



半导体材料与器件科学云讲堂

——快速上手自动化半导体参数测试系统

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25 September 2020

半导体材料与器件科学云讲堂

- ✓ 专业测试平台
- ✓ 六大类测试流程
- ✓ 剖析、解决半导体新问题



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直播日程

第一季 直播课程 (4~6月)

- 纳米材料及纳米电子器件IV和CV测试 4月29日
- 二维材料/石墨烯及其电子器件IV和CV测试 5月15日
- 量子材料及超导材料电输运物性表征测试 5月29日
- 超快脉冲在先进的NVM测试中的应用及神经元网络测试前瞻 6月

番外篇一

测试技巧：半导体参数测试仪使用技巧及案例集锦 7月3日

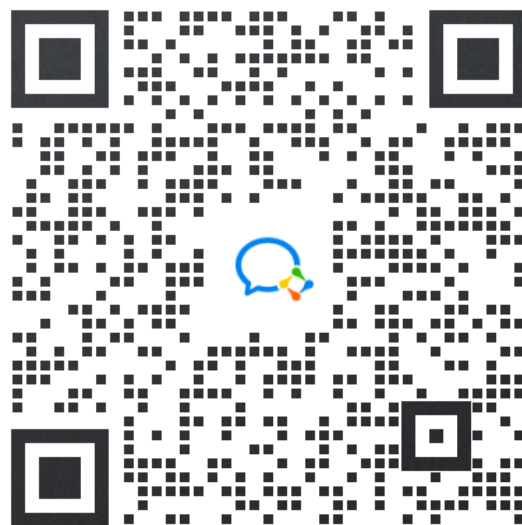
第二季 直播课程 (7~9月)

- 宽禁带半导体 (GaN/SiC) 材料及器件测试 7月17日
- 功率IGBT器件测试系统及自动化简介 7月31日
- 微机电系统MEMS测试概述 8月14日
- MOSFET的准静态CV/超低频CV测试 8月28日
- 半导体器件可靠性HCI/NBTI测试 9月11日
- 快速上手自动化半导体参数测试系统 9月25日



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日程

14: 30 - 15: 00

1.设备线缆及连线的介绍

- ◎不同模块线缆介绍
- ◎连线方法介绍

2.快速设置软件进行测试

- ◎调取测试工程进行测试
- ◎读取数据并画图

3.循环测试及应力测试设置简介

- ◎如何设置循环或应力测试

15: 00 - 15: 30

互动与答疑

15: 30 - 15: 45

抢答有奖



设备线缆及连线的介绍

◎不同模块线缆介绍

◎连线方法介绍

设备线缆及连线的介绍

主机及模块介绍

- ☐ 多模块，集成化
- ☐ DC /pulse/ CV
- ☐ 频率范围DC-10MHz



不同信号，对线缆的要求不同：

- ▲ SMU直流测试，精度高，**线缆考虑漏电**
- ▲ CVU/PMU, 快速信号，**线缆考虑损耗**

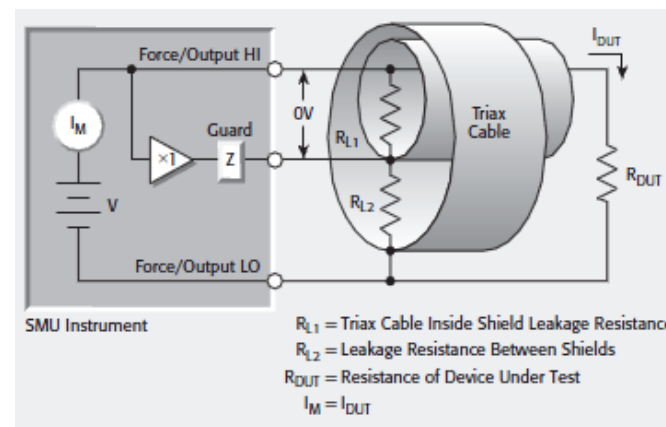


设备线缆及连线的介绍

SMU线缆介绍



Guard层是关键



Electrical specifications

Electrical impedance: 50 Ω

Frequency range: 0 Hz to 4 GHz

Working voltage:

Inner shield to outer shield: 250 VDC

Center conductor to outer shield: 250 VDC

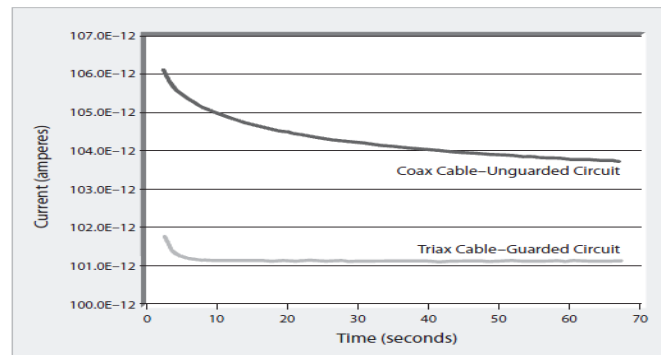
Center conductor to inner shield: < 100 V

Insulation resistance: 1×10^{13} Ω minimum

Operating environment: 0 $^{\circ}$ C to 50 $^{\circ}$ C, up to 70 percent relative humidity at ≤ 35 $^{\circ}$ C

Center conductor resistance: < 0.1 Ω per foot

FIGURE 2-15: Effects of Guarded and Unguarded Circuit When Using an SMU Instrument to Measure a 100G Ω Resistor by Sourcing 10V and Reading Current as a Function of Time



SMU的线缆:

◇ 三同轴接口

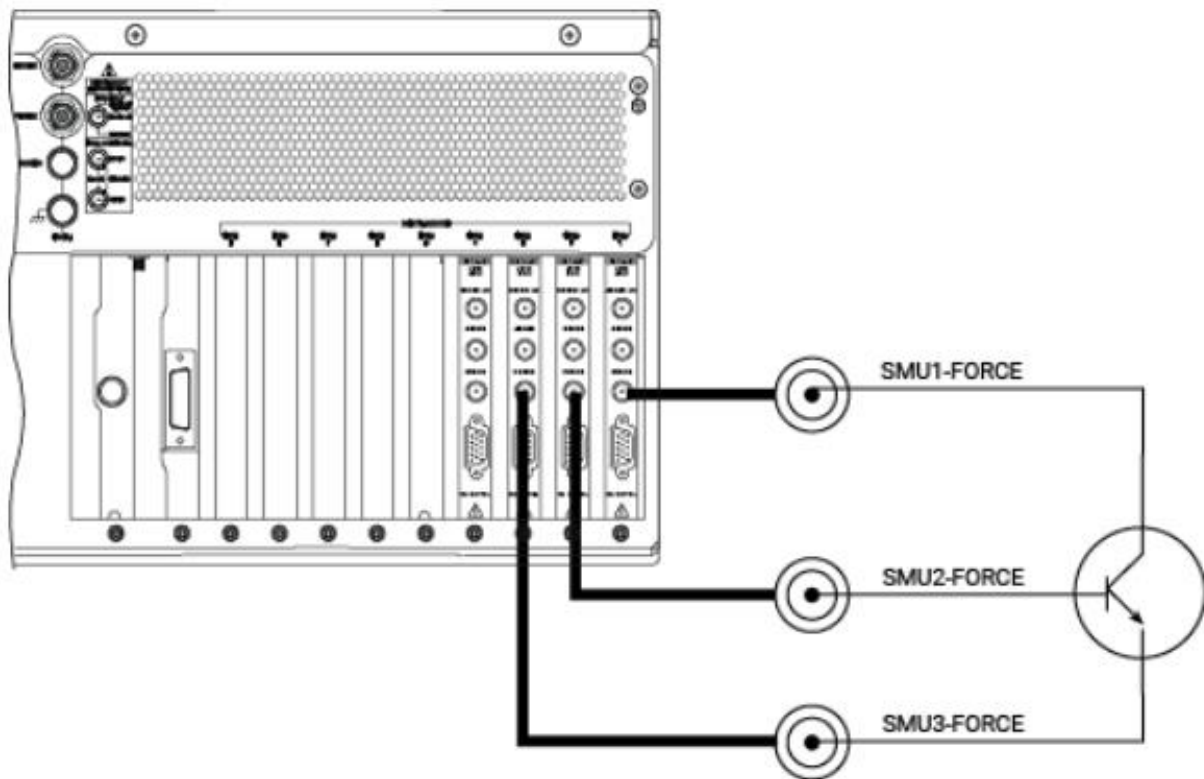
◇ 黑色线缆

◇ 特征阻抗50 Ω

◇ 整个线路都是三同轴 (探针台)

