

USER GUIDE

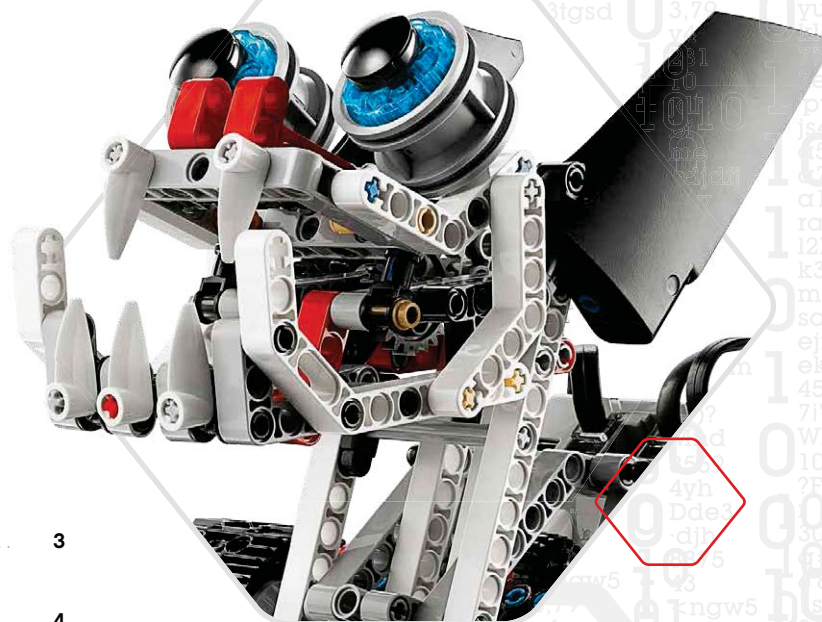


COMPUTER SCIENCE • SCIENCE • TECHNOLOGY • ENGINEERING • MATH

LEGOeducation.com/MINDSTORMS

LEGO **MINDSTORMS**
education **EV3**

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INTRODUCTION

Welcome

LEARNING POWERED BY LEGO® MINDSTORMS® EDUCATION

Since the beginning of this century, LEGO® MINDSTORMS® Education has led the way in STEM (Science, Technology, Engineering, and Math) Education, inspiring users to engage in fun, hands-on learning. The combination of LEGO building systems with the LEGO MINDSTORMS Education EV3 technology is now offering even more ways to learn about robotics and teach the principles of programming, physical science, and mathematics.

The heart of LEGO MINDSTORMS Education is the EV3 Brick, the programmable intelligent brick that controls motors and sensors, as well as providing wireless communication. Choose what motors and sensors you wish to use and build your robot just like you want it to be.

Enter the LEGO MINDSTORMS Education EV3 Software to find everything you need. The EV3 Software Lobby gives you easy access to content, programming, data logging, digital workbooks and more. You can for example choose to follow the Robot Educator and you'll be able to create, program, and run a robot before you know it. The intuitive icon-based programming is full of challenging possibilities and the data logging environment provides a powerful tool for scientific inquiry and experiments.

LEGO Education offers a growing number of EV3-based curriculum packages developed by experienced educators. We are committed to responsive customer support, professional development, and continuing education for teachers using MINDSTORMS robotics in their classrooms.

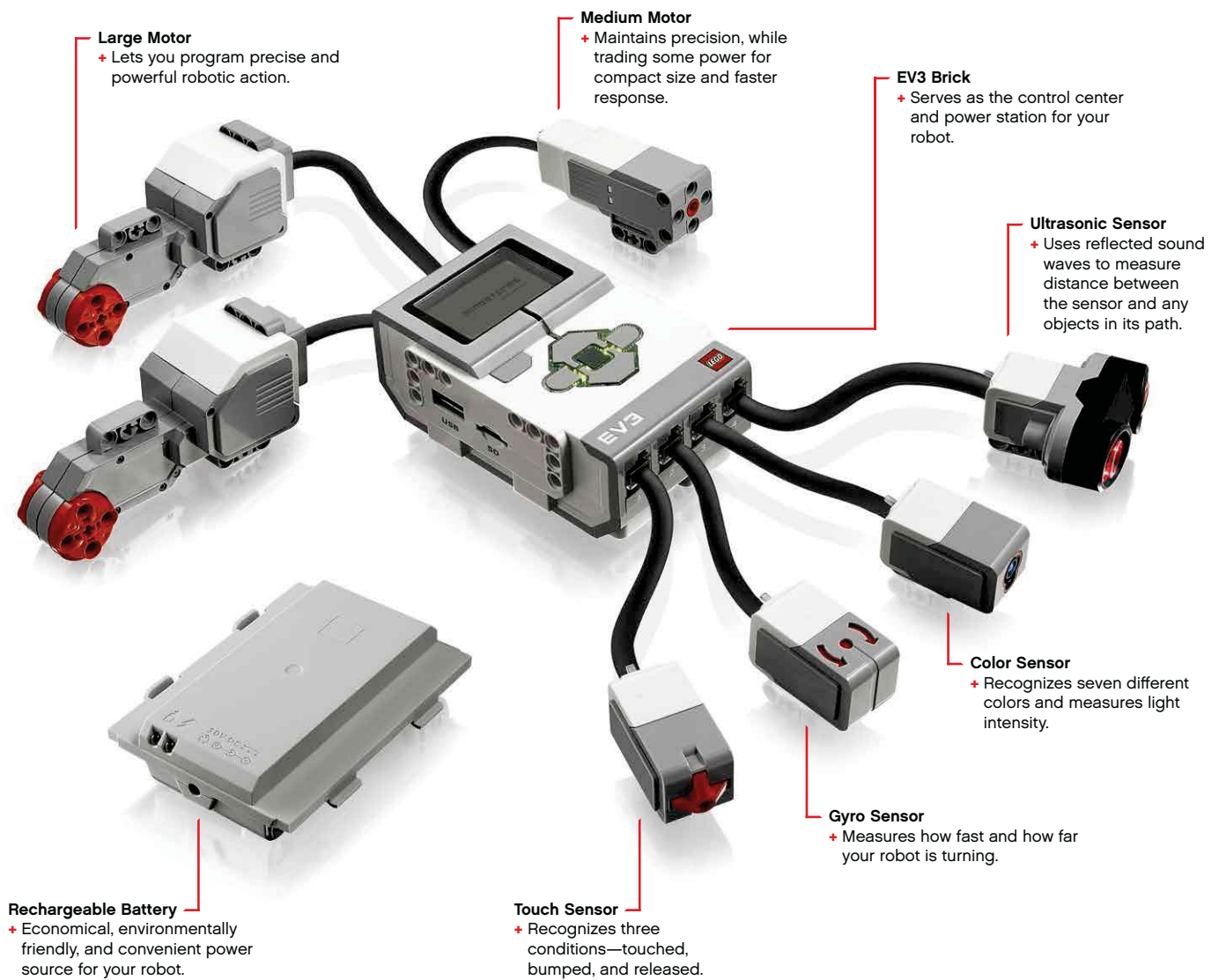
Want to work like real scientists and engineers? Enter the LEGO Education-supported FIRST® LEGO League and World Robot Olympiad—and gain invaluable knowledge, life skills, and increased self-confidence!

