

SNAP CIRCUITS
ELENCO

DISCOVER CODING

Making Coding a Snap®



Hands-On Electronics Learning
Easy App-Driven Projects
Developing STEM Skills in Coding

Requires four (4) "AA" batteries. Not included.
Ages 8 to 108



Project 17

FEATURING
THE SNAP CIRCUITS CODING MODULE
SC CONTROLLER

USE THE BLUETOOTH POWERED MODULE
AND DOWNLOADABLE **SNAP CIRCUITS APP**
FOR ENDLESS CODING FUN!



ELENCO
Learn by doing.®

753060

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WARNING: FOR ALL PROJECTS WITH A ⚠ SYMBOL

Moving parts do not touch the motor or fan during operation. Do not lean over the motor. Do not launch the fan at people, animals, or objects. Eye protection is recommended.



WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!



WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

Conforms to all applicable U.S. government requirements and CAN ICES-3 (B)/NMB-3 (B).

Basic Troubleshooting

1. Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.
2. Be sure that parts with positive/negative markings are positioned as per the drawing.
3. Be sure that all connections are securely snapped.
4. Try replacing the batteries.

Elenco® is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 5 to determine which ones need replacing.

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision:

Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the

child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.



Batteries:

- Use only 1.5V AA type, alkaline batteries (not included).
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix old and new batteries.
- Do not connect batteries or battery holders in parallel.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Remove batteries when they are used up.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.
- When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side.
- Battery installation should be supervised by an adult.

Parts List (Colors and styles may vary) Symbols and Numbers

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER.** Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com.
Customer Service: 150 Carpenter Ave., Wheeling, IL 60090 U.S.A. • You may order additional / replacement parts at www.elenco.com/replacement-parts

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
☐ 3	(1)	1- Snap Wire		6SC01	☐ 1		Jumper Wire, Red		6SCJ2
☐ 6	(2)	2- Snap Wire		6SC02	☐ 1		Jumper Wire, Blue		6SCJ4
☐ 3	(3)	3- Snap Wire		6SC03	☐ 1	(M1)	Motor		6SCM1
☐ 1	(4)	4- Snap Wire		6SC04	☐ 1		Fan		6SCM1F
☐ 1	(5)	5- Snap Wire		6SC05	☐ 1	(Q2)	NPN Transistor		6SCQ2
☐ 1	(6)	6- Snap Wire		6SC06	☐ 1	(R1)	100Ω Resistor		6SCR1
☐ 2	(B1)	Battery Holder - uses two (2) 1.5V type "AA" (not Included)		6SCB1	☐ 1	(R2)	1kΩ Resistor		6SCR2
☐ 1		Base Grid (11.0" x 7.7") Black Tint		6SCBGBK	☐ 1	(R4)	10kΩ Resistor		6SCR4
☐ 2	(D2)	Green LED		6SCD2	☐ 1	(S1)	Slide Switch		6SCS1
☐ 1	(D3)	Diode		6SCD3	☐ 1	(SP2)	Speaker		6SCSP2
☐ 1	(D9)	Blue LED		6SCD9	☐ 1	(U2)	Alarm IC		6SCU2
☐ 2	(D10)	Red/Yellow LED		6SCD10	☐ 1	(U3)	Space War IC		6SCU3
☐ 1		Jumper Wire, Black		6SCJ1	☐ 1	(U33)	SC Controller		6SCU33

How to Use Snap Circuits®

Snap Circuits® uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, light blocks, battery blocks, different length wire blocks, etc. These blocks are different colors and have numbers and letters on them so that you can easily identify them. The blocks you will be using are shown as color symbols, allowing you to easily snap them together to form a circuit.

For Example:

This is the slide switch, it is green and has the marking **(S1)** on it. The part symbols in this booklet may not exactly match the appearance of the actual parts, but will clearly identify them.



This is a wire block which is blue and comes in different wire lengths.

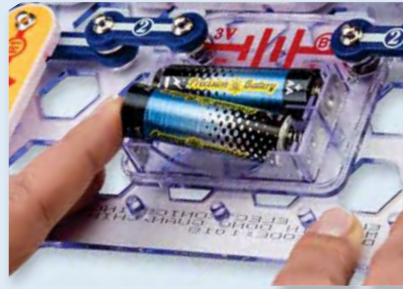
This one has the number **(2)**, **(3)**, **(4)**, **(5)**, or **(6)** on it depending on the length of the wire connection required.



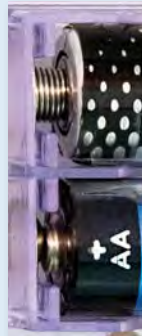
There is also a 1-snap wire that is used as a spacer or for interconnection between different layers.



You need a power source to build each circuit. This is labeled **(B)** and requires two (2) 1.5V "AA" batteries (not included).



When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side. Battery installation should be supervised by an adult.



A large clear plastic base grid is included with this kit to help keep the circuit blocks properly spaced. You will see evenly spaced posts that the different blocks snap into. The base has rows labeled A-G and columns labeled 1-10.

Next to each part in every circuit drawing is a small number in black. This tells you which

level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

Some circuits use the jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.



Usually when the motor **(M1)** is used, the fan will usually be placed on it. On top of the motor shaft is a black plastic piece (the motor top) with three little tabs. Lay the fan on the black piece so the slots in its bottom "fall into place" around the three tabs in the motor top. If not placed properly, the fan will fall off when the motor starts to spin.



Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

DOs and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, LED, motor, integrated circuit, etc.), and wiring paths between them and back. **You must be careful not to create "short circuits"** (very low-resistance paths across the batteries, see examples below) as this will damage components and/or quickly drain your batteries. Only connect the ICs using configurations given in the projects, incorrectly doing so may damage them. **Elenco® is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

ALWAYS USE EYE PROTECTION WHEN EXPERIMENTING ON YOUR OWN.

