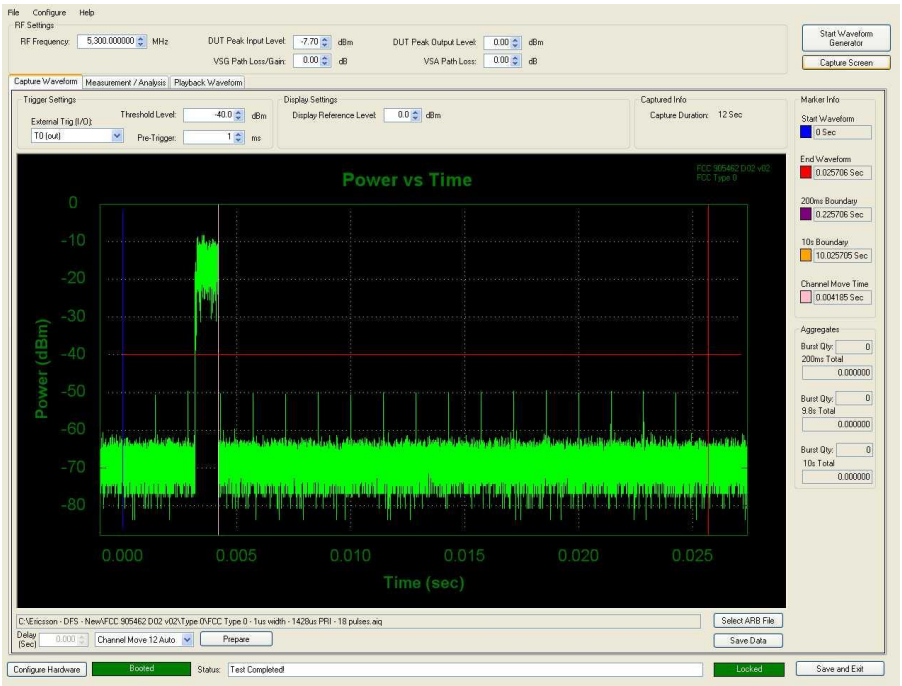


Figure 21 - Radar Test Signal Verification Plot

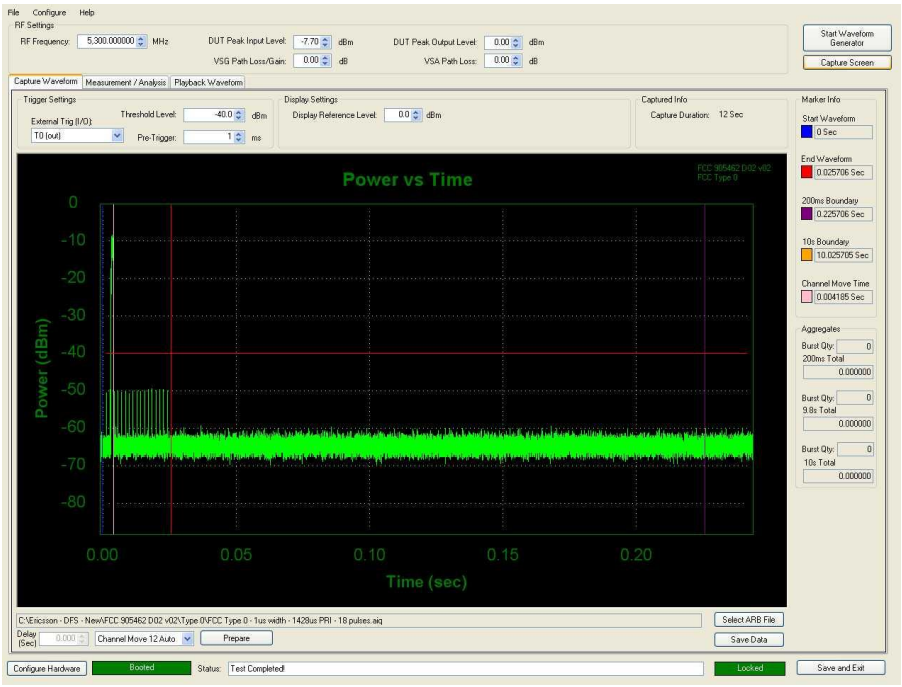


Figure 22 - First 200 ms of Channel Shutdown Period

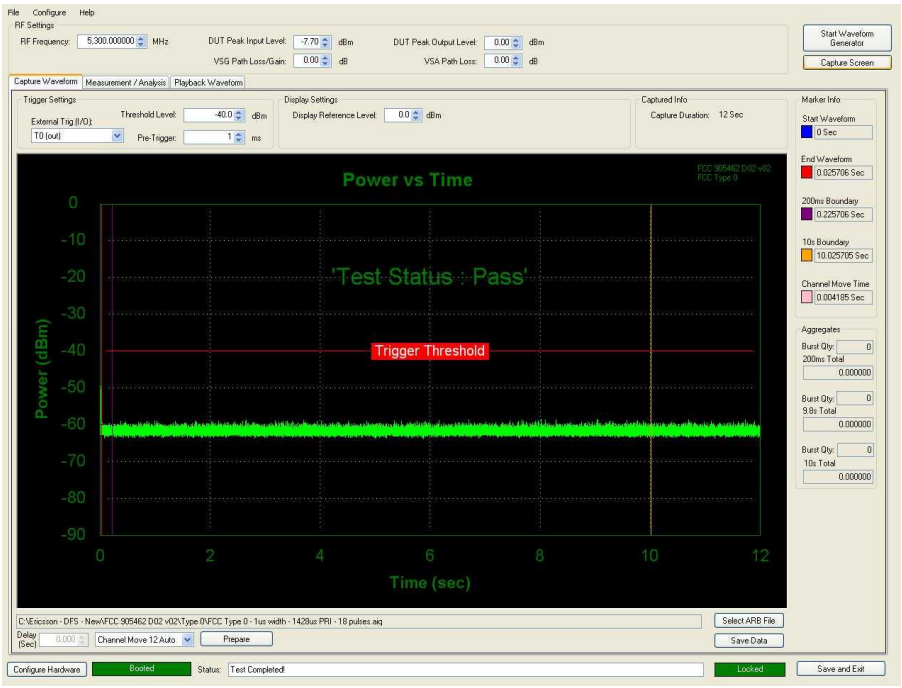


Figure 23 - 10 s Channel Shutdown

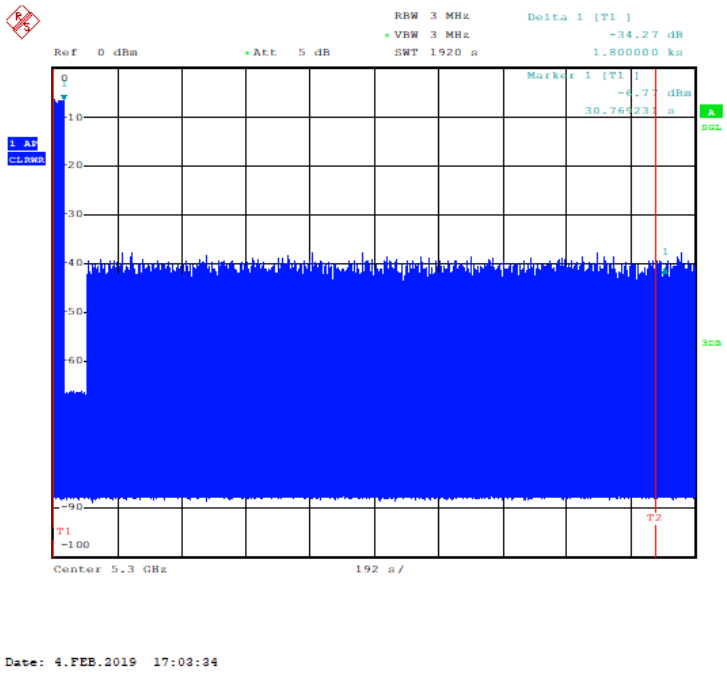


Figure 24 - Non-Occupancy Period

Display line T2 indicates the end of the 30 minute non-occupancy period. Marker 1 is placed at the beginning of the non-occupancy period, and the marker delta represents 30 minutes in seconds. Whilst some transmissions can be observed on the plot during the allotted non-occupancy period, these were confirmed to be originating from a separate adjacent channel.

Carrier Configurations

Furthermore, some additional testing was performed on various carrier configurations as requested. The 26 dB Bandwidth for each of these configurations has been highlighted earlier in this report in section 2.1.5 (Figures 12 – 15). Radar was injected on all carriers for each configuration. Only plots for one carrier position are included in the report, other results are displayed in table form. In the following diagram, the configurations are shown with each green block representing an active carrier.

Carrier Configuration	Channel Layout (Each block = 20 MHz)		
2C High			
2C Low			
2C Split			
3C			

Table 13 - Carrier configuration channel layout diagram.

Master – LTE – 20 MHz – 2C High Carrier Configuration

Test Parameter	Carrier Radar Injection		
	Lower	Centre	Upper
Channel Move Time	N/A	19.3 ms	6.45 ms
Channel Closing Time (Aggregate Time During 200 ms)	N/A	0 ms	0 ms
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	N/A	0 ms	0 ms
Channel Closing Time (Aggregate Time During 10 s)	N/A	0 ms	0 ms

