Metrics ICS Driver Manual

KI82

Metrics ICS

Version 4.5

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KI82 Instrument Driver

Instrument Test Connections

Use the information below to make test connections to the various instruments in the Model 82 system.

Connection Considerations

When making test connections, keep the following points in mind:

- Use the correct coaxial cables when making connections. Use only Model 4801 low-noise cables for Model 590, Model 595, and remote coupler input/output connections. Use the Model 7051 50Ω cables only for trigger and voltage source connections.
- Excessive shunt capacitance in the probe station may degrade measurement accuracy and increase noise.
- To minimize noise currents, tie or tape cables to a stable surface to minimize cable flexing, and avoid vibration during testing.

Test Connection Procedure

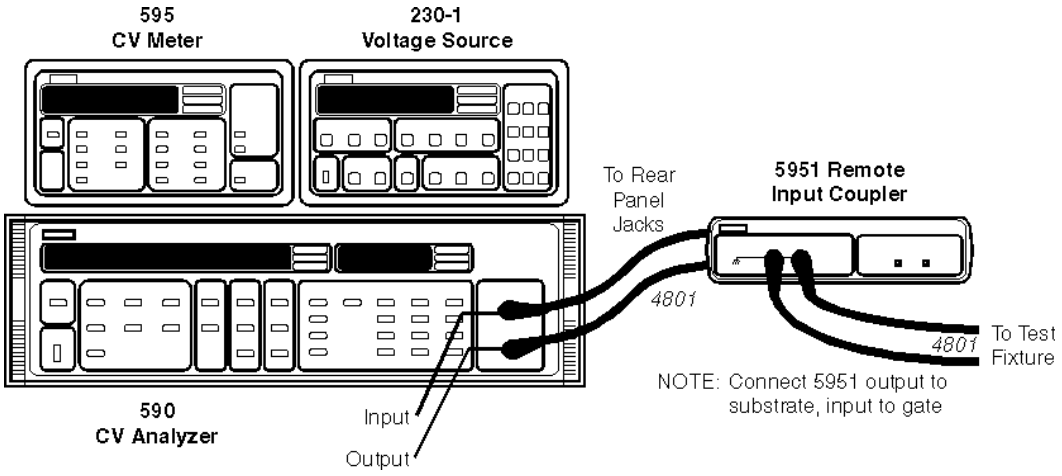


Figure 1: Front panel connections

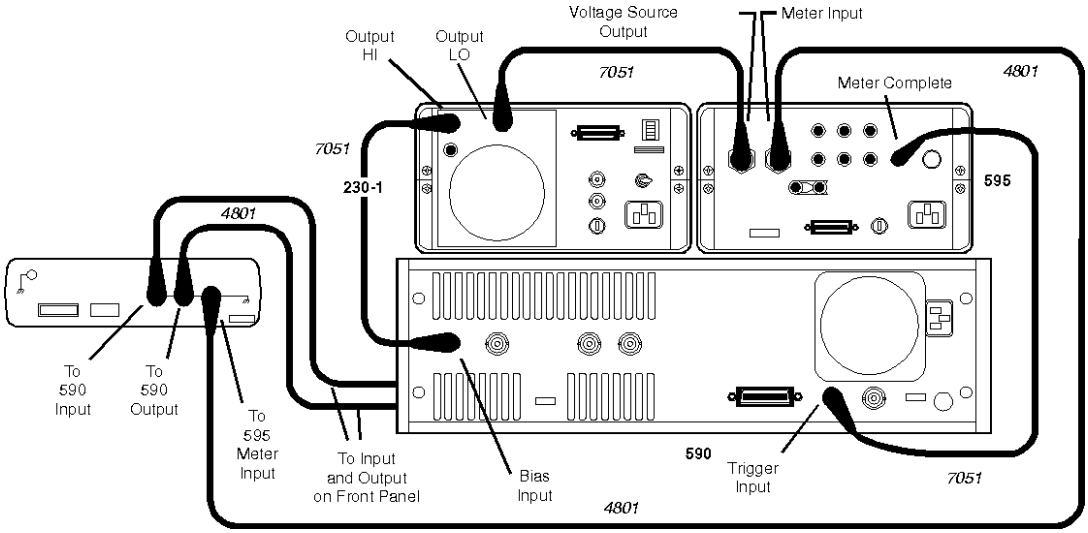


Figure 2: Rear panel connections

Using Figures 1 and 2 as a guide, connect the instrument together as summarized below.

1. Make sure that all equipment power is off before making connections.
2. Connect a Model 4801 low-noise coaxial cable between the Model 590 INPUT jack and the TO 590 INPUT jack of the Model 5951 Remote Input Coupler. Connect a second Model 4801 low-noise cable between the Model 590 OUTPUT jack and the TO 590 OUT jack of the Model 5951.
3. Connect the Model 5951 INPUT and OUTPUT jacks to the chuck test fixture using Model 4801 low-noise cables. To minimize reading noise, connect INPUT to the gate metallization contact, and connect OUTPUT to the substrate contact.
4. Connect the Model 5951 TO 595 METER INPUT jack to the Model 595 METER INPUT jack using a Model 4801 low-noise cable.
5. Using a Model 7051 50Ω cable, connect the Model 595 METER COMPLETE OUTPUT to the EXTERNAL TRIGGER INPUT jack of the Model 590.
6. Using a second Model 7051 50Ω cable, connect the Model 595 VOLTAGE SOURCE OUTPUT jack to the OUTPUT LO jack of the Model 230-1 Voltage Source. In a similar manner, use a Model 7051 cable to connect the Model 230-1 OUTPUT HI jack to the EXTERNAL BIAS INPUT jack of the Model 590 C-V Analyzer.
7. Connect one end of the ribbon cable to the Model 5951 Remote Input Coupler, and connect the opposite end of the cable to the digital I/O port of the Model 230-1 Voltage Source. The two ribbon cable connectors are keyed so they can be installed only in one direction.
8. Connect the Model 5951 chassis ground post to safety earth ground using heavy copper wire.

WARNING

To avoid a possible shock hazard, the Model 5951 chassis must be connected to safety earth ground using #16 AWG or larger wire.

