PXI

DFS Radar Simulator and Analyzer Test Suite

- All-in-one Dynamic Frequency Selection (DFS) test system
- DFS Radar Simulation, pulsed, chirped and frequency hopping, (FCC types 1 to 6)
- DFS response analysis
  - Channel Availability Check
    - ✓ 60 second non-transmit test
    - ✓ 30 minute test
  - Channel Move Time Check
    - ✓ Display of Power vs Time for up to 24 seconds
    - ✓ Aggregate transmission time measurement
    - ✓ Automated Play & Capture
- Portable Hardware system consisting of:
  - General Purpose 6 GHz Signal Generator with dual channel AWG
  - General purpose 6 GHz RF Digitizer
  - Integrated system controller

The DFS Radar Simulator and Response Analyzer Test Suite is a fully integrated system for testing commercial equipment operating in the 5 GHz to 6 GHz UNII frequency band for compliance to Dynamic Frequency Selection (DFS) specifications, FCC 06-96.

The system is comprised of an RF signal generator, capable of simulating defined DFS radar signatures, and an RF signal analyzer uniquely integrated to determine how the Equipment Under Test (EUT) reacts to the required stimulus. Aeroflex provides this in a modular self-contained single-box solution with application specific software.

The system hardware is comprised of Aeroflex PXI 3000 Series modular RF instruments integrated into a compact portable chassis with an embedded system controller running the DFS Radar Simulator and Response Analyzer application software within a Windows XP operating system.

The system application provides an intuitive application-specific, user-friendly interface with the ability to easily generate compliant RF radar signature waveforms as stimulus into the EUT and integrates the RF signal analyzer to synchronously perform measurements of the EUT response. Analysis is fully time synchronized to the test waveforms enabling precise verification of DFS compliance.

The system is compliant with the revision requirements to Parts 2 and 15 of the FCC's rules and regulations as per Memorandum Opinion and Order (MO&O) FCC 06-96, introduced in July 2006, which mandates Dynamic Frequency Selection (DFS) compliance testing on commercial and consumer systems operating in the 5 GHz to 6 GHz UNII band in order to demonstrate non-interference with operational radar systems. The system application fully supports all 6 FCC radar signature simulation types defined in the US standard (radar types 1 through 6), which consist of three basic waveform categories: a group of simple single-carrier CW pulse sequences (Short Pulse Radar Test Waveforms - Types 1-4), a 12 second concatenated sequence of chirped pulses (Long Pulse Radar Test Waveform - Type 5), and pseudo-random frequency hopped pulse sequence (Frequency Hopping Radar Test Waveform - Type 6).

Current emerging DFS requirements are of particular importance in testing commercial products based on IEEE 802.11a (WiFi), wireless telephones, unlicensed IEEE 802.16 (WIMAX) applications as well as other unlicensed devices operating in the UNII band. The DFS Test Suite is designed to be a full-featured testing solution to emerging world standards.

Highlights

DFS Radar Simulator and Response Analyzer - Compliance Testing Suite

The system application provides a simple intuitive user interface, allowing the user to select, create, and play the appropriate DFS waveforms as defined by the applicable governing standard, as well as the ability to precisely capture and analyze the EUT's response.

DFS Radar Simulator - Create

The Create New Waveform screen as shown in figure 1 allows the user to choose a specific standard which he/she wishes to test against and generate the desired waveform type(s) within a given standard, or, if desired, to generate the whole test suite for that standard. The software arranges work activities naturally by "Project", so that all associated files for each test project can be archived as a complete folder, assisting the documenting and archiving process. It also includes the ability to generate the entire required set of waveforms for a given project with the push of a button.

