

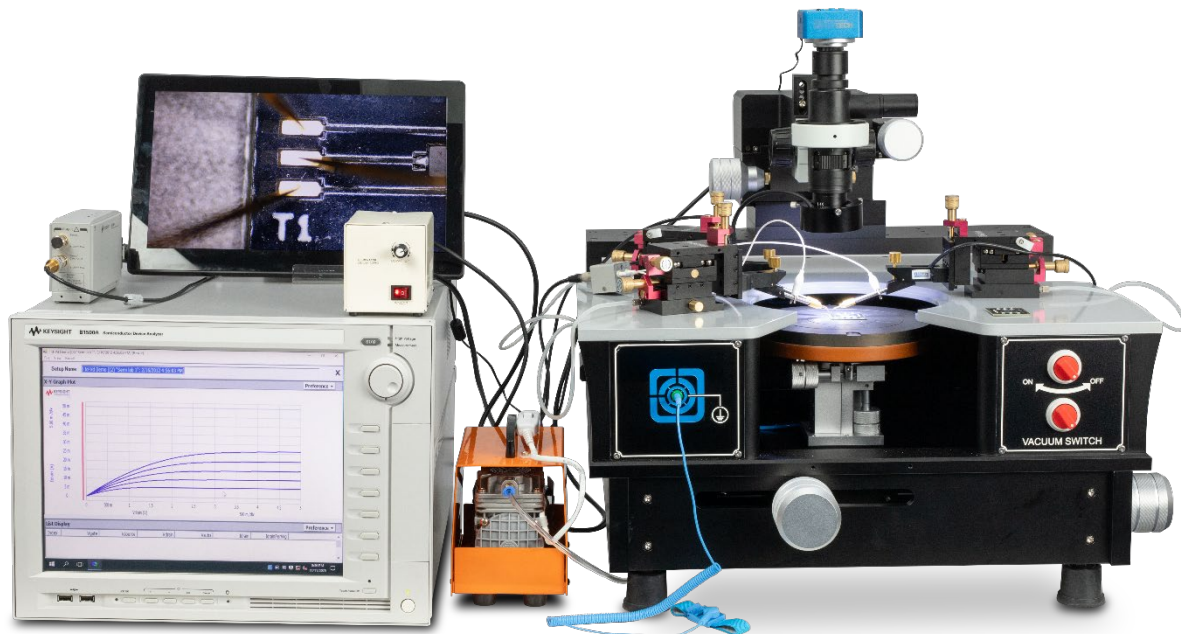
Semiconductor Teaching Lab Solution: Parametric Test and On-Wafer Measurement

Empowering Semiconductor Education with a Ready-to-Teach Semiconductor Device Characterization Lab Solution

Introduction

The UU102LAB Parametric Test and On-Wafer Measurement Teaching Lab provides hands-on training in essential semiconductor parametric testing and on-wafer measurement using Industry-recognized equipment and methodologies.

Designed to help universities strengthen workforce readiness, this solution merges academic theory with real-world semiconductor engineering practices, equipping students with practical skills in parametric testing, on-wafer probing, and advanced measurement techniques.



Module Overview

This module provides practical semiconductor device characterization training using enterprise-class parametric and on-wafer measurement tools, equipping students with competencies in system setup, device testing, and data analysis, ensuring alignment with current semiconductor workforce requirements.

Target University Subjects	Target Year of Study	Prerequisites
Semiconductor physics	Undergraduate/Postgraduate	MOSFET fundamentals
Device characterization		Electrical measurement concepts
Advanced CMOS technology		
Electrical engineering labs		

Learning Outcomes

Through these lab exercises, students will demonstrate competency in semiconductor characterization techniques, system operation, and data analysis with the Keysight B1500A Parameter Analyzer and probe stations.

System Setup and Software Operation

- **Set up and use testing equipment:** Properly set up the B1500A parameter analyzer, use a probe station (MSTECH 8500CL), and specialized modules including the SCUU and ASU.
- **Connect DUT pads:** Acquire skills to connect Device Under Test (DUT) pads with the B1500A using the probe station.
- **Operate EasyEXPERT software:** Gain proficiency in recalling tests and utilizing basic functions within EasyEXPERT (Desktop or B1500A native software).
- **Analyze measurement results:** Analyze measurement results using EasyEXPERT tools, including marker placement and automatic analysis functions.

Core I/V and V_{th} Characterization

- **Perform I/V tests:** Execute I_d - V_d tests using the EasyEXPERT Application Test mode.
- **Evaluate I/V curves:** Analyze I_d - V_d curves and identify MOSFET operating regions: cutoff, linear (ohmic), and saturation (active).
- **Execute an I/V sweep:** Define and execute a custom I_d - V_g sweep using the Classic Test mode.