ALWAYS include at least one component that will limit the current through a circuit, such as a lamp, motor, IC, or an LED (which has an internal protection resistor).

ALWAYS use switches in conjunction with other components that will limit the current through them. Failure to do so will create a short circuit and/or damage those parts.

ALWAYS disconnect your batteries immediately and check your wiring if something appears to be getting hot.

ALWAYS check your wiring before turning on a circuit.

NEVER connect to an electrical outlet in your home in any way.

NEVER leave a circuit unattended when it is turned on.

For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.



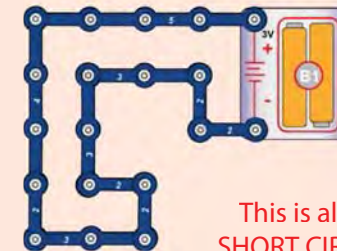
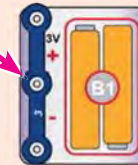
Warning to Snap Circuits® Owners: Do not connect additional voltage sources from other sets, or you may damage your parts. Contact ELENCO® if you have questions or need guidance.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.



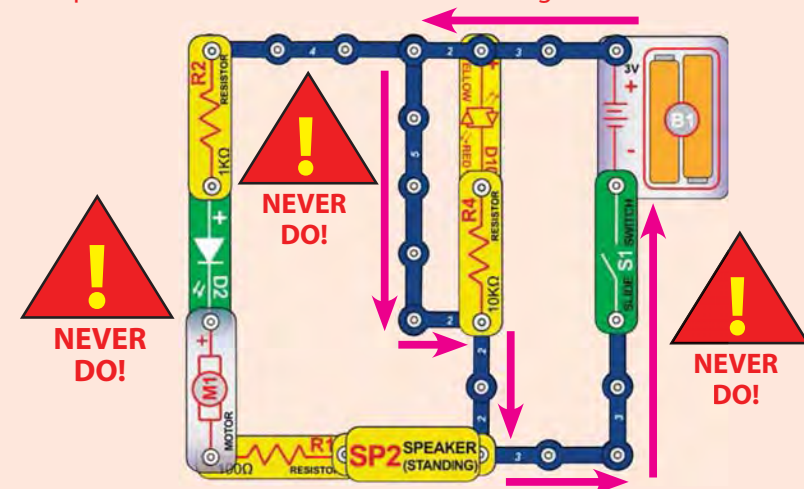
NEVER DO!



NEVER DO!

This is also a SHORT CIRCUIT.

When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.



NEVER DO!



NEVER DO!



NEVER DO!

You are encouraged to tell us about new circuits and structures you create. If they are unique, we will post them with your name and state on our website at: elenco.com/showcase

Send your suggestions (with photos) to ELENCO®: info@elenco.com

ELENCO® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from: www.elenco.com/for-makers.



WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

Advanced Troubleshooting (Adult supervision recommended)

Elenco® is not responsible for parts damaged due to incorrect wiring.

If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

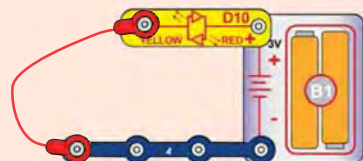
1. Battery holder (B1), motor (M1), and LEDs (D2, D9, & D10):

Place batteries in holder. Place each LED directly across the battery holder (LED "+" to battery "+"), it should light. The red/yellow LED (D10) should be red in one direction and yellow in the other direction. Touch the motor across the battery snaps (motor + to battery +), it should spin to the right at high speed. If none work, then replace your batteries and repeat, if still bad then the battery holder is damaged. If the motor spins but does not balance the fan in the projects, check that there is a black plastic piece with 3 prongs at the top of the motor shaft.

2. Jumper wires: Use this mini-circuit to test each jumper wire, the LED should light.

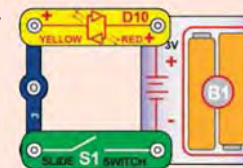


3. Snap wires: Use this mini-circuit to test each of the snap wires, one at a time. The LED should light.

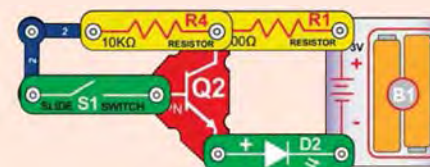


4. Slide switch (S1), speaker (SP2), diode (D3), and resistors (R1, R2, & R4): Use this mini circuit, the LED should be on when the switch is on and off when the switch is off, or the switch is broken. Replace the switch with the speaker, the LED should light or the speaker is broken. Replace the speaker with the diode ("+" on left),

the LED should light or the diode is broken. Replace the diode with the R1 resistor; the LED should light. Replace R1 with R2, LED should be dimmer. Replace R2 with R4, the LED should be much dimmer but still light.



5. NPN transistor (Q2): Use this mini circuit, the green LED (D2) should only be on when the switch (S1) is on, or the transistor is broken.



6. Alarm IC (U2): Build project 11, you should hear a siren. Then make the variants in parts B-D to get different sounds.

7. Space war IC (U3): Build project 14, turning switch S1 on and off should change the sound. Then move the switch to points labeled A & B, turning S1 on and off, this should also change the sound.

8. SC Controller (U33): Build project 1, the blue (Bluetooth) light on the SC Controller should be blinking when the switch (S1) is turned on. Connect the SC Controller to the App and use the Circuit screen of Control mode to light the LEDs connected to the 5 outputs (D1-D4 and A) on the SC Controller. Note: if this test works but turning on the motor (M1)/fan in other projects resets the SC Controller (making the blue Bluetooth light on it flashing instead of staying on) then replace your batteries.

