

Semiconductor Parameter Analyzer

Self-paced Training Manual



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E0598

Caution

The programs and setup files described in this manual and stored in the Demo Disk are only examples.

You may need to modify these programs and setup files for your own application. If these example programs damage your devices, Hewlett-Packard is *NOT LIABLE* for the damage.

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In This Manual

This document is the self-paced training manual to help you to understand what is the HP 4155B/4156B, what functions the HP 4155B/4156B has, how to use the HP 4155B/4156B, and what applications the HP 4155B/4156B contributes to.

- **Module 1. Overview**

This module explains the product concept, product configuration, and the key specifications. You will learn about what is the HP 4155B/4156B.

- **Module 2. Basic Concepts**

This module explains the basic I-V sweep measurement function and the cabling and fixturing issues. You will learn how to measure I-V curves in the course exercises.

- **Module 3. Low Current Measurement**

This module explains the low current measurement technique. You will learn how to measure the low current in the course exercises.

- **Module 4. New Feature**

This module explains the new functions available with the HP 4155B/4156B, and not available with the HP 4145 Parameter Analyzer. You will learn how to use the new functions in the course exercises.

- **Module 5. Time Measurement**

This module explains how to do the time measurement in the sweep measurement mode, not in the sampling measurement mode. You will learn how to do the JEDEC V-Ramp measurement in the course exercise.

- **Module 6. Stress Measurement**

This module explains the stress function. In the course exercise, you will learn how to do the flash memory lifetime test, and the charge pumping method which is used for the MOS device reliability test.

- **Module 7. Printing and Plotting**

This module explains the print/plot function of the HP 4155B/4156B. You will learn how to make hardcopies of the HP 4155B/4156B screen.

- **Module 8. File Management and Help**

This module explains the filer function and the help function. You will learn how to use these functions.

- **Module 9. Programming**

This module provides the information to create the measurement program to control the HP 4155B/4156B via HP-IB, or using the built-in HP IBASIC controller.

- **Module 10. *VXIplug&play* Driver**

This module provides the information to create the measurement program to control the HP 4155B/4156B using the *VXIplug&play* driver. Programming examples use the HP VEE.

- **Module 11. Software Support**

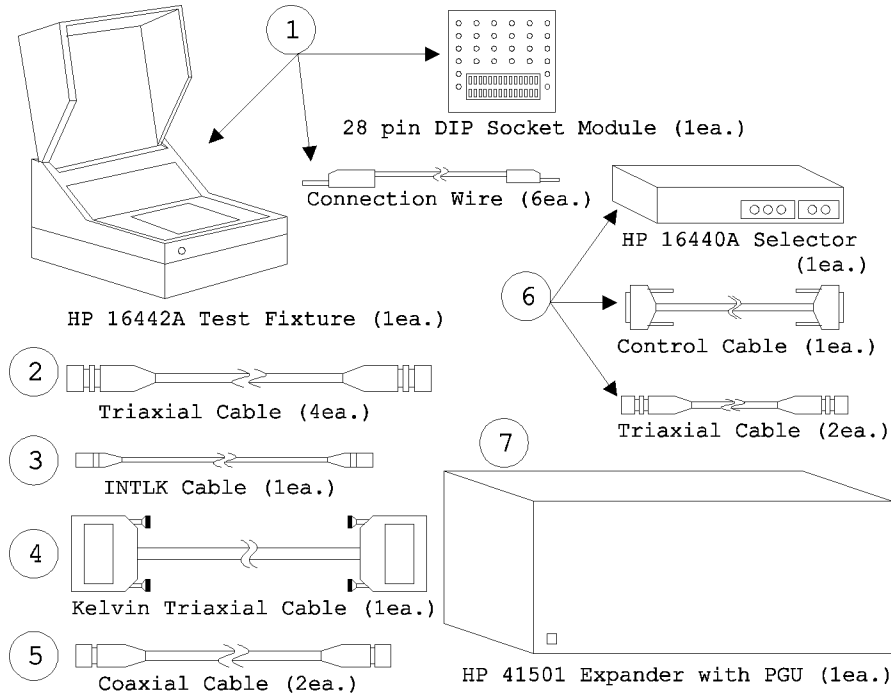
This module just introduces the software packages useful for the automatic measurement, characterization and analysis.

