Semiconductor Teaching Lab Solution: Basic Design and Measurement

Ready-to-Teach Labs for Semiconductor Basic Design and Measurement

Introduction

The Semiconductor Teaching Lab Solution is a comprehensive, hands-on educational platform designed to bridge the gap between theory and practical skills in semiconductor engineering. It equips students with foundational and advanced knowledge in semiconductor device characterization, and mixer and amplifier design using industry-standard tools such as Keysight's B2902C Source/Measure Unit (SMU) and the Advanced Design System (ADS) software.

Beyond technical training, the Semiconductor Teaching Lab Solution supports curriculum development, offering ready-to-use lab sheets and structured modules that save educators significant time in course preparation. It also promotes industry readiness by aligning lab activities with real-world engineering workflows, helping students build practical skills that are directly applicable in semiconductor R&D and manufacturing environments. The solution is scalable and adaptable, making it suitable for a wide range of academic institutions and training programs.

KEYSIGHT

Module Overview

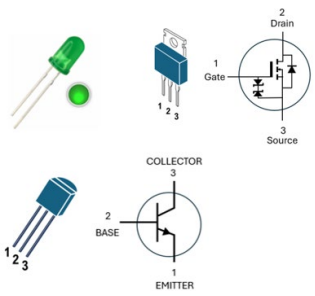
This module provides a structured entry point into the fundamental principles and practices of semiconductor device testing and RF component design and is intended for entry-level undergraduates in electrical and electronics engineering and technical professionals reskilling in IC measurement and RF design.

While prior exposure to basic circuit theory and programming would be advantageous, it is not a prerequisite for this module. The curriculum merges theoretical understanding with hands-on application and covers:

- **Parametric test**: Measure LEDs, BJTs, and MOSFETs using a precision SMU with test automation engine and charting functions.
- **Block-level design and validation**: Progress to a low-power active mixer and a FET-based amplifier. Select device models, build bias networks, perform DC and AC sweeps, run harmonic balance, noise, and stability analyses, create matching networks with Smith Chart utilities, and compare performance to goals. These steps mirror design verification and design-for-test thinking emphasized in industry.

Digital Learning Suite

B2902C



LED, BJT, and MOSFET

Lab sheets

Figure 1. Measurement setup

ADS software

Lab sheets

Figure 2. Design and simulation setup

Learning Outcomes

Through these three lab exercises, students gain hands-on experience in semiconductor device characterization, mixer and amplifier design using industry-standard tools like the **Keysight ADS**, **B2902C Source/Measure Unit (SMU)**, and the **Digital Learning Suite (DLS)**. These labs are designed to build foundational and advanced skills in electronic design, simulation, and analysis, preparing students for real-world applications in electronics and RF engineering.

- **Measure and analyze devices:** Perform current-voltage (I-V) sweeps on LEDs, generate Gummel plots for BJTs, and capture output characteristics of MOSFETs using a precision SMU and automated test plans. Visualize and interpret measurement data to extract key device parameters.
- **Design and bias RF building blocks:** Implement a low-power, single-transistor active mixer, including bias-network design and conversion-gain analysis.
- **Create and validate amplifiers:** Design a small-signal FET amplifier and conduct DC and AC simulations. Perform stability analysis and synthesize matching networks using Smith Chart tools. Execute parametric sweeps and optimization routines to refine performance.
- **Apply engineering workflows:** Set goals, build data sets, document results, and iterate based on empirical evidence. Align design and validation activities with industry-standard verification and test practices.

Lab Contents

Lab Sheet	Title	Focus Topics
1	Basic Semiconductor Devices and Measurements	• LED IV curve measurement • Gummel plot of BJT • Output characteristic measurement of MOSFET
2	Low-Power Single-Transistor Active Mixer Design	• Active mixer design • Biasing network • Matching network • Compression point • Conversion gain
3	Amplifier Design Based on FET	• FET amplifier design • Amplifier gain • Noise consideration • Matching network • Stability analysis • Performance optimization

Recommended Full Module Setup

Item	Description
Software	• Keysight Digital Learning Suite (DLS)[1] • Advanced Design System (ADS)[2]
Bench instruments	• B2902C Source/Measure Unit (SMU)
PC[3]	• Windows-based engineering lab PCs
DUT[3]	• 2SK3736 Silicon N-channel MOSFET • 2N3904 NPN Silicon BJT
Lab sheets	• Lab 1: Basic Semiconductor Devices and Measurements • Lab 2: Low-Power Single-Transistor Active Mixer Design • Lab 3: Amplifier Design Based on FET

1. DLS is used in Lab 1.
2. ADS is used in Lab 2 and Lab 3.
3. Keysight does not provide PCs or DUTs for this module.

Ordering Information

Product Number	Description
Basic Design and Measurement	
UU101LAB	Basic Design and Measurement
Software	
PW9300EDU	Hybrid collaborative learning module
KS8400EDU	Test sequencing & control module
E8900PX[1]	ADS Premier University subscription license
W2130UU[2]	EEsof university all-inclusive donation subscription license

1. Only applicable in the US. For all other regions, contact your local Keysight representative.
2. Only applicable in Europe. For all other regions, contact your local Keysight representative.

Conclusion

The Keysight Semiconductor Teaching Lab Solution closes the gap between theory and practice. Students engage in hands-on measurement of real devices, design RF building blocks, and present results in a clear, repeatable format aligned with standard laboratory practices. Using Keysight precision SMUs, the Digital Learning Suite, and ADS software, they are also provided with the opportunity to follow industry-relevant workflows, from I-V characterization to RF component design.

Adopt the Semiconductor Teaching Lab Solution to accelerate skill development, improve lab throughput, and deliver outcomes from the very first week.

For sample materials, alignment support, and ordering information, contact your Keysight representative or visit keysight.com.