Junior Lab: Lab Notebook — Introduction to Electronics With littleBits

Lab Notebook

Introduction to Electronics With littleBits

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Introduction to Electronics With littleBits

Overview

This module is based on the littleBits™ Rule Your Room Kit. You and your teammates will explore the different ways to build circuits and how they work, develop your teamwork skills, and continue to find new ways to solve problems creatively. After learning the basic functions of the Bits in the box, including the differences between an input and an output, you and your team will design and construct real circuits to power your unique inventions, finishing the module by completing an original project in the final meeting.

The module was developed for STEM Scouts by Eduporium. Eduporium (www.eduporium.com) is an all-encompassing partner of STEM educators and afterschool programs, specializing in creating innovative educational and computer technology solutions to better prepare students for the 21st century. Their experts creatively combine technology tools into engaging solutions for use in small groups or large classrooms, and they design starter activities so students can enjoy meaningful learning. Eduporium encourages early exposure to invention, problem-solving, coding, and collaboration to provide every child with the chance to succeed.

This module requires six STEM Scout meetings of approximately 90 minutes per meeting.

Meeting 1: Getting to Know littleBits

You will explore the littleBits Rule Your Room Kit, and learn the functions of all the different Bits, while learning how to make the most out of them. You and your team will use this new knowledge to build some simple circuits and figure out how many unique inventions could be built with the kit.

Meeting 2: Creepy Eyeballs

You and your team will use the Bits to build a "terrifying" set of creepy eyeballs. Using the sound trigger as an input, you will construct a circuit that lights up when somebody gets too close—a good way to ward off burglars or other intruders! Once you and your team have built the device, you can add different Bits to create inputs that activate the glowing eyes or attach the eyes to different objects in the meeting room.

Meeting 3: Making Things Move

This project is slightly more complicated as it adds the kit's servo Bit and servo hub to help you and your team design decorative artwork that can move. You will use some of the kit's other parts, including the mechanical arm, to set your masterpiece in motion. You and your team will build your circuit and then use the provided images to make an interactive collage.

Meeting 4: Buzzing Booklet

Using conductivity that's naturally in your bodies and the MaKey MaKey Bit, you and your team will invent a device that looks like a booklet with pages that buzz when people come into contact with them. You will learn that it takes only a very small amount of conductivity to make the MaKey MaKey Bit trigger an output. You and your team will use this output to transform a page into an electronic device like a buzzer and then play a trivia game about littleBits and what you have learned in meetings 1, 2, and 3. The first player to push their team's buzzer gets to answer, adding a fun competition to this activity.

Meeting 5: Burglar Buzzer

This meeting is all about protecting prized possessions. First, you and your team will be challenged to design and build a burglar alarm to keep all of your special stuff safe. You will then spend the rest of the meeting trying to "break into" other teams' protected items using what you know about the littleBits setup and how alarm systems work

Introduction to Electronics With littleBits

Meeting 6: Design Your Own

You and your team will be challenged to design a unique device, using all that you have learned from the past five meetings. You get to decide everything—what your device does and how it's built! The goals are simple: This device cannot be exactly like those built in previous meetings and it must use the MaKey MaKey Bit to allow for touch activation of the input. You and your team can even try using multiple Bits to create devices that can be activated in more than one way. The more creative you get, the better!

Lab Notebook

Meeting 1: Getting to Know littleBits

Meeting 1: Getting to Know littleBits

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *friendly*, as in *I will be friendly to all of my teammates and make sure everyone gets to do fun stuff.*

Activity Overview

There are a lot of Bits in the Rule Your Room Kit, and knowing what each of them can be used for is very important.

Meeting 1 will be dedicated to exploring each of the 26 Bits and accessories in the kit so that you can learn how to use them to make fun projects. This is also the time for you to learn how the technology inside littleBits actually works. Each Bit is basically an electronic Lego that can be attached to the other Bits using a magnetic connection. Like magnets, opposites attract and the same forces repel, so to connect two Bits, the opposite charges must be touching each other.

Meeting 1: Getting to Know littleBits

You will learn about the various types of Bits and the functions of each. The Bits can be inputs or outputs, and it's important to understand the differences between the two. In this lab, you and your team will do some first-hand research on the different Bits and their functions, and there will be plenty of time for trying them out.

You will first learn about the different types of Bits in the kit. You and your team will also make a reference chart to use in later meetings showing each Bit, its color and function, and whether it is an input or an output. You will find out why order is important when it comes to inventing with littleBits, then finish up by building some simple circuits to show what you learned.

Once you are familiar with the Bits, a fun exercise will be figuring out how many unique inventions can be built with the seven Bits and 19 different accessories. Hint: It when it comes to inventing w19.

Background

The seven Bits in the kit are:

- Bargraph
- Buzzer
- Dimmer
- MaKey MaKey
- Power
- Servo
- Sound trigger

You should notice that each Bit is a different color. The table on the next page summarizes all the different Bits. You can use this guide during your activities.

Meeting 1: Getting to Know littleBits

Color	Name	Type	Description
Blue	Power	Power	The power Bit is the only source of energy the rest of the Bits have. It's responsible for converting voltage from the nine-volt battery into just five volts because that's what littleBits circuits run on. The power Bit is also the "quarterback" of the circuit in the sense that it sends the power "signal" to the rest of the Bits, indicating that they can then do their job because they've received the power they need. This Bit must be switched on to make all inventions work. It also needs to be fully charged, which can be done by connecting it to the battery using the charging cable.
Pink	Dimmer	Input	An input is any signal that is entered into the circuit. This means these Bits create a specific signal in order to trigger the next action Bit (the output). The dimmer Bit allows Scouts to control the strength of the signal in their circuits with the simple twist of a knob. It's kind of like a gateway that allows electricity into the circuit. The more the knob is twisted clockwise, the stronger the signal is that flows into the circuit.
Pink	Sound trigger	Input	The sound trigger Bit allows you to control circuits using sound. Sounds entering the Bit cause a signal to leave. The louder the sound, the stronger the signal.
Orange	MaKey MaKey	Wire	The wire Bits help you extend your circuits, and the MaKey MaKey Bit also acts as an input Bit by allowing you to turn objects into touch pads. The MaKey MaKey Bit can control your circuit, and even your computer, when it is connected to conductive objects. It works a lot like a keyboard because when you touch the spot that represents a certain key, you get a result on your computer screen.
Green	Bargraph	Output	The bargraph Bit lights up when it receives a signal. Its five lights indicate the strength of that signal with one light being the lowest and five the highest.
Green	Buzzer	Output	The buzzer Bit converts an electrical signal into a vibration, which makes a buzzing sound. The stronger the signal the buzzer receives, the more intense the vibration and the louder the sound.
Green	Servo	Output	The servo Bit is a controllable motor that can swing back and forth and be turned to a specific angle. In turn mode, the signals from the other Bits determine the servo's position. In swing mode, the servo will move back and forth when it receives a signal with a range of about 110 degrees.

Meeting 1: Getting to Know littleBits

Each Bit uses electricity to deliver its input or to do its output action. What exactly does this mean, though, and how can you measure it in a way that lets you know a transfer of electricity is actually taking place? One of the most basic ways to think about a circuit is to remember that if there is a transfer of electricity, certain things are probably happening: Voltage, currents, resistance, and maybe even capacitance.

A current is the actual amount of electrons that are moving in a circuit. The stronger the current, the more work the circuit can do.

Voltage is a force that pushes the current along within the circuit. Think of a water hose. The current in this case is water. The voltage is the pressure that moves the water through the hose.

Resistance is anything that slows down the current. A valve on the water hose slows down the amount of water that gets through it.

Capacitance is a way for the circuit to store an electric charge, just as a bucket stores the water from the hose.

When one of the output Bits lights up, beeps, or buzzes, you know that a current is flowing through it, being pushed by the voltage.

Safety Moment

Be aware of where your littleBits modules are at all times. They can be damaged if stepped on.

Be careful when handling the battery and some of the Bits, as electricity may be flowing through them.

Keep markers away from your face and eyes.

Never connect the two battery terminals to any conducting material, and be sure not to get any littleBits modules wet.

