Welch Allyn Protocol, Inc.

Welch Allyn 802.11a Wireless PC Card

DFS Test Report

Testing Conducted According to
Test Plan: EMC, Lamarr Product Implementations
Part No.: 830-1412-00, Rev. B

September 21, 2007

Report No. PROT0295.3 Rev. 2

Report Prepared By

NORTHWEST EMC

www.nwemc.com
1-888-EMI-CERT

EMC Test Report

22975 NW Evergreen Parkway
Suite 400
Hillsboro, Oregon 97124

Certificate of Test

Issue Date: September 21, 2007
Welch Allyn Protocol, Inc.
Model: Welch Allyn 802.11a Wireless PC Card

Emissions			
Test Description	**Specification**	**Test Method**	**Pass/Fail**
DFS	FCC 15.407:2006	ANSI C63.4:2003 DA 02-2138:2002	**Pass**

Modifications made to the product
See the Modifications section of this report

Test Facility

The measurement facility used to collect the data is located at:

Northwest EMC, Inc.
22975 NW Evergreen Parkway, Suite 400
Hillsboro, OR 97124

Phone: (503) 844-4066 Fax: 844-3826

This site has been fully described in a report filed with and accepted by the FCC (Federal Communications Commission) and Industry Canada.

Approved By:
Ethan Schoonover, Sultan Lab Manager

NVLAP Lab Code: 200630-0

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Product compliance is the responsibility of the client, therefore the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. This Report may only be duplicated in its entirety. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test.

Revision History

Revision Number	Description	Date	Page Number
01	Added correct footers to report	11-19-07	All pages
01	Changed Reference Unknown to Figure 2	11-19-07	18
02	Added revisions section above the scope and product description sections	12-31-07	9

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NVLAP LAB CODE 200629-0
NVLAP LAB CODE 200630-0
NVLAP LAB CODE 200676-0
NVLAP LAB CODE 200761-0

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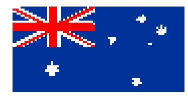

VCCI: Accepted as an Associate Member to the VCCI, Acceptance No. 564. Conducted and radiated measurement facilities have been registered in accordance with Regulations for Voluntary Control Measures, Article 8. *(Registration Numbers. - Hillsboro: C-1071, R-1025, C-2687, T-289, and R-2318, Irvine: R-1943, C-2766, and T-298, Sultan: R-871, C-1784, and T-294).*

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SCOPE

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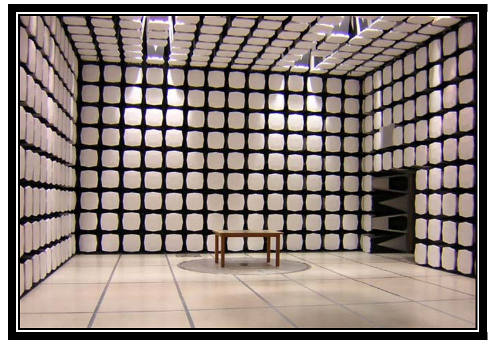

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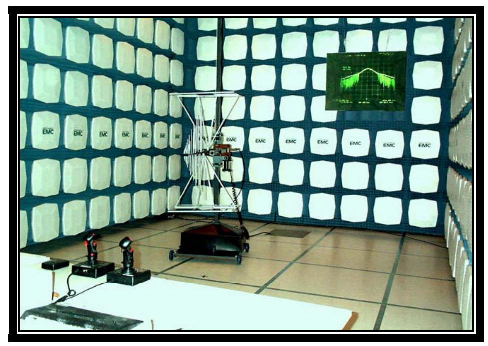

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(503) 844-4066 Fax: (503) 844-3826

Washington – Sultan Facility
Labs SU01 – SU07

14128 339th Ave. SE Sultan, WA 98294
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Party Requesting the Test

Company Name:	Welch Allyn Protocol, Inc.
Address:	8500 SW Creekside Place
City, State, Zip:	Beaverton, OR 97008-7107
Test Requested By:	Bob Jenkins
Model:	Welch Allyn 802.11a Wireless PC Card
First Date of Test:	August 13, 2007
Last Date of Test:	August 21, 2007
Receipt Date of Samples:	August 13, 2007
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT (Equipment Under Test):
802.11a radio

Testing Objective:
These tests were selected to satisfy the DFS requirements for FCC 15.407.

EUT Photo

List of Figures

List of Tables

1 Revision

Revision	Date	Changes
1	11/19/07	Initial report based on testing performed September 11, 2007
2	12/31/07	Inserted new plots and data for the “associated” non-occupancy test performed December 27, 2007.

2 Scope

The purpose of testing was to evaluate the 700-0436-00 against the Dynamic Frequency Selection requirements detailed in the following standards:

- CFR 47 Part 15 Subpart E
- Industry Canada RSS 210 Issue 7 (June 2007) Annex 9 section A9.4

3 Product Description

The 700-0436-00 is a CardBus Card that is designed to be used in a variety of products manufactured by Welch Allyn. The operating characteristics of the device as they relate to the testing performed are detailed below:

Operating Frequency Range(s):

☒ 5180 MHz – 5240 MHz

☒ 5260 MHz – 5320 MHz

☒ 5500 MHz – 5600 MHz

Operating Mode (Master / Client):

☐ Master

☐ Client with radar detection

☒ Client without radar detection

4 Test Configuration

4.1 Master-Client Configuration

To evaluate the DFS characteristics of the 700-0436-00 a radiated test configuration was used. The master device used was an FCC-approved Cisco AP1231 Access Point. The details for all elements of the system under test are detailed below.

Manufacturer / Model	Serial Number	FCC ID	Description
Cisco Systems AP1231 with AIR-RM21A-A-K9	FTX0838R018	LDK102053	802.11abg Router
Welch Allyn 802.11a CardBus Card, Model: 700-0436-00	LA000001	PGUWA11A07	CardBus Card 802.11a adapter
Welch Allyn Cardbus Card Test Fixture, 802.11 A/B/G	18	Not applicable	Test fixture for CardBus Cards

Table 1 System under Test Information

The master device was configured to use its integral antenna. As the gain of the antenna was not known it was assumed that the EIRP exceeded 200mW and a radar detection threshold of -64dBm was used as the reference value.

The client device was located approximately 1m from the master device. Prior to initiating the radar waveform traffic between master and client was established. The traffic generation was performed by moving a 1 Mb file from the master to the client using a specially-designed feature for DFS testing. This was not the streaming mpeg file as detailed in the FCC's rules and associated Report and Order, but prior authorization to use this method had been obtained from both the FCC and NTIA (refer to Appendix A).

The data transfer took approximately 23 seconds and is highlighted in the spectrum analyzer plot of Figure 1 by the white square.

