INSTRUCTOR INFORMATION

Eye-Controlled Device

LEARNING OBJECTIVES

- Supplement classroom instruction of the body's electrical activity and its effects with a hands-on engineering application.
- Control devices (e.g., LED or buzzers) based on input from measured physical quantities (e.g., EKG trace).

RECOMMENDED GRADES/SUBJECTS

Grades 9–12/Biology or Physiology

TIME NEEDED

The project is designed to be completed in one 45 minute period.

RELATED EXPERIMENTS

"Monitoring EKG" – Experiment 28 from *Biology with Vernier*

"Analyzing the Heart with EKG" – Experiment 12 from *Human Physiology with Vernier*

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
ETS1.A. Defining and Delimiting Engineering Problems ETS1.B. Developing Possible Solutions ETS1.C. Optimizing the Design Solution	Patterns Cause and effect Scale, proportion, and quantity Systems and system models	Asking questions and defining problems Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations and designing solutions Engaging in argument from evidence Obtaining, evaluating, and communicating information

INFORMATION FOR THE INSTRUCTOR

For students to be successful in this extension activity, they need to be somewhat familiar with two processes: the Engineering Process and running the Digital Control Unit (DCU). In addition to the information in this document, we have provided the following resources:

- Introduction to Engineering Design: This document includes a brief introduction to the engineering design process and an example of an Engineering Design Sheet. The Design Sheet is a great way to help your students organize their time and efforts. It also provides you with a way to assess student progress and learning.
- Eye-Controlled Device – Example Design Sheet (Word® document): A completed Design Sheet that will help you integrate the use of Engineering Design Sheets in your classroom
- Eye-Controlled Device – Example LP file: An example Logger *Pro* experiment file for this activity that will help you better understand how to program Logger *Pro* to run the DCU
- DCU Tips – Background information about using the DCU, programming it in Logger *Pro* and LabQuest 2, and general troubleshooting tips for the DCU.

In the remainder of this document you will find additional resources to help you successfully integrate this engineering extension activity into your course:

- Follow Up Questions: A few reflection questions to help your students better understand the engineering process and to help you assess their learning
- Challenge Activities: Additional activities for advanced students
- Supplemental Student Instructions: Additional instructions you can give to students if this is their first time using the DCU with Logger *Pro* or a LabQuest 2.

Follow Up Questions

Engineering extension activities usually require a different assessment than a traditional lab. We suggest that you create a rubric for grading the Engineering Design Sheet. Additionally, use follow up questions, such as those below, to help students reflect on the engineering process and to help you evaluate their learning:

- Explain a design decision you made in which you had to choose from multiple ideas. How did you make your choice? Why?
- How did you decide on the conditions that would trigger the device? What circumstances might make you change those conditions?
- What do you see as the strengths and weaknesses of your eye-controlled device? What changes would you make in the next version?

Challenge Activities

If your students need more of a challenge, provide them with one or more of the following options:

- Allow the user to adjust the threshold value using the User Parameters feature in Logger *Pro*.

- In some cases of paralysis, patients retain the ability to blink even though the rest of the body is immobile. How could you adapt your device convey more information than just "on" or "off"? For instance, could you create a kind of Morse code for your device?

SUPPLEMENTAL STUDENT INSTRUCTIONS

We feel that the student sheets present engaging challenges. However, depending on your emphasis for this project and the level of your students, you may wish to provide them with more detailed instructions on various aspects of the software and logic setup as included below.

Preliminary Data Analysis

In most EKG experiments, you create a graphical tracing of your heart's electrical activity. In this activity, you will instead position the EKG electrodes around your eye (see setup instructions below), and then record a tracing of your eye blink. You will need to determine a threshold value that can be used to trigger your device (shown by the dotted line in Figure 1). Choose a value about halfway between the baseline and the peak of your waveform. Note, however, that this value will vary for different subjects.