Table 14 - 2C High In-Service Monitoring Test Results

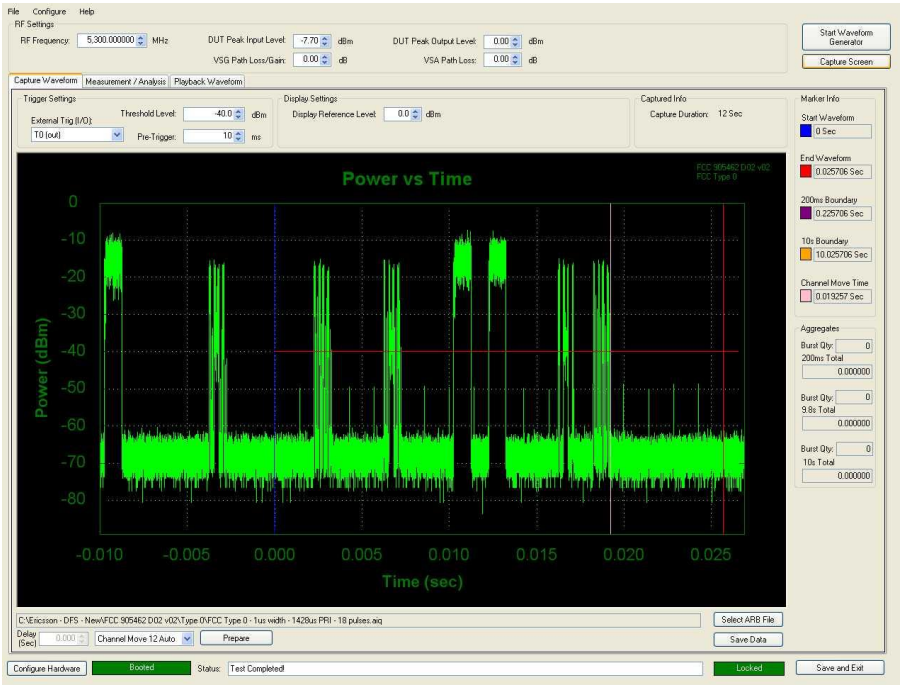


Figure 25 - Radar Test Signal Verification Plot

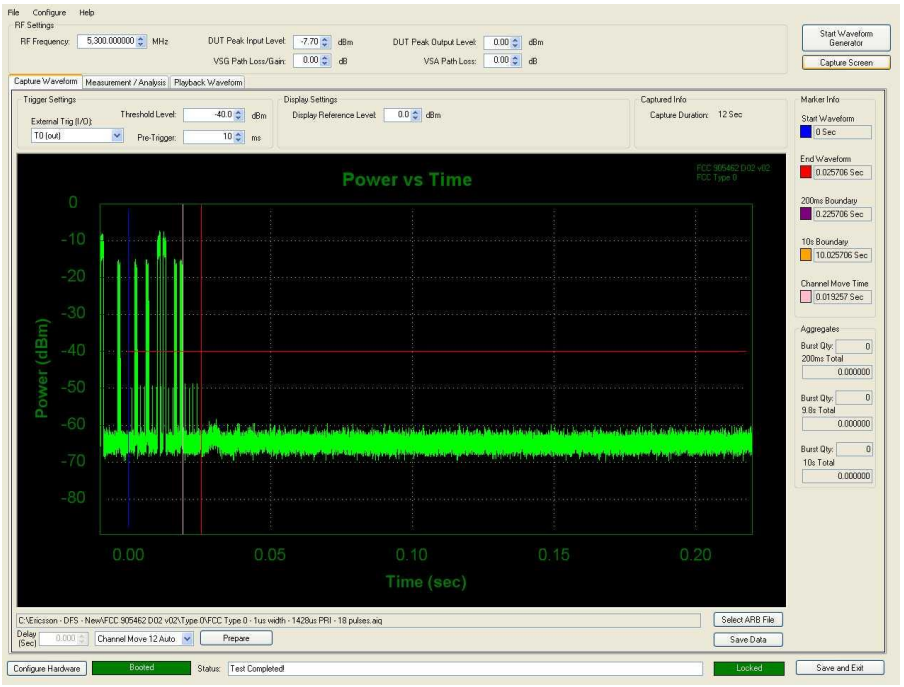


Figure 26 - First 200 ms of Channel Shutdown Period

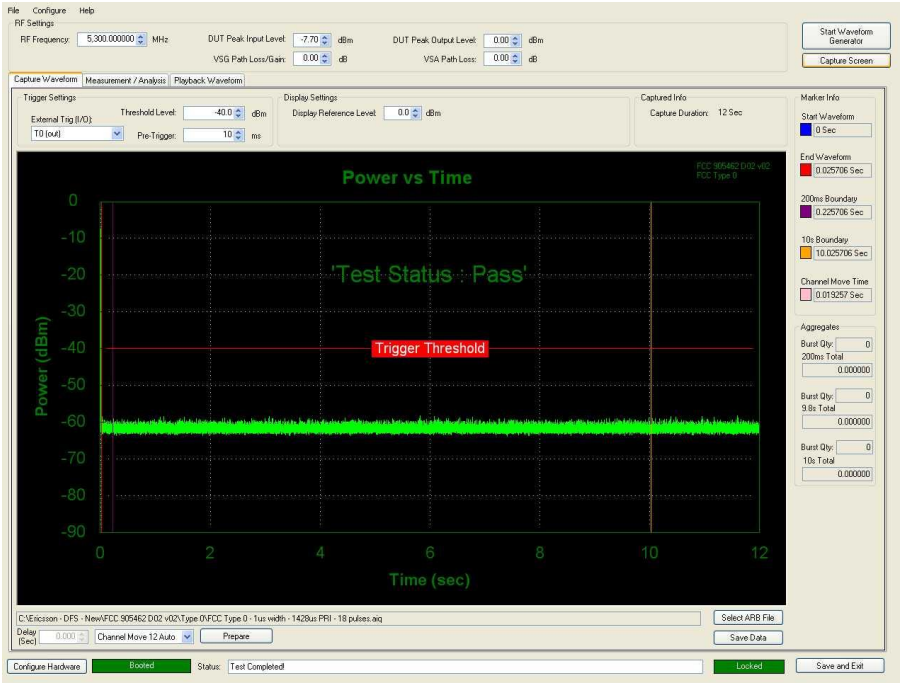


Figure 27 - 10 s Channel Shutdown

Master – LTE – 20 MHz – 2C Low Carrier Configuration

Test Parameter	Carrier Radar Injection		
	Lower	Centre	Upper
Channel Move Time	11.8 ms	47.2 ms	N/A
Channel Closing Time (Aggregate Time During 200 ms)	0 ms	0.22 ms	N/A
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	0 ms	0 ms	N/A
Channel Closing Time (Aggregate Time During 10 s)	0 ms	0.22 ms	N/A

Table 15 - 2C Low In-Service Monitoring Test Results

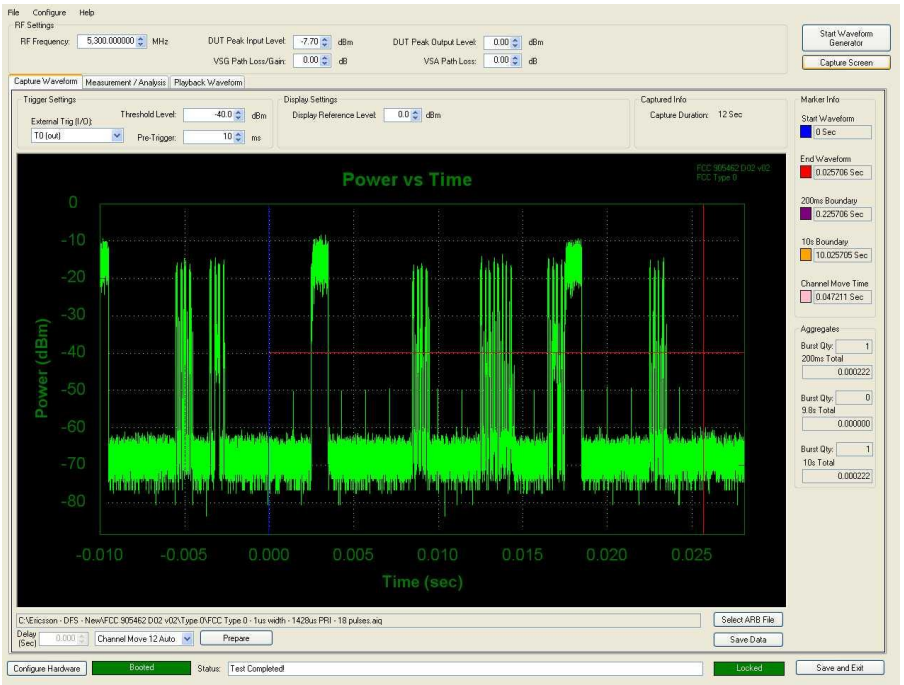


Figure 28 - Radar Test Signal Verification Plot

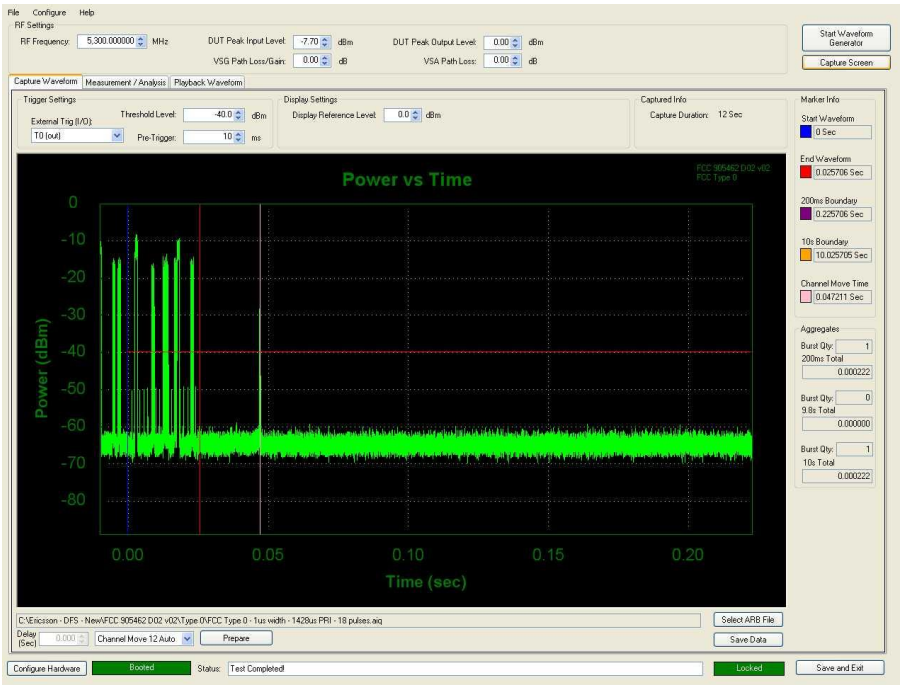


Figure 29 - First 200 ms of Channel Shutdown Period

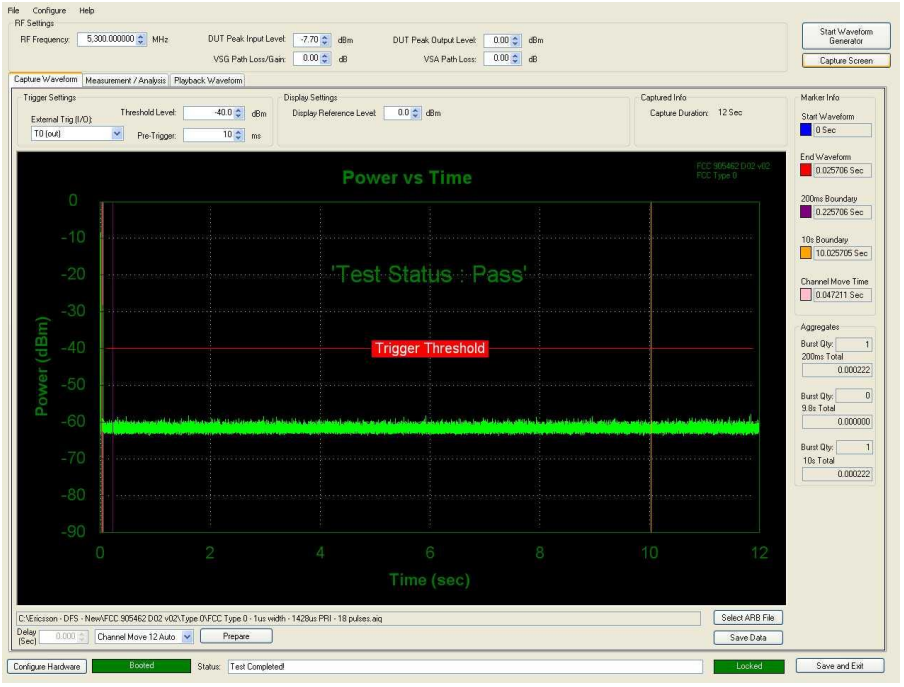


Figure 30 - 10 s Channel Shutdown

Master – LTE – 20 MHz – 2C Split Carrier Configuration

Test Parameter	Carrier Radar Injection		
	Lower	Centre	Upper
Channel Move Time	5.11 ms	N/A	12.8 ms
Channel Closing Time (Aggregate Time During 200 ms)	0 ms	N/A	0 ms
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	0 ms	N/A	0 ms
Channel Closing Time (Aggregate Time During 10 s)	0 ms	N/A	0 ms

