Metrics ICS Driver Manual

HP4280

Metrics ICS

Version 4.5

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The HP4280 Instrument Driver

Getting Started: Creating and Executing a Test Setup

This section will walk you through the steps required to create and execute a sample test setup. This sample test setup will measure the output capacitance, C_{obo}, of a PNP small-signal bipolar transistor as a function of voltage. This characteristic was measured with the HP4280 1MHz C-Meter/C-V Plotter and the HP16080A Test Fixture.

Step 1: Connect a Test Fixture or Cable Set to the Instrument

The capacitance example presented in this section was performed with the HP16080A Test Fixture. Connect either the HP16080A Test Fixture or a compatible two-terminal pair cable set to the instrument UNKNOWN terminals.

Step 2: Connect the HP4280 Instrument Driver

The HP4280 Driver is connected to ICS in the Connect Instruments dialogue box. The Connect Instruments dialogue box is accessed by choosing the CONNECT INSTRUMENTS toolbar button or by selecting INSTRUMENTS/SELECT INSTRUMENT from the main menu bar.

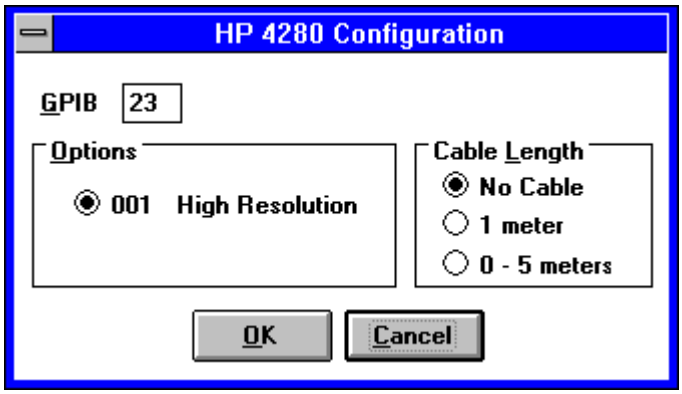
How to Connect the HP4280 Driver:

1. Click the CONNECT INSTRUMENTS toolbar button or select INSTRUMENTS/SELECT INSTRUMENT from the measurement mode menu bar. This will open the Connect Instruments dialogue box.
2. Highlight the HP4280 Driver in the AVAILABLE field.
3. Click the CONNECT button.
4. Your choice will be displayed in the SELECTED field.
5. Clicking the OK button would close the Connect Instruments dialogue box and restore control to the ICS desktop. Keep the Connect Instruments dialogue box displayed for now, because the

next step requires you to click the Connect Instruments CONFIG button.

Step 3: Designate the GPIB Address and Instrument Hardware Configuration

Connect the HP4280 to your computer using a standard IEEE-488 GPIB (General Purpose Interface Bus) as described in Chapter 3 of the HP4280A Operation and Service Manual. The HP-IB hardware discussed in the Operation and Service Manual is Hewlett-Packard's implementation of the IEEE-488 Standard Digital Interface for programmable instrumentation.



The HP4280 Configuration dialogue box is used to designate the instrument's GPIB address and the instrument hardware configuration.

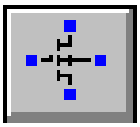
Designating the instrument hardware configuration includes specifying whether Option 001 is installed in the instrument as well as specifying the cable length selection. Option 001 enhances the resolution of the instrument's capacitance measurements. The installation of Option 001 must be designated in the HP4280 Configuration dialogue box in order to apply the added capability from ICS. The selectable Cable Length designations are provided to minimize the parasitic effects of the test fixture or test leads.

How to Designate the HP4280 GPIB Address and Instrument Hardware Configuration:

1. The Connect Instruments dialogue box should still be displayed from the last step. If it isn't, click the toolbar CONNECT INSTRUMENTS button or choose INSTRUMENTS/SELECT INSTRUMENT from the main menu bar. This will re-open the Connect Instruments dialogue box.
2. Open the HP4280 Configuration dialogue box by clicking the CONFIG button at the bottom of the Connect Instruments dialogue box.
3. Enter the HP4280 GPIB address in the GPIB field. The GPIB address is set by positioning the two miniature rotary switches located on the back panel of the instrument. If you wish to change the GPIB address, please refer to procedure outlined in Chapter 3 of the HP4280A Operation and Service Manual. The configured GPIB address can also be read from the C Display after sequentially pressing the front panel blue key followed by the LOCAL key.
4. If applicable, designate the installation of Option 001 by selecting the corresponding switch.
5. Designate the appropriate Cable Length option by selecting the corresponding switch.
6. Click the OK button to close the HP4280 Configuration dialogue box. Click the OK button in the Connect Instruments dialogue box to restore control to the desktop.

Step 4: Create the Test Setup

Test setups are created in the Setup Editor. Open the Setup Editor by selecting the SETUP EDITOR toolbar button. This example will demonstrate how to create a test setup that measures the output capacitance, C_{obo}, of a PNP bipolar transistor as a function of voltage.



Click the corresponding toolbar button to display the Setup Editor.

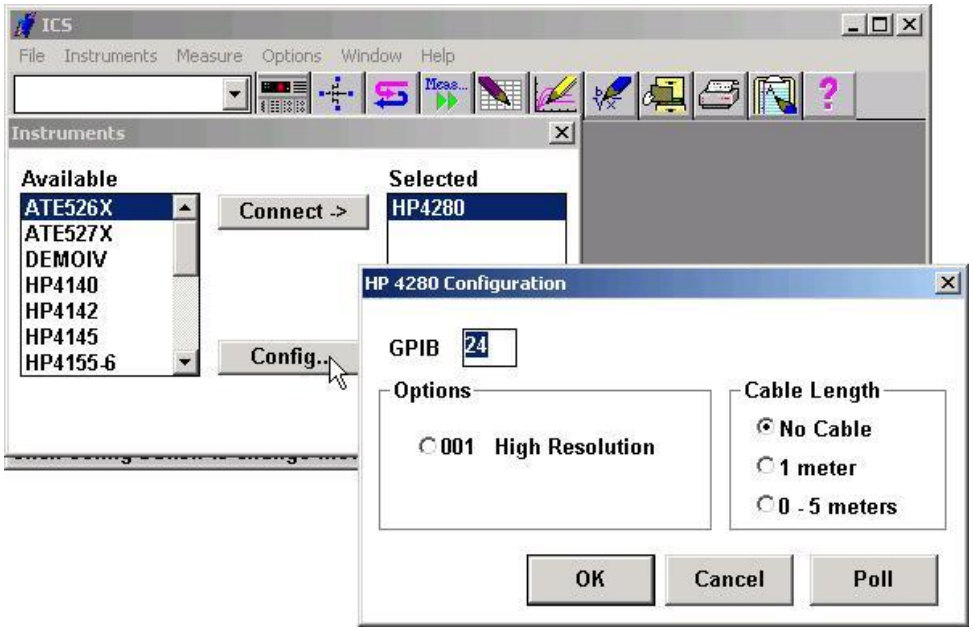


Figure 1: How to Define the HP4280 GPIB Address and Option 001 Status

Step 4A: Specify the Test Setup Name

When creating a new test setup, a test setup name must be specified before any other selections or conditions are designated.