设备线缆及连线的介绍

SMU连线介绍



SMU接线方法:

- ◇ 器件每个端口都连接有SMU/GNDU
- ◇ 一般测试, 使用force端即可
- ◇ 硬件连接与软件设置一致

设备线缆及连线的介绍

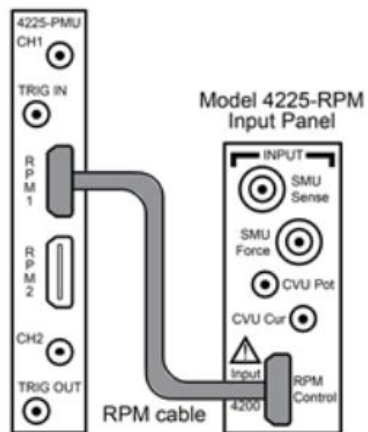
PMU线缆介绍



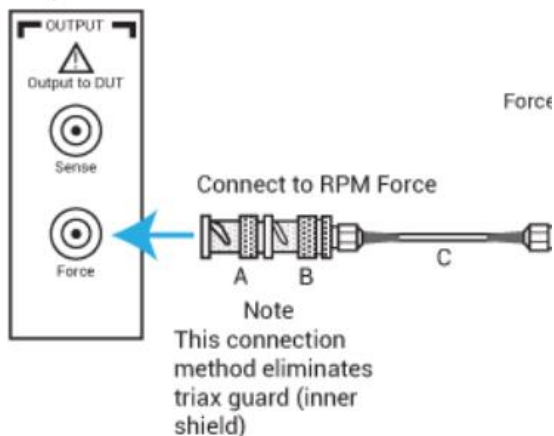
PMU的线缆:

- ◇ SMA接口
- ◇ 白色同轴线缆
- ◇ 特征阻抗50Ω (考虑损耗, 阻抗匹配)

Model 4225-PMU



Model 4225-RPM
Output Panel

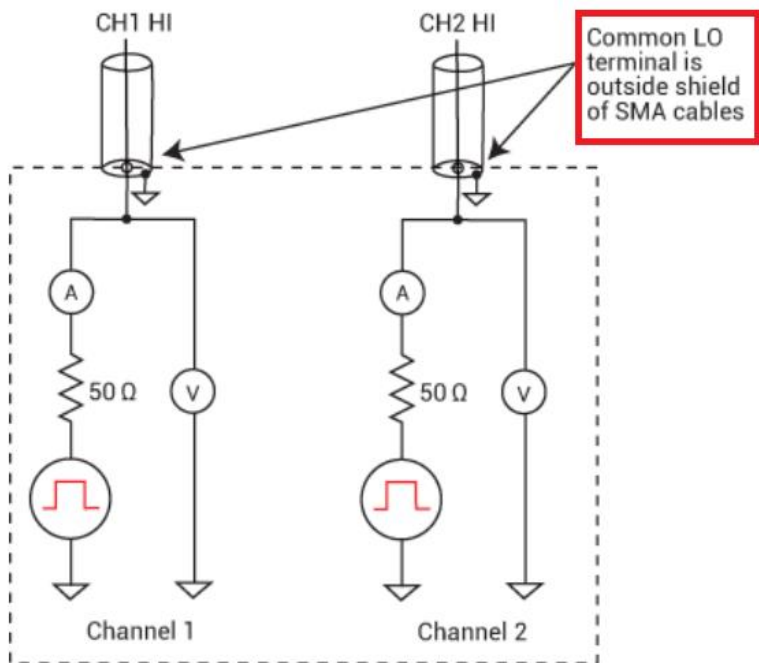


PMU+RPM的线缆:

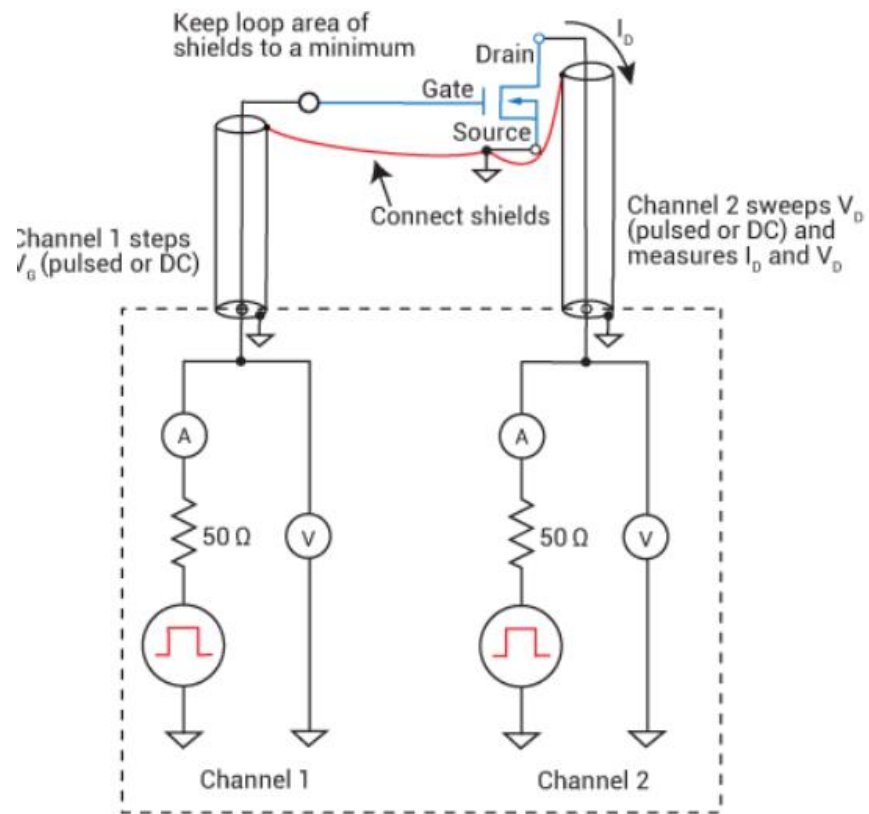
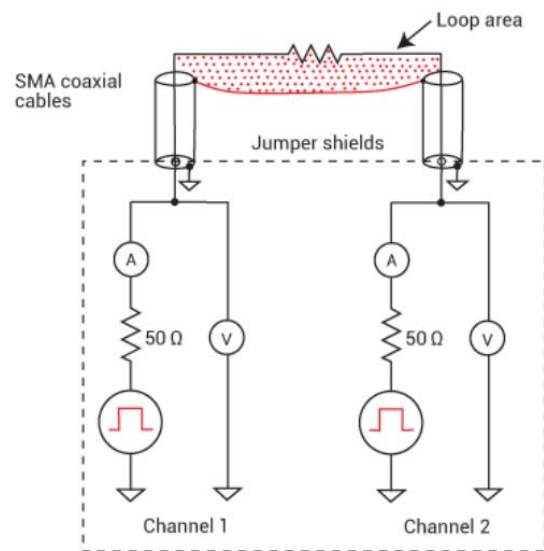
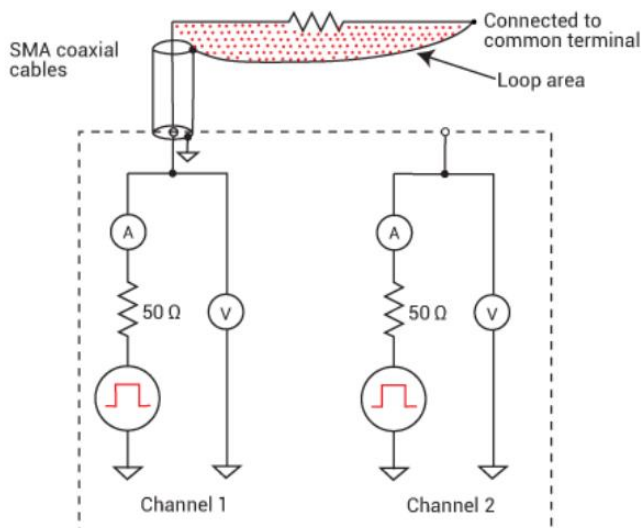
- ◇ 白色HDMI的线连接PMU与RPM
- ◇ BNC三同轴转二同轴, 再转SMA
- ◇ SMA转白色同轴线缆
- ◇ 特征阻抗50Ω (阻抗匹配)
- ◇ 用SMU的三同轴黑线也可以 (50欧姆)

