

**WARNING:** The Wireless Burglar Alarm Electronics kit is longer available.

We will continue to look for viable alternatives and will revise Activities 2, 3, and 4 at a later date if possible. For now, we advise against using this module.

# Wireless Burglar Alarm

## Activity 1: Electric Door Trigger



Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Materials List

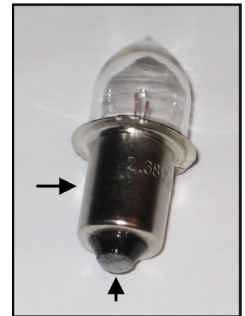
- 2 Long wires (about 3 feet)
- 2 Short wires (about 6 inches)
- AA battery
- Lamp holder
- Lamp
- Small sheet of aluminum foil
- Scotch tape or electrical tape
- Wire strippers

### Procedure

#### Part A: Basic Lamp Circuit

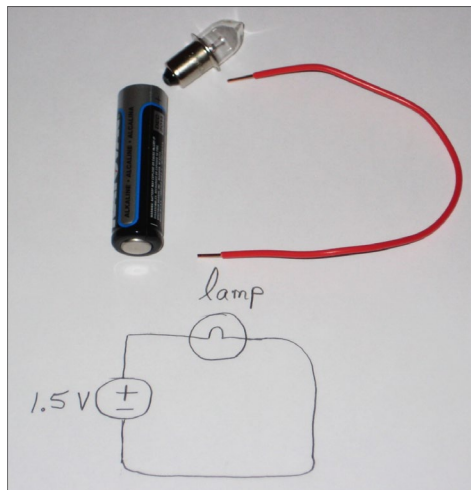
The AA battery is a source of electrical energy. The positive terminal (end) is marked with a "+" sign and has a small round metal tip. The negative terminal has a flat metal surface. Look at your AA battery closely. Can you tell which end is negative and which end is positive?

The lamp converts electricity into light. It has two terminals and electricity flows in one and out the other. The metal tip on the bottom of the lamp is one terminal and the metal case around the bottom is the other (see arrows in picture at right).



1. Look at the circuit diagram below. It shows a 1.5 V (volt) battery connected to a lamp with a wire.
2. Place your parts as shown in the diagram.
3. Can you figure out how to make the lamp light up using the battery and the wire? Work with your partner to hold the parts together.

Be very careful not to connect the ends of the battery directly together with the wire! This is a short circuit and should be avoided!

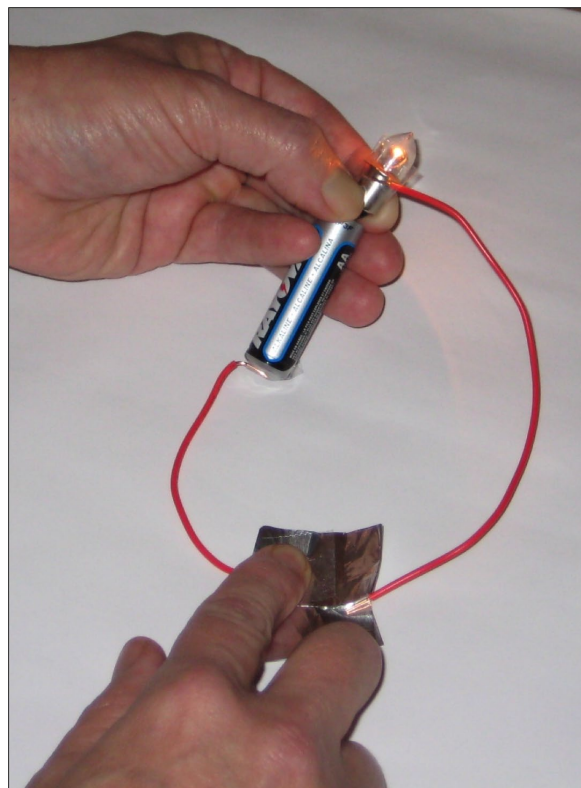
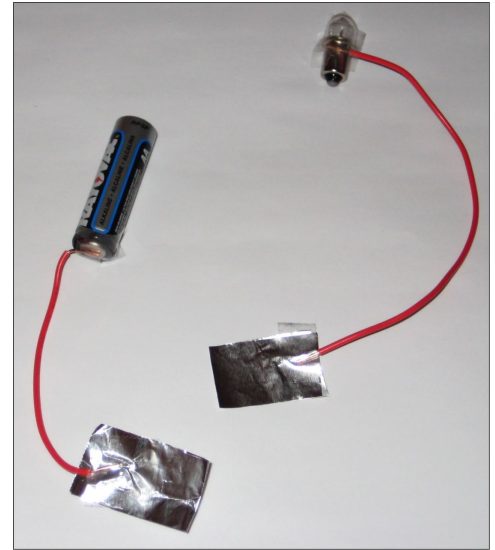


## Activity 1: Electric Door Trigger



### Part B: Foil Switch

1. Use scotch tape to connect the 1st short wire to a piece of aluminum foil and the metal case (terminal) of the lamp.
2. Then use scotch tape to connect the 2nd short wire to the negative terminal of the battery and another piece of aluminum foil. You can fold the foil to make it sturdy.
3. Hold the battery so that one terminal is touching the positive terminal of the lamp.
4. Touch the two pieces of aluminum together.
5. When you touch the two pieces of aluminum together, it makes a complete circuit and the lamp should light up.
6. The aluminum foil pieces form a switch. When the switch is closed, the circuit is closed and the lamp lights up. When the switch is open, the circuit is open and the lamp does not light up.



## Activity 1: Electric Door Trigger



### Engineering Design Challenge

How can you use a switch to determine if a door has been opened? Design a switch where two pieces of aluminum foil touch when the door is opened. Your instructor will provide you with a door, cabinet, or box that needs a protection switch.

### Design Constraints

- You may tape aluminum foil to the door, wall, floor, or box.
- If possible, the switch should complete the circuit if the door is open just a little bit or all the way.

### Testing Procedure

1. Once you have built your switch, connect the two pieces of aluminum foil to the battery and lamp as you did in Part B using the longer wires and holding the lamp and battery together.
2. Open the door (or box) and see if the light turns on.

### Exploration Questions

1. Describe how the lamp circuit works.
2. How could you improve the design of your door trigger switch?



## Activity 2: Wired Communication


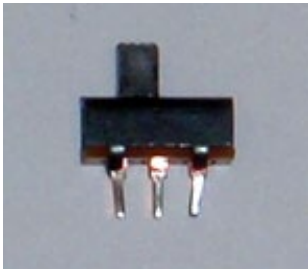
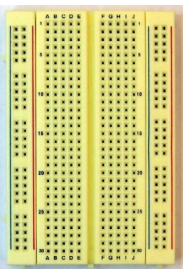
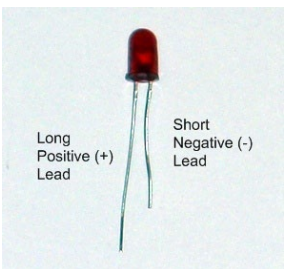


Name: \_\_\_\_\_

Date: \_\_\_\_\_

In this activity, you will be building a wired communication system. One circuit will take your message input—in the form of two switches—and convert it into an electrical signal to send over a wire. Another circuit will receive the message on that wire and display it on two LEDs. You will then be able to set the switches in order to turn the lights (LEDs) on and off.