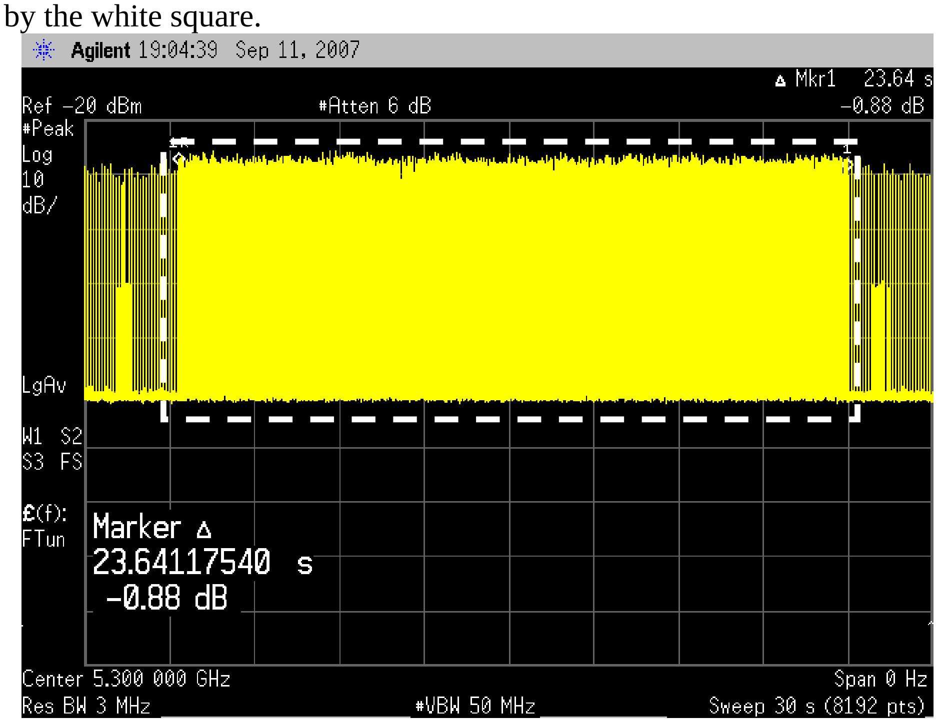


Figure 1 Data Transfer from AP to Client (Spectrum Analyzer Plot)

The traffic duty cycle was evaluated to confirm that it was within the expected values as reported to the FCC in the request for the alternate method. The plot to the left of Figure 2 shows 3 data packets of 1.84ms duration and four, shorter, acknowledgement control signals from the client device in a 20ms time period. The right plot, taken with the traffic monitoring antenna moved closer to the AP to increase the amplitude of the AP transmissions relative to those from the client device is of a 200ms period and shows 13 data packets in this period. This corresponds to a duty cycle of 14%[1]. The anticipated duty cycle was approximately 17%.

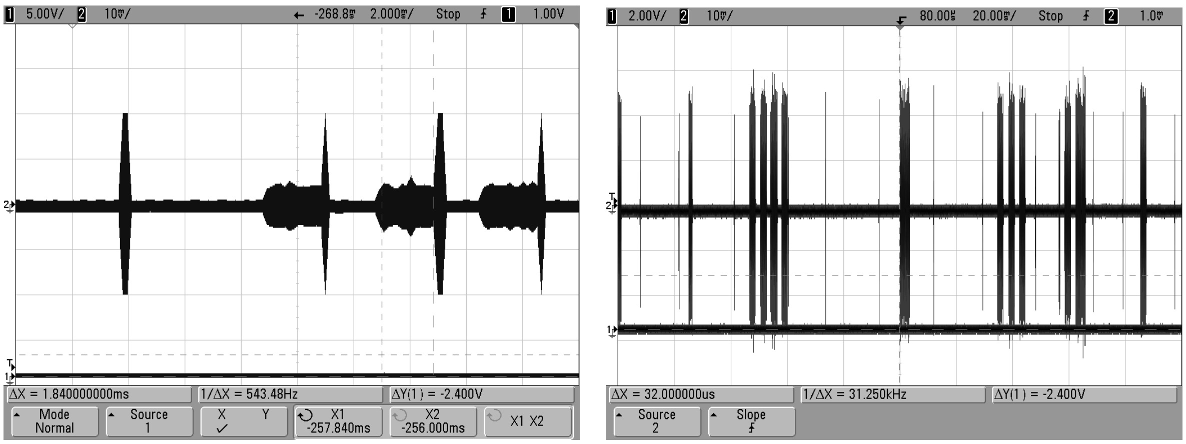


Figure 2 Data Packets From Master and ACKs from Client During Data Transfer

[1] Calculated from (13x1.84)/20.

4.2 Radar Generating Sub-System

The radar generation subsystem used an rf generator with internal pulse modulation capability, an arbitrary waveform generator (AWG) and a horn antenna.

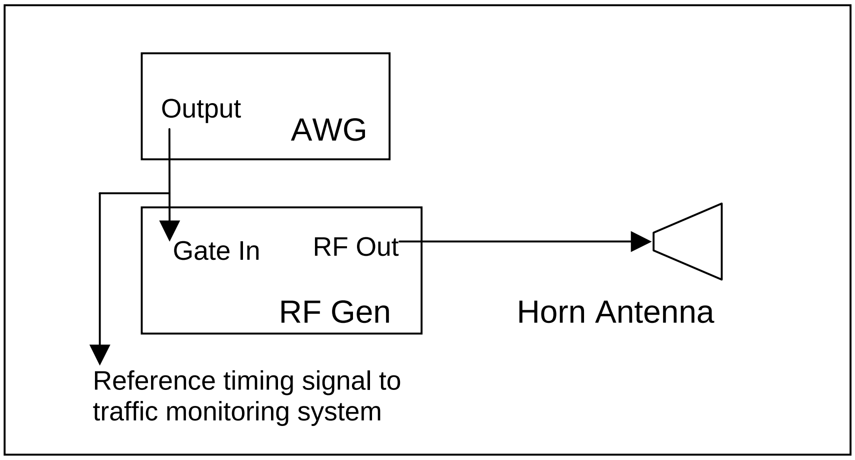


Figure 3 Radar Generation Sub-System

The rf generator was configured to output pulses with the period and width required for FCC radar type 1 (width of 1us, repetition interval of 1428us).

The burst of pulses was generated using an external signal generator to provide a single burst of the correct duration (18 pulses per burst). This pulse was also fed to the traffic monitoring subsystem to provide the reference timing for start of radar (T_0) and end of radar (T_1). Timing of the radar waveform was verified and plots are provided.

The radar generation system was able to reproduce the pulses with ALC turned on and it was confirmed that the peak level of the radar pulses was within 0.2dB of the un-modulated (CW) output of the generator. The CW output was used to establish the reference signal level.

