LitePoint IQsignal™

Connectivity Test System

User's Guide

CONTACT INFORMATION

LitePoint Corporation
575 Maude Court
Sunnyvale, CA 94085-2803
United States of America

Telephone: +1.408.456.5000
Facsimile: +1.408.456.0106

LITEPOINT TECHNICAL SUPPORT

www.litepoint.com/support
Telephone: +1.408.456.5000
Available: weekdays 8am to 6pm, Pacific Standard Time.
E-mail: support@litepoint.com

Doc: 1075-5116-006

July 2012

Table of Contents

Preface

The *LitePoint IQsignalUser's Guide* describes how to use the LitePoint IQsignal for analyzing WiFi, WiMAX, Bluetooth, GPS, and FM applications.

The preface includes the following topics:

- Who should use this guide
- What this guide contains
- Related documentation
- Conventions used in this manual

Who Should Use This Guide

The *LitePoint IQsignalUser's Guide* is intended for test engineers and other technical personnel who use LitePoint to test WiFi, WiMAX, Bluetooth, GPS, and FM applications.

What This Guide Contains

This document is divided into eight chapters and an appendix and includes the following topics:

Chapter 1: provides an overview of the product

Chapter 2: describes how to use the IQsignal Administration tool

Chapter 3: describes how to get started with the IQsignal test system

Chapter 4: describes how to use the IQsignal WLAN applications

Chapter 5: describes how to use the IQsignal Bluetooth application

Chapter 6: describes how to use the IQsignal WiMAX applications

Chapter 7: describes how to use the IQsignal GPS application

Chapter 8: describes how to use the IQsignal FM application

Chapter 9: describes how to use the IQsignal NFC application

Appendix: provides a description of the signal files

Related Documentation

The *LitePoint IQsignal User's Guide* is one component of the IQsignal documentation. The following is a list of related documents available for your reference.

- *LitePoint IQ201X Quick Start Guide*
- *LitePoint IQapi Documentation*

Conventions Used in This Manual

This document uses the typographic conventions listed in the table below.

Bold	Indicates text the user must enter or select, such as, menu items, buttons and commands. Example: In the VSA window system menu, choose **Setup** > **Parameters**.
Italics	Indicates emphasis Example: For detailed information about expanding the frames, refer to the topic *Expanded Viewing*.
`Monospace`	Represents filename, code, function name, variable name, argument name, program examples etc. Example: The `lp_gps_api.h` contains the error structure as shown below.
	Indicates that it is a tip. Provides users with useful tips. Example: LitePoint recommends the Auto Range feature for the first data capture of a DUT. You can also use this feature when the received signal level(s) have changed significantly.
	Indicates that the user must take note. Provides users with helpful suggestions. Example: Saving a configuration does not save impairments.
	Used for warning the user of potential loss of some sort. The user must be careful not to perform something that results in equipment damage or loss of data. Example: Changing the IP address or the subnet mask may affect the Network Address and the Broadcast Address.
	Indicates potential danger in operating the equipment. Users must use caution while operating the equipment. Example: The IQ201X test system will auto-configure when connected to all common AC voltage and frequency mains. Although the system does not contain components that have a high power of dissipation, it is always good practice to keep the ventilation ports of the system free from any obstruction.
	Used for identifying important features or instructions. Example: You can attach the IP address label provided with the unit and attach it to the front of the unit after you have decided on the correct IP address for the instrument.

Chapter 1 Overview

Introduction

The LitePoint IQ201X test system provides the capability to perform Multicom™ testing; in that, it allows simultaneous testing of wireless devices that meet many wireless specification standards. It provides an integrated solution for manufacturing testing of WiFi, Bluetooth, WiMAX, GPS and FM devices.

The terms WiFi and WLAN are used interchangeably throughout this document.

The LitePoint IQ201X test system provides the following key functionalities:

- Allows you to run certain combination of tests that have different specification standards simultaneously, thereby providing reduced test times. For example, the system allows you to measure WLAN and Bluetooth devices in parallel with FM and GPS devices.
- Provides independent receive and transmit measurements for WLAN, Bluetooth or WiMAX devices.
- Provides the capability of single-channel GPS signal generation for manufacturing.

Licensing LitePoint IQsignal Application

The IQ201X base system has WLAN, Bluetooth, GPS and FM measurement capabilities. The WiMAX measurement capability is an independent add-on option.

Minimum System Requirements

Table 1-1 shows the system requirements for the IQ201X test system.

Table 1-1 Minimum System Requirements

Operating System		32-bit Windows 7 32-bit Windows XP with service pack 2 or higher US English Version
Processor	Type	Intel Pentium dual core processor or equivalent
	Min. Speed	1GHz
	Rec. Speed	2GHz or higher
Memory		1024 MB of RAM
Available Hard Disk Space		500 MB of available hard-disk space
Screen Resolution		1024x768 resolution
Connectivity		USB 2.0
FPGA		To perform IQ201X MIMO testing, make sure you have FPGA configuration revision number 022212a0 installed on your test systems.

Core Functionalities

The core functionalities of the IQ201X test system include:

- A signal-vector-based device that integrates VSA and VSG in a single unit used for analyzing WLAN, Bluetooth, WiMAX, GPS and FM signals.
- Integrated test solution for GPS test systems offering comprehensive developer and manufacturing test solutions.
- Comprehensive low-cost manufacturing testing.
- Provides independent receive and transmit measurements for WLAN, Bluetooth or WiMAX devices.
- Provides a variety of RF ports for flexible connection to a number of device configurations.
- The capability to perform specific parallel measurements.
- The capability to perform Multicom™ testing.
- Integrated measurements for single-insertion testing.
- Point and click measurement capability.

Hardware System Setup

The IQ201X test system unit has two panels: the front and the rear panels.

The IQ201X test system uses multiple hardware blocks to provide concurrent test capabilities for WLAN, Bluetooth, and WiMAX in parallel with GPS and FM technologies. Multiple Vector Signal Generator (VSG) sections provide signal generation capabilities for the WLAN, Bluetooth, WiMAX, GPS and FM transmit functionalities.

Table 1-2 provides the frequency range for the various VSG transmit functionalities.

Table 1-2 Range for the VSG Transmit Functionalities

Transmit Functionalities	Range
WLAN	2.4 to 2.5 GHz and 4.9 to 6 GHz
Bluetooth	2.4 to 2.5 GHz
WiMAX	2.15 to 2.7 GHz, 3.3 to 3.8 GHz, and 4.9 to 6 GHz
GPS	1.57542 GHz
FM	76 to 108 MHz

Multiple vector signal analyzer (VSA) sections provide matching capabilities covering identical frequency bands as the VSG sections, with the exception of the GPS frequency band.

The IQ201X test system includes software libraries specific to the particular communication standard of interest. A variety of signal creation and analysis routines are provided and are available through either a graphical user interface (GUI) or a C++ API. All data captured on the IQ201X test system is sent to the controlling PC over a USB 2.0 link and then processed according to the user's instructions. All measurement functions provided in the GUI are also available through the C++ API for custom test program automation in either manufacturing testing or design characterization testing.

Multiple RF connection ports allow the IQ201X test system to accommodate a wide range of DUT configurations containing multiple communication standards. The IQ201X test system includes a dedicated RF connection port for GPS/GLONASS communication standards, a dedicated RF connection port for FM communication standards, as well as two other RF connection ports for testing WLAN, WiMAX, and Bluetooth communication standards. These focused ports allow the user to easily configure the IQ201X test system to the precise port topology of their DUT, ensuring maximum flexibility. The figure below provides a representation of the IQ201X system's basic functional block diagram.

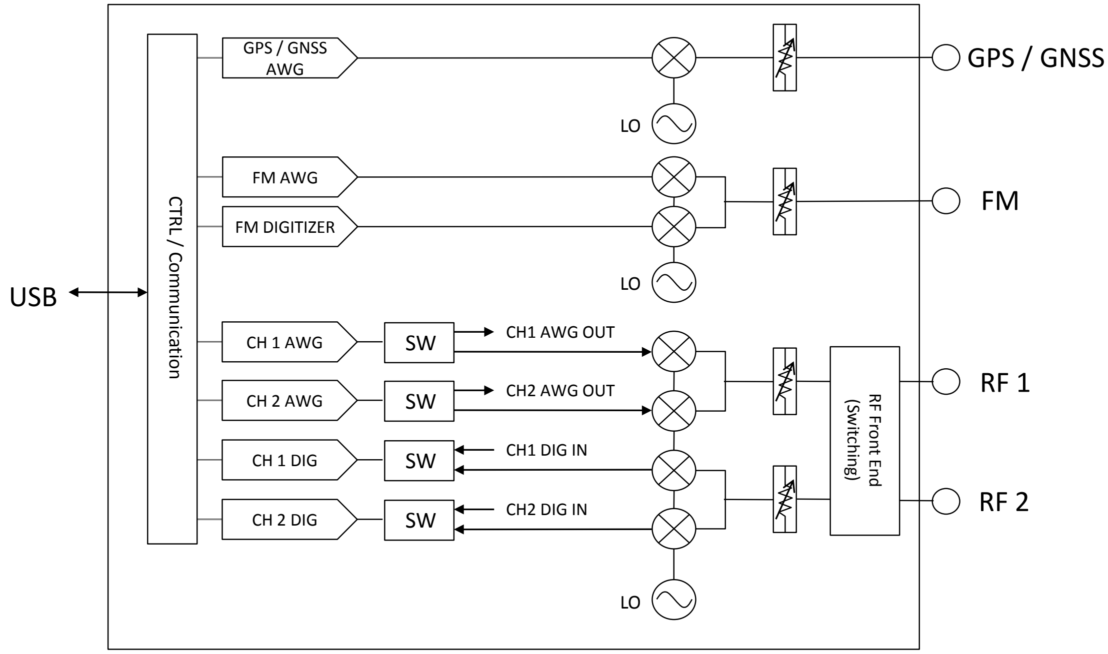


Figure 1-1. LitePoint IQ201X Test System—Basic Functional Block Diagram

IQ201X Test System—Front Panel

The IQ201X test system front panel has four connectors and an LED indicator. Table 1-3 provides a description of the front panel connectors and indicators.

Connector

The front panel has four Type N (f) RF port input/output connectors used for connecting the various test instruments, a power switch and an LED indicator.

LED

The LED indicator in the front panel displays either in green or in red. A green light indicates that the system power is on and the USB connection is recognized by the system. A red light indicates that the system power is on, but the USB connection is not recognized and the connected hardware could be faulty.

Table 1-3. Front Connectors and Indicators

Port/Indicator	Connector Type	Description	Input/Output Freq. Range	Input/Output Power Range
RF Port 1	N-type female	Provides RF connection to DUT #1—DUT for WLAN, Bluetooth or WiMAX technologies.	Input/Output: 2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz	Input: +30 to -148 dBm/Hz Output (CW): +10 to -95 dBm (1 Hz BW)
RF Port 2	N-type female	Provides RF connection to DUT #2—DUT for WLAN, Bluetooth or WiMAX technologies.	Input/Output: 2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz	Input: +30 to -148 dBm/Hz Output (CW): +10 to -95 dBm (1 Hz BW)
FM Port	N-type female	Provides FM connection to the DUT	Input/Output: 76 to 108 MHz	Input/Output: -60 to -110 dBm
GPS Port	N-type female	Provides GPS connection to the DUT	Output: 1.57542 GHz (fixed)	Output: -60 to -145 dBm
Power Switch		Power on/off switch		
Power LED Indicator		LED indicator that displays the status of the test system • LED off—indicates that the test system is powered off • LED red—indicates that the test system is in standby mode • LED green—indicates that the test system is in powered on is active		

Figure 1-2 displays the front panel of the IQ201X Test System.

Figure 1-2. IQ201X Test System—Front Panel

Legend for Figure 1-2.IQ201X Test System—Front Panel

1.	Power Switch
2.	RF GPS Port
3.	HF FM Port
4.	RF Port 1
5.	RF Port 2

IQ201X Test System—Rear Panel

The IQ201X test system rear panel has a switch, an AC power connection, USB connector and eight BNC (f) connectors.

Table 1-4 provides a description of the rear panel connectors.

Connectors

The IQ201X Test System rear panel is provided with the following ports:

- **10 MHz Reference in Connector BNC (f)**—input port with a max input of +5dBm
- **USB Communication Connector**—used for connecting to the external PC
- **AC Power Connection**—used for connecting to the AC main power. The AC cable that is provided with the system can only be used with plugs that are compliant with USA specifications. The cable is replaceable for other countries that follow different specifications.
- **Digitizer Inputs—**two inputs for channel 1 and channel 2
- **AWG Outputs—**two outputs that provide connection for Arbitrary Waveform Generator output for channels 1 and 2
- **Trigger Inputs/Outputs—**two connectors for default signal trigger input and one connector for default signal trigger output. The connectors can function as input or output. The default signal output connector is a marker function of AWG waveform signal.

The IQ201X test system will auto-configure when connected to all common AC voltage and frequency mains. Although the system does not contain components that have a high power of dissipation, it is always good practice to keep the ventilation ports of the system free from any obstruction.

IQ201X does not have any user-serviceable components inside the system. Opening the system by unauthorized personnel voids the system certification and hardware warranty.

Table 1-4. Rear Panel Connectors

Port/Indicator	Connector Type	Description
Trigger Input/Output 1	BNC female	Provides connection for trigger input #1. This is the default input.
Trigger Input/Output 2	BNC female	Provides connection for trigger input #2. This is the default input.
Trigger Input/Output 3	BNC female	Provides connection for marker output. This is the default output.
USB Connector	Type B connector	Provides connection for USB 2.0-compatible connection to external PC controller LitePoint recommends that you use Belkin USB connector with part number:F3U133v06-GLD.
USB Connector	Type A connector	Expansion port 1; auxiliary USB port
USB Connector	Type A connector	Expansion port 2; auxiliary USB port

Port/Indicator	Connector Type	Description
1 PPS OUT	BNC female	External Trigger Output
1 PPS IN	BNC female	External Trigger Input
Digitizer CH 1	BNC female	Digitizer input for channel #1 (for NFC)
Digitizer CH 2	BNC female	Digitizer input for channel #2 (for NFC)
AWG Outputs CH 1	BNC female	Provides connection for Arbitrary Waveform Generator output for channel #1 (for NFC)
AWG Outputs CH 2	BNC female	Provides connection for Arbitrary Waveform Generator output for channel #2 (for NFC)
10 MHz Reference Input	BNC female	Provides connection for 10 MHz reference input with a maximum input of +5dBm
AC Power Supply		Power supply that auto-configures for all common voltages and frequencies of AC mains

Figure 1-3. IQ201X Test System—Rear Panel

Legend for Figure 1-3.IQ201X Test System—Rear Panel

1.	Trigger Input/Output 1—Default Input
2.	Trigger Input/Output 2—Default Input
3.	Trigger Input/Output 3—Default Output
4.	USB Connector Type B
5.	USB Connector Type A—Expansion Port 1
6.	USB Connector Type A—Expansion Port 2
7.	1 PPS OUT
8.	1 PPS IN
9.	Digitizer CH 1
10.	Digitizer CH 2
11.	AWG Outputs CH 1
12.	AWG Outputs CH2
13.	10 MHz Reference Input
14.	AC Power Supply

Connecting IQsignal to the Test System

The IQsignal software communicates directly with the test system via a USB cable or remotely using IP address. The test system is physically connected to a Type B USB port of the PC running the software. The USB drivers must have been successfully installed on the PC running the software.

To launch the IQsignal application:

1. Make sure the test system is turned off
2. Make sure the DUT is connected to the test system
3. Make sure the test system is connected to the host PC that has IQ201X application installed on the system
4. Turn the test system on
5. On the host PC, go to **Start>All Programs>LitePoint>IQ201X Applications>IQ201X** and launch the application
   The IQsignal main window displays.

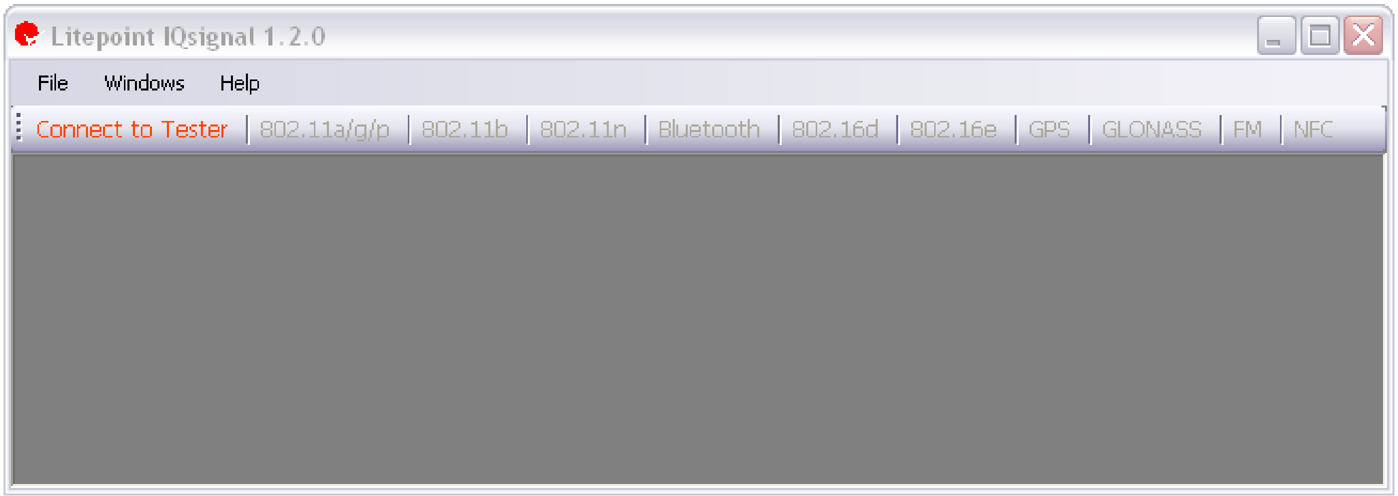


Figure 1-4. IQsignal Application—Dashboard

6. Click **Connect to Tester**.

The text displays *Connect to Tester* in red color when the IQsignal application is not connected to the test system. This text changes to *Tester is Connected* and displays in green color after the application is connected to the test system.

The *Tester Settings* window displays.

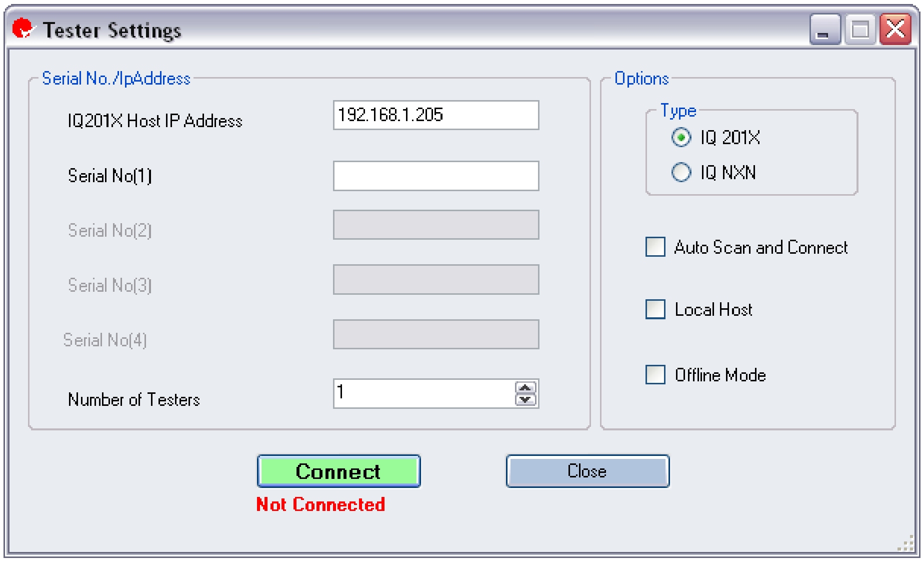


Figure 1-5. IQsignal Application Tester Settings—Connect

You can use the LitePoint IQsignal user interface to connect to one or more of the LitePoint IQnxn test system to perform SISO or MIMO measurements. Or, you can connect to the LitePoint IQ2010 test system to perform WiFi, WiMAX ,MIMO, Bluetooth, GPS, FM and NFC measurements.

Connecting to one or more IQ201X Test Systems

For performing IEEE 802.11n MIMO measurements, before you connect the IQsignal software to multiple IQ201X test systems, make sure the test systems are configured as shown in the image below.

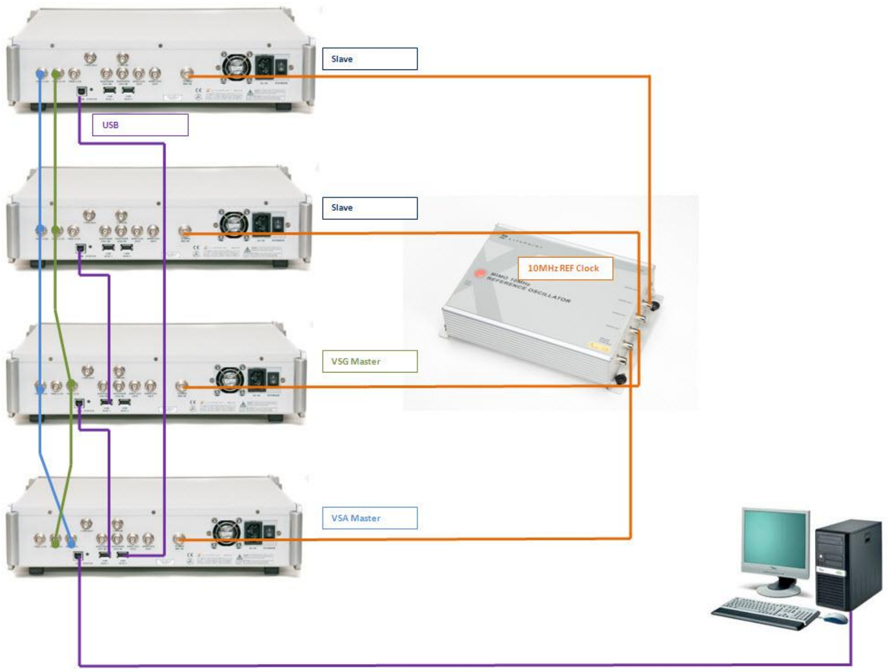


Figure 1-6. IQ2010 Multiple Tester Setup

You can connect to a single IQ201X test system to perform WiFi, WiMAX, Bluetooth, GPS, FM and NFC measurements. You can use a single IQ201X test system to perform IEEE 802.11n SISO measurements and multiple IQ201X test systems to perform IEEE 802.11n MIMO measurements.

7. Perform one of the following actions, depending on your needs, to connect to the test system:
   - *Connecting automatically*
     You can connect the IQ201X test system automatically either to a test system connected locally to your host PC or to a remote test system.
     - To automatically connect to a test system connected locally to your host PC, select the *Auto Scan and Connect* and the *Local Host* checkbox and click **Connect**. This allows you to automatically connect to the test system connected to your host PC every time you close and open the IQsignal application.

       If you leave the *IQ201X Host IP Address* text box blank and select the *Auto Scan and Connect* checkbox, the *Local Host* checkbox is automatically selected.

     - To automatically connect to a remote test system, enter the IP address of the test system in the *IQ201X Host IP Address* text box, select the *Auto Scan and Connect* checkbox and click **Connect**. This allows you to automatically connect to the remote test system every time you close and open the IQsignal application.
   - *Connecting manually*—to connect to the test system manually using the serial number of the test system, deselect the *Auto Scan and Connect* checkbox, enter the serial number of the test system in the *Enter Serial No/IP Address* dialog box and click **Connect**. The serial number is located on the rear panel of the test system.
   - Select the *Offline Mode* checkbox only if you want to analyze previously captured signal files.

If you want to perform an IEEE 802.11n MIMO measurement using two or more IQ201X test systems, in the *Number of Testers* drop-down menu, select the number of testers based on the number of waveform streams you wish to analyze and enter the serial number of each test system in the *Serial Number (#)* text box.

After the IQsignal application gets connected to the test system, the text below **Disconnect** indicates that the tester is connected.

Connecting to one or more IQnxn Test Systems

You can connect to a single IQnxn test system to perform IEEE 802.11n SISO measurements and multiple IQnxn test systems to perform IEEE 802.11n MIMO measurements.

When you connect to an IQnxn system, you can make WiFi and Bluetooth measurements using the following applications:

- 802.11a/g/p
- 802.11b
- 802.11n
- Bluetooth

If you want to perform an IEEE 802.11n MIMO measurement using two or more IQnxn test systems, in the *Number of Testers* drop-down menu, select the number of testers based on the number of waveform streams you wish to analyze and enter the serial number of each test system in the *IP Address (#)* text box.

Select the *Offline Mode* checkbox only if you want to analyze previously captured signal files.

After the IQsignal application gets connected to the test system, the **Connected** text in green below **Disconnect** indicates that the tester is connected.

To access the IQsignal application, click **Close** in the Tester Settings window and then access an application.

To disconnect the IQsignal application from the test system:

1. Click the **Tester is Connected** text on the main window.
   The *Tester Settings* window displays.
2. Click **Disconnect**.

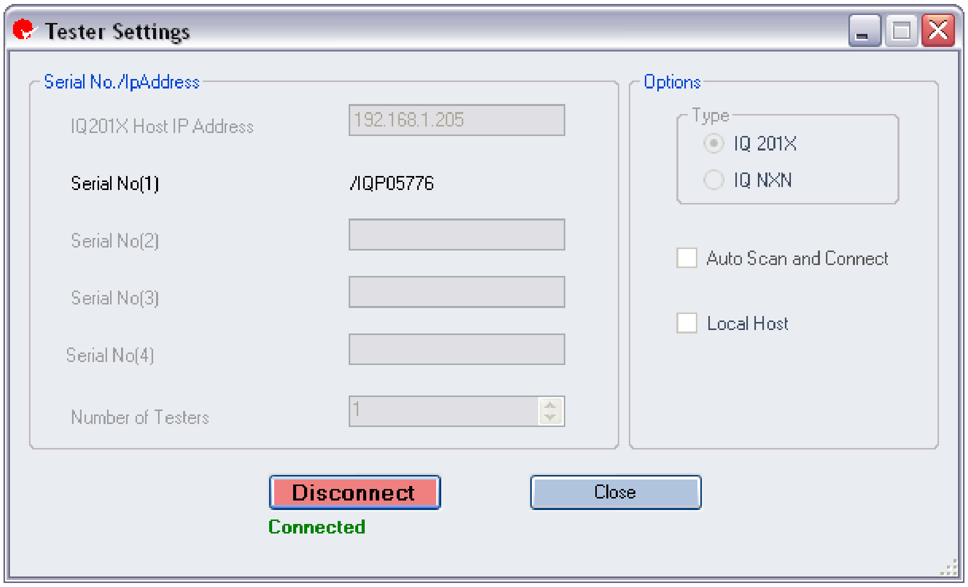


Figure 1-7. IQsignal Application Tester Settings—Disconnect

To perform an analysis on the IQsignal application, you must close the *Tester Settings* window and then click on the desired button in the main window for analysis.

Chapter 2 IQsignal Admin Tool

Introduction

The IQsignal Administration Tool allows you to setup and control LitePoint test systems. This tool allows you to scan USB ports, detect LitePoint test systems connected to the tool and displays the list of detected test systems in the Tester List window.

If you have other IQ201X test system applications running on your system, close the applications before running the IQsignal Administration Tool.

When you select a test system from this window and click **Get Info.**, the information for that tester is displayed in the *Tester Info* area.

Some of the types of test system information that can be retrieved are as follows:

- Tester type
- Serial number
- Calibration date
- Hardware version

The IQsignal Administration Tool User Interface

The IQsignal Administration Tool user interface allows you to perform a variety of administrative functions.

To display the Administration Tool window, go to **Start>All Programs>IQ201X Applications >Accessories> Administration Tool**

The Administration Tool window displays as shown in Figure 2-1.

The IQsignal Administration Tool window is divided into the following three major areas:

- Tester Information
- Tester List
- Status Window

Tester Info.

The tester status area provides you with the following information about the currently selected test system:

- **Tester Type—**displays the type of the test system
- **Serial Number—**displays the serial number of the test system
- **Hardware Version—**displays the hardware version of the test system
- **Setup Version—**displays the firmware version used for default setup files
- **Calibration Date—**displays the date when the system was calibrated
- **Manufacturing Date—**displays the manufacturing date of the test system
- **MAC addr.—**displays the MAC address of the test system
- **Configuration—**displays configuration information
- **Driver Version—**displays the USB driver version
- **GPS Channel (s)—**displays the number of GPS channels

You can right-click the top bar—the bar that displays the *LitePoint Corp. Administration Tool – USB* title—and select **About**, to display the version number of the Administration tool.

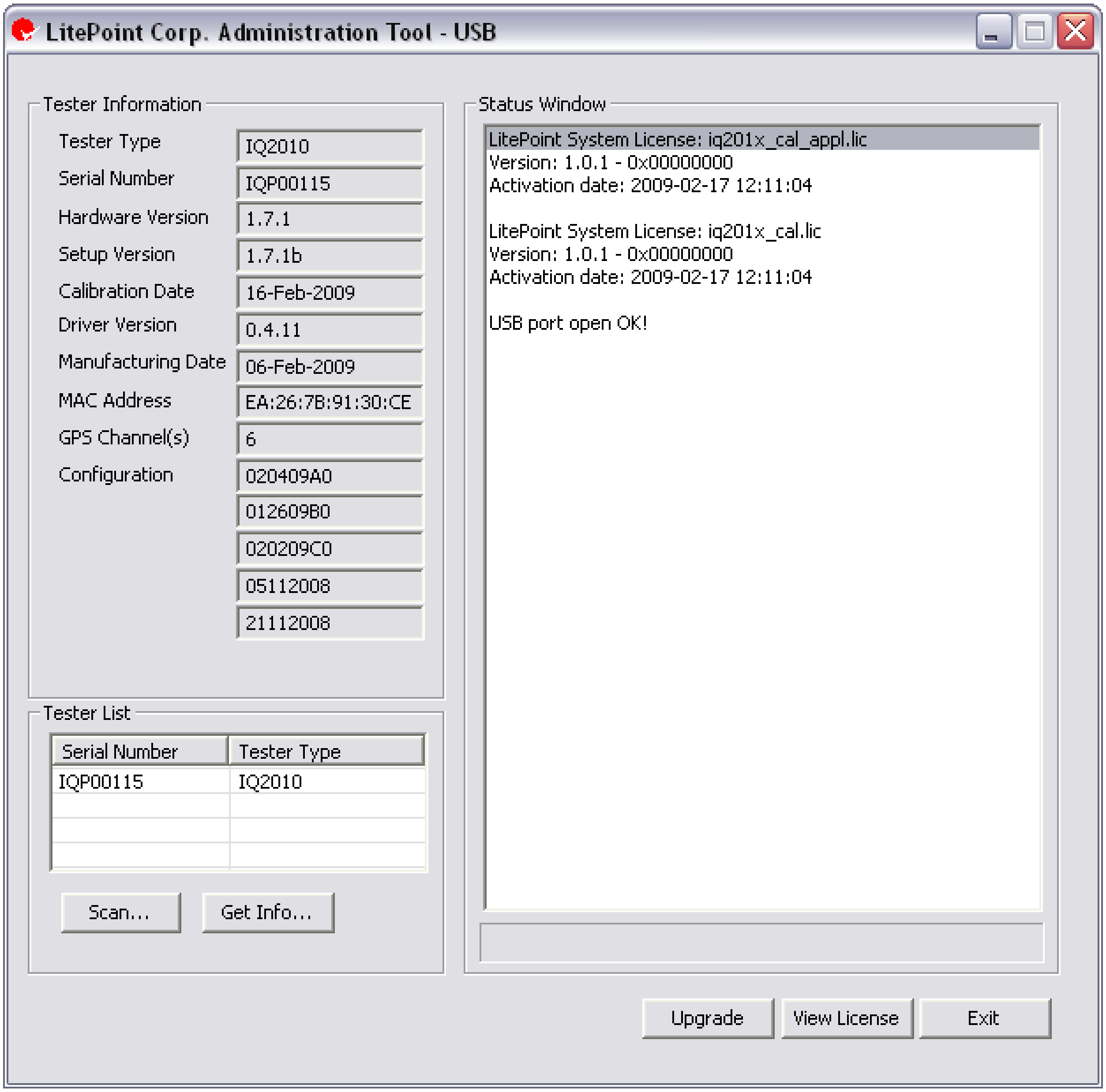


Figure 2-1: IQsignal Administration Tool—Main Window

Tester List

The tester list area provides a list of the IQ201X test systems that are connected to the IQsignal administration tool. When you select a test system from the list, the information about the test system displays in the *Tester Information* area.

Status Window

The Status window displays the USB status.

User Interface Buttons

Button	Description
Scan	Scans and displays the test systems connected to the IQsignal administration tool

Button	Description
Get Info.	Displays the status of all test systems connected to the IQsignal administration tool in the Status Window area
View License	Displays license information of the IQ201X test systems that are connected to the IQsignal Administration tool
Upgrade	Allows you to reprogram a configuration and upgrade the license.
Exit	Exits the application

Getting Started with LitePoint IQsignal Admin Tool

This section describes how to connect the IQ201X application to the test system and how to scan and get the status of the connected test system.

Perform the following actions to scan and get the status of the test system:

1. Make sure that the power cord of the test system is plugged in and the power switch at the rear end of the test system is turned on.
2. Turn on power at the front end of the test system.
3. Connect the USB cable from the test system to the PC.
4. Go to **Start>All Programs>LitePoint>IQ201X Applications>Accessories>Administration Tool**
   The *LitePoint IQsignal Admin Tool* window displays.
5. Click **Scan.**
   The *Tester List* area displays the serial number and the type of connected testers.
6. Select a tester from the tester list window and click **Get Info**.

The *Tester Information* area displays information such as tester type and serial number and the *Status Window* area displays the USB connection status.

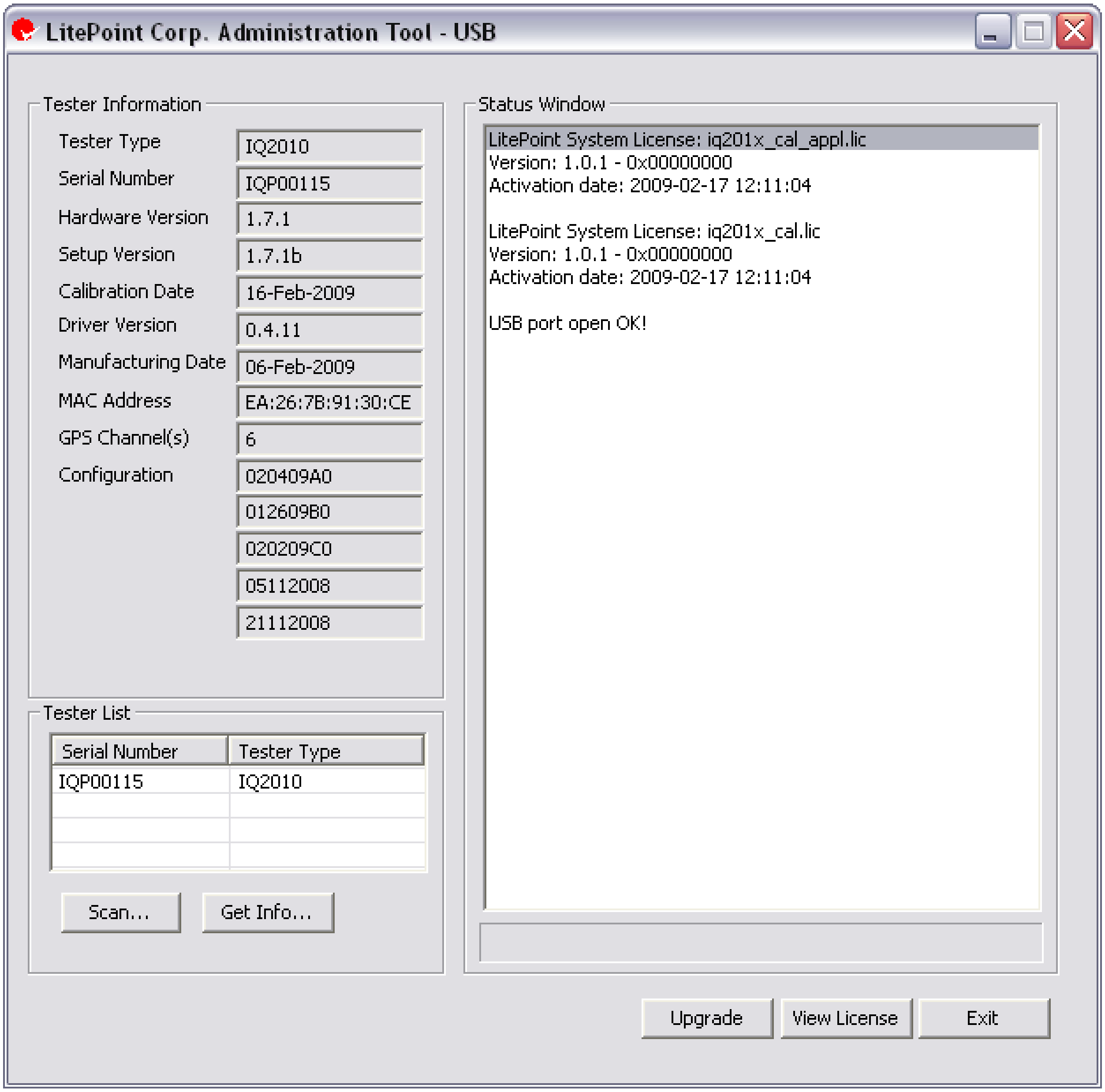


Figure 2-2: IQsignal Administration Tool—Main Window

Upgrading the Test System Configuration

If you have a need to upgrade your test system, download the folder that contains the files to upgrade the LitePoint test system to a local directory.

To upgrade, perform the following actions:

1. Click **Upgrade**.
   The *Open* dialog displays.

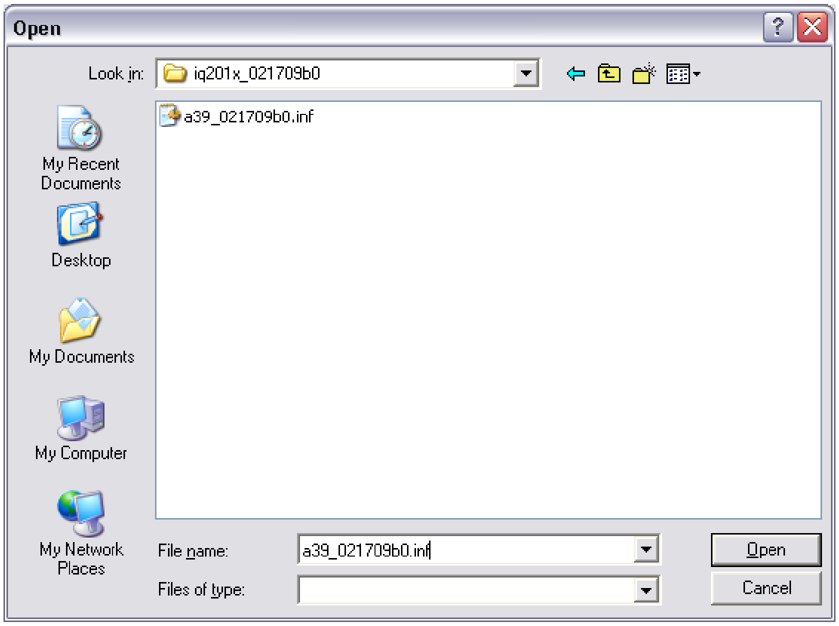


Figure 2-3: IQsignal Administration Tool—Upgrade Screen

2. Navigate to the directory where the files to upgrade the LitePoint test system is located, and select `*.inf`, where '*' refers to any file name with an `.inf` file extension, and click **Open**. If there are more than one `.inf` files in the directory, repeat this step for each of the `.inf` files in the directory.

   This overwrites the existing configuration. The *IQ201X Tester Configuration Programming* window displays. The IQ201X configurations are being reprogrammed and it will take a few minutes to complete the reprogramming. Power-cycle your test system for the upgrade to take effect.

Upgrading the Test System License

The *LitePoint IQsignal Administration Tool* has a common hardware platform with standards-specific features that can be enabled through software licenses. You can purchase these licenses as needed and upgrade the existing license. For example, you can begin the IQsignal installation with WiFi and Bluetooth technologies and add other standards as necessary.

Perform the following actions to upgrade your license:

1. Click **Upgrade**.
   The *IQsignal Software Upgrade* popup window displays. This window provides you with important information about the system settings.
2. Read the information on this window and then click **OK**.
   The *Open* dialog displays.

3. Navigate to the directory where the upgrade file is located, and select the `upgrade.upg` file and click **Open**.

   The `upgrade.upg` file upgrades the existing license.

You have now successfully upgraded the license for the IQsignal Administration Tool.

IQsignal Administration Tool Error Messages

A pop-up message appears if any of the following conditions occur:

- If more than one host application is connected to the test system. For example, if the IQsignal application and the IQsignal Administration Tool application are connected simultaneously to the test system.
- If the host application cannot identify the test system. This could occur due to a number of reasons, for example, if more than one test system is connected to the host PC or if the admin tool cannot locate a license file.
- If there is a problem in the file system.

Chapter 3 Getting Started with the IQsignal Application

The LitePoint IQsignal is used for comprehensive testing of wireless products ranging from WLAN, WiMAX, FM, GPS and Bluetooth products. The IQsignal Graphical User Interface provides the capability to monitor all aspects of wireless product testing. The main screen of the IQsignal application allows you to select the application for testing the various products based on the technology specifications. When you select a task, the user interface for that technology displays and allows you to enter parameters specific to the selected product.

The IQsignal Application Main Window

The IQsignal main screen allows you to monitor the overall performance of the products. The main window displays the following application buttons:

- **802.11a/g/p**—allows you to select options for testing products that comply with OFDM specifications.
- **802.11b**—allows you to select options for testing products that comply with the IEEE 802.11b WLAN specifications.
- **802.11n**—allows you to select options for testing products that comply with the IEEE 802.11n WLAN specifications.
- **Bluetooth**—allows you to select options for testing Bluetooth products.
- **802.16d** —allows you to select options for testing products that comply with the IEEE 802.16d WiMAX specifications.
- **802.16e** —allows you to select options for testing products that comply with the IEEE 802.16e WiMAX specifications.
- **GPS**—allows you to select options for testing GPS products.
- **GLONASS**—allows you to select options for testing products that comply with GLONASS specifications.
- **FM**—allows you to select options for testing FM products.

Figure 3-1. IQsignal Application—Main Screen

The application buttons are enabled based on the applications you have been licensed to use.

The IQsignal application allows you to capture and analyze the signals for WLAN, Bluetooth or WiMAX technologies simultaneously with signal analysis for GPS and FM. The front panel of the IQ201X test system has two RF ports that allow you to connect a DUT for a WLAN, Bluetooth or WiMAX technology.

Launching an Application

To launch an application, click the relevant application button in the main screen. For example, if you want to launch the 802.11a/g/p application, click *802.11a/g/p* button in the main screen. After you launch an application, the button for that application becomes inactive. To make the application active, click inside the application window.

When you have multiple applications open, you can access an application of interest by clicking inside the application window.

Unified IQsignal Graphical User Interface

The WLAN, Bluetooth and WiMAX applications of the IQsignal application have a unified user interface. The interface has three tabs:

- Vector Signal Analyzer
- Vector Signal Generator
- Settings
- RX PER Test

Vector Signal Analyzer

The *Vector Signal Analyzer* tab allows you to set the signal capture parameters and capture, export and save signal files.

The figure below displays the *802.11 a/g/p Vector Signal Analyzer* window as an example.

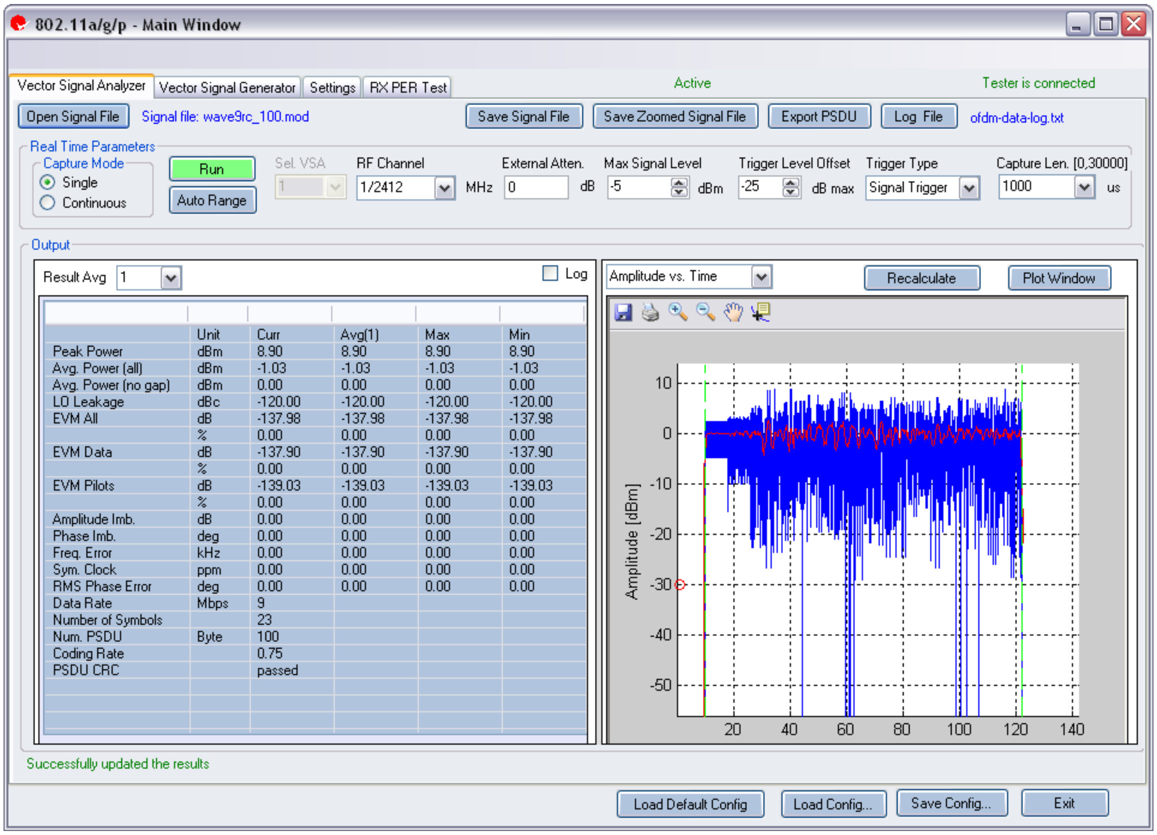


Figure 3-2. IQsignal Application—802.11 a/g/p Vector Signal Analyzer Screen

When you set the VSA and VSG measurements settings such as frequency, frequency offset, trigger type etc. and perform analysis using an IQsignal application, the program automatically saves the setting when you exit the application and loads the saved settings when you launch the application again.

Vector Signal Generator

The Vector Signal Generator reads complex signals in a source file and then uses the information to generate a signal from the Test System's RF or Baseband output ports to verify the receiver portion of the DUT.

The figure below displays the *802.11 a/g/p Vector Signal Generator* window as an example.

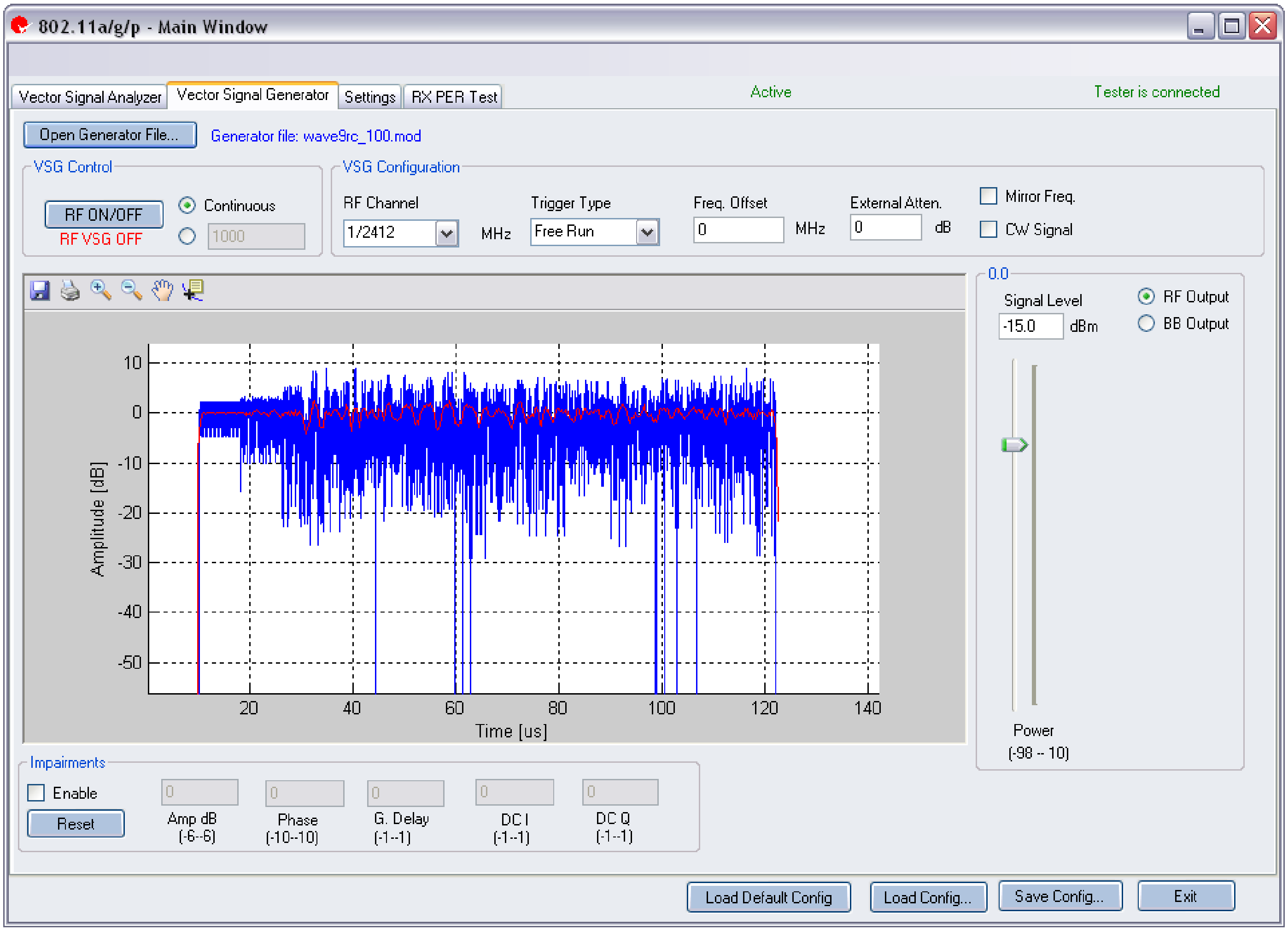


Figure 3-3. IQsignal Application—802.11 a/g/p Vector Signal Generator Screen

Settings

The *Settings* tab allows you to set some of the hardware settings of the VSA/VSG, such as the Instrument VSA IF and all of the analysis parameters to be used by the VSA when measuring the DUT that is connected to the IQ201X test system.

The figure below displays the *802.11 a/g/p Settings* window as an example.

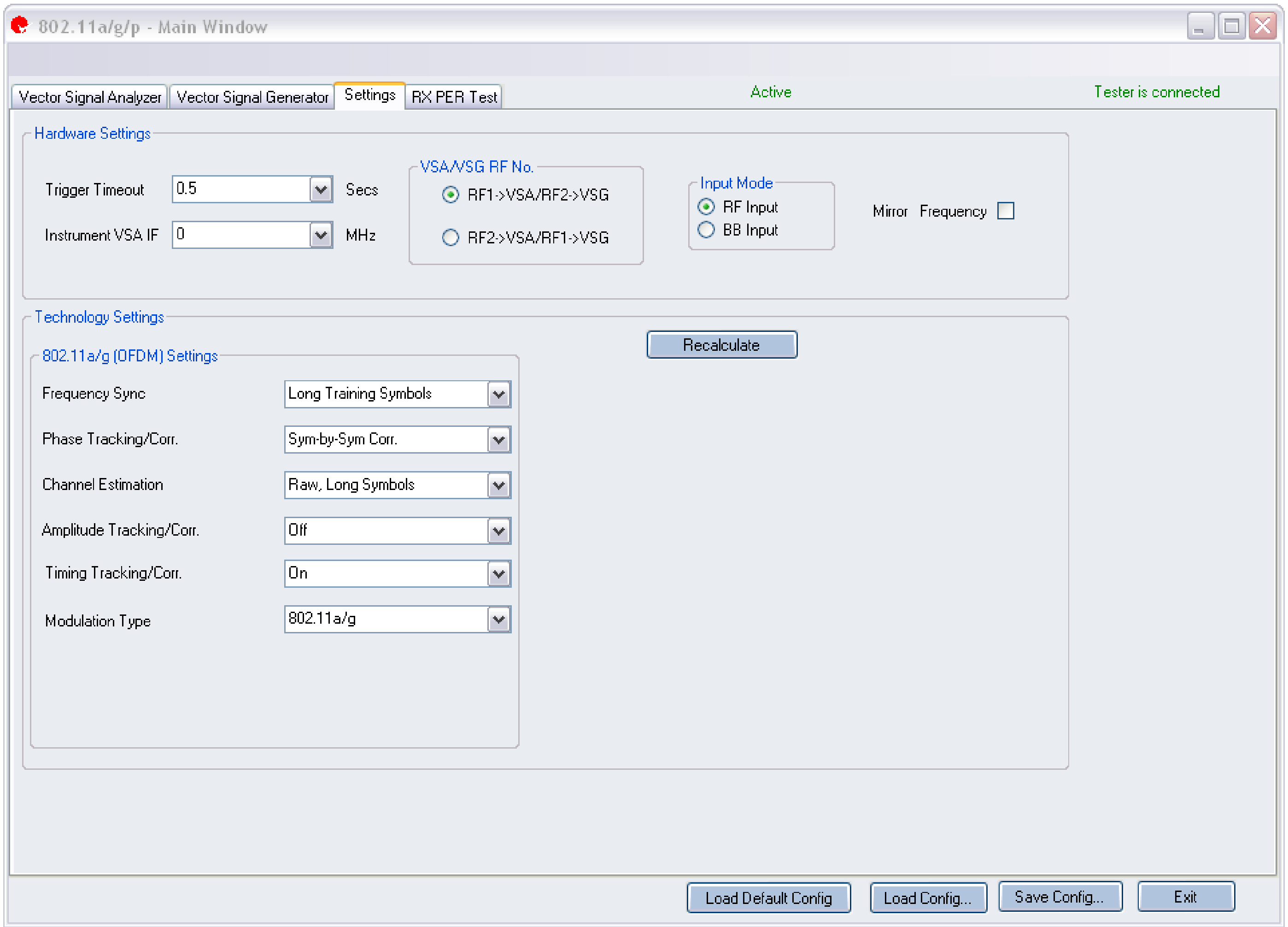


Figure 3-4. IQsignal Application—802.11 a/g/p Settings Screen

RX PER Test

The RX PER test window allows you to check the status of packets sent and received from the DUT.

