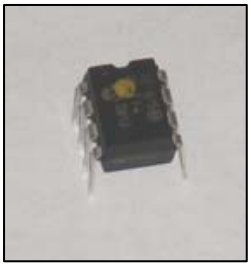
Activity 2: Wired Communication Student Handout

Name: _____

Date: _____

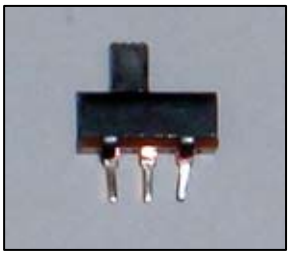
In this activity, you will be building a wired communication system. One circuit will take your message input, in the form of two switches, and convert it into an electrical signal to send over a wire. Another circuit will receive the message on that wire and display it on two LEDs. You will then be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

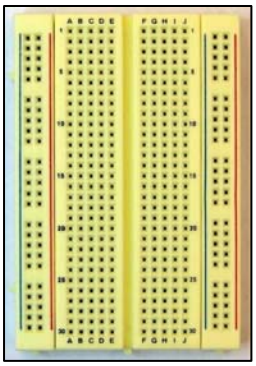
Parts Descriptions



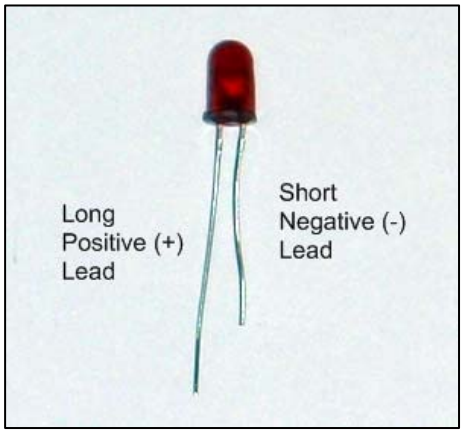
Encoder and Decoder Chips
The encoder and decoder chips look nearly identical, but you can tell them apart by the silver (decoder) and gold (encoder) dots. They have 8 pins. If you orient the chip with the notch on top, the pin numbers are counted going counter-clockwise around the chip starting with the top left as shown in the circuit diagrams on the next two pages.

Slide Switches
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.



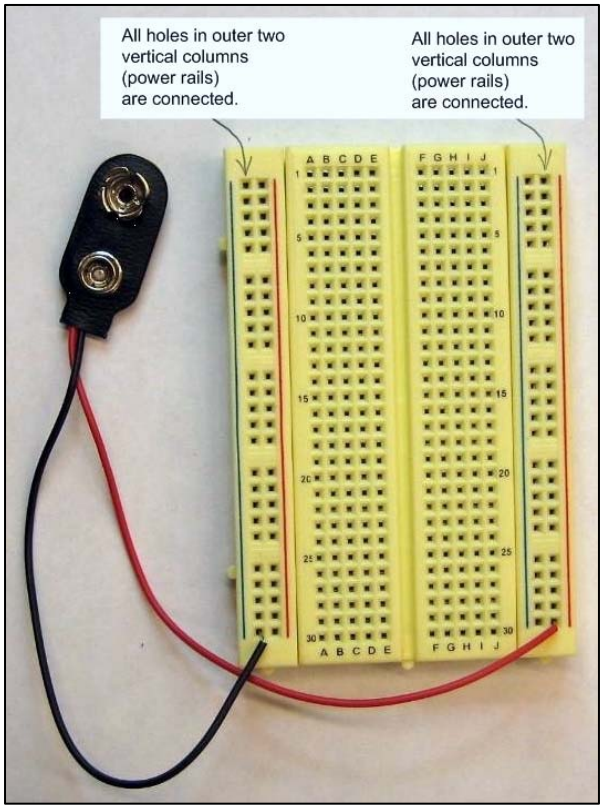


Breadboard
A breadboard or prototyping board is used by electrical engineers to build and test circuits. The holes make it possible for components to be connected together quickly and disconnected while testing a new circuit by pushing components into the holes. You will build your circuits on breadboards.