You may order additional / replacement parts at:
www.elenco.com/replacement-parts

Guidelines For Classrooms or Home Schooling

This product is a tool for opening the exciting worlds of coding & electronics. Following the Learn by Doing® concept, coding & electronics will be easy for students to understand by using Snap Circuits® to learn about circuits and the Snap Circuits® Coding App to learn about coding. This kit emphasizes the practical applications of coding & electronics, without bogging down in mathematics. This course is as much about thinking processes & science as about coding & electronics.

Why should students learn about coding or electronics? Coding & electronics play important and increasing roles in their everyday lives, and so some basic knowledge of them is a must for everyone in today's society. Learning about them teaches how to do scientific investigation, logical thinking, and helps develop basic skills needed in today's world.

This product is intended for ages 8 and up, for adults and children who have attained sufficient maturity to read and follow directions and warnings.

It should take about 6 hours to do this entire book, or about 4 hours to do just the coding projects (projects 1, 10, 12, 13, 15-18). The focus of this set is to learn about coding and then to code on your own, so teachers should determine what is best for their students.

INSTRUCTOR PREPARATION/ORGANIZATION

- Determine what the learning environment will be. Will the students be learning independently or in small groups? How much teacher instruction will there be for each section? Will the students be reading the lesson as homework and then have limited teacher instruction before performing the experiments? Decide if quizzes will be given and how they will be organized.
- Allocate time within the session as needed for:
 - Teacher instruction about the topics being covered during the session.
 - Getting the Snap Circuits® components into the workspace.
 - Teacher instruction about the specific projects to be performed during that session.
 - Building and testing the circuits.
 - Loading the SC Coding App and connecting to a SC Controller circuit.
 - Performing experiments (and teacher verification if desired).
 - Dismantling the circuits and returning Snap Circuits® components to storage area.
 - Reassembling the class for review.
- Make sure the students know their objectives for the day, how much time they will need for cleanup, and where the materials are being stored.
- Students must understand that there are usually many ways of making the same circuit or program, and that the instructor may not know all the answers. They are doing scientific investigation, and many circuit projects & programs suggest variations to experiment with.
- Have students review the DO's and DON'Ts of Building Circuits on page 4 at the beginning of each session.

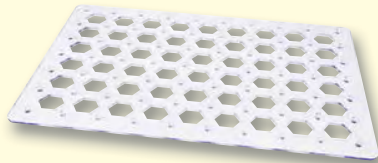
Project Listings

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About Your Snap Circuits® Parts

BASE GRID

The **base grid** is a platform for mounting parts and wires. It functions like the printed circuit boards used in most electronic products, or like how the walls are used for mounting the electrical wiring in your home.



SNAP WIRES & JUMPER WIRES

The blue **snap wires** are wires used to connect components. They are used to transport electricity and do not affect circuit performance. They come in different lengths to allow orderly arrangement of connections on the base grid.



The red, black, and blue **jumper wires** make flexible connections for times when using the snap wires would be difficult. They also are used to make connections off the base grid.



Wires transport electricity just like pipes are used to transport water. The colorful plastic coating protects them and prevents electricity from getting in or out.

(Part designs are subject to change without notice).

BATTERY HOLDER

The **batteries (B1)** produce an electrical voltage using a chemical reaction. This “voltage” can be thought of as electrical pressure, pushing electricity through a circuit just like a pump pushes water through pipes. This voltage is much lower and much safer than that used in your house wiring. Using more batteries increases the “pressure”, therefore, more electricity flows.



Battery Holder (B1)

MOTOR

The **motor (M1)** converts electricity into mechanical motion. An electric current in the motor will turn the shaft and the motor blades, and the fan blade if it is on the motor.

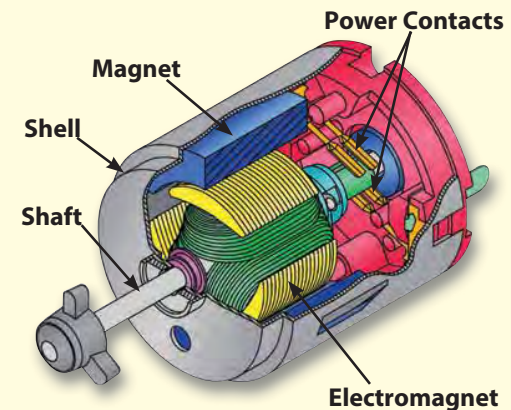


Motor (M1)



This set may have a red fan.

How does electricity turn the shaft in the motor? The answer is magnetism. Electricity is closely related to magnetism, and an electric current flowing in a wire has a magnetic field similar to that of a very tiny magnet. Inside the motor is a coil of wire with many loops wrapped around metal plates. This is called an electromagnet. If a large electric current flows through the loops, it will turn ordinary metal into a magnet. The motor shell also has a magnet on it. When electricity flows through the electromagnet, it repels from the magnet on the motor shell and the shaft spins. If the fan is on the motor shaft, then its blades will create airflow.



About Your Snap Circuits® Parts

DIODES & LEDs

The **diode (D3)** is like a one-way valve that only lets current flow in the direction of the arrow in its symbol. The diode has a turn-on threshold of about 0.7V that voltage must exceed before any current will flow.

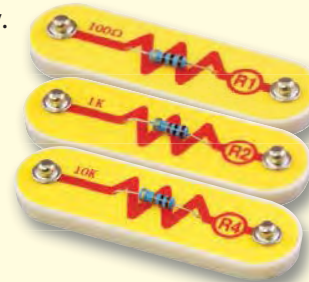
The **green, blue, and red/yellow LEDs (D2, D9, & D10)** are light emitting diodes, and may be thought of as special one-way light bulbs. The color emitted depends on the material used in their construction. Their turn-on threshold is higher than for a normal diode, about 1.5V for red, about 2.0V for green, and about 3.0V for blue; brightness then increases. The red/yellow LED contains red and yellow LEDs connected in opposite directions in the same package. A high current will burn out an LED, so the current must be limited by other components in the circuit, however your Snap Circuits® LEDs have internal resistors to protect against incorrect wiring). Like normal diodes, LEDs block electricity in the "reverse" direction.