How to Specify the Test Setup Name

1. Click the Setup Editor NEW button. This will open the New Setup dialogue box.
2. At the prompt, specify a test setup name. For this example, type "Cobo".
3. Click OK. This will close the New Setup dialogue box.
4. The test setup name will appear in the Setup Editor SETUP window.

Step 4B: Select a Device Schematic Corresponding to the DUT

A device schematic is located at the center of the Setup Editor. ICS provides a library of different device schematics. Select a schematic that is a representation of the DUT.

The device schematic does not have to match the pin layout of the Device Under Test. The device schematic is provided as a convenience for the user so that the user can document the terminal connections required for the corresponding test setup.

A MOSFET schematic will appear at the center of the Setup Editor when the Setup Editor is first opened. In this step the MOSFET schematic will be replaced with a BJT schematic. The MOSFET device is the default Setup Editor schematic. To change the default device schematic, refer to *Chapter 2: The Setup Editor*.

How to Select a Device Schematic:

1. Click the Setup Editor DEVICE button. This will open the Device dialogue box.
2. The Device Type window will display a list of available device schematics. Select "BJT". Notice the selected schematic is previewed in the small window to the right of the Device Type window.
3. Selecting the BJT schematic will display a set of polarity switches. Click the "PNP" designation.
4. Click OK. This will close the Device dialogue box and display the transistor schematic at the center of the Setup Editor.

Step 4C: Designate the Instrument/DUT Connections

The connections between the instrument UNKNOWN terminals and the device under test are designated in the Setup Editor. The Setup Editor display is provided as a tool to document the test fixture or test lead connections required for the corresponding device measurement. The connections designated in the Setup Editor must correspond to the orientation of the DUT in the test fixture or the connections between the DUT and the instrument test leads.

The Setup Editor should display a device schematic that is representative of the DUT (refer to the last step, if necessary). Connections are designated by first clicking either the "high" or "low" source listed in the Source Units dialogue box. After the source is selected, click the blue pad next to one of the device schematic pins. An instrument icon, along with the name of the connected source, will appear above the device schematic pin as a means of indicating the connection.

The instructions presented below will explain how to designate the connection between the HIGH terminals and the base, along with the connection between the LOW terminals and the collector.

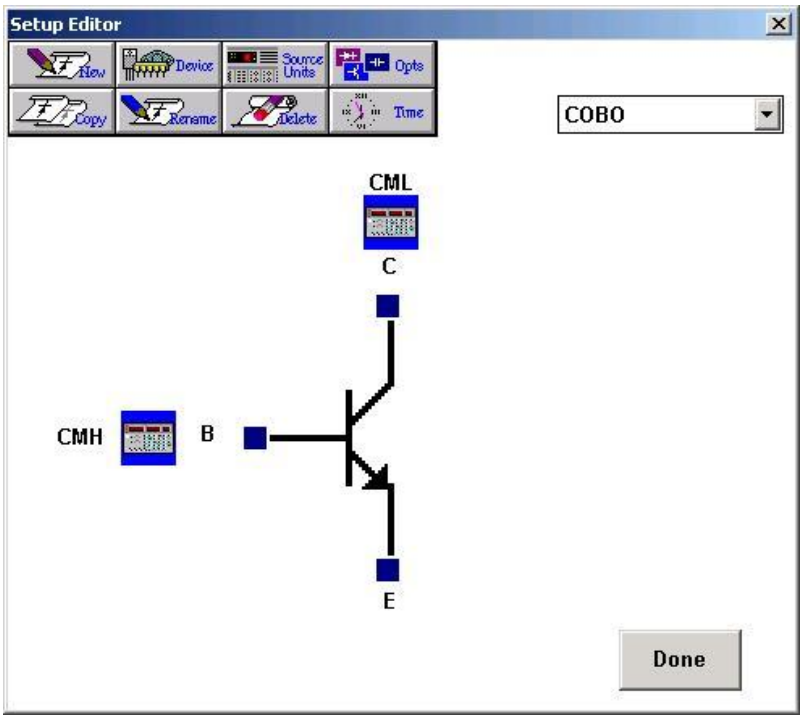


Figure 2: The Setup Editor Designates the Connections Between the Instrument and the Device Under Test.

How to Designate the Instrument/DUT Connections:

1. Select the Setup Editor SOURCES button. This will open the Source Units dialogue box.
2. The Source Units dialogue box will display two sources. One of the sources is designated "high" and the other "low" (HP4280.CMH and HP4280.CML respectively).
3. Click on the "HP4280.CMH" designation.
4. Designate the intended orientation of the DUT in the HP16080A Test Fixture by clicking the blue pad next to the base.
5. Select the "HP4280.CML" designation and click the blue pad next to the collector. An instrument icon will appear above both designated connections.
6. Close the Source Units dialogue box by double-clicking the "-" in the upper left-hand corner of the dialogue box.
7. If an incorrect DUT connection is mistakenly designated, undesignate the connection as described in *Chapter 2, Removing Instrument/DUT Connections.*

Step 4D: Specify the Setup Configuration of the Instrument

The measurement configuration of the HP4280 is controlled from the HP4280 Setup dialogue box. The HP4280 Setup dialogue box is opened by clicking the instrument icon next to the "CMH" connection.

In this example, the HP4280 will source a 30mV 1MHz signal while applying a single staircase voltage sweep across the base-collector junction of a PNP bipolar transistor. The voltage bias will sweep from 0.0V to 30.0V and consist of 61 data points. Capacitance (Cobo) and bias voltage (Vrb) will be returned as data.