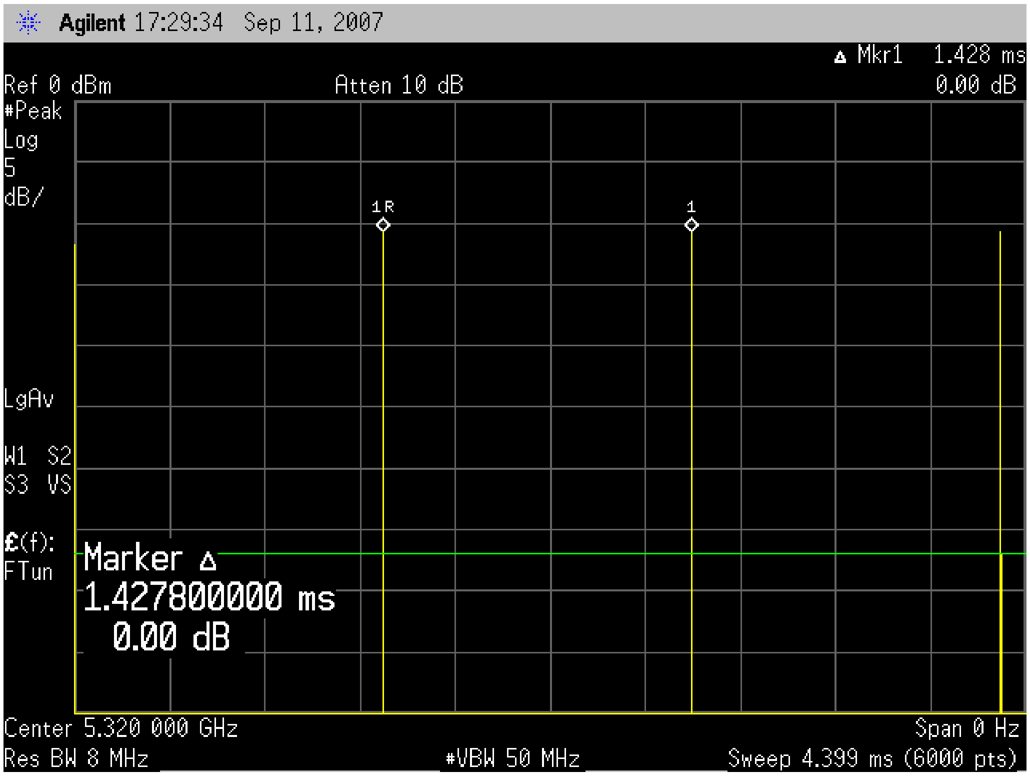


Figure 4 Short Pulse Radar Type 1 – Pulse PeriodVerification (1428us)

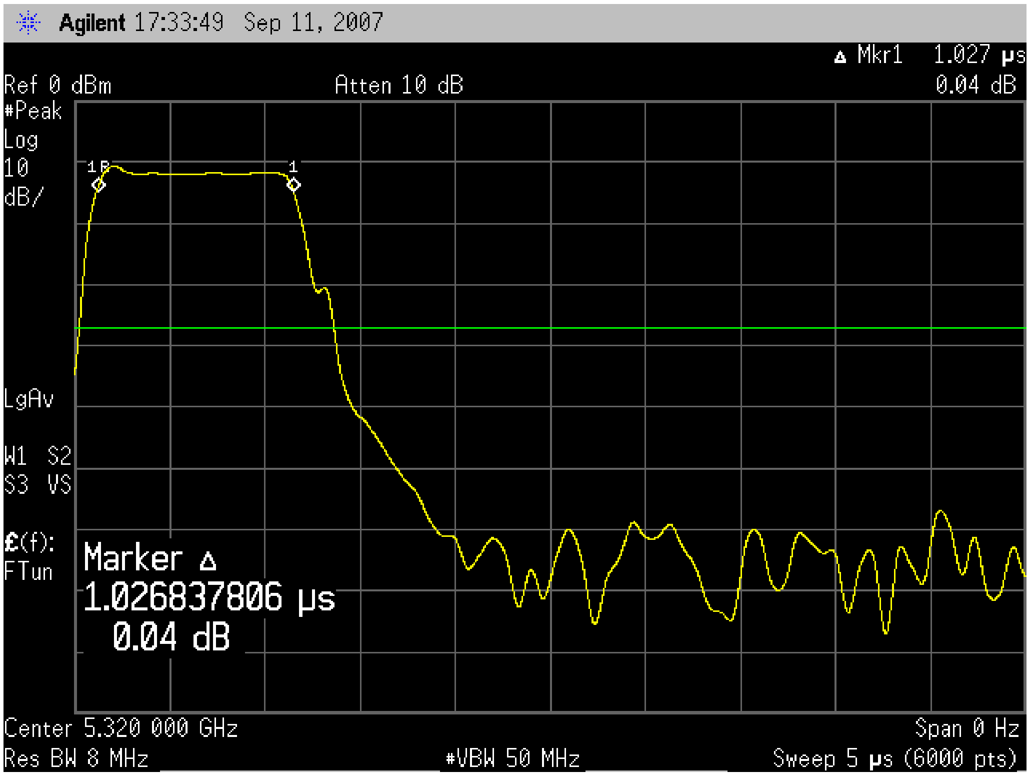


Figure 5 Short Pulse Radar Type 1 – Pulse Width Verification (-3dB points 1us apart)

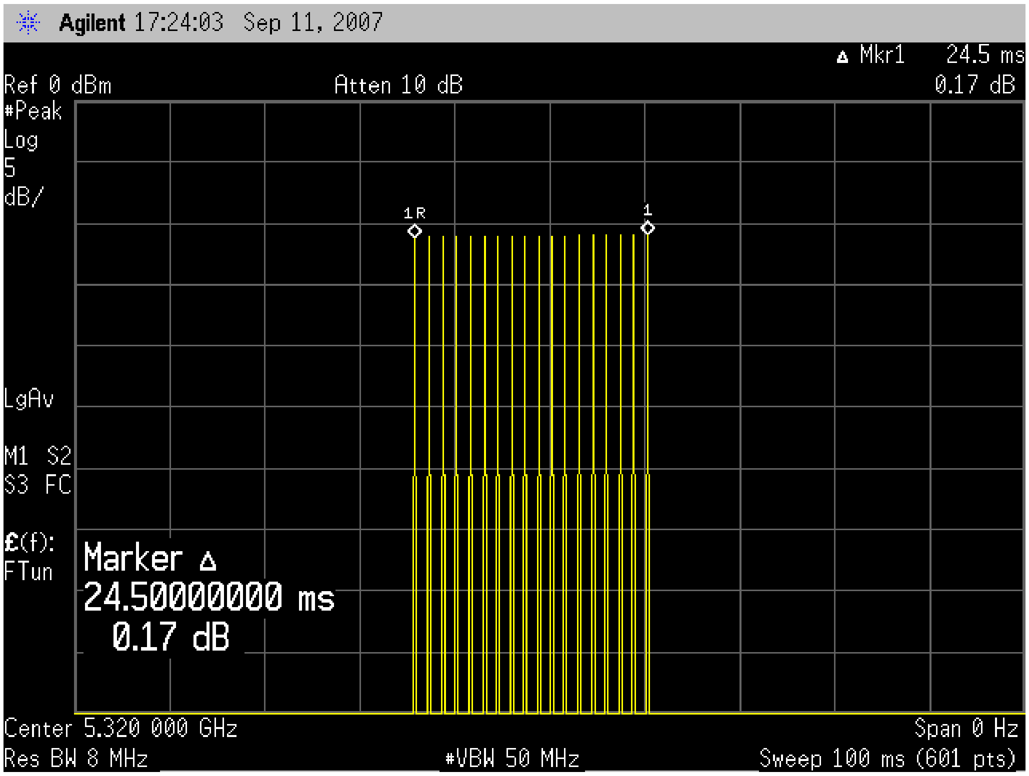


Figure 6 Short Pulse Radar Type 1 – Number of Pulses Verification (18 pulses)

4.3 Traffic Monitoring Sub-System

The traffic monitoring subsystem was comprised of a Spectrum Analyzer and antenna to obtain coarse timing information. The IF output of the analyzer was connected to a digital storage oscilloscope (DSO), as was the burst envelope signal used to gate the radar pulse generator. The DSO was used to provide high resolution timing information. The gate signal's falling edge was the trigger for the DSO's data acquisition cycle. Both Spectrum Analyzer and DSO were set in peak detect mode.

