Tektronix

4200A-SCS Parameter Analyzer Introduction

LUNA KIM

KEITHLEY
A Tektronix Company

Agenda

- System overview
  - SMU
  - CVU
  - PMU
  - Clarius Program with Demo
- KCon / KULT / KXCI
- New products

4200A-SCS Parameter Analyzer

ACCELERATING INSIGHT

- Integrated parameter analyzer that reduces characterization complexity, troubleshooting and test set up time.

- Fully characterize a device, material or process
  - DC I-V Source Measure Units (SMU)
  - AC Impedance Capacitance-Voltage Unit (CVU)
  - Pulsed I-V Pulse Measure Unit (PMU)

- Industry's easiest methods to switch between I-V, C-V and Pulsed I-V measurements

- Jumpstart testing with over 250 user-modifiable, searchable application tests
  - No complex programming required

- Industry's first instrument with built-in measurement videos
  - "YouTube-like" experience
  - Get answers faster and investigate unexpected results more quickly

4200A-SCS Parameter Analyzer

4200A-CVIV Multi-Switch

A Complete Solution from DC to Pulse

4200A-SCS Parameter Analyzer			
System Software	Clarius™ with >450 application tests/projects/devices		
I-V Measurements	Medium Power SMU 210V, 100mA	High Power SMU 210V, 1A	Remote Pre-amplifier 0.1 fA resolution
Pulse I-V/Transient	Pulse Measure Unit	Pulse Generator Unit	
C-V Measurements	Capacitance-Voltage Unit 1kHz to 10MHz	Ramp-Rate (Quasi Static) C-V	Very Low Frequency VLF C-V
Switching	IV/CV Multi-Switch Module	Remote Preamplifier/Switch Module	Ultra Low Current Switch Matrices
Drivers for Probe stations, temp. controllers, external equipment			

DC I-V Source Measure Units (SMU)

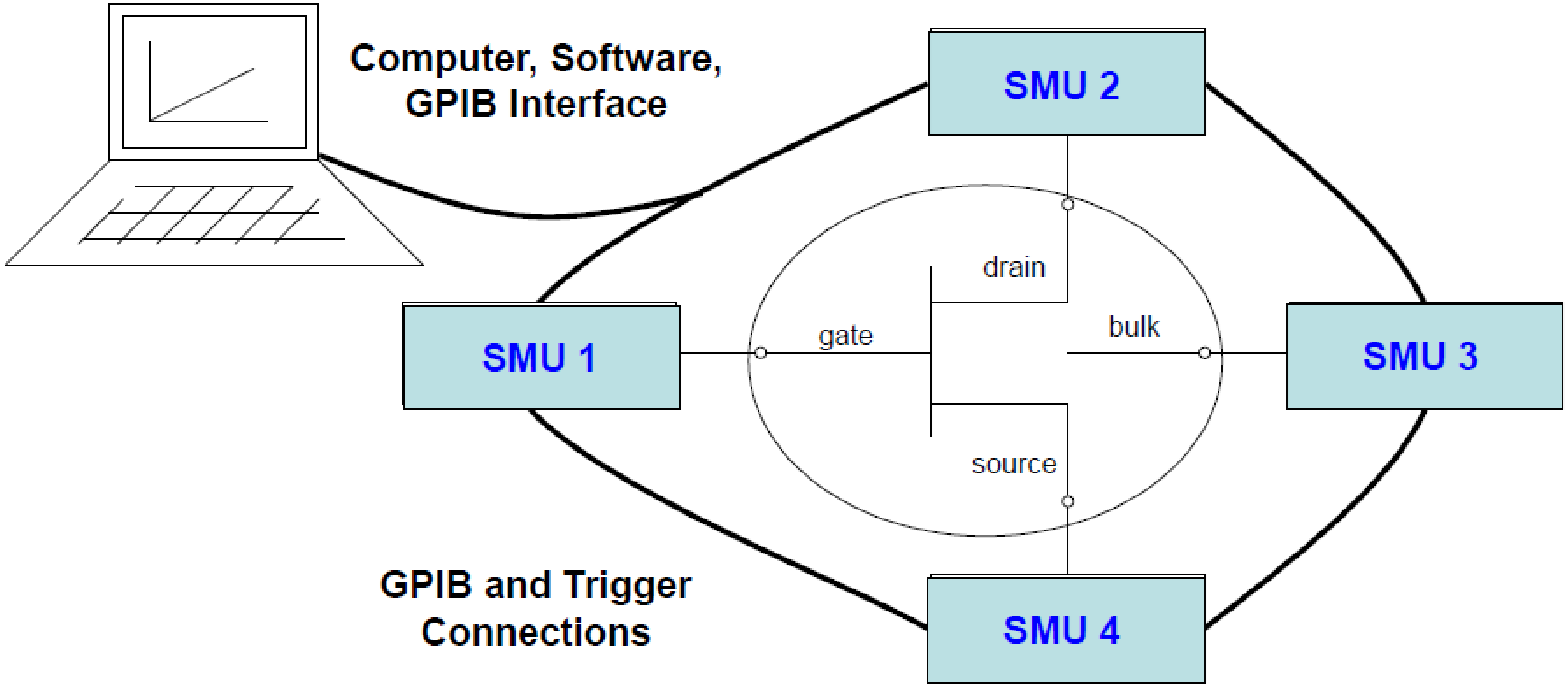
4200-SMU and 4210-SMU

4201-SMU and 4211-SMU

A Parameter Analyzer can have multiples SMUs

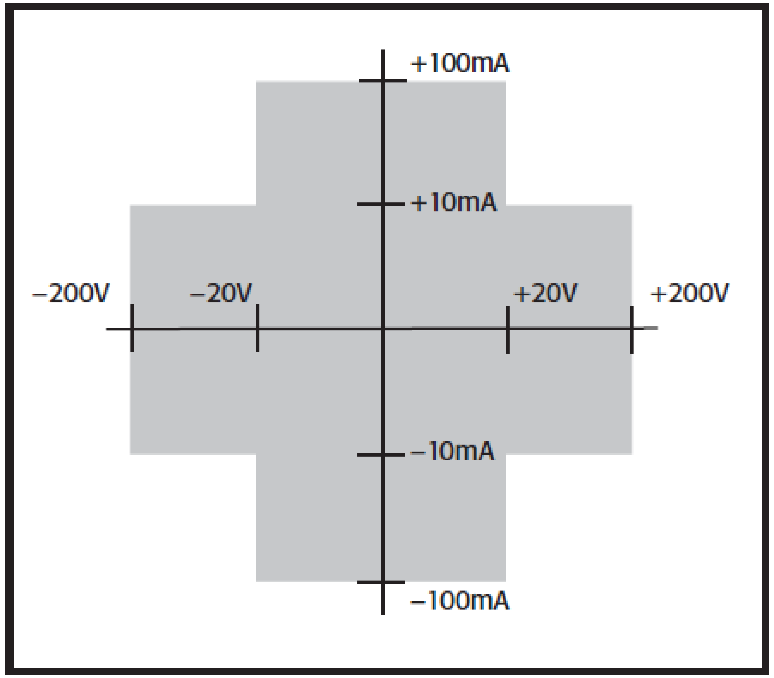
Multiple SMUs are required when performing I-V characterization on devices that have more than two terminals like MOSFETs.

The source and measure timing of all the SMUs in the parameter analyzer are synchronized.



What is a SMU?

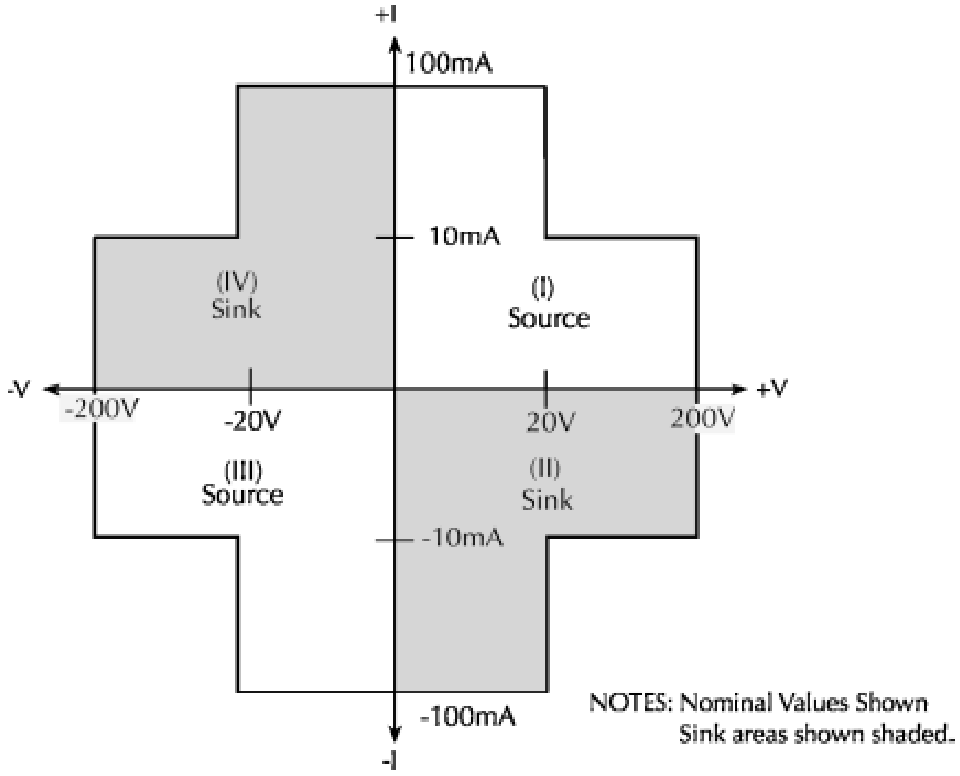
SOURCE MEASURE UNIT (SMU)



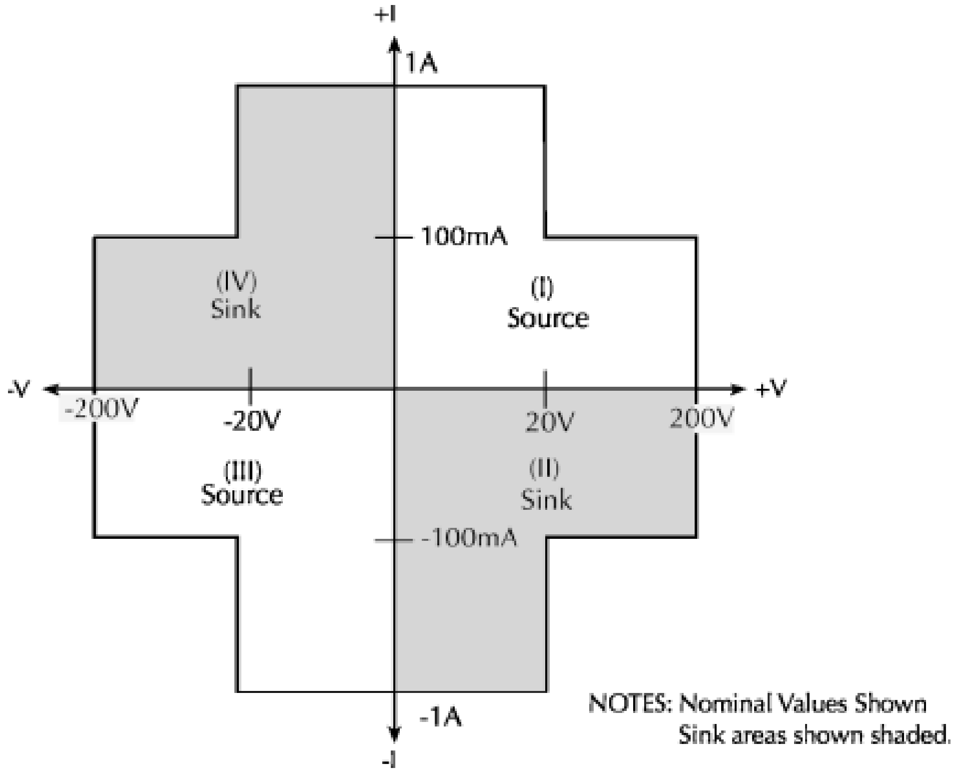
- **4200-SMU Medium Power SMU**
  - +/- 210 V, +/- 100 mA, 100 fA resolution
- **4210-SMU High Power SMU**
  - +/- 210 V, +/- 1 A, 100 fA resolution
- **4200-PA optional pre-amplifier**
  - Extends SMU current range and supports 0.1 fA resolution
- 6 ½ digit A/D per SMU for parallel, simultaneous, high-precision measurements
- *All* slots in the 4200-SCS can be configured with any SMU

Operating Boundaries

4200-SMU: 105mA, 21V
10.5mA, 210V



4210-SMU: 1.05A, 21V
105mA, 210V



SMU Measurement Characteristics

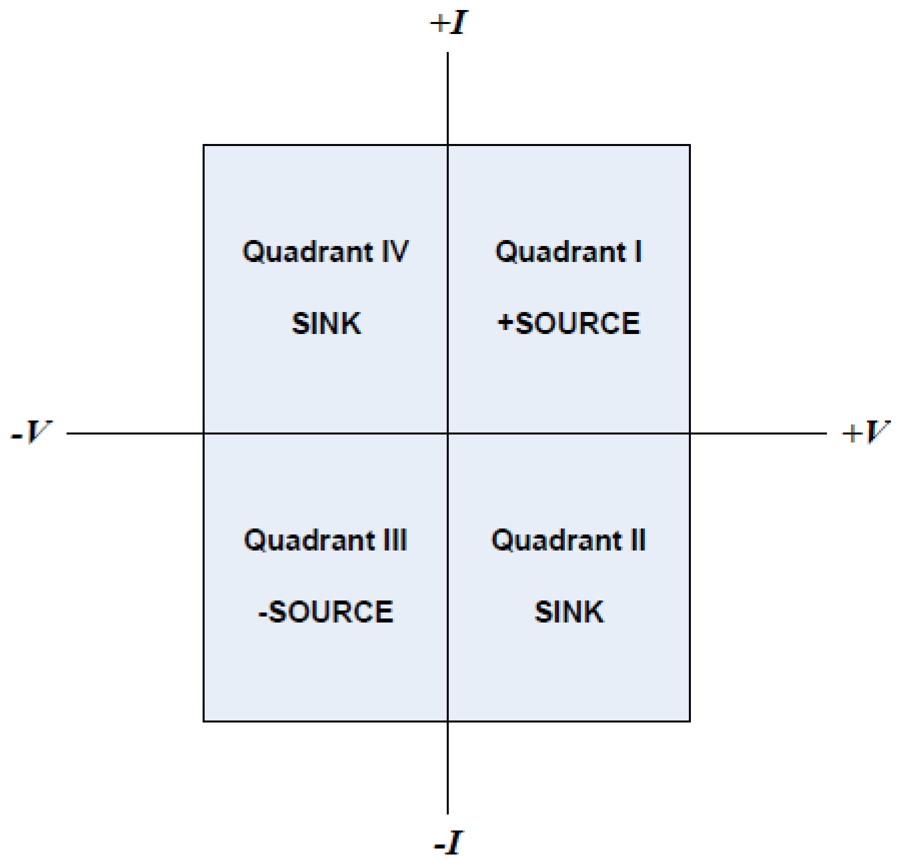
CURRENT SPECIFICATIONS

				MEASURE		SOURCE	
		CURRENT RANGE[1]	MAX. VOLTAGE	RESOLUTION[3]	ACCURACY ±(% rdg + amps)	RESOLUTION[3]	ACCURACY ±(% rdg + amps)
4210-SMU[2] High Power SMU		1 A	21 V	1 µA	0.100% + 200 µA	50 µA	0.100% + 350 µA
		100 mA	210 V	100 nA	0.045% + 3 µA	5 µA	0.050% + 15 µA
	4200-SMU[2] Medium Power SMU	100 mA	21 V	100 nA	0.045% + 3 µA	5 µA	0.050% + 15 µA
		10 mA	210 V	10 nA	0.037% + 300 nA	500 nA	0.042% + 1.5 µA
		1 mA	210 V	1 nA	0.035% + 30 nA	50 nA	0.040% + 150 nA
		100 µA	210 V	100 pA	0.033% + 3 nA	5 nA	0.038% + 15 nA
		10 µA	210 V	10 pA	0.050% + 600 pA	500 pA	0.060% + 1.5 nA
		1 µA	210 V	1 pA	0.050% + 100 pA	50 pA	0.060% + 200 pA
		100 nA	210 V	100 fA	0.050% + 30 pA	5 pA	0.060% + 30 pA
4200-SMU and 4210-SMU with optional 4200-PA PreAmp		10 nA	210 V	10 fA	0.050% + 1 pA	500 fA	0.060% + 3 pA
		1 nA	210 V	3 fA	0.050% + 100 fA	50 fA	0.060% + 300 fA
		100 pA	210 V	1 fA	0.100% + 30 fA	15 fA	0.100% + 80 fA
		10 pA	210 V	0.3 fA	0.500% + 15 fA	5 fA	0.500% + 50 fA
		1 pA	210 V	100 aA	1.000% + 10 fA	1.5 fA	1.000% + 40 fA

VOLTAGE SPECIFICATIONS

VOLTAGE RANGE[1]	MAX. CURRENT		MEASURE		SOURCE	
	4200-SMU	4210-SMU	Resolution[3]	Accuracy ±(% rdg + volts)	Resolution[3]	Accuracy ±(% rdg + volts)
200 V[4]	10.5 mA	105 mA	200 µV	0.015% + 3 mV	5 mV	0.02% + 15 mV
20 V	105 mA	1.05 A	20 µV	0.01 % + 1 mV	500 µV	0.02% + 1.5 mV
2 V	105 mA	1.05 A	2 µV	0.012% + 150 µV	50 µV	0.02% + 300 µV
200 mV	105 mA	1.05 A	1 µV	0.012% + 100 µV	5 µV	0.02% + 150 µV

Four Quadrant Operation



- SMUs can operate in one of four quadrants.
- Quadrants I and III are sourcing (I and V have same polarity):
  - Sourcing SMUs deliver power to load.
- Quadrants II and IV are sinking (I and V have different polarity):
  - Sinking SMUs dissipate power.

Compliance

Built-in mechanism that limits current or voltage depending on whether the SMU is configured as a V-Source or I-Source.

SMU as V-Source

- Compliance limits the maximum current that may be output to the device.
- When compliance is reached, the SMU effectively becomes a constant current source

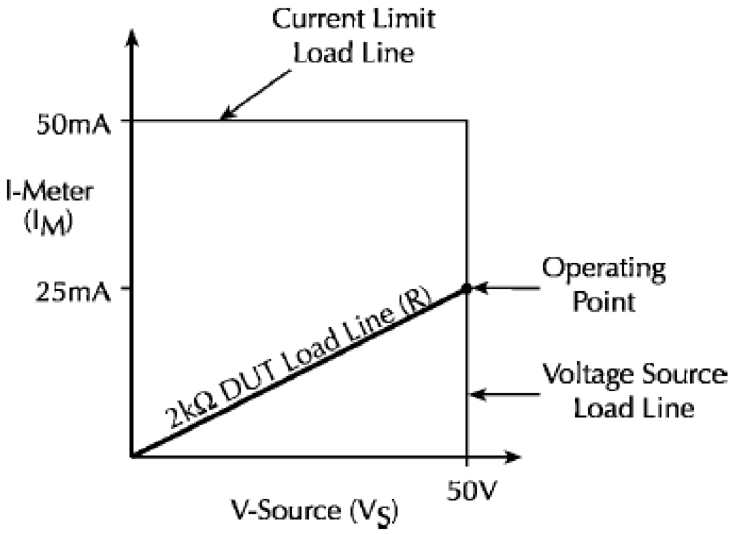
SMU as I-Source

- Compliance limits the maximum voltage that appears across the output terminals (Local sense) or across the device (Remote sense).
- When compliance is reached, the SMU effectively becomes a constant voltage source.

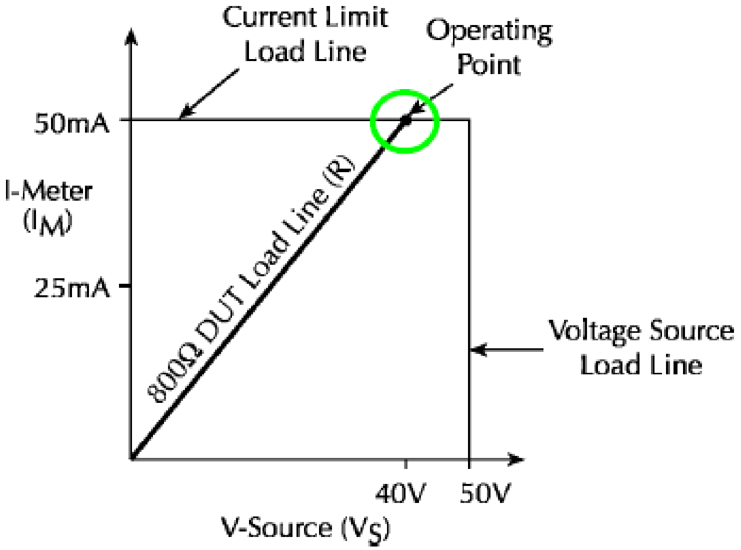
Understanding Compliance

Set Voltage to 50V and Compliance to 50mA

Normal V-Source Operation



V-Source in compliance



R = 2kΩ

$$I_M = V_S / R = (50V) / (2000\Omega) = 25mA$$

R = 800Ω

$$I_M = V_S / R = (50V) / (800\Omega) = 62.5mA$$

No !

I-Limit is 50mA !!

R = 800Ω

$$V_S = I_M \cdot R = (50mA) \cdot (800\Omega) = 40V$$

SMU has become a current source!