Remote Coupler Mounting

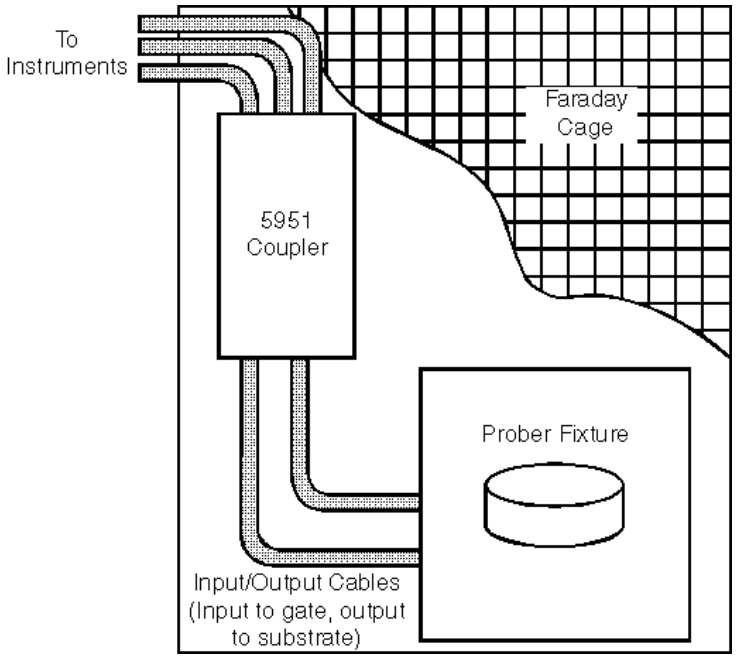


Figure 3: Remote coupler mounting

In many cases, the wafer prober will be located inside a faraday cage to minimize noise. In these situations, the remote coupler can also be placed inside the cage for convenience, and to minimize cable lengths. The coupler can be mounted to the cage by removing the rubber feet and attaching it with #6-32 screws as in the example shown in Figure 3. Be sure that the mounting screws do no extend more than 1/4" inside the Model 5951 case, or they might contact the circuit board inside.

IEEE-488 Connections

Connect the instrument IEEE-488 connectors to each other and the computer using IEEE-488 cables. Use the shorter cables to connect the three instruments together, and use the longer cable to connect the instruments to the computer IEEE-488 connector.

System Power-up

Line voltage selection, power connections, environmental conditions, and instrument warm-up periods are covered in the following paragraphs.

Instrument Power Requirements

The Models 230-1, 590, and 595 are designed to operate from 105-125V or 210-250V, 50 or 60Hz AC power sources (special transformers can be factory installed for 90-110V and 195-235V AC voltage ranges). The factory setting for each instrument is marked on its rear panel, and the line voltage is either internally or externally selectable; see the appropriate instruction manual for details.

CAUTION

Do not operate an instrument on a supply voltage outside the allowed range, or instrument damage may occur.

Line Power Connections

Connect each instrument to a grounded AC outlet using the supplied power cord or the equivalent.

WARNING

Each instrument must be connected to a grounded outlet using the supplied power cord to ensure continued protection from possible electric shock. Failure to use a grounded outlet and a 3-wire power cord may result in personal injury or death because of electric shock.

Environmental Conditions

For maximum measurement accuracy, all instruments and the remote coupler must be operated at an ambient temperature between 0° and 40°C at a relative humidity less than 70%, and with ±5°C of the cable correction temperature.

Warm-up Period

The system can be used immediately when all instruments are first turned on. However, to achieve rated system accuracy, all instruments should be turned on and allowed to warm up for at least two hours before making measurements.

Power-up Procedure

Follow the steps below to turn on the system.

1. With all power off, connect the instruments together and to the IEEE-488 bus as outlined above.
2. Turn on the computer, and boot it up in the usual manner.
3. Turn on each instrument by pressing in its front panel power switch. Verify that each instrument goes through its normal power-up routine, as described below.

Model 230-1 Power-up

1. The instrument first turns on all LEDs and segments.
2. The software revision level is then displayed as in this example: B13
3. The unit then displays the primary address: IE 13
4. Verify the primary address is 13; set it to that value if not (see below).
5. The unit begins normal display.

Model 590 Power-up

1. The Model 590 first displays the software revision level as in this example: REV D13
2. The unit then displays the programmed primary address: IEEE ADDRESS 15
3. Verify the primary address is 15; if not, program it for that value.
4. The unit then begins normal operation.

Model 595 Power-up

1. During normal power-up, “r.r” and “r.o” will appear briefly while RAM and ROM are tested.
2. If a memory error occurs, the “r.r” or “r.o” message will remain on the display.
3. If the instrument was not able to read the stored calibration constants and configuration, the decimal points in the two exponent digits will flash.
4. If no errors occur, the instrument will begin normal operation.

Setting Instrument Primary Addresses

The primary addresses of the Models 230-1, 590, and 595 must be the same as those specified when setting up the driver software. The factory default primary addresses are:

- Model 230-1: 13
- Model 590: 15
- Model 595: 28

Model 230-1 Primary Address

Use the Model 230-1 rear panel DIP switches to set its primary address. The DIP switches represent the binary value of the address, with A5 as the MSB (Most Significant Bit), and A1 the LSB (Least Significant Bit). Table 1 summarizes primary address switch settings.

Table 1: *Model 230-1 primary address switch settings*

Primary address	**Switch settings**				
	A5	A4	A3	A2	A1
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0

Primary address	Switch settings				
13*	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0
31	1	1	1	1	1

* Factory default primary address

Model 590 Primary Address

1. Press SHIFT then IEEE. The instrument will display the present primary address: IEEE ADDRESS 15
2. In this example, the default value (15) is displayed.
3. To exit at this point without changing the primary address, press QUIT.
4. To change the address, key in a new value using the numeric data keys. Keep in mind that the primary address limits are 0-30 inclusive. If you enter address above 30, the unit will set the address to 30.
5. After keying in the desired value, press the ENTER key. The instrument will return to normal operation with the new address in effect.

Model 595 Primary Address

1. Press the PROGRAM MENU button until the present IEEE-488 primary address is displayed. For example, if the current address is 28, the following message will be displayed: IEEE 28
2. To change the address, use the voltage source ADJUST keys to set the displayed address to the desired value.
3. To exit with the new address in effect, press SHIFT then EXIT.

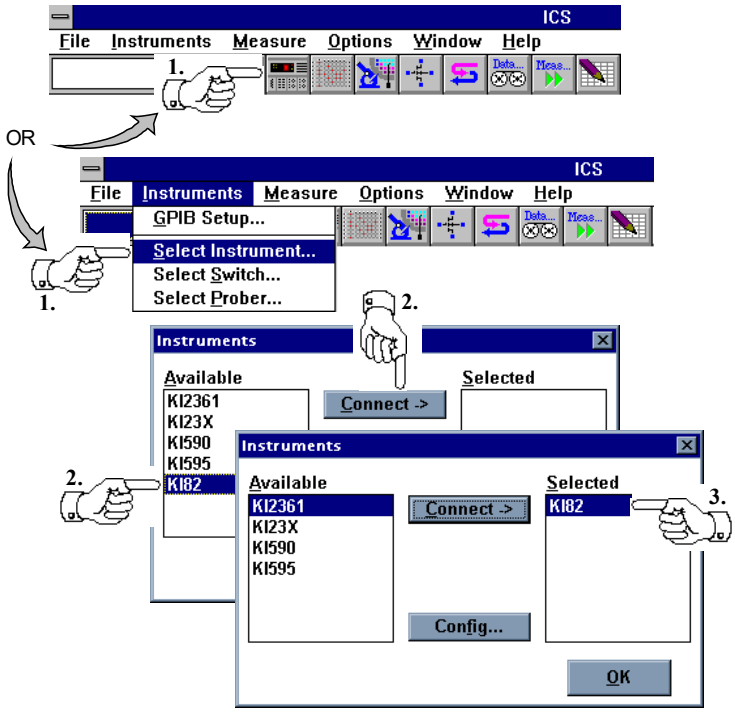
Getting Started: Creating and Executing a Test Setup

This section describes the steps required to create and execute a sample test setup. The sample test setup will be used to measure Drain to Source capacitance of a MOSFET transistor as a function of voltage. The Keithley Model 82 was used to perform the measurements in this manual.