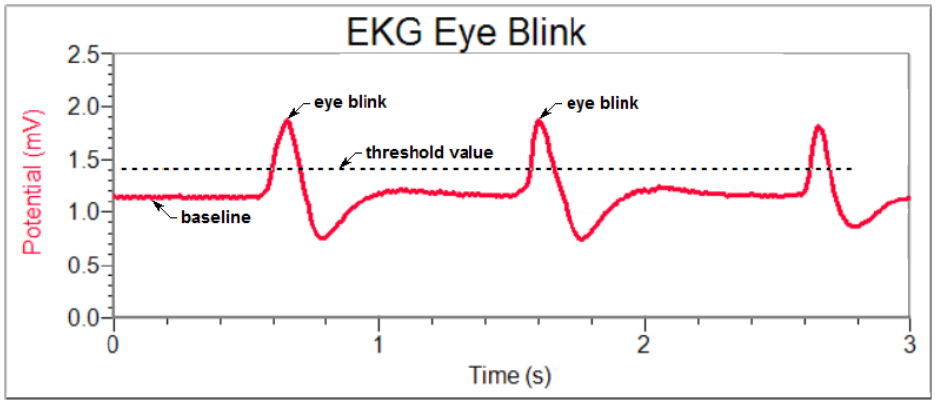

Figure 1

Equipment Setup

1. Connect an LED and resistor between D1 and the GND lines on the DCU. Connect the positive LED lead to the digital line and the negative lead to its matching resistor. Connect the other end of the resistor to the GND lead on the DCU.

   Tip: *LEDs have polarity. If the two leads are of different length, the longer one will be the positive or anode lead. If there is a flat side on the plastic housing, the lead near the flat is the negative, or cathode, lead.*

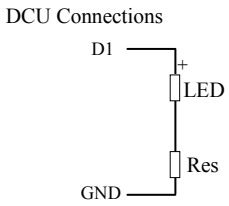

Figure 2

2. Connect a power supply to the DCU.
3. Connect the DCU to the first DIG port on the interface.
4. Connect the EKG Sensor to any analog channel on the interface.
5. Connect the interface to the computer (unless using LabQuest 2 as a stand-alone data collection device). If the interface has a power switch, turn it on.

6. Carefully clean the subject's skin with an alcohol wipe and place three fresh electrode tabs on the subject as shown in Figure 3.

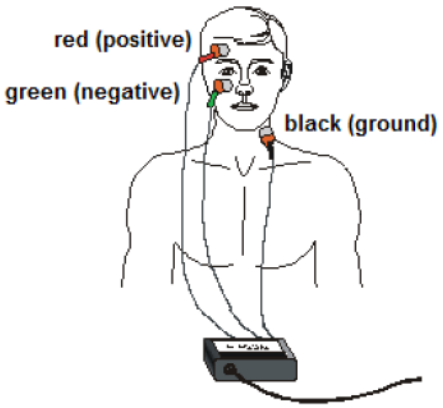

Figure 3

7. Connect the red (positive) alligator clip to the electrode tab above the subject's right eye, the green (negative) clip to the tab below the right eye, and the black (ground) clip to the tab on the left side of the neck.

   Tip: *For best results, the subject should be seated and remain relaxed.*

Software Setup - Logger *Pro*

1. Start Logger *Pro*.
2. Choose Set Up Sensors from the Experiment menu and select your interface from the list.
3. Click the DIG/SONIC1 button and select Digital Out.

