Keysight Precision IV Analyzer
(E5260A/E5262A/E5263A/E5270B)

KEYSIGHT TECHNOLOGIES

Quick Start Guide

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Introduction

The Keysight Precision IV Analyzers (E5260A/E5262A/E5263A/E5270B) enable quickly highly accurate current-voltage measurements using the powerful characterization software, EasyEXPERTgroup+ (“EasyEXPERT”) and integrated source and measurement units (SMUs).

This Quick Start Guide helps you to learn the features of EasyEXPERT and gives you step by step instructions on how to perform the basic current-voltage measurements.

Chapters 1 and 2 provide instructions for the hardware and software setup including the cable connection from the instrument to the device terminal before starting each Lab.

Chapter 3 provides the lab exercises to learn the basic operations, from measurement setup to execution and analysis.

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1. Preparation

1.1 The required instrument configuration, accessories and demo device for the lab

1.1.1 Instrument configuration

The lab exercise in this document requires one of the Precision IV Analyzers (E5260A/E5270B) that are configured with four or more SMUs. This document is described using the E5270B with the following configuration of four SMUs.

- SMU1: E5281B Precision MPSMU
- SMU2: E5281B Precision MPSMU
- SMU3: E5281B Precision MPSMU
- SMU4: E5281B Precision MPSMU

You could use Analyzer E5260A instead of E5270B or another type of SMU besides E5281B MPSMU.

1.1.2 Accessories

- Keysight N1295A Test Fixture x 1

Keysight N1295A Test Fixture

- Power Cable x 1
- GPIB interface x 1
- Triaxial Cable x 4

Power cable

82357B USB/GPIB Interface
High-Speed USB 2.0

16494A Triaxial cable

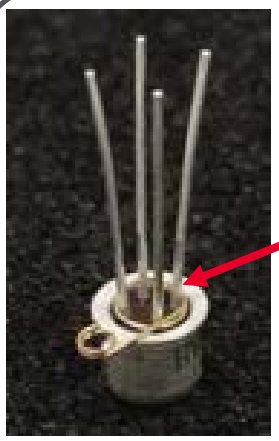
1.1.3 Demo device

The following device is used in this document;

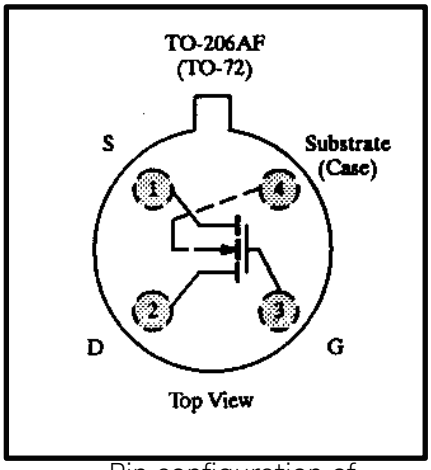
Demo Device : MOSFET SD214DE

Basic characteristics:

- Nch MOS FET
- Max Vd : 10 V
- Max Vg : 10 V
- Max Id : 50 mA
- Vth : <1.5 V
- Typical Ig : <1 pA



Picture of SD214DE



Pin configuration of SD214DE

Note:
There is no protection diode connected to the gate, and it can easily be damaged. Leave the shorting wire in place to protect the gate from damage.
When handling the device without the shorting wire, observe the following precautions:

- Do not touch to the gate pin.
- Discharge your body's static charge by touching a convenient earthing point.

1.2 Installation of EasyEXPERT software

1.2.1 PC prerequisite

Set up a computer which satisfies the system requirements of EasyEXPERT.
For further information, see the README file included in the installation package of EasyEXPERT group+ software (for PC) on K.com.
www.keysight.com/find/easyexpert

1.2.2 Installation of EasyEXPERT

The latest version of EasyEXPERTgroup+ can be downloaded from K.com.
www.keysight.com/find/easyexpert

Install the EasyEXPERT software in your external PC by following the procedure described in the README file.

1.2.3 License file installation for EasyEXPERT

For the purposes of your demo evaluation, EasyEXPERT group+ allows you to execute the measurements for two hours, without the need for the purchased license. When the two hours have passed, you can re-start EasyEXPERT.

If, however, you have the purchased license, refer to the detailed installation procedure in the EasyEXPERT user's guide.

2. Before starting the Lab

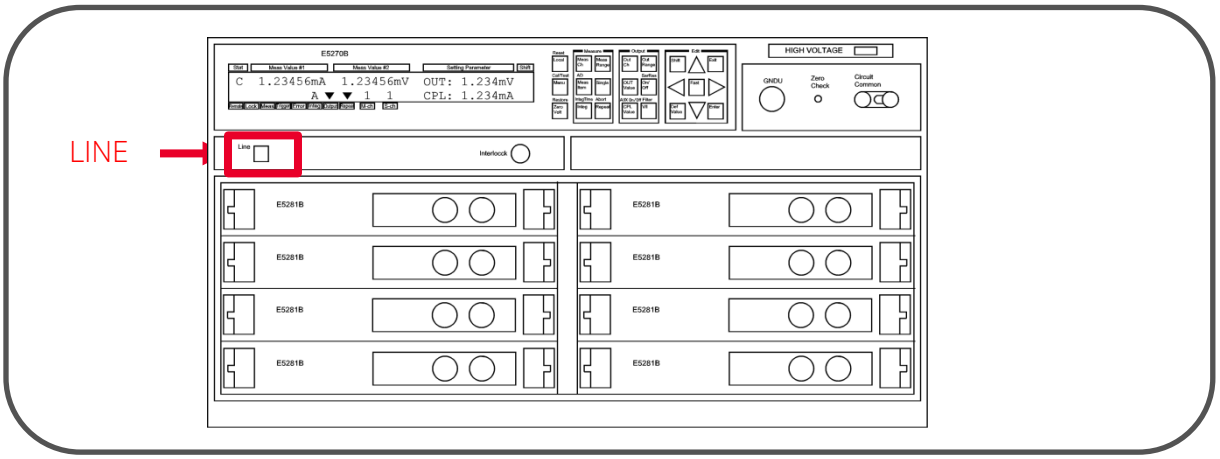
2.1 Instrument setup

This section covers the following topics:

- Turning on the Instrument
- Setting up the instrument GPIB address
- Confirming the GPIB address using Connection Expert

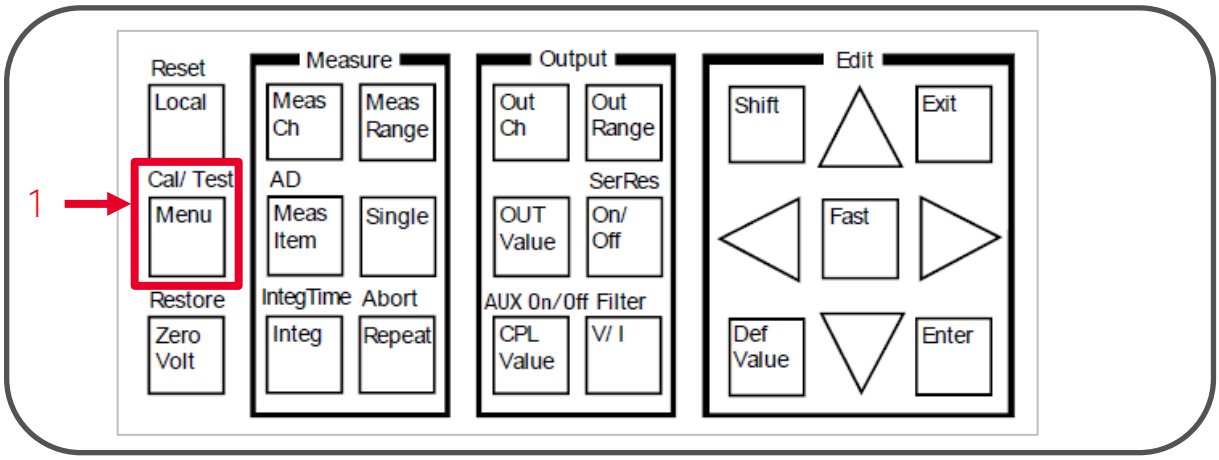
2.1.1 Turning on the instrument

Connect the power cable from the E5270B to an AC power outlet, and press the “Line” switch.

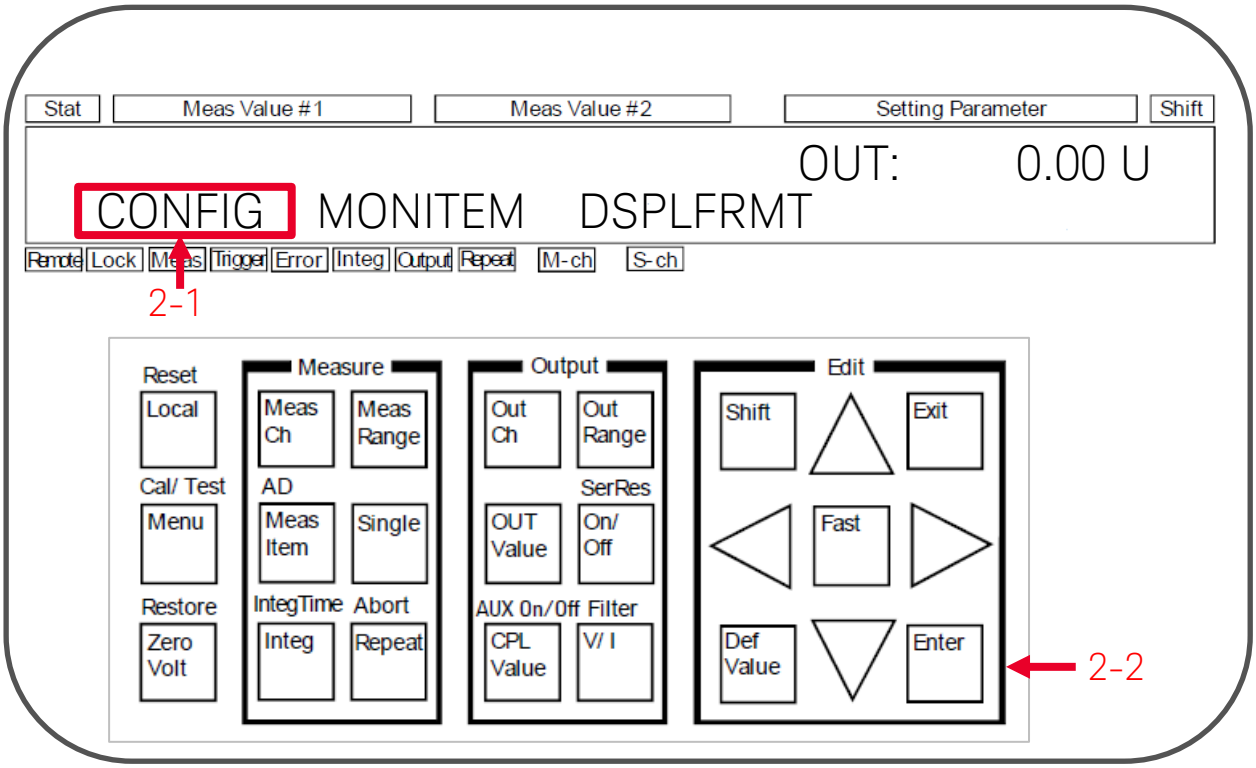


2.1.2 Setting up the instrument GPIB address

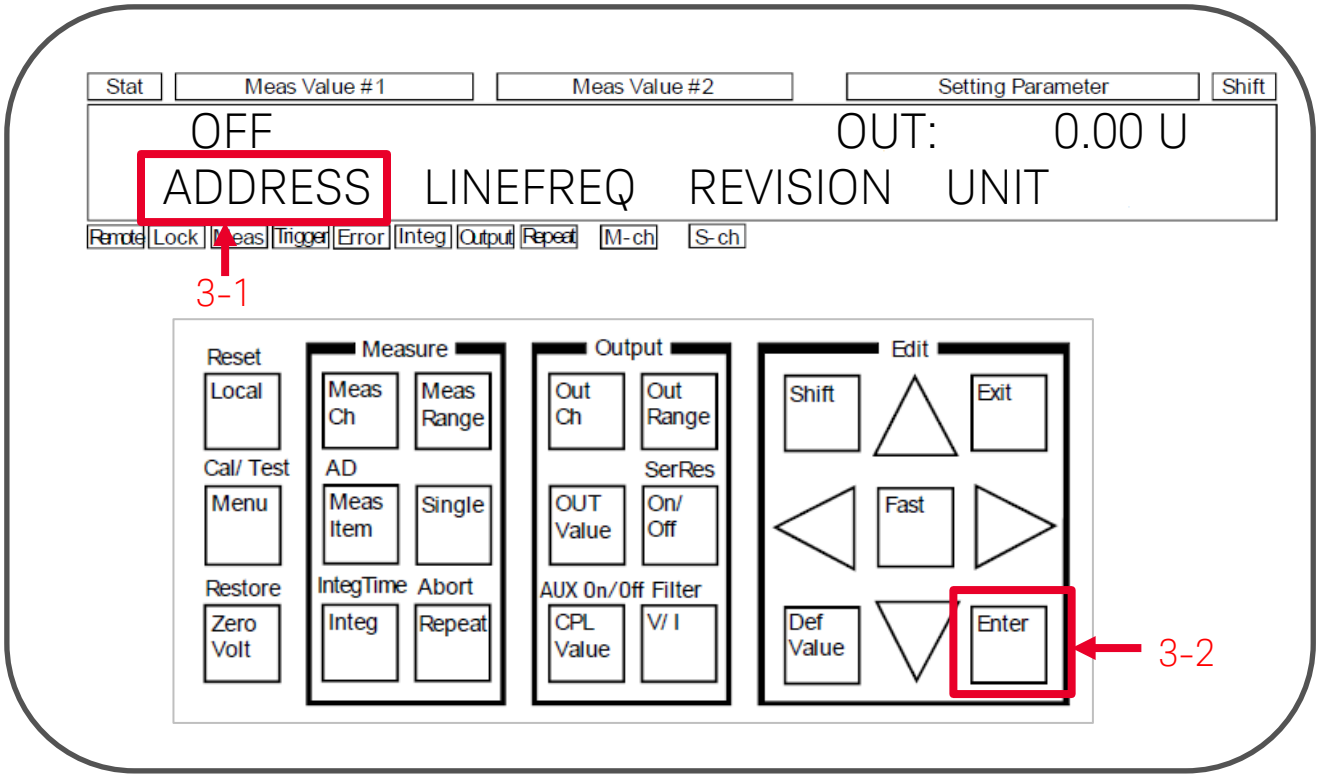
Step 1. Press the Menu key.



Step 2. Move the cursor to CONFIG, and then press the Enter key.

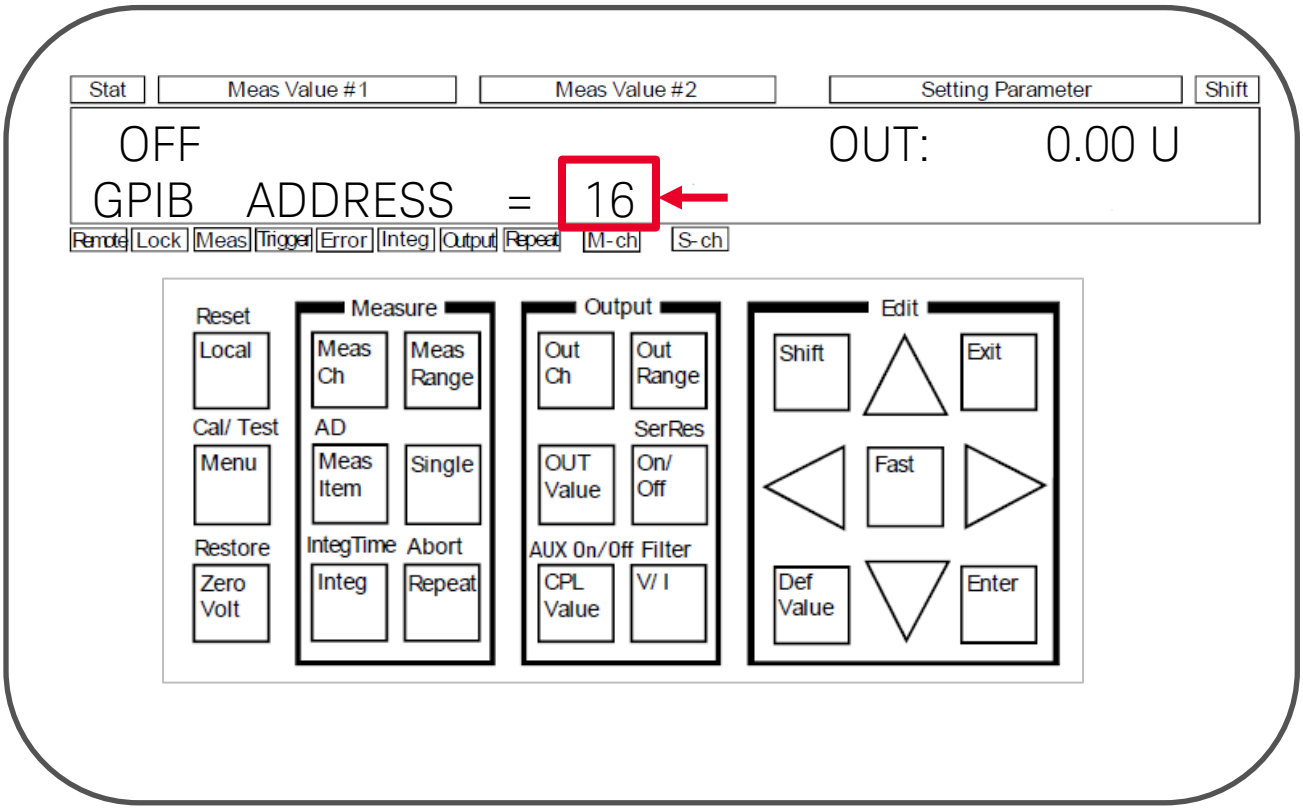


Step 3. Move the cursor to ADDRESS, and press the Enter key.

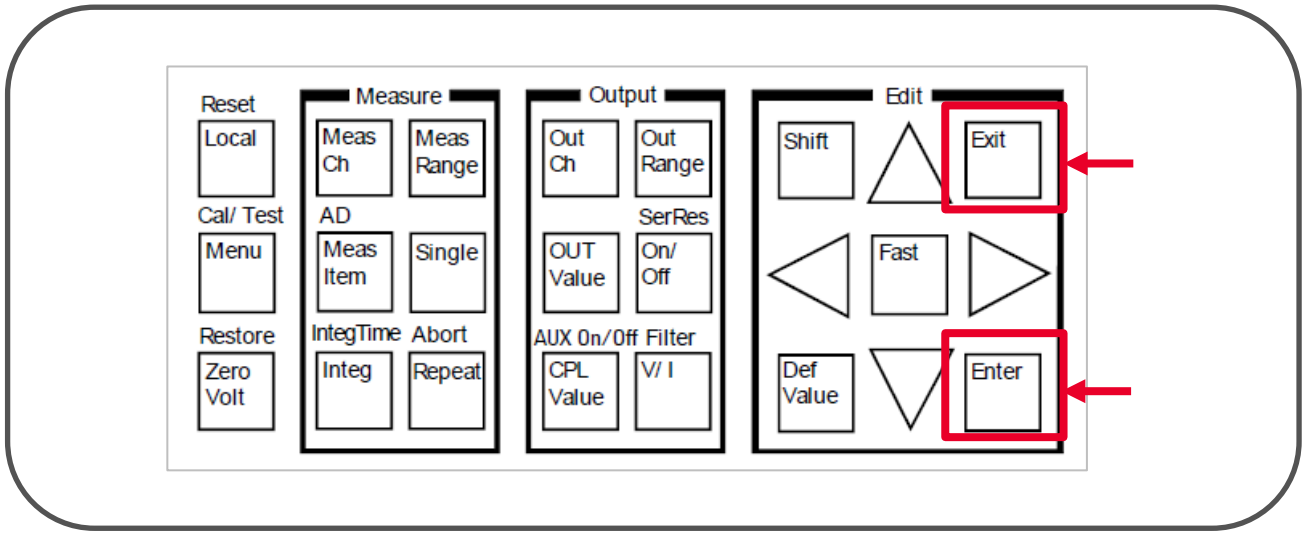


Step 4. Press the arrow keys to set the GPIB address.

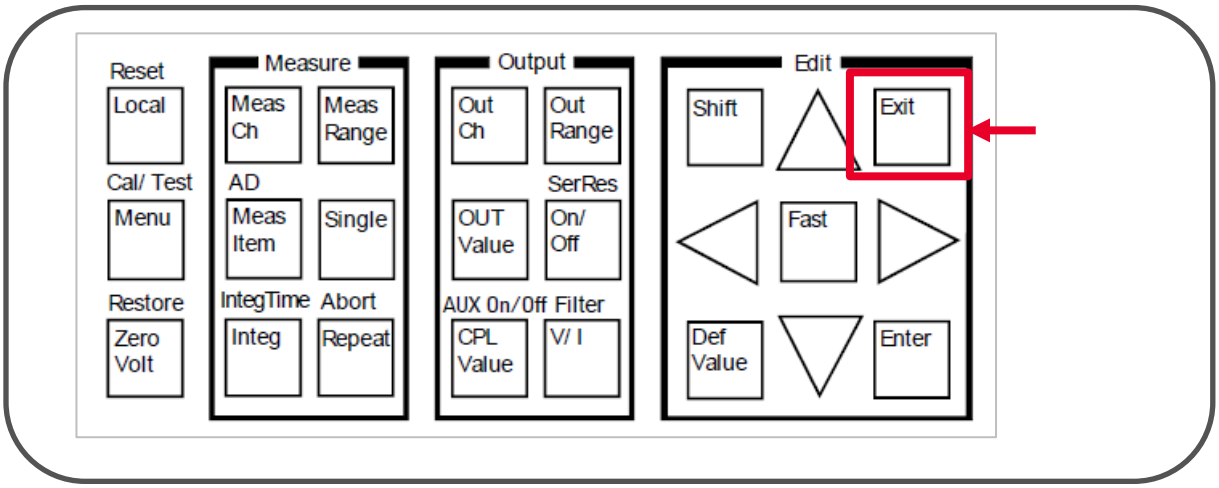
- Left and right arrow keys change the position
- Down and up arrow keys change the GPIB address number.



Step 5. Press the Enter key to make the setup effective, or press the Exit key to cancel any changes to the setup.

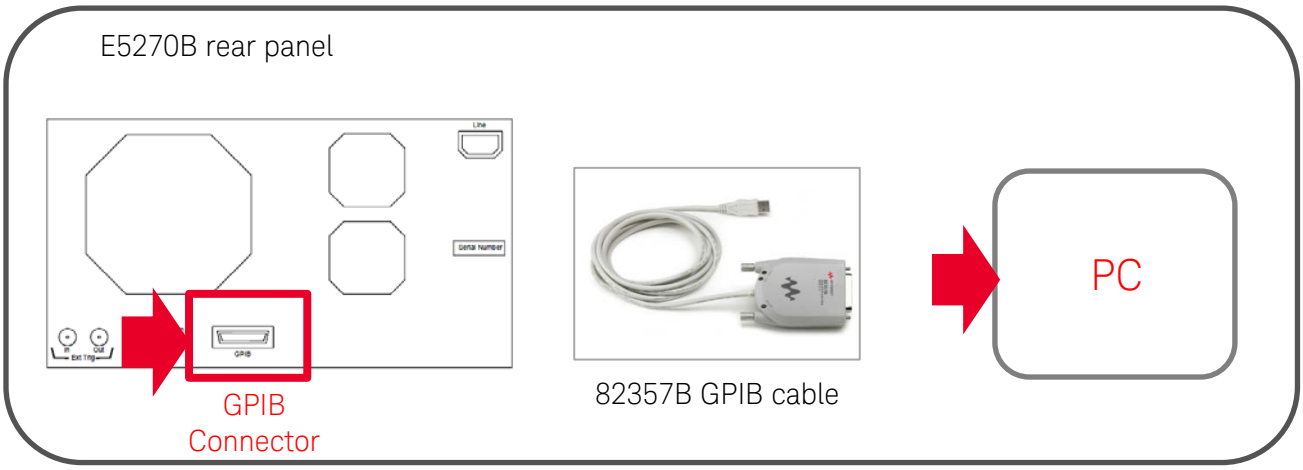


Step 6. Press the Exit key twice to close the setup menu.