Table 16 - 2C Split In-Service Monitoring Test Results

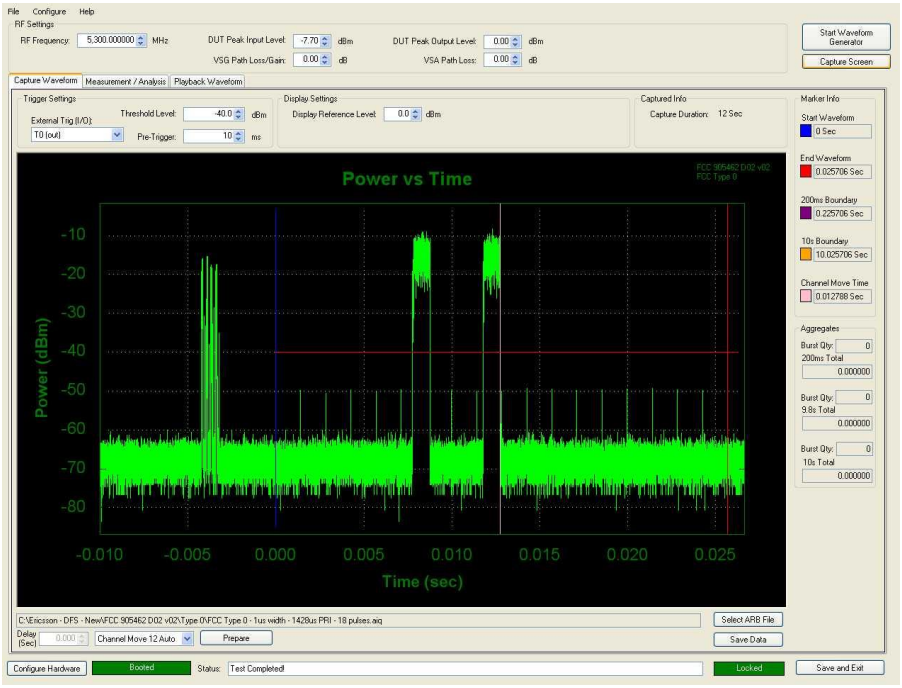


Figure 31 - Radar Test Signal Verification Plot

Product Service

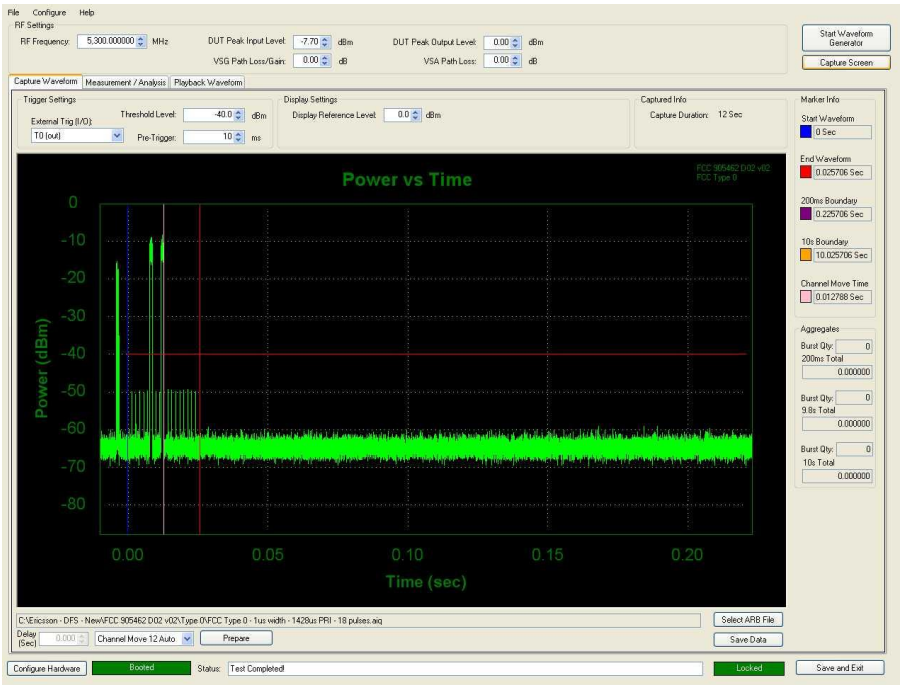


Figure 32 - First 200 ms of Channel Shutdown Period

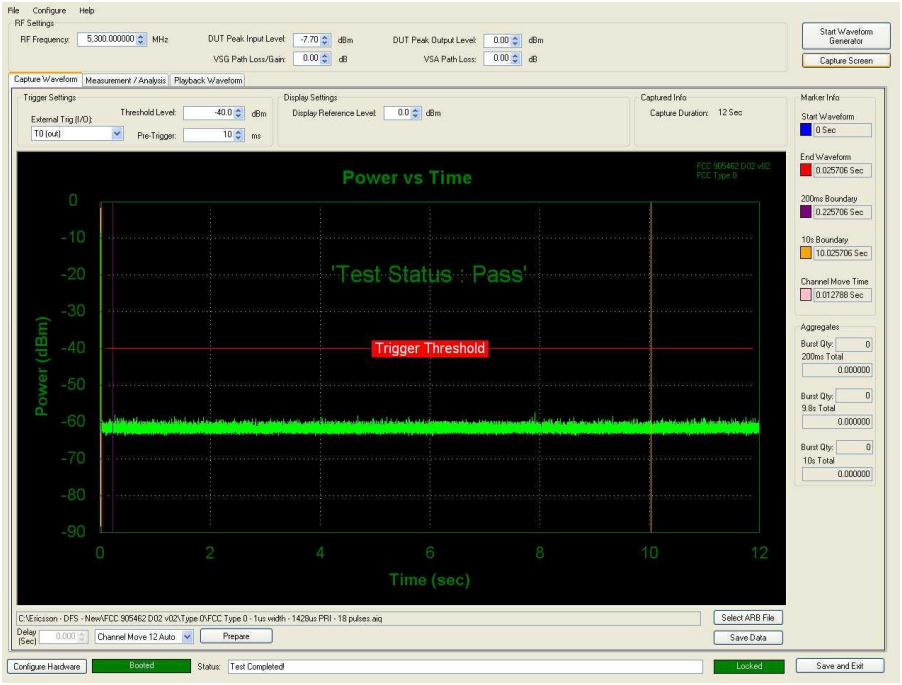


Figure 33 - 10 s Channel Shutdown

Master – LTE – 20 MHz – 3C Carrier Configuration

Test Parameter	Carrier Radar Injection		
	Lower	Centre	Upper
Channel Move Time	22.1 ms	15.9 ms	18.8 ms
Channel Closing Time (Aggregate Time During 200 ms)	0 ms	0 ms	0 ms
Channel Closing Time (Aggregate Time During 200 ms to 10 s)	0 ms	0 ms	0 ms
Channel Closing Time (Aggregate Time During 10 s)	0 ms	0 ms	0 ms

Table 17 - 3C In-Service Monitoring Test Results

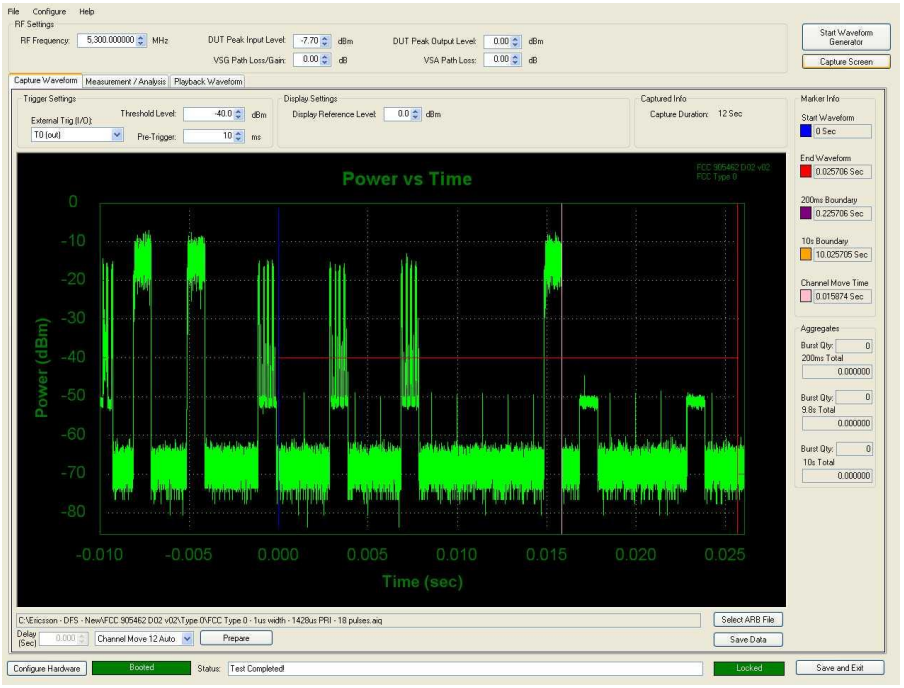


Figure 34 - Radar Test Signal Verification Plot

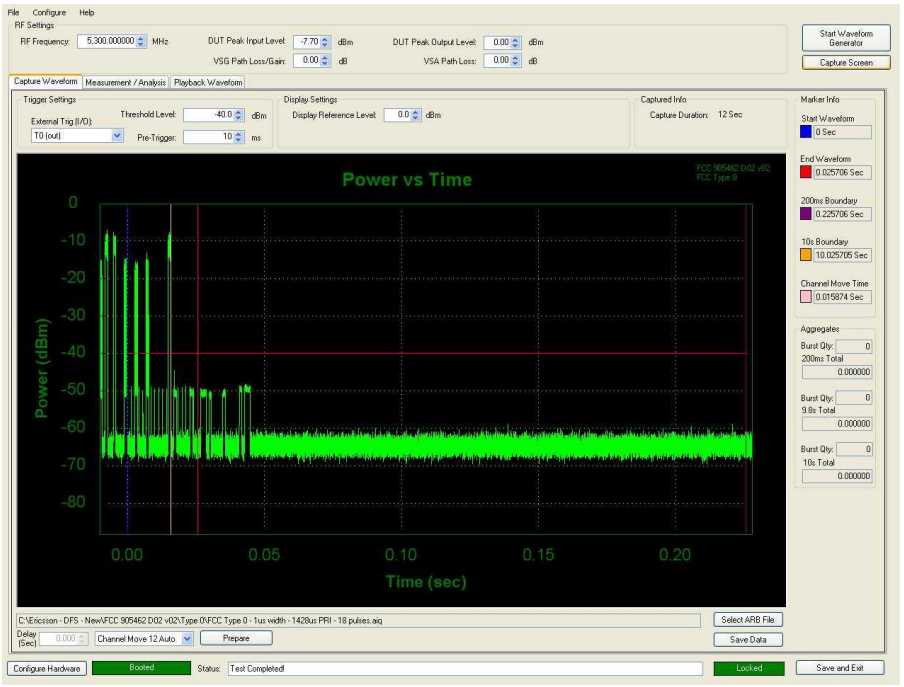


Figure 35 - First 200 ms of Channel Shutdown Period

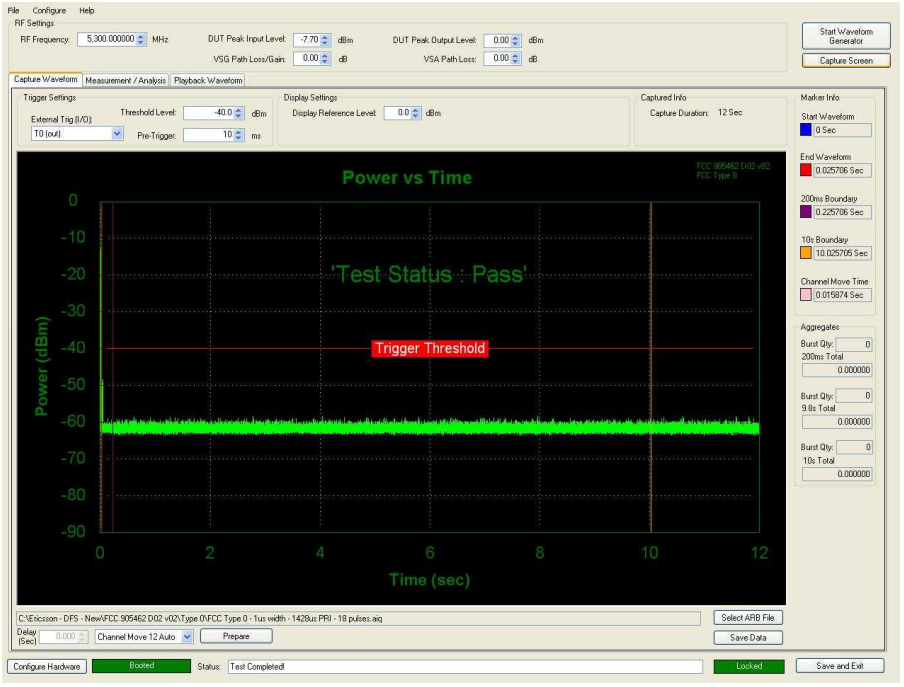


Figure 36 - 10 s Channel Shutdown

FCC 47 CFR Part 15, Limit Clause 15.407 (h)(2)(iii)

Channel Move Time	<10 s
Channel Closing Time (Aggregate Time During 200ms)	<200 ms
Channel Closing Time (Aggregate Time During +200ms to 10s)	<60 ms

FCC 47 CFR Part 15, Limit Clause 15.407 (h)(2)(iv)

Non-occupancy Period	> 30 minutes

Industry Canada RSS-247, Limit Clause 6.3(iii)(iv)(v)

Channel move time: after a radar signal is detected, the device shall cease all transmissions on the operating channel within 10 seconds.

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) over the remaining 10-second period of the channel move time.

Non-occupancy period: a channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30-minute non-occupancy period where the channel cannot be used by the LE-LAN device. The non-occupancy period starts from the time that the radar signal is detected.

KDB 905462 D02, Limit Clause 5.3

Channel Move Time	<10 s
Channel Closing Time (Aggregate Time During 200ms)	<200 ms
Channel Closing Time (Aggregate Time During +200ms to 10s)	<60 ms
Non-occupancy Period	> 30 minutes

Product Service

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 18

O/P Mon - Output Monitored using calibrated equipment

Product Service

2.7 Statistical Performance Check

2.7.1 Specification Reference

FCC 47 CFR Part 15E, Clause 15.407 (h)(2)(iii)(iv)
Industry Canada RSS-247, Clause 6.3.