We hope you enjoy the journey!



EV3 TECHNOLOGY

Overview



Large Motor

+ Lets you program precise and powerful robotic action.

Medium Motor

+ Maintains precision, while trading some power for compact size and faster response.

EV3 Brick

+ Serves as the control center and power station for your robot.

Ultrasonic Sensor

+ Uses reflected sound waves to measure distance between the sensor and any objects in its path.

Color Sensor

+ Recognizes seven different colors and measures light intensity.

Gyro Sensor

+ Measures how fast and how far your robot is turning.

Touch Sensor

+ Recognizes three conditions—touched, bumped, and released.

Rechargeable Battery

+ Economical, environmentally friendly, and convenient power source for your robot.

EV3 TECHNOLOGY

EV3 Brick

Overview

The **Display** shows you what is going on inside the EV3 Brick and enables you to use the Brick Interface. It also allows you to add text and numerical or graphic responses into your programming or experiments. For example, you might want to program the Display to show a happy face (or a sad face) for a comparison response or to display a number that is the result of a mathematical calculation (learn more about using the **Display Block** in the EV3 Software Help).

The **Brick Buttons** allow you to navigate inside the EV3 Brick Interface. They can also be used as programmable activators. For example, you might program a robot to raise its arms if the Up button is pressed or to lower them if the Down button is pressed (for more information, see **Using the Brick Buttons** in the EV3 Software Help).

Wireless Connection Status icons (from the left)

- Bluetooth enabled but not connected or visible to other Bluetooth devices
- Bluetooth enabled and visible to other Bluetooth devices
- Bluetooth enabled and your EV3 Brick is connected to another Bluetooth device
- Bluetooth enabled and visible and your EV3 Brick is connected to another Bluetooth device
- Wi-Fi enabled but not connected to a network
- Wi-Fi enabled and connected to a network

Brick Name

USB
USB connection established to another device

USB icon

Battery level icon

Battery level

Brick Buttons

- 1. Back**
This button is used to reverse actions, to abort a running program, and to shut down the EV3 Brick.
- 2. Center**
Pressing the Center button says "OK" to various questions—to shut down, to select desired settings, or to select blocks in the Brick Program App. You would, for example, press this button to select a checkbox.
- 3. Left, Right, Up, Down**
These four buttons are used to navigate through the contents of the EV3 Brick.

EV3 TECHNOLOGY

TECHNICAL SPECIFICATIONS FOR THE EV3 BRICK

- + Operating System—LINUX
- + 300 MHz ARM9 controller
 - + Flash Memory—16 MB
 - + RAM—64 MB
- + Brick Screen Resolution—178x128/Black & White
- + USB 2.0 Communication to Host PC—Up to 480 Mbit/sec
- + USB 1.1 Host communication—Up to 12 Mbit/sec
 - + Micro SD card—Supports SDHC, Version 2.0, Max 32 GB
- + Motor and Sensor Ports
 - + Connectors—RJ12
 - + Support Auto ID
- + Power—6 AA batteries/rechargeable

EV3 Brick

The **Brick Status Light** that surrounds the Brick Buttons tells you the current status of the EV3 Brick. It can be green, orange, or red and can pulse. Brick Status Light codes are the following:

- + Red = Startup, Updating, Shutdown
- + Red pulsing = Busy
- + Orange = Alert, Ready
- + Orange pulsing = Alert, Running
- + Green = Ready
- + Green pulsing = Running Program

You can also program the Brick Status Light to show different colors and to pulse when different conditions are met (learn more about using the **Brick Status Light Block** in the EV3 Software Help).



Brick Status Light – Red



Brick Status Light – Orange



Brick Status Light – Green

EV3 TECHNOLOGY

EV3 Brick

PC Port

The Mini-USB PC Port, located next to the D port, is used to connect the EV3 Brick to a computer.

Input Ports

Input Ports 1, 2, 3, and 4 are used to connect sensors to the EV3 Brick.

Output Ports

Output Ports A, B, C, and D are used to connect motors to the EV3 Brick.



Speaker

All sounds from the EV3 Brick come through this speaker—including any sound effects used in programming your robots. When the quality of the sound is important to you, try to leave the speaker uncovered while designing your robot. Check out the cool sound files that can be programmed within the EV3 Software (learn more about using the **Sound Block** in the EV3 Software Help).

USB Host Port

The USB Host Port can be used to add a USB Wi-Fi dongle for connecting to a wireless network, or to connect up to four EV3 Bricks together (daisy chain).

SD Card Port

The SD Card Port increases the available memory for your EV3 Brick with an SD card (maximum 32 GB—not included).

EV3 TECHNOLOGY

EV3 Brick

Installing Batteries

With LEGO® MINDSTORMS® Education EV3, you have the choice of using normal AA batteries or the EV3 Rechargeable Battery pack included in the LEGO MINDSTORMS Education EV3 Core Set. If you experiment with both, you will find that each option has characteristics to consider when constructing your robots. For instance, six AA batteries weigh more than the Rechargeable Battery, and the EV3 Brick with the Rechargeable Battery installed is slightly larger than the EV3 Brick with six AA batteries.

The **EV3 Rechargeable Battery** is a convenient and economical alternative to using AA batteries. It can be recharged while inbuilt in a model, saving you the trouble of disassembling and reassembling a robot to replace batteries.

To install the Rechargeable Battery on the EV3 Brick, remove the battery cover on the back of the EV3 Brick by pressing the two plastic tabs on the side. If there are batteries in the EV3 Brick, remove them. Insert the Rechargeable Battery in the slots that held the battery cover in place and snap the battery in place. The battery cover is not used.