Connecting a DUT to the Instrument

The capacitance example presented in this section was performed using Semi-automatic probe station for measuring on wafer.

Connecting the KI82 Instrument Driver

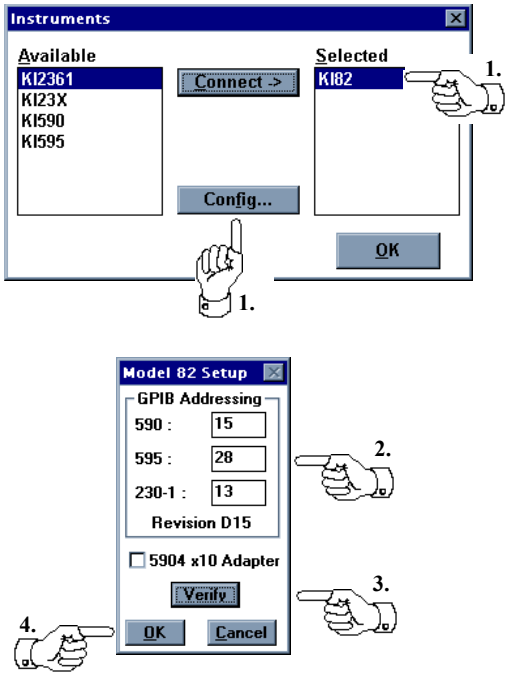


1. Click the **Instruments** button on the toolbar or select **Instruments/Select Instrument.** from the ICS measurement mode menu.
2. Highlight **KI82** in the **Available** field and click on the **Connect** button.
3. Your choice will be displayed in the **Selected** field, and removed from the **Available** field.

Designating the GPIB Address

Connect the KI Model 82 to your computer using a standard IEEE-488 GPIB (General Purpose Interface Bus) as described in the Mode 82 Instruction Manual.

The Model 82 Setup dialog box is used to designate the GPIB addresses of the Model 82 instruments and to verify the instruments are configured correctly.



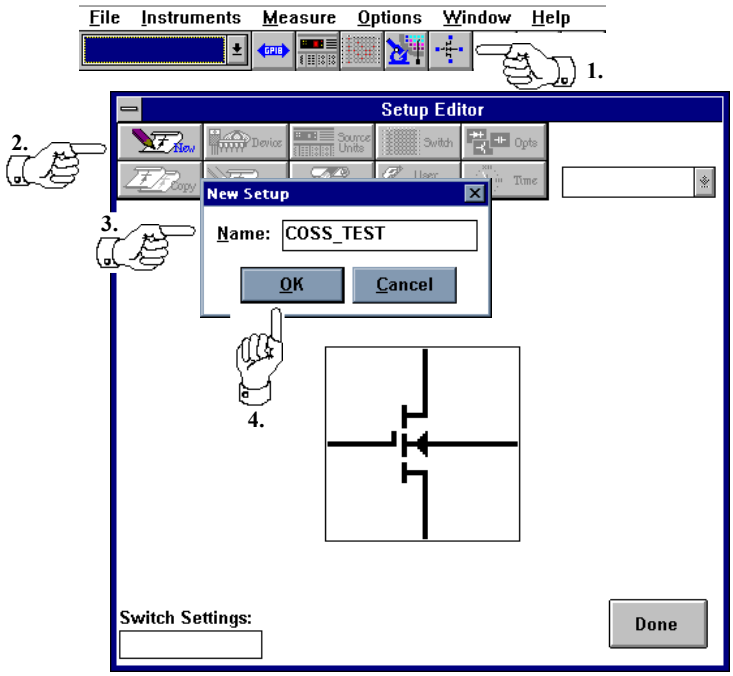
1. With the **KI82** highlighted in the **Selected** field, click on the **Config...** button.
2. Enter the GPIB address of the 590, 595, and the 230 in the appropriate address fields. The GPIB address will be displayed momentarily when the instrument is turned on.
3. Click on the **Verify** button to verify communication with the instruments.
4. Click on the **OK** button.

Creating the Test Setup

Test setups in ICS are created using the Setup Editor. A device schematic is located at the center of the Setup Editor to provide the user with a method of documenting the terminal connections required for the corresponding test setup. The device schematic does not have to match the pin layout of the Device Under Test.

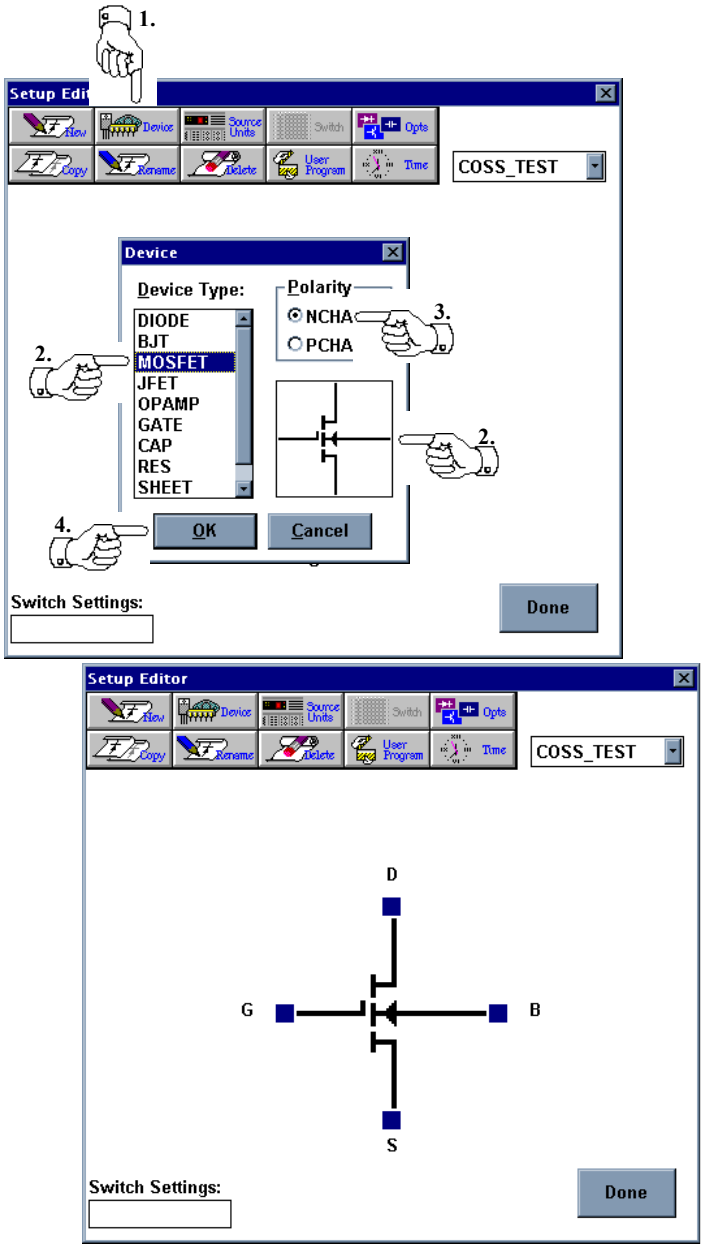
A library of different device schematics is provided in ICS. A MOSFET is the default device type and a MOSFET schematic will appear at the center of the Setup Editor when the Setup Editor is first opened.

