

# Using the Model 4225-RPM Remote Amplifier/ Switch to Automate Switching Between DC I-V, C-V, and Pulsed I-V Measurements

## APPLICATION NOTE



Characterizing a device, material, or process electrically often requires performing multiple types of measurements, including DC I-V, C-V, and pulsed I-V tests. The 4200A-SCS Parameter Analyzer can perform all of these measurements using a combination of 4200-SMU Source Measure Units, 4210-CVU C-V Module, and 4225-PMU Ultra-Fast I-V Module. Once, combining these diverse measurement capabilities into one system would have required re-cabling each module's output manually to the device under test (DUT) in between measurement types. The 4225-RPM Remote Amplifier/Switch solves this problem by acting as a multiplexer, making it possible to switch between precision DC SMUs, the CVU, or the Ultra-Fast I-V Modules automatically (**Figure 1.**)



Figure 1. 4200A-SCS with 4225-RPM Remote Amplifier/Switch accessories.

The 4225-RPM is an accessory for the 4225-PMU 2-Channel Ultra-Fast I-V Module. The 4225-RPM serves two purposes: to extend the 4225-PMU's current measurements down to the 100nA range and to allow switching between the 4200-SMU, 4210-CVU, and 4225-PMU without re-cabling. **The output terminals of each 4225-RPM in the system are connected to a single probe as shown in Figure 2.** The 4225-RPM can be mounted very close to the DUT, reducing cable capacitance effects. The input terminals of the 4225-RPM are connected to the modules in the 4200A-SCS.

This application note explains how to use the 4225-RPM to switch between the SMU, CVU, and PMU and make DC I-V, C-V, and pulsed I-V measurements on a single device. In particular, it describes hardware connections and how to use the system software, Clarius, to configure and execute tests.

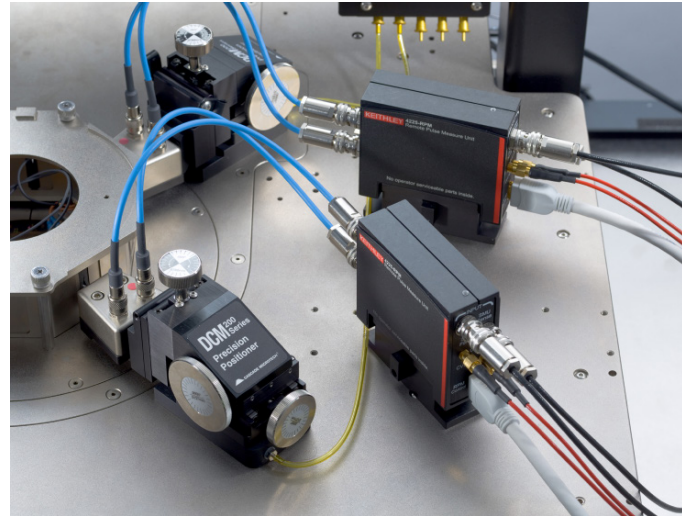


Figure 2. The output terminals of each 4225-RPM module connect to a single probe.

## Making Connections

The SMUs, CVU, and PMU are connected to the input terminals of the RPM using the cables supplied with the instrument modules. The output terminals of the RPM are connected to the DUT. Either two or four-wire connections can be made. Each RPM comes with adaptors and one SMA cable for two-wire measurements. **Figure 3 shows the inputs and output connections of the 4225-RPM.**



Figure 3. Input and output connections of the 4225-RPM Remote Amplifier/Switch.

**The schematic in Figure 4 illustrates the hardware connections from both the input and output terminals of the two 4225-RPMs. The DUT in this example is a diode.**