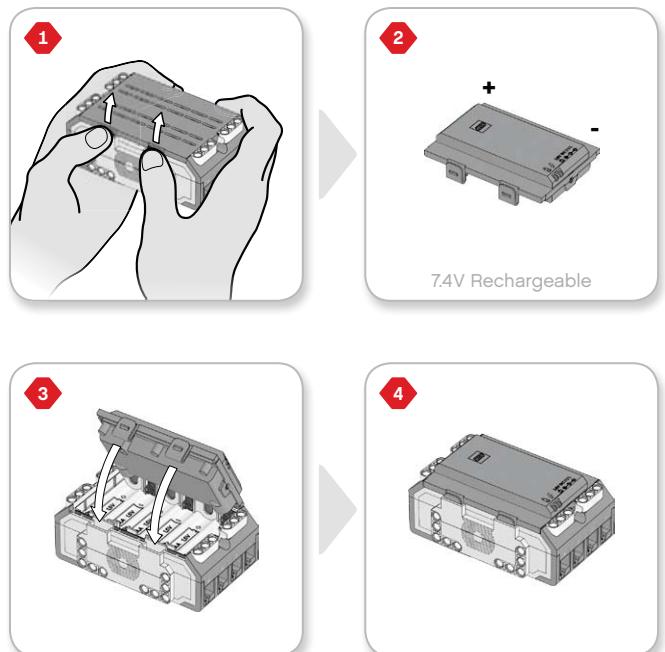
If it is your first use of the battery—or if the battery is completely drained, let the battery and the EV3 Brick charge together for minimum twenty minutes.

Using the enclosed power adaptor cord, connect the Rechargeable Battery to a wall outlet. Make sure to keep the transformer cord and battery where they will not be tripped over or get wet.

When you plug the uncharged battery into a wall socket, a red indicator light will be lit. When charging is complete, the red light will go out and the green light will be illuminated. The recharging process will generally take three to four hours. If you use the EV3 Brick while the battery is charging, it will take longer. Before you start to use the Rechargeable Battery for the first time, it is recommended that it is fully charged.



EV3 Rechargeable Battery



EV3 TECHNOLOGY

EV3 Brick

The EV3 Brick requires **six AA/LR6 batteries** if the EV3 Rechargeable Battery is not used. Alkaline or rechargeable Lithium Ion AA batteries are recommended. The AA batteries option is a good choice when a little more weight is desirable in your robot.

To install the AA batteries, remove the battery cover on the back of the EV3 Brick by pressing the two plastic tabs on the side. After you have inserted the six AA batteries, attach the battery cover again.

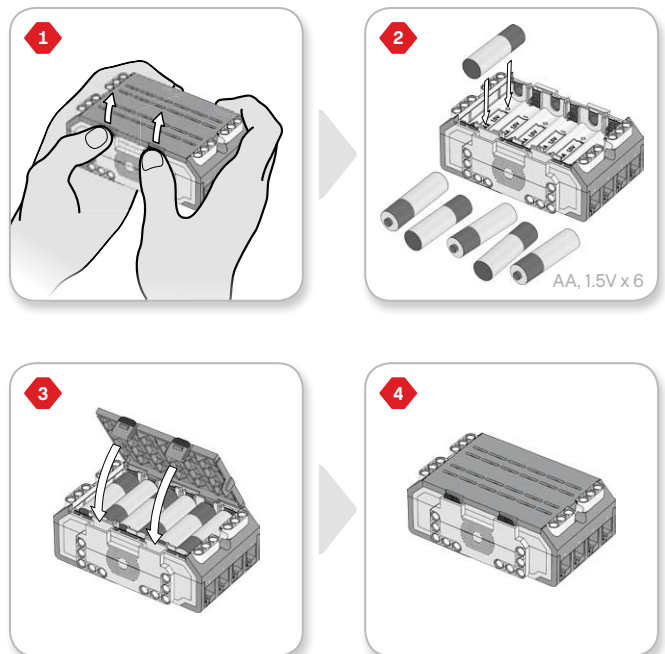
SOME IMPORTANT INFORMATION ABOUT BATTERIES:

- + Never use different kinds of batteries together (including mixing old and new).
- + Remove batteries from the EV3 Brick when not in use.
- + Never use damaged batteries.
- + Use the correct battery charger under the supervision of an adult.
- + Never attempt to recharge batteries that are not rechargeable.

Note: If your batteries are weak, the Brick Status Light may stay red after you press the Start button, while the Display continues to say "Starting."

POWER-SAVING PRACTICES

- + Remove batteries between use.
Remember to keep each set of batteries in its own storage container so they can be used together.
- + Reduce Volume.
- + Adjust Sleep Setting.
- + Turn off Bluetooth and Wi-Fi when not in use.
- + Avoid unnecessary wear on the motors.



Low Battery Power Indicator

EV3 TECHNOLOGY

EV3 Brick

Turning On the EV3 Brick

To turn on the EV3 Brick, press the Center button. After you press the button, the Brick Status Light will turn red and the Starting screen will be displayed.

When the light changes to green, your EV3 Brick is ready.

To turn the EV3 Brick off, press the Back button until you see the Shut Down screen.

The Abort X will already be selected. Use the Right button to select the Accept check mark, then press the Center button for OK. Your EV3 Brick is now turned off. If you press OK while the X is selected, you will return to the Run Recent screen.



Starting screen



Shut Down screen

EV3 TECHNOLOGY

EV3 Motors

Large Motor

The Large Motor is a powerful “smart” motor. It has a built-in Rotation Sensor with 1-degree resolution for precise control. The Large Motor is optimized to be the driving base on your robots.

By using the Move Steering or Move Tank programming block in the EV3 Software, the Large Motors will coordinate the action simultaneously.

Medium Motor

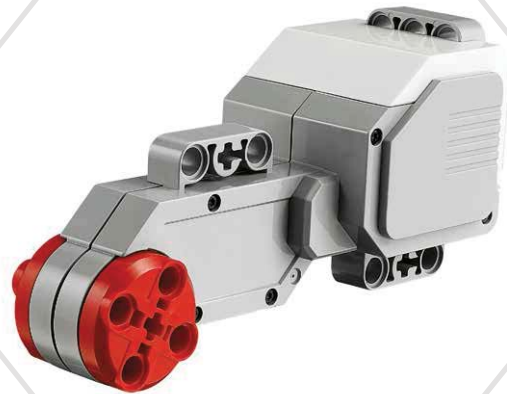
The Medium Motor also includes a built-in Rotation Sensor (with 1-degree resolution), but it is smaller and lighter than the Large Motor. That means it is able to respond more quickly than the Large Motor.

The Medium Motor can be programmed to turn on or off, control its power level, or to run for a specified amount of time or rotations.

COMPARE THE TWO MOTORS:

- + The Large Motor runs at 160–170 rpm, with a running torque of 20 Ncm and a stall torque of 40 Ncm (slower, but stronger).
- + The Medium Motor runs at 240–250 rpm, with a running torque of 8 Ncm and a stall torque of 12 Ncm (faster, but less powerful).
- + Both motors are Auto ID supported.

For more information on using the Rotation Sensor in your programming, see **Using the Motor Rotation Sensor** in the EV3 Software Help.