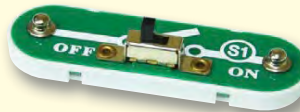
(Part designs are subject to change without notice).

RESISTORS & SWITCH

Resistors "resist" the flow of electricity and are used to control or limit the current in a circuit. This set includes **100Ω (R1), 1kΩ (R2), and 10kΩ (R4) resistors** ("k" symbolizes 1,000, so R4 is really 10,000Ω). Materials like metal have very low resistance (<1Ω), while materials like paper, plastic, and air have near-infinite resistance. Increasing circuit resistance reduces the flow of electricity.



The **slide switch (S1)** connects ("ON") or disconnects ("OFF") the wires in a circuit. When ON it has no effect on circuit performance. Switches turn on electricity just like a faucet turns on water from a pipe.



SPEAKER

The **speaker (SP2)** converts electricity into sound by making mechanical vibrations. These vibrations create variations in air pressure, which travel across the room. You "hear" sound when your ears feel these air pressure variations.



ELECTRONIC MODULES

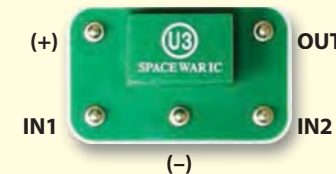
The **alarm and space war ICs (U2 and U3)** contain specialized sound-generation ICs and other supporting components (resistors, capacitors, and transistors) that are always needed with them. This was done to simplify the connections you need to make to use them. Schematics for them are available at www.elenco.com/faqs.



Alarm IC:

IN1, IN2, IN3 - control inputs
(-) - power return to batteries
OUT - output connection

Connect control inputs to (+) power to make five alarm sounds, see project 11 for configurations.



Space War IC:

(+) - power from batteries
(-) - power return to batteries
OUT - output connection
IN1, IN2 - control inputs

Connect each control input to (-) power to sequence through 8 sounds.

The **SC Controller (U33)** lets you control Snap Circuits® parts using Bluetooth. Its functions and use are described on page 33.

TRANSISTORS

The **NPN (Q2) transistor** is a component that uses a small electric current to control a large current, and is used in switching, amplifier, and buffering applications. Transistors are easy to miniaturize, and are the main building blocks of integrated circuits including the microprocessor and memory circuits in computers.



Introduction to Electricity

What is electricity? Nobody really knows. We only know how to produce it, understand its properties, and how to control it. Electricity is the movement of sub-atomic charged particles (called **electrons**) through a material due to electrical pressure across the material, such as from a battery.

Power sources, such as batteries, push electricity through a circuit, like a pump pushes water through pipes. Wires carry electricity, like pipes carry water. Devices like LEDs, motors, and speakers use the energy in electricity to do things. Switches and transistors control the flow of electricity like valves and faucets control water. Resistors limit the flow of electricity.

The electrical pressure exerted by a battery or other power source is called **voltage** and is measured in **volts** (V). Notice the “+” and “-” signs on the battery; these indicate which direction the battery will “pump” the electricity.

The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes** (A) or **milliamps** (mA, 1/1000 of an ampere).

The “**power**” of electricity is a measure of how fast energy is moving through a wire. It is a combination of the voltage and current (Power = Voltage x Current). It is expressed in **watts** (W).

The **resistance** of a component or circuit represents how much it resists the electrical pressure (voltage) and limits the flow of electric current. The relationship is Voltage = Current x Resistance. When the resistance increases, less current flows. Resistance is measured in **ohms** (Ω), or **kilo ohms** (k Ω , 1000 ohms).

Nearly all of the electricity used in our world is produced at enormous generators driven by steam or water pressure. Wires are used to efficiently transport this energy to homes and businesses where it is used. Motors convert the electricity back into mechanical form to drive machinery

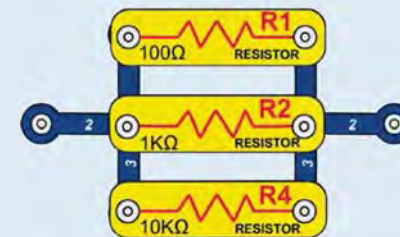
and appliances. The most important aspect of electricity in our society is that it allows energy to be easily transported over distances.

Note that “distances” includes not just large distances but also tiny distances. Try to imagine a plumbing structure of the same complexity as the circuitry inside a portable radio - it would have to be large because we can’t make water pipes so small. Electricity allows complex designs to be made very small.

There are two ways of arranging parts in a circuit, in series or in parallel. Here are examples:



Series Circuit



Parallel Circuit

Placing components in series increases the resistance; highest value dominates. Placing components in parallel decreases the resistance; lowest value dominates.

The parts within these series and parallel sub-circuits may be arranged in different ways without changing what the circuit does. Large circuits are made of combinations of smaller series and parallel circuits.

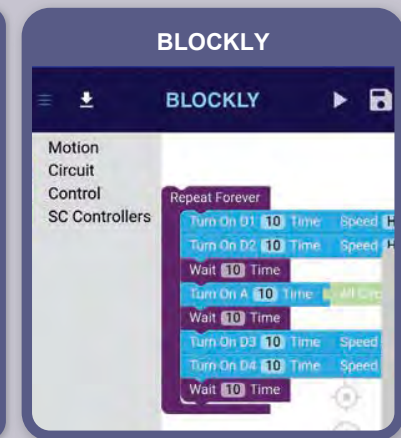
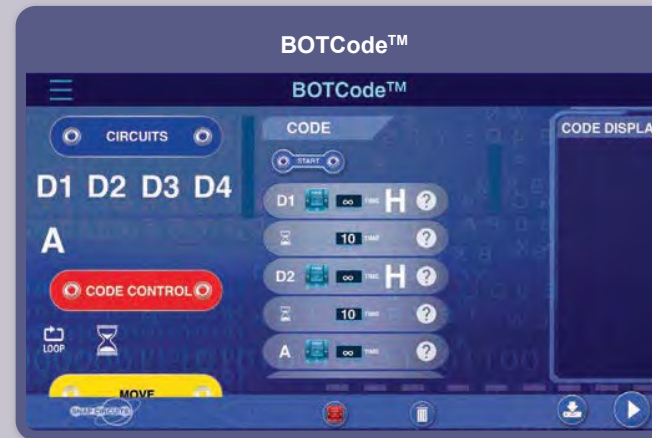
WELCOME TO CODING!