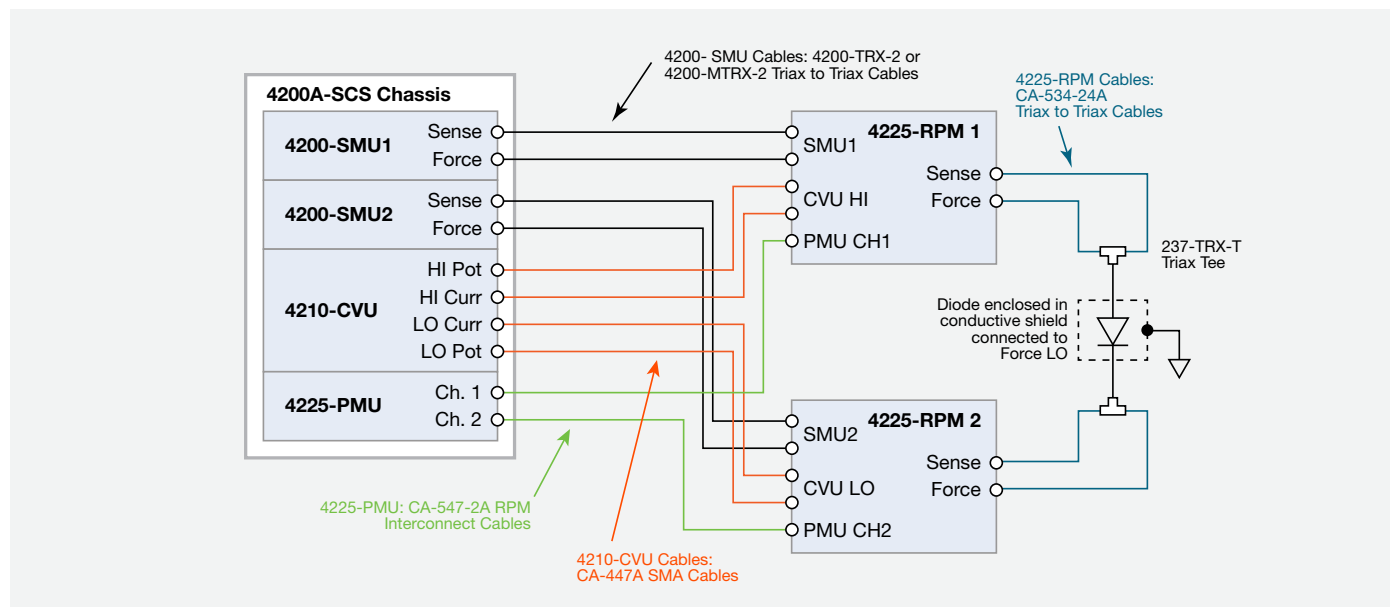


Figure 4. Connections from the 4200A-SCS and 4225-RPMs to the diode.

The output terminals of the two RPMs are connected to the diode in a four-wire configuration to provide the best measurement accuracy and eliminate the effects of the lead resistance on the I-V and C-V measurements. These connections are made using four 24-inch triax cables (Keithley part number CS-534-24A). These triax cables have the performance needed for both low current (I-V) and high frequency (C-V and pulsed I-V) measurements. The Force and Sense output terminals from 4225-RPM Ch1 are connected to the anode of the diode using two triax cables and a triax tee (237-TRX-T). The output terminals of 4225-RPM Ch2 are connected to the cathode of the diode. To prevent noisy measurements, the diode should be enclosed in a conductive shield that is connected to the Force LO terminal (the outside shield of the triax connector).

## Updating the RPM Configuration in the KCON Application

The Keithley Configuration Utility (KCON) is used to manage and configure the 4200A-SCS, including the 4225-RPMs. Before using an RPM for automatic switching, it's essential to update the RPM configuration using the KCON application located on the 4200A-SCS desktop. This will properly associate the instruments connected to each RPM and will enable automatic switching between tests.

**To update the configuration, follow these steps:**

1. Make sure the device under test is disconnected from the outputs of the RPMs.
2. Close the Clarius application.
3. Open KCON (located on the desktop of the 4200A-SCS).
4. Select "Update Preamp, RPM and CVIV Configuration" (see Figure 5.)
5. Validate the configuration.
6. Save the configuration.
7. Close KCON application.

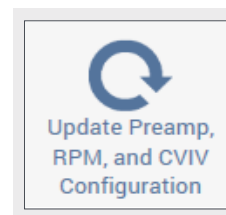


Figure 5. Update RPM configuration in KCON.



# Setting Up the Measurements in the Clarius Application

Once the hardware connections are made and the RPMs are configured in KCON, open the Clarius application and create a project to switch automatically between DC I-V, C-V, and pulsed I-V measurements. Basically, just Select, Configure and Analyze the measurements. In the following paragraphs, these three easy steps are described for creating a project to characterize a diode; however, the same procedure can be followed for other devices and tests, depending upon the application.

