DFS PORTION of FCC 47 CFR PART 15 SUBPART E
DFS PORTION of INDUSTRY CANADA RSS-247 ISSUE 1

CERTIFICATION TEST REPORT

FOR

802.11n 2x2 ACCESS POINT

MODEL NUMBER: MR18-HW

FCC ID: UDX-60026010
IC: 6961A-60026010

REPORT NUMBER: 16U23150-E1V1

ISSUE DATE: APRIL 06, 2016

Prepared for
CISCO SYSTEMS, INC.
170 WEST TASMAN DRIVE
SAN JOSE, CA, 95134, USA

Prepared by
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	04/06/16	Initial Issue	Conan Cheung

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: CISCO SYSTEMS, INC.
170 WEST TASMAN DRIVE
SAN JOSE, CA, 95134, USA

EUT DESCRIPTION: 802.11n 2x2 ACCESS POINT

MODEL: MR18-HW

SERIAL NUMBER: Q2GD-2Y7J-BEDM

DATE TESTED: MARCH 22, 2016 & MARCH 29 – MARCH 30, 2016

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
DFS Portion of CFR 47 Part 15 Subpart E	Pass
INDUSTRY CANADA RSS-247 Issue 1	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:

CONAN CHEUNG
PROJECT LEAD
UL Verification Services Inc.

Tested By:

HENRY LAU
EMC ENGINEER
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with the DFS portion of FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 06-96, FCC KDB 789033, KDB 905462 D02 and D03, ANSI C63.10-2013, RSS-247 Issue 1.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL Verification Services, Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	± 3.52 dB
Radiated Disturbance, 30 to 1000 MHz	± 4.94 dB
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 dB

Uncertainty figures are valid to a confidence level of 95%.

5. DYNAMIC FREQUENCY SELECTION

5.1. OVERVIEW

5.1.1. LIMITS

INDUSTRY CANADA

IC RSS-247 is closely harmonized with FCC Part 15 DFS rules. The deviations are as follows:

RSS-247 Issue 1

Note: For the band 5600–5650 MHz, no operation is permitted.

Until further notice, devices subject to this annex shall not be capable of transmitting in the band 5600–5650 MHz. This restriction is for the protection of Environment Canada weather radars operating in this band.

FCC

§15.407 (h), FCC KDB 905462 D02 “COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION” and KDB 905462 D03 “U-NII CLIENT DEVICES WITHOUT RADAR DETECTION CAPABILITY”.

Table 1: Applicability of DFS requirements prior to use of a channel

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

Table 2: Applicability of DFS requirements during normal operation

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

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar DFS	Client (without DFS)
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in all 20 MHz channel blocks and a null frequency between the bonded 20 MHz channel blocks.		

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see notes)
E.I.R.P. ≥ 200 mill watt	-64 dBm
E.I.R.P. < 200 mill watt and power spectral density < 10 dBm/MHz	-62 dBm
E.I.R.P. < 200 mill watt that do not meet power spectral density requirement	-64 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna
Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.
Note 3: E.I.R.P. is based on the highest antenna gain. For MIMO devices refer to KDB publication 662911 D01.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds (See Note 1)
Channel Closing Transmission Time	200 milliseconds + approx. 60 milliseconds over remaining 10 second period. (See Notes 1 and 2)
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. (See Note 3)

Note 1: *Channel Move Time* and the *Channel Closing Transmission Time* should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.
Note 2: The *Channel Closing Transmission Time* is comprised of 200 milliseconds 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 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.
Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (usec)	PRI (usec)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in table 5a	Roundup: {(1/360) x (19 x 10^6 PRI_{usec})}	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 usec. With a minimum increment of 1 usec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Note 1: Short Pulse Radar Type 0 should be used for the *Detection Bandwidth* test, *Channel Move Time*, and *Channel Closing Time* tests.

Table 6 – Long Pulse Radar Test Signal

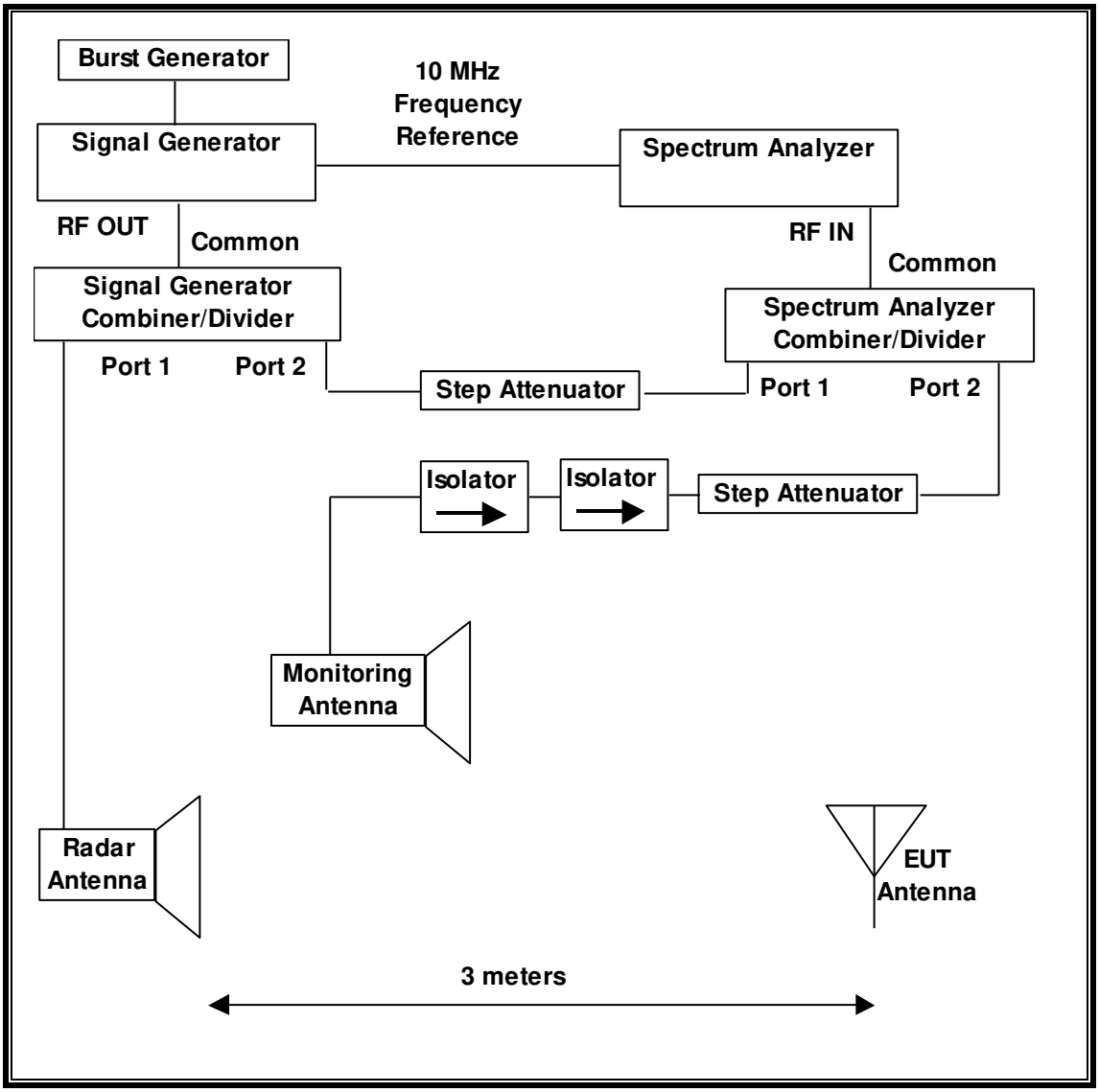
Radar Waveform Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7 – Frequency Hopping Radar Test Signal

Radar Waveform Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	9	0.333	300	70%	30

5.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



SYSTEM OVERVIEW

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

The short pulse types 1, 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of KDB 905462 D02. The frequency of the signal generator is incremented in 1 MHz steps from F_L to F_H for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

SYSTEM CALIBRATION

A 50-ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected to a horn antenna via a coaxial cable, with the reference level offset set to (horn antenna gain – coaxial cable loss). The signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –64 dBm as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. The Reference Level Offset of the spectrum analyzer is adjusted so that the displayed amplitude of the signal is –64 dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –64 dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

ADJUSTMENT OF DISPLAYED TRAFFIC LEVEL

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. The video test file is streamed to generate WLAN traffic. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

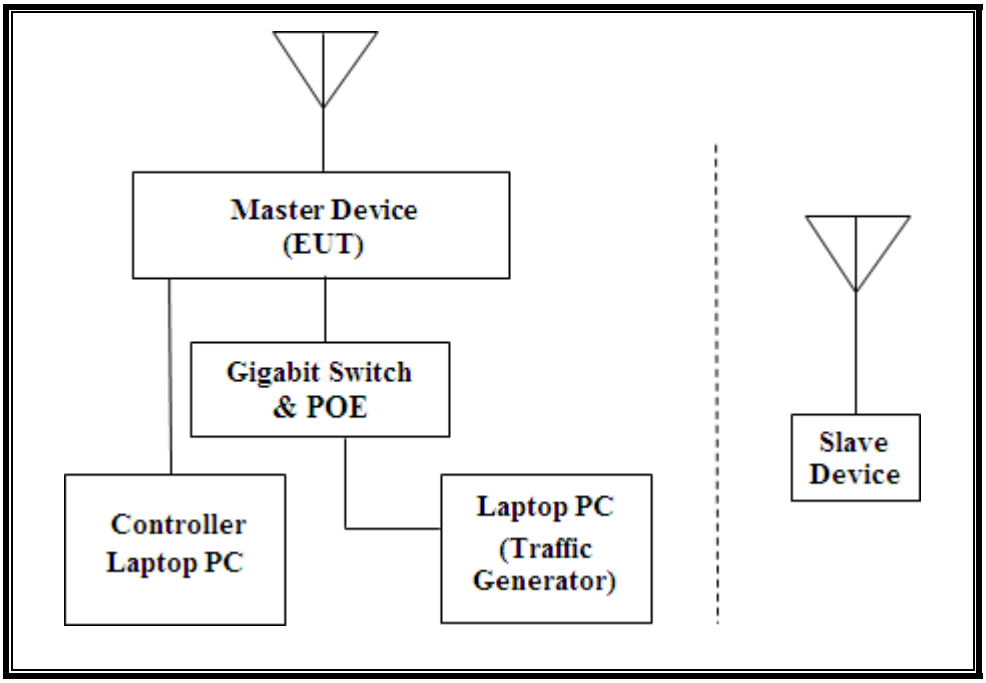
TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the DFS tests documented in this report:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**Cal Due**
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	US51350187	06/01/16
Signal Generator, MXG X-Series RF Vector	Agilent	N5172B	MY51350337	03/11/17
Arbitrary Waveform Generator	Agilent / HP	33220A	MY44037572	04/08/16

5.1.3. SETUP OF EUT

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

The following support equipment was utilized for the DFS tests documented in this report:

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop PC (Controller)	Lenovo	TYPE 3249-2HU	R9-AWVWD 11/01	QDS-BRCM1046
AC Adapter (Controller)	Lenovo	ADLX65NLT2A	11S36200291ZZ300345B5X	DoC
Gigabit Switch & POE	Meraki	MS220-8P	Q2HP-DR3G-TQZS	DoC
Laptop PC (Slave Device)	Apple	A1465	C02KTGMPF5N7	QDS-BRCM1072
AC Adapter (Slave Device)	Apple	A1435	C04341216J2F288BT	DoC
Laptop PC (Traffic Generator)	Lenovo	TYPE 4287-5TU	R9-PLM9D 12/06	QDS-BRCM1046
AC Adapter (Traffic Generator)	Lenobo	45N0121	11S45N0121Z1ZHXU213DMG	DoC

5.1.4. DESCRIPTION OF EUT

The EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges, excluding the 5600-5650 MHz range.

The EUT is a Master Device.

The highest power level within these bands is 26.77 dBm EIRP in the 5250-5350 MHz band and 24.77 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a gain of 3 dBi.

Two identical antennas are utilized to meet the diversity and MIMO operational requirements.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides a margin to the limit.

The EUT uses two transmitter/receiver chains, each connected to an antenna to perform radiated tests.

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic that meets or exceeds the minimum required loading was generated by transferring a data stream from the Master Device to the Slave Device using iPerf version 2.0.5 software package.

TPC is not required since the maximum EIRP is less than 500 mW (27 dBm).

The EUT utilizes the 802.11a/n architecture. Two nominal channel bandwidths are implemented: 20 MHz and 40 MHz.

The software installed in the EUT is firmware_ar7100_version 23-198082M-nileshhirve.

UNIFORM CHANNEL SPREADING

This function is not required per KDB 905462.

5.2. RESULTS FOR 20 MHz BANDWIDTH

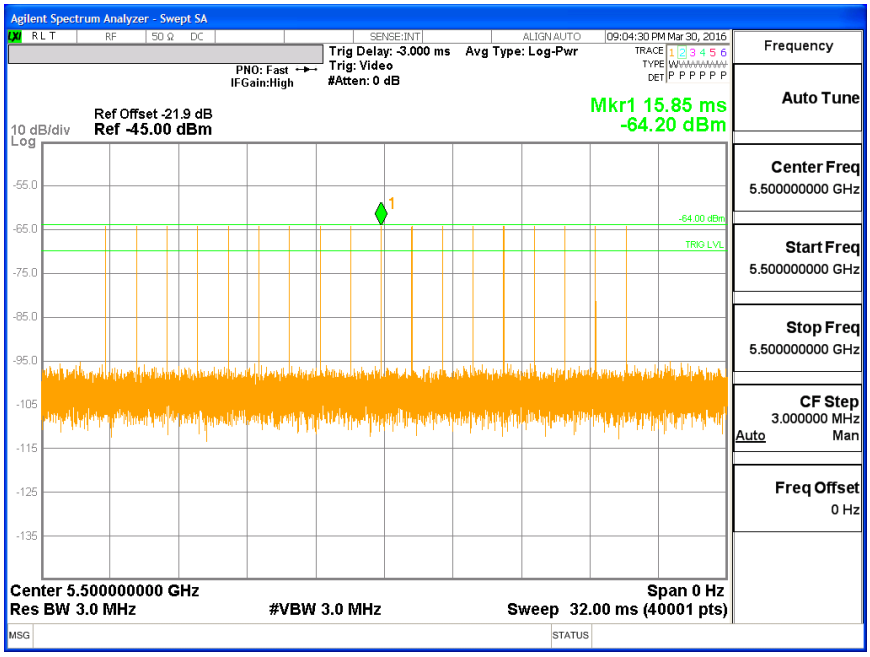
5.2.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5500 MHz.