### Part Descriptions

	<p><b>Encoder and Decoder Chips</b></p> <p>The encoder and decoder chips look nearly identical, but you can tell them apart by the silver (decoder) and gold (encoder) dots. They have 8 pins. If you orient the chip with the notch on top, the pin numbers are counted going counter-clockwise around the chip starting with the top left as shown in the circuit diagrams on the next two pages.</p>
	<p><b>Slide Switches</b></p> <p>The slide switches have three terminals. We will be using only two of these terminals. When the switch is closed, it means that the two terminals are connected together. When the switch is open, it means they are not connected. The inside of the switch has two metal pieces that join together when the switch is closed. This is like the aluminum foil pieces coming together and touching to complete a circuit in the last activity.</p>
	<p><b>Breadboard</b></p> <p>A breadboard or prototyping board is used by electrical engineers to build and test circuits. The holes make it possible for components to be connected together quickly and disconnected while testing a new circuit by pushing components into the holes. You will build your circuits on breadboards.</p>
 <p>Long Positive (+) Lead</p> <p>Short Negative (-) Lead</p>	<p><b>Light Emitting Diode (LED)</b></p> <p>A LED converts electrical energy into light of a single color. It has two metal leads. The longer lead is positive and the shorter lead is negative. A red LED is shown to the right.</p>

## Activity 2: Wired Communication



### Navigating your Breadboard

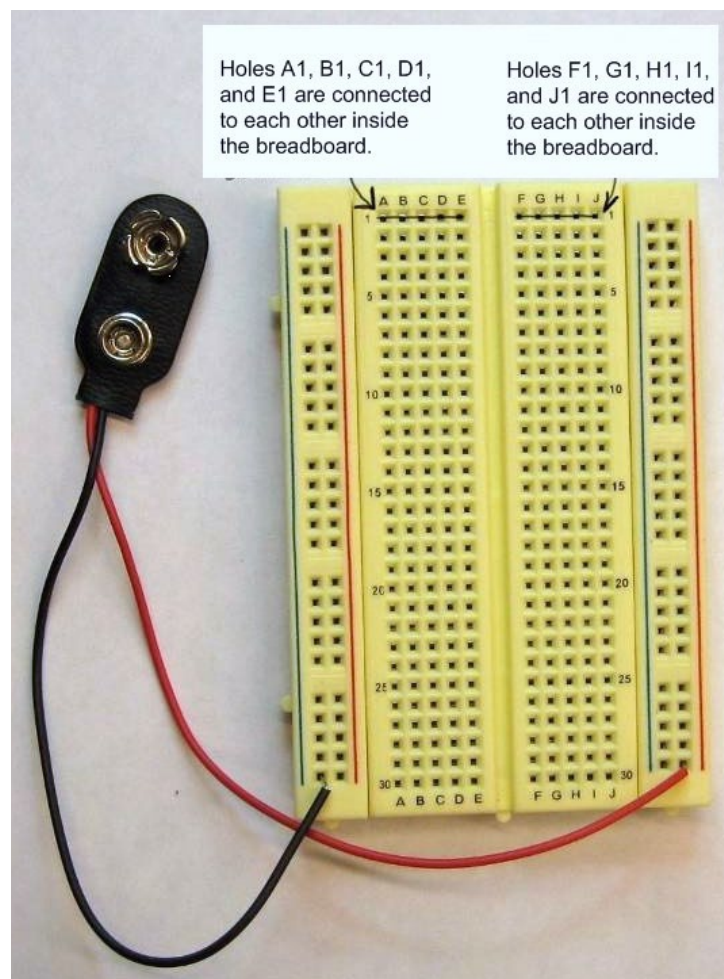
All holes in the outer vertical columns (power rails) are electrically connected inside of the breadboard. There are two power rails on the left side and two power rails on the right side. Generally, the blue power rail is negative and the red power rail is positive. In this module, we will be using one rail on each side.

Note: Some breadboards have the red and blue power rails reversed from the picture.

All five holes in each row on one side of the center are connected together inside of the breadboard. However, the five holes on the left side of the center are NOT connected to the five holes on the right side.

For example:

- A1 is connected to D1
- A1 is NOT connected to A2
- A1 is NOT connected to F1



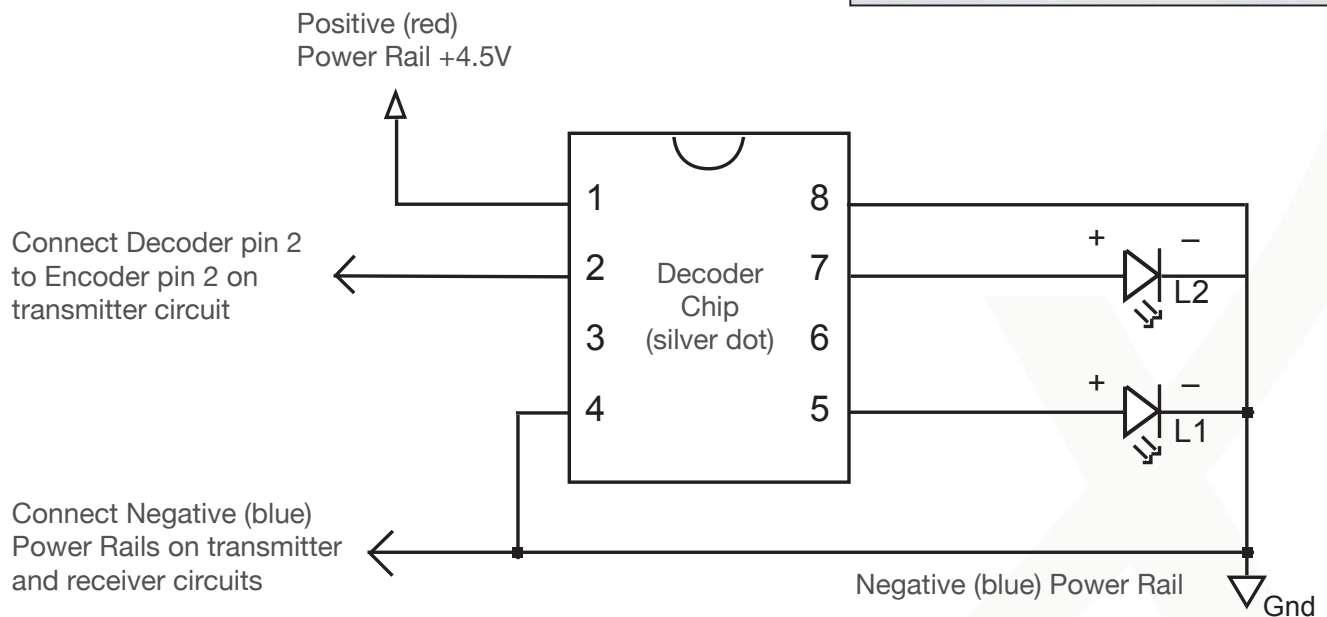
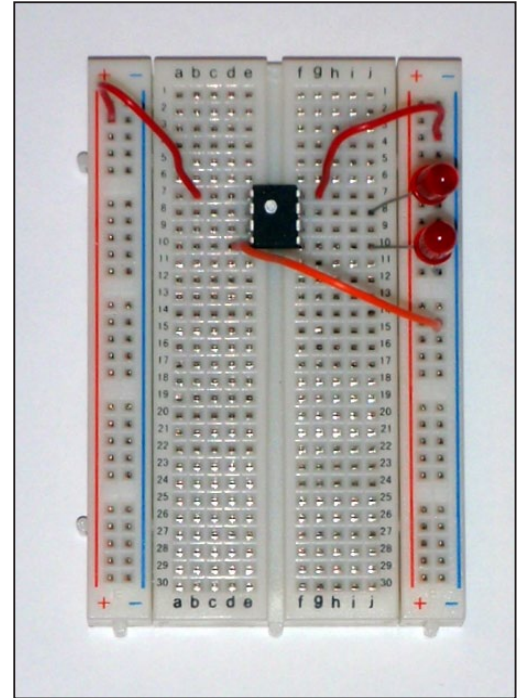
## Activity 2: Wired Communication