Large Motor



Medium Motor

EV3 TECHNOLOGY

EV3 Sensors

Color Sensor

The Color Sensor is a digital sensor that can detect the color or intensity of light that enters the small window on the face of the sensor. This sensor can be used in three different modes: Color Mode, Reflected Light Intensity Mode, and Ambient Light Intensity Mode.

In **Color Mode**, the Color Sensor recognizes seven colors—black, blue, green, yellow, red, white, and brown—plus No Color. This ability to differentiate between colors means your robot might be programmed to sort colored balls or blocks, speak the names of colors as they are detected, or stop action when it sees red.

In **Reflected Light Intensity Mode**, the Color Sensor measures the intensity of light reflected back from a red light-emitting lamp. The sensor uses a scale of 0 (very dark) to 100 (very light). This means your robot might be programmed to move around on a white surface until a black line is detected, or to interpret a color-coded identification card.

In **Ambient Light Intensity Mode**, the Color Sensor measures the strength of light that enters the window from its environment, such as sunlight or the beam of a flashlight. The sensor uses a scale of 0 (very dark) to 100 (very light). This means your robot might be programmed to set off an alarm when the sun rises in the morning, or stop action if the lights go out.

The sample rate of the Color Sensor is 1 kHz/sec.

For the best accuracy, when in Color Mode or Reflected Light Intensity Mode, the sensor must be held at a right angle, close to—but not touching—the surface it is examining.

For more information, see **Using the Color Sensor** in the EV3 Software Help.



Color Sensor



Color Mode



Reflected Light Intensity Mode



Ambient Light Intensity Mode

EV3 TECHNOLOGY

EV3 Sensors

Gyro Sensor

The Gyro Sensor is a digital sensor that detects rotational motion on a single axis. If you rotate the Gyro Sensor in the direction of the arrows on the case of the sensor, the sensor can detect the rate of rotation in degrees per second. (The sensor can measure a maximum rate of spin of 440 degrees per second.) You can then use the rotation rate to detect, for example, when a part of your robot is turning, or when your robot is falling over.

In addition, the Gyro Sensor keeps track of the total rotation angle in degrees. You can use this rotation angle to detect, for example, how far your robot has turned. This feature means you are able to program turns (on the axis the Gyro Sensor is measuring) with an accuracy of +/- 3 degrees for a 90-degree turn.

Note: The sensor must be completely motionless while being plugged into the EV3 Brick. If the Gyro Sensor is attached to a robot, the robot should be held motionless in its starting position as the Gyro Sensor is plugged into the EV3 Brick.

CONNECTING THE GYRO SENSOR

On the EV3 Brick, go to the Brick App screen (third tab) and use the Center button to select Port View.

Using a flat black Connector Cable, connect the Gyro Sensor to the EV3 Brick on Port 2. Make sure to hold the sensor very still while you do this. On the EV3 Brick display, the Port View app should show a "0" reading in the second small bottom window from the left, which is the window representing input values from Port 2.

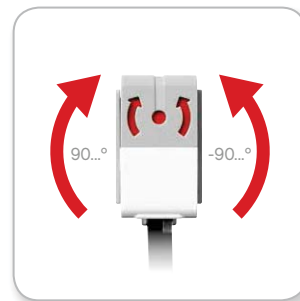
Still without moving the sensor, observe the display for a few seconds. It should continue to display "0" for Port 2 with the Gyro Sensor. In case the Gyro Sensor readings do not constantly display "0" during the connection process, unplug the sensor and repeat the procedure.

When the screen consistently displays "0" for a few seconds, experiment with rotating the sensor and observe how the angle reading changes. Remember, the Gyro Sensor measures the angle of change on only one axis.

For more information, see **Using the Gyro Sensor** in the EV3 Software Help.



Gyro Sensor



Single axis rotation



Brick App screen



Port View with Gyro Sensor

EV3 TECHNOLOGY

EV3 Sensors

Touch Sensor

The Touch Sensor is an analog sensor that can detect when the sensor's red button has been pressed and when it is released. That means the Touch Sensor can be programmed to action using three conditions—pressed, released, or bumped (both pressed and released).

Using input from the Touch Sensor, a robot can be programmed to see the world as a blind person might, reaching a hand out and responding when it touches something (pressed).

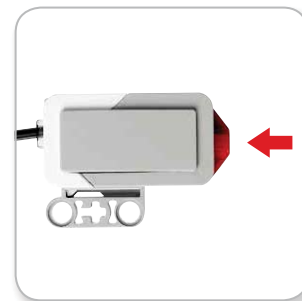
You might build a robot with a Touch Sensor pressed against the surface beneath it. You might then program the robot to respond (Stop!) when your robot is about to drive off the edge of a table (when the sensor is released).

A fighting robot might be programmed to keep pushing forward against its challenger until the challenger retreats. That pair of actions—pressed, then released—would constitute bumped.

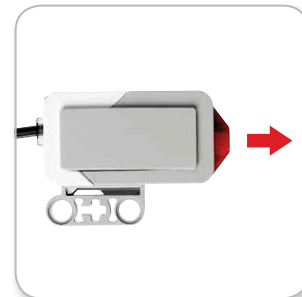
For more information, see **Using the Touch Sensor** in the EV3 Software Help.



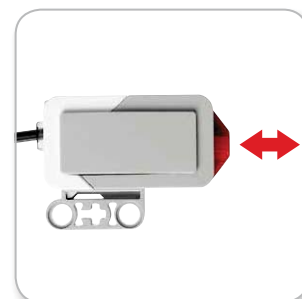
Touch Sensor



Pressed



Released



Bumped

EV3 TECHNOLOGY

EV3 Sensors

Ultrasonic Sensor

The Ultrasonic Sensor is a digital sensor that can measure the distance to an object in front of it. It does this by sending out high-frequency sound waves and measuring how long it takes the sound to reflect back to the sensor. The sound frequency is too high for you to hear.

Distance to an object can be measured in either inches or centimeters. This allows you to program your robot to stop a certain distance from a wall.

When using centimeter units, the detectable distance is between 3 and 250 centimeters (with an accuracy of +/- 1 centimeters). When using inch units, the measurable distance is between 1 and 99 inches (with an accuracy of +/- 0.394 inches). A value of 255 centimeters or 100 inches means the sensor is not able to detect any object in front of it.

A steady light around the sensor eyes tells you that the sensor is in Measure Mode. A blinking light tells you that it is in Presence Mode.

In Presence Mode, this sensor can detect another Ultrasonic Sensor operating nearby. When listening for presence, the sensor detects sound signals but does not send them.

The Ultrasonic Sensor can help your robots avoid furniture, track a moving target, detect an intruder in your room, or “ping” with increasing volume or frequency as an object gets closer to the sensor.