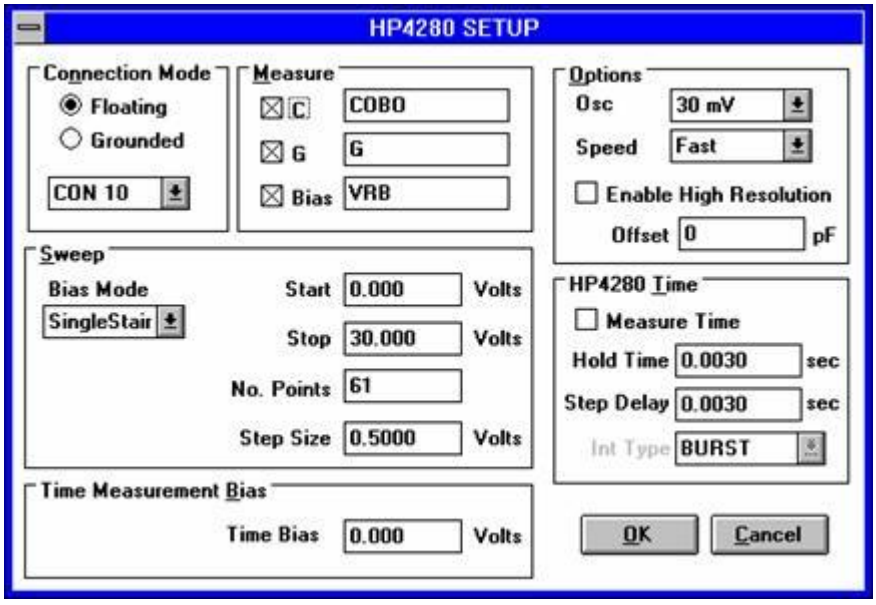


Figure 3: HP4280 Setup Configuration for the C_{obo} Test Setup

How to Specify the Instrument Measurement Configuration:

1. Click once on the "CMH" instrument icon to open the HP4280 Setup dialogue box.
2. Configure the controls as shown in Figure 3. Use the mouse or TAB key to move between the different switches and fields.
3. Click OK to close the HP4280 Setup dialogue box.

Step 5: Calibrate the Instrument

The parasitic effects of the test fixture or test leads introduce device measurement inaccuracies. To eliminate this problem, the HP4280 includes a set of calibration functions that compensate for the LCR characteristics inherent to the test fixture or test leads.

The HP4280 calibration function(s) must be performed AFTER the test setup is defined in the Setup Editor. The HP4280 does not perform calibration routines over a range of preset conditions; instead, the HP4280 performs calibration routines at the conditions specified in the test setup.

The correction functions are controlled from the Calibrate dialogue box. If the "No Cable" or "1m" cable length designation is selected in the HP4280 Configuration dialogue box, only the Zero Open function needs to be performed. This is equivalent to pushing the Zero Open button on the front panel of the instrument. If the "0-5m" cable length designation is selected, then only the Calibrate function needs to be performed. This is equivalent to following the procedure outlined in Chapter 3 of the HP4280 Operation and Service Manual.

How to Calibrate the HP4280:

1. Open the Calibrate dialogue box by clicking the Setup Editor OPTIONS button.
2. Check the Enable box if you want to enable the Zero Open or Calibarion correction functions during measurements. If left un-checked, the above correction functions will not be applied during measurements.
3. Make certain that there is no device inserted in the test fixture. Click the Zero button. The Calibrate dialogue box will remain displayed while the Zero Open function is performed.
4. If the "0-5m" cable length designation is selected, the Calibrate function should be performed. Short the test fixture HIGH and LOW terminals. Click the CALIBRATE button. The Calibrate dialogue box will remain displayed while the Calibrate function is performed.
5. The instrument is successfully calibrated. Click the CLOSE button to restore control to the Setup Editor.

The procedure outlined above is a presentation of the minimal calibration requirements necessary for the C_{obo} measurement specified in the example test setup. For a thorough discussion of the calibration functions, refer to *The HP4280 Calibration Dialogue Box* later in this chapter.

Step 6: Insert the DUT into the Test Fixture

Insert the DUT into the test fixture sockets according to the instrument/DUT connections designated in the Setup Editor. To measure the C_{obo} test setup described in this section, insert the base of the PNP bipolar transistor into the HP16080A HIGH socket. Insert the collector into the LOW socket. Make certain the emitter lead is open and not shorted to either of the test fixture connections.

Step 7: Execute the Measurement

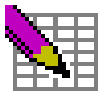
Execute the test setup by clicking the toolbar MEASURE button to open the Measurement Remote Control. Select the measurement type and execute the measurement.

If the instrument has not been calibrated as described in Step 5, the Calibrate dialogue box will be displayed in the center of the desktop after clicking the MEASURE button. The appearance of the Calibrate dialogue box is intended to remind the user that the instrument should be calibrated in order to compensate for the parasitic effects of the test fixture or test leads. If you choose not to calibrate the instrument, click the CLOSE button to continue with the measurement. If you wish to calibrate the instrument, follow the procedure presented earlier in *Step 5: Calibrating the Instrument.* After one or both of the calibration functions are performed, the Calibrate dialogue box will no longer be displayed each time the toolbar MEASURE button is selected.

Step 8: View the Results

Data is automatically 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 labeled Cobo at the bottom of the ICS desktop. The spreadsheet was created after the Cobo test setup name was specified in the Setup Editor, but it contained no data.



Data window spreadsheets are dynamically linked to the test setup. Each time the corresponding test setup is executed, the spreadsheet data is replaced with the most recently measured data. For this reason the data window spreadsheet is automatically named the same as the test setup.

Step 9: Create a Plot of the Results

A plot window is dynamically linked to a corresponding data window spreadsheet. This means that the plot is regenerated any time 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, and each plot can be independently formatted.

The steps below will show you how to create a plot of C_{obo} with respect to the voltage sweep.

How to Create a Plot

1. If there is more than one defined test setup, designate the active test setup in one of two ways:
2. Click once on the appropriate data window spreadsheet icon. Clicking once on a data window spreadsheet icon will display a system menu. Ignore this display and proceed with Step 4.