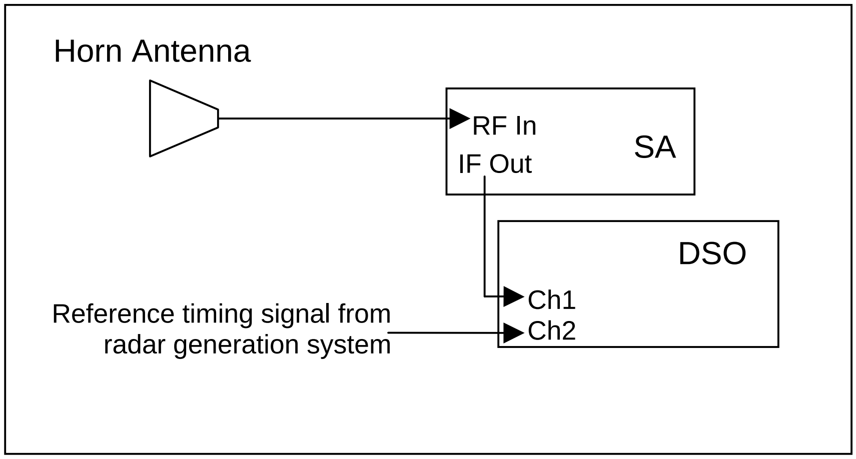


Figure 7 Traffic Monitoring Sub-System

For channel closing plots the analyzer was set for a 60 second sweep time, with a zero-span centered on the frequency of the radar.

A plot verifying that the timing from the traffic monitoring system was within the required accuracy is provided. Figure 8 shows that the falling edge of the gate signal used to determine T_1 is delayed by 32us from the actual end of the radar burst. As this is much smaller than the 200ms measurement used to define the end of "normal" traffic and the 10 second channel move time, no correction for this delay is made during the channel closing transmission time measurements.

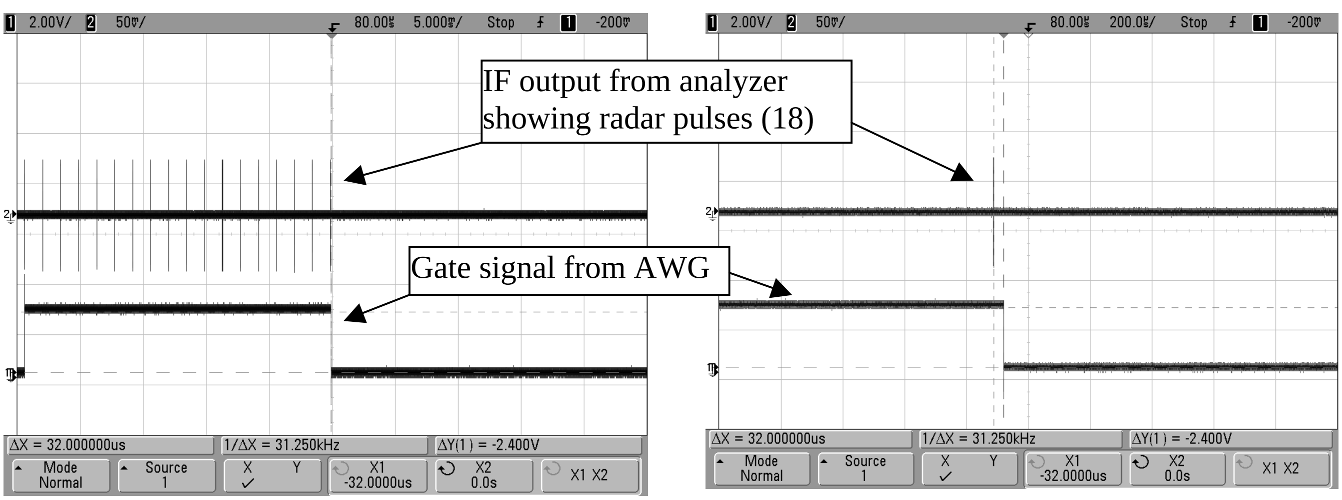


Figure 8 T_1 Timing– Falling Edge of Gate Pulse Delayed 32uS from End of Radar Burst

4.4 Test Method

Testing was performed in a 5m semi-anechoic chamber. The radar generation system was connected to an EMCO 3115 horn antenna, vertically polarized and located 3m from the location of the Master device (Cisco router), at a height level with the height of the master device's antenna.

The radar signal level was set using a second EMCO 3115 horn antenna. The master device was removed and replaced by the second horn antenna, vertically polarized, connected via a cable of known loss to a spectrum analyzer. The signal level of the radar generation system was adjusted at 5320 MHz and 5540 MHz until the signal level received at the second antenna, after accounting for antenna gain and cable loss, was -63dBm.

Frequency	5320 MHz	5540 MHz
Antenna Gain (dBi)	10.9	10.8
Cable Loss (dB)	6.1	6.3
Received Signal Level for -63dBm (dBm)	-58.2	-58.5
Radar Generator Drive Level (dBm)	-10.0	-8.8

Table 2 Radar Signal Reference Level

Having determined the level of the radar signal the master device was returned to the cable. The substitution antenna used to determine the radar signal level was then used as the channel monitoring antenna. The location of the traffic monitoring antenna relative to the client and master devices was adjusted so that the channel closing timing plots clearly delineate, by amplitude, the noise floor, the Master device transmissions and the client device transmissions. It was located 20cm from the EUT for the timing measurements.