- **Extract threshold voltage (V_{th}):** Become familiar with methods to extract V_{th} , including using tangent line analysis in Classic Test and regression analysis in Tracer Test mode.

Advanced Measurement and Optimization

- **C–V measurement:** Conduct C–V measurement by using the SMU CMU Unify Unit (SCUU) to efficiently integrate I/V and C–V measurement setups.
- **Compensate for errors:** Use calibration procedures (Open, Short, Phase) to identify and compensate for common error sources in C–V measurement.
- **Ultra-low current optimization:** Configure the B1500A system for low-current characterization (e.g., using ASU) and perform **zero cancel and self-calibration** to reduce noise.
- **Confirm noise floor:** Verify the system noise floor through I/V–t sampling and assess current resolution and leakage.
- **Dynamic and pulsed testing:** Use the I/V–t Classic Test mode for sampling-based measurements. Apply hold and base hold timing to isolate stable regions within a pulse.
- **Minimize device self-heating:** Implement pulse sourcing techniques in Tracer Test mode to reduce device heating during high-current or extended measurements.

Benefits of the Parametric Test and On-Wafer Measurement Lab

This solution, which combines advanced instrumentation with structured lab exercises, offers the following benefits:

- **Industry-standard equipment:** Provides hands-on experience utilizing complex, industry-grade parametric test equipment (Keysight B1500A, HRSMUs, MPSMU, MFCMU, Probe Station).
- **Comprehensive characterization:** Enables characterization of fundamental MOSFET parameters (I/V, V_{th} , C–V) as well as ultra-low current and sampling measurement.
- **Efficient I/V and C–V integration:** The use of the SCUU eliminates the traditional dilemma of switching between triaxial (DC/I/V) and coaxial (AC/C–V) connections, ensuring low leakage and stable measurements.
- **Flexible software environment:** Utilizes EasyEXPERT, offering pre-configured **Application Tests** for routine tasks, flexible **Classic Test** mode for custom R&D or educational measurements, and the quick, graphical **Tracer Test** for interactive probing and real-time visualization.
- **Optimized low-current accuracy:** Includes specific procedures for noise mitigation, such as zero cancel, self-calibration, and utilization of triaxial cables and the ASU for enhanced current sensitivity.

Lab Content

The course includes seven (7) distinct lab sheets covering characterization principles.

Lab ¹	Title	Focus Area	Lab Time (Approx)
Lab 1	Hardware Setup and Software Basic	System configuration (B1500A, probe station ² , SCUU, ASU) and fundamental EasyEXPERT operation (recalling/analyzing results).	3 hours
Lab 2	Id-Vd Application Test	MOSFET I/V characteristics, performing Id-Vd sweeps, and identifying operating regions (cutoff, linear, saturation).	1 hour
Lab 3	Vth Measurement in Classic Test	Utilizing Classic Test mode for flexible setups, performing Id-Vg sweeps, and extracting threshold voltage (Vth) using tangent line analysis.	2 hours
Lab 4	C-V Measurement	C-V measurement principles, channel configuration, integrating I/V and C-V setups using SCUU, and performing calibration (Phase, Open, Short).	2.5 hours
Lab 5	Ultra-Low Current Measurement	System setup for low current (ASU/HRSMU), performing zero cancel, verifying noise floor via I/V-t sampling, and assessing current resolution.	2.5 hours
Lab 6	Sampling Measurement	Understanding timing in pulsed I/V tests, using I/V-t Classic Test for dynamic analysis, applying hold/base hold timing, and analyzing transient behavior.	1 hour
Lab 7	Id-Vg Tracer Test	Using Tracer Test mode for quick, interactive characterization, implementing pulse sourcing for self-heating reduction, setting stop conditions, and Vth extraction via regression.	1 hour

1. All lab sheets are provided in editable Microsoft Word formatted files.

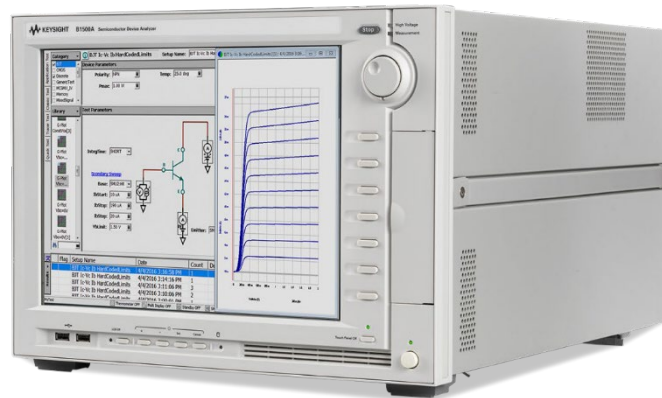
2. Keysight recommends the **MSTech MST8500CL** probe station. Alternative probe stations may be used; however, users are responsible for updating Lab 1 content accordingly.

