As you learn about Edison's parts, you will have a better understanding of how it works. You should notice that the robot has a clear plastic cover. The cover protects the electronic components underneath it. However, we cannot see the light emitting diodes (LEDs) and light sensors at the front of the robot unless the cover is removed. Figure 1 is a labeled photo of the robot motherboard (top view with cover removed). All of Edison's electronic parts are attached to this board.

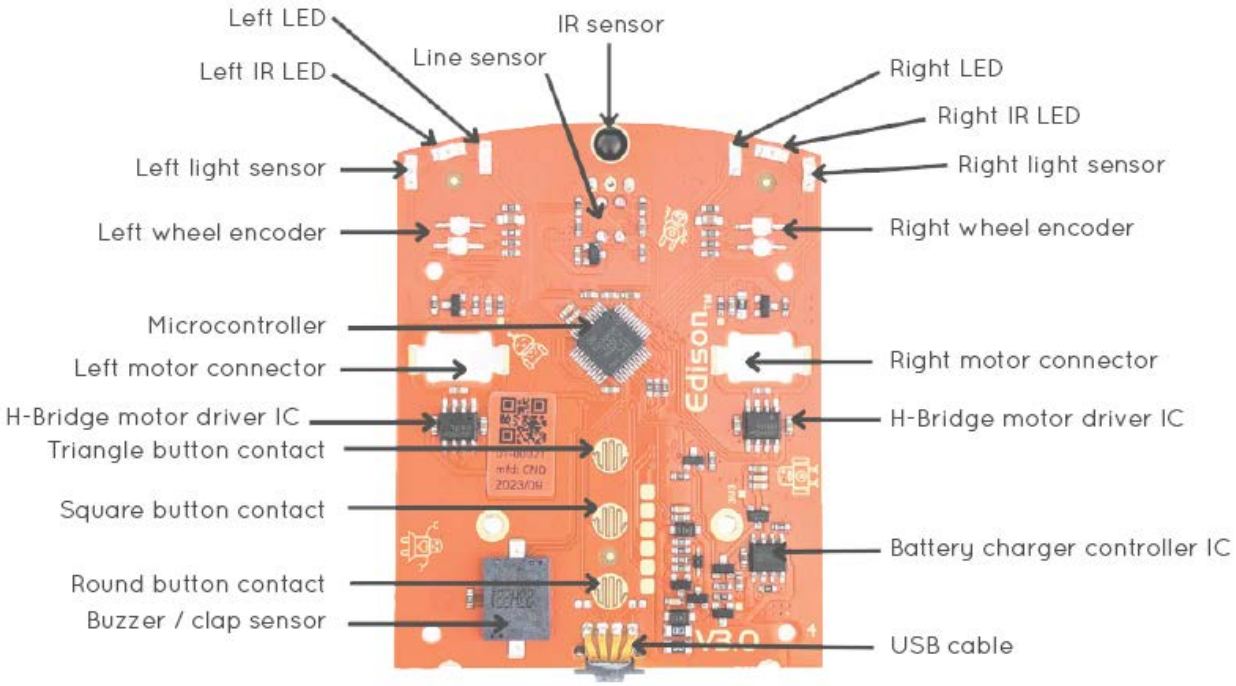

Figure 1 robot motherboard (Edison V3)

At the front of the robot there are four LEDs, two that shine with red light and two that shine with infrared light (IR). Infrared light is invisible to humans but Edison can see it with its **IR sensor**. When IR light is flashed from Edison's right and left IR LEDs, the light will reflect (bounce) off nearby objects and some of the reflected light will be captured by the **IR sensor**. Edison does not flash both IR LEDs at the same time, which allows it to determine if the object in front of the

robot is to the right, left or in the center. If the IR sensor detects light only when the left IR LED flashes, then the object is on the left of the robot. If the IR sensor only sees light when the right IR LED flashes, then the object is on the right. If the IR sensor detects light when right and left IR LEDs flash, the object is centered in front of the robot. This is helpful to know when Edison must drive around something blocking its path.

It may not be obvious, but the LEDs mounted at the front of the motherboard shine light perpendicular to the board surface. Without the clear cover on top, all of the light from the LEDs would shine on the ceiling of the room. That would not help Edison detect an object in front of it. However, the cover has an interesting shape that results in some of the light going up and some shining horizontally in front of the robot. You can check this yourself by turning the robot on. The power switch is the triangular **Play** button (Figure 2). After turning the robot on, take a look at the red LEDs. You should see two flashing red lights,

Figure 2

one on each side of the front when you look down on the top of the robot. Now hold the robot so that it is level with your eyes and look at the front edge of the robot. You should also see the red lights flashing from this viewpoint. Why can you see red light shining out from the front of the robot when it should be shining at the ceiling? The answer is on the next page.