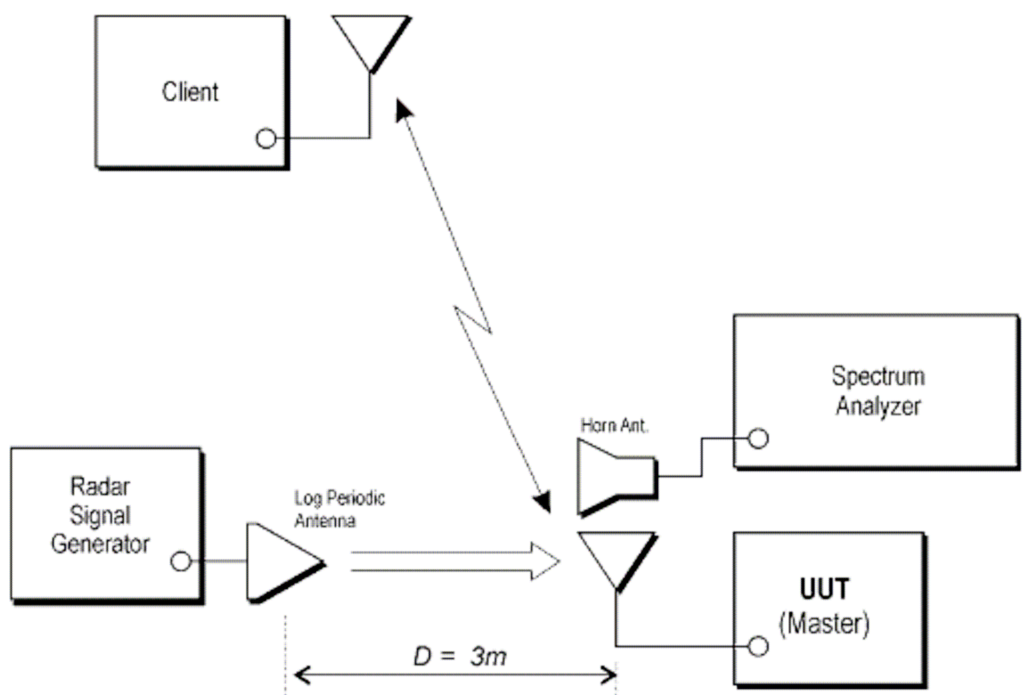


Figure 9 Radiated Test Configuration

4.5 Test Equipment Calibration

The test equipment used to make the channel closing measurements and determine the radar reference level are listed below. Where applicable, the equipment was calibrated and NIST traceable.

Manufacturer	Model	Description	Serial N$^{o.}$	Cal Due
Agilent	33120A	Arbitrary Waveform Generator	MY40004929	N/A
Agilent	DSO6052A	Oscilloscope	MY44004543	9/4/08
Agilent	E8257D	Analog Signal Generator	MY46520075	2/25/08
Agilent	E4446A	Performance Spectrum Analyzer	MY45300089	1/7/08
EMCO	3115	Dual-Ridge Guide Horn Antenna (1 – 18 GHz) - Radar	97105305	8/24/07
EMCO	3115	Dual-Ridge Guide Horn Antenna (1 – 18 GHz) – Traffic Monitoring	2234	5/24/09

Table 3 Test Equipment Calibration Data

Manufacturer	Model	Description	Serial N$^{o.}$	Cal Due
Agilent	33120A	Arbitrary Waveform Generator	MY40004929	N/A
Agilent	E8257D	Analog Signal Generator	MY46520075	2/25/08
Agilent	E4446A	Performance Spectrum Analyzer	MY45300089	1/7/08
EMCO	3115	Dual-Ridge Guide Horn Antenna (1 – 18 GHz) - Radar	-	-
EMCO	3115	Dual-Ridge Guide Horn Antenna (1 – 18 GHz) – Traffic Monitoring	2234	5/24/09

Table 4 Test Equipment Calibration Data (December 2007 – Non-Occupancy Test)

5 Test Results

The channel closing and channel move times were measured with the radar generator set to transmit at 5540 MHz, which was the center frequency of the operating channel of the client-master device.

5.1 Channel Closing Time

The plots of Figure 10 show the channel closing time measurements. The upper plot shows that the last transmission from the client device occurred well within the 200ms period immediately following the end of the radar burst. The 200ms period is marked by the two cursors, the first is aligned to the end of the radar burst as indicated by the falling edge of the radar gating signal and the second cursor is set 200ms after the first cursor. After the end of the 200ms period there are only three transmissions and all are from the master device. These transmissions occurred at T_1+290ms, T_1+392ms, and T_1+495ms. The lower two plots zoom in on the first and last of these to confirm that they were short duration control signals, each lasting ~ 250us (data transmissions were much longer, ~ 1.84ms, refer back to Figure 2. The total channel closing transmission time after T_1+200ms was, therefore, 3 times 250uS, or 750us.

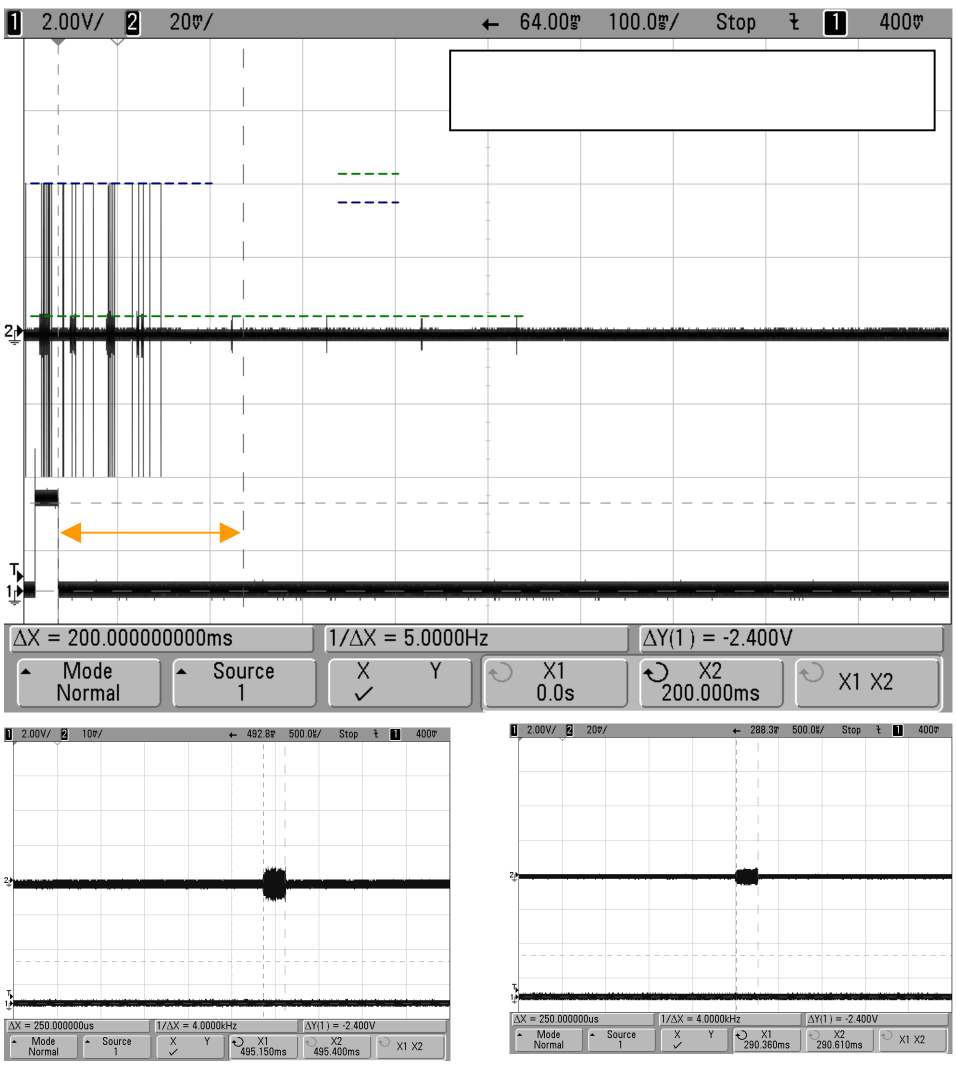


Figure 10 Channel Closing Time – High Resolution Plots

5.2 Channel Move Time

The high resolution plot shows that the last transmission between master and client occurs 495.4ms after the end of the radar burst (T_1).