Required Equipment, Software, and Accessories

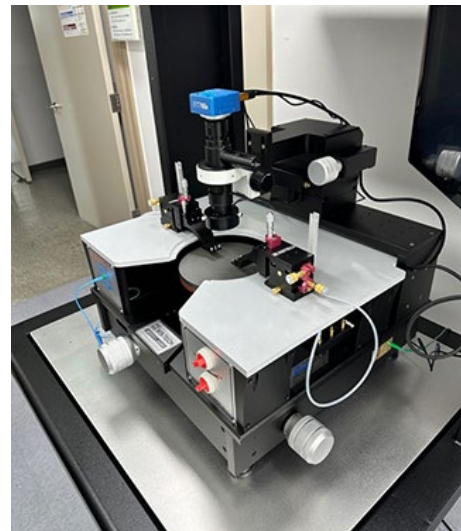
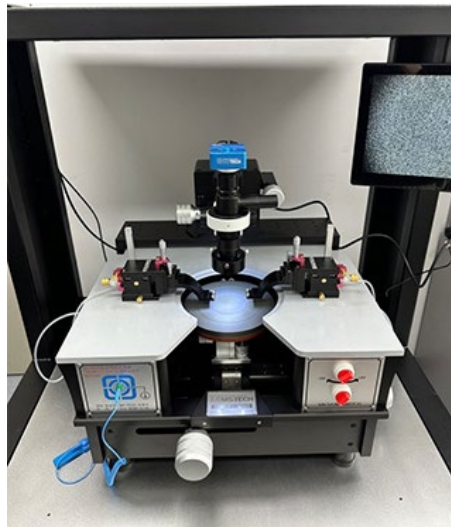
The following are the core system components utilized throughout the lab modules.

Hardware

Equipment	Model
Parameter analyzer	Keysight B1500A



Probe station*	MSTECH 8500CL
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*All images are for reference only, and details may vary based on the device and configuration.

B1500A Configuration Requirements

Item	Description	Qty	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Lab 6	Lab 7
B1500A	Semiconductor device analyzer mainframe	1	✓	✓	✓	✓	✓	✓	✓
B1500A-030	3 m cable length	1	✓	✓	✓	✓	✓	✓	✓
B1500A-050/ B1500A-060	50 Hz/60 Hz power line frequency	1	✓	✓	✓	✓	✓	✓	✓
B1500A-A00	Standard Pack 0 – Empty package for custom solution (No modules)	1	✓	✓	✓	✓	✓	✓	✓
B1500A-A20	Add-on package – Capacitance measurement unit (B1520A) (1 ea.), cable (1 ea.)	1	✓			✓			
B1500A-A11	Add-on package – Mid power source monitor unit (B1511B) (1 ea.), cables	1	✓	✓	✓	✓	✓	✓	✓
B1500A-A17	Add-on package – High-resolution source monitor unit (B1517A) (1 ea.), cables	2	✓	✓	✓	✓	✓	✓	✓
B1500A-A28	Add-on package – Atto Sense Unit (1 ea.) for High Resolution Source Monitor Unit	1	✓				✓		
N1301A-100	SMU CMU Unify Unit (SCUU)	1	For IV/CV switch and triaxial connection	✓	✓	✓	✓	✓	✓
N1301A-200	Guard Switch Unit (GSWU)	1		✓	✓	✓	✓	✓	✓
N1301A-202	GSWU cable (3 m)	1		✓	✓	✓	✓	✓	✓