For more information, see **Using the Ultrasonic Sensor** in the EV3 Software Help.



Ultrasonic Sensor



Detectable distance

NOTE:

Since the Ultrasonic Sensor depends on reflection of the sound waves it may be ineffective at detecting surfaces that are textured or objects that are rounded. It is also possible for an object to be too small for the Ultrasonic Sensor to detect it.

EV3 TECHNOLOGY

EV3 Sensors

Infrared Sensor and Remote Infrared Beacon

The Infrared Sensor is a digital sensor that can detect infrared light reflected from solid objects. It can also detect infrared light signals sent from the Remote Infrared Beacon.

The Infrared Sensor can be used in three different modes: Proximity Mode, Beacon Mode, and Remote Mode.

PROXIMITY MODE

In Proximity Mode, the Infrared Sensor uses the light waves reflected back from an object to estimate the distance between the sensor and that object. It reports the distance using values between 0 (very close) to 100 (far away), not as a specific number of centimeters or inches. The sensor can detect objects up to 70 cm away, depending on the size and shape of the object.

For more information, see **Using the Infrared Sensor Proximity Mode** in the EV3 Help files.

BEACON MODE

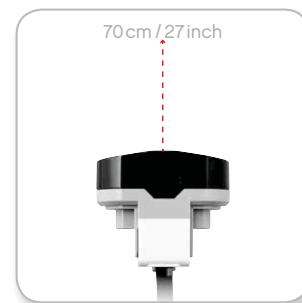
Choose one of the Remote Infrared Beacon's four channels from the red Channel Selector. The Infrared Sensor will detect a beacon signal matching the channel that you specify in your program up to a distance of approximately 200 cm in the direction it is facing.

Once detected, the sensor can estimate the general direction (heading) of and the distance (proximity) to the beacon. With this information, you can program a robot to play hide-and-seek, using the Remote Infrared Beacon as the target of its search. The heading will be a value of between -25 and 25, with 0 indicating that the beacon is directly in front of the Infrared Sensor. The proximity will be values between 0 and 100.

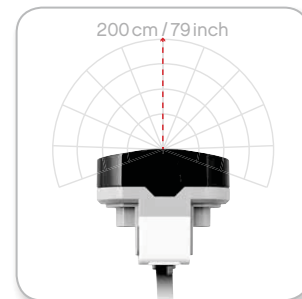
For more information, see **Using the Infrared Sensor Beacon Mode** in the EV3 Help files.



Infrared Sensor



Proximity Mode



Beacon Mode

EV3 TECHNOLOGY

EV3 Sensors

The Remote Infrared Beacon is a separate device that can be handheld or built into another LEGO® model. It requires two AAA alkaline batteries. To turn the Remote Infrared Beacon on, press the big Beacon Mode button on the top of the device. A green LED Indicator will turn on, indicating the device is active and transmitting continuously. Another press on the Beacon Mode button will turn it off (after one hour of inactivity, the beacon will automatically turn itself off).

REMOTE MODE

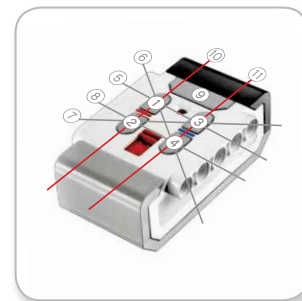
You can also use the Remote Infrared Beacon as a remote control for your robot. When in Remote Mode, the Infrared Sensor can detect which button (or combination of buttons) on the beacon is pressed. There are a total of eleven possible button combinations:

- 0 = No button (and Beacon Mode is off)
- 1 = Button 1
- 2 = Button 2
- 3 = Button 3
- 4 = Button 4
- 5 = Both Button 1 and Button 3
- 6 = Both Button 1 and Button 4
- 7 = Both Button 2 and Button 3
- 8 = Both Button 2 and Button 4
- 9 = Beacon Mode is on
- 10 = Both Button 1 and Button 2
- 11 = Both Button 3 and Button 4

For more information, see **Using the Infrared Sensor Remote Mode** in the EV3 Help files.



Remote Infrared Beacon



Remote Mode

NOTE:

The Infrared Sensor and Remote Infrared Beacon are not part of the LEGO® MINDSTORMS® Education EV3 Core Set but can be acquired as accessories.

EV3 TECHNOLOGY

EV3 Sensors

Temperature Sensor

The Temperature Sensor is a digital sensor that measures the temperature at the tip of its metal probe. The sensor measures in Celsius (-20°C to 120°C) and Fahrenheit (-4°F to 248°F) with an accuracy of 0.1°C.

The Temperature Sensor is most commonly used to collect data for heat-related data logging projects. With a 50 cm-long Connector Cable and a 6.4 cm metal probe, the sensor makes it easy to measure hot liquids away from the EV3 Brick and other electronics.

For more information, see **Using the Temperature Sensor** in the EV3 Software Help.



NOTE:

The Temperature Sensor is not part of the LEGO® MINDSTORMS® Education EV3 Core Set but can be acquired as accessory.

EV3 TECHNOLOGY

Connecting the EV3 Technology

Connecting Sensors and Motors

In order to function, motors and sensors must be connected to the EV3 Brick.

Using the flat black Connector Cables, link sensors to the EV3 Brick using Input ports 1, 2, 3, and 4.

If you create programs while the EV3 Brick is not connected to your computer, the software will assign sensors to default ports. Those default port assignments are:

- + Port 1: Touch Sensor
- + Port 2: Gyro Sensor/Temperature Sensor
- + Port 3: Color Sensor
- + Port 4: Ultrasonic Sensor/Infrared Sensor

If the EV3 Brick is connected to your computer while you program, the software will automatically identify which port is being used for each sensor or motor.

Using the flat black Connector Cables, link motors to the EV3 Brick using Output ports A, B, C, and D.

As with the sensors, if the EV3 Brick is not connected when you are writing a program, each motor will be assigned to a default port. Default port assignments are:

- + Port A: Medium Motor
- + Port B & C: Two Large Motors
- + Port D: Large Motor

If the EV3 Brick is connected to the computer when you are programming, the software will automatically assign the correct port in your programs.



Connecting Sensors



Connecting Motors

NOTE:

The software cannot distinguish between two or more identical sensors or motors.

EV3 TECHNOLOGY

Connecting the EV3 Technology

Connecting the EV3 Brick to Your Computer

Connect the EV3 Brick to your computer by USB Cable or wirelessly using either Bluetooth or Wi-Fi.

USB CABLE

Using the USB Cable, plug the Mini-USB end into the EV3 Brick's PC port (located next to Port D). Plug the USB end into your computer.