All computers, micro-controllers, apps, and websites are controlled using lines of code, which tell the device what to do, in what order, and when. You probably do not realize how many devices in your home or vehicle have microprocessors or simpler micro-controllers that use code to tell them what to do. Code controls thermostats for heating and air conditioning, digital clocks, vehicle fuel injection systems, oven timers, timers for outdoor lighting systems, stoplights, sprinkler control systems, computers, music players, and many others. Code also controls what you see on websites and apps.

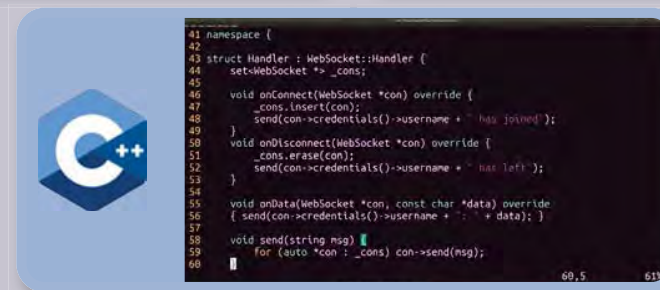
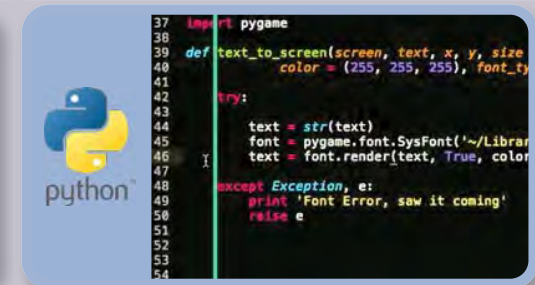
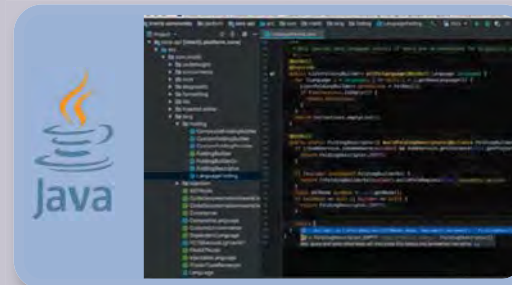
Understanding coding helps you understand logical thinking and problem solving. When you code you create a series of steps to make your device do what you want. It is important that your coding instructions be clear and orderly because a coding controller (or any computer) does what you tell it to do - which may not be what you want it to do.

A computer does not understand any of the programming languages we use, or even graphical programming like BOTCode™. A computer is made up of millions of transistors that can only be turned on or off. These transistors can be grouped together in large numbers to form digital memories and do calculations. The computer or app code we write gets translated into a much longer but very simple form that is used to turn transistors on and off. Many different programming languages have been developed to work with the many different designs for computer hardware (microprocessors, micro-controllers, memories, video controllers), to focus on different applications, or to be easier to use. The BOTCode™ that you will be using is simple and easy to use, making it a great introduction to the world of coding.

