

# RF Application Development Course

Nov 2008

## Overview

The cost of RF test including time to test, development effort and equipment cost has become critical for wireless device manufacturers in the 21<sup>st</sup> century. PXI offers flexibility, performance and software tools to reduce the cost of RF test. This course focuses on how to use PXI based RF hardware and software from National Instruments. It will cover the complete RF hardware and software architecture from baseband to IF to RF as well the Modulation Toolkit and Spectral Measurements Toolkit. Students will use real world analog and digital radios in hands-on exercises to simulate typical RF device testing with the National Instruments PXI RF hardware and software.

## Duration

2 Days

## Audience

- New and practicing test/product engineers who are involved with the production, test and development of RF/wireless solutions in the DC to 6 GHz frequency range
- Engineers who are getting started with the PXI RF hardware and software platform

## Prerequisites

- Minimum - LabVIEW Basics I or equivalent experience
- Recommended – LabVIEW Basics I & II plus LabVIEW Intermediate I & II or equivalent experience
- RF Measurement Fundamentals or equivalent RF knowledge for RF design, test and measurement

## NI Products Used During the Course

- LabVIEW Professional Development System Version 8.5
- PXI-5661 Vector Signal Analyzer
- PXI-5671 Vector Signal Generator
- Modulation Toolkit
- Spectral Measurements Toolkit
- Instructor Only: PXI-5652 CW source, PXI RF switching, PXI-5690 pre-amplifier, NI 5680 USB power meter
- FM radio, FSK transceiver, FM and UHF antennas

## Registration

Register online at [ni.com/training](http://ni.com/training) or call (800)433-3488 Fax: (512)683-9300 [info@ni.com](mailto:info@ni.com)

Outside North America, contact your local NI Office. Worldwide Contact Info: [ni.com/global](http://ni.com/global) NI can also hold this class on-site at your facility.

## Part Number

910765-xx  
-01 NI Corporate or Branch  
-11 Regional  
-21 Onsite  
779928-01 Course Kit Only

## After attending this course, you will be able to:

- Configure and use the PXI-5661 and PXI-5671
- Measure and demodulate an RF signal
- Create a modulated signal and generate it as an RF signal
- Perform spectral measurements
- Record and playback RF signals
- Be familiar with RF switches, pre-amplifier and power meter
- Be familiar with device driver and toolkit palettes for RF
- Understand triggering, clocking and onboard signal processing with VSA and VSG

## Suggested Next Courses

- LabVIEW Intermediate I & II
- LabVIEW Advanced Application Development

## Day 1

### Introduction to RF Platform

Introduction to hardware and software covered in course. Sample RF solutions and configuration for these solutions. Topics include:

- Overview of VSA, VSG, CW source, switching, pre-amp and power meter
- Overview of Modulation Toolkit and Spectral Measurements Toolkit
- Solving application specific RF systems – Digital Video and RFID test

### Hardware Configuration

This lesson familiarizes you with the RF hardware configuration in Measurement and Automation Explorer (MAX). Topics include:

- How to connect your PXI-5661 VSA and PXI-5671 VSG
- Configuration of PXI-5661 and PXI-5671 in MAX
- Introduction to test panels for troubleshooting
- Calibration of PXI-5661 and PXI-5671

### RF Down Conversion and Up Conversion

This lesson describes in detail the PXI-5600 down converter and PXI-5610 up converter. The lesson also covers clocking from internal and external sources plus driver software implementation. Finally it will describe the PXI-565x as well as the Spectral Measurements Toolkit. Topics include:

- Hardware architecture of PXI-5661 and PXI-5671
- Driving the PXI backplane reference clock
- NI-RFSG driver for PXI-5671 VSG
- NI-RFSG waveform creation and scripting
- NI-RFSA driver for PXI-5661 VSA
- NI-RFSA spectral and IQ acquisition
- Hardware architecture of PXI-565x
- Programming PXI-565x for CW, analog and digital modulation generation
- Introduction to Spectral Measurements Toolkit (SMT)
- Programming methods for SMT

### Digital Down Conversion, Digital Up Conversion, Digitizers, and Sources

This lesson focuses on the PXI-5142 digitizer and PXI-544x arbitrary waveform generators (AWG). It describes their architecture including the onboard signal processing features as well as timing and triggering features. Topics include:

- Digital down conversion (DDC) with the PXI-5142
- Digital up conversion (DUC) with the PXI-5441 and PXIe-5442
- PXI-5142 digitizer architecture
- PXI-544x AWG architecture
- Digitizer clocking and triggering
- AWG clocking and triggering
- Fractional re-sampling and external clocking of OSP

## Day 2

### Analog Modulation

This lesson provides an overview of different analog modulation methods and how to implement them with the Modulation Toolkit. Topics include:

- Overview of analog modulation and where it is used
- Amplitude Modulation
- Frequency Modulation
- Phase Modulation
- Analog Modulation Toolkit

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## Digital Modulation

This lesson provides an overview of digital modulation methods and how to implement them with the Modulation Toolkit. Topics include:

- Introduction to Digital Modulation Toolkit
- Modulation and demodulation functions – FSK, ASK, QAM, PSK, CPM, MSK
- Modulation visualization – Constellation, Trellis, Eye Diagram
- Digital modulation measurements – BER, MER, EVM, Rho, Burst Timing
- Channel coding
- Modulation impairments

## Record and Playback

This lesson describes RF record and playback. It shows how to build your own record and playback system with insight into methods and architectures. Topics include:

- Overview of a record and playback system
- Data sizes and types for record and playback applications
- Storage media – RAM, Solid State, Mechanical Drives, RAID
- Memory considerations

- Introduction to RAID (Redundant Array of Inexpensive Drives)
- Bus technology
- Introduction to continuous data streaming
- Software architecture for data streaming
- File I/O methods for data streaming
- Solutions for data streaming
- Applications and considerations for data streaming

## Additional RF Hardware

This lesson covers hardware not used in the normal class exercises but shown in demonstrations. Overview and software programming of the RF pre-amplifier, switches, frequency counting and power meter is described. Topics include:

- Pre-amplification of RF signals
- PXI-5690 pre-amplifier and NI 5690 driver
- Power measurements
- NI 5680 power meter and NI 5680 driver
- Frequency counting with PXI-5661 VSA
- RF switching considerations – insertion loss, VSWR, isolation, cross-talk
- RF and microwave switches in PXI
- NI Switch Executive