Look at the front part of the cover (or see photo in Figure 3). It has a raised edge and the backside of the edge has an angle of 45 degrees (see diagram in Figure 3). Light from the red LED travels through the plastic material of the cover. Something interesting happens when the light reaches the boundary of the plastic and air. Because this surface is angled, some of the light reflects at the boundary and travels out the front of the cover (like light reflecting off a mirror). Some of the light continues to travel upwards, but is bent slightly in its path (this is the effect of a prism, that spreads out white light into the colors of the rainbow). The light sensors and IR sensor are also aimed at the ceiling and without the cover, would only see light shining down on the robot. However, with the cover in place, some of the light entering the front edge of the cover is reflected down to the sensors at the angled edge. Therefore, Edison can send light beams out in front of it and detect light beams shining on its front edge, even though the sensors and LEDs are pointing upward. This is all due to the angled back edge of the front cover that reflects light.

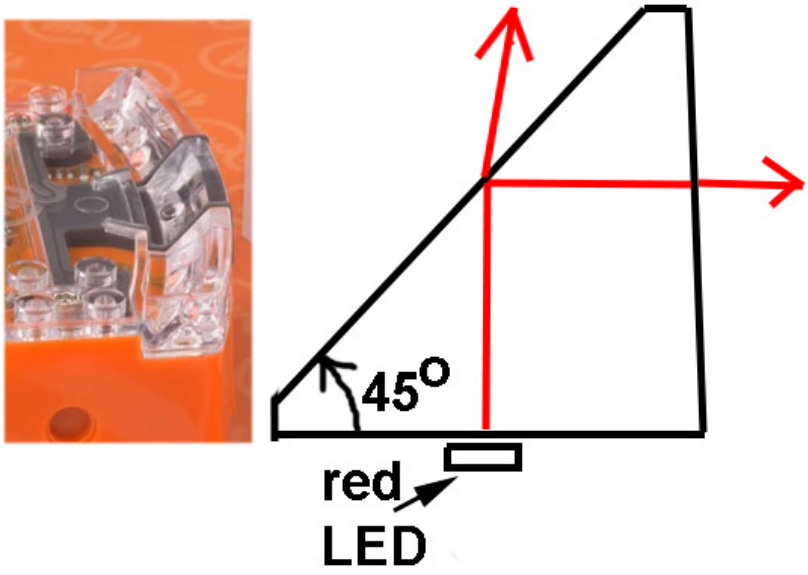

Figure 3 front part of robot cover

You now know that one of the functions of the IR LEDs and IR sensor is to detect objects in front of the robot. Why does the robot have red LEDs? There are many reasons for having the red LEDs. You have already noticed one reason, although

you might not realize it. When you turned on the robot, the red LEDs began to flash. Did you notice they did not flash on at the same time? When the left LED was on the right LED was off and vice versa. This alternate flashing on and off lets you know the robot is powered on and ready to do something. When you connect Edison to your computer and click the **Program Edison** button on the computer screen, the computer starts to send the program to the robot. When this happens, both red LEDs turn off. This is your signal that the transfer of the program is underway. When the computer is finished sending the program to the robot, then the red LEDs begin to flash the same way they did when you turned the robot on. Now the flashing red LEDs are letting you know the robot is ready for something else. If you now press the triangle button on the robot, then it will execute (run) the program you just loaded from the computer.

This should give you an idea of some of the functions of the red LEDs. You can also write programs that turn the red LEDs on and off. These could just be for fun or they might indicate some event. For example, if you wrote a program for the robot to drive around the room, but not crash into any objects, you might want to program the red LEDs to flash each time the robot detected an object in front of it. I am sure you will find many reasons for using the red LEDs as you learn to program the Edison robot.