USB Cable connection

EV3 TECHNOLOGY

Connecting the EV3 Technology

WIRELESS—BLUETOOTH

If your computer is not Bluetooth-enabled, you will need a Bluetooth USB dongle for your computer.

Making a Bluetooth connection to the computer

Before you can make a Bluetooth connection between the EV3 Brick and the computer running the EV3 Software, you will need to enable Bluetooth on the EV3 Brick. Directions for this can be found on page 33.

Once you have enabled Bluetooth on the EV3 Brick, it can now be connected to the computer and EV3 Software.

1. First, confirm that the EV3 Brick is turned on.
2. Open a new or existing program in the EV3 Software (see the **EV3 Software** chapter on page 37 for directions on how to do this).
3. Go to the Hardware Page at the lower right of the screen—expand the window if collapsed (learn more about the Hardware Page on page 46).
4. Click on the Available Bricks tab. If your EV3 Brick is not already listed, click the Refresh button to locate the EV3 Brick and check the Bluetooth box that will appear.
5. Accept the connection on your EV3 Brick manually, then enter the passkey and press the Center button for OK. The default is 1234. Repeat this in the EV3 Software.
6. The connection is now established and a “<>” symbol is shown on the top left of the EV3 Brick Display (next to the Bluetooth icon) to confirm the connection.

To disconnect the EV3 Brick from the computer, click on the Disconnect button next to the Refresh button in the Hardware Page.

More information about Bluetooth settings on the EV3 Brick can be found on page 33.



Wireless connection

EV3 TECHNOLOGY

Connecting the EV3 Technology

WIRELESS—WI-FI

Your first step in connecting to Wi-Fi is to acquire a Wi-Fi USB dongle. For a list of compatible dongles, ask your local LEGO® Education provider or go to the official LEGO® MINDSTORMS® Education website (www.LEGOeducation.com/MINDSTORMS).

To begin the setup, you must have access to a wireless network, and know the network's name and its password.

If the EV3 Software is open, close it and insert your Wi-Fi dongle into the EV3 Brick using the USB Host port.

Before you can connect the EV3 Brick to a network, you will need to enable Wi-Fi on the EV3 Brick. Directions for this can be found on page 35.



Settings screen

NOTE:

The EV3 Brick only supports the following network encryption modes: None and WPA2.

NOTE:

Because of keyboard limitations, the password for the network must be made up of numbers, capital letters, and lowercase letters. You will not be able to use some symbols, such as the # sign, or letters and symbols from non-Latin alphabets.

EV3 TECHNOLOGY

Connecting the EV3 Technology

Connecting the EV3 Brick to a network

After selecting Wi-Fi on the Settings screen, use the Up and Down buttons to select Connections and press the Center button for OK. The EV3 Brick will now search for and list available Wi-Fi networks.

Using the Up and Down buttons for navigation, find your network on the list. If the EV3 Brick is not already connected to your network (indicated by a check mark), select your network using the Center button.

In the Network dialog box that appears, select Connect and press OK with the Center button. You will now be asked to enter the encryption type and the network password using the Left, Right, Up, and Down buttons to navigate (upper and lower cases do matter here).

Once you have entered the correct password, press the check mark for OK. You will now be connected to the network.

If the EV3 Brick does not find your network in its search, the network may be hidden. To connect to a hidden network, select "Add hidden."

You will then be asked to enter the name, encryption type, and password for the hidden network you wish to add (upper and lower cases do matter here). Once done, the EV3 Brick will be connected to the hidden network and the network will be included in the network list.



Network list



Connect to network



Network password



Add hidden network

NOTE:

Once you have connected to a network using its password, the EV3 Brick will remember the password for future connections. Known networks are indicated in the list with an "****".

EV3 TECHNOLOGY

Connecting the EV3 Technology

Making a Wi-Fi connection from the computer to the EV3 Brick

Using the USB Cable, connect the EV3 Brick to the computer.

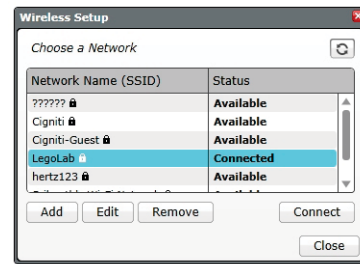
Open an EV3 Software program. Access the Wireless Setup tool in the Hardware Window (at the bottom right of the screen), or select Wireless Setup from the Tools Menu.

The computer will display which networks it detects.

Select the network you want to connect to and click on "Connect" to configure the connection. To add a network that is not broadcasting its Network Name (SSID), click "Add."

To edit the settings of a previously configured network, click Edit.

Click OK to establish a Wi-Fi connection. Once the connection is established, you can unplug the USB Cable.



Wireless Setup tool

EV3 TECHNOLOGY

EV3 Brick Interface

The EV3 Brick is the control center for bringing your robots to life. Using the Display and the Brick Buttons, the EV3 Brick Interface contains four basic screens that give you access to an amazing array of functions unique to the EV3 Brick. It can be something as simple as starting and stopping a program, or something as complicated as writing the program itself.

Run Recent

This screen will be blank until you begin to download and run programs. It is the most recently run programs that will be displayed on this screen. The program at the top of the list which is selected by default is the latest program run.

File Navigation

This screen is where you will access and manage all the files on your EV3 Brick, including files stored on a SD Card.

Files are organized in project folders, which in addition to the actual program files also contain sounds and images used in each project. In the File Navigator, files can be moved or deleted. Programs created using the Brick Program and Brick Datalog apps are stored separately in the BrkProg_SAVE and BrkDL_SAVE folders.



Run Recent screen



File Navigation screen



Open folder in File Navigation

EV3 TECHNOLOGY

EV3 Brick Interface

Brick Apps

The EV3 Brick comes with five brick applications preinstalled and ready to use. In addition, you can also make your own apps in the EV3 Software. Once downloaded to the EV3 Brick, the homemade apps will be displayed here.

The five preinstalled apps are the following:

PORT VIEW

On the first screen in the Port View, you will see, at a glance, which ports have sensors or motors attached. Use the EV3 Brick Buttons to navigate to one of the occupied ports and you will see the current readings returned from the sensor or motor. Attach some sensors and motors and experiment with the different settings. Press the Center button to see or change the current settings for the attached motors and sensors. Press the Back button to get back to the Brick Apps main screen.

MOTOR CONTROL

Control the forward and reverse movement of any motor connected to one of the four output ports. There are two different modes. In one mode, you will be able to control motors connected to Port A (using the Up and Down buttons) and to Port D (using the Left and Right buttons). In the other mode, it is motors connected to Port B (using the Up and Down buttons) and Port C (using the Left and Right buttons) that you control. Use the Center button to toggle between the two modes. Press the Back button to get back to the Brick Apps main screen.