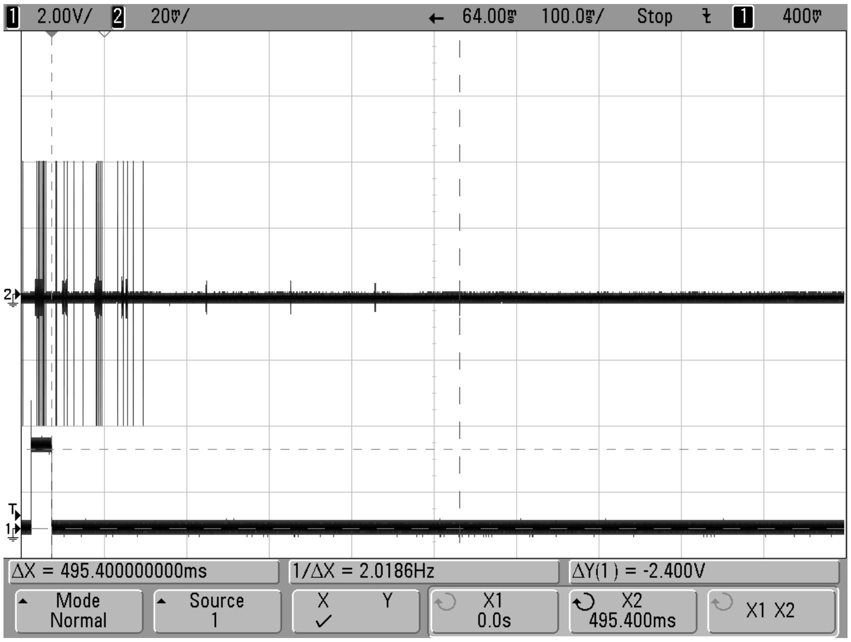


Figure 11 Channel Move Time – High Resolution Plot

As the high resolution plot only shows the first 0.95s immediately after the radar burst a lower resolution plot, taken with the spectrum analyzer, is used to confirm that there are no transmissions from either master or client device for a period of 50+ seconds following the radar burst. The radar burst occurred 6 seconds into the sweep and the plot clearly shows no traffic on the channel following the burst, other than the data shown in the high resolution plot.

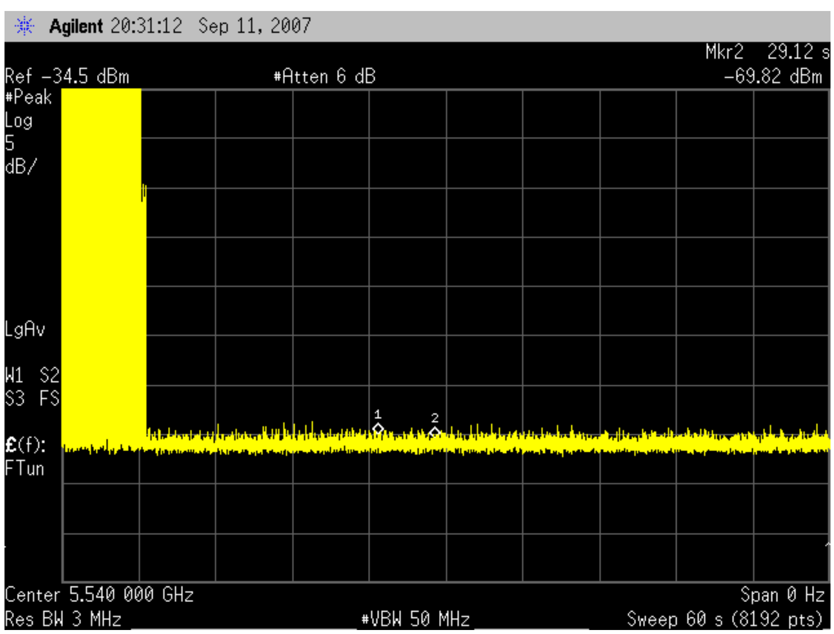


Figure 12 Channel Move Time – Low Resolution Plot

5.3 *Non-Occupancy / Passive Scanning*

As required by recent changes in the FCC's reporting requirements, a confirmation that the client device did not employ active scanning, or transmit without being associated with a master device, and did not transmit on the previously vacated channel (5540 MHz) was also performed.

5.3.1 Non-Occupancy

A communications link between EUT and Master device was established on 5540 MHz. The spectrum analyzer was configured with zero span and tuned to 5540 MHz. The plot below shows the signal level of the transmissions from the Master and EUT with the communications linked established.

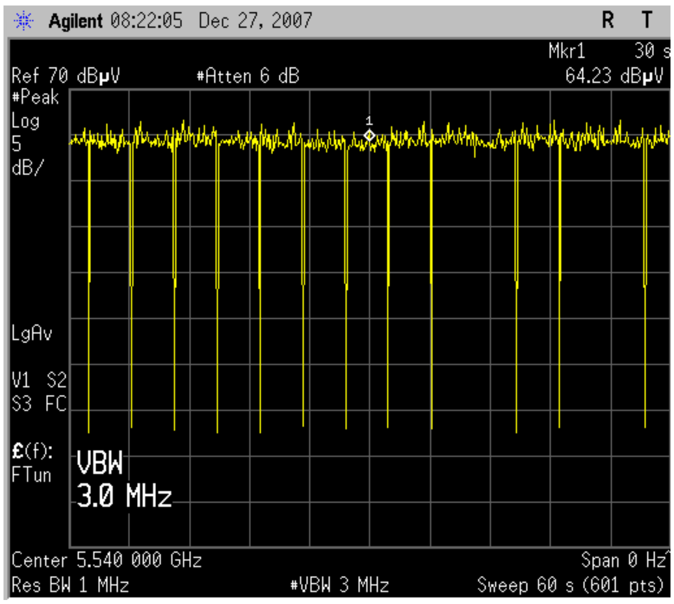


Figure 13 Non-Occupancy Plot – Pre Radar Signal Level

Radar was applied and within about 10 seconds of the channel being vacated the spectrum analyzer was then put into a max-hold mode with a 30-minute (1800 second) sweep. The green display line on the plot is the level of transmissions when the master and client were active (at least 25dB above the noise floor). No transmissions on the vacated channel were observed.