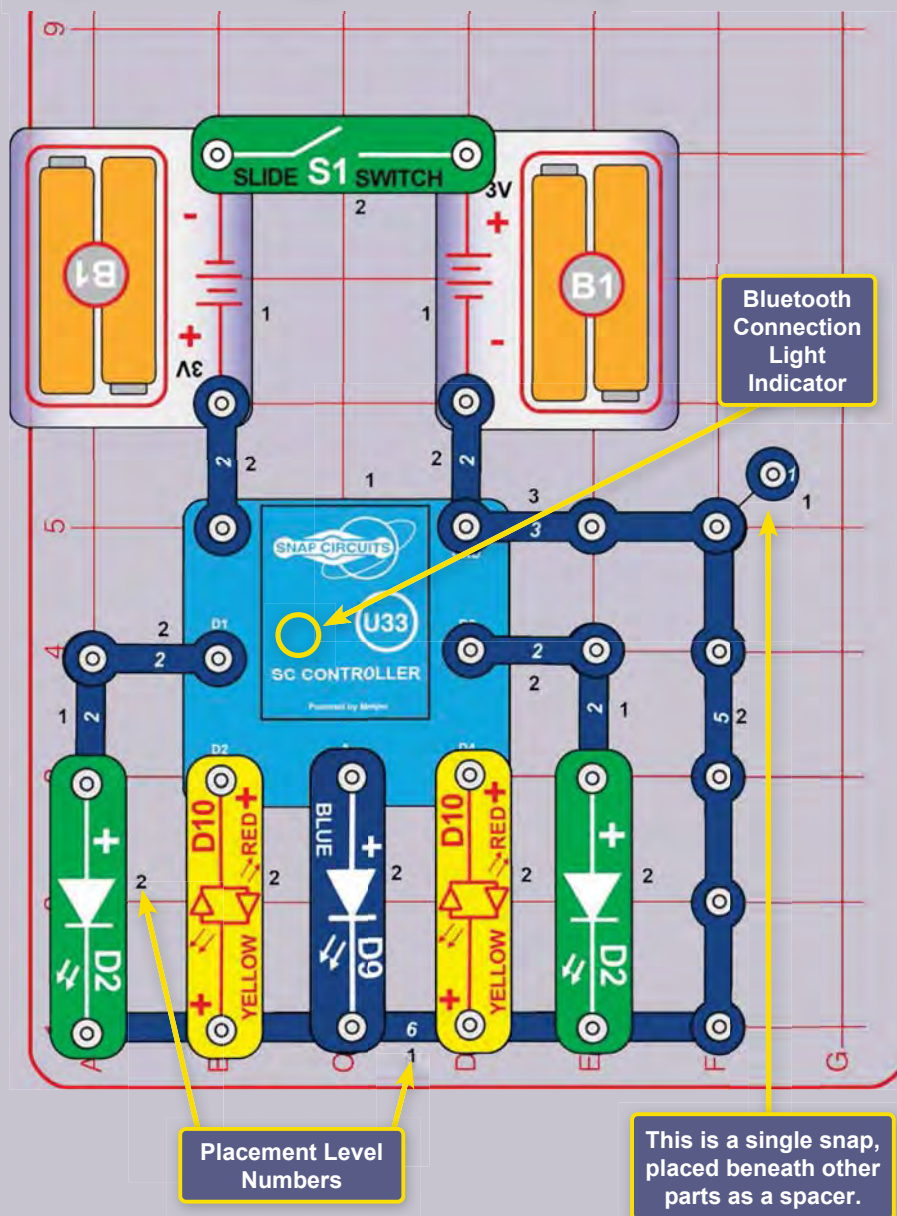
FORMS OF CODE YOU WILL USE



OTHER FORMS OF CODE



PROJECT 1



CODING 5 LIGHTS (QUICK START - DIVE INTO CODING)

This is a summarized version of the Snap Circuits® Coding app instructions for those already familiar with Snap Circuits® and apps and want to just start coding. To first learn more about Snap Circuits® start with projects 2-9, 11, and 14. For more detailed app instructions, see page 33.

Snap Circuits® uses electronic blocks that snap onto a clear plastic grid to build different circuits. These blocks have different colors and numbers on them so that you can easily identify them.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Then, assemble the part marked with a 3. Install two (2) "AA" batteries (not included) into the battery holders (B1) if you have not done so already. **When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side. Battery installation should be supervised by an adult.**

1. Build the circuit shown here, and turn on the slide switch (S1). A blue light on the SC Controller (U33) should be flashing, indicating that the module is waiting for a Bluetooth connection to a device.

2. Go to the app store on your device and find the Snap Circuits® Coding app; install and open it.

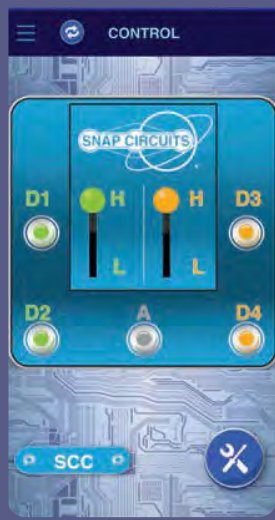


3. The Connect screen should appear, and show device SCC (your SC controller module (U33)). Tap on the red "Not Connected" dot to connect the app to your SC Controller. The red dot on the app should turn green, indicating your SC Controller module is now connected to the app. The Bluetooth indicator light on your SC Controller will now be a solid blue, indicating it is connected. You are now ready to Control or Code.



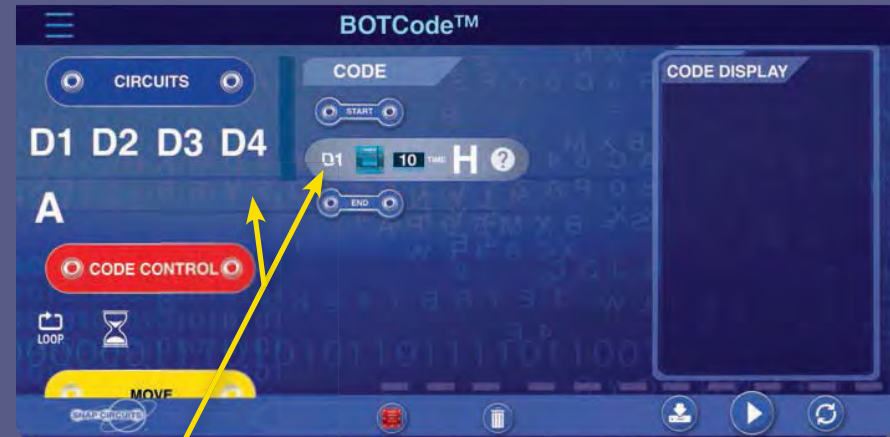
4. Go to the Control Screen by tapping the Control button or using the app menu. The Control screen begins in Circuit mode. The SC Controller has 5 outputs (D1, D2, D3, D4, and A) that are controlled through the app. Outputs D1-D2 and D3-D4 are paired so they can each control a motor in both directions and can be set to either of two output voltage levels, called H (Higher) and L (Lower). Output A has low power and cannot control most motors. Use the app controls to turn the LEDs in your circuit on and off.