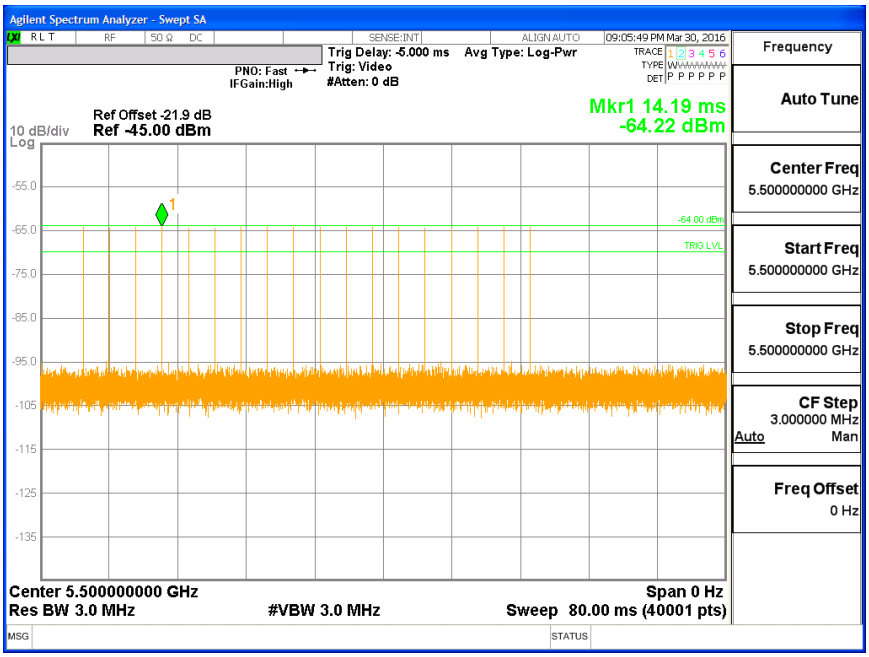
5.2.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

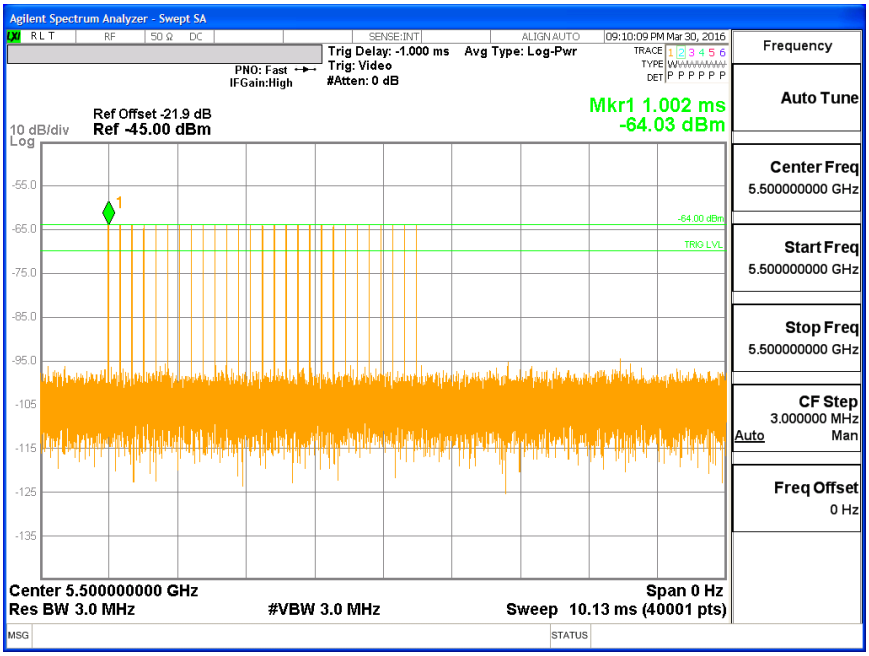
SHORT PULSE RADAR TYPE 0



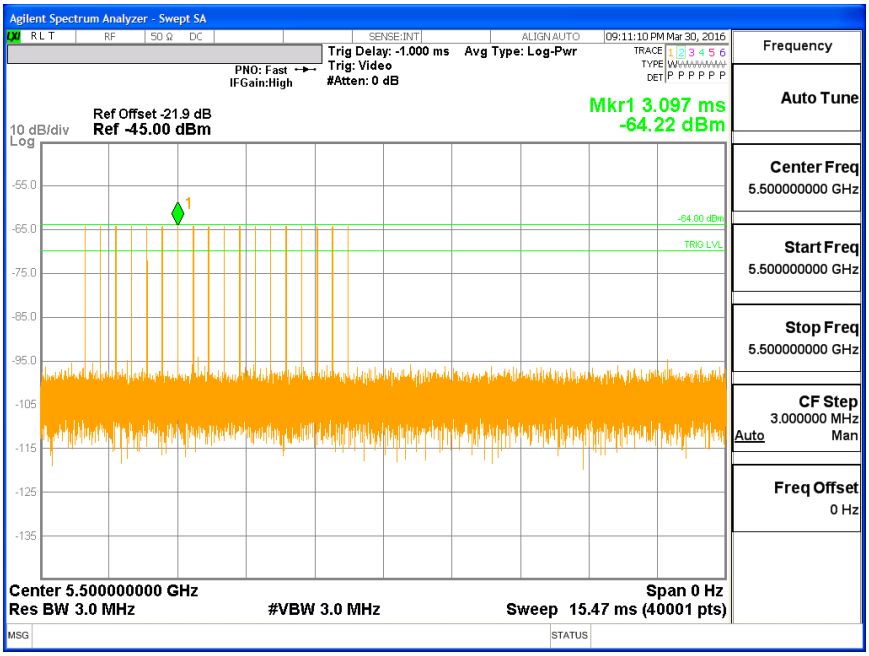
SAMPLE OF RADAR TYPE 1



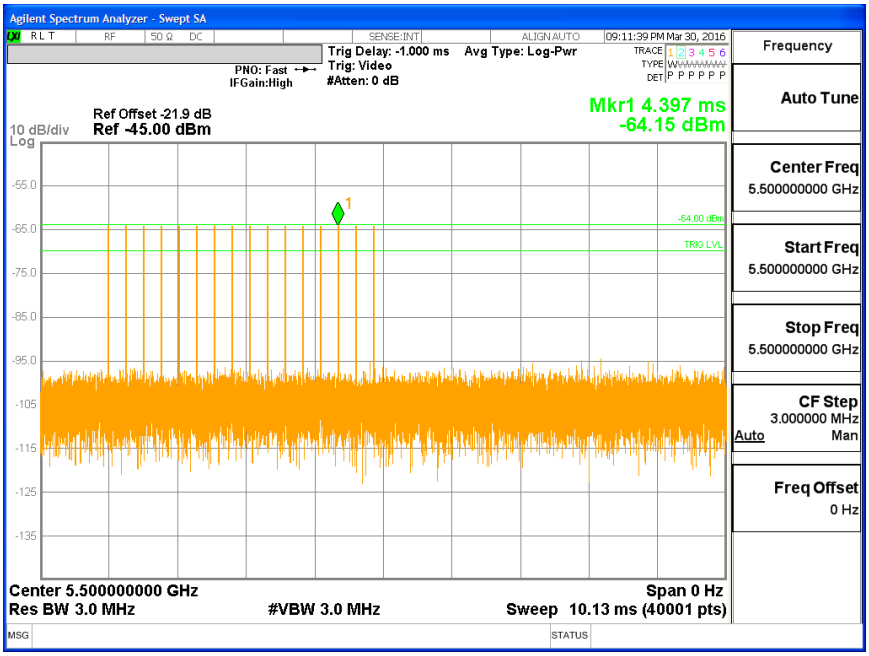
SAMPLE OF RADAR TYPE 2



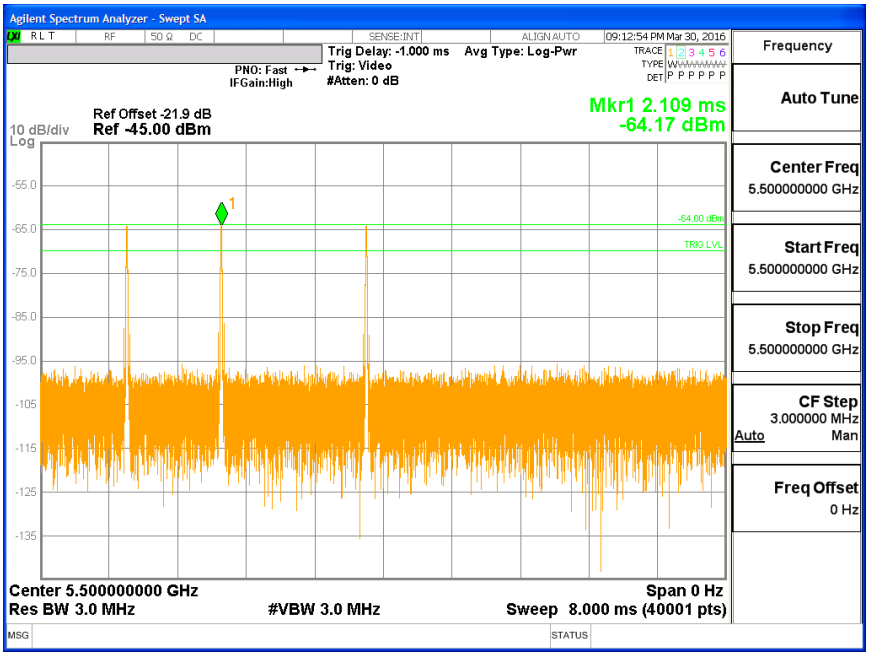
SAMPLE OF RADAR TYPE 3



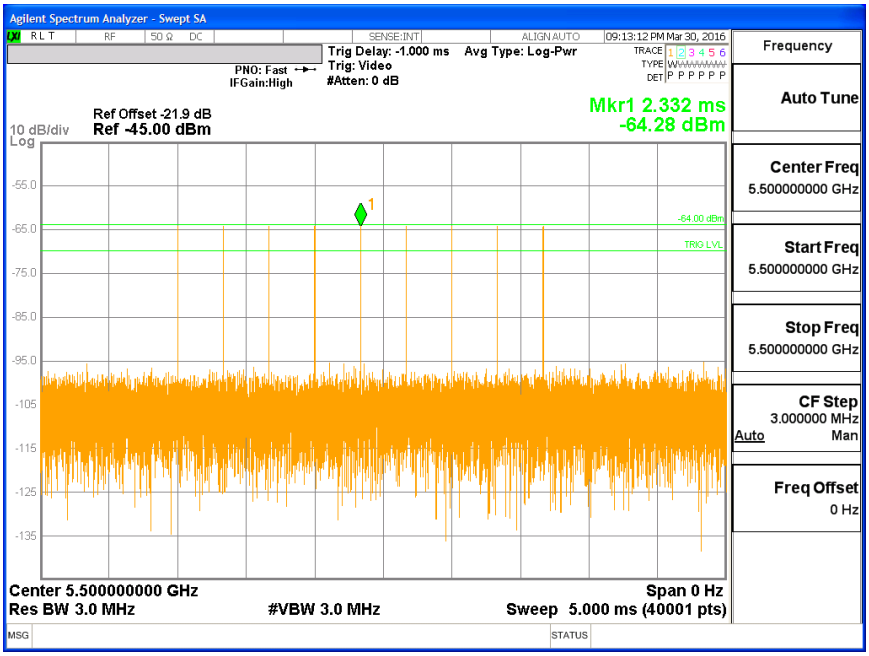
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