2.7.2 Equipment Under Test and Modification State

Radio 2205 B46, S/N: DB27608630 - Modification State 0

2.7.3 Date of Test

04-February-2019

2.7.4 Test Method

This test was performed in accordance with KDB 905462 D02, clause 7.8.4.

Details of the EUT configurations and radar test signals can be found in the Calibration of Test Setup section of this report.

Radar types 0 - 6 were individually applied to the EUT, at a level equal to the detection threshold + 1 dB, accounting for equipment variation/errors.

The test frequency was observed for at least 10 seconds after generating each short pulse radar test signal to ensure detection had occurred. The test frequency was observed for at least 22 seconds after generating each long pulse radar test signal to ensure detection had occurred.

As specified in KDB 905462 D04, the EUT was configured so that upon radar detection, the test mode disabled the 30 minute non-occupancy period and returns the device to the original test frequency. The channel move mechanism was also disabled whilst in test mode to keep the device on the test frequency. Upon successful detection of a radar signal a message was displayed showing that a radar signal was detected.

2.7.5 Environmental Conditions

Ambient Temperature	23.4 °C
Relative Humidity	39.3 %

2.7.6 Test Results

LTE – 20 MHz

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
1	1	5300.0	Y	16	5295.5	Y
	2	5300.0	Y	17	5295.5	Y
	3	5300.0	Y	18	5295.5	Y
	4	5300.0	Y	19	5295.5	Y
	5	5300.0	Y	20	5295.5	Y
	6	5300.0	Y	21	5304.5	Y
	7	5300.0	Y	22	5304.5	Y
	8	5300.0	Y	23	5304.5	Y
	9	5300.0	Y	24	5304.5	Y
	10	5300.0	Y	25	5304.5	Y
	11	5291.0	Y	26	5309.0	Y
	12	5291.0	Y	27	5309.0	Y
	13	5291.0	Y	28	5309.0	Y
	14	5291.0	Y	29	5309.0	Y
	15	5291.0	Y	30	5309.0	Y
EUT Test Frequency : 5300 MHz				Total Detected		30 (100 %)

Table 19 - Statistical Analysis for Radar Type 1

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
2	1	5300.0	Y	16	5295.5	Y
	2	5300.0	Y	17	5295.5	Y
	3	5300.0	Y	18	5295.5	Y
	4	5300.0	Y	19	5295.5	Y
	5	5300.0	Y	20	5295.5	Y
	6	5300.0	Y	21	5304.5	Y
	7	5300.0	Y	22	5304.5	Y
	8	5300.0	Y	23	5304.5	Y
	9	5300.0	Y	24	5304.5	Y
	10	5300.0	Y	25	5304.5	Y
	11	5291.0	Y	26	5309.0	Y
	12	5291.0	Y	27	5309.0	Y
	13	5291.0	Y	28	5309.0	Y
	14	5291.0	Y	29	5309.0	Y
	15	5291.0	Y	30	5309.0	Y
EUT Test Frequency : 5300 MHz				Total Detected		30 (100 %)

Table 20 - Statistical Analysis for Radar Type 2

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
3	1	5300.0	Y	16	5295.5	Y
	2	5300.0	Y	17	5295.5	Y
	3	5300.0	Y	18	5295.5	Y
	4	5300.0	Y	19	5295.5	Y
	5	5300.0	Y	20	5295.5	Y
	6	5300.0	Y	21	5304.5	Y
	7	5300.0	Y	22	5304.5	Y
	8	5300.0	Y	23	5304.5	Y
	9	5300.0	Y	24	5304.5	N
	10	5300.0	Y	25	5304.5	Y
	11	5291.0	Y	26	5309.0	Y
	12	5291.0	Y	27	5309.0	Y
	13	5291.0	Y	28	5309.0	Y
	14	5291.0	Y	29	5309.0	Y
	15	5291.0	Y	30	5309.0	Y
EUT Test Frequency : 5300 MHz				Total Detected		29 (96.67 %)

Table 21 - Statistical Analysis for Radar Type 3

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
4	1	5300.0	Y	16	5295.5	Y
	2	5300.0	Y	17	5295.5	Y
	3	5300.0	Y	18	5295.5	Y
	4	5300.0	Y	19	5295.5	Y
	5	5300.0	Y	20	5295.5	Y
	6	5300.0	Y	21	5304.5	Y
	7	5300.0	Y	22	5304.5	Y
	8	5300.0	Y	23	5304.5	Y
	9	5300.0	Y	24	5304.5	N
	10	5300.0	Y	25	5304.5	Y
	11	5291.0	Y	26	5309.0	Y
	12	5291.0	Y	27	5309.0	Y
	13	5291.0	Y	28	5309.0	Y
	14	5291.0	Y	29	5309.0	Y
	15	5291.0	Y	30	5309.0	Y
EUT Test Frequency : 5300 MHz				Total Detected		29 (96.67 %)

Figure 37 - Statistical Analysis for Radar Type 4

Radar Type	Number of Trials	Number of Successful Detections	Minimum Percentage of Successful Detection
1	30	30	60
2	30	30	60
3	30	29	60
4	30	29	60
Aggregate (100 % + 100 % + 96.67 % + 96.67 %) / 4 = **98.33** % (Verdict = Pass)			

Table 22 – Overall Statistical Analysis Short Radar Types 1 to 4

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
5	1	5300.000	Y	16	5297.859	Y
	2	5300.000	Y	17	5293.859	Y
	3	5300.000	Y	18	5298.259	Y
	4	5300.000	Y	19	5299.059	Y
	5	5300.000	Y	20	5298.259	Y
	6	5300.000	Y	21	5303.341	Y
	7	5300.000	Y	22	5304.941	Y
	8	5300.000	Y	23	5302.541	N
	9	5300.000	Y	24	5305.341	Y
	10	5300.000	Y	25	5306.941	Y
	11	5297.859	Y	26	5305.341	Y
	12	5299.059	Y	27	5303.741	Y
	13	5295.059	Y	28	5302.141	Y
	14	5293.859	Y	29	5305.341	Y
	15	5295.859	Y	30	5306.141	Y
EUT Test Frequency : 5300 MHz				Total Detected		29 (96.67 %)

Table 23 - Statistical Analysis for Radar Type 5

Radar Type	Trial No	Frequency (MHz)	Detection (Y/N)	Trial No	Frequency (MHz)	Detection (Y/N)
6	1	Frequency Hopping	Y	16	Frequency Hopping	Y
	2	Frequency Hopping	Y	17	Frequency Hopping	Y
	3	Frequency Hopping	Y	18	Frequency Hopping	Y
	4	Frequency Hopping	Y	19	Frequency Hopping	Y
	5	Frequency Hopping	Y	20	Frequency Hopping	Y
	6	Frequency Hopping	Y	21	Frequency Hopping	Y
	7	Frequency Hopping	Y	22	Frequency Hopping	Y
	8	Frequency Hopping	Y	23	Frequency Hopping	Y
	9	Frequency Hopping	Y	24	Frequency Hopping	Y
	10	Frequency Hopping	Y	25	Frequency Hopping	Y
	11	Frequency Hopping	Y	26	Frequency Hopping	Y
	12	Frequency Hopping	Y	27	Frequency Hopping	Y
	13	Frequency Hopping	Y	28	Frequency Hopping	Y
	14	Frequency Hopping	Y	29	Frequency Hopping	Y
	15	Frequency Hopping	Y	30	Frequency Hopping	Y
EUT Test Frequency : 5300 MHz				Total Detected		30 (100 %)

Table 24 - Statistical Analysis for Radar Type 6

FCC Part 15E, Limit Clause

None Specified

Industry Canada RSS-247, Limit Clause

None Specified

KDB 905462 D02, Limit Clause 6

Radar Type	Pulse Length Type	Minimum Percentage of Successful Detection (%)	Minimum Number of Trials
0	Short Pulse	-	-
1	Short Pulse	60	30
2	Short Pulse	60	30
3	Short Pulse	60	30
4	Short Pulse	60	30
Aggregate (1-4)	Short Pulse	80	120
5	Long Pulse	80	30
6	Frequency Hopping	70	30

Product Service

2.7.7 Test Location

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (Software Driver)	Hewlett Packard	11713A	116	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	12	16-Apr-2019
Hygrometer	Rotronic	A1	2138	12	21-Feb-2019
Attenuator (11 dB, 1 W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110 dB, 1 W)	Hewlett Packard	8496H	2786	-	O/P Mon
FSQ Signal Analyser	Rohde & Schwarz	FSQ 26	3545	12	14-Mar-2019
PXI RF Digitizer	Aeroflex	3035	4012	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3010	4013	24	15-Mar-2020
PXI RF Synthesizer	Aeroflex	3011	4014	24	15-Mar-2020
PXI Digital RF Signal Generator	Aeroflex	3025	4015	24	15-Mar-2020
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4055	12	15-Mar-2019
Frequency Standard	Spectracom	1200-0408-0601	4393	12	16-Apr-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4742	12	19-Sep-2019
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	19-Sep-2019
Power splitter - 4 port	Mini-Circuits	ZN4PD1-63-S+	4743	12	19-Sep-2019

Table 25

O/P Mon - Output Monitored using calibrated equipment

Product Service

3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
U-NII Detection Bandwidth	Radar Level: ± 1.29 dB
Initial Channel Availability Check	Time: ± 0.47 %
Radar Burst at the Beginning of the Channel Availability Check Time	Time: ± 0.47 %
Radar Burst at the Beginning of the Channel Availability Check Time	Time: ± 0.47 %
In-Service Monitoring	Time: ± 0.47 % Radar Level: ± 1.29 dB
Statistical Performance Check	Radar Level: ± 1.29 dB