2.1.3 Confirming the GPIB address using Connection Expert

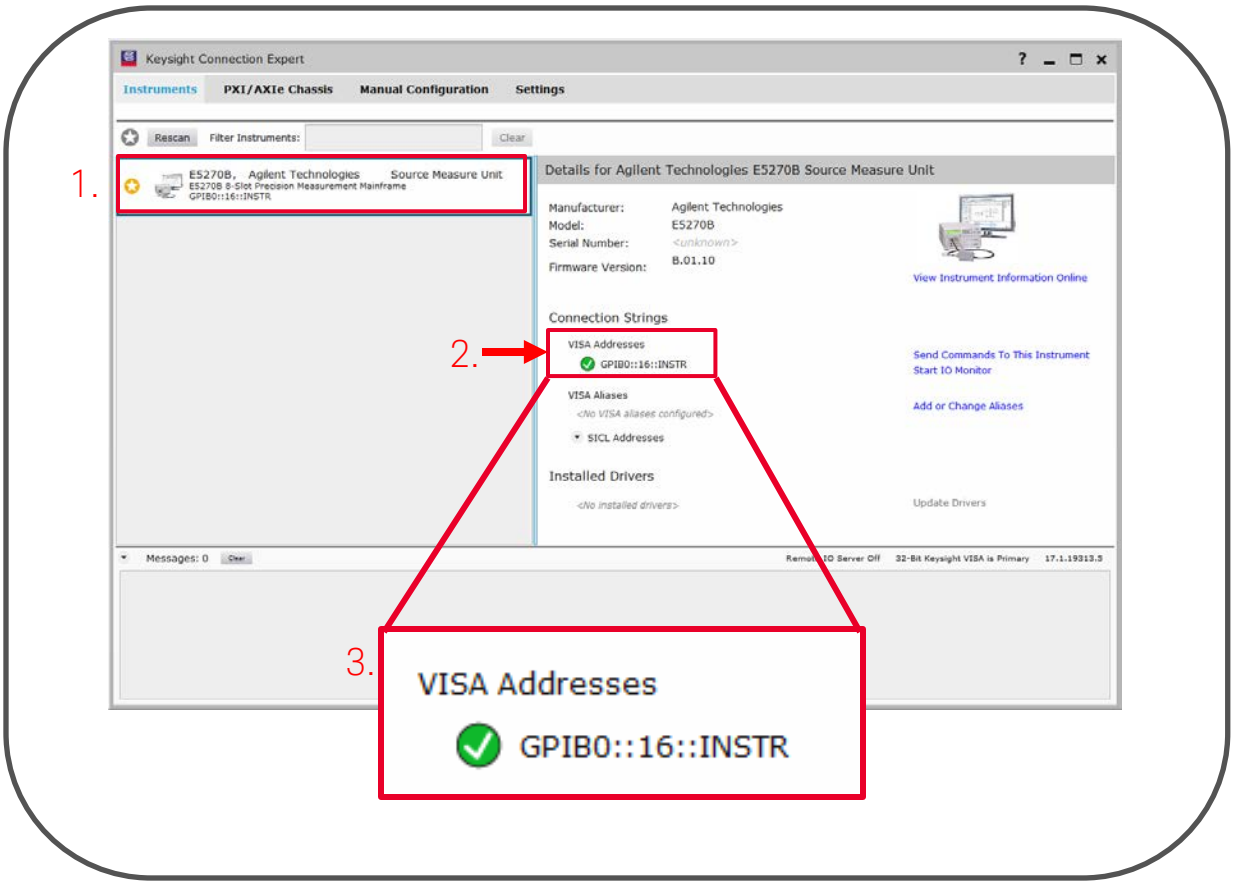
Step 1. Connect the E5270B to your PC using the GPIB interface cable.



Step 2. Check the E5270B GPIB Address using Connection Expert

- Open the “Keysight Connection Expert” from the Windows start menu
- Select the Instruments tab
- Check the VISA insterface ID and the GPIB address as follows.
  In the following example, you can see VISA interface ID is “0” and GPIB Address is “16”.

Note: If the instrument is not displayed in Connection Expert, click Rescan. For more detailed information, refer to Help of Connection Expert.



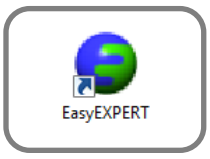
2.2 EasyEXPERT setup

Prepare EasyEXPERT as follows:

- Start EasyEXPERT
- Make a new workspace for the demo
- Set the power line cycle

2.2.1 Starting EasyEXPERT

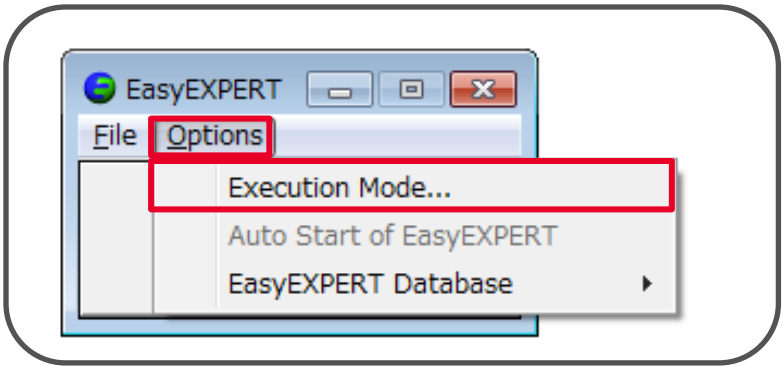
Step 1. Start EasyEXPERT by clicking the following short cut icon on the Windows desktop or by clicking on Start EasyEXPERT in the Start menu.



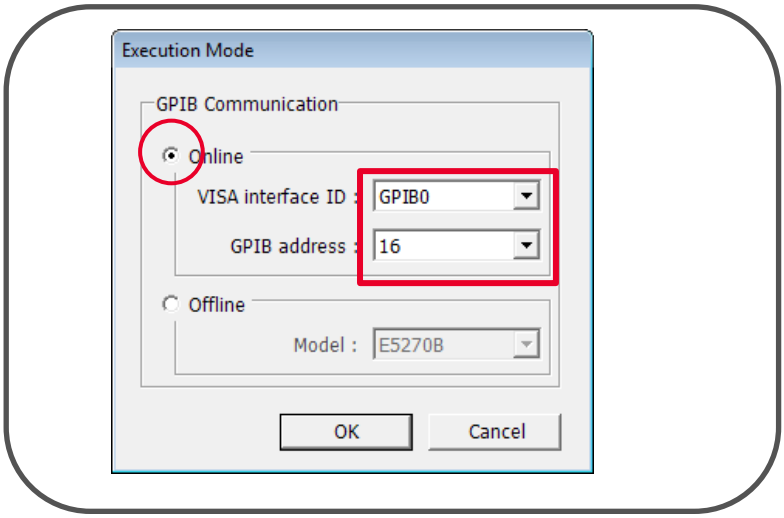
Step 2. Set the online mode and GPIB address of the instrument.

a. Click "Options".

b. Click "Execution Mode...", the Execution Mode window will open.



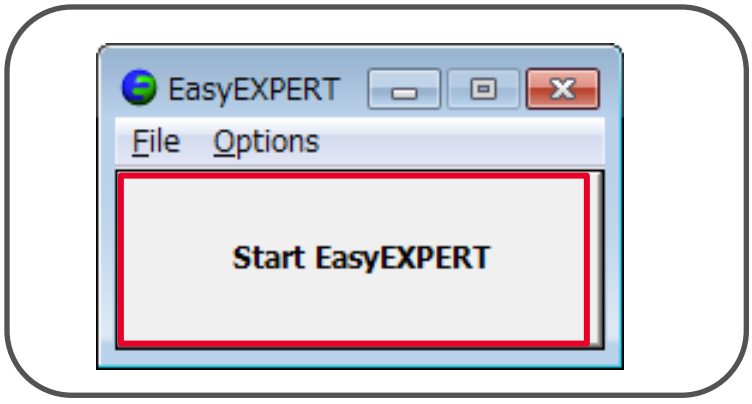
c. Check "Online" and set “VISA interface ID” and ”GPIB address”



Note: If you don’t know what GPIB Address to set here, please refer to “1-4. Preparation of instrument”

d. Click "OK", and close the Execution Mode window

Step 3. Click "Start EasyEXPERT", EasyEXPERT will start.



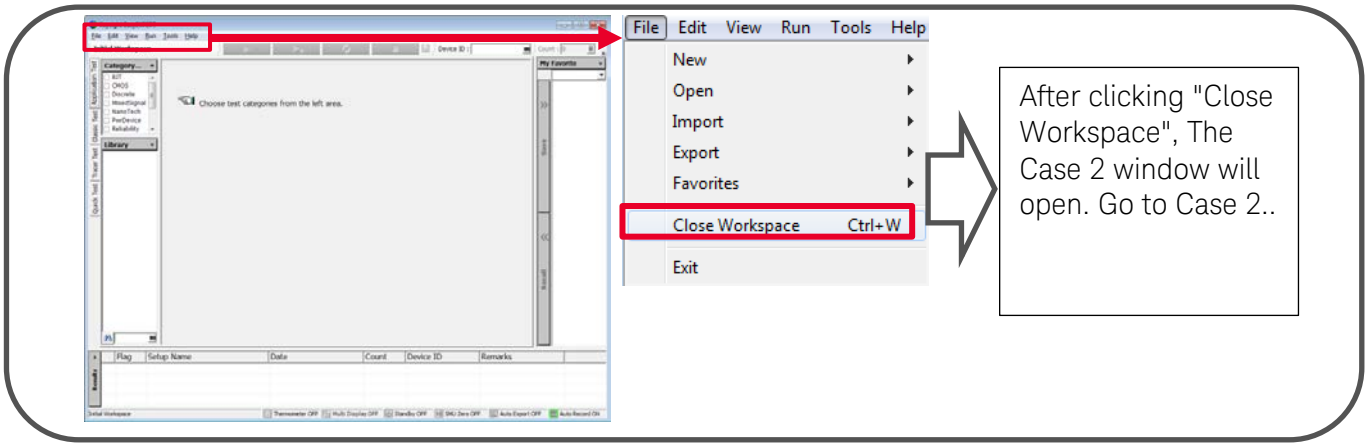
2.2.2 Making a new workspace for the demo

EasyEXPERT group+ has a built-in database called “workspace”. Every time the measurement is performed, the combination of measurement setup and result can be stored automatically into the workspace, allowing you to store and rapidly recall the data that you need. You can create your private workspaces or public workspaces for shared usage.

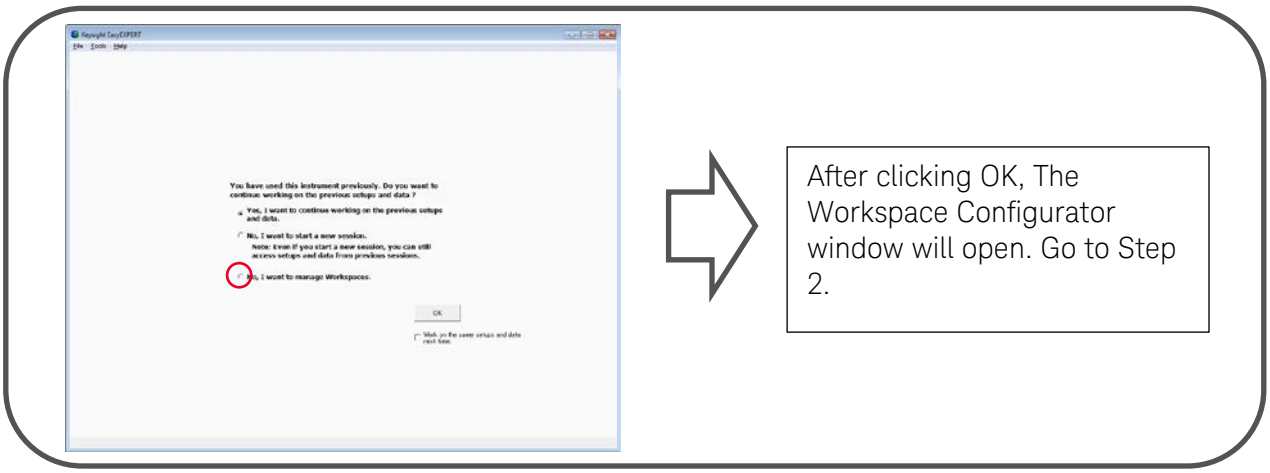
Step 1. Opening the workspace configurator window

When you click Start EasyEXPERT, a window will open, but the contents of the window depends on the number of existing workspaces, Case 1: No existing workspaces (first time use), Case 2: One workspace and Case 3: Two or more workspaces. Create your own case using the Workspace Configuration window, then go to Step 2.

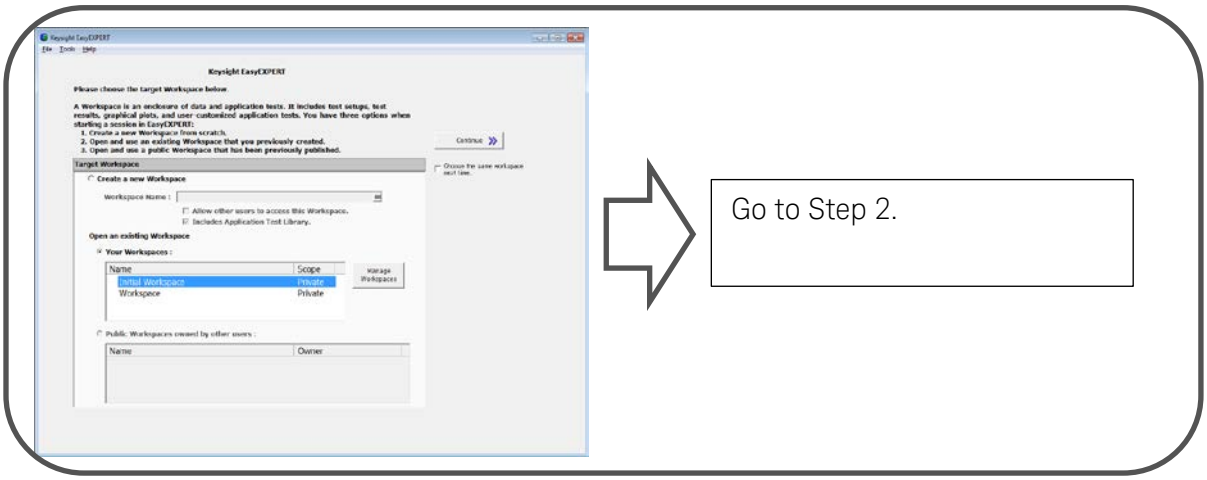
Case 1: No existing workspaces (first time use)
Close workspace by selecting "Close Workspace” from the “File” menu, and go to the EasyEXPERT workspace management window (Case2).



Case 2: One existing workspace
Click the "No, I want to manage Workspaces" radio button.

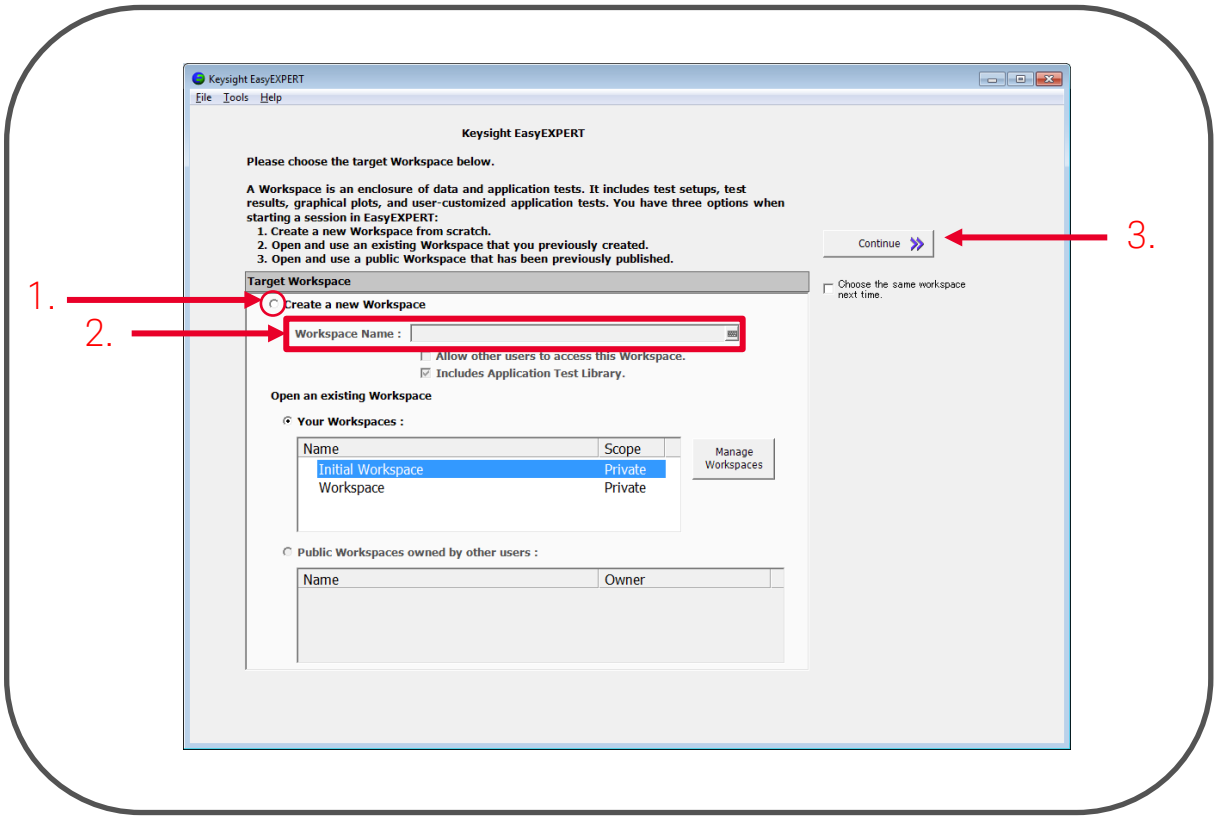


Case 3: Two or more existing workspaces
The Workspace Configuration window will open, then go to Step 2.



Step 2. Making a new Workspace for the demo.

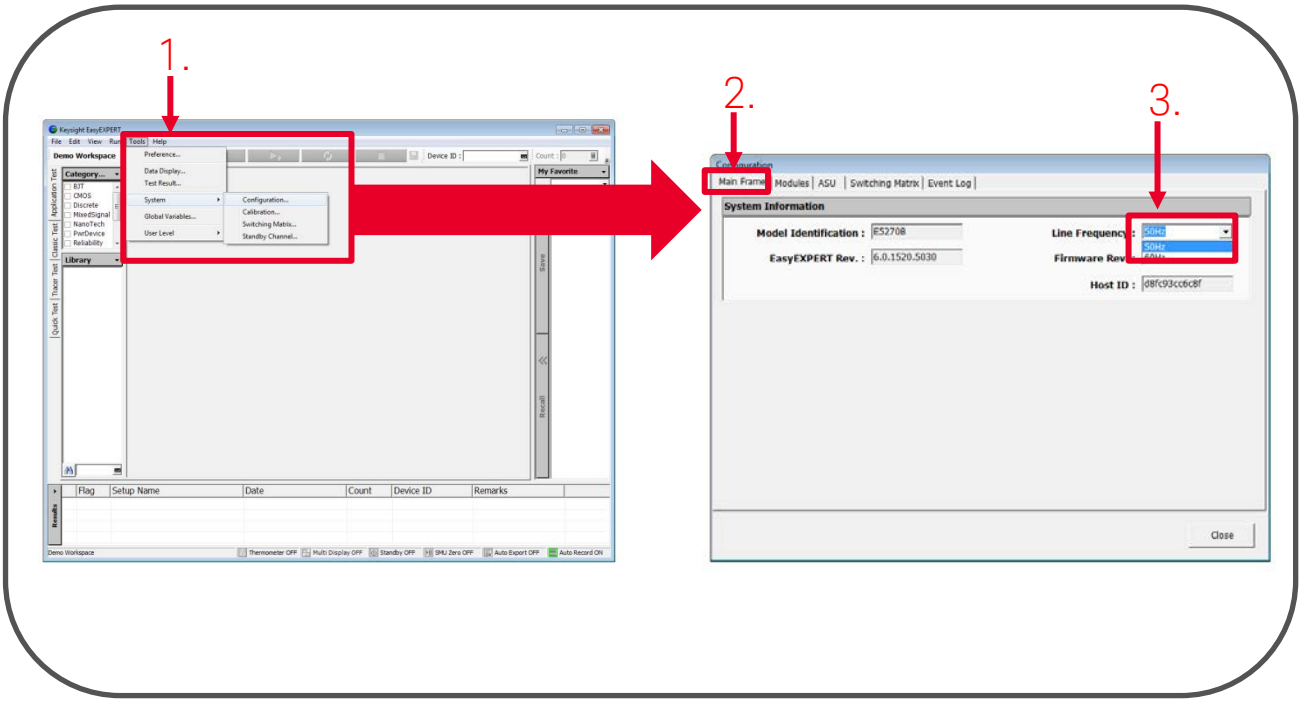
Click on the "Create a new Workspace" radio button. Enter, for example, “Demo Workspace” as a unique name in the new workspace entry field. Click “Continue” and go to “Preparing the Measurement environment”.



2.2.3 Setting the power line frequency

Setting the power line frequency is very important for accurate and stable measurements in low signal voltage or current. Check the line frequency setting of your instrument, and set the line frequency of your area.

Open the Configuration Window by selecting "System -> Configuration" from the “Tools” menu, and go to the Tab of “Main Frame” and check the Line frequency.