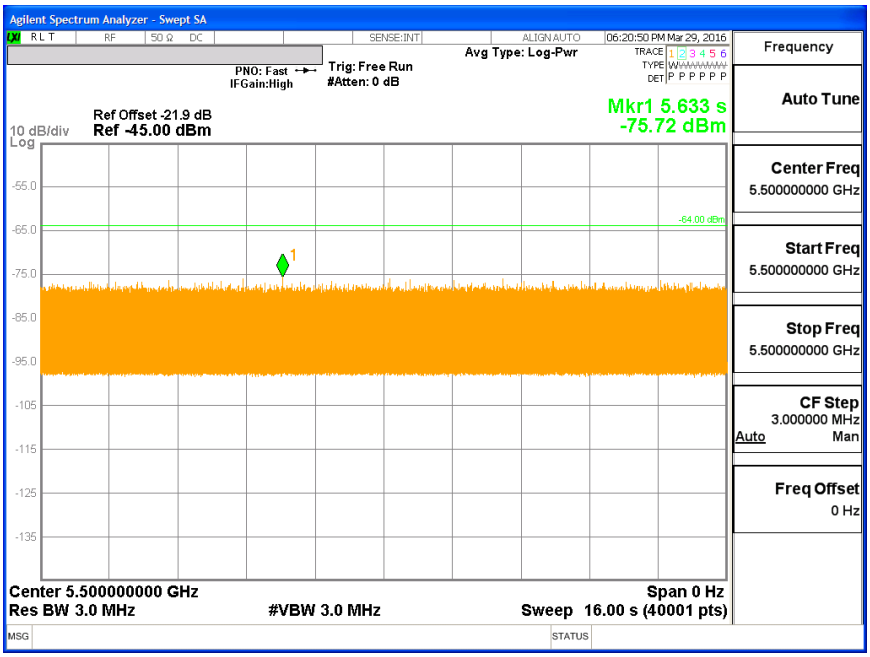


SINGLE BURST OF RADAR TYPE 6

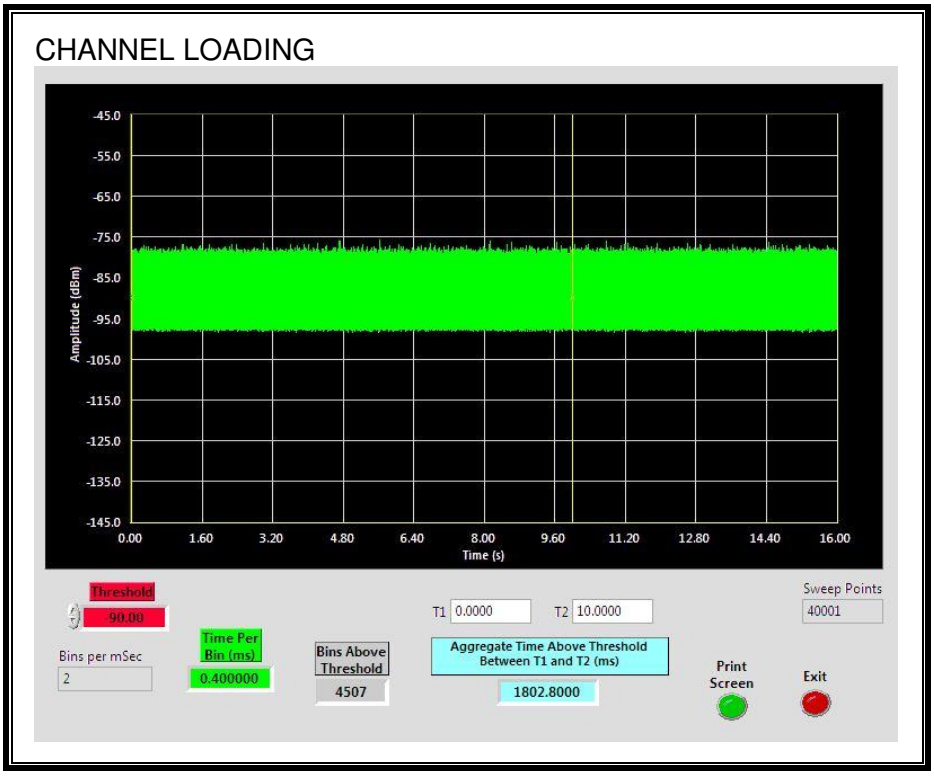


TRAFFIC

TRAFFIC



CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 18.028%

5.2.3. CHANNEL AVAILABILITY CHECK TIME

PROCEDURE TO DETERMINE INITIAL POWER-UP CYCLE TIME

A link was established on channel then the EUT was rebooted. The time from the cessation of traffic to the re-initialization of traffic was measured as the time required for the EUT to complete the total power-up cycle. The time to complete the initial power-up period is 60 seconds less than this total power-up time.

PROCEDURE FOR TIMING OF RADAR BURST

With a link established on channel, the EUT was rebooted. A radar signal was triggered within 0 to 6 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

The Non-Occupancy list was cleared. With a link established on channel, the EUT was rebooted. A radar signal was triggered within 54 to 60 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

QUANTITATIVE RESULTS

No Radar Triggered

Timing of Reboot (sec)	Timing of Start of Traffic (sec)	Total Power-up Cycle Time (sec)	Initial Power-up Cycle Time (sec)
30.47	129.4	98.9	38.9

Radar Near Beginning of CAC

Timing of Reboot (sec)	Timing of Radar Burst (sec)	Radar Relative to Reboot (sec)	Radar Relative to Start of CAC (sec)
30.29	70.5	40.2	1.2

Radar Near End of CAC

Timing of Reboot (sec)	Timing of Radar Burst (sec)	Radar Relative to Reboot (sec)	Radar Relative to Start of CAC (sec)
30.11	127.4	97.3	58.4

QUALITATIVE RESULTS

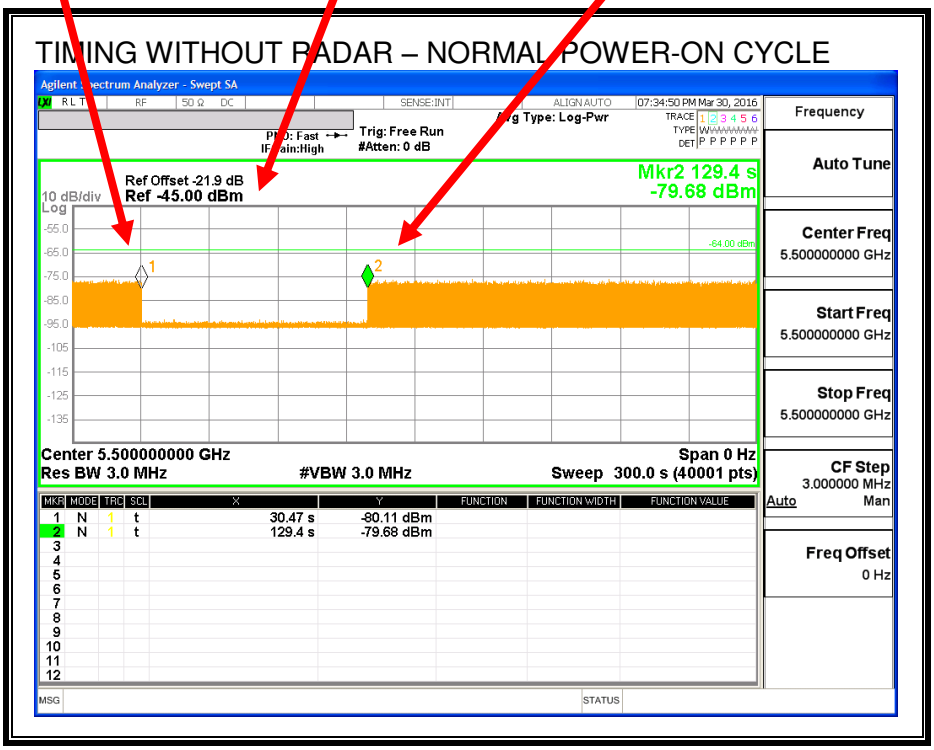
Timing of Radar Burst	Display on Control Computer	Spectrum Analyzer Display
No Radar Triggered	EUT marks Channel as active	Transmissions begin on channel after completion of the initial power-up cycle and the CAC
Within 0 to 6 second window	EUT indicates radar detected	No transmissions on channel
Within 54 to 60 second window	EUT indicates radar detected	No transmissions on channel

TIMING WITHOUT RADAR DURING CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle

End of Initial Power-up cycle
Start of CAC

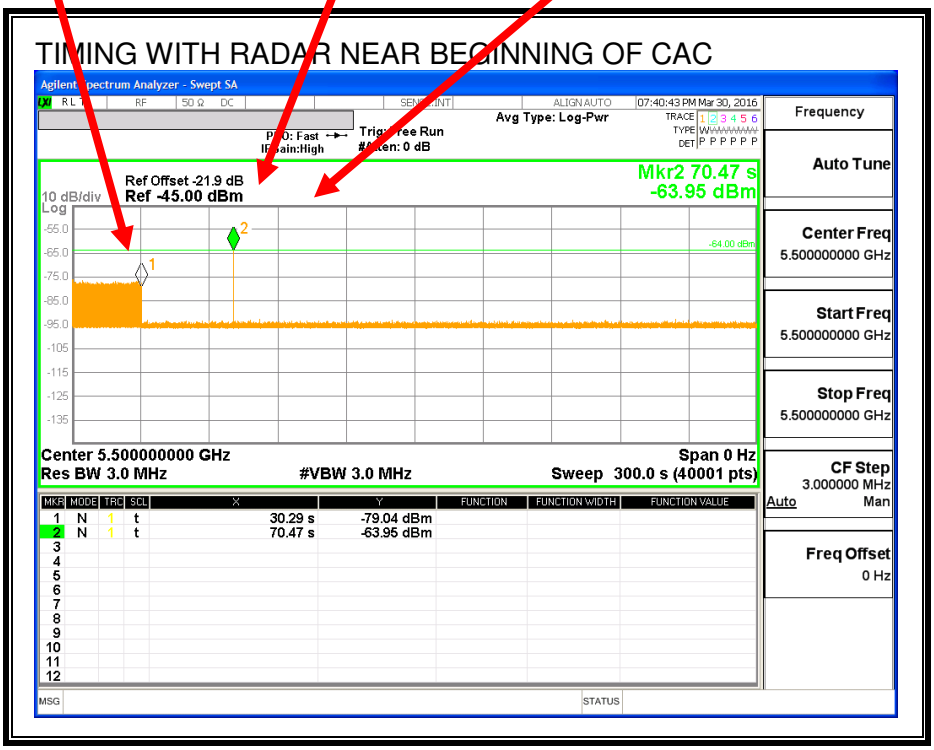
End of CAC
Traffic is Initiated



Transmissions begin on channel after completion of the initial power-up cycle and the CAC.

TIMING WITH RADAR NEAR BEGINNING OF CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle
End of Initial Power-up cycle
Start of CAC
Radar Signal Applied



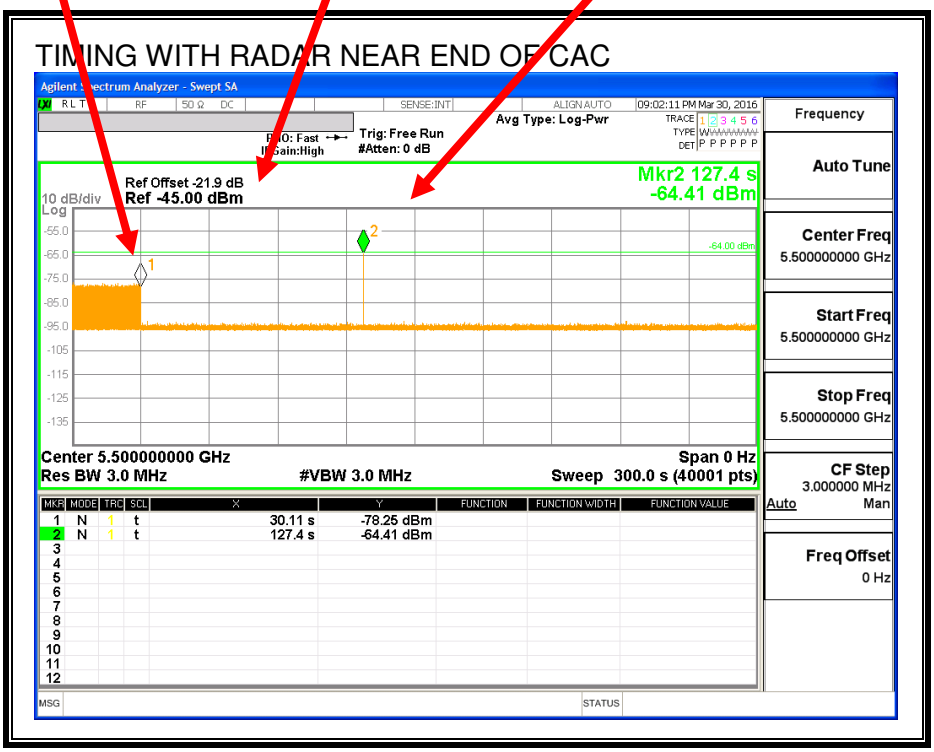
No EUT transmissions were observed after the radar signal.

TIMING WITH RADAR NEAR END OF CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle

End of Initial Power-up cycle
Start of CAC

Radar Signal Applied



No EUT transmissions were observed after the radar signal.

5.2.4. OVERLAPPING CHANNEL TESTS

RESULTS

The channel spacing is not less than the channel bandwidth therefore the EUT does not have an overlapping channel plan.

These tests are not applicable.