The figure below displays the *RX PER Test* window as an example.

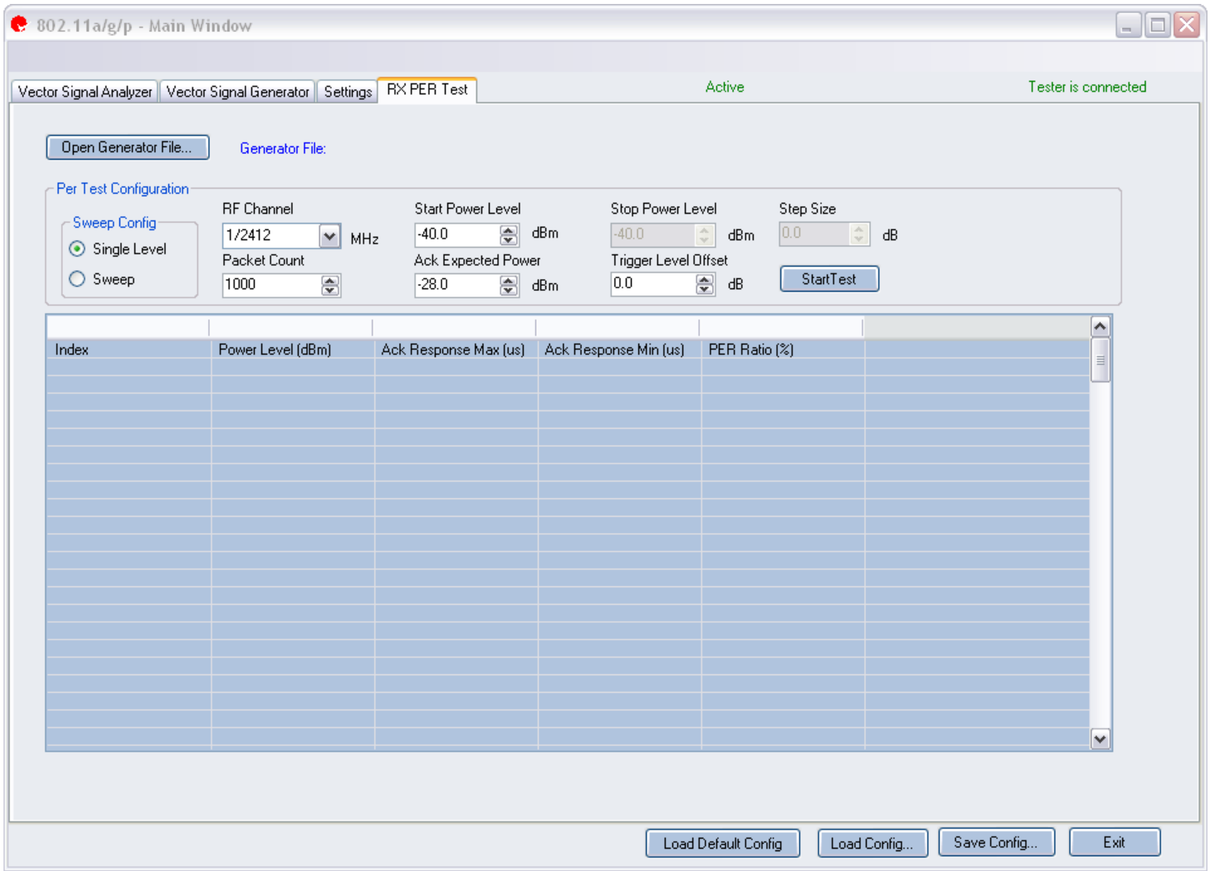


Figure 3-5. RX PER Test

Working with Active Applications

The IQsignal application allows you to perform and analyze a signal capture only if an application is in active mode.

You can open all of the IQsignal applications at the same time, but you can have only one of the following applications active at a given point in time:

- 802.11a/g/p
- 802.11 b
- 802.11 n
- Bluetooth
- 802.16 d
- 802.16 e

The GPS/GLONASS and FM applications are independent of all other applications. You can have only GPS or GLONASS application active at a given point in time. GPS/GLONASS and FM applications can remain active along with an active 802.11, 802.16 or bluetooth application. The FM application window allows you to have either the VSA or the VSG window active at a given point in time.

To make an 802.11, 802.16 or bluetooth application active, connect the main window to the test system, open the application and click inside the window of an application of interest. The GPS/GLONASS and FM applications remain active after you open the application and connect it to the test system.

If an application that is active is capturing a signal in **Continuous** mode, and if you open another application and make it active, the Continuous mode signal capture will cease and you will not be able to complete the signal capture.

The buttons located at the bottom of the window are used for loading and saving the configuration in the *Vector Signal Generator*, *Vector Signal Analyzer* and *Settings* window.

Load Default Config	Loads the default configuration for the VSA and VSG.
Load Config	Allows you to load a configuration file.
Save Config	Allows you to save a configuration. Does not save impairments.
Exit	Allows you to exit the application.

Performing a Signal Measurement Using a Loop-back Connection

Refer to Appendix A for information on signal files for the applications.

This section provides you with an example of how to perform a basic signal measurement.

To perform a signal measurement, do the following:

1. Make sure the test system is connected to the host PC that has the IQsignal application installed.
2. Turn the test system on.
3. On the host PC, go to **Start>All Programs>IQ201X Applications>IQ201X** and launch the IQsignal application.
4. Create a loop-back connection from the VSG to the VSA.
5. Click **Tester Setup**. The window to connect to the tester displays.
6. In the Tester Serial Number window, enter the serial number of the tester to which the PC is connected to and click **Connect**.
7. Click **Close**.
8. In the IQsignal application window, click 802.11 a/g. The IQsignal application for 802.11 a/g opens.

Do not change the default settings in the *Settings*, *Vector Signal Generator*, or *Vector Signal Analyzer* tabs and make sure that the RF Channel Frequency is the same in both, the *Vector Signal Generator*, or *Vector Signal Analyzer* tabs.

9. Click the *Vector Signal Generator* tab and open a Generator (`*.mod`) file and click **RF ON/OFF**.
10. Click the *Vector Signal Analyzer* tab and click **Run**.
11. In the *Vector Signal Analyzer* tab, click **Auto Range**. This optimizes the IQsignal application for signal capture.

You can now analyze, save or export the signal file.

When you change an application from an active to a non-active mode, the test system is reconfigured.

The IQsignal Static and Floating Plot Windows

The IQsignal Vector Signal Analyzer allows you to view the signal plots in two different ways—using a static plot window and a floating plot window.

The static plot window is located at the lower right corner of the window. The floating plot window displays when you click **Plot Window**.

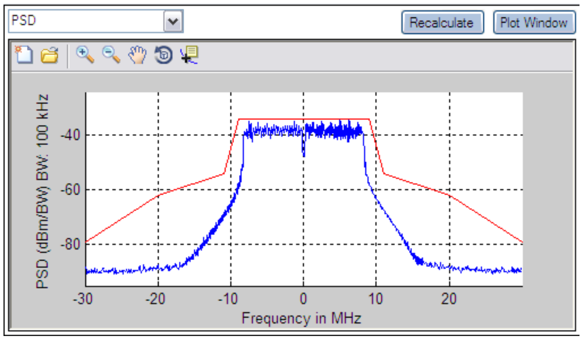


Figure 3-6a. Static Plot Windows

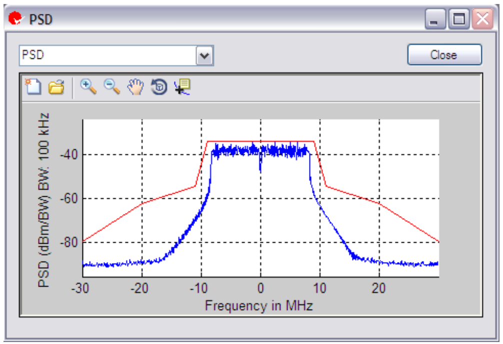


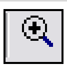
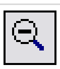
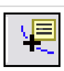
Figure 3-6b. Floating Plot Windows

IQsignal Plot Characteristics

The drop-down menu in the static or floating plot window allows you to select and display a plot that is specific to the application.

The *Amplitude vs. Time* plot cannot be displayed in the floating plot window. To view the plot, you must select the plot from the static plot window.

The table below shows the plot window icons and provides the description for each icon.

Icon	Description
	Click this icon to print the plot.
	Click this icon to zoom in to an area of the plot.
	Click this icon to zoom out of an area of the plot.
	Click this icon to pan the data.
	Click this icon to display the X and Y values of the plot at the cursor location.

To analyze a particular area of the input signal, you can zoom in to that area in the *Amplitude vs. Time* graph. The maximum and minimum values of the time axis determine the section of the signal that is being analyzed. All other plot values are based on the value of this particular area of the input signal being analyzed.

Manipulating the Plots

When you open more than one window, the main window of each application allows you to arrange the windows horizontally, vertically or as a cascade. You can use this window for analyzing multiple plots simultaneously.

If you minimize a window, that window is not included when you arrange the multiple windows.

To arrange the windows horizontally, in the main window, click **Windows>Tile Horizontal**. The figure below shows two plots tiled horizontally.

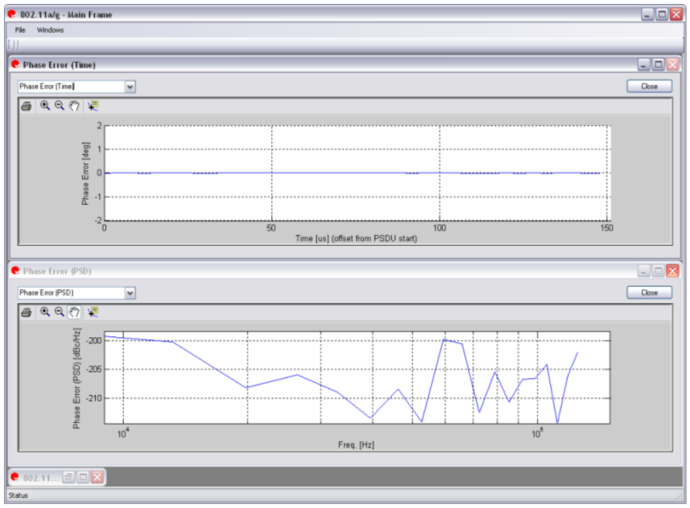


Figure 3-7. IQsignal Application—Tile Horizontal Window

To arrange the windows vertically, in the main window, click **Windows>Tile Vertical**. The figure below shows two plots tiled vertically.

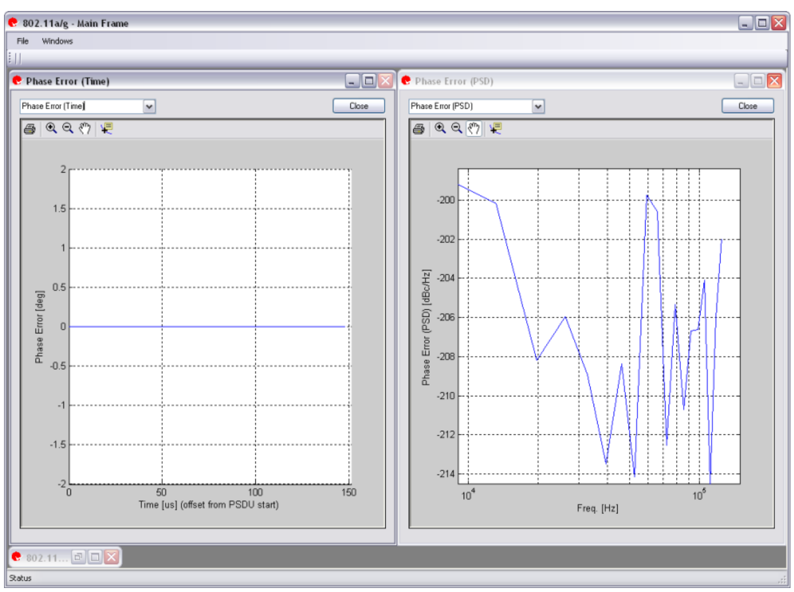


Figure 3-8. IQsignal Application—Vertical Window

To cascade the windows, in the main window, click **Windows>Cascade**. The figure below shows the cascaded plots.

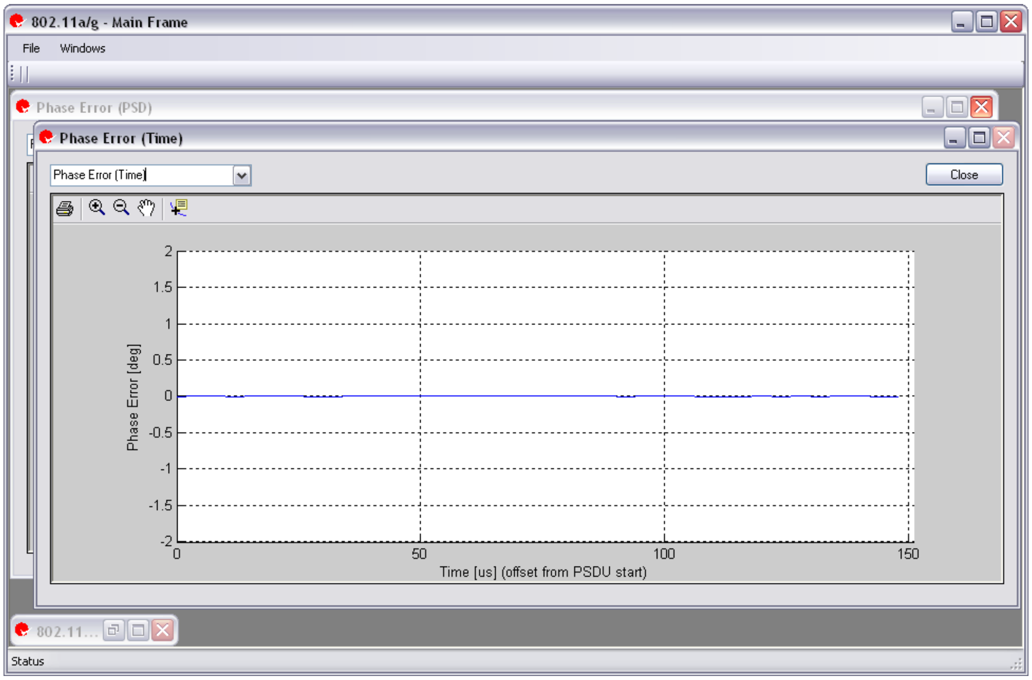


Figure 3-9. IQsignal Application—Cascade Window

Chapter 4 Using LitePoint IQsignal WLAN Applications

This chapter provides you with detailed information on the graphical user interface of the IQsignal WLAN applications.

WLAN

The IQsignal application provides the capability of analyzing complex OFDM signals generated in 802.11 a/g radio frequency (RF) communications.

Additionally, the application is capable of verifying compliance with the applicable 802.11a/g specification.

This application includes four separate tabs:

- **Vector Signal Analyzer**—allows you to set signal capture and analysis parameters
- **Vector Signal Generator**—allows you to set signal generation parameters
- **Settings**—allows you to set hardware settings and VSA analysis parameters
- **RX PER Test**—the RX PER test window allows you to check the status of packets sent and received from the DUT

802.11a/g/p

Vector Signal Analyzer

This section provides you with information on the Vector Signal Analyzer window.

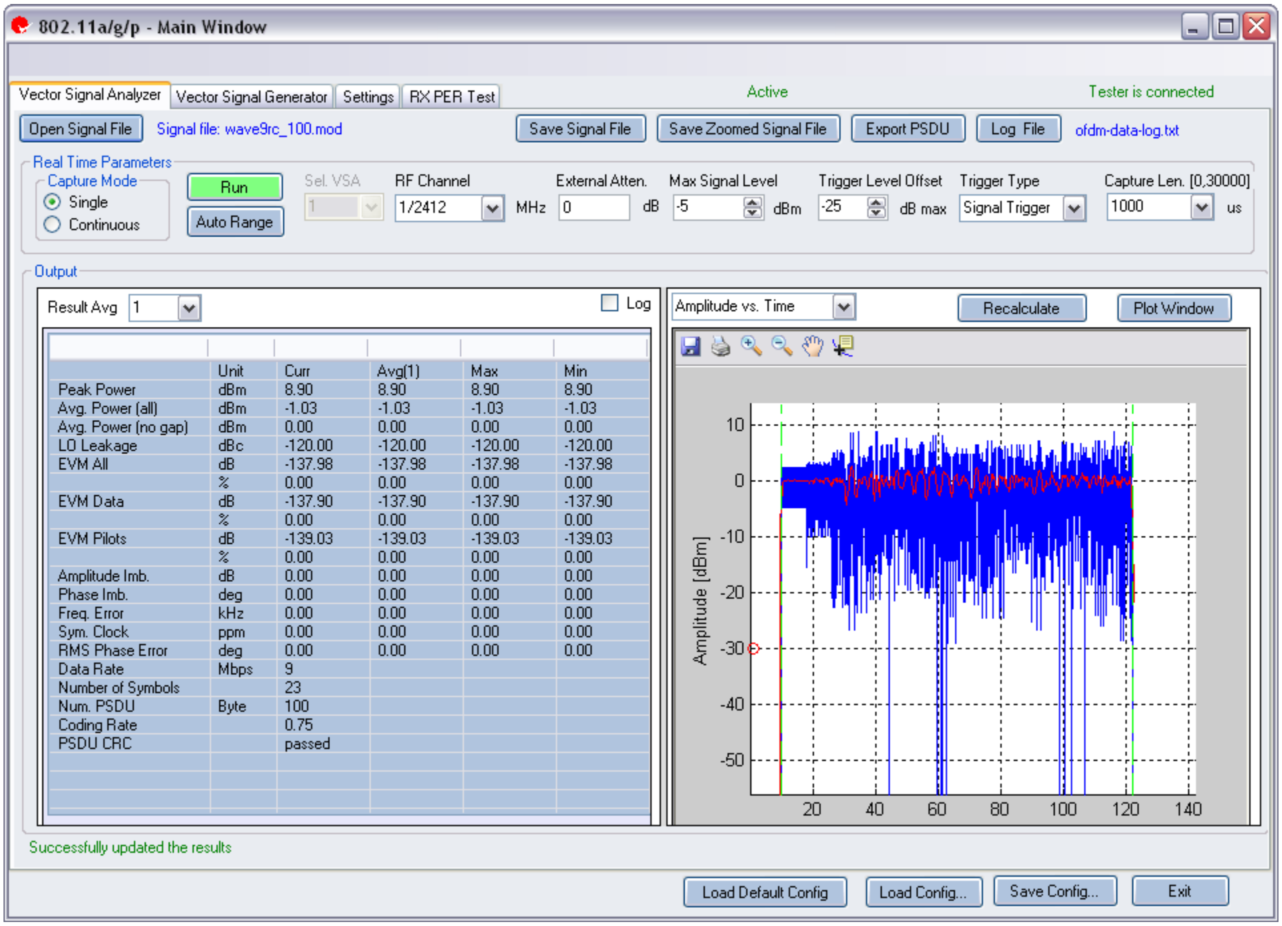


Figure 4-1. IQsignal 802.11a/g/p Application—VSA Screen

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension `.sig`. Wave files with a `.mod` extension can also be opened. The signal file loaded for analysis is independent of the VSA frequency setting. For example, you can load a 20 MHz signal file when the VSA frequency setting is set to 40 MHz.

Save Signal File—Saves captured data to a signal file with extension `.sig` for later analysis.

Save Zoomed Signal File—Saves captured, zoomed data to a signal file with extension `.sig` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Log File—Allows you to save log data to a text file for later analysis.

A `.sig` file is used for signal analysis and a `.mod` file is used by the VSG to generate a signal. A signal file can only be saved with a `.sig` or a `.mod` extension.

Real Time Parameters

RF Channel	Indicates RF channel number and frequency.
Capture Length	Specifies the VSA capture length.
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Trigger Type	This field sets the trigger type Free Run, Signal Trigger or External Trigger. **Free Run—**no trigger; immediate capture **Signal Trigger—**The RF signal level is used to trigger a capture (this type available in RF input mode only) **External Trigger—**An external signal applied to the instrument's Trigger Input port is used to trigger a capture.
Trigger Level Offset	This field specifies the VSA trigger level, relative to the Maximum Signal Level in Signal Trigger Mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box that can be adjusted in increments of 1. After a data capture, a red circle appears to the extreme left of the *Amplitude vs. Time* display, indicating the current trigger level.
Max. Signal Level	Specifies the gain of the VSA receiver chain. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Click **Auto Range** to perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends using *Auto Range* for the first data capture of a DUT. You can also use this feature when the received signal levels have changed significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on all test instruments in the configuration when you click **Run**. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses after you click **Run**. After you click **Run** in *Continuous* mode, the text on the *Run* button changes to *Stop*. Click **Stop** to stop the VSA from operating in the continuous data capturing mode. It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Output

Results Averaging		This field specifies the size of the averaging buffer for averaged measurements. The selections are 1, 10, 20, 40, 60, 80, and 100 averages.
Recalculate		Performs the analysis on the captured data. Recalculates analysis results based on the current analysis settings for the currently zoomed-in signal portion of the plot. When you select an area of the plot with the zoom tool and then click **Recalculate**, the analysis is performed on the selected area only. *Recalculate* is also used to repeat the analysis after changes to the analysis settings have been made.
Plot Window		Opens a window to view the plots.
Results	Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm. This result is displayed on any signal regardless of analysis result.
	Avg. Power (all)	This power measurement is the average power, averaged over the full capture. This result is displayed on any signal regardless of analysis result.
	Avg. Power (no gap)	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts. This result is displayed on any signal, regardless of analysis result.
	EVM all	Reports error vector magnitude (EVM) in dB, averaged over all sub-carriers in the symbols being analyzed.
	EVM data	Reports error vector magnitude (EVM) in dB, averaged over all data sub-carriers in the symbols being analyzed.
	EVM pilots	Reports error vector magnitude (EVM) in dB, averaged over all pilot sub-carriers in the symbols being analyzed.
	Amplitude Imb	Reports IQ amplitude mismatches (in dB) between the in-phase and quadrature components of the transmit chains.
	Phase Imb	Reports IQ phase mismatches (in degrees) between the in-phase and quadrature components of the transmit chains.
	Freq Error	Reports frequency error in kHz.
	Sym. Clock	Reports symbol timing clock error in PPM.
	RMS Phase Noise	Reports phase error in RMS degrees.
	Data Rate	PHY-layer data rate in megabits per second.
	Number of Symbols	Number of OFDM symbols in PSDU
	Num PSDU	Number of PSD Units
	Coding Rate	Indicates the coding rate used when encoding/decoding the data bits with the convolutional encoder.
	PSDU CRC Fail	Indicates if the CRC checksum bits at the end of the payload data are valid or not.

802.11 a/g Plots

Amplitude Error vs. Time	Presents the difference in symbol power at a given symbol in the packet vs. the power of the symbols of the long training sequence (LTS).
Amplitude vs. Time	Instantaneous and peak power averaged over symbol duration (dBm) versus time.
CCDF	Probability of peak signal power being greater than a given power level versus peak-to-average power ratio (dB).
Symbol Const.	Shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.
EVM vs. Carrier	Error Vector Magnitude averaged over all symbols for each subcarrier (dB) versus OFDM subcarrier number.
EVM vs. Symbol	Displays EVM for each symbol averaged over all sub-carriers within frame data.
Freq. Error	The Frequency Error graph displays the frequency error of the captured data during the preamble.
I/Q Signals	The I&Q Signals shows the I and Q signals voltages plotted against time. The I Channel is plotted in red and Q channel in green.
LO (DC) Leakage	The LO (DC) Leakage result is measured during the long training symbol. It shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage.
Phase Error (Time)	Analyzes phase error versus time. Graphs the estimated phase error (noise) of the synthesizer vs. time during the burst. This measurement is also known as *Common Phase Error*.
Phase Error (PSD)	Analyzes phase versus frequency. Graphs the estimated PSD plot of the synthesizer measured during the burst. This data is derived by calculating the PSD of the estimated phase errors per symbol.
Spectral Flatness	Shows the spectral flatness of the sub-carrier spectrum as compared with the limits imposed by the 802.11 specification.
STS Pretzel	The Short Training Symbols (STS) pretzel, is an x-y plot of the I signal (along the x, or real, axis) versus the Q signal (along they, or imaginary, axis) during the short preamble. The term 'pretzel' refers to the pretzel-like shape of the plot.
Spectrogram	The spectrogram mode analyzes the power spectrum of the capture over time. In many cases there can be a disturbing signal that will be difficult to analyze with a normal spectrum plot.
Spectrum Mask	The spectrum mask plot displays PSD over frequency.

Amplitude Error vs. Time

The Amplitude Error vs.Time graph presents the difference in symbol power at a given symbol in the packet vs. the power of the symbols of the long training sequence (LTS). This can be used to detect power variation during the packet, as well as providing an estimate of how accurate the channel estimate is.

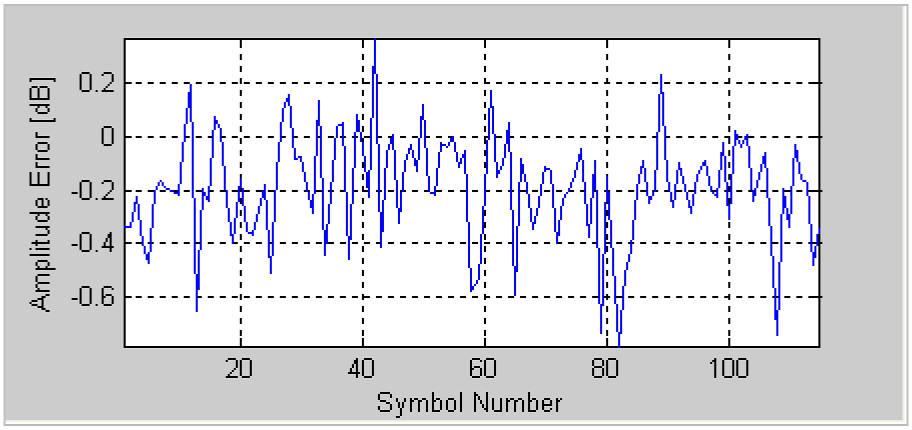


Figure 4-2. IQsignal 802.11a/g—Amplitude Error vs. Time

Amplitude vs. Time

The Amplitude vs.Time Graph shows the captured signal's amplitude over time.

This plot displays a graphical representation of the measured data. The blue trace represents the instantaneous (peak) amplitude value, while the red trace(s) represent(s) the amplitude as a moving average (sliding window of 1µs).

The captured data may include multiple packets or bursts, but only a single packet per capture is analyzed. The analyzed packet is identified by two vertical green dashed lines.

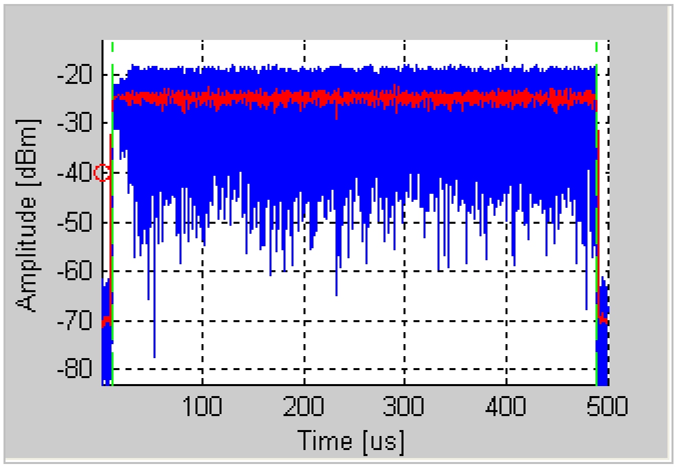


Figure 4-3. IQsignal 802.11a/g—Amplitude vs. Time

CCDF

The figure below displays the CCDF (Complementary Cumulative Distribution Function) graph for OFDM 802.11a/g signal. The blue curve represents the measured signal, and the purple curve represents the ideal curve for an OFDM signal. When compared with an ideal curve, it shows that the OFDM signal is significantly affected by the compression.

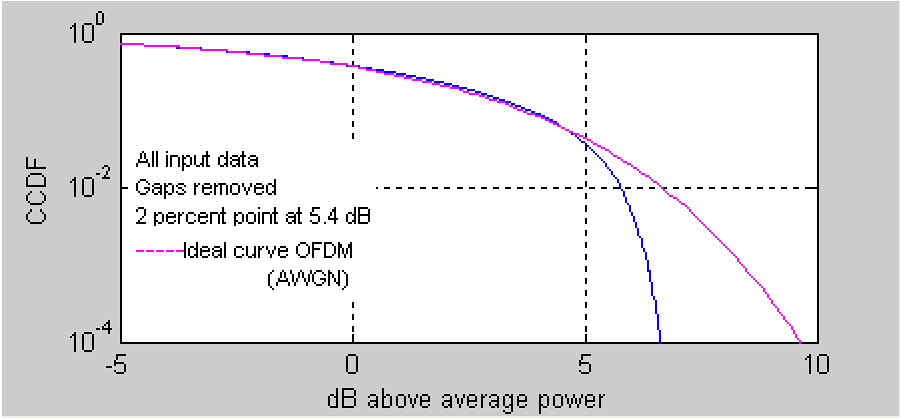


Figure 4-4. IQsignal 802.11a/g—CCDF OFDM Signal

Symbol Constellation

The figure below displays the symbol constellation plot for OFDM 802.11a/g signal. Symbol constellation shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.

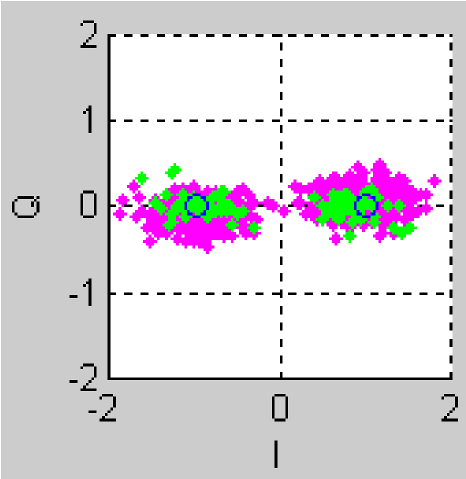


Figure 4-5. IQsignal 802.11a/g—Symbol Constellation

EVM vs. Carrier

The Error Vector Magnitude (EVM) versus the Sub Carrier Number plot graph shows the EVM for each subcarrier averaged over all symbols within the data frame. The figure below illustrates the EVM Versus Carrier graph for OFDM 802.11a/g signal. The green points in the plot represent the rms average EVM of the four pilot carriers, and the red points represent rms EVM of the 48 data carriers.

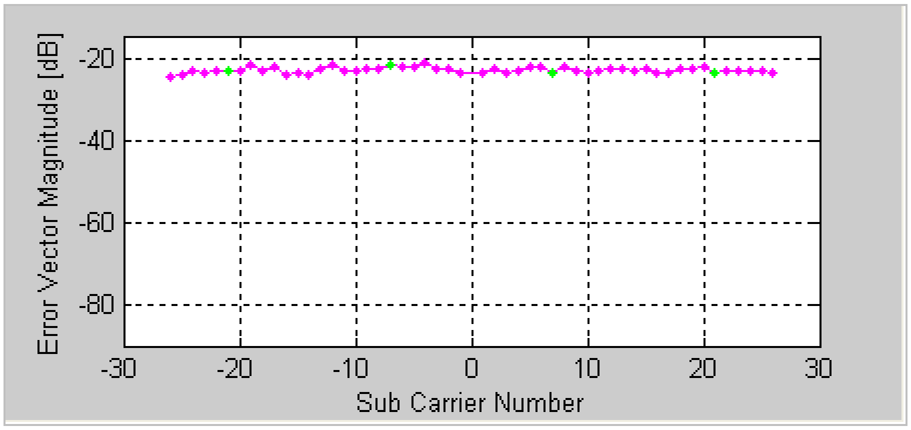


Figure 4-6. IQsignal 802.11a/g—EVM vs. Carrier

EVM vs. Symbol

The EVM versus the Symbol plot shows the EVM for each symbol averaged over all sub-carriers within frame data. The figure below illustrates a graph for the EVM Versus Symbol Number for OFDM 802.11a/g signal. The red points represent the rms EVM for the given symbol.

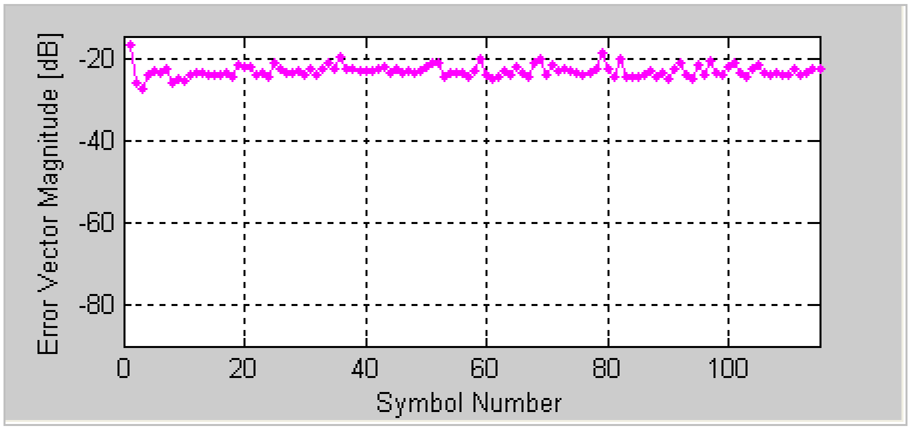


Figure 4-7. IQsignal 802.11a/g—EVM vs. Symbol

Freq. Error

The Frequency Error graph displays the frequency error of the first 16 µsec of the analyzed packet. The figure below illustrates a typical frequency response during the training sequence of an OFDM signal. The first part of the blue graph shows the frequency error during the STS, and the second part illustrates the frequency error of the second symbol in the LTS. The green dots shown represent a linear extrapolation between the two.

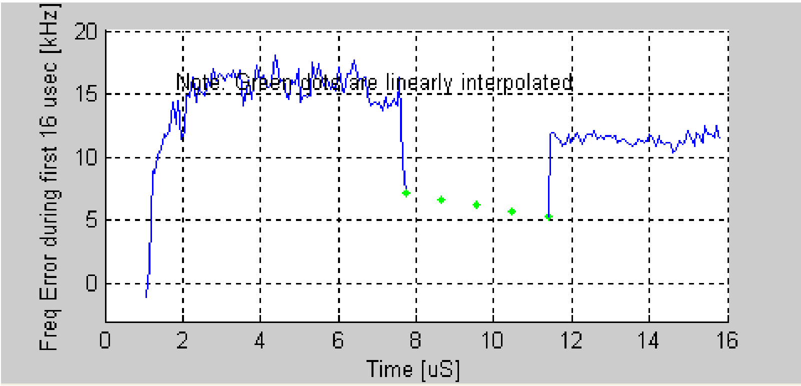


Figure 4-8. IQsignal 802.11a/g—Freq. Error

For OFDM, the frequency error reported in the freq window is measured over the full packet, and does not necessarily correlate with the average frequency error displayed in the graph.

The figure below illustrates frequency pulling of the VCO when the power amplifier is turned on during the short training sequence of an OFDM signal. In this case the frequency settling is completed before the end of the long training symbol. Given this, one should expect significant improvement in the EVM measurement, if one selects the Frequency Sync to use the long Training symbol rather than the short training symbol.

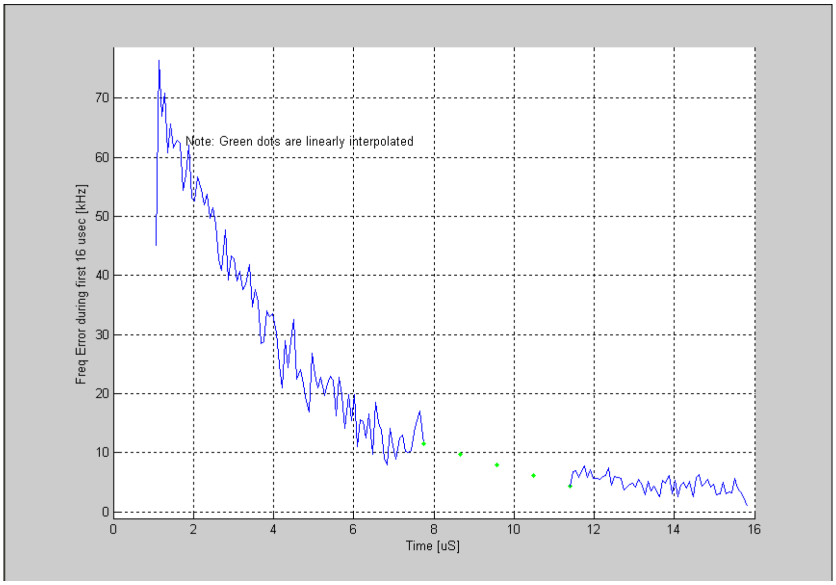


Figure 4-9. IQsignal 802.11a/g—Coarse Frequency Error for Short and Long Training Sequence (OFDM 802.11a/g Signal)

I/Q Signals

The I&Q Signals shows the I and Q signals voltages plotted against time. The I signal is plotted in red and Q channel in green. The figure below illustrates the I&Q Signals graph for OFDM 802.11a/g signal.

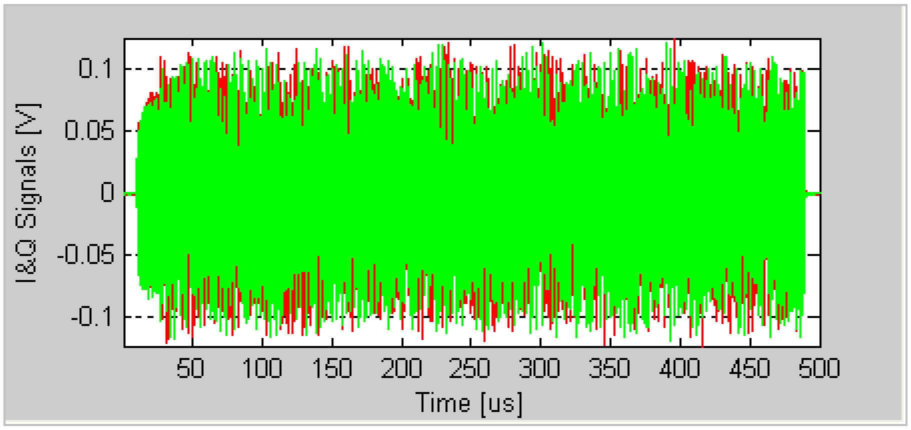


Figure 4-10. IQsignal 802.11a/g—I/Q Signals Plot

LO (DC) Leakage

The LO (DC) Leakage result is measured during the long training symbol. It shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage. The figure below illustrates the LO (DC) Leakage graph for OFDM 802.11a/g signal. The red plus sign (+) represents the IEEE specified 2dB limit.

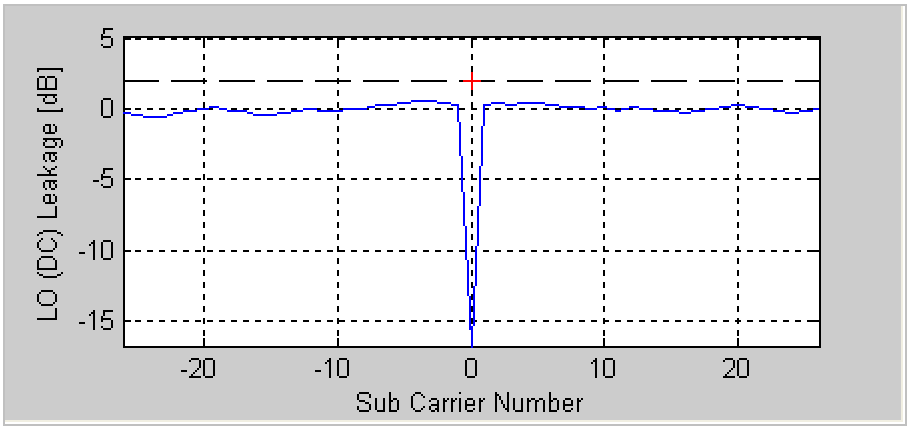


Figure 4-11. IQsignal 802.11a/g—LO DC Leakage Plot

Phase Error (Time)

The figure below illustrates the Phase Error (Time) graph for OFDM 802.11a/g signal. The data is obtained by calculating the common phase error of the pilot carriers for each OFDM symbol. This measurement is also known as Common Phase Error.

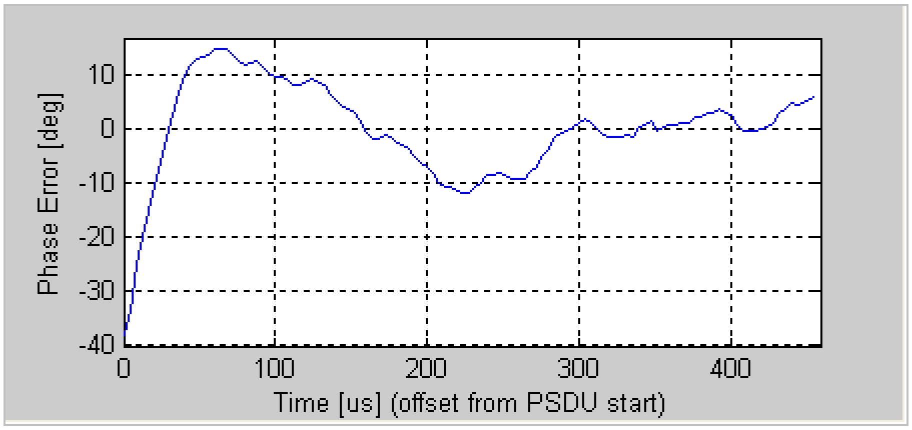


Figure 4-12. IQsignal 802.11a/g—Phase Error (Time) Plot

Phase Error (PSD)

The figure below illustrates the Phase Error (PSD) graph. It is derived by calculating the PSD of the Phase Error (Time) data.

The lower limit of the frequency range is determined by the number of OFDM symbols available for estimation and can be lowered by increasing the number of symbols.

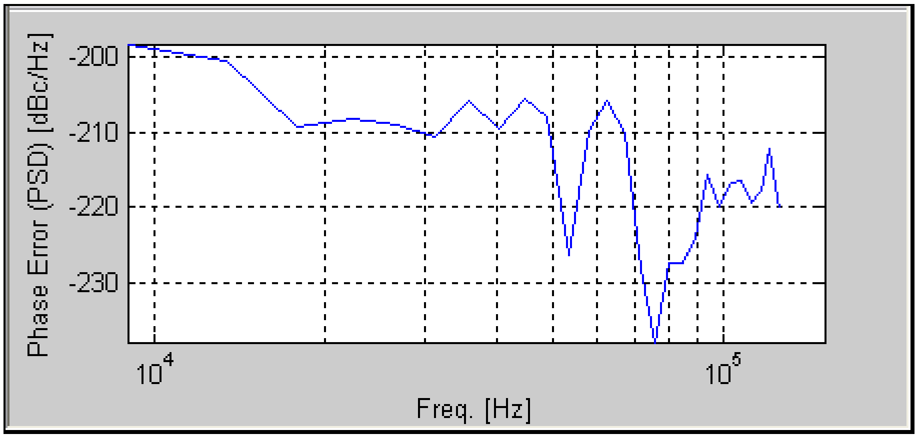


Figure 4-13. IQsignal 802.11a/g—Phase Error (PSD) Plot

Spectrum Mask

The figure below illustrates the Spectrum Mask graph for OFDM 802.11a/g signal. The measurement bandwidth is 100kHz as specified by the IEEE specification. The measurement applies to standard 802.11 a/g signals only. As the other supported OFDM modulations, namely: 802.11 a/g Turbo Mode, ASTM DSRC and Quarter Rate modulations do not have well defined spectral masks, only the spectrum will be shown for these modulations when choosing the spectral mask plot option. The plotted bandwidth stays at +/-30MHz for all analysis.

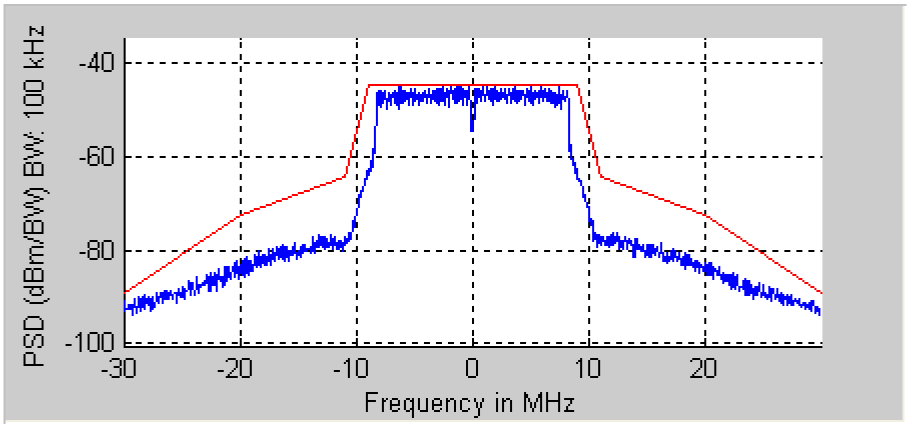


Figure 4-14. IQsignal 802.11a/g—Spectrum Mask Plot

Spectral Flatness

The Spectral Flatness shows an estimate based on the long training sequence of the spectral flatness of the sub-carrier spectrum as compared with the limits imposed by the 802.11 specification.
The figure below illustrates the Spectral Flatness graph for OFDM 802.11a/g signal.

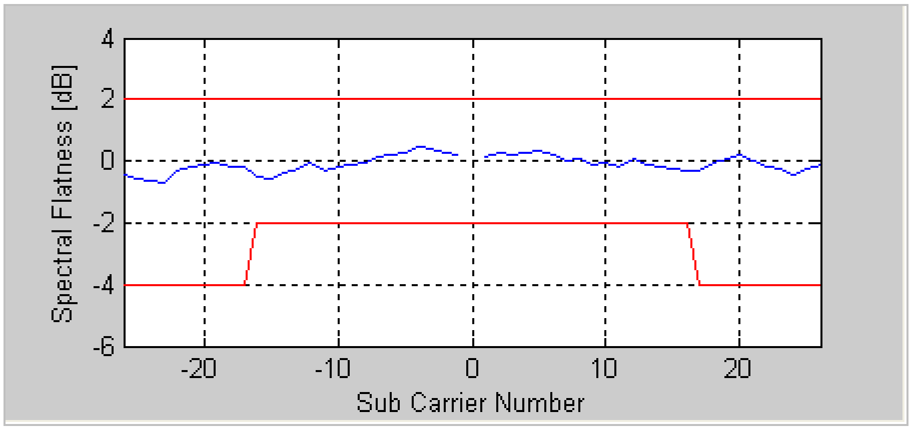


Figure 4-15. IQsignal 802.11a/g—Spectral Flatness Plot

STS Pretzel

The Short Training Symbols (STS) pretzel, is an x-y plot of the I signal (along the x, or real, axis) versus the Q signal (along the y, or imaginary, axis) during the short preamble. The term 'pretzel' refers to the pretzel-like shape of the plot. The effects of phase and frequency errors, compression and filtering, and I/Q mismatch may after some practice) be discerned from the shape of this plot. The figure below illustrates an STS Pretzel measured from an OFDM 802.11a/g signal.

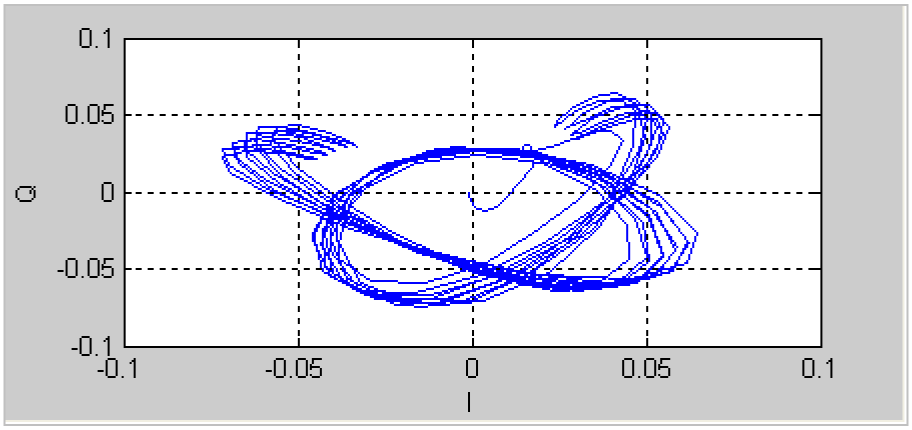


Figure 4-16. IQsignal 802.11a/g—STS Pretzel Plot

Spectrogram

The spectrogram mode is useful for capturing signals with an antenna. In many cases there can be a disturbing signal that will be difficult to analyze with a normal spectrum plot. With the spectrogram the spectrum can be shown over time. The X-axis represents time and the Y-axis represents frequency. The color coding represents the strength on the signal, with red being the maximum strength, and green being minimum strength.

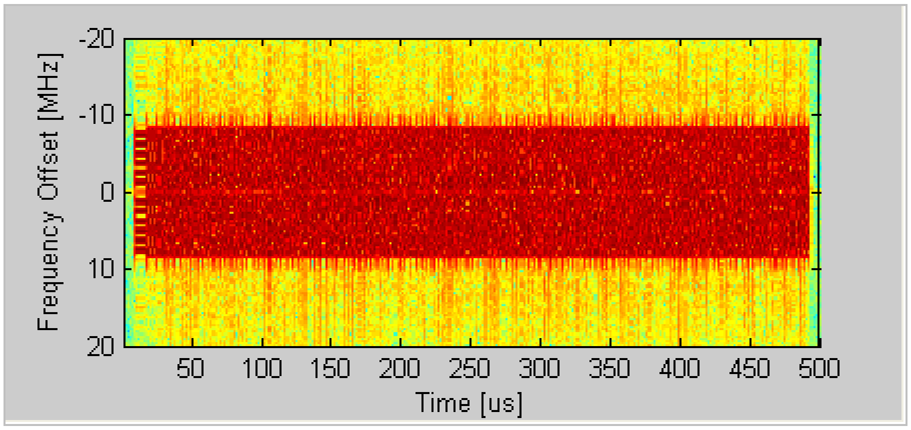


Figure 4-17. IQsignal 802.11a/g—Spectrogram Plot

Vector Signal Generator

This section provides you with information on the *Vector Signal Generator* window.

Open Generator File— Opens modulator file (.mod) and loads data into the Vector Signal Generator. The file has a `*.mod` extension. Data files for most of the 802.11a/b/g data rates are supplied with the IQsignal application. Additional files can be generated with LitePoint's IQwave application or by saving data captured with the VSA, using the `*.mod` extension.