LED
A **Light Emitting Diode**, or **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.

Navigating your Breadboard



All 25 holes in a column of a power rail are connected together inside of the breadboard. There are two power rails on the left side and two power rails on the right side. We will use one power rail on the left and one on the right.

We will make the blue power rail negative and the red power rail positive.

Note: Some breadboards have the red and blue power rails reversed from the picture. Look closely at your breadboard to see where your red and blue rails are located.

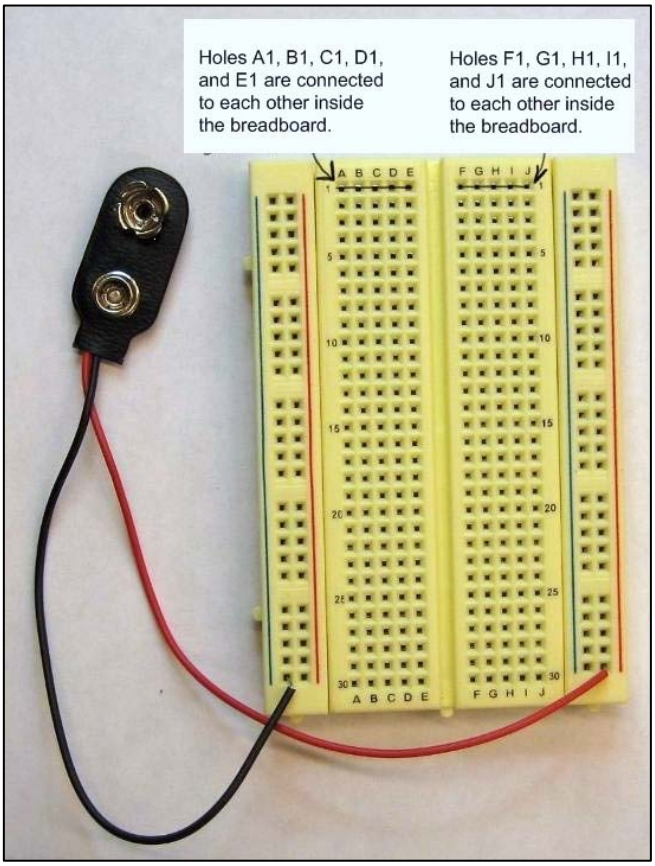
All five holes in one row on one side of the center are connected together inside the breadboard. The five holes on one side of the center are NOT connected to the five holes on the other side.

Examples:

A1 is connected to D1.

A1 is NOT connected to A2.

A1 is NOT connected to F1.



Steps for Building Receiver Circuit

The general plan for building the receiver circuit is to put the decoder chip in place and then connect each of the pins of the chip 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.