3. Click the toolbar setup window arrow and select the desired setup from the displayed drop-down list.
4. Click the NEW PLOT toolbar button. This will open an empty plot window and the Plot Data dialogue box.
5. Designate the independent variable of the plot by double-clicking on the appropriate data vector listed in the Data window. Two quantities were measured in the C_{obo} test setup: output capacitance and voltage. There should be two data vectors in the dialogue box Data window: "Cobo" and "Vrb" (according to the data vector labels specified in Figure 3). This example will create a plot of output capacitance with respect to the voltage sweep. Since voltage will be the independent variable, double-click on "Vrb". Notice that the X-button is now labeled with a "Vrb".
6. Designate a dependent variable by double-clicking the appropriate data vector in the dialogue box Data window. For this example, double-click on "Cobo". Notice that the Y1-button is now labeled with a "Cobo".
7. You could plot up to nine more data vectors with respect to the independent variable if more data vectors were measured. You can measure more than ten data vectors, but only ten data vectors can be plotted in a single plot window.
8. Click the dialogue box APPLY button. This will create the plot but will not close the Plot Data dialogue box.
9. Click the CLOSE button to close the Plot Data dialogue box.

Step 10: Save the Results into a Project File

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 setup(s), and 3) all of the data and plot windows associated with the test setup(s). For more information about project files, refer to *Chapter 1: How ICS Stores Information*.

The HP4280 Setup Dialogue Box

The HP4280 includes two sources: HIGH and LOW. These sources are designated as HP4280.CMH and HP4280.CML respectively in the Source Units dialogue box. HP4280.CMH is the source from which the HP4280 measurement configuration is specified. HP4280.CML is a ground reference.

The HP4280 measurement configuration is specified in the HP4280 Setup dialogue box. The HP4280 Setup dialogue box is opened by clicking the instrument icon displayed above the HP4280.CMH connection designated in the Setup Editor. The layout of the HP4280 Setup dialogue box is shown in Figure 4.

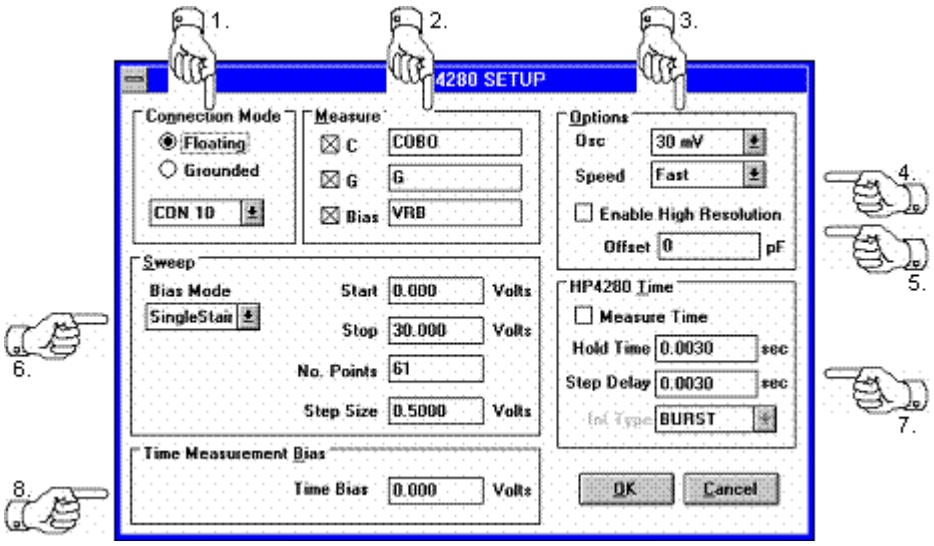


Figure 4: Layout of the HP4280 Setup Dialogue Box.

1. **Connection Mode Controls:** The Connection Mode controls provide the capability to configure the HP4280 in one of the fourteen different internal connection arrangements. The most common modes, floating (CON10) and grounded (CON15), are presented with corresponding switches. These modes can be designated by selecting the respective switch. The remaining modes are designated from the Connection Mode list-box. The list-box is displayed by clicking the scroll arrow in the Connection Mode field.

2. **Measure Controls:** The Measure controls are used to designate the measurement function of the instrument: C, G, or C-G. The Measure controls also designate the device or bias data that will be returned to a data window spreadsheet: capacitance (C), conductance (G), or bias voltage (BIAS). Each Measure switch includes a twelve-character alphanumeric field that allows the user to specify a label for the corresponding data.

3. **Oscillation Level Field:** The Oscillation Level field is used to designate the magnitude of the test signal. Choose between 10mV or 30mV. Both options are displayed by clicking the scroll arrow button at the right of the field. Click the desired choice.

4. **Measurement Speed Field:** The Measurement Speed field is used to designate the measurement rate of the instrument. Select from among FAST, MED, or SLOW. Higher measurement speed results in lower measurement resolution.

5. **High Resolution Controls:** The High Resolution switch is used to activate Option 001, the high resolution capacitance capability. The installation of Option 001 must be designated in the HP4280 Configuration dialogue box in order to select the High Resolution switch. The High Resolution Offset field is used to enter the Offset value to be used for High Resolution measurements.

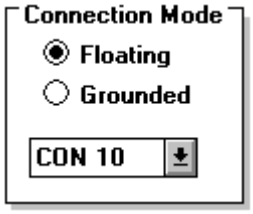
6. **Sweep Controls:** The Sweep controls are used to specify the configuration of the internal dc bias supply and thereby designate the measurement mode of the instrument. The HP4280 can be configured to source a constant, pulsed, staircase sweep, or dual staircase sweep bias voltage. Click the scroll arrow in the Bias Mode field to display a list of the available bias options. Click on the desired selection. The appropriate specification fields are displayed in the Sweep group when a pulsed, staircase sweep, or dual staircase sweep designation is selected in the Bias Mode field.

7. **Time Controls:** The Time controls are used to designate the pulsed bias signal specifications. The Time controls are only available when the

PULSE designation is selected in the Bias Mode field. Select the Measure Time switch to write the time data to the data window spreadsheet.

8. **Time Measurement Bias:** The Time Measurement Bias value indicates the source value to be used during ICS Time measurements.

Connection Mode Controls

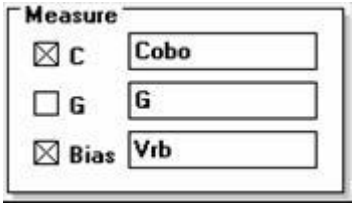


The Connection Mode controls are used to configure the HP4280 in one of the fourteen different internal connection arrangements. The different modes vary the connections between the test signal source, ammeter, internal dc bias source, external bias source (if present), and the UNKNOWN terminals. A schematic of each connection mode is shown in Chapter 3 of the HP4280 Operation and Service Manual.