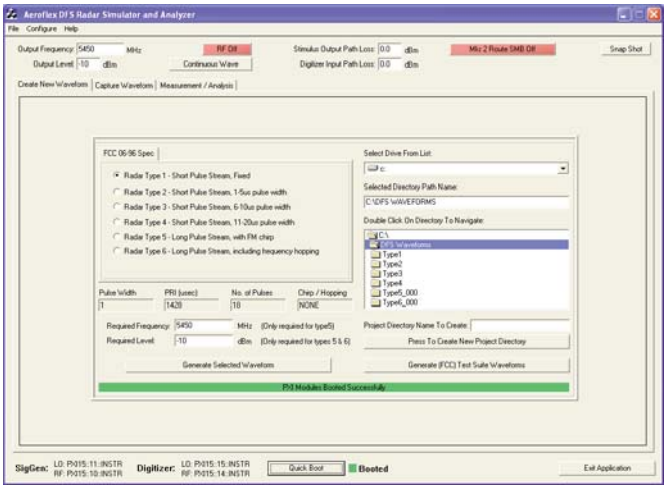

Figure 1. Create New Waveform

Simulation and Analysis - Play and Play/Capture

The system application allows the user to either play individual radar simulations independently or, if desired, to also synchronously capture the EUT response to a given radar stimulus and output the power amplitude vs. time response to a plot file, documenting operational responses for submission to the appropriate authorities.

Stimulus Play Function - Radar Simulation

The play function supports single-shot, repeated, or continuous waveform generation. Single-shot operation is suitable for compliance testing, whereas repeat and continuous operation are provided for trouble shooting EUT responses during the development process. In addition, a continuous eave (CW) mode is provided to support test setup verification activities, e.g. measuring path losses, etc. Frequency and level can be independently user selected (except for Type 6, which requires frequency and level to be chosen at the time the waveform is created). Created waveforms can be identified and replayed as desired, allowing the user to archive and play back waveforms for activities such as initial verification, re-verification, firmware regression testing, as well as operational correlation between compliance test houses and their clients, etc.

Play & Capture Function - Integrated Response Analysis

DFS performance analysis could never have been easier. Documentation required by regulatory agencies showing initial 60 second Channel Availability Checks, with and without radar bursts at the start or end of a Channel Availability Check, In-Service Monitoring Test power versus time plots, or 30 minute non-occupancy tests are easily accomplished. As the software builds each radar simulation waveform, it automatically embeds markers which are used by the signal analyzer to ensure perfect time synchronization capture. Sample rate and capture length can be defined by the user. Moreover, due to this system's integral synchronicity, on-screen markers showing key events in the captured response can be provided to identify important boundaries for different modes of operation.

Basic system capture/analysis modes

1) 60 second Channel Availability Check - provides verification that the EUT does not transmit for a minimum of 60 seconds after turn on (Figure 2). Once the user initiates the test then, if a EUT transmission exceeds the user-defined amplitude threshold, the digitizer will capture and timestamp the offending transmission. Secondly, the FCC requires verification of correct EUT response in the presence of a radar signature at the beginning and end of the 60 second Channel Availability Check time period. The 30 minute non-occupancy test (described below) can be used for this purpose.

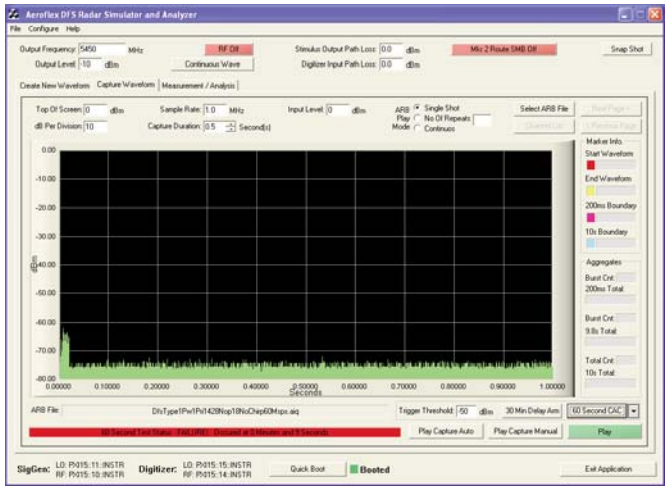

Figure 2. 60 Second Availability Check

2) In-service Monitoring - When a DFS type 1 through 6 stimulus waveform is played, markers within the waveform automatically initiate data capture within user defined pre-trigger settings. After capture, data can then be post-processed by the application to provide additional statistics. The results are displayed in the time domain with colored markers indicating start, stop and intermediate time boundaries, making it easy to interpret the result display. Pre-triggering also enables the user to observe activity prior to the radar signal.