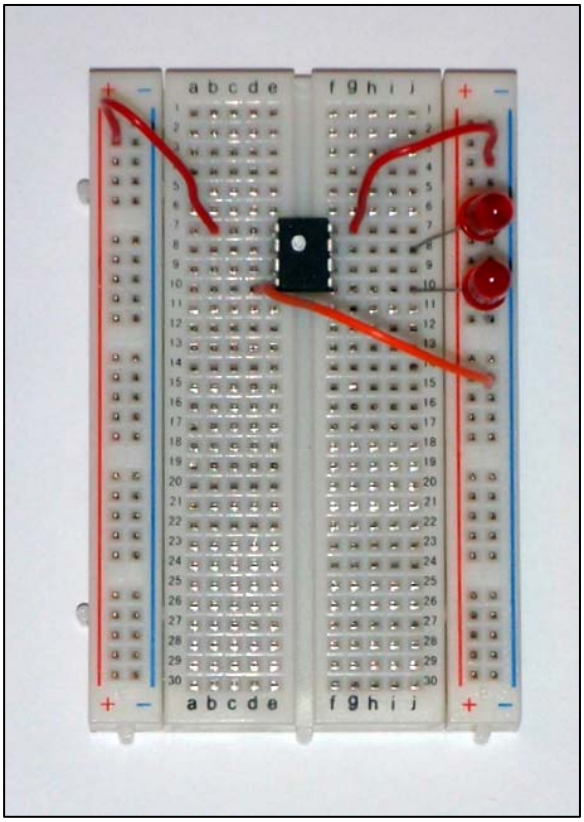
Step	Component	Placement Location *(Suggested holes)*
1	Decoder Chip (Silver Dot)	• Place the chip across middle of breadboard as shown. • *(The notch should face the top of the board)* • *(Bottom pins 4 and 5 should be in row 10)*
2	2" jumper	• Connect pin 1 of the decoder chip to anywhere on the red positive power rail on the left. • (*B7 to left red rail)*
3	2" jumper	• Connect pin 4 of the decoder chip to anywhere on the blue negative power rail on the right. • *(D10 to right blue rail)*
4	Red LED	• LEDs have positive and negative leads. The longer, positive lead connects to pin 5 of the decoder chip. • Connect red LED between pin 5 and anywhere on the blue negative power rail on the right. • *(Long lead in J10, shorter lead to right blue rail)*
5	Red LED	• LEDs have positive and negative leads. The longer, positive, lead connects to pin 7 of the decoder chip. • Connect red LED between pin 7 and anywhere on the blue negative power rail on the right. • *(Long lead in J8, shorter lead to right blue rail)*
6	2" jumper	• Connect pin 8 of the decoder chip to anywhere on the blue negative power rail on the right. • *(G7 to right blue rail)*
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.