Experiment

Get into teams of three for this activity.

Activity 1: Explore littleBits Parts (60 minutes)

Materials List

- 1 littleBits™ Rule Your Room Kit
- 1 set of colored markers

Step 1: Lay out all the Bits and accessories from the Rule Your Room Kit on your table. Separate them into Bits and accessories, and then separate the Bits by color. You should end up with four groups of Bits and one group of all the accessories, making five total.

Step 2: Using the colored markers, fill in the color column of the chart on the next page. You will refer to this chart throughout all meetings.

Meeting 1: Getting to Know littleBits

Color	Name	Type	Electrical Function	Description
	Power	Power		The power Bit is the only source of energy the rest of the Bits have. It's responsible for converting voltage from the nine-volt battery into just five volts because that's what littleBits circuits run on. The power Bit is also the "quarterback" of the circuit in the sense that it sends the power "signal" to the rest of the Bits, indicating that they can then do their job because they've received the power they need. This Bit must be switched on to make all inventions work. It also needs to be fully charged, which can be done by connecting it to the battery using the charging cable.
	Dimmer	Input		An input is any signal that enters into the circuit. This means these Bits create a specific signal in order to trigger the next action Bit (the output). The dimmer Bit allows you to control the strength of the signal in your circuit with the simple twist of a knob. It's kind of like a gate that allows electricity into the circuit. The more the knob is twisted clockwise, the stronger the signal is that flows into the circuit.
	Sound trigger	Input		The sound trigger Bit allows you to control circuits when they detect sound. Sounds entering the Bit cause a signal to leave. The louder the sound, the stronger the signal.
	MaKey MaKey	Wire		The wire Bits help you extend your circuits, and the MaKey MaKey Bit also acts as an input Bit by allowing you to turn objects into touch pads. The MaKey MaKey Bit can control your circuit, and even a computer, when it is connected to conductive objects. It works a lot like a keyboard because when you touch the spot that represents a certain key, you get a result on your computer screen.
	Bargraph	Output		The bargraph Bit lights up when it receives a signal. Its five lights indicate the strength of that signal with one light being the lowest and five the highest.
	Buzzer	Output		The buzzer Bit converts an electrical signal into a vibration, which makes a buzzing sound. The stronger the signal the buzzer receives, the more intense the vibration and the louder the sound.
	Servo	Output		The servo Bit is a controllable motor that can swing back and forth and be turned to a specific angle. In turn mode, the signals from the other Bits determine the servo's position. In swing mode, the servo will move back and forth when it receives a signal with a range of about 110 degrees.

Meeting 1: Getting to Know littleBits

Step 3: Try constructing a basic circuit based on this knowledge using the power Bit, an input Bit, and an output Bit. When you've done this, if you used the bargraph Bit as the output, did it light up? Did all the Bits connect to each other completely and securely? If so, then you correctly constructed a circuit! Draw out your circuit in the space below using the appropriate colors, and explain how it works and what it does.

Meeting 1: Getting to Know littleBits

Step 4: Try adding in the MaKey MaKey Bit (a wire Bit) at some place in your circuit, and connect an alligator clip to it. Hold the alligator clip in your hand and test to see if your conductivity can complete the circuit. Where is the best place to put it? Does placing the MaKey MaKey Bit in different spots affect the circuit in different ways? Below, draw out your circuit using the appropriate colors, and explain how it works and what it does.

Meeting 1: Getting to Know littleBits

Step 5: Keeping the same circuit, try adding some of the accessories from the box in between the input and output Bits. What can you do with the mechanical arm? Or the servo hub? Try connecting your circuit to the mounting board as well! Draw each of your circuits, using the actual colors, and explain how they work and what they do. Next, add information to the chart from Step 2 that describes what each Bit does and which of the electronics basics it represents. For example, the dimmer Bit is a resistor.

Meeting 1: Getting to Know littleBits

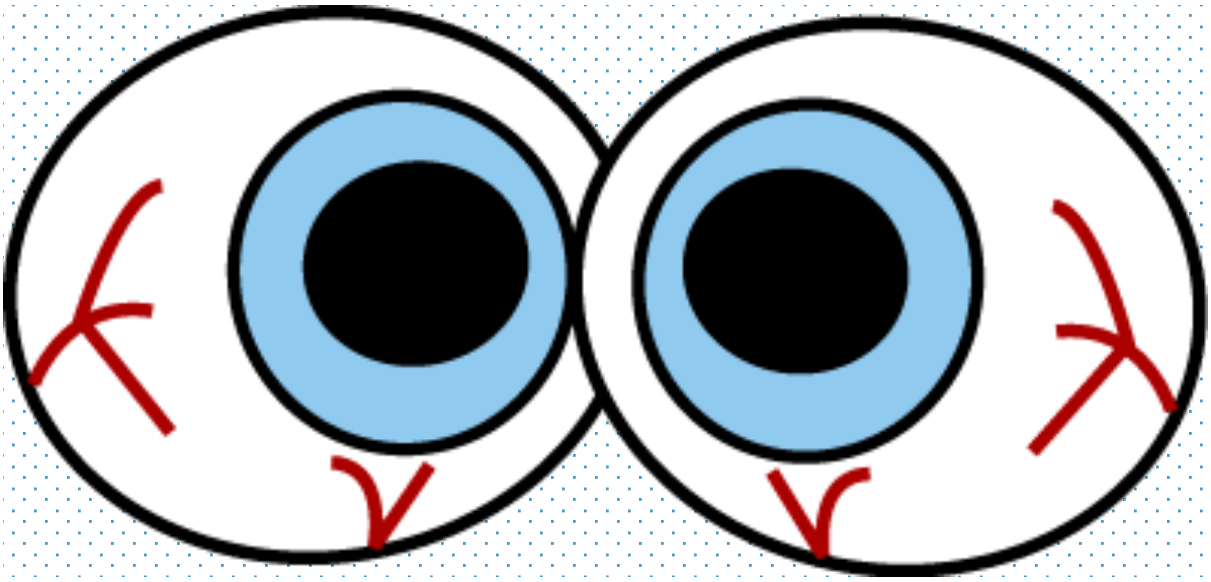
Step 6: If time allows, try swapping out some of your input and output Bits to create other unique circuits. Refer to the chart you made in Step 2 for new inspiration in creating circuits. Got a cool project made? Call over one of your Lab Leaders to let them see!

Cleanup

Turn off the power Bit by flicking the switch, disconnect the battery, and put all the parts you have used back in the littleBits Rule Your Room box.

STEM Innovator Moment Notes

Meeting 2: Creepy Eyeballs



Meeting 2: Creepy Eyeballs

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *trustworthy*, as in *I will show that I am trustworthy by letting other teams try to get around my team's alarm without making noises to make it harder for them.*

Activity Overview

In this lab, you and your team will use the sound trigger Bit as an input to activate a glow-in-the-dark device that can alert you in a unique way when intruders approach. Since this device uses the sound trigger as an input, it will be activated when it detects noise. The circuit is simple to construct. It only needs the power, sound trigger, and bargraph Bits, but make sure they are connected in that order and that the battery is charged before you start building your circuit. A couple of new littleBits components will also be introduced in this activity: the shoes and adhesive shoes, which help stabilize the circuit within the design.

During this project, you and your team will learn how sound can be used as a trigger to light up your security device. This idea can also be translated to other types of coding in which different inputs can create the desired outputs. This activity will show that the input you choose doesn't matter as long as the device is

Meeting 2: Creepy Eyeballs

programmed to translate the input and create the proper output. You and your team will get the chance to be creative and design a template to place over your device, warding off intruders with whatever scary face you decide to draw!

Background

Take a moment to investigate why the Bits are able to do what they do. They work together in a system to create a circuit that could not function if the Bits were not all connected and in the proper order.

Once the power Bit is switched on, it sends a signal into the circuit, indicating that it has the power needed to tell the rest of the circuit what to do. The sound trigger Bit, which is the input in this particular circuit, is connected to the power Bit, which enables it to send a signal to the rest of the circuit as soon as it picks up noise. The input message then goes to the output Bit, which is the bargraph Bit in this case. It should then light up, indicating that it has received the input and is now carrying out its output.