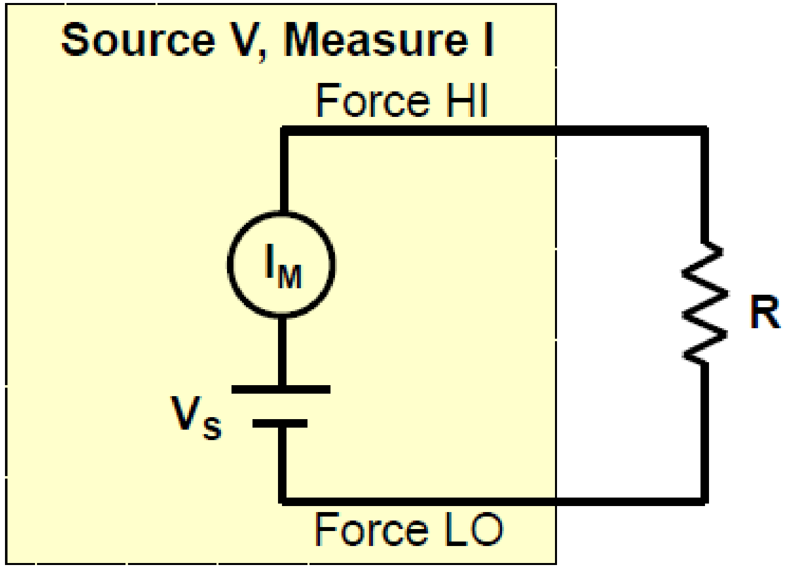
Local vs Remote Sensing

Local Sense

(2-wire measure)

Use when lead resistance is negligible compared to DUT resistance. Examples:

- Measuring resistance of insulators
- Measuring low current

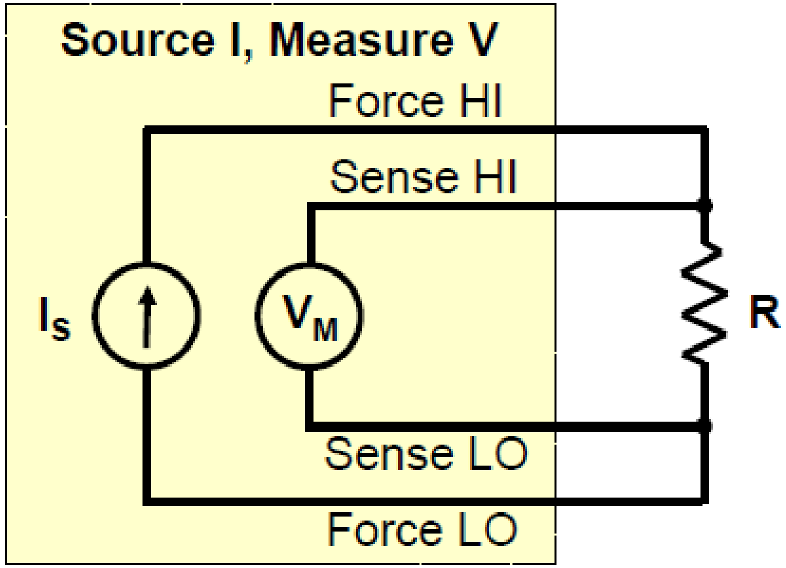


Remote Sense

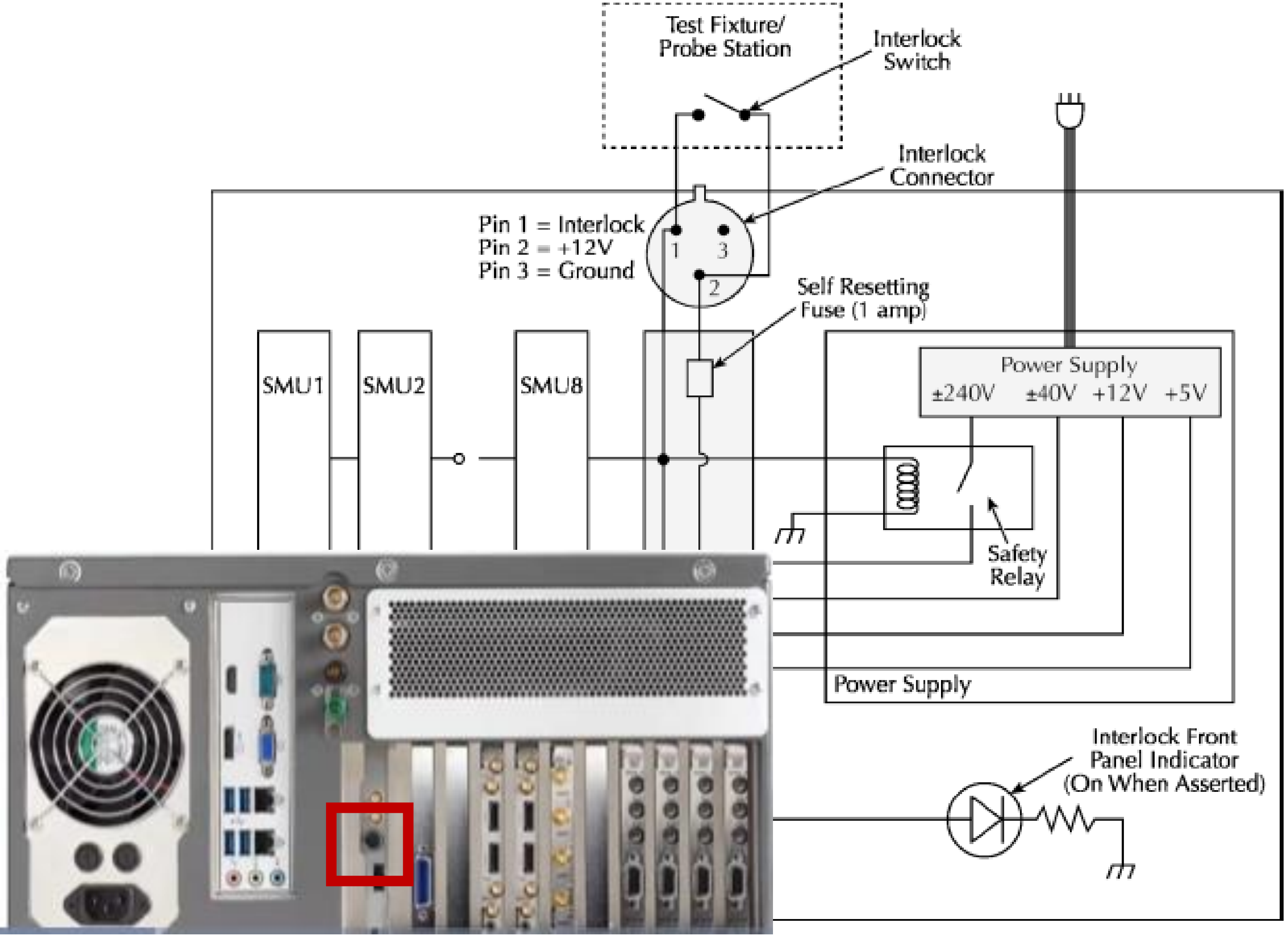
(4-wire measure)

Use to eliminate lead and contact resistance from affecting measure accuracy. Examples:

- Measuring low resistance (<10Ω)
- Sourcing voltage at a high current



Interlock connections



- Without interlock, SMU output is limited to about 42V
- Interlock will engage the 200V range
- Use supplied interlock cable to connect to safety switch on test fixture or probe station dark box
- Safety switch closes circuit between pins 1 and 2 of the interlock cable
- Green Interlock LED on 4200-SCS front panel will be lit when interlock is engaged
- DO NOT SHORT PIN 3 TO OTHER PINS!

Capacitance-Voltage Unit (CVU)

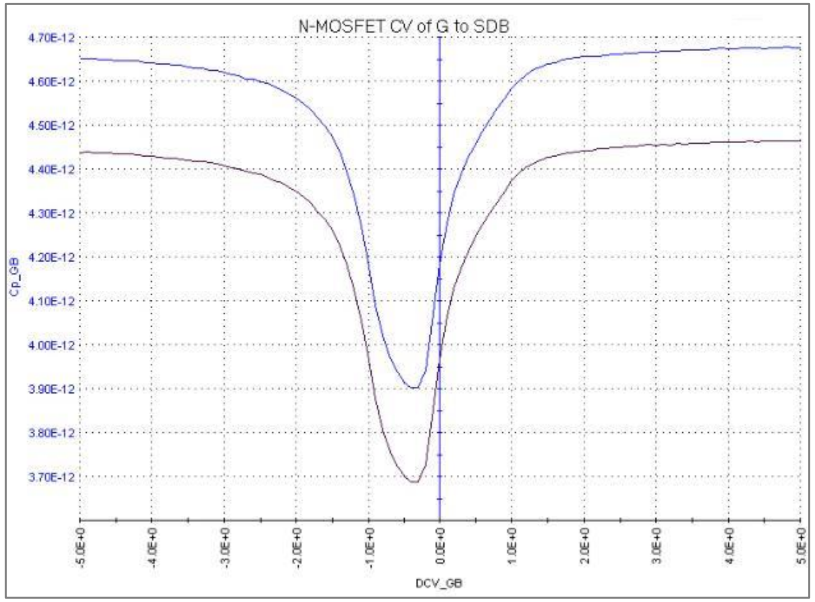
4210-CVU

4215-CVU

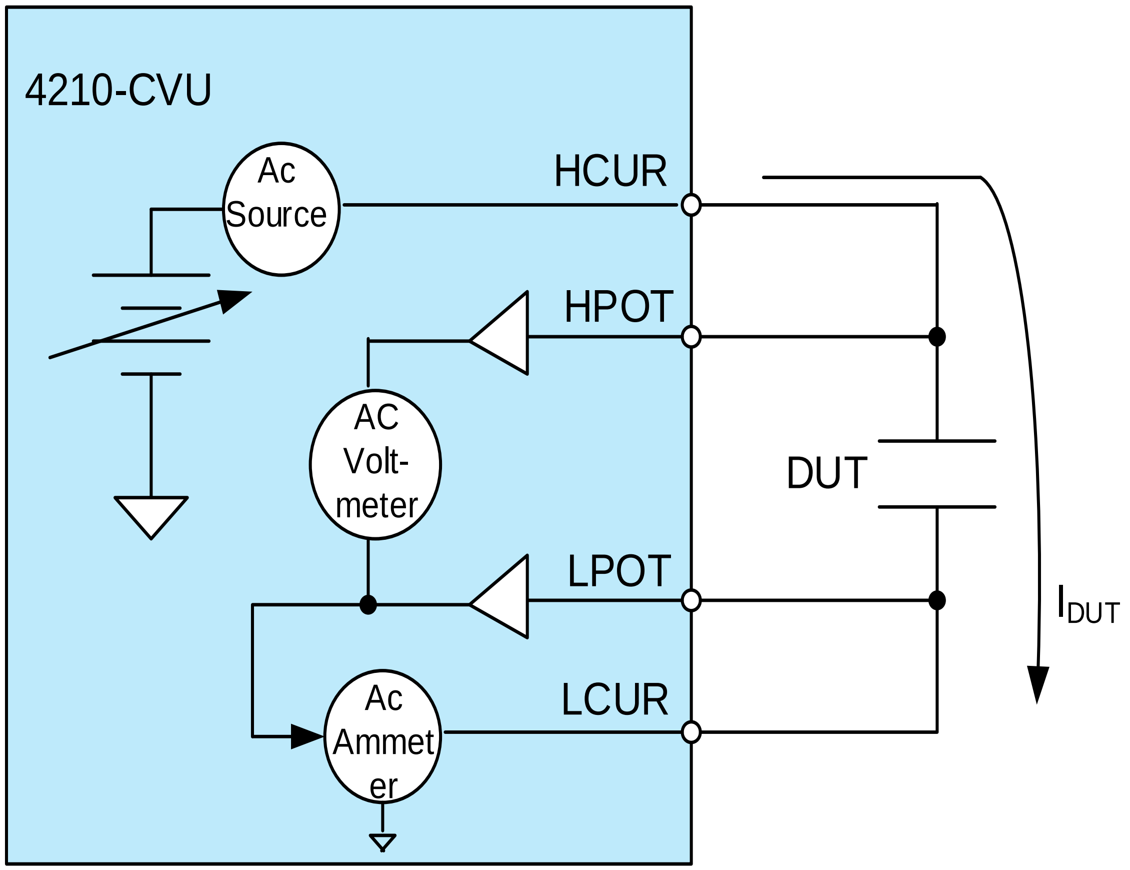
Multi-frequency AC Impedance

4210-CVU CAPACITANCE-VOLTAGE

- Test frequencies from 1KHz to 10MHz
- DC source (sweep) +/-30 V (60 V differential) internal
- External DC bias up to +/- 200V (400V differential) using SMUs
- Extensive sample programs in Clarius library
- Parameter extraction examples



CVU Measurement Overview



Measures AC impedance (Z_{DUT}) of the DUT by sourcing an AC voltage across the device and measuring the resulting AC current and phase.

The time-domain AC values are processed into the frequency-domain to produce the phasor form of the impedance.

The capacitive impedance (and conductance) are calculated based on the measured AC impedance and the phase.

The capacitance is calculated from the impedance and the test frequency:

$$C_{DUT} = \frac{I_{DUT}}{2\pi f V_{ac}}$$

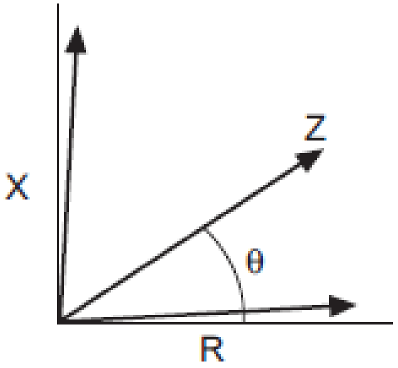
Measured Parameters

The Model 4200-CVU can measure the following parameters:

- Z, Theta — Impedance and Phase Angle
- R + jX — Resistance and Reactance
- Cp-Gp — Parallel Capacitance and Conductance
- Cs-Rs — Series Capacitance and Conductance
- Cp-D — Parallel Capacitance and Dissipation Factor
- Cs-D — Series Capacitance and Dissipation Factor

Figure 15-2 shows the vector diagram and fundamental equations for impedance.

Figure 15-2
Vector diagram for impedance (Z)



$$|Z| = \sqrt{R^2 + X^2}$$

$$Z = R + jX$$

$$\theta = \arctan\left(\frac{X}{R}\right)$$

$$R = Z\cos\theta$$

$$X = Z\sin\theta$$

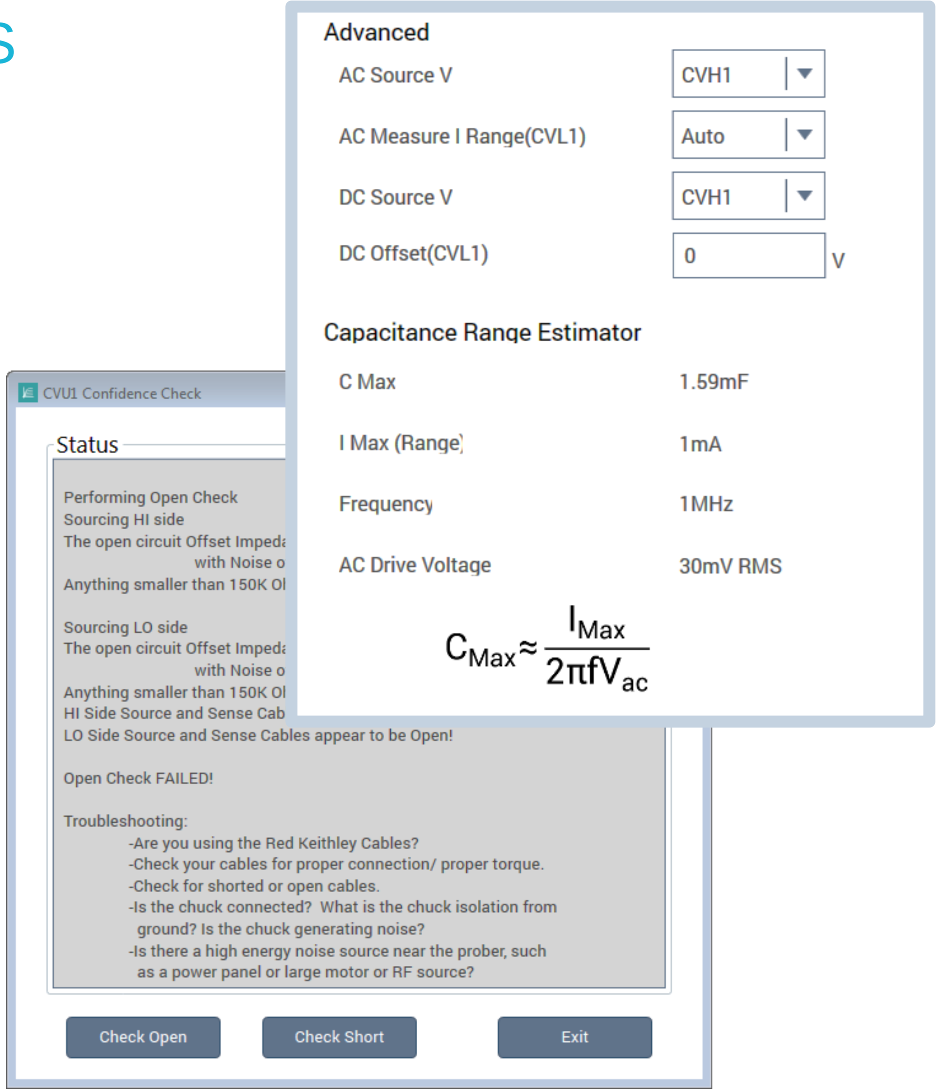
$$Y = \frac{1}{Z} = (G + jB)$$

Z = Impedance
θ = Phase Angle
R = Resistance
X = Reactance
Y = Admittance
G = Conductance

Unique Tools to Simplify C-V Measurements

EXCLUSIVE FEATURES FOUND ONLY IN 4200A-SCS

- Move the AC measurement and DC Bias to least noisy terminal with just a mouse click
  - No re-cabling or changing the test setup
  - Faster research and time to answer
- Real time capacitance measurements
  - Check your switch matrix, prober connections before beginning a test
- Confidence Check
  - Reveals problems before you begin C-V test
  - Provides troubleshooting tips

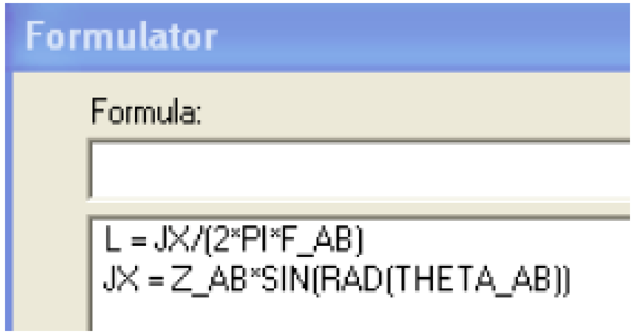


Calculating Inductance

Even though the 4210-CVU does not measure inductance directly, the inductance can be extracted in the Formulator from the Impedance (Z), Phase Angle (theta, θ), and the Test Frequency (f).

$$X = Z\sin\theta$$
$$L = X/2\pi f$$

The Measured Options Parameters must be set to “Z, theta”.
NOTE: The units for “theta” are in degrees. To use the trig functions in the Formulator, you must convert to rads using the “rad” function as shown below.

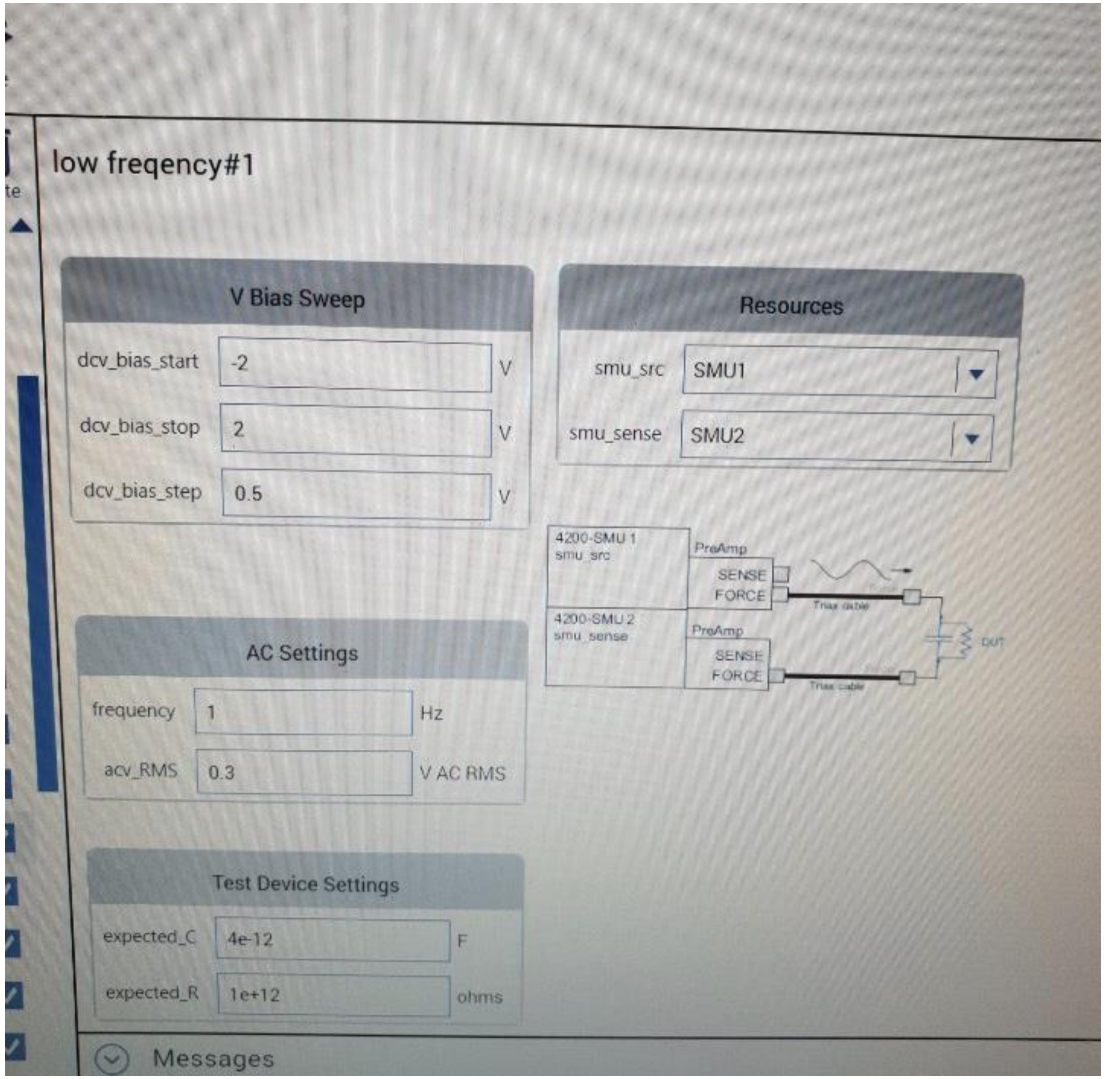


	A	B	C	D
1	Z_AB	Theta_AB	F_AB	L
2	201.2324E+0	89.6566E+0	10.0000E+3	3.1791E-3
3	201.2161E+0	89.6538E+0	10.0000E+3	3.1800E-3
4	201.2274E+0	89.6600E+0	10.0000E+3	3.1778E-3
5	201.2336E+0	89.6614E+0	10.0000E+3	3.1773E-3
6	201.2417E+0	89.6572E+0	10.0000E+3	3.1791E-3
7	201.2281E+0	89.6566E+0	10.0000E+3	3.1791E-3
8	201.2226E+0	89.6583E+0	10.0000E+3	3.1783E-3
9	201.2371E+0	89.6578E+0	10.0000E+3	3.1787E-3

Very Low Frequency

KEITHLEY ONLY

- UTM
- SMU-based
- Test frequencies from 0.1Hz to 10Hz
- Measures from 1pF ~ 10nF



Ultra-fast Pulse Measure Unit

4225-PMU and 4225-RPM

4225-PMU Basic Capabilities

- Voltage Source
  - 1 slot, 2 channels
  - 2 source ranges (10V, 40V: both into 50Ω)

- Current measure range
  - 10V : 10mA, 200mA
  - 40V : 100uA, 10mA, 800mA
  - With 4225-RPM : extends to 100nA

- Up to 6 cards per chassis
  - 12 channels per chassis, all synchronized

Remote Preamplifier/Switch Module

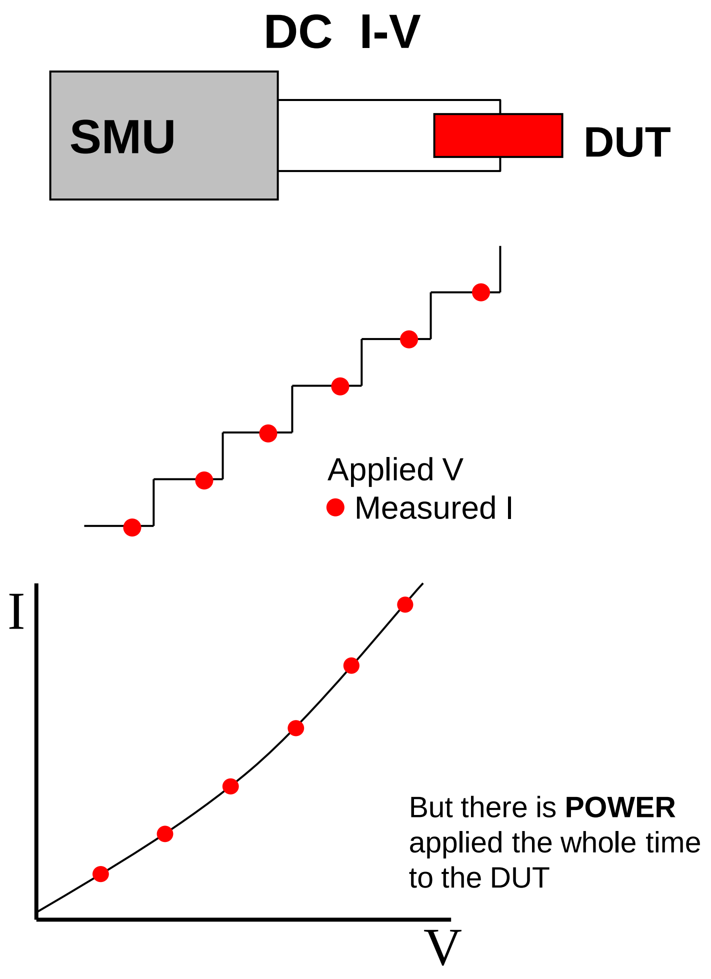
4225-RPM

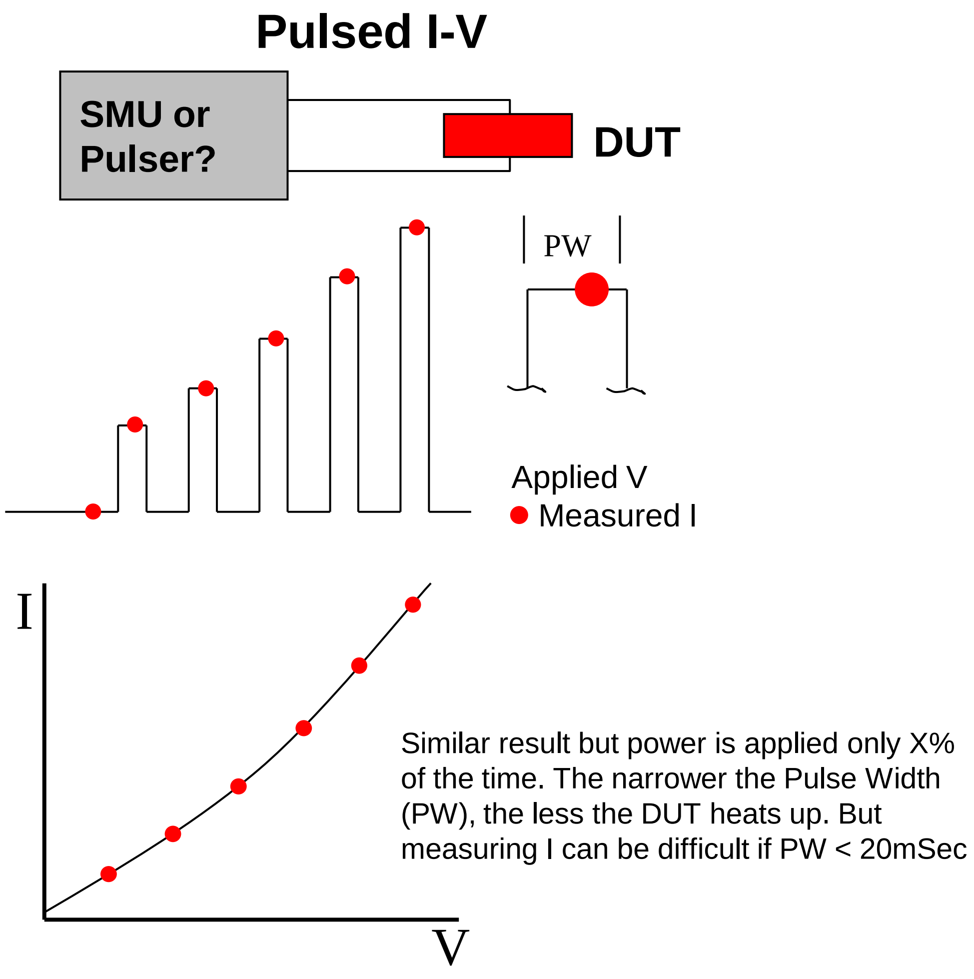
- Single channel module simplifies connections to DUT and extends current range of PMU
- Automatic switching between I-V, C-V and Ultra-fast Pulsed I-V measurements
  - No changing test setup or cables
- Extends the current range of the 4225-PMU
  - Provides current sensitivity down to tens of pico-amps
  - Reduces cable capacitance effects
- Magnetic and vacuum base available for easy installation on prober platen

Why is Pulsed I-V needed?