### Receiver Circuit Parts List

- Decoder chip with silver dot (R-8PD Decoder integrated circuit)
- L1, L2: Red LEDs
- 3 Jumper wires
- 3 AA Batteries
- Battery pack
- Breadboard

When your receiver is completed, it will look like the circuit in the picture to the right. The schematic diagram is shown below.



## Activity 2: Wired Communication



### Building the Receiver Circuit

To build the receiver circuit, place the decoder chip on the breadboard and then connect each of the chip's pins with the proper component. Once connected to the transmitter circuit, the LEDs will turn on and off based on the signal sent by the transmitter. Follow the steps below. A photo and schematic diagram are on the previous page for reference.

Step	Component	Location	Why did I just do that?
1	Decoder Chip (silver dot)	Place the chip across middle of breadboard as shown.  The notch should face the top of the board.  Bottom pins 4 and 5 should be in row 10.	The chip needs to split the middle of the board so that each of the 8 pins is connected to a separate row.
2	2" Jumper wire	Connect B7 to anywhere on the left red power rail.	Connect pin 1 of the decoder chip to anywhere on the red positive power rail on the left.
3	2" Jumper wire	Connect D10 to anywhere on the right blue power rail.	Connect pin 4 of the decoder chip to anywhere on the blue negative power rail on the right.
4	Red LED	Insert the long wire from the LED into J10 and the short wire into anywhere on the right blue power rail.	LEDs have positive and negative leads. The longer, positive lead connects to pin 5 of the decoder chip.  The negative lead connects to the blue negative power rail on the right.
5	Red LED	Insert the long wire from the LED into J8 and the short wire into anywhere on the right blue power rail.	LEDs have positive and negative leads. The longer, positive lead connects to pin 7 of the decoder chip.  The negative lead connects to the blue negative power rail on the right.
6	2" Jumper wire	Connect G7 to anywhere on the right blue power rail.	Connect pin 8 of the decoder chip to anywhere on the blue negative power rail on the right.
7	Battery pack	Don't connect the battery pack yet. The battery pack will be connected after you have connected the transmitter circuit to the receiver circuit. Next, build the transmitter circuit according to the directions.	



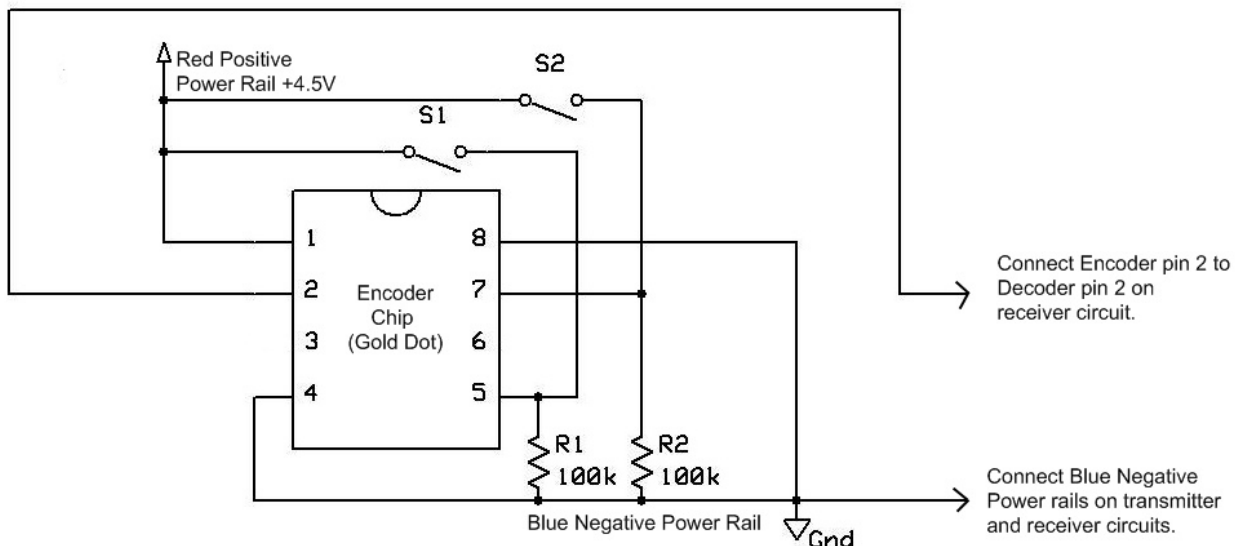
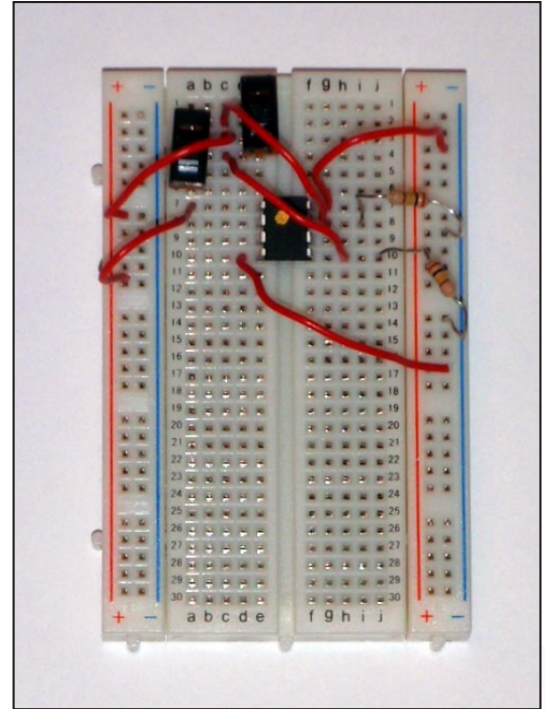
## Activity 2: Wired Communication



### Transmitter Circuit Parts List

- Encoder chip with gold dot  
(R-8PE Encoder integrated circuit)
- 3 Jumper wires
- S1, S2: Slide switches
- R1, R2: 100 k $\Omega$  Resistors (Brown, Black, Yellow)
- 3 AA Batteries
- Battery pack
- Breadboard

When your transmitter is completed, it will look like the circuit in the picture to the right. The schematic diagram is shown below.