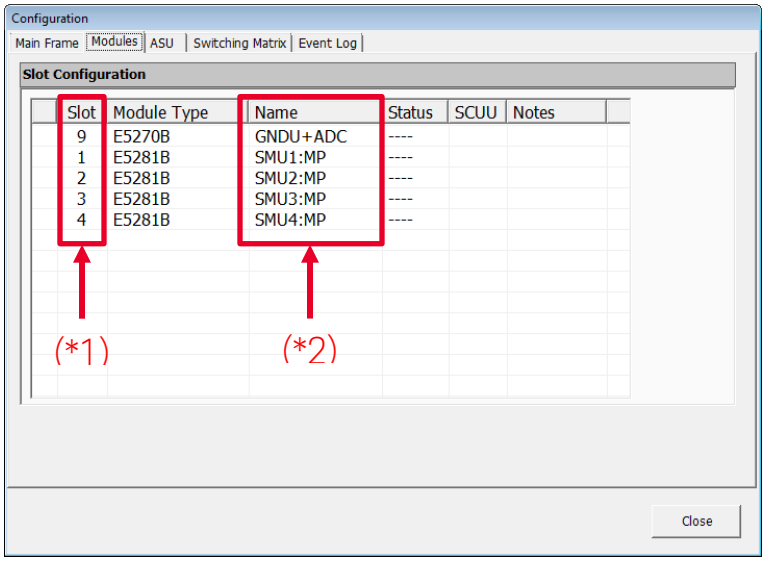
2.3 Making connections between the instrument and the demo device

The connection between the instrument and the demo device is made by undertaking the following:

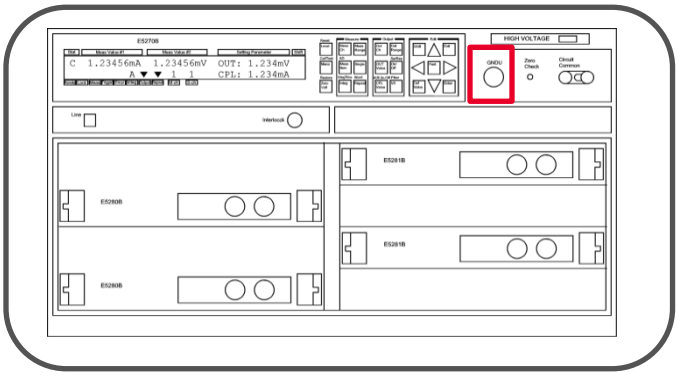
- Checking the configuration on EasyEXPERT.
- Connecting the cables between the instrument and the demo device

2.3.1 Checking the configuration on EasyEXPERT

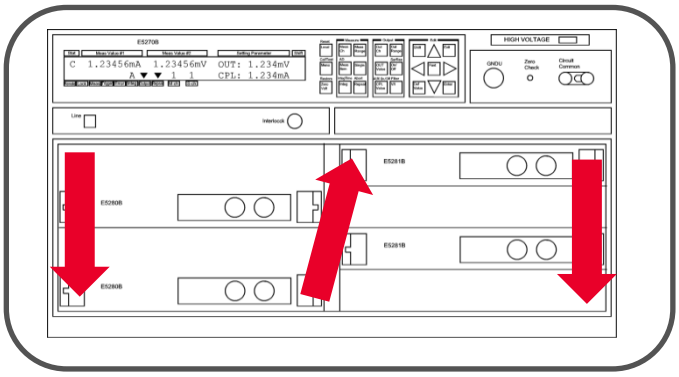
Open the Configuration by selecting Tools > System > Configuration... and check each Slot (*1) number against its corresponding module Name used in EasyEXPERT (*2).



➢ The Ground Unit is referred to as "GNDU" in EasyEXPERT. The GNDU is located within the mainframe of the Precision IV analyzer and its terminal is located on the front panel of the instrument.

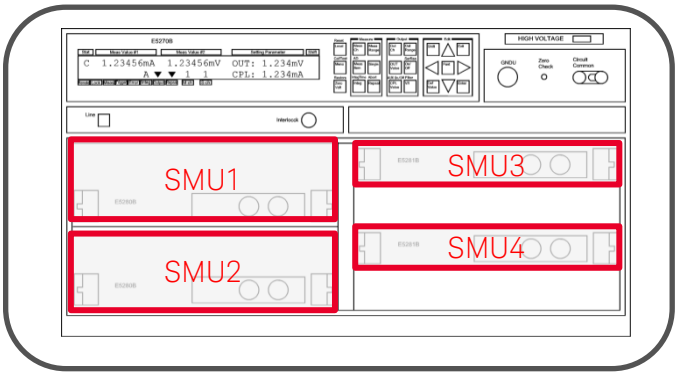


- The SMU is named according to the SMU number +":" + Module Type. (i.e. HR for HRSMU) on EasyEXPERT. The SMU number is dictated by the following rules. Note that the SMU number is not the same as the slot number.
    - Count the SMU numbers in ascending order of the slot numbers as illustrated in the diagram below.



    - HPSMU occupies the 2 slots of the mainframe, but the increment of the SMU number is 1.
    - Do not count the empty slots.

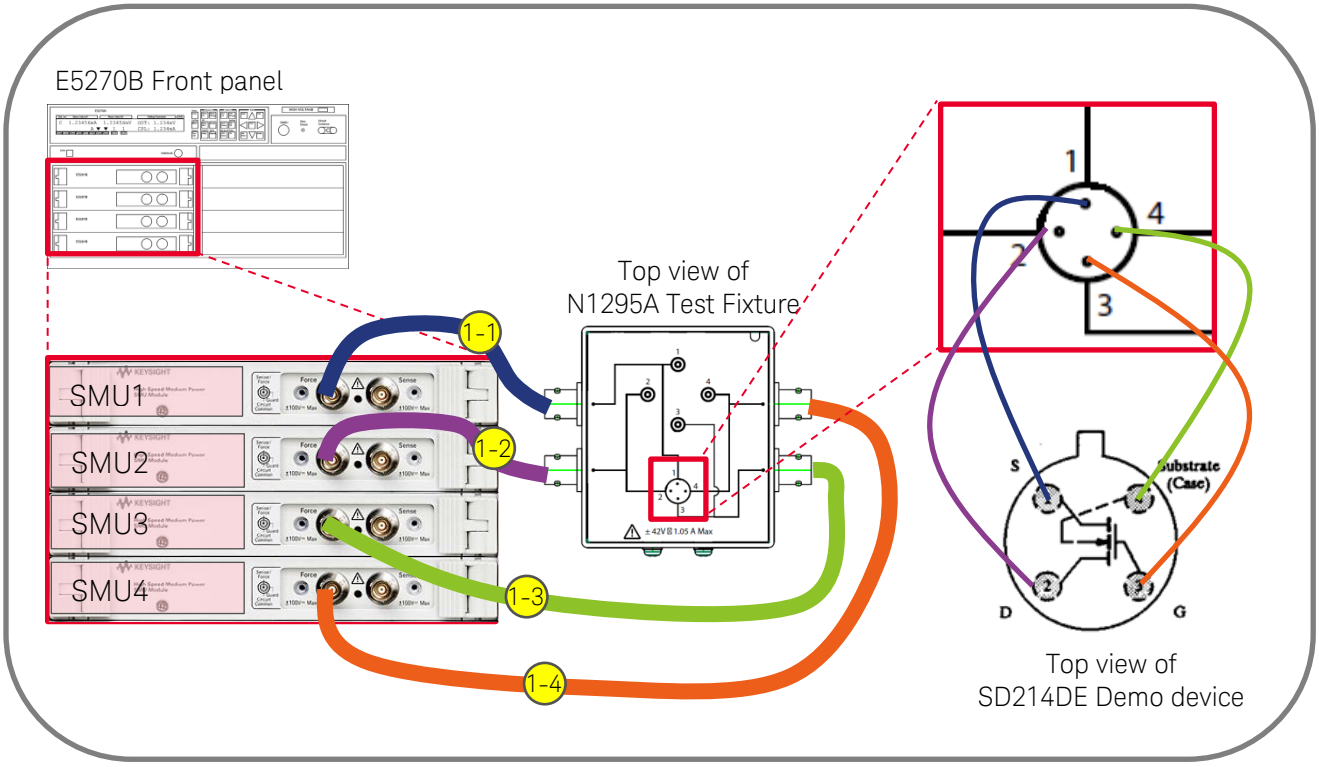
      Below illustrates an example of two HPSMUs installed in slots 2 and 4, and two MPSMUs installed in the slots 5 and 7.



Note: For the remainder of this document, the SMU number will be used to specify a SMU on the instrument.

2.3.2 Cabling between the instrument and the demo device

The following diagram illustrates the connection overview. Connect the cables between the instrument and the test fixture, then set the demo device on the test fixture.



Step 1. Connect the instrument to the Fixture (N1295A)

A SMU has both Force and Sense terminals. In the labs in this guide, only the Force terminal is used, the Sense terminal should be kept Open.

1-1. Connect the Force terminal of SMU1 to Port1 of the N1295A Test Fixture using a triaxial cable.

1-2. Connect the Force terminal of SMU2 to Port2 of the N1295A Test Fixture using a triaxial cable.

1-3. Connect the Force terminal of SMU3 to Port3 of the N1295A Test Fixture using a triaxial cable.

1-4. Connect the Force terminal of SMU4 to Port3 of the N1295A Test Fixture using a triaxial cable.

Front View of a SMU

Note: A Sense line is used for high current measurement or low resistance measurement to minimize the measurement error caused by the residual resistance of the connection cables.

Step 2. Set the SD214 Demo Device to the N1295A Test Fixture

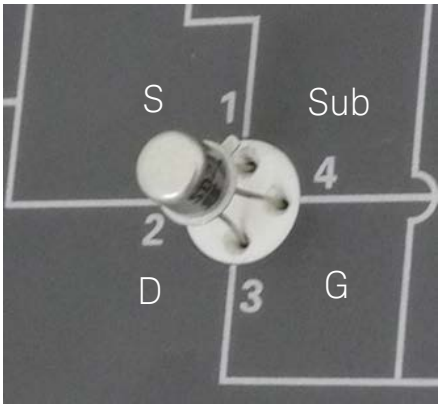
Step 2-1. Before connecting, position the Demo Device leads so that they fit to the N1295A device socket.

Note: While positioning the leads, leave the shorting wire in place to protect the gate from any damage.

Step 2-2. Insert the device (SD214DE) into the socket on the Test Fixture

Connection table

N1295A Port number	Pin Name
1	Source
2	Drain
3	Gate
4	Sub



Step 2-3. Remove the shorting wire

You have now completed the connections, as detailed below, between the instrument and the demo device.

Unit	N1295A Port number	Pin Name
SMU1	1	Source
SMU2	2	Drain
SMU3	3	Gate
SMU4	4	Sub

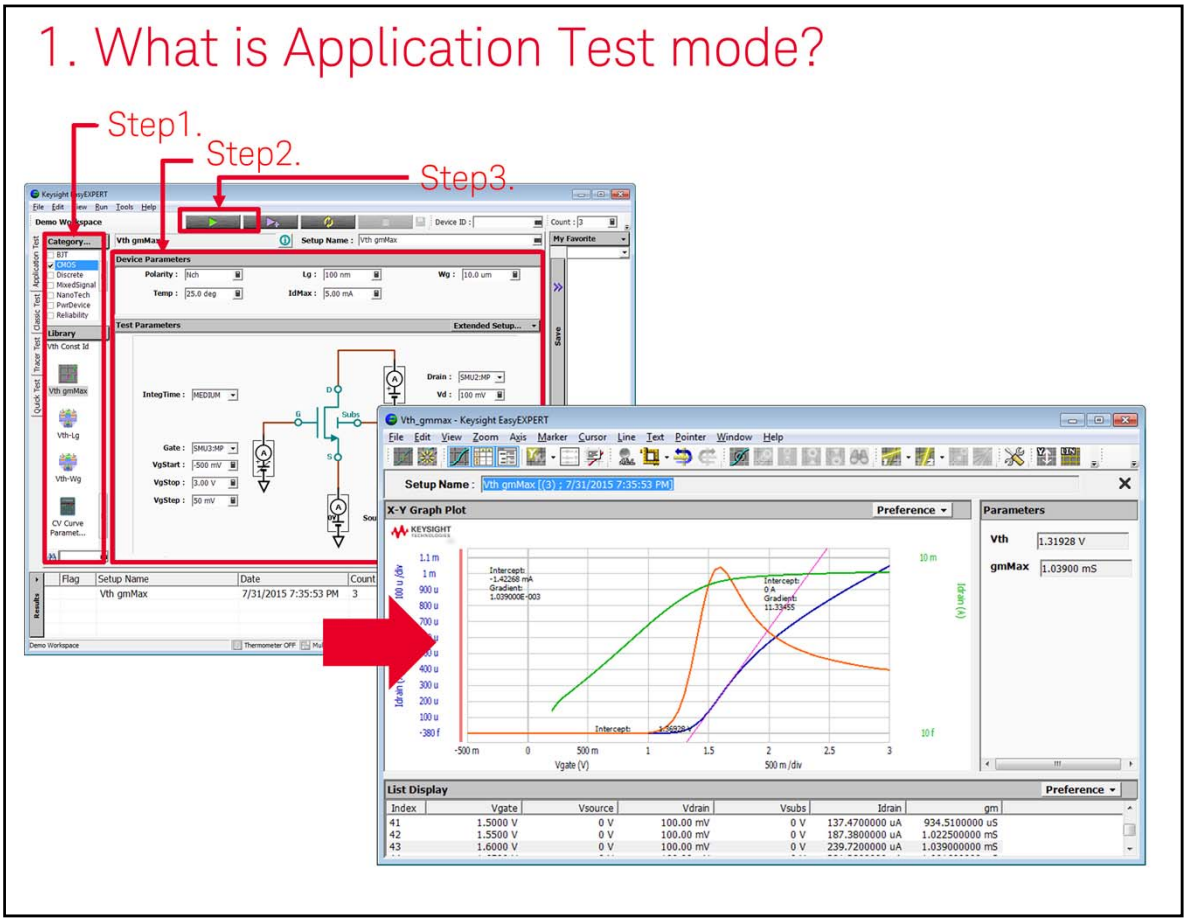
Lab 1:
Taking measurements using pre-defined tests - Application Test mode

Objective:

In this section, you will learn about "Application Test Mode", an easy to use software feature of EasyEXPERT that provides extensive libraries of pre-defined tests that allow you to make parametric measurements with just a few simple clicks of the mouse.

Conents

1. What is Application Test mode?
2. Taking a measurement - Performing an Id - Vd Application test.
    1. Id-Vd measurement setup
    2. Executing a measurement
    3. Data Display
    4. How to use the Test Result Editor
3. Managing your setup
4. Summary



Application Test Mode supports measurements in three easy steps by utilizing extensive libraries of hundreds of pre-defined tests.

Step 1: Select a measurement from one of the furnished libraries.

Step 2. Modify the measurement parameters as needed.

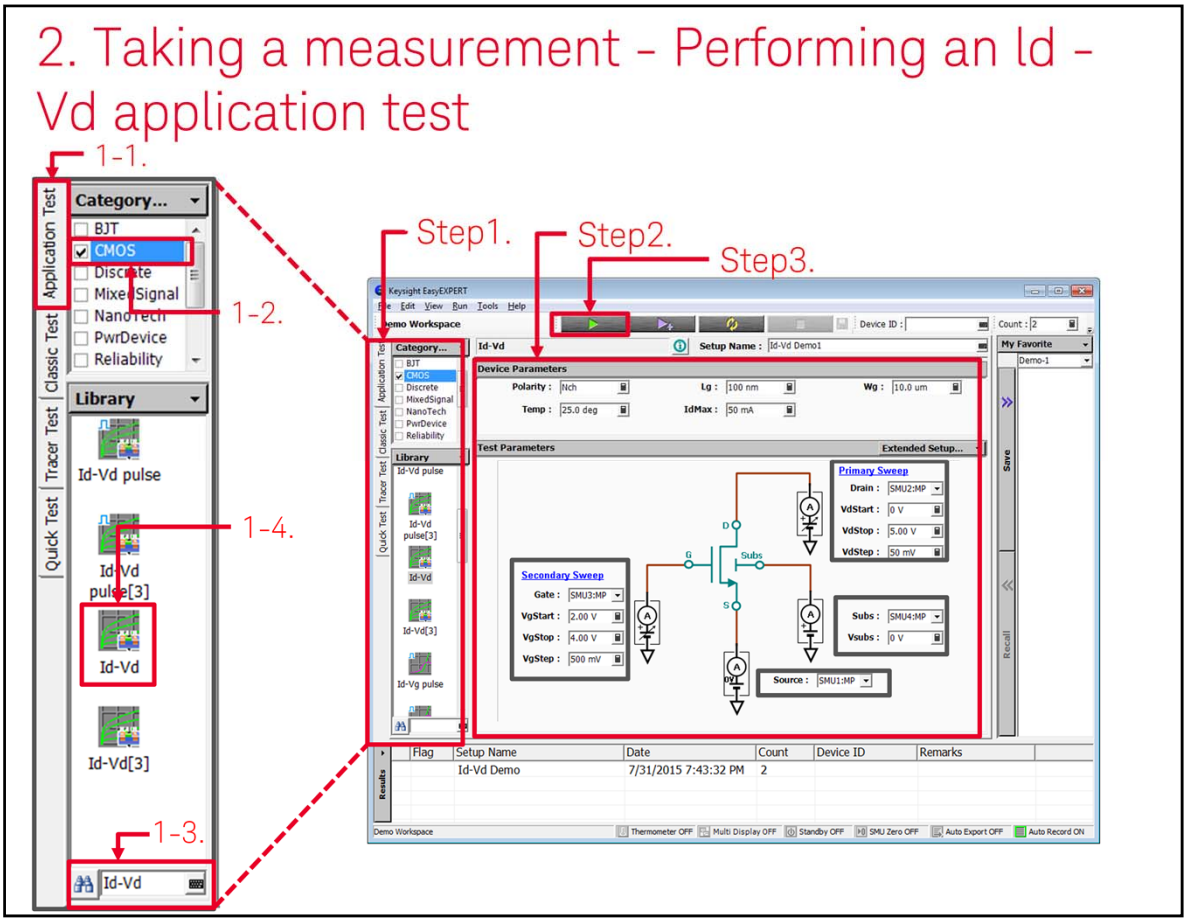
Step 3. Click the measure button to start the measurement.

=> Measurements are performed and parameters are automatically extracted.

– You can store your chosen test setup (Step 2) into a "My Favorite Setup" list for quick future execution.

– Application tests can easily be modified and customized using EasyEXPERT's built-in graphical programming environment.

– For customized tests, Classic Test mode which allows full hardware control is also available as detailed in Lab2 – Classic Test Mode.



Let's start the Lab. Using application test mode, measurements can be executed in three simple steps.

– Step1:Select a measurement from one of the furnished libraries.

1-1. Click "Application Test" Tab

1-2. Put a check mark to CMOS in the Category menu.

1-3. Input "Id-Vd" into the Incremental search box.

1-4.Select Id-Vd, then click "Select".

– Step2:Modify the measurement parameters as needed.

Enter the following parameters,

Polarity	Nch	Lg	100nm	Wg	10.0um
Temp	25.0 deg	IdMax	50mA		

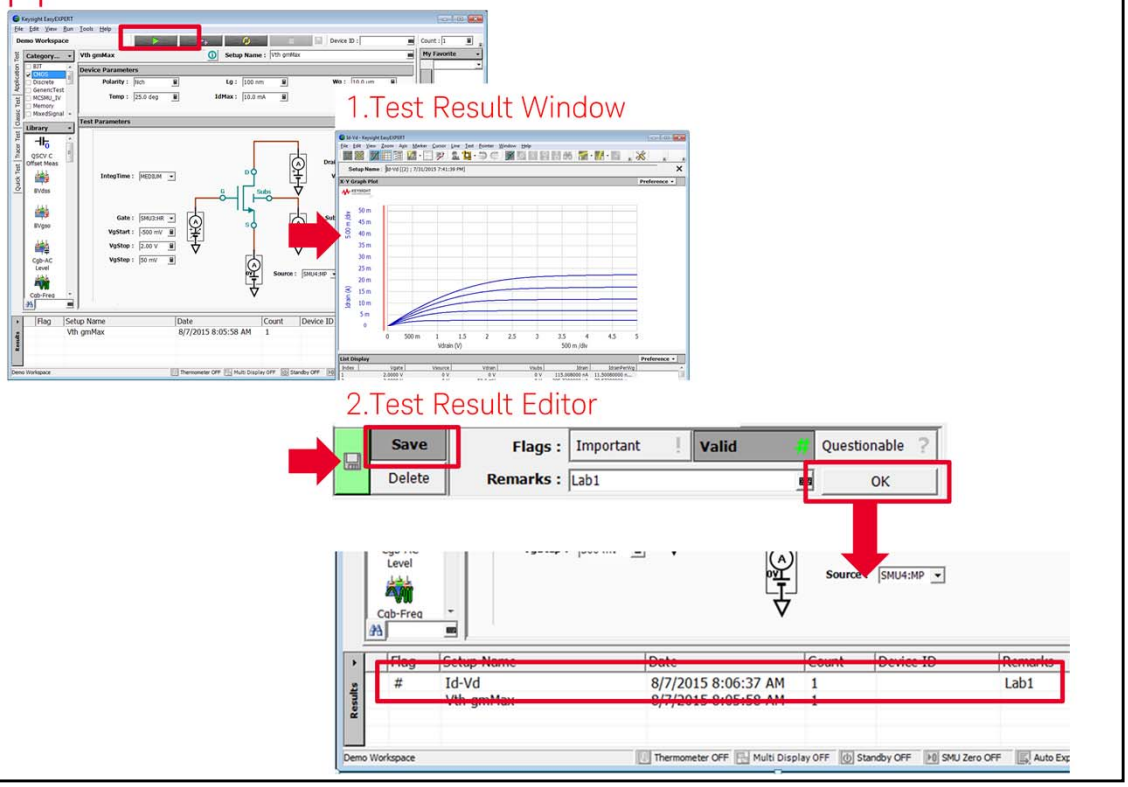
Primary Sweep	
Gate	SMU3:MP
VgStart	2.00V
VgStop	4.00V
VgStep	500mV

Secondary Sweep	
Drain	SMU3:MP
VdStart	0V
VdStop	5.00V
VdStep	50mV

Subs	SMU4:MP
Vsubs	0V
Source	SMU1:MP

– Step3:Click the measure button to start the measurement.

2. Taking a measurement - Performing an Id - Vd application test



– After you click the single measure button,

  1.The Test Result window showing the measurement data of the Id-Vd Demo application test will open.

  2.The Test Result Editor box will pop up after each measurement.

– To save your data:

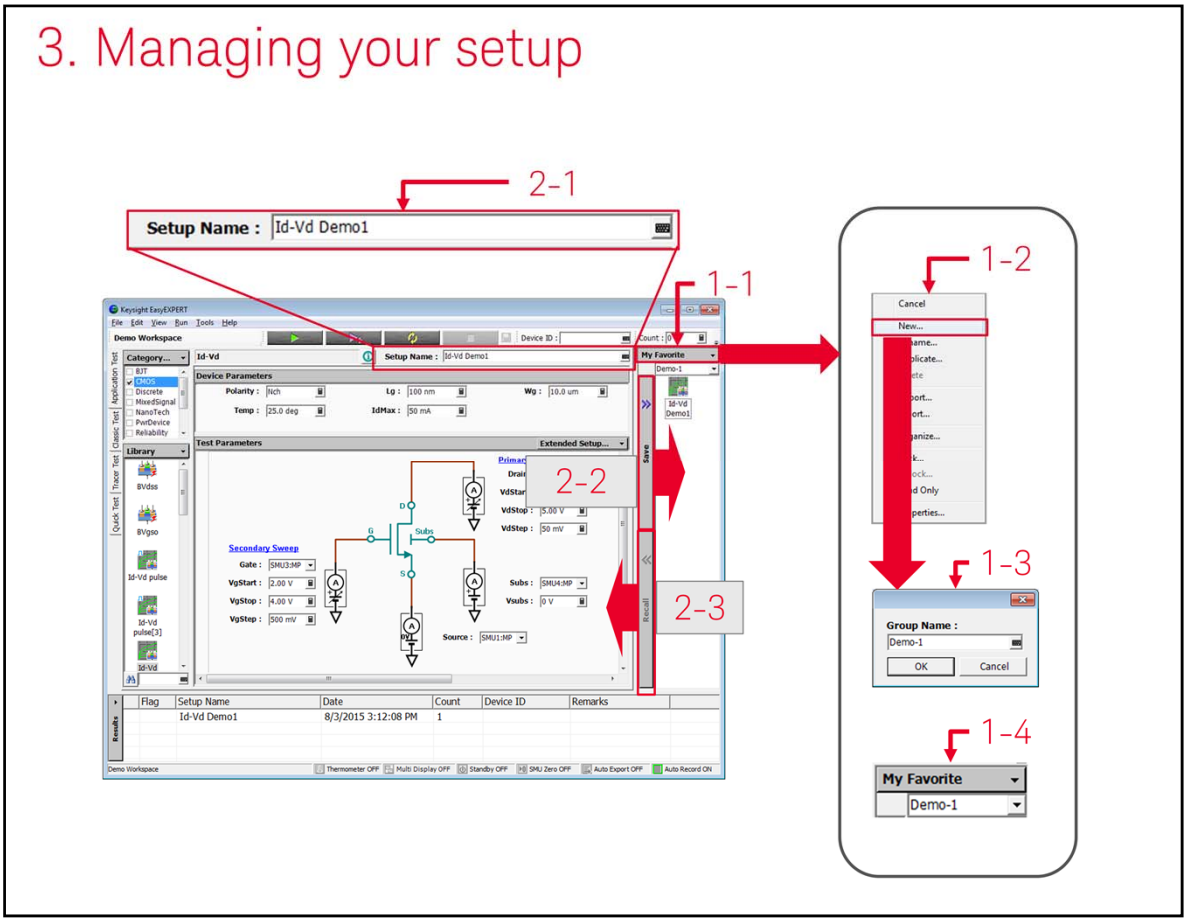
  - Unless you click the "Delete" button on the "Test Result Editor", by default, all of your measurement data will be saved to the "Test Record List" area.
  - You can add “Flags” (to indicate the status of your test result) and “Remarks” to your test result, and you can use these parameters for filtering your test results when you produce a report.