The measurement result displaying markers and time values allow verification of -Channel Closing Time and Channel Move Time as shown in figures 3 and 4 below.

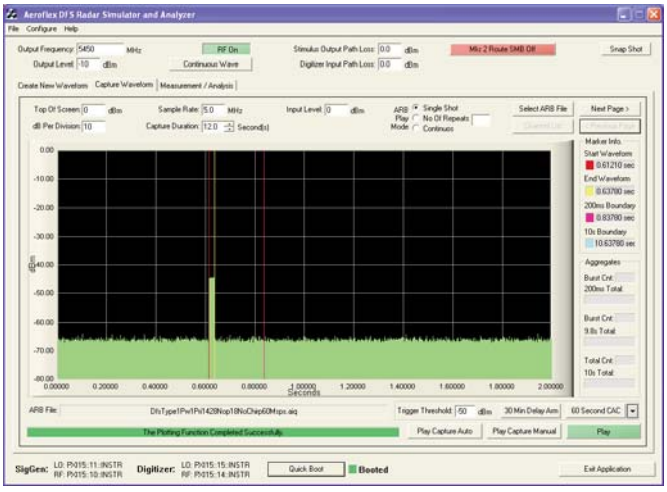

Figure 3. Channel Closing Time/Channel Move Time

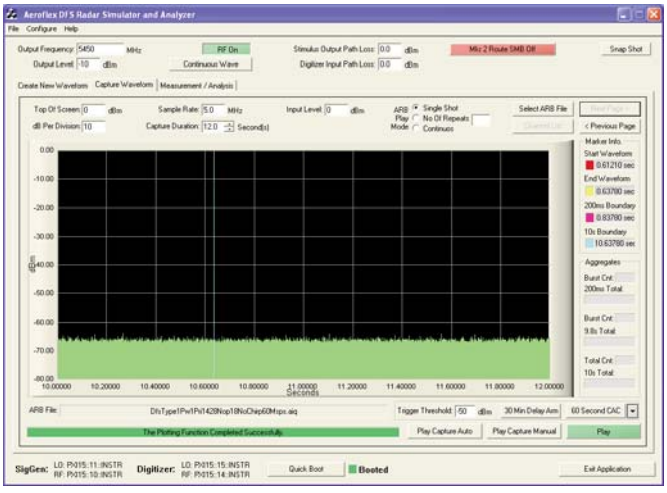

Figure 4. Channel Closing Time/Channel Move Time

3) 30 minute Non-Occupancy test, as shown in figure 5 verifies the EUT makes no transmission after the 10 second boundary, for a period of 30 minutes. Initiating this test triggers the selected waveform to be played and then arms the digitizer 10 seconds after the end of waveform play to trigger on any RF input exceeding the user-defined level threshold. If a trigger event occurs within this 30 minute period the transmission is captured and is time stamped.

