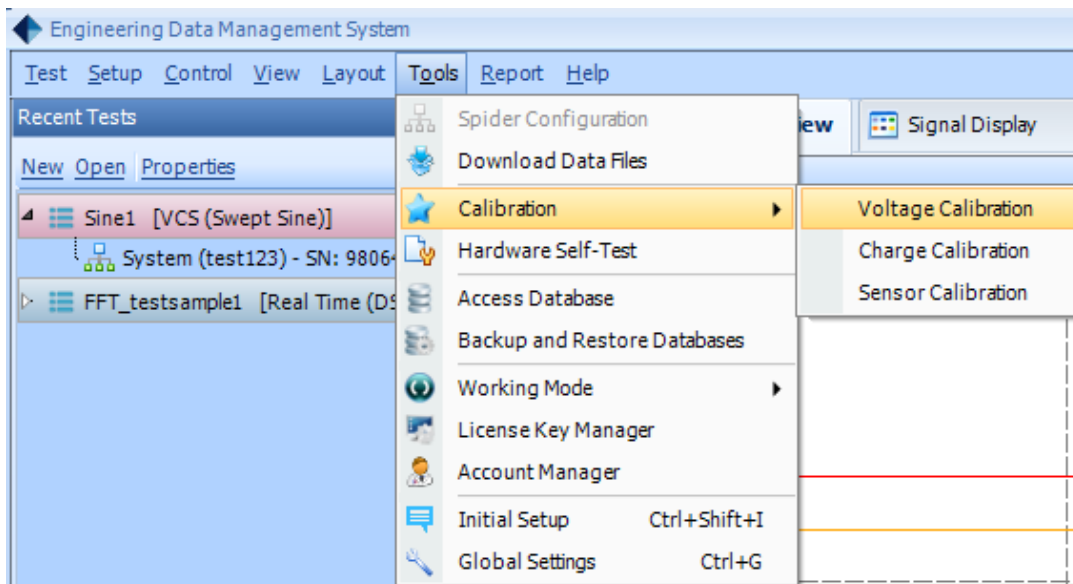


## Spider Calibration

The Spider hardware requires periodic calibration of the input and output channels. The voltage input modes (AC, DC, and IEPE) are calibrated separately from the charge input modes (for Spiders equipped with a charge amplifier). Both should be calibrated at least once per year. The EDM desktop software provides Calibration Wizards that help automate these processes. The process is the same for all Spider hardware, including the Spider-80, Spider-81, and Spider-81B.

There is also a Sensor Calibration feature that can determine the sensitivity of external sensors connected to the Spider and exposed to a known excitation. External sensors should be calibrated per the manufacturer's suggestions.

All three types of calibration are accessed under the Tools menu in EDM Spider Working Mode: **Voltage Calibration** for voltage modes, **Charge Calibration** for charge modes, and **Sensor Calibration** for the sensors. The Spider must be powered on and connected to EDM for these to be available.



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## Input / Output Channel Calibration

The voltage input modes (AC, DC, and IEPE) have *offset* and *gain* adjustments. The offset adjustment changes the zero level and the gain adjustment sets the multiplication factor. The calibration process detects errors in both adjustments and corrects them. One adjustment affects the other, so they must be set for each input range (0.2 V and 20 V).

The signal source used for calibration is the Spider's own signal generator. Before it can be used to calibrate the input channels, it must be calibrated itself. This is done by measuring the output with an accurate multimeter. The accuracy of this meter determines the accuracy of the calibration; in general, the meter should be four times as accurate as the target accuracy of the unit being calibrated. So to calibrate the Spider to  $\pm 1\%$  accuracy, the meter should have an accuracy of  $\pm 0.25\%$ .

The calibration process consists of four major steps:

1. Calibrate the output channel(s)
2. Calibrate the input channels
3. Validate the calibration results
4. Generate a calibration report

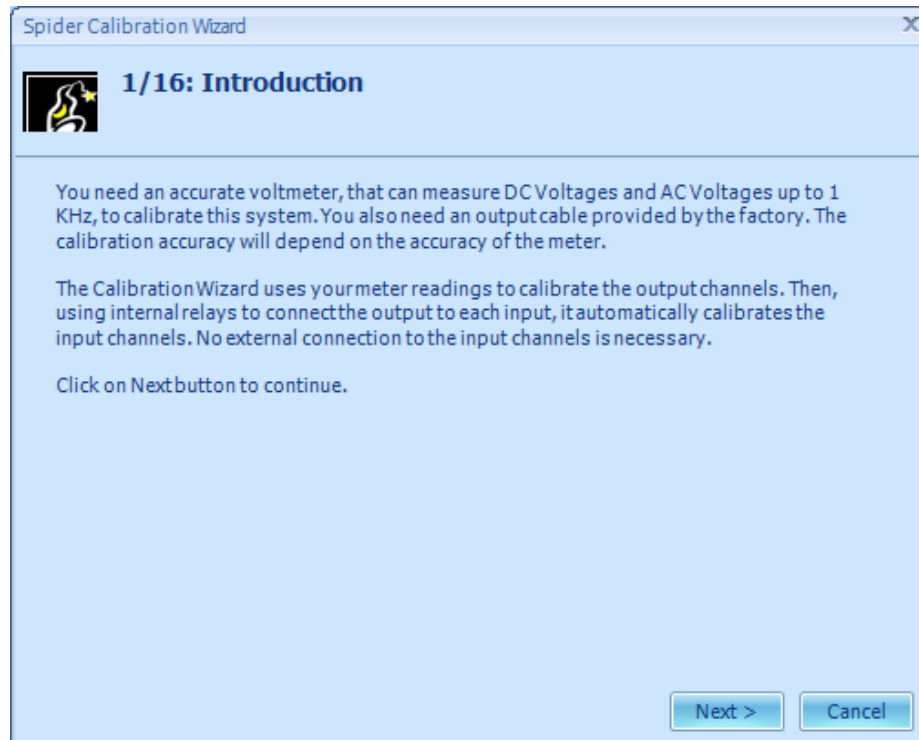
After the output channel is calibrated against the multimeter, it is used to generate a Sine tone to calibrate the input channels. The signal is automatically routed through internal relays, so the user does not need to make any external connections.

The *Spider Calibration Wizard* will guide the user through all the necessary steps of the whole process, which involves measuring output signals from the Spider in both AC and DC modes in various ranges. This determines the gain and offset errors in each range. Once the output error has been determined, the internal relays will connect the output to each input channel and measure gain and offset errors of the inputs. The adjustments will be set to make these errors zero. Lastly, there is a verification step that checks to ensure the calibration was made to acceptable tolerances.