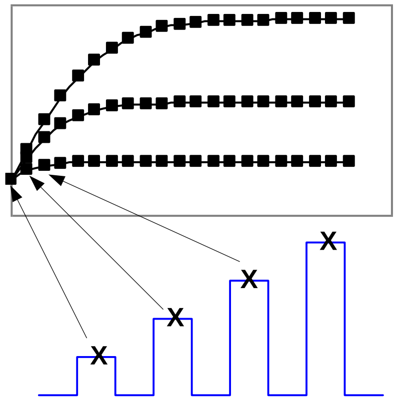
DC-LIKE RESULTS

- Minimizes self-heating effects (Joule heating)
- Certain tests require pulsing, for example, non-volatile memory devices





Operating Modes of 4225-PMU

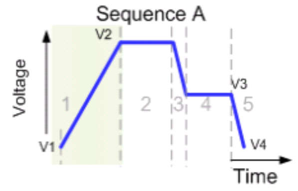


Pulsed I-V

- Pulse and measure with DC-like results
- Step, sweep, pulse train and DC outputs

Pulsed Sourcing

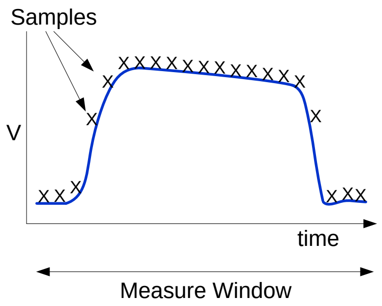
- Two-level or multi-level pulsing
- Arbitrary Waveform Generator
- Segment ARB



Sequence A Definition			
Segment	Start V	Stop V	Duration
1	V1	V2	T1
2	V2	V2	T2
3	V2	V3	T3
4	V3	V3	T4
5	V3	V4	T5

Transient I-V

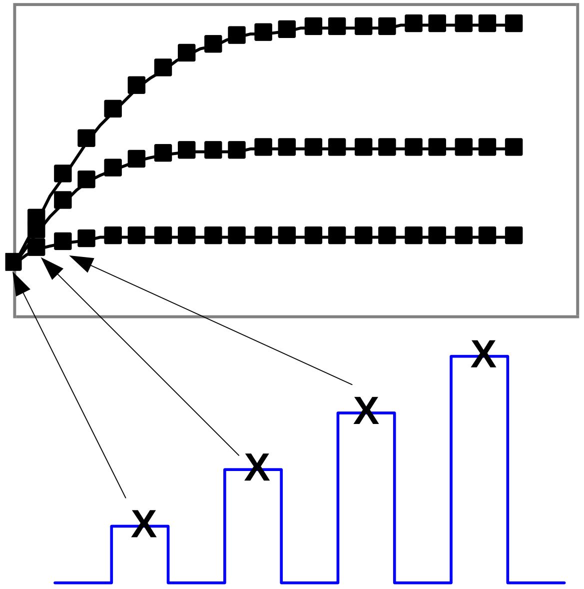
- waveform capture
- time-based current and voltage measurements



Pulsed I-V Mode

425-PMU PULSED I-V

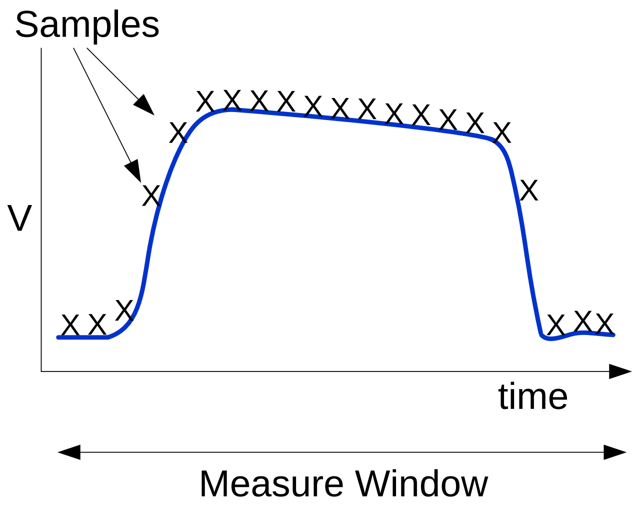
- Pulsed source and a corresponding high speed, time-based measurement that provides DC like results.
- For each pulse an average of readings are taken in a predefined window – called “spot mean”.
- User defines the parameters include:
  - Pulse width
  - Duty cycle
  - Rise/fall times
  - Amplitude



Transient I-V Mode

4225-PMU WAVEFORM CAPTURE MODE

- Transient I-V is also known as Waveform Capture similar to an oscilloscope
- Time-based current and/or voltage measurement that captures the pulsed waveform.
- Used to evaluate a dynamic test circuit
- Used as a diagnostic tool for choosing the appropriate pulse settings in the pulse I-V mode.



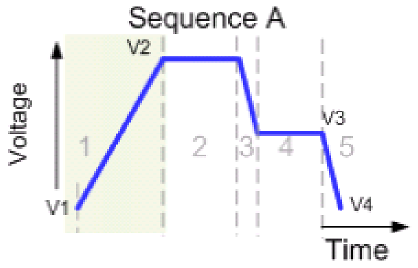
Pulsed Sourcing

4225-PMU SEGMENT ARBITRARY WAVEFORM

- **Two-level pulsing**: user inputs a high and low value of the pulse. Can choose to measure the “spot mean” at both the high and low values.

- **Multi-level pulsing with Segment Arb**: user inputs individual segments of the desired pulse. This mode allows measuring.

- **Arbitrary Waveform Generator** (KPULSE): user creates the arbitrary waveform in KPULSE and then implements the waveform in a UTM. This mode does not allow measuring.



Sequence A Definition			
Segment	Start V	Stop V	Duration
1	V1	V2	T1
2	V2	V2	T2
3	V2	V3	T3
4	V3	V3	T4
5	V3	V4	T5

Segment Arb

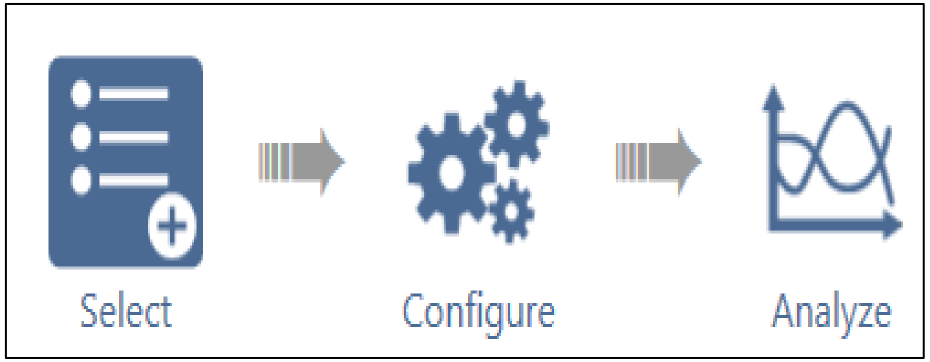
New Clarius™ User Interface

Clear, Uncomplicated Analysis

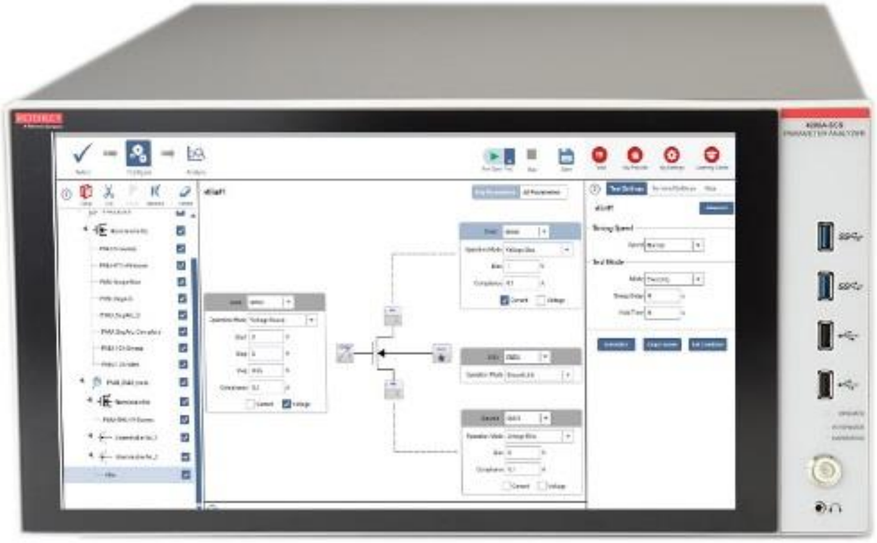
Clarius Software

- Primary user interface for the 4200A.
- Replaces the KITE software.
- Includes built-in Help and Learning Center
- Embedded Videos

- Finding, setting up, and viewing the results is broken down in 3 easy steps:
  - ✓ Select
  - ✓ Configure
  - ✓ Analyze



Select – Configure – Analyze Views

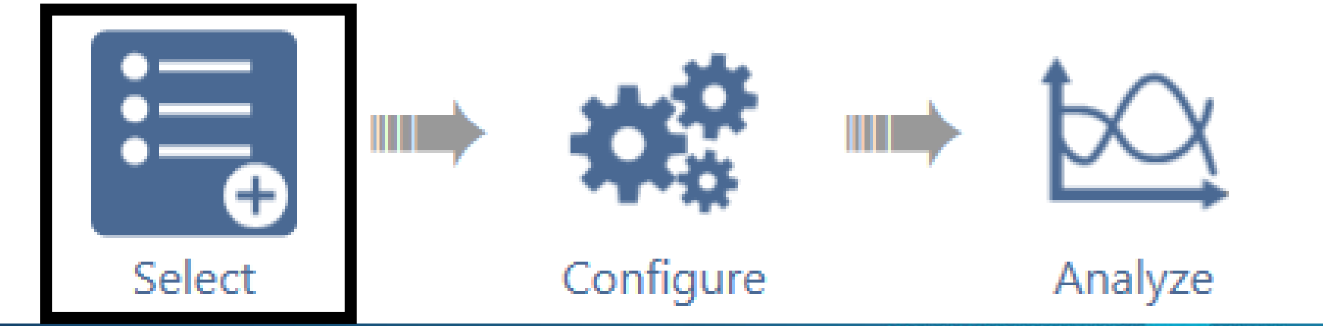


Select

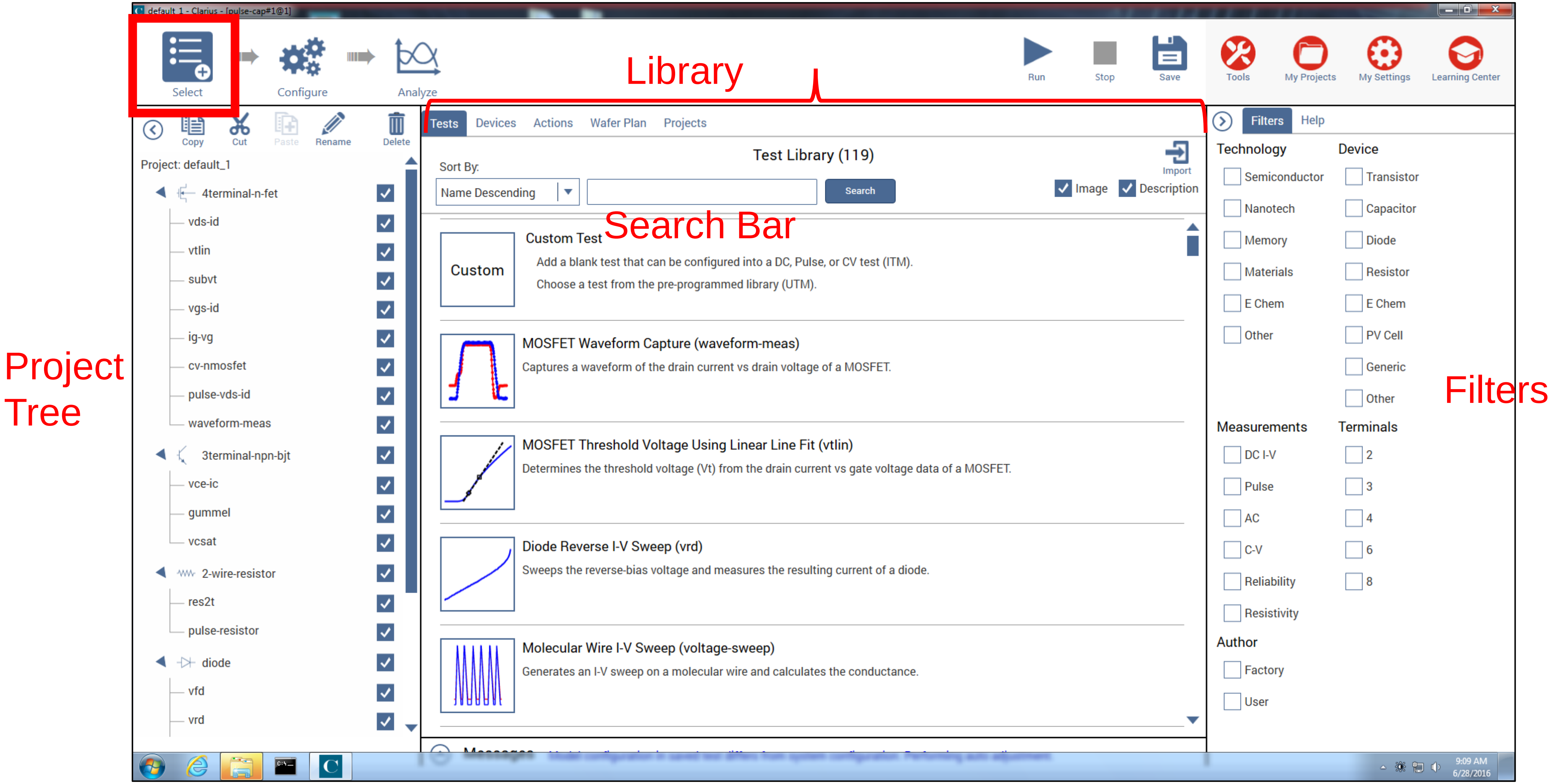
Configure

Analyze

Select View

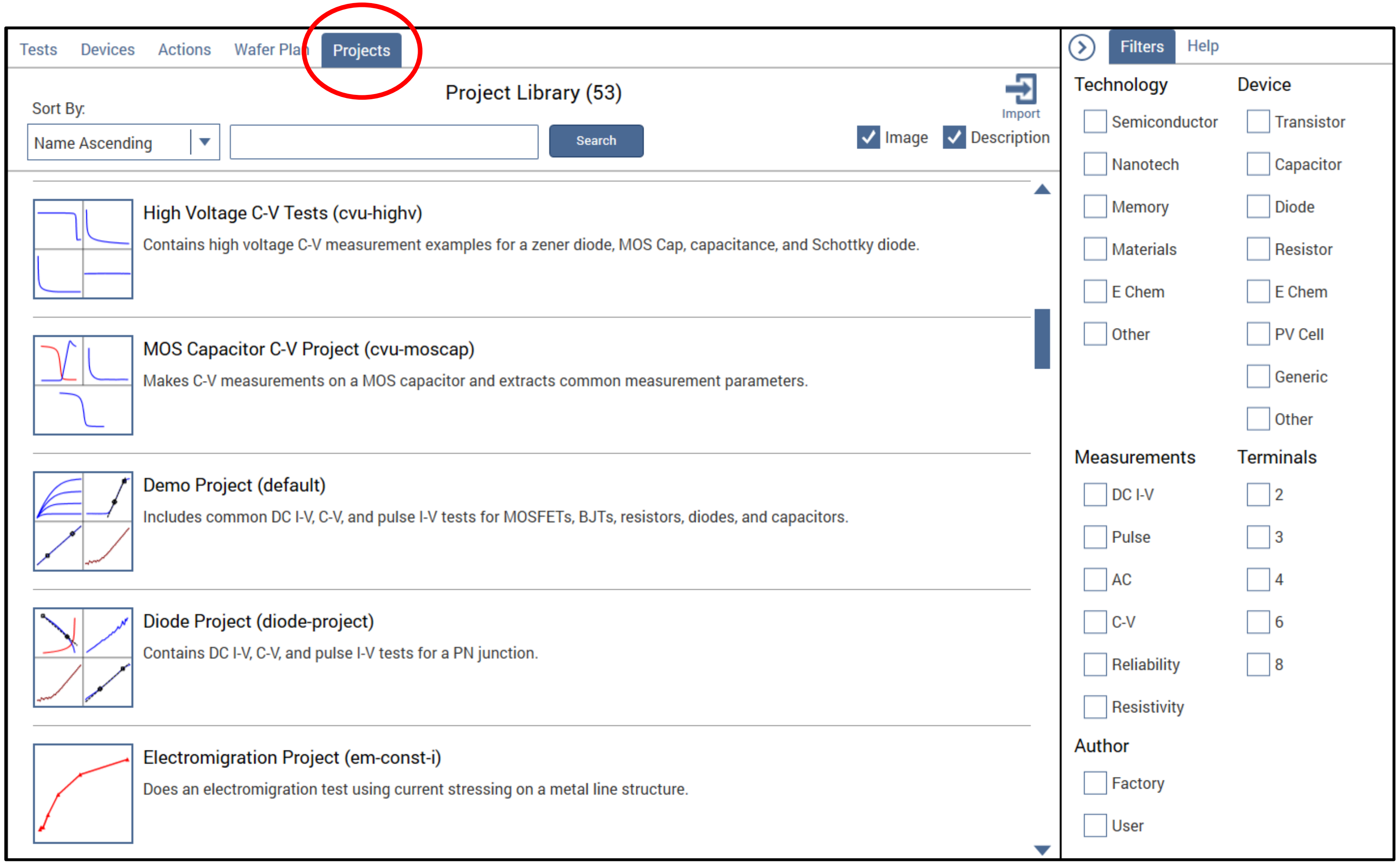


Clarius Select Screen



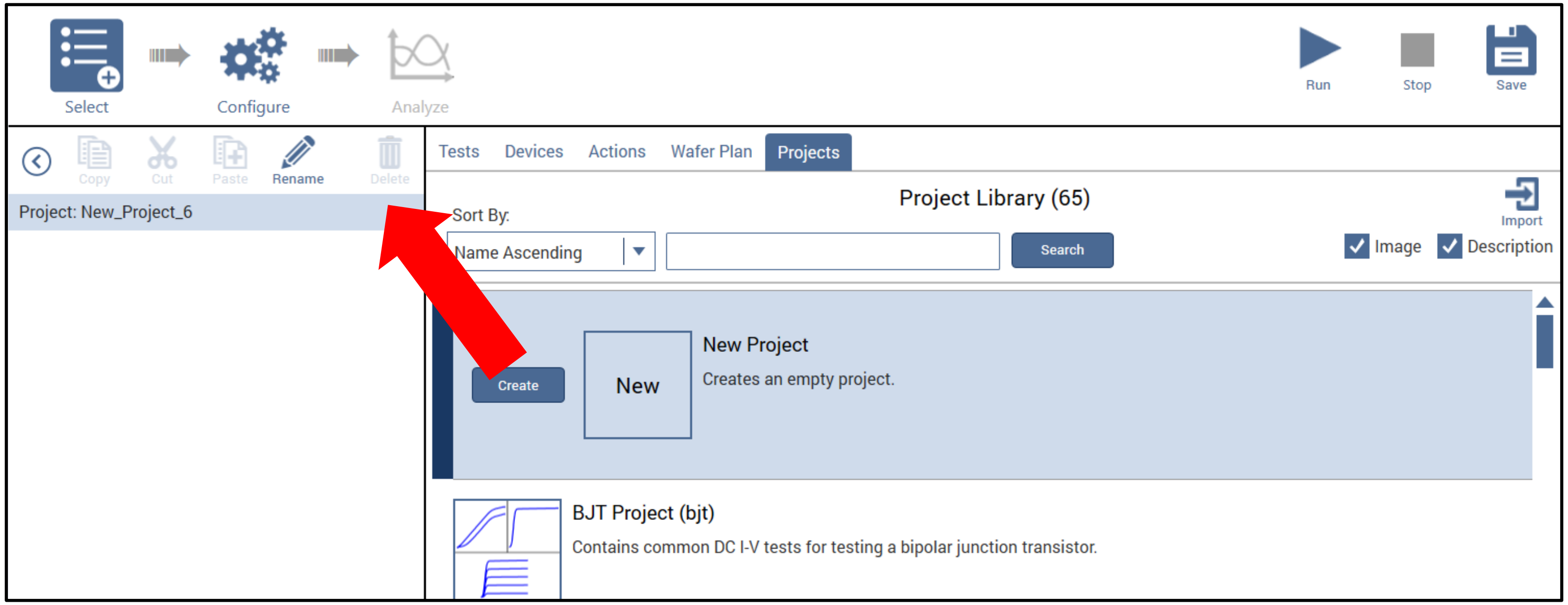
Projects Library

Contains predefined projects and also can create own project.



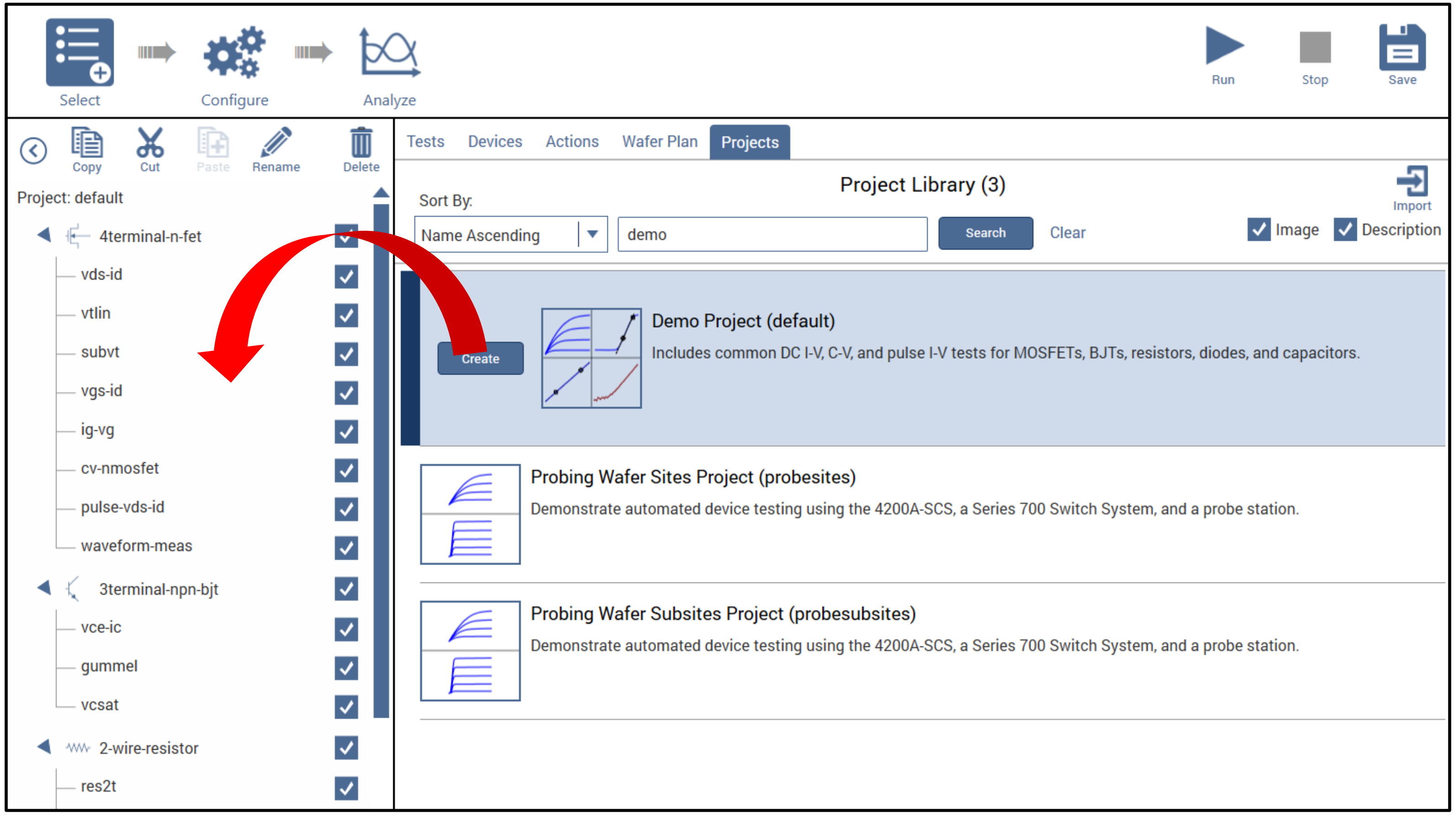
Select and Open a New Project

Instead of using one of the preconfigured projects from the Library, you can choose to create a New Project.