The most common connection modes, floating (CON10) and grounded (CON15), can be designated by selecting the corresponding switch. The remaining connection modes must be designated in the Connection Mode field. Click the scroll arrow button at the right of the Connection Mode field to display a list-box of available selections. Click the desired option.

While ICS allows the user to designate any of the connection modes supported by the instrument, many of the connection modes include an external source in the test circuit. ICS cannot control sources external to the HP4280.

Measure Controls



The Measure controls are used to designate the measurement function of the instrument: C, G, or C-G. The Measure controls also designate the device or bias data that will be returned to a data window spreadsheet: capacitance (C), conductance (G), and/or bias voltage (BIAS).

Each switch includes a twelve-character alpha-numeric field that allows the user to specify a label for the corresponding data.

Designating the Measurement Function

The measurement function of the instrument is determined by the configuration of the capacitance (C) and conductance (G) switches. The configuration of the bias voltage switch (BIAS) does not contribute to the determination of the measurement function.

When both the capacitance (C) and conductance (G) switches are selected, the instrument will measure both C and G. This is referred to as the C-G function in Chapter 3 of the HP4280 Operation and Service Manual.

When the capacitance (C) switch is selected and the conductance (G) switch is OFF, only capacitance is measured. This is referred to as the C function in Chapter 3 of the HP4280 Operation and Service Manual. The time required to perform the C function is about half of what is required to perform the C-G function.

When the capacitance (C) switch is OFF and the conductance switch (G) is selected, only conductance is measured. This is referred to as the G function in Chapter 3 of the HP4280 Operation and Service Manual. The time required to perform the G function is about half of what is required to perform the C-G function.

Specifying Data Return

Select the appropriate Measure switch to return capacitance, conductance, and/or bias voltage data to the data window spreadsheet. There is no restriction to the configuration of the Measure switches. Any combination of switch positions is acceptable.

When the bias voltage switch (BIAS) is selected, the bias voltage data will be written to the data window spreadsheet. The actual bias voltage applied to the DUT is not returned by the instrument. The values displayed in the instrument's V·t display are calculations and not measured data. The bias voltage values written to a data window spreadsheet are not read from instrument memory; instead, the bias voltage values are calculated by ICS.

Labeling Measured Data

All of the data that corresponds to a single curve or spot measurement is collectively referred to as a "data vector". Each data vector is identified by a "data vector label" that must be defined in the text field to the right of the C, G, or BIAS switch. A data vector label can be any alphanumeric string up to twelve characters in length.

Oscillator Level Field

The test signal amplitude can be set to either 10mV or 30mV. Click the scroll arrow in the Oscillator Level field to display a list-box of the two choices. Click the desired option.

Measurement Speed Field

The Measurement Speed designation, along with the designated measurement mode, determines the required time for the instrument to obtain a measured value. The measurement speed can be set to FAST, MED, or SLOW. Click the scroll arrow in the Measurement Speed field to display a list-box of available choices. Click on the desired option.

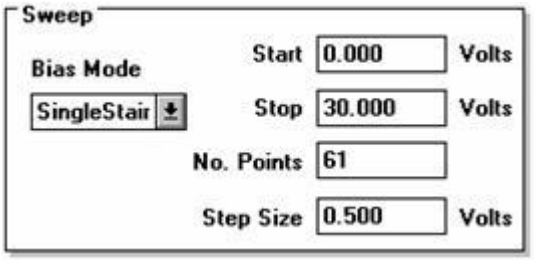
When FAST is selected, or MED is selected along with a 10mV oscillator level, the measurement resolution of the instrument will be one digit less than it would be otherwise. When SLOW is designated, the instrument will average the results of ten MED measurements.

Measurement speed is discussed in Chapter 3 of the HP4280 Operation and Service Manual. Refer to Chapter 1 in the same source for a presentation of the measurement times associated with each combination of measurement *speed* and measurement *mode*.

High Resolution Switch

The High Resolution switch is used to apply Option 001 with the specified High Resolution Offset. Option 001 enhances the resolution of the instrument's capacitance measurements. The installation of Option 001 must be designated in the HP4280 Configuration dialogue box in order to select the High Resolution switch (see *Step 3: Designate the GPIB Address and Instrument Hardware Configuration*). Refer to Chapter 1 of the HP4280 Operation and Service Manual for a brief discussion of Option 001.

Sweep Controls

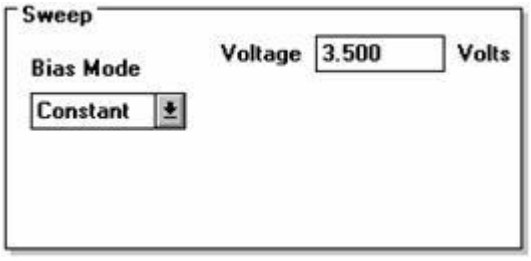


The Sweep controls are used to specify the configuration of the internal dc bias supply. The configuration of the Sweep controls also determines the measurement mode of the instrument: C, C·V, or C·t.

ICS provides the capability to generate characteristic curves in response to bias sweeps and bias pulses. The HP4280 can source a constant, pulsed,

staircase sweep, or dual staircase sweep bias signal. ICS allows the user to define a bias sweep or pulse signal that consists of up to 2048 measurements.

C Mode: Constant Bias Signal



The C Mode sources a constant dc bias signal resulting in a single-point spot measurement. Select the "Constant" designation in the Bias Mode field to configure the instrument in C Mode.

How to Configure a Constant Bias Signal:

1. Select the "CONSTANT" option in the Bias Mode field. Click the scroll-arrow at the right end of the Bias Mode field to display the available options. Click the "CONSTANT" designation.
2. Specify a bias signal amplitude in the voltage field. Highlight the present value and specify a new value directly.

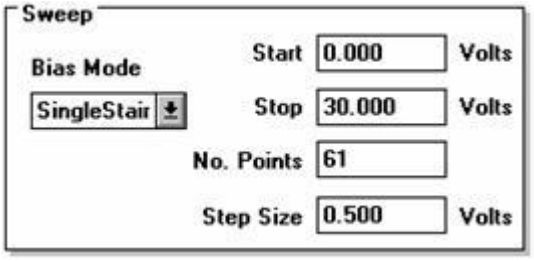
C·V Mode: Sweep Bias Signals

When configured in C·V Mode, the instrument will measure the capacitance and/or conductance of a device in response to a swept dc bias voltage. The output of the internal bias source can be swept in either a single staircase sweep or a dual staircase sweep. The instrument is configured in C·V Mode when either of the two sweep options is designated in the Bias Mode field of the Sweep controls.

