

TRAINING, COURSES AND SEMINARS

BSW TestSystems & Consulting AG



The need for training

You are operating in the fast growing field of the semiconductor and/or telecommunications industry. Fast turnover times of products, and types of products require fast adoption of new design, measurement, test techniques and methods by you and your employees. Whether you are active in this field for many years or just changed college bench for a company desk: there might be holes in your understanding of how high frequency device measurements are done exactly!

How we can help

BSW offers you a broad spectrum of training possibilities of which the actual form is determined by the needs of the customer. Are you looking for a course to broaden your theoretical background only, or do you want additional hands-on to improve your practical abilities? Maybe you want to cover a topic in the form of a seminar by merging overview and background presentations with contributions out of the field, done by your colleagues and/or invited speakers? In all cases BSW can be your partner to gather the material and organize the occasion.

Company background

Several years ago BSW started off as a company to answer the increasing demand for turnkey solutions in the field of semiconductor device characterization and RF/microwave measurement and testing. Our experience originating from these and on-going projects, is now being shared with you by means of the training projects discussed in this brochure.

S-PARAMETER AND NETWORK ANALYZER BASICS

Description:

The growing demand for high frequency components and circuits makes more and more development and test engineers accept the need to measure S-parameters. And, although measuring S-parameters tends to be more common, the necessary equipment is still very complex. A basic understanding of the underlying theory is needed to properly set the equipment and perform accurate measurements. The material is basically vendor independent (Agilent Technologies, Rohde & Schwarz, Anritsu , ...). Practical 'tips-and-tricks' will be given and could also be demonstrated on the students or BSW's S-parameter measurement setup.

Who should attend:

Engineers who are faced with doing S-parameter measurements but need to know about the underlying theory and the practical handling to perform accurate measurements.

Contents:

- The Smith-chart.
- S-parameter basics
- S-parameter measurement equipment.
- Coaxial and on-wafer device-measurements.
- NWA calibration techniques (SOLT, TRL, ...).
- NWA accuracy considerations and enhancement.
- Fixture design; characterizing and de-embedding the fixture.
- Exercises.

Pre-requisites:

- Background in electronics engineering or equal by experience
- Basic understanding of electronic circuit theory.

Duration:

2 days

ADVANCED NETWORK ANALYSIS TECHNIQUES **(accurate on-wafer and in-fixture device measurements)**

Description:

The accuracy of $\mu\text{W}/\text{RF}$ measurements (S- and noise parameters, load- and sourcepull, ...) is greatly determined by the circuit or fixture that holds the Device Under Test. This course addresses techniques to enhance the accuracy of your on-wafer or in-fixture device measurements. To demonstrate the techniques hands-on sessions will be given in which the network analyzer is controlled by computer programs for data acquisition, calculation and analysis.

Who should attend:

The mix between theory and practice makes the course best suited for design and test engineers who do measurements in various circuits or fixtures and need accurate de-embedded device data.

Contents:

- Review of S-parameters, gain and noise equations; transmissionlines.
- S-parameters for circuit design and semiconductor device characterization.
- S-parameters measurement equipment.
- NWA calibration techniques (SOLT, TRL, ...) and accuracy considerations.
- De-embedding techniques.
- (mechanical) fixture considerations.
- Balanced circuits and fixtures
- Trends in fixturing.
- Exercises.

Pre-requisites:

- Knowledge about linear circuit S-parameters.
- Experience in performing $\mu\text{W}/\text{RF}$ measurements, specifically network analyzer measurements.
- An open mindset to switching back and forth between theory and practice.

Duration:

'Presentation-only' course: 1 day.
Full course, including hands-on exercises: 2 days

BALANCED/UNBALANCED CIRCUIT MEASUREMENTS USING A 4-PORT NETWORK ANALYZER

Description:

Modern μ W/RF circuits, designed for high noise immunity at low bias, are not the classical 'signal-to-ground' 2-port (unbalanced) circuits anymore but are 4-port balanced circuits. This course addresses the measurement difficulties they present and gives possibilities to overcome them.

Who should attend:

The mix between theory and practice makes the course best suited for design and test engineers who start to do 4-port measurements or do so already and want to have a better understanding.

Contents:

- Why balanced devices?
- The 4-port network analyzer; calibration and (de-)embedding.
- Common, differential and mixed mode S-parameters.
- Examples and exercises.

Pre-requisites:

- Knowledge about linear circuit 2-port S-parameters.
- General experience in performing μ W/RF measurements.