Table 26

Product Service

4 DFS Test Equipment

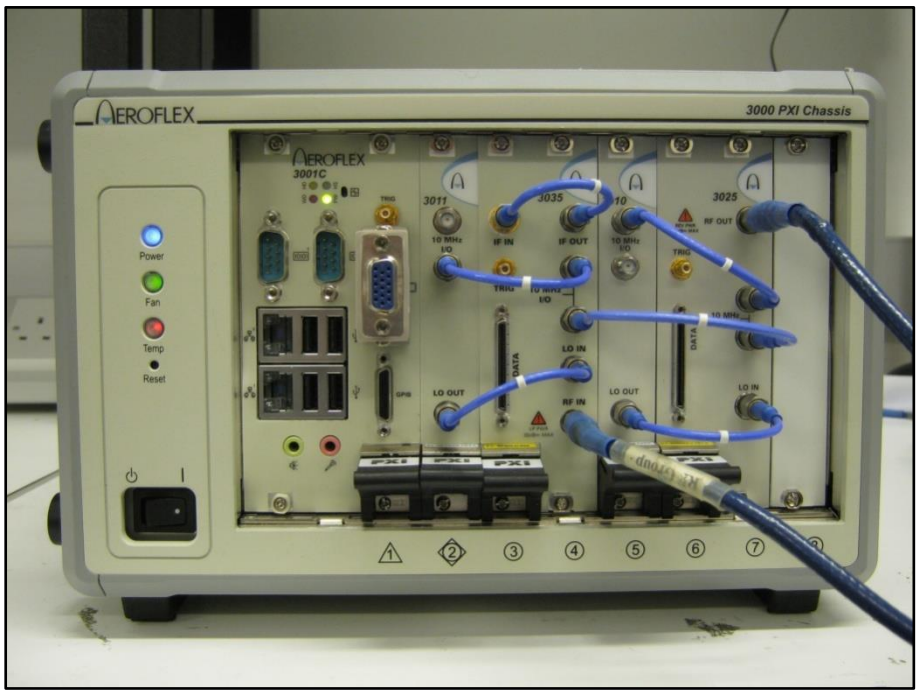


Figure 38 - Test Set Up

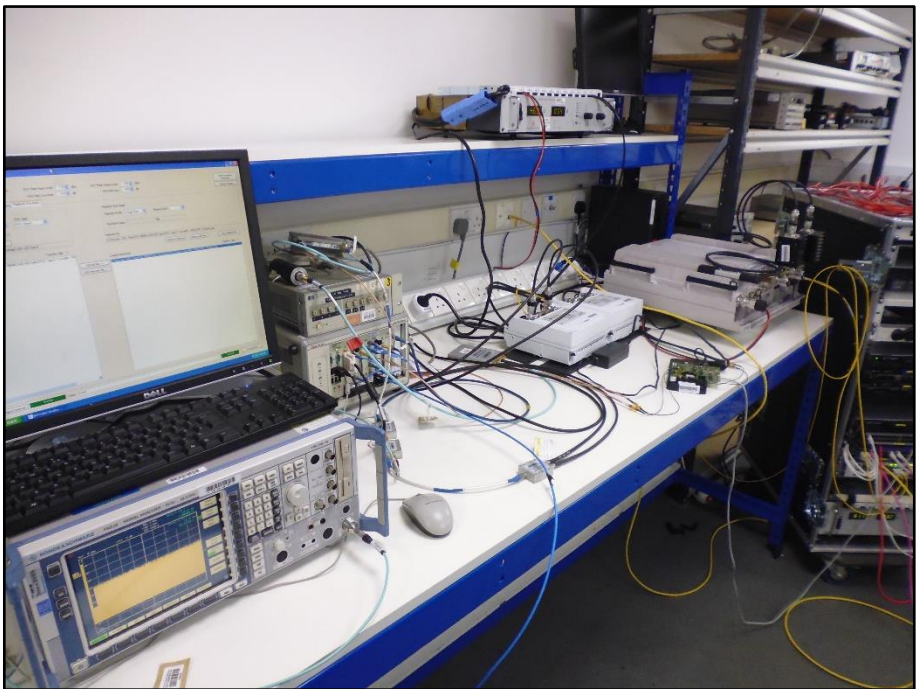


Figure 39 - Test Set Up

ANNEX A

TEST WAVEFORMS USED

U-NII Detection Bandwidth

Type 0

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1	18	1428

Channel Availability Check – Radar Burst at the Beginning

Type 0

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1	18	1428

Channel Availability Check – Radar Burst at the End

Type 0

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1	18	1428

In-service Monitoring

Type 0

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1	18	1428

Type 1

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1	39	1381

Type 2

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
1.6	26	179

Type 3

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
10	18	236

Type 4

Pulse Width (µs)	Number of Pulses	Pulse Repetition Interval (µs)
11.8	14	269

Type 5

Burst	Number of Pulses	Pulse Width (µs)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µs)	Pulse 2-to-3 spacing (µs)	Starting Location Within Interval (µs)
1	1	83	10	0	0	592644
2	1	80	10	0	0	349064
3	3	72	10	1257	1254	910903
4	1	85	10	0	0	558403
5	3	69	10	1866	1451	612678
6	1	59	10	0	0	306730
7	1	84	10	0	0	133022
8	1	72	10	0	0	687275
9	3	95	10	1231	1611	326388
10	3	71	10	1506	1616	206815
11	2	93	10	963	0	418210
12	2	60	10	1498	0	98148
13	1	86	10	0	0	812942
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0

Type 6

Hopping Frequency List (MHz)
5518,5286,5460,5399,5466,5515,5661,5650,5697,5712,5432,5638,5468,5321,5452,5289,5529,5602,5471,5439,5657,5440,5594,5360,5402,5433,5709,5557,5425,5410,5724,5487,5319,5552,5575,5565,5568,5542,5499,5257,5496,5448,5279,5312,5284,5676,5687,5494,5631,5560,5574,5543,5592,5328,5417,5350,5722,5282,5531,5353,5475,5536,5713,5670,5641,5612,5445,5711,5464,5668,5446,5716,5298,5368,5706,5595,5655,5504,5413,5637,5501,5685,5398,5545,5450,5392,5710,5636,5290,5366,5455,5325,5299,5644,5457,5599,5395,5336,5576,5302

Statistical Performance Check

RADAR TYPE 1			
Trial #	Pulse Repetition Frequency Number (1 to 23)	Pulse Repetition Frequency (Pulses Per Second)	Pulse Repetition Interval (Microseconds)
1	TEST B	724.1	1381
2	TEST B	583.1	1715
3	TEST B	519.5	1925
4	TEST B	517.1	1934
5	TEST B	496.8	2013
6	TEST B	446.2	2241
7	TEST B	411.9	2428
8	TEST B	398.7	2508
9	TEST B	385.8	2592
10	TEST B	343.3	2913
11	TEST B	330.6	3025
12	TEST B	330.5	3026
13	23	326.2	3066
14	1	1930.5	518
15	TEST B	1876.2	533
16	2	1858.7	538
17	5	1672.2	598
18	6	1618.1	618
19	7	1567.4	638
20	TEST B	1508.3	663
21	10	1432.7	698
22	12	1355.0	738
23	13	1319.3	758
24	TEST B	1295.3	772
25	14	1285.3	778
26	16	1222.5	818
27	18	1165.5	858
28	19	1139.0	878
29	20	1113.6	898
30	21	1089.3	918

RADAR TYPE 2			
Trial #	Number Pulses per Burst	Pulse Width (µs)	PRI (µs)
1	26	1.6	179
2	27	1.6	212
3	24	1.7	152
4	23	2.0	187
5	28	2.3	189
6	27	2.5	173
7	28	2.6	157
8	24	2.7	230
9	26	2.9	211
10	27	3.0	223
11	25	3.1	162
12	26	3.1	164
13	26	3.5	160
14	23	3.5	167
15	26	3.6	174
16	28	3.6	230
17	28	3.9	196
18	25	3.9	203
19	28	3.9	205
20	24	4.0	171
21	26	4.0	172
22	28	4.2	220
23	23	4.3	202
24	23	4.6	227
25	27	4.8	172
26	23	4.8	186
27	24	4.8	189
28	23	4.9	213
29	27	5.0	174
30	25	5.0	210

RADAR TYPE 3			
Trial #	Number Pulses per Burst	Pulse Width (µs)	PRI (µs)
1	18	10	236
2	16	6.2	390
3	17	6.3	460
4	17	6.4	204
5	17	6.6	408
6	17	6.6	484
7	16	6.7	309
8	17	7.3	206
9	17	7.3	242
10	17	7.4	323
11	17	7.6	500
12	17	7.7	397
13	18	7.9	350
14	16	8.0	237
15	16	8.1	291
16	18	8.1	484
17	17	8.2	309
18	17	8.3	498
19	18	8.4	447
20	18	8.5	310
21	16	8.7	265
22	16	8.7	364
23	18	8.9	212
24	17	9.0	290
25	17	9.0	295
26	18	9.0	314
27	16	9.1	464
28	18	9.4	330
29	17	9.7	280
30	18	9.9	351

RADAR TYPE 4			
Trial #	Number Pulses per Burst	Pulse Width (µs)	PRI (µs)
1	14	11.8	269
2	16	12.1	256
3	16	12.3	268
4	12	12.8	379
5	15	12.8	471
6	12	13	280
7	14	13.1	299
8	16	13.2	293
9	16	13.8	369
10	16	14.2	236
11	15	14.4	285
12	12	14.9	271
13	14	15	399
14	16	15.4	373
15	12	15.5	488
16	16	15.9	237
17	13	16.5	240
18	15	16.7	470
19	12	17	469
20	15	17.4	383
21	14	17.8	292
22	14	18.2	205
23	13	18.2	238
24	12	18.4	415
25	14	18.6	401
26	15	18.9	342
27	14	19.1	470
28	14	19.3	382
29	13	19.3	415
30	13	19.5	368

RADAR TYPE 5						
Trial Number: 1						
Number of Bursts in Trial: 13						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	83	10	0	0	592644
2	1	80	10	0	0	349064
3	3	72	10	1257	1254	910903
4	1	85	10	0	0	558403
5	3	69	10	1866	1451	612678
6	1	59	10	0	0	306730
7	1	84	10	0	0	133022
8	1	72	10	0	0	687275
9	3	95	10	1231	1611	326388
10	3	71	10	1506	1616	206815
11	2	93	10	963	0	418210
12	2	60	10	1498	0	98148
13	1	86	10	0	0	812942

RADAR TYPE 5						
Trial Number: 2						
Number of Bursts in Trial: 14						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	67	13	1121	0	127581
2	3	83	13	1880	977	342428
3	3	56	13	1701	1387	853684
4	1	83	13	0	0	18316
5	1	55	13	0	0	600066
6	3	98	13	1718	1102	629213
7	3	91	13	1031	946	36117
8	3	94	13	1120	1231	757390
9	2	58	13	1470	0	639059
10	3	86	13	1078	1072	772601
11	3	85	13	1042	1112	233737
12	2	56	13	1472	0	663535
13	3	93	13	1386	1427	844230
14	2	96	13	1738	0	718644

RADAR TYPE 5						
Trial Number: 3						
Number of Bursts in Trial: 8						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	63	10	0	0	813507
2	1	55	10	0	0	1372910
3	2	75	10	1363	0	265260
4	3	77	10	1726	1835	415728
5	1	82	10	0	0	927171
6	3	80	10	1837	1111	132137
7	2	74	10	1333	0	1271954
8	1	55	10	0	0	1253107

RADAR TYPE 5						
Trial Number: 4						
Number of Bursts in Trial: 9						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	90	19	0	0	902170
2	2	57	19	953	0	111621
3	2	98	19	1534	0	119671
4	2	90	19	1216	0	901008
5	2	86	19	1286	0	369655
6	1	100	19	0	0	573485
7	2	51	19	1130	0	135531
8	2	86	19	980	0	423834
9	2	80	19	1002	0	121237

RADAR TYPE 5						
Trial Number: 5						
Number of Bursts in Trial: 13						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	81	5	0	0	817368
2	2	77	5	1413	0	593709
3	1	55	5	0	0	452041
4	2	58	5	1673	0	221655
5	2	87	5	1471	0	809749
6	3	86	5	1272	1555	433104
7	1	68	5	0	0	348583
8	1	82	5	0	0	235628
9	2	76	5	1632	0	830454
10	3	69	5	1016	1418	601945
11	3	75	5	1711	1081	859632
12	3	73	5	1401	1903	759466
13	3	82	5	962	1122	182689

RADAR TYPE 5						
Trial Number: 6						
Number of Bursts in Trial: 17						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	57	15	1776	0	180283
2	1	60	15	0	0	9645
3	1	81	15	0	0	687308
4	3	63	15	994	1805	268381
5	1	96	15	0	0	139417
6	2	97	15	1104	0	497795
7	3	80	15	1813	1322	327193
8	3	81	15	1362	1231	357877
9	1	51	15	0	0	549319
10	3	83	15	1315	1442	212816
11	3	56	15	1264	1662	368872
12	1	96	15	0	0	676239
13	2	69	15	1071	0	4418
14	3	89	15	1356	1799	263989
15	1	68	15	0	0	532422
16	3	61	15	1346	1110	465307
17	2	53	15	976	0	63090

RADAR TYPE 5						
Trial Number: 7						
Number of Bursts in Trial: 13						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	84	14	1004	0	140741
2	1	69	14	0	0	56132
3	1	84	14	0	0	447336
4	2	65	14	1181	0	278522
5	1	85	14	0	0	404946
6	2	95	14	1460	0	381561
7	1	89	14	0	0	525954
8	2	86	14	1063	0	52011
9	1	57	14	0	0	819520
10	3	50	14	1723	1585	306502
11	3	81	14	1290	1421	289832
12	1	84	14	0	0	248913
13	1	97	14	0	0	149093

RADAR TYPE 5						
Trial Number: 8						
Number of Bursts in Trial: 19						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	3	81	10	1366	1118	563871
2	1	74	10	0	0	570096
3	2	81	10	1273	0	149592
4	1	99	10	0	0	339541
5	2	82	10	1210	0	297962
6	3	99	10	1884	1724	133112
7	2	62	10	1180	0	225270
8	2	67	10	1547	0	351680
9	1	85	10	0	0	236980
10	2	72	10	1597	0	76410
11	2	58	10	1372	0	126289
12	1	50	10	0	0	166950
13	1	60	10	0	0	88241
14	3	79	10	1553	1610	126651
15	2	87	10	1712	0	147762
16	3	83	10	1864	1030	252768
17	1	50	10	0	0	502338
18	3	65	10	1529	945	97890
19	3	58	10	1831	1446	340472

