Low Current Measurement with Agilent E5250A Switch Mainframe

Application Note E5250A-1

Agilent E5250A Low Leakage Switch Mainframe

Introduction

As device geometry scales down, low current must be precisely measured to characterize the new generation semiconductor devices and processes.

This application note introduces Agilent's new solution for precise characterization of multiple semiconductor devices by switching.

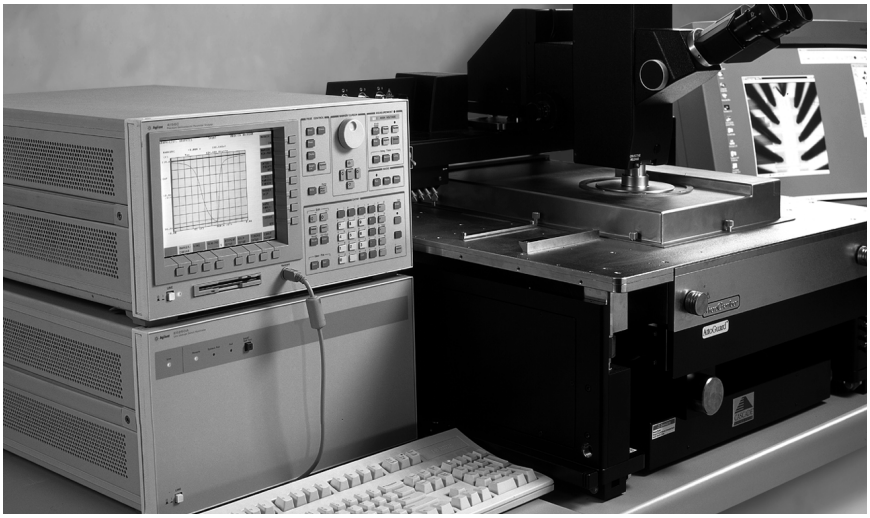
Problems of Today's Semiconductor Evaluation

With the Agilent 4156C Precision Parameter Analyzer, you can measure low current with 1 fA resolution and 20 fA offset. Its unprecedented accuracy and functionality enable you to characterize your sub-micron geometry devices accurately.

To improve productivity, it is required to switch multiple devices to automate test. However, there has been no low cost switching matrix with low enough leakage current to keep the performance of the parameter analyzer.

New System Solution from Agilent

Now you can configure a device characterization system by using the Agilent E5250A Low Leakage Switch Mainframe.



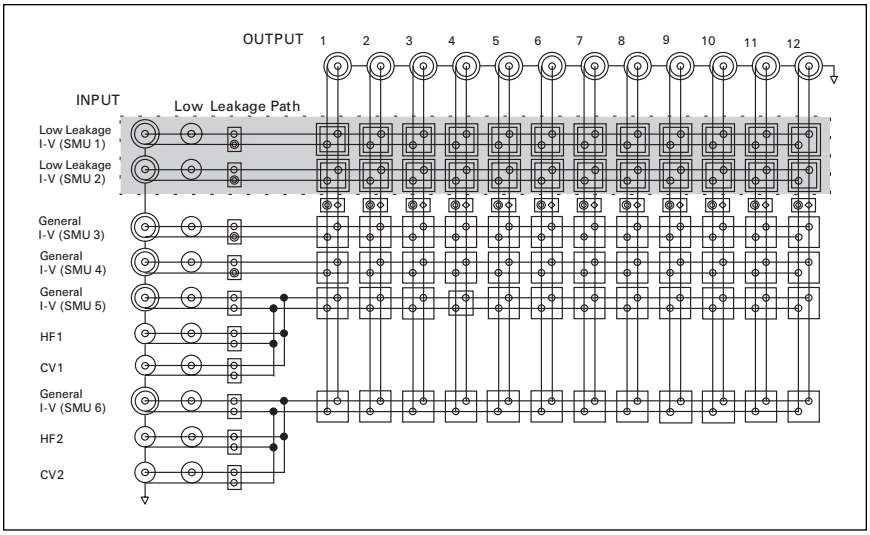


Figure 1. Block diagram of the low leakage switching matrix of the Agilent 5250A

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Figure 1 shows the diagram of the Agilent E5250A Option 001 low leakage switching matrix module. This switching matrix is designed for precise semiconductor device characterization. It has 10 input ports and 12 output ports. The SMU1 and SMU2 ports are specially designed for ultra low current measurement with 100 fA offset and 1.0 E +13 Ω isolation. The two C-V ports are for accurate capacitance measurement with compensation using the Agilent 4284A. The Agilent E5250A has 4 slots for installing matrix modules. You can configure a 10-input and 48-output matrix for measuring a sequence of many devices on a test structure.

The solid line in Figure 2 shows the noise current of the Agilent 4156C plus switching matrix module. The dotted line is the noise current of the Agilent 4156C.

Thus, the switching matrix does not degrade measurement accuracy of the Agilent 4156C. Therefore, you can precisely measure very low current of multiple devices with switching.

Id-Vg Measurement with Switching Matrix

Figure 3 is the connection diagram of n-channel MOSFET Id-Vg measurement using the Agilent 4156C and E5250A. Id-Vg curve is one of the most important characteristics to determine device gain and threshold voltage. Its subthreshold region can also reveal gate oxide or substrate defects. The measurement current in this region is typically in the sub-pA range, though it depends upon device geometry.