Receiver Circuit

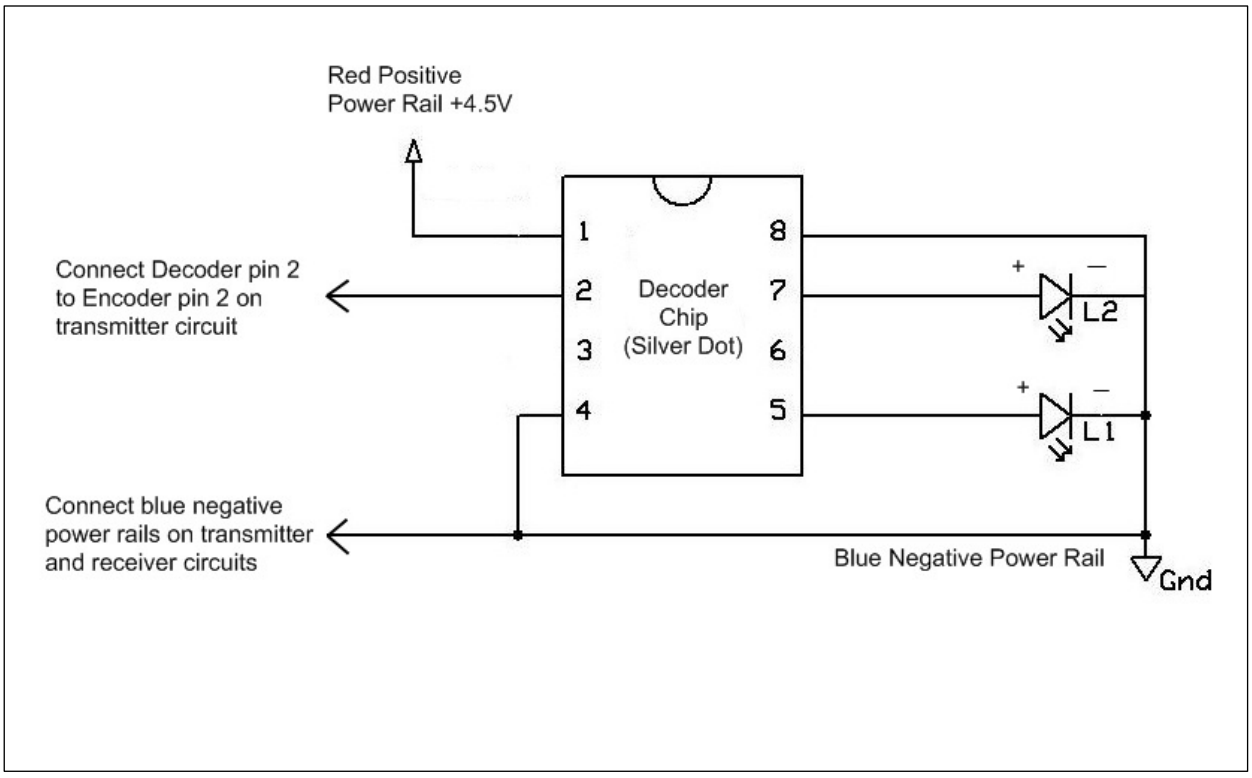
Receiver Parts

- 1 Decoder chip with silver dot (R-8PD Decoder integrated circuit)
- L1, L2: Red LEDs
- 2” Jumper Wires
- 3 AA Batteries
- Battery case
- Breadboard