5.2.5. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

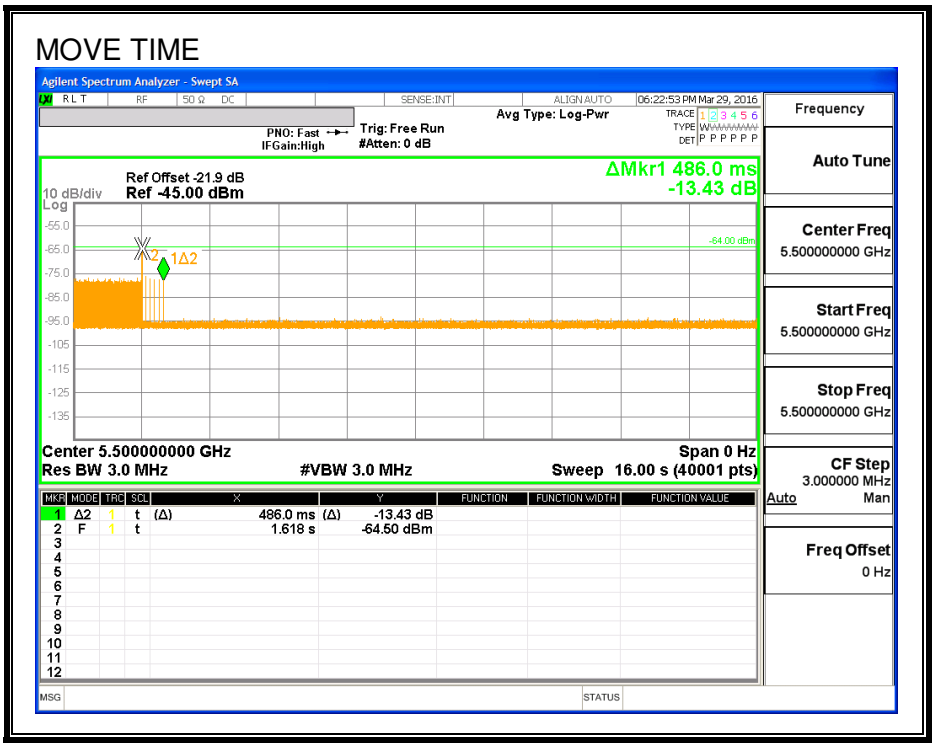
The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

RESULTS

Channel Move Time (sec)	Limit (sec)
0.486	10

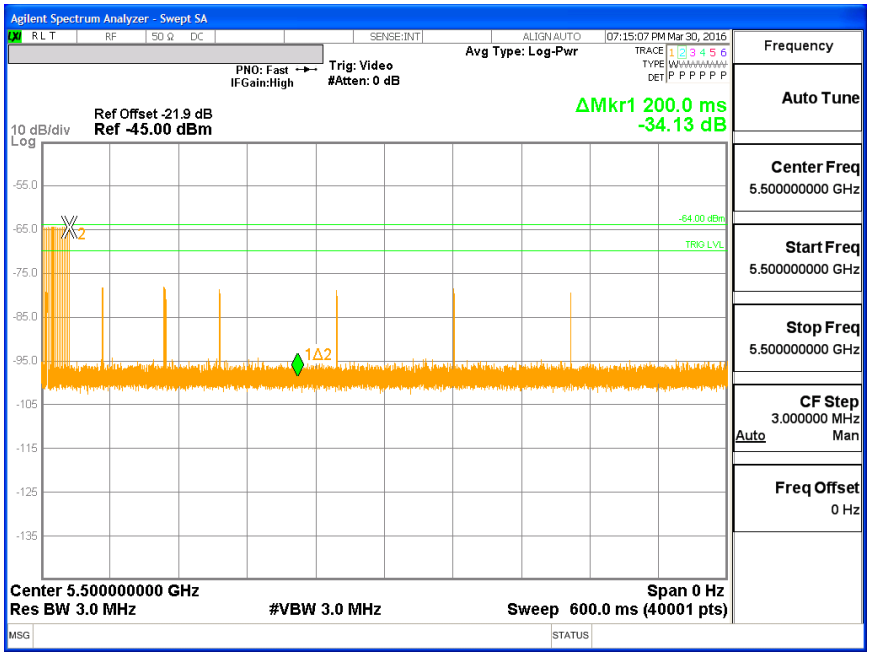
Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
2.4	60

MOVE TIME



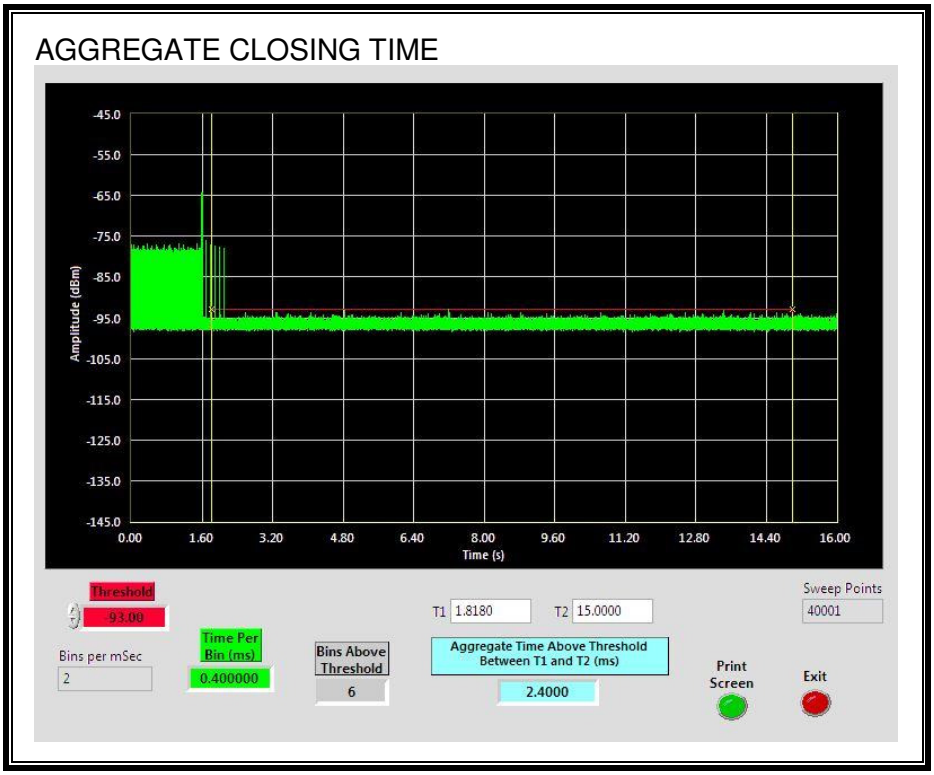
CHANNEL CLOSING TIME

CLOSING TIME



AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

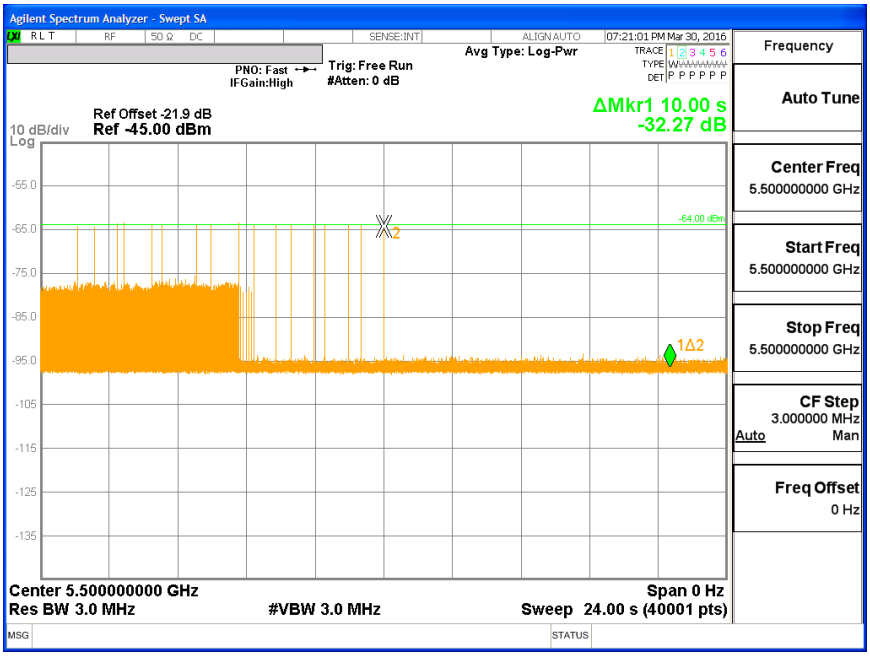
Only intermittent transmissions are observed during the aggregate monitoring period.



LONG PULSE CHANNEL MOVE TIME

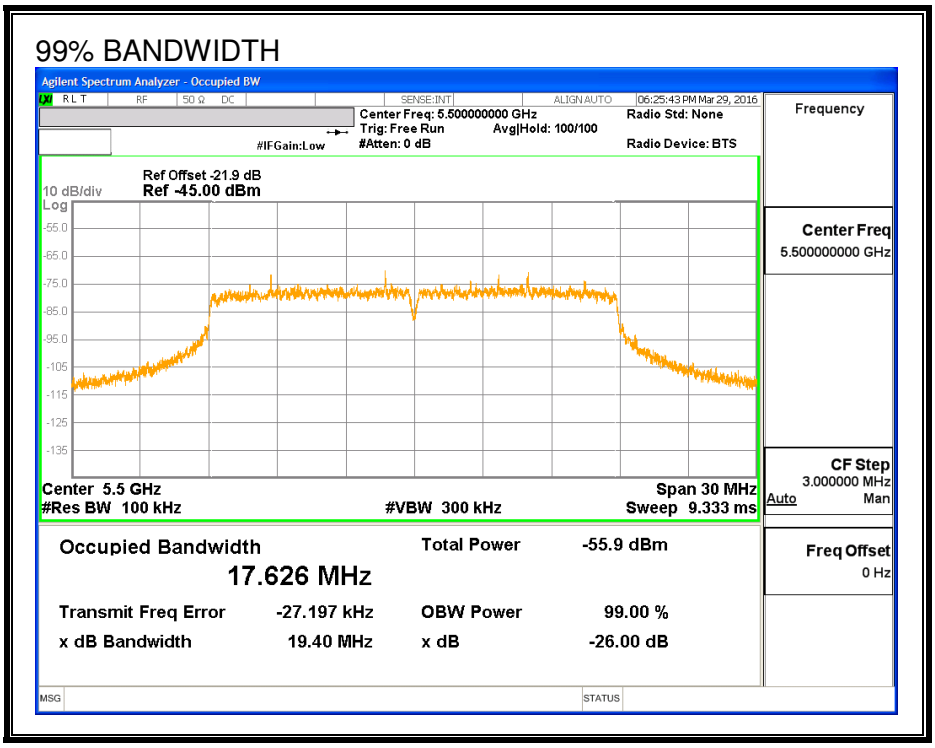
The traffic ceases prior to 10 seconds after the end of the radar waveform.

MOVE TIME FOR LONG PULSE RADAR



5.2.6. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5491	5509	18	17.626	102.1	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results				
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5490	10	8	80	
5491	10	10	100	FL
5492	10	10	100	
5493	10	10	100	
5494	10	10	100	
5495	10	10	100	
5500	10	10	100	
5505	10	10	100	
5506	10	10	100	
5507	10	10	100	
5508	10	10	100	
5509	10	10	100	FH
5510	10	8	80	

5.2.7. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth		80% of Det BW	
					FL	FH	FL5	FH5
FCC Short Pulse Type 1	30	100.00	60	Pass	5491	5509		
FCC Short Pulse Type 2	30	83.33	60	Pass	5491	5509		
FCC Short Pulse Type 3	30	90.00	60	Pass	5491	5509		
FCC Short Pulse Type 4	30	86.67	60	Pass	5491	5509		
Aggregate		90.00	80	Pass				
FCC Long Pulse Type 5	30	100.00	80	Pass	5491	5509	5493	5507
FCC Hopping Type 6	38	100.00	70	Pass	5491	5509		

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1						
Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5500	Yes
1002	1	878	61	A	5500	Yes
1003	1	578	92	A	5500	Yes
1004	1	718	74	A	5500	Yes
1005	1	518	102	A	5500	Yes
1006	1	678	78	A	5500	Yes
1007	1	918	58	A	5500	Yes
1008	1	898	59	A	5500	Yes
1009	1	738	72	A	5500	Yes
1010	1	598	89	A	5500	Yes
1011	1	858	62	A	5500	Yes
1012	1	798	67	A	5500	Yes
1013	1	938	57	A	5500	Yes
1014	1	838	63	A	5500	Yes
1015	1	538	99	A	5500	Yes
1016	1	648	82	B	5500	Yes
1017	1	2957	18	B	5500	Yes
1018	1	3043	18	B	5500	Yes
1019	1	2934	18	B	5500	Yes
1020	1	1954	28	B	5500	Yes
1021	1	1975	27	B	5500	Yes
1022	1	2478	22	B	5500	Yes
1023	1	1433	37	B	5500	Yes
1024	1	712	75	B	5500	Yes
1025	1	2345	23	B	5500	Yes
1026	1	560	95	B	5500	Yes
1027	1	1127	47	B	5500	Yes
1028	1	2019	27	B	5500	Yes
1029	1	2716	20	B	5500	Yes
1030	1	2542	21	B	5500	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	4.9	175	27	5500	Yes
2002	1.2	180	25	5500	Yes
2003	2.1	174	24	5500	Yes
2004	4.5	183	23	5500	Yes
2005	3.7	181	26	5500	Yes
2006	4.5	194	26	5500	No
2007	1.7	158	26	5500	Yes
2008	4.8	175	29	5500	No
2009	4.4	187	26	5500	Yes
2010	1.5	208	29	5500	Yes
2011	3.5	223	27	5500	Yes
2012	2.9	211	27	5500	Yes
2013	1	230	29	5500	Yes
2014	4.8	222	26	5500	Yes
2015	3.1	207	25	5500	Yes
2016	1	203	29	5500	Yes
2017	1.7	193	28	5500	Yes
2018	4	155	23	5500	Yes
2019	4.9	191	26	5500	Yes
2020	3.2	157	28	5500	Yes
2021	2.4	198	24	5500	No
2022	3.2	169	23	5500	No
2023	2.5	213	27	5500	Yes
2024	3.5	150	26	5500	Yes
2025	3.1	161	24	5500	Yes
2026	2.4	182	27	5500	No
2027	2.2	198	28	5500	Yes
2028	1.6	185	25	5500	Yes
2029	3.8	205	27	5500	Yes
2030	3.5	196	24	5500	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	349	18	5500	Yes
3002	8.5	336	17	5500	Yes
3003	9.4	304	17	5500	No
3004	7.1	437	16	5500	Yes
3005	8.2	300	16	5500	Yes
3006	8.9	446	17	5500	Yes
3007	5.1	321	18	5500	Yes
3008	6.1	480	18	5500	Yes
3009	5.3	368	16	5500	Yes
3010	6.5	304	16	5500	Yes
3011	6	456	18	5500	Yes
3012	5.1	272	17	5500	Yes
3013	9.9	319	17	5500	Yes
3014	9.3	281	16	5500	Yes
3015	6.9	341	16	5500	Yes
3016	6.5	315	18	5500	Yes
3017	7.1	270	18	5500	No
3018	6.9	390	18	5500	No
3019	7.8	358	16	5500	Yes
3020	5.5	358	18	5500	Yes
3021	6.6	472	18	5500	Yes
3022	7.3	366	16	5500	Yes
3023	8.6	493	17	5500	Yes
3024	9.6	401	17	5500	Yes
3025	8.8	422	16	5500	Yes
3026	10	476	18	5500	Yes
3027	9.5	377	17	5500	Yes
3028	8.6	326	16	5500	Yes
3029	8.3	491	16	5500	Yes
3030	7.7	452	18	5500	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	10.6	261	16	5500	Yes
4002	15.2	369	14	5500	Yes
4003	10.9	441	13	5500	Yes
4004	16	311	14	5500	No
4005	12.3	279	13	5500	Yes
4006	17.9	412	15	5500	Yes
4007	10	392	14	5500	Yes
4008	11.4	287	13	5500	Yes
4009	14	414	13	5500	Yes
4010	15.9	454	12	5500	Yes
4011	14.4	343	15	5500	Yes
4012	16.8	396	15	5500	Yes
4013	15.8	298	15	5500	No
4014	14	497	15	5500	Yes
4015	13.4	411	16	5500	Yes
4016	12.1	373	14	5500	Yes
4017	17.5	315	15	5500	Yes
4018	12	289	15	5500	No
4019	17.8	362	12	5500	Yes
4020	12.8	482	13	5500	Yes
4021	19.2	450	12	5500	Yes
4022	14.7	332	13	5500	Yes
4023	12.2	313	13	5500	Yes
4024	18.3	459	12	5500	Yes
4025	10.8	334	16	5500	Yes
4026	12.8	375	16	5500	Yes
4027	11.2	263	13	5500	Yes
4028	13.6	317	13	5500	No
4029	12.6	469	14	5500	Yes
4030	10.8	418	13	5500	Yes