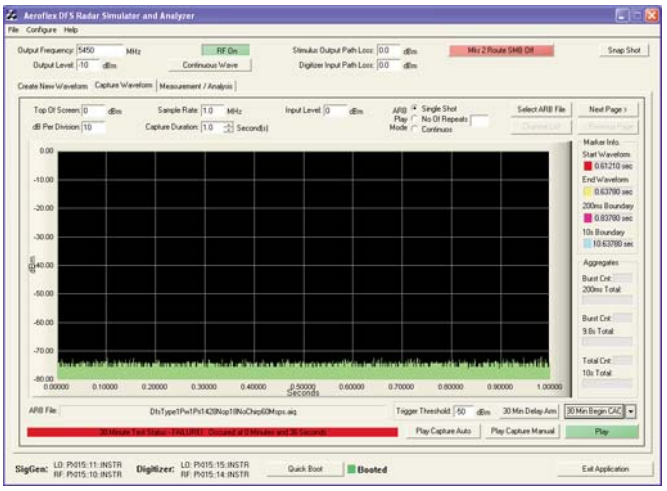

Figure 5. 30 Minute Test

DFS Response Analyzer - Measurement and Analysis

Post-analysis of signals captured by the Play & Capture function provides measurement of aggregate transmission times from the end of the waveform to the 10 second no-transmit boundary. This function provides three values, including the total aggregates over the full 10 second period (required for ETSI), as well as the number of pulses occurring in the first 200 ms and those falling in the 9.8 seconds following that (required by the FCC). The Play & Capture Auto function not only captures the waveform, it invokes the Measurement and Analysis function, as well as outputting the full set of plots to .JPEG screen capture files.

This feature also presents important information such as the Rising Edge and Falling Edge of any detected bursts from the EUT. The Pulse Width and Average Power for each detected pulse are also displayed for the user to view. This feature can be utilized as a verification for the Capture Waveform function. See Figure 6.

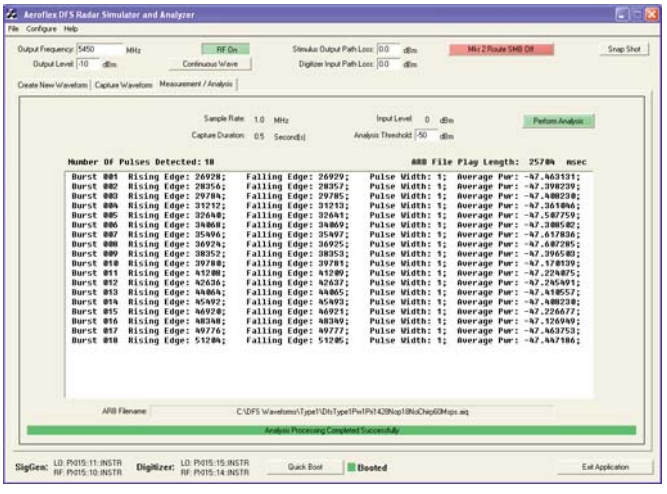

Figure 6. Measurement Analysis

SPECIFICATIONS

The following specifications apply when DFS Test Suite is used in conjunction with Aeroflex PXI 3000 series modules comprising 3011, 3035, 3010, 3025.

For general purpose RF performance refer to product specifications for Aeroflex 3000 series modules.

STIMULUS

Frequency Range

5250.0 - 5350.0 MHz and 5470.0 - 5725.0 MHz

RADAR WAVEFORM SIMULATION MODES

Play: Radar Simulation only

Play/Capture (manual and Auto): Radar Simulation and Analysis (see Channel Closing Time/Channel Move Time)

ARB PLAY MODES

Single, Repeat(N), Continuous

Pulse width accuracy (50% points)

Typically ±16 ns (i.e. 1/60 Msample/sec) ± reference accuracy

SMB output

Selectable SMB output provides marker identifying beginning of radar simulation

Waveform Structures

Default Waveform Library Folder Structure

C:/<Project Name> (user defined)

C:/<Project Name>/<waveform type>

- ✓ *Types 1 through 4 name each simulation uniquely, storing all identical types in a common folder (e.g. all Type 4 waveforms are in a common Type 4 folder)*
- ✓ *Each Type 5 and 6 waveform creates uniquely named independent directories for each simulation*

Arbitrary Waveform Files

Arbitrary waveform files are stored in .AIQ files. File names are automatically generated and provide a description of the file content, e.g.