## Activity 2: Wired Communication



### Building the Transmitter Circuit

To build the transmitter circuit, put the encoder chip in place and then connect each pin of the chip to the proper component as you did while building the receiver circuit. The switches allow you to tell the transmitter what message to send. The resistors limit the flow of electricity when the switches are on so the LEDs do not break. In later activities, one of the switches will be replaced with your door trigger so that the transmitter will tell the receiver when the door is opened.

Step	Component	Location	Why did I just do that?
1	Encoder Chip (gold dot)	Place the chip across middle of breadboard. The notch should face the top of the board. Bottom pins 4 and 5 should be in row 10.	The chip needs to split the middle of the board so that each of the 8 pins is connected to a separate row.
2	2" Jumper	Connect C7 to anywhere on the left red power rail.	Connect pin 1 of the decoder chip to anywhere on the red positive power rail on the left.
3	2" Jumper	Connect D10 to anywhere on the right blue power rail.	Connect pin 4 of the encoder chip to anywhere on the blue negative power rail on the right.
4	S1	Place the pins of the switch in A3, A4, and A5. Ensure the pins are in the correct holes by looking under it as you begin to insert it into the breadboard.	Place switch S1 on breadboard. Direction is not important.
5	S2	Place the pins of the switch in E1, E2, and E3. Ensure the pins are in the correct holes by looking under it as you begin to insert it into the breadboard.	Place switch S2 on breadboard. Direction is not important.
6	2" Jumper	Connect C3 to anywhere on the left red power rail.	This connects both switches to the red positive power rail on the left since both switches are already connected to row 3.
7	2" Jumper	Connect C2 to G8.	Connect the middle pin of switch S2 to pin 7 of the encoder chip.
8	2" Jumper	Connect C4 to H10.	Connect the middle pin of switch S1 to pin 5 of the encoder chip.
9	R1	Connect resistor J10 to anywhere on the right blue power rail.	Connect 100 kΩ resistor (Brown, Black, Yellow) R1 between pin 5 of the encoder chip and right negative power rail.
10	R2	Connect resistor I8 to anywhere on the right blue power rail.	Connect 100 kΩ resistor (Brown, Black, Yellow) R2 between pin 7 of the encoder chip and right negative power rail.
11	2" Jumper	Connect G7 to anywhere on the right blue power rail.	Connect pin 8 of the encoder chip to anywhere on the blue negative power rail on the right.
12	Battery pack	Don't connect the battery pack yet. Move on to the next section.	

## Activity 2: Wired Communication

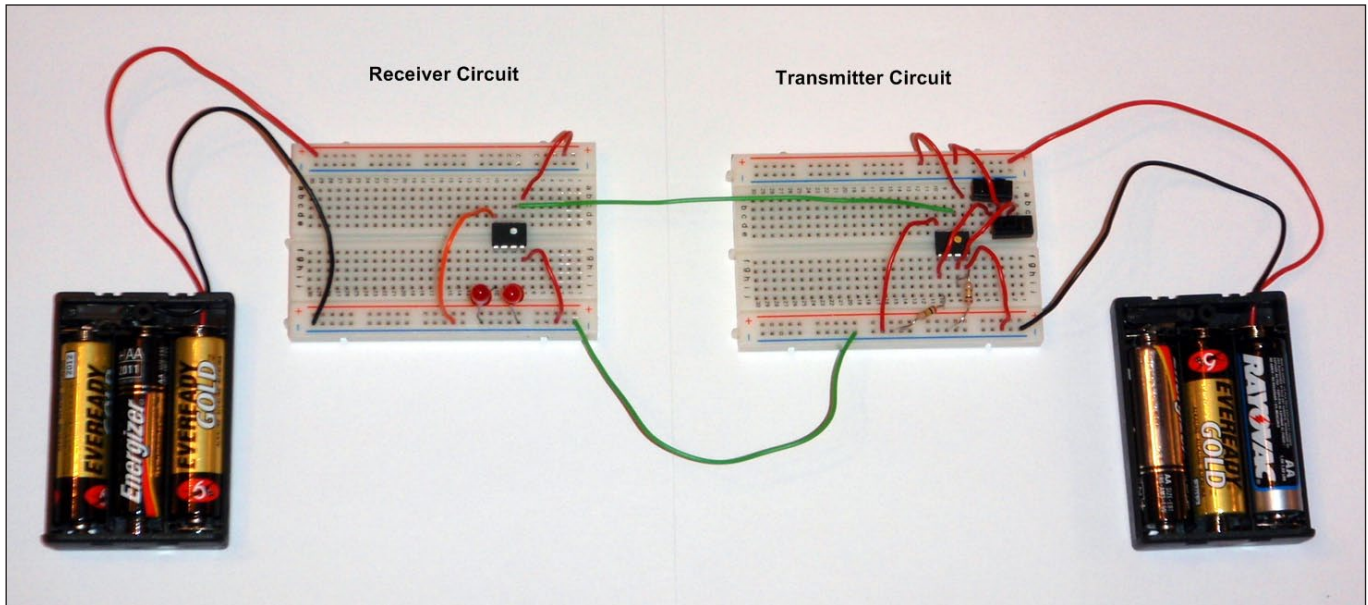


### Connecting the Transmitter and Receiver

You will now connect the transmitter to the receiver. Once connected, each switch should operate one of the two LEDs. Your two long wires will be used to connect the transmitter and receiver circuits. The transmitter and receiver can be as far apart as these wires allow. The switches on the transmitter code information that is sent over the two long wires from the transmitter to the receiver.

Step	Component	Location	Why did I just do that?
1	Long wire	Connect the <b>transmitter right blue rail</b> to the <b>receiver right blue rail</b> .	Connect long wire from the transmitter blue negative power rail to the receiver blue negative power rail.  This wire provides a ground for the two circuits.
2	Long wire	Connect <b>transmitter C8</b> to <b>receiver C8</b> .	Connect the other long wire from pin 2 of the encoder chip to pin 2 of the decoder chip.  This transmits the signal.
3	Receiver Battery Pack	Connect red wire of battery pack anywhere on the <b>receiver left red rail</b> .  Connect the black wire of the battery pack anywhere on the <b>receiver right blue rail</b> .	This provides power for the receiver.
4	Transmitter Battery Pack	Connect red wire of battery pack anywhere on the <b>transmitter left red rail</b> .  Connect the black wire of the battery pack anywhere on the <b>transmitter right blue rail</b> .	This provides power to the transmitter circuit.  If we used a long wire connecting the left red positive power rails in the 2 circuits, we would not need 2 battery packs for this activity. However, in the next activity, we will remove the wires to transmit the signal wirelessly and we will need 2 battery packs.
5	Testing and Troubleshooting	Try flipping each switch and make sure that it controls an LED on the receiver.  If either of the LEDs do not work, move on to the troubleshooting section to figure out what is wrong.	