Control Screen Mode



5. Go to the BOTCode™ screen using the app menu. Drag commands from the list on left to the program area in the center.

BOTCode™ Screen



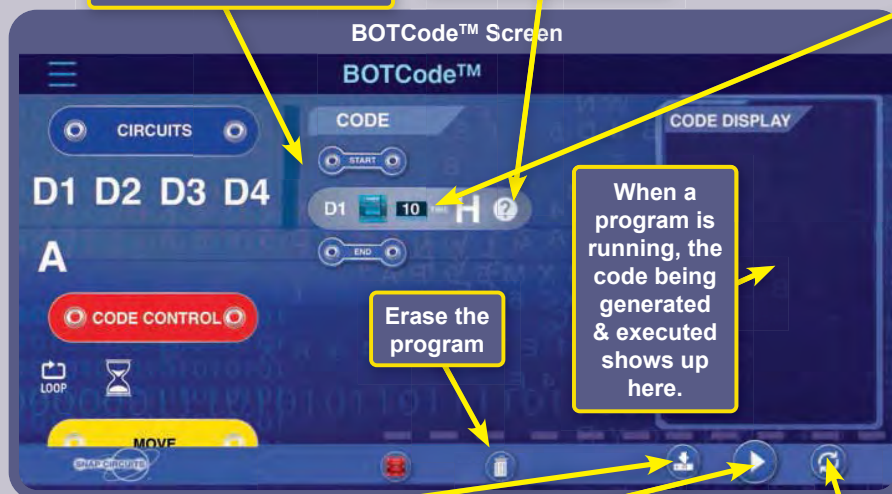
Drag & Drop Commands from the choices on the left to the CODE area in the center to create a program routine.

Drag & Drop Commands to create a program.

? - Add a Comment

Select the command and change the SC Controller voltage level (H=5V and L=3V) and time on each command. **NOTE: "TIME" units are roughly 0.1 seconds but varies so "10" is about 1 second.**

H (Higher=5V) and L (Lower=3V) output voltage level only applies to outputs D1-D4, not output A.

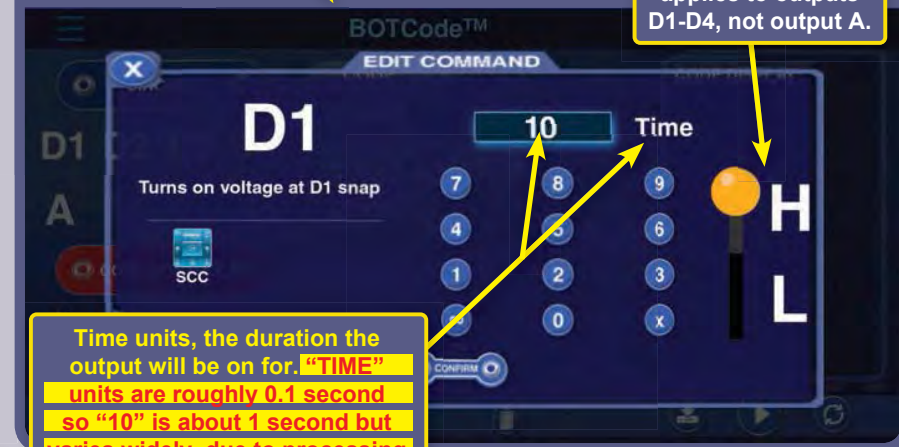


Save code & reuse. Modify it later

Run the program on your SC Controller once, then stop.

Run the program on your SC Controller continuously.

Editing a Command



Time units, the duration the output will be on for. "TIME" units are roughly 0.1 second so "10" is about 1 second but varies widely, due to processing and Bluetooth delays. Value can be set from 1 to 100, or ∞ (to leave it on) and 0 (to turn it off).

Now that you know the basics of BOTCode™, program the SC Controller to do different things with the lights in this circuit. Here are some programming examples: drag-n-drop the commands into the program area, edit the time and voltage levels, and then run the program once or continuously.

Experiment with changing parameters for commands, such as the time duration.

Turn on D1, low brightness, then high brightness.



Turn on the 5 LEDs one at a time.

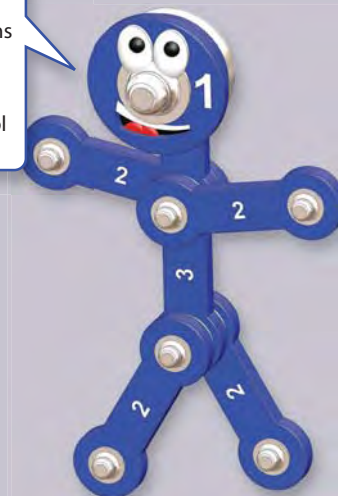


Turn on LEDs one at a time until all are on, then turn them off one at a time.



Limitations of the SC Controller and BOTCode™:
The SC Controller has only circuit outputs (no inputs), so cannot make measurements or decisions based on anything happening in your circuit.

