

FACILITATOR GUIDE

DIY Potentiometer



Learning Objectives

1. Learn the difference between input and output devices.
2. Make a DIY paper potentiometer connected to a micro:bit to send different messages from rotating a pointer.
3. Make sense of code and micro:bit programming to read an input signal and convert these to desired outputs.

Activity Goals

- Explore the concept of input and output (see image below) by building a working hands-on model that incorporates an analog rotation potentiometer connected to a micro:bit.
- Use this model to explore the relationship between the code and the flow of information from the analog potentiometer through the micro:bit, including processing and eventual transmission via the micro:bit radio device.
- Use the DIY paper potentiometer connected to a microbit to explore the difference between discrete and continuous variables.

Materials

Provide every small group (2-3 learners) the following materials:

- 13 inches of copper tape
- Potentiometer paper template
- Small Post-It note
- Micro:bit
- Mini USB cable
- Computer
- Scissors

Safety

- When micro:bits are not in use for an extended period, remove the batteries to prevent potential leakage and damage to the device.
- Store batteries separately in a designated battery container

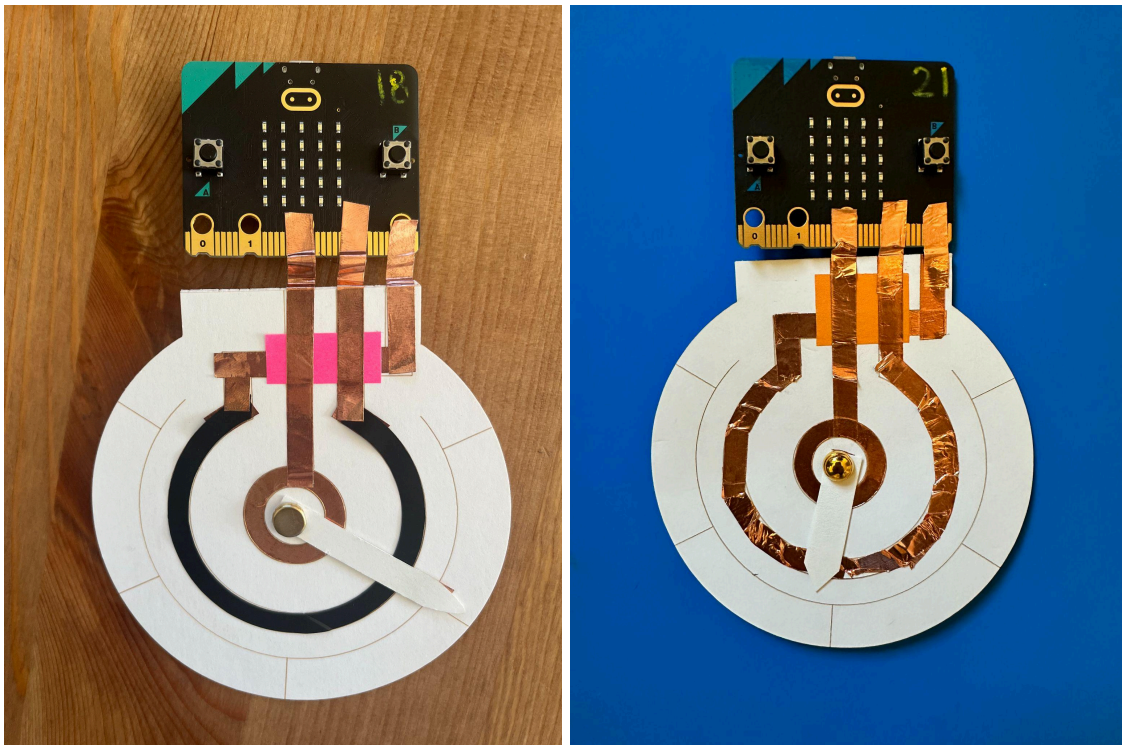
Advance Preparation

- Give yourself enough time to assemble a potentiometer so that you can test it before this activity. Make sure you are familiar with its assembly and the code the micro:bit uses to transform the input from the potentiometer into a desired output.
- Test the code using the following link:
https://makecode.microbit.org/_gLyFEWCU1Kvq