RADAR TYPE 5						
Trial Number: 9						
Number of Bursts in Trial: 18						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	56	18	0	0	619336
2	1	61	18	0	0	551715
3	3	100	18	1770	978	210647
4	2	87	18	1119	0	571187
5	2	82	18	967	0	18846
6	1	50	18	0	0	147898
7	1	50	18	0	0	405809
8	1	76	18	0	0	411050
9	2	90	18	1608	0	559274
10	3	99	18	940	1588	483213
11	3	95	18	1480	1321	12392
12	3	94	18	1893	1866	186468
13	3	55	18	1652	1196	301543
14	2	88	18	1732	0	646753
15	3	97	18	1334	991	206126
16	1	76	18	0	0	46356
17	2	74	18	1602	0	499842
18	1	58	18	0	0	490908

RADAR TYPE 5						
Trial Number: 10						
Number of Bursts in Trial: 17						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	81	7	1902	0	208339
2	2	51	7	1598	0	597059
3	2	75	7	1680	0	386519
4	1	66	7	0	0	143133
5	1	53	7	0	0	613664
6	3	74	7	1734	1190	192745
7	2	93	7	1406	0	359250
8	1	77	7	0	0	552338
9	3	99	7	1421	1202	42164
10	1	92	7	0	0	477751
11	2	95	7	1687	0	169334
12	3	82	7	1685	1439	96536
13	1	74	7	0	0	419592
14	1	65	7	0	0	656952
15	1	67	7	0	0	133813
16	2	74	7	1366	0	653971
17	2	68	7	1250	0	553390

RADAR TYPE 5						
Trial Number: 11						
Number of Bursts in Trial: 15						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	98	17	0	0	213943
2	1	66	17	0	0	312026
3	2	96	17	1597	0	452704
4	2	82	17	1649	0	268000
5	2	68	17	1744	0	746393
6	3	82	17	957	1182	761586
7	3	91	17	1262	1146	368046
8	2	71	17	1852	0	763550
9	1	100	17	0	0	393072
10	1	94	17	0	0	332090
11	1	86	17	0	0	658235
12	1	78	17	0	0	622966
13	3	85	17	1668	1019	451948
14	1	78	17	0	0	306383
15	1	97	17	0	0	596046

RADAR TYPE 5						
Trial Number: 12						
Number of Bursts in Trial: 17						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	62	20	1904	0	107593
2	1	76	20	0	0	194736
3	2	78	20	1490	0	527688
4	3	58	20	1422	1338	464016
5	3	91	20	921	1610	123774
6	1	55	20	0	0	423590
7	1	95	20	0	0	170943
8	3	77	20	1778	1064	166436
9	3	60	20	1424	1106	217319
10	2	91	20	1423	0	202156
11	1	55	20	0	0	92000
12	1	63	20	0	0	282732
13	3	58	20	1665	1071	80206
14	3	53	20	1759	1141	96770
15	2	50	20	1073	0	190533
16	2	55	20	1656	0	300014
17	2	56	20	1904	0	700797

RADAR TYPE 5						
Trial Number: 13						
Number of Bursts in Trial: 10						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	50	10	1448	0	495964
2	1	55	10	0	0	1176483
3	2	94	10	1400	0	686677
4	3	91	10	1634	936	603524
5	2	70	10	1220	0	34756
6	3	77	10	1605	1167	1047294
7	1	69	10	0	0	845061
8	2	57	10	1384	0	807281
9	3	68	10	1645	1036	280731
10	2	89	10	1005	0	188503

RADAR TYPE 5						
Trial Number: 14						
Number of Bursts in Trial: 18						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	85	7	1620	0	192228
2	3	70	7	938	1387	374066
3	3	60	7	1348	1820	217159
4	1	77	7	0	0	9089
5	3	64	7	1040	1669	34852
6	3	89	7	1355	923	612914
7	1	50	7	0	0	417537
8	1	94	7	0	0	115625
9	2	52	7	1495	0	112847
10	3	70	7	1236	1413	454467
11	3	99	7	1628	1865	552205
12	3	99	7	1012	1657	256601
13	3	83	7	1330	1494	529527
14	3	93	7	1881	1382	489873
15	2	97	7	1413	0	218792
16	1	74	7	0	0	183059
17	3	68	7	1206	1233	644331
18	2	52	7	1122	0	619939

RADAR TYPE 5						
Trial Number: 15						
Number of Bursts in Trial: 8						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	57	12	0	0	434060
2	3	94	12	1715	1897	760834
3	3	74	12	1675	1170	1339362
4	2	92	12	1653	0	358043
5	3	73	12	1324	1657	515935
6	2	63	12	1680	0	721432
7	1	96	12	0	0	64829
8	2	70	12	1797	0	1307024

RADAR TYPE 5						
Trial Number: 16						
Number of Bursts in Trial: 12						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	72	17	0	0	546309
2	1	85	17	0	0	338248
3	3	76	17	1723	1884	124694
4	2	94	17	1046	0	876274
5	3	61	17	1413	1595	748595
6	3	82	17	934	1074	388105
7	3	54	17	1411	1558	73446
8	3	68	17	1463	1571	498687
9	1	85	17	0	0	874930
10	3	53	17	950	1781	702226
11	1	81	17	0	0	101960
12	1	89	17	0	0	165851

RADAR TYPE 5						
Trial Number: 17						
Number of Bursts in Trial: 15						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	61	7	1552	0	765792
2	3	72	7	1317	1606	779326
3	1	63	7	0	0	719022
4	3	53	7	1701	1796	183046
5	2	79	7	1037	0	285860
6	3	80	7	1668	920	748114
7	3	77	7	1210	1431	246560
8	1	52	7	0	0	723246
9	2	57	7	1861	0	542420
10	3	93	7	1210	1104	620038
11	3	87	7	1849	1893	188147
12	3	62	7	1925	1069	464945
13	2	91	7	1582	0	495223
14	3	98	7	1651	1631	676986
15	2	73	7	1876	0	766946

RADAR TYPE 5						
Trial Number: 18						
Number of Bursts in Trial: 18						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	80	18	1852	0	365663
2	3	86	18	1727	1074	624564
3	3	50	18	1015	1909	310021
4	3	51	18	1470	1127	475335
5	2	54	18	1763	0	355236
6	1	86	18	0	0	42771
7	1	73	18	0	0	538096
8	1	93	18	0	0	521253
9	1	58	18	0	0	433005
10	1	66	18	0	0	290708
11	1	94	18	0	0	418541
12	2	87	18	1738	0	572692
13	3	90	18	1171	1084	236735
14	3	89	18	1156	1141	483675
15	3	53	18	1827	1776	505493
16	2	68	18	1285	0	421725
17	3	61	18	1914	1740	541944
18	2	86	18	999	0	581684

RADAR TYPE 5						
Trial Number: 19						
Number of Bursts in Trial: 19						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	54	20	1656	0	119904
2	3	63	20	1809	1216	283255
3	2	54	20	1483	0	542419
4	2	94	20	1106	0	278876
5	2	77	20	1200	0	168876
6	1	55	20	0	0	556630
7	2	96	20	1894	0	279565
8	3	82	20	1782	1815	246609
9	1	64	20	0	0	432763
10	2	85	20	915	0	307795
11	3	54	20	1849	1221	541738
12	3	55	20	1315	1883	132274
13	1	74	20	0	0	209870
14	2	86	20	1056	0	621821
15	3	78	20	1832	1207	268763
16	2	91	20	1404	0	116402
17	1	81	20	0	0	90319
18	1	93	20	0	0	475805
19	2	52	20	1511	0	117711

RADAR TYPE 5						
Trial Number: 20						
Number of Bursts in Trial: 13						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	98	18	0	0	743066
2	2	75	18	1478	0	345282
3	2	78	18	1740	0	484595
4	1	85	18	0	0	486439
5	1	54	18	0	0	187625
6	1	78	18	0	0	88428
7	3	84	18	1457	1413	208782
8	3	68	18	1448	1804	256376
9	1	77	18	0	0	688840
10	1	91	18	0	0	551243
11	1	83	18	0	0	850692
12	3	72	18	1037	1549	300024
13	1	100	18	0	0	457351

RADAR TYPE 5						
Trial Number: 21						
Number of Bursts in Trial: 12						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	93	14	1183	0	620406
2	1	52	14	0	0	341830
3	2	65	14	1327	0	761288
4	1	93	14	0	0	513574
5	1	91	14	0	0	994773
6	2	77	14	1641	0	539675
7	3	77	14	1288	1526	662073
8	3	52	14	1163	1354	228155
9	1	52	14	0	0	900537
10	2	71	14	1665	0	908296
11	2	56	14	1411	0	184517
12	3	63	14	1096	1712	571446

RADAR TYPE 5						
Trial Number: 22						
Number of Bursts in Trial: 15						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	54	10	1546	0	766908
2	2	53	10	1476	0	249449
3	3	50	10	1586	1319	227108
4	1	96	10	0	0	131002
5	2	57	10	1901	0	125223
6	3	53	10	1032	1900	328725
7	1	68	10	0	0	152367
8	1	60	10	0	0	662052
9	1	53	10	0	0	577410
10	3	65	10	1564	1222	356185
11	3	92	10	1024	1732	710523
12	3	88	10	1094	1900	711716
13	1	82	10	0	0	507665
14	2	72	10	1406	0	358696
15	1	82	10	0	0	438452

RADAR TYPE 5						
Trial Number: 23						
Number of Bursts in Trial: 12						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	52	16	1654	0	190446
2	2	64	16	1499	0	500713
3	2	77	16	1149	0	692777
4	1	66	16	0	0	740824
5	1	59	16	0	0	143033
6	2	53	16	1315	0	296771
7	1	78	16	0	0	192966
8	2	82	16	1161	0	245937
9	1	100	16	0	0	739362
10	1	55	16	0	0	489908
11	1	56	16	0	0	700712
12	1	73	16	0	0	618759

RADAR TYPE 5						
Trial Number: 24						
Number of Bursts in Trial: 14						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	71	9	1870	0	412924
2	1	87	9	0	0	173586
3	3	75	9	1814	1204	299730
4	1	95	9	0	0	124402
5	3	53	9	1603	1266	218027
6	1	78	9	0	0	417588
7	2	51	9	1788	0	574952
8	1	75	9	0	0	753216
9	1	72	9	0	0	755801
10	3	79	9	1063	1173	848562
11	2	75	9	968	0	411791
12	2	93	9	1726	0	646160
13	2	59	9	1915	0	601099
14	1	91	9	0	0	256549

RADAR TYPE 5						
Trial Number: 25						
Number of Bursts in Trial: 11						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	97	5	0	0	376795
2	2	63	5	1002	0	80662
3	1	81	5	0	0	750825
4	3	73	5	971	1237	3150
5	3	53	5	1074	1760	230140
6	3	53	5	1583	1724	293860
7	2	75	5	1080	0	860512
8	3	70	5	1081	1581	1078293
9	2	60	5	1847	0	583395
10	1	72	5	0	0	1057795
11	1	93	5	0	0	177490

RADAR TYPE 5						
Trial Number: 26						
Number of Bursts in Trial: 20						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	94	9	1877	0	572322
2	1	84	9	0	0	291759
3	1	59	9	0	0	568447
4	1	78	9	0	0	112114
5	3	79	9	1840	1456	561204
6	1	84	9	0	0	490912
7	1	88	9	0	0	475002
8	3	77	9	1793	1294	144298
9	2	61	9	1412	0	470996
10	3	100	9	1529	1085	497092
11	2	86	9	1579	0	377758
12	3	81	9	1836	1257	208156
13	2	94	9	957	0	371720
14	3	94	9	1218	1374	210205
15	1	59	9	0	0	70772
16	2	91	9	1023	0	465622
17	2	87	9	1735	0	467466
18	1	95	9	0	0	564625
19	3	85	9	1289	1488	7673
20	1	62	9	0	0	83282

RADAR TYPE 5						
Trial Number: 27						
Number of Bursts in Trial: 19						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	75	13	0	0	315600
2	1	51	13	0	0	195341
3	2	74	13	1442	0	398729
4	2	50	13	1665	0	623369
5	3	78	13	1776	1185	556673
6	1	78	13	0	0	92103
7	2	97	13	1221	0	578443
8	2	65	13	1234	0	177220
9	1	99	13	0	0	191172
10	2	69	13	1244	0	387600
11	2	75	13	1342	0	137513
12	1	85	13	0	0	166113
13	2	87	13	1902	0	242120
14	2	73	13	1260	0	624810
15	1	89	13	0	0	596643
16	1	50	13	0	0	359454
17	3	56	13	1716	1250	110378
18	1	77	13	0	0	338102
19	3	54	13	1551	1545	587482