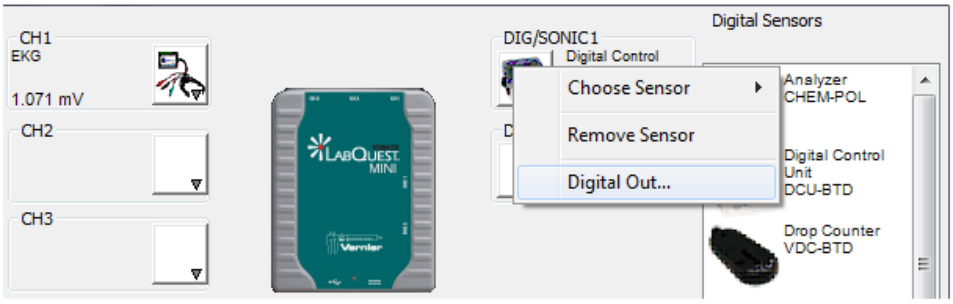

Figure 4

4. Check the box next to Activate Line 1 and enter your threshold EKG value into the box.

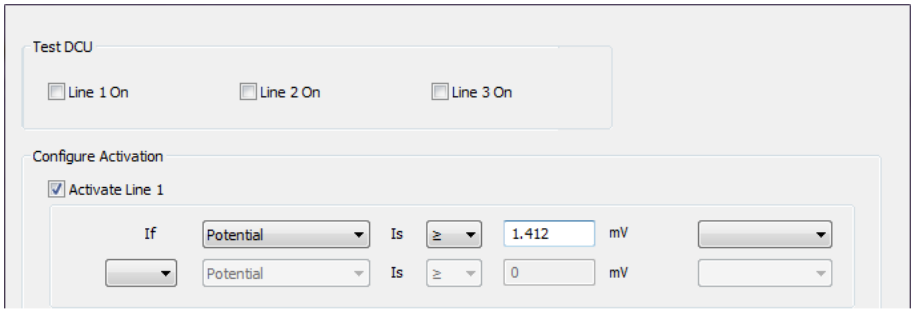

Figure 5

5. Click the radio button next to Start activation when dialog is closed.

   Tip: *When you click OK, the DCU immediately assumes control of the LED. The other option is to select Start activation when experiment run is started. With this option, the DCU will wait to control the LED until after you click Collect.*

6. Click OK and close the Set Up Sensors window.
7. Tell the subject to slowly close his or her eye. You should see the LED on the DCU light up.

Software Setup - LabQuest 2

1. Start your LabQuest 2, connect the DCU to one of the DIG ports and your sensor to one of the CH ports.
2. Choose the Sensors tab from the app and select DCU Setup and select the DCU from the list.

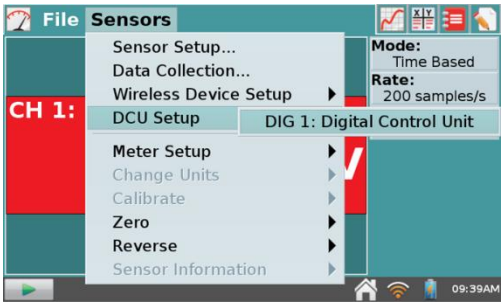

Figure 6

3. First test your hardware setup. The green LED on your DCU should light up when the DCU is connected. Check the box next to Line 1 On and confirm the red LED on the DCU lights up. Check other lines as necessary. Fix any problems and uncheck all boxes.

Figure 7

4. Check the box next to Activate Line 1 and enter your threshold EKG value into the box.

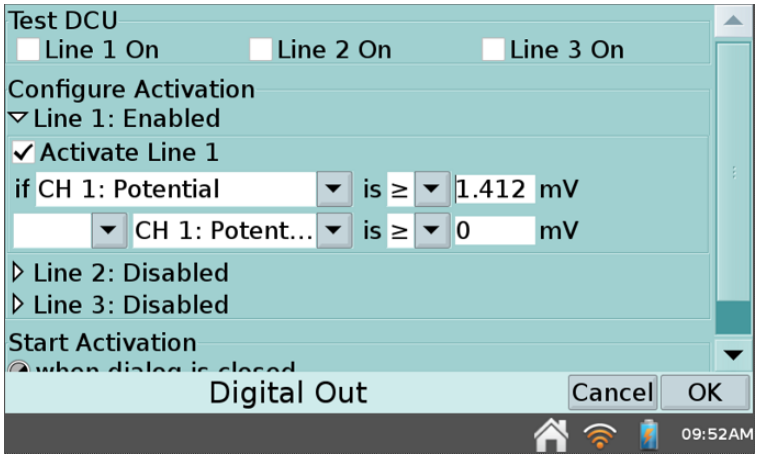

Figure 8

5. Click the radio button next to Start activation when dialog is closed.

Tip: *When you click OK, the DCU immediately assumes control of the LED. The other option is to select Start activation when experiment run is started. With this option, the DCU will wait to control the LED until after you click Collect.*

6. Click OK.
7. Tell the subject to slowly close his or her eye. You should see the LED on the DCU light up.

TROUBLESHOOTING

- You can test that your LED is working correctly by returning to the DCU setup window in Logger *Pro*. If you check the box next to Line 1 On, the LED should immediately turn on.
- Make sure the DCU is connected to a power supply.
- Make sure the electrode tabs are making good contact with the subject's skin. If the tabs appear to be loose, clean the skin with an alcohol wipe, dry it thoroughly, and apply a fresh electrode tab.
- For additional information on the DCU, refer to the *User Manual* (available at www.verniercom/dcu-btd).