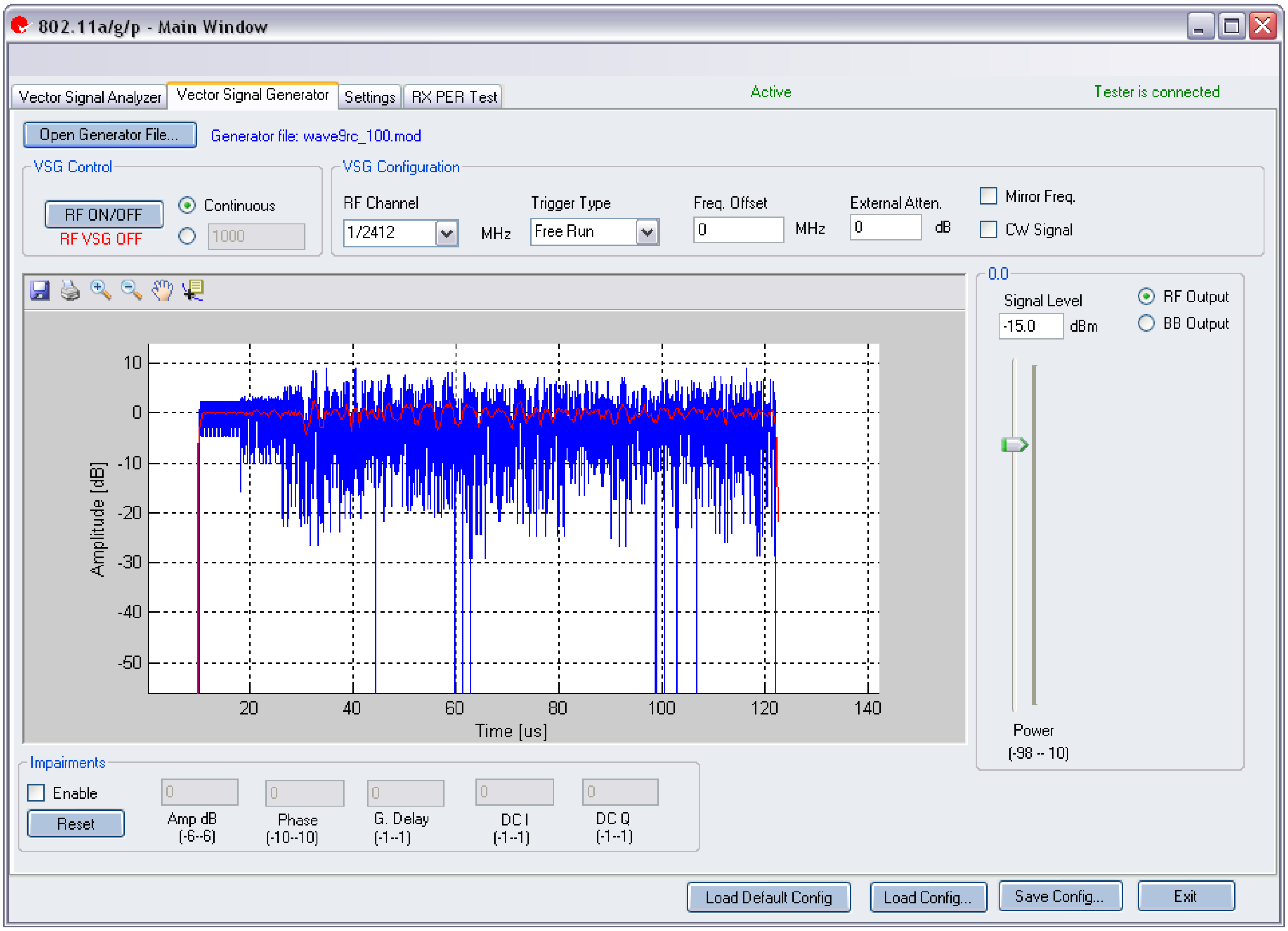


Figure 4-18. IQsignal 802.11a/g Application—VSG window

VSG Control

RF ON/OFF	Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous**—Continuous transmission of waveforms. The range for specified number of packets to be transmitted is between 1 and 65,534. When the VSG signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted (MHz).
Mirror Freq	Mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
CW Signal	Selects this check box for a continuous-wave signal transmission.
Freq. offset	Specifies how much offset of the signal relative to the RF channel frequency is sent out of the VSG. This is specified in KHz.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate start of transmission **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.

Power

Power	Signal Level	Shows the signal level of the current output signal. Use the slider to set the desired level or type the desired level in the input box.
	Power	Sets the output RF power level

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp dB	**Amp (Amplitude Imbalance)**—This field/slider specifies the Amplitude Imbalance in percent. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	**Phase (Phase Imbalance)**—This field/slider specifies the Phase Imbalance in degrees. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	**G (Group) Delay**—This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	**DC (Offset) I**—This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	**DC (Offset) Q**—This field/slider specifies the DC Offset for the Q channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		**Reset**—This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Settings

This section provides you with information on the *Settings* window.

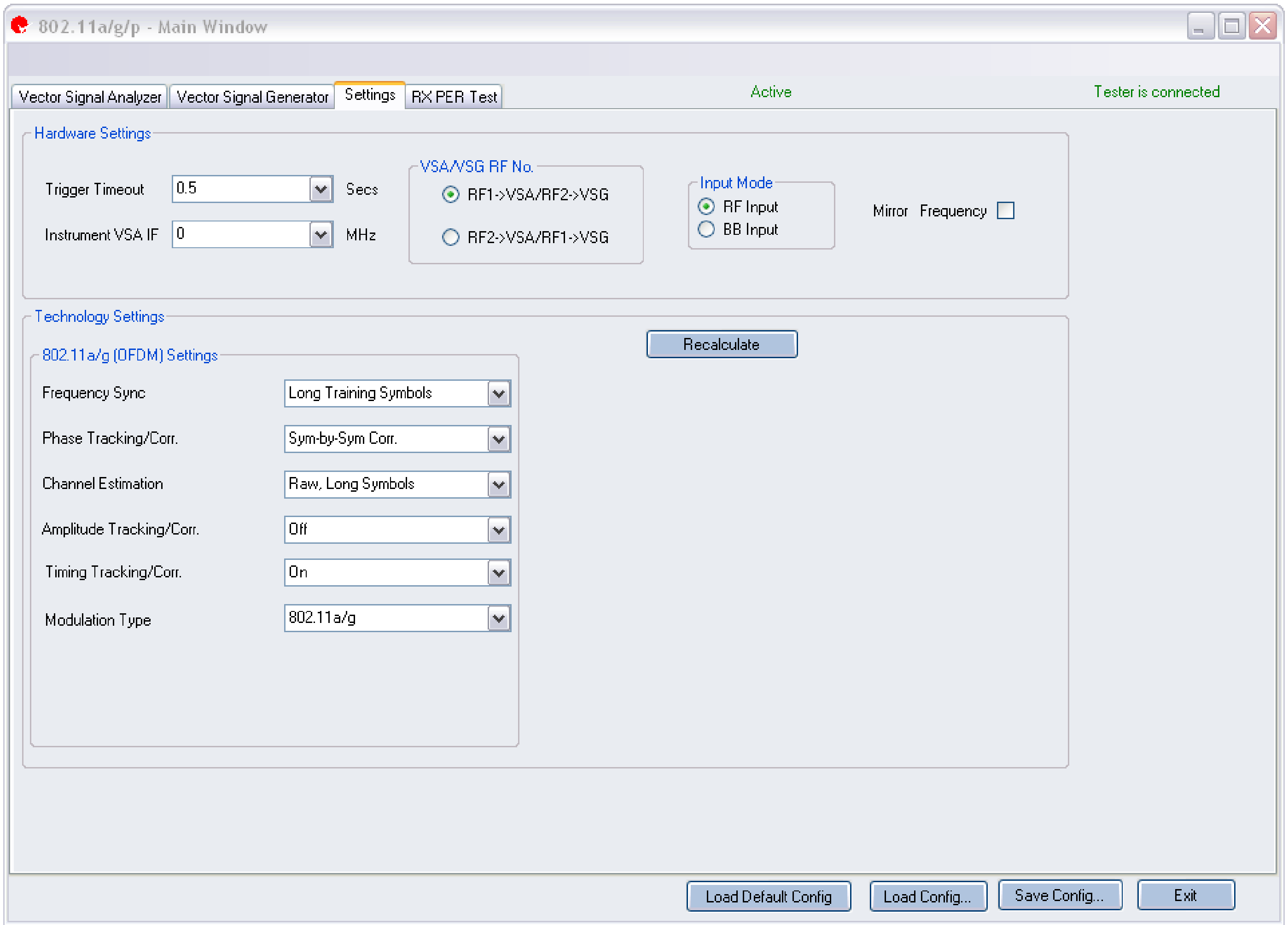


Figure 4-19. IQsignal 802.11a/g Application—Settings Screen

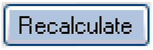
Hardware Settings

Instrument VSA IF	The VSA uses a direct-down conversion scheme; i.e. the down converter is tuned to the center frequency of the RF channel to be captured. In some cases, the residual VSA LO Leakage interferes with a measurement and in this case the VSA is tuned to the center frequency of the RF channel and Instrument VSA IF (in MHz). The analysis software shifts the received signal back to the center frequency.
RF 1->VSA / RF 2->VSG	Uses port #1 for VSA input and port #2 for VSG output.
RF 2->VSA /RF 1->VSG	Uses port #2 for VSA input and port #1 for VSG output.

Mirror Freq.	Mirrors the frequency spectrum of the captured waveform. This is equivalent to flipping the sign of the baseband Q channel.

Technology Settings

802.11a/g (OFDM) Settings	
Phase Tracking/Corr	Phase tracking method selection. Available options are as follows: **OFF—**Can be used when the carriers and references of the transmitter and receiver are phase-locked or when low-frequency carrier phase noise could be present. **Sym-by-Sym—** Tracks the carrier phase symbol by symbol. This is the mode recommended in the standard for EVM measurements. This mode tends to mask the impact phase noise. This can be used as a diagnostic tool in combination with the next option. If the EVM improves significantly when switching from Moving Average to Symbol-to-Symbol, the transmitter is likely to have excessive phase noise. **Moving Avg. 10 Sym.—**Averages phase error over 10 symbols before applying phase corrections. This mode will track phase noise with very low frequencies only.
Frequency Sync	Carrier frequency error estimation method. Before the OFDM symbols are demodulated with an FFT, the received signal has to be corrected for the carrier frequency error. This error is either estimated on the basis of the Short or Long training symbols or over the full packet. Available options are as follows: **Short Training Symbols—**Only the short training symbols at the beginning of the packet are used to estimate the frequency error. **Long Training Symbols—**The short and long training symbols are used to estimate the frequency error. We recommend that you use long training symbols for frequency error estimation. **Full Data Packet—**In addition to the short and long training symbols, the data symbols of the entire packet are used to estimate the frequency error. If the received signal shows frequency dynamics even after the preamble, the Full Data Packet method can be used.
Channel Estimation	This field controls the algorithm used for estimating the channel between the DUT and the VSA. **Raw, Long Symbols—** In this mode the channel estimation algorithm uses the Long Channel Estimation symbols in the preamble. **2nd Order Polyfit—** The channel response is approximated by the best 2nd order polynomial over the frequency band occupied by the long OFDM

	symbols. This mode should only be selected if the channel is essentially flat over the frequency band occupied by the OFDM signal. This mode should not be used when there is a substantial roll-off over the frequency band due to transmit filtering. **Raw, Full Packet—**This option performs channel estimation on the full packet and uses data carriers.
Amplitude Tracking/Corr.	Available options are as follows: **On—**Enables amplitude tracking options for analysis. **Off—**Disables amplitude tracking options for analysis.
Timing Tracking/Corr.	Available options are as follows: **On—**Enables timing track/correlation options for analysis. This is the recommended setting. **Off—**Disables timing track/correlation options for analysis.
OFDM Modulation Type	**802.11a/g—**analyzes normal 802.11 OFDM signals **802.11a/g Turbo Mode—**analyzes Atheros Turbo Mode® signals. The signal resembles a standard OFDM signal with 52 sub-carriers, but everything is spaced at twice that of the normal 802.11 signal, resulting in a signal with approximately 40MHz bandwidth. Additionally the number of symbols in the short training sequence is doubled resulting in the same duration of the short training sequence as in 802.11 OFDM modulated signals. **ASTM DSRC—(**or half rate) analyzes half rate OFDM modulated signals. This signal also resembles a standard OFDM signal with 52 sub-carriers, but everything spaced at half that of the normal 802.11 signal, resulting in a signal with approximately 10MHz bandwidth. **Quarter Rate—**analyzes quarter-rate OFDM signals. The signal resembles a standard OFDM signal with 52 sub-carriers, but everything is spaced at a quarter of that of the normal 802.11 signal, resulting in a signal with approximately 5MHz bandwidth.
	Recalculates analysis results based on the current analysis.

802.11b

The IQsignal application provides the capability of analyzing complex signals generated in 802.11b radio frequency (RF) communications.

Additionally, the application is capable of verifying compliance with the applicable 802.11b specification.

This application includes four separate tabs:

- **Vector Signal Analyzer—**allows you to set signal capture and analysis parameters
- **Vector Signal Generator—**allows you to set signal generation parameters
- **Settings—**allows you to set hardware settings and VSA analysis parameters
- **RX PER Test**—the RX PER test window allows you to check the status of packets sent and received from the DUT

Vector Signal Analyzer

This section provides you with information on the *Vector Signal Analyzer* window.

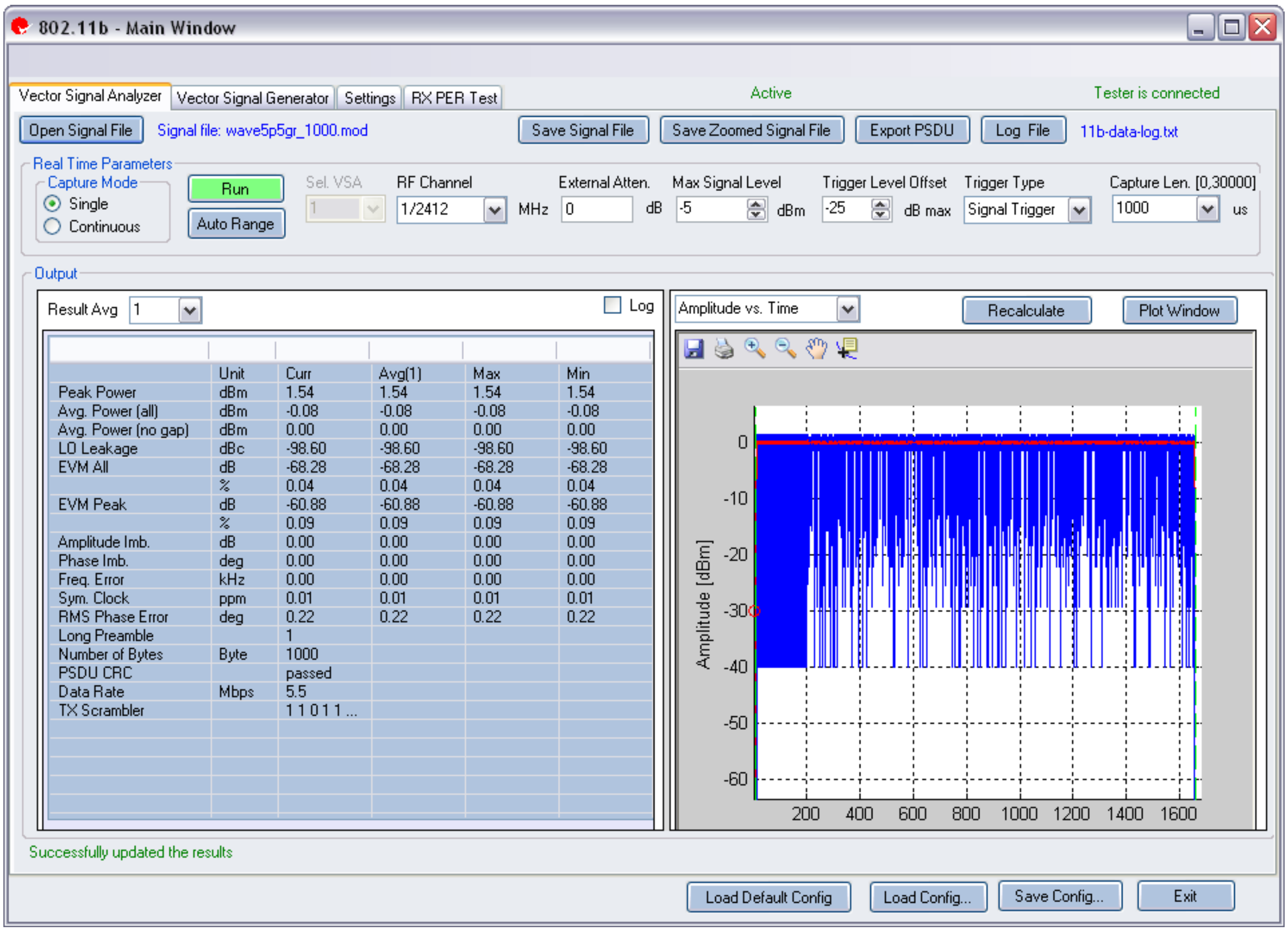


Figure 4-20. IQsignal 802.11b—VSA Screen

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension .SIG. Wave files with extension .MOD can also be opened.

Save Signal File—Saves captured data to a signal file with extension .SIG for later analysis.

Save Zoomed Signal File—Saves captured, zoomed data to a signal file with extension `.sig` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Log File—Allows you to save log data to a text file for later analysis.

A `.sig` file is used for signal analysis and a `.mod` file is used by the VSG to generate a signal. A signal file can only be saved with a `.sig` or a `.mod` extension.

Real Time Parameters

RF Channel	Indicates RF channel number and frequency.
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Capture Length	Specifies the VSA capture length.
Trigger Type	This field sets the trigger type Free Run, Signal Trigger or External Trigger. **Free Run:** no trigger; immediate start of transmission **Signal Trigger:** The RF signal level is used to trigger a capture (this type available in RF input mode only) **External Trigger:** An external signal applied to the instrument's Trigger Input port is used to trigger transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.
Trigger Level Offset	This field specifies the VSA trigger level, relative to the Maximum Signal Level in Signal Trigger Mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box to adjust in increments of 1. After a data capture, a red circle appears to the extreme left of the Amplitude vs. Time display, indicating the current trigger level.
Max. Signal Level	Specifies the gain of the VSA receiver chain. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Pressing the *Auto Range* button will perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends the Auto Range feature for the first data capture of a DUT. You can also use this feature when the received signal level(s) have change significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on all test instruments in the configuration, when you click the Start button. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses, after you click the Start button. After you click the Start button in *Continuous* mode, the text on the *Start* button changes to ***Stop***. Pressing the *Stop* button or selecting the Single mode button will stop the VSA from

		operating in the continuous data capturing mode. It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Output

Results Averaging		This field specifies the size of the averaging buffer for averaged measurements. The selections are 1, 10, 20, 40, 60, 80, and 100 averages.
Recalculate		Performs the analysis on the captured data. Recalculates analysis results based on the current analysis settings for the currently zoomed-in signal portion of the plot. When you select an area of the plot with the zoom tool and then click **Recalculate**, the analysis is performed on the selected area only. *Recalculate* is also used to repeat the analysis after changes to the analysis settings have been made.
Plot Window		Opens a window to view the plots.
Results	Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm. This result is displayed on any signal regardless of analysis result.
	Avg. Power (all)	This power measurement is the average power over the full waveform time. This result is displayed on any signal regardless of analysis result.
	Avg. Power (no gap)	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts. This result is displayed on any signal, regardless of analysis result.
	LO Leakage	The LO (DC) Leakage result is measured during the long training symbol. It shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage.
	EVM all	Reports error vector magnitude (EVM) in dB, averaged over all sub-carriers in the symbols being analyzed.
	EVM Peak	Reports the maximum error vector magnitude (EVM) value in dB over all sub-carriers in the symbols being analyzed.
	Amplitude Imb	Reports IQ amplitude mismatches (in dB) between the in-phase and quadrature components of the transmit chains.
	Phase Imb	Reports IQ phase mismatches (in degrees) between the in-phase and quadrature components of the transmit chains.
	Freq Error	Reports frequency error in kHz.
	Sym. Clock	Reports symbol timing clock error in PPM.
	RMS Phase Noise	Reports phase error in RMS degrees.
	Long Preamble	Reports the long preamble of the data.
	Num of Bytes	Payload data.
	PSDU CRC Fail	Indicates if the CRC checksum bits at the end of the payload data are valid or not.

	Data Rate	Data rate of the signal.
	TX Scrambler	The 802.11b data is fed through a scrambler in the transmitter. The initial state of this scrambler is explicitly available in a 802.11b signal. This initial state, as measured, is displayed in this field.

802.11b Plots

Spectral Mask	Plots the power density versus the frequency spectrum for the analyzed signal, over the range of +/- 30 MHz from the center frequency
CCDF	Plots the peak to average power distribution, an alternative measure for crest factor. The horizontal axis is for the power level above the average power level, and the vertical axis plots the probability of that power level occurring. The CCDF is only measured over a single packet, so the gap does not contribute to the measurement. The packet used for the analysis is marked with purple markers. If the capture contains more than one packet, one can zoom on the other packet in the capture, and press the Zoom button, where after the CCDF is calculated for the packed displayed in the main analysis window. This graph reveals any compression of the signal that may exist.
I/Q Signals	The I&Q Signals shows the I and Q signals voltages plotted against time. The I channel is plotted in red, the Q channel in green.
Symbol Const	Shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame. For 802.11b symbols of the preamble are colored green, and the data symbols are colored red.
Phase Error (Time)	Analyzes phase error versus time. Graphs the estimated phase error (noise) of the synthesizer vs. time during the burst.
EVM vs. Symbol	Shows error vector magnitude captured over time.
Freq. Error	The frequency error graph displays the frequency error of the captured data packet.
Eye Diagram	The eye graph analyzes the error vector magnitude.
LO (DC) Leakage	Shows the energy level of the carriers relative to that of ± 1 MHz of the center of the overall signal and therefore reveals the amount of LO Leakage.
Power Down Ramp	Analyzes the down-ramp time for an 802.11b signal. For accurate results an un-modulated CW signal should be used.
Power On Ramp	Analyzes the on-ramp time for an 802.11b signal. For accurate results, an un-modulated CW signal should be used.
Spectrogram	Analyzes the power spectrum of the capture over time. The display is a “top view” of a spectrum analyzer over time, where the color coding represents the signal strength at the given frequency. Red represents the strongest signal and green represents the weakest signal.
Amplitude vs. Time	Instantaneous and peak power averaged over symbol duration (dBm) versus time.

CCDF

The figure below displays the CCDF (Complementary Cumulative Distribution Function) graph for OFDM 802.11b signal. The blue curve represents the measured signal, and the purple curve represents the ideal curve for an OFDM signal.

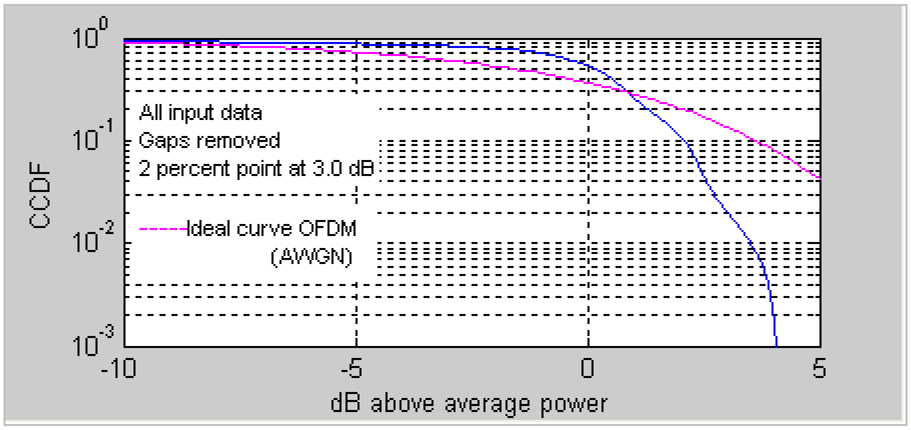


Figure 4-21. IQsignal 802.11b—CCDF OFDM Signal

Symbol Const

The Symbol Constellation graph, shown in the figure below shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.

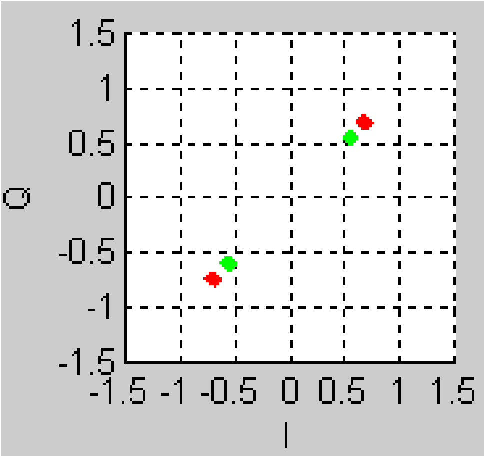


Figure 4-22. IQsignal 802.11b—Symbol Constellation Plot

Eye Diagram

The Eye graph analyzes the error vector magnitude.

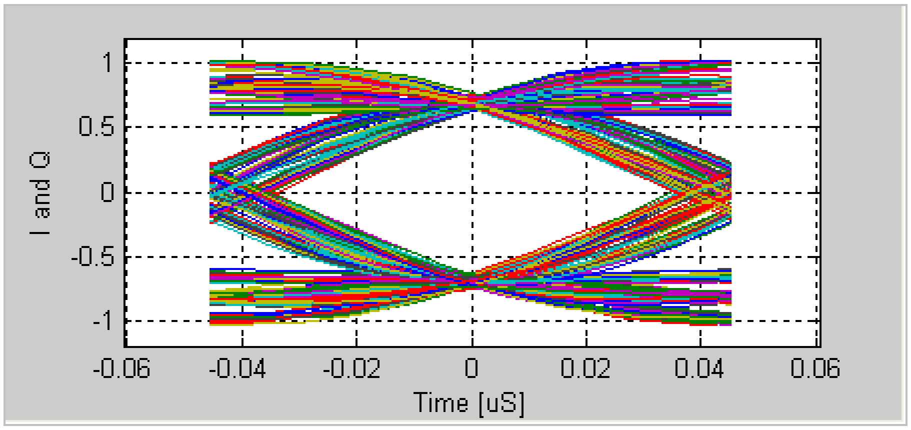


Figure 4-23. IQsignal 802.11b—Eye Diagram Plot

Freq. Error

The Frequency Error graph displays the frequency error of the captured data. The frequency error throughout the packet is displayed. In the figure below, the blue line represents the instantaneous frequency measured over symbol. The red line is the frequency averaged over symbols.

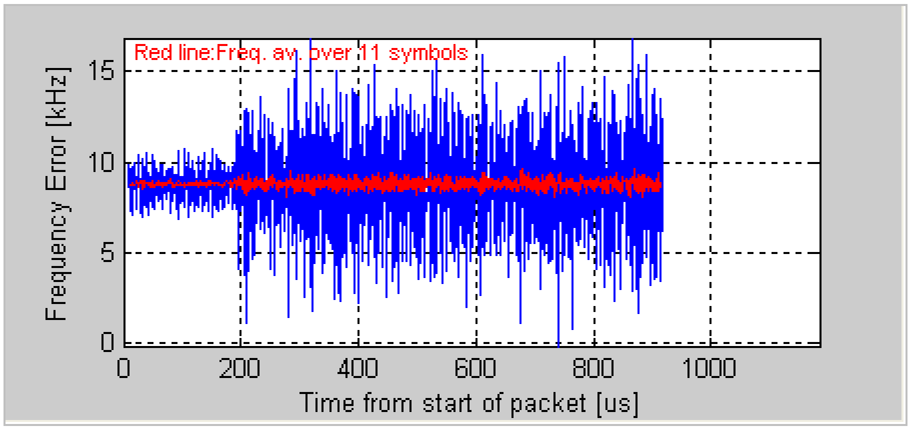


Figure 4-24. IQsignal 802.11b—Frequency Error Plot

I/Q signals

The I&Q Signals shows the I and Q signals voltages plotted against time. The figure below illustrates the I&Q Signals graph for 802.11b.

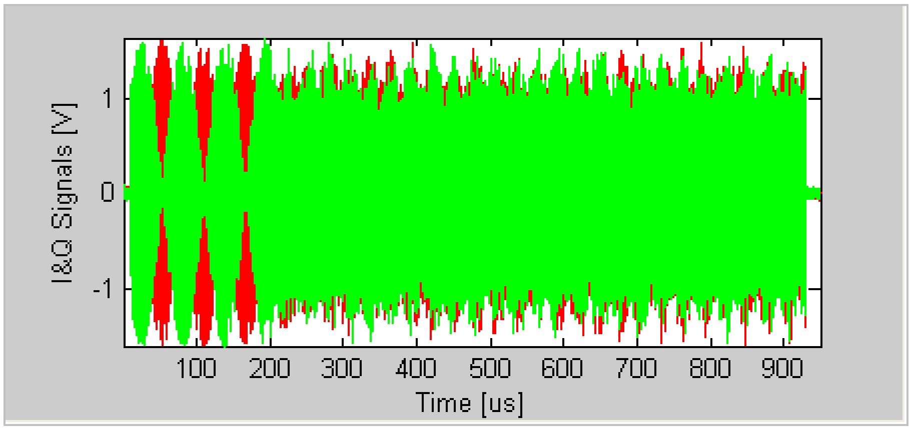
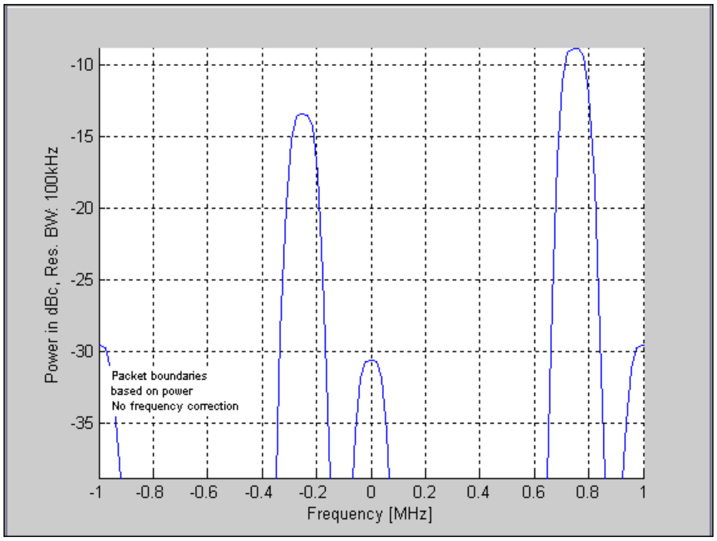
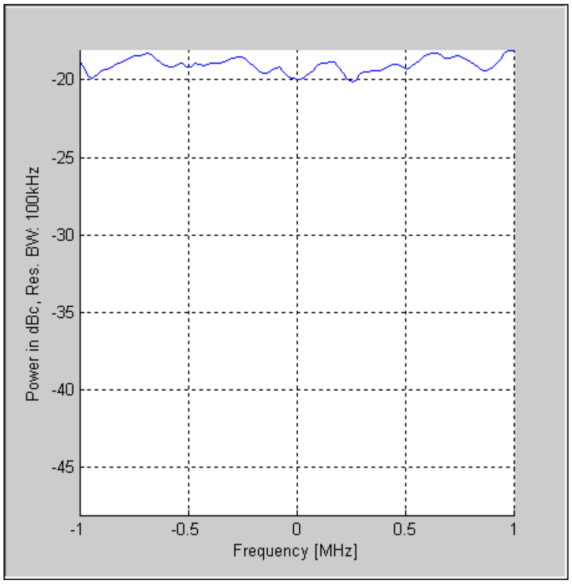


Figure 4-25. IQsignal 802.11b—I/Q Signals Plot

LO (DC) Leakage

According to the 802.11b standard, measuring LO leakage on an 802.11b DSSS signal requires a special test signal that is provided by the DUT. According to the IEEE specification [1] a 0101 modulated signal with the scrambler turned off must be transmitted.





IQsignal 802.11b

Figure 4-26a. LO (DC) Leakage for Correct[1] Test Signal

Figure 4-26b. LO (DC) Leakage for 802.11b DSSS Signal

[1] The test information presented in the left figure is caused by lack of packet header in the test signal.

The figure above shows the LO leakage measurement window for the special test signal as well as a normal 802.11b DSSS signal when measuring LO leakage.

Phase Error (Time)

The figure below illustrates the Phase Error (Time) graph for a CCK modulated 802.11b signal. The abrupt change in the graph illustrates the transition from BPSK modulation to QPSK modulation.

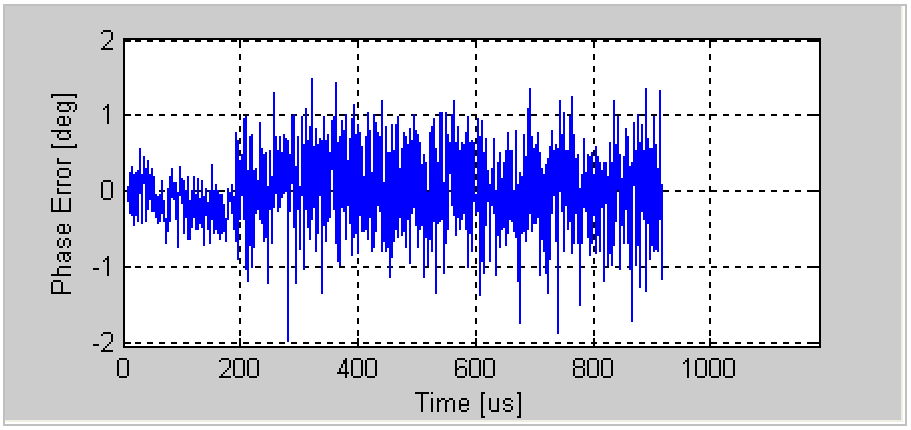


Figure 4-27. IQsignal 802.11b—Phase Error (Time) Plot

Power On Ramp

The figure below illustrates the Power Down Ramp graph for 802.11b (CCK) modulated signal. The plot shows an averaged version of the power (Black) as well as a peak hold measured over a 1µs rolling window (Green). The measured Power-Down time is presented (the time it takes the power to go from 90% to 10%), along with information of the time difference between the time where the packet goes below 90% for more than 1µs and the actual end of the packet1. The nature of the CCK signal may cause erroneous power down results. Using an un-modulated CW signal provides the most reliable measurement results.

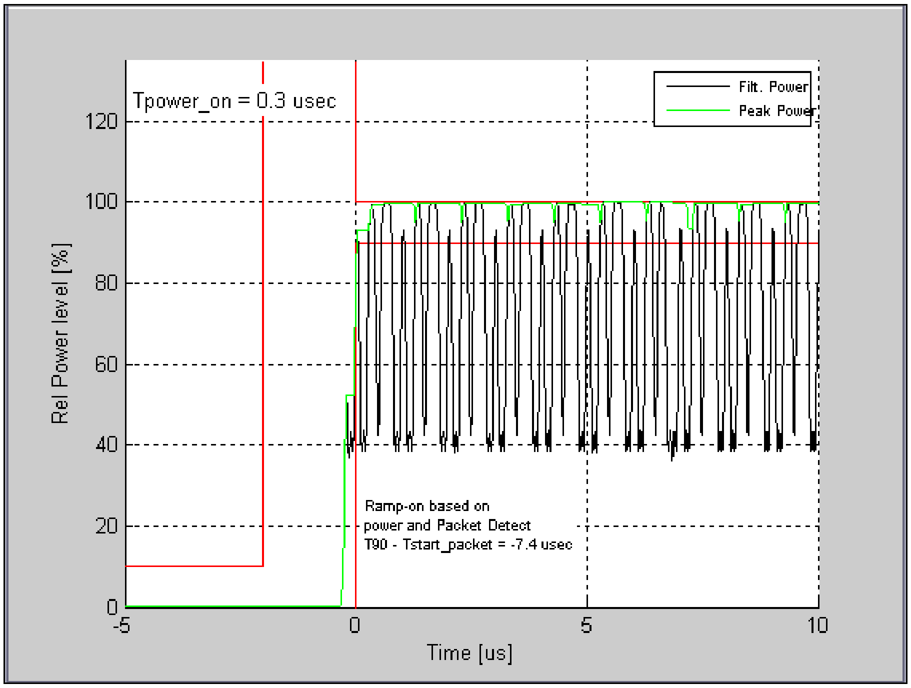


Figure 4-28. IQsignal 802.11b—Power On Ramp Plot

Spectral Mask

The figure below illustrates the Power Spectrum Density (PSD) graph for an 802.11b signal. The measurement bandwidth is 100kHz as specified by the IEEE specification. The plotted bandwidth stays +/-30MHz for all analysis.

Power spectral density plot can be used to display the power spectral density of signals other than 802.11 signals. The power spectral density of, for e.g. a CW signal, can be displayed when the system is operated in free-run mode.
The figure below illustrates the Spectrum Mask graph for OFDM 802.11b signal.

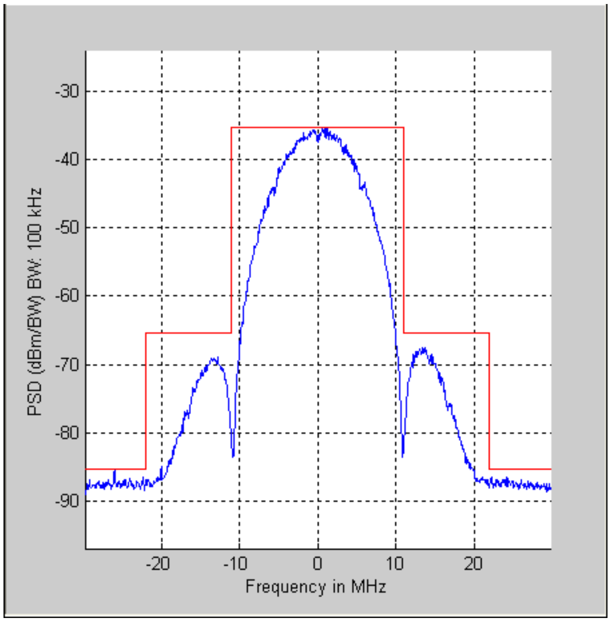


Figure 4-29. IQsignal 802.11b—PSD Plot

EVM vs. Symbol

The figure below illustrates the EVM versus time for 802.11b signal with the 11b EVM calculation set to “rms error vector”. The instantaneous EVM per symbol is plotted - the blue lines. The red line in the graph shows the EVM averaged over 11 symbols (chips). The horizontal axis is time since start of packet. The plot shows the EVM over the full packet, except for the first approximately 10 µsec.

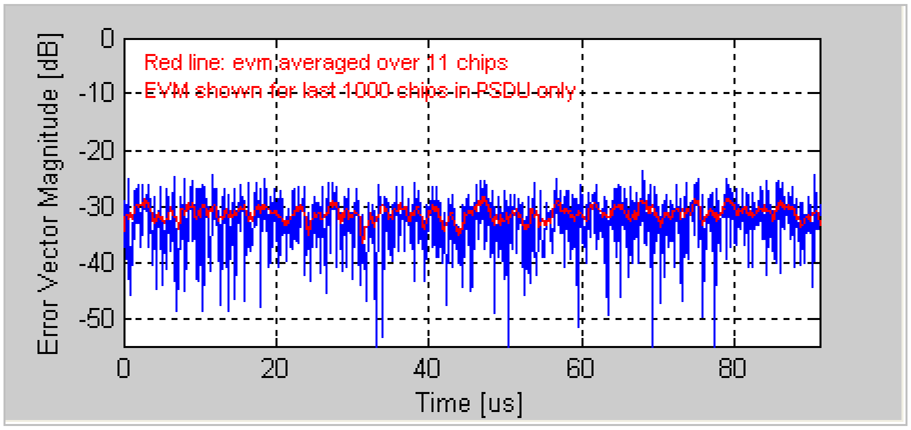


Figure 4-30. IQsignal 802.11b—EVM vs. Symbol Plot

Ampl. vs. Time

Shows the captured signal's amplitude over time. The plot shows both instantaneous power and the peak power averaged over a symbol time.

The captured data may include multiple packets or bursts, but only a single packet per capture is analyzed. The analyzed packet is identified by two vertical green dashed lines.

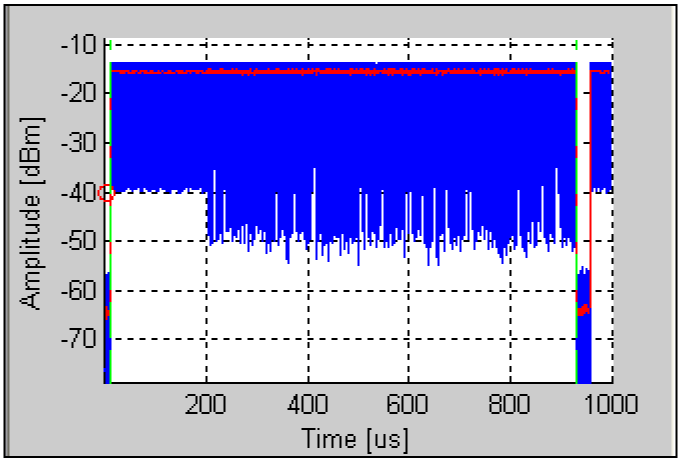


Figure 4-31. IQsignal 802.11b—Amplitude vs. Time

Spectrogram

Analyzes the power spectrum of the capture over time. The display is a "top view" of a spectrum analyzer over time, where the color coding represents the signal strength at the given frequency. Red represents the strongest signal and green represents the weakest signal.

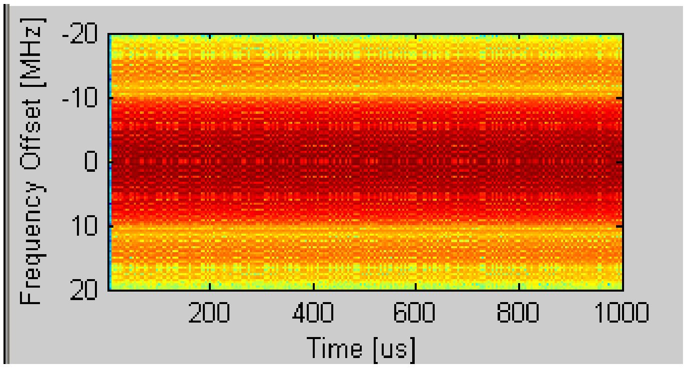


Figure 4-32. IQsignal 802.11b—Spectrogram

Vector Signal Generator

This section provides you with information on the *Vector Signal Generator* window.

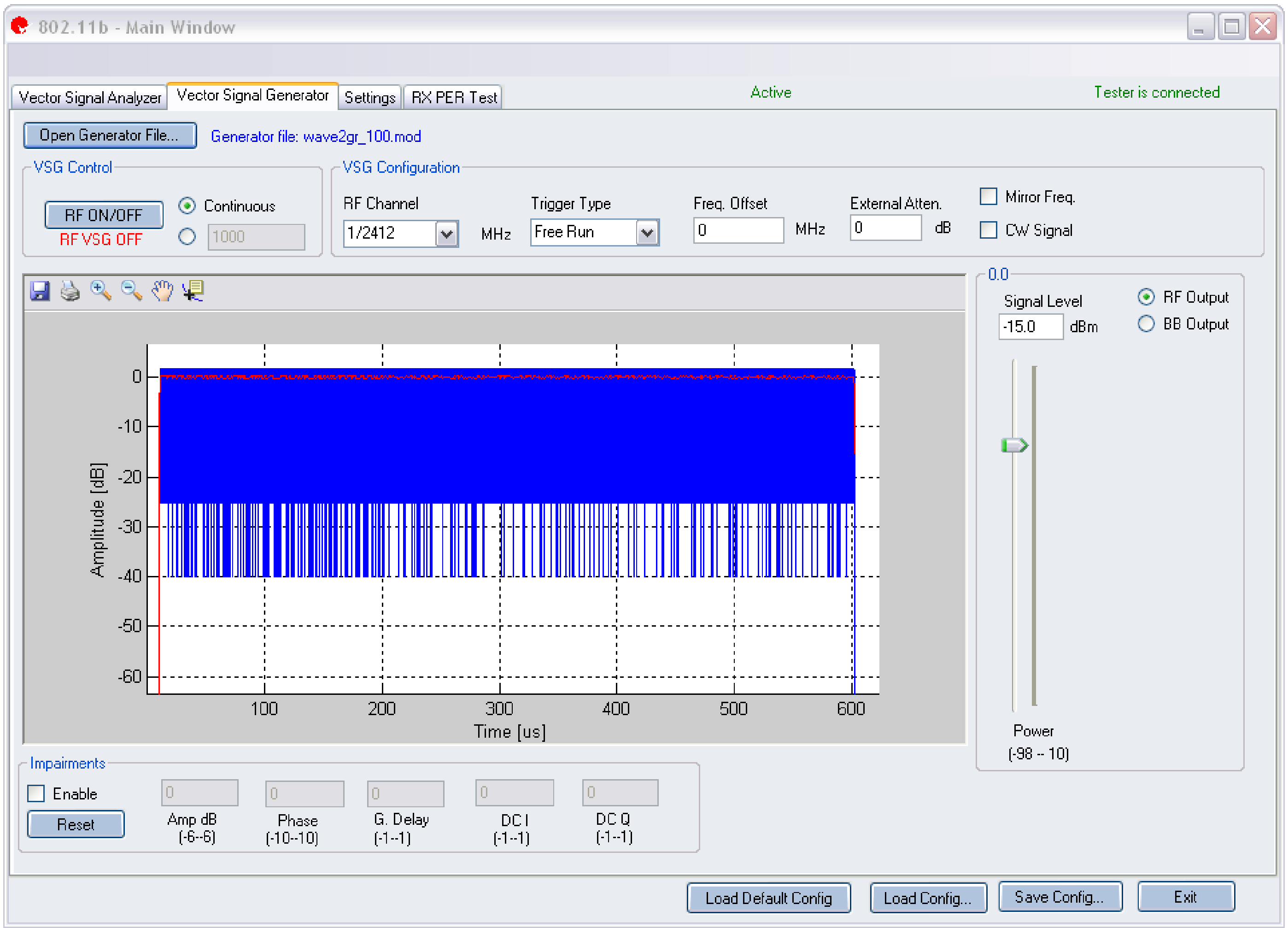


Figure 4-33. IQsignal 802.11b—VSG Screen

Open Generator File— Opens modulator file (.mod) and loads data into the Vector Signal Generator. The file has a `.mod` extension.

RF ON/OFF	Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous—**Continuous transmission of waveform. The range for specified number of packets to be transmitted is between 1 and 65,534. When the RF signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted (MHz).
Mirror Freq	Mirrors the frequency spectrum of the transmitted waveform. This is

	equivalent to flipping the sign of the baseband Q channel.
CW Signal	Selects a continuous-wave signal transmit.
Freq. offset	This field specifies how much offset relative to the RF channel frequency the signal is sent out of the VSG. This is specified in KHz.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate start of transmission **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.

Power

Power	Signal Level	RF Output signal level represented in dBm.
	Power	Power level of the signal represented in dBm.

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp	**Amp (Amplitude Imbalance)**—This field/slider specifies the Amplitude Imbalance in percent. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	**Phase (Phase Imbalance)**—This field/slider specifies the Phase Imbalance in degrees. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	**G (Group) Delay**—This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	**DC (Offset) I**—This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	**DC (Offset) Q**—This field/slider specifies the DC Offset for the Q channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		**Reset**—This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Settings

This section provides you with information about the *Settings* window.

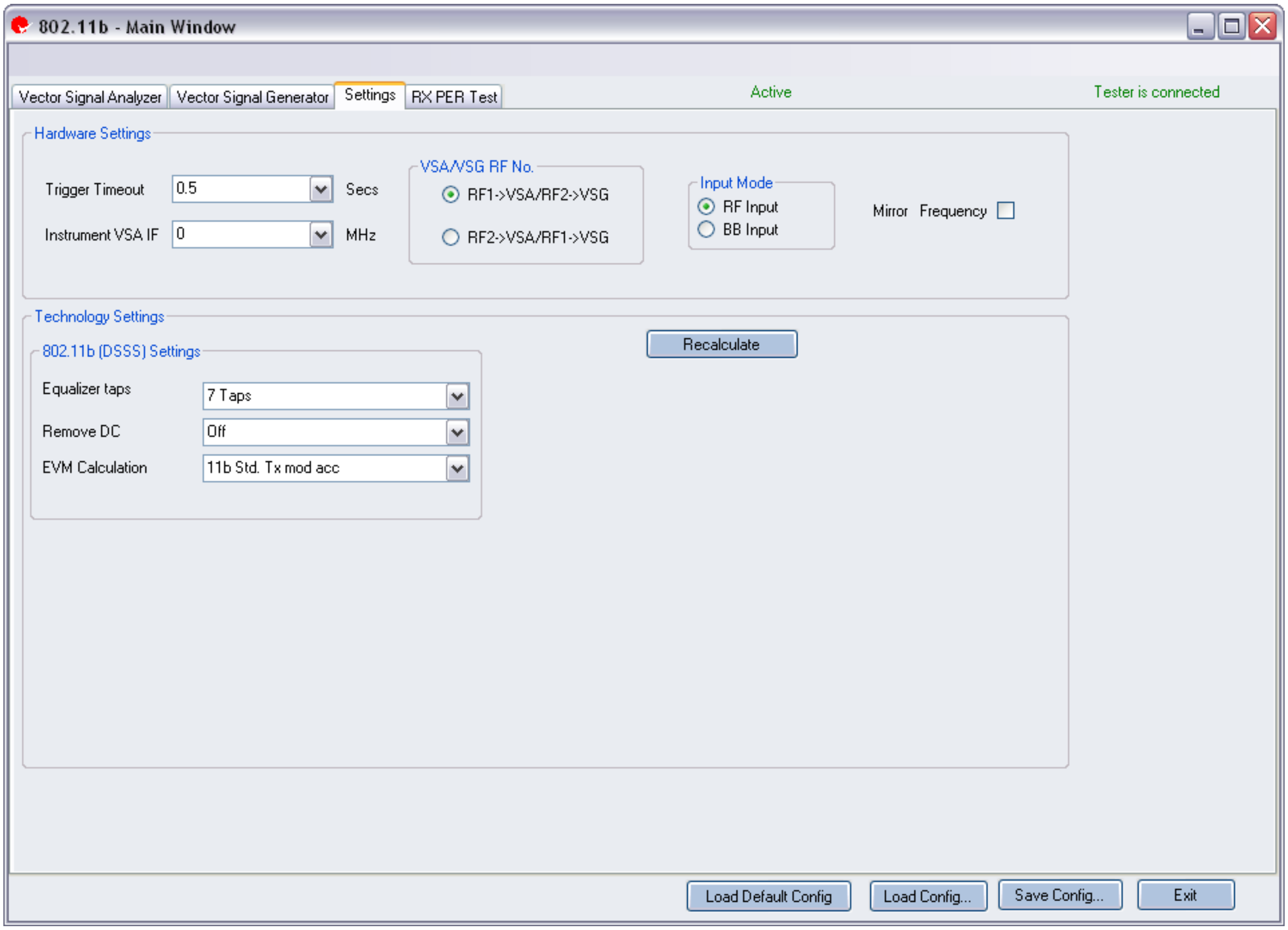
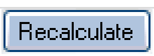


Figure 4-34. IQsignal 802.11b—Settings Screen

Hardware Settings

Instrument VSA IF	The VSA uses a direct-down conversion scheme, i.e. the down converter is tuned to the center frequency of the RF channel to be captured. In some cases, the residual VSA LO Leakage interferes with a measurement and in this case the VSA is tuned to the center frequency of the RF channel plus Instrument RX IF (in MHz). The analysis software shifts the received signal back to the center frequency.
RF1->VSA /RF2->VSG	Uses port #1 for VSA input and port #2 for VSG output.
RF2->VSG/ RF1->VSA	Uses port #2 for VSA input and port #1 for VSG output.
Mirror Freq.	Mirrors the frequency spectrum of the captured waveform. This is equivalent to flipping the sign of the baseband Q channel.

802.11b (DSSS) Settings	
Equalizer taps	Available options are Equalizer Off, 5 Taps, 7 Taps or 9 Taps. **Equalizer Off—**Recommended setting. **5 Taps—**Use this setting when the performance of a transmitter and receiver pair with matching filters is to be assessed. The larger the number of taps, the more the equalizer can correct for Inter Symbol Interference (ISI) present in the transmitter. If the EVM improves substantially when changing from 5 to 9 Taps, the transmitter is likely to have too much ISI. If you use the *11b Std. Tx mod acc*, option for EVM Calculation, then you must set the Equalizer Taps to Equalizer Off.
Remove DC	Available options are *Off* or *On*. **Off—**Recommended setting. **On—**Use only if the DC Offsets are known to be substantial relative to the desired signal level. This can be the case if the RF signal level is extremely low, or if there is a DC present when using the baseband inputs.
EVM Calculation	Available options are 11b Std., Tx mode acc or rms error vector. **11b Std., Tx mode acc—**The *11b Standard Transmit Modulation Accuracy* method applies the algorithm defined in IEEE 802.11b-1999 Standard Section 18.4.7.8 to the sampled data after carrier and symbol timing recovery. **rms error vector—**The *rms error vector* method applies the standard rms error vector algorithm.[2]
	Recalculates analysis results based on the current analysis.

[2] rms_evm = $\sqrt{(s\_in\_norm(k) - s\_dec(k))^2}$ with s_in_norm(k) = $\frac{s\_in(k)}{\sqrt{|s\_in(k)|^2}}$ and s_dec(k) = $\frac{\pm 1 \pm j}{\sqrt{2}}$ selects closest to s_in_norm(k).

s_in(k) is the sampled data, once per chip, after carrier and symbol recovery.

802.11n

The IQsignal application provides the capability of analyzing complex signals generated in 802.11n radio frequency (RF) communications.

Additionally, the application is capable of verifying compliance with the applicable 802.11n specification.