ICS enhances the HP4280 C·V performance by providing the capability to return time as a variable. The capability provided by ICS in C·V Mode is similar to the capability provided by the instrument in C·t Mode. When a swept bias source is selected, the timing of the bias signal can be written to the data window spreadsheet. This option is designated by selecting the Measure Time switch in the Time controls.

When the instrument is configured in C·V Mode, the instrument firmware does not provide GPIB accessibility to the timing characteristics of the bias sweep. When time is designated as a returned variable, the timing characteristics of the sweep signal are calculated by ICS. These calculations are based upon the Hold Time and Step Delay specifications. This added capability allows the user to create plots that graph both the bias signal magnitude and device response as a function of time.

Single Staircase Sweep



Selecting the single staircase sweep designation in the Bias Mode field of the Sweep controls configures the instrument in C·V Mode.

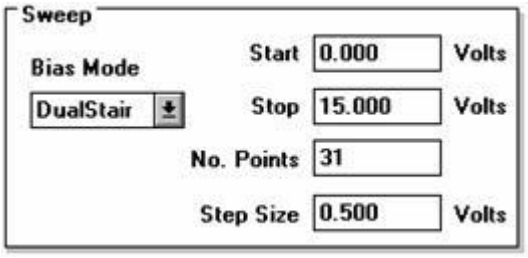
When the "SingleStair" designation is selected, the internal bias supply will output a staircase sweep signal in one direction only. Refer to Chapter 3 of the HP4280 Operation and Service Manual for a diagram of the staircase sweep bias signal waveform. ICS provides the capability to configure the HP4280 to source a staircase sweep bias signal consisting of up to 2048 data

points. The single stair sweep bias is fully defined by specifying three of the four sweep parameters: START, STOP, NO. POINTS, and STEP size.

How to Configure a Single Staircase Sweep Bias Signal:

1. Select the "SingleStair" option in the Bias Mode field of the Sweep controls. Click the scroll-arrow at the right end of the Bias Mode field to display a list-box of the available options. Click the "SingleStair" designation. Selecting the "SingleStair" designation will display a set of definition fields specific to the staircase sweep mode.
2. Specify the initial value of the bias signal in the START field. Highlight the present value and specify a new value directly.
3. Hit the TAB key once or use the mouse to advance to the STOP field. If desired, specify a final value for the bias sweep. If a STEP SIZE is specified by the user, the STOP field will be updated automatically to accommodate the change.
4. Hit the TAB key once or use the mouse to advance to the NO. POINTS field. Specify the number of voltage increments that will comprise the sweep signal. The increment quantity is also the number of data points that will comprise the resultant parameter curve.
5. If necessary, hit the TAB key once or use the mouse to advance to the STEP SIZE field. The STEP SIZE designates the magnitude of the sweep signal voltage increment. If the START, STOP, and NO. POINTS fields have been specified, the STEP SIZE field will be calculated automatically. If desired, the STEP SIZE calculation can be redesignated by the user. If the STEP SIZE designation is changed, the STOP field will be updated automatically to accommodate the change.
6. Specify the initial and final sweep delay in the HOLD TIME field. Designate any value between 3ms and 650s. The value specified in the HOLD TIME field will be interpreted in milliseconds. If a HOLD TIME value is not specified, a default value of 3ms will be used.
7. Specify the measurement delay of each voltage increment in the STEP DELAY field. Designate any value between 3ms and 650s. The value specified in the STEP DELAY field will be interpreted in milliseconds. If a STEP DELAY value is not specified, a default value of 3ms will be used.
8. If desired, select the MEASURE TIME switch to designate time as a measured variable. If the MEASURE TIME switch is selected, the time data corresponding to the bias sweep will be written to the data window spreadsheet.

Dual Staircase Sweep



Selecting the dual staircase sweep designation in the Bias Mode field of the Sweep controls configures the instrument in C-V Mode.

When the "DualStair" designation is selected, the internal bias supply will output a staircase sweep signal that has both ascending and descending components. Refer to Chapter 3 of the HP4280 Operation and Service Manual for a diagram of the staircase sweep bias signal waveform. ICS provides the capability to configure the HP4280 to source a staircase sweep bias signal consisting of up to 2048 data points. The single stair sweep bias is fully defined by specifying three of the four sweep parameters: START, STOP, NO. POINTS, and STEP size.

How to Configure a Dual Staircase Sweep Bias Signal:

1. Select the "DualStair" option in the Bias Mode field of the Sweep controls. Click the scroll-arrow at the right end of the Bias Mode field to display a list-box of the available options. Click the "DualStair" designation. Selecting the "DualStair" designation will display a set of definition fields specific to the staircase sweep mode.
2. Specify the initial value of the bias signal in the START field. Highlight the present value and specify a new value directly.
3. Hit the TAB key once or use the mouse to advance to the STOP field. If desired, specify a peak value for the bias sweep. If a STEP SIZE is specified by the user, the STOP field will be updated automatically to accommodate the change.
4. Hit the TAB key once or use the mouse to advance to the NO. POINTS field. Specify the number of voltage increments that will comprise one direction of the sweep signal. The number of data points that will comprise the resultant parameter curve is equal to twice the NO. POINTS specification.

5. If necessary, hit the TAB key once or use the mouse to advance to the STEP SIZE field. The STEP SIZE designates the magnitude of the sweep signal voltage increment. If the START, STOP, and NO. POINTS fields have been specified, the STEP SIZE field will be calculated automatically. If desired, the STEP SIZE calculation can be redesignated by the user. If the STEP SIZE designation is changed, the STOP field will be updated automatically to accommodate the change.
6. Specify the initial and peak sweep delay in the HOLD TIME field. Designate any value between 3ms and 650s. The value specified in the HOLD TIME field will be interpreted in milliseconds. If a HOLD TIME value is not specified, a default value of 3ms will be used.
7. Specify the measurement delay of each voltage increment in the STEP DELAY field. Designate any value between 3ms and 650s. The value specified in the STEP DELAY field will be interpreted in milliseconds. If a STEP DELAY value is not specified, a default value of 3ms will be used.
8. If desired, select the MEASURE TIME switch to designate time as a measured variable. If the MEASURE TIME switch is selected, the time data corresponding to the sweep bias will be written to the data window spreadsheet.