Now what about the **light sensors** on the front of the robot? These sensors are for visible light, the kind humans can see. There could be many reasons why you want the robot to detect visible light. You could program your robot to drive toward a bright light. An example of a real-world engineering project that involves a light sensor would be turning on and off streetlights. It is common for streetlights to be controlled by light sensors. When it gets dark, the light sensor detects darkness and it participates in the control that turns on the electric power to the light. When the sun rises in the morning, the light sensor helps the control circuity to turn off the electric power to the light. You could program the Edison robot to act like a streetlight, by turning on a red LED when the room is dark and turning the red LED off when the lights are on in the room. With a little thought I am sure you can come up with other ideas for using the light sensors on the Edison robot.

Do not let Edison's size fool you, it is a very capable robot. Near the center of the motherboard is the **microcontroller** (Edison's brain - see Figure 1 on page one). You can make Edison perform a nearly endless variety of tasks by writing programs for it. The programs are stored in the microcontroller's memory. When the robot is running, the microcontroller reads the program instructions stored in its memory. These instructions might include turning a light on or off, or running a motor, which turns one of Edison's wheels. Edison can detect objects close to it by flashing infrared light with its IR LEDs as you have already learned. The IR light reflects (bounces) off objects and returns to the robot to be detected by the IR sensor. If Edison is moving forward, then its program might instruct the robot to avoid crashing into an object when it is detected.

If you looked carefully at the photo of the motherboard on page one, you might have noticed two electronic components labeled **H-bridge**, one for each of Edison's motors. While the microcontroller is responsible for turning the motors on and off, it cannot do that directly because the motors consume more electrical current than the microprocessor can provide. A small current signal is sent from the microcontroller to the H-bridge, which then controls how much current the motor receives. More current means faster speed and more power to the wheels.

As I said, Edison is a very capable robot. You can program it to drive an exact distance. How does it know when it has traveled a certain distance? It has a device on each motor called an **encoder**. The encoder allows the microcontroller to measure how many times the motor has turned. In order to understand how this works, we need to open up the robot, taking off the motherboard, so we can see the motors inside the robot (**do not do this yourself as you may damage the robot**).

There is a photo of the inside of the robot on the next page. After you look at it, go on to the next page.