Naming the Setup



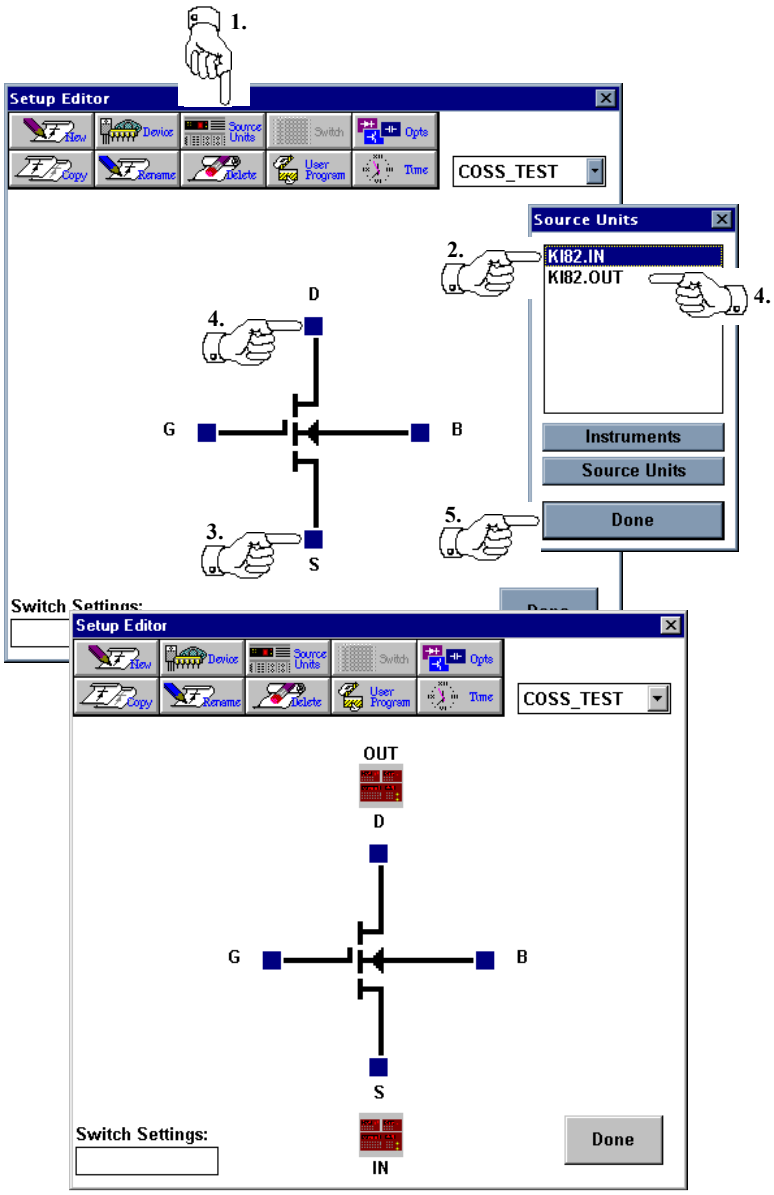
1. Click on the **SETUP EDITOR** button on the toolbar.
2. Click on the **New** button in the Setup Editor window.
3. Enter a **Name** for the test setup. Setup names should not contain spaces.
4. Click on the **OK** button. Note that the setup name appears in the pull-down menu in the Setup Editor window and a data spreadsheet icon with the setup name appears at the bottom of the ICS workspace.

Selecting a Device Type



1. Click the **Device** button  in the Setup Editor window.
2. The Device Type window will display a list of available device schematics. Select **MOSFET** from this list. Notice that a preview of the schematic is shown to the right of the list of devices.
3. Selecting the MOSFET schematic will display polarity options. Select the **NCHAN** option.
4. Click **OK**. This will close the Device dialog box and display the selected schematic at the center of the Setup Editor window.

Designating the Instrument/DUT Connections

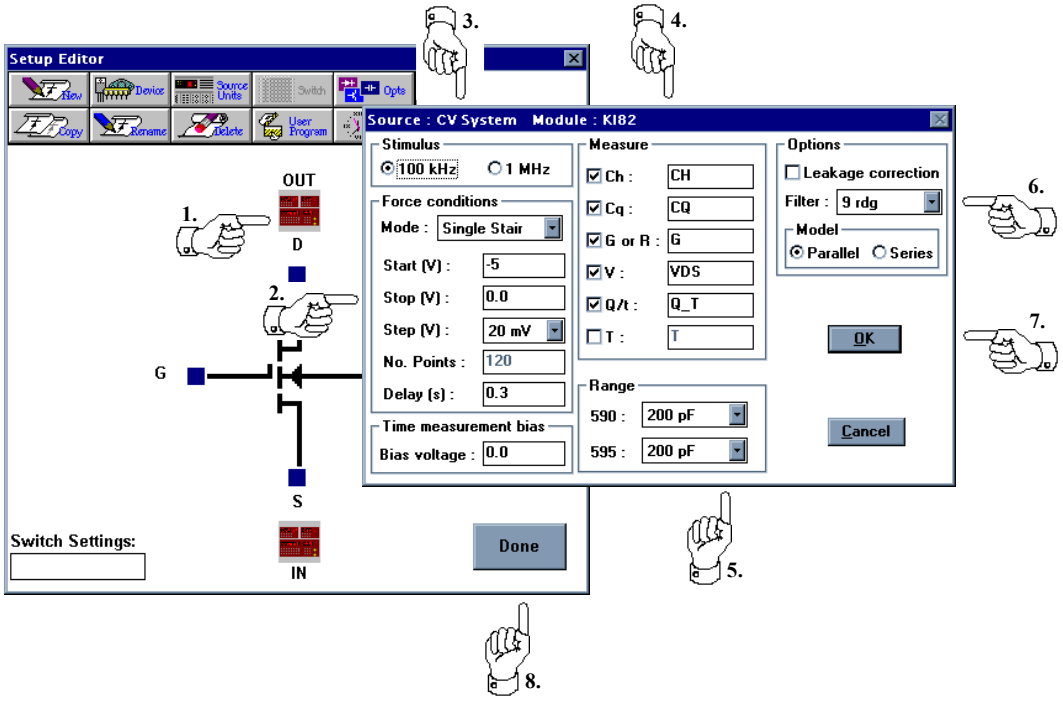


1. Select the Setup Editor **Source Units** button  to open the Source Units dialog box. The Source Units dialog box will list two sources: KI82.IN and KI82.OUT.
2. Click on the **KI82.IN** source.
3. Assign the KI82.IN source to the source by clicking the blue pad next to the letter **S**. An instrument icon will appear next to the connection.
4. Assign the KI82.OUT source to the drain by selecting the **KI82.OUT** source and then clicking the blue pad next to the letter **D**.
5. Click on the **Done** button to close the Source Units dialog box.