This is a very simple representation of an alarm, which has been created using an “if this, then that” system.

If the alarm system receives the proper input, it will then create a specific output. This is basically how home and business alarm systems work. These systems use motion as the input that sets off their output: a loud beeping noise. Sensors communicate directly with a central system, usually located in a closet or another hidden area. This system monitors all the sensors and sends any new information to a control panel installed somewhere in the building, typically near the entrance. Sensors are placed throughout the building or home next to doors and windows intruders could use to break in so that they can detect movement if anyone tried coming in.

In your littleBits circuits, the pink sound trigger Bit is the sensor. The circuit will help you create an “invisible” zone that cannot be breached without the alarm going off—exactly how a home security system works. However, instead of motion, this circuit is designed to detect and react to noise within its zone.

Safety Moment

Be aware of where your littleBits modules are at all times. They can be damaged if stepped on.

Be careful when handling the battery and some of the Bits as electricity may be flowing through them.

Keep markers away from your face and eyes, and be careful when using scissors.

Do not handle these materials unless you are using them for your project.

Never connect the two battery terminals to any conducting material, and be sure not to get any littleBits modules wet.

Do not stick tape to any other surfaces besides the ones you are using while completing your project.

Meeting 2: Creepy Eyeballs

Experiment
Get into your teams of three.

Activity 1: Design and Build Your Alarm System (25 minutes)

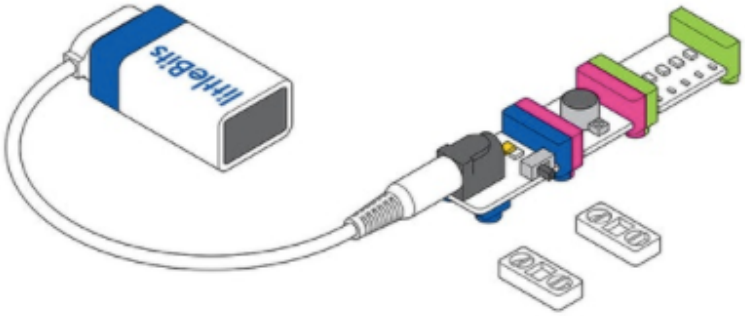
Materials List

- littleBits™ Rule Your Room Kit items
  - Bargraph Bit
  - Power Bit
  - Sound trigger Bit
  - Screwdriver
  - 2 littleBits shoes
  - 2 littleBits adhesive shoes
  - littleBits battery and cable
  - Project templates
- Pen, pencil, or marker
- Tape
- Scissors

Step 1: Draw the circuit you want to build using blocks for the different Bits. Show the order you will connect them in. Since this is a fairly straightforward circuit, you will only need the power, sound trigger, and bargraph Bits.

Meeting 2: Creepy Eyeballs

Step 2: Connect two adhesive shoes to the bottom side of your circuit. One of them should connect between the power and sound trigger Bits, and the other should connect between the sound trigger and bargraph Bits. These pieces act as extra support to keep your circuit together (see the picture below).

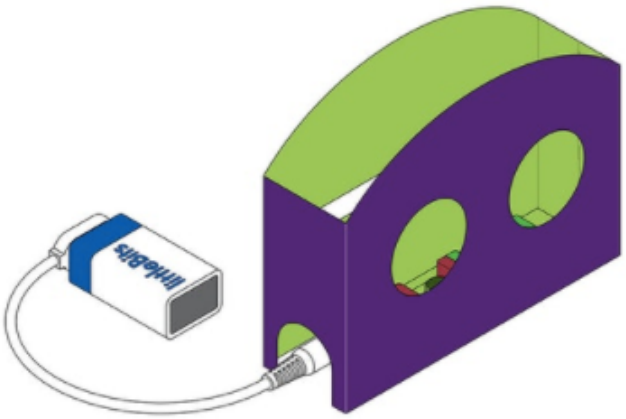


Step 3: Using the screwdriver, turn the small sensitivity knob (circled below) on the sound trigger Bit all the way clockwise (to the left). It should stop turning once it reaches the proper position. This turns up the sensitivity of the sound trigger so that it can pick up noises more easily.

Step 4: Switch the power Bit on, and test out the sound trigger. Clap forcefully, close enough to the sound trigger Bit that it will be able to pick up noise. Did the bargraph Bit light up? If so, the sound trigger Bit was able to detect your sound. If it lit up only partially or not at all, try getting a bit closer or clapping a bit louder. You might also test out different sounds and volumes to get a sense of how well each noise works as an input—maybe a phone's ringer, dropping a book on the floor, or just talking at a normal volume. If the circuit is triggered by all the sounds, reduce the sensitivity by turning the knob down (to the right) just a bit.

Meeting 2: Creepy Eyeballs

Step 5: Now it's time to get artistic. Using the project template, you're going to build a cool-looking mask to place around your circuit, giving it a place to hide. Construct the mask following Template A in the guidebook, then slide it over your circuit, making sure to leave the battery and its wire outside.



Step 6: Place the eyes from your kit into the mask, making sure that they fit inside the eye holes. Then tape the paper edges of the eyes to the inside of the mask. Now, it's definitely ready to ward off intruders.

Activity 2: Test Your Alarm System (25 minutes)

Stay in your teams of three.

Materials List

- 1 alarm circuit (built in Activity 1)
- Mask (built in Activity 1)

Step 1: Set up your security device in a busy area or next to something you would consider to be valuable. As you watch your alarm in action, take a moment to recall why it's working like this: The power Bit provides the electricity for the input and output Bits to work.

The input Bit (the sound trigger) controls the circuit with sound. It listens to the noise level in the room and creates an "n a signal once the noise reaches a certain level (once it becomes loud enough). This tells the output Bit to activate the line of lights on the bargraph Bit once that certain noise level is reached.

Meeting 2: Creepy Eyeballs

Step 2: Now try swapping your outputs. Replace the bargraph Bit with the buzzer Bit, then set up the security device in the same place. Now, when it detects a sound, your device will buzz loudly, alerting everyone in the area to a possible intrusion.

Which output was more effective: the bargraph or the buzzer? In your opinion, would any other Bit work equally well, or more effectively, as an output? In a real-life situation, what other types of outputs might help you keep your possessions safe? Use the table on the next page to compare the different output Bits, and rate each one, with 1 being the best and 3 being the worst. Write your reasons next to each rating.

	Buzzer Bit	**Servo Bit**	**Bargraph Bit**
Positives			
Negatives			
Rating			

Step 3: Now invite other teams to try to reach the thing you're protecting without setting off your alarm. Was anyone able to keep quiet enough to steal it? (Remember, a Scout is Trustworthy: Don't make your own noise to set off the alarm!)