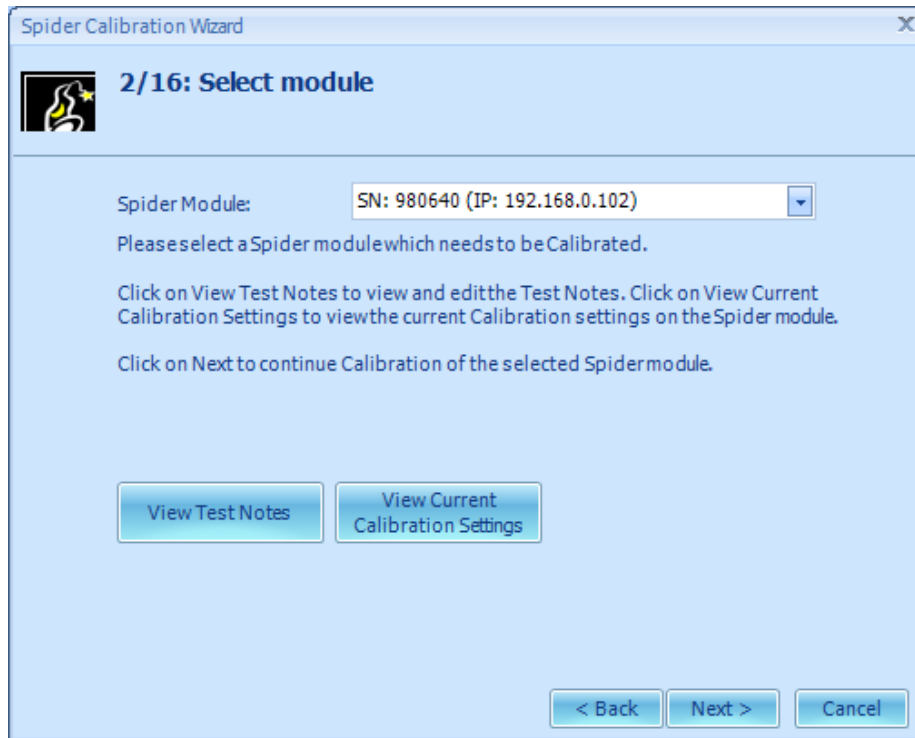
The multimeter used for the calibration process should be an accurate, NIST-traceable or equivalent meter capable of measuring both DC and AC RMS voltage with 5 significant figures up to 10 V. Connect the output 1 of the Spider to the meter input with a BNC cable.



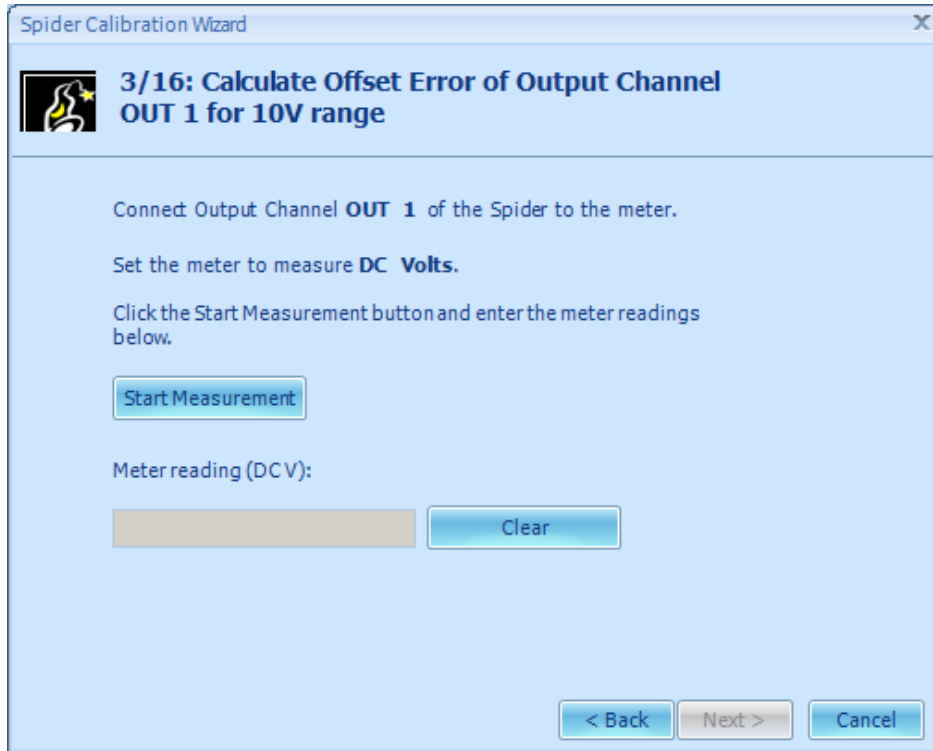
To begin the calibration wizard, select **Input/Output Calibration** from the EDM Tools menu and follow the on-screen instructions. Go through the 16 steps by clicking the **Next** button on the windows.



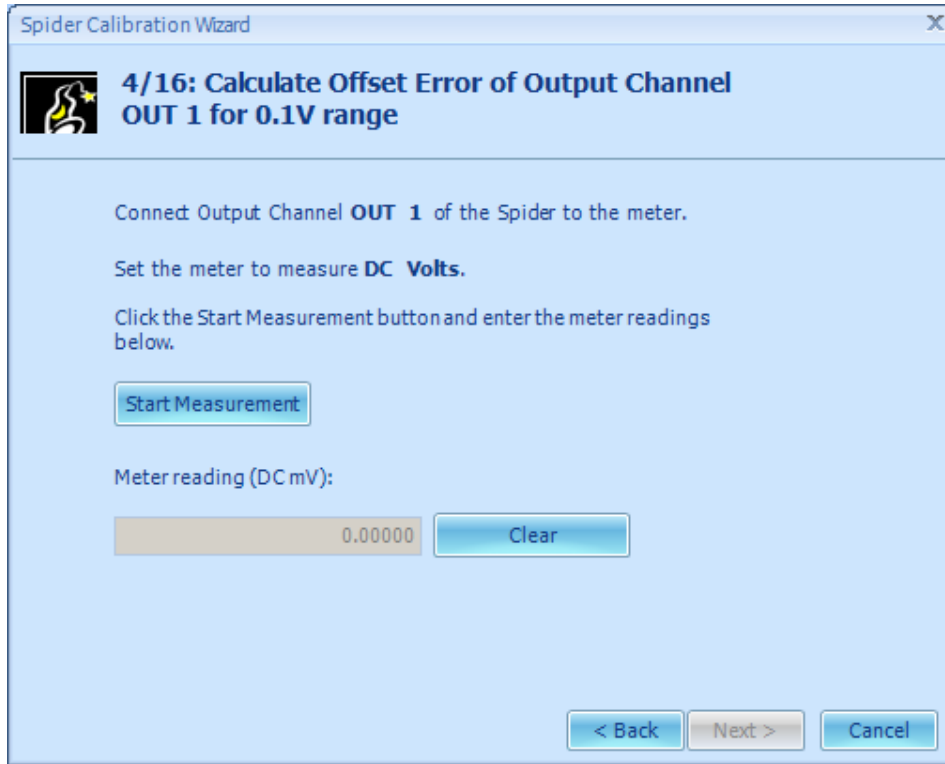
In step 2, select a Spider module in the currently connected system to calibrate. You can also enter test notes and view results from the previous calibration.