    You can ignore this window if there is no comment on the measurement result. Your data is saved automatically.
  - If you do not wish to save this test result, click "Delete". The data will still automatically be saved and flagged as deleted data.

– Analyzing your data:

  - You can analyze your measurement data - please see Lab 3: "Graph Analysis Function" for details.

3. Managing your setup



– Saving the setup with modified parameters:
  - You can save the setup with modified parameters into "My Favorite Setups (preset group)“. You can create your own groups and save your setups within them. It allows you to quickly start the measurement without the need for parameter modification. The test setup can be exported and imported by the group level.

– To create a new group:

  1-1. Click "My Favorite Setups". -> "My favorite Setup" menu opens.

  1-2. Click "New ... " -> "Group Name" the input window will pop up.

  1-3. Enter the Group name, for example "Demo-1“ and click "OK" .

  1-4. A new preset group is created.

– To save and recall an application test setup:

  2-1. Enter a new setup name to "Setup name" field, for example, Id-Vd Demo1

  2-2. Click "save" - the test setup is saved to "My Favorite Setup group“

  2-3. To recall a test setup, select it from within your chosen setup group and click the "Recall" button.

4. Summary

We learned the following in this lab:

- What a Application Test mode is
- How to perform an application test
- How to set up an application test

Lab 2: Fully customizable measurement parameter test mode -Classic Test mode

Objective:

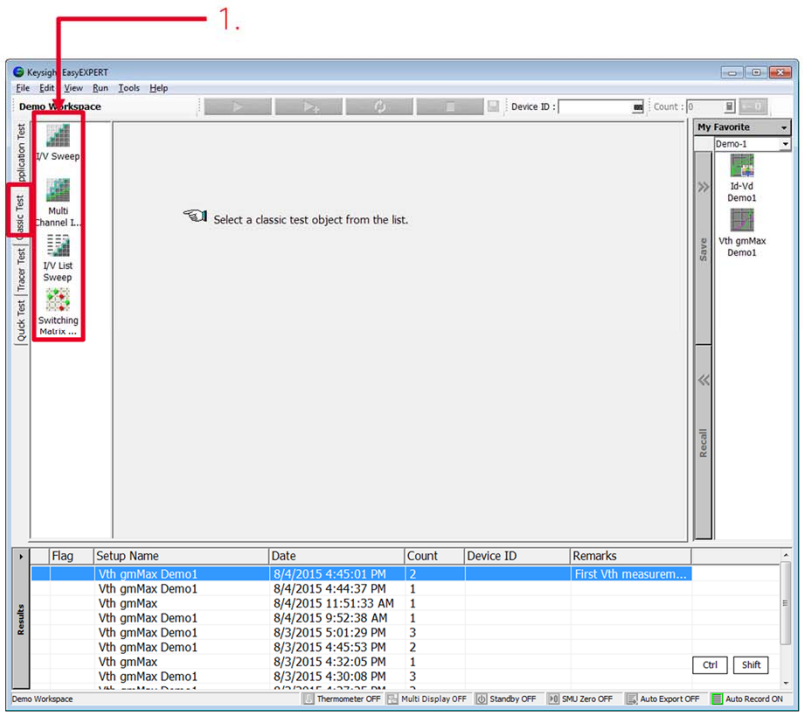
Classic Test mode provides direct access to the analyzer's hardware capabilities. By taking full advantage of the windows-based features, you can set various parameters such as output voltage/current, number of sweep steps, range etc.

In this Lab you will learn how to take a measurement using "Classic Test mode", enabling you to take customized measurements in the future.

Contents

1. What is Classic Test mode?
2. Taking a measurement - Creating an Id - Vg Classic test
    1. How to select Classic Test mode
    2. Channel setup
    3. Setting up a measurement
    4. Function setup
    5. Setting up auto analysis
    6. Display setup
3. Executing your measurement
4. Summary

1. What is Classic Test Mode?



– What is Classic Test mode?

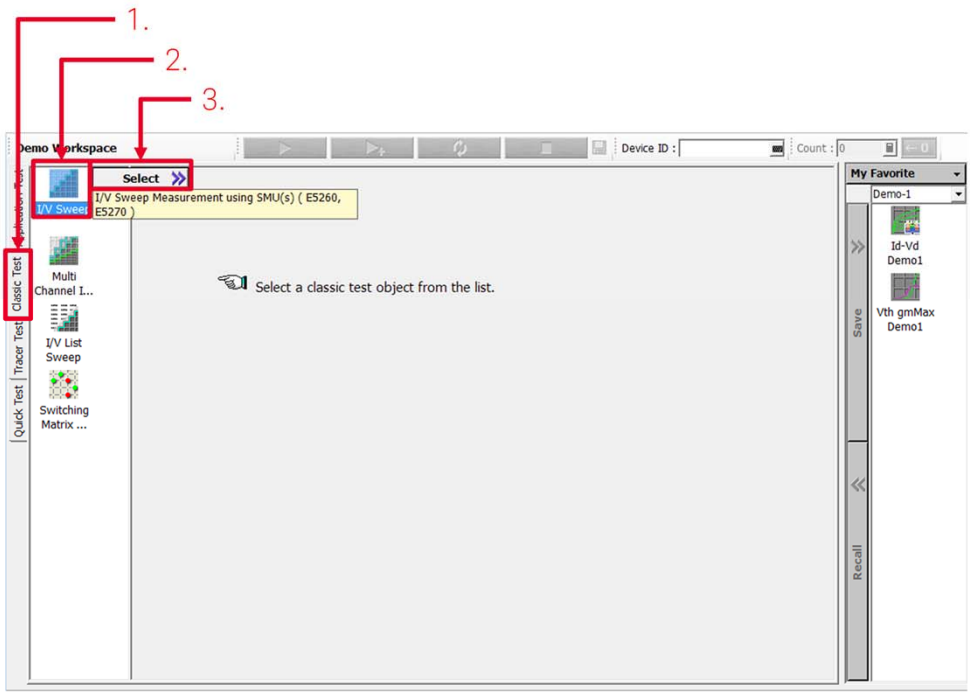
- Classic Test mode can be used as a standalone test engine and it can define a unique test.
- Any application or functionality not furnished in the Application Test library can be performed using Classic Test mode.
- The user interface of the Classic Test mode can be easily learned and adopts the same concepts as the Keysight 4155/56 parameter analyzer that has been the 'go to' standard analyzer for some time.
- Classic Test mode represents the fundamental method of instrument control, and all of the pre-defined application tests included in the Application Test mode libraries internally use the Classic Test mode.

– Classic Test mode

The following modes are available.

- I/V Sweep: For X-Y measurements of I or V.
- Multi Channel I/V Sweep: For simultaneous multi channel sweep measurements of I or V.
- I/V List Sweep: For multi channel I/V sweep measurements using list data.
- Switching Matrix Control: For B2200/E5250 switching matrix control.

2. Taking a measurement - Selecting Classic Test Mode



Let's start the Lab. In this Lab, you will be taking the same measurement as the Vth gmMax Application Test undertaken in Lab 1, but this time in Classic Test Mode.

Note: In this Lab, you will learn the various parameters of Classic Test mode. See the EasyEXPERT User's guide for further details.

– To Select Classic Test Mode

I/V Sweep Classic Test mode is used in the demonstration.

Alternatively, you can use "Multi Channel I/V Sweep" Classic Test mode. There is no difference between the two tests but there is a minor difference in the user interface when setting up the measurement parameters.

– Follow the next steps to open the I/V Sweep Classic Test mode:

1. Click "Classic Test" tab

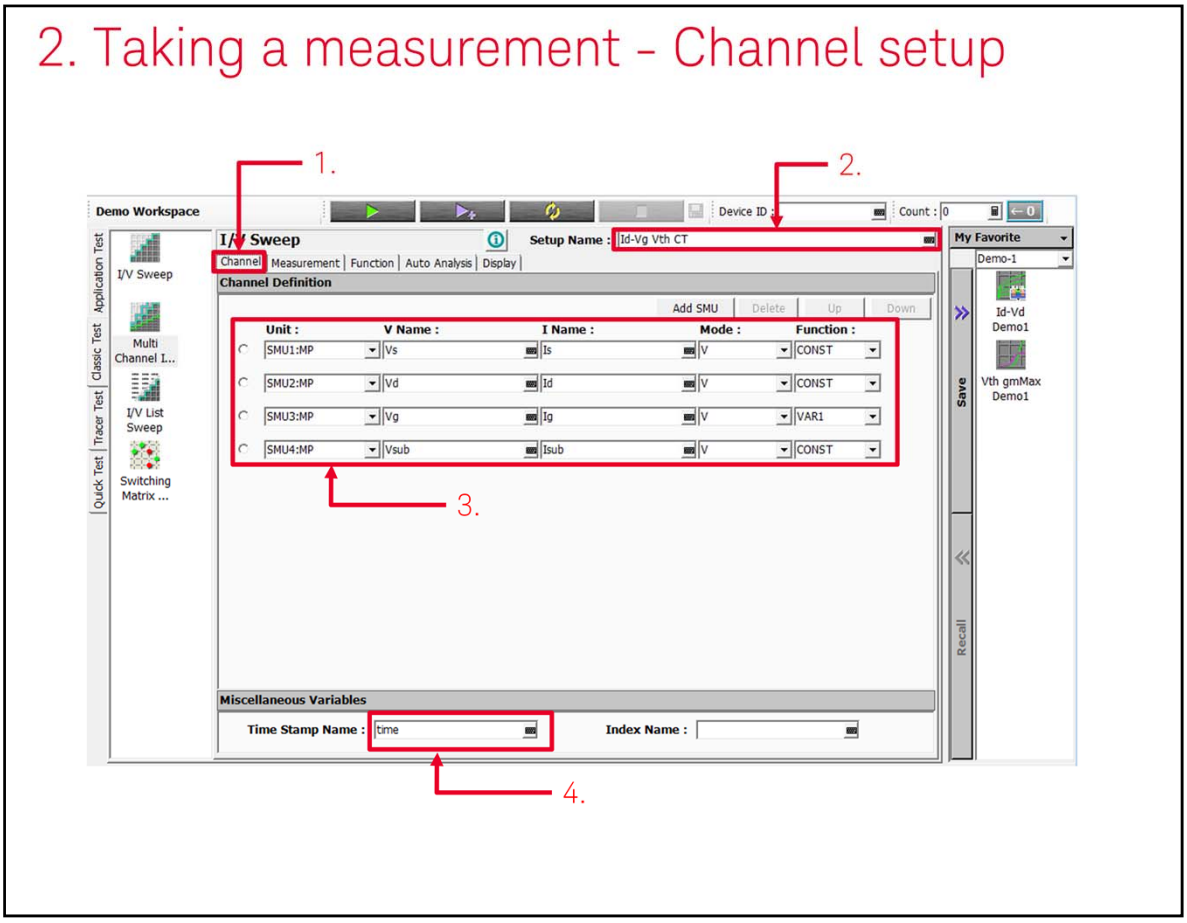
   The Classic Test execution mode icon appears.

2. Click I/V Sweep mode icon.

   "Select" button appears.

3. Click "Select" button.

   The I/V Sweep classic test setup editor with Channel Definition page opens.



– Define Source/Measure Channels

1. Click the Channel Setup tab to display the channel definition screen.
2. Enter the Setup Name for the test setup to be defined on the setup editor.
   Enter "Id-Vg Vth CT". Note: The suffix CT denotes "Classic Test mode".
3. List the SMUs used for source output: Note: You can delete unused SMUs from the list.
4. Enter the following parameters for the selected SMUs.

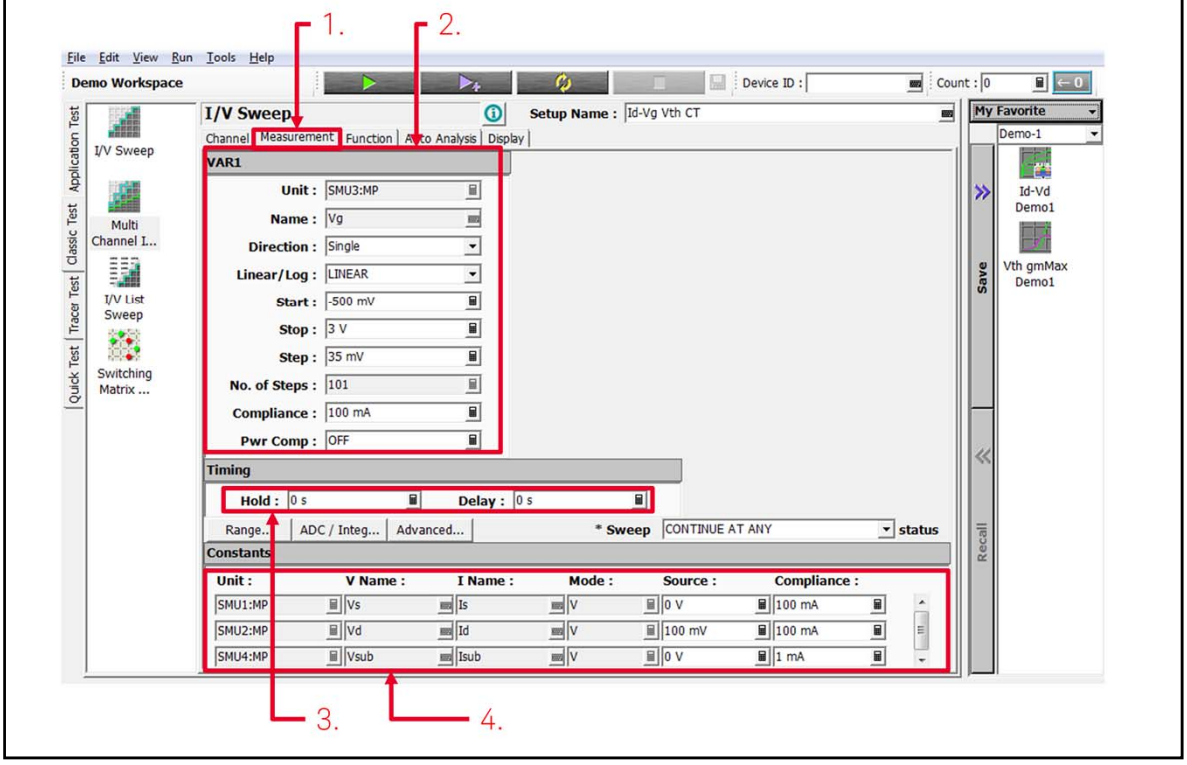
Unit:	V Name:	I Name:	Mode:	Function:
SMU1	Vs	Is	V	CONST
SMU2	Vd	Id	V	CONST
SMU3	Vg	Ig	V	VAR1
SMU4	Vsub	Isub	V	CONST

5. (Optional): Time Stamp setup

You can record the measurement timing of each sweep step (VAR1).

If you choose this option, enter a variable name in this field, for example "Time".

2. Taking a Measurement - Setting up a measurement



– Measurement Setup

Click the Measurement Setup tab to display the measurement parameter definition screen. The Measurement Setup tab screen is used to set the source output value parameters.

– Setting the Measurement Setup page:

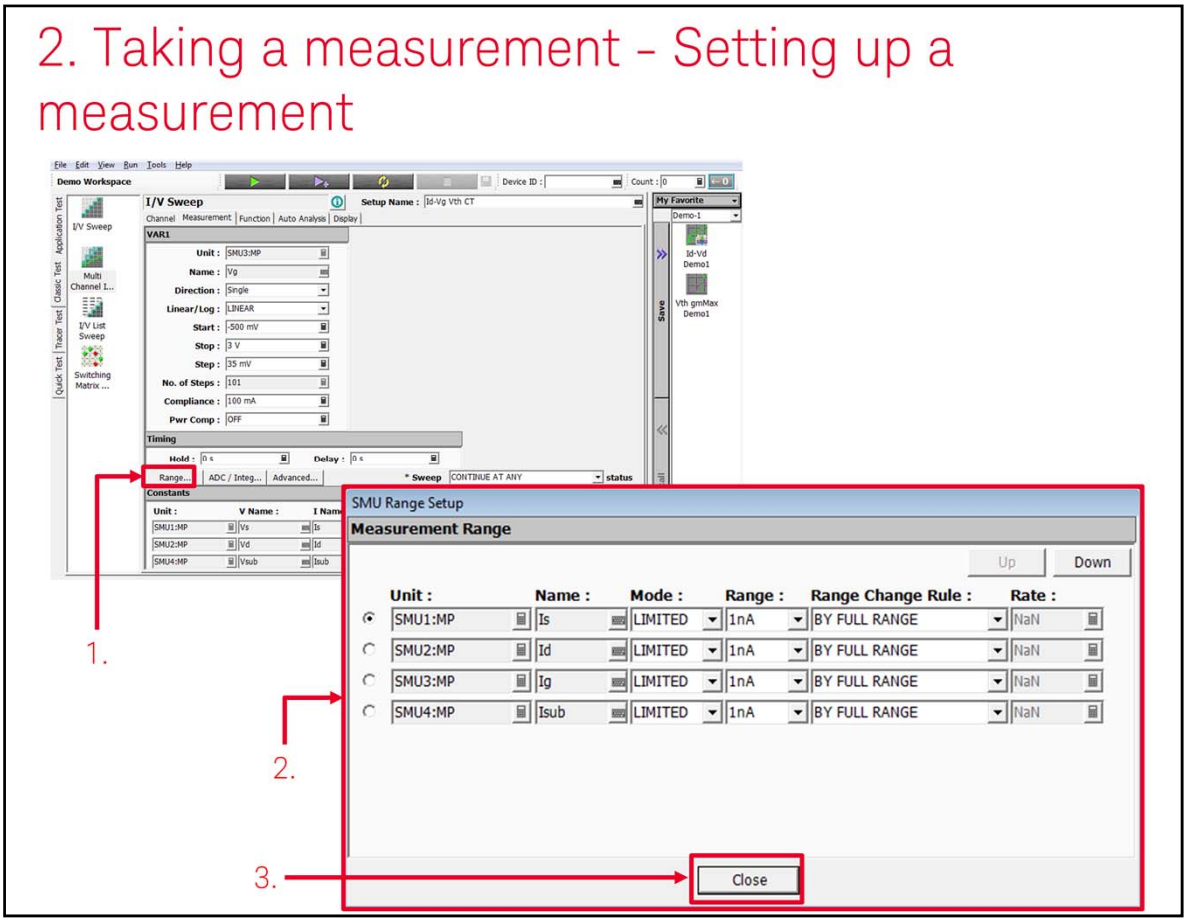
1. Setting the Primary Sweep Source: VAR1 parameters. Enter the following parameters:

Unit:	Name	Direction	Linear/Log	Start	Stop	Step	No. of Step	Compliance	PwrComp
SMU3	Vg	Single	Linear	-500mV	3V	35mV	101	100uA	OFF

2. Setting the Constants: CONST parameters. Enter the following parameters:

Unit:	V Name	I Name	Mode	Source	Compliance
SMU1	Vs	Is	V	0V	100mA
SMU2	Vd	Id	V	100mV	100mA
SMU4	Vsub	Isub	V	0V	1mA

2. Taking a measurement - Setting up a measurement



– Setting the Ranging Mode

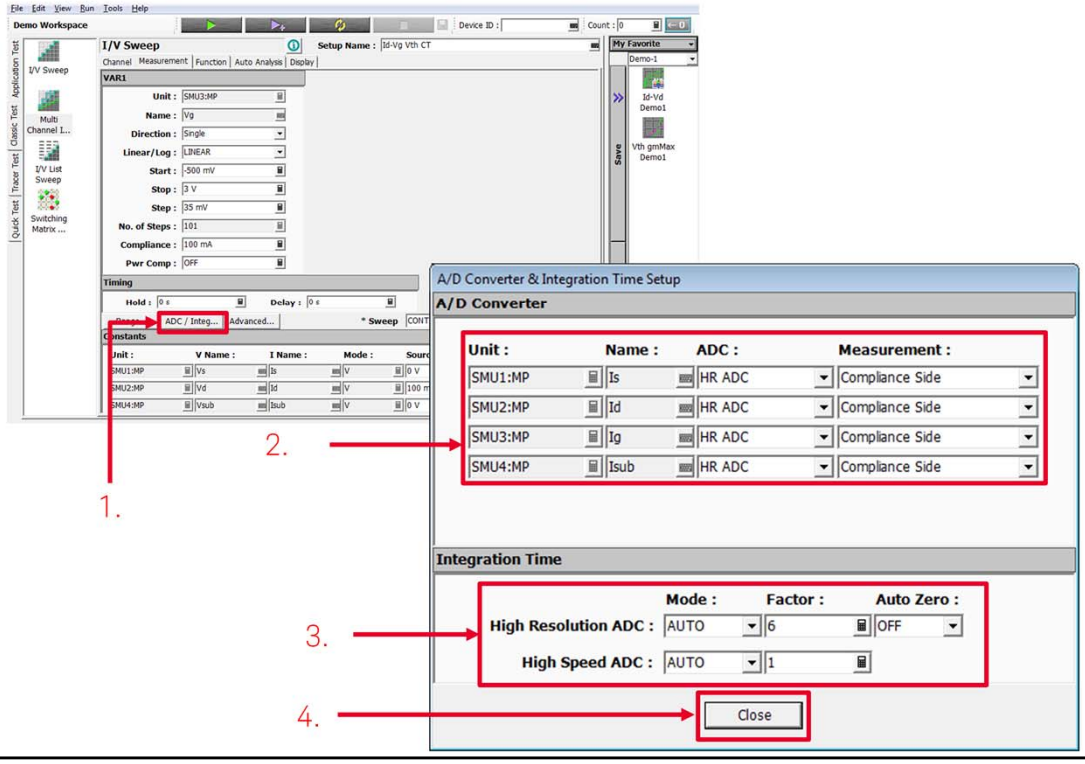
The dialog box is used to set the measurement ranging mode.

The available minimum range depends on SMU type.

– To Set the Measurement Range:

1. Click the Range button.
2. The SMU Range Setup dialog box opens. Set the following parameters by necessity.
   - Unit: SMU name or number
   - Name: Variable name for the measurement data
   - Mode: Ranging mode, AUTO, LIMITED, or FIXED
   - Note: For the limited auto ranging, the instrument does not use a range lower than the specified range value.
   - Range: Range value
   - Range Change Rule: BY FULL RANGE, GO UP AHEAD, or UP AND DOWN AHEAD
   - Rate: Value used for range changing.
   - Specify the Rate value, 11 to 100, which fixes the boundary of the ranging.
3. Click “Close”.