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5506	Yes
2	5504	Yes
3	5506	Yes
4	5500	Yes
5	5501	Yes
6	5499	Yes
7	5506	Yes
8	5502	Yes
9	5499	Yes
10	5505	Yes
11	5495	Yes
12	5494	Yes
13	5496	Yes
14	5504	Yes
15	5506	Yes
16	5494	Yes
17	5507	Yes
18	5505	Yes
19	5503	Yes
20	5507	Yes
21	5506	Yes
22	5506	Yes
23	5499	Yes
24	5499	Yes
25	5498	Yes
26	5496	Yes
27	5506	Yes
28	5505	Yes
29	5493	Yes
30	5507	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop
NTIA August 2005 Hopping Sequence

Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	234	5491	7	Yes
2	709	5492	2	Yes
3	1184	5493	2	Yes
4	1659	5494	2	Yes
5	2134	5495	6	Yes
6	3084	5496	5	Yes
7	3559	5497	3	Yes
8	4034	5498	4	Yes
9	4509	5499	6	Yes
10	4984	5500	3	Yes
11	5459	5501	7	Yes
12	5934	5502	2	Yes
13	6409	5503	3	Yes
14	6884	5504	5	Yes
15	7359	5505	4	Yes
16	7834	5506	5	Yes
17	8309	5507	3	Yes
18	8784	5508	3	Yes
19	9259	5509	2	Yes
20	9734	5491	3	Yes
21	10209	5492	1	Yes
22	10684	5493	5	Yes
23	11159	5494	2	Yes
24	11634	5495	4	Yes
25	12109	5496	1	Yes
26	12584	5497	3	Yes
27	13059	5498	4	Yes
28	13534	5499	2	Yes
29	14009	5500	4	Yes
30	14484	5501	5	Yes
31	14959	5502	3	Yes
32	15434	5503	5	Yes
33	15909	5504	5	Yes
34	16384	5505	3	Yes
35	16859	5506	4	Yes
36	17334	5507	4	Yes
37	17809	5508	4	Yes
38	18284	5509	2	Yes

5.3. RESULTS FOR 40 MHz BANDWIDTH

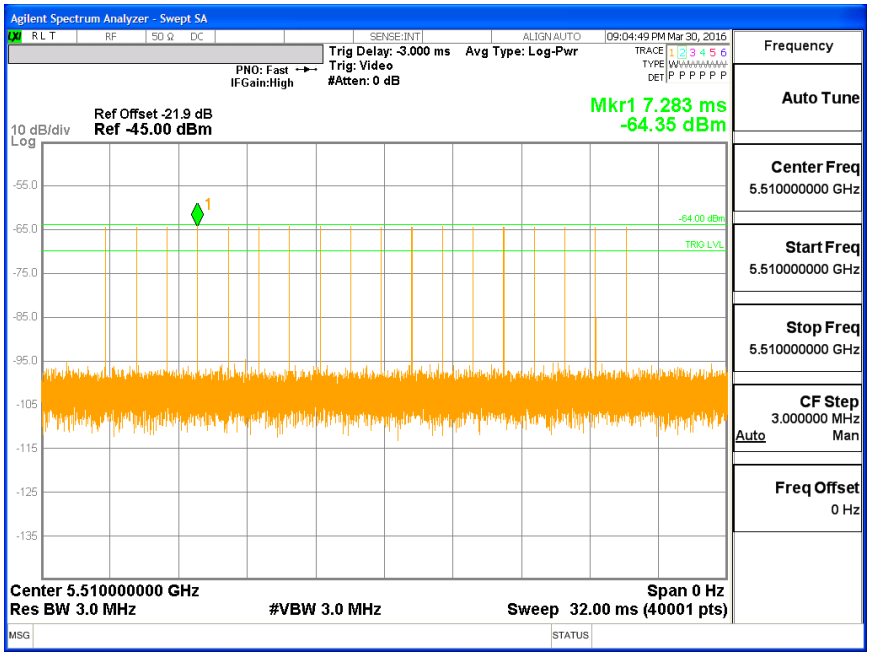
5.3.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5510 MHz.

