**Reading Solar Power with NI myDAQ \_\_\_\_**

Complete this lesson to read the amount of solar energy gathered by a solar panel and to begin exploring solar engineering.

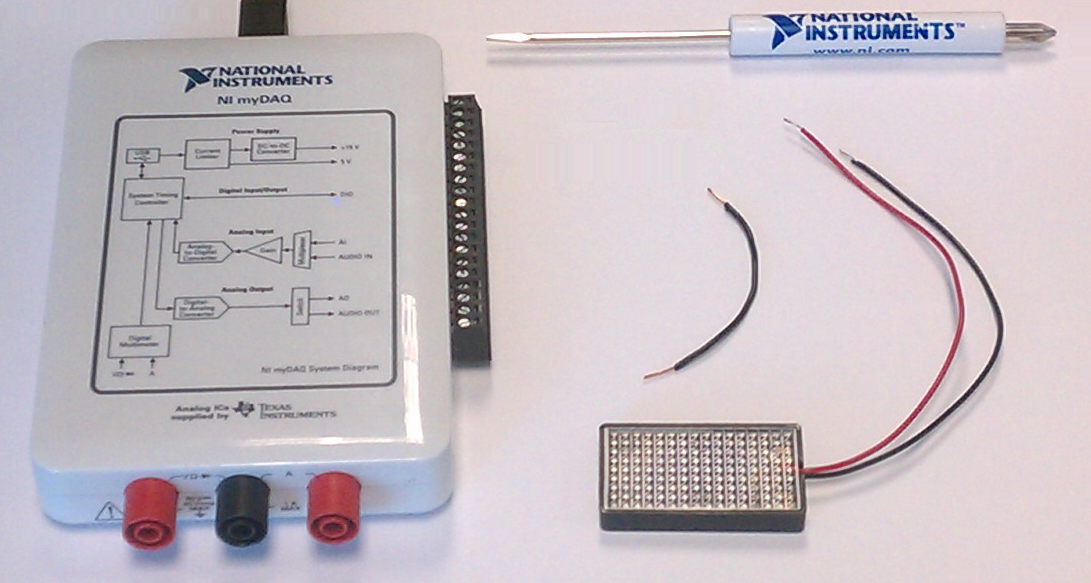
**Learning Objectives**

As students complete this lesson, they’ll have the opportunity to meet the following STEM learning objectives:

* **Engineering or Robotics**—Students understand different types of sensors used in engineering and robotics.
* **Computer Science**—Students use system input, output, processing, and interfaces. Students apply language-specific programming techniques.
* **Career and Technology**—Students use tools and precision measuring instruments to develop prototypes. Students develop a fundamental understanding of the science behind solar cells and take the same measurements technicians would take in the field.
* **Critical Thinking**— Students collect and analyze data to identify solutions and/or make informed decisions.

**Materials**

* LabVIEW for Education software
* NI myDAQ hardware and software
* LabVIEW Virtual Instrument (VI) 2\_Reading Solar Power with NI myDAQ.vi
* National Instruments screw driver (included with myDAQ)
* .5 v 100mA Solar Cell (solar cells may look different than the one shown)
* Wire



**What’s a Solar Panel and How Does It Work?**

Solar panels (also called solar cells) are electrical devices that capture energy from sunlight and convert it directly into electricity. Solar panels are also called photo-voltaic devices because they convert light photons from the sun into a voltage that is used to generate power. That electricity can then be used to power things such as lights, cars, and even everything electrical inside a house or building. You can even find solar panels that charge mobile phones and portable mp3 players.

When you put several solar panels together, you create a module. Notice that each module in this picture is made up of 5 solar panels. The more solar panels and the more modules you have, the more solar energy you can gather.

How much solar energy (power) do you think the panels in this picture gather each day? What could you do with all that electricity?

In this lesson, you will use myDAQ and a solar cell to experiment with gathering solar energy and think about what might affect how much energy you can gather.

**Hardware Setup**

To get started you first need to design and set up your hardware system. Make sure you have already installed LabVIEW for

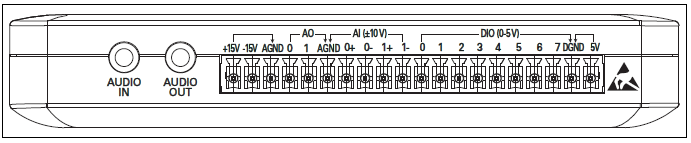
Education and configured the myDAQ according to the instructions it came with. Then proceed to designing your system.

**Design the System**

You know that 1) the myDAQ has to connect to the computer, and 2) the solar panel has to connect to the myDAQ.