2. Taking a measurement - Setting up a measurement



– Setting the ADC/Integration Time

The dialog box is used to select the ADC for each SMU and to set the integration time for each ADC (high resolution or high speed).

– To set the ADC/Integration Time:

1. Click the “ADC/Integ” button. The A/D Converter & Integration Time Setup dialog box opens.
2. A/D Converter Setup:

- Unit: SMU name or number
- Name: Variable name of the measurement data
- ADC: ADC type, HR ADC (high resolution) or HS ADC (high speed)
- Measurement: Compliance side measurement or Force and Compliance sides measurement.

3. Integration Time Setup:

- Mode: ADC operation mode
- Factor: Coefficient for the reference value of the integration time.
- Auto Zero: Auto Zero function ON or OFF. For HR ADC.

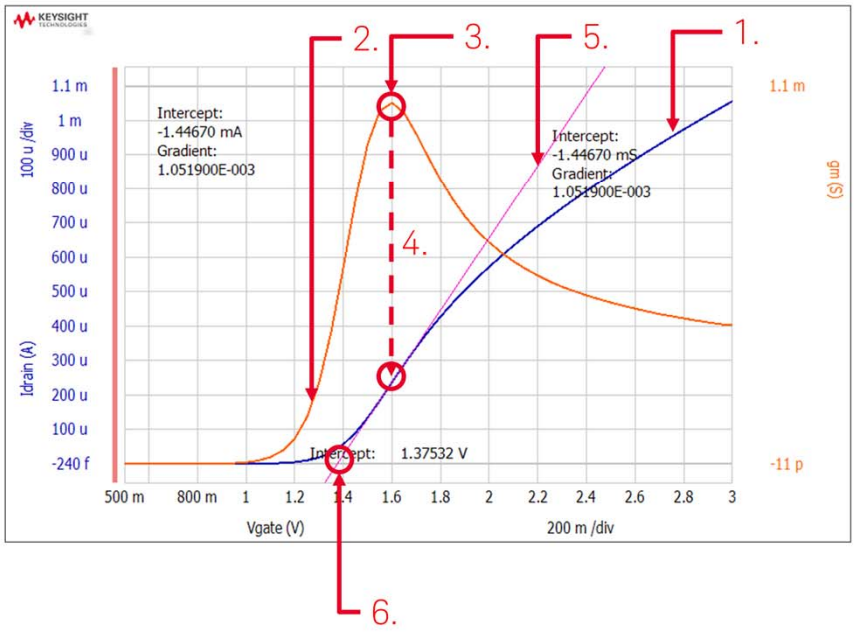
– HR ADC Set Example:

Integ Time	Mode	Factor
Short	AUTO	8
Medium	PLC	1
Long	PLC	16

Note: Vth definition of “Vth gmMax“

Vth definition of “Vth gmMax” application test:

- Vth = Von – Vd / 2



– Vth definition of “Vth gmMax“

The definition of the threshold voltage Vth used in the "Vth gmMax" application test is

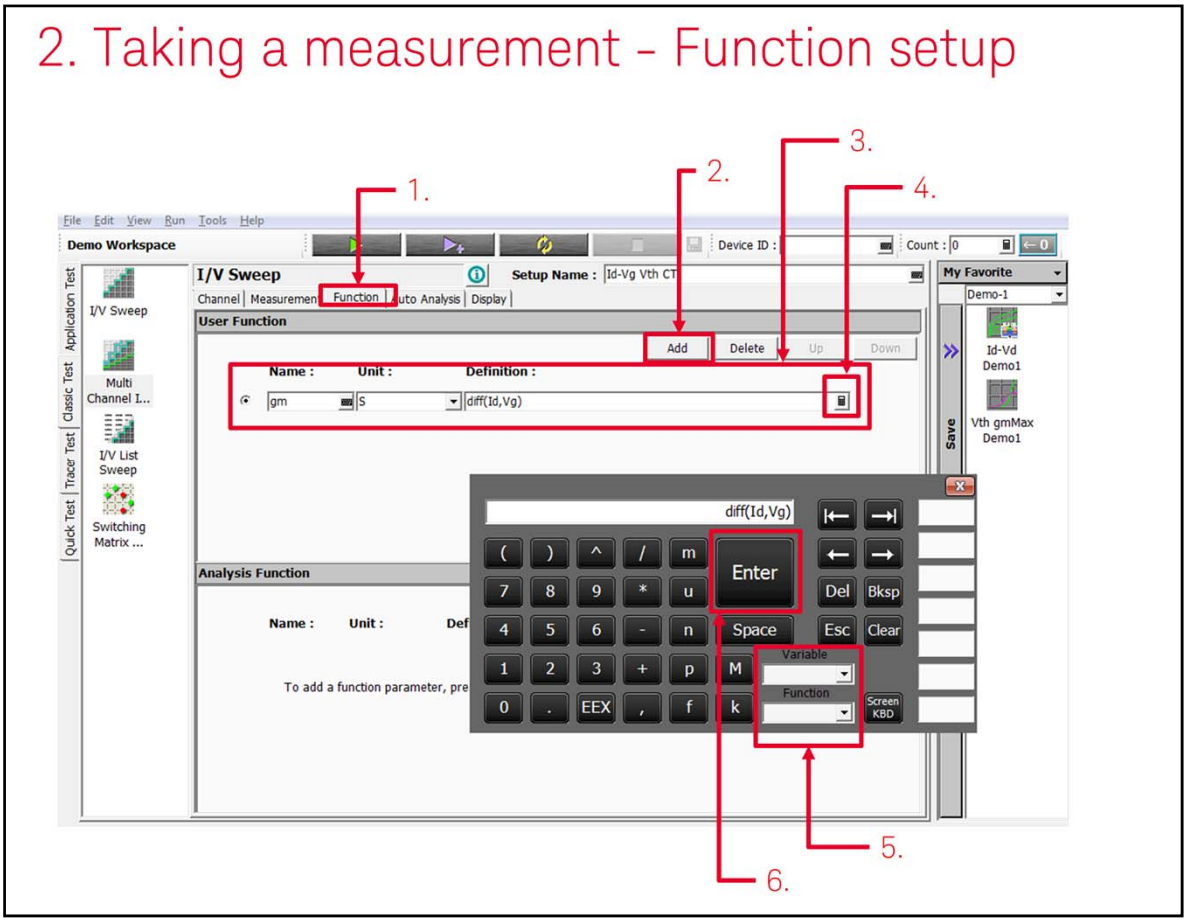
Vth=Von-(Vd/2)

where,

- Von is the Vgs intercept of the tangent line drawn on the Id-Vg curve at the maximum gradient point.
- Vd is the drain voltage applied to the drain for measuring Id-Vg characteristics.

– To find the maximum gradient point of Id-Vg characteristics:

1. Measure the Id-Vg characteristics.
2. Create the Gm curve by differentiating the Id-Vg curve.
3. Find the maximum point of Gm curve, the X-coordinate.
4. Put a marker on the X-coordinate found in step 3 on the Id-Vd curve. This is the maximum gradient point of the Id-Vg curve.
5. Draw a tangent line on the marker of the Id-Vg curve.
6. The intercept of this line on the Vgs X-axis is the Von, and the Vth is calculated by Vth=Von-Vd/2.



– Setting the User & Analysis Function

Click the Function Setup tab to display the User Function/Analysis Function setup screen.

The user functions can be displayed on the X-Y Graph Plot, List Display, and Parameters area of the Data Display window.

The analysis functions can be displayed on the Parameters area of the Data Display window.

We set up the same Vth analysis function used in the Lab 2 "Vth gmMax" application test definition.

– To Set User Function:

1. Click the “Function” Setup tab.
2. Click "Add" to display the User Function setup line.
3. The User Function Setup line will appear.

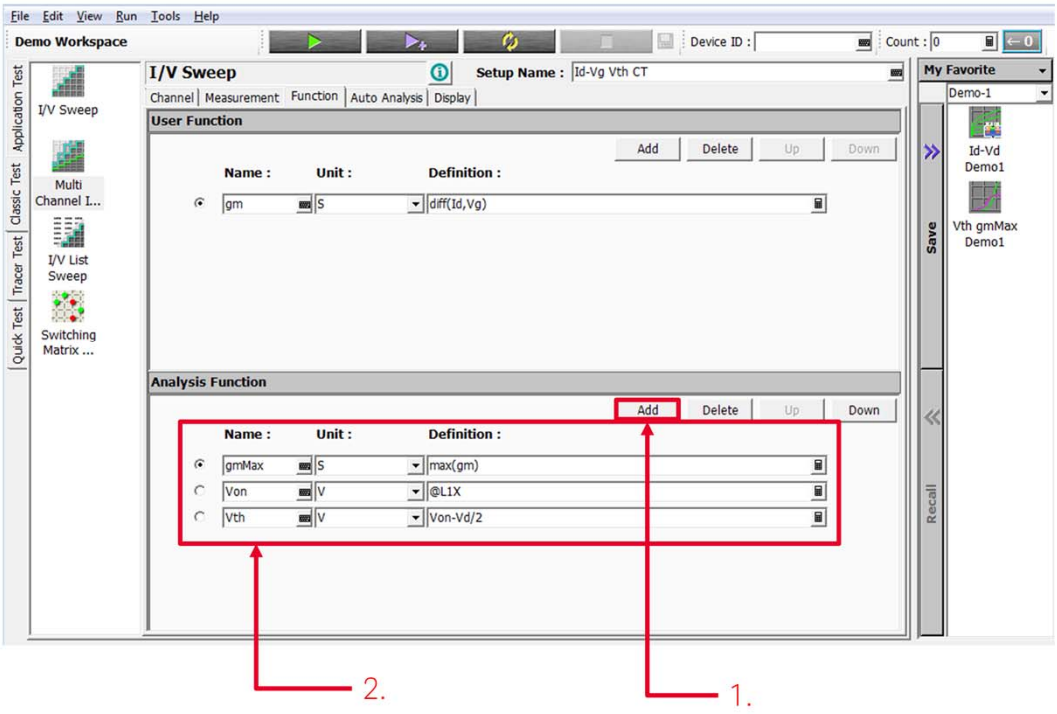
Set the following parameters:

Name:	gm	Unit:	S	Definition:	diff(Id,Vg)

Tips: To enter the Definition.

4. In the Definition field, open the keypad.
5. Click the down arrow of the Variable field and Function Field to set the parameters. You can select from the available “Variable” list and available “Function” list. This will eliminate typos and result in faster test setup.
6. Click “Enter” to save the definition.

2. Taking a measurement - Function setup



– To Set the Analysis Function:

1. Click "Add" to display the Analysis Function setup line.
2. The User Function Setup line appears.

Set the following parameters:

Name	Unit	Definition	Note
gmMax	S	max(gm)	Search the maximum value of gm
Von	V	@L1X	Find the intercept of X axis of LIne1
Vth	V	Von-Vd/2	Calculation

· Name: Function name

· Unit: Unit of the function

· Definition: Definition of the function. The following identifiers can be used.

-Variables for the measurement/output data used in this test

-Functions defined in the above lines

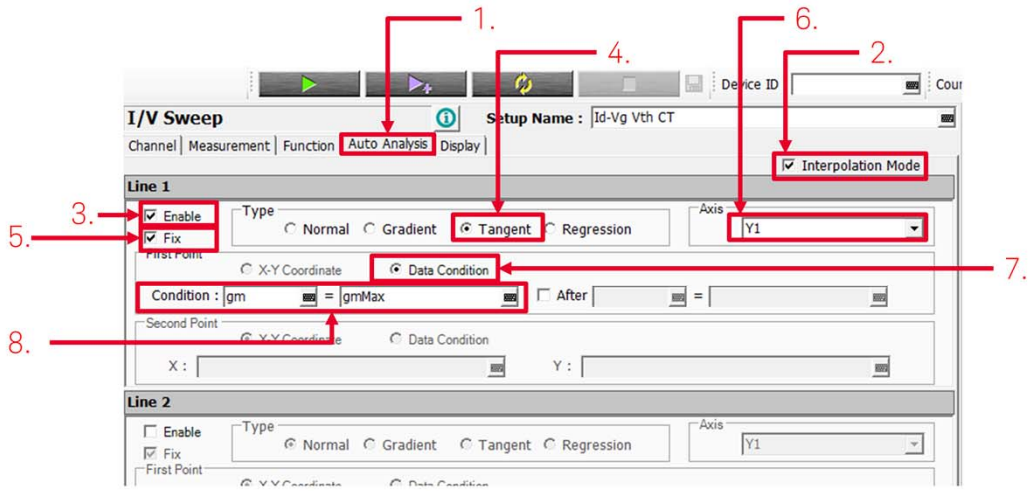
-Local variables passed from the application test that calls this test as a component

-Built-in functions and global variables

-Read out functions

For details, see online help or User's Guide.

2. Taking a measurement - Setting up auto analysis



– Auto Analysis Line Function Setup

Click the Auto Analysis Setup tab to display the auto analysis setup screen.

The auto analysis capability allows you to display/move the marker/line on the data graph automatically after the measurement has been taken.

The above example draws a tangent line at the gmMax data point for Y1 data (=Id).

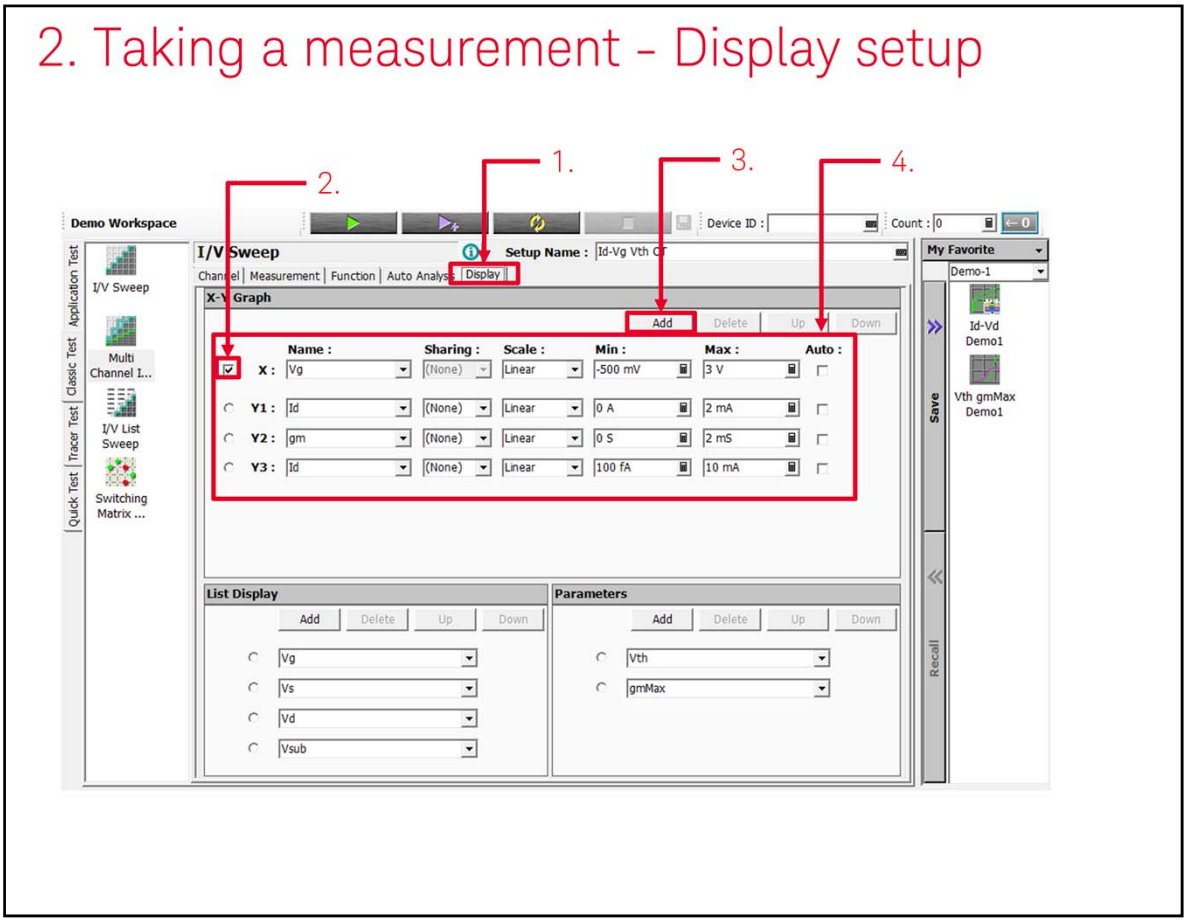
– To Draw a tangent Line on a Specific Y1-axis Data Point:

Create an automatic line analysis by following the next steps.

1. Click the “Auto Analysis” Setup tab.
2. Put a check mark in the "Interpolation mode" box: You can position the marker between measurement points.
3. Put a check mark in the "Enable“ box to enable Line 1.
4. Select Line Type: “Tangent” line.
5. Put a check mark in the "Fix" box of Line 1. This will fix the line on the Y1 axis.
6. Select the effective axis to draw the line: Y1 line
7. Put a check mark in the "Data Condition" box to set a condition to draw a line. The line is drawn on a data point.
8. Enter a variable name and a condition expression to specify where you want the marker to be displayed and draw a tangent line on the marker.

Enter the following condition to set the data condition:

Condition: gm = gmMax



– Defining the Data Display Parameters

1. Click the “Display” Setup tab to display the data display setup screen.
   - The X-Y Graph area is used to set the X axis and Y axis of the X-Y Graph Plot area in the Data Display window.
   - The List Display area selects the variables to be listed in the List Display area of the Data Display window.
   - The Parameters area selects the variables to be listed in the Parameters area of the Data Display window.

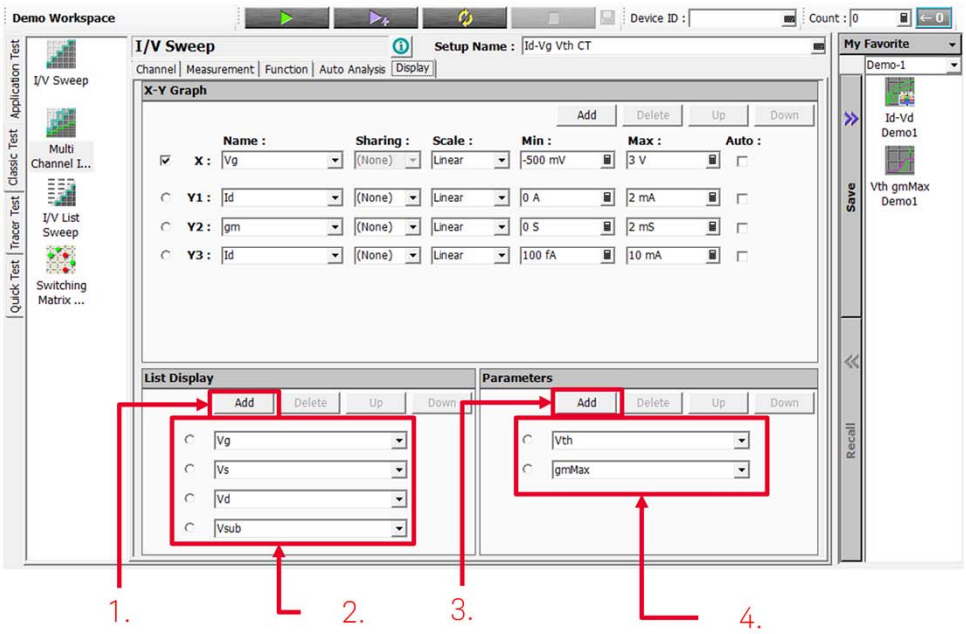
– To set the X-Y Graph:

Follow the next steps to define the X-Y Graph.

2. Put a check mark in the box of X: axis input line. The X-axis input field becomes active.
3. Click the "Add" button to add an additional line. Y1, Y2 and Y3 scale input field will open.
4. Enter the following parameters:

Axis	Name	Sharing	Scale	Min	Max
X	Vg	(None)	Linear	-500mV	3V
Y1	Id	(None)	Linear	0V	2mA
Y2	Gm	(None)	Linear	0S	2mS
Y3	Id	(None)	Linear	100fA	10mA

2. Taking a measurement - Display setup



– Setting the List Display:

Follow the next steps to define the list display.

1. Click the "Add" button to add a list display line.
2. The list display line will appear.

Enter the following parameters:

- Vg, Vs, Vd, Vsub

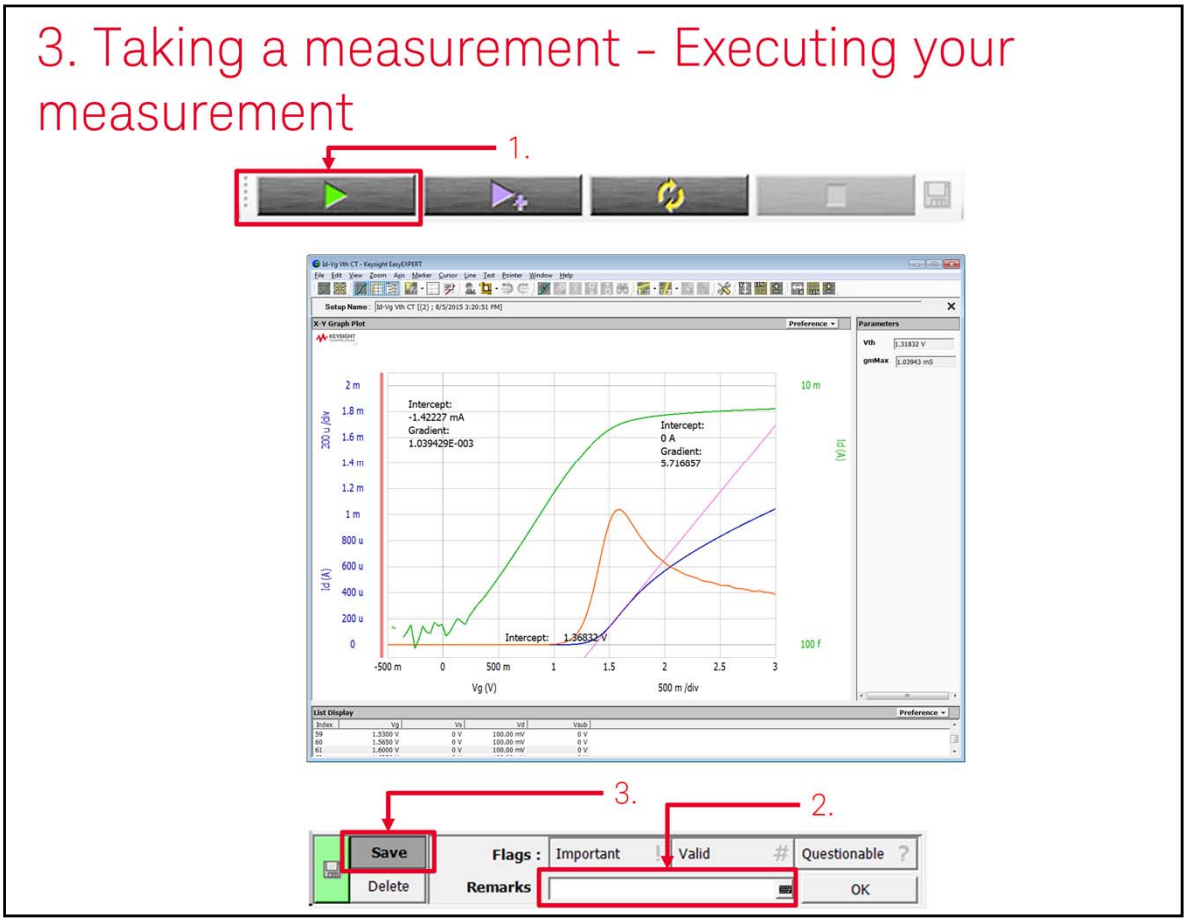
– Setting the Parameters area:

Follow the next steps to define the Parameters area.