Activity Procedure

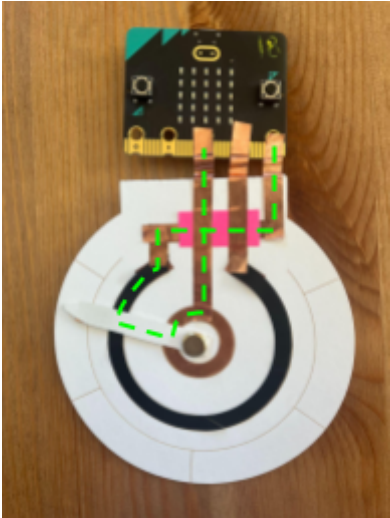
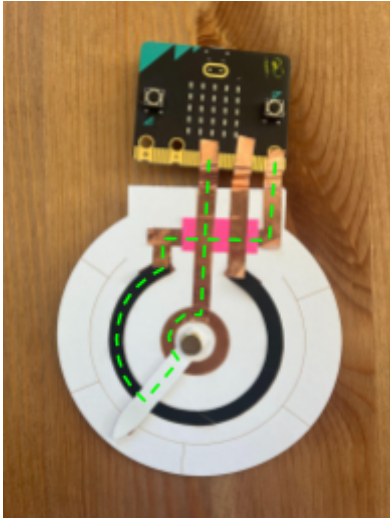
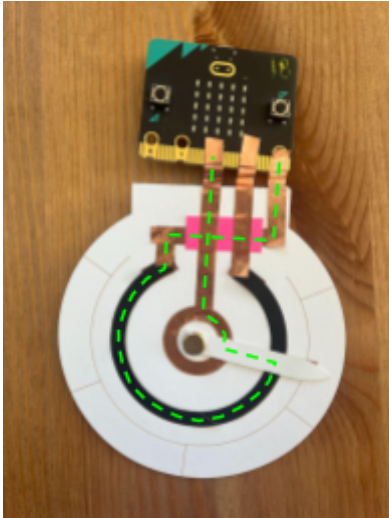
1. **Motivate the discussion:** discuss how we use buttons and slider in our modern devices, using smartphones as an example. You can use the following prompts for this discussion:
 - Think about the difference between pressing buttons and using sliders on a smartphone or a tablet. How does the experience of pushing a button differ from sliding a control?
 - In what situations do you find one more useful than the other?
 - Share your experiences on how the design of buttons and sliders impacts the ways you use smart devices.
2. **Listen for these ideas from learners:**
 - a. Buttons are switches used to turn things on and off, like a phone light, while slides are used to increase or decrease the volume or the screen brightness.

3. Ask learners to consider the limitations of using buttons, and how sliders can expand the range of applications in modern devices. Look for learners to mention:
 - a. Buttons generally result in two outcomes (e.g., on and off)
 - b. Sliders can produce many different outcomes, such as adjusting the brightness of the light to any desired intensity.
4. Use their ideas as a motivation to learn more about sliders.
5. Introduce the potentiometer as a tool that will help us make sense of sliders. Organize the class into groups of 2-3 learners, and distribute materials.
6. Use the projector to display the image below, and ask learners to use the materials to connect the copper tape from the potentiometer to the micro:bit, as shown in the image. Point to the post-it note (pink paper in the left image, or orange paper in the right one), making sure that learners place it in the right position.



If only using copper tape, the image may look like the one on the right.

7. Once learners finish putting the micro:bit and the potentiometer together, project the image below to discuss how the potentiometer affects the amount of electricity that flows through the micro:bit. Highlight the length of the path as the mechanism that allows users to change the amount of resistance in the system.

Short path (Less resistance)	Medium path (Medium resistance)	Long path (More resistance)
		

8. Use this as an opportunity to introduce the term input device. You can say something like: Input devices are any physical devices that allow us to send data to the micro:bit (or computing device) that can trigger specific actions. When we press a button on the micro:bit, or we change the resistance with the potentiometer, we are sending inputs to the computer to do specific actions.
9. Ask learners to connect their micro:bit to the computer using the USB cable. Find more information for how to connect the micro:bit [here](#).
10. Have learners download the [code](#) into their micro:bit. Find more information for how to transfer the code to the micro:bit [here](#)
11. Discuss/unpack the code with learners. Help them understand how the code relates to the input it receives from the potentiometer to the number of LEDs turned on in the micro:bit. In the code used here, we are telling the micro:bit to turn a specific number of LEDs based on the resistance that we change with the potentiometer.