"DfsType1Pw1Pri1428Nop18NoChirp60Msps.aiq"

DFS type 1 waveform, 1 µs pulse width, 1.428 ms pulse repetition interval, 18 pulses, 60 Msamples/sec arb sampling rate

Sequenced Waveforms

Sequenced waveforms, such as FCC Type 5 (12 second concatenated series of chirps) or Type 6 (frequency hopped), use 3025 List Mode functionality to administrate these complex waveforms requiring sequencing of events. The program will create table listings in text formats defining all stimulus waveform characteristics administered for a given waveform (e.g. Type 5 will include List Mode Entries and Table Listing text files explain the waveform characteristics, the Type 6 Chirp Hop list will show the frequencies and order of play for the waveform).

Supported Waveform types (with integrated markers for analysis triggering)

FCC

CW bursts

FCC Types 1-4

Conventional CW pulses with the following characteristics:

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses
1	1	1428	18
2	1-5	150-230	23-29
3	6-10	200-500	16-18
4	11-20	200-500	12-16

Concatenated Chirps

FCC Type 5

8 to 60 concatenated groups of 1 to 3 chirps, randomly chosen for chip widths of 5-20 MHz and pulse widths of 50 to 100 µs with the following characteristics:

Number of Bursts	Number of Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)
8-20	1-3	50-100	5-20	1000-2000

Programmatic sequence for type 5 waveform construction:

1) Desired level and frequency are supplied by the user.

2) Burst_Count, a number between 8 and 20 inclusive is chosen representing the number of "bursts" (or waveform segments). Type 5 waveform length is 12 seconds, thus each "burst" length will be BL = 12/ Burst_Count.

3) Pulse_Count, a number between 1 and 3 inclusive is chosen for each burst segment (1 through Burst_Count) representing the number of chirped pulses for each burst segment.

4) For each burst segment, the following chirp parameters are randomly chosen (all chirped pulses within a given burst segment are the same, whether 1, 2, or 3 chirped pulses are chosen):

a) Frequency width (5 MHz to 20 MHz, a linear and symmetrical ramp)

b) Pulse period (50 µs to 100 µs)

c) Pulse Rate Interval (1 ms to 2 ms, in 1 µs increments)

*d) The start of the first pulse in a given burst segment is randomly chosen (in 1 µs increments) between 1 µs and [(the total burst length - (total of all pulse periods within a burst) + (the total space between pulses within a burst)]. Or stated otherwise, 1 µs to [(BL - (Pulse_Count * pulse period) + (Pulse_Count - 1)* randomly chosen PRI Interval)].*

Frequency Hopping

FCC Type 6

100 frequencies randomly chosen in 1 MHz increments from operation frequency range noted above, playing the following CW pulse waveform at each frequency:

Pulse Width (µs)	PRI (µs)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (ms)
1	333	9	0.333	300

Programmatic sequence for type 6 waveform construction:

1) *User must supply desired level and a frequency within the EUT detection bandwidth.*
2) *A sequence of 100 numbers, n1 to n100, are randomly chosen from between 1 to 475 and then removed from the sequence producing 100 unique random numbers.*
3) *Frequency assignments are 5250 MHz + n.*
4) *If the list generated from steps 2 and 3 does not include at least one frequency is between 5250 to 5350 MHz or 5470 to 5725 MHz, the list is regenerated.*
5) *Secondly, in order to verify that at least one frequency in the list is at the EUT frequency plus or minus ½ the EUT detection bandwidth (i.e. at least one of the frequencies in the list must conflict with the EUT's operation such that the EUT will attempt to relocate when the sequence is played), the frequency supplied by the user is inserted into the list, replacing one selection.*

ANALYSIS

Digitizer Input Path Loss (dB):

External loss compensation, this value is used to correct top of screen on the display.