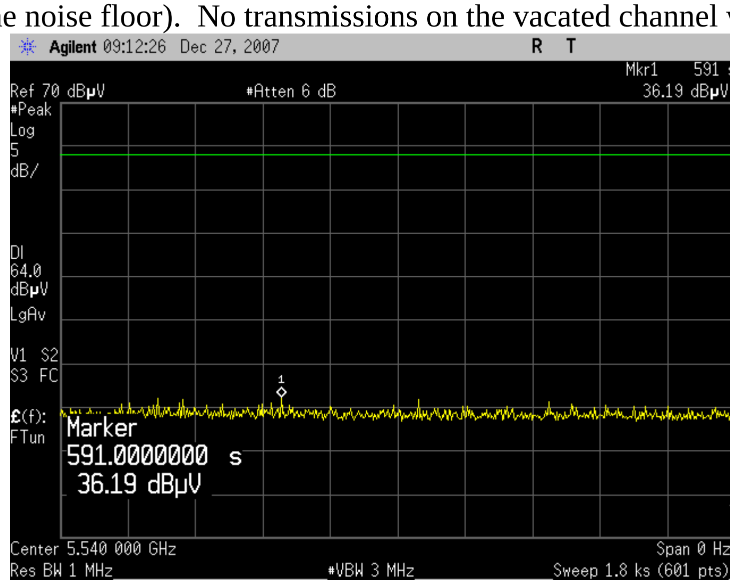


Figure 14 Non-Occupancy Plot

5.3.2 Passive Scanning

The spectrum analyzer was configured to sweep through both DFS bands (5250 – 5350 MHz and 5470 – 5725 MHz). Once the channel move had been completed and verified (communications between client and master were established on a new channel – 5300 MHz – and evident on the spectrum analyzer display) the master device was powered down. The spectrum analyzer was then put into a max-hold mode and left sweeping for a period of 30-minutes. As demonstrated by the plot in Figure 15, no transmissions on any channels were observed indicating that the client device was not employing active scanning, was not transmitting without being associated with a master device and did not transmit on the previously vacate "radar" channel.

The green display line on the plot is the level of transmissions when the master and client were active. The noise floor is more than 30dB below the display line.

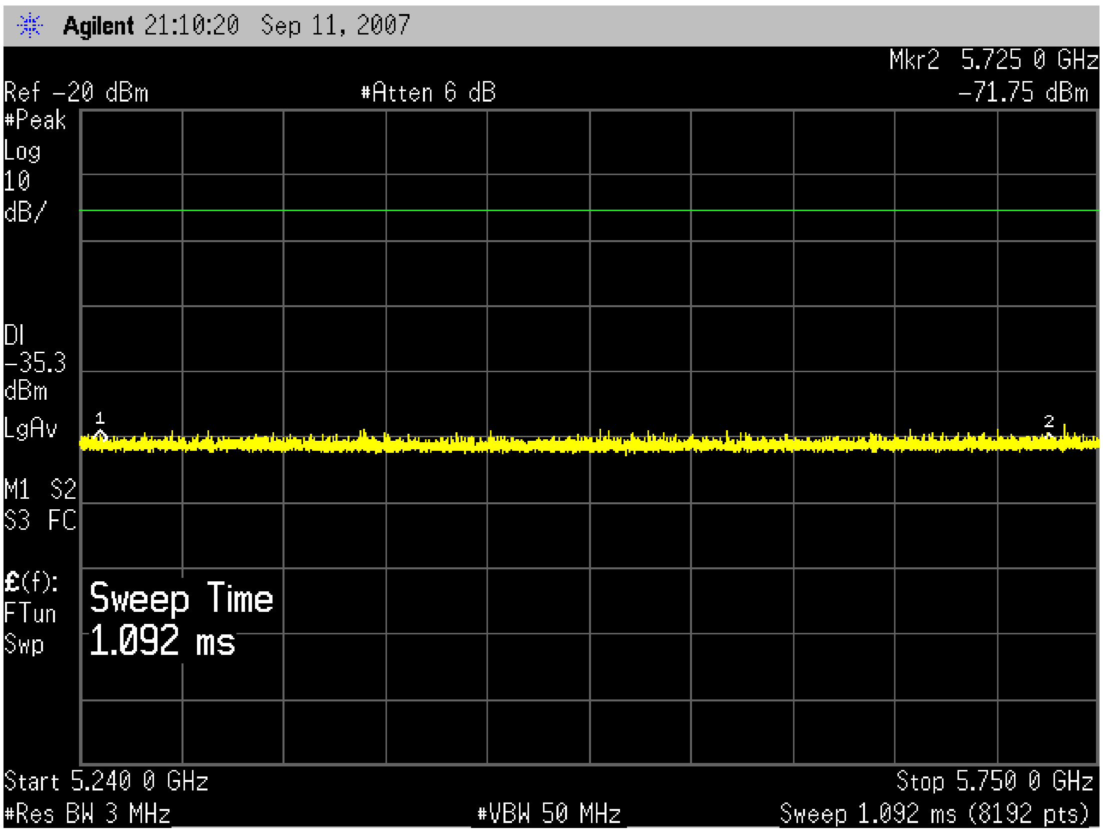


Figure 15 Passive Scanning Plot

5.4 Results Summary

Parameter	Measured	Required	Status
Channel Closing Transmission Time (after first 200ms)	750us	< 60ms	Complied
Channel move Time	503ms	< 10s	Complied
No transmissions without master device	Monitored the radar channel for a period of 30 minutes after the channel move had completed – no transmissions observed. Monitored all channels for a period of 30 minutes after switching off master device. – no transmissions observed.		Complied

Table 5 Test Results Table

Appendix A Authorization from FCC / NTIA for Alternate Channel Loading

The email confirmation from the FCC and the proposal are contained in this appendix.

E-mail Confirmation

From: Andrew Leimer <Andrew.Leimer@fcc.gov>
To: Mark Briggs <mark_briggs1966@yahoo.com>
Cc: Joe Dichoso <Joe.Dichoso@fcc.gov>; Rashmi Doshi <Rashmi.Doshi@fcc.gov>; Richard Tseng <Richard.Tseng@fcc.gov>
Sent: Wednesday, October 10, 2007 12:54:31 PM
Subject: RE: Proposed channel loading for DFS evaluation of a client device - Welch Allyn

Mark,

The FCC has reviewed your proposal for your DFS client medical monitoring device and approved it. Please remember to upload the proposal and the approval to the application exhibits. This is your formal approval letter.

Regards,

Andy Leimer

FCC/OET/EAB

From: Mark Briggs [mailto:mark_briggs1966@yahoo.com]
Sent: Monday, August 20, 2007 5:42 PM
To: Andrew Leimer
Cc: Joe Dichoso; mark_briggs1966@yahoo.com
Subject: Proposed channel loading for DFS evaluation of a client device - Welch Allyn

Dear Andy

Please find attached a proposed method for channel loading during DFS measurements of channel move time and channel closing transmission time for a client device that is unable to support the streaming mpeg file method of channel loading. For reference the manufacturer is Welch Allyn.