## Activity 2: Wired Communication



### Troubleshooting

If one or both LEDs are not working when you move the switches, you will need to troubleshoot your circuit. Troubleshooting is the process of figuring out why a circuit does not work. It is a very important part of being an electrical engineer. The problem with the circuit will be one of the mistakes listed below. You must go through each step carefully until you find and correct the problem.

1. Check that the LED is not inserted backwards. The shorter, negative, lead should be connected to the blue negative power rail.
2. Check that the transmitter circuit has the encoder chip (gold dot) and the receiver circuit has the decoder chip (silver dot).
3. Are there any rows in either breadboard with only one hole out of five filled? If so, that component is not connected to anything. Look at the circuit diagram/instructions and see what it should be connected to.
4. Check to make sure each component is connected to the correct other components. Start with the encoder and decoder chips. The tables on the next page provide a reference for what should be connected to each pin. Note that some of these connections may be made through jumpers rather than having that particular component connected directly to the pin. After checking the connections to the chips, check the other connections in the circuit.
5. The batteries may be dead. Try a different battery pack or new batteries.
6. Check for connections that are in the correct location but may be loose.
7. If all else fails, try replacing the encoder and decoder chips one at a time.



## Activity 2: Wired Communication



Encoder Chip Pin Table

Pin	Connections
1	Red positive power rail Switch S1 Switch S2
2	Encoder chip pin 2 should be connected to decoder chip pin 2 on the other breadboard (receiver circuit)
3	Not connected to anything
4	Blue negative power rail
5	Switch S1 100 k $\Omega$ resistor (Brown, Black, Yellow)
6	Not connected to anything
7	Switch S2 100 k $\Omega$ resistor (Brown, Black, Yellow)
8	Blue negative power rail

Decoder Chip Pin Table

Pin	Connections
1	Red positive power rail
2	Decoder chip pin 2 should be connected to encoder chip pin 2 on the other breadboard (transmitter circuit)
3	Not connected to anything
4	Blue negative power rail
5	Longer positive lead of LED L1
6	Not connected to anything
7	Longer positive lead of LED L2
8	Blue negative power rail

### Exploring the Wired Transmitter and Receiver

You now have a transmitter and receiver that are connected by two wires. Imagine that the transmitter is in the kitchen at your house and the receiver with two LEDs is in your bedroom connected with long wires between your bedroom and kitchen. Your Mom or Dad can use those switches to turn the two LEDs in your room on and off.

How many messages can your parents send to you in your room by turning the LEDs on and off? Describe how they would send the messages.

## Activity 3: Wireless Communication

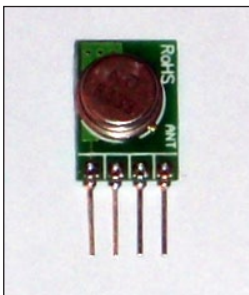


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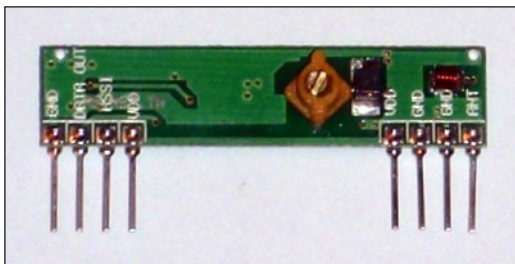
In this activity, you will be modifying your wired communication system to make it wireless. In the end, the transmitter/receiver pair will behave exactly the same as it did with the wired system, except that the wire transmitting the data has been replaced with a radio frequency (RF) link. The only additional components in these circuits are the RF transmitter chip and the RF receiver chip.

### Part Descriptions



#### RF Transmitter Chip

The RF Transmitter Chip takes the electrical signal from the decoder and radiates it as a radio signal. This radio signal is transmitted in all directions.



#### RF Receiver Chip

The RF Receiver Chip receives the radio signal sent by the transmitter. It is connected to the decoder where the wire was connected in the wired system.

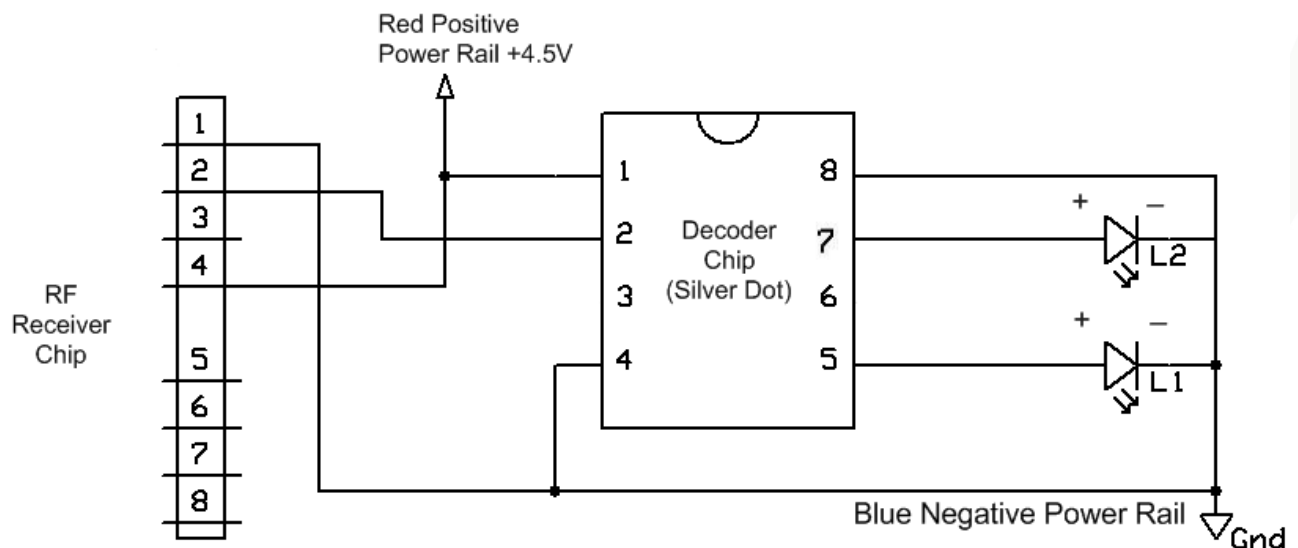
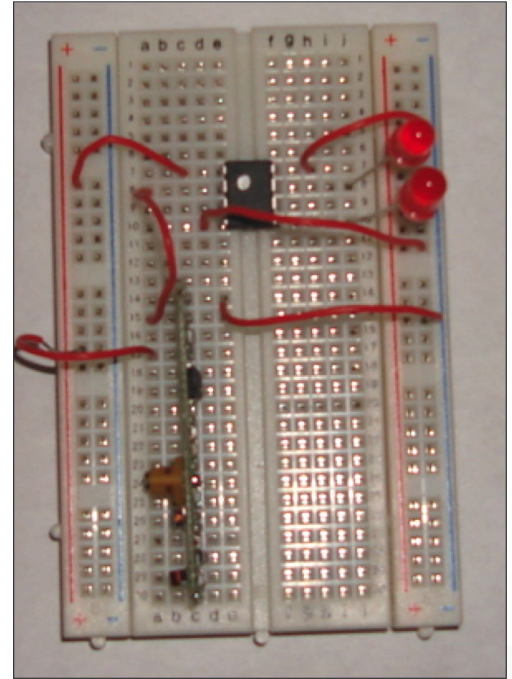
Radio signals are sent at different frequencies. This receiver operates at the same radio frequency as the transmitter, 433 MHz.