Step 3 is the first of 4 output measurements. Make sure OUT 1 from the Spider is connected to the multimeter, and that the meter is set to DC volts mode, 10 V range. When ready, press Start Measurement, and enter the meter reading in the text box. The reading should be between +0.5 V and -0.5 V; if it is outside this range the software cannot calibrate it and you must contact Crystal Instruments support.



Step 4 measures the 0.1 V DC output. Set the meter to the 0.1 V DC range and measure the output just like step 3.



Spider Calibration Wizard

 **4/16: Calculate Offset Error of Output Channel OUT 1 for 0.1V range**

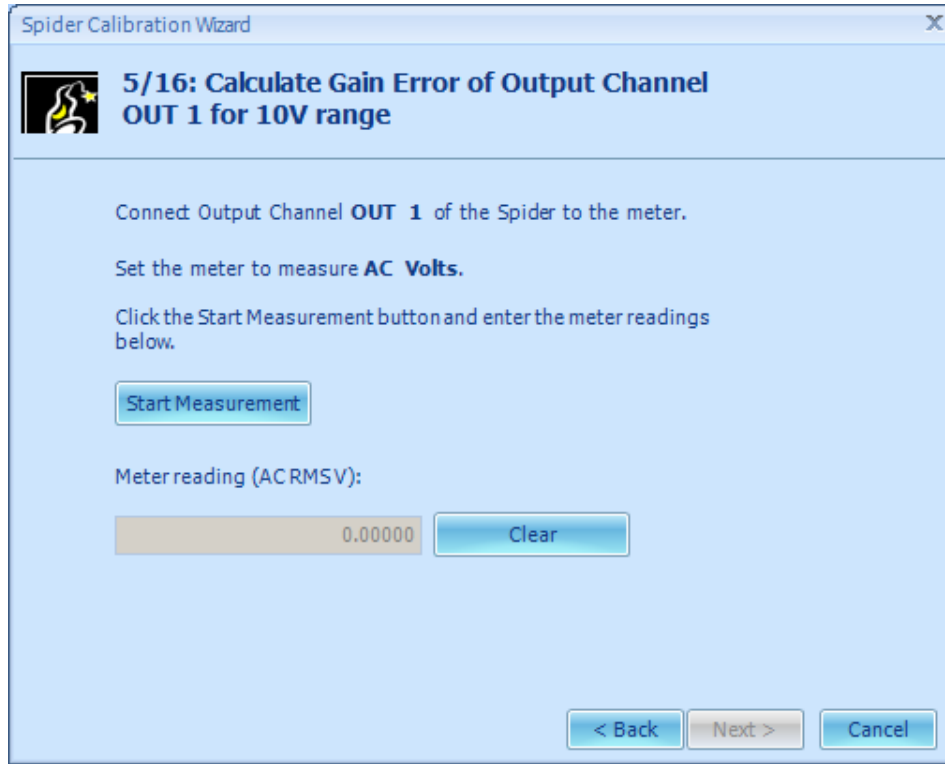
Connect Output Channel **OUT 1** of the Spider to the meter.

Set the meter to measure **DC Volts**.

Click the Start Measurement button and enter the meter readings below.

Meter reading (DC mV):

Step 5 measures the AC output at 10 V range. For this step, make sure the meter is in AC RMS mode.



Spider Calibration Wizard

**5/16: Calculate Gain Error of Output Channel OUT 1 for 10V range**

Connect Output Channel **OUT 1** of the Spider to the meter.

Set the meter to measure **AC Volts**.

Click the Start Measurement button and enter the meter readings below.

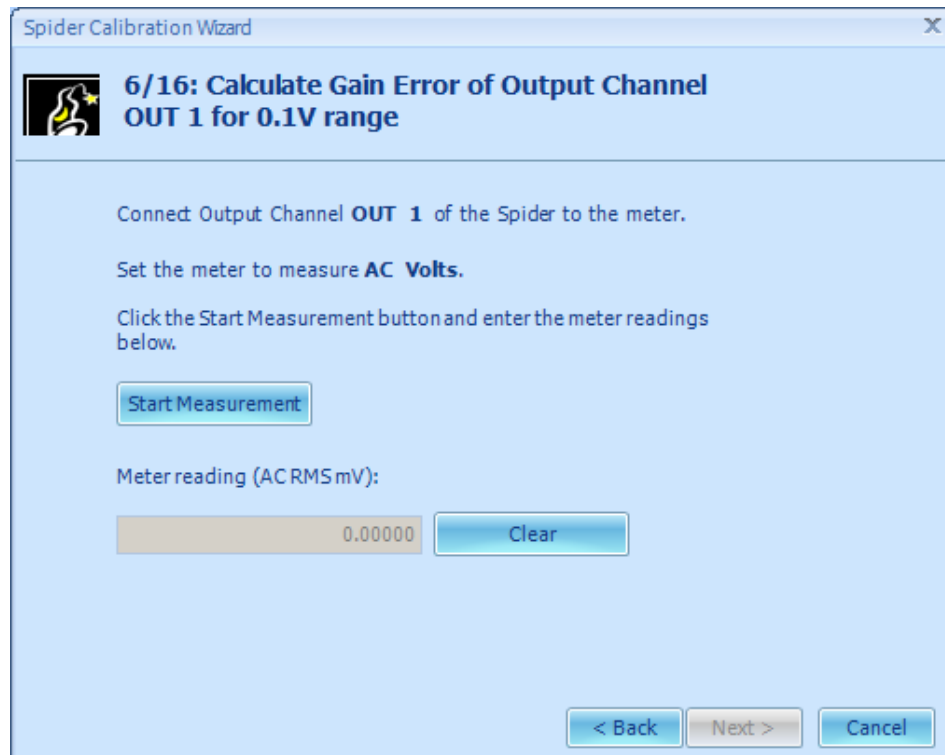
Start Measurement

Meter reading (ACRMSV):

0.00000 Clear

< Back Next > Cancel

Step 6 measures the 0.1 V AC range.



Spider Calibration Wizard

**6/16: Calculate Gain Error of Output Channel OUT 1 for 0.1V range**

Connect Output Channel **OUT 1** of the Spider to the meter.

Set the meter to measure **AC Volts**.