设备线缆及连线的介绍

PMU连线介绍



线缆外层的屏蔽层是common LO端

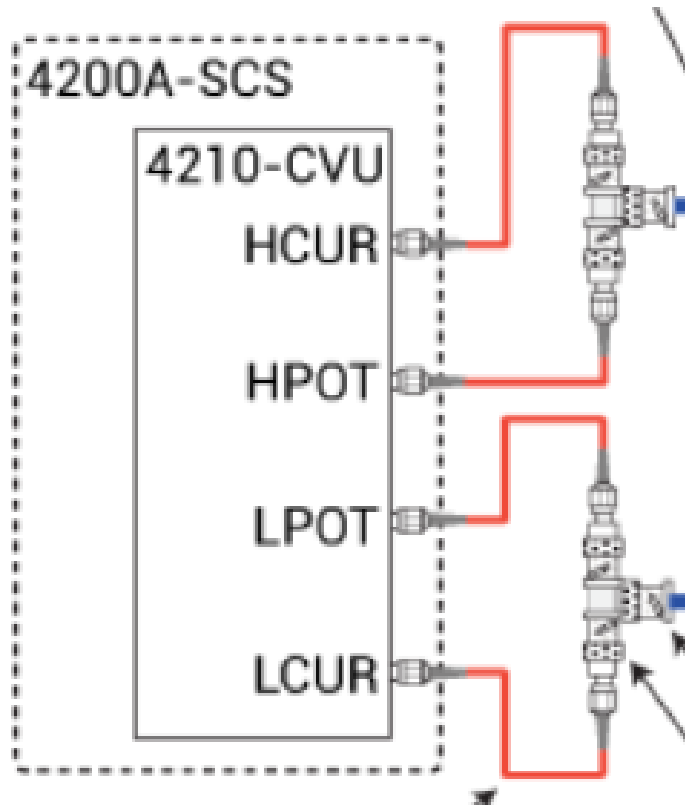


PMU测试连线:

- ◇ 就近接地, loop area最小
- ◇ 两端器件, 两种接法均可

设备线缆及连线的介绍

CVU线缆及连线介绍



Electrical characteristics

- Impedance: 100 Ω
- Maximum voltage: 50 V_{RMS}
- Maximum current: 100 mA

CVU的线缆:

- ◇ 四条红色同轴线缆
- ◇ 特征阻抗100 Ω (二合一之后也是50 Ω)

快速设置软件进行测试

◎调取测试工程进行测试

◎读取数据并画图

快速设置软件进行测试

测试工程的调取

default - Clarius PC Edition

Select → Configure → Analyze

Run Stop Save Tools My Projects My Settings Learning Center

Tests Devices Actions Wafer Plan **Projects**

Project Library (60) **60个project**

Sort By: Name: A to Z Search Image Description

- Capacitor Measurements Project (cap-measurements)
Contains tests for measuring C-V and C-f on a capacitor.
- Charge Pumping Project (chargepumping)
Contains several tests for performing common charge pumping measurement techniques on a MOSFET.
- Slow Single Pulse Charge Trapping Using the PMU Project (chargetrapping-pmu)
Uses the single pulse method to look at the charge trapping and de-trapping behavior within a single gate pulse.
- Carbon Nanotube Transistor Characterization Project (cntfet-characterization)
Includes tests for DC I-V, pulsed I-V, and C-V measurements on a carbon nanotube (CNT) FET.