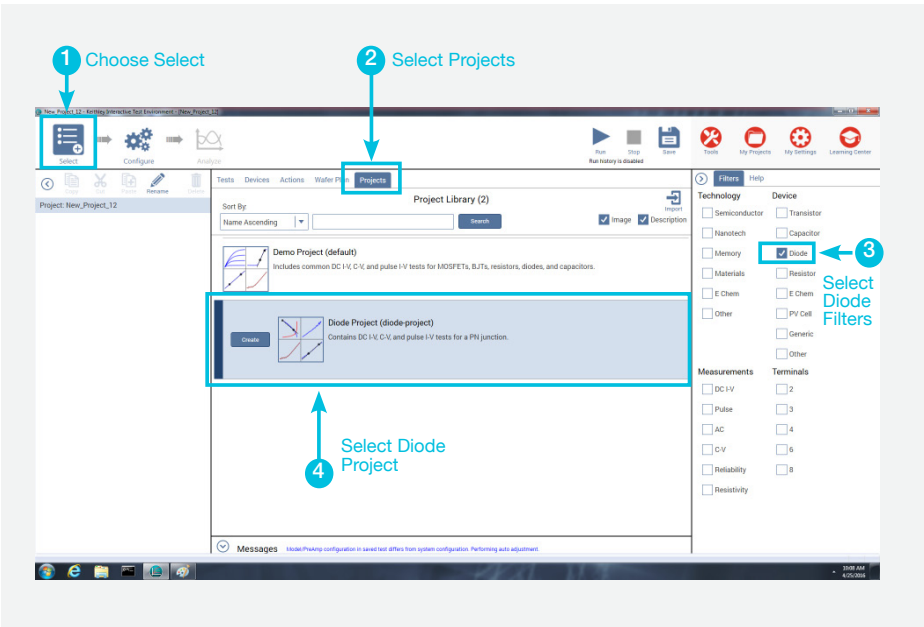


Figure 6. Select the diode project.

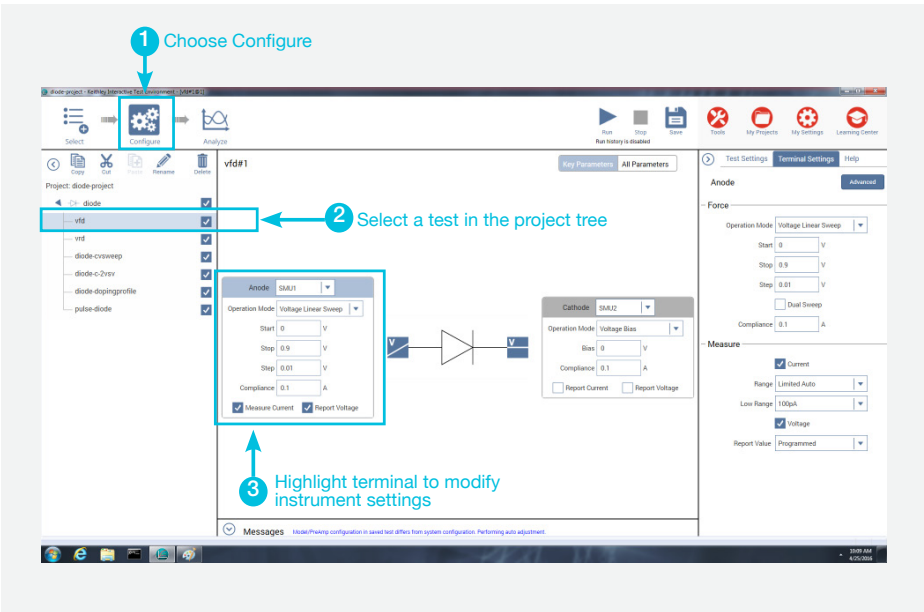


Figure 7. Configure tests in the diode project.

## Select the Diode Project (Figure 6).

Choose Select in the top left corner of the screen. In the Library, select the Projects tab. Select the Diode in the Filters pane on the right-hand side of the screen. Select the Diode Project in the Project Library and create a new project when prompted.

## Configure the Tests (Figure 7).

The Diode Project has tests for measuring I-V, C-V, and pulsed I-V. Each test can be opened up and configured based upon the test requirements. To configure each test, choose Configure in the top left-hand corner of the screen. Highlight the test to be configured. Highlight the terminal to modify the instrument settings. More detailed settings can be found in the Test Settings and Terminal Settings tabs on the right-hand side of the screen.

### Analyze the Results (Figure 8).

Once the tests are configured, the three tests can be executed consecutively. Start by selecting Analyze in the top left corner of the screen. This will bring up the Analyze pane in the center of the screen. To execute the tests sequentially, highlight the device in the project tree and then select Run at the top of the screen. The tests will begin to run sequentially from the top of the project tree. The RPMs will automatically switch the instrument outputs based on the test being executed.