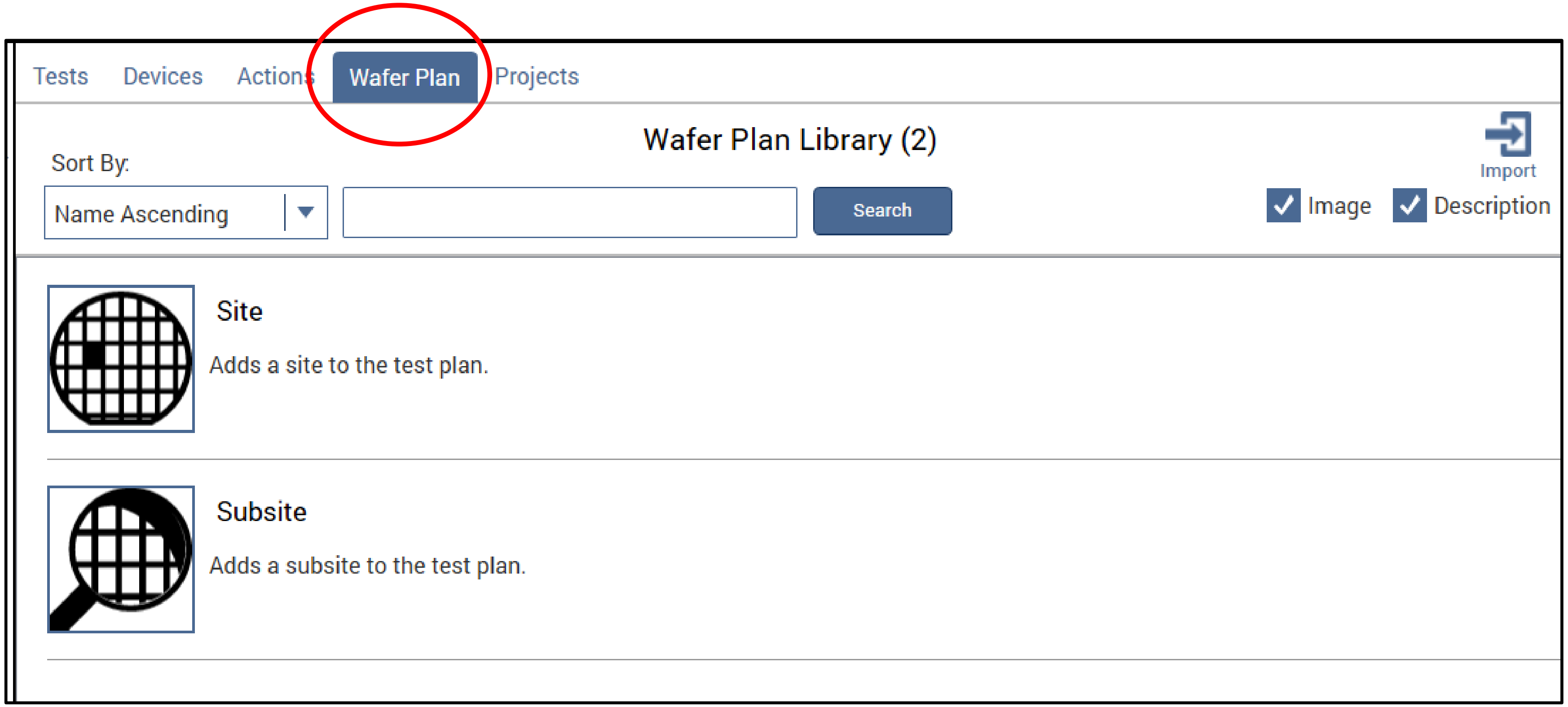
Open a Project from the Library

To open a project or test, select (or highlight) it and then press Create.
The project will open up into the Project Tree.



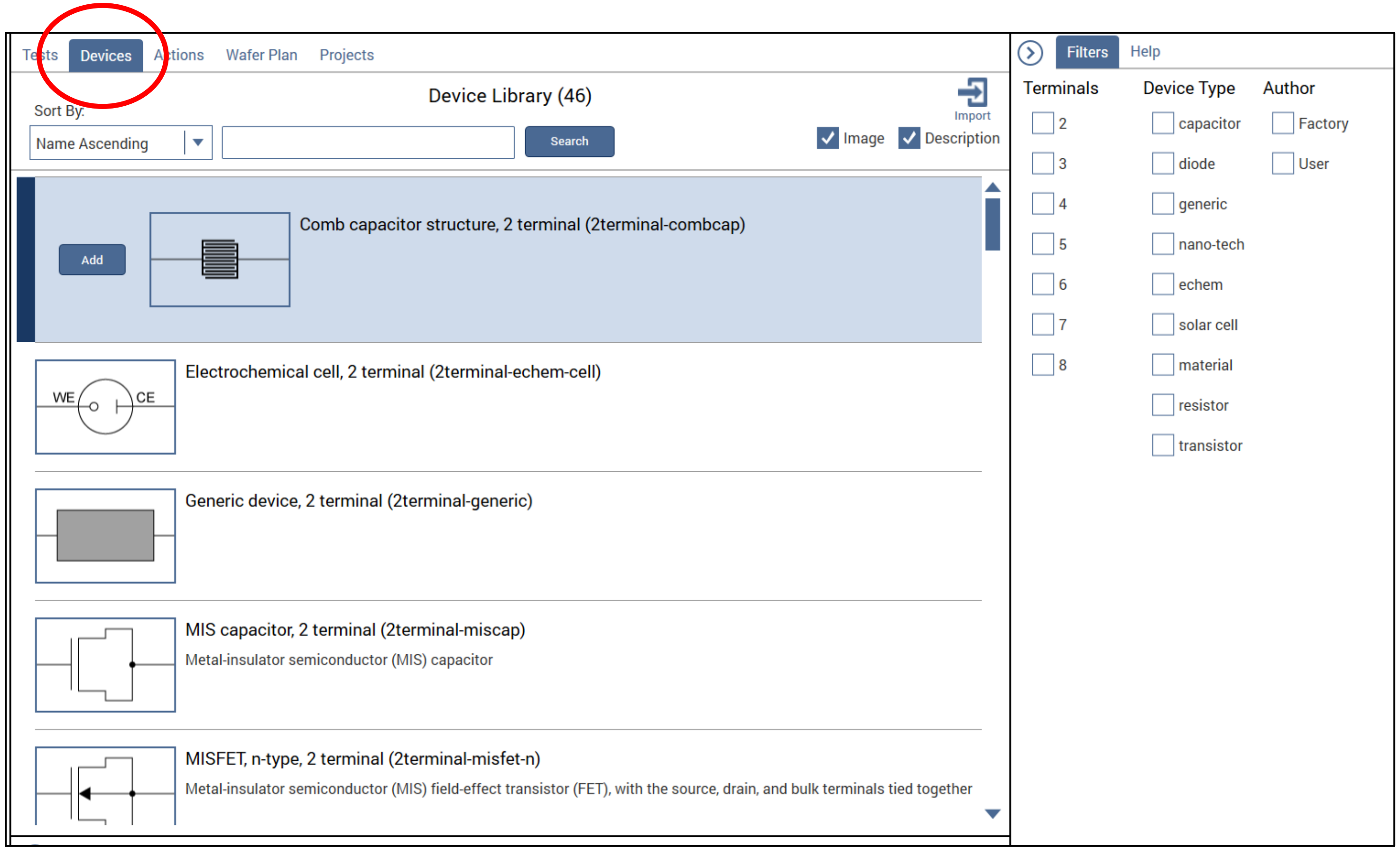
Wafer Plan

Contains sites and subsites.
A site is used for



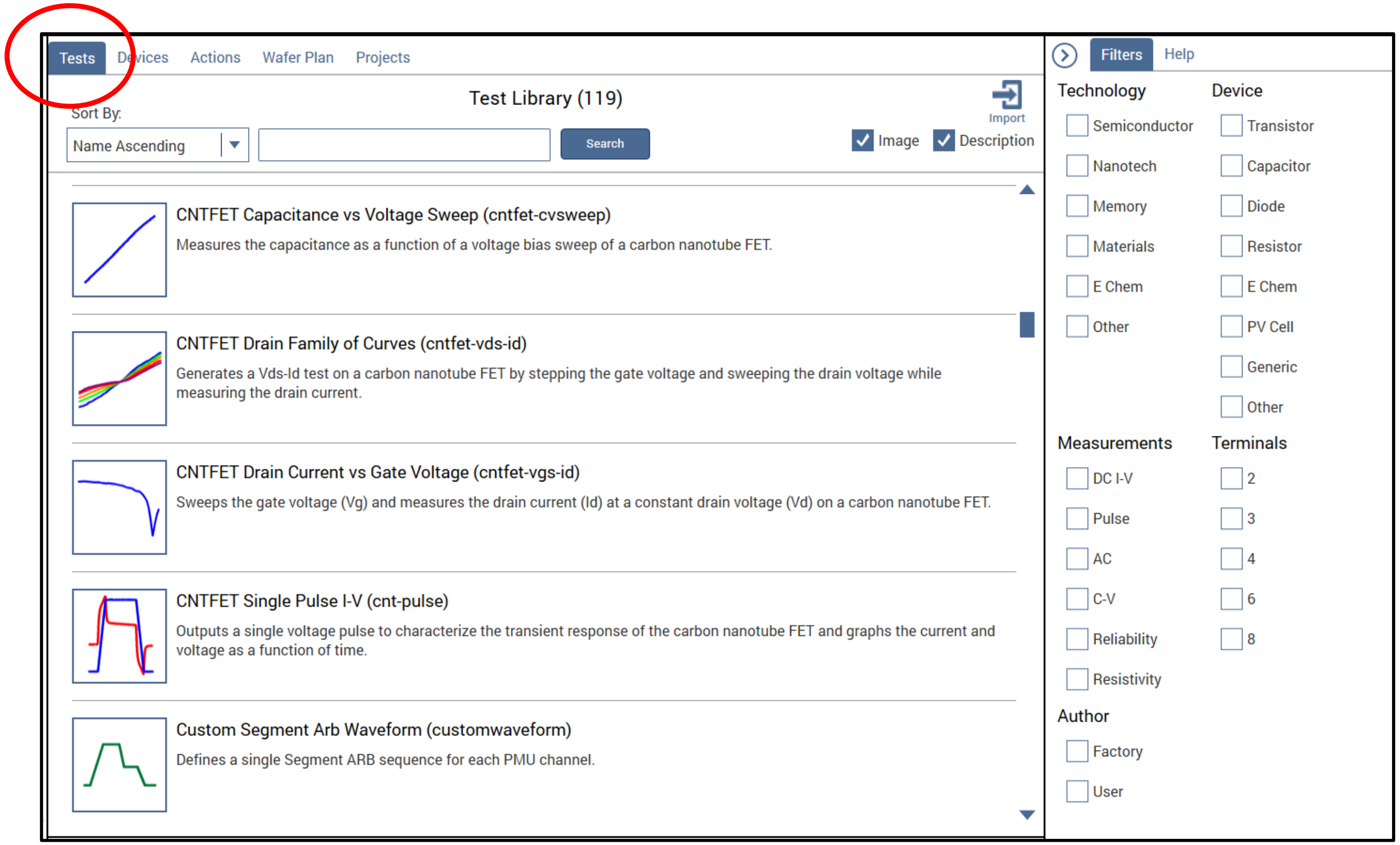
Devices

Contains sites and subsites.
A site is used for



Tests

Contains sites and subsites.
A site is used for



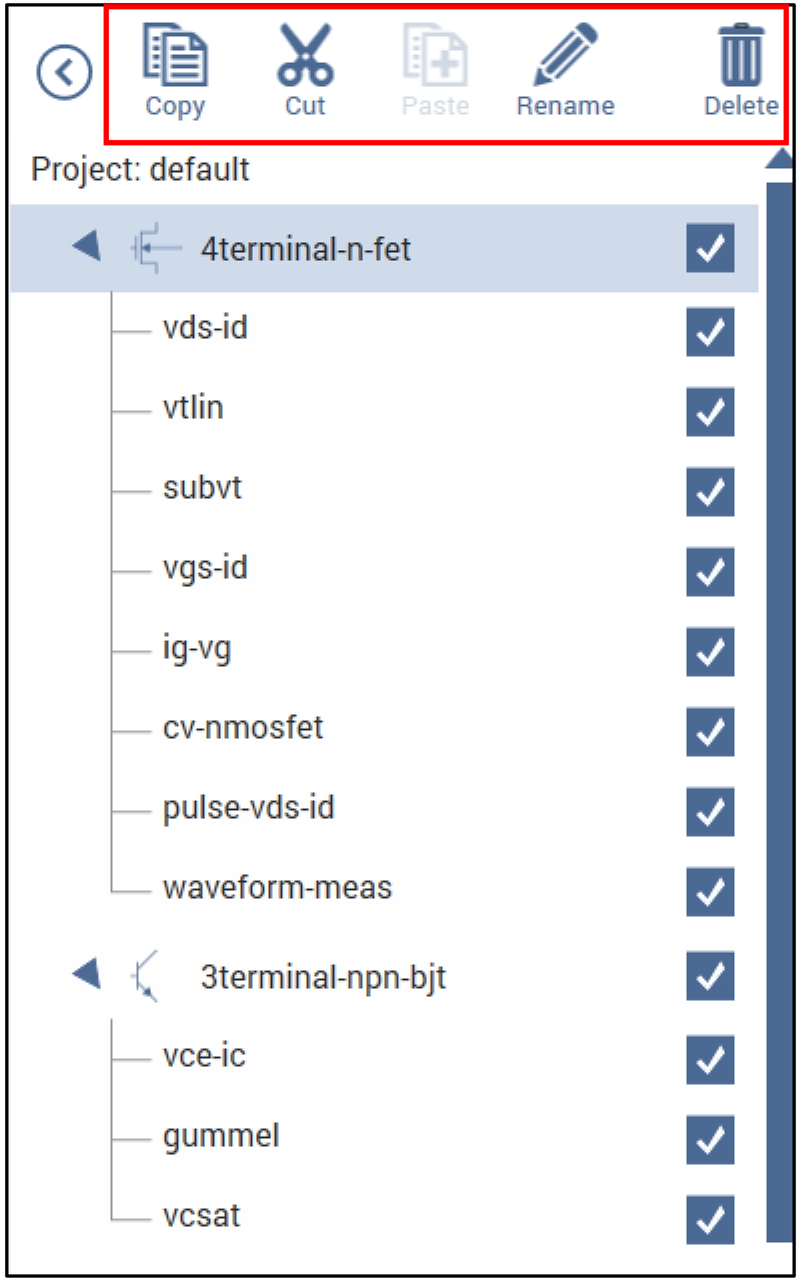
Project Tree

Project Trees no longer require Sites and Subsites.

Across the top of the Project Tree are new functions:

- **Copy, Cut, and Paste**: Used to move and add tests.
- **Rename**: All names in the project tree can be renamed.
- **Delete:** removes tests from Project Tree

The new functions are also available by right clicking on test.

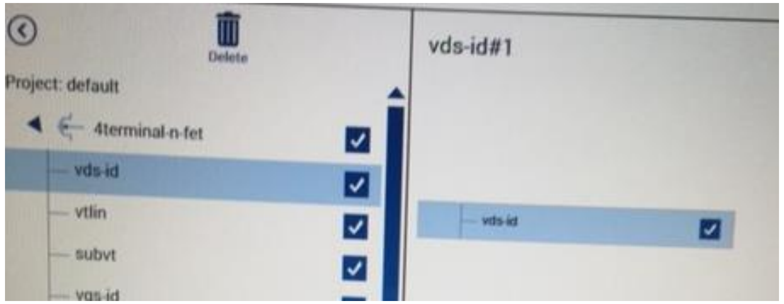


Relocate objects in the Project Tree

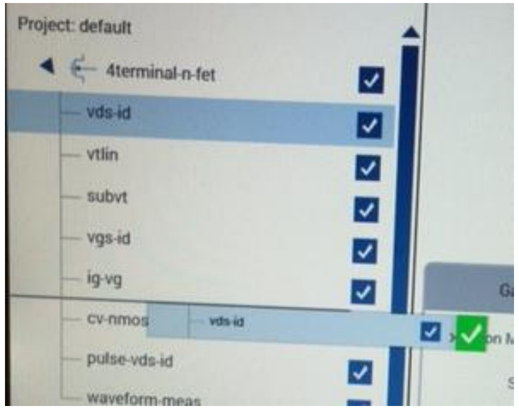
The location of an object within a project can also be changed by dragging it to a new spot in the project tree. Here is example of moving vds-id test:

1. Highlight the test (vds-id) you want to move.

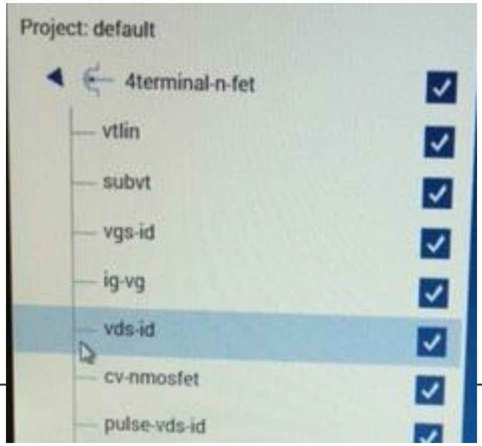
2. Drag the highlighted test to the right.



3. Move the test back towards project tree until line will be above where you want to place the test.

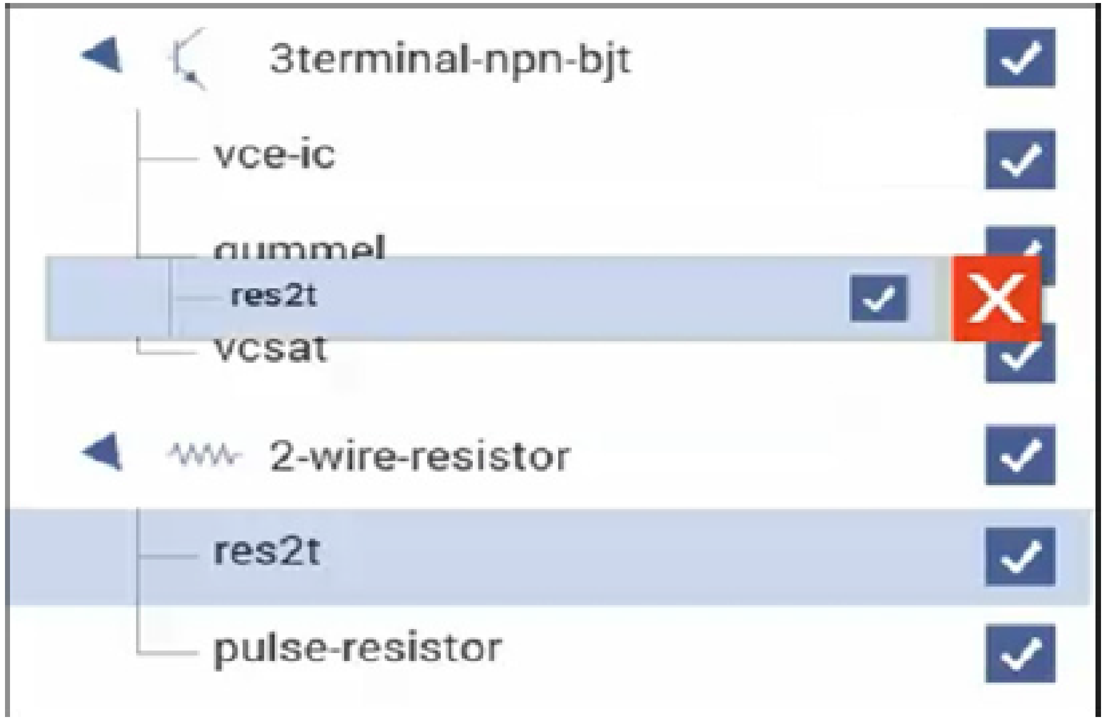


4. vds-id test in new location in project tree.

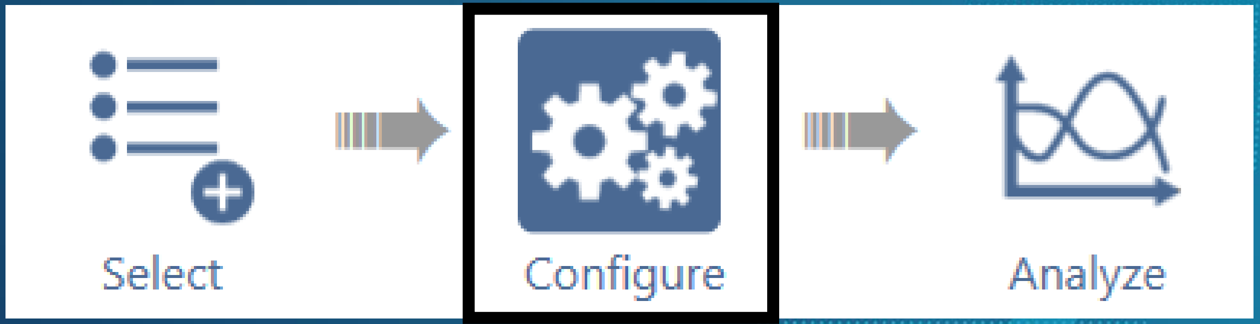


Relocate objects in the Project Tree

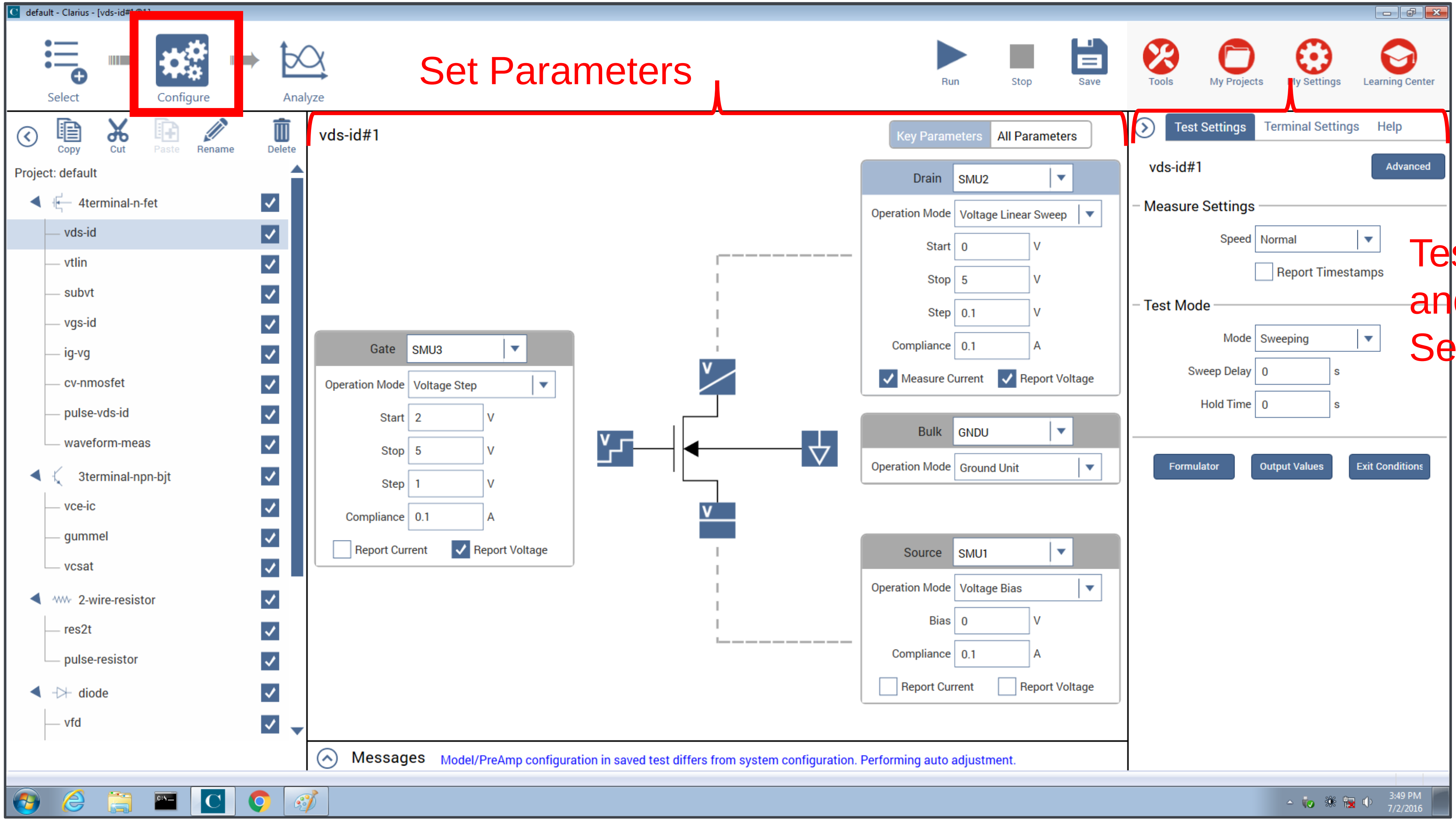
If the object cannot be located in the selected location, a red X is displayed. In the example below, a resistor test cannot be placed under a BJT device.



