Course ID
VECTOR
Course Duration
3-5 days

Course Title
Spectrum Monitoring: Principles of Vector Network Analysis, Procedures, and Key Results

Related Courses

- Spectrum Management: Planning, Monitoring, Licensing, and Economics (SPECMGT, 2-3 days)
- Spectrum Monitoring Workshop: Principles and Practice (SPECMON, 3-5 days)
- Radio Measurements Equipment: Principles and Operation (RMEQUIP, 2-3 days)
- Wireless All-in-One: RF Propagation, Cellular Principles, Personal Radio Services, WiFi, WiMAX, CDMA, and GSM (ALL-IN-ONE, 5 days)
- LTE: A Comprehensive Three Day Course (LTE-C3DC, 3 days)
- WIMAX: A Comprehensive Three Day Course (WIMAX-C3DC, 3 days)
- 3G Systems: WCDMA/UMTS and CDMA2000 (3G5D, 5 days)
- 3G Systems: WCDMA/UMTS and CDMA2000 Overview (3G3D, 3 days)
- GSM, GPRS, and EDGE: An Intensive Tutorial (GSMPLUS, 3 days)

Aimed At

Those with RF/wireless background who wish to study the vector network analysis techniques as applied to spectrum monitoring, clearance, and management.

Group Size

5-15

Prerequisites

- RF Propagation Models, Fading Characteristics, and Link Budget Analysis (RFPROP, 3 days)
- RF Systems: Principles, Design, and Deployment (RFSYS, 3 days)
- Wireless Network Structure, Operation, and Technologies (3 days, WIRELESSNET)

Participants should have a basic understanding of RF and wireless technologies and at least one year experience in spectrum monitoring.

Course In a Nutshell

This course is one of a series of courses that bring together in one curriculum the technologies that relate to spectrum monitoring, vector analysis, and spectrum management as well as spectrum monitoring system organization and measurement equipment characteristics. The present course is aimed at those who wish to learn more about the vector network analysis issues and radio measurements. The course duration, indicated as 3-5 days, depends on the desired depth of coverage.

Customize It!

Customize this course to your own requirements at little-to-no additional cost. We can tailor the course to meet the varying needs of audiences such as recent university graduates with no experience, those with prior experience in spectrum monitoring/management, managers/executives, and non-technical personnel.

Course Outline

- Introduction and Course Overview
- Radio Spectrum Fundamentals
  - Current Trends in Spectrum Usage
  - Administrative Divisions of the Frequency Spectrum
  - Cognitive Radio
  - Modern Modulation Techniques and Systems
  - Spectrum Monitoring Future and Challenges: A Summary and Discussion
- Modulations and Signal Types Overview
  - Modulations in Communication and Broadcasting Systems
  - Types of Analog Modulations and Signal Reception
    - Amplitude Modulation
    - Angle Modulations (FM/PM)
  - Types of Digital Modulations and Signal Reception
    - Amplitude Shift Keying
    - Phase Shift Keying
    - Frequency Shift Keying
  - Multiplex and Multiple Access
    - TDM/TDMA
    - FDM/FDMA
    - CDM/CDMA
    - OFDM
  - Modulations and Signal Types: Session Review and Discussion
- Radio Monitoring Equipment
  - Problems, Classification and Structure of Radio Monitoring Equipment
  - Design Philosophy and Constraints
- Design of Heterodyne N-Port Network Analyzer
  - Block Diagram
  - Design of the Test Set
    - Constancy of the Wave
    - Reflection Tracking
    - Directivity
  - Implementation of the Directional Element
    - VSWR Bridge