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



Receiver Circuit Diagram

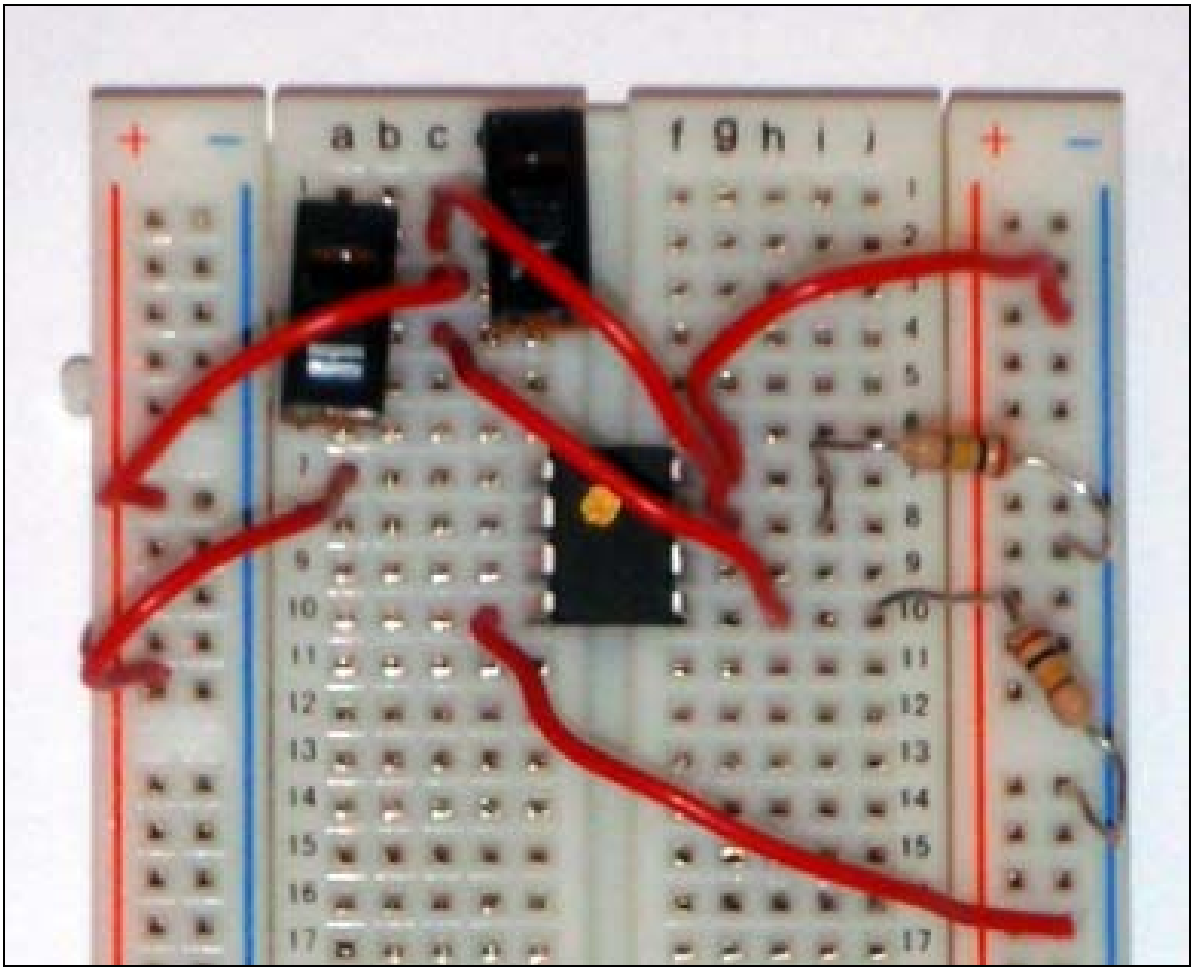


Steps for Building Transmitter Circuit

The general plan for building the transmitter circuit is to put the encoder chip in place and then connect each of the pins of the chip with 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	Placement Location *(Suggested holes)*
1	Encoder Chip (Gold 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)*
2	2” jumper	• Connect pin 1 of the encoder chip to anywhere on the red positive power rail on the left. • (*C7 to left red rail)*
3	2” jumper	• Connect pin 4 of the encoder chip to anywhere on the blue negative power rail on the right. • *(D10 to right blue rail)*
4	S1	• Place switch S1 on breadboard. Direction is not important. • *(Pins in A3, A4, and A5)*
5	S2	• Place switch S2 on breadboard. One of its pins should be in the same row as one of the pins of switch S1. Direction is not important. • *(Pins in E1, E2, and E3)*
6	2” jumper	• Connect one outer pin of both switches to the red positive power rail on left. This is the row that both switches are connected to. • *(C3 to left red rail – both switches connected to row 3)*
7	2” jumper	• Connect the middle pin of switch S2 to pin 7 of the encoder chip. • *(C2 to G8)*
8	2” jumper	• Connect the middle pin of switch S1 to pin 5 of the encoder chip. • *(C4 to H10)*

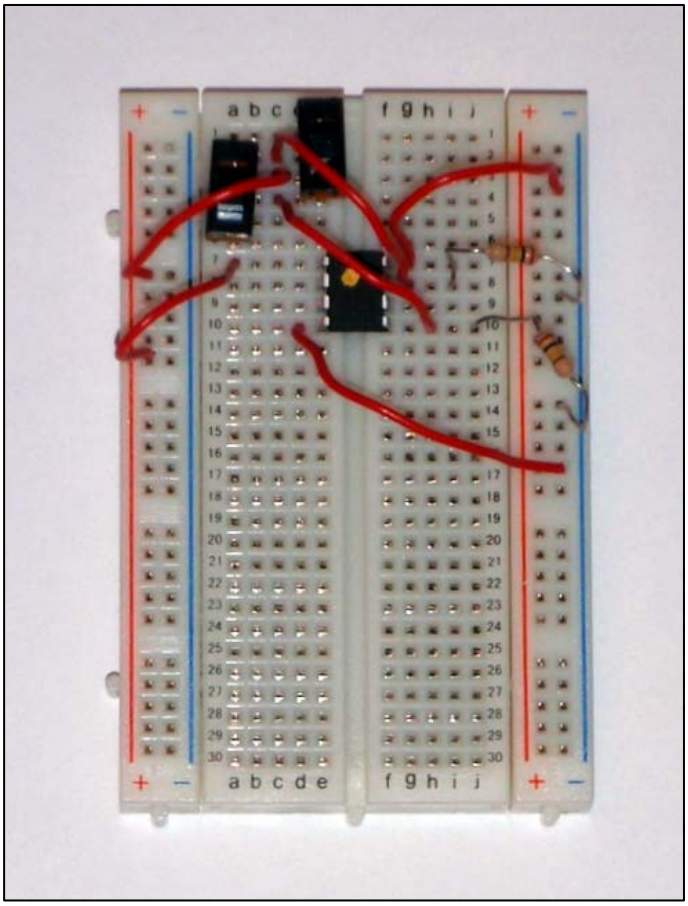
9	R1	• Connect 100 kΩ resistor (Brown, Black, Yellow) R1 between pin 5 of the encoder chip and right negative power rail. • *(J10 to right blue rail)*
10	R2	• Connect 100 kΩ resistor (Brown, Black, Yellow) R2 between pin 7 of the encoder chip and right negative power rail. • *(I8 to right blue rail)*
11	2" jumper	• Connect pin 8 of the encoder chip to anywhere on the blue negative power rail on the right. • *(G7 to right blue rail)*
12	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 in the next section.