12. Introduce the term output device. You can say something like: A computer, like the micro:bit, has physical devices such as the screen or the speaker that communicate information with us. For example, the number of LEDs telling us the amount of resistance or playing a sound are examples of outputs.
13. Mention that the primary outputs of the micro:bit are the LED matrix, the sound through the built-in speaker or buzzer, and the radio signals it can send to communicate with other devices.
14. Allow learners to use the potentiometer to change different outputs. Invite some volunteers to share what they discovered during this exploration. Additional outputs include changing the images the LED display, or the sounds the micro:bit can produce.
15. Use the following prompts to discuss with learners
 - a. What other applications do we think make use of sliders? (How) could we use a button to carry out the same function?
 - b. How could we use the potentiometer to send radio signals to other micro:bits?
 - c. What are the limitations of this paper potentiometer?

- d. How do you think the slider works to increase/decrease the screen brightness?
What is the input? What is the output?
16. Have learners present to the rest some of the ways they adapted the use of the potentiometer. If working with larger groups, ask learners to present their work with one or two peers sitting next to them.
17. Discuss the inputs and outputs learners explored. Use the following prompts:
- What additional outputs did you explore?
 - How did you use the potentiometer to change the output?

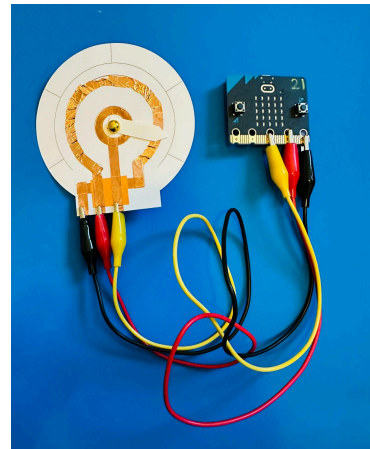
Notes to the Presenter

Working with small groups: If working with small groups, have learners share with each other the outputs they tested before inviting them to share with the whole class.

Working with large/class groups: If some groups finish early, encourage them to modify the code in order to explore how the outputs of the micro:bit are changed.

Larger projects

Learners may want to place their micro:bit into a larger craft project. Use alligator clips to connect the potentiometer to the micro:bit.



Conversational Prompts

- What other applications do we think make use of sliders? How could we use a button to carry out the same function?
- How could we use the potentiometer to send radio signals to other micro:bits?
- What are the limitations of this paper potentiometer?
- How do you think the slider works to increase/decrease the screen brightness? What is the input? What is the output?

Content Background

What Is a Potentiometer?

A potentiometer works by changing the amount of electricity that flows through it, usually with a knob or a slider. For example, the volume control knobs on lights: as you turn the knob, the sound gets louder or more quiet depending on the direction you rotate it.

Think of the potentiometer like a little doorway that the electricity has to go through to get to a lightbulb. The potentiometer can make the doorway bigger or smaller, so that more or less electricity can flow through. And the more electricity that flows, the brighter the lightbulb will be.

In our potentiometer, changing the dial also changes the length and amount of material which electrical current needs to pass through. Thus, a potentiometer is used to change the amount of resistance in a circuit and the resulting voltage. Potentiometers are sometimes called voltage dividers for this reason.

Science behind Potentiometers

The potentiometer is a useful tool for changing how much power goes into the micro:bit. It lets us send different amounts of power by turning the paper pointer. It works like a faucet that can send a little bit of power, a lot of power, or something in between. For example, we can program the micro:bit to play a sound when it receives little power. We can use the potentiometer to make the micro:bit do all sorts of things!

List of Terms

Input device: Inputs are any physical devices that allow us to send data to the micro:bit (or computing device) that can trigger specific actions. When we press a button on the micro:bit, or we change the resistance with the potentiometer, we are sending inputs to the computer to do specific actions.

Output device: A computer, like the micro:bit, has physical devices such as the screen or the speaker that communicate information with us. For example, the number of LEDs telling us the amount of resistance or playing a sound are examples of outputs.



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