Note: Source assignments can be changed by selecting a source in the Source Units dialog box and then clicking on the blue pad indicating the terminal where it is to be removed.

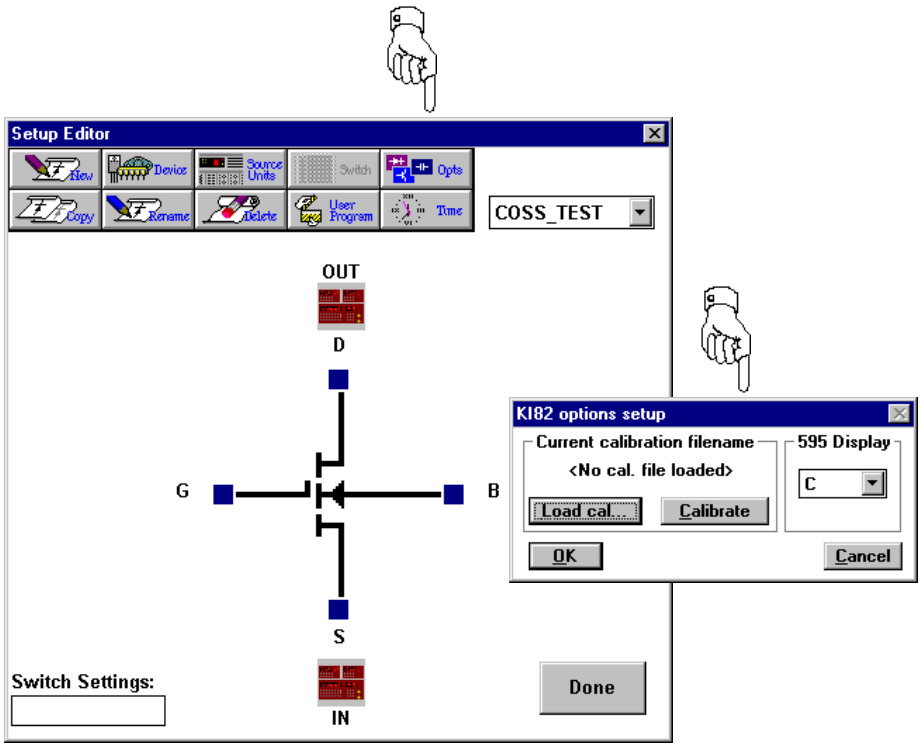
Note: To achieve best measurement performance, in cases other than measurement of COSS, place KI82.OUT on the substrate and KI82.IN on the Gate. When connected in this manner, the voltage setup fields represent the voltage from the Substrate to the Gate (Vsg). For ease of analysis, after the measurement is executed use the ICS Transform Editor to change the voltage polarity to represent Vgs.

Specifying the Instrument Configuration



1. Click once on the **OUT** instrument icon to open the Model 82 setup dialog box.
2. Specify the Model 82 **Force Conditions** for the Coss measurement.
3. Select the **Stimulus** frequency.
4. Select the Parameters to be measured from the **Measure** group. The names of the parameters may be changed by typing the desired name into the corresponding name field.
5. Select the desired measurement ranges for the 590 and 595 in the **Range** group.
6. Specify the desired options in the **Options** group.
7. Click on the **OK** button to the Model 82 setup dialog.
8. Click on the **Done** button to close the Setup Editor.

Accessing KI82 Options and Cable Calibration



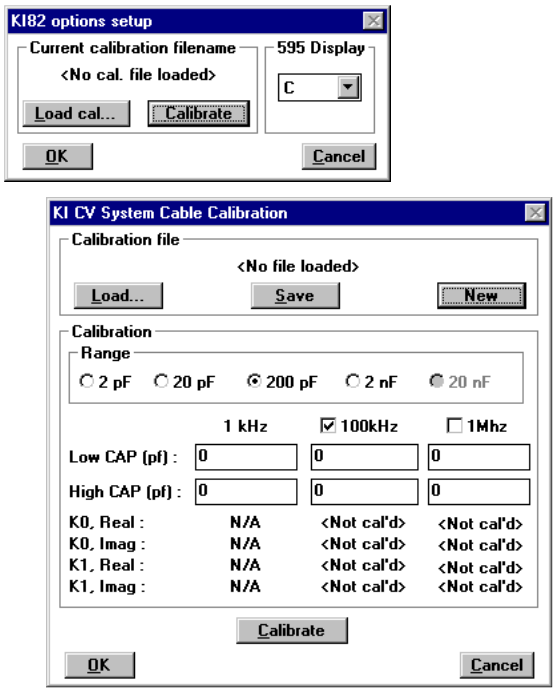
1. From the Setup Editor, click Options button to display the KI82 Options Setup dialog box.

KI82 Option 595 Display

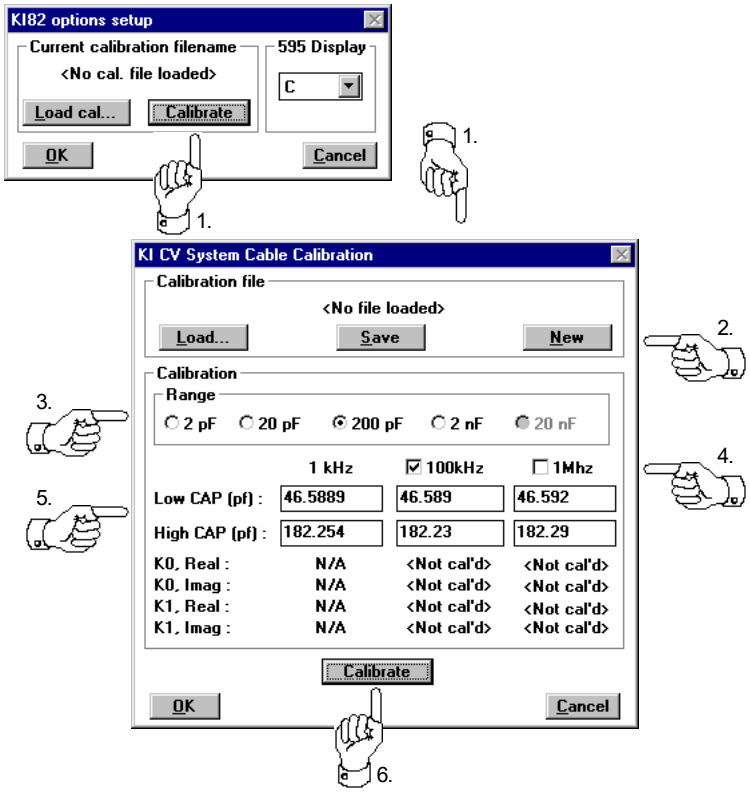
The 595 Display option allows the user to select what is displayed on the front panel of the 595. Selectable values are C, V Src, and Q/t.

KI82 Cable Calibration

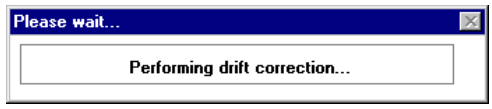
KI82 Cable Calibration is performed through the KI82 Options Setup dialog box.