Click the Start Measurement button and enter the meter readings below.

Start Measurement


Meter reading (ACRMS mV):

0.00000 Clear

< Back Next > Cancel

Steps 7 through 10 repeat steps 3 through 6 for the second output. Be sure to connect the meter to OUT 2 on the Spider.

X
Spider Calibration Wizard



### 7/16: Calculate Offset Error of Output Channel OUT 2 for 10V range


Connect Output Channel **OUT 2** of the Spider to the meter.

Set the meter to measure **DC Volts**.

Click the Start Measurement button and enter the meter readings below.

Meter reading (DCV):

X
Spider Calibration Wizard



### 8/16: Calculate Offset Error of Output Channel OUT 2 for 0.1V range

Connect Output Channel **OUT 2** of the Spider to the meter.


Set the meter to measure **DC Volts**.

Click the Start Measurement button and enter the meter readings below.

Meter reading (DCmV):



Spider Calibration Wizard

 **9/16: Calculate Gain Error of Output Channel OUT 2 for 10V range**


Connect Output Channel **OUT 2** of the Spider to the meter.

Set the meter to measure **AC Volts**.

Click the Start Measurement button and enter the meter readings below.

Meter reading (ACRMSV):

Spider Calibration Wizard

 **10/16: Calculate Gain Error of Output Channel OUT 2 for 0.1V range**

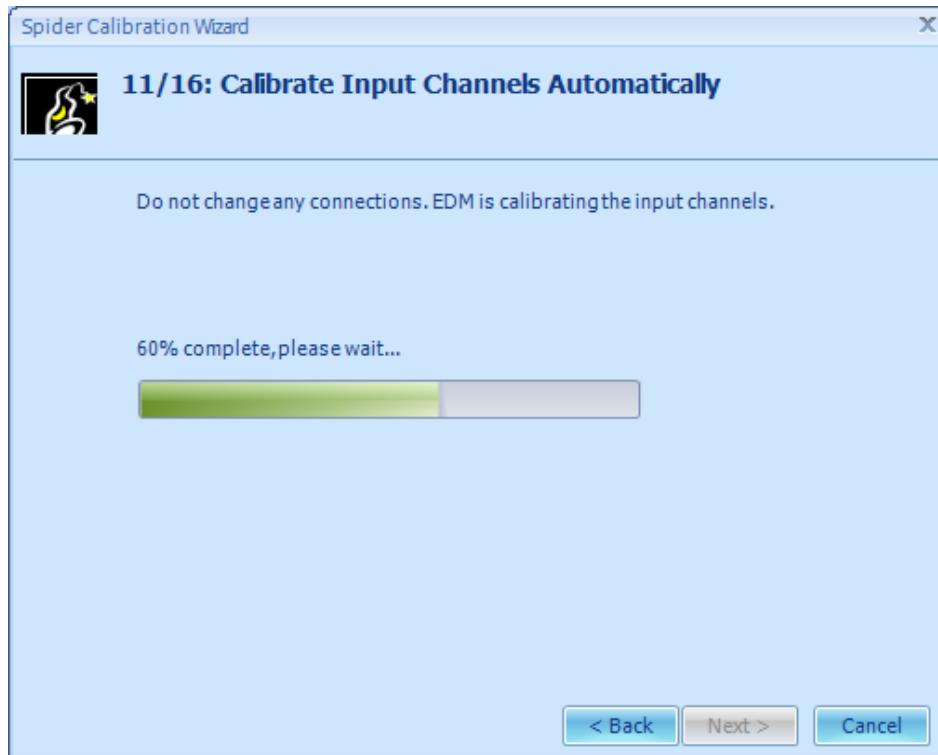
Connect Output Channel **OUT 2** of the Spider to the meter.

Set the meter to measure **AC Volts**.

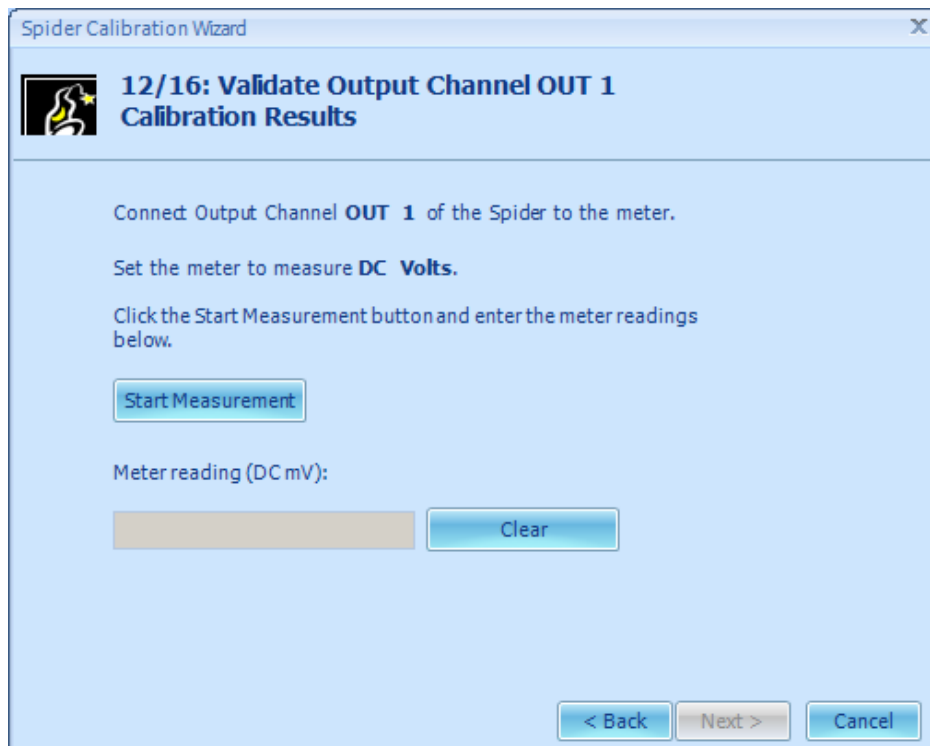
Click the Start Measurement button and enter the meter readings below.