Hold Time

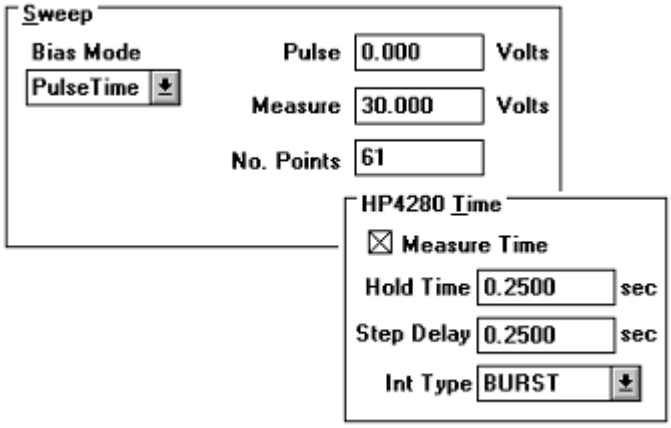
The HOLD TIME is a delay applied at both the beginning and end of the sweep signal. The HOLD TIME specification is provided to accommodate the stabilization of both the START and STOP bias values. The HOLD TIME can be set to any value between 3ms and 650s. Values specified in the HOLD TIME field will be read as milliseconds.

Step Delay

The STEP DELAY is applied after each voltage increment. The STEP DELAY specification is provided to accommodate the stabilization of each step prior to performing a measurement. The limitations of the STEP DELAY are the same as the HOLD TIME limitations. Values specified in the STEP DELAY field will be read as milliseconds.

C-t Mode: Pulsed Bias Signal

When configured in C-t Mode, the instrument will measure the capacitance and/or conductance of a device at a constant measurement interval in response to a dc pulse bias. The instrument is configured in C-t Mode when the "Pulse" designation is selected in the Bias Mode field of the Sweep controls. The pulse bias consists of two components: stress duration and measurement duration.



The stress component of the pulse bias occurs before the device is measured. The device is first biased to a constant DC voltage. After an appropriate settling time determined by the instrument's firmware, the device is stressed by applying a single step PULSE voltage. The device is stressed for a length of time referred to as the pulse width. The pulse width is specified by designating a value in the HOLD TIME field.

The measurement component of the pulse bias occurs after the device is stressed at the PULSE voltage. At the end of the pulse width duration, the device is biased in a single step to the MEASURE voltage. Capacitance and/or conductance measurements are performed at the end of each measurement duration designated in the STEP DELAY field. The duration of the pulse bias measurement component is determined by the NO. POINTS designation and the measurement duration.

The designations that must be specified in C-t Mode are summarized below. Refer to Chapter 3 of the HP4280 Operation and Service Manual for a diagram of the pulse bias waveform.

Pulse Voltage

The PULSE voltage field designates the bias level at which the device will be stressed. The PULSE voltage is applied in a single step after the DC bias has settled but prior to the application of the MEASURE voltage. The device is biased at the PULSE voltage for a length of time specified by the pulse width.

Measure Voltage

The Measure field designates the bias level of the device while capacitance and/or conductance measurements are performed. The Measure voltage is applied in a single step pulse at the end of the Pulse voltage stress.

No. Points

The NO. POINTS field designates the number of measurements that will be performed while the device is biased at the MEASURE voltage. The NO. POINTS designation and the measurement interval designated in the STEP DELAY field determine the duration of the pulse bias measure component.

Hold Time

The HOLD TIME field designates the pulse width of the stress signal. The pulse width is the length of time that the Pulse voltage bias will be applied to the device.

Step Delay

The STEP DELAY field designates the pulse bias measurement interval. The measurement interval is the length of time between each consecutive capacitance and/or conductance measurement performed at the MEASURE voltage bias level. The STEP DELAY designation (measurement interval) and the NO. POINTS designation determine the duration of the pulse bias measure.

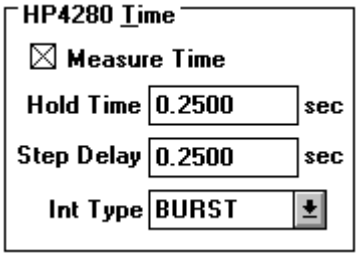
Int Type

The Int. Type control is used to designate the type of Sampling Integration to be used during the time measurement. The Sampling Integration may be set to either Burst or Sampling mode.

How to Configure a Pulse Bias Signal:

1. Select the "Pulse" option in the Bias Mode field of the Sweep controls. Click the scroll-arrow at the right end of the Bias Mode field to display a list-box of the available options. Click the "Pulse" designation. Selecting the "Pulse" designation will display a set of definition fields specific to the pulse mode.
2. Specify the Pulse value in the Pulse voltage field. Highlight the present value and specify a new value directly.
3. Hit the TAB key once or use the mouse to advance to the Measure field. Specify the value of the bias signal that will be applied to the device when the capacitance and/or conductance measurements are performed. The Measure voltage is applied to the device after the device is stressed at the Pulse voltage.
4. Hit the TAB key once or use the mouse to advance to the No. Points field. Specify the number of measurements that will be performed while the device is biased at the Measure voltage.
5. Specify the pulse width in the Hold Time field of the Time controls. The pulse width is the length of time that the device will be stressed at the Pulse voltage.
6. Specify the measurement interval in the Step Delay field of the Time controls. The measurement interval is the length of time between each consecutive capacitance and/or conductance measurement performed at the Measure voltage.
7. If desired, select the Measure Time switch to designate time as a measured variable. If the Measure Time switch is selected, the time data corresponding to the pulse bias will be written to the data window spreadsheet.
8. Select the "Integration Type" option in the Int Type field of the Time controls. Click the scroll-arrow at the right end of the Int Type field to display a list-box of the available options. Click on either "Burst" or "Sampling".

Time Controls



The Time controls complement the Sweep controls when the instrument is configured in C·V or C·t Mode.

The function of each Time field relative to the designated bias signal is discussed in the appropriate segment of the *Sweep Controls* section. A summary of each field is presented below.

Measure Time

The Measure Time switch designates the option of returning time as a measured variable. If the Measure Time switch is selected, the time data corresponding to the bias signal will be written to the data window spreadsheet.

The HP4280 firmware does not provide the capability to write time data over the GPIB when the instrument is configured in C·V Mode. If the Measure Time switch is selected in C·V Mode, the time data written to the data window spreadsheet is calculated by ICS. When the instrument is operated in C·t Mode, time data can be written over the GPIB. If the Measure Time switch is selected in C·t Mode, the time data written to the data window spreadsheet is generated by the instrument.