Do you know which myDAQ terminals the positive and negative wires of the solar panel go to? Think about these facts:

1. You want to gather information (input) from the solar panel.
2. You want to know the value of the solar panel (analog), not just whether the solar panel is on or off (digital).
3. The red wire is positive, and the black wire is negative.



AI – Analog Input

AO – Analog Output

DIO – Digital Input or Output

With all of the above information, draw what you think your hardware system might look like. It’s okay if it’s not exact. This is your best educated guess.

**Your System Design Draft**

**System Design Explanation**

This system includes a solar cell that produces a voltage that is proportional to the amount of light that hits the cell surface. To measure this voltage, you have to connect both the negative and positive wires of the solar cell to the myDAQ device. The analog input channels on the myDAQ device have a negative input and a positive input. You connect the red positive wire to the AI 1+ (analog input channel 1, positive) and the negative wire to the AI 1- (analog input channel 1, negative) terminal. Finally, to provide a ground for the solar cell, you connect the AI 1- terminal to the AGND terminal. This completes the measurement system.

Your system should look similar to the image in step 3 below.

**Build the System**

Follow these steps to build your solar energy system. Again, make sure you have already installed LabVIEW for Education and configured the myDAQ according to the instructions.

1. If you haven’t already done so, connect the screw terminal to the myDAQ. For new devices it may require a firm press, so make sure the terminal block is in all the way.

To ensure the wire terminals are all open, gently turn each screw counterclockwise until it stops.

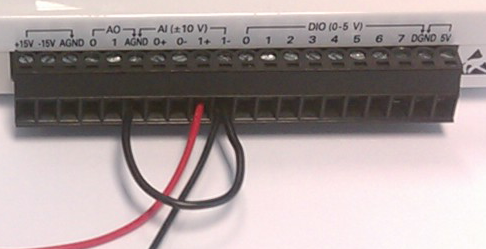
1. Place the positive wire (red) of the solar panel into the AI (analog input) 1+ terminal and the negative wire (black) into the AI (analog input) 1- terminal. Use the NI screwdriver to tighten the screw terminal just enough to hold the wires in place.

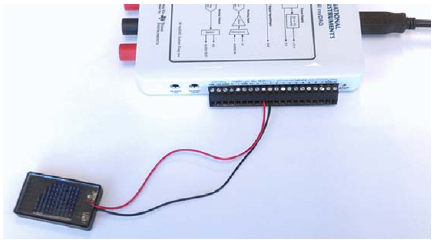
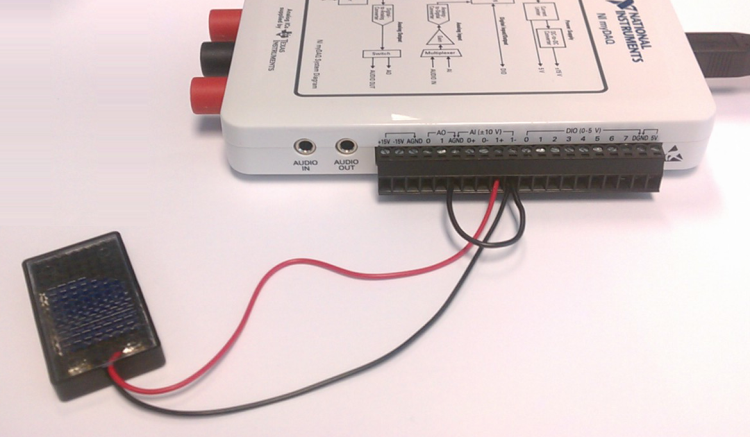
You use the analog terminals because you want to gather data (input) from a sensor that gives you many different values. (This is different from digital data, which is either yes or no, as in on or off. In this case, we don’t want to know if that solar panel is on or off. We want to read the solar energy voltage.)

1. To ground the negative wire of the solar panel, connect the wire provided in the kit from the AI 1- terminal to the AGND terminal.
2. Connect the myDAQ to the computer using the USB cord provided with the myDAQ.
3. Now that you know the correct hardware setup, go back and draw a detailed system design underneath the draft you already drew, and label each component of your system.

You’re ready to read solar energy data!







**Solar Panel Voltage Programming Code**

You now have a solar panel that gathers solar energy, and you have connected that panel to the myDAQ, which can read the voltage of the solar energy. The next step is to use a computer program to view that data. The computer program we will use is a LabVIEW virtual instrument (VI) called Reading Solar Power.

Open the Reading Solar Power.vi file to see the program. After you open the VI, press Ctrl+E to change between the front panel (user interface) and the block diagram (the programming code).

**Try It!**

Your hardware system is ready, and you have a computer program to run the solar energy system. Give it a try.