Meter reading (ACRMS mV):

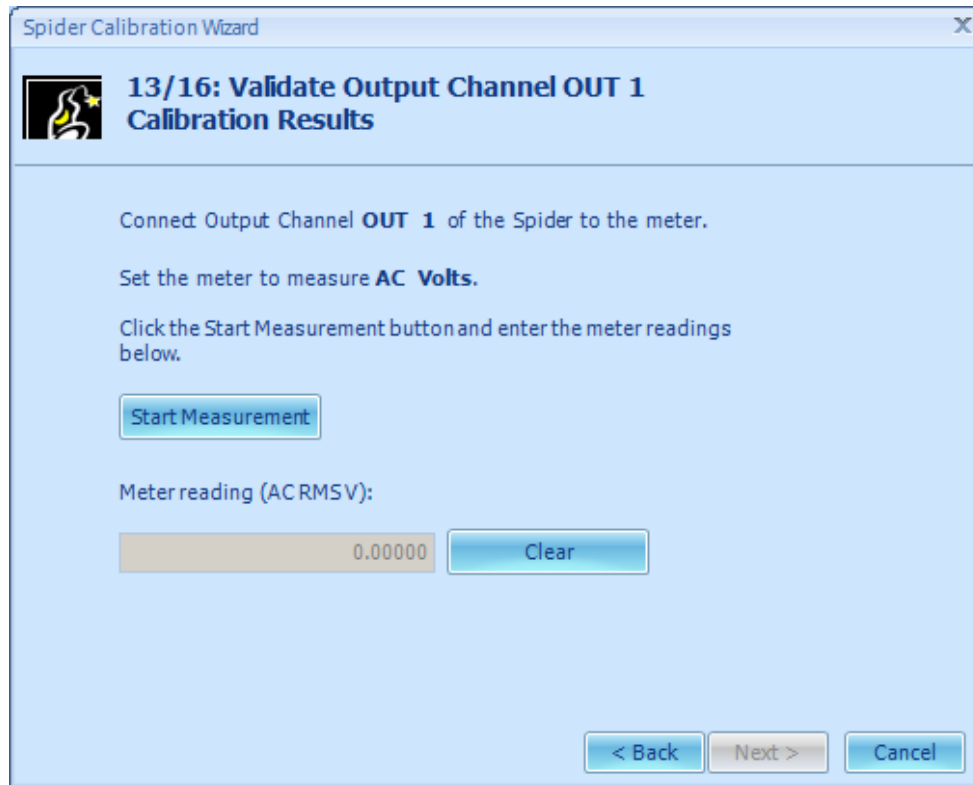
At step 11, the software will use the previously entered readings to make the offset and gain adjustments to all the channels.



Step 12 begins the validation measurements. Connect the meter back to OUT 1, and put it in DC V mode. Click Start Measurement when ready and enter the reading in the text box.



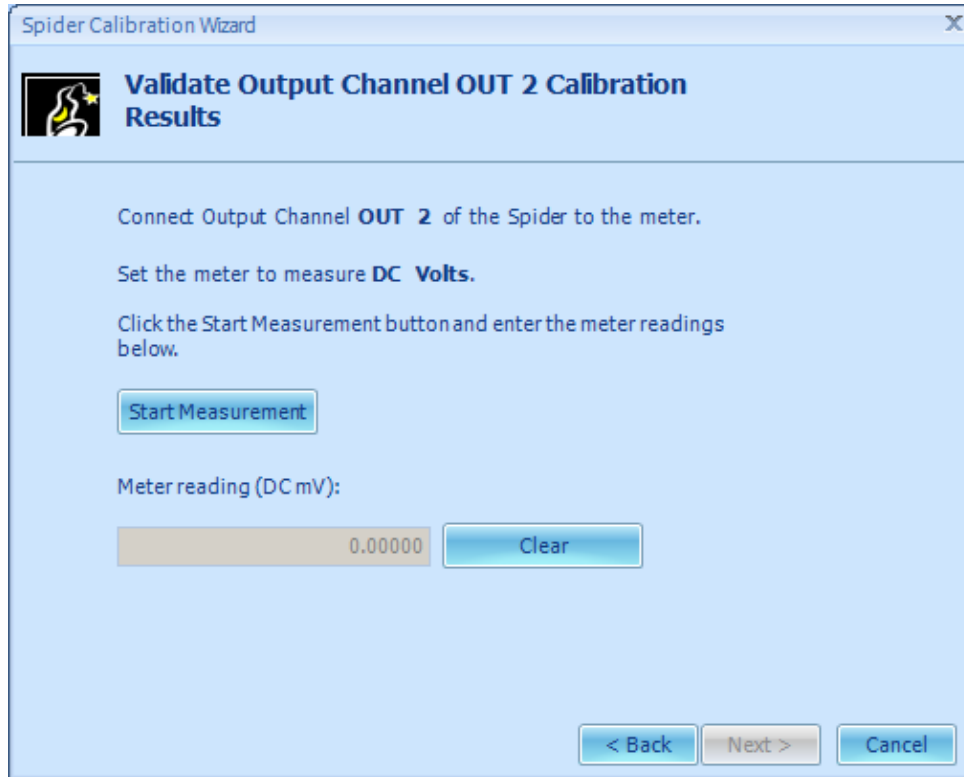
Step 13 measures the AC output. Switch the meter to AC V mode and take a measurement.




The screenshot shows a software window titled "Spider Calibration Wizard" with a close button (X) in the top right corner. The window has a light blue background and contains the following elements:

- Header:** A small icon of a spider and the text "13/16: Validate Output Channel OUT 1 Calibration Results".
- Instructions:**
  - Connect Output Channel **OUT 1** of the Spider to the meter.
  - Set the meter to measure **AC Volts**.
  - Click the Start Measurement button and enter the meter readings below.
- Buttons:** A "Start Measurement" button.
- Meter Reading:** The label "Meter reading (AC RMSV):" is positioned above a text input field containing the value "0.00000". To the right of the input field is a "Clear" button.
- Navigation:** At the bottom right, there are three buttons: "< Back", "Next >", and "Cancel".

For step 14 and 15, connect the meter to OUT 2 on the Spider and repeat the previous two measurements.