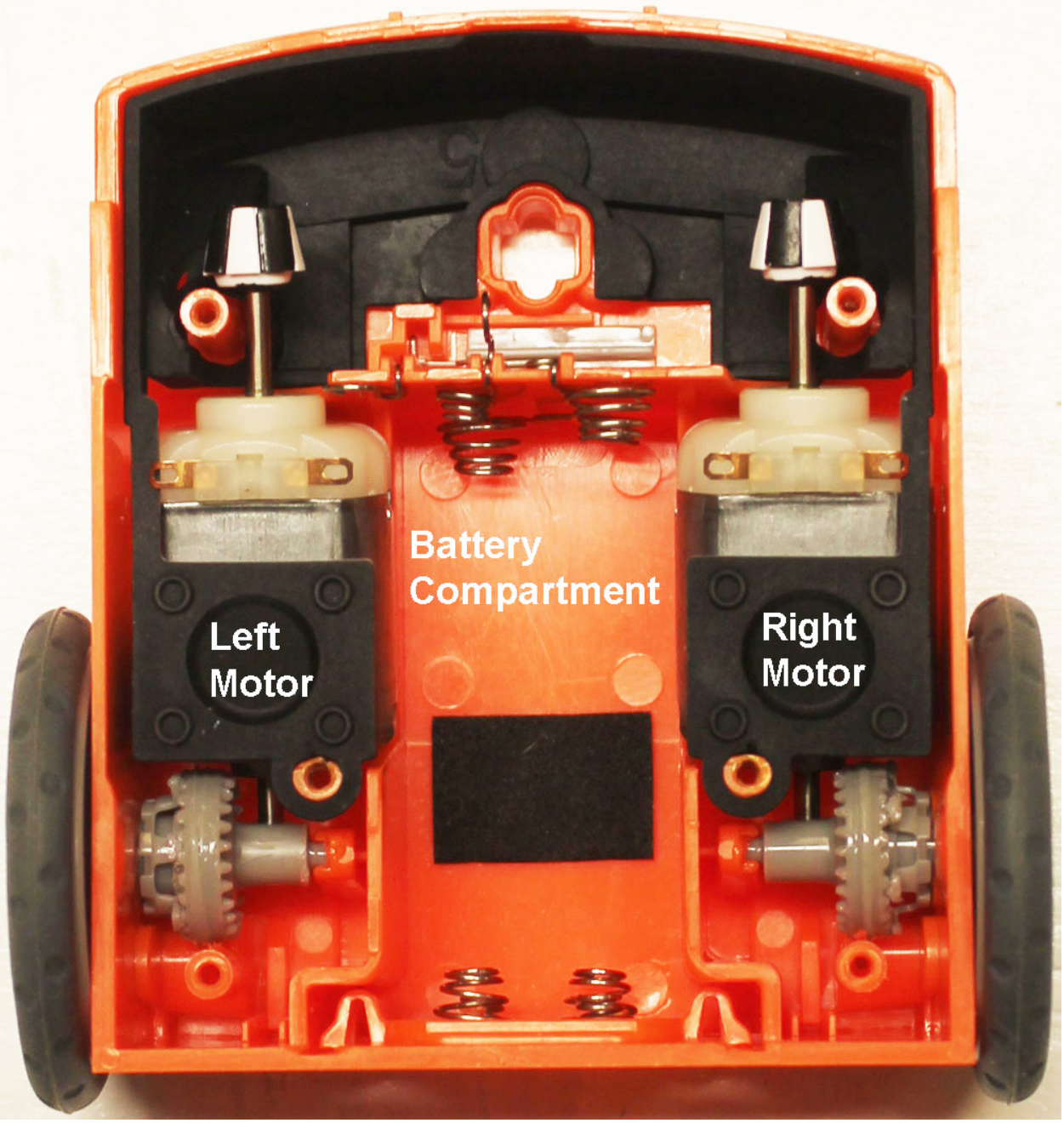

Figure 4 interior of robot. Note: this is a version 2 robot. GEAR club now uses version 3 robots which have a different battery compartment.

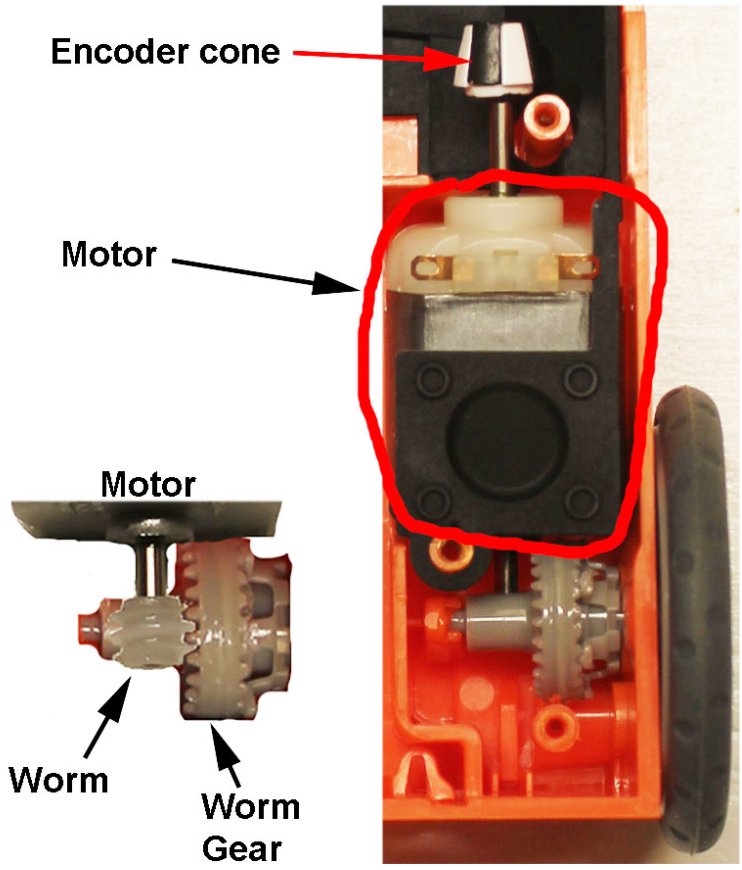

Figure 5 motor and encoder detail

Each motor has a shaft that sticks out of each end of the motor body. On the shaft towards the front of the robot is attached the **encoder cone**. Notice that it has alternating black and white sectors. As the motor spins, the encoder cone also spins. Just above the cone, on the bottom side of the motherboard, there is a LED and a light sensor (see Figure 6 below). The light sensor will see different amounts of reflected light as the cone rotates (white reflects more light than black). The light sensor converts the variable amount of light to a variable electrical voltage. The variable voltage is converted to a digital signal and then sent to the microcontroller.

Figure 6 encoder LED and light sensor on bottom side of motherboard

The microcontroller reads the digital signal to count the number of turns the motor makes.