Input Level

Up to +30dBm (Peak) sets digitizer input settings

Input Frequency

Derived from stimulus settings

Sample Rate(MHz) & Capture Duration(secs)

Maximum values are set by the product of Sample Rate x Capture Duration ≤60 or as constrained by 3030 Series digitizer maximum sample rate and Sample memory

MEASUREMENTS

Channel Closing Time and Channel Move Time; Channel Availability Check; 30 minute Non-Occupancy test

CHANNEL CLOSING TIME AND CHANNEL MOVE TIME

The Power versus Time capture enables measurement of the Channel Move Time and Channel Closing Time together with a display of power versus time trace including a pre-trigger time period.

Burst Detection Threshold

User define- user definable (dBm), resolution 1 dB

Aggregate Time and Burst Count

Time and count values are declared for each of the initial 200 ms, the subsequent 9.8 s and the total 10 s periods within the 12 s capture duration.

Aggregate time after the first 200 ms, within the 9.8 sec period should be <60 ms to be compliant with FCC

Trace Marker Info

Color coded indication of: Waveform start, Waveform end, 200 ms Boundary, 10 s Boundary

CHANNEL AVAILABILITY CHECK

Burst Detection Threshold

User define- user definable (dBm), resolution 1 dB

Modes

60 seconds, 30 min beginning and 30 min end

60 seconds Measurement

The 60 second channel availability check verifies that the EUT makes no attempt to transmit on frequency within the first 60 s following initiation.

30 mins beginning Measurement

30 min, beginning - fires the selected waveform 10 s after test is started to verify the EUT remains inactive for a minimum of 30 minutes following the simulated radar emission.

30 mins end Measurement

30 min, end - fires the selected waveform 50 s test is started to verify the EUT remains inactive for a minimum of 30 minutes following the radar emission.

Indication

Pass/Fail (with time stamp, with time stamp resolution 0.1 s)

30 minute non-occupancy test

Measurement

Verification that EUT ceases transmission for a min of 30 minutes on completion of channel close and channel move time.

Trigger Source

Internal (burst power detector)

Trigger Threshold, user definable (dBm), resolution 1 dB

Indication

Pass/Fail (with time stamp with 0.1 sec resolution)

Power (dBm) versus time (mins/sec) plot (page(s)) in the event of failure

GENERAL

PXI hardware minimum requirements

PXI chassis with 6 vacant PXI peripheral slots all on the same PXI bus segment

One of each of Aeroflex 3000 series modules, 3025, 3035, 3010, 3011

3010 and 3011 PXI RF synthesizer with option 01 enabled*

**note export restrictions may apply.*

PXI Module driver software

Revision 6.9.0 or later

PC minimum requirements

Operating System

Windows XP with service pack 2

National Instruments Visa

Version 3-1 or higher

Memory

1 GByte or greater

VERSIONS AND ACCESSORIES

When ordering please quote full ordering number information

Orders will only be supplied as a configured system with all software pre-installed and PXI modules fitted and interconnected.

For information on PXI chassis/controller and module configurations refer to Aeroflex sales.

Order as:

Software

46886/055	DFS Radar Simulator and Response Analyzer test Suite

Hardware

Add line items for each of the required PXI hardware components as follows:

1) Select one PXI chassis from:

3000 - 8 slot PXI chassis

82565 – 18 slot chassis

2) Select one PXI controller from:

3001B - 3U PXI™ Pentium® M 760 2.0 GHz system controller with Windows XP™

3001C 3U PXI™ Intel® Core™2 Duo T7500 2.2 GHz system controller with Windows XP™

46885/386 MXI-4 PXI-PCI Interface card external controller

46885/416 MXIexpress PXI-PCIe interface card external controller

3) Add one of each of:

3025 PXI 6 GHz RF Signal Generator

3035 PXI 6 GHz RF Digitizer with option 198

3010 PXI RF Synthesizer with option 01* enabled

3011 PXI RF synthesizer with OXCO reference with option 01* enabled

*note export restrictions may apply.

Supplied with:

CD-ROMs

PXI module drivers and PXI Studio application (pre-installed)

DFS Radar Simulator and Response Analyzer Application (pre-installed)

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AEROFLEX
A passion for performance.

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.

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