This application includes four separate tabs:

- **Vector Signal Analyzer**—allows you to set signal capture and analysis parameters
- **Vector Signal Generator**—allows you to set signal generation parameters
- **Settings**—allows you to set hardware settings and VSA analysis parameters
- **RX PER Test**—the RX PER test window allows you to check the status of packets sent and received from the DUT

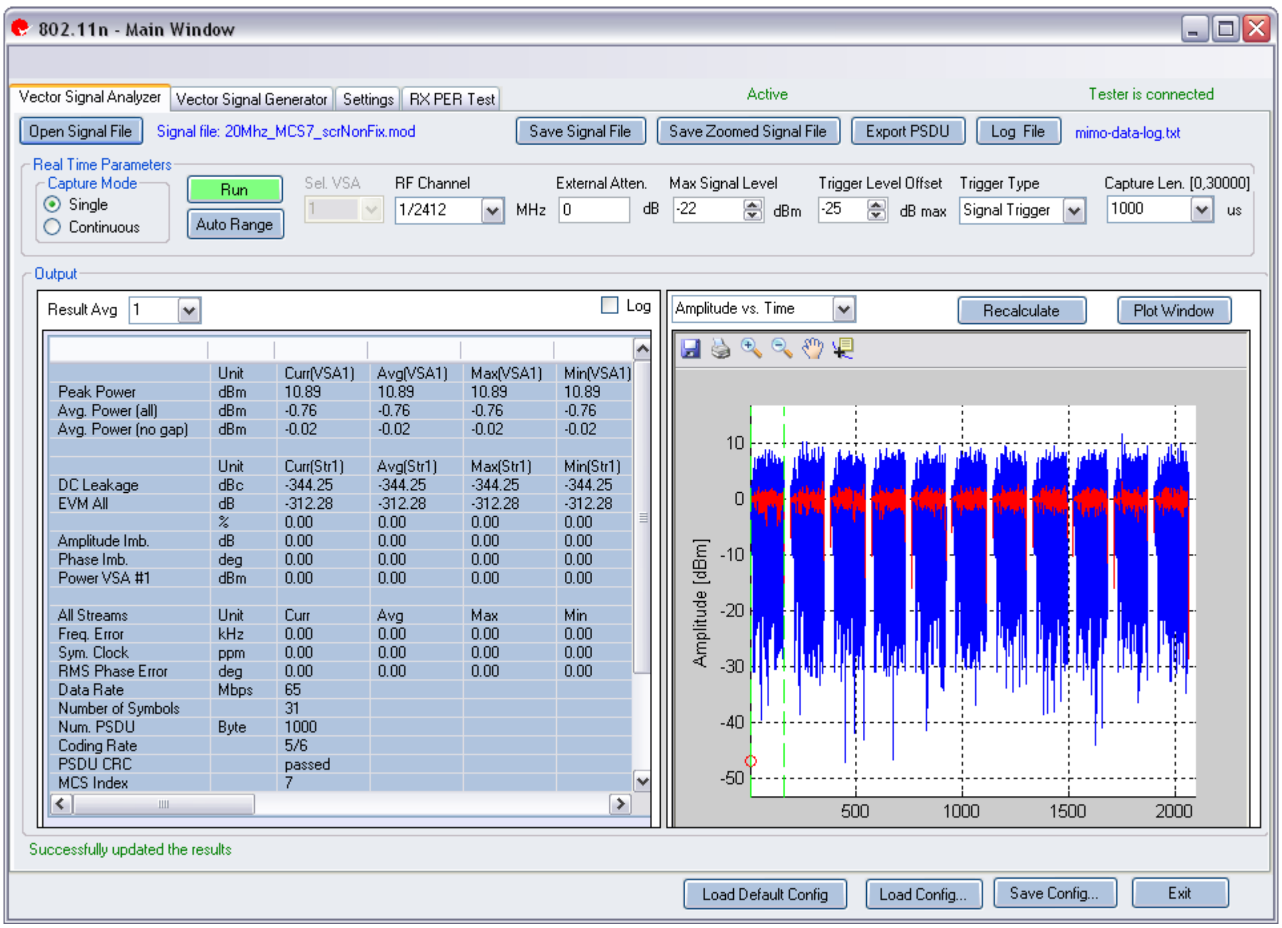


Figure 4-35. IQsignal 802.11n—VSA

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension `.SIG`. Wave files with extension `.MOD` can also be opened.

Save Signal File—Saves captured data to a signal file with extension `.SIG` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Vector Signal Analyzer

Real Time Parameters

RF Channel	Indicates RF channel number and frequency. 20 MHz—for 20 MHz bandwidth the input RF frequency range is 2400-2500 MHz and 4900-6000 MHz 40 MHz—for 40 MHz bandwidth the input RF frequency range is 2422-2462 MHz and 5190-5795 MHz
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Capture Length	Specifies the VSA capture length.
Trigger Type	This field sets the trigger type Free Run, Signal Trigger or External Trigger. **Free Run:** no trigger; immediate start of data capture **Signal Trigger:** The RF signal level is used to trigger a capture **External Trigger:** An external signal applied to the instrument's Trigger Input port is used to trigger capture start.
Trigger Level	This field specifies the VSA trigger level, relative to the Maximum Signal Level in Signal Trigger Mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box to adjust in increments of 1. After a data capture, a red circle appears to the extreme left of the Amplitude vs. Time display, indicating the current trigger level.
Max. Signal Level	Specifies the maximum level of the VSA receiver input. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Pressing the *Auto Range* button will perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends the Auto Range feature for the first data capture of a DUT. You can also use this feature when the received signal level(s) have change significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on the test instrument in the configuration, when you click the Start button. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses, after you click the Start button. After you click the Start button in *Continuous* mode, the text on the *Start* button changes to ***Stop***. Pressing the *Stop* button or selecting the Single mode button will stop the VSA from operating in the continuous data capturing mode. It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Output

Plot Window		Opens a window to view the plots.
Results	Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm. This result is displayed on any signal regardless of analysis result.
	Avg. Power (all)	This power measurement is the average power over the full waveform time. This result is displayed on any signal regardless of analysis result.
	Avg. Power (no gap)	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts. This result is displayed on any signal, regardless of analysis result.
	DC Leakage	Energy level of the center carrier relative to the overall signal power.
	EVM	Reports error vector magnitude (EVM) in dB.
	Power VSA #1	Power of the input signal.
	Amplitude Imb	Reports IQ amplitude mismatches (in dB) between the in-phase and quadrature components of the transmit chain.
	Phase Imb	Reports IQ phase mismatches (in degrees) between the in-phase and quadrature components of the transmit chain.
	Data Rate	Data rate of the signal.
	Freq Error	Reports frequency error in kHz.
	Sym. Clock	Reports symbol timing clock error in PPM.
	RMS Phase Error	Reports phase error in RMS degrees.
	PSDU CRC Fail	Indicates if the CRC checksum bits at the end of the payload data are valid or not.
	Number of Symbols	Number of OFDM symbols in PSDU.
	Num PSDU	Number of PSD bytes.

802.11n Plots

I/Q Signals	The I&Q Signals shows the I (red) and Q (green) signals voltages plotted against time.
CCDF	Probability of peak signal power being greater than a given power level versus peak-to-average power ratio (dB).
Channel Responses	Channel response estimates per stream for each VSA.
Symbol Const	Symbol constellation shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.
Spectral Flatness	The spectral flatness plot indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power.
Phase Noise (PSD)	Analyzes phase noise density versus frequency.
Phase Error (Time)	Displays the phase error (in degrees), estimated per symbol.
EVM vs. Carrier	Error Vector Magnitude averaged over all symbols for each subcarrier (dB).
EVM vs. Time	The EVM versus Time plot shows the EVM measurements displayed over time.
Frequency Error	The Frequency Error plot shows the frequency error through the legacy short and long training fields.
Amplitude vs. Time	Displays Amplitude vs. Time.
Spectrum Mask	Power spectrum of the signal in the specified capture range.
Spectrogram	Analyzes the power spectrum of the capture over time.

I/Q Signals

The I/Q signals plot shows the I and Q signals voltages plotted against time. The I component is plotted in red, the Q component in green.

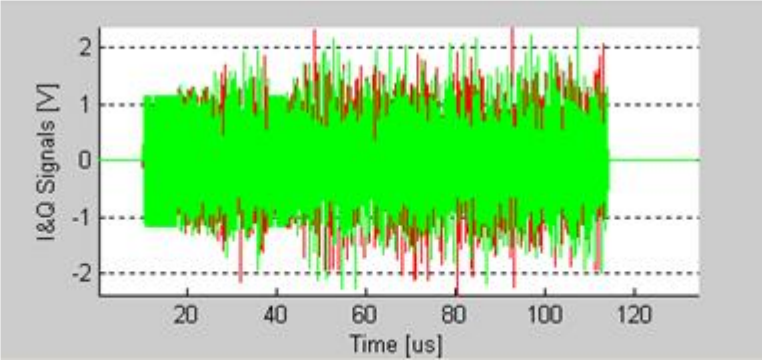


Figure 4-36. IQsignal 802.11n—I/Q Signals

CCDF

The CCDF (Complimentary Cumulative Distribution Function) window plots the peak to average power distribution. The horizontal axis plots the power level above the average power level, and the vertical axis plots the probability that the actual power is greater than this amount. The CCDF is only measured over a single packet, so the gap does not contribute to the measurement.

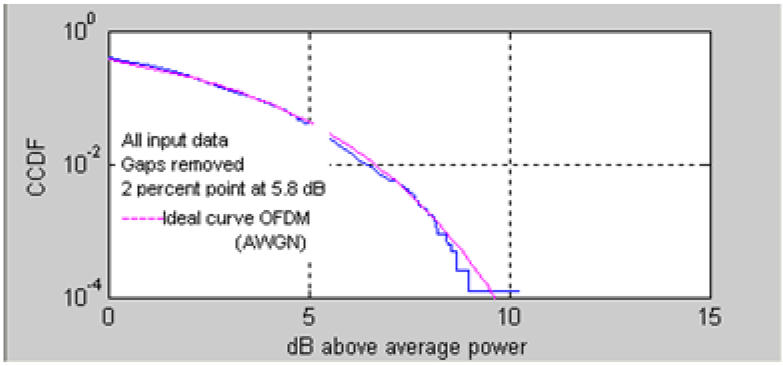


Figure 4-37. IQsignal 802.11n—CCDF

Channel Responses

The Channel Response plot shows the channel response estimates per stream for each VSA.

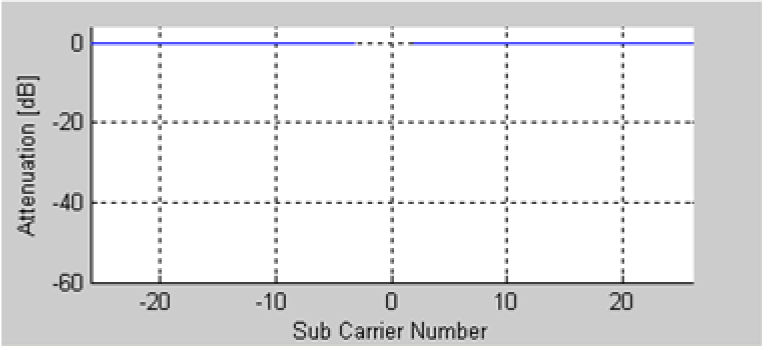


Figure 4-38. IQsignal 802.11n—Channel Responses

Symbol Const

The Symbol Constellation plot is used to indicate the quality of the demodulated data in the complex plane for each symbol in the analyzed frame. The noisier and more degraded the signal, the cloudier the constellation will appear. For all constellation types, the pilot tones are plotted in green.

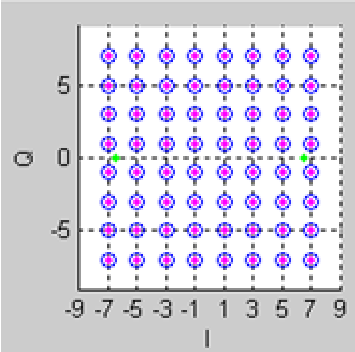


Figure 4-39. IQsignal 802.11n—Symbol Constellation

Spectral Flatness

The spectral flatness plot indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power.

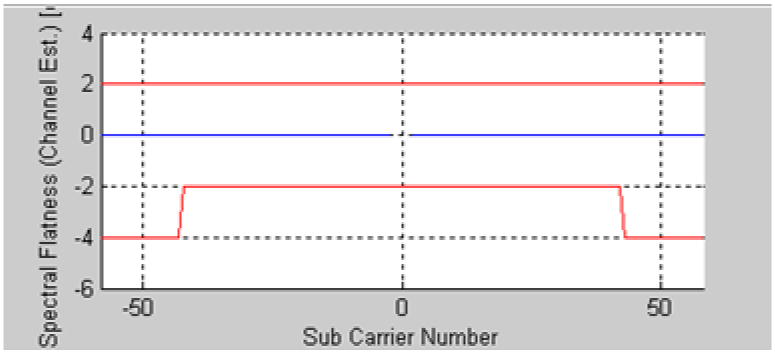


Figure 4-40. IQsignal 802.11n—Spectral Flatness

Phase Error (PSD)

The Phase Error (PSD) plot analyzes phase noise density versus frequency. It graphs the estimated PSD plot of the synthesizer measured during the burst.

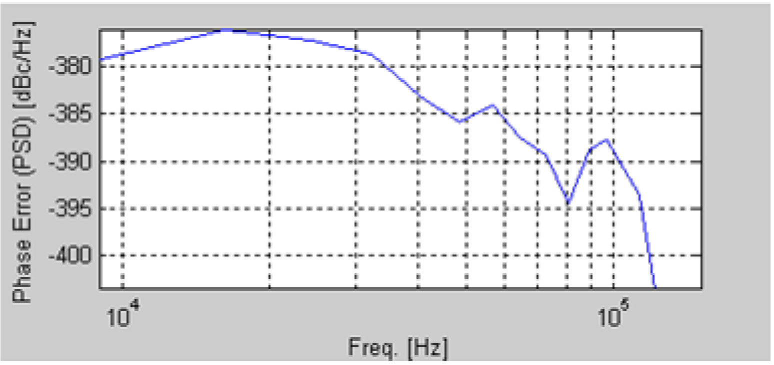


Figure 4-41. IQsignal 802.11n—Phase Error (PSD)

Phase Error (Time)

This graph displays the phase error (in degrees), estimated per symbol. The data is obtained by calculating the common phase error of the pilot carriers for each symbol.

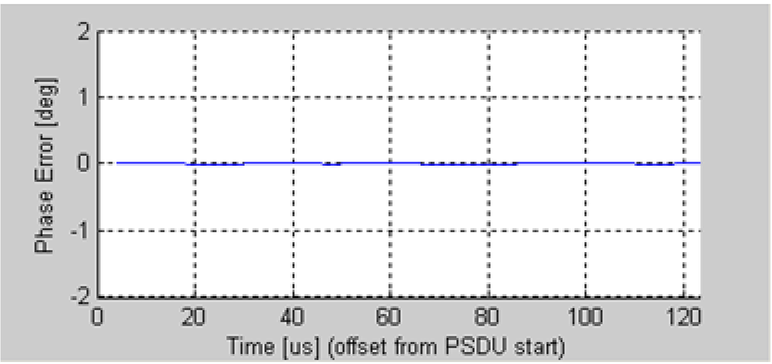


Figure 4-42. IQsignal 802.11n—Phase Error (Time)

EVM vs. Carrier

The Error Vector Magnitude (EVM) versus Carrier graph shows the EVM for each sub-carrier averaged over all symbols. The EVM results for pilot sub-carriers are plotted in green.

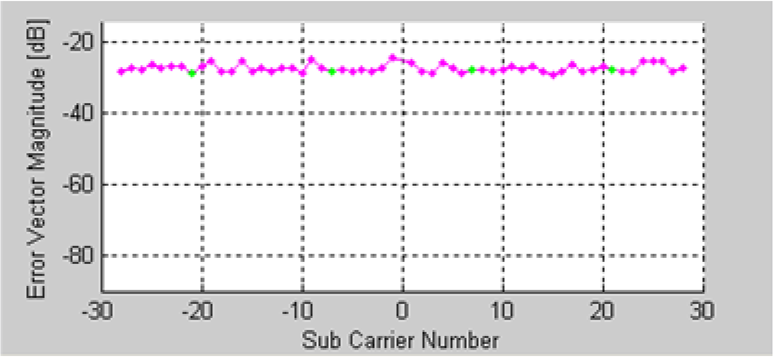


Figure 4-43. IQsignal 802.11n—EVM vs. Carrier

EVM vs. Time

The EVM versus Time plot shows the EVM measurements displayed over time. The EVMs are averaged over all tones for each OFDM symbol and displayed per stream.

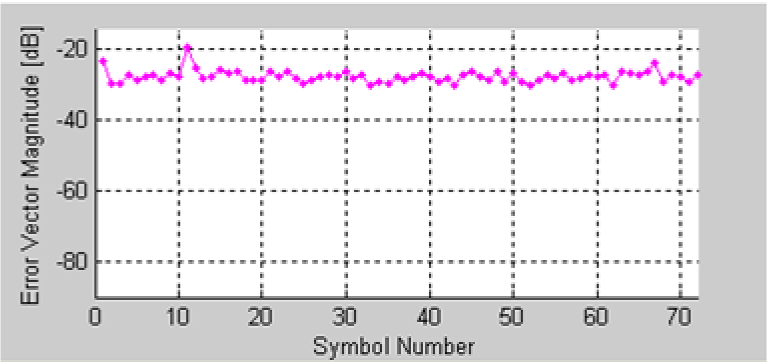


Figure 4-44. IQsignal 802.11n—EVM vs. Time

Frequency Error

The Frequency Error plot shows the frequency error through the legacy short and long training fields. The frequency error during the short training sequence is shown to the left of the green dots. The frequency error of the second part of the first long training sequence is shown to the right of the green dots. The green dots shown represent a linear interpolation between the two.

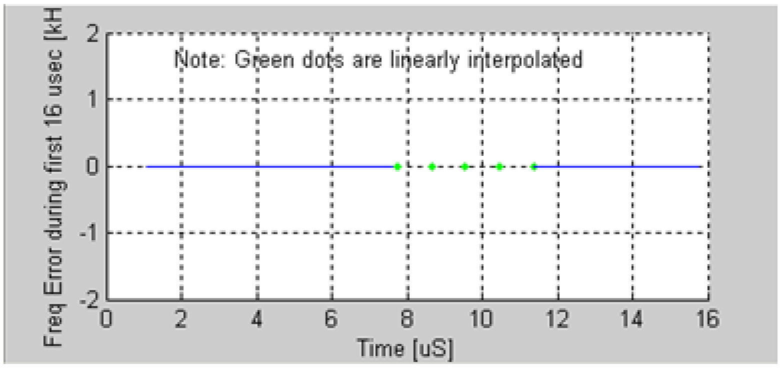


Figure 4-45. IQsignal 802.11n—Frequency Error

Amplitude vs. Time

This plot displays a graphical representation of the measured data. The blue trace represents the instantaneous amplitude value, while the red trace represents the amplitude as a moving average (sliding window of 1µs).

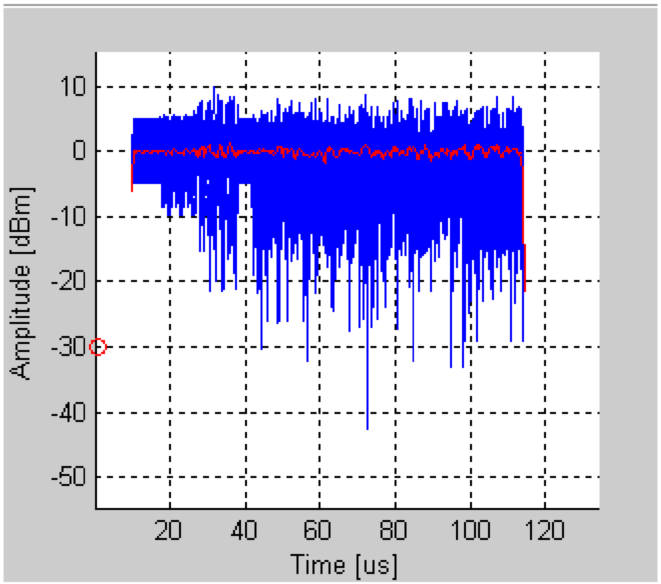


Figure 4-46. IQsignal 802.11n—Amplitude vs. Time

Spectrum Mask

The figure below illustrates the Spectrum Mask graph for an 802.11 n signal. The resolution bandwidth is 100kHz as specified by the IEEE specification.

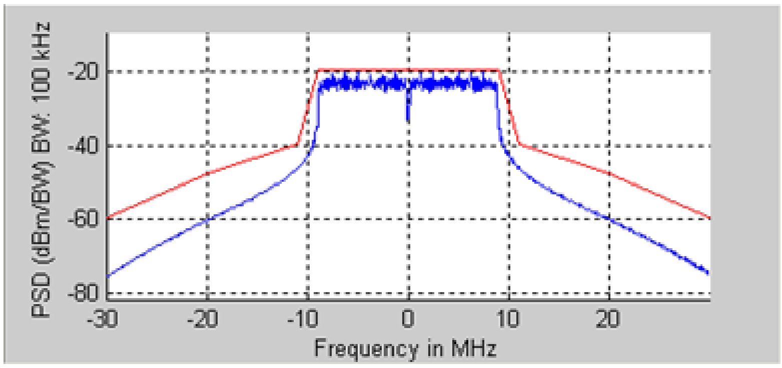


Figure 4-47. IQsignal 802.11n—Spectrum Mask

Spectrogram

The spectrogram mode is useful for capturing signals with an antenna. In many cases there can be a disturbing signal that will be difficult to analyze with a normal spectrum plot. With the spectrogram the spectrum can be shown over time. The X-axis represents time and the Y-axis represents frequency. The color coding represents the strength on the signal, with red being the maximum strength, and green being minimum strength.

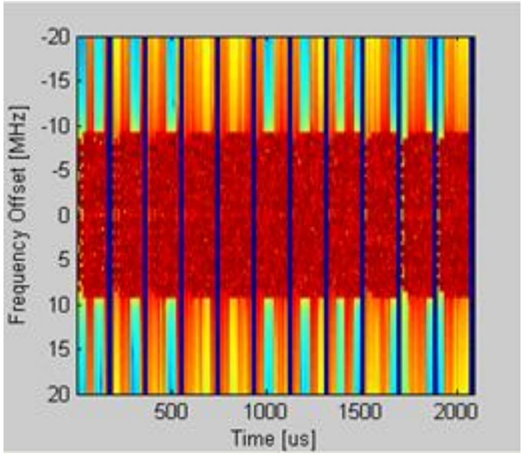


Figure 4-48. IQsignal 802.11n—Spectrogram

Vector Signal Generator

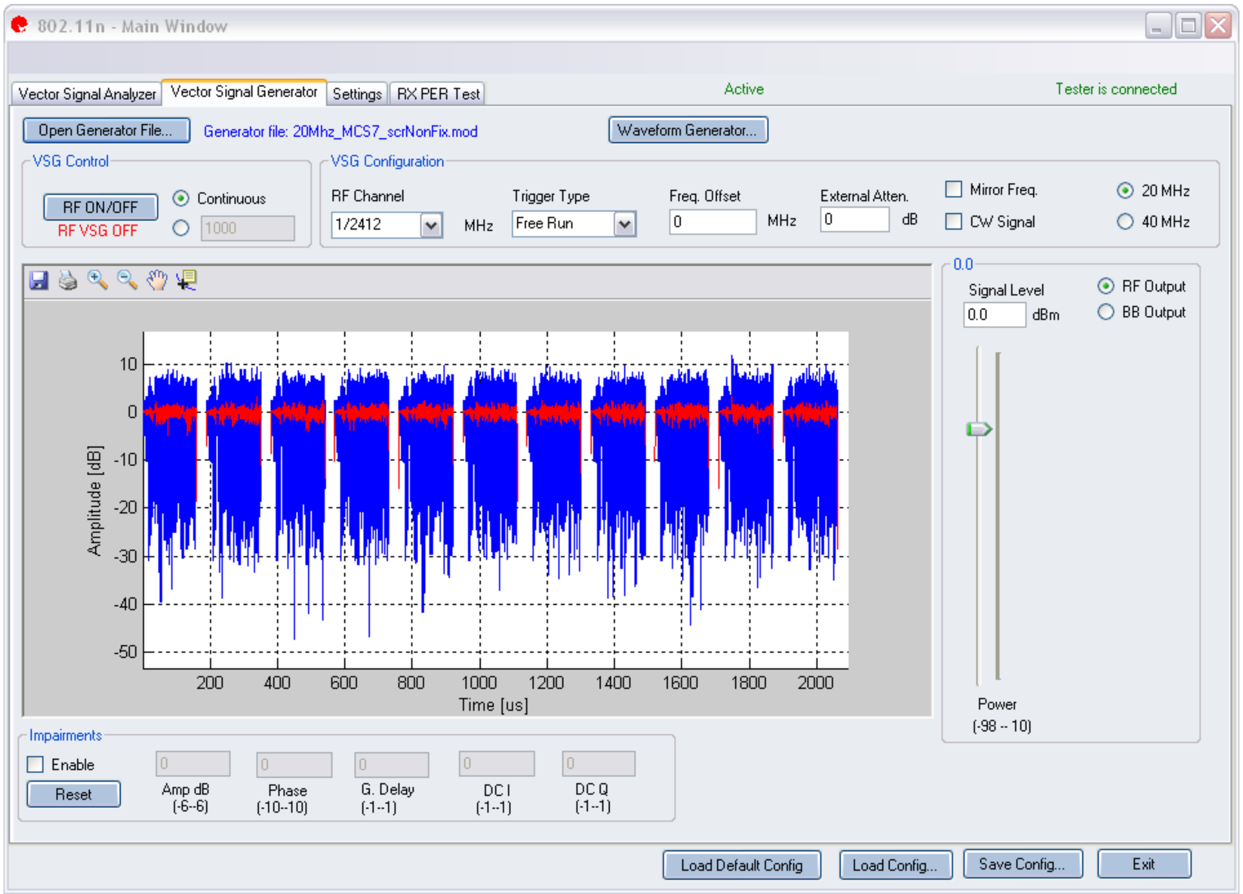


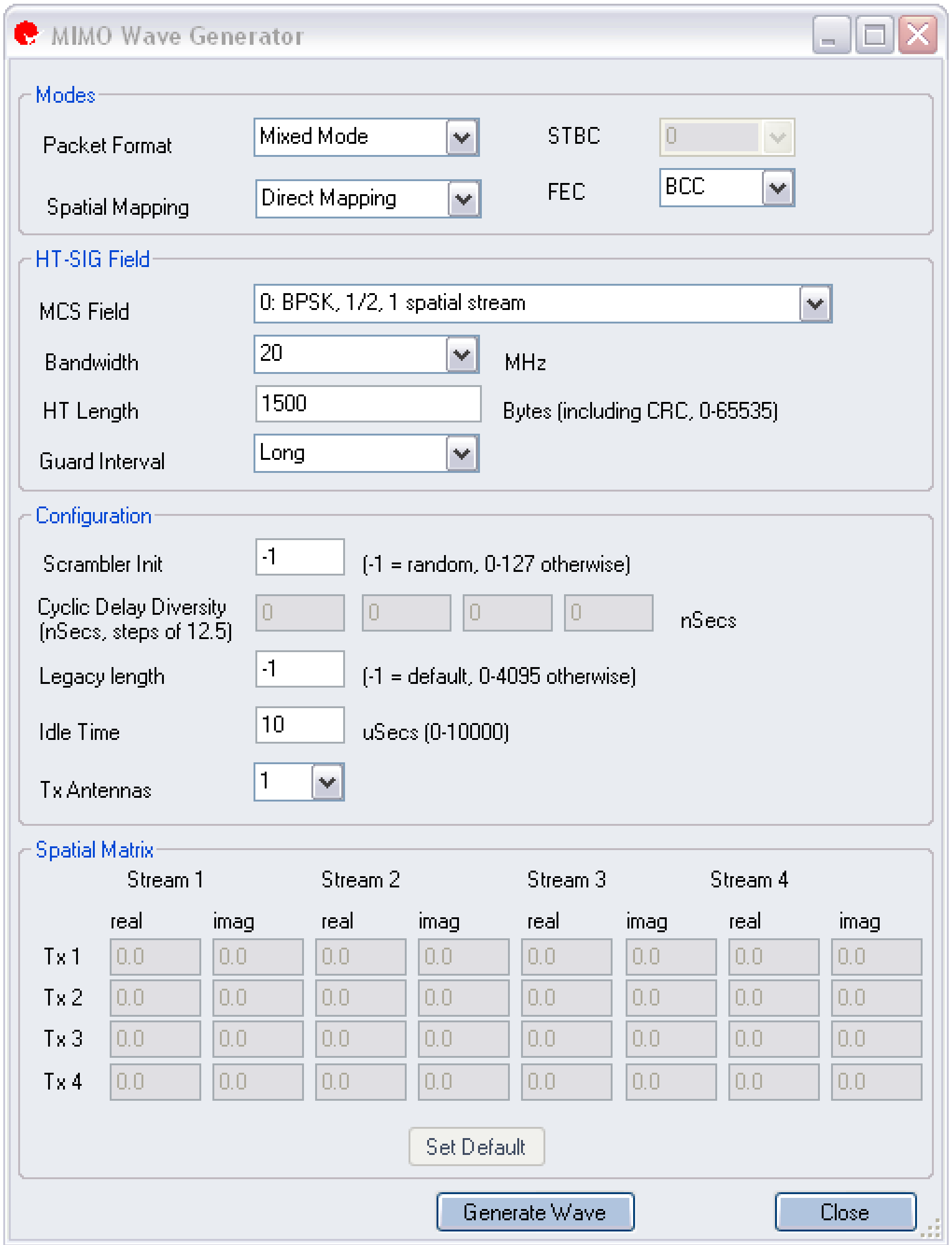
Figure 4-49. IQsignal 802.11n—VSG

Open Generator File— Opens modulator file (`.mod`) and loads data into the Vector Signal Generator. The file has a `.mod` extension.

Waveform Generator— Generates waveforms.

MIMO Wave Generator

The MIMO Wave Generator screen allows you to configure the generated Tx signals from the VSGs in an IQnxn or IQ201X test system. The Vector Signal Generator screen displays data for options configured in this screen.



Accessing the MIMO Wave Generator

Click the Waveform Generator button in the Vector Signal Generator screen to access the MIMO Wave Generator screen.

Modes

This section allows you to define parameters for MIMO versus legacy 802.11n standards.

Packet Format	**Packet Format** – This field sets the transmitted packet compatibility of the VSGs. • **Mixed Mode** sets packet compatibility to both MIMO and legacy 802.11 standards. • **Green Field** mode transmits high-throughput packets without a legacy compatible component.
Spatial Mapping	**Spatial Mapping** –This field defines the method of transmitting the translated streams into transmit chains. • **Direct Mapping** sends each sequence into a different transmit chain. • **Spatial Expansion** sends each stream sequence, multiplied by a matrix to produce the input, to the transmit chains. Spatial Expansion is useful when the number of transmit chains exceeds the number of independent data streams.
STBC	**STBC (**Space Time Coding Block) – This field selects the difference between the number of space-time streams and spatial streams in the HT-SIG field; for non-STBC, this value 0. For STBC, you can select either STBC 1 or 2. STBC = 1: allowed MCS from the set {0 to 23, 33 to39, 41, 43, 46, 48, 50} STBC= 2: allowed MCS from the set {8 to 15} Software will report error if the above limitation is not satisfied.
FEC	Forward Error Correction **BCC:** block convolutional coding defined in 17.3.5.5 of standard **LDPC:** low-density parity-checking coding defined in 20.3.11.6 of standard

HT-SIG Field

This section allows you to define the parameters for the high throughput signal field.

MCS Field	**MCS Field** – This (Modulation and Coding Scheme) field defines the modulation (BPSK, 64-QAM etc.) and the coding rate (1/2, 5/6 etc.) of the generated signal. Currently, the number of streams is restricted to a maximum of 4, and the modulation type is at maximum of 64-QAM.
Bandwidth	**Bandwidth** – This field specifies the bandwidth of the generated signal from the VSG with two options that follow the 802.11 standard specifications. • 20 MHz • 40 MHz
HT Length	**HT Length** – The HT length defines the high-throughput length of the payload in bytes. It includes any CRC bytes.
Guard Interval	**Guard Interval** – This field set the guard interval in micro second time duration. • **Long** interval designates a .8 us time duration. • **Short** interval designates a .4 us time duration.

Configuration

This section allows you to define the configuration parameters to generate the waveform.

Scrambler Init	This is the initial value used in the scrambler registers to scramble the payload data bits.
Cyclic Delay Diversity	Cyclic Delay Diversity – This field indicates an optional amount (in ns) of cyclic shift to be applied to each frame when spatial expansion is desired (one entry for each Tx chain). The cyclic shift is in addition to the mandatory delay specified by the 802.11n standard per stream/transmitter and can be coupled with a spatial matrix as discussed below.
Legacy Length	This field has a different meaning in mixed mode, from the traditional meaning in legacy mode, and is used to spoof legacy devices to defer transmission for a period corresponding to the length of the rest of the packet.
Idle Time	Time between packets.
Tx Antennas	This field is only available when Spatial Expansion is selected in Wave Generator Modes and it allows you to select the number of transmit chains. It is equal to the number of streams in direct mode but this feature is not available for editing in Direct Mode. In spatial expansion mode, it can take values up to 4.

Spatial Matrix

The fields in this section allow you to enter values for the spatial matrix located at the bottom of the MIMO Wave Generator dialog. The matrix dimension is transmitter X streams. The matrix dimension is adjusted to accommodate the other settings and always has the right dimension visible for editing. Usually orthogonal columns are desired in the matrix definition. The default settings provide a matrix example for various dimensions. The matrix is only available in the spatial expansion mode where each transmit chain can send a combination of streams rather than a single stream. The matrix definition provides the mapping of streams to transmitters.

This section allows you to enter the values for the spatial matrix.

Tx1 to Tx4	Transmit chain for each stream.
Stream 1 to Stream 4	Transmitter streams.
Real	Real part of data.
Imag	Imaginary part of data.
Set Default	Click this button to set default parameter settings.

Generate Wave	Click this button to generate the waveform.
Close	Click this button to close the Waveform Generator screen.

MCS (Modulation and Coding Scheme) Field Selections

Modulation and Coding Scheme Number	**Description**
MCS 0	BPSK, 1/2, 1 Stream
MCS 1	QPSK, 1/2, 1 Stream
MCS 2	QPSK, 3/4, 1 Stream
MCS 3	16QAM, 1/2, 1 Stream
MCS 4	16QAM, 3/4, 1 Stream

MCS 5	64QAM, 2/3, 1 Stream
MCS 6	64QAM, 3/4, 1 Stream
MCS 7	64QAM, 5/6, 1 Stream
MCS 8	BPSK, 1/2, 2 Spatial Streams
MCS 9	QPSK, 1/2, 2 Spatial Streams
MCS 10	QPSK, 3/4, 2 Spatial Streams
MCS 11	16QAM, 1/2, 2 Spatial Streams
MCS 12	16QAM, 3/4, 2 Spatial Streams
MCS 13	64QAM, 2/3, 2 Spatial Streams
MCS 14	64QAM, 3/4, 2 Spatial Streams
MCS 15	64QAM, 5/6, 2 Spatial Streams
MCS 16	BPSK, 1/2, 3 Spatial Streams
MCS 17	QPSK, 1/2, 3 Spatial Streams
MCS 18	QPSK, 3/4, 3 Spatial Streams
MCS 19	16QAM, 1/2, 3 Spatial Streams
MCS 20	16QAM, 3/4, 3 Spatial Streams
MCS 21	64QAM, 2/3, 3 Spatial Streams
MCS 22	64QAM, 3/4, 3 Spatial Streams
MCS 23	64QAM, 5/6, 3 Spatial Streams
MCS 24	BPSK, 1/2, 4 Spatial Streams
MCS 25	QPSK, 1/2, 4 Spatial Streams
MCS 26	QPSK, 3/4, 4 Spatial Streams
MCS 27	16QAM, 1/2, 4 Spatial Streams
MCS 28	16QAM, 3/4, 4 Spatial Streams
MCS 29	64QAM, 2/3, 4 Spatial Streams
MCS 30	64QAM, 3/4, 4 Spatial Streams
MCS 31	64QAM, 5/6, 4 Spatial Streams
MCS 32	BPSK, 1/2, 1 Spatial Streams
MCS 33	16QAM,QPSK, 1/2, 2 Spatial Streams
MCS 34	64QAM,QPSK, 1/2, 2 Spatial Streams
MCS 35	64QAM,16QAM, 1/2, 2 Spatial Streams
MCS 36	16QAM,QPSK, 3/4, 2 Spatial Streams
MCS 37	64QAM,QPSK, 3/4, 2 Spatial Streams
MCS 38	64QAM,16QAM, 3/4, 2 Spatial Streams
MCS 39	16QAM,QPSK,QPSK, 1/2, 3 Spatial Streams
MCS 40	16QAM,16QAM,QPSK, 1/2, 3 Spatial Streams
MCS 41	64QAM,QPSK,QPSK, 1/2, 3 Spatial Streams
MCS 42	64QAM,16QAM,QPSK, 1/2, 3 Spatial Streams
MCS 43	64QAM,16QAM,16QAM,1/2, 3 Spatial Streams
MCS 44	64QAM,64QAM,QPSK, 1/2, 3 Spatial Streams
MCS 45	64QAM,64QAM,16QAM,1/2, 3 Spatial Streams
MCS 46	16QAM,QPSK,QPSK, 3/4, 3 Spatial Streams
MCS 47	16QAM,16QAM,QPSK, 3/4, 3 Spatial Streams
MCS 48	64QAM,QPSK,QPSK, 3/4, 3 Spatial Streams
MCS 49	64QAM,16QAM,QPSK, 3/4, 3 Spatial Streams
MCS 50	64QAM,16QAM,16QAM,3/4, 3 Spatial Streams

MCS 51	64QAM,64QAM,QPSK, 3/4, 3 Spatial Streams
MCS 52	64QAM,64QAM,16QAM, 3/4, 3 Spatial Streams
MCS 53	16QAM,QPSK,QPSK,QPSK, 1/2, 4 Spatial Streams
MCS 54	16QAM,16QAM,QPSK,QPSK, 1/2, 4 Spatial Streams
MCS 55	16QAM,16QAM,16QAM,QPSK, 1/2, 4 Spatial Streams
MCS 56	64QAM,QPSK,QPSK,QPSK, 1/2, 4 Spatial Streams
MCS 57	64QAM,16QAM,QPSK,QPSK, 1/2, 4 Spatial Streams
MCS 58	64QAM,16QAM,16QAM,QPSK, 1/2, 4 Spatial Streams
MCS 59	64QAM,16QAM,16QAM,16QAM, 1/2, 4 Spatial Streams
MCS 60	64QAM,64QAM,QPSK,QPSK, 1/2, 4 Spatial Streams
MCS 61	64QAM,64QAM,16QAM,QPSK, 1/2, 4 Spatial Streams
MCS 62	64QAM,64QAM,16QAM,16QAM, 1/2, 4 Spatial Streams
MCS 63	64QAM,64QAM,64QAM,QPSK, 1/2, 4 Spatial Streams
MCS 64	64QAM,64QAM,64QAM,16QAM, 1/2, 4 Spatial Streams
MCS 65	16QAM,QPSK,QPSK,QPSK, 3/4, 4 Spatial Streams
MCS 66	16QAM,16QAM,QPSK,QPSK, 3/4, 4 Spatial Streams
MCS 67	16QAM,16QAM,16QAM,QPSK, 3/4, 4 Spatial Streams
MCS 68	64QAM,QPSK,QPSK,QPSK, 3/4, 4 Spatial Streams
MCS 69	64QAM,16QAM,QPSK,QPSK, 3/4, 4 Spatial Streams
MCS 70	64QAM,16QAM,16QAM,QPSK, 3/4, 4 Spatial Streams
MCS 71	64QAM,16QAM,16QAM,16QAM, 3/4, 4 Spatial Streams
MCS 72	64QAM,64QAM,QPSK,QPSK, 3/4, 4 Spatial Streams
MCS 73	64QAM,64QAM,16QAM,QPSK, 3/4, 4 Spatial Streams
MCS 74	64QAM,64QAM,16QAM,16QAM, 3/4, 4 Spatial Streams
MCS 75	64QAM,64QAM,64QAM,QPSK, 3/4, 4 Spatial Streams
MCS 76	64QAM,64QAM,64QAM,16QAM, 3/4, 4 Spatial Streams

RF ON/OFF	Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous—**Continuous transmission of waveform. The range for specified number of packets to be transmitted is between 1 and 65,534. When the RF signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted (MHz). 20 MHz—for 20 MHz bandwidth the input RF frequency range is 2400-2500 MHz and 4900-6000 MHz 40 MHz—for 40 MHz bandwidth the input RF frequency range is 2422-2462 MHz and 5190-5795 MHz
Mirror Freq	Mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
CW Signal	Selects a continuous-wave signal transmit.
Freq. offset	This field specifies how much offset relative to the RF channel frequency the signal is sent out of the VSG. This is specified in KHz.
Trigger Type	Sets the VSG trigger type Free Run or External Trigger.

	Free Run—no trigger; immediate start of transmission **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.

Power

Signal Level	RF Output signal level represented in dBm.

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp	**Amp (Amplitude Imbalance)**—This field/slider specifies the Amplitude Imbalance in percent. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	**Phase (Phase Imbalance)**—This field/slider specifies the Phase Imbalance in degrees. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	**G (Group) Delay**—This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	**DC (Offset) I**—This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	**DC (Offset) Q**—This field/slider specifies the DC Offset for the Q channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		**Reset**—This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Settings

This section provides you with information about the *Settings* window.

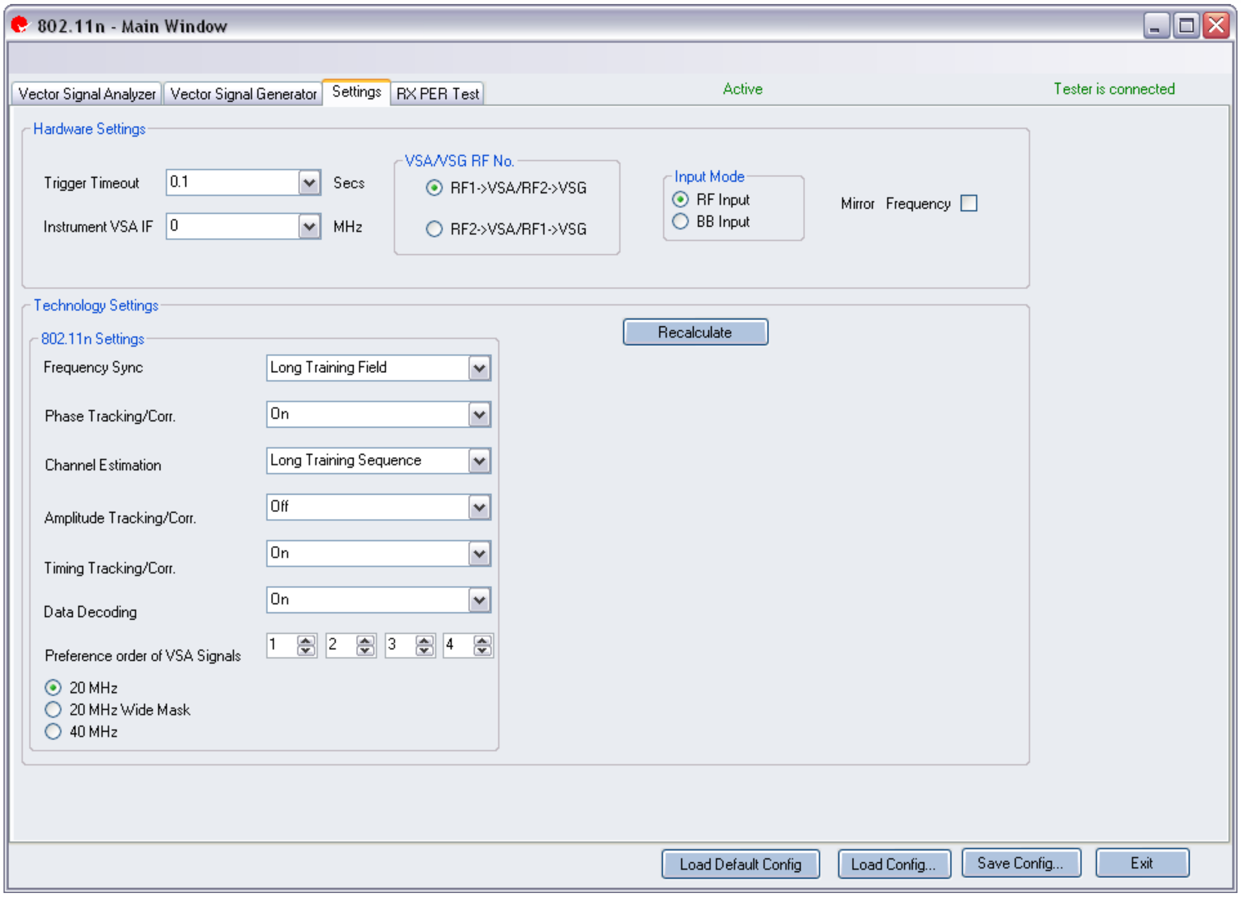


Figure 4-50. IQsignal 802.11n—Settings

Hardware Settings

Trigger Timeout	Specifies the trigger timeout. This setting is only used in non-Free Run Trigger modes, such as Signal Trigger. If a timeout occurs, a Free Run data capture will be performed when the trigger times out.
Instrument RX IF	The VSA uses a direct-down conversion scheme, i.e. the down converter is tuned to the center frequency of the RF channel to be captured. In some cases, the residual VSA LO Leakage interferes with a measurement and in this case the VSA is tuned to the center frequency of the RF channel plus Instrument RX IF (in MHz). The analysis software shifts the received signal back to the center frequency.
VSA/VSG RF No.	Select the RF port to configure as input/output.
Mirror Freq.	Mirrors the frequency spectrum of the captured waveform. This is equivalent to flipping the sign of the baseband Q channel. RF1->VSA/RF2-> VSG : Uses port #1 for VSA input and port #2 for VSG output. RF2->VSA/RF1-> VSG: Uses port #2 for VSA input and port #1 for VSG output.
Input Mode	RF Input—uses RF as input mode BB Input—uses baseband as input mode

802.11n Settings	
Frequency Sync	Carrier frequency error estimation method. Available options are as follows: • Long Training Field—section of waveform • LTF + SIG Fields—performs additional frequency offset estimation in the SIG fields • Full Packet—performs additional frequency offset estimation on the full packet
Phase Tracking/Correction	Enables or disables phase tracking method.
Channel Estimation	Enables and disables channel estimation based on all symbols in the whole packet, If this option is disabled, then channel estimation is performed on the long training field (default).
Amplitude Tracking/Corr.	Enables/disables amplitude tracking options for analysis.
Time Tracking/Corr.	Enables/disables time tracking options for analysis.
Data Decoding	Enables/disables decoding of PSDU.
Recalculate	Performs the analysis on the captured data. Recalculates analysis results based on the current analysis settings for the currently zoomed-in signal portion of the plot. When you select an area of the plot with the zoom tool and then click **Recalculate**, the analysis is performed on the selected area only. *Recalculate* is also used to repeat the analysis after changes to the analysis settings have been made.
Preference order of VSA signals	Preference order used to select input signals. Default: 1,2,3,4 (Use any permutation of the numbers 1,2,3, and 4) Specifies the sequence of input signals that must be used for analysis. If the number of available input signals (captures) are more than that is required to demodulate a MIMO signal, this parameter allows you to specify the sequence of the input signals that must be used for the analysis. Note : The number of required captures is equal to the number of data streams in a MIMO signal. As an example, when you analyze a one-stream signal with prefOrderSignals parameter set to [2 1 3 4], the analysis first checks the capture from VSA 2 (input signal 2) for a valid signal. If the signal is valid, the analysis will be performed on capture from VSA 1 (input signal 1). If it is not valid, the next signal capture will be performed on capture 1. This process is continued until the required number of valid signals has been found or until all available captures have been checked. In this case, the required number of valid signals is one, because this analysis is on a one-stream signal.
• 20 MHz • 20 MHz Wide Mask • 40 MHz	Option to select a 20 MHz, 20 MHz Wide Mask or a 40 MHz spectrum mask. See description of spectrum masks in next section.

Types of Spectrum Masks

The IEEE 802.11n specification offers the following three types of Spectrum Masks:

- 20 MHz
- 20 MHz Wide Mask
- 40 MHz

20 MHz Mask

The figure below shows a normal mask captured at 60 MHz frequency.

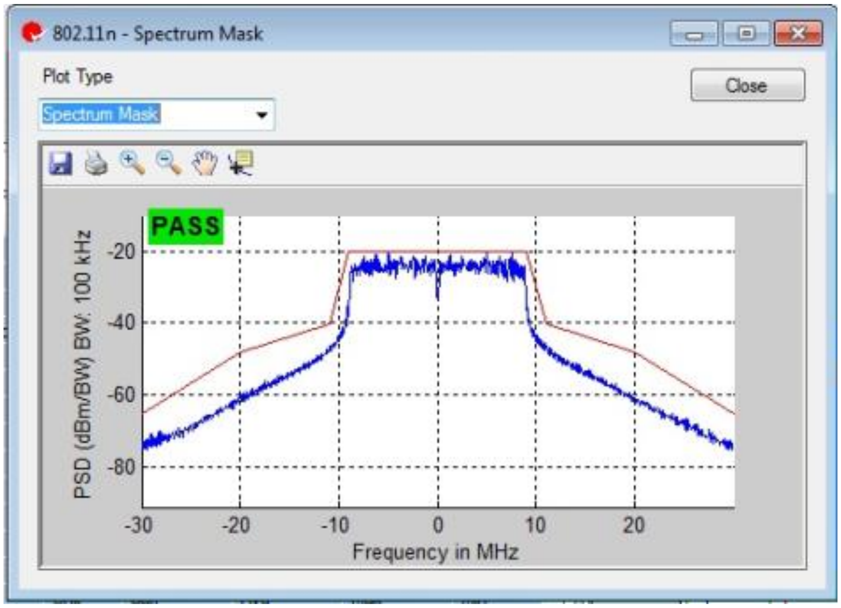


Figure 4-51. IQsignal 802.11n—Spectrum Mask at 60 MHz Frequency

HT 20 MHz Wide Mask

The figure below shows a high-throughput wide mask captured at 100 MHz frequency.

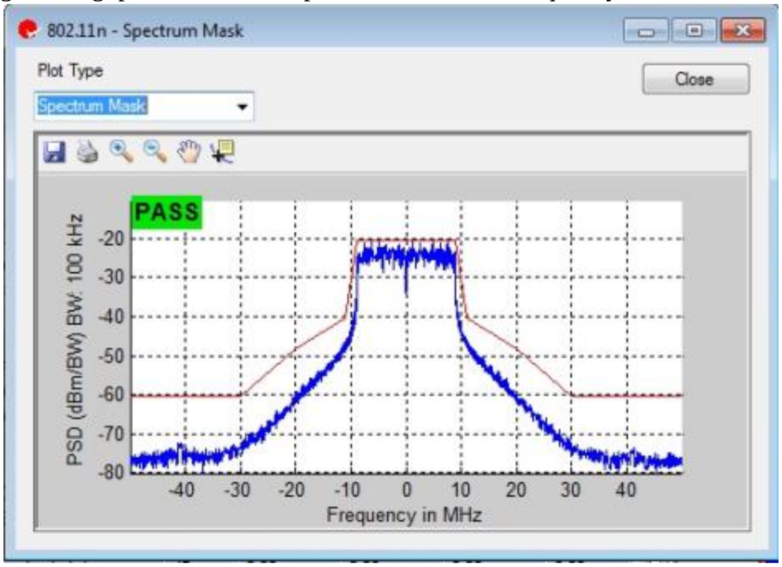


Figure 4-52. IQsignal 802.11n—Spectrum Mask at 100 MHz Frequency

HT 40 MHz Mask

The figure below shows a wide mask capture at 120 MHz frequency.

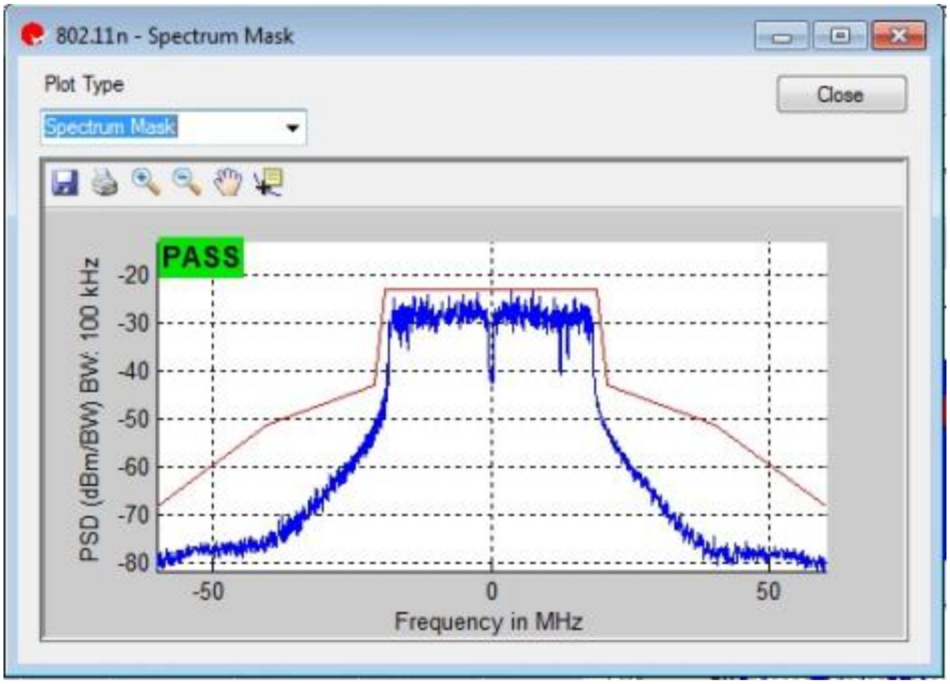


Figure 4-53. IQsignal 802.11n—Spectrum Mask at 120 MHz Frequency

Chapter 5 Using LitePoint IQsignal Bluetooth Application

Bluetooth

The IQsignal application provides the capability of analyzing complex Bluetooth signals.