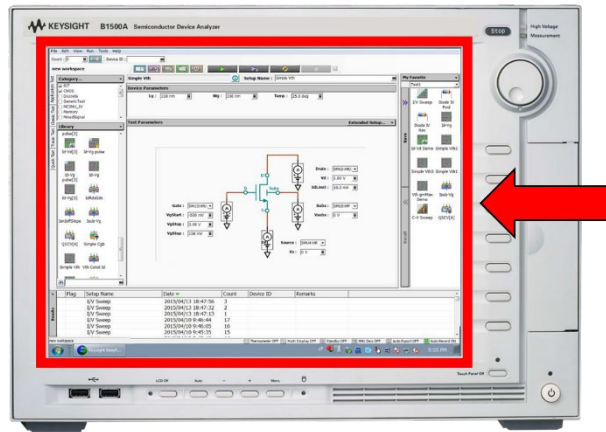
Software

Software

Description

EasyEXPERT

Installed on the Keysight B1500A



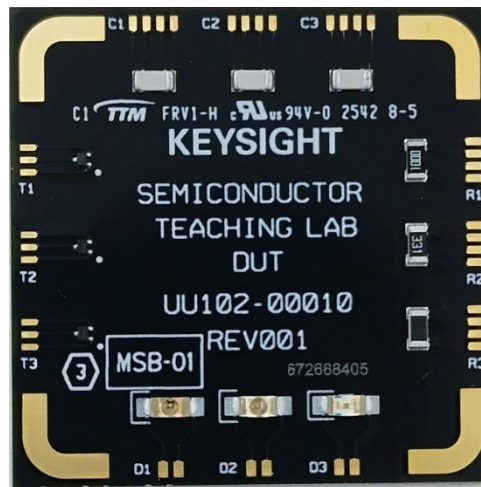
Accessories

Equipment

Model

Device Under Test (DUT)

UU102LAB-DUT Keysight Semiconductor Teaching Lab DUT

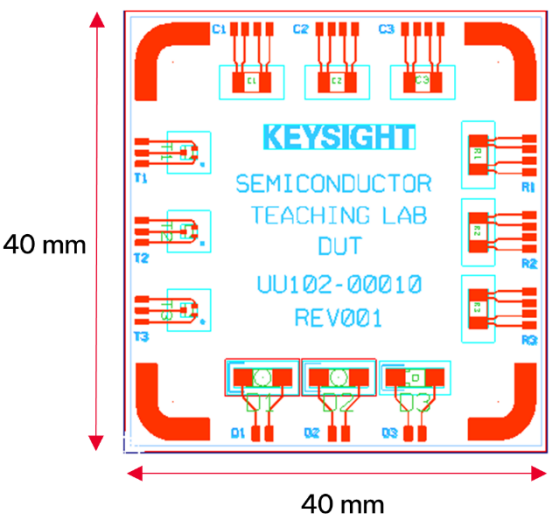


ESD SENSITIVE DEVICE

Handle with care. To prevent damage, discharge static electricity from your body before touching this component.

Features

- Dimensions: 40 mm x 40 mm x 1.2 mm



- Double layer PCBA board.
- Components:

Type	Specification
Capacitor	• C1 – 56 pF • C2 – 100 pF • C3 – 330 pF
Resistor	• R1 – 100 Ω • R2 – 330 Ω • R3 – 1k Ω
LED	• D1 – Red • D2 – Green • D3 – Blue
N-channel MOSFET (T1, T2, T3)	

Applications

- A Device Under Test (DUT) for the Parametric Test and On-Wafer Measurement Teaching Lab solution.
- A lower cost DUT in replacement of a real semiconductor wafer for teaching in the universities.

Regulatory Compliance

Regulatory Markings



The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.



The UKCA (UK Conformity Assessed) marking is a UK product marking that is used for goods being placed on the market in Great Britain (England, Wales, and Scotland)



This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use.

Forty years is the expected useful life of the product.

Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU

The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.



Please refer to [keysight.com/go/takeback](https://www.keysight.com/go/takeback) to understand your Trade in options with Keysight in addition to product takeback instructions.

Ordering Information

Product Number	Description
UU102LAB	Parametric Test and On-Wafer Measurement Teaching Lab - B1500A Semiconductor device parameter analyzer - UU102LAB-DUT Semiconductor teaching lab DUT - UU102-90002 Lab sheet
Optional (Recommended)	
MS tech probe station ¹	

1. Keysight recommends the **MSTech MST8500CL** probe station. Alternative probe stations may be used; however, users are responsible for updating Lab 1 content accordingly.

Conclusion

The UU102LAB Parametric Test and On-Wafer Measurement Teaching Lab provides universities with a comprehensive, ready-to-teach solution that blends theoretical semiconductor education with practical, industry-relevant skills. By combining Keysight's B1500A Parameter Analyzer, EasyEXPERT software, and structured hands-on lab exercises, this solution enables students to build real-world competencies in device characterization, low-current measurement techniques, C-V analysis, and on-wafer probing workflows.

Focused on essential semiconductor measurement methodologies and system-level operation, the UU102LAB empowers educators to deliver high-impact experiential learning while preparing students to meet the growing demands of the global semiconductor workforce.

For sample materials, alignment support, and ordering information, contact your Keysight representative or visit [keysight.com](https://www.keysight.com).



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