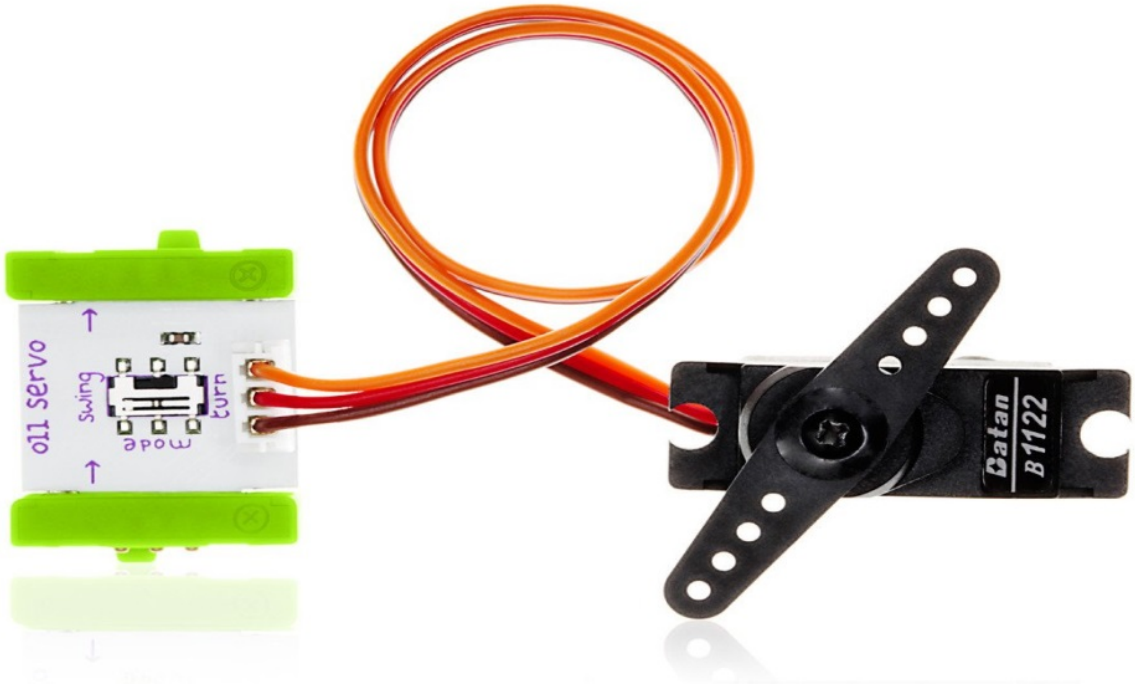
Cleanup

Turn off the power Bit by flicking the switch, disconnect the battery, and put all the parts used back into the tray in the Rule Your Room Kit. Put the backings back on the adhesive shoes if they were removed.

Meeting 2: Creepy Eyeballs

STEM Innovator Moment Notes

Meeting 3: Making Things Move



Meeting 3: Making Things Move

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *loyal*, as in *I will be loyal to my team and help make sure that everyone gets to do a part of this lab*.

Meeting 3: Making Things Move

Activity Overview

In this lab, you will be introduced to the littleBits servo module and learn about what makes servos unique while using the technology to construct some artwork that moves. Adding the servo hub and the mechanical arm will allow you to build some slightly more complex circuits.

You and your team will use your creativity to mount this circuit to a wall in front of a cool background image. You will make it appear as though the background image and a foreground image are interacting—with help from the mechanical arm and the servos!

In building this device, you will learn the basics of servo technology as you and your team develop an eye for artistic creativity. As you see how the servos work, you can begin thinking about other uses servos might have.

At the end of the meeting, you and your team will get a chance to redo your circuit and add a different input. Can you make your mechanical arm swing by making enough noise? It might just depend on how creative you get!

Background

The word *servo* is short for servomechanism. The servos in the littleBits kit are small devices, but servos come in all sizes. Pictured below is a large example of a servo all motion simulator for the U.S. Army's M1 Abrams Tank. It can hold the actual tank turret, which weighs many thousands of pounds, using large, strong servos at the bottoms of the big hydraulic rams.

Photo from U.S. Army TARDEC Center

Servos are made of different parts, including a DC motor, gear train, potentiometer, integrated circuit, and output shaft. Servos are commonly used in powerful machines, like cars, to balance the workload among the parts so that no one component is doing too much. This contributes to the machine's ability to work efficiently. The servos generally give the machine greater speed without adding much torque, which is exactly the case with the circuit you will be building.

Meeting 3: Making Things Move

Essentially, servos move something large by using only a small amount of power. Some servos turn a shaft to a defined position. Others move levers back and forth to control steering. They rotate a shaft that is connected to the engine throttle, which affects the speed of the machine. Servos are found in fuel-powered cars, aircrafts, radios, and even DVD players.

Inside the servo, an electrical signal is sent to a computer, indicating how far down something is being pressed. For example, when a driver slams on a car's brakes, they work to their full capability, and they work less forcefully when the driver's foot is eased onto them. You will see this principle in action with help from the dimmer Bit: The more you twist the knob, the more forcefully it will operate.

Safety Moment

Be aware of where your littleBits modules are at all times. They can be damaged if stepped on.

Be careful when handling the battery and some of the Bits as electricity may be flowing through them.

Keep tape away from your face and skin.

Never connect the two battery terminals to any conducting material, and be sure not to get any littleBits modules wet.

Be careful around scissors and do not handle them unless you are using them.

Experiment

Get into your teams of three.

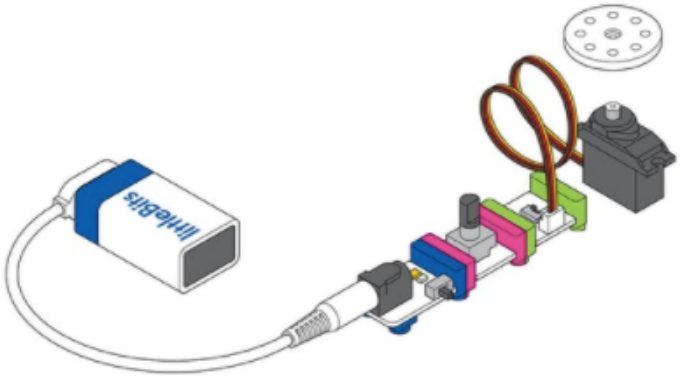
Activity 1: Setting Up Your Servo (25 minutes)

Materials List

- littleBits™ Rule Your Room Kit items
  - Power Bit
  - Dimmer Bit
  - Servo Bit
  - Servo hub
  - Screwdriver
  - 3 screws
  - Mechanical arm
  - 4 adhesive shoes
- Colored markers

Meeting 3: Making Things Move

Step 1: First, you and your team members should work together to draw the circuit needed for this project on a piece of paper. You'll only need three Bits again, but this time you'll be using the dimmer Bit as the input and the servo Bit as the output. The circuit should look like the one in the picture below.



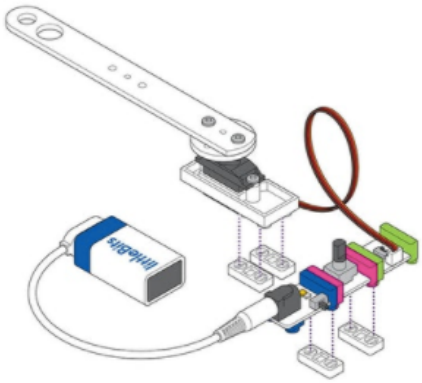
Step 2: Once your drawing is finished, put the circuit together with the littleBits modules according to what you drew. Snap your circuit together in the correct order.

Step 3: Attach the servo hub (the circle-shaped white piece) onto the top of the servo as the picture below Step 1 shows. It should slide right into the small rod that's positioned on the top of the black component. Secure the hub tightly (it should snap in).

Meeting 3: Making Things Move

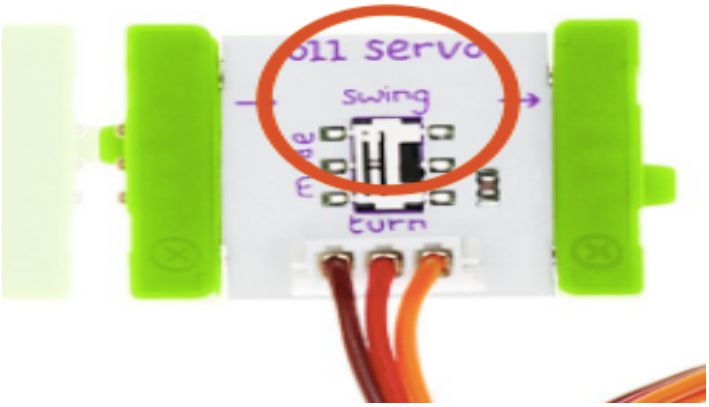
Step 4: Press the servo into the servo mount and use the screwdriver to screw the servo into the mount.

Step 5: Connect the mechanical arm to the servo hub using two screws. The screws should go into the hub on opposite sides.



Step 6: Secure two sets of the littleBits adhesive shoes to the bottom of your circuit—one between the power Bit and input Bit and the other between the input Bit and output Bit (see illustration above). Then secure two more adhesive shoes to the bottom of your servo device, on the white plastic.

Step 7: There is a small switch on your output servo Bit. Set it to "swing" mode. Now, power on your circuit by flicking the switch on the power Bit. Did anything happen? If not, try twisting the knob on the dimmer input Bit and see if the servo starts swinging the mechanical arm.