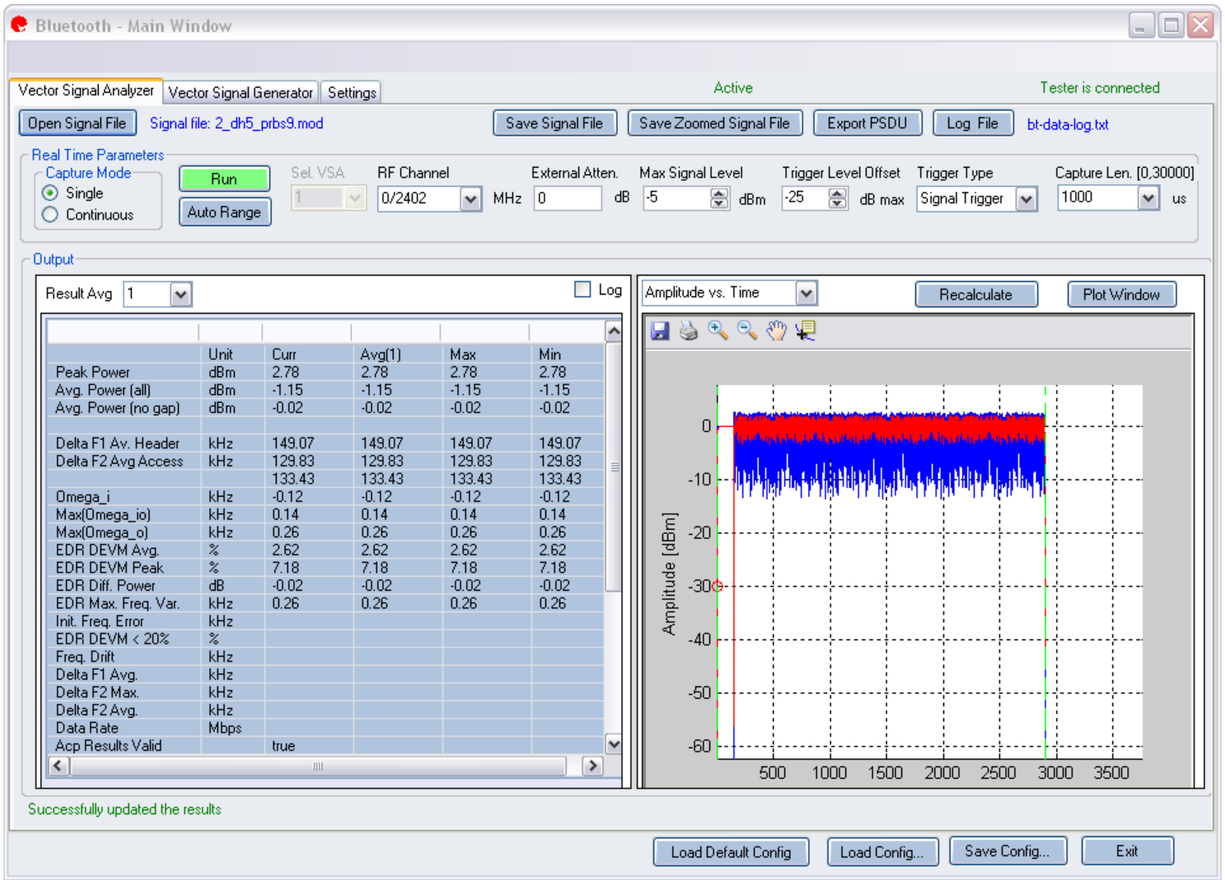
Additionally, some of the analysis for 802.11b is also available in this mode.

This application includes three separate tabs:

- **Vector Signal Analyzer—**allows you to set signal capture and analysis parameters
- **Vector Signal Generator—**allows you to set signal generation parameters
- **Settings—**allows you to set hardware settings and VSA analysis parameters

Vector Signal Analyzer

This section provides you with information on the *Vector Signal Analyzer* window.



	Unit	Curr	Avg(1)	Max	Min
Peak Power	dBm	2.78	2.78	2.78	2.78
Avg. Power (all)	dBm	-1.15	-1.15	-1.15	-1.15
Avg. Power (no gap)	dBm	-0.02	-0.02	-0.02	-0.02
Delta F1 Av. Header	kHz	149.07	149.07	149.07	149.07
Delta F2 Avg Access	kHz	129.83	129.83	129.83	129.83
		133.43	133.43	133.43	133.43
Omega_i	kHz	-0.12	-0.12	-0.12	-0.12
Max(Omega_io)	kHz	0.14	0.14	0.14	0.14
Max(Omega_o)	kHz	0.26	0.26	0.26	0.26
EDR DEVM Avg.	%	2.62	2.62	2.62	2.62
EDR DEVM Peak	%	7.18	7.18	7.18	7.18
EDR Diff. Power	dB	-0.02	-0.02	-0.02	-0.02
EDR Max. Freq. Var.	kHz	0.26	0.26	0.26	0.26
Init. Freq. Error	kHz				
EDR DEVM < 20%	%				
Freq. Drift	kHz				
Delta F1 Avg.	kHz				
Delta F2 Max.	kHz				
Delta F2 Avg.	kHz				
Data Rate	Mbps				
Acp Results Valid		true			

Figure 5-1. IQsignal Bluetooth Application—VSA Screen

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension .SIG. Wave files with extension .MOD can also be opened.

Save Signal File—Saves captured data to a signal file with extension .SIG for later analysis.

Save Zoomed Signal File—Saves captured, zoomed data to a signal file with extension `.sig` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Log File—Allows you to save log data to a text file for later analysis.

A `.sig` file is used for signal analysis and a `.mod` file is used by the VSG to generate a signal. A signal file can only be saved with a `.sig` or a `.mod` extension.

Real Time Parameters

RF Channel	Indicates RF channel number and frequency.
Capture Length	Specifies the VSA capture length.
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate capture **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger a capture. **Signal Trigger—**The RF signal level is used to trigger a capture (this type available in RF input mode only). If you select Signal Trigger, a Free Run data capture will occur upon trigger timeout, which can be specified in the Settings tab.
Trigger Level	This field specifies the VSA trigger level, relative to the Maximum Signal Level in Signal Trigger Mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box to adjust in increments of one. After a data capture, a red circle appears to the extreme left of the Amplitude vs. Time display, indicating the current trigger level.
Max. Signal Level	Specifies the gain of the VSA receiver chain. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Pressing the *Auto Range* button will perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends using the *Auto Range* feature for the first data capture of a DUT. You can also use this feature when the received signal level(s) have change significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on all test instruments in the configuration, when you click **Start**. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses, after you click **Start**. After you click the Start button in *Continuous* mode, the text on

		the *Run* button changes to *Stop*. Click **Stop** to stop the VSA from operating in the continuous data capturing mode. It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Output

Results Averaging		This field specifies the size of the averaging buffer for averaged measurements. The selections are 1, 10, 20, 40, 60, 80, and 100 averages.
Recalculate		Recalculate measurements.
Plot Window		Opens a window to view the plots.
Results	Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm. This result is displayed for any signal regardless of analysis result.
	Avg. Power (all)	This power measurement is the average power over the full waveform time. This result is displayed for any signal regardless of analysis result.
	Avg. Power (no gap)	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts. This result is displayed for any signal, regardless of analysis result.
	Delta F1 Av. Header	Delta F1 Avg equivalent measured from header.
	Delta F2 Max Access	Delta F2 Max equivalent measured from access part of packet.
	Delta F2 Avg Access	Delta F2 Avg equivalent measured from access part of packet.
	Omega_i	Frequency offset measured in the header packet, ω_i, used for EDR quality measurement.
	Max(Omega_io)	The maximum frequency error relative to the center frequency observed during the payload.
	Max(Omega_o)	The maximum frequency correction that takes place during the EDR payload processing, after the frequency error measured in ω_i has been compensated for. Any estimation error in ω_i is included in ω_o. In many cases the estimation error of ω_i dominates the max (ω_o) value.
	Freq. Drift	Only valid if payload data has the following

		pattern: 10101010 and when data rate is 1 Mbps.
	Delta F1 Av	Only valid if payload data has the following pattern: 00001111 and when data rate is 1 Mbps.
	Delta F2 Max	Only valid if payload data has the following pattern: 10101010 and when data rate is 1 Mbps.
	Delta F2 Avg	Only valid if payload data has the following pattern: 10101010 and when data rate is 1 Mbps.
	EDR DEVM Avg	RMS differential EVM calculated from DPSK section of packet.
	EDR DEVM Peak	Peak differential EVM calculated from DPSK section of packet.
	EDR Diff Power	Difference in power between GFSK and DPSK section of packet.
	EDR Max Freq Var	Maximum frequency variation during DPSK section of packet, or max (abs(ω_o))
	Init Freq Error	Initial Carrier Frequency Tolerance of packet measured from the first 4 symbols of the packet.
	Data Rate	Data rate of the input signal specified in the Vector Signal Analyzer window in the Bluetooth Settings area; this value represents either the value that was auto-detected or the value that was manually entered.
	EDR DEVM	Percentage of symbols with DEVM below threshold (20 % for 3 Mbps and 30 % for 2 Mbps).

EDR values only apply to data rates of 2 and 3 Mbps.

Vector Signal Generator

This section provides you with information about the *Vector Signal Generator* window.

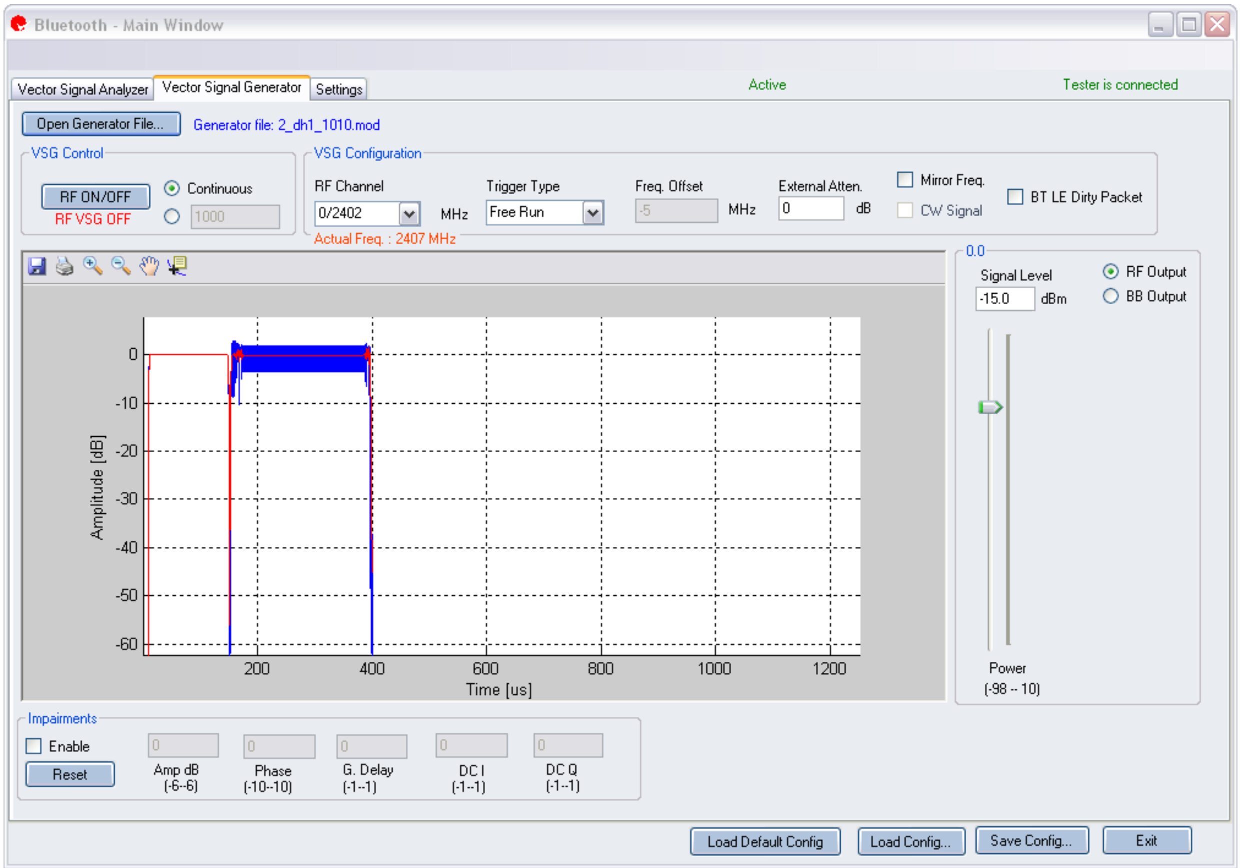


Figure 5-2. IQsignal Bluetooth Application—VSG Screen

Open Generator File— Opens modulator file (.mod) and loads data into the Vector Signal Generator. The file has a `.MOD` extension.

RF ON/OFF	Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous—**Continuous transmission of waveforms. Specified number of packets—The range for specified number of packets to be transmitted is between 1 and 65,534. When the RF signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted (MHz).
Mirror Freq	Mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
CW Signal	Selects a continuous-wave signal transmit.
Freq. offset	This field specifies how much offset relative to the RF channel frequency the

	signal is sent out of the VSG. This is specified in KHz.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate start of transmission **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger a transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.
BT LE Dirty Packet	Allows you to generate a waveform with a pre-defined Bluetooth dirty packet. Selecting this checkbox loads predefined BT LE Dirty Packets and disables **Open Generator File**. When you click **RF ON/OFF**, the predefined waveform is loaded. To load a different BT LE Dirty Packet, make sure the BT LE Dirty Packet is deselected, click **Open Generator File**, select the BT LE Dirty Packet of your choice and click **RF ON/OFF**.

Power

Power	Signal Level	Shows the signal level of the current output signal. Use the slider to set the desired level or type the desired level in the input box.

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp	**Amp (Amplitude Imbalance)**—This field/slider specifies the Amplitude Imbalance in percent. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	**Phase (Phase Imbalance)**—This field/slider specifies the Phase Imbalance in degrees. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	**G (Group) Delay**—This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	**DC (Offset) I**—This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	**DC (Offset) Q**—This field/slider specifies the DC Offset for the Q channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		**Reset**—This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Bluetooth Plots

Amplitude vs. Time	Instantaneous and peak power averaged over symbol duration (dBm) versus time.
Spectrum Mask	Plots the power density versus the frequency spectrum for the analyzed signal, over the

	range of +/- 20 MHz from the center frequency.
I/Q Signals	The I&Q Signals shows the I and Q signals voltages plotted against time. The I Channel is plotted in red and Q channel in green.
Symbol Const	Shows the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.
EVM vs. Symbol	Shows error vector magnitude over time.
Freq. Error	The Frequency Error graph displays the frequency error of the captured data during the payload.
Eye Diagram	The eye diagram is plotted as Amplitude (Inphase and Quadrature) vs. Time.
Power Down Ramp	Analyzes the down-ramp time for a bluetooth signal. For accurate results an un-modulated CW signal should be used.
Power On Ramp	Analyzes the on-ramp time for a bluetooth signal. For accurate results an un-modulated CW signal should be used.
Spectrogram	This plot analyzes the power spectrum of the capture over time. In many cases there can be a disturbing signal that will be difficult to analyze with a normal spectrum plot.
FM Demodulator	The FM demodulator graph shows the output of the FM demodulator analysis as function of time.
20 dB Bandwidth	Spectrum measured with a 10 kHz resolution bandwidth and the 20 dB mask.
LO (DC) Leakage	Shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage.

EVM vs. Symbol

The EVM versus Symbol plot shows the Differential EVM of the DPSK signal at 50 µsec intervals, as specified in the bluetooth test standard.

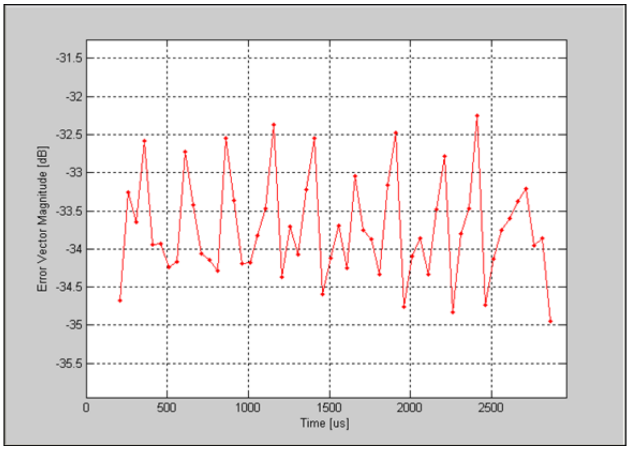


Figure 5-3. IQsignal Bluetooth—EVM vs. Symbol Plot

Eye Diagram

The eye diagram is plotted as Amplitude (Inphase and Quadrature) vs. Time. An Eye Diagram is constructed by taking the time-domain signal and overlapping the traces for a certain number of symbols and assumes two symbols per trace and shows the traces over a 2 µsec., or 2 symbols, interval.

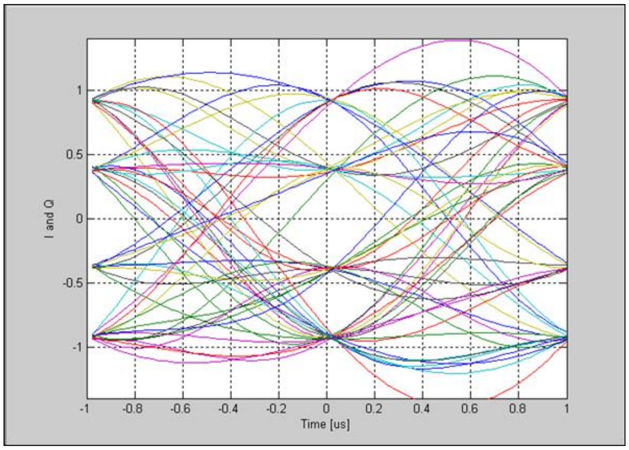


Figure 5-4. IQsignal Bluetooth—Eye Diagram Plot

Freq. Error

The Frequency Error graph displays the frequency error of the captured data during the ERD section of the packet. The frequency error shown includes the error measured during the header, i.e. the frequency shown is $\omega_i + \omega_o$. The error is calculated once every 50 µsec.

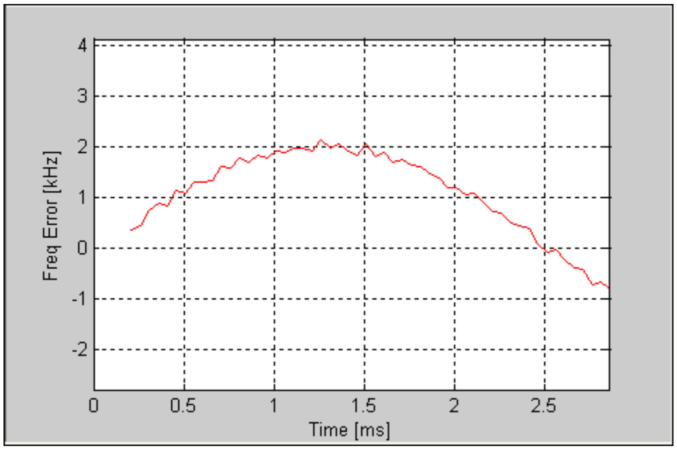


Figure 5-5. IQsignal Bluetooth—Frequency Error Plot

I/Q Signals

The I&Q Signals plot shows the I and Q signal voltages plotted against time. The figure below illustrates the I&Q Signals graph for the bluetooth signal.

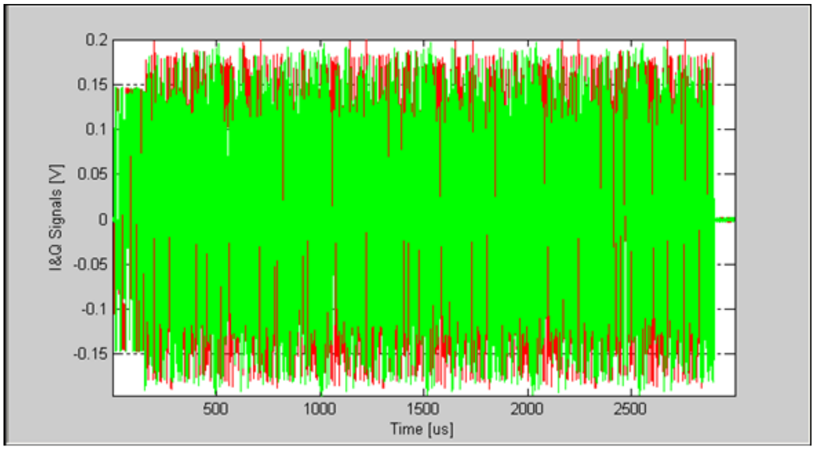


Figure 5-6. IQsignal Bluetooth—I/Q Signals Plot

Power On Ramp

The figure below illustrates the Power On Ramp graph for the bluetooth signal. The plot shows an averaged version of the power (Black) as well as a peak hold measured over a 1μs rolling window (Green). The measured Power-On time (the time it takes the power to go from 10% to 90%) is presented, along with information of the time difference between the time where the packet reaches 90% of power, and the actual start of the packet.

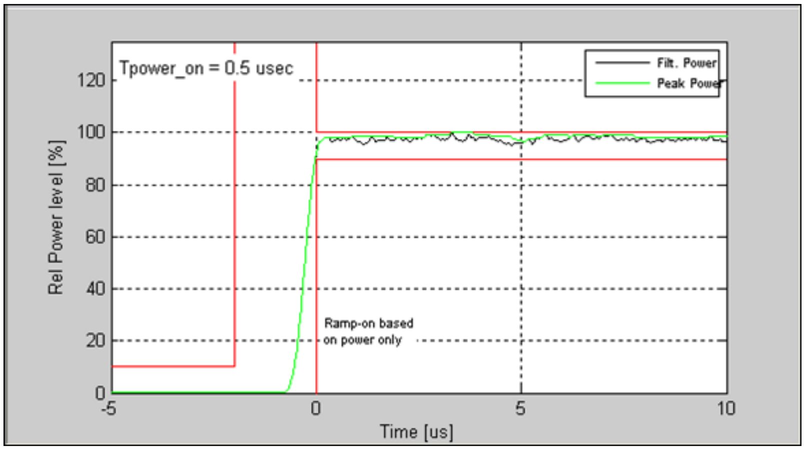


Figure 5-7. IQsignal Bluetooth—Power On Ramp Plot

Power Down Ramp

The figure below illustrates the Power Down Ramp graph for the bluetooth signal. The plot shows an averaged version of the power (Black) as well as a peak hold measured over a1µs rolling window (Green). The measured Power-Down time is presented (the time it takes the power to go from 90% to 10%), along with information of the time difference between the time where the packet goes below 90% for more than 1µs and the actual end of the packet1. Using an un-modulated CW signal provides the most reliable measurement results.

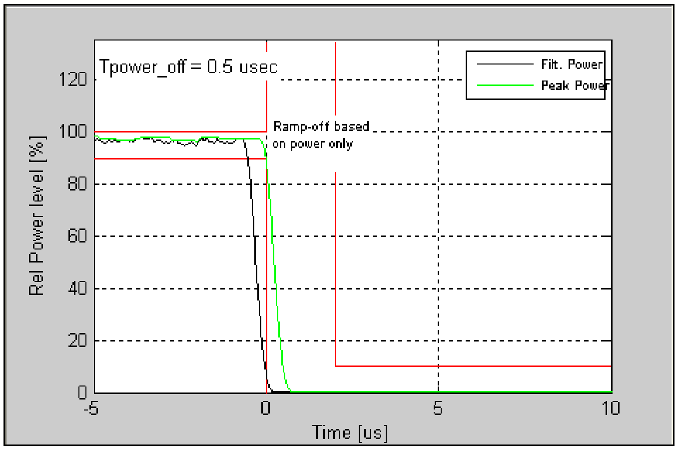


Figure 5-8. IQsignal Bluetooth—Power Down Ramp Plot

Spectrum Mask

The figure below shows the power spectrum density of one bluetooth signal.

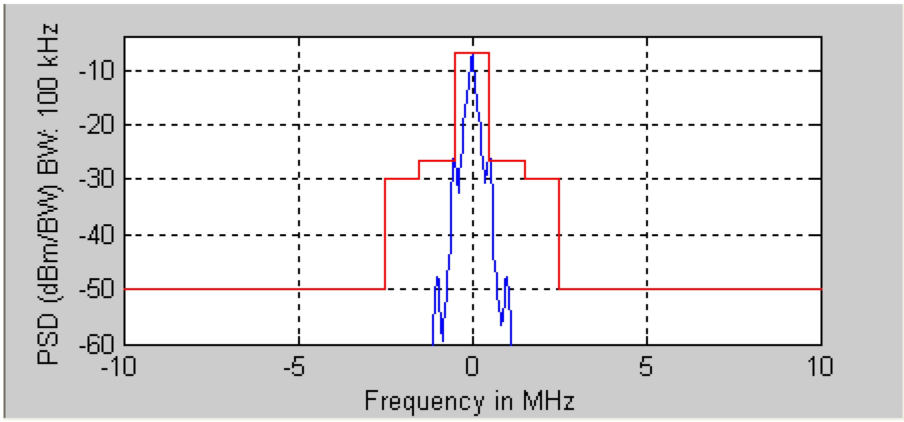


Figure 5-9. IQsignal Bluetooth—Spectrum Mask Plot

20 dB Bandwidth

The figure below shows the spectrum measured with a 10 kHz resolution bandwidth and the 20 dB mask. It reports the 20 dB bandwidth inside the plot window. The 20 dB bandwidth is defined as the difference between the lowest frequency below the center frequency and the highest frequency above the center frequency at which the spectrum power is less than or equal to 20 dB below the maximum spectrum measured in the 2 MHz band around the center frequency.

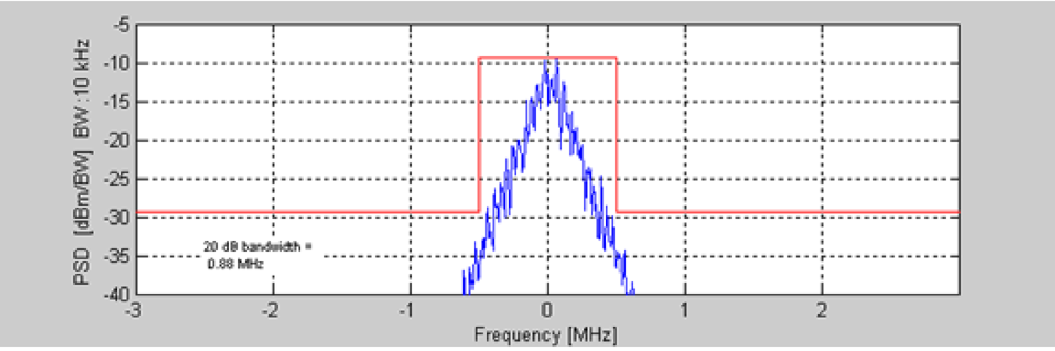


Figure 5-10. IQsignal Bluetooth—20 db Bandwidth Plot

Spectrogram

With the spectrogram, the spectrum can be shown over time. The X-axis represents time and the Y-axis represents frequency offset. The color coding represents the strength on the signal, with red being the maximum strength, and green being minimum strength. The figure below shows the spectrogram plot of a captured signal.

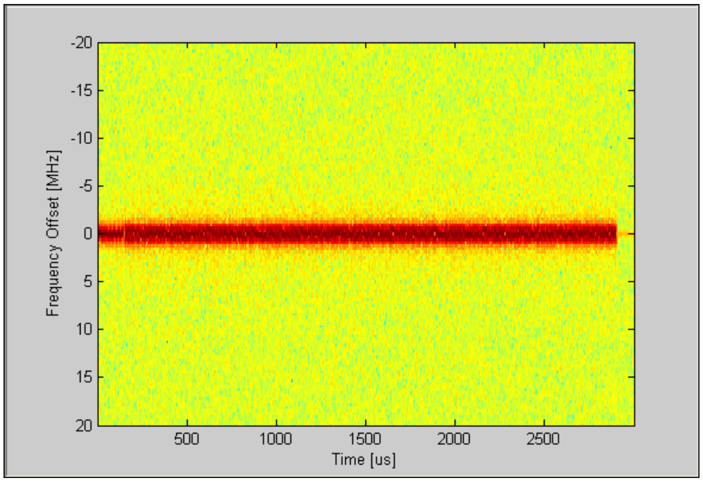


Figure 5-11. IQsignal Bluetooth—Spectrogram Plot

FM Demodulator

FM demodulator plot is the output of the FM demodulator analysis as function of time. The graph below shows zoomed-in FM demodulator of a1Mbps signal.

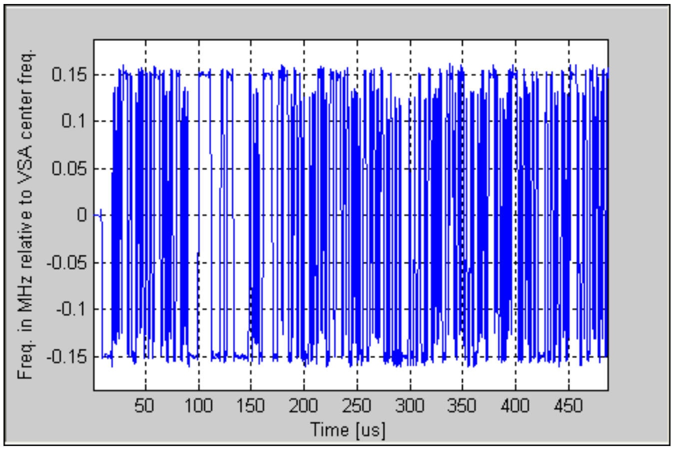


Figure 5-12. IQsignal Bluetooth—FM Demodulator Plot

Amplitude vs. Time

This plot displays a graphical representation of the measured data. The blue trace represents the instantaneous (peak) amplitude value, while the red trace(s) represent(s) the amplitude as a moving average (sliding window of 1μs).

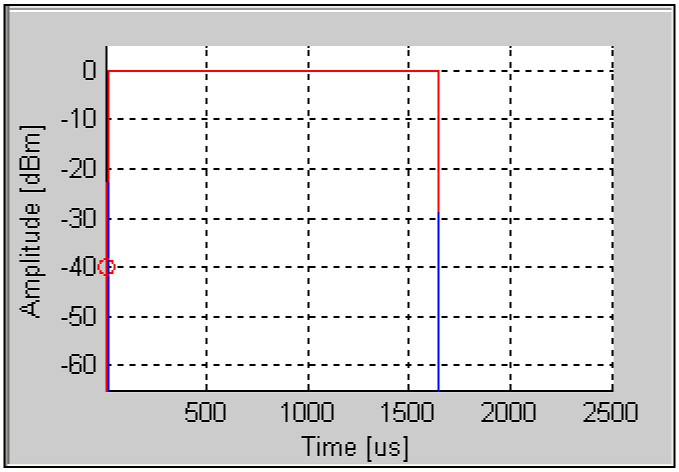


Figure 5-13. IQsignal Bluetooth—Ampl. vs. Time Plot

Symbol Constellation

The Symbol Constellation plot is used to indicate the quality of the demodulated data in the complex plane for each symbol in the analyzed frame. The constellation shows the differential I/Q values for the bluetooth signal.

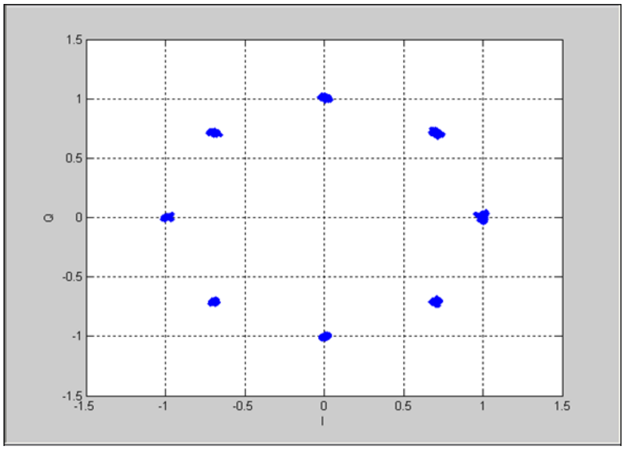


Figure 5-14. IQsignal Bluetooth—Symbol Constellation Plot

LO (DC) Leakage

The LO (DC) Leakage shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage.

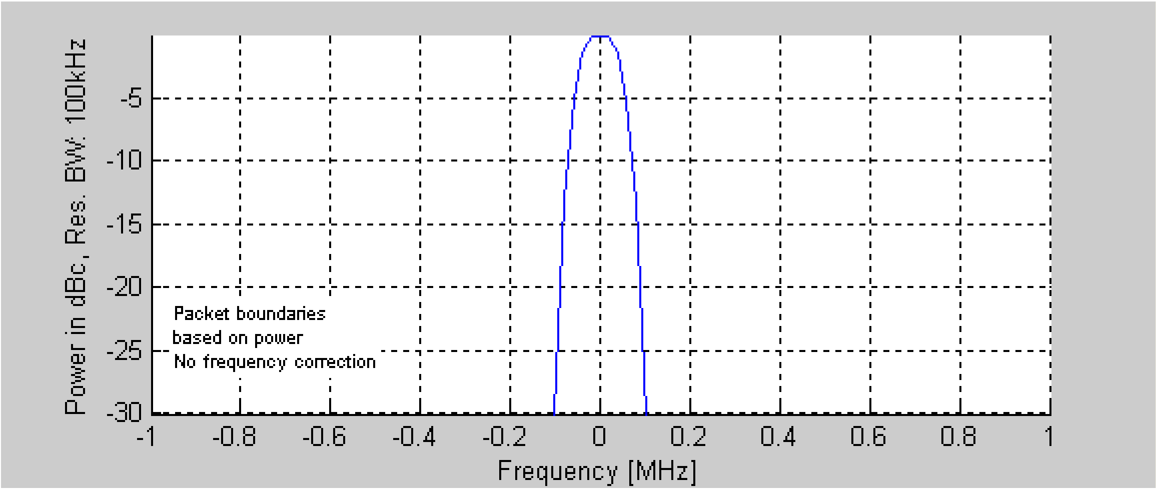


Figure 5-15. IQsignal Bluetooth—LO (DC) Leakage

Settings

This section provides information about the *Settings* window.

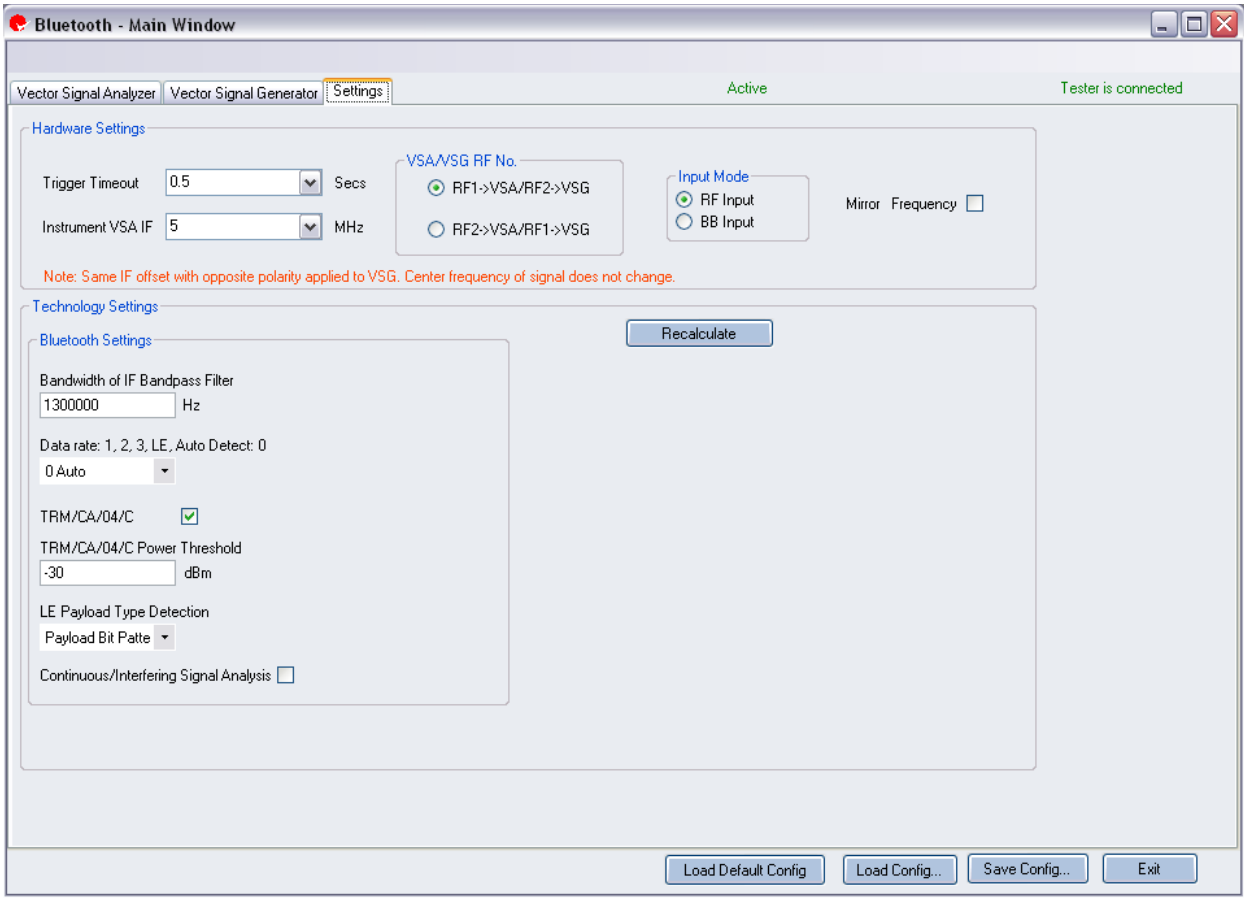


Figure 5-16. IQsignal Bluetooth Application—Settings Screen

Hardware Settings

Instrument VSA IF	Intermediate frequency of the VSA signal.
Mirror Freq.	Mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
RF1->VSA/RF2->VSG	Uses port #1 for VSA input and port #2 for VSG input.
RF2->VSG/RF3->VSA	Uses port #2 for VSA input and port #1 for VSG input.

Bluetooth Settings

Bandwidth of IF bandpass filter	For FM-related signal processing. The nominal bandwidth is 1300000 Hz.

Data rate: 1,2,3. Autodetect: 0	Data rate of the packet to be analyzed; represented in Mbps. If 0 is selected, the analysis will auto-detect the data rate of the received signal and report the detected data rate. When you load the signal file onto VSA or VSG, make sure that the data rate of the signal file (represented in the file name) matches the data rate set in the Settings window. You can set a data rate value of 0 with any of the signal files for auto-detection.
TRM/CA/04/C	Select this checkbox to enable testing of the frequency range. When this option is selected, the Vector Signal Analyzer displays Fl (lower frequency) and Fh (upper frequency) as defined in the standard (TRM/CA/04/C) for 1Mbps data rate.
LE Payload Type Detection	PDU Header— Determines the LE (low energy) payload pattern based on header contents per standard, regardless of the actual payload. Payload Bit Pattern—Automatically recognizes LE payload pattern based on payload bits, regardless of the payload header content.
Continuous/Interfering Signal Analysis	Select this check box to enable analysis of continuous/interfering Bluetooth signal. You must specify a data rate that matches the capture. Auto detection of data rate is not supported.
Recalculate	Recalculates analysis results based on the current analysis.

Chapter 6 Using LitePoint IQsignal WiMAX Applications

WiMAX

802.16d

The IQsignal for WiMAX software GUI application performs PHY layer analysis on 802.16d-2004 (fixed) WiMAX signals. In combination with the LitePoint Test System, the application combines a Vector Signal Analyzer (VSA) and a Vector Signal Generator(VSG) function in the same software application.

This application includes three separate tabs:

- **Vector Signal Analyzer—**allows you to set signal capture and analysis parameters
- **Vector Signal Generator—**allows you to set signal generation parameters
- **Settings—**allows you to set hardware settings and VSA analysis parameters

Vector Signal Analyzer

This section provides you with information about the Vector Signal Analyzer window.

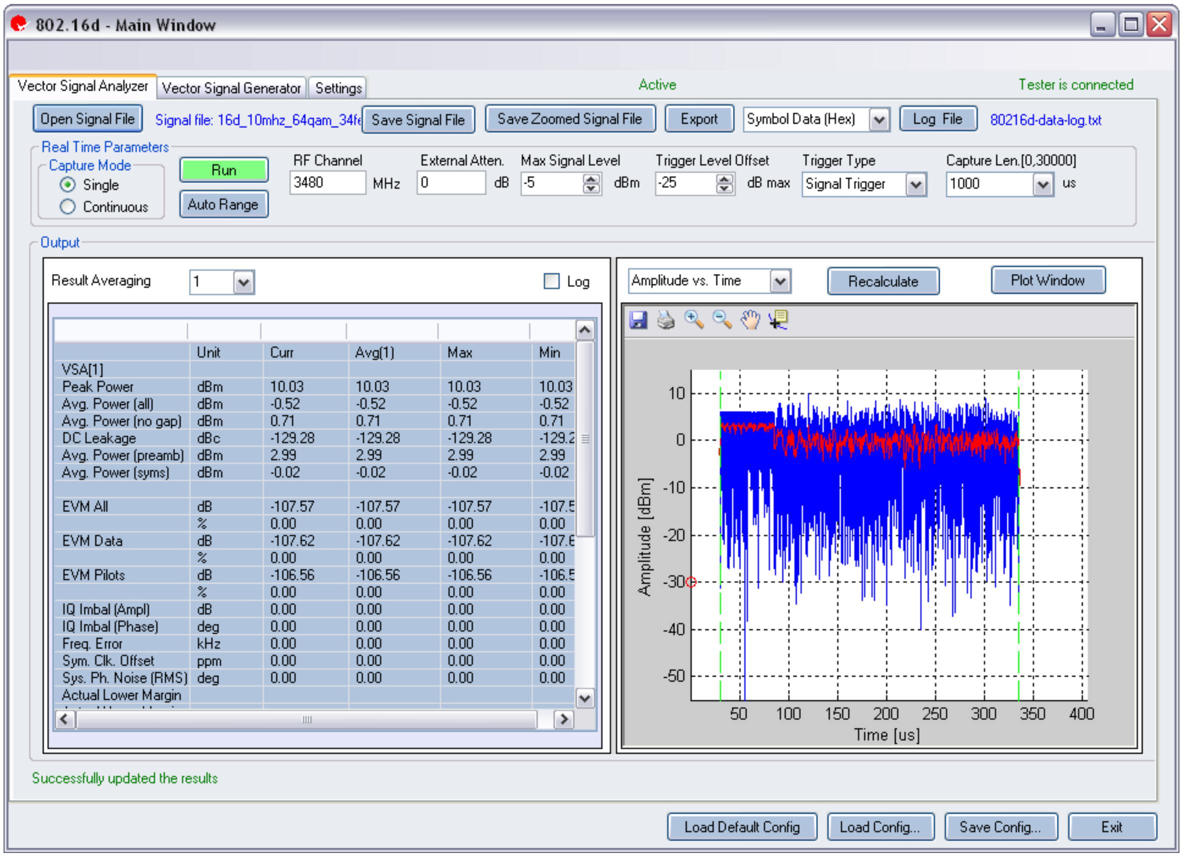


Figure 6-1. IQsignal 802.16d Application—VSA Screen

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension .SIG. Wave files with extension .MOD can also be opened.

Save Signal File—Saves captured data to a signal file with extension .SIG for later analysis.

Save Zoomed Signal File—Saves captured, zoomed data to a signal file with extension `.sig` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Log File—Allows you to save log data to a text file for later analysis.

A `.sig` file is used for signal analysis and a `.mod` file is used by the VSG to generate a signal. A signal file can only be saved with a `.sig` or a `.mod` extension.

Real Time Parameters

RF Channel	Indicates RF channel number and frequency.
Capture Length	Specifies the VSA capture length.
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate capture **External Trigger—**An external signal applied to the instrument's Trigger Input port is used to trigger a capture. **Signal Trigger—**The RF signal level is used to trigger a capture (this type available in RF input mode only). If you select Signal Trigger, a Free Run data capture will occur upon trigger timeout, which can be specified in the Settings tab.
Trigger Level	Specifies the VSA trigger level, relative to the Maximum Signal Level in Signal Trigger Mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box to adjust in increments of 1. After a data capture, a red circle appears to the extreme left of the Amplitude vs. Time display, indicating the current trigger level.
Max. Signal Level	Specifies the gain of the VSA receiver chain. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Pressing the *Auto Range* button will perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends that you use the *Auto Range* feature for the first data capture of a DUT. You can also use this feature when the received signal levels have change significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on all test instruments in the configuration, when you click the Start button. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses, after you click **Run**. After you click **Run** in *Continuous* mode, the text on the *Run* button changes to *Stop*. Pressing the *Stop* button or selecting the Single mode button will stop the VSA from operating in the continuous data capturing mode.

		It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Results Averaging	This field specifies the size of the averaging buffer for averaged measurements. The selections are 1, 10, 20, 40, 60, 80, and 100 averages.
Recalculate	Performs the analysis on the captured data. Recalculates analysis results based on the current analysis settings for the currently zoomed-in signal portion of the plot. When you select an area of the plot with the zoom tool and then click **Recalculate**, the analysis is performed on the selected area only. *Recalculate* is also used to repeat the analysis after changes to the analysis settings have been made.
Plot Window	Opens a window to view the plots.

VSA 1	
Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm.
Avg Power [all]	This power measurement is the average power over the full waveform time.
Avg Power [no gap]	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts.
DC Leakage	Reports DC or LO Leakage in dBc.
Avg Power [preamble]	This is the average power during the preamble of the sub-frame being analyzed. This result is available only for valid fixed WiMAX sub-frames and mobile WiMAX Downlink sub-frames.
Avg Power [syms]	This is the average power during the sub-frame, excluding the preamble.
EVM All	Reports error vector magnitude (EVM) in dB, averaged over all sub-carriers in the symbols being analyzed.
EVM Data	Reports error vector magnitude (EVM) in dB, averaged over all data sub-carriers in the symbols being analyzed.
EVM Pilots	Reports error vector magnitude (EVM) in dB, averaged over all pilot sub-carriers in the symbols being analyzed.
IQ Imbal [Ampl]	Reports IQ amplitude mismatches (in dB) between the in-phase and quadrature components of the transmit chains.
IQ Imbal [Phase]	Reports IQ phase mismatches (in degrees) between the in-phase and quadrature components of the transmit chains.
Freq Error	Reports frequency error in kHz.
Sym Clk Offset	Reports symbol timing clock error in PPM.
Sys Ph Noise [RMS]	Reports phase error in RMS degrees.

802.16d Plots

Amplitude vs. Time	Instantaneous and peak power averaged over symbol duration (dBm) versus time.

Spectrum Mask	Shows the power spectrum of any signal in the captured range.
CCDF	Plots the peak to average power distribution, an alternative measure for crest factor.
CCDF Payload	Performs the CCDF calculation over the payload portion of the packet only.
Symbol Constellation	Indicates the quality of the demodulated data in the complex plane for each symbol in the analyzed frame.
Spectral Flatness	Indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power.
Phase Error	Displays the phase error (in degrees), estimated per symbol.
I/Q Signals	The I/Q signals plot shows the I and Q signals voltages plotted against time.
EVM vs. Carrier	Plots the EVM for each sub-carrier averaged over all symbols within the zone or sub-frame.
EVM vs. Symbol	Plots the EVM measurement, displayed over time.
Phase Error (PSD)	Analyzes phase versus frequency. Graphs the estimated PSD plot of the synthesizer measured during the burst. This data is derived by calculating the PSD of the estimated phase errors per symbol.
Spectral Delta	Displays the absolute difference for all sub-carriers.
Frequency Error	Plots the frequency error through the short and long training fields.
Spectrogram	Analyzes the power spectrum of the capture over time.

Amplitude vs. Time

The Amplitude vs. Time Graph presents the difference in symbol power at a given symbol in the packet vs. the power of the symbols of the long training sequence (LTS).

This plot displays a graphical representation of the measured amplitude vs. time data. The blue trace represents the instantaneous (peak) am IQsignal 802.16d Application—amplitude value, while the red trace(s) represent(s) the amplitude as a moving average (sliding window of 1µs).

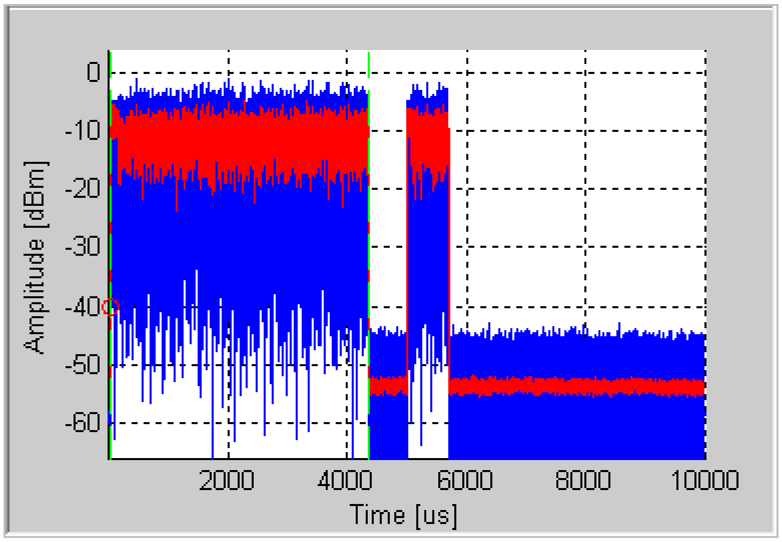


Figure 6-2. IQsignal 802.16d—Amplitude vs. Time Plot

CCDF and CCDF Payload

The CCDF (Complimentary Cumulative Distribution Function) window plots the peak to average power distribution, an alternative measure for crest factor. The horizontal axis plots the power level above the average power level, and the vertical axis plots the probability that the actual power is greater than this amount. The CCDF is only measured over a single packet, so the gap does not contribute to the measurement. This graph reveals any compression of the signal that may exist and is given per stream. Typical plots are shown below. For comparison, also plotted is the ideal distribution for an OFDM signal with no compression (in red). The preamble of an 802.16 signal has an average power level which is higher than the data portion. This explains why, especially for short signals, the plot shows some compression even if there is none. Selecting “CCDF Payload” as the plot type will perform the CCDF calculation over the payload portion of the packet only.

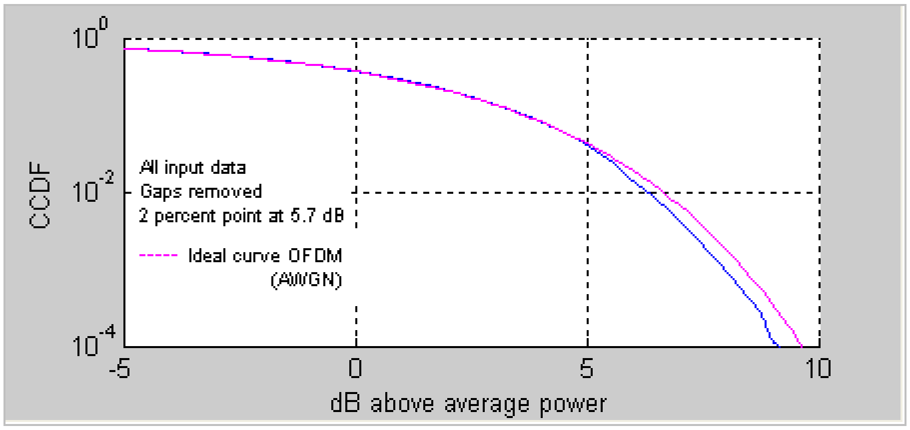


Figure 6-3. IQsignal 802.16d—CCDF OFDM Signal

EVM vs. Carrier

The Error Vector Magnitude (EVM) versus Carrier graph shows the EVM for each sub-carrier averaged over all symbols within the zone or sub-frame. The EVM results for pilot sub-carriers are plotted in green.

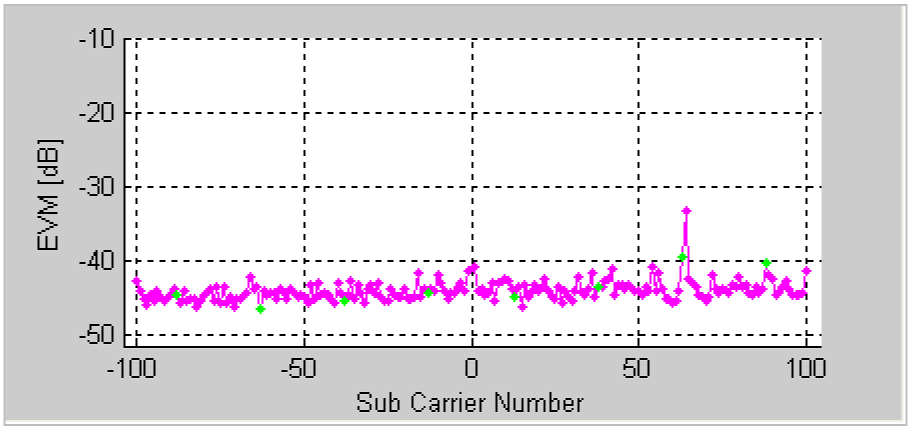


Figure 6-4. IQsignal 802.16d—EVM Plot

EVM vs. Symbol

The EVM versus Symbol plot shows the EVM measurement, displayed over time. The EVMs are averaged over all sub-carriers for each OFDM symbol.

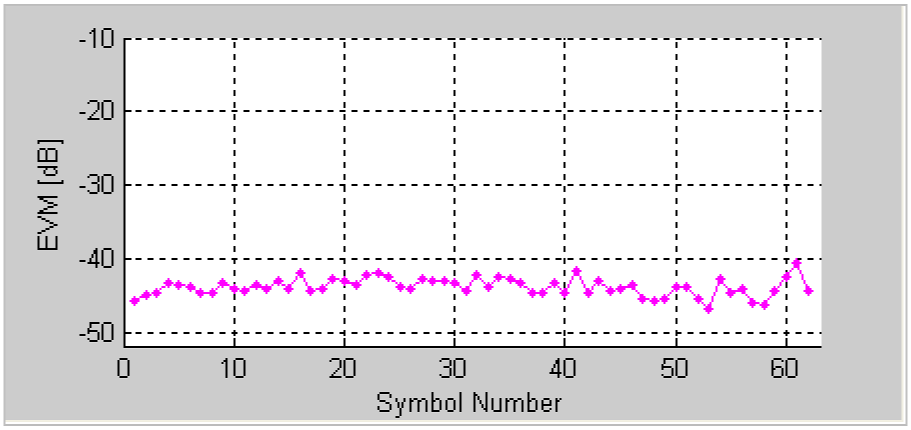


Figure 6-5. IQsignal 802.16d—EVM vs. Symbol Plot

Frequency Error

The *Frequency Error* plot shows the frequency error through the short and long training fields. The frequency error during the first training symbol is illustrated to the left of the green dots. The frequency error during STS applies only to fixed WiMAX Downlink frames.