Configure View

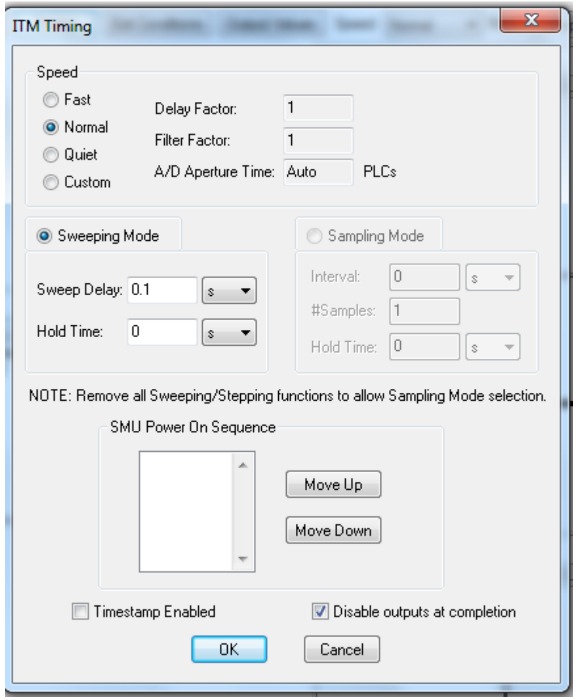


Configure View

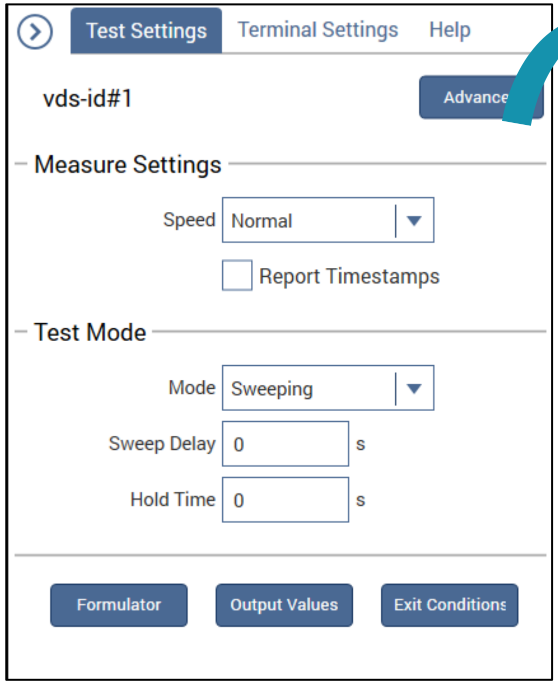


Test Settings (timing) -SMU (CVU)

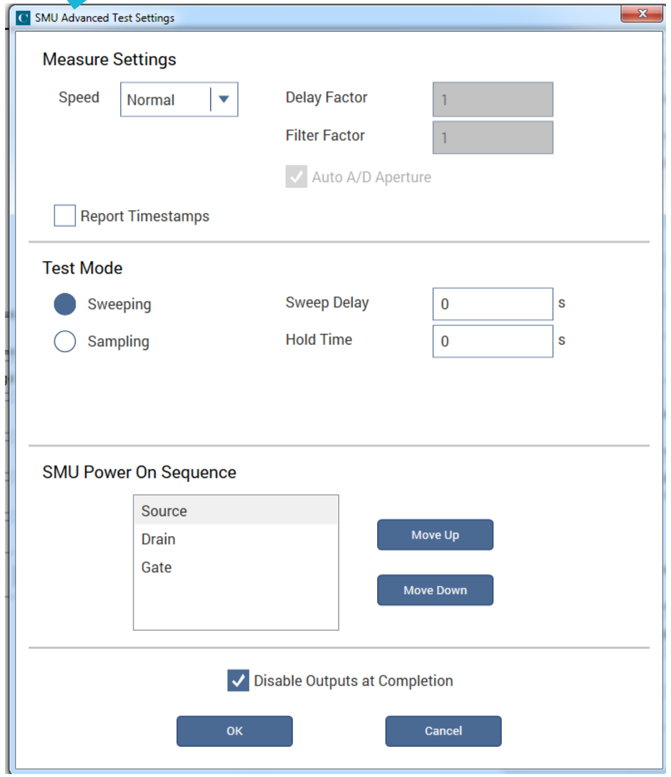
4200 Timing Window



4200A Test Settings Pane



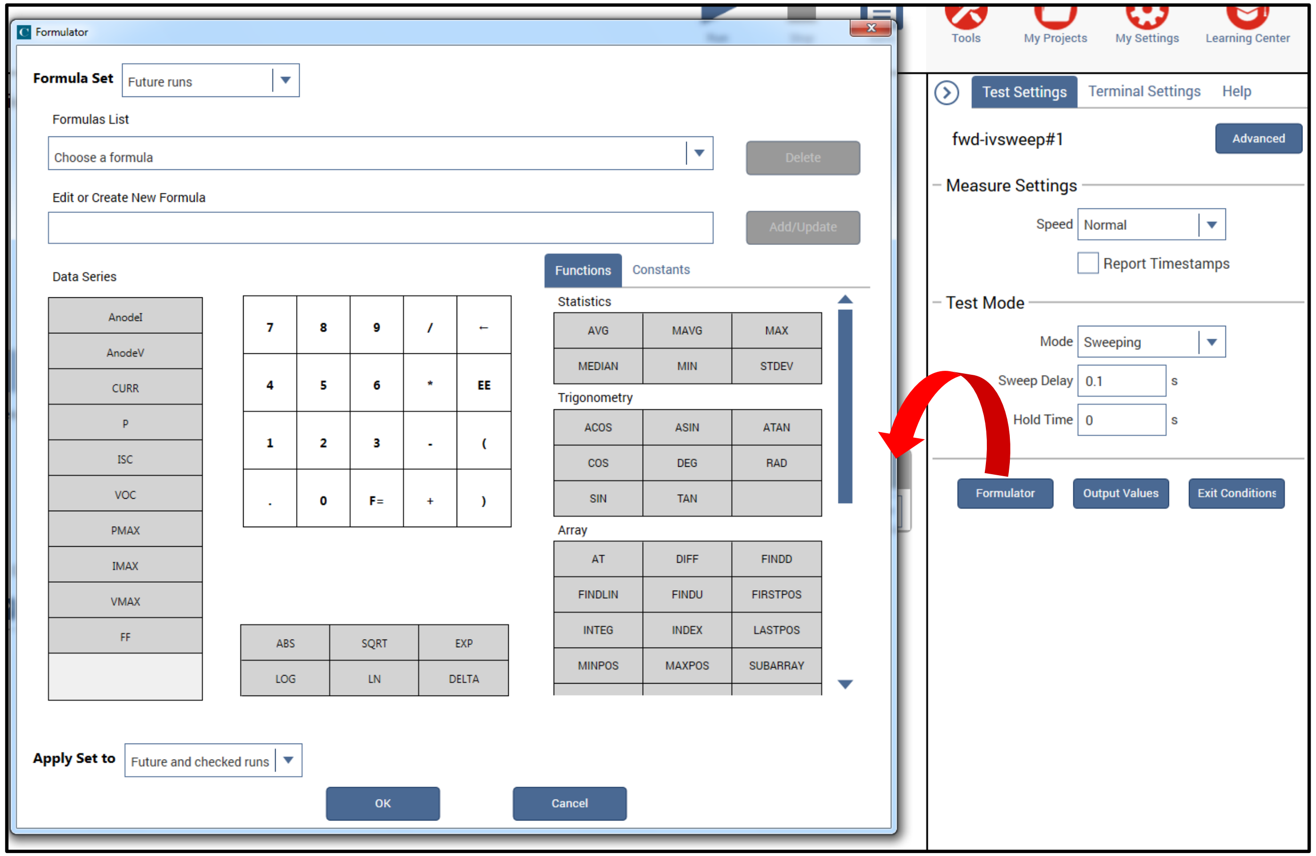
4200A Advanced Test Settings Window



On right hand side of screen is Test Settings pane. The Test Settings pane is where timing parameters are set for the SMU, CVU, and PMU.

Formulator

The Formulator is accessed in the Test Settings pane.

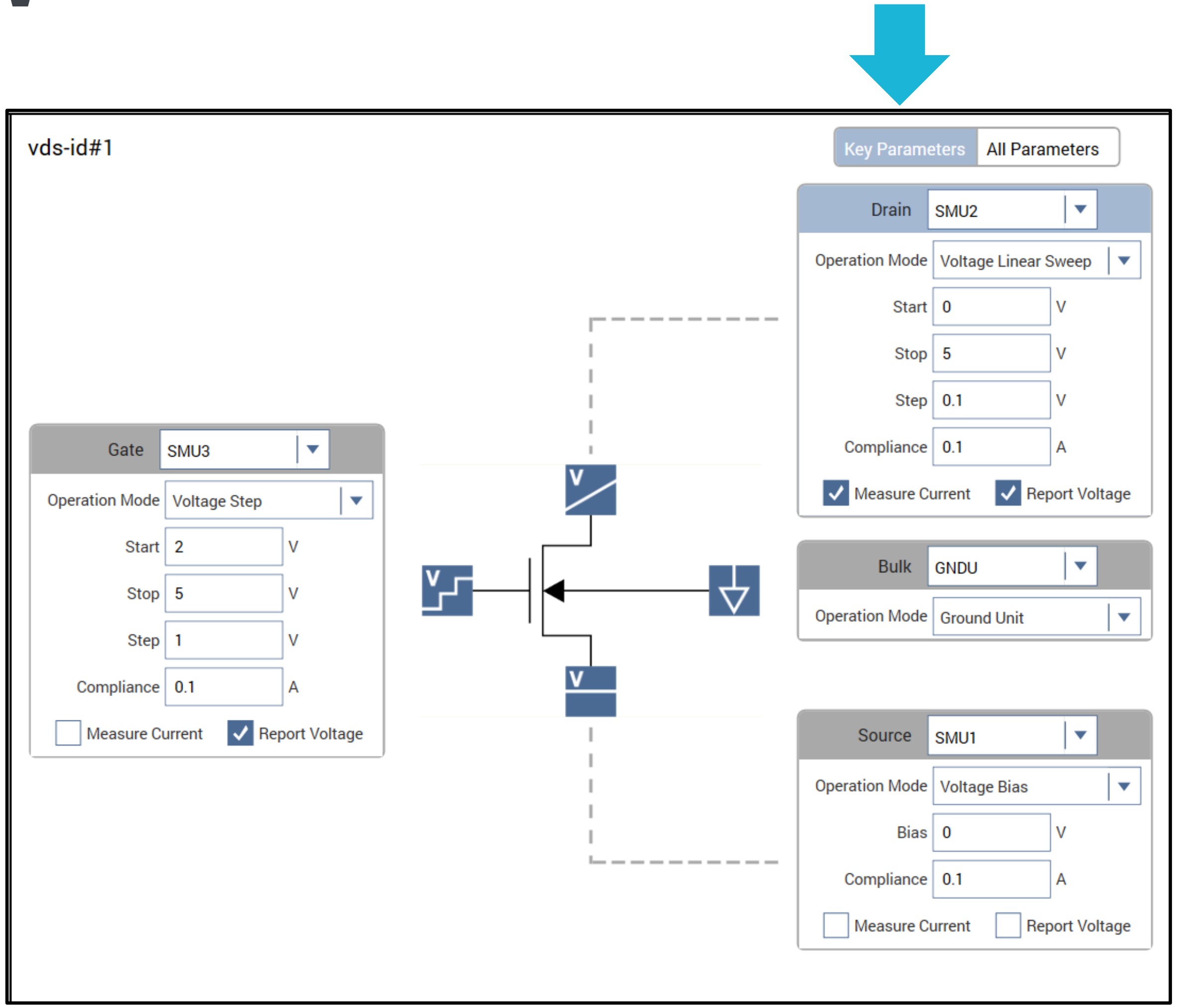


- Updated dialog box.
- You can choose which Runs you want to apply the formulas.

Key Parameters View

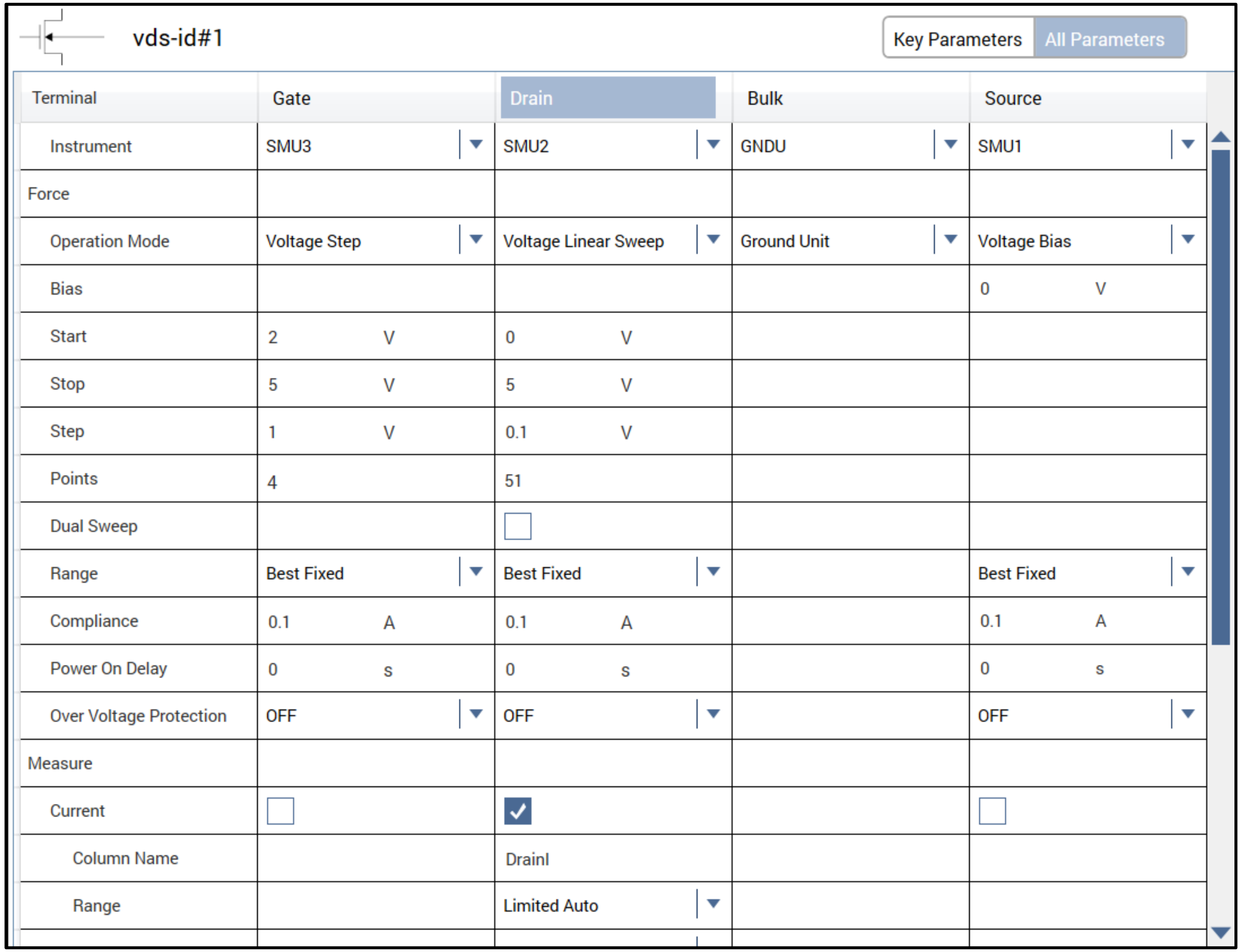
Key Parameters of a terminal include the name of the terminal, the device connected to the terminal, the operation mode, and basic settings for that mode.

Notice the operation mode icons next to each terminal.



All Parameters View

Or, if you want to view all the terminal parameters at once, select the All Parameters view.

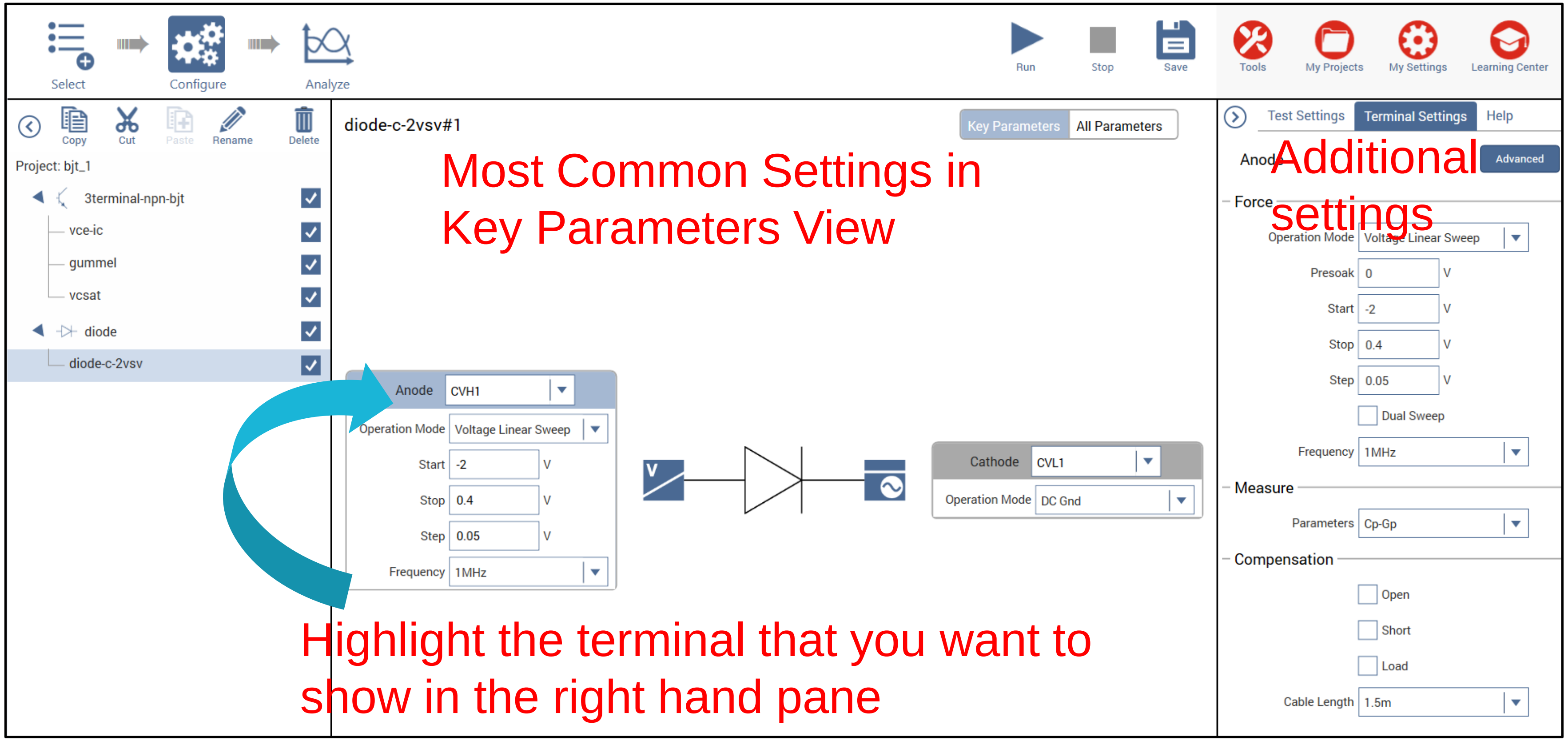

vds-id#1

Key Parameters | All Parameters

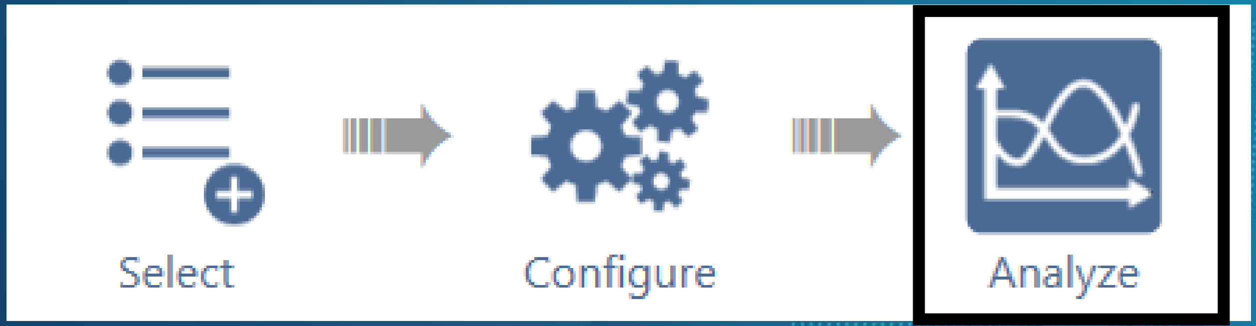
Terminal	Gate	Drain	Bulk	Source
Instrument	SMU3	SMU2	GNDU	SMU1
Force				
Operation Mode	Voltage Step	Voltage Linear Sweep	Ground Unit	Voltage Bias
Bias				0 V
Start	2 V	0 V		
Stop	5 V	5 V		
Step	1 V	0.1 V		
Points	4	51		
Dual Sweep		☐		
Range	Best Fixed	Best Fixed		Best Fixed
Compliance	0.1 A	0.1 A		0.1 A
Power On Delay	0 s	0 s		0 s
Over Voltage Protection	OFF	OFF		OFF
Measure				
Current	☐	☑		☐
Column Name		DrainI		
Range		Limited Auto		

Terminal Settings panes

The most common terminal settings are available in the center pane when Key Parameters is selected. Additional common test settings are available in the right Terminal Settings pane. The SMU, CVU, and PMU have different panes.