The screen shown in Figure 8 allows viewing the data in tabular format at the top of the pane or graphically at the bottom. This screen can also be configured for viewing only the data or the graph. On the right-hand side of the screen, the Run History pane allows selecting and analyzing the data and graphs taken from any previous executions of the test.

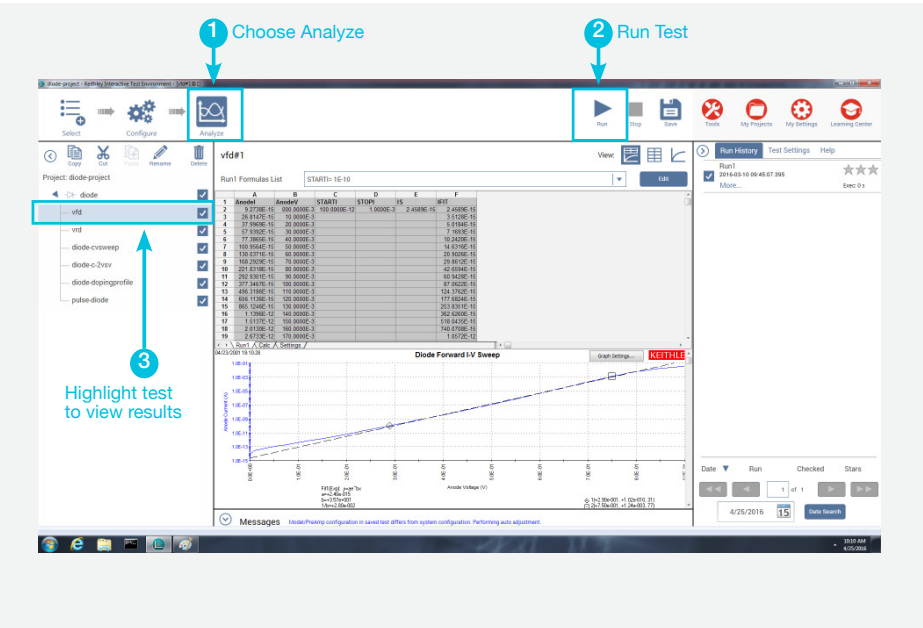


Figure 8. Analyze the test results.

## Conclusion

Fully characterizing a device often requires precision DC I-V, C-V, and pulsed I-V measurements. Re-cabling between measurements can be a time-consuming manual process. The 4225-RPM Remote Amplifier/Switch option for the 4225-PMU supports automatic switching between the PMU, CVU, and SMU modules installed in the 4200A-SCS chassis, saving valuable time and avoiding the potential for re-cabling errors.

## **Contact Information:**

**Australia\*** 1 800 709 465  
**Austria** 00800 2255 4835  
**Balkans, Israel, South Africa  
and other ISE Countries** +41 52 675 3777  
**Belgium\*** 00800 2255 4835  
**Brazil** +55 (11) 3759 7627  
**Canada** 1 800 833 9200  
**Central East Europe / Baltics** +41 52 675 3777  
**Central Europe / Greece** +41 52 675 3777  
**Denmark** +45 80 88 1401  
**Finland** +41 52 675 3777  
**France\*** 00800 2255 4835  
**Germany\*** 00800 2255 4835  
**Hong Kong** 400 820 5835  
**India** 000 800 650 1835  
**Indonesia** 007 803 601 5249  
**Italy** 00800 2255 4835  
**Japan** 81 (3) 6714 3010  
**Luxembourg** +41 52 675 3777  
**Malaysia** 1 800 22 55835  
**Mexico, Central/South America  
and Caribbean** 52 (55) 56 04 50 90  
**Middle East, Asia, and North Africa** +41 52 675 3777  
**The Netherlands\*** 00800 2255 4835  
**New Zealand** 0800 800 238  
**Norway** 800 16098  
**People's Republic of China** 400 820 5835  
**Philippines** 1 800 1601 0077  
**Poland** +41 52 675 3777  
**Portugal** 80 08 12370  
**Republic of Korea** +82 2 6917 5000  
**Russia / CIS** +7 (495) 6647564  
**Singapore** 800 6011 473  
**South Africa** +41 52 675 3777  
**Spain\*** 00800 2255 4835  
**Sweden\*** 00800 2255 4835  
**Switzerland\*** 00800 2255 4835  
**Taiwan** 886 (2) 2656 6688  
**Thailand** 1 800 011 931  
**United Kingdom / Ireland\*** 00800 2255 4835  
**USA** 1 800 833 9200  
**Vietnam** 12060128

**\* European toll-free number. If not  
accessible, call: +41 52 675 3777**



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