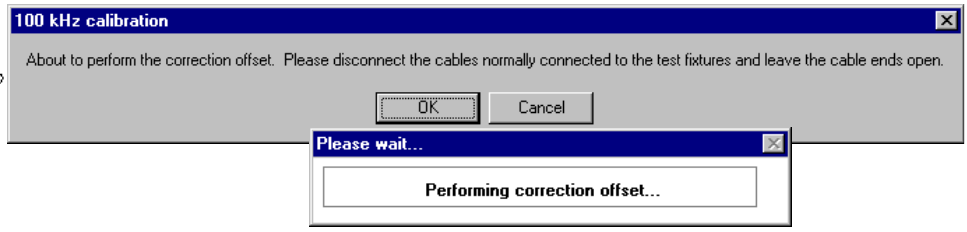
Create a New Cable Calibration Settings



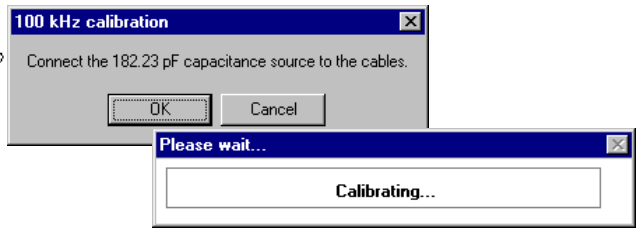
6.


Please wait...
Performing drift correction...

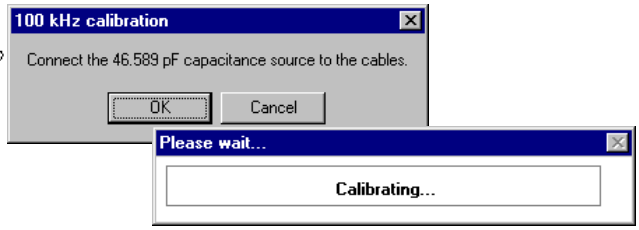
7.


100 kHz calibration
About to perform the correction offset. Please disconnect the cables normally connected to the test fixtures and leave the cable ends open.
OK
Cancel
Please wait...
Performing correction offset...

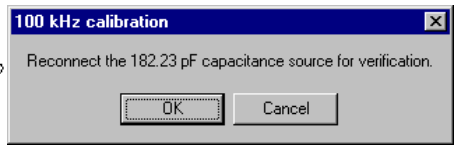
8.


100 kHz calibration
Connect the 182.23 pF capacitance source to the cables.
OK
Cancel
Please wait...
Calibrating...

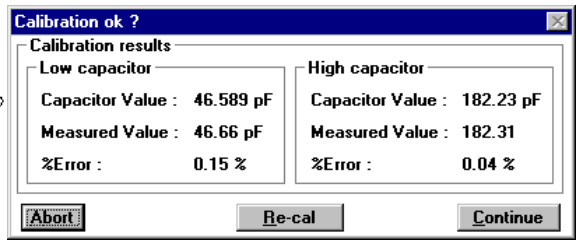
9.


100 kHz calibration
Connect the 46.589 pF capacitance source to the cables.
OK
Cancel
Please wait...
Calibrating...

10.


100 kHz calibration
Reconnect the 182.23 pF capacitance source for verification.
OK
Cancel

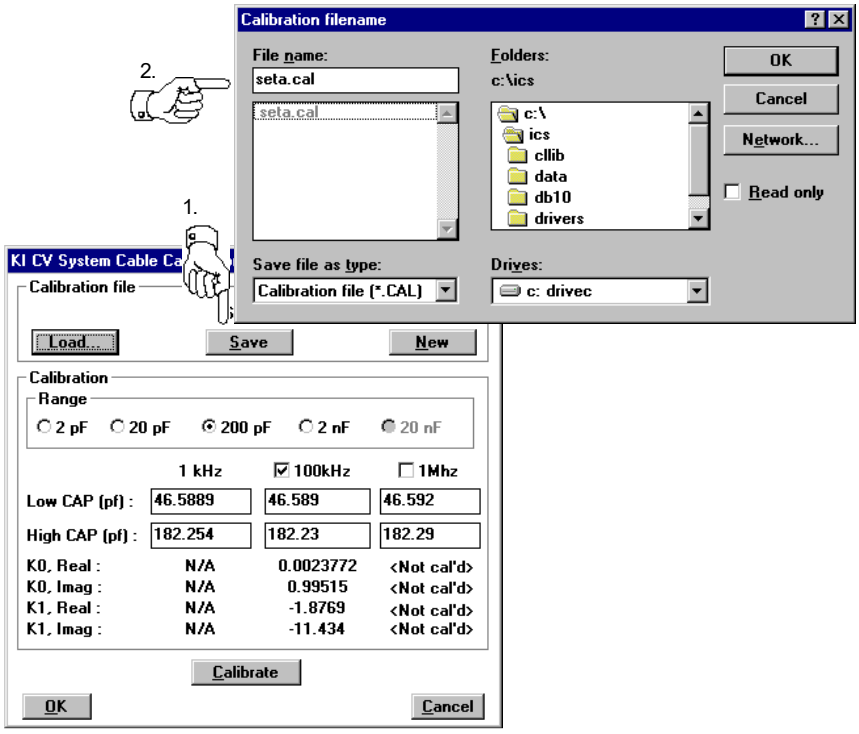
11.


Calibration ok ?
Calibration results
Low capacitor
Capacitor Value : 46.589 pF
Measured Value : 46.66 pF
%Error : 0.15 %
High capacitor
Capacitor Value : 182.23 pF
Measured Value : 182.31
%Error : 0.04 %
Abort
Re-cal
Continue

1. Click on the Calibrate button to open the KI CV System Cable Calibration dialog box.
2. Click on the New button to start a New Calibration file.
3. Select the Range to be calibrated from the Range controls. This range should match the measurement range and the calibrated capacitors to be used for calibration.
4. Select the frequencies at which calibration is to be performed.
5. Enter the capacitor values for the calibrated capacitors to be used during calibration. The calibrated capacitors must have values in the range being calibrated.
6. Click on the Calibrate button to begin the calibration process with Drift Correction.
7. Remove all cable connections and press OK to the prompt to perform the Correction Offset feature.
8. Connect the High CAP calibrated capacitor and press OK to perform calibration on the High CAP.
9. Connect the Low CAP calibrated capacitor and press OK to perform calibration on the Low CAP.
10. Re-connect the High CAP calibrated capacitor and press OK to perform verification on the High CAP.
11. Calibration status is displayed after the completion of calibration at frequency. If too much error exists check the system configuration press the Re-cal button to re-perform the calibration. If more than one frequency was selected for calibration the calibration procedure would begin again with Step 6 for the next frequency.