Spider Calibration Wizard

 **Validate Output Channel OUT 2 Calibration Results**

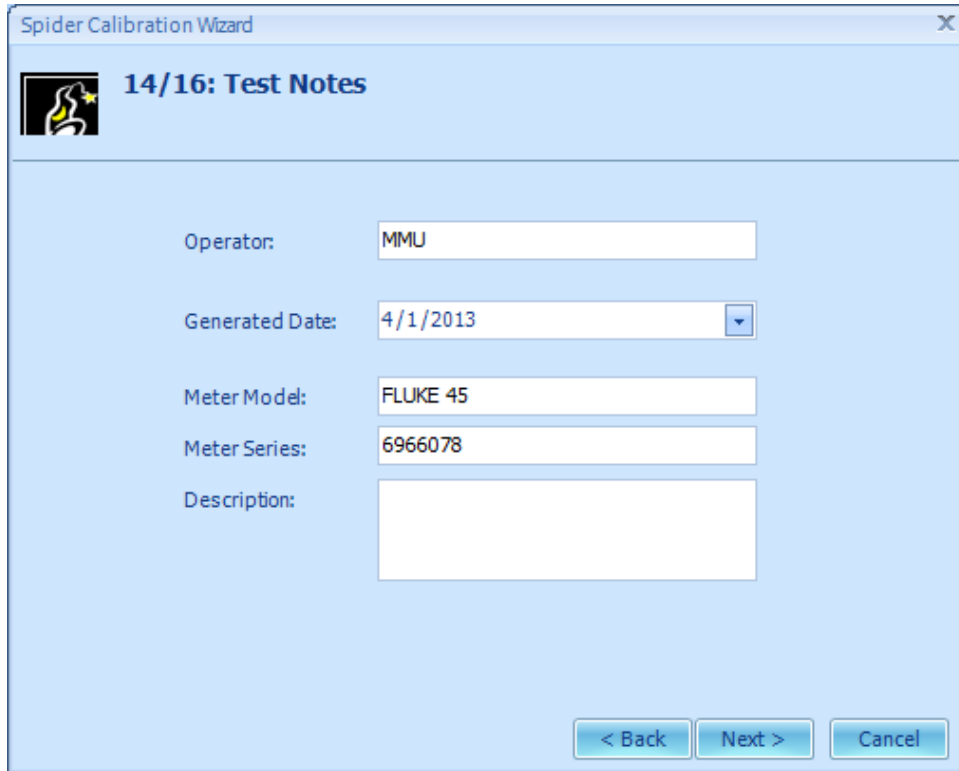
Connect Output Channel **OUT 2** of the Spider to the meter.

Set the meter to measure **DC Volts**.

Click the Start Measurement button and enter the meter readings below.

Meter reading (DC mV):

At this point, the calibration process is complete. On step 14, enter the operator name, the model and serial number of the multimeter that was used, and optionally enter a description. This information will be stored with the calibration results.



Spider Calibration Wizard

**14/16: Test Notes**

Operator:

Generated Date:

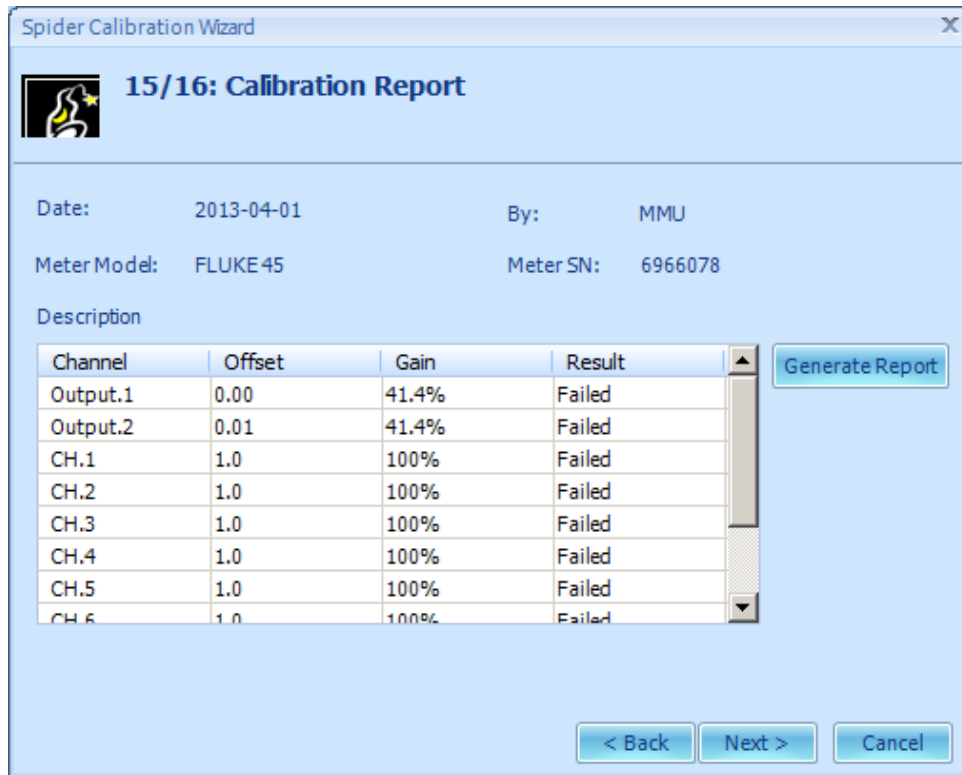
Meter Model:

Meter Series:

Description:

< Back   Next >   Cancel

Step 15 summarizes the results in a table. Click **Generate Report** to create an MS Word calibration report.



**15/16: Calibration Report**

Date: 2013-04-01 By: MMU  
 Meter Model: FLUKE 45 Meter SN: 6966078

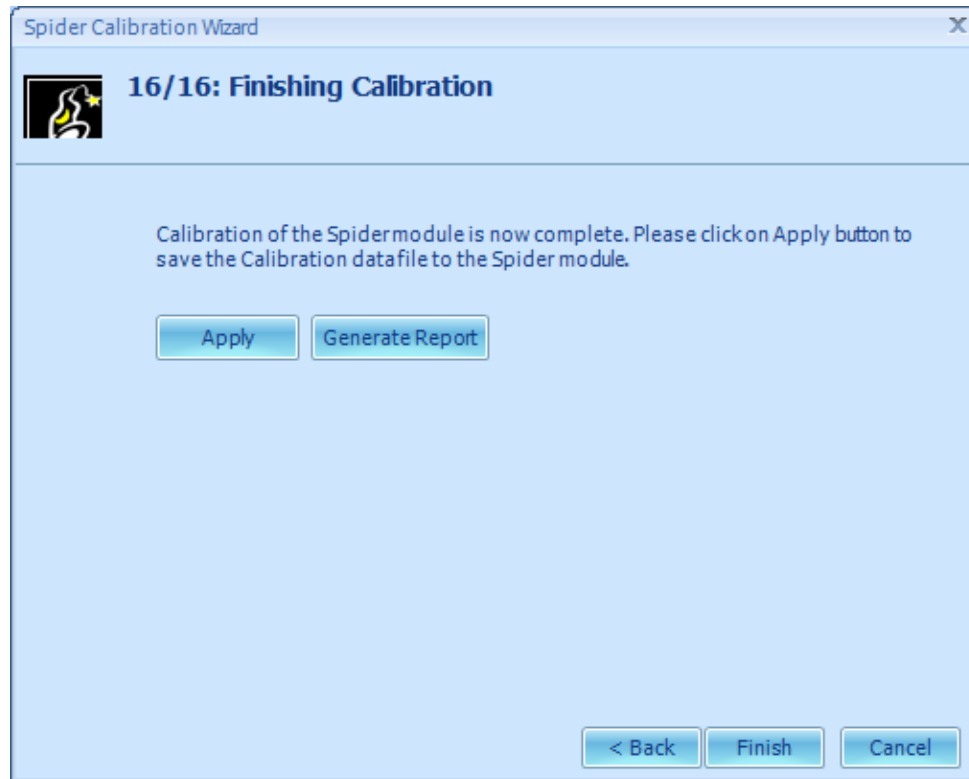
Description

Channel	Offset	Gain	Result
Output.1	0.00	41.4%	Failed
Output.2	0.01	41.4%	Failed
CH.1	1.0	100%	Failed
CH.2	1.0	100%	Failed
CH.3	1.0	100%	Failed
CH.4	1.0	100%	Failed
CH.5	1.0	100%	Failed
CH.6	1.0	100%	Failed

Generate Report

< Back   Next >   Cancel

In the final step, click Apply to apply the calibration adjustments to the output and input channels on the Spider.