- **Module 12. Prober Connection**

This module provides how to connect the HP 4155B/4156B to a prober.

Accessories Required.

You need the following accessories to do the class exercises in this text book. Prepare the accessories shown below. Kelvin triaxial cable (4) is needed if you use both HP 4156B and HP 16442A, and to do the Re measurement exercise. Coaxial cables (5) are required for the DVM Mode, Flash EEPROM, and Charge Pumping exercises. Selector (6) is only for the Flash EEPROM exercise. And the Expander (7) is required to do the Flash EEPROM and the Charge Pumping exercises.



Designation	Description	Model No.	Qty.
1	Test Fixture with 28 pin socket module/wire(6ea.)	HP 16442A ¹	1 ea.
2	Triaxial Cable ²	HP 16493C	4 ea.
3	Interlock Cable ³	HP 16493J	1 ea.
4	Kelvin Triaxial Cable ⁴ for HP 4156B/16442A	HP 16493K	1 ea.
5	Coaxial Cable ³	HP 16493B	2 ea.
6	Selector with control cable/triaxial cables(2ea.)	HP 16440A	1 ea.
7	Expander with PGU	HP 41501A/B	1 ea.

1 HP 16058A Test Fixture for HP 4145A/B may be substituted for the HP 16442A Test Fixture. If you use the HP 16058A, you also need HP 16435A Interlock Adapter.

2 Furnished with HP 4155B.

3 Furnished with HP 4155B/4156B.

4 Furnished with HP 4156B without option 010. Two triaxial cables may be substituted for the Kelvin cable.

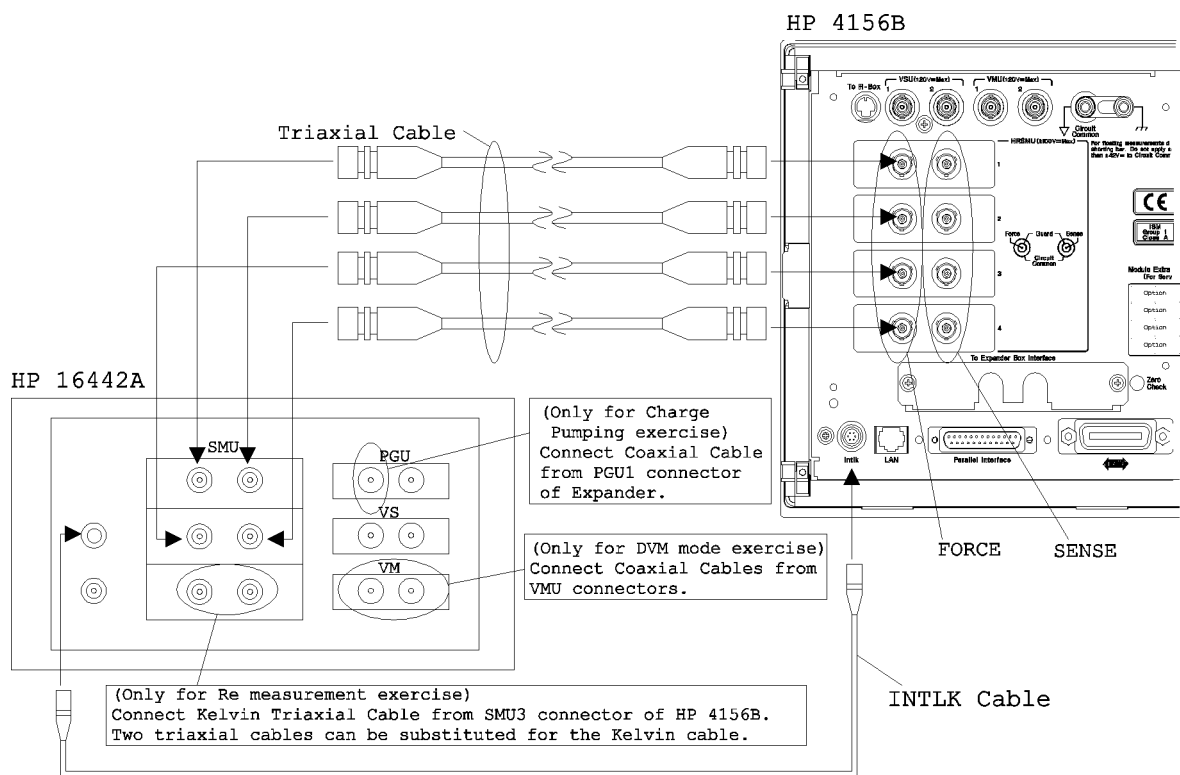
Note



For the class exercises in Module 10 *VXIplug&play Driver*, you need a Windows based PC with the HP-IB interface card, HP VEE software, HP-IB cable and so on. To do the exercises, prepare the required environment shown in Module 10.