Save the Current Calibration Settings to File

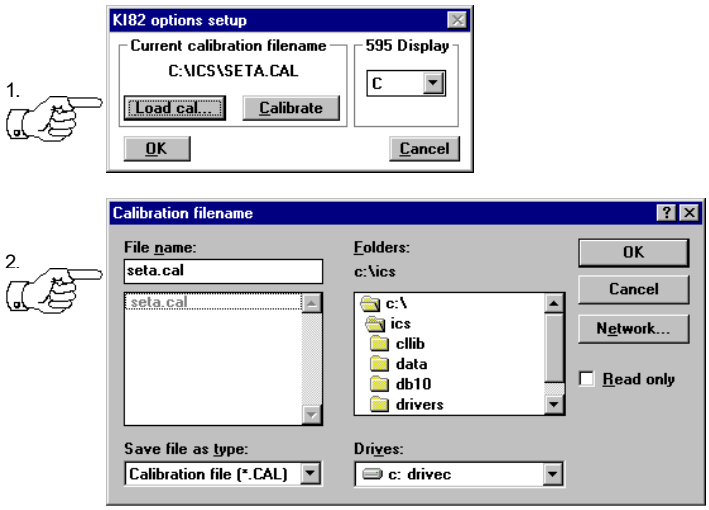
In order to allow calibration settings to be re-used at a later time the settings must be saved to a file which may be loaded and used with multiple measurement setups.



1. Click on the Save button to open the Calibration Filename dialog box.
2. Enter a name for the file which will contain the current calibration settings.

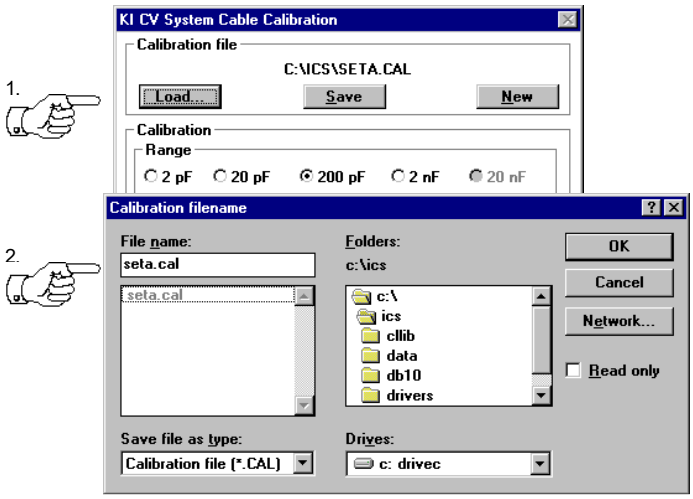
Load an Existing Calibration Settings from File

In order to allow calibration settings to be edited or re-used at a later time the settings must be saved to a file which may be loaded and used with multiple measurement setups. Calibration files may be loaded either from the KI82 Options Setup dialog or the KI CV System Cable Calibration dialog box.



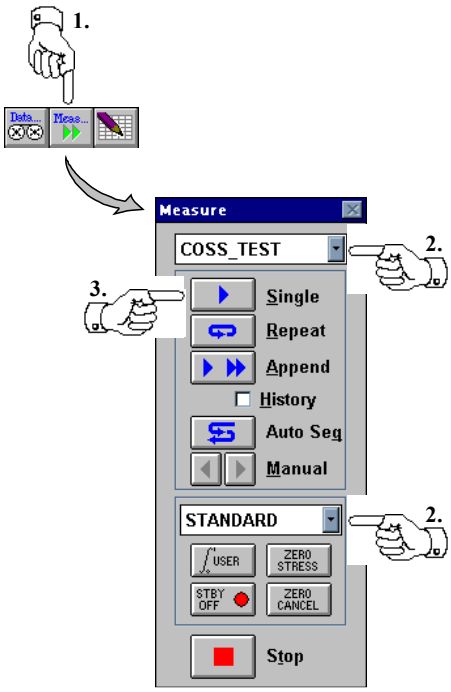
1. From the KI82 Options Setup dialog box click on the Load Cal... button to open the Calibration Filename dialog box.
2. Locate the select the desired calibration file to be loaded and used with the current measurement setup.

OR



1. From the KI CV System Cable Calibration dialog box click on the Load... button to open the Calibration Filename dialog box.
2. Locate the select the desired calibration file to be loaded and used with the current measurement setup.

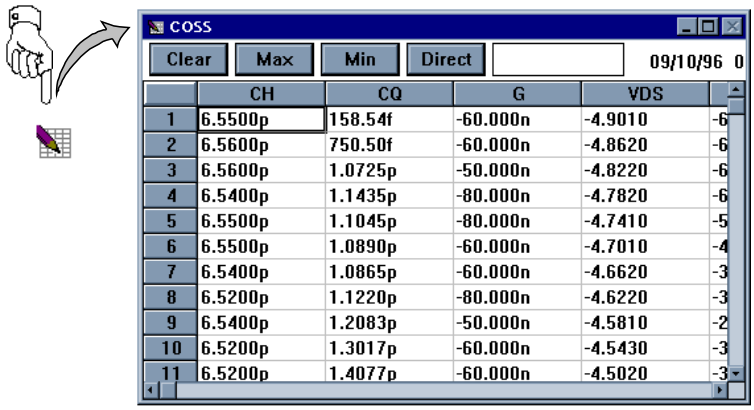
Executing the Measurement



1. Click on the **Measure** button  on the toolbar to access the Measurement Remote Control.
2. Verify that the test setup to be executed is selected and that **Standard** mode is selected.
3. Click on the **Single** button to execute the measurement.

Viewing the Results

Data values are written to the corresponding data window spreadsheet each time the measurement is executed. To display the numerical data, double click on the white spreadsheet icon corresponding to the test setup.