## Activity 3: Wireless Communication



### RF Receiver Circuit Parts List

- Receiver circuit from Activity 2 with decoder chip (silver dot)
- RF Receiver chip
- Jumper wires
- 3 AA Batteries
- Battery pack



## Activity 3: Wireless Communication



### Building the RF Receiver Circuit

Before modifying your current receiver circuit, connect your transmitter and receiver circuits from the last activity to make sure they are still working. If they do not work, follow the troubleshooting steps in Activity 2. Disconnect your battery pack before you begin changing the circuit according to the steps below.

Now, you will remove the wire links between the transmitter and receiver and replace the wires with radio frequency (RF) transmitter and receiver chips.

Step	Component	Location	Why did I just do that?
1	Battery pack	If connected, disconnect the battery pack from the transmitter and receiver.	Working on the circuit while the power is connected can be damaging to components.
2	Long wires	If connected, disconnect two long wires connecting transmitter and receiver circuits.	This version is going to transmit the signal wirelessly. The RF transmitter and receiver chips will replace the wire.
3	RF Receiver chip	Insert the RF receiver chip so that the text and copper wire loop face to the left, and so that the bottom pin is in the bottom row of the breadboard (row 30). Pin 1 should be in <b>C14</b> and pin 8 in <b>C30</b> .	Insert the RF receiver chip into the breadboard. Make sure all the pins are in the same column of the breadboard and are not bending. Do not put the RF receiver chip in a power rail.
4	2" Jumper	Connect <b>E14</b> to the <b>right blue</b> rail.	Connect pin 1 of the RF receiver chip to anywhere on the blue negative power rail on the right.
5	2" Jumper	Connect <b>A17</b> to <b>left red</b> rail.	Connect pin 4 of the RF receiver chip to the red positive power rail on the left.
6	2" Jumper	Connect <b>A16</b> to <b>C8</b> .	Connect pin 2 of the RF receiver chip to pin 2 of the decoder chip. This will carry the signal.
7	Battery pack	Don't connect the battery pack yet. The battery pack will be connected <b>after</b> you have completed the transmitter circuit. Next, build the transmitter circuit according to the directions. In your group, some students may not build transmitters. In this case, borrow one of your friends' transmitters.	

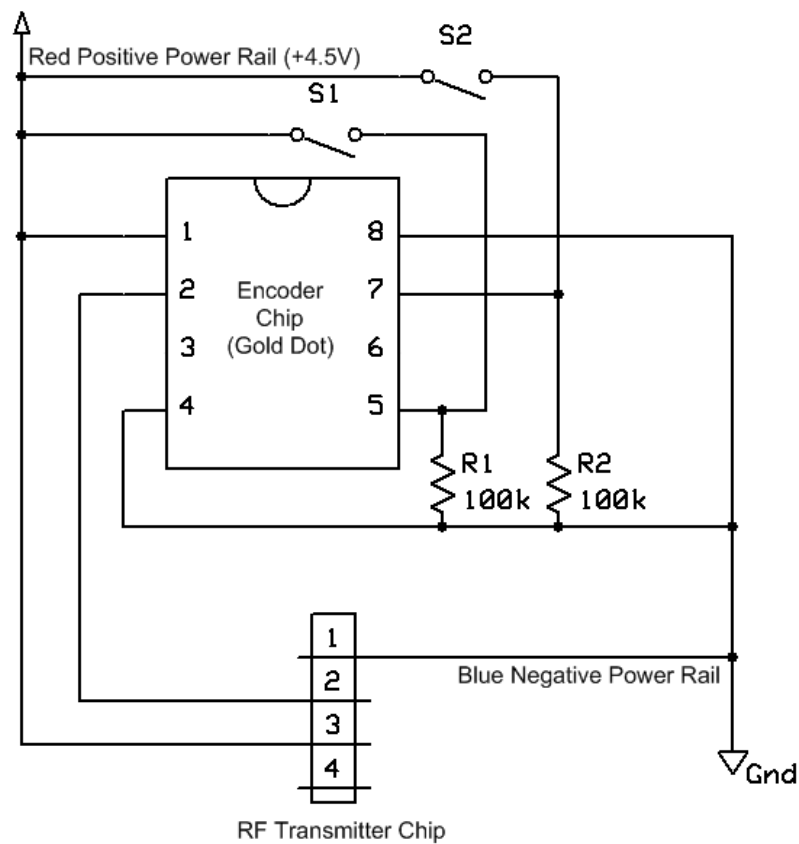
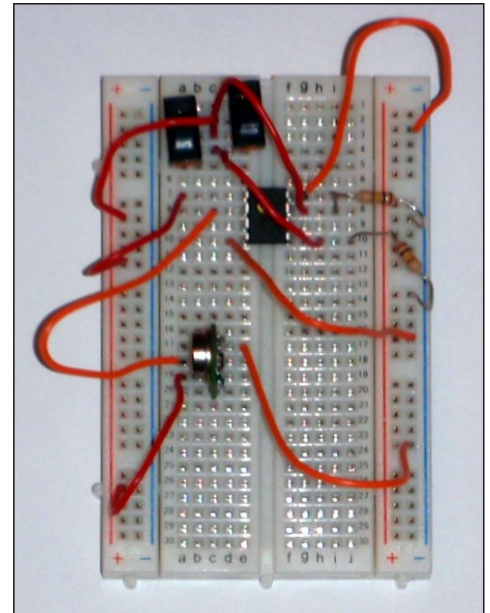


## Activity 3: Wireless Communication



## RF Transmitter Circuit Parts List

- Transmitter circuit from Activity 2 with encoder chip (gold dot)
- RF Transmitter chip
- Jumper wires
- 3 AA Batteries
- Battery pack



## Activity 3: Wireless Communication



### Building the RF Transmitter Circuit

Now, you'll modify your transmitter circuit to use the RF transmitter chip in the same way you modified the receiver circuit. Only one transmitter may be tested in the room at one time, so your instructor may ask that you bring your transmitter up to the front of the room to test it.

Step	Component	Location	Why did I just do that?
1	Battery pack	If connected, disconnect the battery pack from the transmitter and receiver.	Working on the circuit while the power is connected can be damaging to components.
2	RF Transmitter Chip	Insert the RF transmitter chip so that the text and silver disc face to the left, and so that the bottom pin is in row 20. Place <b>pin 1</b> in <b>C17</b> and <b>pin 4</b> in <b>C20</b> .	Insert the RF transmitter chip into the breadboard. Make sure all the pins are in the same column of the breadboard and are not bending. Do not put the RF transmitter chip in a power rail.
3	2" Jumper	Connect <b>E17</b> to the <b>right blue</b> rail.	Connect pin 1 of the RF transmitter chip to anywhere on the blue negative power rail on the right.
4	2" Jumper	Connect <b>A19</b> to the <b>left red</b> rail.	Connect pin 3 of the RF transmitter chip to the red positive power rail on the left.
5	2" Jumper	Connect <b>A18</b> to <b>C8</b> .	Connect pin 2 of the of the RF transmitter chip to pin 2 of the encoder chip.  This will carry the signal.
6	Battery pack	Instructions for connecting your battery packs are on the following page.	