Measurement Cable Connections for Class Exercises.

The following figure shows the measurement cable connections between the HP 4156B and the HP 16442A fixture. Figure below is the typical setup for class exercises. You may change the setup in every exercise. For the proper setup, confirm the connections explained in each exercise.

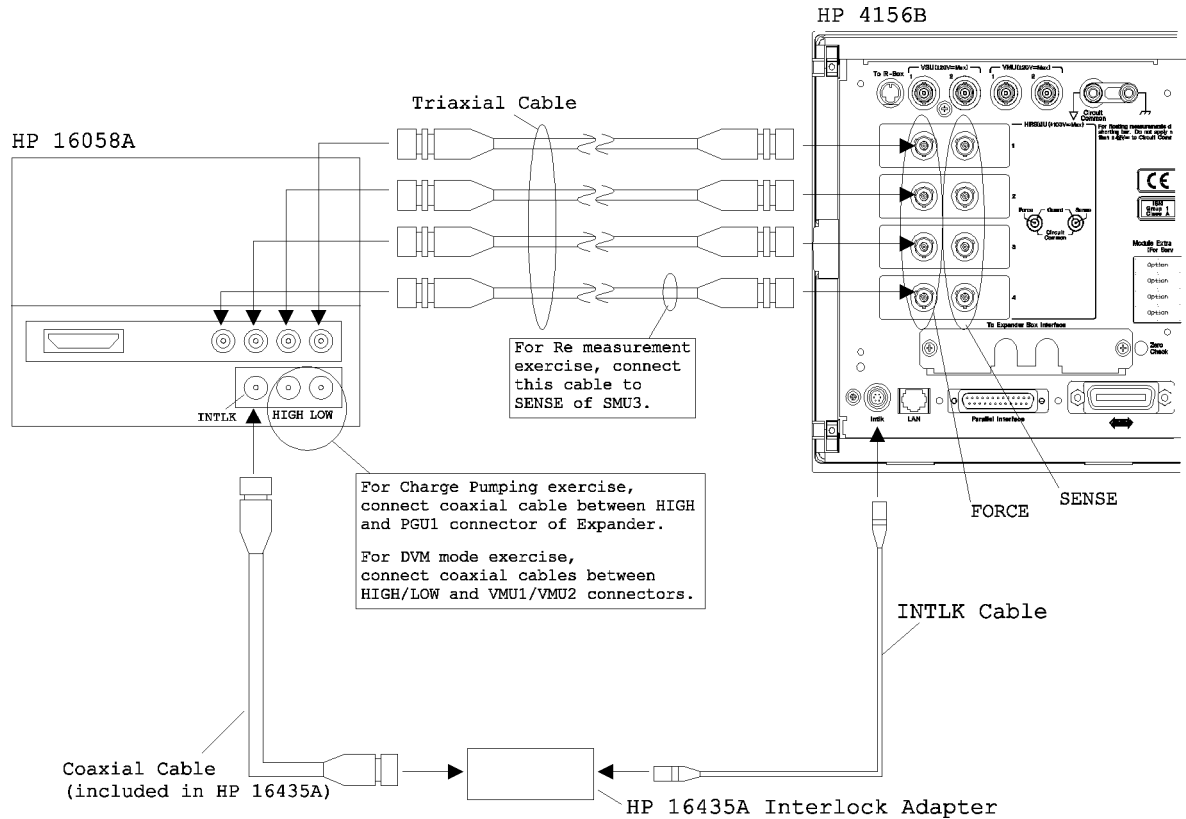


Note



If you use the HP 4155B, ignore the SENSE terminals on the figure.