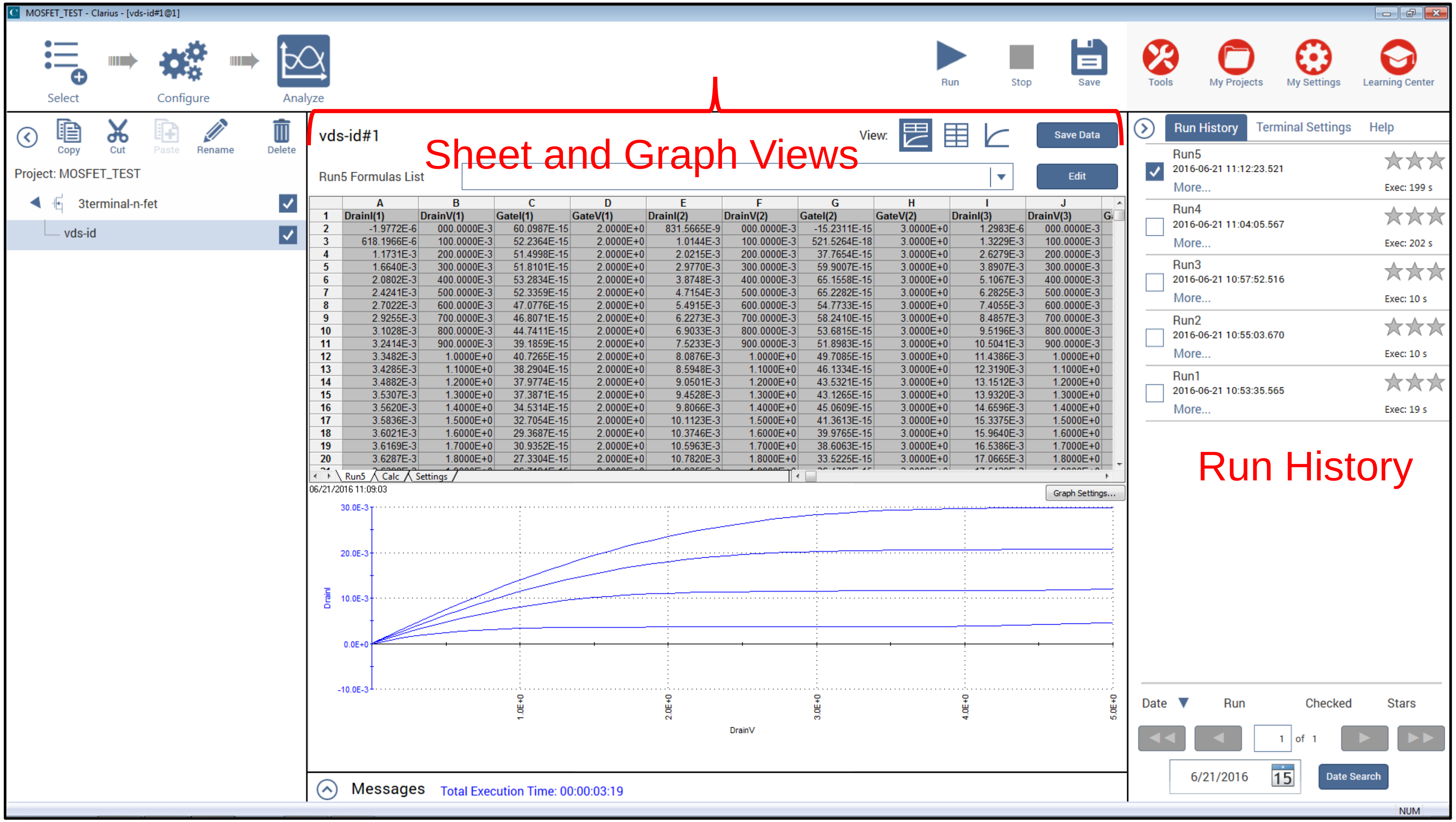


Analyze View



Analyze View

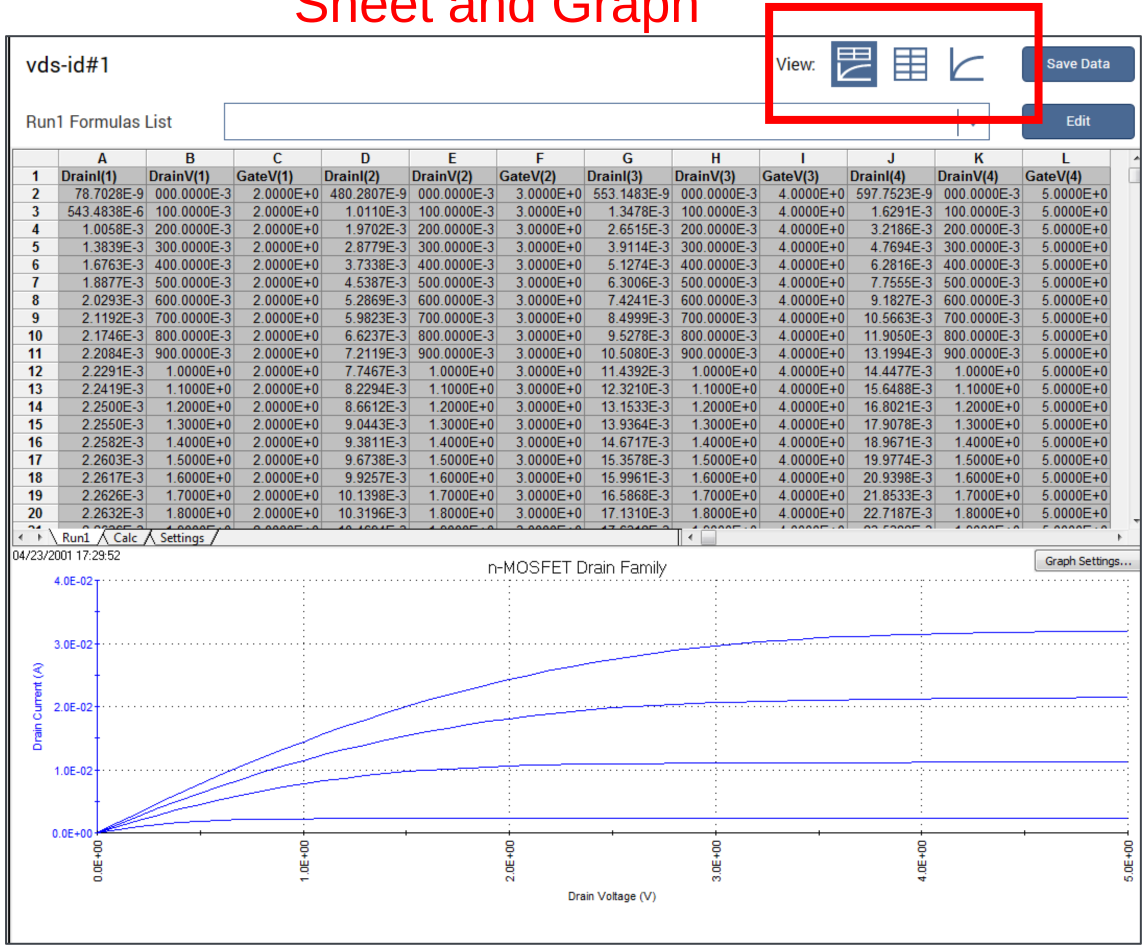
Project Tree



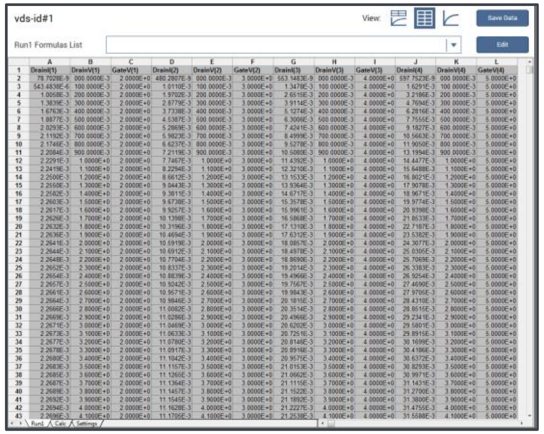
Analyze View

The Analyze View enables the user to simultaneously view both readings logged in the Sheet and graphing in real time.

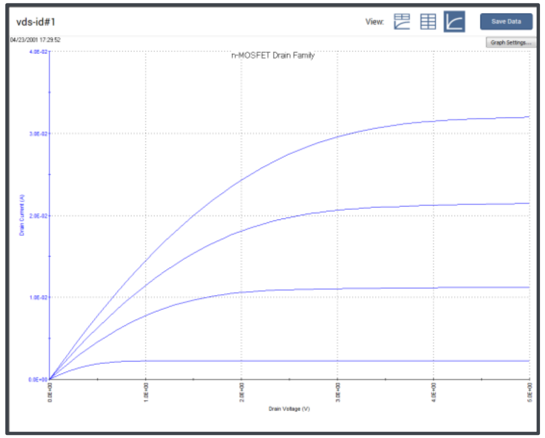
Sheet and Graph



Sheet

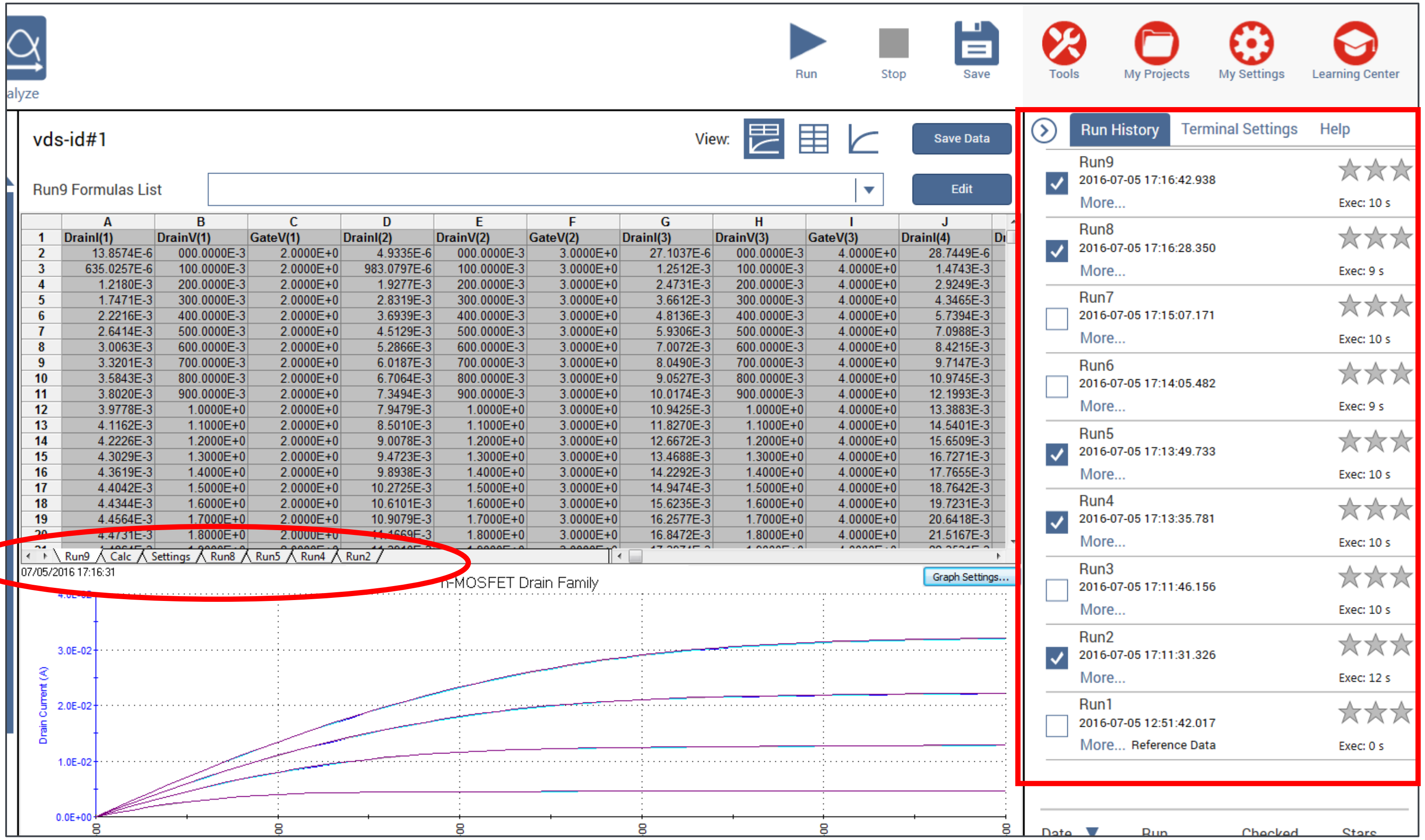


Graph



Run History

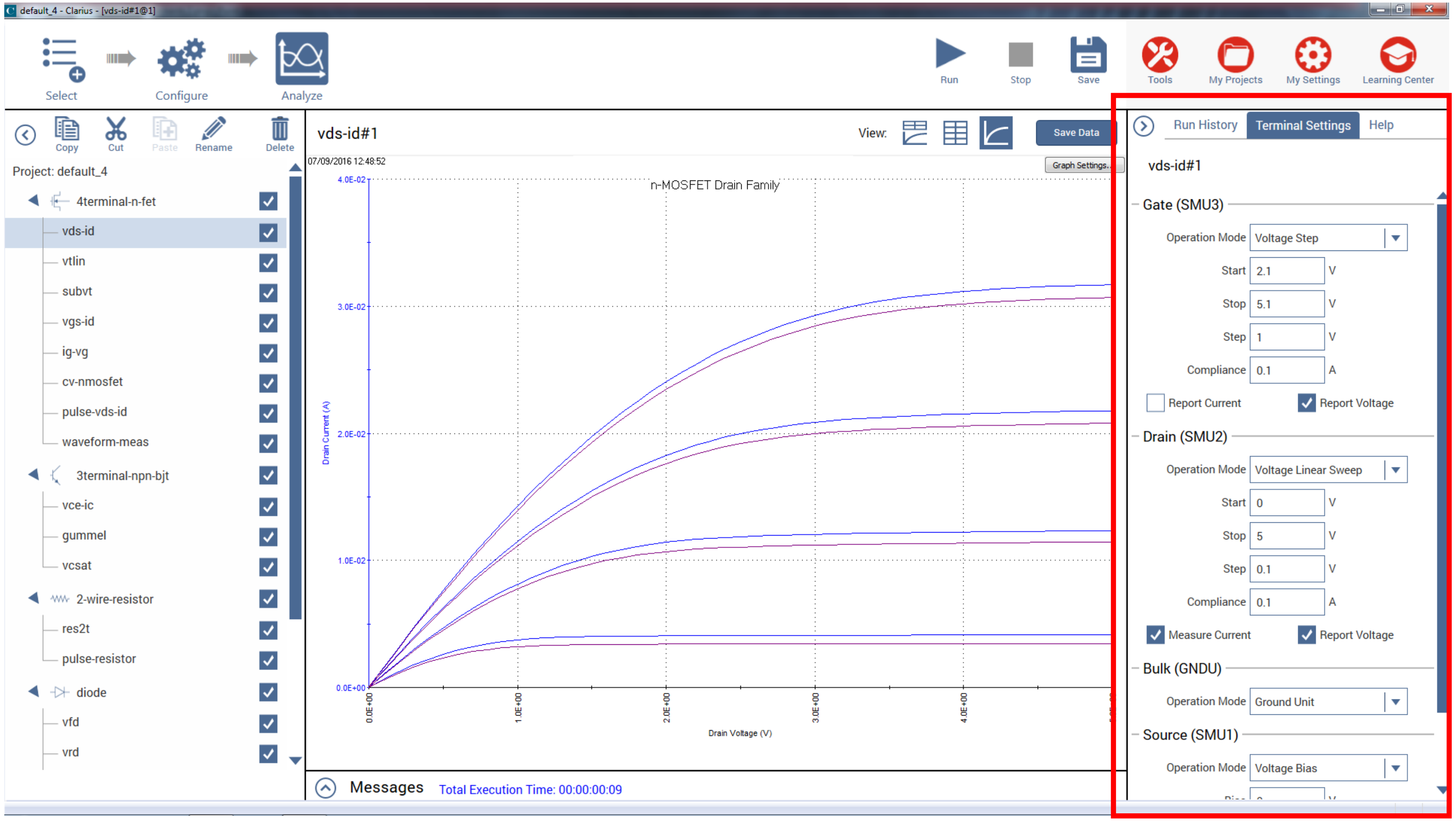
The 4200A has one Run button for executing all tests and projects.



Only the checked boxes appear on the Graph and Sheet.

Analyze View – Terminal Settings

To be able to easily make changes as you are actively testing, there is a Terminal Settings tab to quickly make parameter changes to your test.



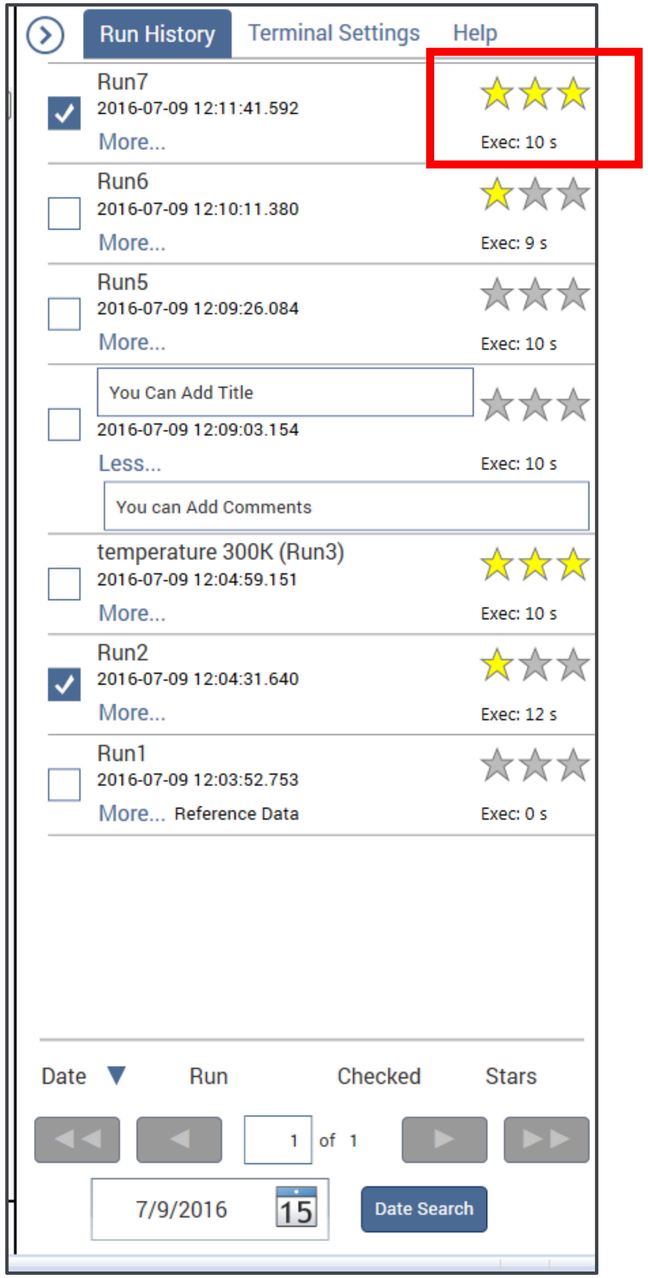
Run History

You can have up to **10,000** Runs for each test.

If exceed 10,000 oldest Run will be removed first.

- A timestamp that shows the date and time when the test was run.
- The execution time.
- Rating stars that you can use to flag specific tests.
- Notes. Select the **More** link and select the text box to add notes

about the run. Select **Enter** when the notes are complete.



Others

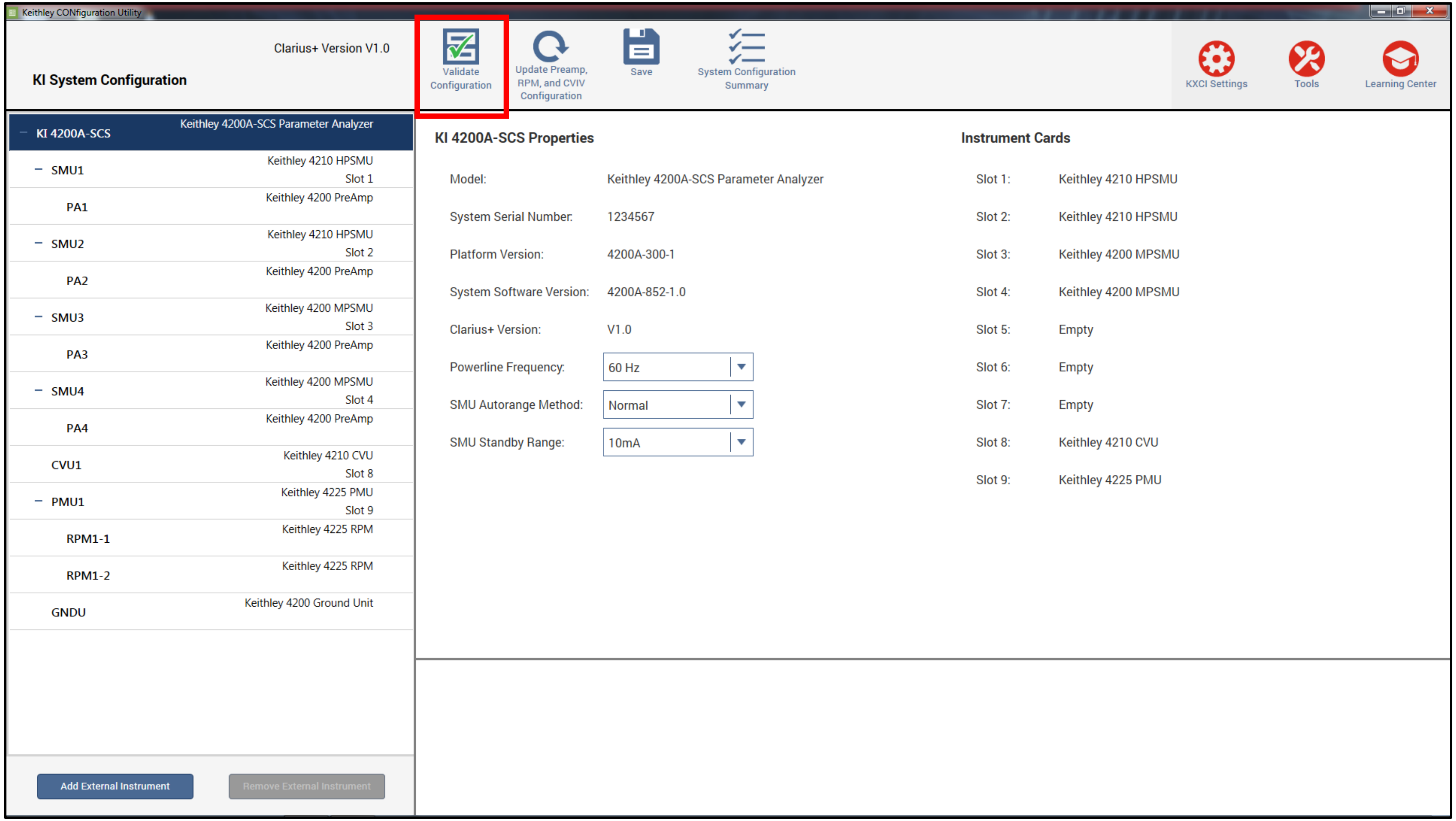
Software Apps – Desktop

4200 Apps - KTEI	4200A Apps – Clarius+
Complete Reference contains manuals, white papers, applications notes, release notes and other related literature	**Learning Center** contains manuals, white papers, applications notes, release notes, videos and other related literature
KITE – Keithley Interactive Test Environment	**Clarius** – Keithley Interactive Test Environment
KULT – Keithley User Library Tool	**KULT** – Keithley User Library Tool
KCON – Keithley Configuration Utility	**KCon** – Keithley Configuration Utility
KXCI – Keithley External Control Interface	**KXCI** – Keithley External Control Interface
	KPulse – Keithley Pulse

KCon

Keithley Configuration Utility

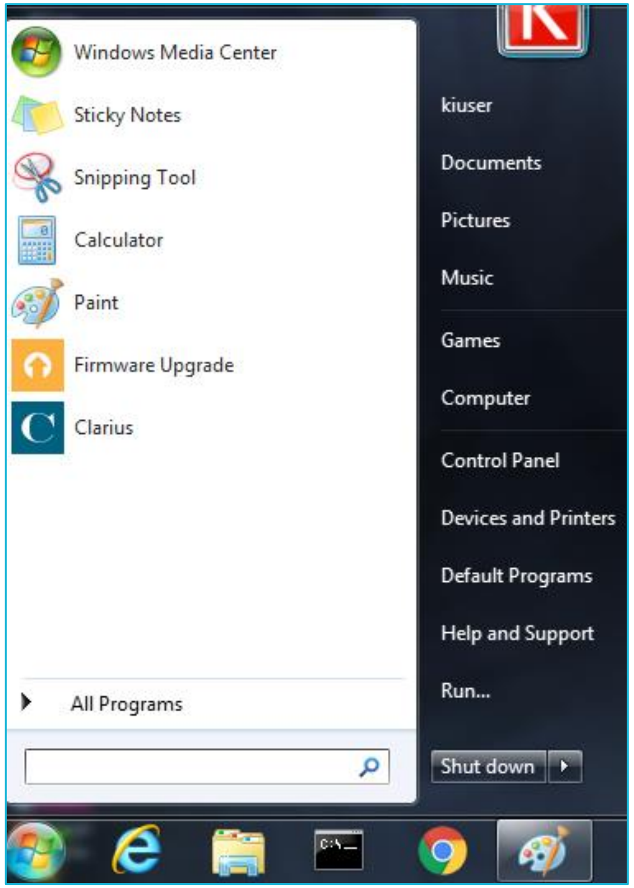
KCon

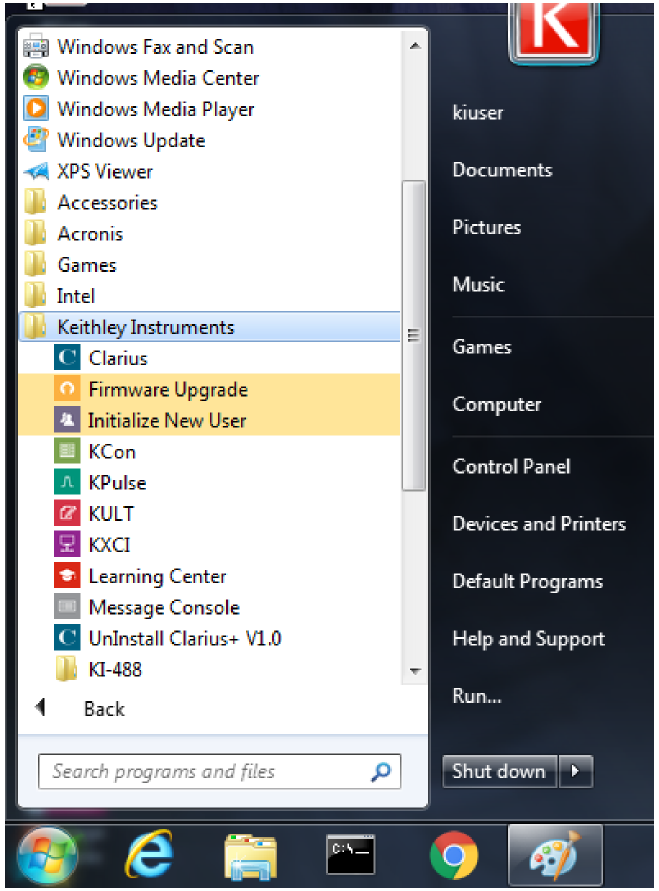


Keithley CONFiguration Utility
Clarius+ Version V1.0
KI System Configuration
Validate Configuration
Update Preamp, RPM, and CVIV Configuration
Save
System Configuration Summary
KXCI Settings
Tools
Learning Center
KI 4200A-SCS
Keithley 4200A-SCS Parameter Analyzer
SMU1
Keithley 4210 HPSMU
Slot 1
PA1
Keithley 4200 PreAmp
SMU2
Keithley 4210 HPSMU
Slot 2
PA2
Keithley 4200 PreAmp
SMU3
Keithley 4200 MPSMU
Slot 3
PA3
Keithley 4200 PreAmp
SMU4
Keithley 4200 MPSMU
Slot 4
PA4
Keithley 4200 PreAmp
CVU1
Keithley 4210 CVU
Slot 8
PMU1
Keithley 4225 PMU
Slot 9
RPM1-1
Keithley 4225 RPM
RPM1-2
Keithley 4225 RPM
GNDU
Keithley 4200 Ground Unit
Add External Instrument
Remove External Instrument
KI 4200A-SCS Properties
Model: Keithley 4200A-SCS Parameter Analyzer
System Serial Number: 1234567
Platform Version: 4200A-300-1
System Software Version: 4200A-852-1.0
Clarius+ Version: V1.0
Powerline Frequency: 60 Hz
SMU Autorange Method: Normal
SMU Standby Range: 10mA
Instrument Cards
Slot 1: Keithley 4210 HPSMU
Slot 2: Keithley 4210 HPSMU
Slot 3: Keithley 4200 MPSMU
Slot 4: Keithley 4200 MPSMU
Slot 5: Empty
Slot 6: Empty
Slot 7: Empty
Slot 8: Keithley 4210 CVU
Slot 9: Keithley 4225 PMU

