

# HP4145A Semiconductor Parameter Analyzer.

## Introduction:

A semiconductor parameter analyzer (SPA) contains voltage sources, current sources, voltage monitors, and current monitors that can be programmed via a menu-driven user-interface. An SPA is very useful for characterizing semiconductor devices. Possible measurements include, I-V curve of a simple two terminal device, Id-Vds-Vg graphs for mosfets, switching characteristics of logical gates, etc.. Programming of an SPA is simple, can be learned in two hours, and is basically nothing else than filling out two tables. The HP4145 SPA comes with a shielded 16058A test-fixture. This test-fixture can be closed so that highly shielded and dark testing is possible. Socket boards that allow testing of resistors, diodes, transistors, TO-package (8, 10 and 12 pins), and dual in line package (18, 24, and 28 pins) are available. We have three complete setups.

For testing of devices that are not packaged yet, we have the availability over a wafer prober. Bobby Duran has developed a way to connect the wafer prober to a 16058A test-fixture. At the moment it is not possible to export the measurement data to a computer other than taking a picture of the screen or scanning a plotted screen-dump.

## Programmable Sources and Monitors:

The HP4145A contains four SMUs (=Source Monitor Units). Each of these can be programmed to be a voltage source, a current source, or a ground (see Fig.1) by specifying the source mode field (V, I, COM) on the Channel Definition Page (see Fig. 2). If you program it as a current source you will automatically get a voltage monitor for free. If you program it as a voltage source you will automatically get a current monitor for free. No gifts for the ground choice though (see also Fig. 1). Output voltage or output current of each SMU can be held constant or can be swept by specifying the source function field (CONST, VAR1, VAR2) on the Channel Definition Page (see Fig. 2). Output voltage and current, sweep mode (linear or log), start, stop , step , and compliance (maximum current/voltage) are specified on the Source Setup Page (see Fig. 3). In addition to the four SMUs, the HP4145 contains two programmable voltage sources (Vs1, Vs2), and two programmable voltage monitors (Vm1, Vm2) (see Fig. 4). Those

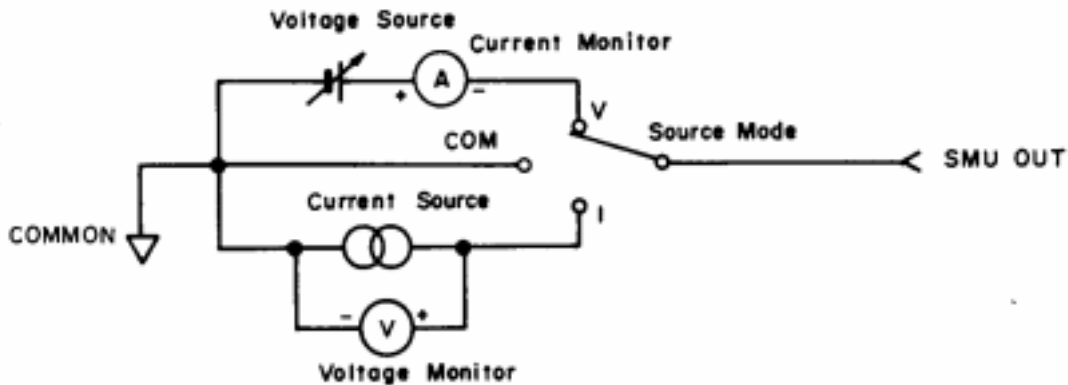


Fig. 1: Source Monitor Unit.

voltage sources and monitors can also be programmed via the Channel Definition Page (see lower part of the top table in Fig. 2) and the Source Setup Page (see the lower table in Fig. 3).