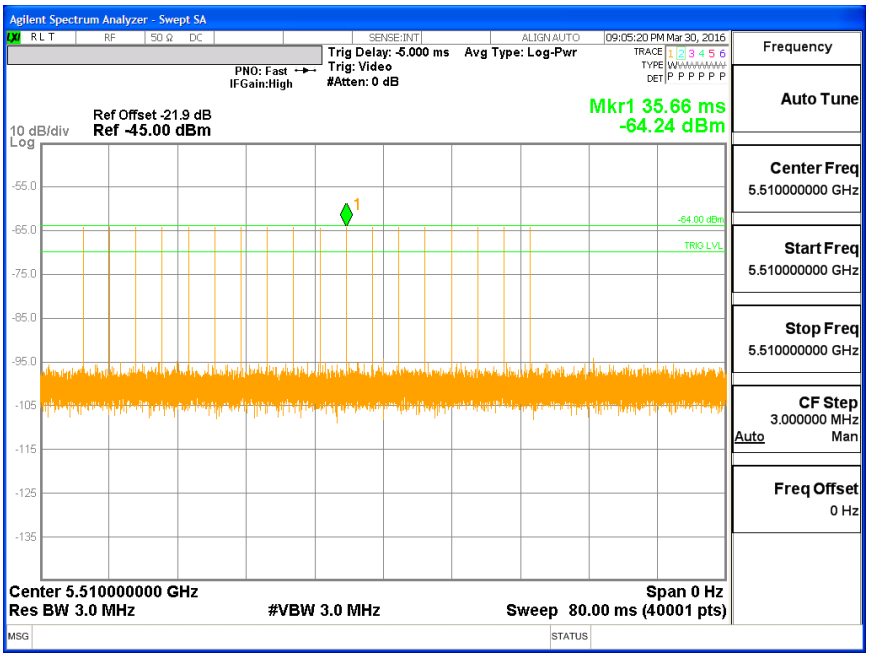
5.3.2. RADAR WAVEFORMS AND TRAFFIC

RADAR WAVEFORMS

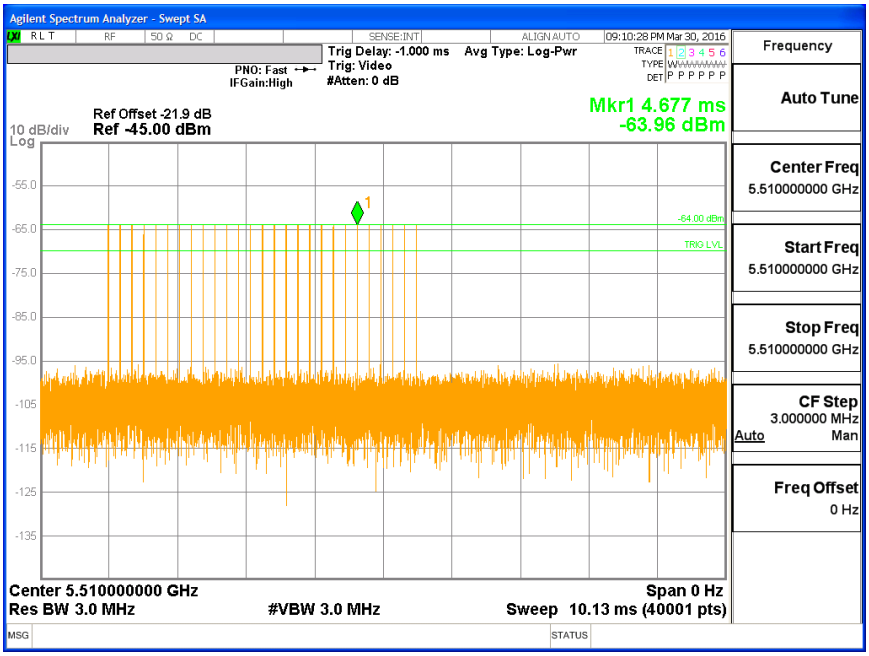
SHORT PULSE RADAR TYPE 0



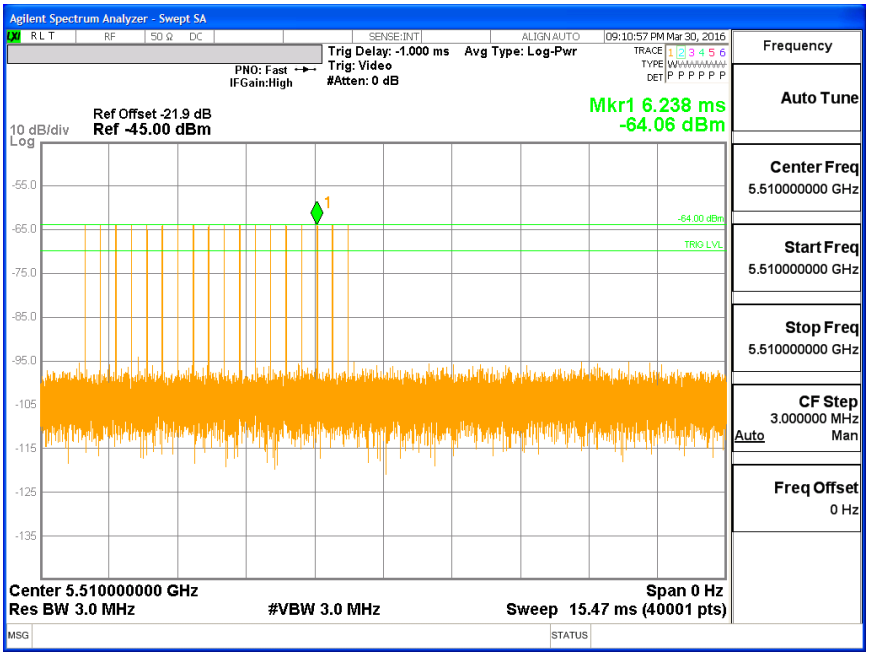
SAMPLE OF RADAR TYPE 1



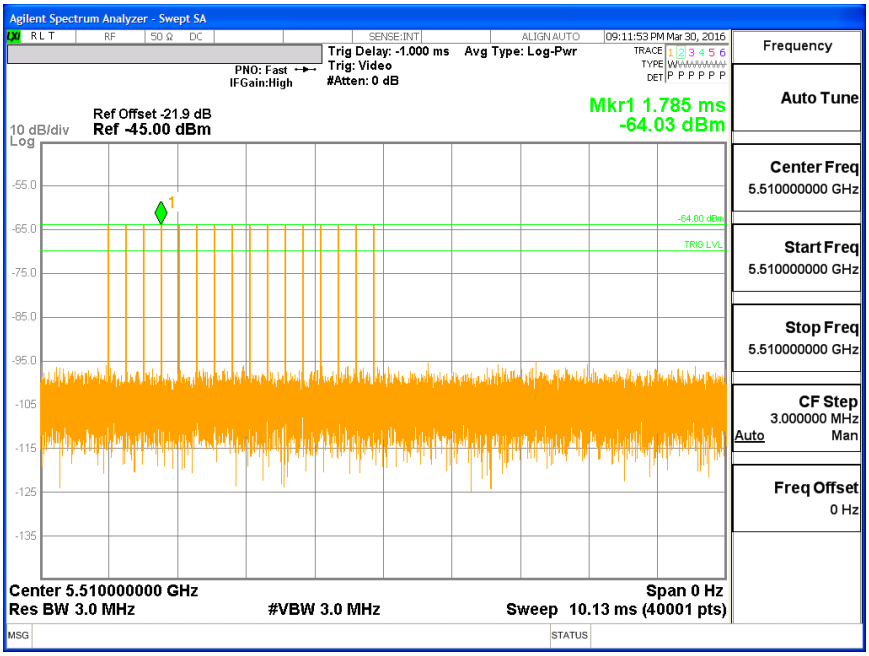
SAMPLE OF RADAR TYPE 2



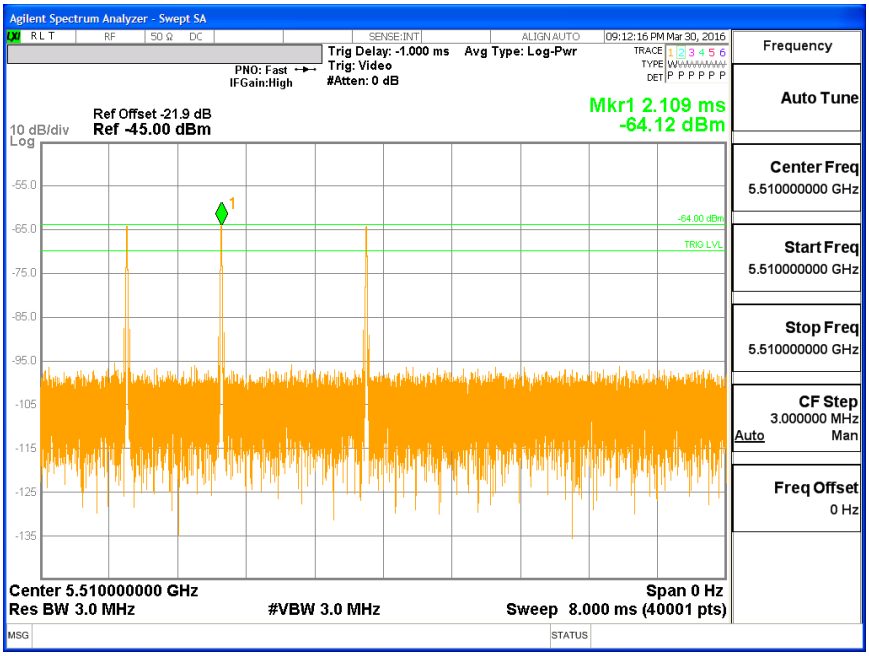
SAMPLE OF RADAR TYPE 3



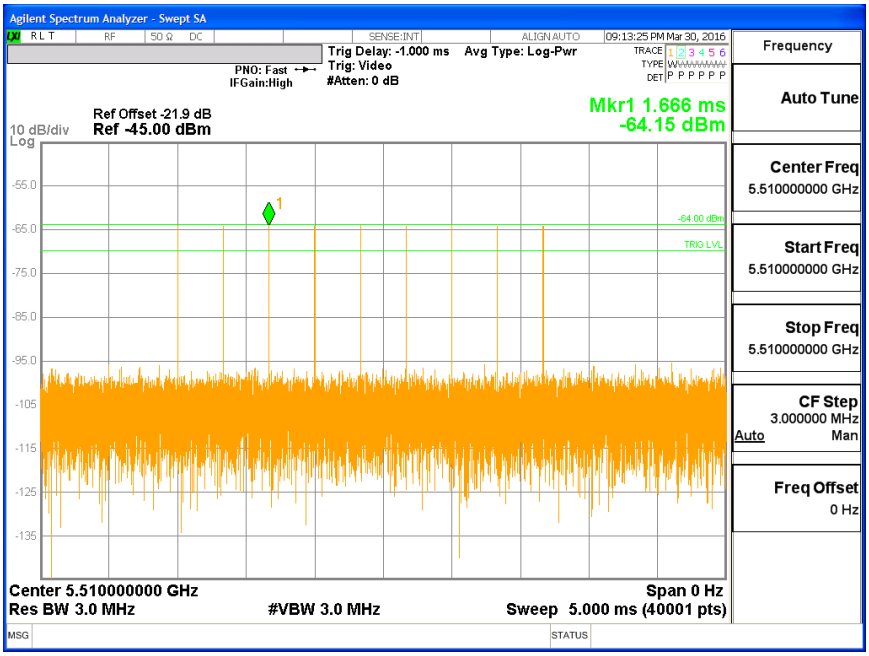
SAMPLE OF RADAR TYPE 4



SAMPLE OF SINGLE BURST OF RADAR TYPE 5

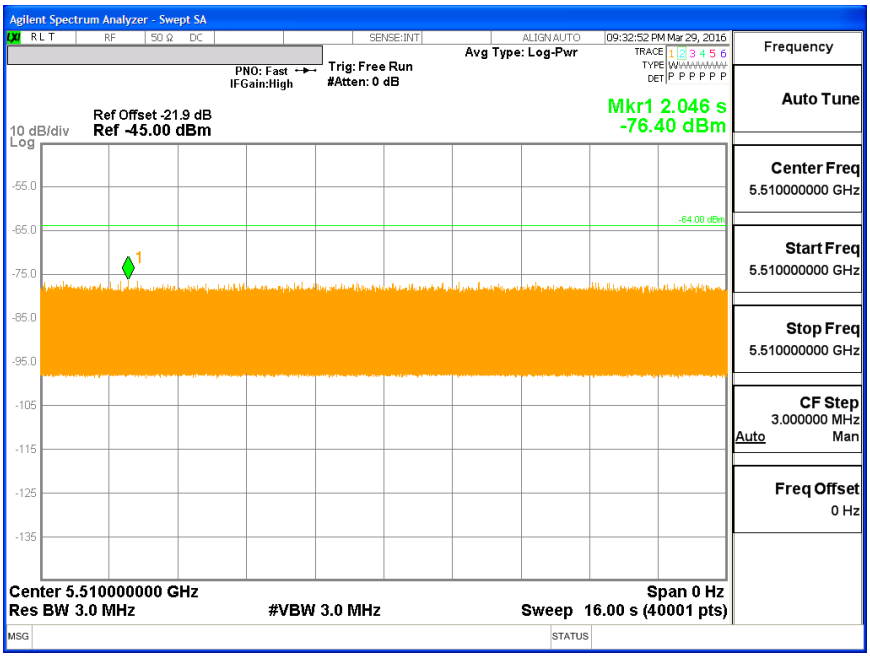


SINGLE BURST OF RADAR TYPE 6

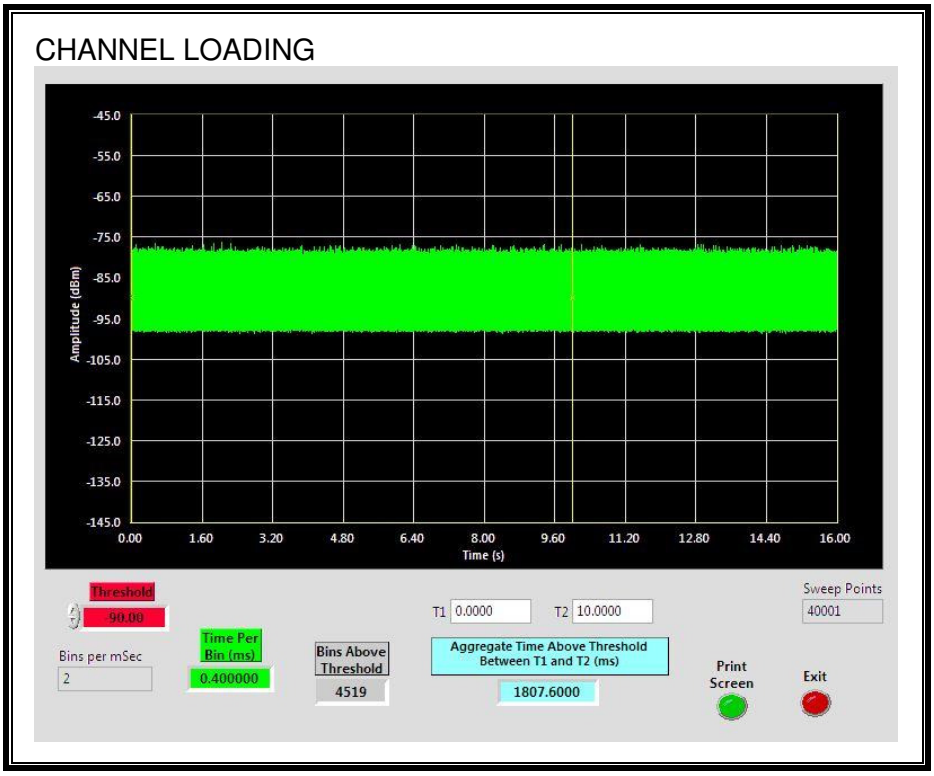


TRAFFIC

TRAFFIC



CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 18.076%

5.3.3. CHANNEL AVAILABILITY CHECK TIME

PROCEDURE TO DETERMINE INITIAL POWER-UP CYCLE TIME

A link was established on channel then the EUT was rebooted. The time from the cessation of traffic to the re-initialization of traffic was measured as the time required for the EUT to complete the total power-up cycle. The time to complete the initial power-up period is 60 seconds less than this total power-up time.

PROCEDURE FOR TIMING OF RADAR BURST

With a link established on channel, the EUT was rebooted. A radar signal was triggered within 0 to 6 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

The Non-Occupancy list was cleared. With a link established on channel, the EUT was rebooted. A radar signal was triggered within 54 to 60 seconds after the initial power-up period, and transmissions on the channel were monitored on the spectrum analyzer.

QUANTITATIVE RESULTS

No Radar Triggered

Timing of Reboot (sec)	Timing of Start of Traffic (sec)	Total Power-up Cycle Time (sec)	Initial Power-up Cycle Time (sec)
30.35	129.7	99.4	39.4

Radar Near Beginning of CAC

Timing of Reboot (sec)	Timing of Radar Burst (sec)	Radar Relative to Reboot (sec)	Radar Relative to Start of CAC (sec)
30.22	71.0	40.7	1.4

Radar Near End of CAC

Timing of Reboot (sec)	Timing of Radar Burst (sec)	Radar Relative to Reboot (sec)	Radar Relative to Start of CAC (sec)
30.41	127.9	97.5	58.1

QUALITATIVE RESULTS

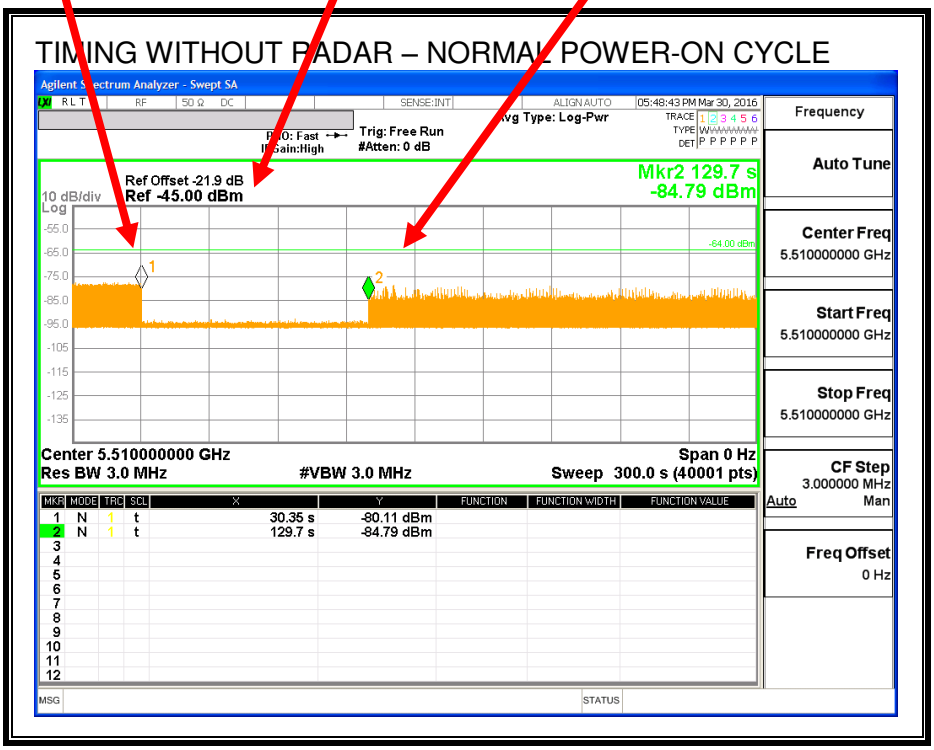
Timing of Radar Burst	Display on Control Computer	Spectrum Analyzer Display
No Radar Triggered	EUT marks Channel as active	Transmissions begin on channel after completion of the initial power-up cycle and the CAC
Within 0 to 6 second window	EUT indicates radar detected	No transmissions on channel
Within 54 to 60 second window	EUT indicates radar detected	No transmissions on channel

TIMING WITHOUT RADAR DURING CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle

End of Initial Power-up cycle
Start of CAC

End of CAC
Traffic is Initiated



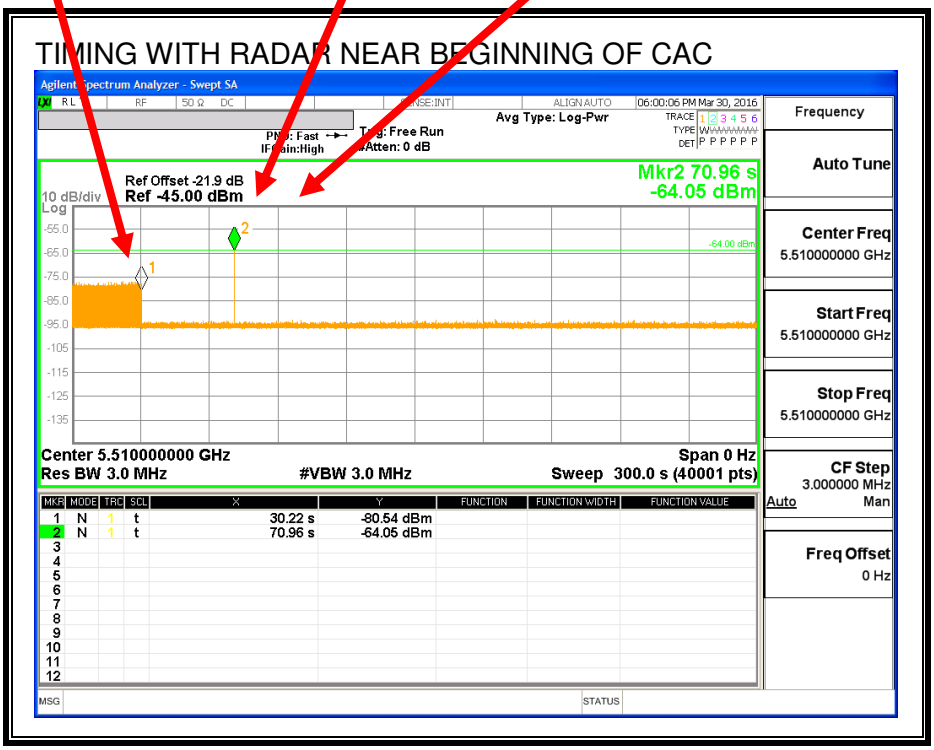
Transmissions begin on channel after completion of the initial power-up cycle and the CAC.