Meeting 3: Making Things Move

Activity 2: Art Show (20 minutes)

Materials List

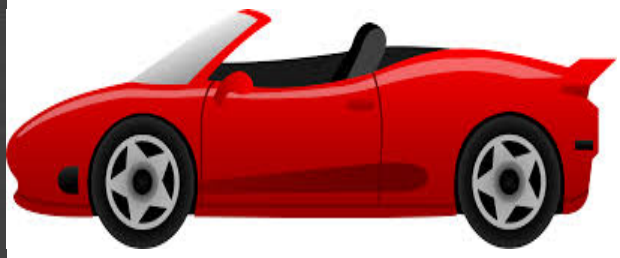
- littleBits™ Rule Your Room Kit items
  - Power Bit
  - Dimmer Bit
  - Servo Bit
  - Servo hub
  - Screwdriver
  - 3 screws
  - Mechanical arm
  - 4 adhesive shoes
- 2 images (portal download)
- Scissors
- Tape

Step 1: Now it's time to create your moving images. For this project, you will need two images, which have been supplied for you. The two images must be selected from the same group. One will serve as the foreground image (the one that's moving) and the other will serve as the background image, which will stay attached to the wall.

Step 2: Attach the "moving image" (the smaller one) to the end of the mechanical arm using tape. Tape the background image to the wall at the appropriate height.

Step 3: Peel the back off of the adhesive shoes and stick your circuit near the background image you taped to the wall. Be sure to use enough force to attach the circuit and the servo.

Step 4: Make sure the power is still on, then begin twisting the dimmer, sometimes turning it quickly and sometimes slowly. Are your images interacting? Look at the example below of the car pulling into a parking space. Are your images working together? How could the interaction be adjusted? Do the different speeds of the moving image give it a higher or lower quality?



Meeting 3: Making Things Move

Step 5: If there is time, try replacing the dimmer with a different input Bit—maybe one that you have already used. For example, can your combined images be set in motion by making a sound? Switch the input Bits quickly while trying to leave your image combination intact.

Cleanup

Turn off the power Bit by flicking the switch, disconnect the battery, and put all the parts you have used back into the tray in the littleBits™ Rule Your Room Kit.

Put the backings back onto the adhesive shoes and check to be sure your kit is not missing any Bits.

STEM Innovator Moment Notes

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Meeting 4: Buzzing Booklet

Meeting 4: Buzzing Booklet

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *cheerful*, as in *As I work through learning how to make these projects work, I will always be cheerful.*

Activity Overview

In this lab, you and your team will work together to activate an alarm using a conductive object and the touch function enabled by the MaKey MaKey Bit. This is your chance to observe the power of circuitry up close as you create a touch-activated alarm system that works like the real thing. The MaKey MaKey Bit has multiple connection points, so there are a number of ways you could build the circuit. You and your team will explore the power of conductivity using objects as simple as a pencil and a sheet of paper.

Meeting 4: Buzzing Booklet

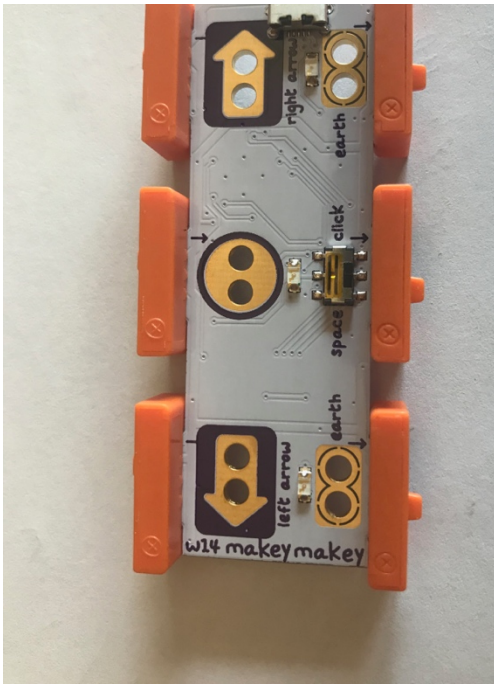
This lab is designed to show you how you can use circuitry and conductivity to transform just about any conductive object into an electronic device. The MaKey MaKey Bit helps you create all sorts of inventions and, as long as something conductive (like you!) is connected to the Bit with one of the alligator clips, you can control the functions of the circuit through touch. It's not just people that can activate the circuit, though. Any conductive material can start the electronic interaction, creating a different kind of circuit. Does that mean a person's hands can be considered an input? Well, that depends on what you define as a circuit and how creatively the buzzer device is designed!

You can use the device in a number of clever ways, but in this lab we will focus on playing a trivia game. Each member of a team will take turns asking questions; the first to push their team's new buzzer and get it to sound will have the chance to answer.

Background

The MaKey MaKey Bit has been added to the littleBits group from another popular and powerful STEM tool known simply as the MaKey MaKey. The inventors of the MaKey MaKey created a compact computer that enables you to literally *make* anything a *key*. But what does this mean? Well, the MaKey MaKey is a device that uses the natural conductivity found in everyday objects (and people) to complete a circuit. Once that circuit is complete—meaning there is something conductive for the current to pass through—you can use the MaKey MaKey to execute a desired action, usually done by connecting the MaKey MaKey alligator clips to the space or arrow slots on the board and plugging its USB cable into a computer.

When the circuit is closed, the MaKey MaKey sends a command to the computer in the same way as when you press certain buttons on a computer keyboard. So you really can use a random object to make your own key, as long as that object is conductive. The littleBits MaKey MaKey Bit operates on the same principle. It's an even smaller computer interface that can connect to other littleBits modules and create outputs when it receives an input through a conductive material. To get the output in their circuit (in this case, the buzzer) to buzz, you'll need power and a conductive force. Many different conductive materials can make this circuit buzz everything from water to silverware and even fruit! As long as it's conductive, you should be able to create a touch-activated circuit, and using your new buzzer, you can try your hand at a game of Jeopardy.



Look at the MaKey MaKey board in your kit (photo on the right). You should notice the ports labeled "space" and "click" and the four-way arrow ports—similar to the space, click, and arrow options you would see when using a computer keyboard and mouse. This board can send those signals to your computer in the same way that a keyboard does. It gives you a different option for typing besides using only the keyboard. As in almost all circuits, the MaKey MaKey works like a button. When you press a button down (like a key on your keyboard), the circuit that sends a message to the computer becomes closed. With the MaKey MaKey, the circuit becomes closed once it meets anything conductive. The MaKey MaKey Bit works in the same way. Once the circuit is completed, the MaKey MaKey Bit sends a signal to the next littleBits module in the circuit, telling it to complete its output.

Meeting 4: Buzzing Booklet

Safety Moment

Like the MaKey MaKey Bit, the actual MaKey MaKey kit is very safe. Many of the projects involve water—which, of course, usually doesn't mix well with electricity. However, MaKey MaKey is different because it is powered by a USB connection, not an AC current. It should never be connected to an AC outlet. The voltage is similar to three AA batteries, or 50 micro amps. MaKey MaKey uses resistive touch sensing, and it is FCC compliant.

Be aware of where your littleBits modules are at all times. They can be damaged if stepped on.

Be careful when handling the battery and some of the Bits as they may have electricity flowing through them.

Never connect the two battery terminals to any conducting material, and be sure not to get any littleBits modules wet.

Experiment

Get into your teams of three.

Activity 1: Building Your Circuit (15 minutes)

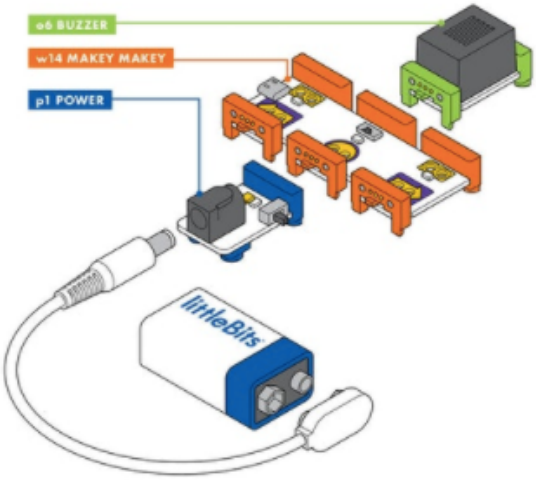
Materials List

- littleBits™ Rule Your Room Kit items
  - MaKey MaKey Bit
  - littleBits battery and cable
  - 2 littleBits adhesive shoes
  - 2 littleBits shoes
  - Power Bit
  - Buzzer Bit

Step 1: Start by drawing out your circuit on the next page using the different colored markers to represent the different types of Bits.