Transmitter Circuit

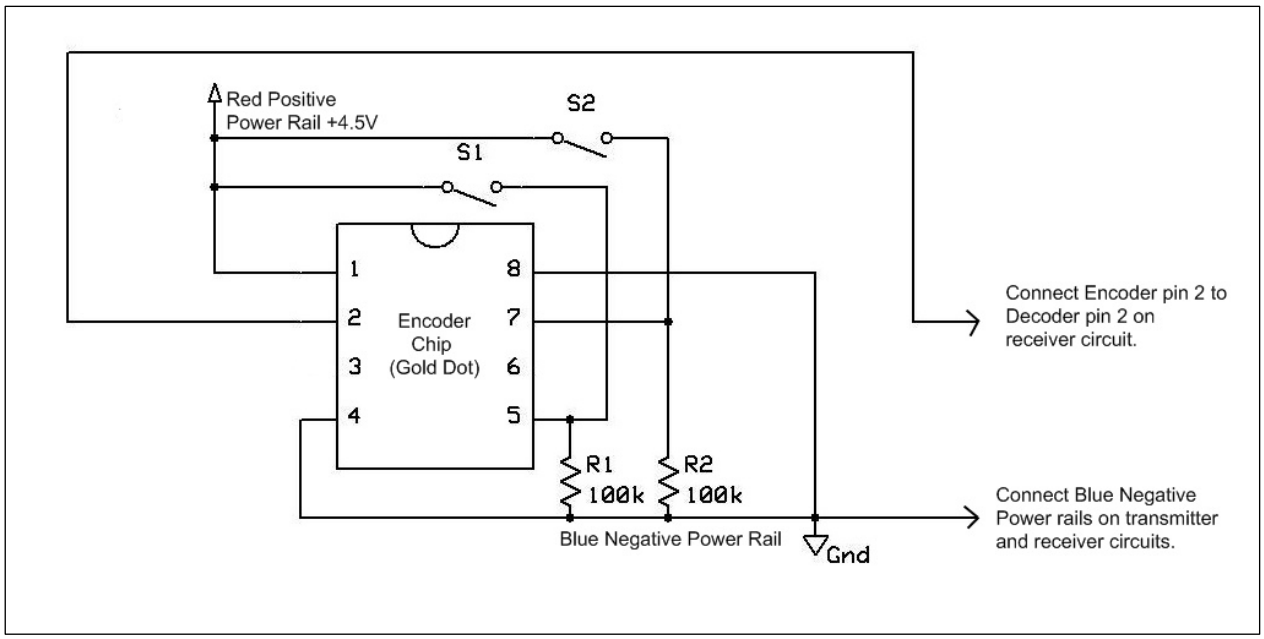
Transmitter Parts

- Breadboard
- 2” Jumper Wires
- 1 Encoder chip with gold dot (R-8PE Encoder integrated circuit)
- S1, S2: Slide switches
- R1, R2: 100 kΩ Resistors (Brown, Black, Yellow)
- 3 AA Batteries
- Battery case