Your feedback regarding the suitability of the test mode would be appreciated. As the goal is to move forward with DFS testing within the next two weeks I would appreciate it if you would let me know if the review will not be completed by the end of this week.

Best regards,

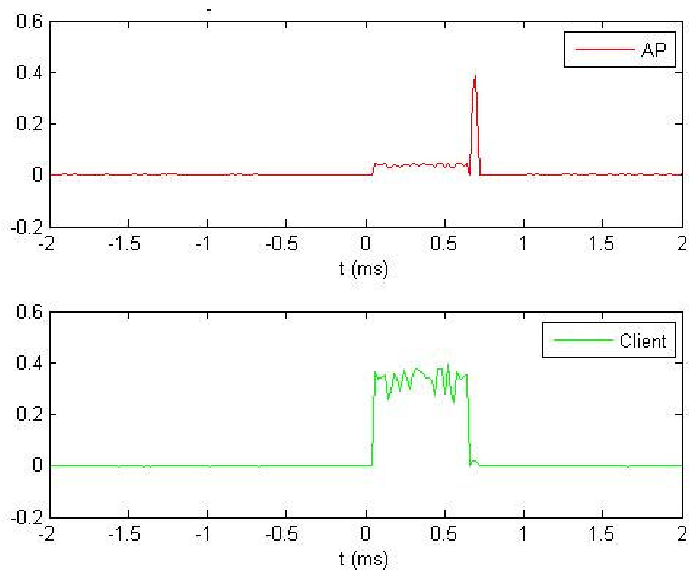
Mark

DFS Test Configuration Proposal

The purpose of this document is to propose to the Commission a test method to evaluate the DFS parameters of channel move time and channel closing transmission time for a client device. The device in question is a medical monitoring system that uses an 802.11a protocol to transmit telemetry data to a remote server. The system is designed only to transmit and receive patient telemetry data and therefore is unable to receive the streaming mpeg file that is the default file transfer mechanism detailed in the FCC's test methods.

The normal mode of operation for this system is that the medical monitor is designed to transmit telemetry (12,500 bits of data) every second to the server via a master device (Access Point). The transaction (shown below) consists of a transmission from the client device that is approximately 650 us long followed by a much shorter duration acknowledge signal from the access point. In the plot the slight bump in the AP plot (red plot) is breakthrough of the client transmission.

Figure 1 Transmissions During A Normal "Telemetry" Mode of Operation



Every 3 seconds, and asynchronous to the telemetry transmissions, the monitor receives 112 bits of data from the Access Point (about 200us of transmission) and the client device sends an acknowledge frame back to the AP. The duty cycle in this mode is very low, with transmissions primarily from client device to Access Point

The system does have a second mode of operation that uses a higher duty cycle of transmissions to the client device. This mode is rarely used and is intended to update flash memory on the client device. During a flash upgrade the data transmission would be of a relatively short duration, followed by an extended period of silence while the flash memory is re-programmed.

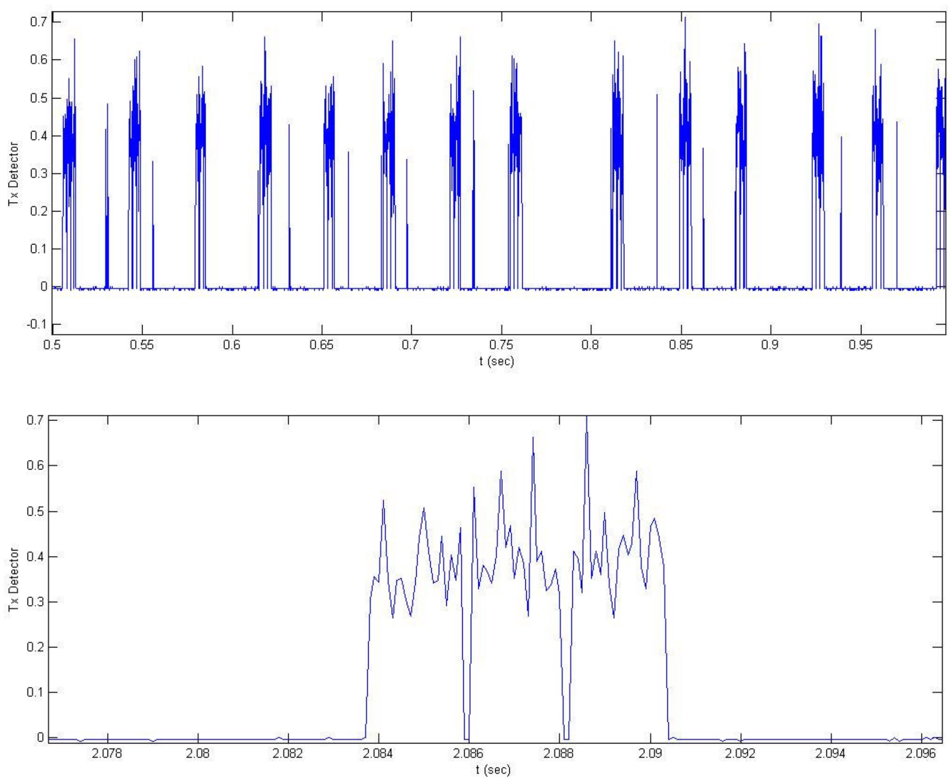
For the purposes of DFS testing the manufacturer is proposing the use of a modified version of the flash upgrade utility since this mode most closely matches the streaming of data from Access Point to client device described in the FCC's test procedures for DFS.

The proposed modification will allow the client to download a file and throw all data away as soon as it is received, rather than attempting to download the file into flash memory. This will provide the capability to transfer a much larger file to the client device from the AP than the standard flash memory upgrade file. The result is an extended length transmission with higher AP transmit duty cycle than could be achieved when the device downloads a firmware upgrade to flash memory or sends its normal telemetry data.

With the software modifications to support the proposed higher duty cycle file download the AP's transmit duty cycle is slightly higher than 16%. The test setup has a PC connected to an AP via a hard-wired Ethernet connection and the manufacturer's device connected to that AP via an RF connection. An RF power splitter was used to sample the AP transmission. The manufacturer's device downloads a file from the PC via the Access Point.

A plot of the wireless traffic transmitted by the AP is shown in Figure 2. The upper image shows a 500 ms-duration window, which includes some 802.11 management data (such as a beacon at t=0.53, 0.63, 0.73, 0.83 and 0.93 seconds) in addition to the data downloads. There are 14 data packets shown in the 500ms period. A typical data download packet of approximately 6 ms duration is shown in the lower panel of Figure 2. The duty cycle, discounting control signals, is calculated from 14 data packets at 6ms each, i.e. 84ms of transmissions, in a 500ms period.

Figure 2 Transmissions During Proposed Modifed File Transfer Mode



The Commission's comments on the acceptability of the proposed test method would be appreciated.

Appendix B DFS Test Configuration Photographs