Now let us talk about the rest of the motor. On the shaft that points to the rear of the robot there is mounted a **worm** (a kind of gear - see Figure 5). The worm meshes (touches) the **worm gear**, which is attached to the wheel.

The worm has to turn 24 times to make the worm gear turn one time. This is known as **gear reduction**. The motor turns too fast and we need to reduce the rotation rate by using gears to make the wheels turn at a slower rate. Automobiles (cars) have transmissions, which contain gears to reduce the rotation rate of the motor before it is connected to the drive wheels.

Otherwise, the car would travel much too fast (that is if it had enough power, which it does not). The other reason to use gears is to increase the **torque** applied to the wheels. Torque is the twisting force applied to the wheel. Without the gear reduction, the Edison motors would not have enough torque to spin the wheels and move the robot. By reducing the rotation rate by a factor of 24, the torque of the motor is multiplied by nearly 24 at the wheel (there is some loss of power due to friction in the gears). The wheel will have almost 24 times more twisting force than the motor, trading faster rotation of the motor for greater twisting force. This is necessary to enable the robot to move.

Let us now return to another sensor mounted on the top side of the motherboard. This is the **buzzer/clap sensor** (see photo on page one). Edison has an ear and a voice. It uses this sensor to hear and to make sounds. It can even play a tune if you program it. The sensor can hear any loud sound, like clapping your hands. You could program the robot to do something when it hears a clap. It is also possible to program it to do something else if it hears two loud sounds, one right after the other. Or three sounds, etc. The same sensor can be used to generate sounds. This could be a buzzer or a musical note. You will learn more about this in later lessons.

The last set of sensors mounted to the top side of the motherboard are the wheel encoders (see photo on page one). Each sensor includes an LED and a light sensor. These are mounted over holes in the motherboard so that the light can shine on the encoder cone inside and reflect back to the light sensor.

Attached to the bottom side of the motherboard is a long post holding a red LED and a light sensor (see Figure 7 on next page). This red LED and light sensor can be seen peeking out of the bottom of the robot when it is fully assembled (Figure 8). The combination of red LED and light sensor is used for line following. In line following you program Edison to follow a dark line on a light-colored floor. When the red light shines on the floor, different amounts of the light are reflected back to the light sensor depending on whether the surface is dark or light colored.