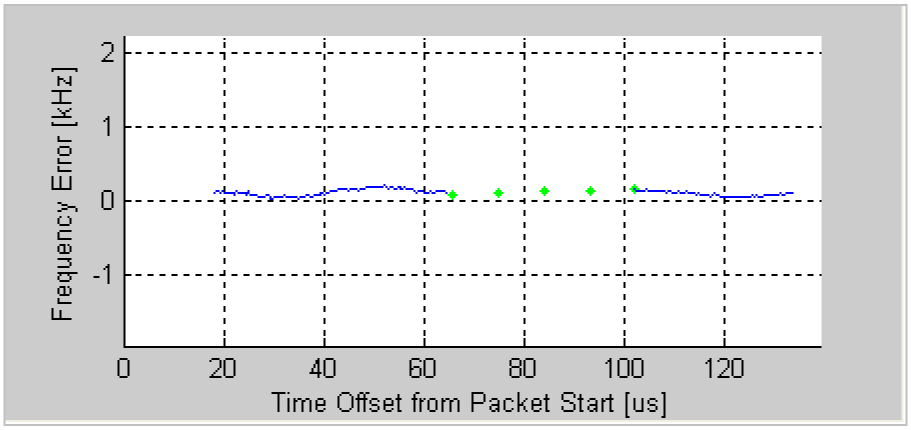


Figure 6-6. IQsignal 802.16d—Frequency Error Plot

The frequency error of the second part of the first long training sequence is illustrated to the right of the green dots. The green dots shown represent a linear interpolation between the two.

This plot does not contain valid data for mobile WiMAX Uplink frames.

I/Qsignals

The I/Q signals plot shows the I and Q signals voltages plotted against time.

The I-channel is represented in red and the Q-channel in green.

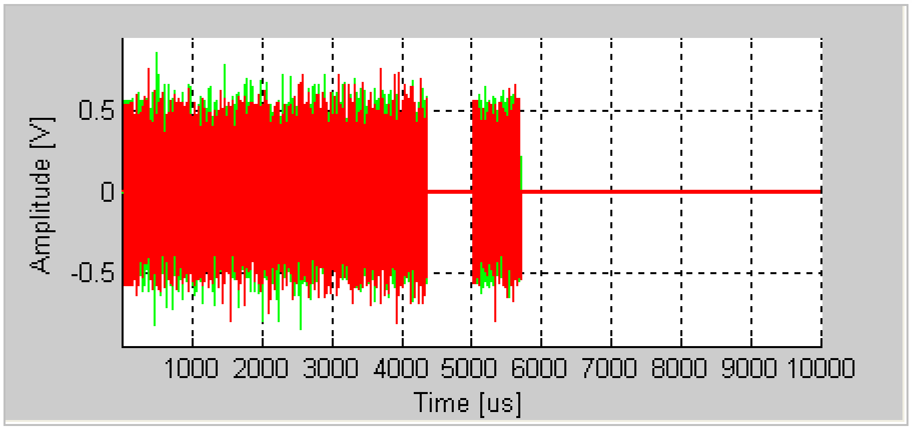


Figure 6-7. IQsignal 802.16d—I/Q Signals Plot

Phase Error

This graph displays the phase error (in degrees), estimated per symbol.

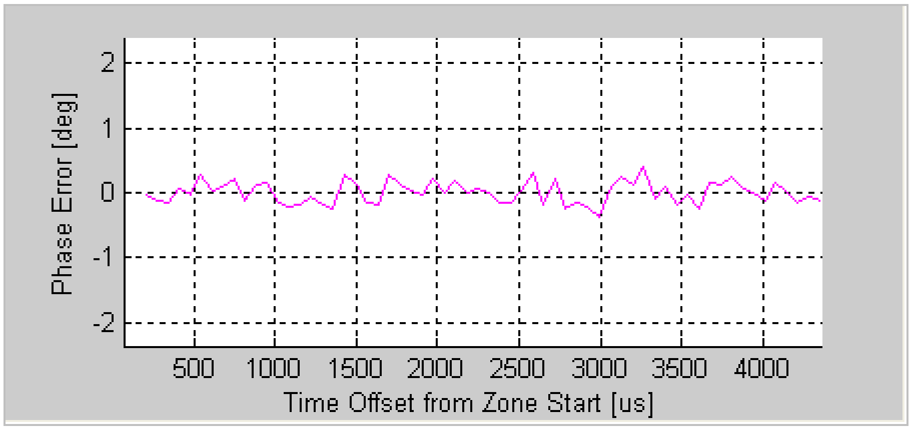


Figure 6-8. IQsignal 802.16d—Phase Error Plot

Phase Error [PSD]

Analyzes phase versus frequency. Graphs the estimated PSD plot of the synthesizer measured during the burst. This data is derived by calculating the PSD of the estimated phase errors per symbol.

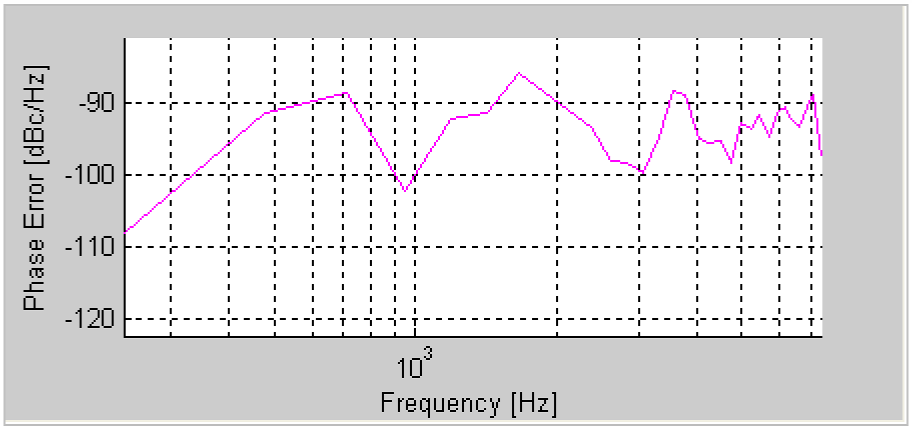


Figure 6-9. IQsignal 802.16d—Phase Error PSD Plot

Spectral Delta

In addition to the spectral flatness requirement, the 802.16 standard specifies that the absolute difference between adjacent sub-carriers shall not exceed 0.1 dB. The Spectral Delta plot shows this absolute difference for all sub-carriers. The spectral delta plot (like the spectral flatness plot) is derived from the channel estimate. It may be necessary to enable full packet channel estimator to get a sufficiently accurate channel estimate to verify the 0.1 dB difference.

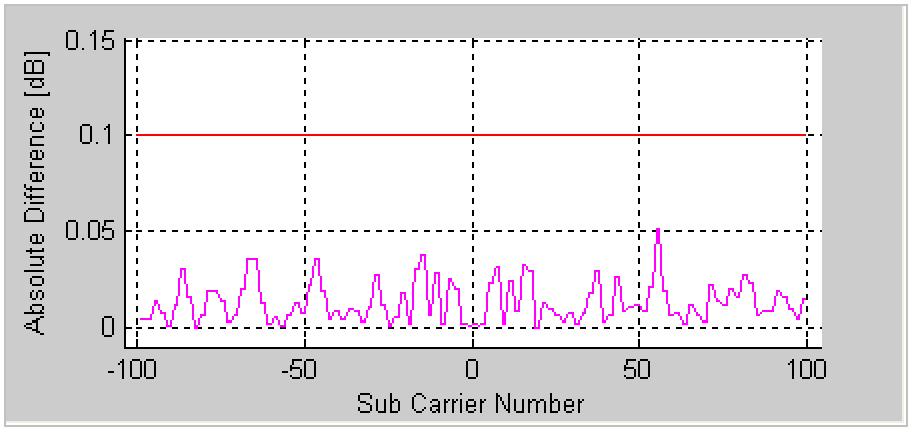


Figure 6-10. IQsignal 802.16d—Spectral Delta Plot

Spectral Flatness

The spectral flatness plot indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power. The limits plotted in red are taken from the 802.16 specification.

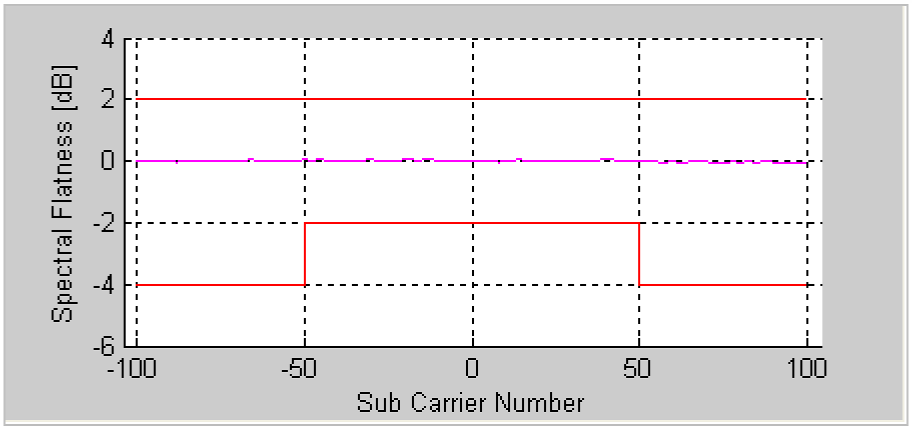


Figure 6-11. IQsignal 802.16d—Spectral Flatness Plot

Symbol Const

The Symbol Constellation plot is used to indicate the quality of the demodulated data in the complex plane for each symbol in the analyzed frame. The noisier and more degraded the signal, the cloudier the constellation will appear. For all constellation types, the pilot tones are plotted in green.

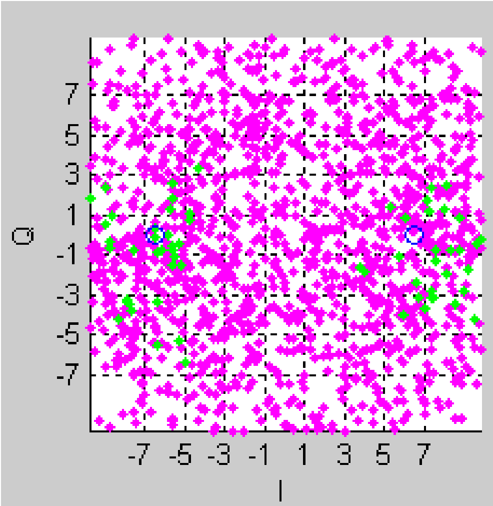


Figure 6-12. IQsignal 802.16d—Symbol Constellation Plot

Spectrogram

The spectrogram plot displays the power spectrum of the capture over time. In many cases there can be a disturbing signal, which will be difficult to analyze with a normal spectrum plot. With the spectrogram the spectrum can be shown over time. The X axis represents time and the Y axis represents frequency. The color coding represents the strength on the signal, with red being the maximum strength, and green being minimum strength.

If there are multiple signal streams present in the captured/loaded waveform, a separate spectrogram plot can be displayed for each stream.

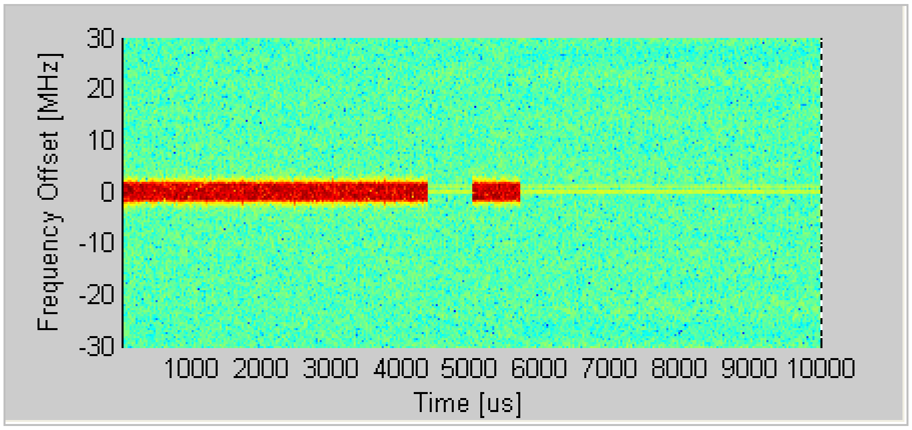


Figure 6-13. IQsignal 802.16d—Spectrogram Plot

Spectrum Mask

The Spectrum Mask plot shows the power spectrum of any signal in the captured range. This plot shows the average RF power spectral density (in dBm/100kHz) of the entire signal shown in the Amplitude vs. Time plot.

Zooming in on a particular area in the *Amplitude vs.Time* plot and clicking **Recalculate** shows the PSD plot for that area. When a valid WiMAX signal is detected, the spectrum mask is superimposed on the plot, in red.

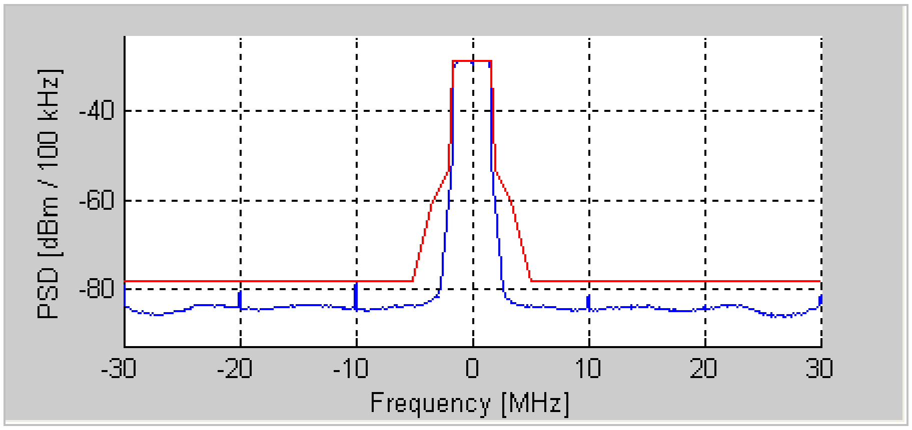


Figure 6-14. IQsignal 802.16d—PSD Plot

Vector Signal Generator

This section provides you with information about the *Vector Signal Generator* window.

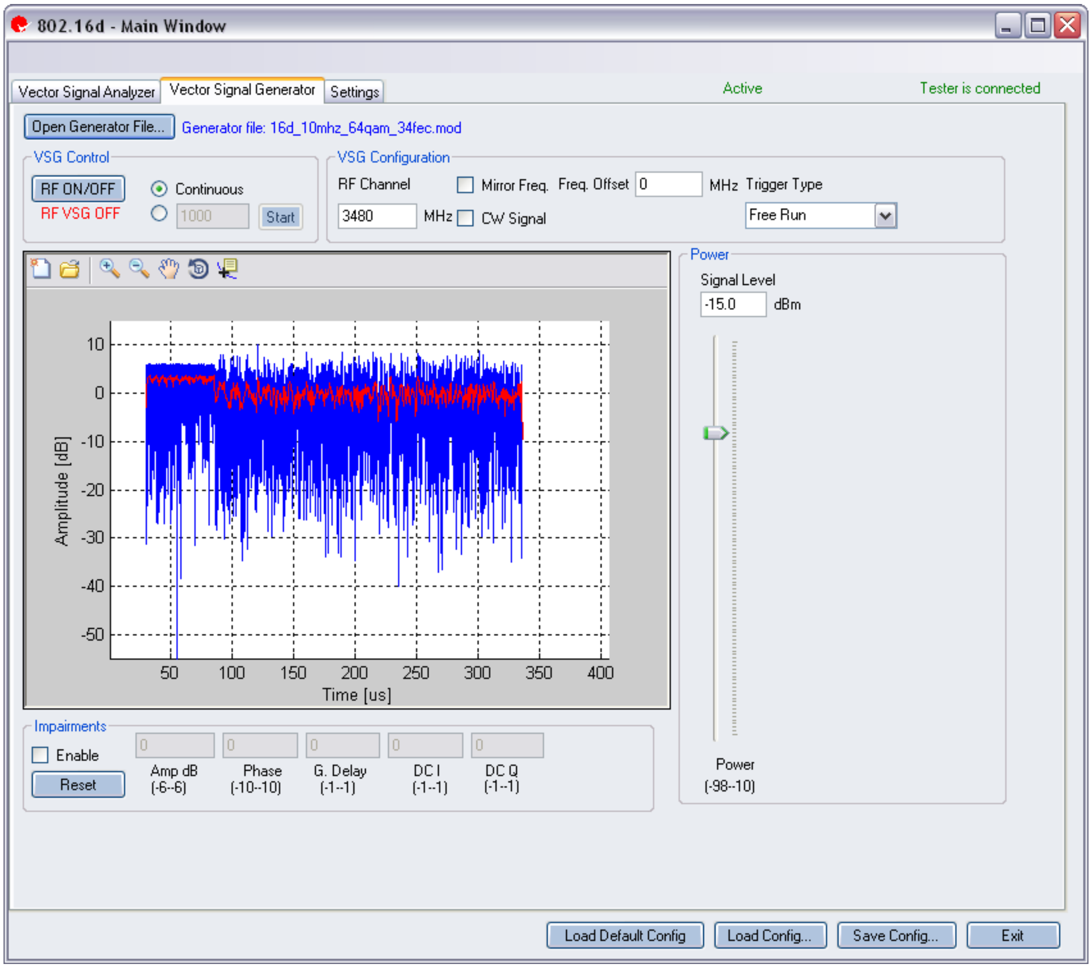


Figure 6-15. IQsignal 802.16d Application—VSG Screen

Open Generator File—Opens modulator file (`.mod`) and loads data into the Vector Signal Generator. The file has a `.MOD` extension.

VSG Control

RF ON/OFF	Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous**—Continuous transmission of waveforms. Specified number of packets—Performs transmission to the DUT. The range for specified number of packets to be transmitted is between 1 and 65,534. When the RF signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted in MHz.
Mirror Freq	If selected, mirrors the frequency spectrum of the transmitted waveform.

	This is equivalent to flipping the sign of the baseband Q channel.
CW Signal	If selected, provides a continuous-wave signal transmit.
Freq. offset	This field specifies how much offset relative to the RF channel frequency the signal is sent out of the VSG. This is specified in KHz.
Trigger Type	This field allows you to select from the following trigger types: **Free Run:** no trigger; immediate start of transmission **External Trigger:** An external signal applied to the instrument's Trigger Input port is used to trigger transmission start. An external trigger signal can be used to control the start of transmissions from the VSG.

Power

Power	**Signal Level**	RF Output signal level represented in dBm.
	Power	Range of signal level that can be set is from -98 to 10 dBm.

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp	**Amp (Amplitude Imbalance)**—This field/slider specifies the Amplitude Imbalance in percent. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	**Phase (Phase Imbalance)**—This field/slider specifies the Phase Imbalance in degrees. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	**G (Group) Delay**—This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	**DC (Offset) I**—This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	**DC (Offset) Q**—This field/slider specifies the DC Offset for the Q channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		**Reset**—This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Settings

This section provides you with information about the *Settings* window.

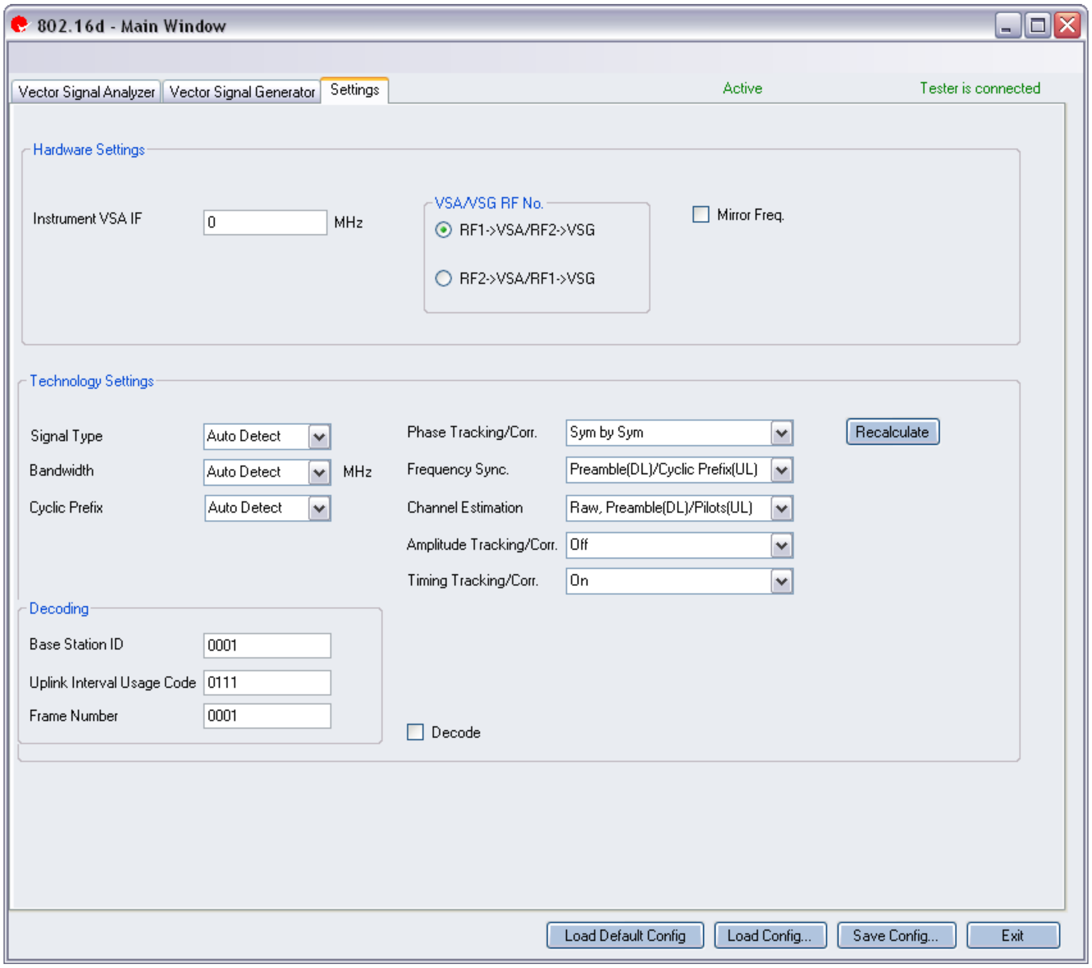


Figure 6-16. IQsignal 802.16d Application—Settings Screen

Hardware Settings

Instrument VSA IF	The VSA uses a direct-down conversion scheme, i.e. the down converter is tuned to the center frequency of the RF channel to be captured. In some cases, the residual VSA LO Leakage interferes with a measurement and in this case the VSA is tuned to the center frequency of the RF channel plus Instrument VSA IF (in MHz). The analysis software shifts the received signal back to the center frequency.
Mirror Freq.	If enabled, mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
VSA Port1/VSG Port2	Uses port #1 for VSA input and port #2 for VSG output.
VSA Port2/VSG Port1	Uses port #2 for VSA input and port #1 for VSG output.

Technology Settings

Signal Type	This field specifies the type of sub-frame signal. Available options are as follows: **Downlink—**Specifies the downlink subframe. **Uplink—**Specifies the uplink subframe. **Auto Detect—**Automatically detects the correct signal type. This is the default setting. For faster analysis, you can specify the bandwidth instead of using auto-detect.
Bandwidth	This field specifies the bandwidth of the input signal in MHz. The signal bandwidth can be selected from the dropdown menu, or can be set to Auto Detect (default). For faster analysis, you can specify the bandwidth instead of using auto-detect.
Cyclic Prefix	This field specifies the cyclic prefix of the input signal. The cyclic prefix value can be selected from the dropdown menu, or can be set to Auto Detect (default). For faster analysis, you can specify the cyclic prefix length instead of using auto-detect.
Phase Tracking/Corr	Phase tracking method selection. Available options are as follows: **OFF—**Can be used when the carriers and references of the transmitter and receiver are phase locked or when low frequency carrier phase noise is suspected to be present. **Sym-by-Sym—** Phase offsets are tracked and corrected for each symbol.
Frequency Sync	Carrier frequency error estimation method. Available options are as follows: **Off—**Frequency sync is turned off. **Preamble[DL]/Cyclic Prefix[UL]—**The preamble is used to perform frequency synchronization. Downlink signals and initial ranging signals have a long preamble (two symbols) while uplinks data signals have a short preamble (one symbol). **Full Packet—**In addition to the preamble, the data symbols of the entire packet are used to estimate the frequency error. During the start of the packet, if the received signal shows frequency dynamics even after the preamble, the Full Data Packet method improve signal demodulation.
Channel Estimation	This field is an estimate of the amplitude and phase shift caused by the wireless channel from the available pilot information. **Raw, Preamble[DL]/Pilots[UL]—**Channel estimation is performed on the preamble. **Raw, Full Packet—**This option performs channel estimation on the full packet and uses data carriers.
Enable Amplitude Tracking/Corr.	Enables/disables amplitude tracking option for analysis.
Enable Timing Tracking/Corr.	Enables/disables timing tracking option for analysis. The recommended setting is to enable Timing Tracking/Corr.

Decoding

These settings are only needed for complete decoding of the data bursts.

Base Station ID	Base Station ID
Uplink Interval Usage Code	Uplink Interval Usage Code
Frame Number	Frame Number
Decode	Enables data decoding

802.16e

The IQsignal for WiMAX software GUI application performs PHY layer analysis on 802.16e-2005 (mobile)WiMAX signals. In combination with the LitePoint Test System, the application combines a Vector Signal Analyzer (VSA) and a Vector Signal Generator (VSG) function in the same software application.

This application includes three separate tabs:

- **Vector Signal Analyzer—**allows you to set signal capture and analysis parameters
- **Vector Signal Generator—**allows you to set signal generation parameters
- **Settings—**allows you to set hardware settings and VSA analysis parameters

Vector Signal Analyzer

This section provides you with information about the *Vector Signal Analyzer* window.

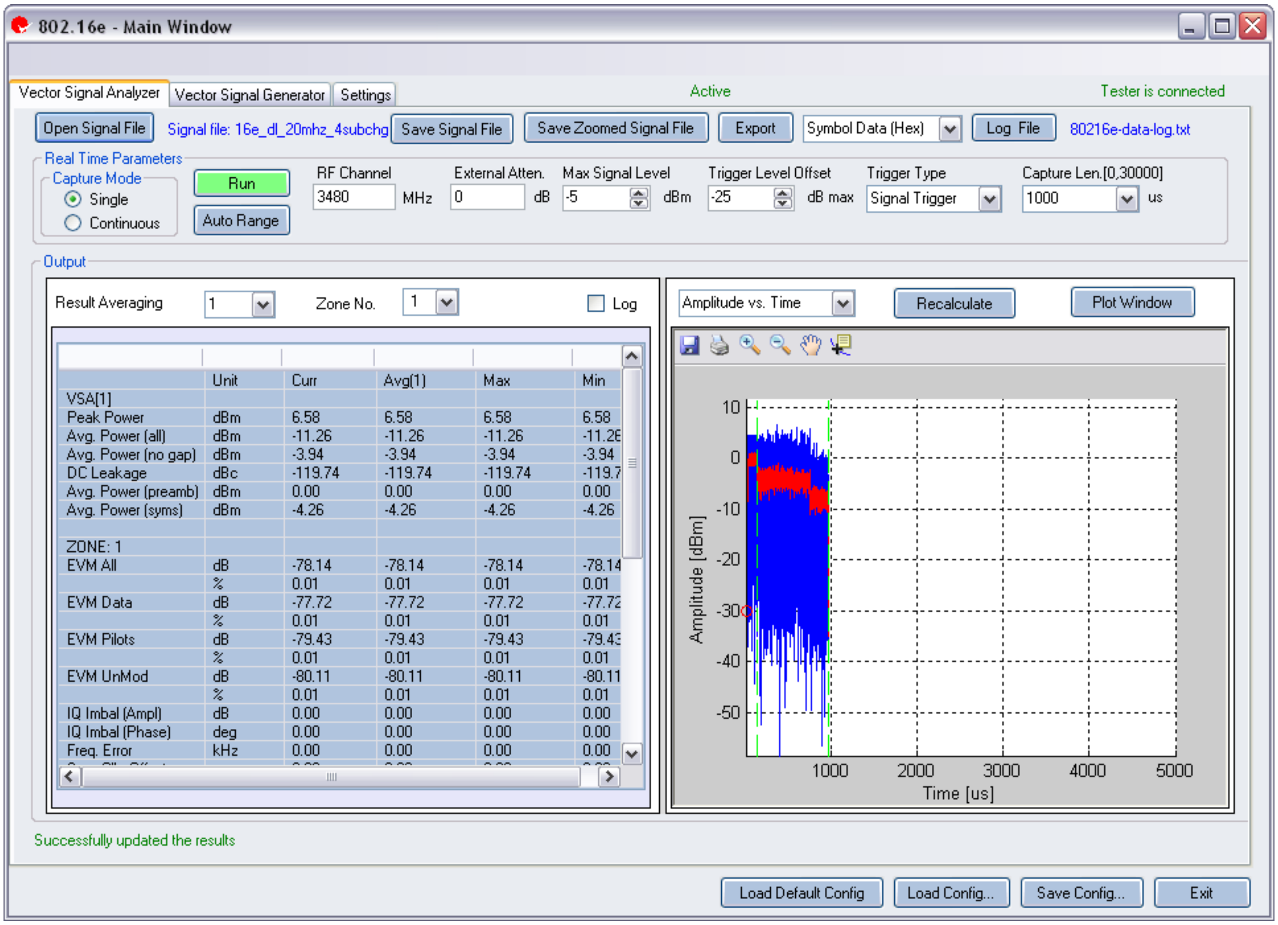


Figure 6-17. IQsignal 802.16e—VSA Screen

Open Signal File—Opens previously captured and saved data from a signal file for analysis. The filename for a signal file has the file extension .SIG. Wave files with extension .MOD can also be opened.

Save Signal File—Saves captured data to a signal file with extension .SIG for later analysis.

Save Zoomed Signal File—Saves captured, zoomed data to a signal file with extension `.sig` for later analysis.

Export PSDU—Allows you to export the decoded payload data from the captured signal to a text file.

Log File—Allows you to save log data to a text file for later analysis.

A `.sig` file is used for signal analysis and a `.mod` file is used by the VSG to generate a signal. A signal file can only be saved with a `.sig` or a `.mod` extension.

Real Time Parameters

RF Channel	Indicates RF channel number and frequency.
Capture Length	Specifies the VSA capture length.
External Atten.	Sets the value of the external attenuator used in reporting the DUT RF power.
Trigger Type	Sets the trigger type Free Run External Trigger or Signal Trigger. **Free Run—**no trigger; immediate capture **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger a capture. **Signal Trigger—**The RF signal level is used to trigger a capture (this type available in RF input mode only). If you select **Signal Trigger**, a Free Run data capture will occur upon trigger timeout, which can be specified in the *Settings* tab.
Trigger Level	This field specifies the VSA trigger level, relative to the maximum signal level in *Signal Trigger* mode. The desired value is entered in the text edit box, or by using the up/down arrows to the right of the edit box to adjust in increments of one. After a data capture, a red circle appears to the extreme left of the *Amplitude vs. Time* display, indicating the current trigger level.
Max. Signal Level	Specifies the gain of the VSA receiver chain. This should be set to the approximate peak power of the input signal.
Auto Range	This feature sets the VSA gain levels to the optimum condition based upon the input signal(s) and provides the best possible dynamic range for those input signals. Click **Auto Range** to perform a capture and change the automatic gain setting to optimize the dynamic range of the receiver. LitePoint recommends the *Auto Range* feature for the first data capture of a DUT. You can also use this feature when the received signal level(s) have change significantly.

Signal Capture

Capture mode	Single	This mode performs a single capture on all test instruments in the configuration, when you click the Start button. Once the data is collected and analyzed, the measurement results are plotted based on the settings of the plot and measurements parameters described in more detail in the following pages.
	Continuous	This mode performs repeated data captures and analyses, after you click **Start**. After you click **Run** in *Continuous* mode, the text on the *Run* button changes to *Stop*. Pressing the *Stop* button or selecting the Single mode button will stop the VSA from operating in the continuous data capturing mode. It may take a few seconds for all data capture and analysis cycles to complete and for the VSA to return to an idle state.
Run		Performs data capture and runs analysis on the received signal.

Output

Results Averaging		This field specifies the size of the averaging buffer for averaged measurements. The selections are 1, 10, 20, 40, 60, 80, and 100 averages.
Recalculate		Recalculate measurements.
Plot Window		Opens a window to view the plots.
Results	Peak Power	The peak power displays the maximum instantaneous power in the captured signal in dBm. This result is displayed on any signal regardless of analysis result.
	Avg. Power (all)	This power measurement is the average power over the full waveform time. This result is displayed on any signal regardless of analysis result.
	Avg. Power (no gap)	This power measurement removes gaps (noise and non-signal portions) from the signal and only calculates the power spanned by the sub-frame bursts. This result is displayed on any signal, regardless of analysis result.
	DC Leakage	Shows the energy level of the carriers relative to that of the center carrier, and thus reveals the amount of LO Leakage.
	Avg Power [preamb]	Average power of the preamble portion.
	Avg Power [syms]	Average power of the symbol portion.
	The results indicated below are data represented for each zone.	
	EVM All	Reports Error vector magnitude (EVM) in dB, averaged over all sub-carriers in the symbols being analyzed.
	EVM Data	Reports Error vector magnitude (EVM) in dB, averaged over all data sub-carriers in the symbols being analyzed.
	EVM Pilots	Reports Error vector magnitude (EVM) in dB, averaged over all pilot sub-carriers in the symbols being analyzed.
	EVM Unmod	Reports Error vector magnitude (EVM) in dB, averaged over all un-modulated sub-carriers in the symbols being analyzed. This applies to mobile WiMAX signals only.
	IQ Imbal [Ampl]	Reports IQ Amplitude mismatches (in dB) between the in-phase and quadrature components of the transmit chains.
	IQ Imbal [Phase]	Reports IQ Phase mismatches (in degrees) between the in-phase and quadrature components of the transmit chains.
	Freq Error	Reports frequency error in kHz
	Sym Clk Offset	Reports symbol timing clock error in PPM
	Sys Ph Noise [RMS]	Reports phase error in RMS degrees
	CINR	Reports Carrier to Interference plus Noise Ratio in dB

802.16e Plots

Amplitude vs. Time	Instantaneous and peak power averaged over symbol duration (dBm) versus time.
Spectrum Mask	Shows the power spectrum of any signal in the captured range.
CCDF	Plots the peak to average power distribution, an alternative measure for crest factor.
CCDF Payload	Performs the CCDF calculation over the payload portion of the packet only.
Symbol Constellation	Indicates the quality of the demodulated data in the complex plane for each symbol in the

	analyzed frame.
Spectral Flatness	Indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power.
Phase Error	Displays the phase error (in degrees), estimated per symbol.
I/Q Signals	The I/Q signals plot shows the I and Q signals voltages plotted against time.
EVM vs. Carrier	Plots the EVM for each sub-carrier averaged over all symbols within the zone or sub-frame.
EVM vs. Symbol	Plots the EVM measurement, displayed over time.
Phase Error (PSD)	Analyzes phase noise density versus frequency.
Spectral Delta	Displays the absolute difference for all sub-carriers.
Frequency Error	Plots the frequency error through the short and long training fields.
Spectrogram	Analyzes the power spectrum of the capture over time.

Amplitude vs. Time

The *Amplitude vs. Time* Graph presents the difference in symbol power at a given symbol in the packet vs. the power of the symbols of the long training sequence (LTS).

This plot displays a graphical representation of the measured data. The blue trace represents the instantaneous (peak) amplitude value, while the red trace(s) represent(s) the amplitude as a moving average (sliding window of 1μs).

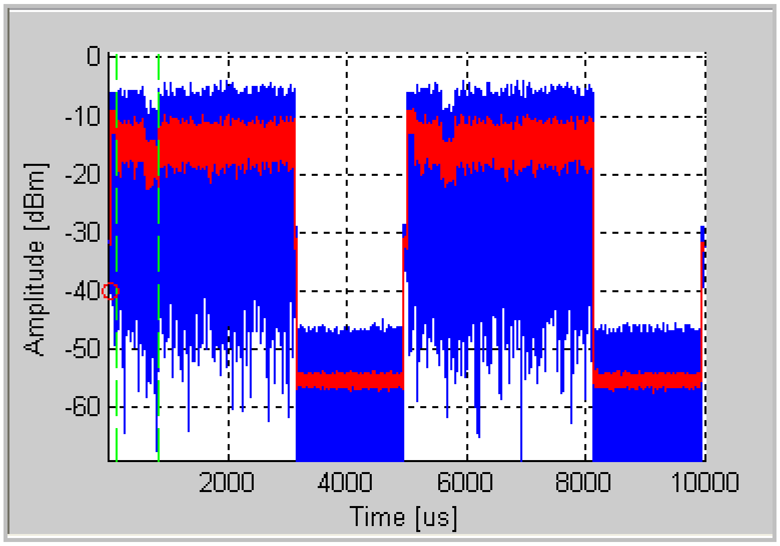


Figure 6-18. IQsignal 802.16e—Amplitude vs. Time Screen

CCDF and CCDF Payload

The CCDF (Complimentary Cumulative Distribution Function) window plots the peak to average power distribution, an alternative measure for crest factor. The horizontal axis plots the power level above the average power level, and the vertical axis plots the probability that the actual power is greater than this amount. The CCDF is only measured over a single packet, so the gap does not contribute to the measurement. This graph reveals any compression of the signal that may exist and is given per stream. Typical plots are shown below. For comparison, also plotted is the ideal distribution for an OFDM signal with no compression (in red). The preamble of an 802.16 signal has an average power level which is higher than the data portion. This explains why, especially for short signals, the plot shows some compression even if there is none. Selecting *CCDF Payload* as the plot type will perform the CCDF calculation over the payload portion of the packet only.

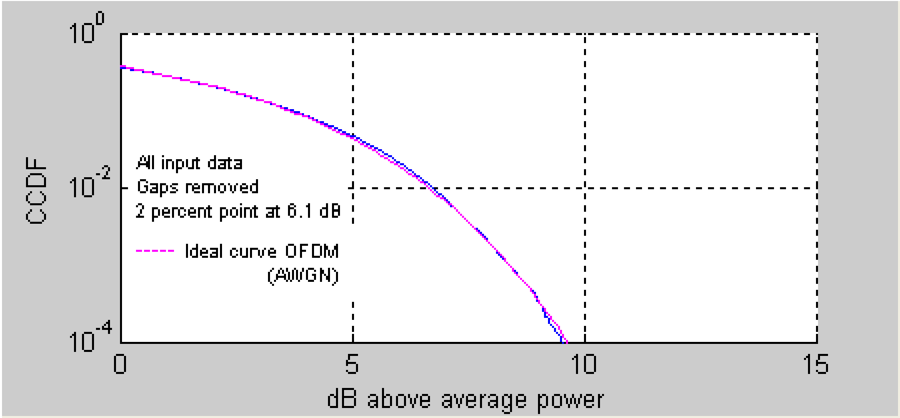


Figure 6-19. IQsignal 802.16e—CCDF OFDM Signal

EVM vs. Carrier

The Error Vector Magnitude (EVM) versus Carrier graph shows the EVM for each sub-carrier averaged over all symbols within the zone or sub-frame.

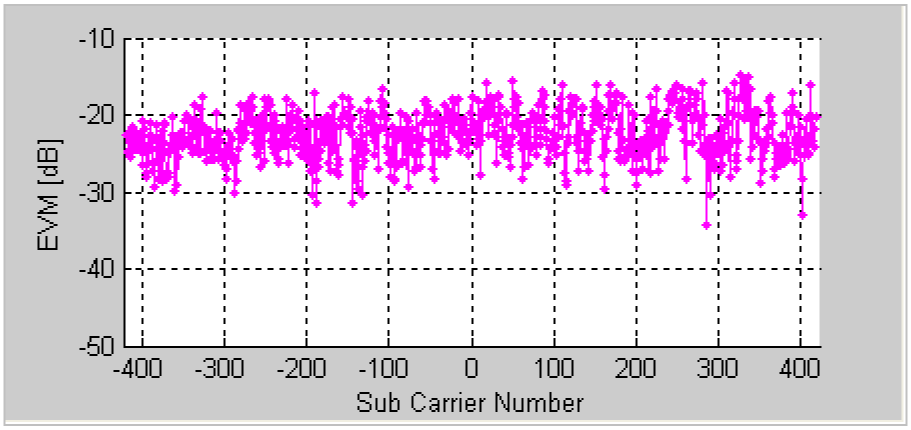


Figure 6-20. IQsignal 802.16e—EVM vs. Carrier Plot

EVM vs. Symbol

The EVM versus Symbol plot shows the EVM measurement, displayed over time. The EVMs are averaged over all sub-carriers for each OFDM symbol.

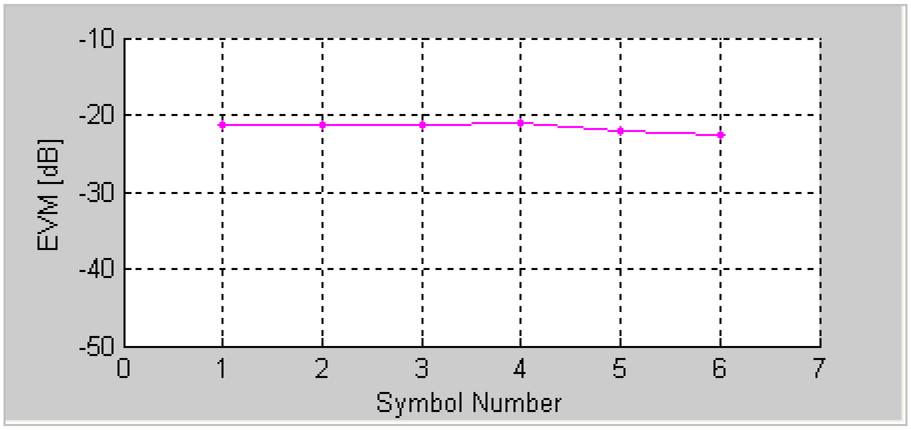


Figure 6-21. IQsignal 802.16e—EVM vs. Symbol

Frequency Error

The Frequency Error plot shows the frequency error through the preamble symbol. The frequency error during the short training sequence is illustrated to the left of the green dots.

The frequency error during STS applies only to fixed WiMAX Downlink frames.

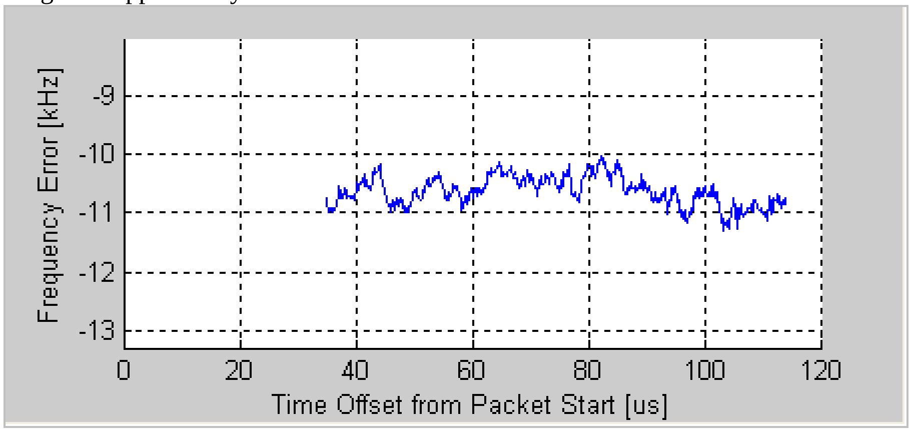


Figure 6-22. IQsignal 802.16e—Frequency Error

This plot does not contain valid data for mobile WiMAX uplink frames.

I/Qsignals

The I/Q signals plot shows the I and Q signals voltages plotted against time.

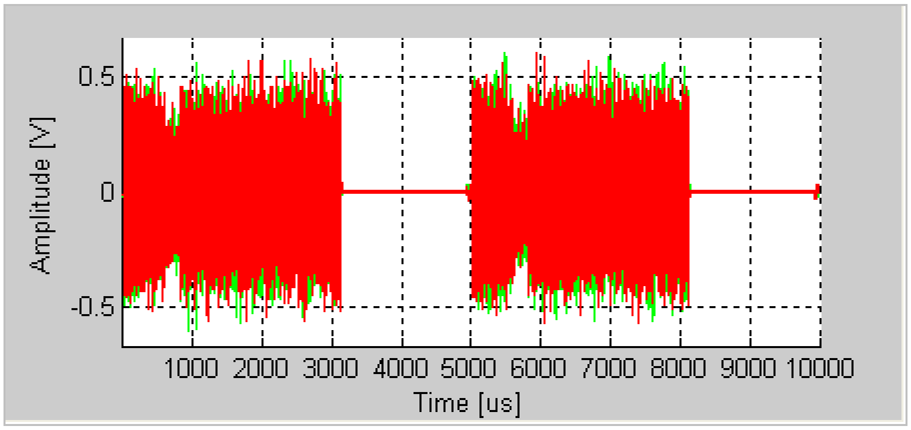


Figure 6-23. IQsignal 802.16e—I/Qsignals Plot

Phase Error

This graph displays the phase error (in degrees), estimated per symbol.

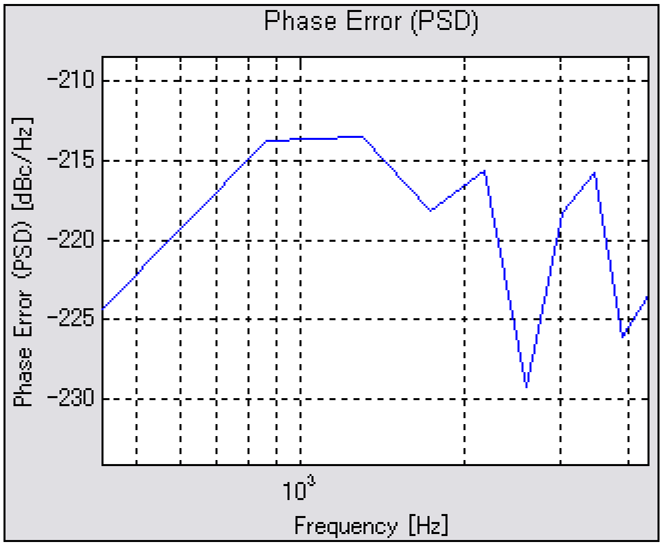


Figure 6-24. IQsignal 802.16e—Phase Error Plot

Phase Error PSD

The Phase Error (PSD) plot analyzes phase noise density versus frequency. It graphs the estimated PSD plot of the synthesizer measured during the burst.

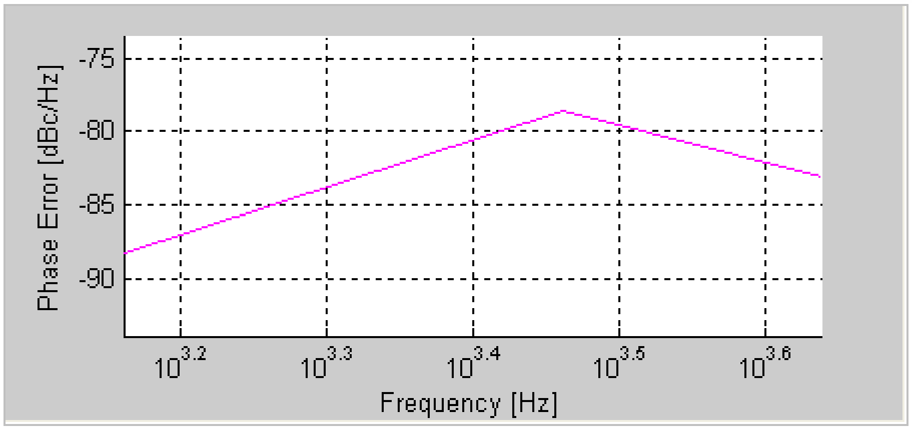


Figure 6-25. IQsignal 802.16e—Phase Error (PSD) Plot

Spectral Delta

In addition to the spectral flatness requirement, the 802.16 standard specifies that the absolute difference between adjacent sub-carriers shall not exceed 0.1 dB. The Spectral Delta plot shows this absolute difference for all sub-carriers. The spectral delta plot (like the spectral flatness plot) is derived from the channel estimate. It may be necessary to enable full packet channel estimator to get a sufficiently accurate channel estimate to verify the 0.1 dB difference.

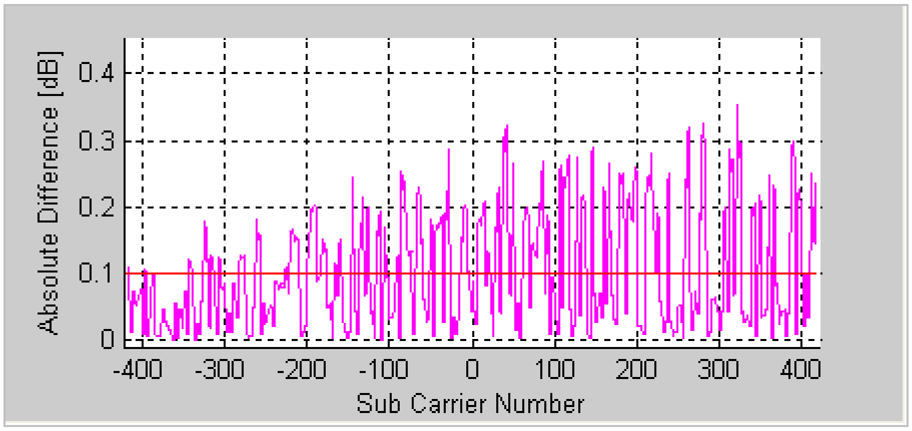


Figure 6-26. IQsignal 802.16e—Spectral Delta Plot

Spectral Flatness

The spectral flatness plot indicates the passband quality of the signal per sub-carrier, showing how the power level for each sub-carrier differs from the average power. The limits plotted in red are taken from the 802.16 specification.

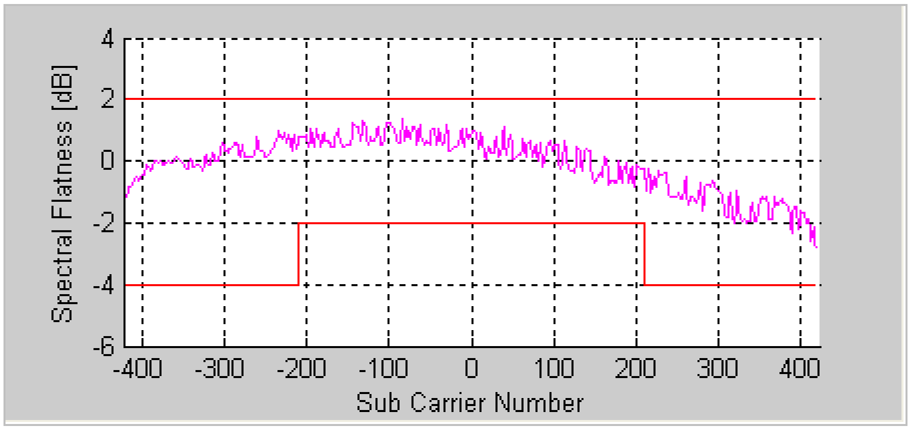


Figure 6-27. IQsignal 802.16e—Spectral Flatness Plot

Symbol Const

The Symbol Constellation plot is used to indicate the quality of the demodulated data in the complex plane for each symbol in the analyzed frame. The noisier and more degraded the signal, the cloudier the constellation will appear. For all constellation types, the pilot tones are plotted in green.

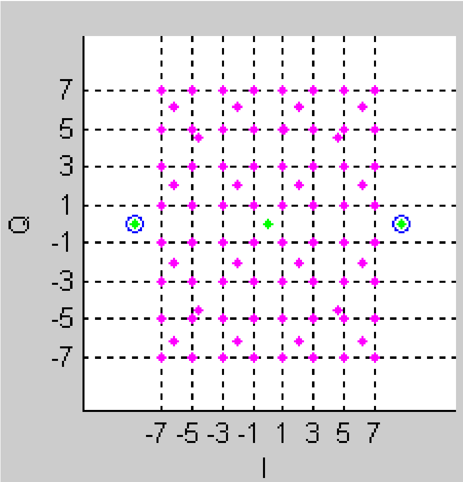


Figure 6-28. IQsignal 802.16e—Symbol Constellation Plot

Spectrogram

The spectrogram plot analyzes the power spectrum of the capture over time. In many cases there can be a disturbing signal, which will be difficult to analyze with a normal spectrum plot. With the spectrogram the spectrum can be shown over time. The X-axis represents time and the Y-axis represents frequency. The color coding represents the strength on the signal, with red being the maximum strength, and green being minimum strength.

If there are multiple signal streams present in the captured/loaded waveform, a separate spectrogram plot can be displayed for each stream.

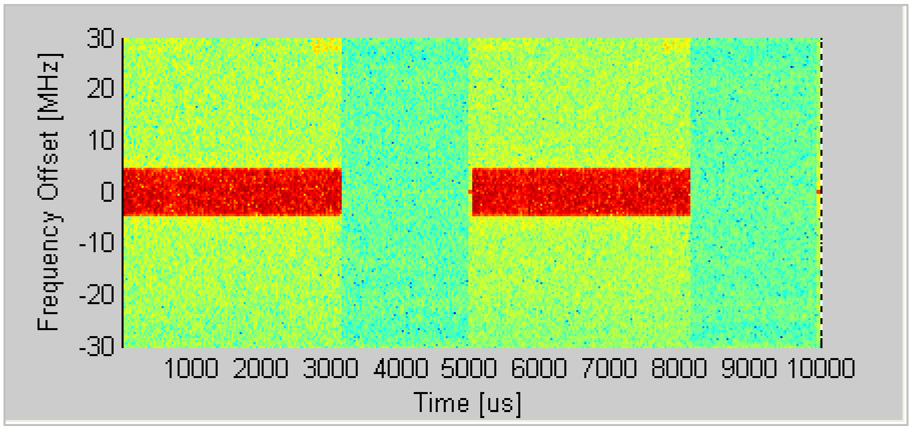


Figure 6-29. IQsignal 802.16e—Spectrogram Plot

Spectrum Mask

The Spectrum Mask plot shows the power spectrum of any signal in the captured range. This plot shows the average RF power spectral density (in dBm/100kHz) of the entire signal shown in the Amplitude vs. Time plot.

You can view the Spectrum Mask plot for an area by zooming in on a particular area in the Amplitude vs.Time plot and then clicking **Recalculate**. When a valid WiMAX signal is detected, the Spectrum Mask is superimposed on the plot, in red.