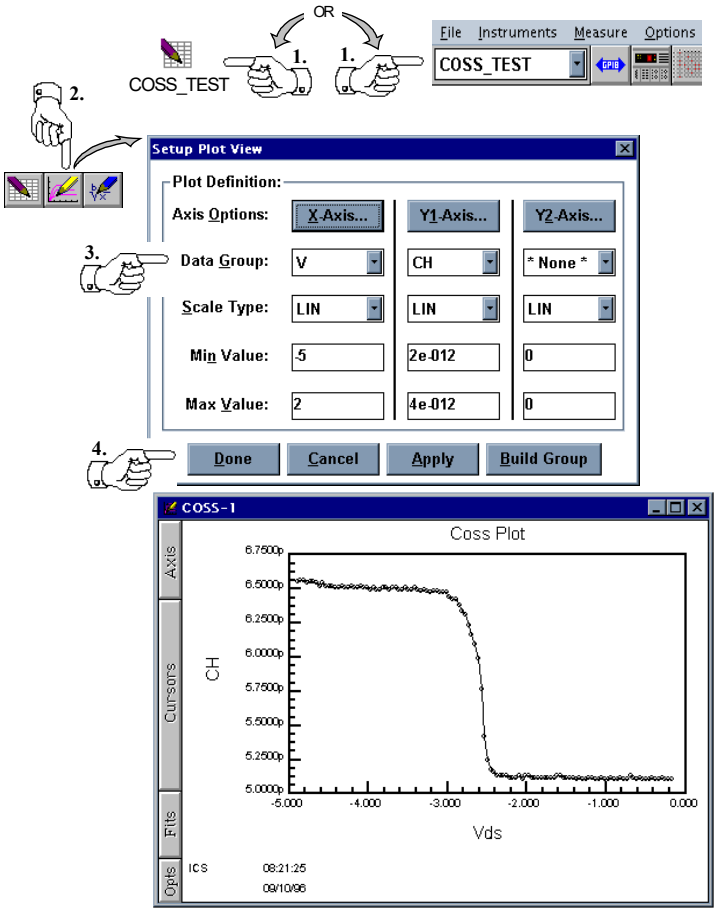


	CH	CQ	G	VDS	
1	6.5500p	158.54f	-60.000n	-4.9010	-6
2	6.5600p	750.50f	-60.000n	-4.8620	-6
3	6.5600p	1.0725p	-50.000n	-4.8220	-6
4	6.5400p	1.1435p	-80.000n	-4.7820	-6
5	6.5500p	1.1045p	-80.000n	-4.7410	-5
6	6.5500p	1.0890p	-60.000n	-4.7010	-4
7	6.5400p	1.0865p	-60.000n	-4.6620	-3
8	6.5200p	1.1220p	-80.000n	-4.6220	-3
9	6.5400p	1.2083p	-50.000n	-4.5810	-2
10	6.5200p	1.3017p	-60.000n	-4.5430	-3
11	6.5200p	1.4077p	-60.000n	-4.5020	-3

Data window spreadsheets are linked dynamically to the test setup. Each time the corresponding test setup is executed, the spreadsheet data is replaced with the most recently measured data. Each spreadsheet has the same name as the setup that was executed to measure the data.

Creating a Plot of the Results

Plot windows are linked dynamically to a corresponding data window spreadsheet. Just as the spreadsheets are updated after each measurement, the plots are regenerated anytime there is a change to the corresponding spreadsheet data. If the test setup is executed more than once, the plot window is regenerated after each measurement. Up to ten plots can be created from a single data window spreadsheet; each plot can be formatted independent of the others.



1. If there is more than one defined test setup, designate the active test setup by using the pull-down menu at the left end of the toolbar. A setup can also be made active by clicking once on the corresponding data window spreadsheet icon. Clicking once on a data window spreadsheet icon will display a system menu; ignore this display.
2. Click the **Create Plot** button  on the toolbar. This will open an empty plot window and the Plot Data dialog box.
3. Using the **Data Group** pull-down lists, select the vectors to be plotted on the x- and y-axes.
4. Click the **Done** button.

Saving Test Data

Project Files

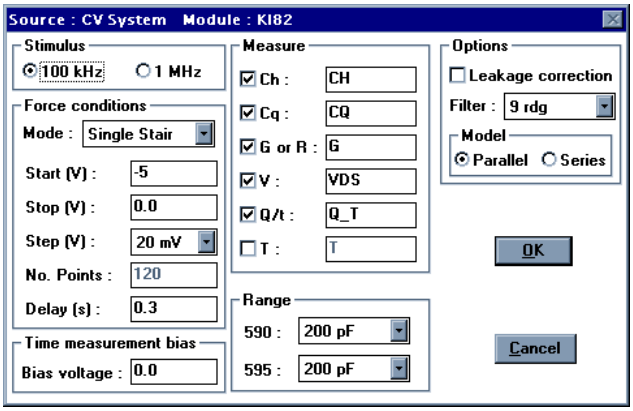
A project file includes all of the information necessary to execute a test setup or group of test setups. A single project file includes: 1) the instrument driver selection, 2) any defined test setups, and 3) all of the data and plot windows associated with the test setups.

Saving the Results to a Project File

1. Open the File Manager by clicking the **Save As** button  on the toolbar or by selecting **File/Save As...** from the menu bar.
2. Select a directory and then enter a filename.
3. Click the **OK** button, or hit the keyboard **ENTER** key.

The KI Model 82 "OUT" Setup Dialog Box

Options for configuring the OUT source unit of the Model 82 can be found in the Model 82 setup dialog box. This dialog box is accessed by clicking on the OUT source icon in the Setup Editor schematic.



Stimulus

The stimulus controls are used to setup the frequency stimulus for the Model 82.

100KHz

The 100KHz option is used to place the 5951 Remote Input Coupler in 100KHz mode and the Model 590's source frequency value to 100KHz.

1MHz

The 1MHz option is used to place the 5951 Remote Input Coupler in 1MHz mode and the Model 590's source frequency value to 1MHz.

Force Conditions

The Force Conditions controls are used to specify the form of the voltage source output for the 595. The 590 uses the 595 for it's bias source. The Model 82 hardware has a 40V maximum sweep span which may be used anywhere from -120V to +120V.

Mode

In **Squarewave** mode the base voltage remains fixed at the Start value throughout the measurement, while pulsing at the Step value for quasistatic C measurements.

In **Single Stair** mode the output voltage is changed from the start value to the stop value in increments of the step value.

In **Double Stair** mode the output voltage is changed from the start value to the stop value in increments of the step value and then returns the output voltage to the start value in the same step increments.

In **C vs Delay** mode the capacitance is measured as a function of measurement delay time. There are 10 logarithmically spaced delay times starting at 70ms and ending at the time specified in the Delay field. This measurement mode is useful for determining device thermal equilibrium time. Typical settings for the Delay field are 10 to 20 seconds.

Start

The Start parameter specifies the starting voltage for the staircase modes and the base voltage for Squarewave and C vs Delay modes.

Stop

The Stop parameter controls the stopping voltage for the staircase modes. This parameter is not used when the Force Conditions are in Squarewave or C vs Delay mode.

Step

The Step parameter specifies the voltage increments between Start and Stop for the staircase modes and is the voltage pulse used in Squarewave and C vs Delay modes.

No. Points

No. Points displays the number of samples to be included in the measurement.

Delay

The Delay parameter is used to specify the time before a measurement is made after each voltage change for the staircase modes and is the final delay value when in C vs Delay mode.

Time Measurement Bias

The Time Measurement Bias controls are used to specify the bias values used during ICS Time, Bias Delay, Sequence Stress, and Sequence Bias mode measurements.

Bias Voltage

The Bias Voltage parameter specifies the voltage to be used for all ICS Time Measurements.

Measure

The Measure controls are used to specify parameter names and what parameters are to be measured on the Model 82.

Parameter Check Boxes

The Parameter Check boxes allow the user to specify the parameters which are to be measured by checking the associated check box.

Parameter Names

The Parameter Name fields are used to specify a user defined name for the associated parameter.

Ranging

The range functions allows the user to choose the range to be used when measurements are performed.

590

590 Range specifies the value for a fixed range measurement. Values can be selected from a pull-down menu, and vary from 2pF to 2nF. With the optional 5904 adapter, a 20nF range is available at 100kHz.

595

595 Range specifies the value for a fixed range measurement. Values can be selected from a pull-down menu, and vary from 200pF to 20nF.

Options

Leakage Correction

The Leakage Correction parameter is used to enable or disable the Leakage Correction feature of the Model 595 CV meter.

Filter

The Filter parameter is used to specify the number of readings to be integrated into and single sample. Values can be selected from a pull-down menu, and vary from 1 to 24. See the Model 595 Operator's Manual for a complete description of filter modes.

Model

The Model parameter is used to specify either a Parallel or Series measurement model. See the Model 590 Operator's Manual for a complete description of parallel and series measurement modes.