RADAR TYPE 5						
Trial Number: 28						
Number of Bursts in Trial: 11						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	94	17	1155	0	499700
2	1	75	17	0	0	645618
3	3	57	17	1579	1780	1031039
4	1	86	17	0	0	569253
5	3	67	17	1233	978	777533
6	2	82	17	1830	0	142719
7	2	87	17	1807	0	23838
8	3	89	17	973	1439	71961
9	1	89	17	0	0	986528
10	3	79	17	1717	988	305474
11	1	81	17	0	0	731550

RADAR TYPE 5						
Trial Number: 29						
Number of Bursts in Trial: 12						
Chirp Center Frequency: See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	2	91	9	1091	0	425332
2	1	65	9	0	0	889081
3	2	69	9	1755	0	962718
4	1	50	9	0	0	489676
5	2	79	9	960	0	373292
6	2	65	9	1817	0	876999
7	3	81	9	1896	1670	501788
8	3	72	9	1119	954	240758
9	3	58	9	1240	1024	837431
10	2	76	9	1687	0	637487
11	2	93	9	1867	0	937919
12	2	79	9	1227	0	457922

RADAR TYPE 5						
Trial Number: 30						
Number of Bursts in Trial: 17						
Chirp Center Frequency:See test page						
Burst	Number of Pulses	Pulse Width (µsec)	Chirp Width (MHz)	Pulse 1-to-2 spacing (µsec)	Pulse 2-to-3 spacing (µsec)	Starting Location Within Interval (µsec)
1	1	54	7	0	0	21546
2	2	78	7	1793	0	397687
3	2	76	7	1720	0	641013
4	1	59	7	0	0	562734
5	3	66	7	1774	1125	370096
6	3	79	7	1783	1732	470424
7	2	51	7	1930	0	476941
8	2	58	7	1139	0	366453
9	3	52	7	1730	1092	535162
10	3	88	7	1123	1186	10886
11	3	99	7	1629	1295	457237
12	1	61	7	0	0	176287
13	3	55	7	1877	1926	403515
14	2	64	7	1296	0	25241
15	2	95	7	1793	0	34322
16	2	80	7	1310	0	279157
17	1	50	7	0	0	408726

RADAR TYPE 6	
Trial #	Hopping Frequency List (MHz)
1	5518,5286,5460,5399,5466,5515,5661,5650,5697,5712,5432,5638,5468,5321,5452,5289,5529,5602,5471,5439,5657,5440,5594,5360,5402,5433,5709,5557,5425,5410,5724,5487,5319,5552,5575,5565,5568,5542,5499,5257,5496,5448,5279,5312,5284,5676,5687,5494,5631,5560,5574,5543,5592,5328,5417,5350,5722,5282,5531,5353,5475,5536,5713,5670,5641,5612,5445,5711,5464,5668,5446,5716,5298,5368,5706,5595,5655,5504,5413,5637,5501,5685,5398,5545,5450,5392,5710,5636,5290,5366,5455,5325,5299,5644,5457,5599,5395,5336,5576,5302
2	5604,5301,5498,5482,5545,5282,5549,5316,5680,5699,5463,5702,5415,5612,5263,5525,5461,5329,5524,5656,5652,5420,5552,5520,5605,5584,5681,5526,5627,5539,5410,5546,5666,5677,5634,5414,5465,5333,5374,5580,5480,5586,5321,5478,5569,5347,5324,5658,5257,5371,5676,5606,5671,5687,5664,5423,5593,5391,5642,5536,5474,5447,5311,5615,5296,5450,5308,5572,5528,5564,5534,5355,5361,5429,5403,5494,5294,5714,5533,5255,5475,5431,5597,5578,5684,5438,5669,5509,5254,5372,5285,5433,5611,5531,5718,5523,5398,5291,5600,5278
3	5380,5317,5481,5301,5586,5510,5385,5397,5492,5484,5638,5305,5668,5546,5269,5436,5719,5568,5375,5714,5274,5351,5713,5393,5369,5718,5596,5501,5495,5566,5643,5345,5363,5365,5526,5347,5652,5530,5521,5267,5459,5704,5489,5315,5512,5532,5529,5554,5640,5469,5289,5356,5690,5632,5467,5517,5514,5620,5721,5642,5395,5650,5275,5450,5630,5320,5442,5471,5447,5574,5256,5581,5504,5413,5604,5334,5694,5691,5262,5576,5635,5603,5398,5598,5619,5605,5266,5626,5271,5577,5314,5304,5463,5590,5607,5461,5336,5333,5571,5349
4	5359,5713,5468,5587,5589,5430,5651,5279,5630,5544,5264,5397,5461,5482,5447,5548,5590,5312,5558,5541,5710,5253,5439,5390,5451,5604,5653,5383,5265,5282,5614,5288,5609,5400,5267,5521,5560,5699,5716,5671,5495,5289,5316,5379,5375,5513,5467,5380,5311,5364,5355,5523,5446,5526,5703,5418,5399,5701,5410,5724,5571,5443,5563,5573,5515,5722,5567,5719,5307,5669,5319,5323,5658,5326,5341,5436,5252,5678,5500,5657,5335,5291,5545,5582,5530,5566,5694,5334,5677,5532,5656,5426,5366,5618,5314,5437,5369,5298,5579,5373
5	5593,5626,5676,5308,5515,5407,5295,5362,5320,5511,5477,5355,5277,5521,5389,5286,5402,5337,5585,5279,5371,5375,5395,5291,5699,5542,5387,5614,5540,5381,5608,5481,5252,5422,5376,5681,5579,5507,5429,5652,5719,5564,5462,5394,5673,5261,5591,5319,5649,5400,5691,5685,5718,5259,5251,5467,5480,5634,5334,5697,5269,5406,5546,5664,5627,5721,5353,5580,5433,5432,5620,5633,5657,5285,5532,5637,5342,5688,5318,5690,5414,5648,5487,5717,5421,5451,5669,5423,5457,5632,5563,5267,5523,5491,5677,5260,5465,5693,5321,5302
6	5311,5698,5444,5555,5478,5542,5371,5270,5676,5440,5407,5499,5704,5483,5360,5409,5486,5707,5487,5447,5426,5275,5514,5364,5484,5389,5305,5665,5394,5474,5421,5342,5596,5268,5702,5328,5697,5377,5302,5436,5681,5372,5585,5273,5512,5443,5522,5576,5412,5455,5599,5600,5285,5501,5655,5719,5402,5316,5329,5531,5690,5711,5357,5307,5341,5431,5408,5259,5395,5714,5319,5325,5653,5340,5696,5671,5507,5338,5706,5715,5468,5720,5390,5492,5297,5612,5699,5710,5356,5399,5406,5591,5404,5386,5254,5473,5345,5454,5610,5691
7	5425,5251,5350,5272,5456,5533,5715,5549,5699,5270,5664,5362,5642,5573,5384,5520,5281,5385,5409,5608,5644,5643,5304,5474,5542,5535,5325,5669,5702,5491,5594,5263,5359,5423,5316,5295,5512,5680,5492,5427,5365,5575,5431,5578,5651,5292,5468,5582,5260,5458,5441,5684,5252,5297,5507,5672,5600,5455,5646,5296,5571,5401,5650,5469,5506,5339,5258,5326,5618,5707,5319,5462,5450,5547,5499,5467,5659,5494,5299,5635,5693,5357,5375,5534,5347,5636,5694,5318,5253,5698,5289,5724,5645,5449,5313,5484,5703,5471,5302,5681
8	5580,5715,5362,5327,5408,5490,5682,5620,5343,5697,5716,5347,5577,5296,5263,5424,5316,5488,5273,5546,5459,5392,5294,5659,5569,5630,5597,5397,5489,5601,5583,5518,5704,5680,5650,5540,5661,5293,5394,5631,5353,5654,5351,5513,5269,5300,5310,5637,5531,5448,5481,5471,5572,5349,5282,5473,5646,5301,5670,5458,5365,5308,5305,5284,5468,5390,5673,5337,5502,5315,5410,5288,5334,5667,5396,5549,5536,5485,5402,5352,5297,5452,5381,5581,5617,5317,5264,5717,5371,5685,5538,5587,5454,5688,5265,5567,5496,5361,5703,5406

9	5352,5534,5265,5339,5326,5346,5446,5461,5435,5500,5687,5386,5261,5578,5628,5611,5498,5605,5322,5510,5669,5450,5393,5520,5330,5666,5586,5564,5694,5714,5349,5291,5374,5616,5350,5571,5566,5527,5715,5642,5635,5370,5576,5451,5443,5360,5362,5680,5722,5702,5289,5442,5627,5391,5469,5259,5384,5485,5606,5491,5445,5400,5645,5262,5477,5306,5295,5695,5615,5404,5284,5674,5273,5604,5473,5475,5263,5716,5372,5252,5656,5447,5430,5517,5580,5406,5638,5304,5655,5438,5323,5607,5276,5337,5609,5452,5427,5677,5367,5525
10	5380,5636,5260,5405,5478,5454,5278,5643,5330,5690,5280,5600,5673,5427,5284,5722,5326,5615,5620,5304,5263,5415,5400,5592,5394,5353,5368,5701,5494,5312,5546,5387,5669,5396,5483,5639,5575,5665,5262,5358,5357,5576,5430,5687,5573,5302,5612,5375,5536,5307,5313,5511,5485,5392,5489,5718,5525,5714,5537,5376,5290,5339,5567,5295,5363,5251,5293,5265,5688,5390,5366,5707,5480,5328,5414,5436,5724,5421,5434,5254,5472,5514,5336,5671,5462,5482,5367,5315,5617,5560,5532,5286,5533,5675,5510,5632,5442,5296,5709,5372
11	5306,5330,5422,5492,5276,5607,5436,5655,5332,5300,5474,5574,5488,5328,5357,5262,5392,5281,5623,5608,5588,5453,5536,5551,5485,5343,5295,5524,5627,5433,5411,5721,5399,5723,5544,5358,5557,5450,5584,5287,5318,5498,5656,5724,5522,5665,5615,5500,5294,5570,5631,5633,5530,5525,5577,5518,5596,5257,5658,5561,5637,5277,5613,5477,5424,5490,5508,5430,5667,5421,5451,5519,5680,5605,5688,5402,5405,5274,5583,5505,5338,5594,5447,5692,5565,5686,5442,5650,5585,5374,5291,5599,5292,5497,5347,5425,5501,5589,5459,5431
12	5314,5623,5438,5517,5443,5504,5571,5540,5502,5630,5509,5591,5402,5437,5285,5541,5508,5538,5711,5490,5602,5688,5290,5683,5466,5310,5478,5635,5722,5331,5564,5590,5560,5684,5681,5678,5325,5460,5372,5562,5624,5600,5556,5603,5609,5464,5311,5355,5458,5660,5397,5558,5702,5343,5629,5589,5427,5277,5537,5601,5326,5585,5554,5463,5272,5578,5279,5479,5375,5391,5332,5634,5431,5594,5421,5661,5552,5381,5274,5534,5369,5347,5495,5367,5592,5697,5446,5573,5269,5251,5532,5481,5616,5584,5428,5682,5256,5475,5318,5261
13	5473,5457,5568,5653,5600,5627,5405,5479,5302,5301,5435,5365,5502,5461,5448,5612,5403,5669,5484,5614,5429,5312,5542,5293,5320,5515,5678,5414,5464,5528,5618,5279,5483,5619,5348,5273,5571,5671,5589,5497,5480,5552,5296,5501,5704,5373,5705,5381,5311,5716,5428,5556,5411,5639,5389,5610,5529,5361,5452,5314,5562,5498,5541,5336,5268,5566,5349,5588,5359,5347,5538,5275,5657,5715,5382,5517,5341,5391,5697,5344,5332,5466,5575,5652,5458,5434,5609,5408,5292,5559,5387,5433,5642,5304,5686,5531,5606,5272,5689,5427
14	5403,5624,5579,5648,5256,5342,5438,5694,5479,5480,5281,5638,5486,5340,5358,5639,5703,5675,5305,5613,5473,5661,5627,5353,5379,5585,5341,5612,5310,5502,5449,5422,5277,5603,5510,5316,5589,5633,5463,5412,5272,5567,5653,5595,5423,5691,5478,5321,5634,5515,5400,5665,5712,5354,5714,5308,5359,5387,5332,5419,5504,5313,5312,5350,5609,5450,5364,5705,5259,5476,5424,5508,5375,5383,5713,5593,5250,5632,5601,5662,5522,5499,5326,5520,5495,5380,5717,5493,5378,5533,5667,5561,5377,5437,5433,5335,5535,5391,5439,5324
15	5294,5539,5524,5672,5262,5674,5431,5636,5438,5406,5435,5542,5581,5576,5532,5654,5608,5459,5603,5483,5394,5656,5560,5700,5469,5538,5256,5525,5409,5640,5347,5460,5473,5448,5454,5512,5721,5535,5582,5664,5432,5375,5705,5526,5630,5503,5451,5325,5680,5362,5704,5548,5453,5668,5631,5476,5522,5309,5319,5383,5371,5269,5658,5326,5701,5422,5537,5716,5377,5344,5558,5455,5619,5439,5271,5673,5517,5518,5342,5533,5329,5284,5488,5629,5356,5392,5372,5305,5572,5404,5610,5569,5348,5339,5257,5367,5370,5669,5359,5614
16	5462,5261,5569,5333,5288,5276,5527,5589,5278,5461,5485,5721,5667,5658,5293,5431,5574,5255,5481,5711,5300,5258,5311,5314,5648,5583,5509,5401,5697,5682,5477,5695,5394,5275,5617,5511,5308,5334,5345,5503,5707,5375,5399,5378,5406,5689,5660,5520,5570,5438,5320,5628,5412,5252,5507,5269,5365,5418,5268,5437,5306,5504,5257,5522,5632,5400,5644,5516,5645,5386,5510,5253,5650,5584,5702,5491,5427,5544,5465,5426,5361,5289,5624,5588,5614,5694,5652,5519,5318,5619,5326,5353,5609,5498,5538,5265,5254,5649,5301,5535
17	5624,5487,5393,5530,5334,5598,5715,5448,5697,5604,5692,5375,5281,5294,5510,5641,5476,5676,5459,5274,5458,5581,5689,5625,5557,5607,5653,5255,5449,5422,5436,5712,5339,5591,5351,5471,5680,5345,5661,5286,5547,5439,5358,5702,5578,5453,5278,5349,5502,5698,5567,5416,5631,5428,5629,5716,5312,5442,5497,5432,5681,5705,5414,5668,5289,5521,5580,5523,5713,5635,5391,5463,5517,5579,5279,5450,5644,5395,5553,5425,5445,5