3. Click the "Add" button to add a list parameter line.
4. The list parameter line will appear.

Enter the following parameters:

- Vth, gmMax



– Executing a measurement

1. Click the “Measure” button to start the measurement.

The Test Result window showing the measurement data of the Id-Vg Vth Classic Test will open and the Test Result Editor will pop up after each measurement.

– Test Result Editor

2. In the "Remarks" field of the Test Results Editor enter, for example "First Vth measurement".
3. Click "OK". The data will be re-saved.

4. Summary

We learned the following in this lab:

- What Classic Test mode is
- How to produce a test setup in Classic Test mode
- How to execute a measurement

Lab3 : Graph Analysis features

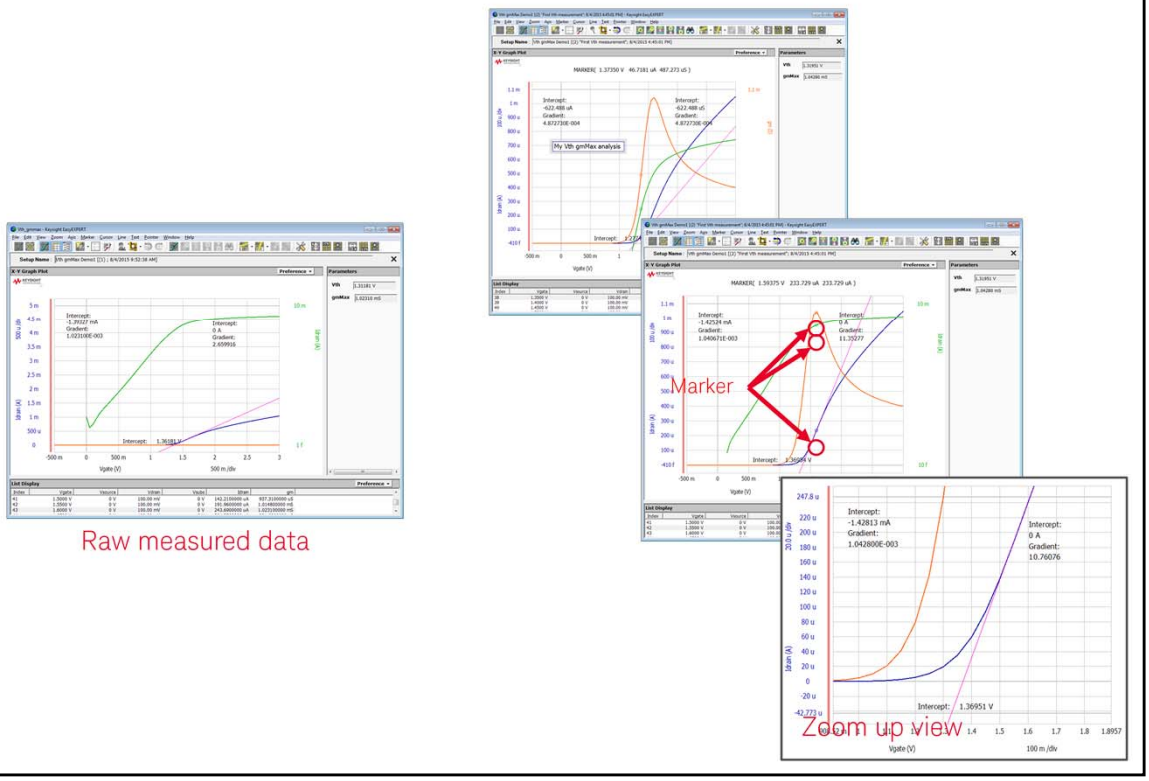
Objective:

In this Lab, you will learn about graph analysis features. EasyEXPERT provides powerful graphical and analysis features including auto pop-up data display windows and graph analysis that can be applied to data display such as auto-scaling, marker, multiple Y axes capabilities etc.

Contents

1. The Analysis Function on Data Display
2. Taking a measurement - Performing a Vth gmMax Application test
    1. The Vth gmMax measurement setup
    2. Executing a measurement
3. Over View of Data Display
4. Graph Analysis
    1. Auto scaling the Y Axis
    2. Using the Zoom function
    3. Marker control
    4. Adding text to the graph
    5. Saving the analysis results
5. Summary

1. Using the Analysis Functions on Data Display

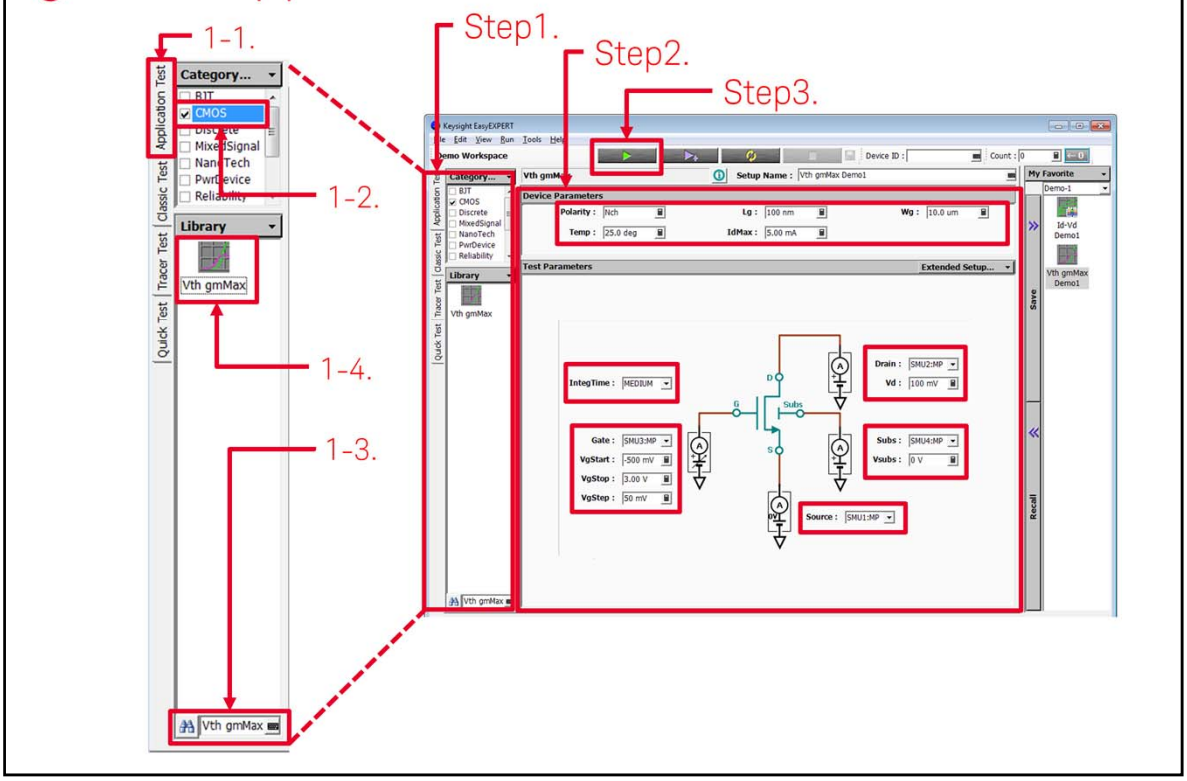


The Auto-analysis and graphical display features of EasyEXPERT help to accelerate your analysis, providing many powerful analysis tools such as auto-scaling, marker and line operation, multiple Y axes capabilities etc. For example, the data display and intuitive GUI operation allows for the quick extraction of the threshold voltage by finding the max position on the gm curve in Y2, drawing the tangent line on the Id curve in Y1 and reading out the intercept to the X axis, as illustrated below.

In this Lab, you will learn about the following analysis functions using the Vth gmMax Application Test.

1. Auto scaling the Y Axis
2. Using the Zoom function
3. Marker control
4. Adding text to the graph
5. Saving the analysis results

2. Taking a measurement - Performing a Vth gmMax Application test



– Lets start the Labs.

– Step1:Select a measurement from one of the furnished libraries.

1-1. Click "Application Test" mode.

1-2. Put a check mark in the "CMOS" category.

1-3. Find and click the "Vth gmMax" application test icon.

1-4. enter "gm" in the search field.

– Step2:Modify the measurement parameters as needed.

Enter the following parameters,

Device Parameters

IdMax	2mA

Test Parameters

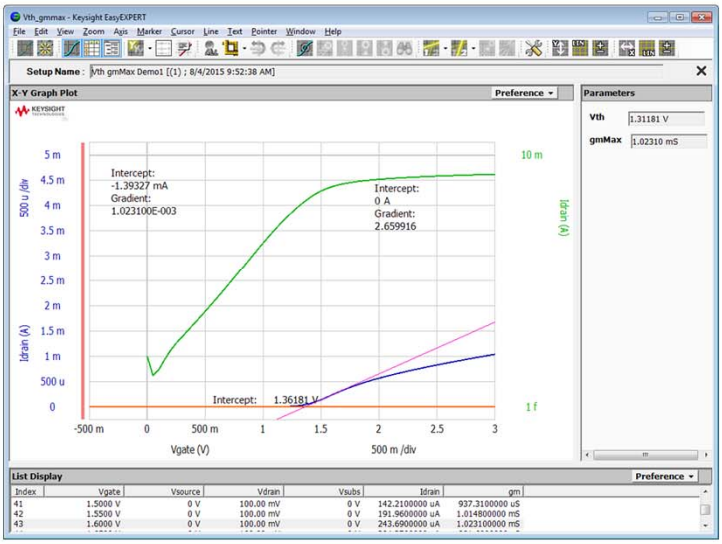
IntegTime	MEDIUM

Source	SMU1	Drain	SMU2	Gate	SMU3	Subs	SMU4
		Vd	100mV	VgStart	-500mV	Vsubs	0V
				VgStop	3.00V		
				VgStep	50mV		

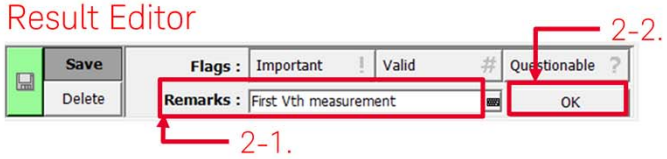
– Step3:Click the measure button to start the measurement.

2. Taking a measurement - Performing a Vth gmMax Application test

1.Test Result Window



2.Test Result Editor

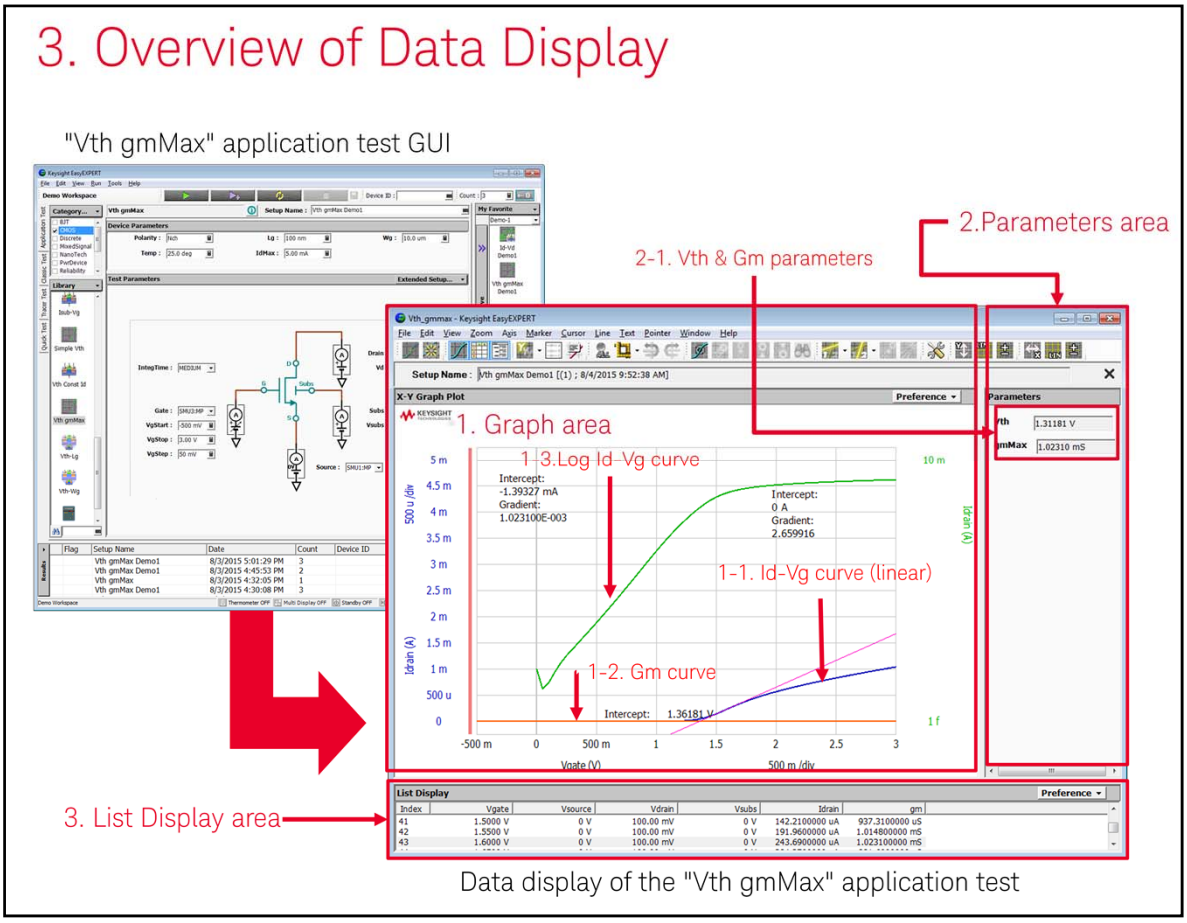


– After clicking the single measure button, the Test Result window showing the measurement data of the Vth gmMax Demo application test will open and the Test Result Editor will pop up after each measurement.

– Test Result Editor

1. Enter, for example, "First Vth measurement" in the Remarks field of the Test Result Editor.
2. Click "OK".

The data will be re-saved.



– What is a “Vth gmMax” application test?

The above slide illustrates the GUI of the “Vth gmMax” application test (left) and the data display graph that appears on the measurement or when the data is rerecalled (right).

The output of the “Vth gmMax” application test shows the following output in three categories in Data Display window.

– 1. Graph area

The graph area displays the measurement and analysis graphs with marker, cursor and lines.

1-1. Id-Vg curve (in linear scale).

1-2. Gm curve.

1-3. Log scale Id-Vg curve: This is useful for checking the low current characteristics of the MOSFET.

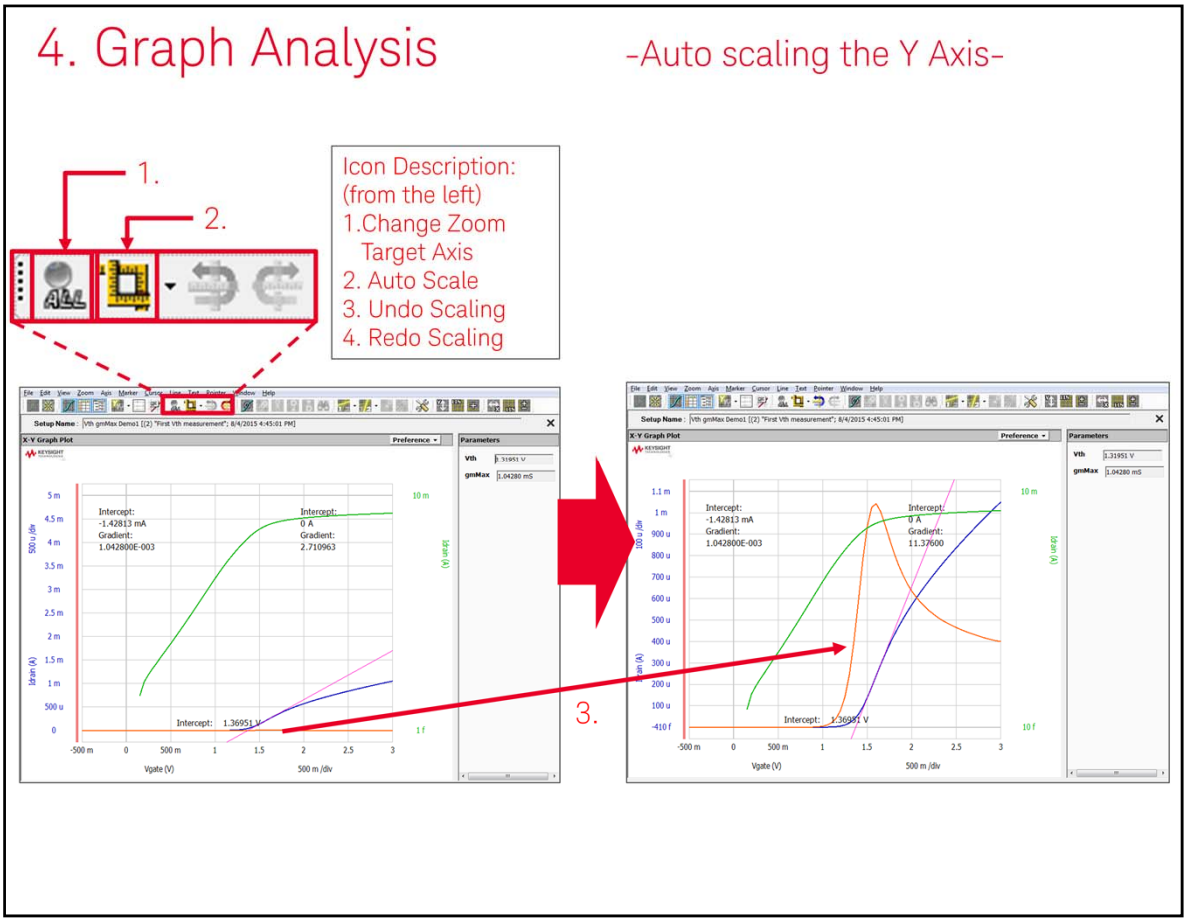
– 2. Parameters area

2-1. This shows the extracted parameters - Vth and gmMax - on the graph analysis.

– 3. List Display area

- The following parameters are listed in number format:

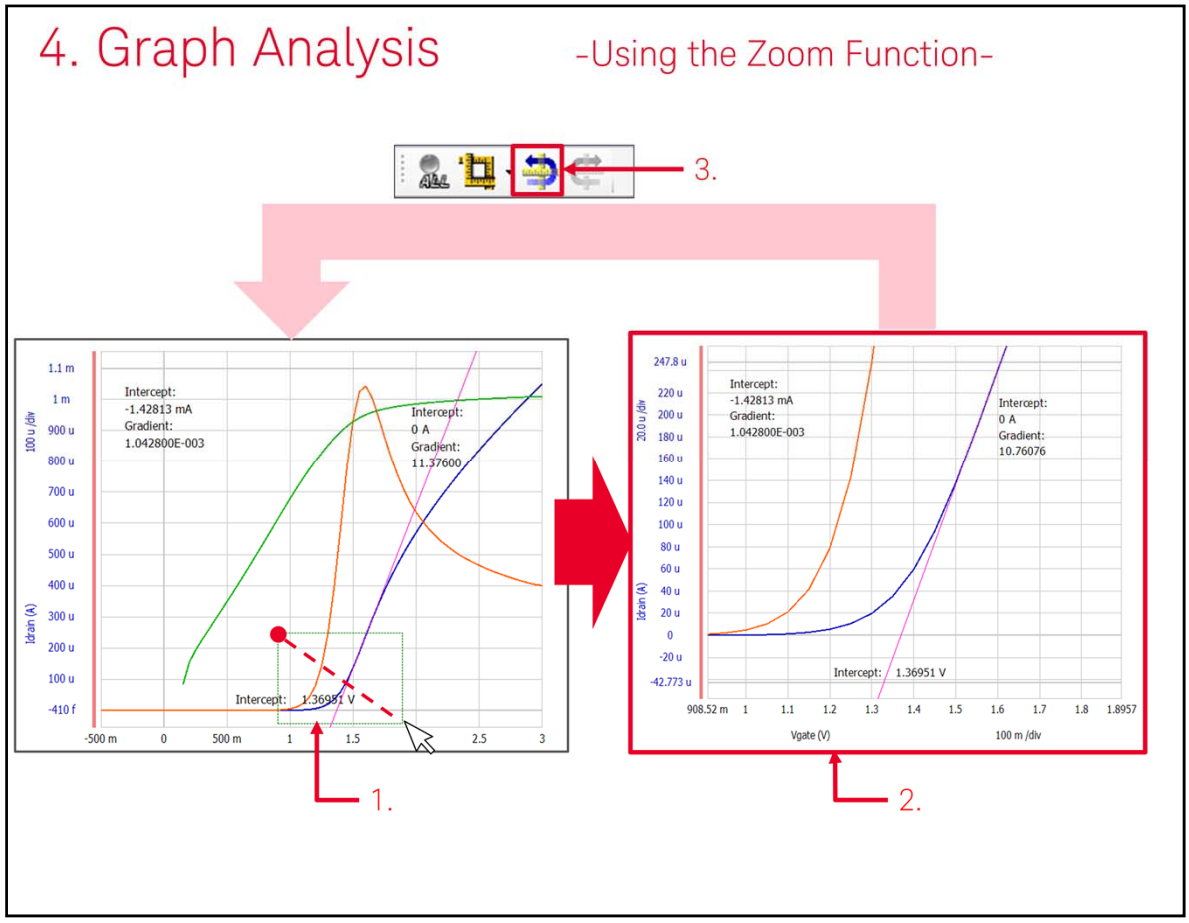
  Vgate, Vsource, Vdrain, Vsubs, Idrain, gm



– Y Axis Scaling

The orange Y2 gm data cannot read the value from the graph because the Y2 scale is too large. Change the Y axis scale as follows:

1. Click the icon and change to the .
2. Click the Auto-scale icon.
3. The graph scale is automatically changed to fit the trace in the graph.

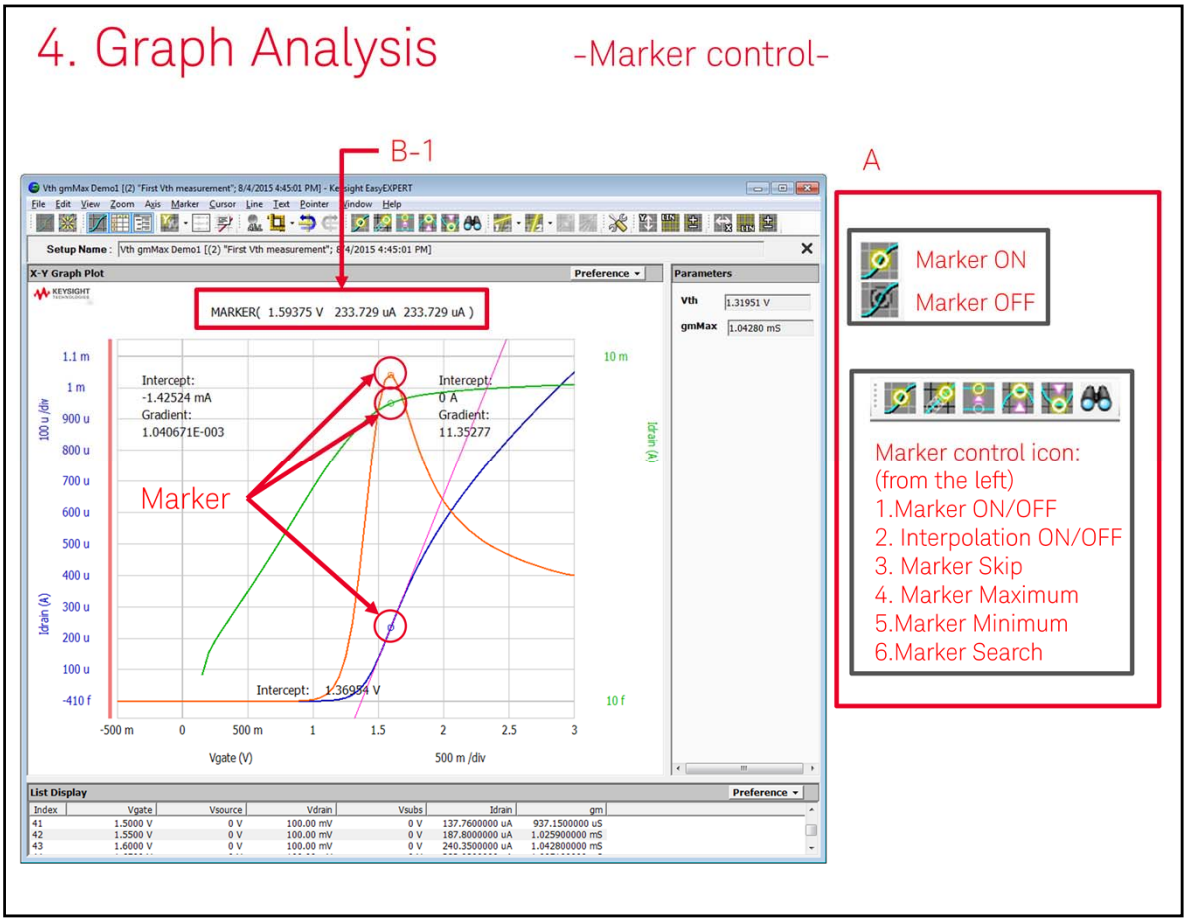


– The Zoom function

Using mouse click and drag operations, you can zoom in on the graph to check the details of the test results and the analysis data within a specified area.