Filters Help

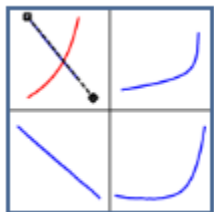
Technology	Device Type
<input type="checkbox"/> Electrochemistry	<input type="checkbox"/> Capacitor
<input type="checkbox"/> Materials	<input type="checkbox"/> Diode
<input type="checkbox"/> Memory	<input type="checkbox"/> Electrochemistry
<input type="checkbox"/> Nanotech	<input type="checkbox"/> Generic
<input type="checkbox"/> Organic	<input type="checkbox"/> Resistor
<input type="checkbox"/> Semiconductor	<input type="checkbox"/> Solar Cell
<input type="checkbox"/> Other	<input type="checkbox"/> Transistor

条件筛选

Measurements	Terminals
<input type="checkbox"/> C-V	<input type="checkbox"/> 2
<input type="checkbox"/> DC I-V	<input type="checkbox"/> 3
<input type="checkbox"/> Pulse	<input type="checkbox"/> 4
<input type="checkbox"/> Reliability	<input type="checkbox"/> 6
<input type="checkbox"/> Resistivity	<input type="checkbox"/> 8

快速设置软件进行测试

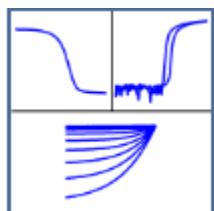
测试工程的调取



Solar Cell Project (solarcell)

太阳能电池

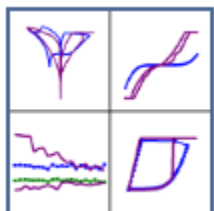
Contains several tests for electrical characterization of solar cells that includes I-V sweeps, C-V sweeps, C-f sweep, DLCP, pulse I-V, and resistivity.



Organic FET Characterization Project (ofet)

有机场效应晶体管

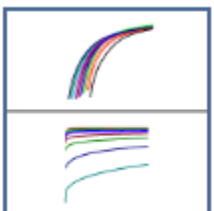
Contains tests for measuring I_d - V_{ds} , I_d - V_{gs} , very low frequency C-V, and high frequency C-V on an organic FET.



Resistive Nonvolatile Memory Characterization Project (resistive-nvm-examples)

Characterizes Resistive Memory (ReRAM) cells.