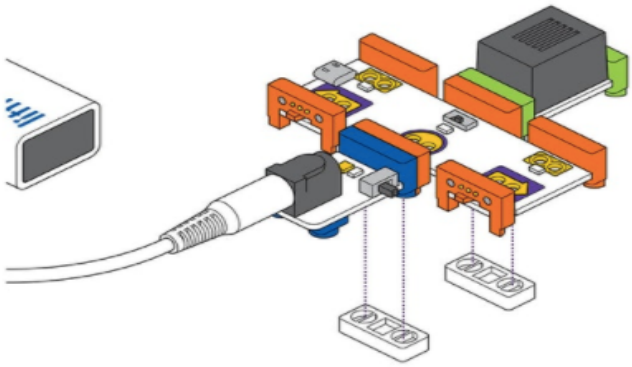
Meeting 4: Buzzing Booklet

Step 2: Begin building your buzzing circuit using the power Bit, MaKey MaKey Bit, and buzzer Bit. Usually, the Bits are connected and form a straight line in littleBits circuits. However, since you are using the MaKey MaKey Bit, this one will look a little bit different.

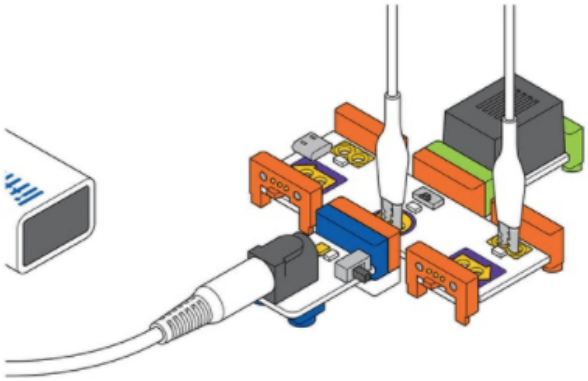


Meeting 4: Buzzing Booklet

Step 3: Next, place two of the adhesive littleBits shoes on the bottom of your circuit. Follow the picture below and connect the shoes to the power Bit and the MaKey MaKey Bit.



Step 4: Attach two separate alligator clips to the MaKey MaKey Bit—one connected to the "space/click" pad (inside the purple and yellow circle) and the other connected to one of the two "earth" pads as shown in the picture.



Step 5: Test that your circuit is built correctly by holding the tips of both alligator clips in your hands (the same person should be holding both) and turning on the power Bit by flicking the switch. Since your body is a natural conductor of electricity, it should be able to complete the circuit and, as electricity flows through your body, it will send a signal to the output Bit, causing it to buzz. Allow all team members to test their own conductivity and, once the circuit works successfully, move on to Activity 2.

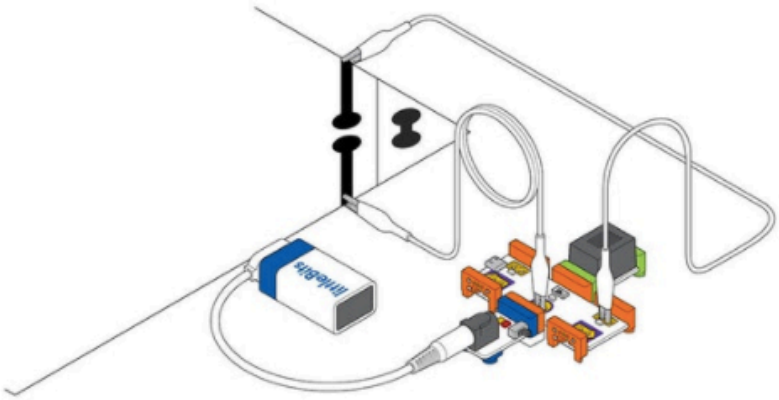
Meeting 4: Buzzing Booklet

Activity 2: Activating Your Circuit and Playing a Game (40 minutes)

Materials List

- littleBits™ Rule Your Room Kit items
  - MaKey MaKey Bit
  - littleBits battery and cable
  - 2 littleBits adhesive shoes
  - 2 littleBits shoes
  - Power Bit
  - Buzzer Bit
- Pencil
- Question-and-answer sheets

Step 1: Take the blank page out of your Lab Notebook (you can find it at the end of this meeting) and grab a pencil. The graphite inside the pencil's tip is a conductive material and can be used to complete circuits. On the top right corner of your paper, draw the designs below exactly as they appear in the diagram. Then fold the very top of the corner as indicated below.



Step 2: Connect each of your two alligator clips to the pencil marks on either side of the page. Eventually, this is what will help you complete your circuit. Be sure to connect the clips to the same markings they are connected to in the picture above.

Step 3: Now fold the corner of your paper over so that the pencil markings touch. The conductivity of the graphite should be enough to complete the circuit and allow your buzzer to go off. Did your buzzer buzz? If it did not work, try darkening the pencil marks and make sure the alligator clips are securely attached in the correct places. Also check to see that the power Bit is switched on.

Meeting 4: Buzzing Booklet

Step 4: Now it's time to play a little game. You may have heard of the show Jeopardy. If not, your parents have, so ask them about it later! Teams will compete against each other to answer questions about littleBits that include information you covered previously in these labs. Each team will pair up with another team and take turns asking questions. One person from each team will be up first, and someone from one of the teams will volunteer to read the question (this person can be switched after each question or as often as you want). The first "team" to buzz their buzzer has the opportunity to answer the question (in the form of a question, i.e., "What is the bargraph Bit?") just like on Jeopardy. There will be 16 questions, and the team that answers the most questions correctly wins. Note that you won't really be slamming your buzzers as if you were pressing a button, but rather just folding them over to make the two graphite spots touch and sound the buzzer. But move quickly, though! If there is a tie after all 16 questions are answered, Lab Leaders can use the tiebreaker question.

Cleanup

Replace the piece on the bottom of the adhesive shoes to protect the adhesive for the next use.

Turn off the power Bit by flicking the switch, disconnect the battery, and put all the parts you have used back into the tray in the littleBits Rule Your Room box.

STEM Innovator Moment Notes

Meeting 4: Buzzing Booklet

Use this page for Activity 2

Meeting 5: Burglar Buzzer

Meeting 5: Burglar Buzzer

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *helpful*, as in *I will be helpful to each of my teammates and make sure we all share in building this project*.

Activity Overview

In this lab, you and your team will construct a simple circuit that that will help you learn about conductivity using a cool input, and you will learn a new way to keep your belongings safe! This invention calls for placing a valuable object on top of the littleBits box, then designing a clever way to keep it safe with a loud enough alarm to scare off even the boldest of burglars.

Meeting 5: Burglar Buzzer

Despite its simple design, this burglar buzzer is actually based on a home alarm system using the tripwire concept. A tripwire is something that can alert you to an intruder by emitting a signal when someone enters a specific area. The alert may come in the form of a really loud beep or it may even be silent so the intruder does not know anyone has caught on to their presence. Using some simple materials and conductive foil, you and your team will work together to create a tripwire that keeps your stuff safe. Then, as a challenge, each team will spend some time trying to "break into" the other teams' security systems in a way that can't be detected!

Background

Aluminum foil does have "aluminum" in its name, but you may not have realized that it is a conductive material. You probably knew that most metals are conductive, but one usually thinks of metal as a hard, solid material unlike the softer, crinkly texture of aluminum foil. However, aluminum foil is indeed conductive, so it can be connected to the MaKey MaKey Bit to help complete a littleBits circuit. Some other conductive materials that you might not have thought of include water, bare wire, soda cans, and fruits and vegetables. Non-conductive materials include plastics, paper, cardboard, and most fabrics.