– How to zoom in and cancel the zoom.

1. Choose the area you want to zoom in on using mouse click and drag.
2. This is the zoomed view
3. Click the "Undo Scaling" button to cancel the zoom.



You can control Marker functionality in several ways.

A. Controlling the Marker

EasyEXPERT has the following Marker function.

1. Marker ON/OFF icon enables or disables the marker.
2. Interpolation ON/OFF icon enables or disables the interpolation function of measurement data. You can read the interpolation data between two actual measurement points.
3. Marker Skip icon moves the marker to the next measurement curve that is added by the VAR2 variable.
4. Marker Maximum icon moves the marker to the maximum measurement point.
5. Marker Minimum icon moves the marker to the minimum measurement point.
6. Marker Search icon opens the Direct Marker/Cursor dialog box used to specify the coordinate values to move the marker.

B. Reading the Marker value

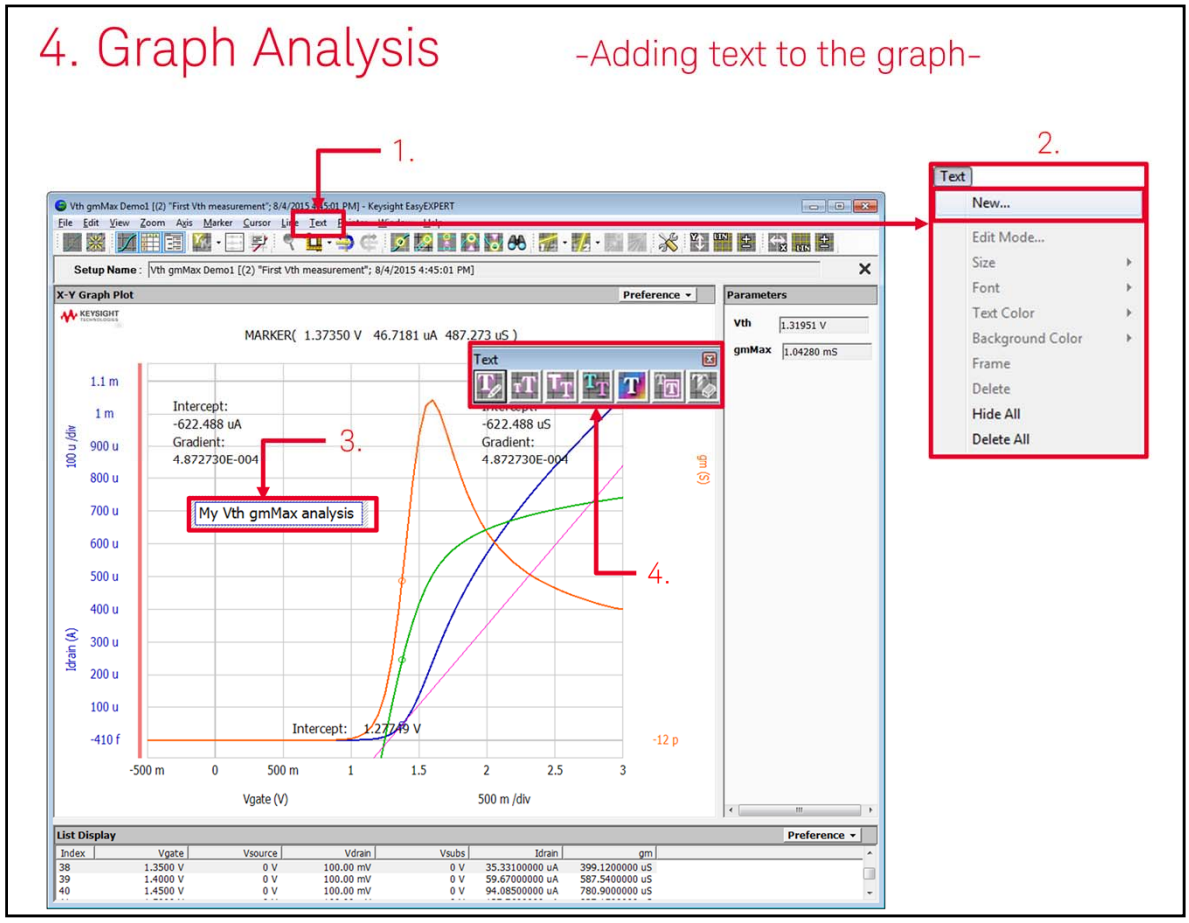
The marker position data is shown in the Marker readout field(B-1).

The display order of the parameters is, from the left;

X axis value, Y1 axis value and Yx (Y2, Y3, Y4 ...) axis value.

C. Moving the Marker

You can move the marker by rotating the mouse wheel.



– Adding Text to the Graph Display

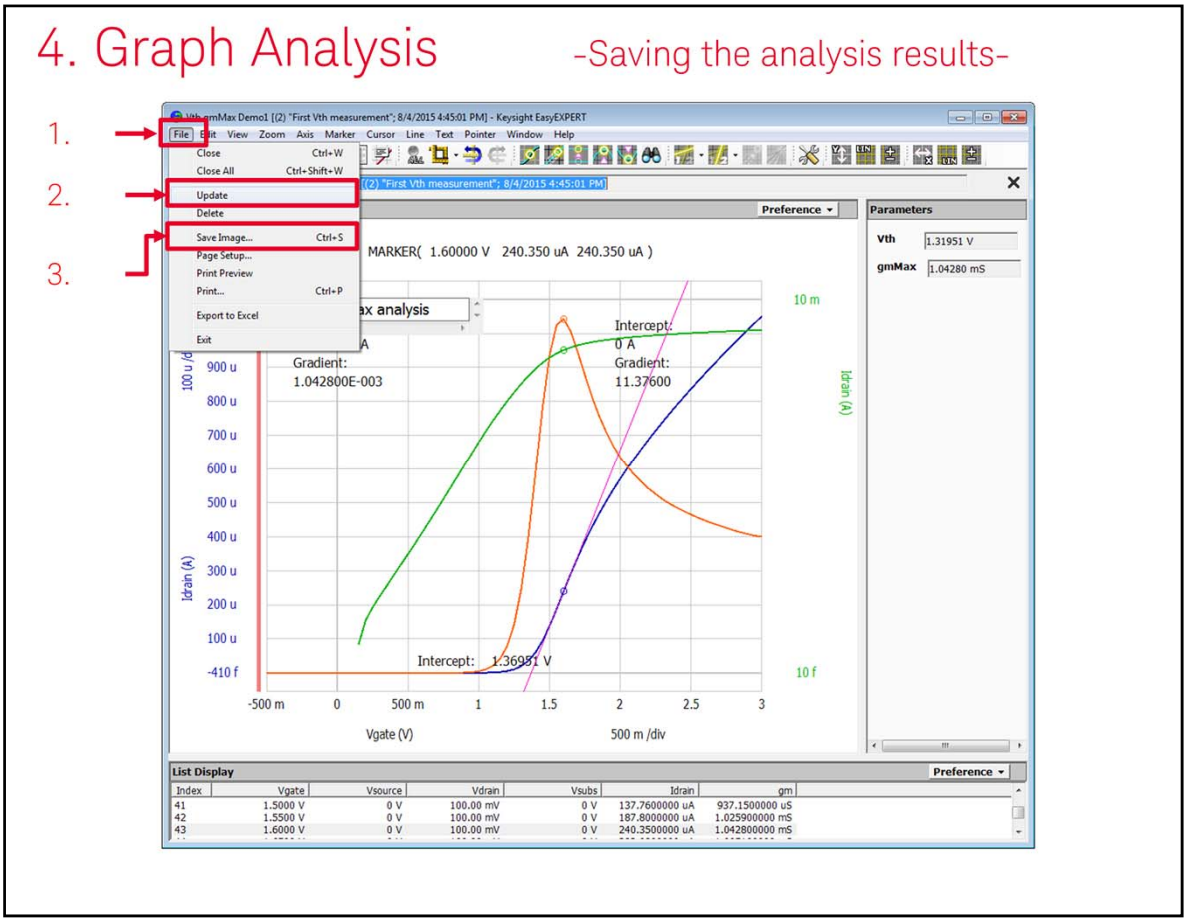
Adding text to the graph display area can be beneficial for future reporting and analysis..

– To add text:

1. Click on “Text” .
2. Click “New”.
3. The Text Editorbox appears. Enter your text, for example, "My Vth gmMax analysis".
4. The following functions are available for the selected text(s) via the Text menu

   From the left,

   - Edit Mode: Edits the selected text.
   - Size: Sets the font size of the selected text(s).
   - Font: Sets the font of the selected text(s).
   - Text Color: Sets the text color of the selected text(s).
   - Background Color: Sets the background color of the selected text(s).
   - Hide Frame/Show Frame: Hides or shows the frame for the selected text(s).
   - Delete: Deletes the selected text(s).
   - Note: Click and drag text to move it.



– Saving the analysis results

After analyzing the results, they can be saved in a re-usable form, allowing you to review and update the test results as necessary.

Note: Any modification information will be destroyed if you do not save it.

– Saving the analysis results - retaining all graph modifications

1. Click on the "File" menu..
2. Select "Update" from the menu. This will update all the modification you made on the data.

– Only saving the graph image

3. Click "Save Image" to save the image as a bmp, emf, gif, or png file.

Note: By only saving the graph image, any modifications that you have made will not be saved and the information will be destroyed.

5. Summary

We learned the following in this lab:

- Overview of Data Display
- How to perform the graph analysis on Data Display
- How to save the analysis result

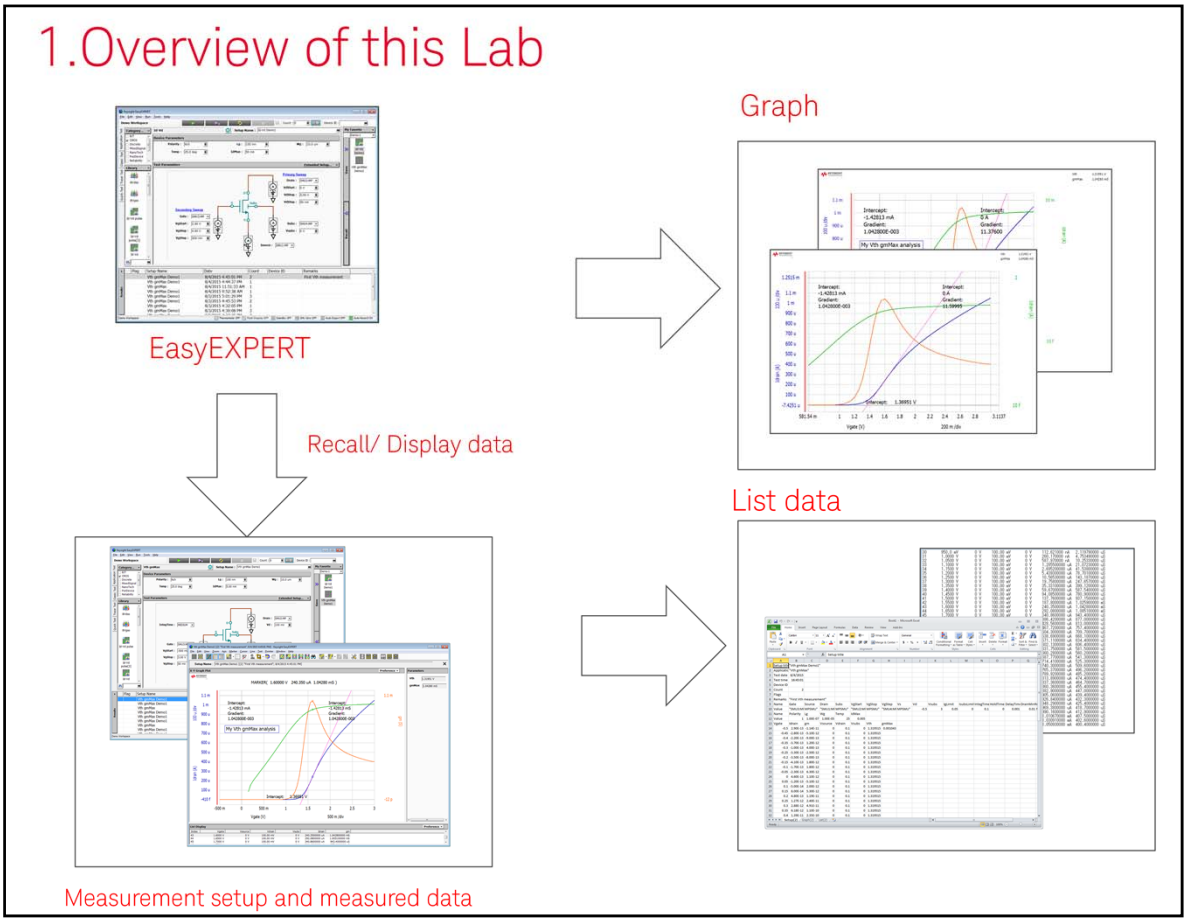
Lab 4: Reporting

Objective:

In this Lab, you will learn about the EasyEXPERT tools, such as recalling measurement setups and viewing graphical analysis, that you can use to report results and export data for future analysis.

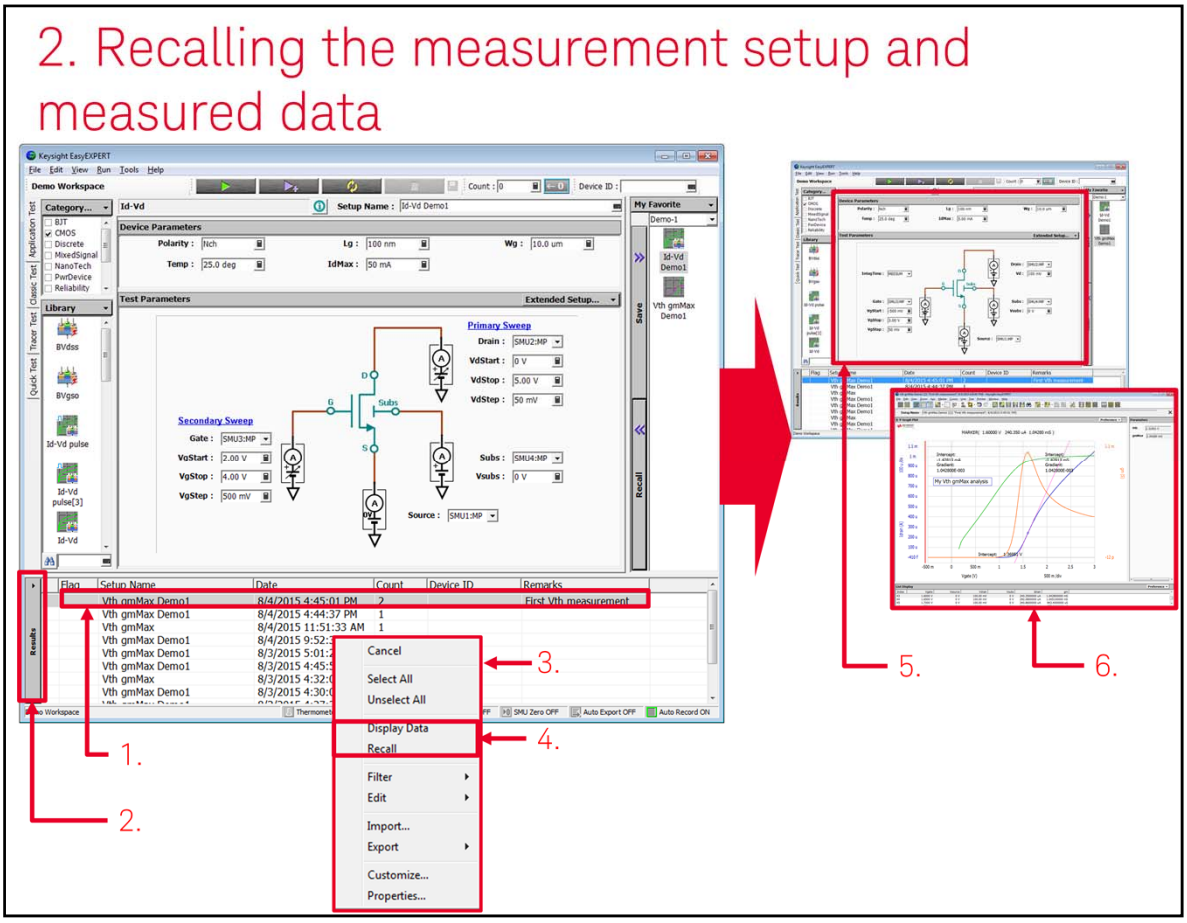
Contents

1. Overview of this Lab
2. Recalling measurement setup and measured data
3. Editing and saving a graph
    1. Adding measurement information to the graph
    2. Copying the image
    3. Saving the image as your preferred file type
4. Exporting the data
    1. Direct Excel Export
    2. Copy List
    3. Exporting the data in various format
5. Summary



In this Lab you will learn how to:

1. Recall measurement setup and measured data.
2. Edit and save a graph report
3. Export the data



– Recalling the measurement setup and measured data

Every time a measurement is performed, the combination of measurement setup and result can be stored automatically into the built-in database known as a “workspace”. The data stored in the “workspace” can be recalled for analysis, measurement reproduction and producing a report.

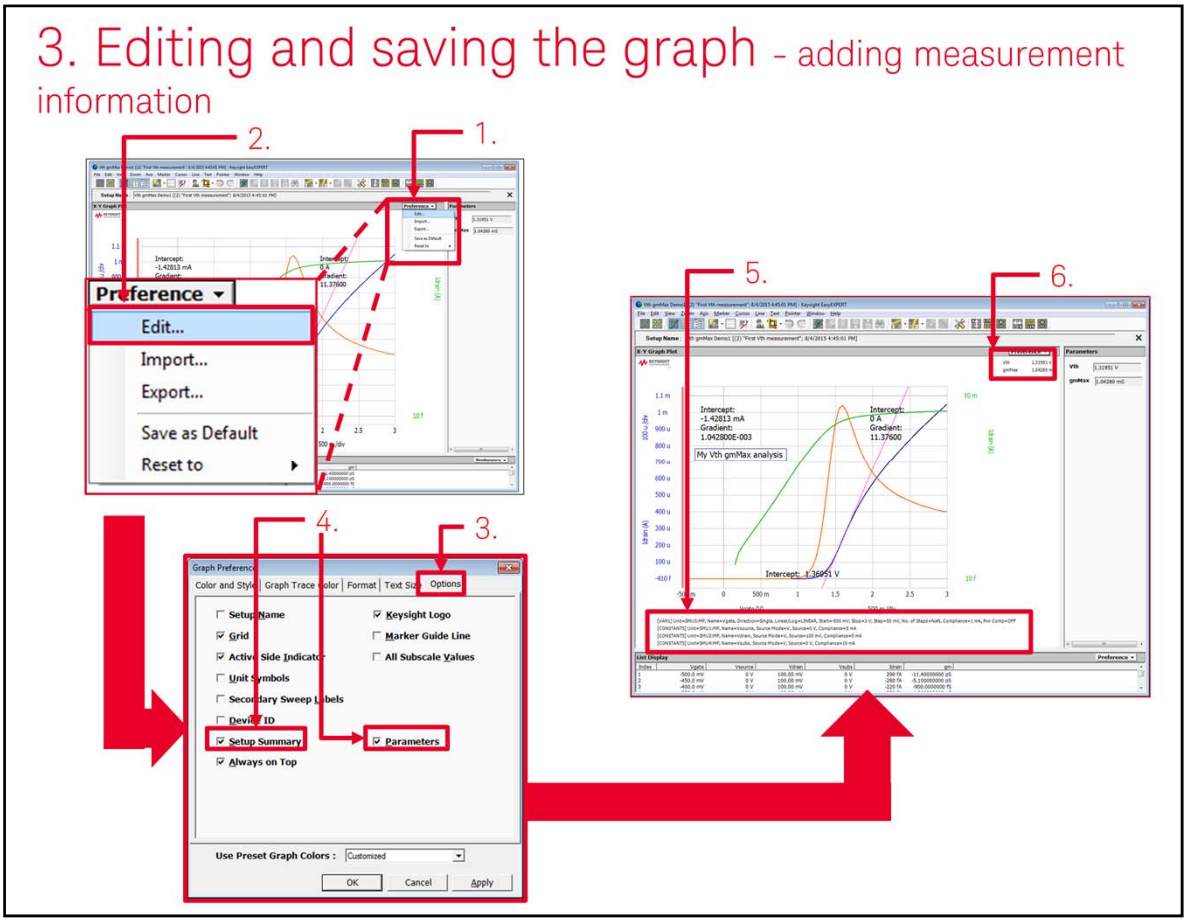
To recall the measurement setup and measured data,

1. Select the result data line of the "Test Record List" area

   In this Lab, select the “Vth gmMax Demo1(remarks: First Vth measurement)” which we made in Lab1.

2. Click the "Results" button or right click on the data line.
3. The "Results" menu will open.
4. Select “Recall”.

The measurement setup (5) in the above figure, and the data display window (6) will pop up. Recalling data is useful when you need to check the measurement setup, or want to take another measurement after reviewing your data.