## Activity 3: Wireless Communication



### Testing the RF Transmitter and Receiver

This circuit should operate exactly the same as the wired one from Activity 2, the only change you've made is to replace the wired connection between the breadboards with a wireless one. The electrical signal goes from the encoder chip to the RF transmitter chip, which then transmits the radio signal. The RF receiver chip receives the radio signal and sends the electrical signal to the decoder. The decoder interprets the signal and determines which LEDs to turn on.

Step	Component	Location
1	Receiver Battery Pack	Connect red wire of battery pack to anywhere on the left red positive power rail of the receiver.  Connect the black wire of the battery pack to anywhere on the right blue negative power rail of the receiver.
2	Transmitter Battery Pack	Connect red wire of battery pack to anywhere on the left red positive power rail of the transmitter.  Connect the black wire of the battery pack to anywhere on the right blue negative power rail of the transmitter.
3	Test Circuit	Try flipping each switch to make sure that it controls an LED on the receiver.
4	Troubleshooting	If either of the LEDs do not work, move on to the troubleshooting section to figure out what is wrong.

### Troubleshooting

It is possible that one or both of the LEDs will flash rather than shining constantly. This is normal. If one or both LEDs are not working at all when you move the switches, you will need to troubleshoot your circuit. The problem with the circuit will be one of the mistakes listed below. You must go through each step carefully until you find and correct the problem.

1. Follow troubleshooting steps from Activity 2.
2. Check that the RF transmitter and RF receiver chips are both inserted with their wording to the left.
3. Check the connection to each pin of the RF transmitter and RF receiver chips.

## Activity 3: Wireless Communication



### Exploring the Wireless Transmitter and Receiver

Only one group at a time can test its transmitter. All of the other groups will test their receiver circuits based on the signals from this single transmitter circuit.

1. How reliable is the wireless communication? Turn one of the LEDs on and try to block the signal by putting objects between the transmitter and receiver.
2. Are you able to break the link? (If the LED starts flashing, this typically means the receiver is not getting a strong signal).
3. How far can you separate the transmitter from the receiver before they start to lose the connection? Record the distance in the table below.
4. Insert a wire (2" jumper or longer) into the breadboard row connected to pin 4 of the RF transmitter chip (RF transmitter circuit hole E20). This will act as an antenna. Record the distance that you can now separate your transmitter and receiver.
5. You can also try using an antenna on the receiving end by putting a wire (2" jumper or longer) into pin 8 of the RF receiver (RF receiver circuit hole E30). Record the distance that you can now separate your transmitter and receiver.

	Distance before losing signal
No antenna	
Antenna on RF transmitter	
Antenna on RF reciever	

### Exploration Questions

1. What are advantages of using an RF transmitter and receiver compared to a wired transmitter and receiver?
2. What might be some advantages of the wired system you built last time over the wireless system you built today?



## Activity 4: Sounding the Alarm



Name: \_\_\_\_\_

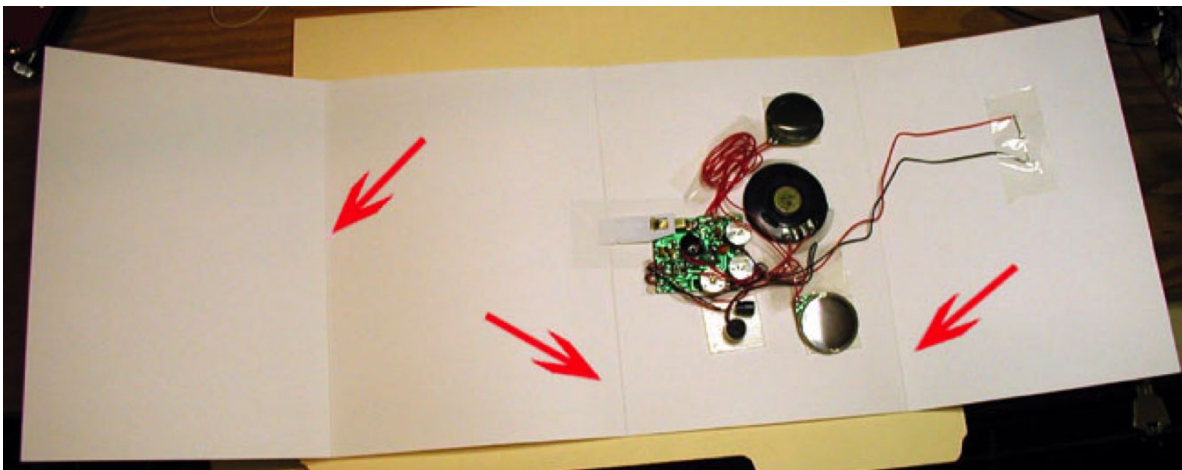
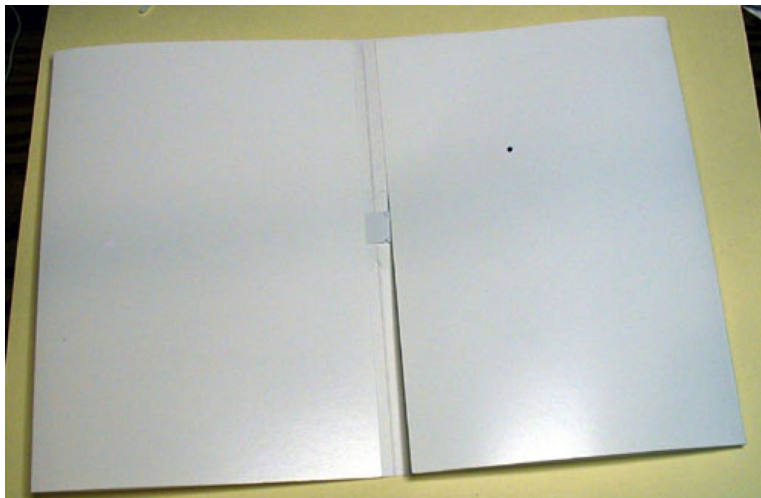
Date: \_\_\_\_\_

In this activity, you will be defining an engineering problem and putting together an alarm system. First, you will learn how to use the sound recording modules. Note that your sound recording module may be different than the ones shown. Second, you can use the sound recording module, the transmitter and receiver circuit, and two door trigger switches to build a prototype alarm system demonstrating your idea.

### Using the Sound Recording Module

Note: If your card is different than the one shown, follow the instructions provided with your card.