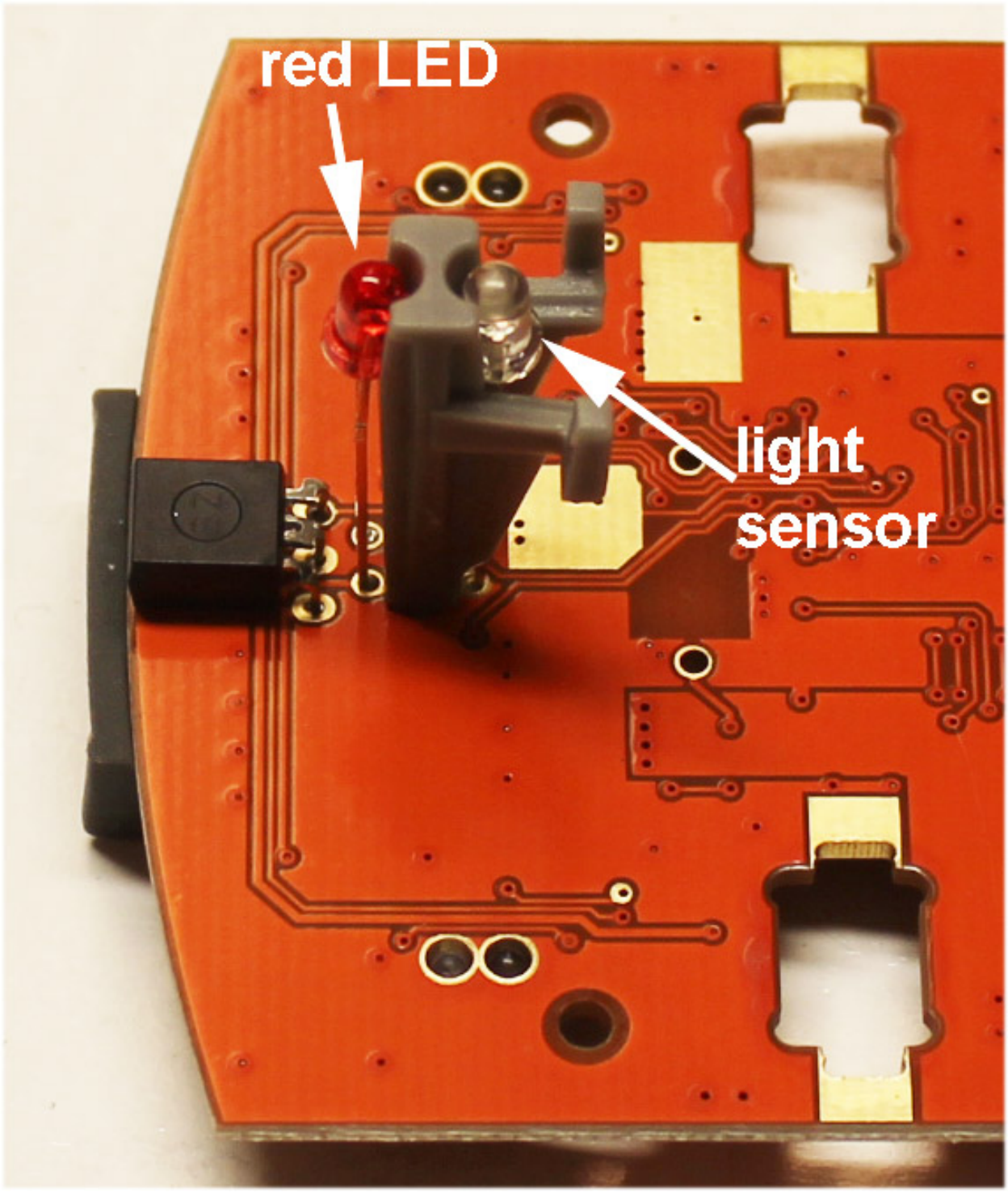

Figure 7 line following red LED and light sensor as seen mounted on bottom of motherboard

The photo below shows the view of the red LED and light sensor on the bottom of the robot, when fully assembled. This is the line following sensor.

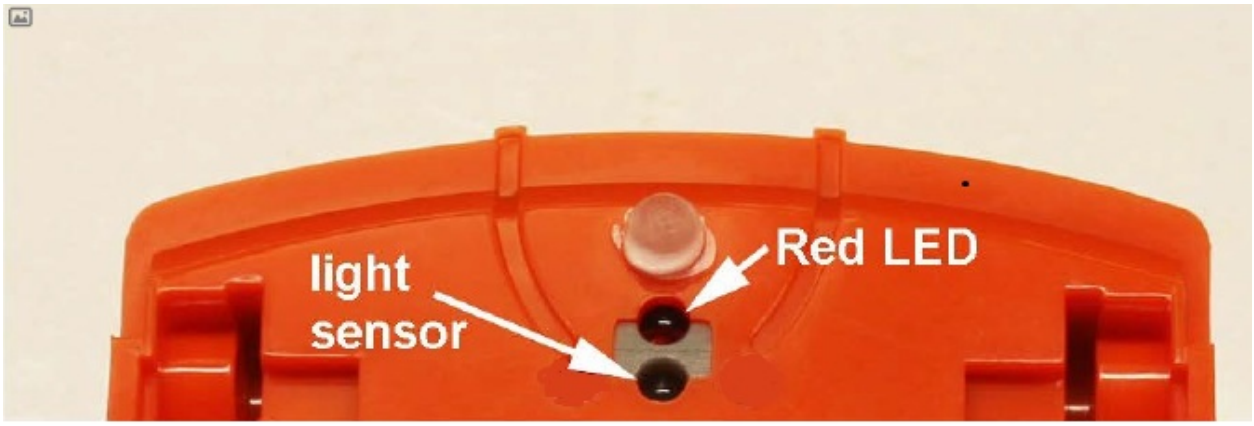

Figure 8 line following red LED and light sensor as seen in assembled robot

Edison robots can be programmed with three different languages. You will be using the one named EdScratch. EdScratch is opened in your computer web browser by going to this address: https://www.edscratchapp.com/v3/

Note: this document was edited January 17, 2026 to apply to version 3 of the Edison robot. The original document covered version 2 of the robot, which GEAR club replaced with version 3 robots in 2025. Some of the photos in this document are of a version 2 robot, but are nevertheless valid as resources for understanding how the robot operates, whether version 2 or 3.