Hold Time

The Hold Time specification designates the sweep signal delay or the pulse width, depending upon the measurement mode of the instrument. When the instrument is operated in C·V Mode, the Hold Time specification designates the sweep signal delay. The sweep signal delay is the length of time the instrument will wait after applying the sweep signal Start and Stop voltages. When the instrument is operated in C·t Mode, the Hold Time specification designates the pulse width. The pulse width is the length of time the device will be stressed at the Pulse voltage.

Step Delay

The Step Delay specification designates the voltage increment of a sweep bias or the measurement interval of a pulse bias. When the instrument is operated in C-V Mode, the Step Delay specification designates the sweep signal voltage increment. When the instrument is operated in C-t Mode, the Step Delay specification designates the measurement interval of the pulse bias. The measurement interval is the length of time between consecutive capacitance and/or conductance measurements performed at the Measure voltage of the pulse signal.

Int Type

The Int. Type control is used to designate the type of Sampling Integration to be used during the time measurement. The Sampling Integration may be set to either Burst or Sampling mode. This control is only available for Pulse and External Pulse time measurements.

The HP4280 Calibration Dialogue Box

The parasitic effects of the test fixture introduce device measurement inaccuracies. To eliminate this problem, the HP4280 includes a set of calibration functions: Calibration, Cable Length Correction, and Zero Open. These functions calculate correction factors that compensate for the LCR characteristics inherent to the test fixture or test leads. The HP4280 also includes a Self Test function that evaluates the basic capability of the instrument.

Self Test

The HP4280 includes a Self Test function that ensures the instrument is functioning properly. The Self Test function consists of nine different tests. If any of the diagnostics fail the appropriate error code will be displayed in the instrument C display. Refer to Chapter 3 of the HP4280 Operation and Service Manual for a description of each test and the corresponding error codes.

The Self Test function is executed from the HP4280 Calibrate dialogue box. Click the Self Test ON button once to initiate the sequence of Self Test diagnostics. The instrument will continue to cycle through the Self Test diagnostics until the Self Test OFF button is clicked.

The Self Test function will clear the instrument's memory of any correction factors generated by the calibration functions. **The instrument must be recalibrated if the Self Test function is executed between measurements and High Resolution measurements are being performed.**

How to Execute the HP4280 Self Test Function:

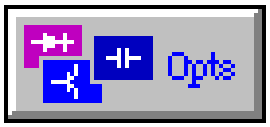
1. Open the Calibrate dialogue box by clicking the OPTIONS button in the Setup Editor.
2. Click the Self Test ON button to initiate the Self Test diagnostics. Any errors will be displayed in the instrument's C display. The instrument will continue to cycle through the Self Test diagnostics until the function is terminated by the user. Terminate the Self Test function by clicking on the Self Test OFF button.
3. Click the CLOSE button to restore control to the Setup Editor.

Calibration

The Calibration function corrects for the residual impedance in series with the device under test. The execution of the Calibration function is only necessary when the "0-5m" Cable Length designation is selected. Turning on the Correction Enable switch enables the Correction functionality of the HP4280.

Zero Open

The Zero Open function cancels errors due to the stray admittance in parallel with the device under test. The Zero Open function should be performed if the Cable Length designated in the HP4280 Configuration dialogue box is set to either 0 or 1 meter. Turning on the Correction Enable switch enables the Correction functionality of the HP4280.



The calibration functions are controlled from the Calibration dialogue box. The Calibration dialogue box can be displayed by clicking the Setup Editor Options button.

In order to optimize the accuracy of the correction factors generated by the Calibration and Zero Open functions, the instrument must be calibrated at the conditions of the device measurement; i.e., connection mode, measurement mode, measurement function, oscillator level, etc. **For this reason, the instrument must be calibrated after the instrument setup configuration is defined in the HP4280 Setup dialogue box.**

If a test setup is executed without first calibrating the instrument, ICS will display the Calibrate dialogue box as a reminder that the instrument is uncalibrated. If you wish to calibrate the instrument, follow the procedure described below. The calibration prompt will no longer be displayed during the current session of ICS after one of the calibration functions is performed. If you do not wish to calibrate the instrument, click the Close button and the instrument will execute the measurement. If desired, select the Suppress switch before closing the Calibrate dialogue box to suppress any future appearance of the calibration prompt (see *Suppressing the Calibration Prompt* later in this chapter). This feature provides for the use of an uncalibrated instrument without the need to acknowledge the calibration prompt every time a measurement is executed.

How to Execute the HP4280 Calibration Functions:

1. Before calibrating the instrument, specify the setup configuration of the instrument in the HP4280 Setup dialogue box.
2. Open the Calibrate dialogue box by clicking the Setup Editor Options button. The dialogue box will be displayed automatically if the instrument was actuated without being calibrated.
3. If the "0-5m" Cable Length designation is selected in the HP4280 Configuration dialogue box, perform the Calibration function. Make sure the ends of the test leads are shorted together. Click the Calibrate button. The Calibrate dialogue box will remain displayed while the calibration function is performed. If the Correction Enable switch is turned ON then the HP4280 Correction function will be enabled on the instrument after completion of the Calibration function.
4. The Zero Open function should be performed only if "0m" or "1m" Cable Length is designated in the HP4280 Configuration dialogue box. Make certain that there is no device inserted in the test fixture. Click the Zero Open button. The Calibrate dialogue box will remain displayed while the Zero Open function is performed. If the Correction Enable switch is turned ON then the HP4280 Correction function will be enabled on the instrument after completion of the Zero Open function.
5. The instrument is successfully calibrated. Click the Close button to restore control to the Setup Editor. If you calibrated the instrument after initiating the measurement, the instrument will automatically continue with the measurement after the Close button is selected.

Suppressing the Calibration Prompt

If the user initiates a measurement from the Measure Remote control without first calibrating the instrument, ICS will display the Calibrate dialogue box as a reminder to the user that the instrument is uncalibrated. If you wish to continue testing without calibrating the instrument, select the Suppress switch in the Calibrate dialogue box. This feature will suppress any future calibration prompt.

When the Suppress switch is selected, the suppression of the calibration prompt is applied to every test setup in the project file. However, the suppression option will not be preserved if ICS is closed or the HP4280 driver is unloaded.