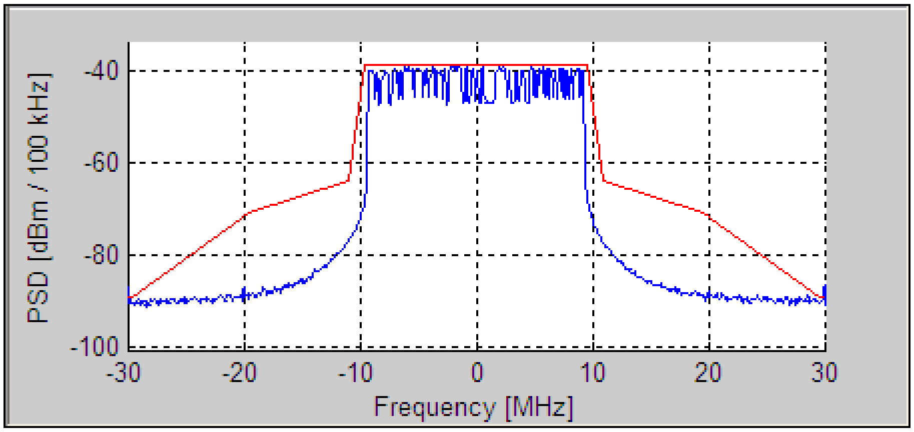


Figure 6-30. IQsignal 802.16e—PSD plot

Vector Signal Generator

This section provides you with information on the *Vector Signal Generator* window.

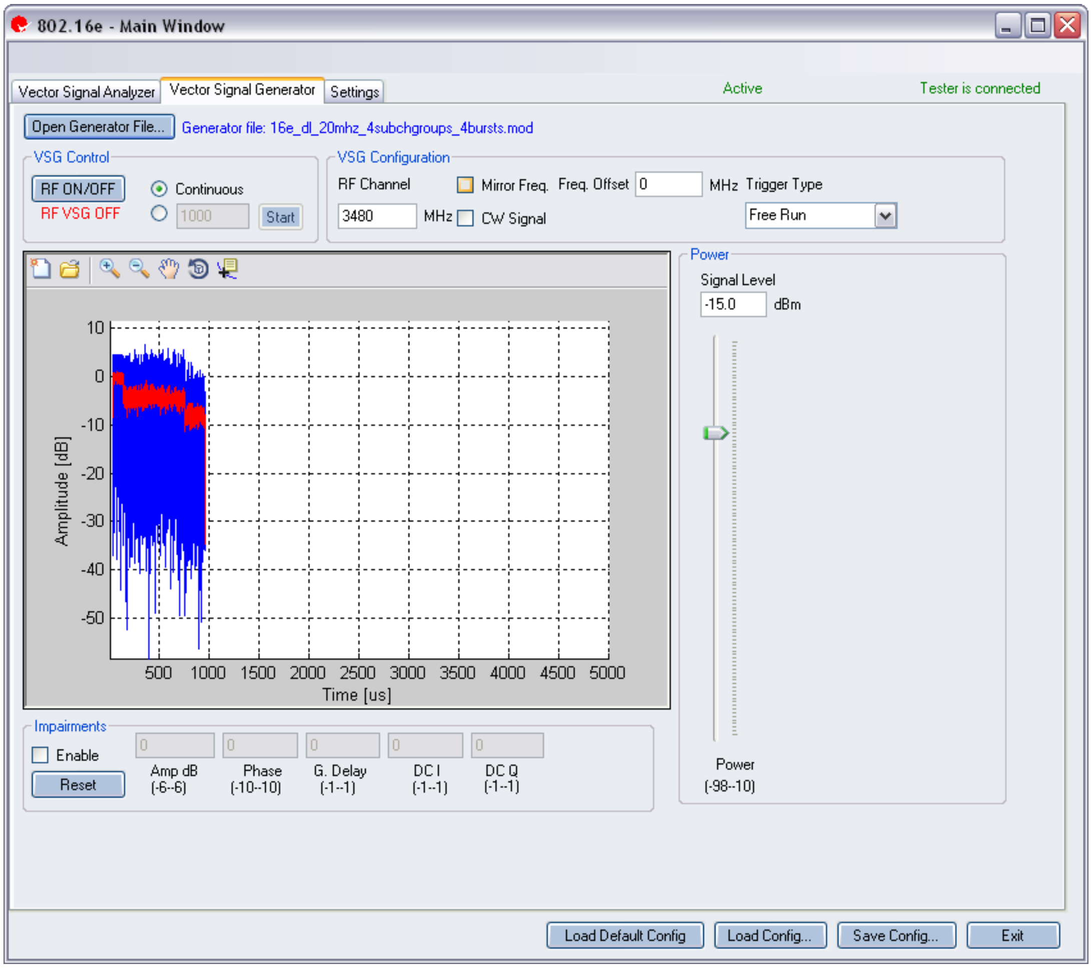


Figure 6-31. IQsignal 802.16e—VSG Screen

Open Generator File— Opens modulator file (`.mod`) and loads data into the Vector Signal Generator. The file has a `.MOD` extension.

VSG Control

RF ON/OFF	**RF ON/OFF**—Turn RF signal transmission mode on or off. Select continuous or specified number of packets to be transmitted. **Continuous**—Continuous transmission of waveforms. Specified number of packets—Performs transmission to the DUT. The range for specified number of packets to be transmitted is between 1 and 65,334. When the RF signal transmission mode is turned on, it is indicated below the RF ON/OFF button.

VSG Configuration

RF Channel	Center frequency of channel to be transmitted (MHz).
Mirror Freq	Mirrors the frequency spectrum of the transmitted waveform. This is

	equivalent to flipping the sign of the baseband Q channel.
CW Signal	Selects a continuous-wave signal transmit.
Freq. offset	This field specifies how much offset relative to the RF channel frequency the signal is sent out of the VSG. This is specified in KHz.
Trigger Type	Sets the trigger type Free Run or External Trigger. **Free Run—**no trigger; immediate start of transmission **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger start of transmission. An external trigger signal can be used to control the start of transmissions from the VSG. **External Trigger—** An external signal applied to the instrument's Trigger Input port is used to trigger a capture.

Power

Power	Signal Level	RF Output signal level represented in dBm.
	Power	Represents power level

Impairments

When impairments are enabled, text at the top right corner of the VSA window indicates that VSG impairments have been enabled.

Enable	Amp	This field/slider specifies the amplitude imbalance in percent. If *Enable* is not checked or there are no values set in the field/slider the default value is zero (0) %.
	Phase	This field/slider specifies the phase imbalance in degrees. If *Enable* is not checked or there are no values set in the field/slider the default value is zero (0) degrees.
	G. Delay	This field/slider specifies the Group Delay of the Q Channel in nanoseconds. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) nanoseconds delay.
	DC I	This field/slider specifies the DC Offset for the I channel in volts. If the Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
	DC Q	This field/slider specifies the DC Offset for the Q channel in volts. If Enable is not checked or there are no values set in the field/slider the default value is zero (0) volts.
Reset		This button resets all of the impairments settings to zero (0) value.

By default, the impairments are disabled. Saving a configuration does not save impairments.

Settings

This section provides you with information about the *Settings* window.

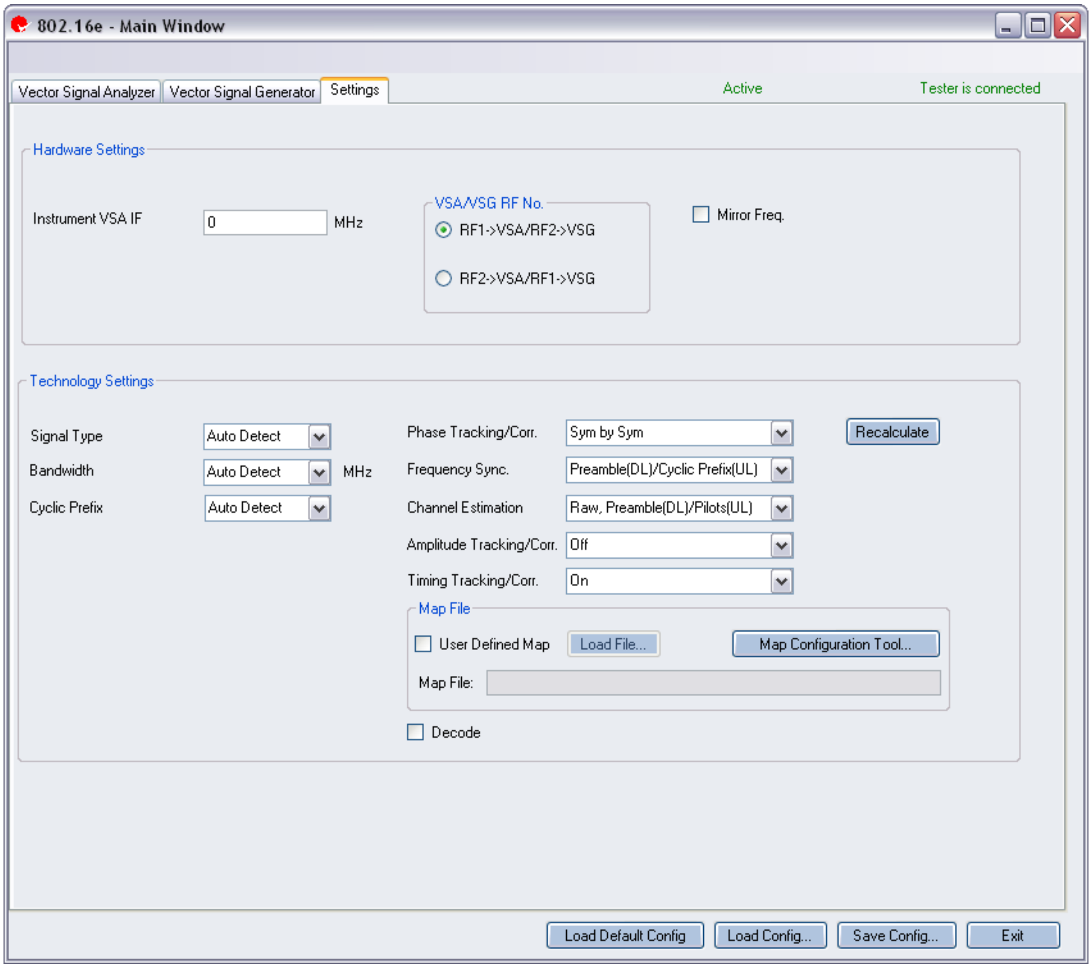


Figure 6-32. IQsignal 802.16e—Settings Screen

Hardware Settings

Instrument VSA IF	The VSA uses a direct-down conversion scheme, i.e. the down converter is tuned to the center frequency of the RF channel to be captured. In some cases, the residual VSA LO Leakage interferes with a measurement and in this case the VSA is tuned to the center frequency of the RF channel plus Instrument VSA IF (in MHz). The analysis software shifts the received signal back to the center frequency.
Mirror Freq.	Mirrors the frequency spectrum of the transmitted waveform. This is equivalent to flipping the sign of the baseband Q channel.
VSA Port1/VSG Port2	Uses port #1 for VSA input and port #2 for VSG output.
VSA Port2/VSG Port1	Uses port #2 for VSA input and port #1 for VSG output.

Technology Settings

Signal Type	This field specifies the type of subframe signal. Available options are as follows: **Downlink—**Specifies the downlink subframe. **Uplink—**Specifies the uplink subframe. **Auto Detect—**Automatically detects the correct signal type. This is the default setting.
Bandwidth	This field specifies the bandwidth of the input signal. The signal bandwidth can be selected from the dropdown menu, or can be set to *Auto Detect* (default).
Cyclic Prefix	This field specifies the cyclic prefix of the input signal. The cyclic prefix value can be selected from the dropdown menu, or can be set to *Auto Detect* (default).
Phase Tracking/Corr	Phase tracking method selection. Available options are as follows: **OFF—**Used when the carriers and references of the transmitter and receiver are phase-locked or when low-frequency carrier phase noise is suspected to be present. **Sym-by-Sym—**Phase offsets are tracked and corrected for each symbol.
Frequency Sync	Carrier frequency error estimation method. Available options are as follows: **Preamble[DL]/Cyclic Prefix[UL]—**For downlink signals, the frequency synchronization is performed on the preamble symbol. For Uplink signals, the frequency error is derived from the cyclic prefixes, averaged over all symbols. **Full Data Packet—**In addition to preamble/cyclic prefixes, the data symbols of the entire packet are used to estimate the frequency error. During the start of the packet, if the received signal shows frequency dynamics even after the preamble, the Full Data Packet method can be used.
Channel Estimation	**Raw, Preamble[DL]/Pilots[UL]—**For Downlink signals, the preamble is used for channel estimation. For mobile WiMAX Uplink bursts which do not have a preamble, this option does channel estimation on the pilots of the full burst. **Raw, Full Packet—**This option performs channel estimation on the full packet and uses data carriers.
Enable Amplitude Tracking/Corr.	Enables/disables amplitude tracking options for analysis.
Enable Timing Tracing/Corr.	Enables/disables timing tracking options for analysis. The recommended setting is to enable Timing Tracking/Corr.

Map File

User Defined Map	Enables or disables use of map configuration file. If no map file is used, the configuration is derived from the DL-MAP in the signal (for downlink signals) or automatically detected for uplink signals.
Load File	Loads the map configuration file.
Map Configuration Tool	Allows you to create and store map files.

Decode	Specifies if payload of data bursts should be decoded or not.

Chapter 7 Using LitePoint IQsignal GPS Application

GPS

Connecting the GPS application to the test system

Follow the instructions below to launch the IQsignal application and connect to the test system:

1. Make sure the test system is turned off
2. Make sure the DUT is connected to the test system
3. Make sure the test system is connected to the host PC where the GPS application is installed
4. Turn the test system on
5. On the host PC, go to **Start>All Programs>IQ201X >IQ201X Applications** and launch the application
   The IQsignal main window displays.
6. Click **GPS**
   The GPS main window displays.
7. Enter the settings and click **Apply**.
   This connects the GPS application on the host PC to the IQ201X test system.

The GPS feature provides you with a Graphical User Interface (GUI) to simplify the operations of the unit. The GUI allows you to enter or modify the following parameters:

- Space Vehicle Number
- Power Level
- Output Mode
- Source Frequency
- C/A Rate
- Data File
- RF Output
- Trigger Mode
- Channel One

Below is the description of the parameters in the GPS test system GUI.

Space Vehicle Number	This sets the satellite (Space Vehicle) code. Valid data are values from 1 to 32 (integer).
Power Level	This sets the output RF power level at the type N connector on the front panel of the GPS test system. Valid range is from -60 dBm to -145 dBm (0.25 dB increments).
Output Mode	This sets the signal type to one for the following: **No Modulation (CW)—**Captures signal in Continuous Wave mode **Modulated (1M)—**Captures satellite signals **Modulation OFF**—Modulation is turned off
Source Frequency	This displays the output frequency of the unit. Read only.
Doppler Frequency	This displays the Doppler frequency shift added to the source frequency.
C/A Rate (Mcps)	This displays the modulation rate of the output. Read only.
Data File	Allows you to load data file for multiple channel location test. This option is not available for single channel options.
RF Output	This turns the RF output on or off.
Reference	This displays the source for the 10 MHz reference. It is automatically set to external if an external reference source is connected.

Trigger Mode	This sets the input trigger mode. Available modes are as follows: **SW—**Software **1PPS 1N—**External Trigger Input
Power Level	Power level of each channel, represented in dBm.

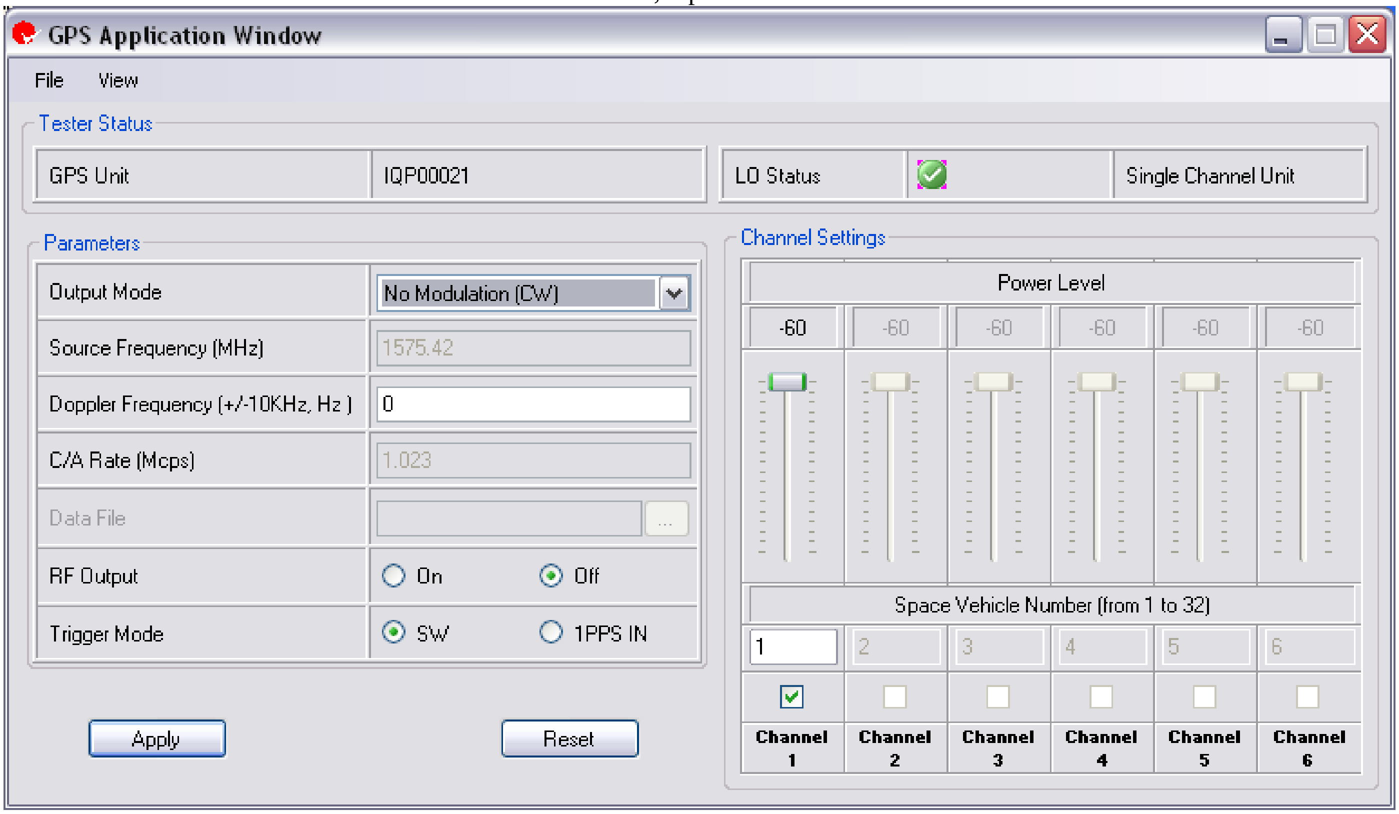


Figure 7-1. IQsignal—GPS

GPS Test System—Menu Items

The GPS test system has the following menu items:

- File

  File>Exit allows you to exit the application.

- View

  File>Message Window displays a window at the bottom of the window. This window displays any error messages or warnings in the application.

- Help

  Help>About displays information about the GPS Test System application.

GPS Test System—Trigger Mode

The GPS trigger mode supports two modes of operation:

- Software Trigger
- 1 PPS IN Trigger (Hardware Trigger)

Software Trigger

The Software Trigger mode is the default operating mode. In this mode, the unit sends a signal as soon as the signal mode is selected and applied.

1 PPS IN Trigger

The 1 PPS IN trigger mode supports an external hardware trigger from the BNC 1 PPS IN connector on the rear panel. You can select this mode either using the GUI or through the API. The trigger responds on a low to high transition applied to this connector.

To use the 1PPS IN Trigger mode, perform the following actions:

1. Launch the GPS application
2. In the Output Mode drop-down menu, select Modulation Off
   This disarms the trigger.
3. In the Trigger Mode option, select 1PPS IN
4. Set up the following parameters for the GPS system
   a. Doppler Frequency
   b. Data File
   c. RF Output (set to ON)
   d. Power Level
5. In the Output Mode drop-down menu select Modulation (1M) or No Modulation (CW)
   This arms the trigger.
6. Click **Apply**
   The arms the GPS unit and the unit waits for a trigger.

If you have multiple devices in the loop, perform the following actions for repeated testing:

Do not change any other GPS parameter other than the output mode.

1. In the Output Mode drop-down menu, select Modulation Off
   This disarms the trigger.
2. Click **Apply**
3. In the Output Mode drop-down menu, select Modulation (1M) or No Modulation (CW)
   This arms the trigger.
4. Click **Apply**
   This arms the GPS unit and the unit waits for a trigger.

The GPS simulation begins upon receiving the low to high transition on the 1 PPS IN connection (TTL level). The 1 PPS OUT signal, which is a low to high transition, will be the output on the 1 PPT OUT connection. The GPS signal is generated 540 ns after the 1 PPS IN signal (+/- 6 ns).

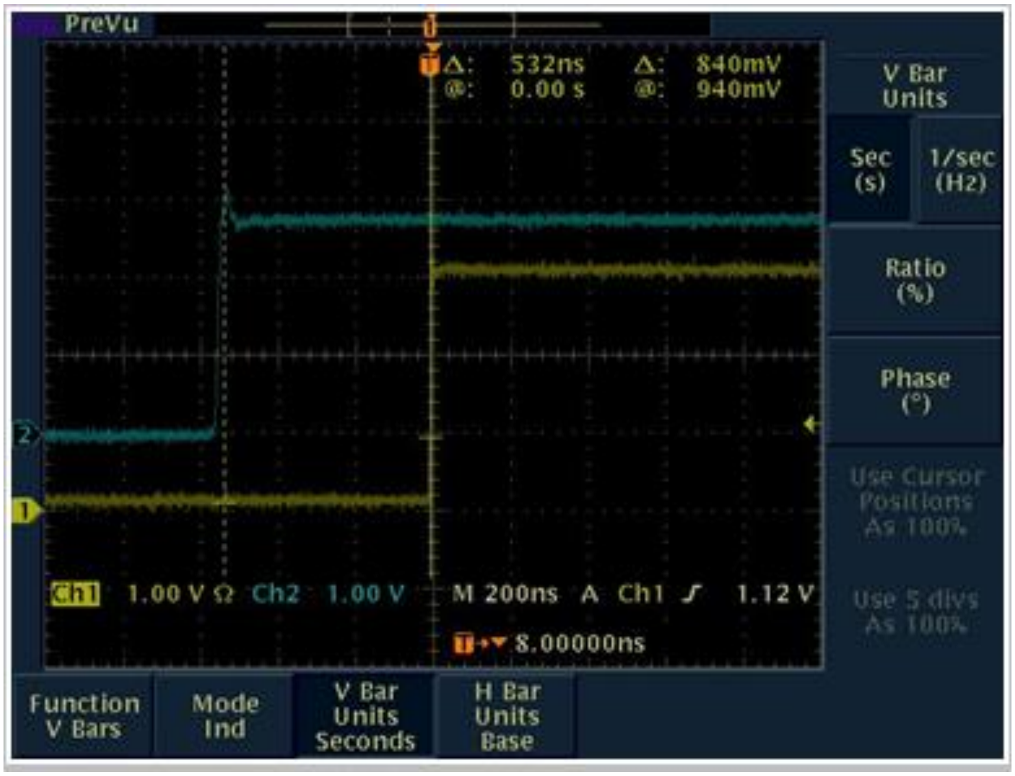


Figure 7-2: 1 PPS IN to 1 PPS OUT

The triggering system of the GPS test system is designed to specifically address the needs of A-GPS testing commonly used in CDMA handsets.

In the figure above, the blue trace represents the 1 PPS IN trigger input signal and the yellow trace represents the 1 PPS OUT trigger signal.

When an external trigger is received, as is typically generated by a handset tester’s trigger OUT, the GPS generator receives the signal and begins the GPS signal modulation sequence. When the GPS signal modulation sequence is initiated, the GPS generator sends the 1 PPS OUT signal within 540 ns of receiving the input trigger (1 PPS IN).

Chapter 8 Using LitePoint IQsignal GLONASS Application

GLONASS

Connecting the GLONASS application to the test system

Follow the instructions below to launch the IQsignal application and connect to the test system:

1. Make sure the test system is turned off
2. Make sure the DUT is connected to the test system
3. Make sure the test system is connected to the host PC where the GPS application is installed
4. Turn the test system on
5. On the host PC, go to **Start>All Programs>IQ201X >IQ201X Applications** and launch the application
   The IQsignal main window displays.
6. Click **GLONASS**
   The GLONASS main window displays.
7. Enter the settings and click **Apply**.
   This connects the GLONASS application on the host PC to the IQ201X test system.

The GLONASS feature provides you with a Graphical User Interface (GUI) to simplify the operations of the unit. The GUI allows you to enter or modify the following parameters:

- Operation Mode
- Source Frequency
- C/A Rate
- Data File
- RF Output
- Trigger Mode
- Channel One

Below is the description of the parameters in the GPS test system GUI.

Operation Mode	This sets the signal type to one of the following: **No Modulation (CW)—**Indicates that operation mode is Continuous Wave (CW) mode **Modulated (Data On)—**Indicates that CA Code modulation is turned on with navigation data ON **Modulated(Data Off)—**Indicates that CA Code modulation is turned on with navigation data OFF **Modulation OFF**— Indicates that CA Code modulation is turned off
Channel Frequency	This displays the channel frequency of the unit.
Doppler Frequency	This displays the Doppler frequency shift added to the source frequency.
Ranging Code	This displays the pseudo random ranging code, which is a sequence of the maximum length of a shift register (Msequence) with a period 1 millisecond and bit rate 511 kilobits per second. Read only.
RF Output	This turns the RF output on or off.
Power Level	Power level of each channel, represented in dBm.
Trigger Mode	Reserved for future use.
Reset	Reset the settings to default value.

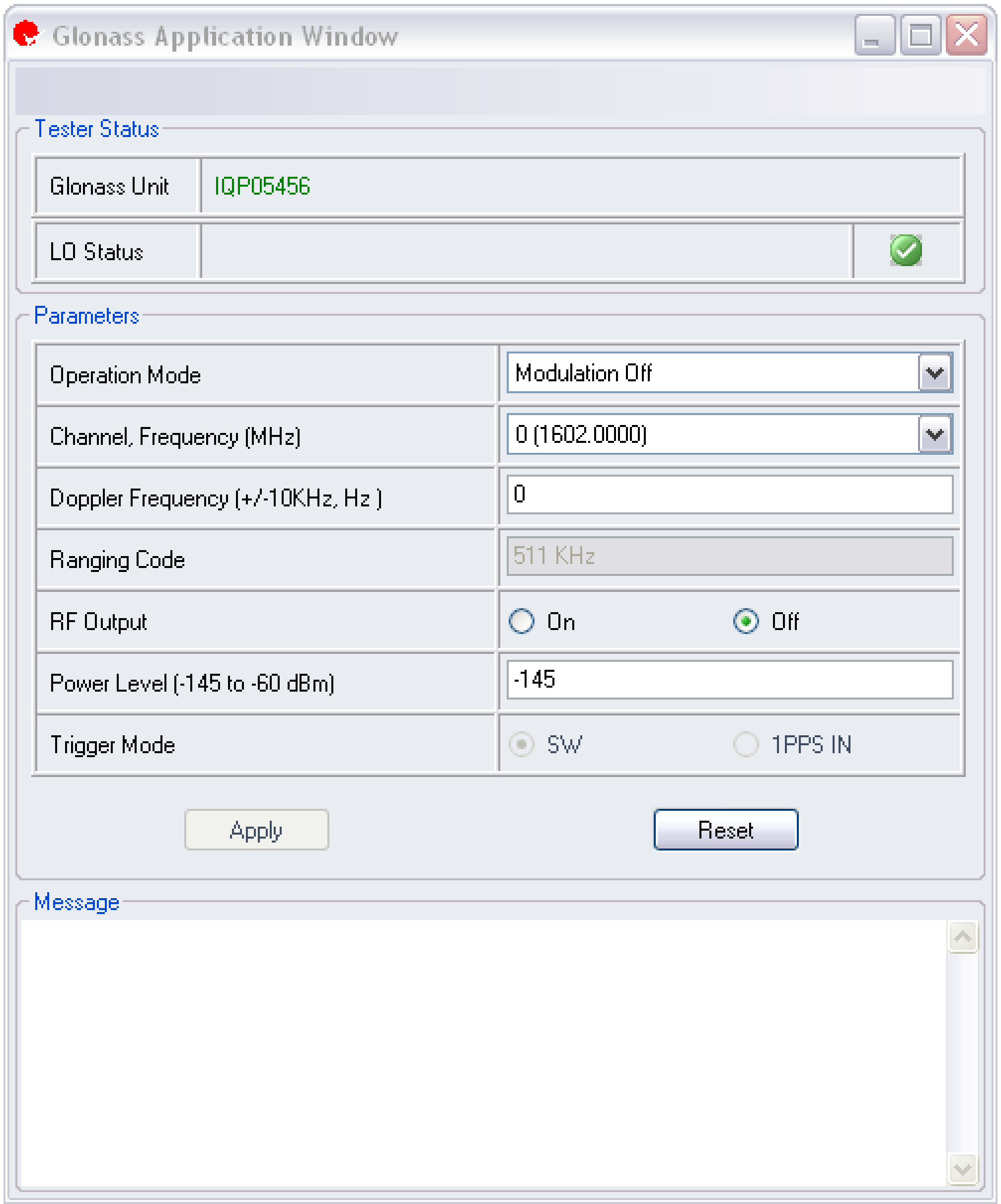


Figure 8-1. IQsignal—GLONASS

Chapter 9 Using LitePoint IQsignal FM Application

FM

The FM feature provides you with a Graphical User Interface (GUI) to simplify the operations of the unit.

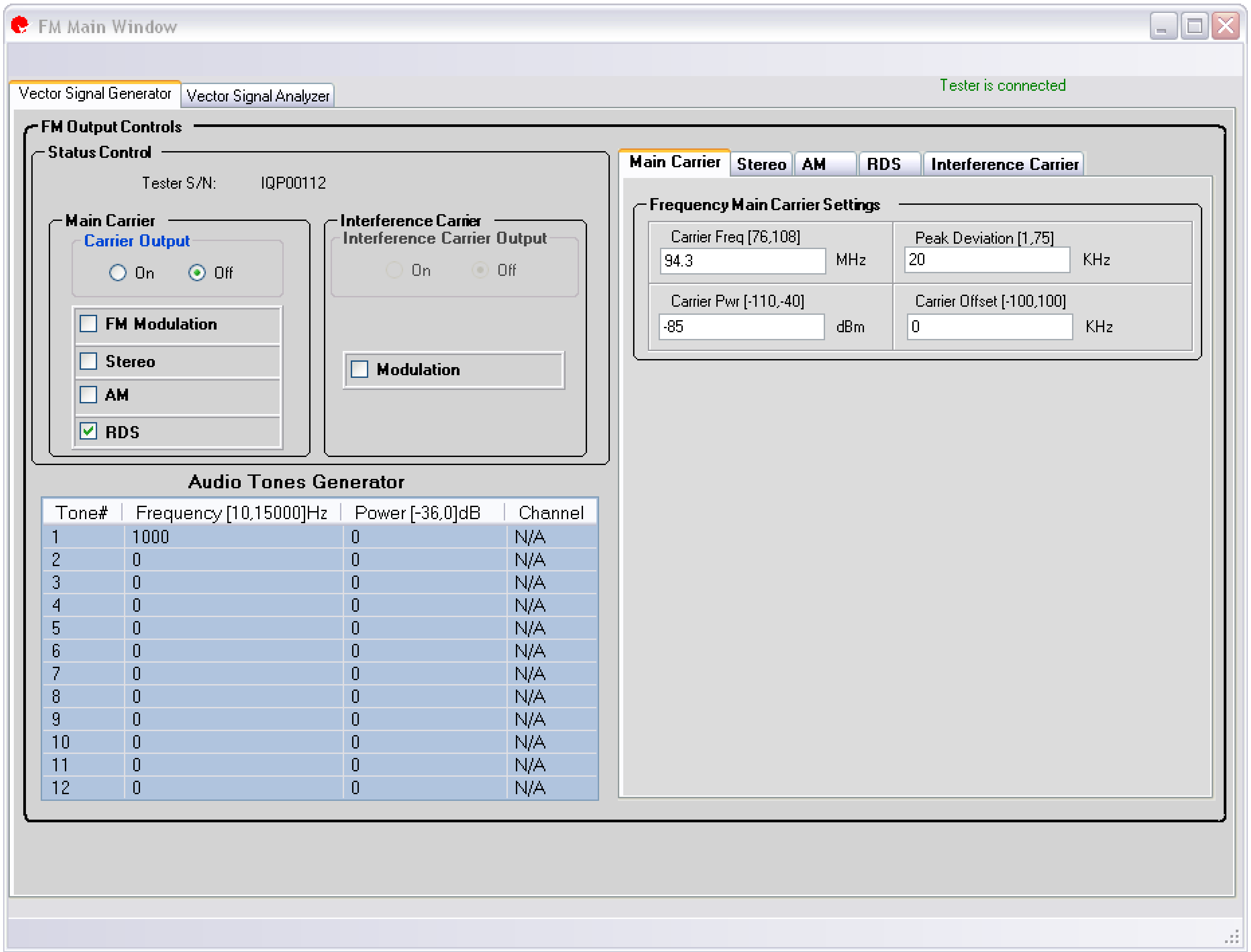


Figure 9-1. IQsignal—FM Main Window

Connecting the FM application to the test system

Follow the instructions below to launch the IQsignal application and connect to the test system:

1. Make sure the test system is turned off
2. Make sure the DUT is connected to the test system
3. Make sure the test system is connected to the host PC where the FM application is installed
4. Turn the test system on
5. On the host PC, go to **Start>All Programs>IQ201X >IQ201X Applications** and launch the application

The IQsignal main window displays.

6. Click **FM**

   The FM main window opens.

7. Click **Tester Connect**.

This connects the FM application on the host PC to the IQ201X test system.

To disconnect from the test system, click **Tester Disconnect**.

Vector Signal Generator

The Vector Signal Generator (VSG) allows you to evaluate the performance of analog FM signals accurately and effectively.

The FM VSG allows you to set the following FM output controls for the generated signal:

- Main Carrier
- Stereo
- AM
- RDS
- Interference Carrier
- Audio Tones Generator

The *Status Control* area of the IQsignal application user interface allows you to set the basic settings for testing FM functionalities. When the tester is connected, the serial number of the tester to which the software is connected is displayed in the Status Control area.

Main Carrier Tab

The settings in the *Main Carrier* tab allow you to set the frequency settings of the main carrier. In *Main Carrier Controls* section, select the Carrier Output mode as on or off. Carrier output indicates RF signal transmission.

If the Carrier Ouput mode is set to *On* and if the FM modulation checkbox is selected, the RF signal is transmitted as a modulated signal. If the Carrier Ouput mode is set to *On* and if the FM modulation checkbox is not selected, the RF signal is transmitted as a Continuous Wave (CW) signal.

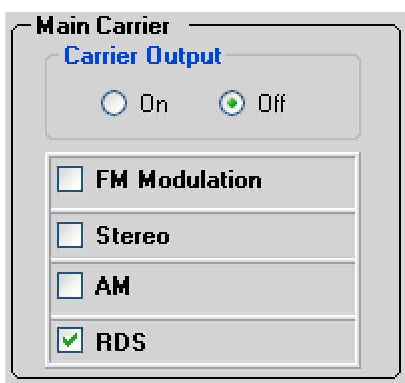


Figure 9-2. IQsignal—Main Carrier Tab

The figure below displays the frequency settings of the main carrier.

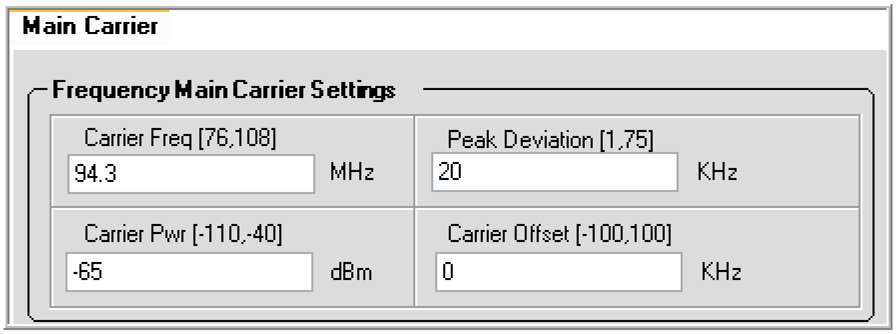


Figure 9-3. IQsignal—Main Carrier Tab

Carrier Freq.	Specifies the frequency of the unmodulated signal output. Valid range is from 76 to 108 MHz.
Carrier Pwr	Specifies the output power range. Valid range is from -110 to -40 dBm.
Peak Deviation	Specifies the FM deviation range. Valid range is from 1kHz to 75kHz. FM modulation has to be turned on to set peak deviation.
Carrier Offset	Specifies how much offset relative to the RF carrier frequency the signal is sent out of the VSG. Valid range is from -100 to 100 kHz.

Stereo Tab

The settings in the *Stereo Settings* tab allow you to set the settings for the stereo output. You must select the *Stereo* check box in the *Main Carrier Controls* section to enable the stereo settings.

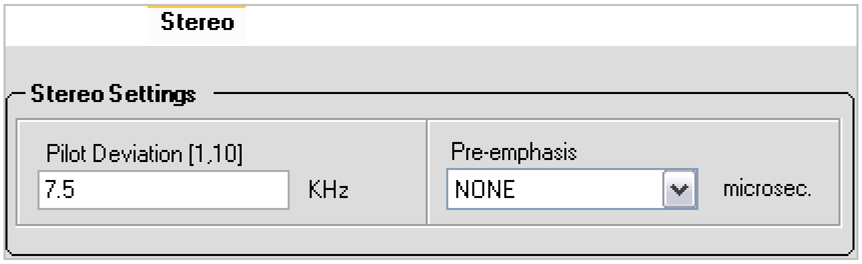


Figure 9-4. IQsignal—Stereo Tab

Stereo Output	Select the stereo output mode as stereo or mono.
Pilot Deviation	Pilot Deviation controls the pilot amplitude in the composite FM signal. If only pilot were transmitted, the measured FM deviation should be the pilot deviation. Enter value for pilot frequency deviation. Valid value is ≤ 10 kHz.
Pre-emphasis	Select pre-emphasis value from the drop-down menu. Pre-emphasis effectively increases the power of higher frequency audio signals to improve the quality of these signals at FM demodulator output. Valid values are NONE, 25, 50, 75 µs.

AM Tab

The settings in the *AM* tab allow you set the AM frequency and depth. You must select the *AM* check box in the *Main Carrier Controls* section to enable the AM settings.

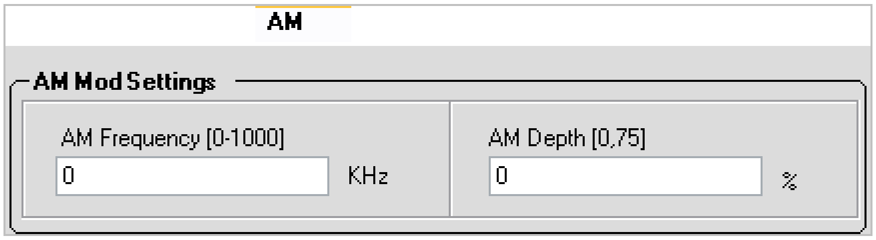


Figure 9-5. IQsignal—AM Tab

AM Output	Select the AM output frequency range mode as on or off.
AM Frequency	Enter AM output frequency range. Valid range is from 10 Hz to 15 kHz. A value of ‘0’ indicates that the AM setting is disabled.
AM Depth	Enter percentage of AM depth. The AM Depth value indicates depth of FM carrier modulated with AM. Valid range is from 0 to 75%. A value of ‘0’ indicates that the AM setting is disabled.

RDS Tab

Radio Data System (RDS), also known as Radio Broadcasting Data Systems (RDBS), is a standard for sending small amounts of digital information using conventional FM radio broadcasts. The settings in the *RDS* tab allow you to set Radio Data System settings. You must select the *RDS* check box in the *Main Carrier Controls* section to enable RDS settings.

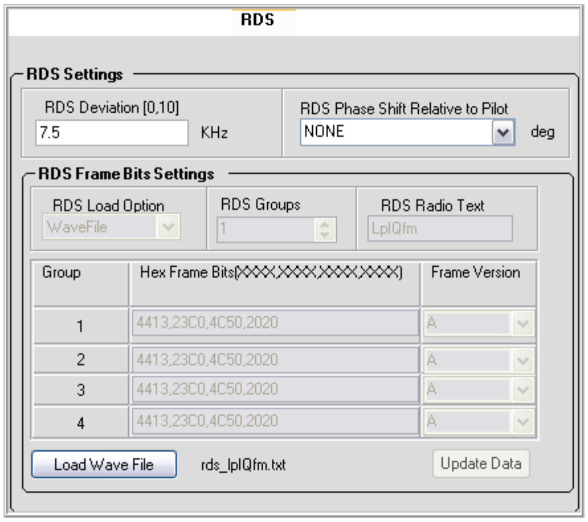


Figure 9-6. IQsignal—RDS Tab

RDS Deviation	RDS Deviation controls the RDS amplitude in the composite FM signal. If only RDS were transmitted, the measured FM deviation should be the RDS deviation. Enter value for RDS frequency deviation. Valid value is ≤ 10 kHz.
RDS Phase Shift Relative to Pilot	The phase of 57 kHz RDS carrier relative to the 19 kHz pilot tone. 0 or 90 degree.

RDS Frame Bits Settings

RDS Load Option	Select from one of the following three options: **Frame User Bits—**Enter the hex letters for the RDS frame bits in the Hex Frame

	column. **Radio Text—**Enter text for RDS in the RDS Radio Text dialog box. The maximum number of characters that can be entered is 15. RDS group type 2 will be generated with this option. **Wave File—**Click the **Load Wave File** button and load the wave file.
RDS Groups	Enter number of RDS groups to be transmitted or select the number using the scroll button. The maximum number of RDS groups that can be entered is 4.
RDS Radio Text	Enter text for RDS. The maximum number of characters that can be entered is 15.
Group	Enter group number for the RDS frame bits. Maximum number of groups that can be entered is four.
Hex Frame Bits	Enter RDS hex frame bit value.
Frame Version	Select frame version. Valid values are A, B, MMBS (offset word E) For more information on MMBS (offset word E), refer to the U.S. RDBS standards specification document.
Load Wave File	Click this button to load wave file. The file name displays next to this button after it is loaded.
Update Data	Select or enter appropriate RDS data in the RDS Frame Bits Settings area and click **Update**. This updates the data entered in this area.

Interference Signal Tab

The settings in the *Interference Carrier* tab allow you to set FM interfering signal settings. In the *Interference Carrier Controls* section, select the *Interference Carrier Output* mode as on or off. If the *Interference Carrier Output* mode is set to off, then the interfering signals are not transmitted.

If the Interference Carrier Ouput mode is set to *On* and if the Modulation checkbox for the interfering signal is selected, the RF signal is transmitted as a modulated signal. If the Interference Carrier Ouput mode is set to *On* and if the Modulation checkbox is not selected, the RF signal is transmitted as a Continuous Wave (CW) signal.

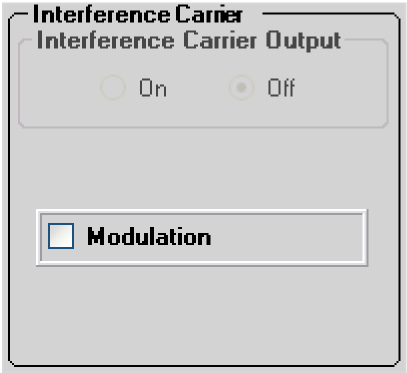


Figure 9-7. IQsignal—Interfering Carrier Tab

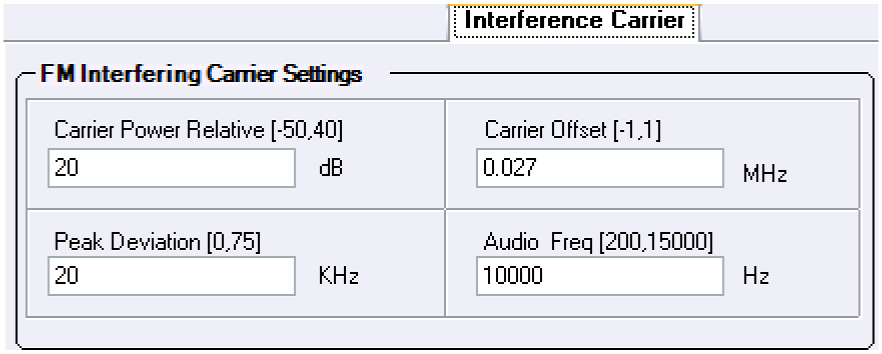


Figure 9-8. IQsignal—Interfering Carrier Tab

FM Output	Select the interfering FM output mode as on or off. FM output indicates RF signal transmission.
Carrier Power Relative	Displays the power of the interfering signal relative to the main FM carrier. Valid range is from -50 dB to + 40 dB with an accuracy of ± 1 dB. The Modulation checkbox for the interfering carrier output must be selected.
Peak Deviation	Displays peak deviation. Valid range is from 1 kHz to 75 kHz with 1 kHz resolution. The Modulation checkbox for the interfering carrier output must be selected.
Audio Freq.	Frequency of the audio tone of the interfering signal. Note that this is limited to a single tone signal. Valid range is from 10 to 15000 Hz.
Carrier Frequency Offset (CFO)	The frequency of the interfering carrier relative to the main carrier frequency. Valid range is from -1MHz to 1MHz. The Modulation checkbox for the interfering carrier output must be selected.

Audio Tones Generator

The *Audio Tones Generator* area in the user interface allows you to set the frequency and power for the audio signal to be transmitted.

Tone	Indicates the sequential number of the audio tone. Allows you to enter information on up to a maximum of twelve audio tones.
Frequency	Specifies frequency of an audio tone. Valid range is from 10 Hz to 15 kHz. You cannot have two tones with an identical frequency in the same audio channel.
Power	Sets relative power among the transmitted audio tones. Valid range is from -36 to 0 dB.
Channel	Indicates left or right channel. • You can set a maximum of up to 8 audio tones for the right (R) channel. Therefore, by default, the audio tone sequence numbers 1 to 4 are set to the left channel (L) and the application does not allow you to change this setting. You can set the audio tone sequence numbers 5 to 12 to either the left or the right

	channel using the drop-down menu. • A value of ‘0’ in the Frequency field indicates that the audio tone for that channel is disabled. • The application does not allow you to set a combination of 7 audio tones for the left channel and 5 for the right channel. You can set any other permutation and combination of left and right channels.

Vector Signal Analyzer

The IQsignal Vector Signal Analyzer allows you to analyze audio, FM and RDS parameters.

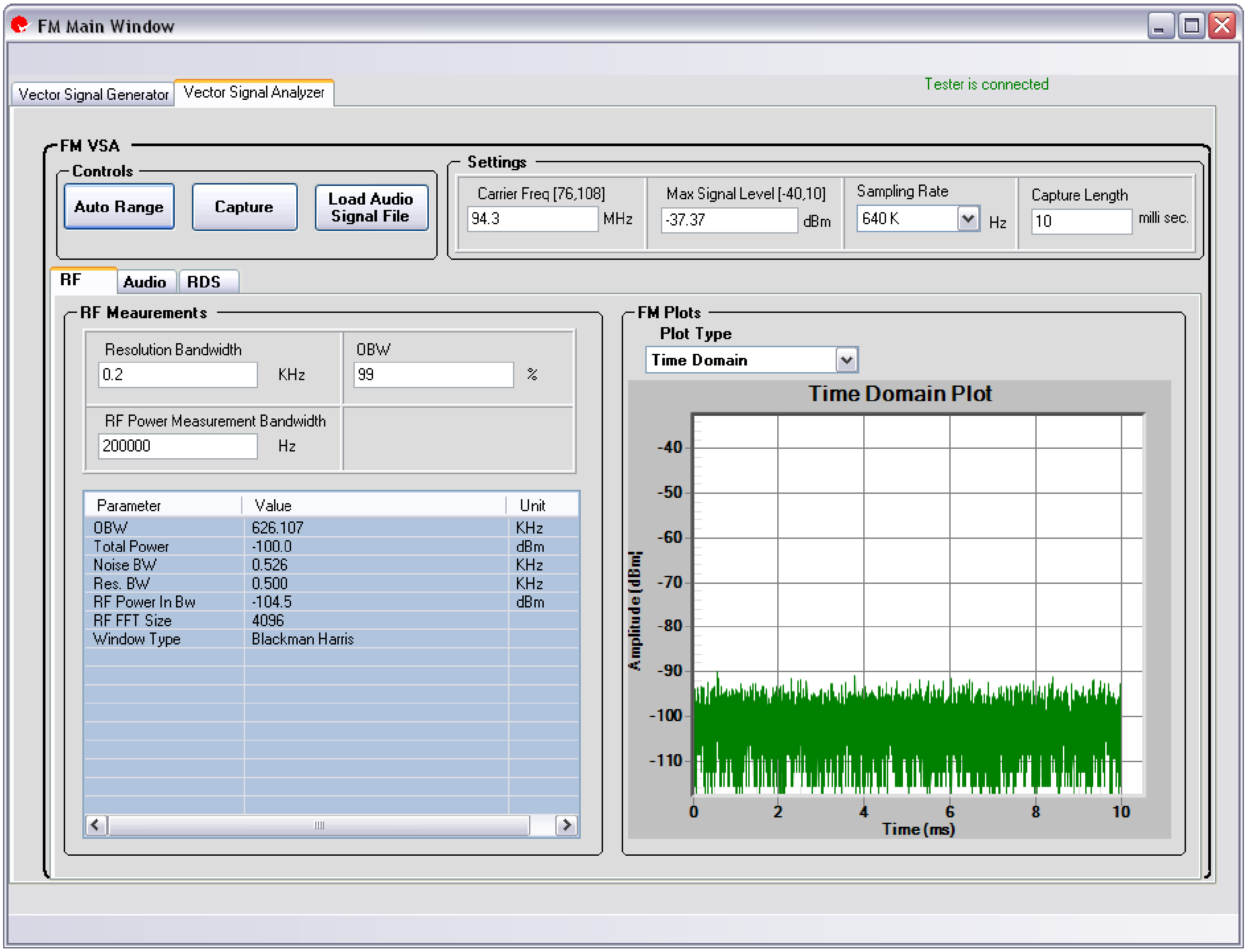


Figure 9-9. IQsignal—FM VSA

Control Area

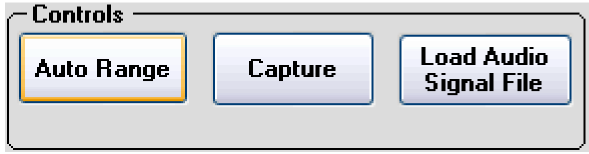


Figure 9-10. IQsignal—Controls

The *Control* area of the IQsignal application VSA user interface allows you to set the basic settings for signal capture.

	Select the AGC checkbox to perform an automatic gain control.
	Button that allow you to capture the signal.
	Loads an audio signal file in `.wav` format.

Settings

The *Settings* area of the IQsignal application VSA user interface allows you to set the basic settings for signal capture.

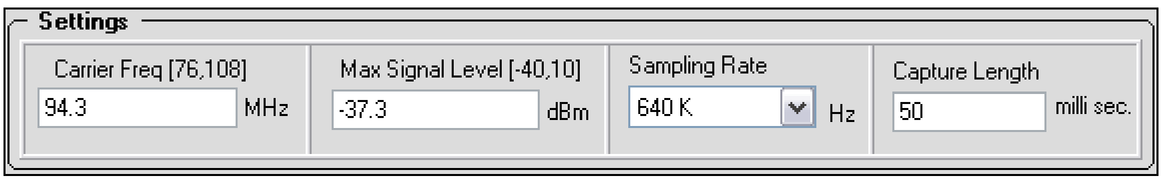


Figure 9-11. IQsignal—Settings

Carrier Frequency	Enter the carrier frequency value. Valid range is from 76 to 108 MHz
Max Signal Level	Enter the maximum signal level value. Valid range is from -20 dBm to + 20dBm.
Sampling Rate	From the drop-down menu, select the sampling rate at FM demodulator output. Valid value is 640 kHz. Additional values will be added in future.
Capture Length	Enter length of signal capture in milliseconds. Default is 50 ms.

The FM VSA allows you to set the following FM output controls for the generated signal:

- RF
- Audio
- RDS

RF

The RF tab allows you to set RF measurement settings and to view FM plots based on those settings.