If the HP 16442A Test Fixture is not available, you can use the HP 16058A which is the test fixture for the HP 4145A/B Semiconductor Parameter Analyzer. The following figure shows the cable connections between the HP 4156B and the HP 16058A fixture. Figure below is the typical setup for class exercises. You may change the setup in every exercise. For the proper setup, confirm the connections explained in each exercise.



Note

If you use the HP 4155B, ignore the SENSE terminals on the figure.

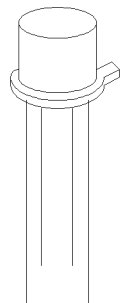


Furnished Accessories.

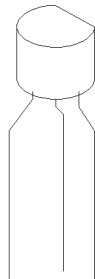
You will see the class exercise pages in the most modules, and you will use the demo disk and devices listed below.

- Demo Disk
- Devices for exercises

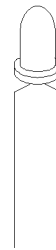
Description	HP part number	Qty.
N-channel MOSFET	1855-0723	2 ea.
NPN Bipolar Transistor	1854-0215	1 ea.
Red Miniature LED	1990-0486	1 ea.
0.1 μ F Capacitor 50 V	0160-4835	1 ea.
1.0 Ω Resistor 1/8 W	0698-8812	1 ea.
1.1 k Ω Resistor 1/8 W	0757-0424	1 ea.
511 k Ω Resistor 1/8 W	0698-8958	1 ea.



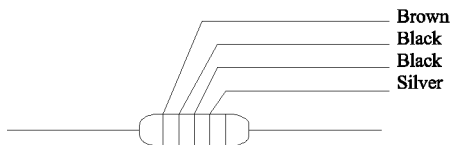
N-ch MOSFET



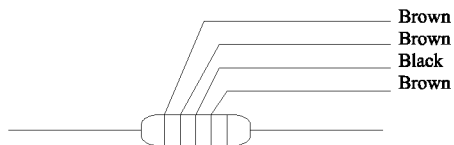
NPN bipolar Transistor



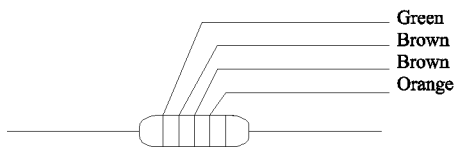
LED



1 ohm Resistor



1.1 kohm Resistor



511 kohm Resistor



0.1 uF Capacitor

Contents of Demo Disk.

The following files are stored in the demo disk. The all files are just example for the exercises in this manual. The following table lists the file name in alphabetical order.

File Name	Description	Page
CHP.ASC	Square Pulse Charge Pumping demo result data	6-50
CHP.DAT	Square Pulse Charge Pumping setup with data	6-50
CHP.MES	Square Pulse Charge Pumping setup	6-50
CPDIST3	Trapezoidal Charge Pumping program (HP IBASIC)	6-56
CPF3	Triangle Charge Pumping program (HP IBASIC)	6-56
CPFD.ASC	Trapezoidal Charge Pumping demo result data	6-56
CPFD.DAT	Trapezoidal Charge Pumping setup with data	6-56
CPF.ASC	Triangle Charge Pumping demo result data	6-56
CPF.DAT	Triangle Charge Pumping setup with data	6-56
CPV5	Square Pulse Charge Pumping program (HP IBASIC)	6-50
CPV.DAT	Charge Pumping (using VAR1' sweep) setup with data	6-57
DFET.VEE	A couple of MOSFETs Id-Vg measurement program (HP VEE)	10-41
FDEMO	Flash EEPROM demo program (HP IBASIC)	6-36
FERS.STR	Flash EEPROM demo erase stress setup	6-36
FLASH.DAT	Flash EEPROM demo result data	6-29
FVTHE.MES	Flash EEPROM demo erase Vth measurement setup	6-36
FVTHW.MES	Flash EEPROM demo write Vth measurement setup	6-36
FWRT.STR	Flash EEPROM demo write stress setup	6-36
GM.DAT	MOSFET GM measurement setup with data	4-38
GUMMEL.DAT	Bipolar Tr Gummel plot measurement setup with data	3-23
HCIVT.DAT	HCI demo result data	6-26
IDVD.DAT	MOSFET Id-Vd measurement setup with data	2-7,4-6,4-17, 4-30,4-48
IDVG.DAT	MOSFET Id-Vg measurement setup with data	3-16
LATCHUP	Latchup demo program (HP IBASIC)	9-39
MULTI.VEE	MOSFET Id, R, C measurement program (HP VEE)	10-44
PMSHOT	MOSFET Id spot measurement program using program memory (HP IBASIC)	9-58
REKELV.DAT	Bipolar Tr Re measurement setup with data	2-36
RMEAS.VEE	Resistance measurement program (HP VEE)	10-31