SKP 3

[hp] \*\*\* CHANNEL DEFINITION \*\*\*

CHAN	V	I	MODE	FCTN
SMU1	V1	I1	COM	CONST
SMU2	V2	I2	I	VAR2
SMU3	V3	I3	V	VAR1
SMU4	V4	I4	V	CONST
Vs 1	VS1	-----	V	CONST
Vs 2	VS2	-----	V	CONST
Vm 1	VM1	-----	-----	-----
Vm 2	VM2	-----	-----	-----

USER  
FCTN NAME (UNIT) = EXPRESSION

1			
2			

Fig. 2: Channel Definition Page

SKPI0

[hp] \*\*\*\*\* SOURCE SET UP \*\*\*\*\*

	VAR1	VAR2
NAME	V3	I2
SWEEP MODE	LINEAR	LINEAR
START	. 0000V	20. 00uA
STOP	1. 0000V	-----
STEP	. 0100V	20. 00uA
NO. OF STEP	101	5
COMPLIANCE	100. 0mA	2. 0000V

CONSTANT	SOURCE	COMPLIANCE
V1	COM	. 0000V 100. 0mA
V4	V	. 0000V 100. 0mA
VS1	V	. 0000V -----
VS2	V	. 0000V -----

Fig. 3: Source Definition Page

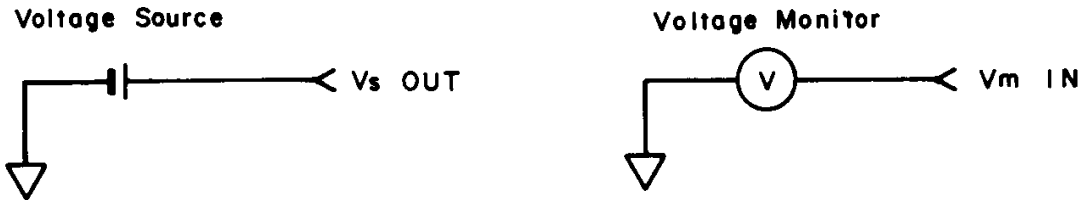


Fig. 4: Programmable voltage source (Vs1, Vs2) and programmable voltage monitor (Vm1, Vm2).