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

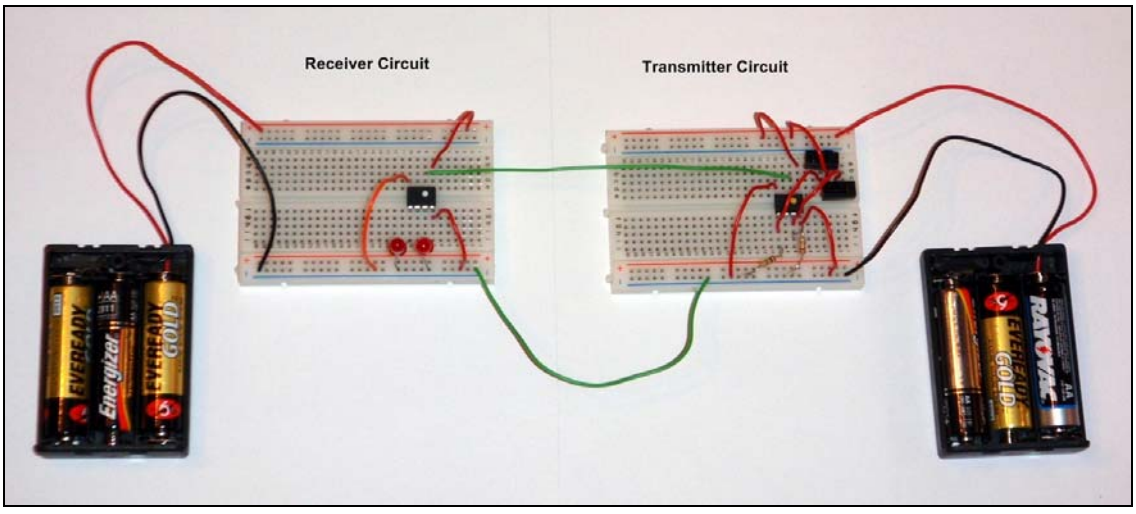
Transmitter Circuit Diagram



Steps for 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. For this activity, you will use your two long wires 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	Placement Location *(Suggested holes)*
1	Long wire	• Connect long wire from the transmitter blue negative power rail to the receiver blue negative power rail. • *(Transmitter right blue rail to Receiver right blue rail)*
2	Long wire	• Connect the other long wire from pin 2 of the encoder chip to pin 2 of the decoder chip. • *(Transmitter C8 to Receiver C8)*
3	Receiver Battery Pack	• Connect red wire of battery pack to anywhere on the receiver left red positive power rail. • Connect the black wire of the battery pack to anywhere on the receiver right blue negative power.
4	Transmitter Battery Pack	• Connect red wire of battery pack to anywhere on the transmitter left red positive power rail. • Connect the black wire of the battery pack to anywhere on the transmitter right blue negative power.
5	Test Circuit	• Try flipping each switch and make sure that it controls an LED on the receiver.
6	Troubleshooting	• If either of the LEDs do not work, move on to the troubleshooting section to figure out what is wrong.



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.

Step 1. Check that the LED is not inserted backwards. The shorter, negative, lead should be connected to the blue negative power rail.

Step 2. Check that the transmitter circuit has the encoder chip (gold dot) and the receiver circuit has the decoder chip (silver dot).

Step 3. Are there any rows 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.

Step 4. Check to make sure each component is connected to the correct other components. Start with the encoder and decoder chips. The following tables 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.

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 kΩ resistor (Brown, Black, Yellow)
6	• Not connected to anything
7	• Switch S2 • 100 kΩ 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

Step 5. The batteries may be dead. Try a different battery pack or new batteries.

Step 6. Check for connections that are in the correct location, but may be loose.

Step 7. If all else fails, try replacing the encoder and decoder chips one at a time.

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?