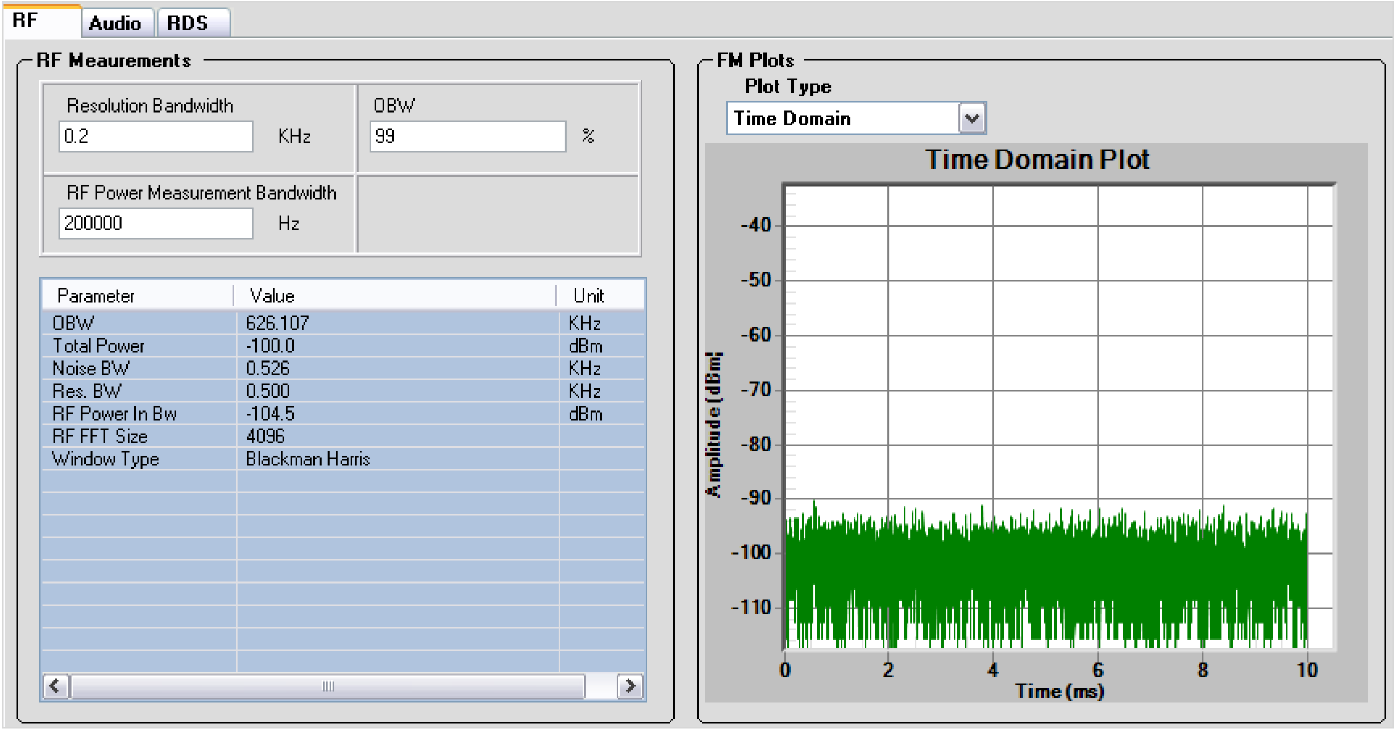


Figure 9-12. IQsignal—Audio

Resolution Bandwidth	The resolution bandwidth determines the smallest frequency range that can be resolved.
OBW	The percentage (e.g., 99%) of the total integrated power of the entire spectrum to be used in computation for the occupied bandwidth.
RF Power in Bw (RF Power Measurement Bandwidth)	The power measurement bandwidth of the signal centered at the carrier frequency value.

Parameter	OBW—Occupied bandwidth
	Total Power—Total power Total integrated RF power over the entire capture spectrum.
	Noise BW—Noise bandwidth
	Res. BW—Resolution bandwidth
	RF Power In Bw—measured RF power in the given channel bandwidth
	RF FFT Size—Size of the FFT window used in measurement
	Window Type—Type of window used in measurement
Value	Displays the value for the specified parameter.
Unit	Indicates the unit of measurement for the specified parameter.

FM Plots

Time Domain Plot	Displays the plot for amplitude versus time.
Frequency Domain Plot	Displays the plot for power versus frequency.

Audio

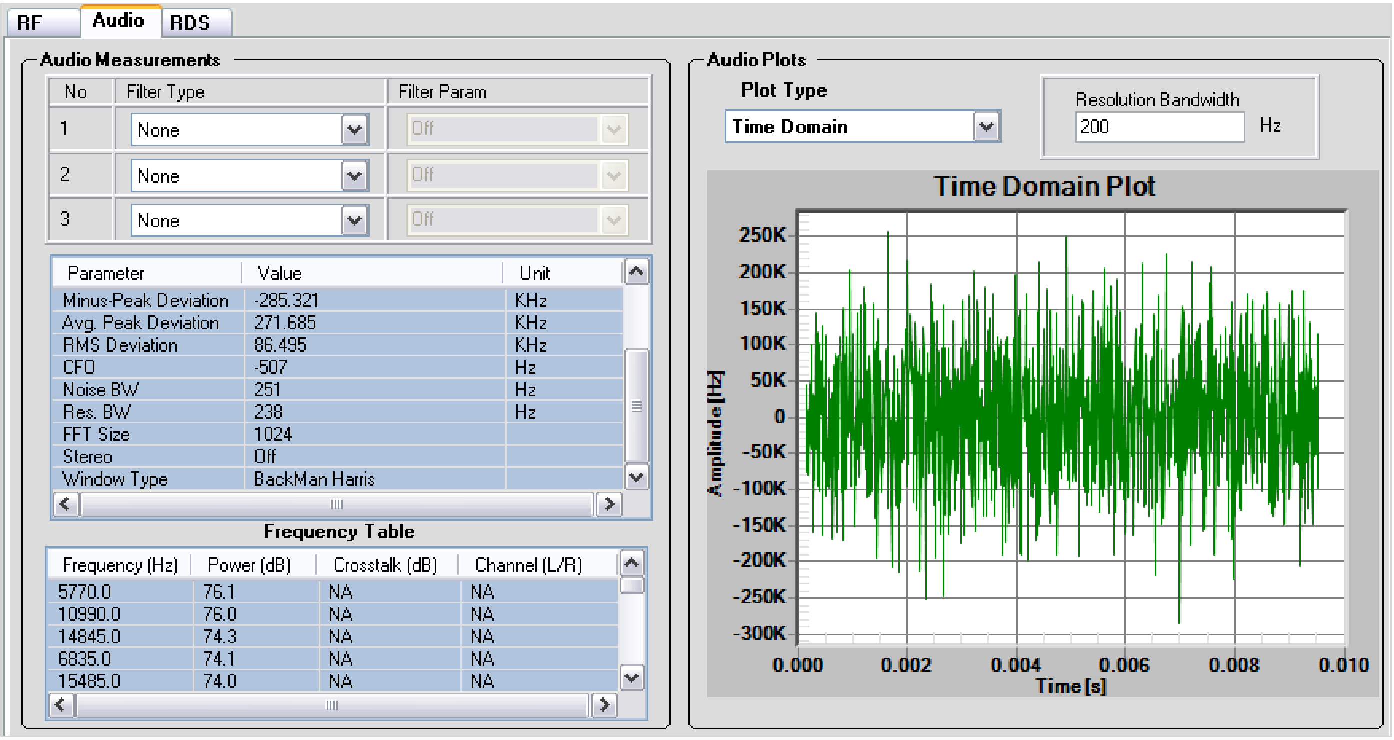


Figure 9-13. IQsignal—Audio

Audio Measurements

No.	Column number
Filter Type	Type of filter. Available values are as follows: • High Pass—passes high-frequency signals and attenuates signals with frequencies lower than the cutoff frequency. If the cutoff frequency is 20 Hz, the slope is 18dB/octave, else the slope is 12dB/octave. • Low Pass—passes low-frequency signals and attenuates signals with frequencies higher than the cutoff frequency at 30dB/octave • De Emphasis—low pass filter. Deemphasis time constant choices are 25,50 and 75 micro sec. • CCITT P53—spectrum weighting according to CCITTP53 (or ITU-T Rec. 0.41) standard • C Message—standard C message spectrum weighting • A Weighting—A-frequency weighting • C Weighting—C-frequency weighting • ITU R 468 Weighted—spectrum weighting according to ITUR 468 standard unweighted specification

<table>
<tr><td></td><td>ITU R 468 Unweighted— spectrum weighting according to ITUR 468 standard unweighted specification (18dB/octave HPF cutoff frequency 22.4Hz, and 30dB/octave LPF cutoff frequency 22.4KHz</td></tr>
<tr><td>Filter Param</td><td>Filter Parameter
Filter parameter types for each filter type:
<table>
<tr><th>Filter Type</th><th>Parameter</th></tr>
<tr><td>High Pass</td><td>20 Hz
22 Hz
50 Hz
100 Hz
200 Hz
300 Hz
500 Hz</td></tr>
<tr><td>Low Pass</td><td>15-22 KHz</td></tr>
<tr><td>De Emphasis</td><td>25 micro-sec
50 micro-sec
75 micro-sec</td></tr>
<tr><td>CCITT P53</td><td>none</td></tr>
<tr><td>C Message</td><td>none</td></tr>
<tr><td>A Weighting</td><td>none</td></tr>
<tr><td>C Weighting</td><td>none</td></tr>
<tr><td>ITU R 468 Weighted</td><td>none</td></tr>
<tr><td>ITU R 468 Unweighted</td><td>none</td></tr>
</table></td></tr>
</table>

Resolution Bandwidth	The resolution bandwidth determines the smallest frequency range that can be resolved.

Parameter	SNR(Signal to Noise Ratio)—indicates the audio signal to noise (including distortion) ratio; specified in dB
	SINAD(Signal to Noise and Distortion) —indicates ratio of the signal (including noise and distortion) to the noise-and-distortion component; specified in dB
	THD (Total Harmonic Distortion dB or %)—analyzed audio spectrum for THD; available only when the signal contains a single tone; specified in dB. The ratio of the total harmonic power to the power of the single tone. The harmonic frequency tones are searched over the audio frequency range.
	TNHD (Total Non-Harmonic Distortion dB or %; spurious tones with frequencies not as integer multiples of the signal frequency)—analyzes the audio spectrum for TNHD; indicates the ratio of the total spurious power to the power of the single tone. The spurious tones are searched over the audio frequency range; available only when the signal contains a single tone; specified in dB
	Plus-peak Deviation—displays plus-peak deviation value of the FM signal; specified in kHz
	Minus-peak Deviation—displays minus-peak deviation value of the FM signal; specified in kHz

	Avg. Peak Deviation—displays average peak deviation value of the FM signal; specified in kHz. The average value is half of the sum of the absolute values of the plus-and minus-peak deviations.
	RMS Deviation—displays RMS deviation value of the FM signal; specified in kHz
	CFO—displays measured FM carrier frequency offset value from the value entered in the GUI; specified in kHz
	Noise BW—noise bandwidth
	Res. BW—resolution bandwidth
	FFT Size—FFT window size
	Stereo—indicates whether stereo is on or off
	Window Type—Window type used in measurement
Value	Displays the value for the specified parameter.
Unit	Indicates the unit of measurement for the specified parameter.

Frequency Table

Frequency	Displays the detected frequency tones presented in the audio frequency range at the FM demodulator output or the stereo demultiplexer output.
Power	Displays power of detected tones.
Crosstalk	Displays crosstalk for multi-tone stereo audio; specified in dB. This is only available for stereo signal. Set the audio signal tone to one audio channel and leave the corresponding frequency empty in the other channel.
Channel [L/R]	Indicates whether the indicated frequency is for left or right channel.

Audio Plots

Time Domain Plot	Displays the plot for amplitude versus time for the FM demodulator output.
Frequency Domain Plot	Displays the plot for power versus frequency for the FM demodulator output.

RDS

This tab allows you to perform and analyze Radio Data System (RDS) measurements.

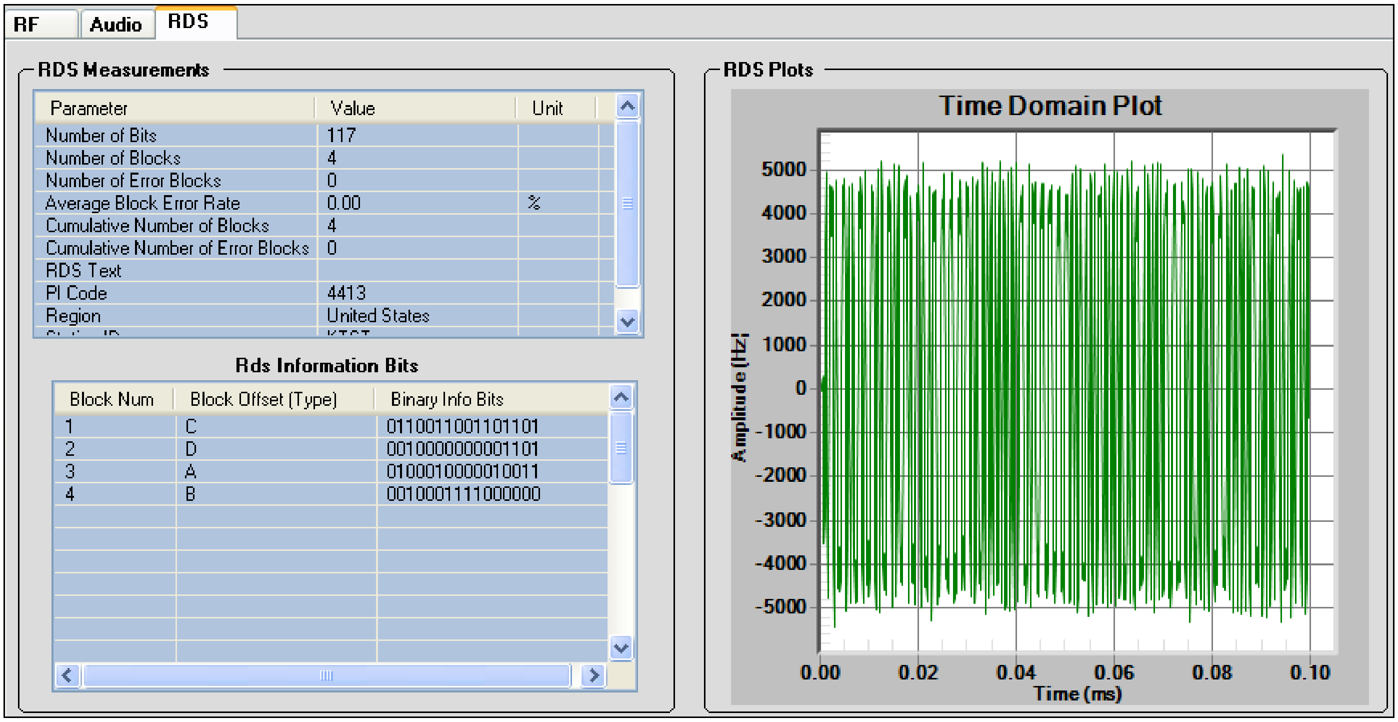


Figure 9-14. IQsignal—Audio

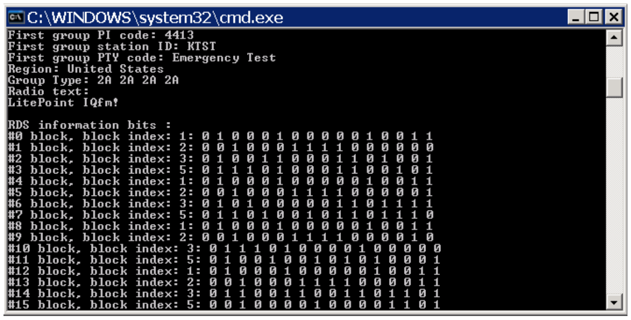


Figure 9-15. IQsignal—RDS Information Bits

Parameter	Number of Bits—number of received raw bits.
	Number of Blocks—number of decoded RDS blocks (codewords).
	Number of Error Blocks— number of error blocks
	Average Block Error Rate—accumulated average block error rate. Changing channel frequency and power resets average error rate to 0
	Cumulative Number of Blocks— number of RDS blocks accumulated since last reset. Changing channel frequency and power resets cumulative number of blocks to zero.

	Cumulative Number of Error Blocks— number of error blocks among cumulative number of blocks
	RDS Text—radio text carried by the group. Available *only* if the group type is 2
	PI (Program Identification) Code [HEX]—PI code of each group
	Region—broadcast region, such as United States, Canada, World
	Station ID—the station call letters corresponding to the PI code
Value	Displays the value for the specified parameter.
Unit	Indicates the unit of measurement for the specified parameter.

RDS Information Bits

RDS Information bits	Displays information bits in HEX.
Block Num	Block index in the captured signal.
Block Offset (Type)	Offset words associated with each block: A,B,C,C’,D,E.
Binary Info Bits	Information bits carried by each block.

Chapter 10 Using LitePoint IQsignal NFC Application

NFC

The NFC feature provides you with a Graphical User Interface (GUI) to simplify the operations of the unit.

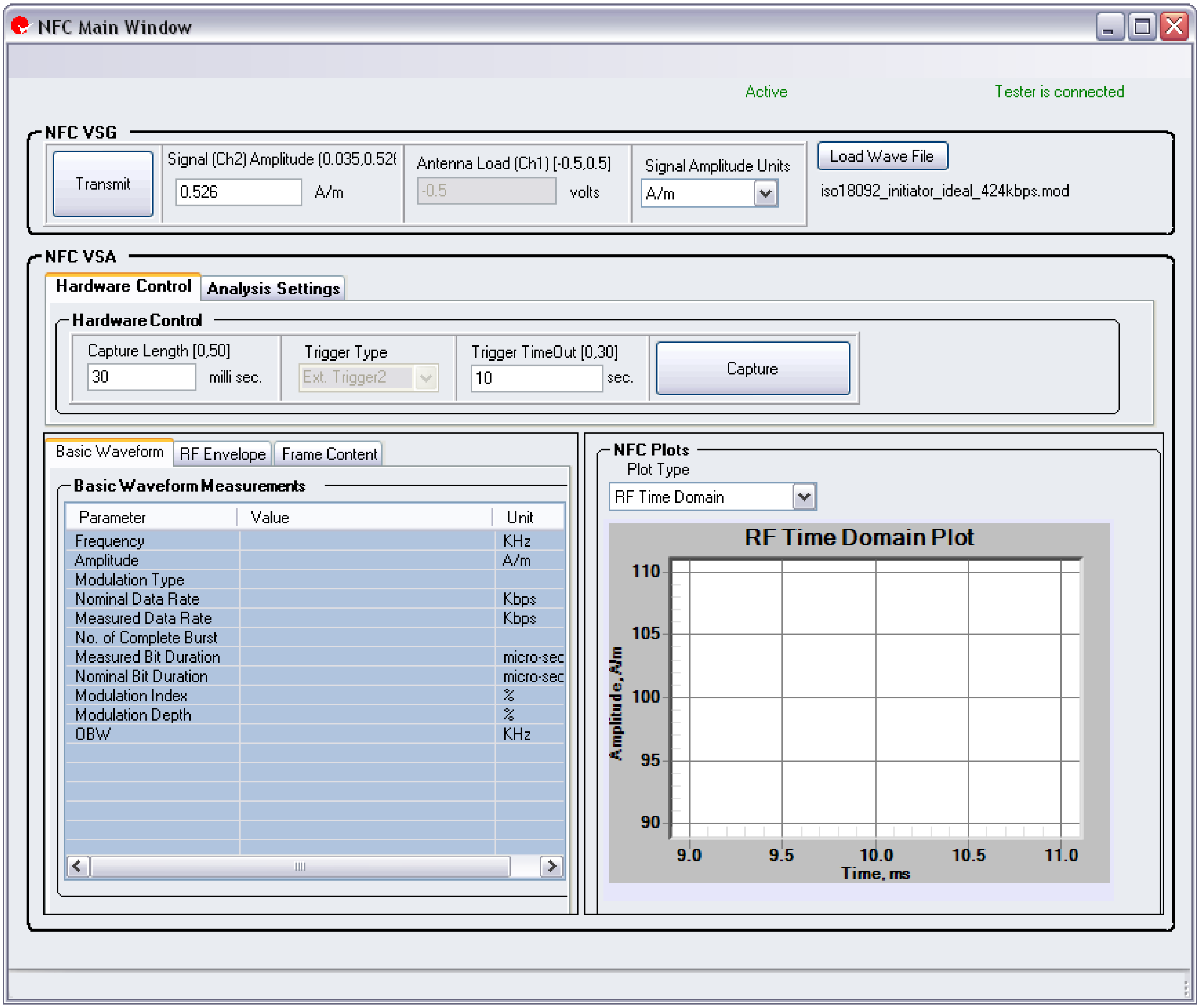


Figure 10-1. IQsignal—NFC Main Window

Connecting the NFC application to the test system

Follow the instructions below to launch the IQsignal application and connect to the test system:

1. Make sure the test system is turned off

2. Make sure the DUT is connected to the test system
3. Make sure the test system is connected to the host PC where the FM application is installed
4. Turn the test system on
5. On the host PC, go to **Start>All Programs>IQ201X >IQ201X Applications** and launch the application
   The IQsignal main window displays.
6. Click **NFC**
   The FM main window opens.
7. Click **Tester Connect**.
   This connects the FM application on the host PC to the IQ201X test system.

To disconnect from the test system, click **Tester Disconnect**.

Vector Signal Generator

The Vector Signal Generator (VSG) allows you to evaluate the performance of NFC signals accurately and effectively.

Perform the following actions to transmit a signal:

1.In the Signal Amplitude Units drop-down menu, select volts or A/m depending on whether you would like to express the signal amplitude in A/m or volts.

2. In the **Signal Amplitude** text box, enter the signal strength of the magnetic field.
   The minimum value for the signal amplitude is 0.035A/m or 0 volts and the maximum value is 0.526A/m or 0.2 volts. These values are displayed next to the field name.

3. In the **Antenna Load** text box, enter the load voltage for the NFC antenna .
   The minimum value is -0.5 and the maximum value is 0.5 volts.

4. Click **Load Wave File**, select a wave file and then click **Transmit** to transmit the signal.

5. Click **Transmit**.

Vector Signal Analyzer

The IQsignal NFC Vector Signal Analyzer allows you to analyze basic waveform, RF Envelope and Frame Count.

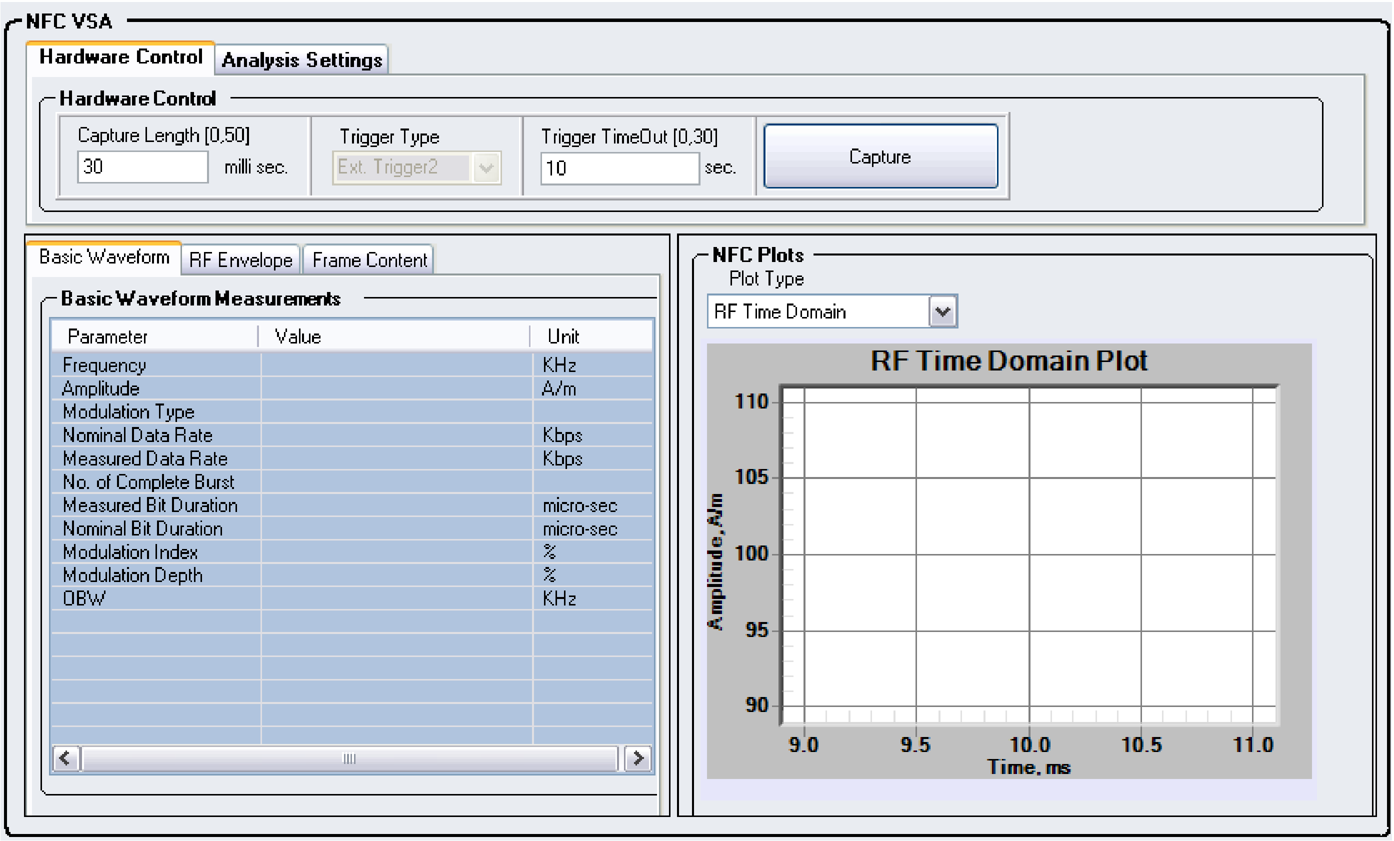


Figure 10-2. IQsignal—NFC VSA

Hardware Control

The *Hardware Control* area of the IQsignal application NFC VSA user interface allows you to set the basic settings for signal capture.

Capture Length	Indicates the length of signal capture. The minimum value is 0 and the maximum value is 50.
Trigger Type	Indicates the type of trigger. Available options are as follows: Free Run—no trigger; immediate capture Ext Trigger 1—an external signal applied to the instrument‘s Trigger Input port is used to trigger a capture. Ext Trigger 2—an external signal applied to the instrument‘s Trigger Input port is used to trigger a capture.
Trigger Timeout	Indicates timeout for the trigger in seconds.
	Button that allows you to capture the signal.

Analysis Settings

The *Analysis Settings* area of the IQsignal application NFC VSA user interface allows you to set the basic settings for signal capture.

OBW	Represents the occupied bandwidth. The percentage (e.g., 99%) of the total integrated power of the entire spectrum to be used in computation for the occupied bandwidth.
RWB	Represents the resolution bandwidth. The resolution bandwidth determines the smallest frequency range that can be resolved.
Analysis Amplitude Units	Drop-down menu for amplitude units represented in volts or A/m

Basic Waveform

The *Basic Waveform* tab displays the basic waveform parameters of the signal capture.

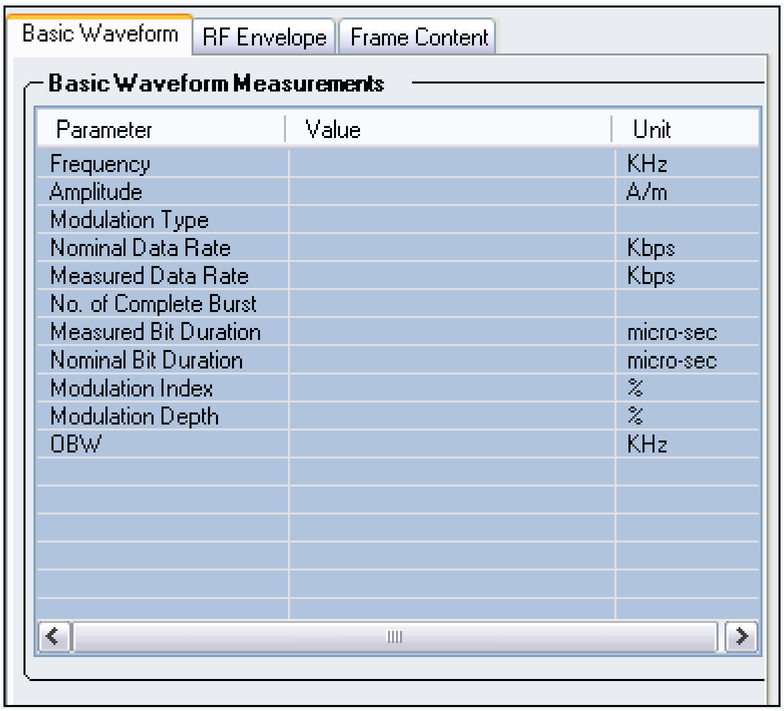


Figure 10-3. IQsignal—NFC Basic Waveform

Frequency	Carrier frequency of NFC TX signal from DUT
Amplitude	Average amplitude of DUT signal in dB scale. dB-A/m = 20log10(A/m)
Modulation Type	Detected modulation type of the DUT signal. Available options are as follows: • Modified miller (coded ASK) • Manchester
Nominal Data Rate	Detected nominal date rate of the DUT signal. Available options are as follows:

	• 105.94Kbps • 211.88Kbps • 423.75kbps
Measured Data Rate	Measured data rate of the DUT signal
No. of Complete Burst	Detected number of complete bursts or packets
Measured Bit Duration	Measured bit duration of DUT signal in micro-sec
Nominal Bit Duration	Detected nominal bit duration of DUT signal in micro-sec Available options are as follows: • 9.44 microsecs • 4.72 microsecs • 2.36 microsecs
Modulation Index	The modulation index of a modulation scheme describes by how much the modulated variable of the carrier signal varies around its unmodulated level. The value displays the measured modulation index of the DUT waveform
Modulation Depth	Sets the amplitude level at which the signal is varied and is expressed in percent.
OBW	Represents the occupied bandwidth. The percentage (e.g., 99%) of the total integrated power of the entire spectrum to be used in computation for the occupied bandwidth.

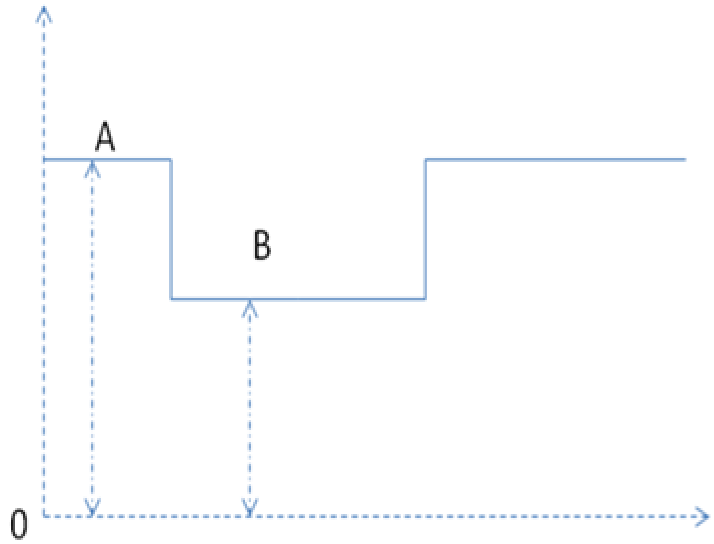


Figure 10-4. Modulation Index and Modulation Depth

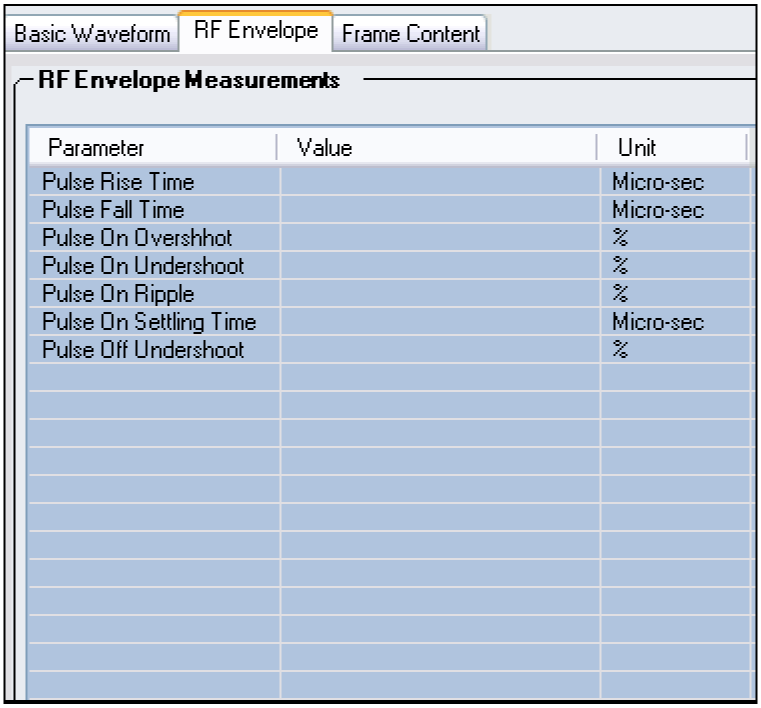


Figure 10-5. IQsignal—NFC RF Envelope

Pulse Rise Time	Rise time of a pulse = t3 for Miller coded ASK at 106kbps. This is indicated in the Pulse Shape for Miller coded ASK at 106kbps figure below. Miller coded ASK at 106kbps, t1, t2,t3, t4 are also reported as defined in the figure below. Rise time of a pulse = tr for Manchester coded waveform at 212kbps and 424kbps. This is indicated in the Pulse Shape for Manchester Coding at 202kbps and 424kbps figure below.
Pulse Fall Time	Fall time of a pulse = t1-t2 for Miller coded ASK at 106kbps. This is indicated in the Pulse Shape for Miller coded ASK at 106kbps figure below. Fall time of a pulse = tf for Manchester coded waveform at 212kbps and 424kbps. This is indicated in the Pulse Shape for Manchester Coding at 202kbps and 424kbps figure below.
Pulse On Overshoot	r/(a-b). Refer to Overshoot, Undershoot and Settling Time figure below.
Pulse On Undershoot	f/(a-b). Refer to Overshoot, Undershoot and Settling Time figure below.
Pulse On Ripple	(r+f)/(a-b). Refer to Overshoot, Undershoot and Settling Time figure below.
Pulse On Settling Time	Elapsed time from the end of the rise section of the pulse, which is indicated in the Pulse Shape for Miller Coded ASK and Pulse Shape for Manchester Coding figures below, to the end of the Pulse on under shoot, which is indicated in the Overshoot, Undershoot and Settling Time figure below.
Pulse Off Undershoot	u/(a-b). Refer to Overshoot, Undershoot and Settling Time figure below.

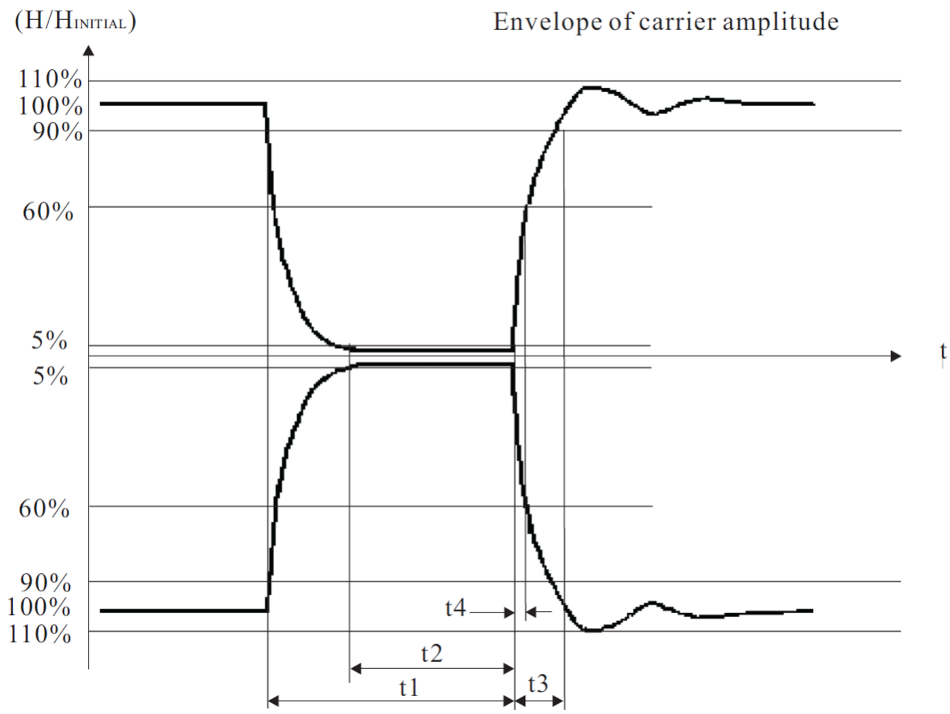


Figure 10-6. Pulse Shape for Miller coded ASK at 106kbps [Courtesy of ISO18092 (ECMA340) Specification]

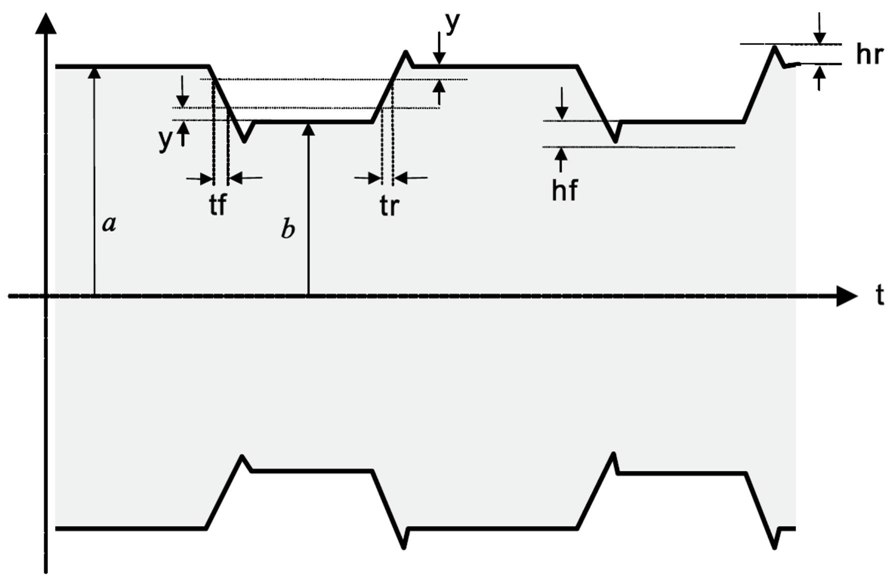


Figure 10-7: Pulse Shape for Manchester Coding at 202kbps and 424kbps [Courtesy of ISO18092 (ECMA340) Specification]

	212 kbps	424 kbps
tf	2,0 µs max	1,0 µs max
tr	2,0 µs max	1,0 µs max
y	0,1 (*a* – *b*)	0,1 (*a* – *b*)
hf, hr	0,1 (*a* – *b*) max	0,1 (*a* – *b*) max

Table 10-1. Definition of Manchester Code Waveform [Courtesy of ISO18092 (ECMA340) Specification]

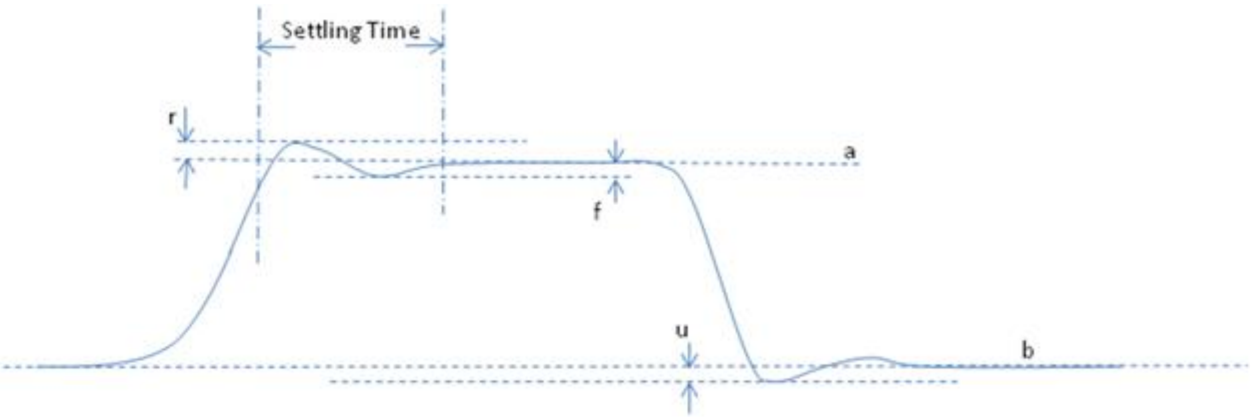


Figure 10-8. Overshoot, Undershoot and Settling Time

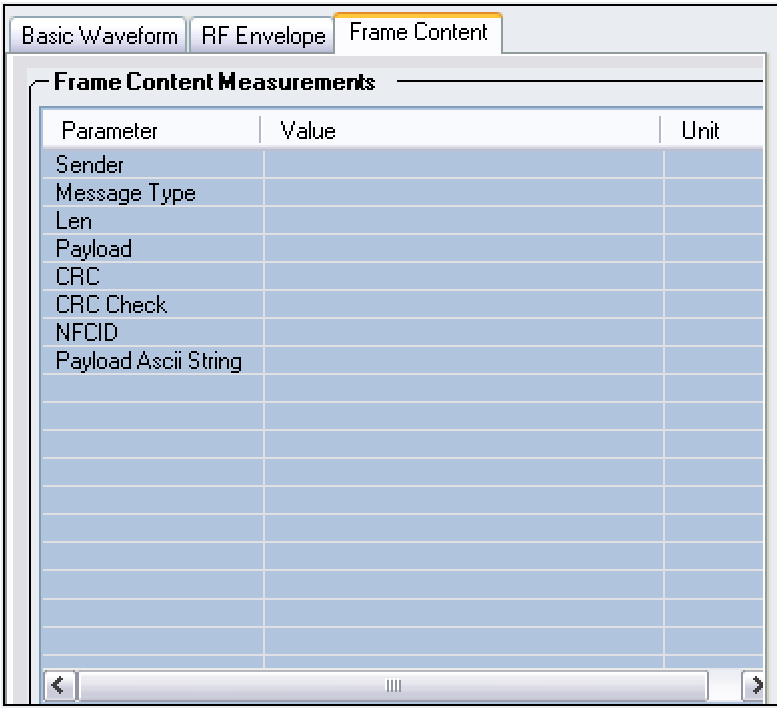


Figure 10-9. IQsignal—NFC Frame Content

Sender	Initiator or Target as defined in Section 4 of ISO18092 Specification. **Initiator:** Initiates the NFC communication **Target:** Responds to Initiator command using the modulation of a self-generated RF field
Message Type	The following message types as defined in NFCIP-1 Protocol Command Set in the ISO18092 specification: ATR_REQ/ATR_RES, WUP_REQ/WUP_RES, PSL_REQ/RSL_RES, DEP_REQ/DEP_RES, DSL_REQ/DSL_RES, RLS_REQ/RLS_RES.
Len	Length of the frame; specified in bytes
Payload	Payload data; specified in Hex string
CRC	CRC bits; specified in hex
CRC Check	Indicates pass or fail for CRC check
NFCID	NFC ID number extracted from payload; specified in hex
Payload Ascii String	ASCII text converted from Payload; specified in bits

Table 19 — NFCIP-1 Protocol Command Set

Mnemonic	Command Bytes		Definition
	CMD0	CMD1	
ATR_REQ	(D4)	(00)	Attribute Request (sent by Initiator)
ATR_RES	(D5)	(01)	Attribute Response (sent by Target)
WUP_REQ	(D4)	(02)	Wakeup Request (sent by Initiator in Active mode only)
WUP_RES	(D5)	(03)	Wakeup Response (sent by Target in Active mode only)
PSL_REQ	(D4)	(04)	Parameter selection Request (sent by Initiator)
PSL_RES	(D5)	(05)	Parameter selection Response (sent by Target)
DEP_REQ	(D4)	(06)	Data Exchange Protocol Request (sent by Initiator)
DEP_RES	(D5)	(07)	Data Exchange Protocol Response (sent by Target)
DSL_REQ	(D4)	(08)	Deselect Request (sent by Initiator)
DSL_RES	(D5)	(09)	Deselect Response (sent by Target)
RLS_REQ	(D4)	(0A)	Release Request (sent by Initiator)
RLS_RES	(D5)	(0B)	Release Response (sent by Target)

Table 10-2. NFCIP-1 Protocol Command Set [Courtesy of ISO18092 (ECMA340) Specification]

Appendix Description of Signal Files

The IQsignal application is packaged with sample waveform and corresponding text files for WLAN, Bluetooth and WiMAX technologies. The waveform files have a `*.mod` extension and are used to generate signals. Each text file that corresponds to a `*.mod` file contains payload data that was used to generate the `*.mod` file.

802.11 a/g Waveform Files

The table below provides examples and descriptions for waveform files and the corresponding text files that are provided with the IQsignal application for the 802.11 a/g technology.

File name	**File Name Description**
`wave9rc_100.mod` `psdu_wave9rc_100.txt`	• *wave9rc_100.mod* represents the modulation file that the VSG uses to generate signals • *9* refers to the data rate of the signal • *rc* represents the raised cosine window • *100* represents the PSDU length in bytes • *psdu_wave9rc_100.txt* represents the corresponding text file that contains the payload data
`Wave36rc_1000.mod` `psdu_wave36rc_1000.txt`	• *wave36rc_1000.mod* represents the modulation file that the VSG uses to generate signals • *36* refers to the data rate of the signal • *rc* represents the raised cosine window • *1000* represents the PSDU length in bytes • *psdu_wave36rc_1000.txt* represents the corresponding text file that contains the payload data
`wave54_half.mod` `psdu_wave54_half.txt`	• *wave54_half.mod* represents the modulation file that the VSG uses to generate signals • *54* represents the data rate of the signal • *half* represents half of the data rate, which is 54/2=27Mbps • *psdu_wave54_half.txt* represents the corresponding text file that shows the payload data
`wave54_quarter.mod` `psdu_wave54_quarter.txt`	• *wave54_quarter.mod* represents the modulation file that the VSG uses to generate signals • *54* represents the data rate of the signal • *quarter* represents quarter of the data rate, which is 54/4=13.5 Mbps • *psdu_wave54_quarter.txt* represents the corresponding text file that shows the payload data
`wave54_turbo.mod` `psdu_wave54_turbo.txt`	• *wave54_turbo.mod* represents the modulation file that the VSG uses to generate signals • *54* represents the data rate of the signal • *turbo* represents twice the data rate, which is 54x2=108 Mbps • *psdu_wave54_quarter.txt* represents the corresponding text file that shows the payload data

The table below lists the waveform files and corresponding text files for the 802.11 a/g packaged with the application.

File names of *.mod files	File names of *.txt files
wave9rc_100.mod	psdu_wave9rc_100.txt
wave9rc_1000.mod	psdu_wave9rc_1000.txt
wave18rc_1000.mod	psdu_wave18rc_1000.txt
wave36rc_1000.mod	psdu_wave36rc_1000.txt
wave54_half.mod	psdu_wave54_half.txt
wave54_quarter.mod	psdu_wave54_quarter.txt
wave54_turbo.mod	psdu_wave54_turbo.txt
wave54rc_1000.mod	psdu_wave54rc_1000.txt

802.11 b Waveform Files

The table below provides examples and descriptions for waveform files and the corresponding text files that are provided with the IQsignal application for the 802.11 b technology.

File name	File Name Description
wave1gr_100.mod psdu_wave1gr_100.txt	• *wave1gr_100.mod* represents the modulation file that the VSG uses to generate signals • *1* refers to the data rate of the signal • *gr* represents Gaussian and Rectangular filter • *100* represents the PSDU length in bytes • *psdu_wave1gr_100.txt* represents the corresponding text file that contains the payload data
wave5p5gr_100.mod psdu_wave5p5gr_100.txt	• *wave5p5gr_100.mod* represents the modulation file that the VSG uses to generate signals • *5p5* refers to 5.5 Mpbs data rate of the signal • *gr* represents Gaussian and Rectangular filter • *100* represents the PSDU length in bytes • *psdu_wave5p5gr_100.txt* represents the corresponding text file that contains the payload data
wave11gr_1000.mod psdu_wave11gr_1000.txt	• *wave11gr_1000.mod* represents the modulation file that the VSG uses to generate signals • *11* refers to the data rate of the signal • *gr* represents Gaussian and Rectangular filter • *1000* represents the PSDU length in bytes • *psdu_wave11gr_1000.txt* represents the corresponding text file that contains the payload data
wave11rc_1000.mod psdu_wave11rc_1000.txt	• *wave11rc_1000.mod* represents the modulation file that the VSG uses to generate signals • *11* refers to the data rate of the signal • *rc* represents the raised cosine filter • *1000* represents the PSDU length in bytes • *psdu_wave11rc_1000.txt* represents the corresponding text

	file that contains the payload data
wave11rc_1000.mod psdu_wave11rc_1000.txt	• *wave11rc_1000.mod* represents the modulation file that the VSG uses to generate signals • *11* refers to the data rate of the signal • *rc* represents the raised cosine filter • *1000* represents the PSDU length in bytes • *psdu_wave11rc_1000.txt* represents the corresponding text file that contains the payload data

The table below lists the waveform files and corresponding text files for the 802.11 b packaged with the application.

File names of *.mod files	File names of *.txt files
wave1gr_100.mod	psdu_wave1gr_100.txt
wave1gr_1000.mod	psdu_wave1gr_1000.txt
wave1rc_100.mod	psdu_wave1rc_100.txt
wave2gr_100.mod	psdu_wave2gr_100.txt
wave2gr_1000.mod	psdu_wave2gr_1000.txt
wave2rc_100.mod	psdu_wave2rc_100.txt
wave5p5gr_100.mod	psdu_wave5p5gr_100.txt
wave5p5gr_1000.mod	psdu_wave5p5gr_1000.txt
wave5p5rc_100.mod	psdu_wave5p5rc_100.txt
wave11gr_1000.mod	psdu_wave11gr_1000.txt
wave11rc_1000.mod	psdu_wave11rc_1000.txt
wave1gr_100.mod	psdu_wave1gr_100.txt

Bluetooth Waveform Files

The table below lists the some of the sample waveform files that are provided with the IQsignal application for the Bluetooth technology.

File name	File Name Description
1_dh3_00001111	• 1 represents the data rate of the signal • dh represents the packet type • 3 represents length of packet in number of timeslots • 00001111 represents the payload pattern of the signal
2_dh3_1010	• 2 represents the data rate of the signal • dh represents the packet type • 3 represents length of packet in number of timeslots • 1010 represents the payload pattern of the signal
2_dh1_pbrs9	• 2 represents the data rate of the signal • dh represents the packet type • 1 represents length of packet in number of timeslots • pbrs9 represents the payload pattern of the signal
3_dh1_1010	• 3 represents the data rate of the signal • dh represents the packet type • 1 represents length of packet in number of timeslots • 1010 represents the payload pattern of the signal

The table below lists the waveform files and corresponding text files for the 802.11 b packaged with the application.

File names of *.mod files	File names of *.txt files
1_dh1_1010.mod	1_dh1_1010.txt
1_dh1_00001111.mod	1_dh1_00001111.txt
1_dh1_prbs9.mod	1_dh1_prbs9.txt
1_dh3_1010.mod	1_dh3_1010.txt
1_dh3_00001111.mod	1_dh3_00001111.txt
1_dh3_prbs9.mod	1_dh3_prbs9.txt
1_dh5_1010.mod	1_dh5_1010.txt
1_dh5_00001111.mod	1_dh5_00001111.txt
1_dh5_prbs9.mod	1_dh5_prbs9.txt
2_dh1_1010.mod	2_dh1_1010.txt
2_dh1_00001111.mod	2_dh1_00001111.txt
2_dh1_prbs9.mod	2_dh1_prbs9.txt
2_dh3_1010.mod	2_dh3_1010.txt
2_dh3_00001111.mod	2_dh3_00001111.txt
2_dh3_prbs9.mod	2_dh3_prbs9.txt
2_dh5_1010.mod	2_dh5_1010.txt
2_dh5_00001111.mod	2_dh5_00001111.txt
2_dh5_prbs9.mod	2_dh5_prbs9.txt
3_dh1_1010.mod	3_dh1_1010.txt
3_dh1_00001111.mod	3_dh1_00001111.txt
3_dh1_prbs9.mod	3_dh1_prbs9.txt
3_dh3_1010.mod	3_dh3_1010.txt
3_dh3_00001111.mod	3_dh3_00001111.txt
3_dh3_prbs9.mod	3_dh3_prbs9.txt
3_dh5_1010.mod	3_dh5_1010.txt
3_dh5_00001111.mod	3_dh5_00001111.txt
3_dh5_prbs9.mod	3_dh5_prbs9.txt

802.16d Waveform Files

The table below lists the sample waveform file that is provided with the IQsignal application for the 802.16d technology.

File name	File Name Description
16d_10Mhz_64qam_34fec	• 16 d represents the 802.16d technology • 10MHz represents the signal bandwidth • 64qam represents the quadrature amplitude modulation of the signal

	• 34 fec represents the forward error correction of the signal

802.16e Waveform Files

The table below lists the sample waveform file that is provided with the IQsignal application for the 802.16e technology.

File name	File Name Description
16e_dl_20Mhz_4subchgroups_4bursts	• 16e represents the 802.16e technology • DL represents down link • 20 MHz represents the frequency of the signal • 4 subchgroups represents the number of channel subgroups in the signal • 4 bursts represents the number of bursts in the signal

NFC Waveform Files

File name	File Name Description
iso18092_initiator_carrier1kHzoffset_424kbps.mod	• ISO18092 represents the NFC specification number • initiator indicates that is initiates the NFC communication • carrier1kHzoffset indicates that the waveform has a 1 KHz carrier offset • 424 kbps represents the signal data rate
iso18092_initiator_ideal_106kbps.mod	• ISO18092 represents the NFC specification number • initiator indicates that is initiates the NFC communication • ideal indicates an ideal waveform that has no distortion 106 kbps represents the signal data rate
iso18092_initiator_ideal_212kbps.mod	• ISO18092 represents the NFC specification number • initiator indicates that is initiates the NFC communication • ideal indicates an ideal waveform that has no distortion • 212 kbps represents the signal data rate
iso18092_initiator_ideal_424kbps.mod	• ISO18092 represents the NFC specification number • initiator indicates that is initiates the NFC communication • ideal indicates an ideal waveform that has no distortion • 424kbps represents the signal data rate

iso18092_initiator_wrongCRC_106kbps.mod	• ISO18092 represents the NFC specification number • initiator indicates that is initiates the NFC communication • wrongCRC indicates that a CRC failure is returned; used for verifying CRC • 424kbps represents the signal data rate

LitePoint Corporation - Corporate Headquarters

575 Maude Court, Sunnyvale, CA 94085 | +1.408.456.5000 | www.litepoint.com | sales@litepoint.com