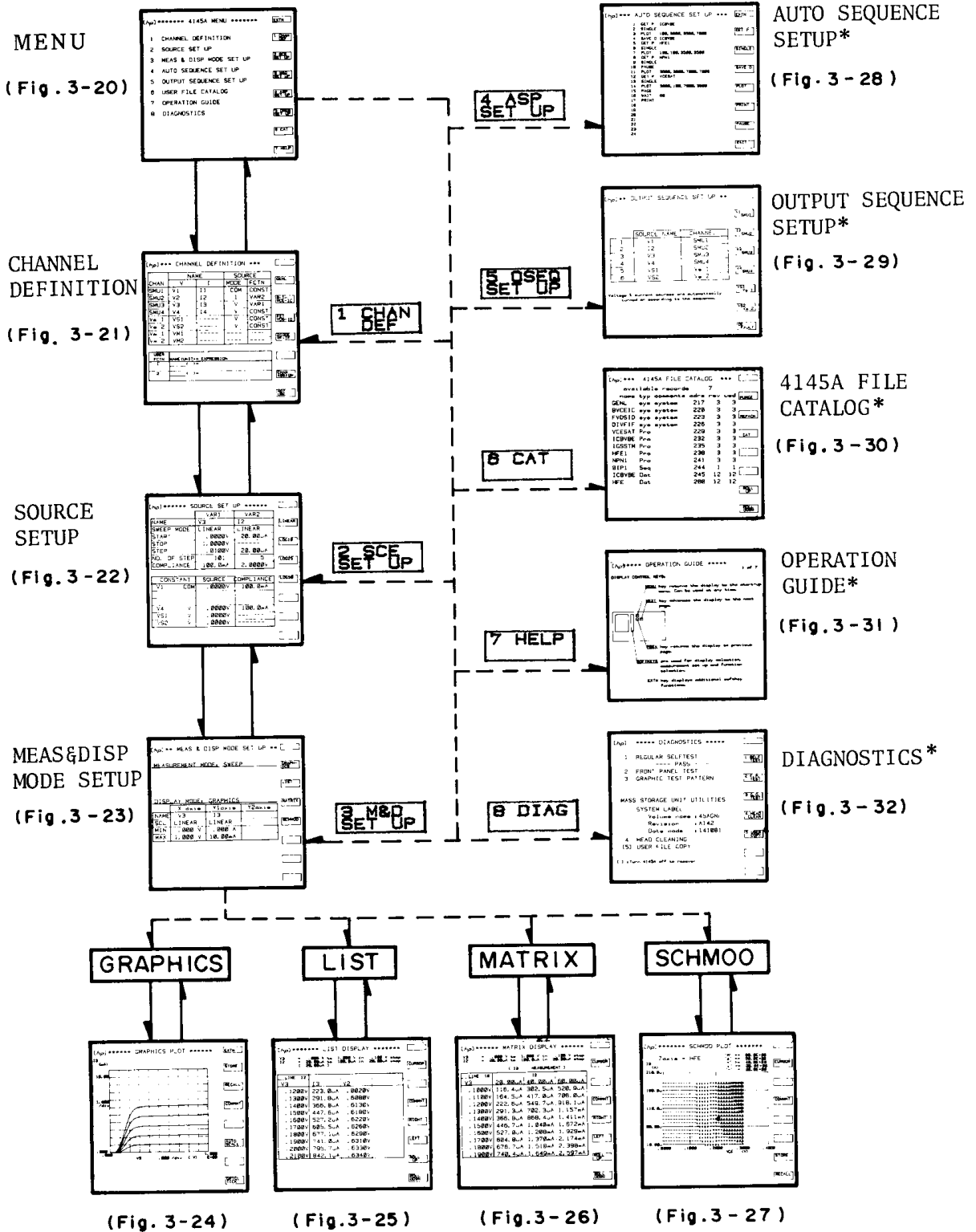
SMU1, SM2, SM3, SM4, Vs1, Vs2, Vm1, and Vm2 are available on the test-fixture. The ground of those programmable devices, i.e. the open arrows in Fig. 1 and 4 are all connected to the ground of the SPA. The cables between the SPA and the test-fixture are triax cables. The inner shield of those is connected to Gd1, Gd2, Gd3, and Gd4 connector of the 16058 text-fixture. Do not confuse these connections with the ground in figures 1 and 4 (see Fig. 3-34 on page 3-79 of the manual). Gd1, Gd2, Gd3, and Gd4 are only used for guarding purposes. For more information see Fig. 3-36 on page 3-82 of the manual.

The easiest way to learn to work with the SPA is to select one of the three standard measurement programs:

- B-Tr Vce-Ic: for measuring a series of Vce-Ic curves of a bipolar transistor.
- Fet Vds-Id: for measuring a series of Vds-Id curves (different Vg) for a FET.
- Diode Vf-If: for measuring the I-V curve of a two-terminal device.

Other measurement programs are available from the floppy (IBM and Mac INCOMPATABLE). Use the Get P command on the auto sequence setup page. The

figure below shows the complete menu structure of the SPA. For more information see manual.



Please find below an example of a program to measure the Id-Vds characteristic of an n-mosfet transistor. The program entered by the

**Channel Definition \*\*\*\*\***

CHAN	NAME		SOURCE	
	V	I	MODE	FUNCTION
SMU1	VS	IS	COM	CONST
SMU2	VDS	ID	V	VAR1
SMU3	VG	IG	V	VAR2
SMU4				
Vs1		-----	V	
Vs2		-----	V	
Vm1		-----	-----	-----
Vm2		-----	-----	-----

User Function	Name (unit) = Expression
1	
2	

**Source set up \*\*\*\*\***

	VAR1	VAR2
Name	VDS	VG
Sweep Mode	LINEAR	LINEAR
Start	0	0
Stop	5	-----
Step	0.05	0.5
Number of steps	101	10
Compliance	20 mA	1 mA

CONSTANT	Source	Compliance
VS COM	0.00V	105 mA