1. Make sure LabVIEW for Education is open, and extract and open the 3\_Using Solar Energy\_started.vi file from the K12Lab page where you got this document.
2. Make sure the myDAQ is plugged into the computer with the USB cable, and the solar panel is connected correctly.
3. Run the Reading Solar Power VI by clicking the Run button, shown at left.
4. Cover the solar panel with your hand or another object and check out the Solar Voltage Reading and the chart on the front panel of the VI. The higher the number or the higher the wave goes on the chart, the more power you’re getting from the solar panel.

That's it!

**What's Going on in the Code?**

In LabVIEW, we used the blue DAQ Assistant Express VI (a) to get the data from the Analog Input terminals of the myDAQ. For our front panel, or user interface, we created a waveform chart (b) to display the voltage signal as a waveform, and we created a numeric indicator (c) so we can also see the precise numeric value of the voltage signal.

c

This numeric indicator shows the voltage reading as a numeric value instead of a waveform.

This is the block diagram object that represents the waveform chart that appears on the front panel.

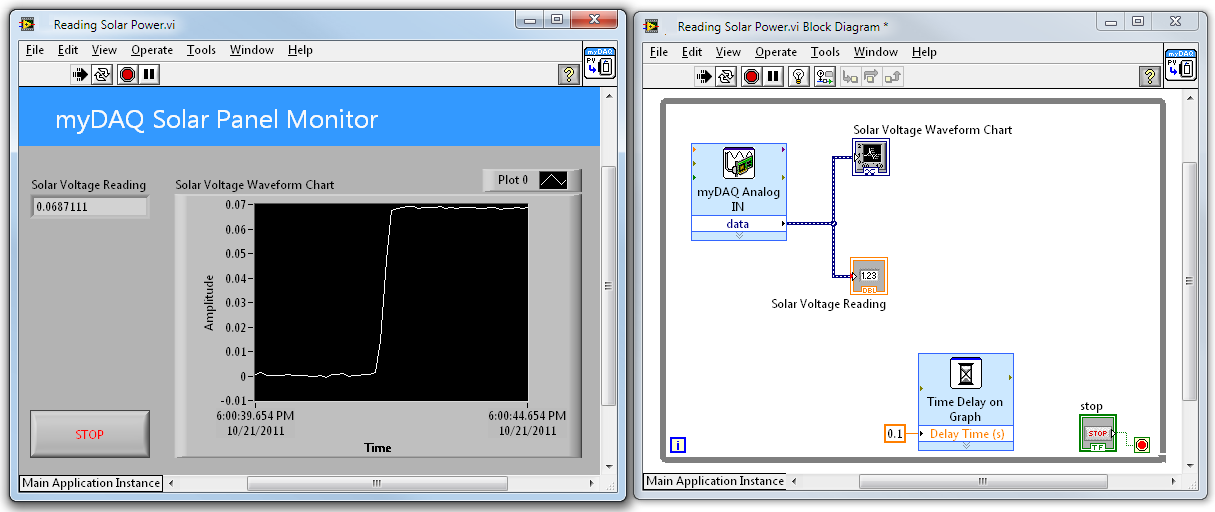
a

A DAQ Assistant Express VI gets the solar voltage signal from the AI 1+ and AI 1- terminals on the myDAQ

b

A waveform chart graphs the solar voltage signal from the solar panel.

The Run button shows that the program is running.



**Block Diagram** (the code)

This is the block diagram object that represents the Stop button on the front panel. Notice it is connected to the stop condition of the While Loop.

**Front Panel** (the user interface)

A Time Delay Express VI delays the voltage reading and waveform date that appears on the front panel. This delay makes it easier to see the data change.

This is the block diagram object that represents the numeric indicator that appears on the front panel.

Use the Stop button to stop this program, or virtual instrument (VI).

**Check for Understanding**

Now that you know more about solar engineering, answer the following questions to apply that knowledge.

* What caused you to see a low solar energy voltage, and what caused you to see a high solar energy voltage?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* What does covering and uncovering the solar panel represent out in the real world?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* What happens to the solar voltage reading when you move your hand closer to the solar panel? What about when you move it farther from the solar panel? Why does that happen?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* What data appears in the chart on the program’s front panel?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Experiment with the programming code by changing the time delay of the waveform chart. To change the Time Delay, go to the block diagram of the VI and double-click on .1 inside the orange box that’s to the left of the Time Delay on the Graph Express VI. Change the input to .5 or .01. How does this change affect how the waveform appears on the chart?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Now that you see how much solar power you can gather with a small solar panel, imagine how much power you can gather with a much larger solar panel. Complete the following table:

|  |  |
| --- | --- |
| **List or draw 3 items you might be able to power with a small solar panel.** | **List or draw 3 items you might be able to power with a larger solar panel (maybe one that’s the size of a poster board).** |
| Example: Night light | Example: iPad |