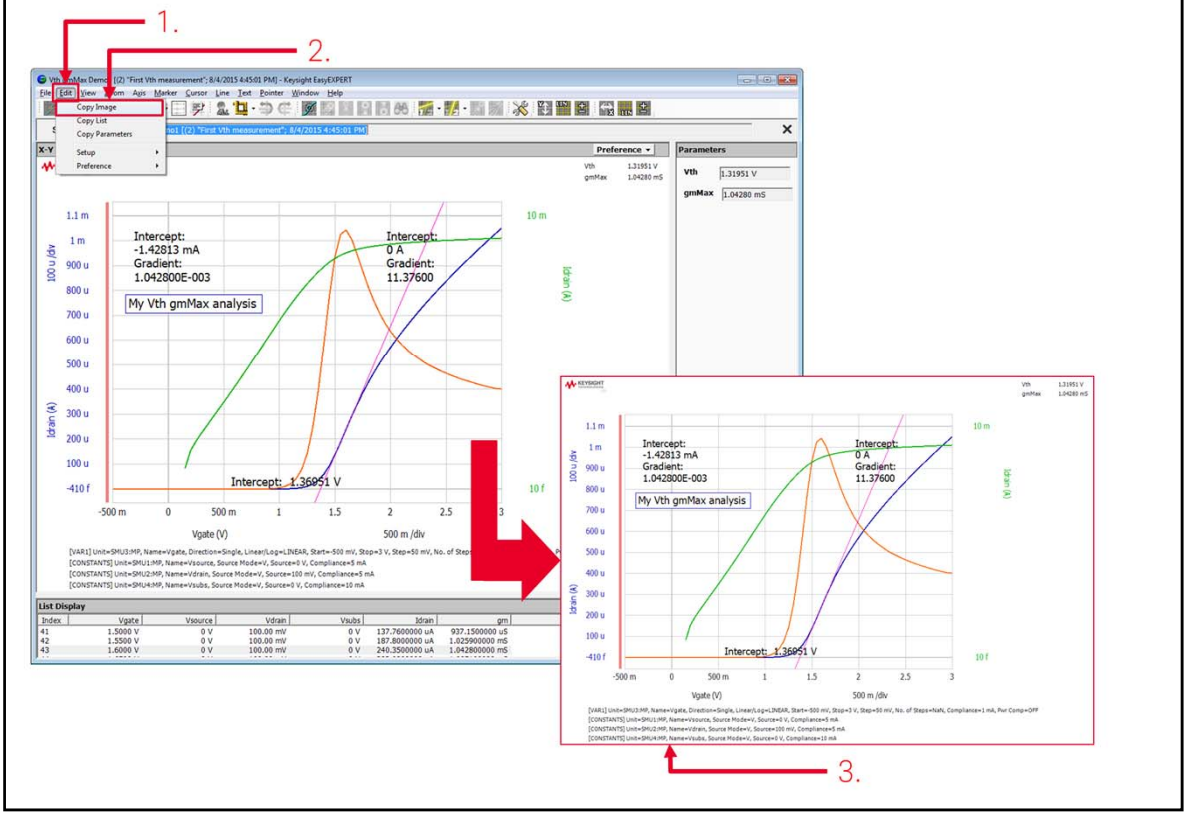
– Adding measurement information

You can add the measurement information to a graph using the Graph Preference function of EasyEXPERT.

For example, follow these steps to add a Setup Summary and Parameters to the graph.

1. Click the “Preference” button.
2. Select “Edit...”
3. The Graph Preference window appears. Select the “Option” Tab.
4. Put a Check mark to the "Setup Summary" and "Parameters" boxes.
5. This is the Setup Summary.
6. These are the Parameters.

3. Editing and saving the graph - Copying the graph



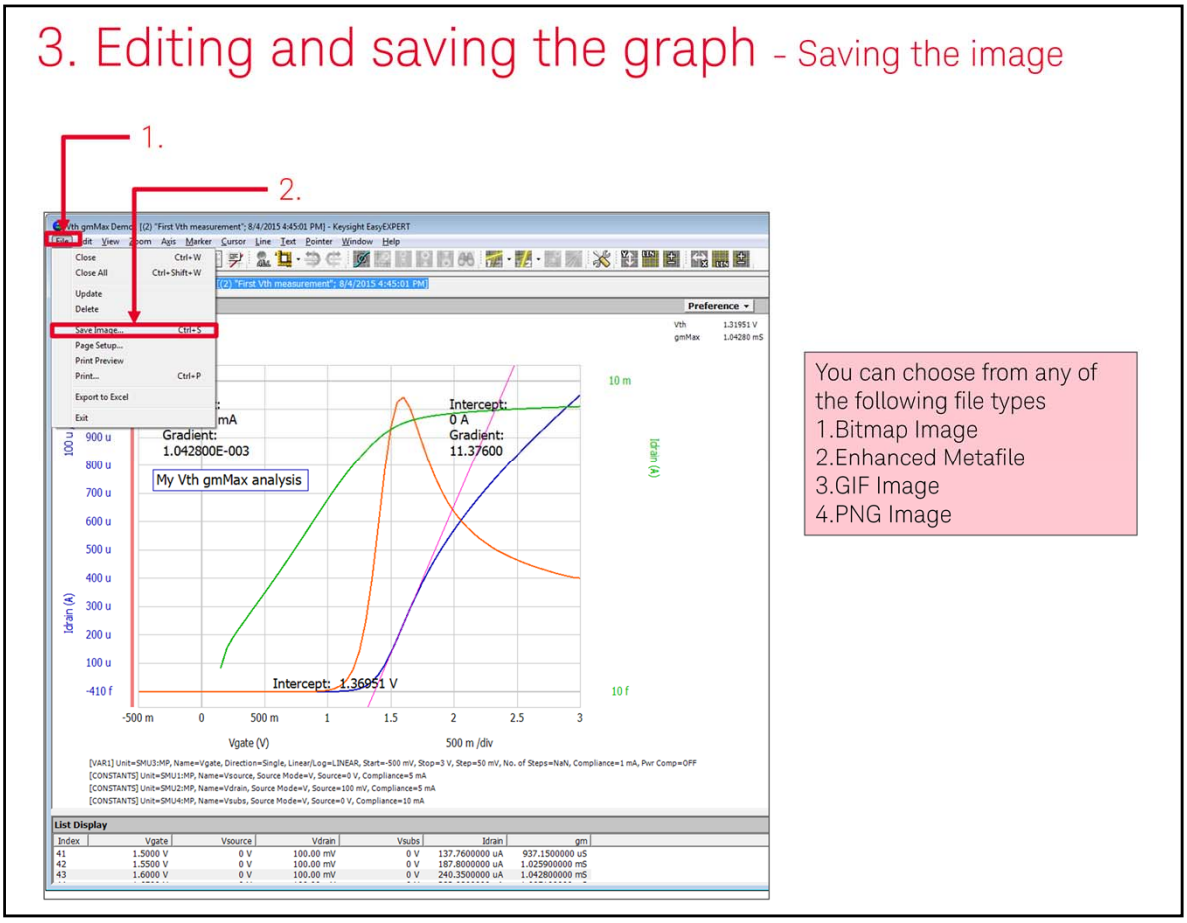
There are two ways to save the graph file by either copying it or by saving the image.

– Copying the graph

The graph displayed on the data display window can be copied to the clipboard.
You can paste the graphic image to other Windows applications.
In the above example, the graph image is pasted to the WordPad.

To copy the graph:

1. Click “Edit” on the Data Display window.
2. Select “Copy image”.
3. Open another application and paste the copied image of the graph.



– Saving the image

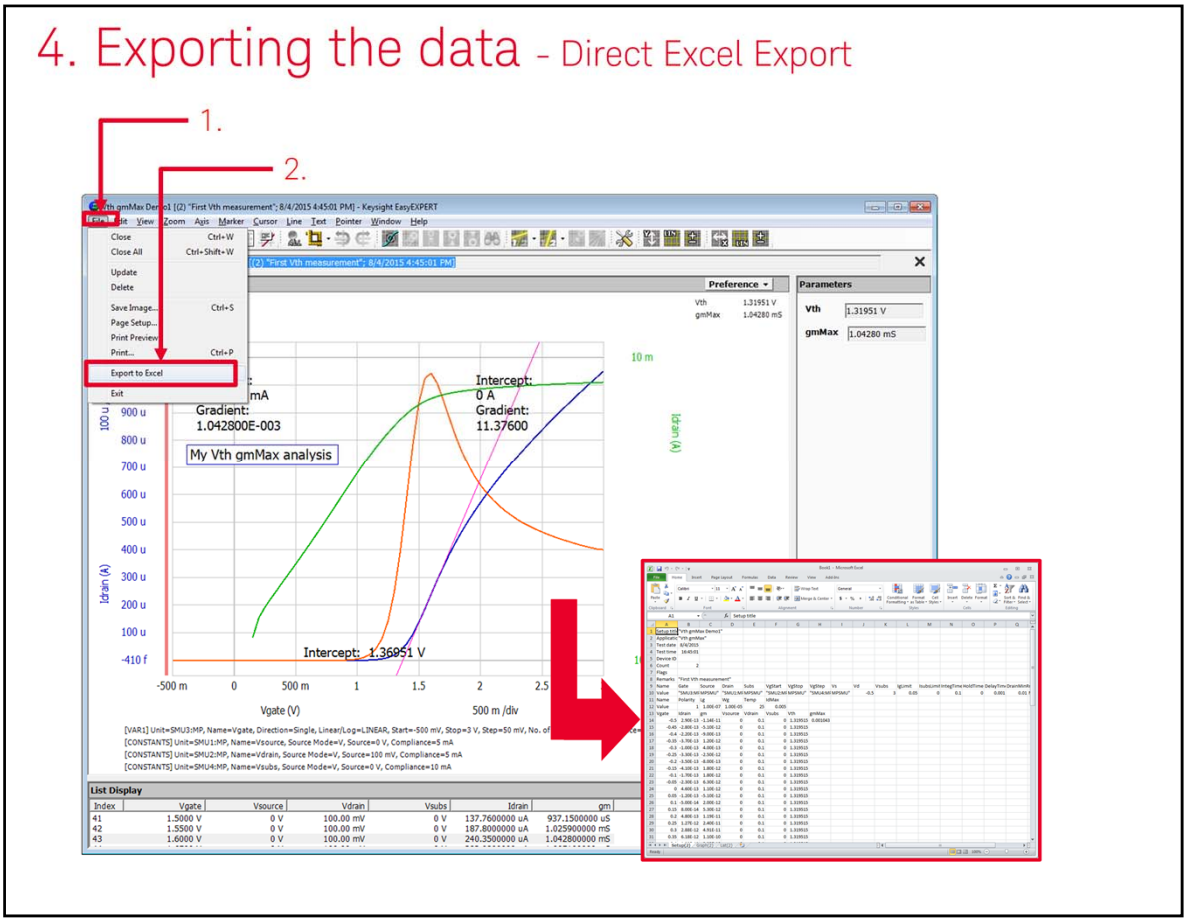
The graph displayed on the data display window can be saved as any of the following:

You can choose following file type

1.Bitmap Image, 2.Enhanced Metafile, 3.GIF Image, and 4.PNG Image.

To save the image:

1. Click “File” on the Data Display window.
2. Select “Save image...”
3. Specify the file name and the directory in which you want to save the data. Select the data formats and save.



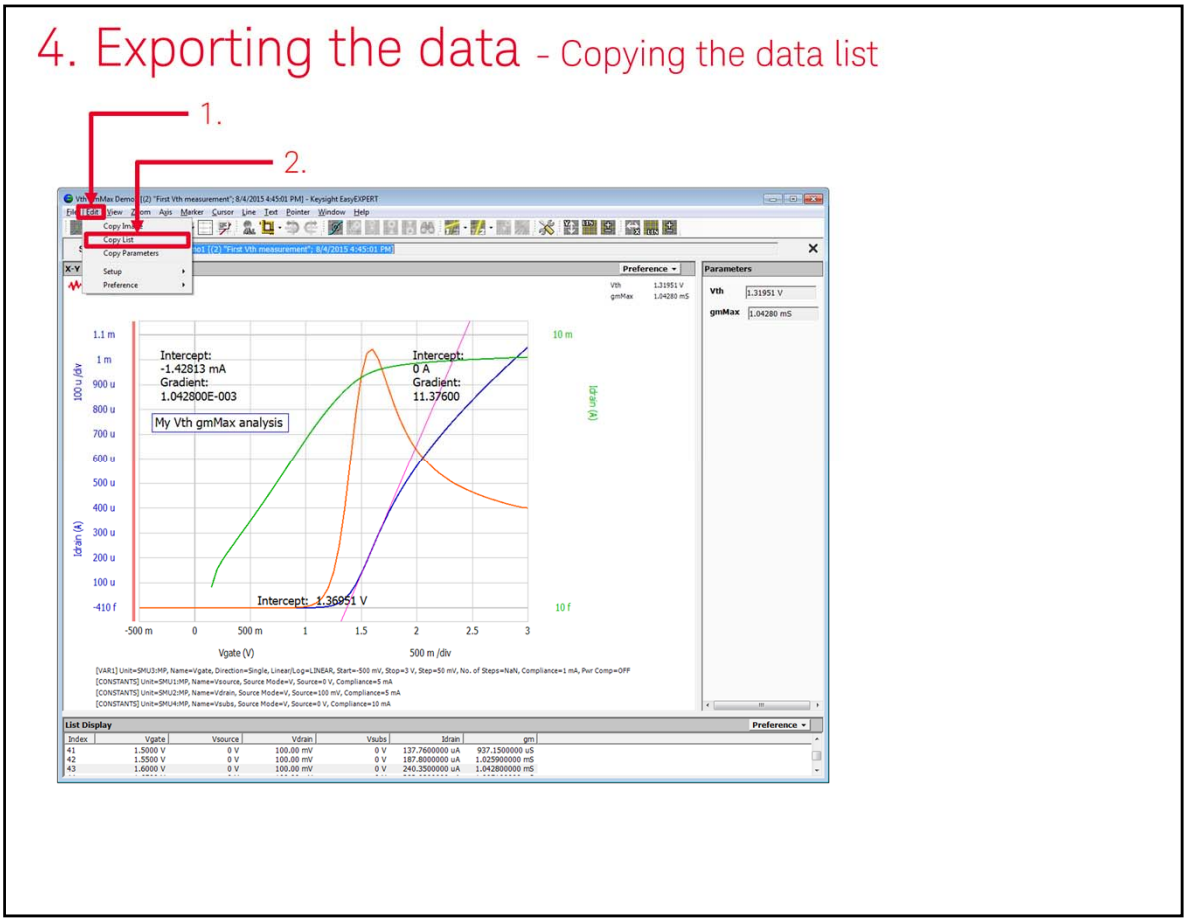
– Exporting the data

You may be needed to extract the list data to analyze the test results in Excel or in another file format. This Lab. describes the three ways to extract list data. Direct Excel Export, Copy List, and Export Test Record.

– Direct Excel Export

The data display allows you to export data directly to an Excel spreadsheet without having to save the data as a CSV file, allowing for more efficient post analysis on any computer.

1. Click “File” on the Data Display window
2. Select "Export to Excel". The graph image, list data and parameter data will export to Excel and the Excel spreadsheet will open automatically.

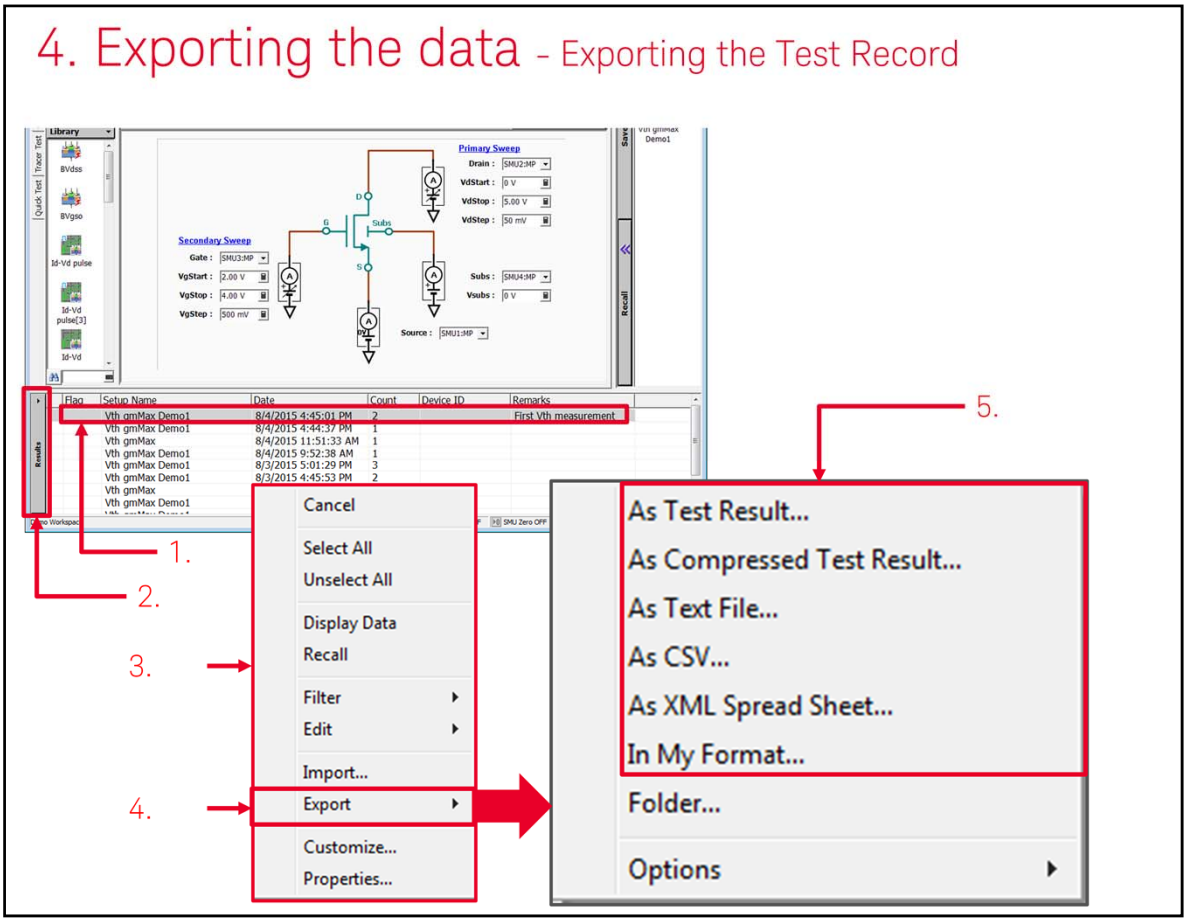


– Copying the data list

The data list shown on the data display window can be copied to the clipboard, allowing you to paste the data to other Windows applications.

To copy list, follow the next steps.

1. Click “Edit” on the Data Display window.
2. Select “Copy List”.
3. Open your chosen application and paste the list.



- Exporting the Test Record:

The measurement data can be exported in various formats.

To export the test result record, follow the next steps.

1. Highlight the result data line of the "Test Record List" area.
2. Click the "Results" button or right click on the data line.
3. The "Results" menu will open.
4. Select “Export”.
5. Select the format in which you want to export the Test record.
6. Specify the file name and directory in which you want to save the data.

5.Summary

We learned the following in this lab:

- How to recall measurement setup and measured data.
- How to edit and save a graph report
- How to export the data

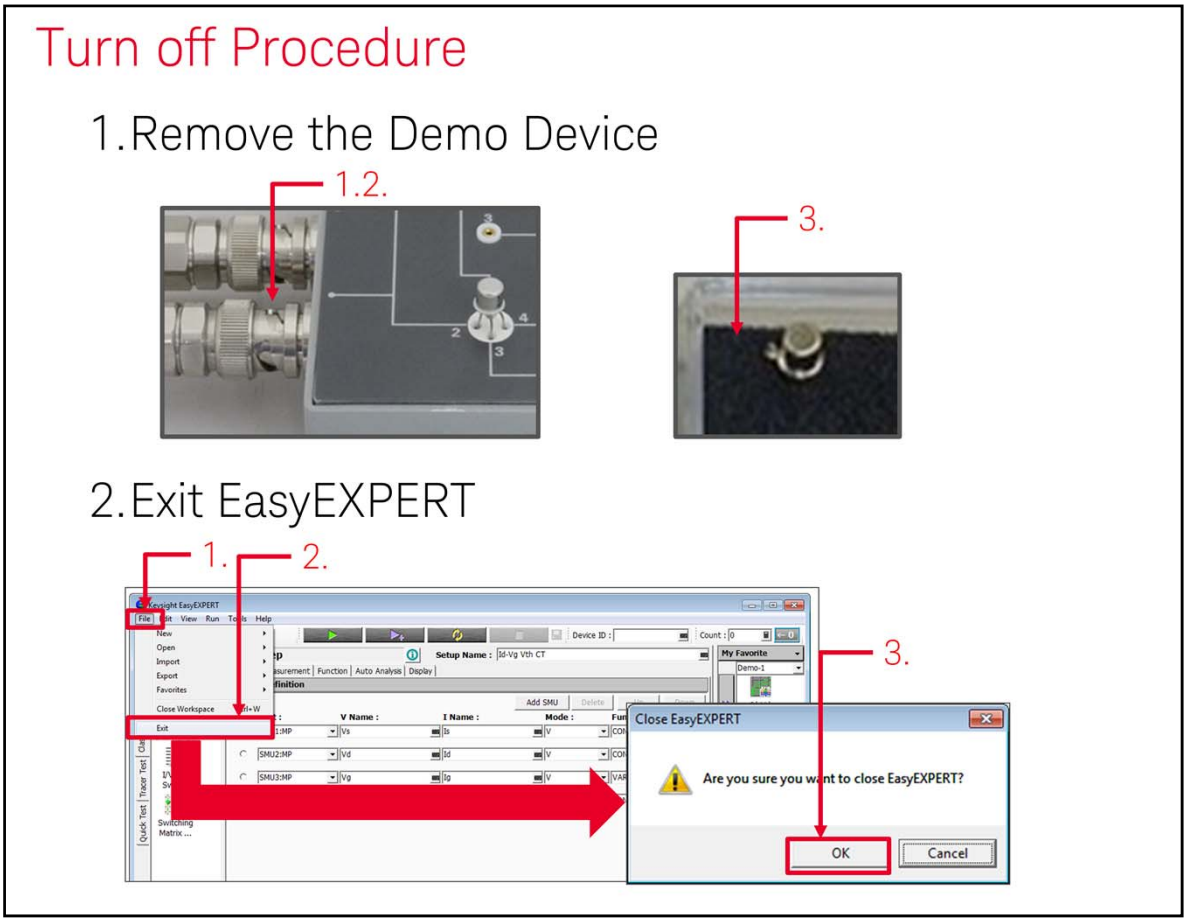
Lab 5: Turn off procedure

Objective:

In this Lab, you will learn how to exit EasyEXPERT and safely turn off the Instrument.

Contents

1. Removing the Demo Device
2. Exiting EasyEXPERT
3. Powering off the instrument
4. Summary



1. Removing the Demo Device

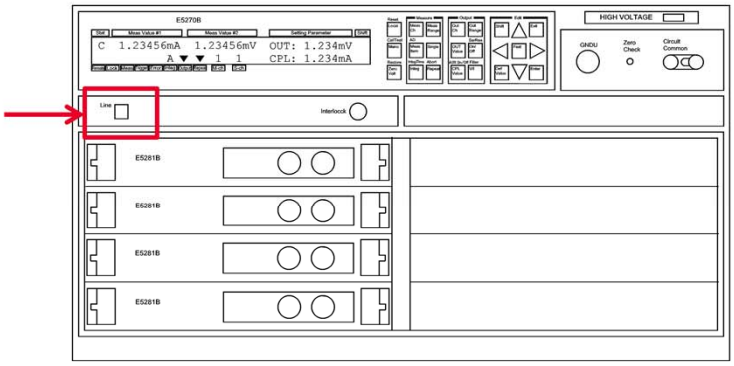
1. Touch your hand to the Earth ground or circuit common of the test fixture to remove static charge - See above picture for details.
2. Remove (pull out) the MOSFET from the test fixture by keeping one of your hands touching to the Earth ground - See above picture for details.
3. Place the MOSFET back in the User Demonstration Device Kit.

2. How to exit EasyEXPERT

1. Click “File”.
2. Select “Exit”.
3. The "Close EasyEXPERT" window pops up, click "OK".

Turn off Procedure

3. Powering off the instrument



3. Power off the instrument by pressing the “Line“ button.

Lab: Summary

We learned the following in this lab:

- How to remove the Demo Device
- How to exit EasyEXPERT
- How to power off the instrument

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