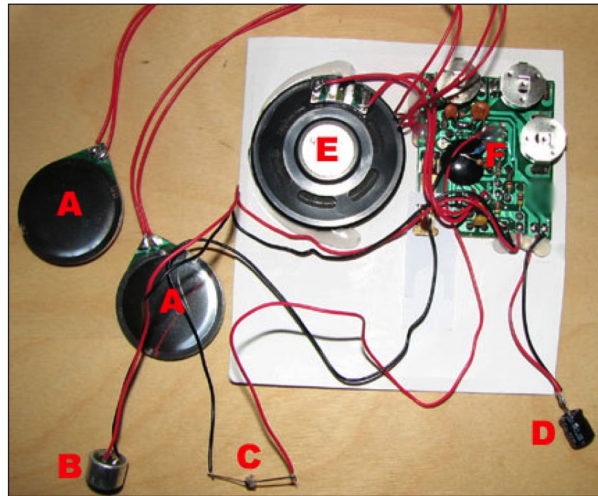
1. Open the card and locate the sound recording module on the right side. Carefully tear open this part of the card if it has not been opened already. You will see the sound recording module.



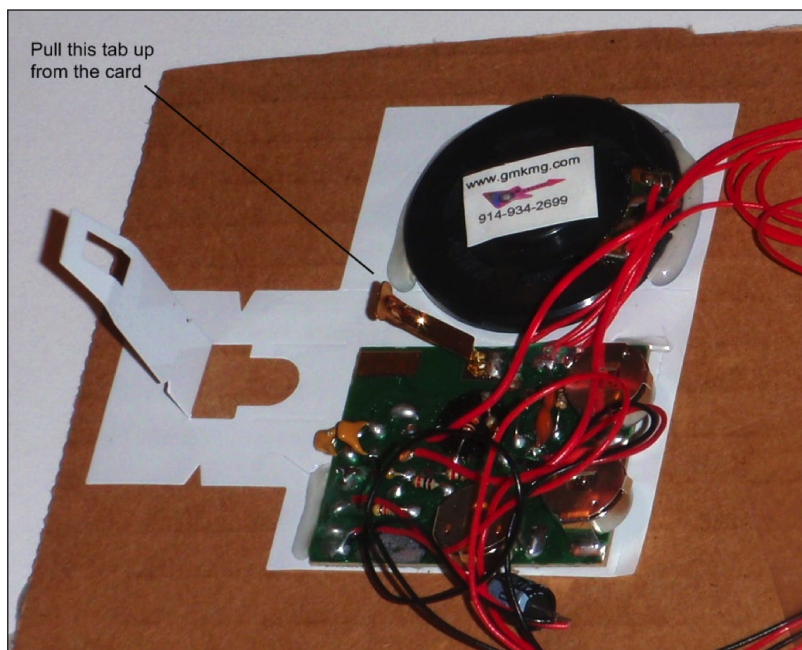
## Activity 4: Sounding the Alarm



2. Identify each of the parts of the sound recording module labeled A-F in the picture below: (A) record buttons, (B) microphone, (C) red LED record indicator, (D) audio filter, (E) speaker, and (F) circuit board.



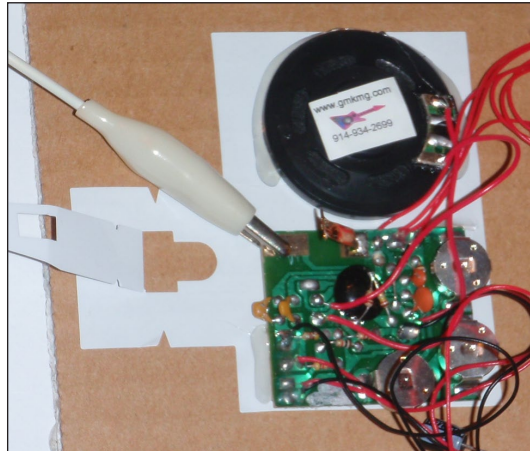
3. Recording: Press the two record buttons (A) together until they click and the LED (C) lights up. This indicates the module is recording. Speak into the microphone (B). You will have about 10 seconds of record time.
4. Playing: If it has not already been opened, pull the tab up that completes the circuit when the card opens. This is the switch on the card. Pressing this tab down will play the current sound on the card.



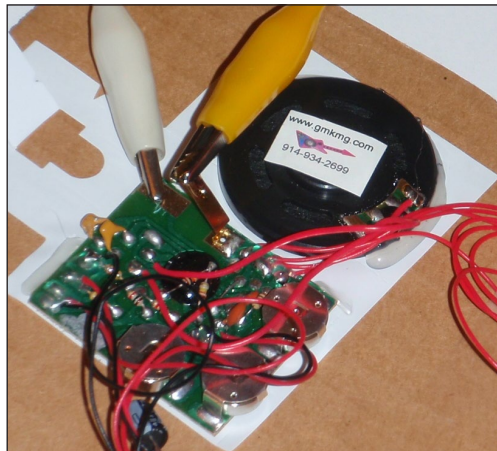
## Activity 4: Sounding the Alarm



5. Connect one wire with an alligator clip to the lower metal contact (located on the top of the circuit board). See alligator clip below.



6. Connect another wire with an alligator clip to the metal tab you pulled up from the board in Step 4.



7. Touch the ends of these two alligator clip wires together. The card will play because the circuit is completed.

## Activity 4: Sounding the Alarm



### Materials List

- Aluminum foil door trigger(s)
- RF Transmitter circuit
- RF Receiver circuit
- Sound recording module
- Jumper wires
- Alligator clip wires
- Scotch tape
- Wire strippers
- Additional aluminum foil
- Additional long wires

### Engineering Design Challenge

In most TechXcite activities, the engineering design problem is provided to you. In this activity, you will define the problem that you will solve with your alarm system. The problem should be specific and describe where you will use your alarm (ex: a door, room, or box with something particular in it).

Describe what your alarm is protecting:

### Design Constraints

Engineers design their solutions to problems within specific constraints. Describe your own alarm specifications. This is what you would expect your alarm to do once complete. The prototype you will be building to demonstrate your idea does not need to meet all of these specifications. Examples: the trigger is waterproof if it is outside or the receiver is shockproof and may be dropped from 6 feet.

Describe the constraints and specifications for your design:



## Activity 4: Sounding the Alarm



### Warning the Burglar

In order to warn the burglar, you may record an appropriate warning for your alarm on the card module. Then, you might design a second door switch for the same door and connect the card to it. This is a challenge, but with the information provided above, you can do it.

### Connecting the Receiver to the Door

1. Remove the jumper wire currently connected to hole H10 from the transmitter board (If not in H10, this could be in G10, I10, or J10).
2. On the transmitter circuit, insert one end of a 2" jumper wire into the row containing pin 5 of the encoder chip on the transmitter circuit (G10).
3. Insert one end of another 2" jumper wire into the positive power rail (left red rail). There should now be two jumper wires sticking up out of the board.
4. Use the alligator clips to connect the two contacts from the door trigger circuit to the two jumper wires that are sticking up. You may ask your instructor for longer wires if necessary.
5. Remove switch S1 (pins in A3, A4, and A5). The door trigger switch is replacing S1.

At this point, when the door opens, the RF transmitter will turn on LED L1 warning you that someone has opened the door.

### Exploration Questions

1. Explain how your RF wireless burglar alarm system works.
2. What are the major parts of your system?
3. What parts (not included in the prototype) would you include in your actual alarm to meet the design constraints above?