

RF Measurement Fundamentals

Overview

RF and wireless communication is becoming the standard in everyday device design. Understanding RF and its fundamentals is critical to being successful when designing and testing RF devices. This course covers a range of topics from overall RF device architecture, mathematics basics like Fourier Transforms, modulation, RF measurements, and RF test considerations. This course is appropriate for beginning students or more advanced engineers wanting a refresher course in RF. It prepares the student for the RF Application Development course.

Duration

Three (3) 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 want to expand their existing RF knowledge to cover both traditional and current RF technologies

Prerequisites

- Basic understanding of LabVIEW and the environment; LabVIEW programming experience is not essential for this course, but helpful
- Basic understanding of analysis methods (FFT, DFT, decibel, etc.)

NI Products Used During the Course

- LabVIEW Professional Development System Version 8.5 or later
- PXI-5661 Vector Signal Analyzer
- PXI-5671 Vector Signal Generator
- Modulation Toolkit
- Spectral Measurements Toolkit
- FM radio, LNA kit, FM and UHF antennas

After attending this course, you will be able to:

- Understand important RF terminology and what it means
- Understand traditional measurements like gain, power compression, third-order intercept, harmonics, Adjacent Channel Power Ratio, phase noise, noise figure and more

Registration

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

Outside North America, contact your local NI Office.
Worldwide Contact Info: ni.com/global

Part Number

910764-xx
-01 NI Corporate or Branch
-11 Regional
-21 Onsite (at your facility)

- Read specifications of common RF instrumentation and RF devices
- Understand modulation and modulation measurements like BER, EVM, and MER
- Break down super-heterodyne and Zero IF block diagrams into their constituent parts (amplifiers, modulators, mixers, phase locked loops, filters, Digital-to-Analog Converters, Analog-to-Digital Converters)

Suggested Next Courses

- RF Application Development
- LabVIEW Core 3
- LabVIEW Connectivity
- Advanced Architectures in LabVIEW

RF Measurement Fundamentals Outline

Day 1

RF SOC Device Architectures

This lesson introduces you to common RF devices and their architectures. It also reviews orders of magnitude common to RF. Topics include:

- Basic Radio Components
- RF SOC Device Architectures
- Device Integration Paths
- Orders of Magnitude
- Decibels

Fourier Transforms and FFTs

This lesson reviews frequency and time domain signals. It describes how the Fourier transform works and covers areas like Nyquist Sampling Theory, Signal to Noise Ratio and Complex FFT. Topics include:

- Frequency versus Time Domain
- Fourier Transform
- Relationship of Time and Frequency
- Nyquist Sampling
- Coherent Sampling and Windowing
- Signal to Noise Ratio (SNR)
- IQ Modulation/Complex FFT

Complex and Digital Modulation

This lesson introduces you to modulation and IQ data (complex data). It describes the different methods of digital modulation using phase and magnitude variations. It also introduces you to modulation measurements like Error Vector Magnitude (EVM) and Modulation Error Ratio (MER). Finally it describes IQ imbalances (impairments). Topics include:

- Modern Digital Communication System
- Modulation Basics
- Modulation Techniques
- EVM and MER
- Imbalance Effects

Orthogonal Frequency Division Multiplexing (OFDM)

This lesson describes OFDM and its importance in future RF systems. It describes how OFDM works and methods for measuring. Topics include:

- Orthogonal Frequency Division Multiplexing (OFDM) Overview
- OFDM in 802.11a and 802.11g
- OFDM and Orthogonal Carriers
- OFDM Frequency Spectrum versus Time Domain
- OFDM and EVM

Day 2

RF Parametric Measurement Overview for Discrete Devices

This lesson introduces you to important concepts in RF. It describes RF power and methods for measuring power. It covers noise in RF signals and measurement systems. The lesson also goes into details of important RF specifications for devices and instrumentation.

Topics include:

- RF Power
- What is a spectrum analyzer?
- Noise
- Transmission Line Theory
- Scattering Matrix (S-parameters)
- Gain
- Major RF Measurements
- Mixers
- Intermodulation Distortion
- Adjacent Channel Power Ratio (ACPR)
- Phase Noise
- M. Dynamic Range (DR) vs. Spurious Free Dynamic Range

RF Measurement Fundamentals Outline

Day 3

Zero IF Receivers

This lesson discusses the two transceiver architectures that were mentioned in the first lesson, the superheterodyne and homodyne (ZIF), in more depth.

Topics include:

- Today's SOC Radios
- Superheterodyne Transceivers
- Homodyne Zero (ZIF) Transceivers

Digitizers and Arbitrary Waveform Generators

This lesson explains important topics regarding digitizers and AWG (arbitrary waveform generators) necessary for understanding good and bad measurements. Topics include:

- DC Offsets and Peak-to-Peak Voltages
- Maximizing Dynamic Range
- Impedance Considerations
- Single-to-Differential Signal Conversion
- Effective Number of Bits (ENOB)
- Block Diagram of Digital Upconversion and Downconversion
- Resolution Bandwidth (RBW)

Bit Error Rate (BER)

This lesson explains Bit Error Rate and why it is important for device testing. Topics include:

- Receiver Tests Overview
- Bit Error Rate (BER) Testing
- BER Receiver Measurements

Multiple Input Multiple Output (MIMO)

This lesson gives a background on MIMO and why it is important for future RF devices. Topics include:

- Overview of MIMO
- Channel Estimation and Recovery