TIMING WITH RADAR NEAR BEGINNING OF CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle

End of Initial Power-up cycle
Start of CAC

Radar Signal Applied



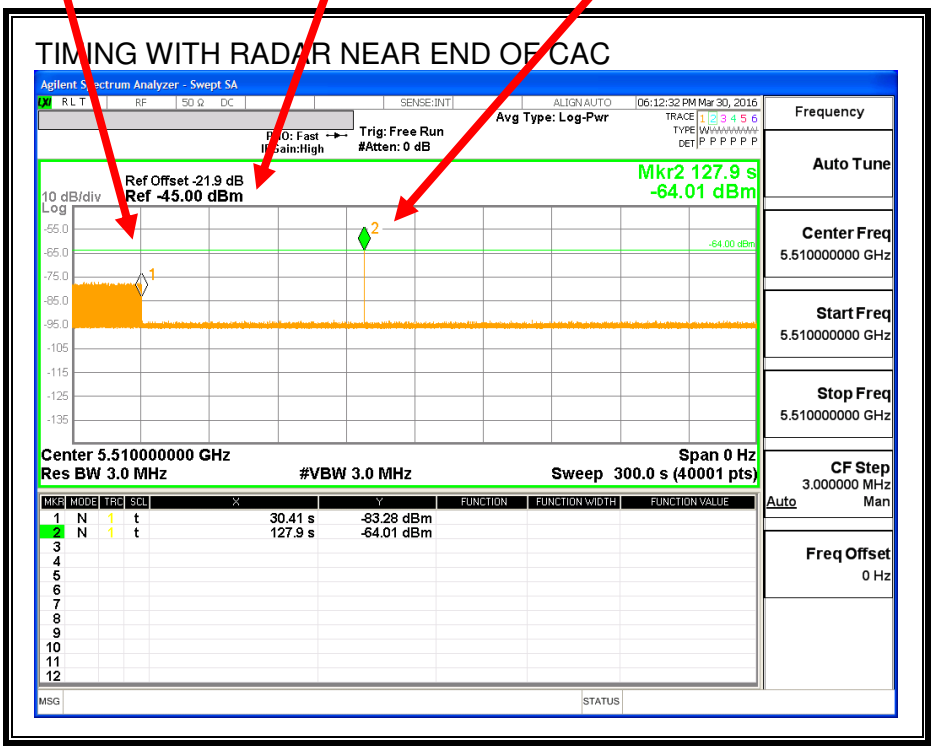
No EUT transmissions were observed after the radar signal.

TIMING WITH RADAR NEAR END OF CAC

AP is rebooted
Traffic ceases
Start of Initial Power-up cycle

End of Initial Power-up cycle
Start of CAC

Radar Signal Applied



No EUT transmissions were observed after the radar signal.

5.3.1. OVERLAPPING CHANNEL TESTS

RESULTS

The channel spacing is not less than the channel bandwidth therefore the EUT does not have an overlapping channel plan.

These tests are not applicable.

5.3.2. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

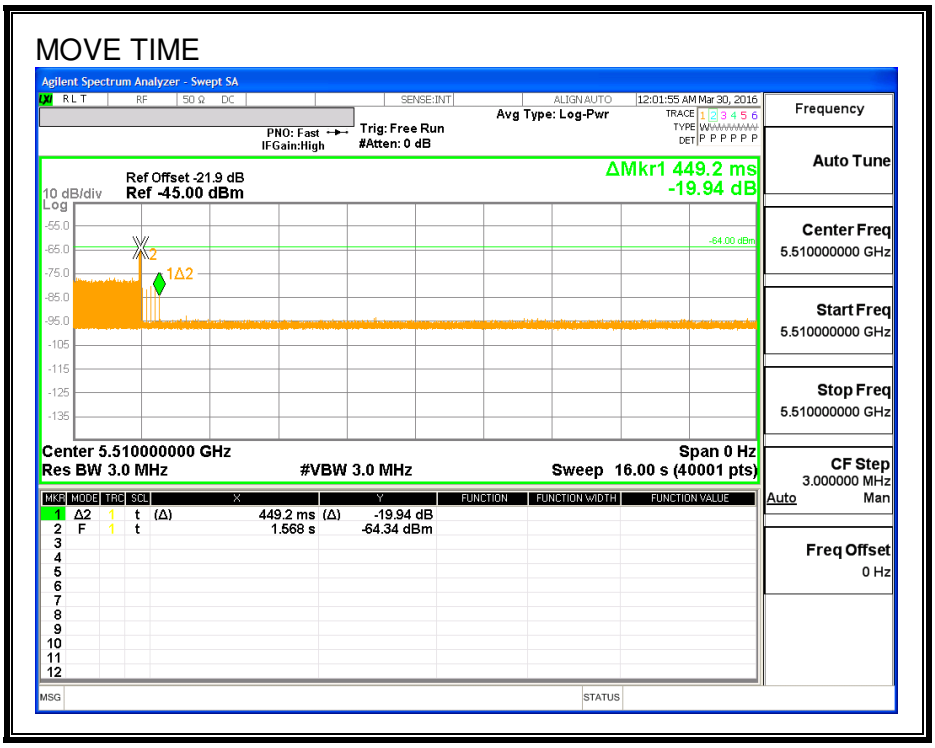
The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

RESULTS

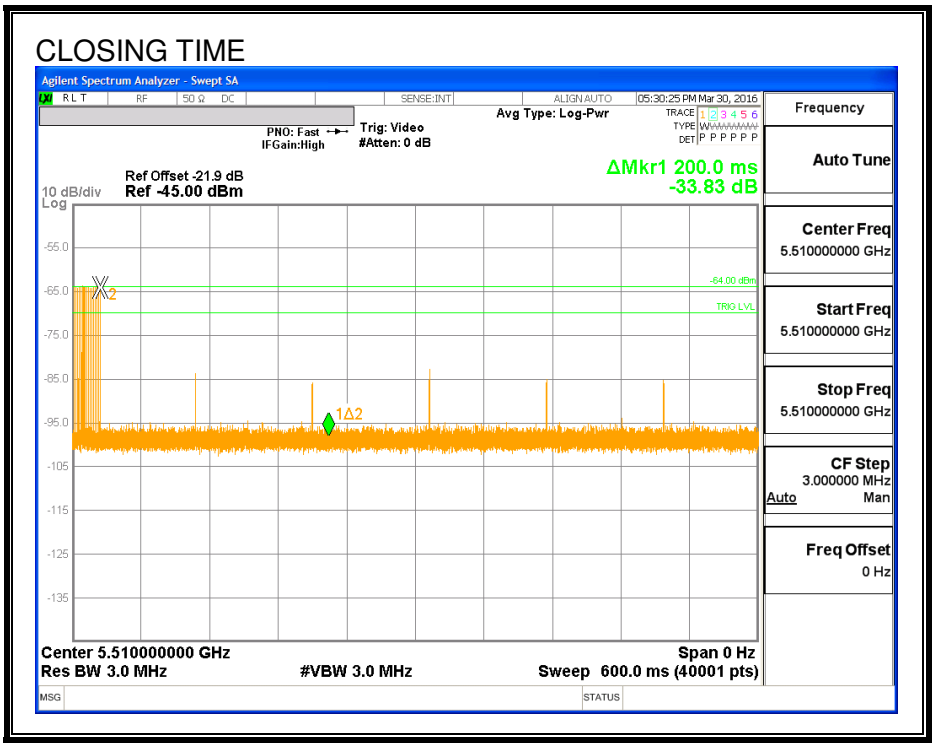
Channel Move Time (sec)	Limit (sec)
0.449	10

Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
2.4	60

MOVE TIME

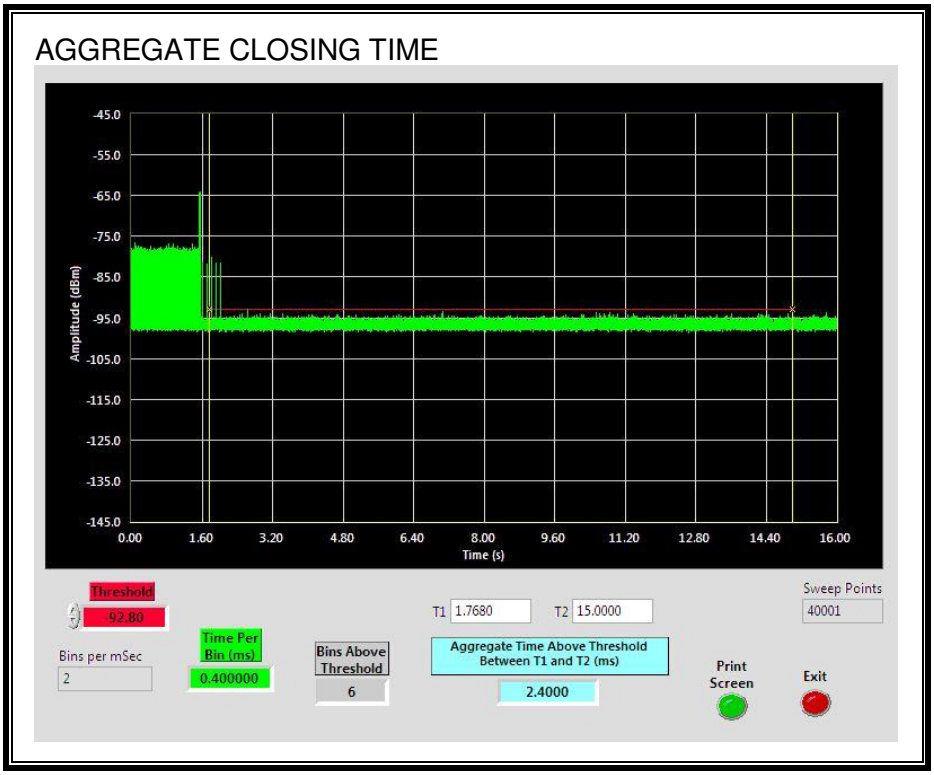


CHANNEL CLOSING TIME



AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

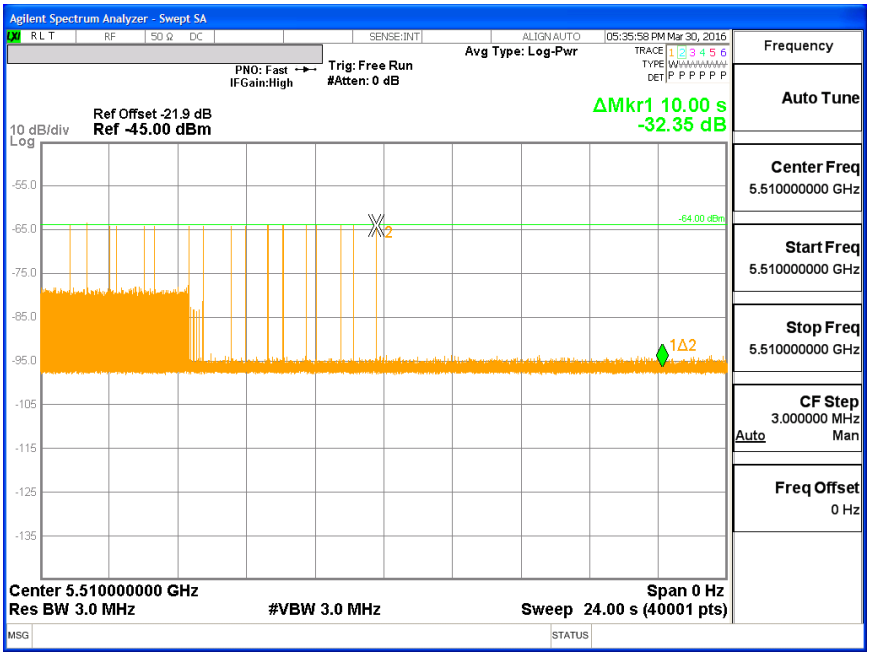
Only intermittent transmissions are observed during the aggregate monitoring period.



LONG PULSE CHANNEL MOVE TIME

The traffic ceases prior to 10 seconds after the end of the radar waveform.