In this meeting, you will be using aluminum foil to create something called a tripwire. A tripwire is a device used to detect and respond to physical movement. Usually, the tripwire is attached to a specific object and sends out a signal when that device is touched or moved, or if somebody gets too close to it. When the tripwire detects a sensation or a signal at a high enough level, its hidden alert potential is activated. As you and your team build a similar device during this lab, you should keep in mind that one of the goals of a tripwire is to keep it hidden so that nobody will know it's there. You and your team will put your creativity and careful planning to the test as you try to design a device that nobody can get by!

Safety Moment

Do not let the scissors or the aluminum foil touch a littleBits part, as that might create a short circuit and destroy the part!

Be aware of where your Bits are at all times and be sure not to get them wet or step on them.

Only stick tape to appropriate surfaces while constructing your project, and always be careful when using scissors.

Meeting 5: Burglar Buzzer

Experiment
Get into teams of three.

Activity: Building a Security Device (50 minutes)

Materials List

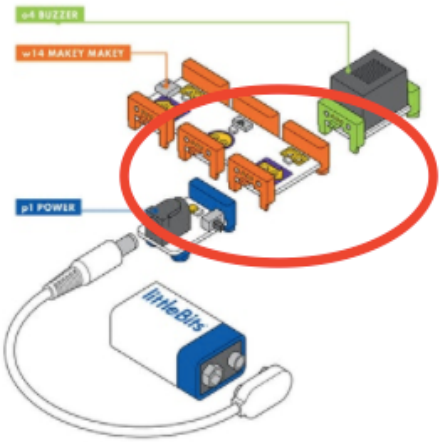
- littleBits™ Rule Your Room Kit items
  - Buzzer Bit
  - Power Bit
  - Mounting board
  - MaKey MaKey Bit
  - littleBits battery and cable
  - Rule Your Room box
- Tape
- String
- Aluminum foil
- Paper
- Scissors
- Object to protect

Step 1: Before building your circuit, draw it out in your Lab Notebook. It should look like the one in the picture in Step 2.

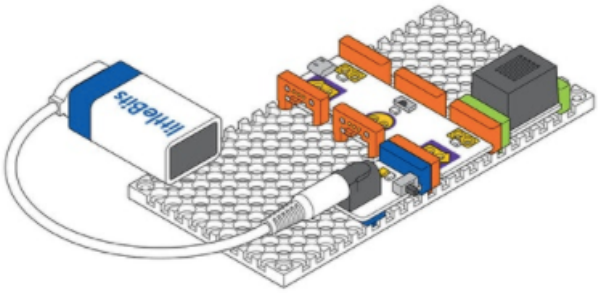
Meeting 5: Burglar Buzzer

Meeting 5: Burglar Buzzer

Step 2: Now it's time to start building your circuit. You will notice that it involves the same components you used in last week's meeting: the battery, power Bit, MaKey MaKey Bit, and the buzzer Bit. This time, however, you're going to connect the power and buzzer Bits to the MaKey MaKey Bit using one of its outer connections rather than the middle connection.

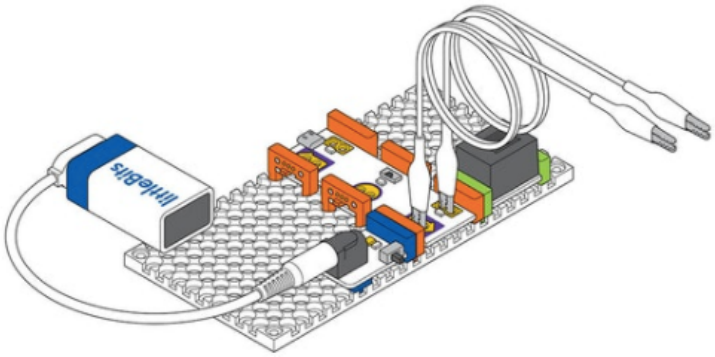


Step 3: After you have built your circuit, connect it to the mounting board. The MaKey MaKey Bit will stretch all the way across the board and attach right near the middle, allowing the buzzer Bit to settle into the corner. Make sure all the pieces are securely fastened to the board. See the picture below for exact alignment.



Meeting 5: Burglar Buzzer

Step 4: Attach one alligator clip to the left arrow pad of the MaKey MaKey Bit and another to the "earth" pad. The clips should be connected to the same section of the MaKey MaKey Bit as the power and buzzer Bits.

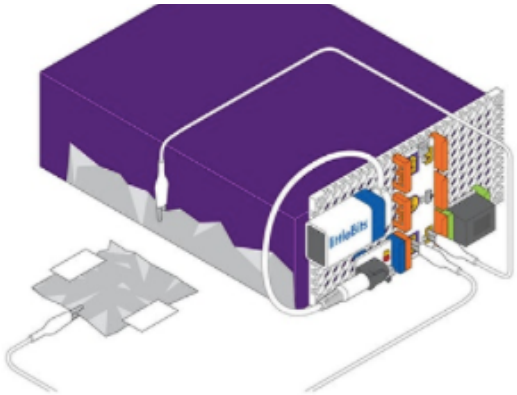


Step 5: Turn the power Bit on and take turns grasping the alligator clips in your hands to test your circuit. If you hear a buzz, you're good to go. This also confirms that you are conductive.

Step 6: Attach your circuit to the side of the littleBits box by applying tape to the backside of the board as shown in the picture below. Fold the tape so that you're only placing it on the back side of the mounting board.

Step 7: Break off a large piece of foil and tape it to the bottom of the Rule Your Room box. It should cover the entire bottom side of the box and should extend over on one side (as pictured below). Then cut out a smaller piece of foil (about 3 inches by 3 inches) and tape it to your desk or table, or to the floor.

Step 8: Place the box on your surface with the foil side down.

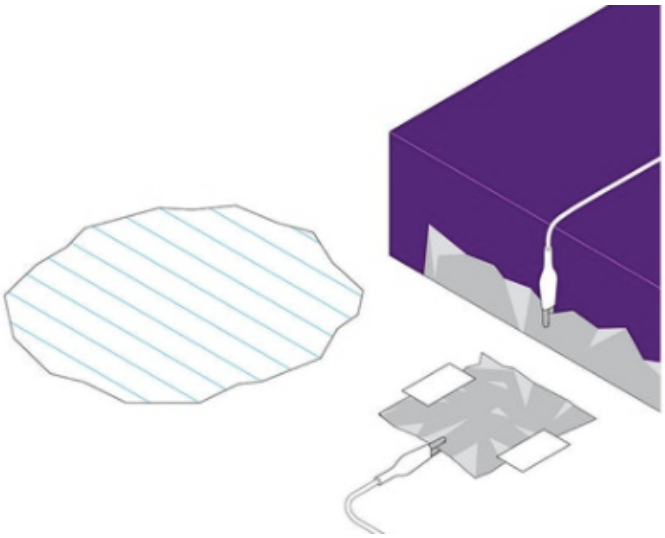


Step 9: Attach one alligator clip to each piece of foil. Aluminum foil is very conductive and is actually used in large projects, including radiation shields and cable liners.

Meeting 5: Burglar Buzzer

Step 10: Construct a "tripwire" that will cause the alarm to sound when it is moved. To do this, cut out a piece of paper slightly larger than the small piece of foil you out a piece of paper (6 inches by 6 inches should be good).

Step 11: Tape one end of your string to the paper tripwire and the other end to the object you want to protect. Your Lab Leader will provide something for you to place on the top of the littleBits box. Be sure that your string is long enough to stretch between the two objects.



Step 12: Place the tripwire over the small piece of foil so that it's completely covered, which keeps it from touching the other foil on the bottom of the box.

Step 13: Set your Rule Your Room box down on top of the tripwire. Be sure all the connections have remained intact. Now, set the object you want to protect on top of the Rule Your Room box, making sure the box stays connected to the tripwire.

Step 14: Now you're ready to see if your invention works. Pull your object off the box. Since the box is connected to the tripwire, that piece of paper should move too when you pull your object away. This will cause the two pieces of foil to meet and complete the circuit. What happens when you complete the circuit? Sound the alarm!