## Charge Calibration

The Spider-81 has built-in charge amplifiers that can be used with charge-mode sensors. These sensors output an electrical charge instead of a voltage, which is read in Coulombs. There are two charge-mode ranges: 10,000 picoCoulomb (pC) and 49,000 pC. The sensitivity of the charge amplifier must be periodically adjusted to maintain accuracy.

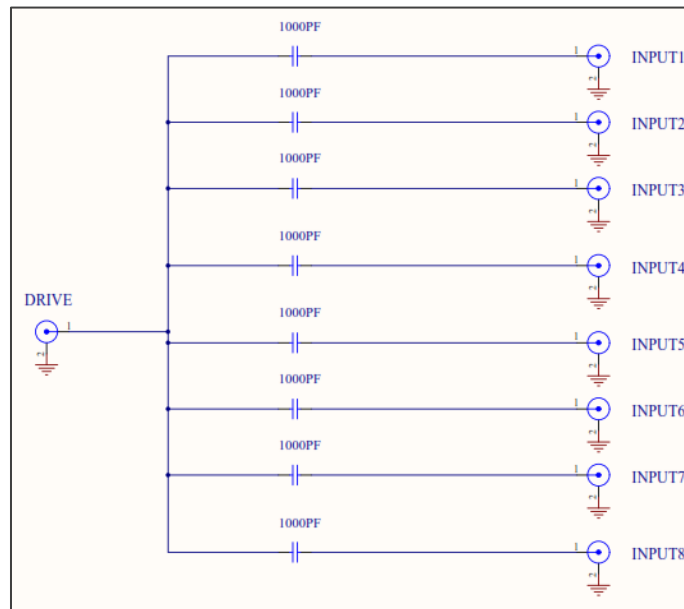
To calibrate the charge amplifiers, a reference source of a precisely known charge amount is needed. This reference charge can be generated by putting a voltage potential across a capacitor. A potential  $V$ , in Volts, across a capacitance of  $C$ , in Farads, will give a charge  $Q$ , in Coulombs, given by

$$Q = CV$$

The accuracy of the calibration is determined by both the accuracy of the voltage source and the tolerance of the capacitance value.

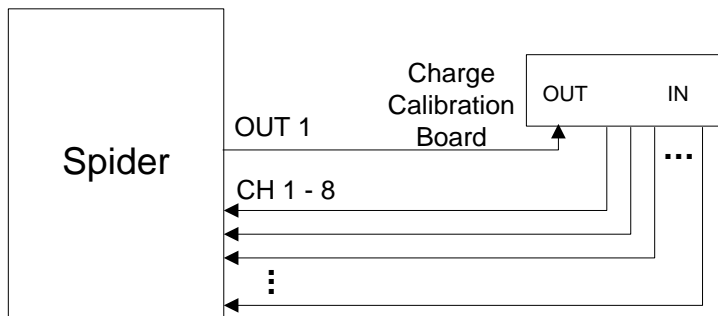
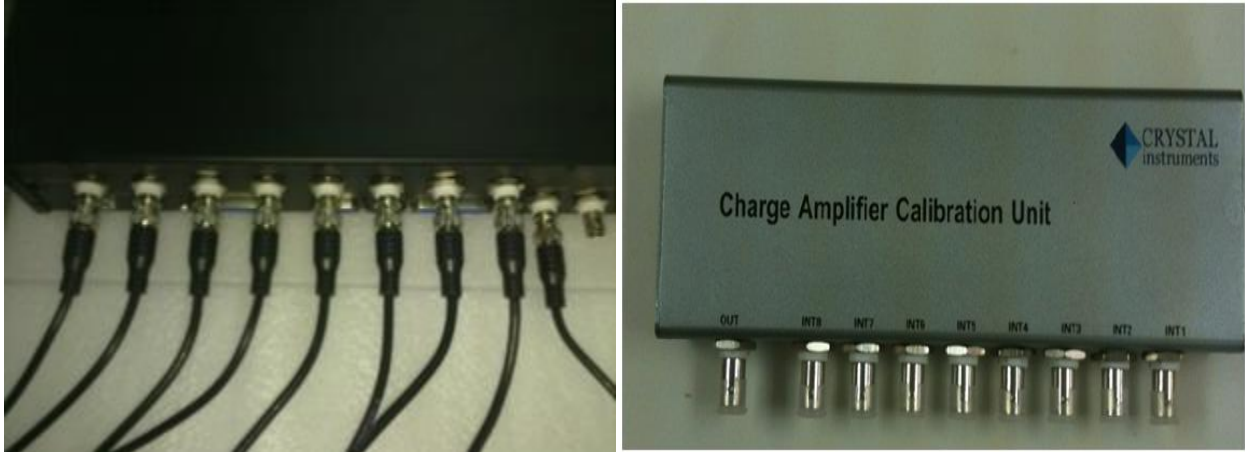
The Spider output is used as the voltage source, so before the charge calibration the Spider should be well calibrated in the voltage mode (see above). 1000 pF capacitors must be connected between the Spider output and all the inputs. The Spider will then output a calibration voltage and read the charge on the inputs. The difference between the measured charge and the known actual charge is the charge sensitivity error, and this value is stored as an offset for each channel.

A calibration board with the required capacitors, pictured below, is available from Crystal Instruments. You can also make your own calibration circuit with the wiring diagram shown here.





To begin the charge calibration process, you will need this calibration board and 9 BNC cables. First, connect the Spider to EDM and power it on. Then, connect the output and all inputs to the calibration board with the cables, as shown in the pictures below.



When everything is connected, select Tools -> Charge Calibration in EDM. The two charge ranges, 10,000 pC and 49,000 pC, must be calibrated separately. To choose the range to calibrate, select it under Calibrate Mode and then press **Set Charge Mode**. Then, run the calibration process by clicking **Start Charge**. The whole process is automatic and will complete within a couple seconds.