Brick Apps screen



Port View app



Motor Control app

EV3 TECHNOLOGY

EV3 Brick Interface

IR CONTROL

Control the forward and reverse motion of any motor connected to one of the four output ports using the Remote Infrared Beacon as remote control and the Infrared Sensor as receiver (the Infrared Sensor must be connected to Port 4 in the EV3 Brick). There are two different modes. In one mode, you will be using Channels 1 and 2 on the Remote Infrared Beacon. On Channel 1, you will be able to control motors connected to Port B (using Buttons 1 and 2 on the Remote Infrared Beacon) and to Port C (using Buttons 3 and 4 on the Remote Infrared Beacon). On Channel 2, you will be able to control motors connected to Port A (using Buttons 1 and 2) and to Port D (using Buttons 3 and 4). In the other mode, you can control your motors in the exact same way by using Channels 3 and 4 on the Remote Infrared Beacon instead. Use the Center button to toggle between the two modes. Press the Back button to get back to the Brick Apps main screen.



IR Control app

NOTE:

The Remote IR Beacon and Infrared Sensor are not part of the LEGO® MINDSTORMS® Education EV3 Core Set but can be acquired as accessories.

EV3 TECHNOLOGY

EV3 Brick Interface

BRICK PROGRAM

The EV3 Brick comes with an on-brick programming application similar to the software installed on your computer. These instructions provide you with the basic information you will need to get started.

Create program

Open up your Brick Program App.

The Start screen provides you with a Start and a Loop block that are connected via a Sequence Wire. The vertical broken Add Block line in the middle indicates that you can add more blocks to your program. Press the Up button to add a new block from the Block Palette.

In the Block Palette, you can choose which new block to add by navigating using the Left, Right, Up, and Down buttons. Navigating farther up, additional blocks will show. Navigating all the way down will take you back to your program. Generally, there are two types of blocks—Action and Wait. The Action Block Indicator is a small arrow at the top right on the block. The Wait Block Indicator is a small hourglass. In total, there are six different Action blocks and eleven different Wait blocks to choose from.

When you find the block you want, navigate to it and press the Center button. You will be taken back to your program.

In your program, you can navigate between the blocks using the Left and Right buttons. Press the Center button to change the settings of the highlighted block (always the block in the middle of the screen) or to add a new block when the Sequence Wire is highlighted and the Add Block line is visible.

On each programming block, you can change one setting using the Up and Down buttons. For example, on the Action Move Steering block, you can change the direction of your robot's path. When you have chosen the setting you want, press the Center button.



Start screen



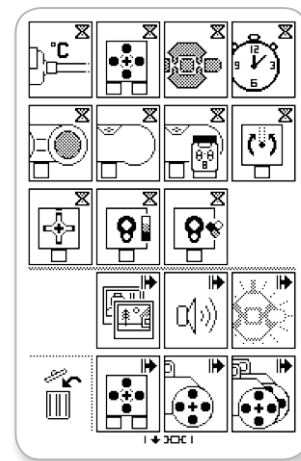
Block Palette



New block added



Adjust block setting



Full Block Palette

EV3 TECHNOLOGY

EV3 Brick Interface

Delete blocks

If you want to delete a block from a program, highlight the block you want to delete and press the Up button to go to the Block Palette.

In the Block Palette, navigate to the trashcan on the far left and press the Center button. The block is now deleted.

Run program

To run your program, use the Left button to navigate to the Start block at the very beginning of the program. Press the Center button and your program will run.

Save and open program

To save your program, navigate to the Save icon on the far left of your program. When clicking on the Save icon, you will be asked to name your program or accept the default name. Once you are done, click OK and your program is now saved in the BrkProg_SAVE folder that can be accessed from the File Navigation screen (see page 25).

You can also open any existing EV3 Brick Program by clicking on the Open icon located above the Save icon. Use the Up and Down buttons to toggle between those two icons.



Delete block



Run program



Save program

EV3 TECHNOLOGY

EV3 Brick Interface

BRICK DATALOG

The EV3 Brick comes with a simple-to-use, on-brick data logging application. These instructions provide you with the basic information you will need to get started.

Main screen

When you open the EV3 Brick Datalog app, you will see to the left a Graph Area. If a sensor or motor is connected to the EV3 Brick, a graph will show live readings from one of the sensors like an oscilloscope (if a motor is connected, it is readings from the in-built rotation sensor).

To the right of the graph, the following numbers are displayed (from the top): actual reading, duration, highest reading, lowest reading, and average reading. Duration will only be shown when running an experiment—not when in Oscilloscope Mode.

Underneath, a small window will indicate what port the values are currently read from (Input Port 1, 2, 3, or 4, or Output Port A, B, C, or D). To change the port, use the Left and Right buttons to click through the available ports.



Main screen

NOTE:

Only ports with a sensor or motor connected will be displayed!

EV3 TECHNOLOGY

EV3 Brick Interface

Set up and run experiment

If you wish to set up and run an experiment, start by clicking on the Brick Datalog Settings button in the bottom right corner symbolized by a wrench. Use the Down and Right buttons to navigate to it and the Center button to click OK.

You can now decide the sample rate of your experiment, ranging from one sample per minute to a thousand samples per second. Use the Up and Down buttons to highlight Rate, then use the Left and Right buttons to select the sample rate you wish to use for your experiment.

Next, you can choose what sensor to use for your experiment. Highlight Sensor Setup and click OK with the Center button.

You will now get a list of sensors connected to your EV3 Brick. Use the Up and Down buttons to highlight the sensor you want to use. When a sensor is highlighted, use the Left and Right buttons to select sensor mode (for example, if the Color Sensor should measure color or ambient light). Once you have found the correct sensor mode, use the Center button to click OK and you will be taken back to the Settings screen. On the Settings screen, click the check mark button and you are now back at the main EV3 Brick Datalog screen.

To run your experiment, select and click on the Record button (next to the Settings button with the wrench).

A live graph will now show the incoming values from the selected sensor. To the right you can see the statistics of your experiment, including duration. The flashing Record button and pulsing green EV3 Brick Buttons Light indicate that your experiment is running. To stop your experiment, click the Center button.

When stopping your experiment, you will be asked to name your experiment or accept the default name. Once you are done, click OK and your experiment is now saved in the BrkDL_SAVE folder that can be accessed from the File Navigation screen (see page 25).



Sample rate



Sensor setup



Run experiment

NOTE:

The live graph is not supported when logging data at higher rates than ten samples per seconds. The incoming values will then only be shown as numbers.

EV3 TECHNOLOGY

EV3 Brick Interface

Settings

This screen will enable you to see and adjust various general settings on the EV3 Brick.