Step 15: If you think you've successfully created a security device to keep your object safe, challenge members from another team to find a way to steal it without setting off the alarm.

Cleanup

Turn off the power Bit, disconnect the battery, and put all the parts you used back in the Rule Your Room box.

Make sure that your kits are not missing any Bits.

Dispose of all foil and paper properly in the trash.

Meeting 5: Burglar Buzzer

STEM Innovator Moment Notes

Meeting 6: Design Your Own

Meeting 6: Design Your Own

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *clean*, as in *My team and I will clean everything up after this lab and carefully return all of the Bits to their box in the right order*.

Activity Overview

You have used the different input and output Bits to create devices that make sound as well as respond to it. What you and your team do in this final meeting is completely up to you! The goal is to use the Bits creatively to design a device that can help you accomplish a task in a unique way. The one catch is that you must use at least one object found in the room you are in. Is the object conductive? If so, this could give you an advantage if you are using the MaKey MaKey Bit. Or can you use the object to project sound more loudly? Get creative!

Meeting 6: Design Your Own

You and your team will also be responsible for documenting the steps you take during this meeting in your notebooks. You should include everything your team discusses during the meeting, including your thought process, the circuit you decided to create, why you chose this device, what it could be used for in the real world, and why it worked (or did not work). You should also include a description or drawing of the circuit you created.

Background
Sometimes the best and most useful inventions are discovered by accident. That's what you and your team may be accomplishing in this final lab as we mix and match Bits to try to create something nobody has seen before.

Safety Moment
Be aware of where your littleBits modules are at all times. They can be damaged if stepped on.

Be careful when handling the battery and some of the Bits as they may have electricity flowing through them.

Never connect the two battery terminals to any conducting material, and be sure not to get any littleBits modules wet.

Experiment
Get into teams of three.

In this meeting, you will be using the modules and parts in the Rule Your Room Kit to create your own invention. You can also use other objects you find in the room if they add to what you are trying to accomplish while working with your teammates to create a device that would be helpful in some way.

What your circuit does and how it works will be entirely up to you. You've seen plenty of examples during the first five meetings, and now your challenge is to invent something of your own.

Each team will decide what kind of circuit they want to build. You and your team will plan out the parts you need, draw up a rough sketch of what the circuit will look like, and then build it using whatever littleBits pieces you select.

Get together in your teams of three.

Materials List
- 1 littleBits™ Rule Your Room Kit
- Conductive objects (

Meeting 6: Design Your Own

Step 1: Define the Question You Want to Answer

As a team, discuss the kind of circuit you want to build. To make it more of a challenge, you could try using both of the input Bits or both of the output Bits (or all four), though you don't have to do this! For this particular lab, the big question may be: Which input Bits will help create the coolest outputs?

With your team, define and write down questions that you want to find the answers to. Possible questions include:

- Is the sound trigger Bit or the dimmer Bit a better input for the circuit you're inventing?
- What outside variables (separate from your circuit) do you think will contribute to the success or failure of your input Bit in this circuit?
- Will your output be noticeable, or do you think others will have a hard time determining what it is?

Meeting 6: Design Your Own

Step 2: Background Research

Review the information below. There are basically two types of circuits you could build. Challenge yourself to make yours as creative as possible.

Simple Circuit

- Power
- Input
- Output

Advanced Circuit

- Power
- Multiple inputs
- Multiple outputs
- Accessories

You will have access to the following components:

- Bargraph Bit
- Buzzer Bit
- Dimmer Bit
- MaKey MaKey Bit
- Power Bit
- Servo Bit
- Sound trigger Bit
- Battery and cable
- Mechanical arm
- Mounting board
- Screwdriver
- Screws
- Servo hub
- Servo mounts

Important Properties of Circuits:

- There are many potential paths for electricity to flow in a circuit.
- There is one voltage across all components in a circuit.
- When a charge flows through the wires of a circuit, a current exists.
- Charges encounter resistance when they flow through a circuit, which decreases the strength of its flow.
- A current is inversely proportional to the overall resistance present in a circuit, meaning that the more resistance there is, the less powerful the current is.
- A short circuit can be created if the positive and negative terminals of a battery are connected with a low-resistance conductor.
- When there is low resistance and a high current, there is too much energy in a short amount of time, leading to a short circuit.
- Since you will be using various inputs and outputs, you will likely have multiple variables in your experiment.

Meeting 6: Design Your Own

Step 3: **Formulate Your Hypothesis and Test Variables**

Work together to come up with your hypothesis. Decide which combination of Bits you think will work best for the particular circuit you are building, and why you believe this. Why do you think this approach is ideal for the outcome you are trying to accomplish?

Define what you are going to vary from test to test (your variables). These tests should be designed to answer the questions you had and to ultimately prove your hypothesis. A hypothesis is your best guess as to what the results of the experiment will be, based on your knowledge of the variables and the littleBits components you are using.

Scientists use their knowledge and experience to predict results, which helps them in designing an experiment. Then they run the experiment and observe to see if the results match their prediction or not.

A good way to organize this is to write down a statement in the form of: "**If I … then … because …**"

Examples:

> "**If I** use the dimmer Bit as an input, **then** my circuit will be louder than if I had used the sound trigger Bit, **because** it will be able to convert the input of light more efficiently than the input of sound."

Next, determine the variables for your experiment and write them down in the table below. There are three types of variables: independent, dependent, and control.

An independent variable is the one thing you are changing. A dependent variable is what you are testing, which will change when you change the independent variable. All the other things that do not change are your control variables.

Example:

- **Hypothesis:** "**If I** use the dimmer Bit as an input, **then** my circuit will be more effective **because** it will convert the input of light more effectively than the input of sound.t
- **Independent variable:** the input Bit
- **Dependent variable:** circuit effectiveness
- **Control variables:** power Bit and output Bit

Fill in the following to make your hypothesis:

If I _____

then _____

because _____

Meeting 6: Design Your Own

Independent Variables	
Dependent Variables	
Control Variables	

Draw out your circuit in your notebooks. Finalize as a group what you hope to accomplish by creating this circuit, and determine what it could be used for in the real world.

Lab Notebook

Meeting 6: Design Your Own

Step 4: Design the Experiment

Meeting 6: Design Your Own

You and your team should plan out what you are going to do and how you are going to do it, then write down the plan. Your plan should include the Bits you will use, how you are going to test your results, and who is going to do what on your team.

Build your circuit, and explain in your notebook why you connected the Bits in the particular order you chose. Include what your thought process was when designing and building the circuit.

Meeting 6: Design Your Own

Find at least one object in the room to include in your project. You can use this object however you would like. If it's conductive, maybe it can be a part of your circuit. If the object is valuable, maybe you can build something to protect it. Think about some of the past lab activities when deciding on an object.

Step 5: Conduct the Experiment

Now that you have your plan, go ahead and run your experiment. Don't forget to keep everyone on the team involved and to record all of your observations.

Write down how you plan to use your circuit, and test out the effectiveness of your invention.

If something interesting happens that was not in your plan or hypothesis, you can always do some more observations or testing as long as you have time.

If you do not confirm your hypothesis, make some changes and try again. Continue until you make it work, and take notes of the changes and the results in your Lab Notebook.

Meeting 6: Design Your Own

Observations:

Step 6: Analyze the Results and Draw Conclusions

As a team, review all of your observations and results.

What do these observations and results tell you about your hypothesis and your original question?

If the results and your hypothesis are different from each other, why do you think that is so? Is there another experiment you could do to explore your results more?

Summarize your experiment along the following outline:

- What was your question?
- What were your hypotheses?
- What were your variables?
- How did your experiment work out?
- What did your experiment tell you about your hypotheses and questions?
- What did you conclude from this?
- What would you do differently next time?

Meeting 6: Design Your Own

Meeting 6: Design Your Own

Step 7: Communicate the Results

Your Lab Manager will ask each team to report on the results of their experiment.

Cleanup

Turn off the power Bit, disconnect the battery, and put all the parts you used back into the tray in the littleBits Rule Your Room box.

Clean up any other supplies and throw out scraps, and return the objects you used in the room to the spot where you found them.

STEM Innovator Moment Notes