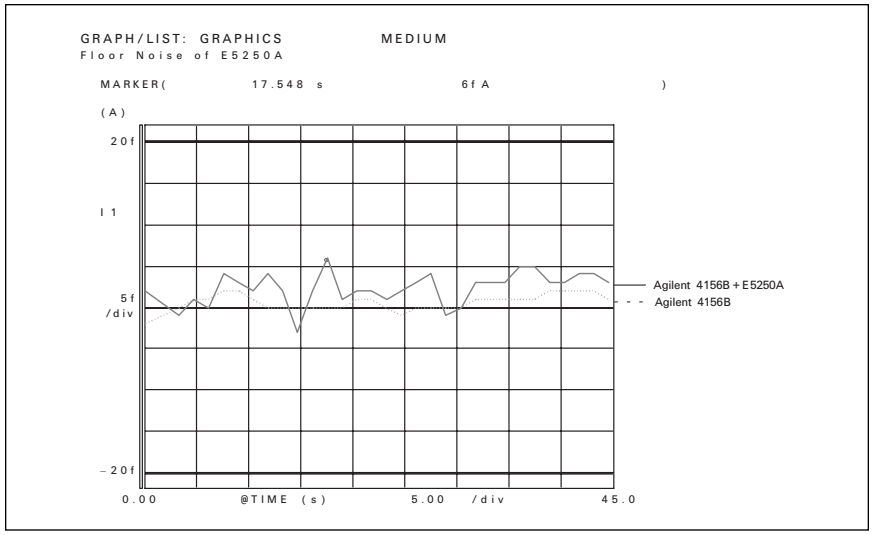

Figure 2. Noise current of the Agilent 4156A and Agilent E5250A

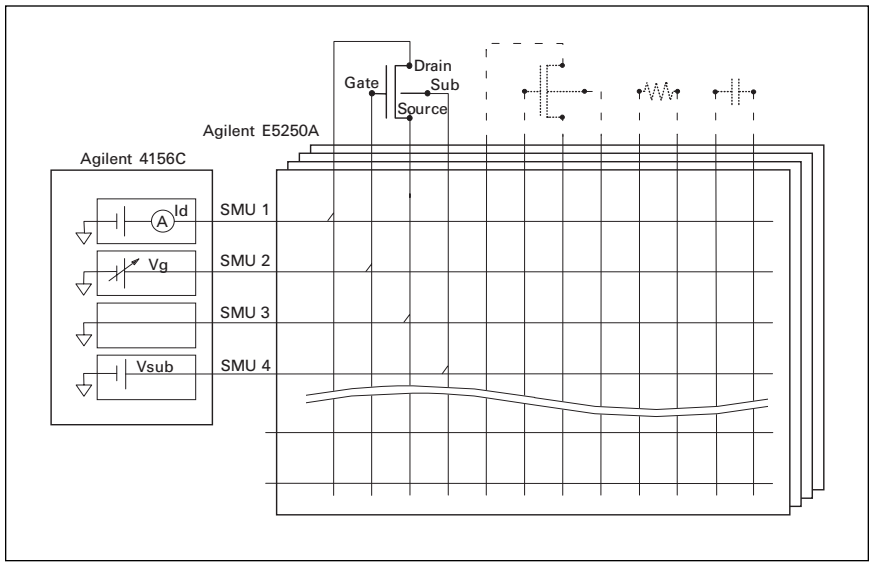

Figure 3. Measurement diagram of the Id-Vg curve of n-channel MOSFET

Figure 4 is an example measurement result obtained by using the Agilent 4156C with a switching matrix module of the Agilent E5250A. You can perform fA level current measurement accurately.

Conclusion

Using the Agilent E5250A, you can expand the one box parametric analyzer to an integrated device characterization system for next generation semiconductor development.

With the multiplexer module option of the Agilent E5250A, you can also configure a long term reliability test system.

In addition, this integrated system can be controlled for maximum productivity and ease-of-use by the Agilent E5230B Interactive Characterization Software (ICS).

Note: The information in this application note referring to the Agilent 4156C also applies to the Agilent 4156A and 4156B.

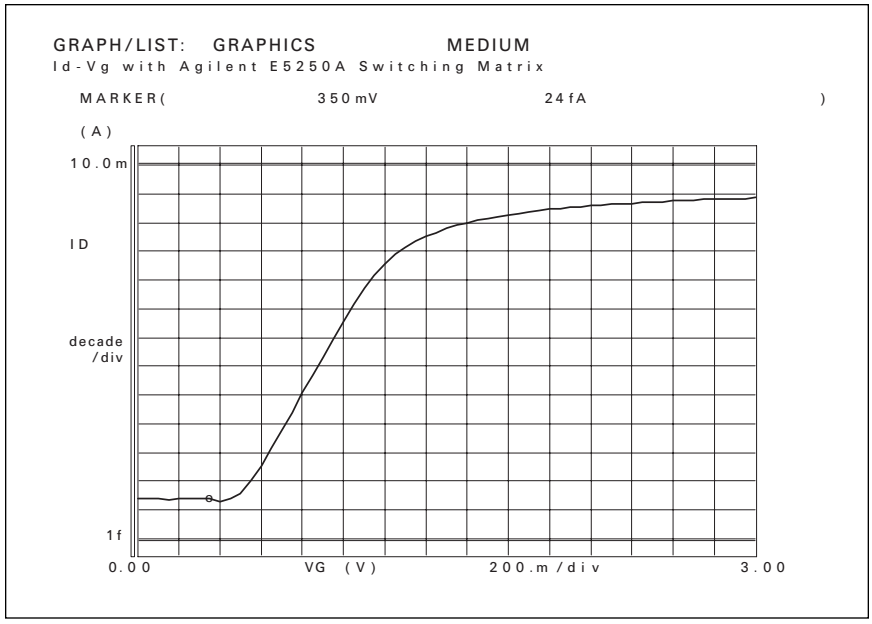

Figure 4. Id-Vg curve obtained using the Agilent 4156C with E5250A

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