        - Directional Coupler
    - Other Components of the Test Set
        - Receiver Step Attenuators
        - Generator Attenuators
        - Active and Passive Test Sets
    - Generator
    - Reference and Measurement Receiver
        - Tuned Radio Measurements Receiver
        - Main Radio Receiver Parameters
    - Measurement Procedure
        - S-Parameter Measurement Procedure
        - Measurement Data Processing Chain
        - Trace Generation
    - Main Setting Parameters
        - User Interface
        - Channel Settings
        - Trace Settings
    - Remote Control of the Instrument
        - Usage of Simple Digital Signals
        - Protocol-Based Interfaces
        - Automation
    - Simplified Implementations
        - N+1 Receiver Analyzer
        - Network Analyzer with N-Port Switching Matrix
    - Design of a Network Analyzer: Session Review and Discussion
- Measurement Accuracy and Calibration
    - Reduction of Random Measurement Errors
        - Thermal Drift
        - Repeatability
        - Noise
    - Correction of Systematic Measurement Errors
        - Nonlinear Influences
        - Linear Influences
    - Calibration Standards
        - Coaxial Calibration Standards
        - Waveguide Calibration Standards
        - Microstrip Calibration Standards
        - Coplanar Calibration Standards
        - Uniform Model of the Calibration Standards
    - Linear Error Models and Calibration Techniques
        - 3-Term Error Model (OSM Technique)
        - 7-Term Error Model (Different Techniques)
        - 10-Term and 12-Term Error Models (TOSM Technique)
        - 15-Term Error Model (TOM-X technique)
        - Incomplete Calibration Techniques
    - Verification

        - T-check and Beatty Standard
        - Measurement of the Effective System Data
        - Analysis of the Measurement Uncertainty
    - Measurement Accuracy and Calibration: Session Review and Discussion

- Examples of Linear Measurements
    - Performing a TOM Calibration
    - Performing a TNA Calibration
    - Measurement of the Reflection Coefficient and SWR
    - Measurement of Group Delay and Phase Delay
    - Measurement of Stability
    - Measurement of the Far-End and Near-End Crosstalk
    - Filter with Balanced and Unbalanced Port, Imbalance and Common-Mode Rejection
    - Measurement of Switching Times and Drift Effects
    - Measurement of the Efficiency
    - Linear Measurements: Session Review and Discussion

- Time Domain Measurements
    - Impulse and Step Response
    - Time-Domain Analysis of Linear RF Networks
    - Time domain Reflectometry Using an Oscilloscope
    - Fourier Transform
    - Numerical Inverse Fourier Transform
        - Inverse Discrete Fourier Transform
        - Windowing
        - Bandpass Mode
    - Time-Domain Option
        - Operation in Lowpass Mode
        - Operation in Bandpass Mode
        - Benefits of Extrapolation
        - Processing Sequence
    - Time Gate
    - Time Domain Measurements: Session Review and Discussion

- Examples of Time Domain Measurements
    - Measurements on a SAW Filter in the Time Domain
    - RF Imaging for Nondestructive Evaluation
    - Examples of Time Domain Measurements: Session Review and Discussion

- Nonlinear Measurements
    - Features Used for Nonlinear Measurements
        - Automatic Level Control
        - Source Power Calibration
        - Receiver Power Calibration

        - Power Sweep
        - Multiple Source Concept
        - Arbitrary Mode
        - Direct Generator and Receiver Access
        - Power Sensors as Receivers
        - External Generator Control
        - Additional Equipment
    - Measurement of the Detector Characteristic
    - Harmonics
        - Model of Harmonic Distortions
        - Measurement of the Harmonics and Their Intercept Point
    - Intermodulation
        - Model of Intermodulation Distortions
        - Measurement of the Harmonics and Their Intercept Point
    - Non Linear Measurements: Session Review and Discussion
- Mixer Measurements
    - Signals and Parameters for a Mixer
        - Input and Output Signals of a Mixer
        - Higher Order Mixing Products
        - Important Mixer Parameters
    - Example of Mixer Measurements
    - Example of Measurements on a Down-Converting Module
    - Frequency Extension
    - Mixer Measurements: Session Review and Discussion
- Antenna and Radar Cross Section Measurements
    - Antenna Measurements
    - Important Antenna Measurement Quantities
    - Radar Cross Section Measurements
    - Antenna Measurements: Session Review and Discussion
- Course Recap and Conclusion

How You Will Learn

- You will learn from an instructor who's well versed in spectrum monitoring and management techniques as well as a host of RF/wireless technologies.
- Along with the lecture, we will use exercises and interesting group activities to enrich the instruction and drive home the important points.
- If you already know something about the topics dealt with in this course, we will build on that. We'll compare and contrast what's familiar with what's new, making the new ideas easier to learn as well as more relevant.
- If your background is less technical, we will use meaningful examples and analogies to simplify the complex subject matter.
- The Participant Handbook will provide you with a framework to which you can add the information and insight provided in real-time, turning it into a valuable reference resource you can take back to your job.

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