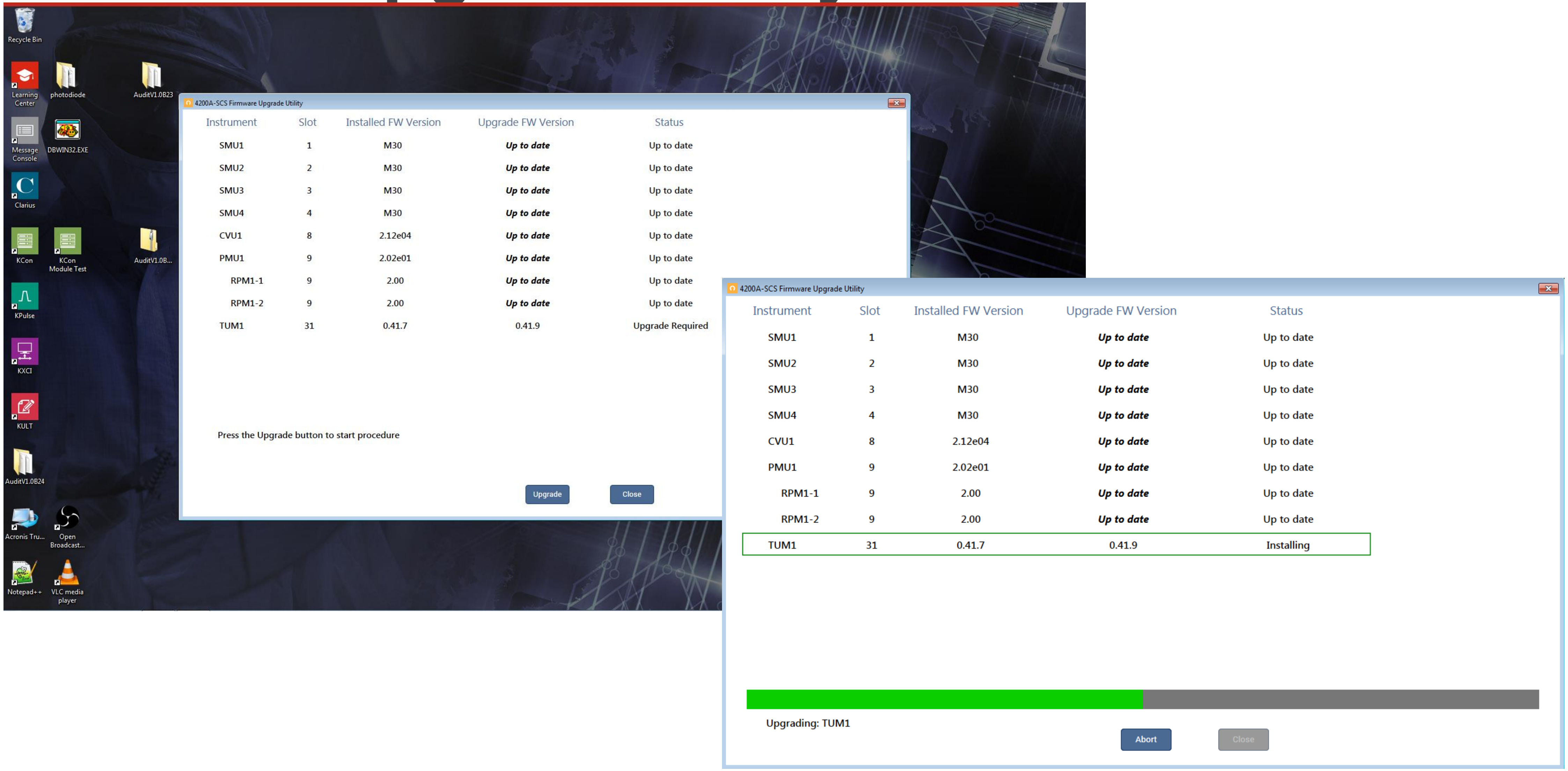
New Firmware Upgrade Utility

To verify or update the firmware revision of the instruments, use the Firmware Upgrade utility. Firmware Upgrade can be found from the Start menu by going to All Programs -> Keithley Instruments -> Firmware Upgrade.

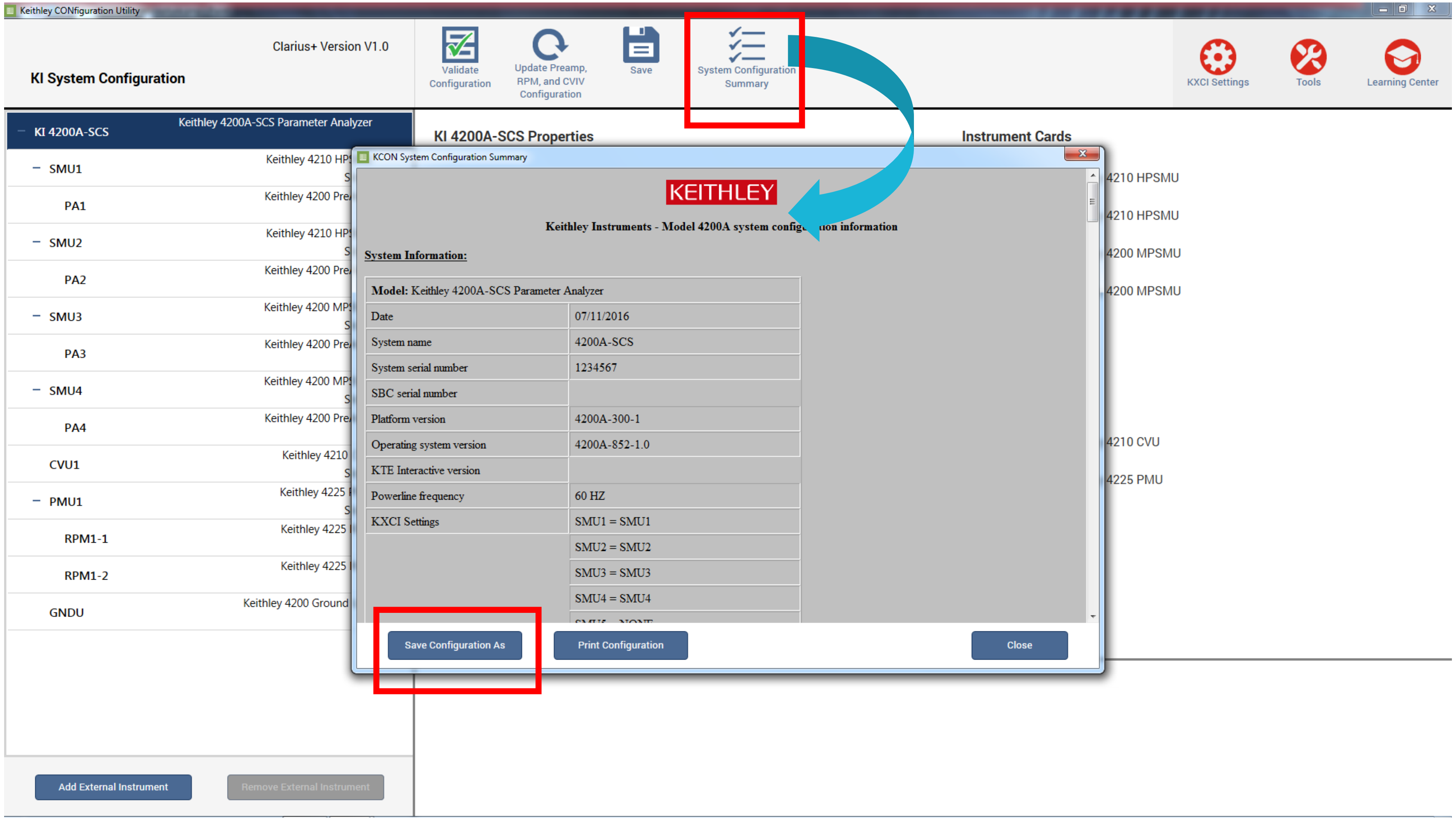




Firmware Upgrade Utility

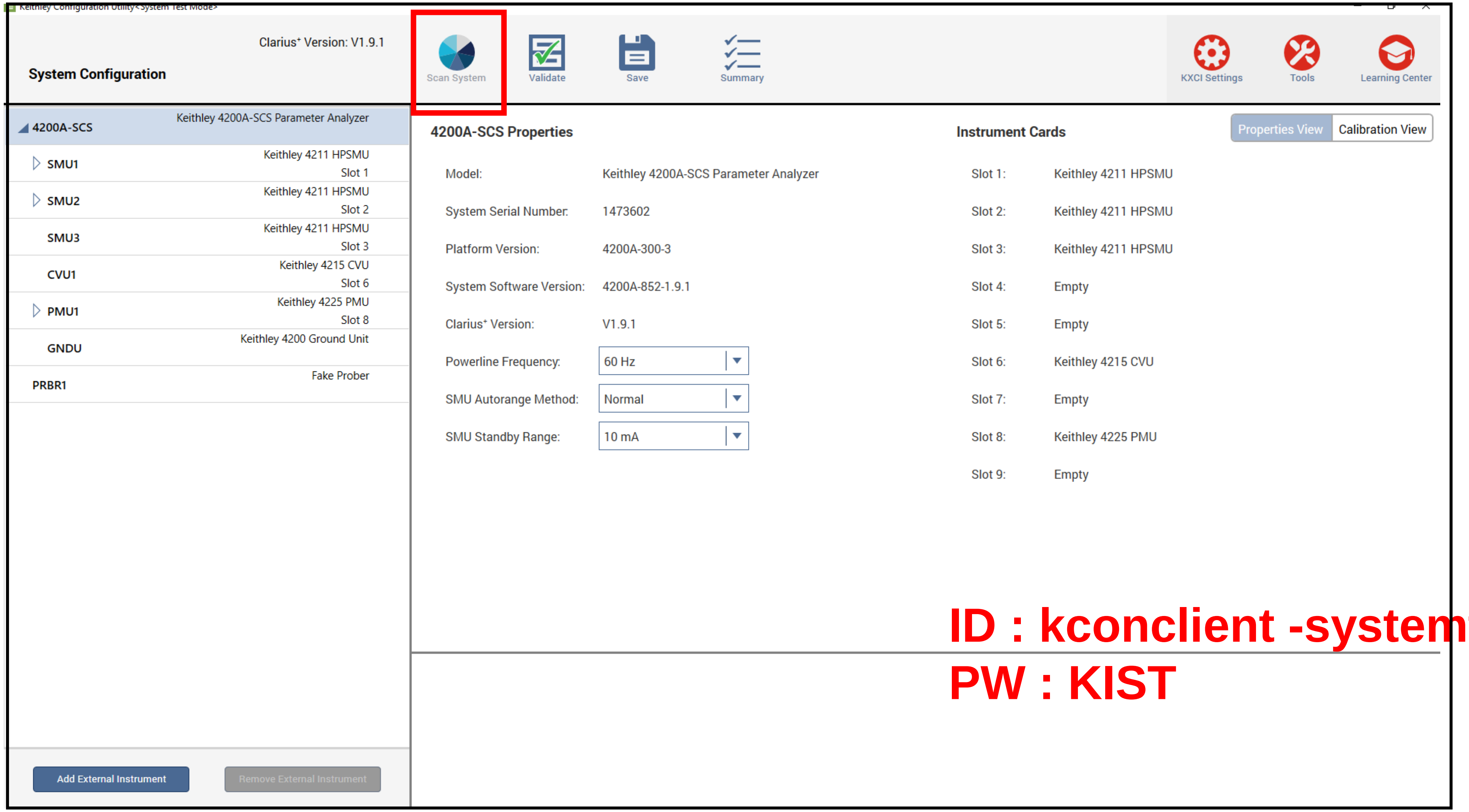


KCon



Keithley CONfiguration Utility
Clarius+ Version V1.0
KI System Configuration
Validate Configuration
Update Preamp, RPM, and CVIV Configuration
Save
System Configuration Summary
KXCI Settings
Tools
Learning Center
KI 4200A-SCS
Keithley 4200A-SCS Parameter Analyzer
SMU1
PA1
SMU2
PA2
SMU3
PA3
SMU4
PA4
CVU1
PMU1
RPM1-1
RPM1-2
GNDU
KI 4200A-SCS Properties
Instrument Cards
4210 HPSMU
4210 HPSMU
4200 MPSMU
4200 MPSMU
4210 CVU
4225 PMU
KCON System Configuration Summary
KEITHLEY
System Information:
Model: Keithley 4200A-SCS Parameter Analyzer
Date 07/11/2016
System name 4200A-SCS
System serial number 1234567
SBC serial number
Platform version 4200A-300-1
Operating system version 4200A-852-1.0
KTE Interactive version
Powerline frequency 60 HZ
KXCI Settings SMU1 = SMU1
SMU2 = SMU2
SMU3 = SMU3
SMU4 = SMU4
Save Configuration As
Print Configuration
Close
Add External Instrument
Remove External Instrument

KCon Admin



ID : kconclient -systemtest

PW : KIST

KULT

Keithley User Library Tool

KULT

• **KULT** is a tool used to create and manage *user libraries*.

• A user library is a collection of one or more *user modules*.

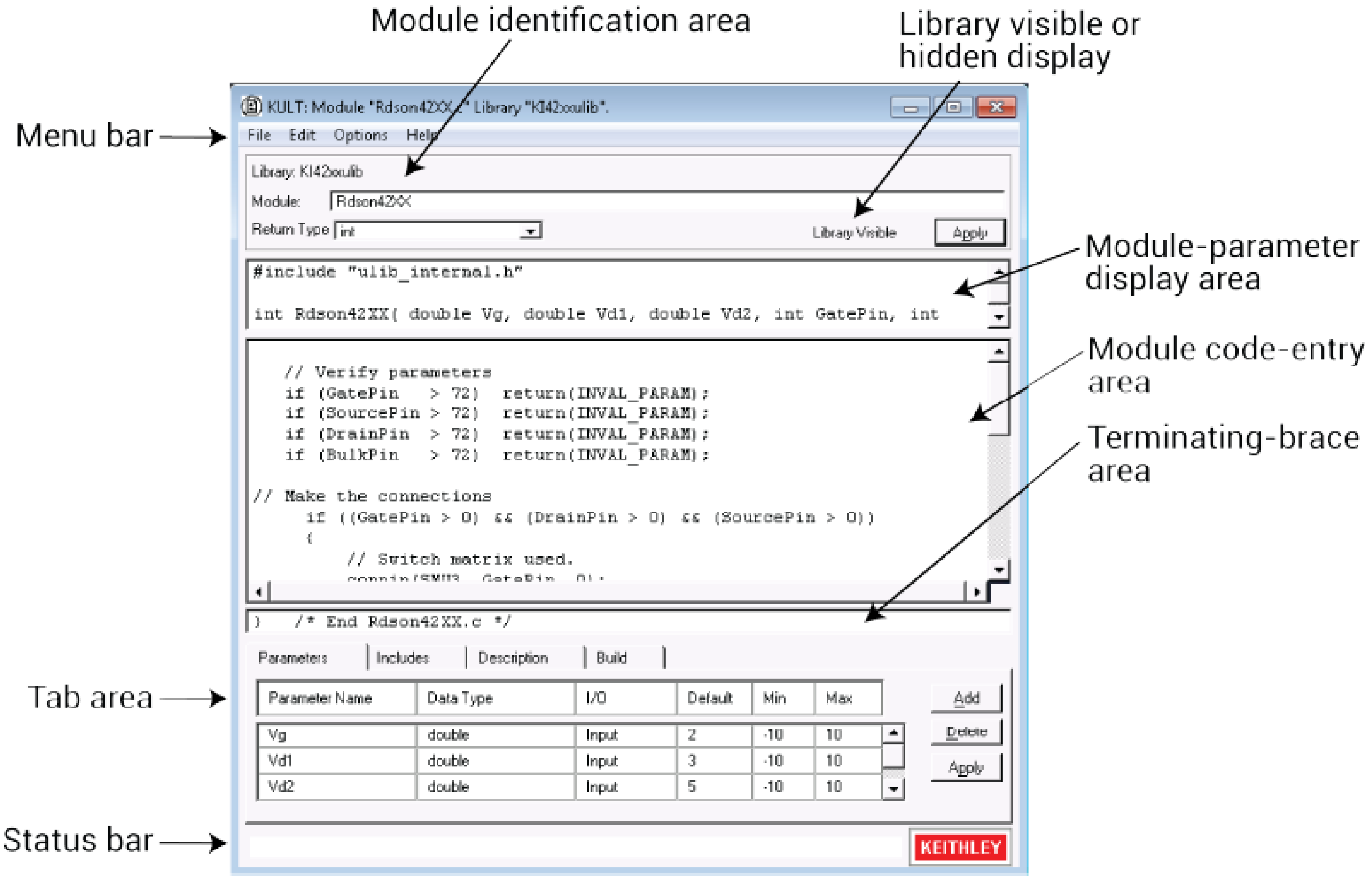
• User modules are C programming language subroutines.

• User libraries are created to control instrumentation, analyze data, or perform any other system automation task programmatically.

• Once a user library has been successful built using **KULT**, its user modules can be executed using **KITE/Clarius**.

• To execute a **KULT** user module in **KITE/Clarius**, you create a UTM and connect it to the user module.

KULT


Module identification area
Library visible or hidden display
Menu bar
Module-parameter display area
Module code-entry area
Terminating-brace area
Tab area
Status bar
KULT: Module "Rdson42XX.c" Library "KI42xxulib".
File Edit Options Help
Library: KI42xxulib
Module: Rdson42XX
Return Type int
Library Visible
Apply
#include "ulib_internal.h"
int Rdson42XX(double Vg, double Vd1, double Vd2, int GatePin, int
// Verify parameters
if (GatePin > 72) return(INVAL_PARAM);
if (SourcePin > 72) return(INVAL_PARAM);
if (DrainPin > 72) return(INVAL_PARAM);
if (BulkPin > 72) return(INVAL_PARAM);
// Make the connections
if ((GatePin > 0) && (DrainPin > 0) && (SourcePin > 0))
{
// Switch matrix used.
} /* End Rdson42XX.c */
Parameters
Includes
Description
Build
Parameter Name
Data Type
I/O
Default
Min
Max
Vg
double
Input
2
-10
10
Vd1
double
Input
3
-10
10
Vd2
double
Input
5
-10
10
Add
Delete
Apply
KEITHLEY

KXCI

Keithley External Control Interface

KXCI

- KXCI allows you to use an external computer to remotely control.

  → operation by GPIB, Ethernet

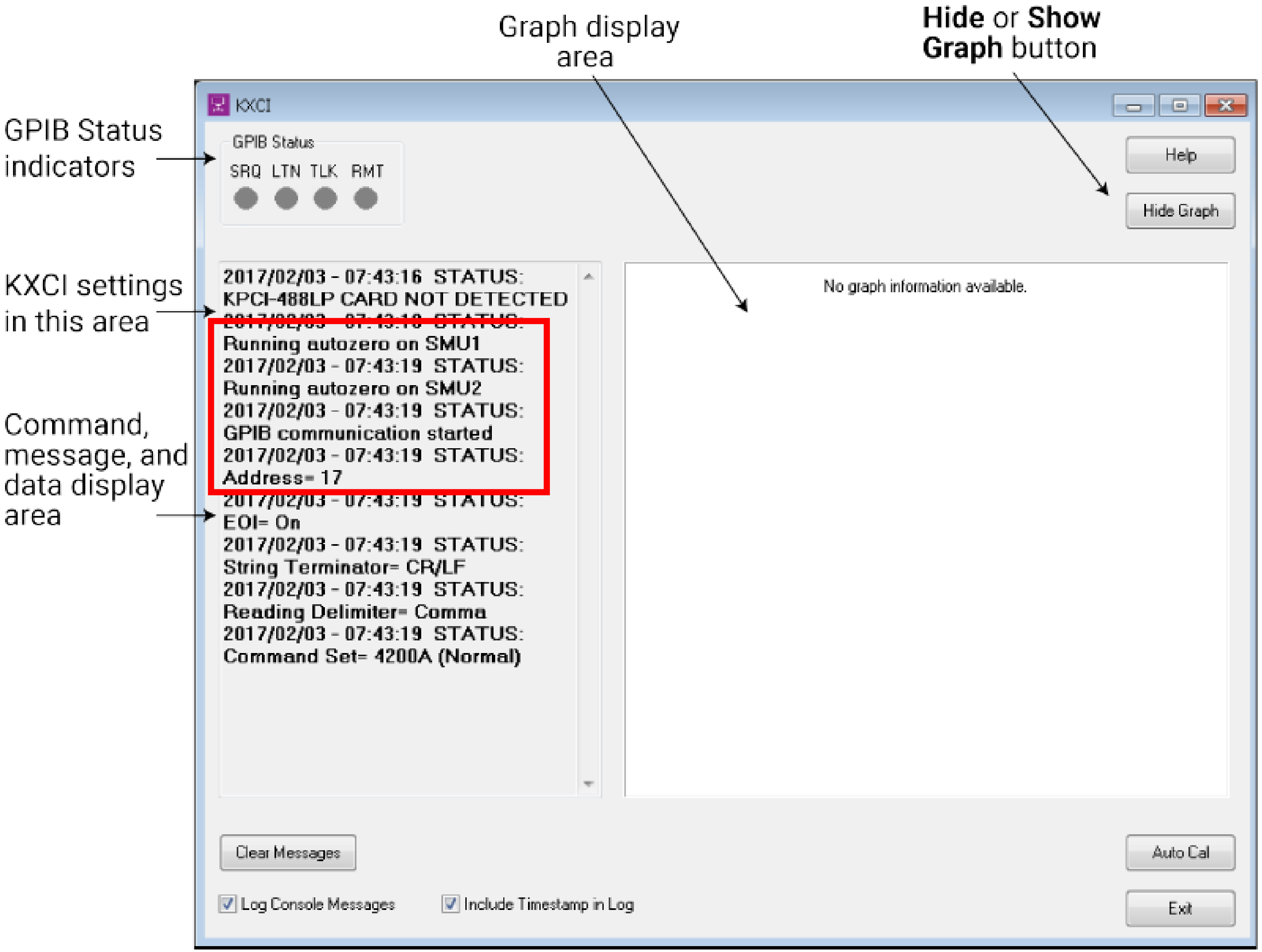
- The SMU, CVU, and PMU each have different types of command sets.