VOLUME

There may be occasions when you will want to adjust the volume of the sound coming from the EV3 Brick Speaker. To change the speaker volume, go to the Settings screen. As the top menu, Volume will already be highlighted. Press the Center button.

Use the Right and Left buttons to change the volume setting, which can be intervals from 0% to 100%. Press the Center button to accept. This will return you to the Settings screen.

SLEEP

To change the amount of inactive time that passes before the EV3 Brick goes into Sleep Mode, go to the Settings screen and navigate to the Sleep menu using the Down button. Press the Center button.

Use the Right and Left buttons to select a lower or higher time period, which can be intervals from 2 minutes to never. Press the Center button to accept. This will return you to the Settings screen.



Settings screen



Adjust volume



Adjust sleep

EV3 TECHNOLOGY

EV3 Brick Interface

BLUETOOTH

This is where Bluetooth is enabled on the EV3 Brick, and where you can choose some specific privacy and Apple iOS settings. Here you can also connect to other Bluetooth devices such as another EV3 Brick.

When you select Bluetooth on the Settings page, there are four options presented—Connections, Visibility, Bluetooth, and iPhone/iPad/iPod. To go back to the main Settings screen, press the Down button until the check mark at the bottom of the screen is highlighted, then press the Center button for OK.

Bluetooth

It is here that you enable standard Bluetooth on the EV3 Brick. Using the Up and Down buttons, select the word “Bluetooth,” then press the Center button for OK. A check mark will appear in the Bluetooth box. Bluetooth is now enabled on your EV3 Brick, and a Bluetooth icon will be shown in the top left of the EV3 Brick Display.

Note: This setting will not allow you to connect to an iOS device. For this, you will need to select the iPhone/iPad/iPod setting (see below)!

To disable Bluetooth, repeat the above procedure, this time unchecking the Bluetooth box.

iPhone/iPad/iPod

Select this setting only if you specifically want your EV3 Brick to connect with Apple iOS devices—iPhones, iPads, and iPods—using Bluetooth (make sure Bluetooth is enabled on your iOS device).

Note: Using this setting will not allow you to communicate with other Bluetooth devices, including computers and other EV3 Bricks!

You cannot choose to enable both standard Bluetooth and Bluetooth communication for Apple iOS devices at the same time.

To enable and disable Bluetooth communication for iOS devices, use the Up and Down buttons to select “iPhone/iPad/iPod,” then press the Center button for OK. A Bluetooth icon will be shown on the top left of the EV3 Brick Display.



Enable Bluetooth

NOTE:

Your EV3 Brick will run more efficiently if you disable the Bluetooth setting when it is not in use.

EV3 TECHNOLOGY

EV3 Brick Interface

Connections

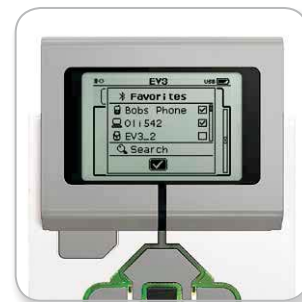
This option allows you to discover and choose other available Bluetooth devices (make sure Bluetooth is enabled). If you click on “Connections,” you will be taken to a Favorites screen, where the devices you trust are displayed and identified with a check mark. No passkeys are needed for your trusted devices. Using the check boxes, you can manage which devices you wish to have as Favorites.

If you then click on “Search,” the EV3 Brick will scan the area for all detectable Bluetooth-emitting devices—including other EV3 Bricks. Your favorite devices will be shown with an asterisk “*” symbol.

Use the Up and Down buttons to select the device on the list you wish to connect to. Press the Center button for OK. If you choose to connect to a device not yet marked as a Favorite, you will be asked to enter the passkey to establish the connection. Once the other device verifies the passkey, you are automatically connected to the device.

Visibility

If the Visibility setting is selected, other Bluetooth devices (including other EV3 Bricks) will be able to discover and connect to your EV3 Brick. If Visibility is unchecked, the EV3 Brick will not respond to search commands from other Bluetooth devices.



Favorites list



Device list

EV3 TECHNOLOGY

EV3 Brick Interface

WI-FI

This is where you enable Wi-Fi communication on the EV3 Brick and connect to a wireless network. After selecting Wi-Fi on the Settings screen, use the Up and Down buttons to select the word "Wi-Fi" and press the Center button for OK. A check mark will appear in the Wi-Fi box. Wi-Fi is now enabled on your EV3 Brick, and a Wi-Fi icon will be shown in the top left of the EV3 Brick Display.

To go back to the main Settings screen, press the Down button until the check mark at the bottom of the screen is highlighted, then press the Center button for OK.

For information on how to connect your EV3 Brick to a wireless network, see the Connecting the **EV3 Brick to Your Computer** section on page 22.

BRICK INFO

When you need to know the current technical specifications of your EV3 Brick, such as hardware and firmware version and EV3 Brick OS build, this is where you will find that information. This is also where you can find out how much free memory you have available.



Enable Wi-Fi



Brick Info

EV3 SOFTWARE

MINIMUM SYSTEM REQUIREMENTS

Prerequisites:

- + Silverlight 5.0 or newer
- + Microsoft Dot Net 4.0 or newer

Operating systems:

- + Windows: Windows XP, Vista, Windows 7, and Windows 8 (excluding Win RT) (32/64 bit) with the latest service packs
- + Macintosh: Mac 10.6, 10.7, and 10.8 with the latest service packs

System requirements:

- + 2 GB of RAM or more
- + 1.5 GHz processor or faster
- + Minimal supported screen resolution—1024*600

LEGO® MINDSTORMS® Education EV3 does not support tablets or certain netbooks with hardware that does not meet the above requirements.

While building robots is fun, the heart of robotics is bringing them to life—making them move and accomplish tasks. You will find the LEGO® MINDSTORMS® Education EV3 Software to be:

- + A visual and intuitive introduction to programming
- + A helpful and comprehensive data logging tool
- + A digital workbook where instructions are given and findings documented
- + A natural opportunity to inspire and show interest in the fields of science, technology, engineering, and mathematics.

Installing the Software

Once you have confirmed that your computer meets the minimum system requirements, you are ready to install the software. Close all other programs, then double-click on the installation file in the EV3 Software application folder. Installation will now begin.

TEACHER AND STUDENT EDITION

During the installation process you will be asked if you want to install the Teacher or Student Edition of the EV3 Software. On Macintosh, Teacher Edition can be selected when choosing Customized installation.

In the Teacher Edition you will find additional information and resources that can be useful in a classroom setting and in other teaching situations. You will also have extended Content Editor capabilities to access, create, and manage content used for teaching: for example, by making programs inaccessible to students. It is recommended that all educators install the Teacher Edition.