Keysight Technologies
Noise Figure Measurements
Course Overview

Course Numbers:
Keysight Training Center: H7215B #303

Learn how to operate the NFA series of Noise Figure Analyzers

Course Overview

This course introduces the principles of Noise Figure Measurements, and trains operators in the use of the NFA series of noise figure analyzers to maximize application performance.

What You will Learn

- Describe the basics of noise processes in devices
- Understand how the NFA series of noise figure analyzers measures the noise figure of two-port devices
- Understand frequencyconverting noise figure measurements and the differences between single sideband and double sideband measurements
- Operate the NFA series of noise figure analyzers using front panel control of the measurement calibration, measurement and data output process
- Understand how to avoid measurement errors, reduce unavoidable errors, and quantify the uncertainties that remain

Specifications

Course type

User Training

Audience

Test engineers and technicians

Prerequisites

Basic RF measurement concepts and terminology

Course length

1 day

Course format

Lecture and Lab

Delivery method

Scheduled at Keysight Technologies, Inc. locations, or

Dedicated at a customer site.

To save you time and travel, many Keysight courses can be delivered at your site. Keysight can provide required equipment, or you can save money by furnishing your own.

Detailed Course Agenda

Introduction

- Why is noise figure important?
- Outline of main topics
- Discussion of how case study lab measurements to be used in the afternoon demonstration
- Course is coordinated with the NFA Series User Manual, and with Keysight Technologies, Inc. Application Notes 57-1 (Pub number 5952-8255E) and 57-2 (Pub number 5952-3706E) which give further in-depth information

Noise basics

- Where does noise come from?
- Importance of signal/noise ratio

Noise figure fundamentals

- What is noise figure?
- What is noise temperature?
- Noise temperature/figure of two cascaded stages: the basis for the measurement technique

How to measure noise figure

- Y-factor method
- Noise sources and the ENR concept
- The two-step process: calibration followed by measurement with DUT
- A simple worked example (no corrections or uncertainties)

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Introduction to the NFA series of noise figure analyzers

- Main features
- New facilities and other differences from older instruments
- Frequency-swept NF measurements
- Averaging and bandwidth
  - Basic tradeoff between reduced jitter and increased measurement time
  - Measurements that may need reduced bandwidth
  - Three-way tradeoffs between reduced jitter, reduced bandwidth and increased measurement time
- Calibration concepts and facilities
- Measurement and readout concepts and facilities

Two-port (non-frequency converting) measurements

- Types of DUTs?
- Choosing a noise source with a suitable ENR
- Demo: analyzer calibration
- Demo: a simple measurement – frequency-swept, wide bandwidth, simple DUT
- How to avoid errors – checklist based on AN 57-2 (*Noise Figure Measurements Accuracy – The Y Factor*, Pub number 5952-3706E) and "10 Hints":
  - Prevent interfering signals
  - Avoid non-linearity or unstable performance
  - Minimize mismatch uncertainties – explain background
  - Use the appropriate noise source
  - Use averaging to avoid display jitter
  - Choose the appropriate measurement bandwidth
  - Use a preamplifier where necessary
  - Account for losses
  - Correct for physical temperatures
- How to compensate for losses and physical temperatures, using built-in features of the NFA
- How to quantify uncertainties that remain, based on AN 57-2 (*Noise Figure Measurements Accuracy – The Y Factor*, Pub number 5952-3706E) and the Spreadsheet Uncertainty Calculator

Frequency-converting measurements

- What kinds of DUTs? – exclude DUTs requiring a system downconverter
- Swept-frequency modes:
  - Swept NFA – focus of this course
  - Swept LO – see NFA User Manual
- Control of external LO
- Concepts of SSB versus DSB measurements:
  - Which to choose
  - Estimating SSB noise figure from a DSB measurement
  - Choice of IF
  - LO Problems – Noise and Leakage
- Analyzer calibration
- Measurement – demonstration: SSB, frequency-swept NFA, wide bandwidth, simple DUT
- How to avoid errors:
  - Same basic checklist as nonfrequency-converting measurements
  - Extra checks for frequency-converting measurements
- How to compensate for additional uncertainties of frequency-converting measurements
- How to quantify uncertainties that remain

Introduction and Lab exercises

Lab 1: Non-frequency converting measurements

- Simple DUT
- In-depth assessment of errors and uncertainties:
  - Measure a narrowband two-port DUT which requires reduced bandwidth
  - Measure a very low-noise DUT with high input reflection coefficient
  - Measure a low-noise, low-gain DUT and use graphs to estimate increased uncertainties.

Lab 2: Frequency-converting measurements

- DSB measurement, emphasizing different calibration technique
- DSB measurements at a range of IFs, emphasizing differences in results obtained
- SSB measurement

This course is part of Keysight Technologies' Accelerated Education Test and Measurement Fundamentals Curriculum. It is designed to quickly give you the expertise you need to solve measurement problems effectively and efficiently. The courses in these curricula are the same ones Keysight uses to train newly hired engineers and engineers who are changing jobs within the company.

For a complete listing of available Accelerated Education curricula, go to **www.keysight.com/find/accelerated_education**

Ordering Information

H7215B-303 Noise Figure Measurements course, delivered on-site

For the latest information on class schedules and locations, visit our website: www.keysight.com/find/education

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