MOVE TIME FOR LONG PULSE RADAR

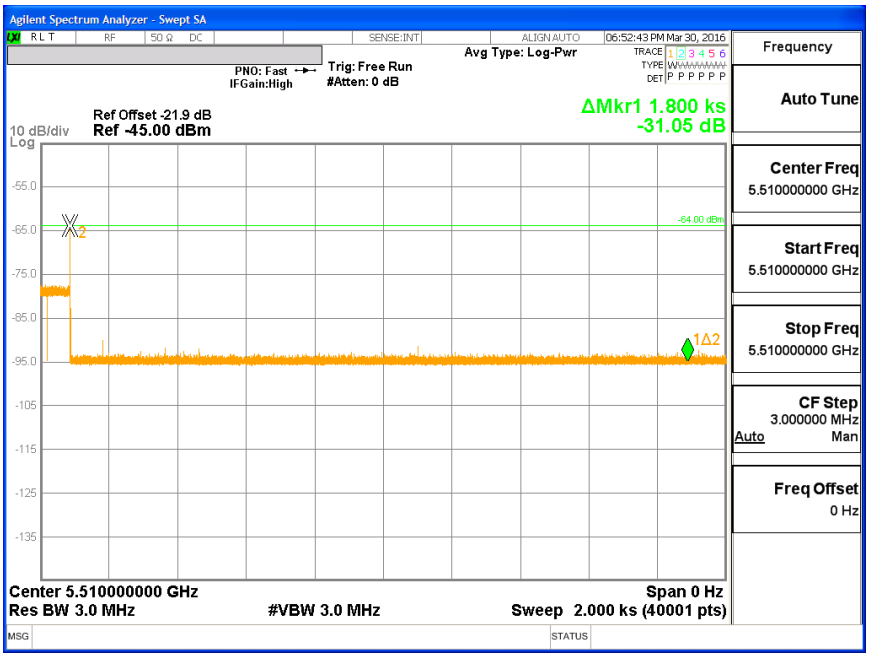


5.3.1. NON-OCCUPANCY PERIOD

RESULTS

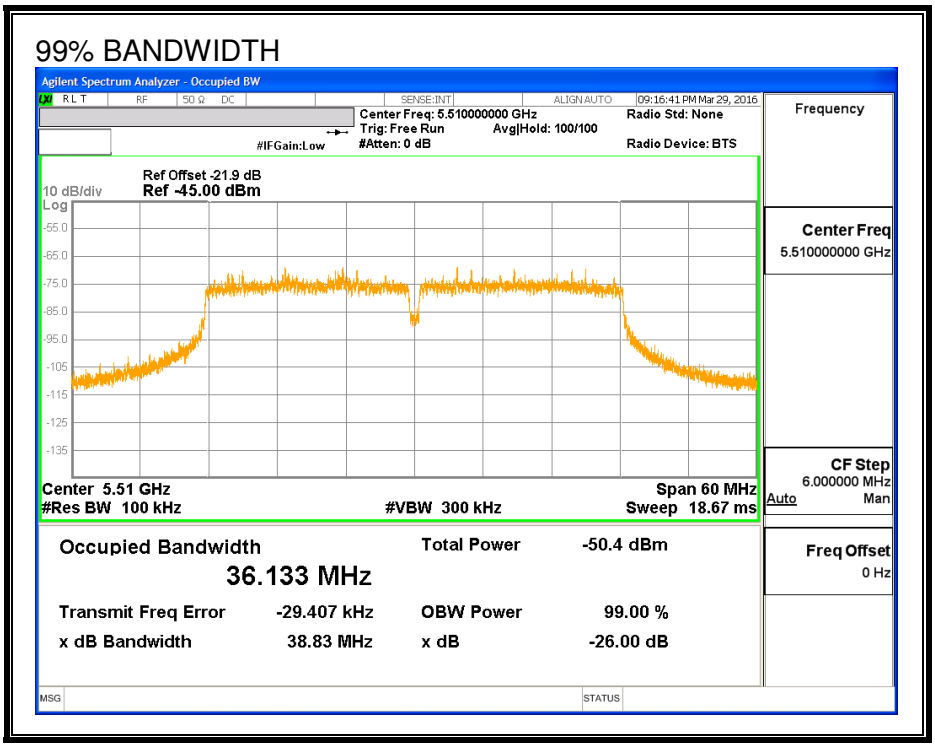
No EUT transmissions were observed on the test channel during the 30-minute observation time.

NON-OCCUPANCY PERIOD



5.3.2. DETECTION BANDWIDTH

REFERENCE PLOT OF 99% POWER BANDWIDTH



RESULTS

FL (MHz)	FH (MHz)	Detection Bandwidth (MHz)	99% Power Bandwidth (MHz)	Ratio of Detection BW to 99% Power BW (%)	Minimum Limit (%)
5491	5528	37	36.133	102.4	100

DETECTION BANDWIDTH PROBABILITY

DETECTION BANDWIDTH PROBABILITY RESULTS

Detection Bandwidth Test Results				
FCC Type 0 Waveform: 1 us Pulse Width, 1428 us PRI, 18 Pulses per Burst				
Frequency (MHz)	Number of Trials	Number Detected	Detection (%)	Mark
5490	10	2	20	
5491	10	10	100	FL
5492	10	10	100	
5493	10	10	100	
5494	10	10	100	
5495	10	10	100	
5500	10	10	100	
5505	10	10	100	
5510	10	10	100	
5515	10	10	100	
5520	10	10	100	
5525	10	10	100	
5526	10	10	100	
5527	10	10	100	
5528	10	10	100	FH
5529	20	12	60	

5.3.3. IN-SERVICE MONITORING

RESULTS

FCC Radar Test Summary

Signal Type	Number of Trials	Detection (%)	Limit (%)	Pass/Fail	Detection Bandwidth		80% of Det BW	
					FL	FH	FL5	FH5
FCC Short Pulse Type 1	30	100.00	60	Pass	5491	5528		
FCC Short Pulse Type 2	30	83.33	60	Pass	5491	5528		
FCC Short Pulse Type 3	30	73.33	60	Pass	5491	5528		
FCC Short Pulse Type 4	30	83.33	60	Pass	5491	5528		
Aggregate		85.00	80	Pass				
FCC Long Pulse Type 5	30	93.33	80	Pass	5491	5528	5495	5524
FCC Hopping Type 6	38	100.00	70	Pass	5491	5528		

TYPE 1 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 1

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Test (A/B)	Frequency (MHz)	Successful Detection (Yes/No)
1001	1	3066	18	A	5510	Yes
1002	1	878	61	A	5510	Yes
1003	1	578	92	A	5510	Yes
1004	1	718	74	A	5510	Yes
1005	1	518	102	A	5510	Yes
1006	1	678	78	A	5510	Yes
1007	1	918	58	A	5510	Yes
1008	1	898	59	A	5510	Yes
1009	1	738	72	A	5510	Yes
1010	1	598	89	A	5510	Yes
1011	1	858	62	A	5510	Yes
1012	1	798	67	A	5510	Yes
1013	1	938	57	A	5510	Yes
1014	1	838	63	A	5510	Yes
1015	1	538	99	A	5510	Yes
1016	1	648	82	B	5510	Yes
1017	1	2957	18	B	5510	Yes
1018	1	3043	18	B	5510	Yes
1019	1	2934	18	B	5510	Yes
1020	1	1954	28	B	5510	Yes
1021	1	1975	27	B	5510	Yes
1022	1	2478	22	B	5510	Yes
1023	1	1433	37	B	5510	Yes
1024	1	712	75	B	5510	Yes
1025	1	2345	23	B	5510	Yes
1026	1	560	95	B	5510	Yes
1027	1	1127	47	B	5510	Yes
1028	1	2019	27	B	5510	Yes
1029	1	2716	20	B	5510	Yes
1030	1	2542	21	B	5510	Yes

TYPE 2 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 2

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
2001	4.9	175	27	5510	No
2002	1.2	180	25	5510	Yes
2003	2.1	174	24	5510	Yes
2004	4.5	183	23	5510	Yes
2005	3.7	181	26	5510	Yes
2006	4.5	194	26	5510	Yes
2007	1.7	158	26	5510	Yes
2008	4.8	175	29	5510	Yes
2009	4.4	187	26	5510	Yes
2010	1.5	208	29	5510	Yes
2011	3.5	223	27	5510	Yes
2012	2.9	211	27	5510	No
2013	1	230	29	5510	Yes
2014	4.8	222	26	5510	Yes
2015	3.1	207	25	5510	No
2016	1	203	29	5510	Yes
2017	1.7	193	28	5510	Yes
2018	4	155	23	5510	Yes
2019	4.9	191	26	5510	Yes
2020	3.2	157	28	5510	No
2021	2.4	198	24	5510	Yes
2022	3.2	169	23	5510	No
2023	2.5	213	27	5510	Yes
2024	3.5	150	26	5510	Yes
2025	3.1	161	24	5510	Yes
2026	2.4	182	27	5510	Yes
2027	2.2	198	28	5510	Yes
2028	1.6	185	25	5510	Yes
2029	3.8	205	27	5510	Yes
2030	3.5	196	24	5510	Yes

TYPE 3 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 3

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
3001	8.7	349	18	5510	Yes
3002	8.5	336	17	5510	Yes
3003	9.4	304	17	5510	Yes
3004	7.1	437	16	5510	No
3005	8.2	300	16	5510	Yes
3006	8.9	446	17	5510	Yes
3007	5.1	321	18	5510	No
3008	6.1	480	18	5510	Yes
3009	5.3	368	16	5510	Yes
3010	6.5	304	16	5510	No
3011	6	456	18	5510	Yes
3012	5.1	272	17	5510	Yes
3013	9.9	319	17	5510	Yes
3014	9.3	281	16	5510	No
3015	6.9	341	16	5510	No
3016	6.5	315	18	5510	Yes
3017	7.1	270	18	5510	Yes
3018	6.9	390	18	5510	No
3019	7.8	358	16	5510	Yes
3020	5.5	358	18	5510	Yes
3021	6.6	472	18	5510	Yes
3022	7.3	366	16	5510	No
3023	8.6	493	17	5510	No
3024	9.6	401	17	5510	Yes
3025	8.8	422	16	5510	Yes
3026	10	476	18	5510	Yes
3027	9.5	377	17	5510	Yes
3028	8.6	326	16	5510	Yes
3029	8.3	491	16	5510	Yes
3030	7.7	452	18	5510	Yes

TYPE 4 DETECTION PROBABILITY

Data Sheet for FCC Short Pulse Radar Type 4

Waveform	Pulse Width (us)	PRI (us)	Pulses Per Burst	Frequency (MHz)	Successful Detection (Yes/No)
4001	10.6	261	16	5510	Yes
4002	15.2	369	14	5510	Yes
4003	10.9	441	13	5510	Yes
4004	16	311	14	5510	Yes
4005	12.3	279	13	5510	Yes
4006	17.9	412	15	5510	Yes
4007	10	392	14	5510	No
4008	11.4	287	13	5510	No
4009	14	414	13	5510	Yes
4010	15.9	454	12	5510	Yes
4011	14.4	343	15	5510	Yes
4012	16.8	396	15	5510	Yes
4013	15.8	298	15	5510	Yes
4014	14	497	15	5510	No
4015	13.4	411	16	5510	Yes
4016	12.1	373	14	5510	Yes
4017	17.5	315	15	5510	Yes
4018	12	289	15	5510	Yes
4019	17.8	362	12	5510	Yes
4020	12.8	482	13	5510	Yes
4021	19.2	450	12	5510	No
4022	14.7	332	13	5510	Yes
4023	12.2	313	13	5510	Yes
4024	18.3	459	12	5510	Yes
4025	10.8	334	16	5510	Yes
4026	12.8	375	16	5510	Yes
4027	11.2	263	13	5510	Yes
4028	13.6	317	13	5510	No
4029	12.6	469	14	5510	Yes
4030	10.8	418	13	5510	Yes

TYPE 5 DETECTION PROBABILITY

Data Sheet for FCC Long Pulse Radar Type 5		
Trial	Frequency (MHz)	Successful Detection (Yes/No)
1	5520	Yes
2	5512	No
3	5501	Yes
4	5506	Yes
5	5513	Yes
6	5508	Yes
7	5509	Yes
8	5512	Yes
9	5514	Yes
10	5500	Yes
11	5510	Yes
12	5522	No
13	5514	Yes
14	5496	Yes
15	5508	Yes
16	5515	Yes
17	5500	Yes
18	5498	Yes
19	5513	Yes
20	5507	Yes
21	5500	Yes
22	5510	Yes
23	5508	Yes
24	5512	Yes
25	5505	Yes
26	5503	Yes
27	5512	Yes
28	5503	Yes
29	5499	Yes
30	5500	Yes

Note: The Type 5 randomized parameters tested are shown in a separate document.

TYPE 6 DETECTION PROBABILITY

Data Sheet for FCC Hopping Radar Type 6
1 us Pulse Width, 333 us PRI, 9 Pulses per Burst, 1 Burst per Hop
NTIA August 2005 Hopping Sequence

Trial	Starting Index Within Sequence	Signal Generator Frequency (MHz)	Hops within Detection BW	Successful Detection (Yes/No)
1	367	5491	4	Yes
2	842	5492	4	Yes
3	1317	5493	9	Yes
4	1792	5494	9	Yes
5	2267	5495	6	Yes
6	2742	5496	6	Yes
7	3217	5497	5	Yes
8	3692	5498	7	Yes
9	4167	5499	6	Yes
10	4642	5500	7	Yes
11	5117	5501	6	Yes
12	5592	5502	6	Yes
13	6067	5503	6	Yes
14	6542	5504	7	Yes
15	7017	5505	8	Yes
16	7492	5506	7	Yes
17	7967	5507	3	Yes
18	8442	5508	9	Yes
19	8917	5509	7	Yes
20	9392	5510	10	Yes
21	9867	5511	6	Yes
22	10342	5512	7	Yes
23	10817	5513	12	Yes
24	11292	5514	10	Yes
25	11767	5515	5	Yes
26	12242	5516	6	Yes
27	12717	5517	11	Yes
28	13192	5518	7	Yes
29	13667	5519	5	Yes
30	14142	5520	12	Yes
31	14617	5521	8	Yes
32	15092	5522	8	Yes
33	15567	5523	7	Yes
34	16042	5524	8	Yes
35	16517	5525	12	Yes
36	16992	5526	12	Yes
37	17467	5527	8	Yes
38	17942	5528	3	Yes

6. BRIDGE MODE RESULTS

Per KDB 905462, Section 5.1 (footnote 1):

Networks Access Points with Bridge and/or MESH modes of operation are permitted to operate in the DFS bands but must employ a DFS function. The functionality of the Bridge mode as specified in §15.403(a) must be validated in the DFS test report. Devices operating as relays must also employ DFS function. The method used to validate the functionality must be documented and validation data must be documented. Bridge mode can be validated by performing a test statistical performance check (Section 7.8.4) on any one of the radar types. This is an abbreviated test to verify DFS functionality. MESH mode operational methodology must be submitted in the application for certification for evaluation by the FCC.

This device does not support Bridge Mode therefore this test was not performed.