File Name	Description	Page
SETUP.MES	Triangle/Trapezoidal Charge Pumping setup	6-56
SMOS.DAT	Manual Stress/Measurement demo setup with data	6-9
SMOS.STR	Manual Stress/Measurement demo stress setup	6-9
SMPTH.DAT	Thinned-out sampling measurement demo setup with data	4-54
SPOTID	MOSFET Id spot measurement program (HP IBASIC)	9-58
SWP.VEE	MOSFET Id-Vg measurement program (HP VEE)	10-35
VRDEMO	V-Ramp demo program (HP IBASIC)	5-23
VRDS.MES	V-Ramp demo initial spot measurement setup	5-23
VRDW.MES	V-Ramp demo sweep measurement setup	5-23
VRSWEP.DAT	Time plot demo setup with data	5-26
VTH	MOSFET Vth measurement program (HP IBASIC)	9-26

Caution



The programs and setup files stored in the Demo Disk are only examples.

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Note



You should copy contents of the Demo Disk to a diskette that you will use as your working diskette. You can modify setup files by remote programming or interactively by front-panel keys.

Class Exercises.

This manual contains the following exercises. And exercises use the devices and the demo data files shown below. The demo files are stored in the Demo Disk.

Module	Exercise	Device	Demo File	Page
Module 1	no exercise	—	—	—
Module 2	Id-Vd measurement	MOSFET	IDVD.DAT	2-7
	Re measurement (only for HP 4156B)	Bipolar Tr	REKELV.DAT	2-36
Module 3	Zero check	—	—	3-8
	Subthreshold measurement	MOSFET	IDVG.DAT	3-16
	Gummel plot	Bipolar Tr	GUMMEL.DAT	3-23
Module 4	Standby Mode	MOSFET and LED	IDVD.DAT	4-6
	SMU Pulse Mode	MOSFET	IDVD.DAT	4-17
	Knob Sweep	MOSFET	IDVD.DAT	4-30
	Auto Analysis	MOSFET	GM.DAT	4-38
	Graphics Overlay	MOSFET	IDVD.DAT	4-48
	Thinned-Out Sampling	0.1 uF and 511 k Ω	SMP TH.DAT	4-54
	DVM Mode	1.0 Ω	—	4-63
Module 5	Time Plot	Bipolar Tr	VRSWEP.DAT	5-12
	V-Ramp	Bipolar Tr	VRDEMO	5-23
			VRDS.MES	
			VRDW.MES	
Module 6	Manual Stress/Measure	MOSFET	SMOS.DAT	6-9
			SMOS.STR	
	Flash EEPROM Test	MOSFET	FDEMO	6-36
			FERS.STR	
			FWRT.STR	
			FVTHE.MES	
			FVTHW.MES	
	Square Pulse Charge Pumping	MOSFET	CPV5	6-50
			CHP.ASC	
			CHP.MES	
			CHP.DAT	

Module	Exercise	Device	Demo File	Page
Module 6	Charge Pumping using VAR1' sweep	MOSFET	CPV.DAT	6-57
Module 7	no exercise	—	—	—
Module 8	Screen Dump HP-GL and TIFF	—	—	8-18
Module 9	ASP-like Programming	MOSFET	—	9-16
	4145 Syntax Programming	MOSFET	VTH	9-26
	SCPI Programming	1.1 k Ω	LATCHUP	9-39
	HP FLEX Programming	MOSFET	SPOTID	9-58
			PMSPOT	
Module 10	Resistance Measurement	511 k Ω	RMEAS.VEE	10-31
	Id-Vg Measurement	MOSFET	SWP.VEE	10-35
Module 11	no exercise	—	—	—
Module 12	no exercise	—	—	—

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