Charge Calibration

**Calibration**

Select a module: SN: 980640 (IP: 192.168.0.102)

Charge Amplifier Calibration Unit Serial Number:

Calibrate Mode

10,000PC  49,000PC


Channel ID	Offset	Gain	Result

Start Charge

Create Report

<Back Finish Cancel

The results will be shown in the table. For each channel, if the gain error is within the acceptable range the result will show as “Pass”. Press **Finish** to complete the calibration and accept the changes.



## Calibration

Select a module: SN: 980640 (IP: 192.168.0.102)

Charge Amplifier Calibration Unit Serial Number:

Calibrate Mode

10,000PC
 49,000PC

Channel ID	Offset	Gain	Result
Channel 1	0.09674	0.57197	Pass
Channel 2	0.00013	7.05069	Failed
Channel 3	0.00023	7.03884	Failed
Channel 4	-0.00015	6.98880	Failed
Channel 5	-0.00002	6.88289	Failed
Channel 6	-0.00074	7.02062	Failed
Channel 7	-0.00034	6.95407	Failed
Channel 8	-0.00014	6.88130	Failed

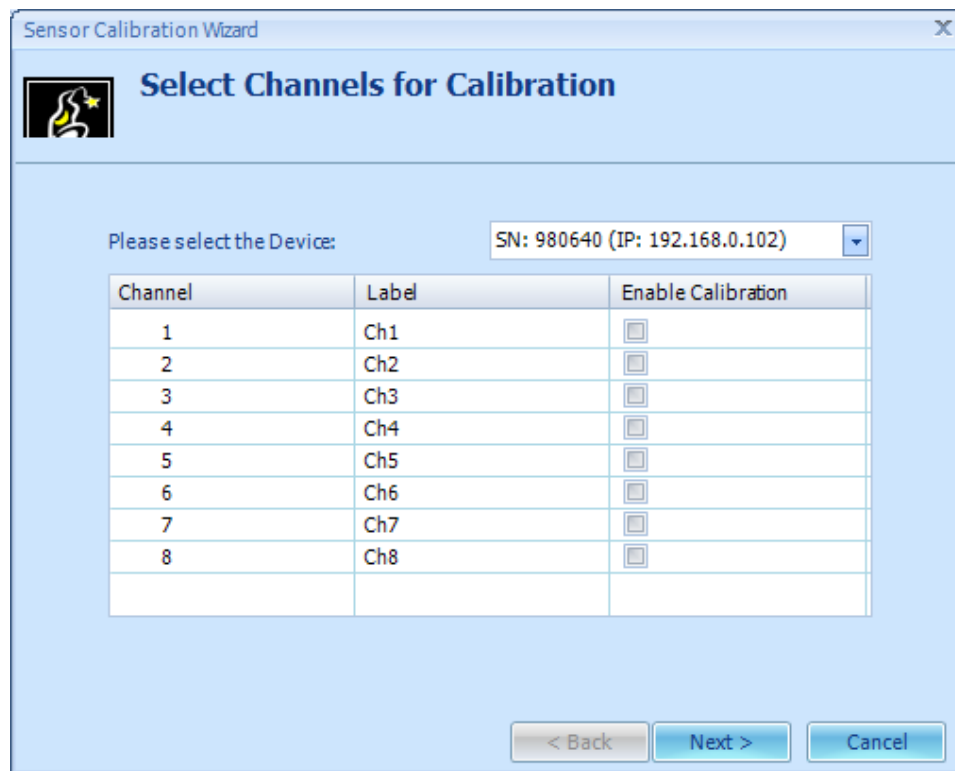
Start Charge  
Create Report

<Back
Finish
Cancel

## Sensor Calibration

The Sensor Calibration function can determine the sensitivity of a sensor exposed to a known excitation. This excitation can be a shaker with a precisely known output acceleration level for accelerometers or a speaker with a known output SPL for microphones. The accuracy of this calibration is determined by how accurately the sensor excitation is known.

To start the Sensor Calibration Wizard, select **Sensor Calibration** from the EDM Tools menu. In the first window, select the channel or channels that will be used to calibrate sensors. More than one can be calibrated at a time.



It is assumed that the excitation signal will be a sine wave. The frequency of this signal is set in the second window. The excitation amplitude, entered in the third window, can be given in a magnitude or decibel value. The choice between the two types of values is set in this window, along with the reference value for dB readings.

The screenshot shows a software window titled "Sensor Calibration Wizard" with a close button (X) in the top right corner. The main title of the dialog is "Define Excitation Signal used as Reference". Below the title is a small icon of a spider. The main text area contains the following instructions: "Reference Value(dB) and Reference Value(linear) are linked to each other. The user only needs to input one of them. Please make sure all parameters are correct. Click Next to start transducer calibration." Below this text are five input fields: "Calibration Signal Type" (a dropdown menu showing "sine wave"), "Calibration Signal Frequency(Hz)" (a numeric spinner box showing "250.00"), "Use RMS or dBrms reading" (two radio buttons, with "RMS" selected), "Reference value(linear)" (a numeric spinner box showing "1.00000"), and "Reference value(dB)" (a numeric spinner box showing "0.00"). At the bottom of the dialog are three buttons: "< Back", "Next >", and "Cancel".

The signal reading, which is the RMS or dB amplitude of the sensor excitation, is entered here.


The screenshot shows a window titled "Sensor Calibration Wizard" with a close button (X) in the top right corner. On the left is a small icon of a spider. The main title is "Enter the RMS level of Calibration Signal". Below the title is a text box containing the instruction: "Please enter the expected accurate value. It is either an RMS level measured by a standard transducer or the reference signal generated from pistonphone." Below this is a label "Calibration Signal RMS Level(m/s<sup>2</sup>)" followed by a text input field containing the value "0.70700" and a small spinner control. At the bottom right are three buttons: "< Back", "Next >", and "Cancel".

Now, the sensor is ready for calibration. Activate the excitation and press **Start Calibration**. After a few moments, the correct sensitivity will be calculated.

The screenshot shows a window titled "Sensor Calibration Wizard" with a close button (X) in the top right corner. On the left is a small icon of a spider. The main title is "Channel Calibration". Below the title are three labels with corresponding text input fields: "Channel ID" with the value "Ch1", "Old Sensitivity", and "New Sensitivity". Below these fields is a "Start Calibration" button. At the bottom right are three buttons: "< Back", "Next >", and "Cancel".

The final window gives a table that summarizes the results.

Sensor Calibration Wizard

 **Calibration Report**

Calibrated on: 4/1/2013

Channel ID	Old Sensitivity	New Sensitivity
Ch1	10.19716mV/(m/s <sup>2</sup> )	10.19716mV/(m/s <sup>2</sup> )
Ch2	10.19716mV/(m/s <sup>2</sup> )	0.01193858mV/(m/s <sup>2</sup> )
Ch3		
Ch4		
Ch5		
Ch6		
Ch7		
Ch8		

< Back   Finish   Cancel