	293,5544,5427,5354,5599,5569,5300,5256,5519,5378,5665,5413,5632,5706,5367,5522,5505,5489,5690
18	5362,5647,5687,5586,5464,5397,5513,5468,5559,5457,5714,5473,5720,5623,5343,5476,5649,5393,5585,5385,5668,5388,5639,5591,5664,5713,5442,5663,5346,5351,5281,5644,5680,5328,5431,5505,5391,5262,5354,5628,5301,5544,5458,5423,5286,5717,5259,5612,5615,5370,5378,5353,5271,5699,5257,5646,5475,5679,5574,5372,5425,5320,5517,5642,5441,5562,5335,5636,5288,5682,5641,5617,5569,5430,5417,5433,5455,5705,5724,5577,5306,5498,5295,5340,5604,5673,5618,5653,5282,5494,5325,5542,5299,5530,5339,5436,5379,5552,5268,5479
19	5496,5523,5641,5477,5522,5320,5665,5586,5708,5314,5289,5546,5409,5259,5273,5688,5483,5398,5384,5645,5615,5251,5650,5497,5538,5287,5390,5652,5328,5670,5367,5321,5374,5426,5344,5261,5582,5485,5282,5553,5463,5559,5709,5490,5637,5655,5678,5413,5414,5621,5404,5588,5609,5558,5606,5716,5705,5525,5658,5630,5369,5647,5474,5284,5557,5653,5677,5625,5638,5281,5555,5432,5305,5267,5584,5607,5333,5701,5487,5431,5516,5503,5437,5541,5544,5547,5270,5602,5500,5250,5278,5530,5590,5568,5620,5371,5484,5462,5720,5491
20	5556,5304,5376,5550,5504,5370,5351,5674,5548,5420,5448,5577,5393,5286,5468,5262,5356,5656,5273,5387,5281,5526,5627,5401,5566,5421,5711,5687,5467,5275,5436,5672,5383,5414,5719,5292,5438,5481,5398,5300,5455,5359,5263,5425,5402,5358,5378,5530,5696,5353,5524,5502,5474,5423,5715,5673,5364,5330,5395,5261,5551,5445,5628,5303,5268,5314,5516,5713,5706,5321,5517,5646,5388,5390,5295,5559,5579,5339,5469,5465,5647,5605,5665,5545,5664,5447,5532,5284,5313,5374,5689,5443,5704,5472,5348,5312,5429,5365,5543,5431
21	5681,5502,5689,5574,5628,5530,5382,5716,5650,5521,5629,5297,5273,5363,5448,5374,5270,5708,5679,5642,5671,5553,5453,5676,5411,5548,5460,5489,5275,5407,5285,5532,5580,5423,5293,5699,5597,5479,5656,5288,5646,5710,5616,5664,5291,5445,5625,5484,5378,5298,5262,5413,5329,5319,5618,5691,5493,5486,5347,5442,5380,5404,5400,5398,5449,5711,5538,5514,5531,5394,5349,5475,5336,5366,5564,5370,5579,5719,5686,5434,5550,5410,5287,5416,5520,5435,5464,5599,5461,5513,5639,5589,5492,5593,5658,5704,5568,5605,5376,5701
22	5488,5635,5525,5410,5439,5688,5503,5289,5673,5372,5718,5370,5684,5265,5475,5620,5385,5547,5473,5448,5409,5715,5476,5342,5500,5570,5566,5266,5535,5393,5489,5458,5701,5689,5304,5301,5324,5654,5587,5646,5690,5548,5595,5371,5634,5643,5479,5610,5307,5628,5541,5642,5534,5658,5346,5438,5657,5561,5575,5606,5288,5510,5565,5334,5543,5585,5323,5419,5355,5433,5581,5340,5618,5381,5478,5291,5502,5297,5495,5367,5702,5466,5447,5283,5711,5269,5408,5605,5694,5357,5559,5335,5302,5374,5472,5414,5553,5637,5567,5555
23	5525,5333,5335,5565,5558,5510,5463,5320,5692,5495,5327,5655,5290,5433,5350,5590,5274,5701,5371,5581,5644,5404,5428,5589,5378,5549,5330,5538,5315,5609,5337,5617,5483,5628,5659,5649,5575,5344,5480,5287,5557,5313,5257,5656,5262,5334,5289,5314,5688,5613,5604,5445,5294,5669,5414,5387,5693,5382,5639,5714,5403,5430,5442,5568,5397,5531,5529,5416,5665,5424,5607,5616,5473,5273,5580,5396,5496,5577,5293,5509,5266,5426,5254,5573,5252,5512,5606,5686,5297,5608,5540,5338,5527,5484,5623,5272,5438,5722,5554,5545
24	5645,5558,5509,5615,5366,5339,5379,5698,5553,5253,5437,5677,5549,5718,5315,5413,5403,5542,5646,5300,5425,5594,5697,5581,5408,5712,5491,5275,5368,5552,5257,5311,5277,5618,5630,5467,5621,5489,5597,5436,5324,5575,5604,5352,5385,5290,5534,5418,5459,5593,5326,5504,5370,5586,5653,5457,5572,5354,5579,5250,5265,5430,5616,5521,5349,5410,5670,5507,5302,5299,5588,5351,5269,5342,5478,5272,5672,5681,5633,5684,5341,5656,5532,5632,5567,5293,5539,5360,5274,5331,5469,5574,5647,5494,5493,5434,5514,5335,5568,5276
25	5640,5269,5281,5493,5424,5434,5432,5616,5498,5671,5291,5649,5334,5614,5507,5367,5380,5343,5667,5274,5506,5606,5420,5479,5556,5503,5428,5497,5573,5368,5598,5629,5613,5536,5524,5365,5704,5652,5383,5558,5523,5533,5664,5398,5410,5604,5615,5717,5625,5252,5387,5585,5264,5592,5655,5254,5650,5552,5417,5400,5593,5442,5250,5695,5567,5265,5364,5673,5333,5612,5539,5407,5548,5569,5682,5710,5597,5627,5482,5475,5675,5510,5298,5648,5633,5513,5530,5692,5603,5681,5602,5611,5360,5435,5304,5698,5450,5562,5430,5528
26	5691,5684,5500,5270,5307,5493,5315,5340,5602,5290,5363,5496,5275,5376,5669,5612,5634,5591,5253,5710,5517,5297,5421,5701,5310,5312,5461,5467,5465,5665,5377,5553,55

	64,5257,5353,5661,5715,5600,5536,5520,5483,5394,5666,5451,5424,5557,5436,5486,5636,5533,5542,5423,5329,5293,5721,5430,5579,5597,5386,5349,5668,5289,5288,5368,5566,5676,5643,5716,5441,5440,5283,5627,5480,5610,5274,5706,5608,5401,5269,5417,5390,5345,5618,5719,5419,5682,5647,5346,5295,5680,5508,5384,5518,5317,5645,5685,5388,5709,5342,5352
27	5389,5258,5573,5517,5361,5675,5554,5616,5557,5465,5558,5648,5597,5623,5272,5541,5307,5649,5546,5483,5662,5582,5524,5716,5475,5686,5682,5311,5593,5469,5416,5652,5314,5250,5336,5425,5350,5607,5377,5281,5513,5371,5584,5512,5620,5294,5353,5627,5464,5413,5583,5560,5452,5401,5299,5526,5610,5714,5555,5689,5721,5391,5532,5622,5660,5366,5681,5291,5327,5356,5485,5399,5277,5402,5382,5688,5315,5637,5691,5255,5253,5318,5479,5523,5375,5549,5722,5504,5451,5704,5587,5359,5711,5670,5422,5335,5477,5324,5302,5374
28	5621,5393,5647,5649,5684,5597,5722,5716,5388,5653,5303,5349,5250,5715,5382,5294,5572,5576,5284,5575,5444,5423,5519,5708,5317,5528,5696,5270,5557,5643,5566,5404,5470,5536,5479,5405,5325,5555,5544,5579,5551,5659,5651,5623,5358,5721,5538,5378,5487,5625,5290,5452,5654,5448,5599,5663,5581,5406,5626,5701,5409,5469,5337,5604,5439,5486,5693,5267,5281,5430,5273,5602,5585,5307,5419,5699,5457,5428,5666,5364,5606,5280,5531,5386,5678,5574,5407,5346,5277,5268,5485,5561,5593,5429,5301,5592,5263,5412,5711,5494
29	5705,5314,5395,5509,5586,5558,5455,5419,5556,5292,5618,5476,5424,5445,5484,5263,5279,5400,5500,5464,5620,5268,5659,5322,5504,5563,5554,5413,5518,5505,5537,5401,5276,5329,5426,5281,5493,5407,5335,5392,5577,5427,5699,5358,5254,5580,5357,5250,5261,5460,5436,5599,5686,5380,5323,5273,5253,5291,5626,5301,5480,5466,5449,5344,5269,5452,5562,5510,5718,5415,5434,5478,5481,5347,5698,5306,5517,5653,5525,5666,5564,5352,5488,5384,5332,5713,5490,5526,5672,5483,5633,5635,5561,5629,5316,5295,5252,5370,5520,5623
30	5700,5584,5439,5279,5710,5358,5373,5680,5525,5609,5613,5529,5551,5459,5271,5583,5332,5446,5712,5614,5534,5589,5487,5648,5387,5402,5354,5586,5506,5620,5562,5335,5668,5252,5377,5629,5670,5302,5253,5381,5403,5716,5682,5273,5281,5328,5678,5295,5409,5687,5531,5382,5631,5339,5360,5347,5515,5617,5558,5254,5511,5423,5297,5528,5548,5331,5366,5638,5280,5442,5581,5461,5542,5463,5626,5355,5323,5400,5541,5658,5677,5287,5267,5532,5404,5420,5543,5303,5701,5468,5505,5597,5653,5496,5656,5338,5526,5521,5454,5608