忆阻器



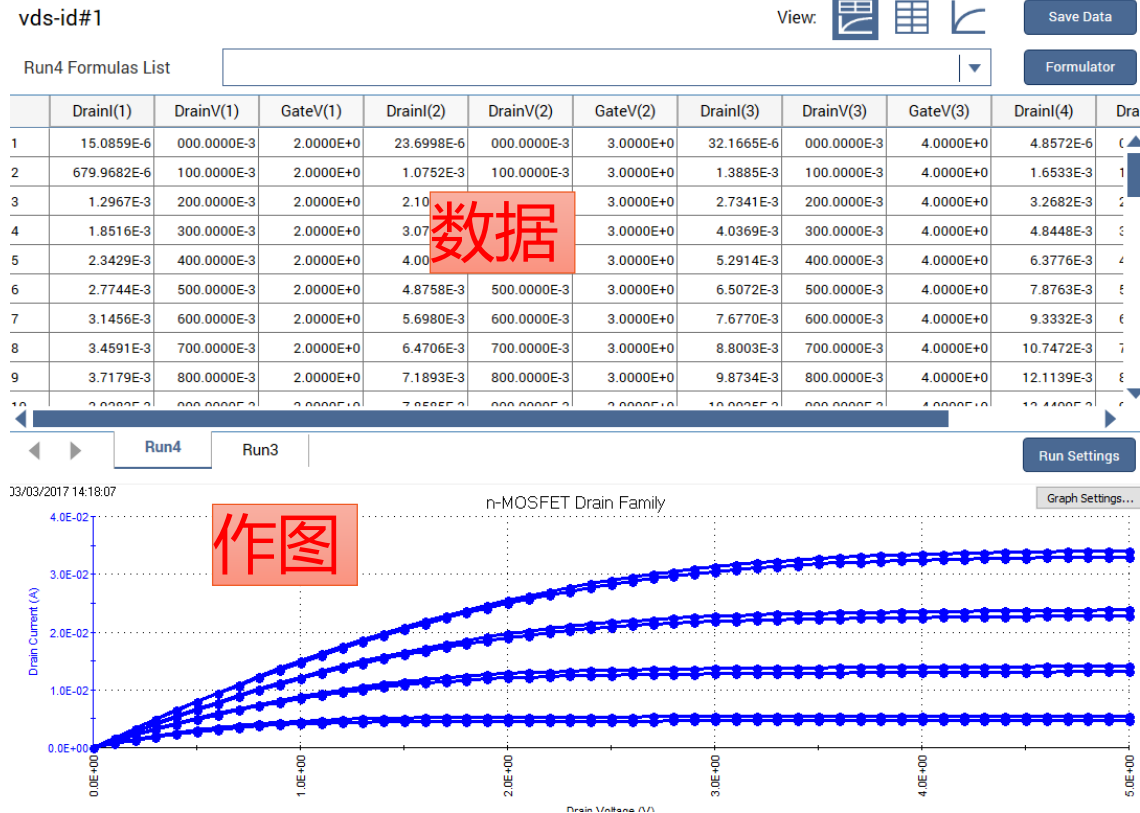
Lake Shore Temperature Controller Example Project (lake-shore-temp-controller)

Controls the Lake Shore LS336 Temperature Controller and measures the transfer characteristics of a transistor as a function of temperature.

Lakeshore探针台控温

快速设置软件进行测试

读取数据并画图



Define Graph...

- Dual Graph
- Auto Scale
- Axis Properties...
- Cursors...
- Line Fits...

Graph Definition - n-MOSFET Drain Family

Data Series	Sheet	Column	X	Y1	Y2
DrainI*	Run4	1		*	
DrainV*	Run4	2	*		
DrainI*	Run3	2	*		
GateV*	Run3	3			

选择XY轴数据

Enable Multiple X's

Clear All

Axis Properties...

OK

Cancel

设置坐标轴

循环测试及应力测试设置简介

©如何设置循环或应力测试

循环测试及应力测试设置简介

如何设置循环或应力测试

The screenshot illustrates the configuration process for a test. The 'Configure' button is highlighted in a red box. Below it, a tree view shows a 'Subsite' item selected and highlighted in a red box. To the right, a 'Subsite' configuration panel is shown with a dropdown menu for 'Subsite Operation' set to 'None', with 'Cycle' and 'Stress' options visible in the dropdown.

Subsite Operation
None
None
Cycle
Stress

Cycle: 循环测试

Stress: 应力测试

循环测试及应力测试设置简介

如何设置循环或应力测试

The screenshot displays a software interface for configuring tests. On the left, a file tree shows a 'Subsite' directory containing several test files: '4terminal-n-fet', 'vds-id', 'Custom Test_6', 'vtlin', 'subvt', 'vgs-id', 'ig-vg', 'cv-nmosfet', 'pulse-vds-id', 'waveform-meas', '3terminal-npn-bjt', 'vce-ic', 'gummel', and 'vcsat'. A red box highlights the 'Subsite' directory and its contents. On the right, the 'Subsite' configuration panel is shown, with a red box highlighting the 'Subsite Operation' dropdown menu (set to 'Cycle'), the 'Number of Cycles' input field (set to '10'), and the 'Cycle Delay' input field (set to '0').

Cycle: 循环测试

Subsite目录下选中的测试，将依次进行测试，循环10遍，一般用于高吞吐量测试

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实验室具备数十台测试仪器组成的电源设计全流程测试方案，功率器件选择，查找主要损耗点，优化效率及电源标准预认证。另外实验室里还有GaN, SiC评估板供您体验!



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