- Can call KULT user libraries remotely

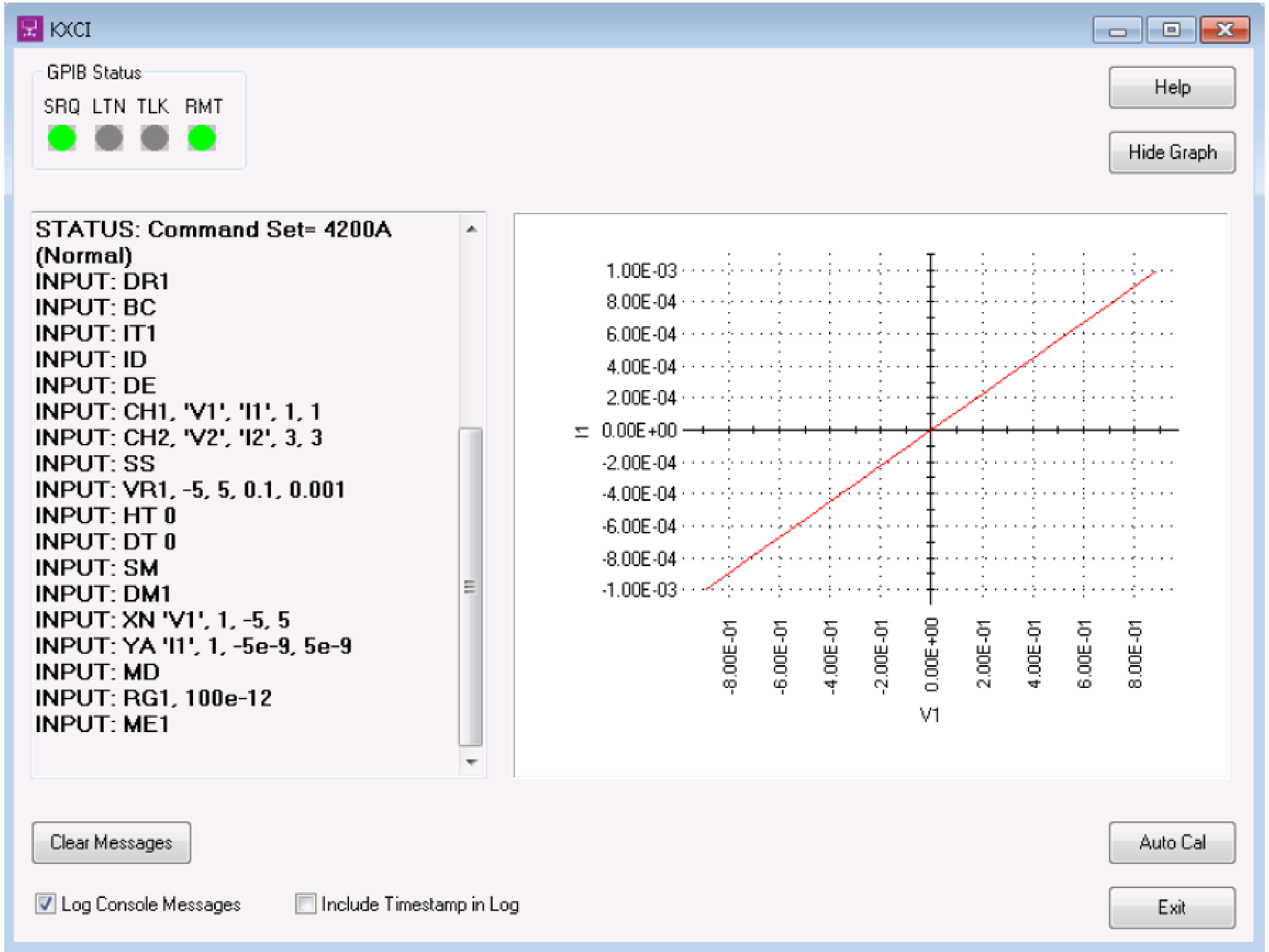
- When controlled by an external computer, the Model 4200 functions like any other GPIB instrument.

- The GPIB command set is provided in Section 9 of the Model 4200 Reference Manual.

KXCI

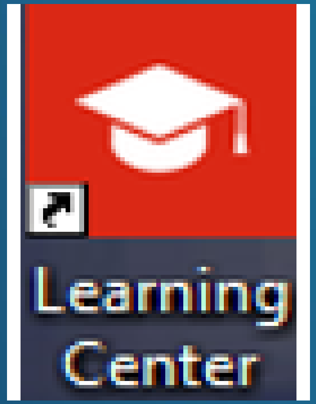

Graph display area
Hide or Show Graph button
GPIB Status indicators
KXCI settings in this area
Command, message, and data display area
KXCI
GPIB Status
SRQ LTN TLK RMT
Help
Hide Graph
2017/02/03 - 07:43:16 STATUS:
KPCI-488LP CARD NOT DETECTED
Running autozero on SMU1
2017/02/03 - 07:43:19 STATUS:
Running autozero on SMU2
2017/02/03 - 07:43:19 STATUS:
GPIB communication started
2017/02/03 - 07:43:19 STATUS:
Address= 17
EOI= On
2017/02/03 - 07:43:19 STATUS:
String Terminator= CR/LF
2017/02/03 - 07:43:19 STATUS:
Reading Delimiter= Comma
2017/02/03 - 07:43:19 STATUS:
Command Set= 4200A (Normal)
No graph information available.
Clear Messages
Auto Cal
Log Console Messages
Include Timestamp in Log
Exit

KXCI Test

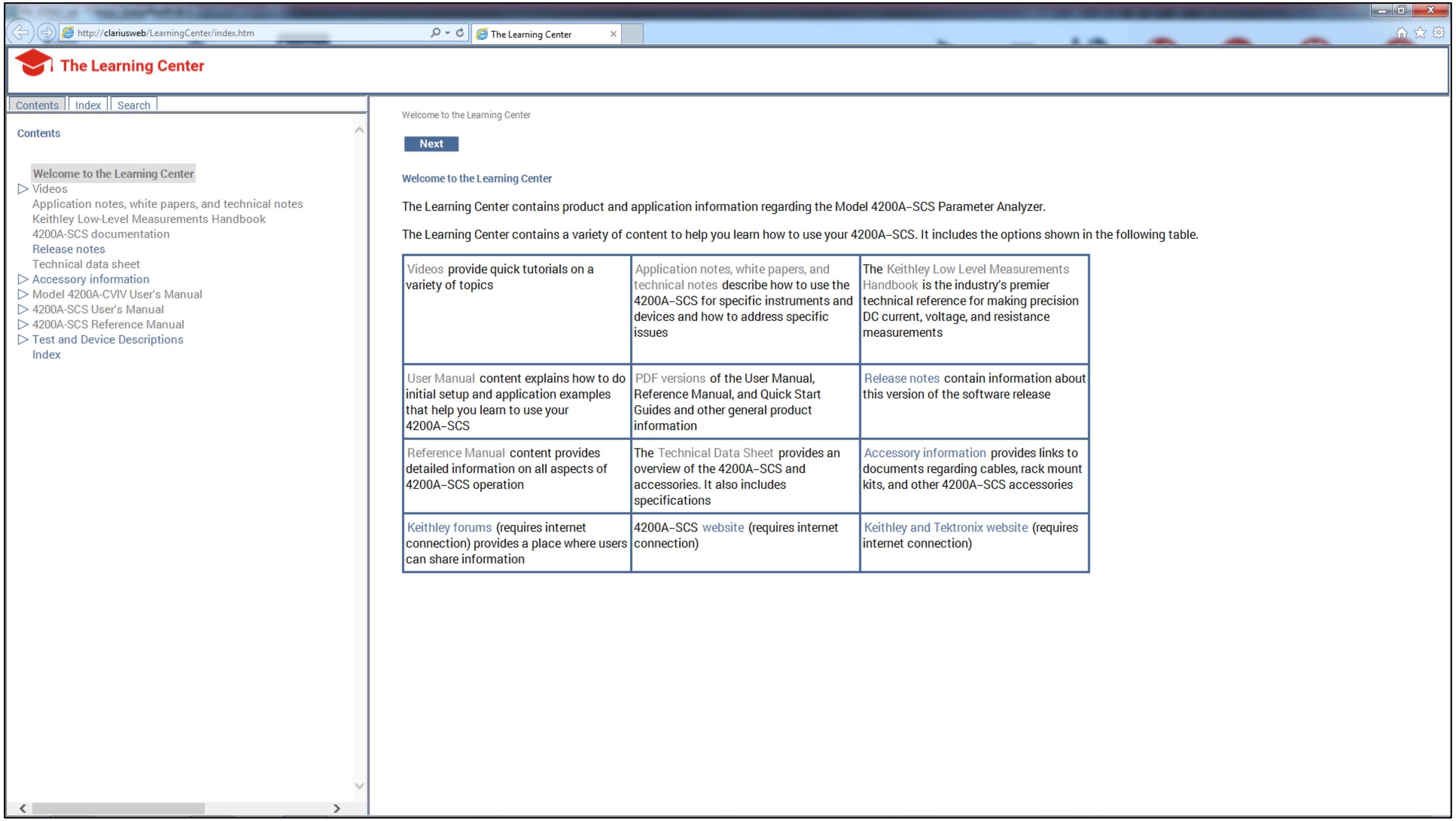


KXCI
GPIB Status
SRQ LTN TLK RMT
Help
Hide Graph
STATUS: Command Set= 4200A (Normal)
INPUT: DR1
INPUT: BC
INPUT: IT1
INPUT: ID
INPUT: DE
INPUT: CH1, 'V1', 'I1', 1, 1
INPUT: CH2, 'V2', 'I2', 3, 3
INPUT: SS
INPUT: VR1, -5, 5, 0.1, 0.001
INPUT: HT 0
INPUT: DT 0
INPUT: SM
INPUT: DM1
INPUT: XN 'V1', 1, -5, 5
INPUT: YA 'I1', 1, -5e-9, 5e-9
INPUT: MD
INPUT: RG1, 100e-12
INPUT: ME1
I1
1.00E-03
8.00E-04
6.00E-04
4.00E-04
2.00E-04
0.00E+00
-2.00E-04
-4.00E-04
-6.00E-04
-8.00E-04
-1.00E-03
-8.00E-01
-6.00E-01
-4.00E-01
-2.00E-01
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
V1
Clear Messages
Auto Cal
Log Console Messages
Include Timestamp in Log
Exit

Learning Center



Learning Center



New products

4201-SMU and 4211-SMU

4215-CVU

V1.7 Released – New SMUs

- New features include:

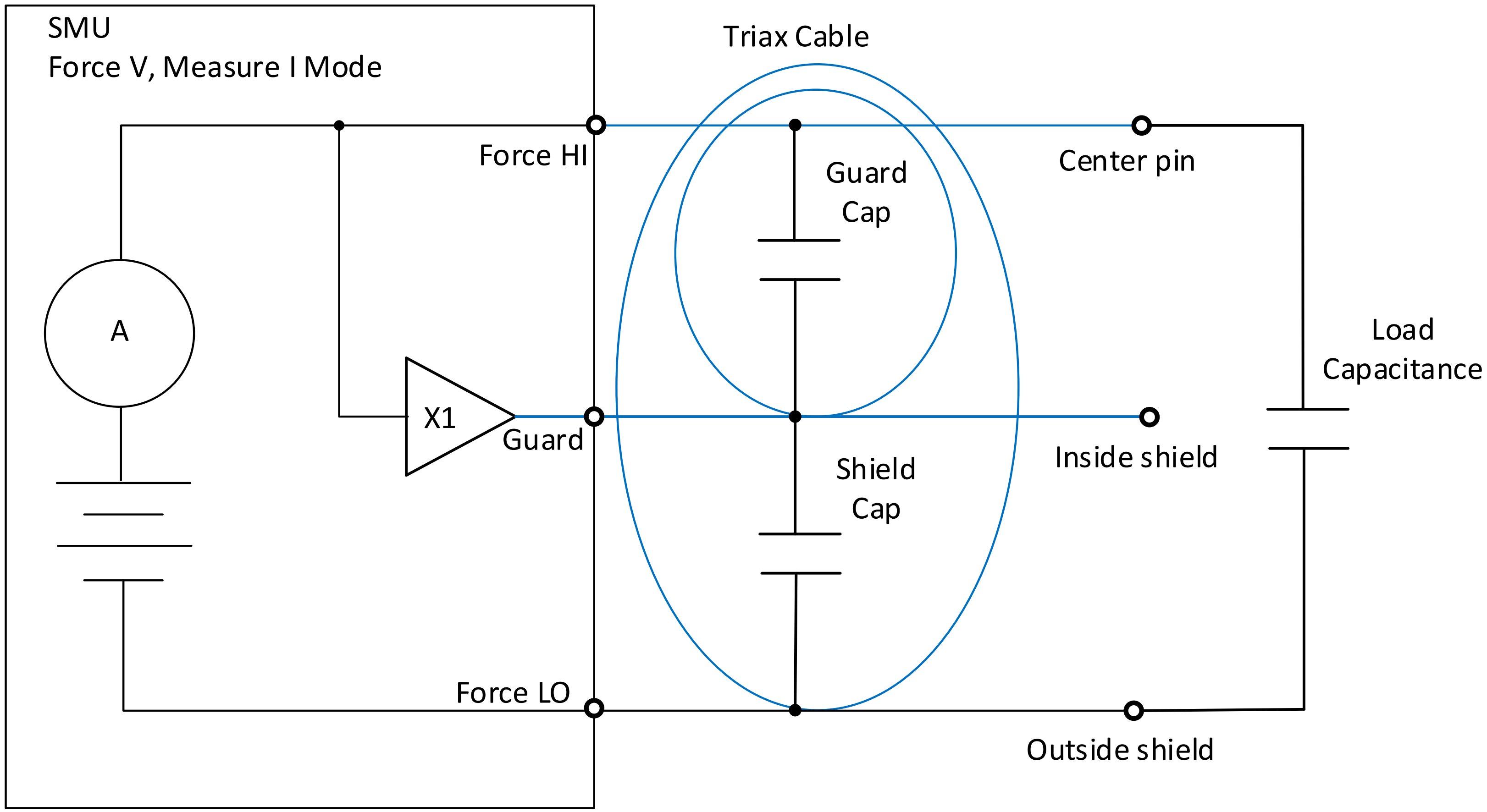
  - Release of two new SMUs:
    - 4201-SMU Medium Power SMU – same specs as 4200-SMU except higher cap specs
    - 4211-SMU High Power SMU – same specs as 4210-SMU except higher cap specs

- This upgrade is no charge to customers with 4200A with Win 10.

- If users do not have Win10 and want to upgrade to V1.6, they can purchase **4200A-WIN10-UP** which includes both Win 10 and V1.5. Then upgrade to V1.6.

New SMUs! Models 4201-SMU, 4211-SMU

INCREASED MAXIMUM CAPACITANCE SPECS FOR IMPROVED STABILITY WHEN MAKING SENSITIVE LOW CURRENT MEASUREMENTS

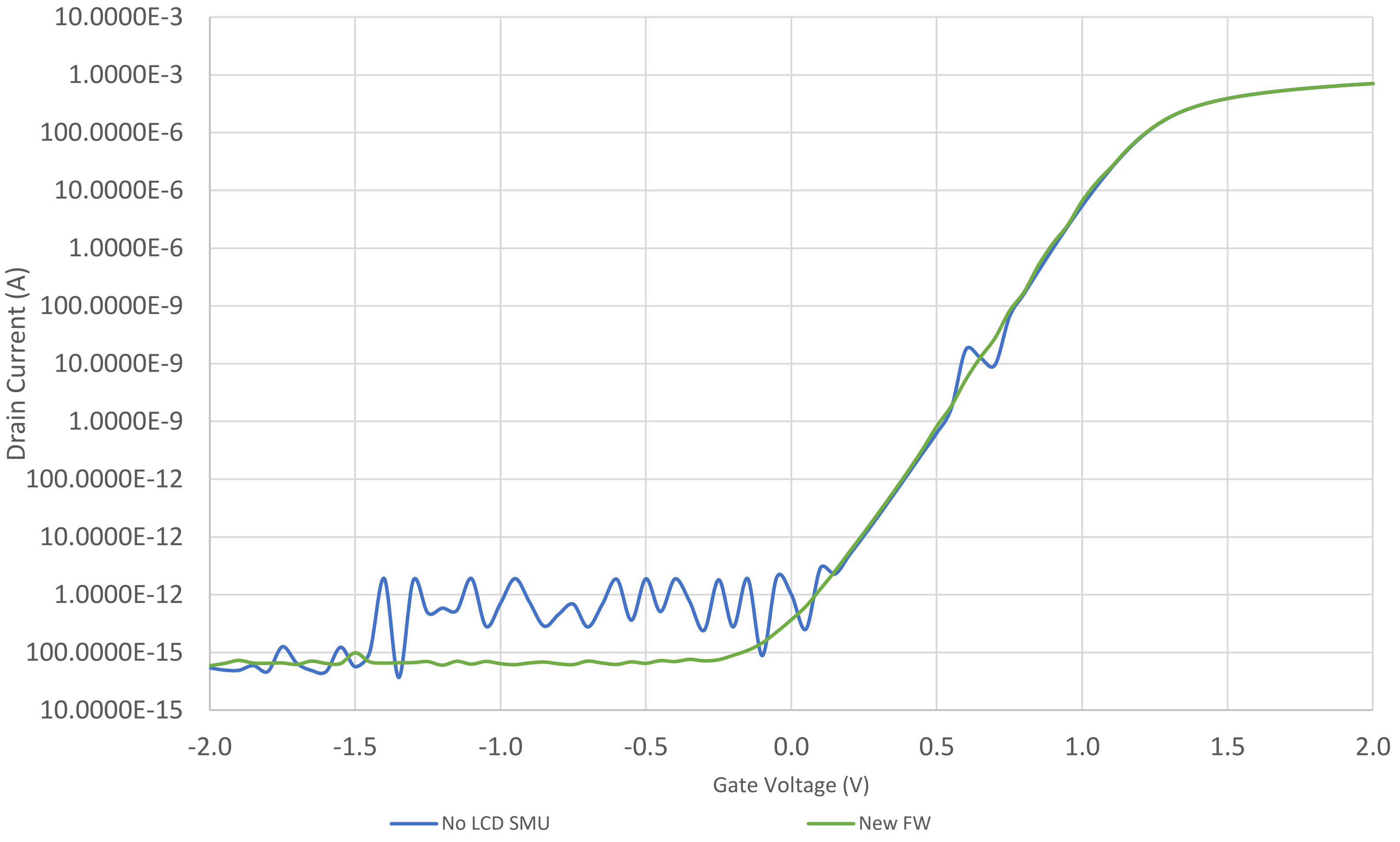


PRELIMINARY SPECS:

- Max Guard Capacitance:
  42X0-SMU spec: 100pF
  New 42X1-SMU spec: 5nF
- Max Shield Capacitance:
  42X0-SMU spec: 330pF
  New 42X1-SMU spec: 10nF
- Max Load Capacitance:
  42X0-SMU spec: 10nF
  New 42X1-SMU spec: 10µF

Long Cables: MOSFET Id-Vg (TG-439 Demo DUT)

Run Settings: Sweep 2 to -2 V on Gate, Measure Current on Drain, Limited Auto 1pA, 20m Cable, best fixed source range,

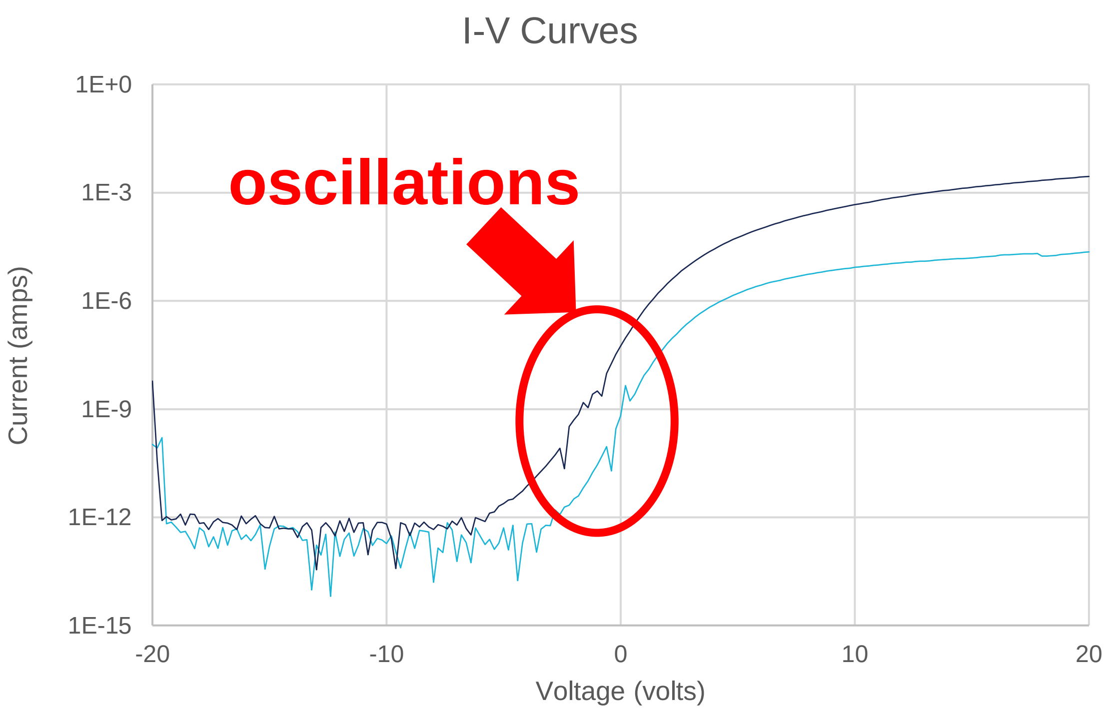


Drain SMU:

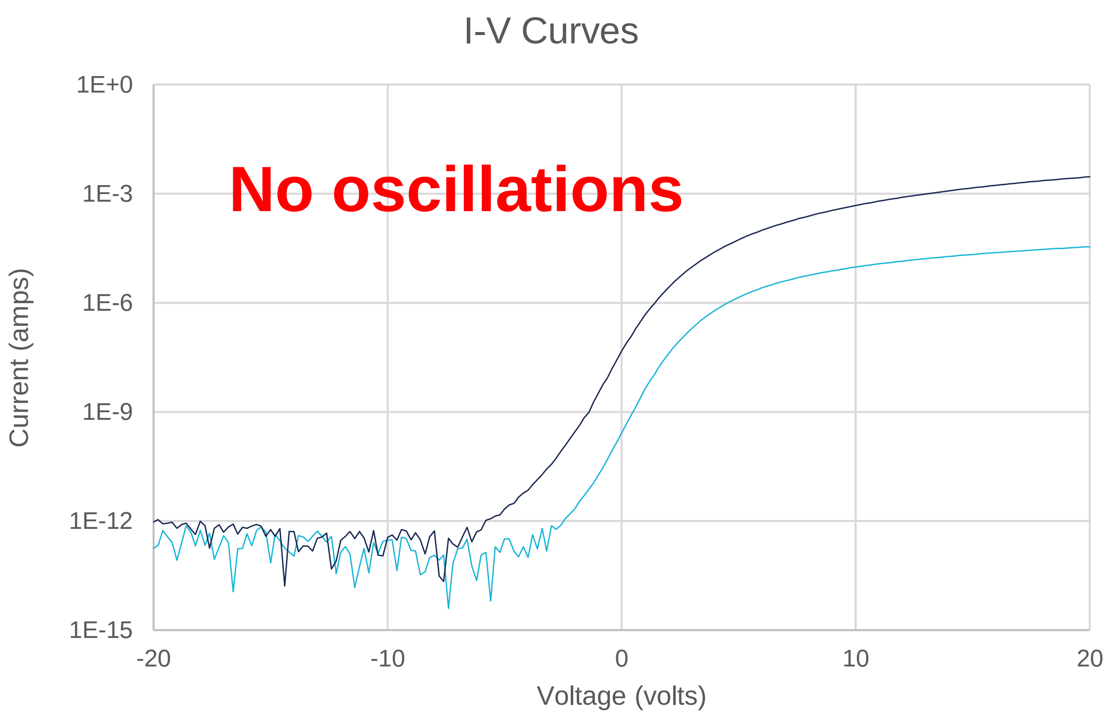
Blue Curve– 4200-SMU
Green Curve - 4201-SMU

OLED Device for Display

SATURATION AND LINEAR TRANSFER CURVES



Measured with 4200-SMU



Measured with 4211-SMU

V1.8 Released – New CVU

Here are some of the proposed list of new features:

- New 4215-CVU
- KULT Editor
- New Graph Tool
- USB controlled external instruments (still being defined)
- New projects and tests

4215-CVU Preliminary Specs

Has all the capabilities of the 4210-CVU and….

- 1V rms ac drive voltage
- 1kHz to 10Mhz, with1kHz test frequency resolution
  - For example, 8.121 MHz is a test frequency
- Logarithmic frequency sweep capability
- Y-theta measurement function
- Averaging Filter Modes: Noise reduction, point averaging

Why higher AC drive voltage?

- Measuring very small capacitances, <pF

- Making high impedance measurements (or measuring low capacitance at a low test frequency)

  Example: 10pF device with 10kHz test frequency and 100mV ac drive voltage:

  $C = \frac{Iac}{(2*\pi*f*Vac)}$ or $Iac = \mathrm{C}(2*\pi*f*Vac) = 10pF(2*\pi*10kHz*100mV) = 63nAac$

  The lowest current range full scale is 1uA. By increasing the voltage to 1Vac the measured current becomes 630nA ac which becomes easier to measure.

- Keysight B1500A MFCMU ac drive voltage: 10mV to 250mV rms

Key Specs

Key Specs

Modules	Description	Key Measurements	Range
4200-SMU 4201-SMU	Medium power Source Measure Unit	• DC I-V • VLF C-V (Very low frequency C-V) • QSCV	±100 mA, ±210 V
4210-SMU 4211-SMU	High power Source Measure Unit		±1 A, ±210 V
4200-PA	Remote Preamplifier Module		Extends current ranges for all SMU's
4210-CVU 4215-CVU	Capacitance-Voltage Unit	• AC Impedance • C-V, C-f, C-t	1 kHz – 10 MHz ±30 V built-in DC bias (60 V differential) ±210 V DC bias with SMU's
4200A-CVIV	I-V/C-V Multi-Switch Module	DC I-V and C-V with automatic switching	-
4225-PMU	Ultra-Fast Pulse Measure Unit	• Pulsed I-V • SegmentARB® multi-level pulsing • Transient Waveform Capture	±40 V (80 V p-p), ±800 mA 200 M Sa/s simultaneous I and V measure 2048 unique segments 20 ns PW source only 60 ns PW source/measure
4225-RPM	Remote Preamplifier/Switch Module	DC I-V, C-V, Pulsed I-V with automatic switching	Extends current range of 4225-PMU unit
4220-PGU	High Voltage Pulse Generator Unit	• Pulsed voltage source • SegmentARB® multi-level pulsing	±40 V (80 V p-p) 2048 unique segments
Ground Unit	Low noise, ground unit	-	Triaxial connection: 2.6 A Binding post: 9.5 A

Thank you

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