Duration:

1 day.

NOISE FIGURE AND NOISE PARAMETER MEASUREMENT TECHNIQUES

Description:

The sensitivity of receiver systems is limited by device noise behavior which is easily described by a set of noise parameters. This course in-depth covers methods to determine semiconductor device noise parameters. The material is basically independent of vendor systems (ATN/Agilent, Maury, Focus, ...). Practical 'tips-and-tricks' will be given and could also be demonstrated on the students in-house noise parameter measurement setup.

Who should attend:

The mix between theory and practice makes the course best suited for design and test engineers who start to do noise parameter determination or do so already and want to have a better understanding of it.

Contents:

- Review of noise, noise power, noise figure; gain.
- Physical noise sources in devices.
- The noise figure models for devices; noise circles.
- The linear gain model for devices; gain circles.
- Noise figure meter, tuners; measurement systems.
- Noise figure measurement enhancement techniques.
- Fitting measurement data to the models.
- Trends in noise parameter determination and measurement equipment.
- Exercises.

Pre-requisites:

- Familiarity with linear circuit S-parameters.
- General experience in performing $\mu\text{W}/\text{RF}$ measurements.

Duration:

3 days.

LOADPULL MEASUREMENT TECHNIQUES

Description:

Modern power amplifier design and verification strongly relies on load- and sourcepull measurement data. This course gives a thorough insight in theory and practice of load- and sourcepull measurements on power devices. The material is basically independent of vendor systems (ATN, Maury, Focus,). Practical 'tips-and-tricks' will be given and could also be demonstrated on the students in-house loadpull setup.

Who should attend:

The mix between theory and practice makes the course best suited for design and test engineers who start to do loadpull measurements or do so already and want to have a better understanding of it.

Contents:

- Review of linear and non-linear device behaviour.
- Tuners and fixtures.
- Gain equations.
- Efficiently measuring power, intermodulation, adjacent channel power rejection ratio (ACPR),
- Calibration; system correction for power and impedances.
- Interpreting data and making performance trade-offs.
- Trends in loadpull systems.
- Exercises.

Pre-requisites:

- Knowledge about linear circuit S-parameters.
- General experience in performing μ W/RF measurements.
- General knowledge about semiconductor device behavior.
- An open mindset to switching back and forth between theory and practice.

Duration:

3 days.

EFFICIENT AUTOMATED μ W/RF LAB MEASUREMENTS WITH Agilent-VEE

Description:

All too often a simple computer control program to perform just one type of measurement evolves into 'spaghetti' code over time. This course puts a structured method forward that, when used consistently, avoids too many re-work and reduces maintenance time and cost. The course is based on Agilent-VEE as the programming language but the concept is just as valid for any other data acquisition language. Part of the course is to work out a measurement automation problem in class, together.

Who should attend:

Design and test engineers who automate their own or other engineers' measurement needs.

Contents:

- Review of programming concepts: data and control flow, variables, decision statements.
- Sharing and maintaining code: encapsulation and libraries.
- Introduction/review of Agilent-VEE.
- The 'no-keyboard' phase to the measurement problem.
- Learn your instrumentsfrom a distance.
- Close the measurement loop....
- Trends in automated μ W/RF measurements and data acquisition.
- Exercises.

Pre-requisites:

- Basic knowledge about programming and instrument control or data acquisition.
- General experience in performing μ W/RF measurements.

Duration:

2 days.

PRICING

Standard courses:

The minimum number of students per class is three; maximum is eight. The „training-day“ is assumed to be 8 working hours.

For pricing please ask for a offer.

Paper copies of the training material are included.

If not otherwise mentioned, a training is assumed to be held at the customer's site with instrumentation made available by the customer. Training in BSW training facilities is available upon request. Please get in contact with us for further details.

Please contact:

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Customer-specific training program:

BSW offers you the possibility to compose your own, customer-specific training or course. Usually this can start off by taking any of the standard courses and deleting certain modules or adding modules from other courses. E.g. training on programming your Network Analyzer for various device characterization tasks, consists of modules from the NWA courses and the Lab.-automation training.

In most case of a customer-specific training program, build upon standard modules, the standard pricing policy is still valid.

Non-standard courses:

Prices of non-standard courses are highly dependent on actual content of the training, course or seminar. Especially with a seminar, it also highly depends on the cooperation of the technical staff. Pricing is based upon our standard consulting fee. Just tell us your needs and we, together, will setup a program and offer it for a fair price.