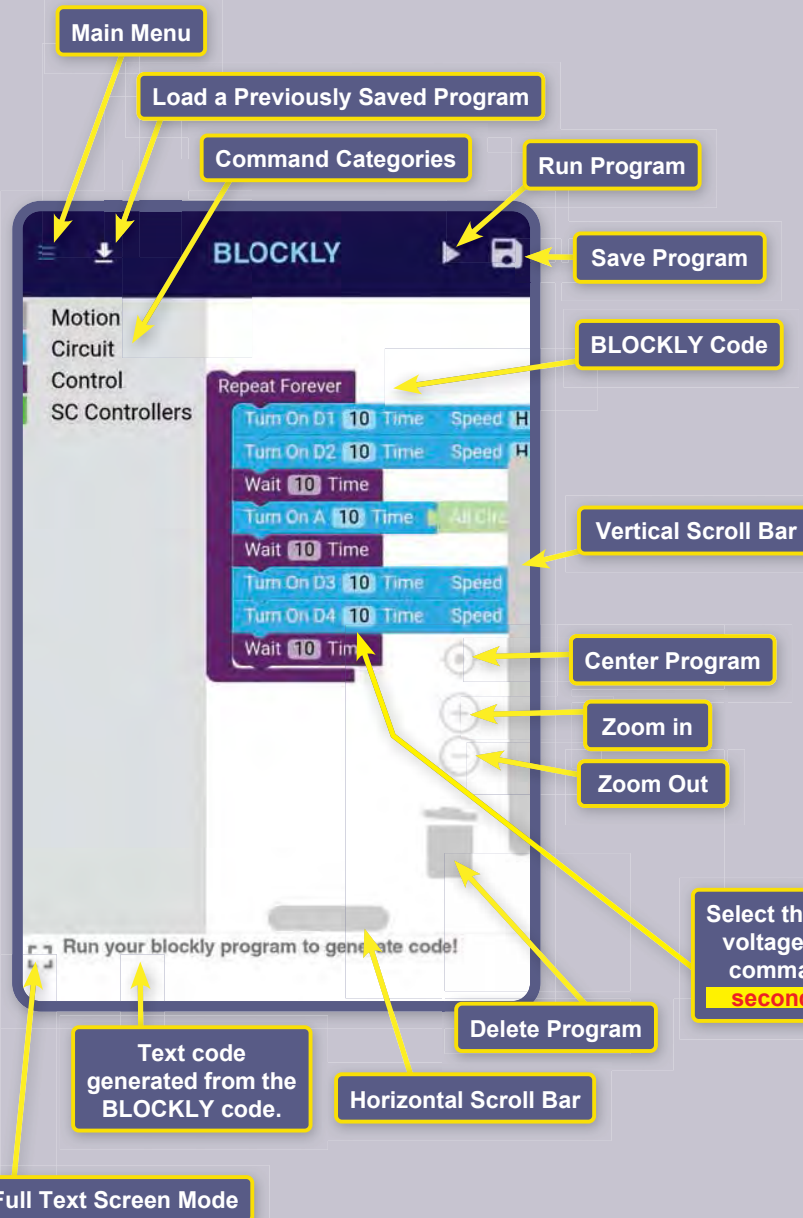
Also, the A output on the SC Controller can only supply low currents, so it cannot be used to control the motor (M1) directly.



CHALLENGES

- Turn on only the green LEDs, then only the red LEDs.
- Make an LED turn on for several seconds, then off for a much shorter time.
- Make an LED flash every 20 seconds.
- Flip one of the red/yellow LEDs (D10) around to its yellow side, then program a stoplight pattern using red, yellow, and green LEDs.
- Try to get the lights blinking in a pattern like a beat to a song.

Turn on the LEDs, alternately between yellow and red.



BLOCKLY CODING:

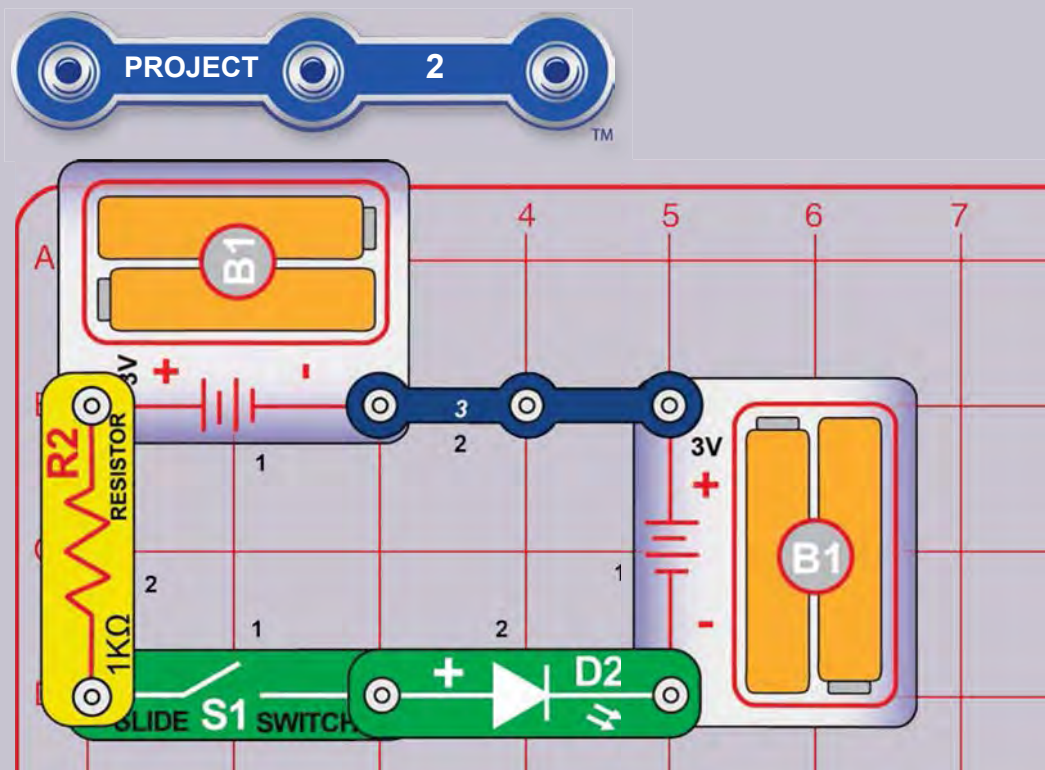
BLOCKLY is another form of visual block programming that makes it easy to program the SC Controller (U33) to turn on lights, sounds, or motors, in any order or for different durations. BLOCKLY is similar to how BOTCode™ works.

To try BLOCKLY coding, build the project 1 circuit, turn on the circuit, open the SC Coding app on your device, and connect your SC Controller to it as described earlier. Go to the BLOCKLY screen and enter a program like this one.

To enter the program, get the D1-D4 and A commands from the Circuit category, and the Delay and Forever command from the Control category. Select the category, click on the command to bring it into your program area, then drag it to attach to the other commands in your program. Put the Forever command around the others. Click on the command to change the Time and voltage level (H or L) if you like. The Run button is at the top of the BLOCKLY screen.

Select the command and change the SC Controller voltage level (H=5V and L=3V) and time on each command. **NOTE: "TIME" units are roughly 0.1 seconds but varies so "10" is about 1 second.**

NOTE: Projects 2-9, 11, and 14 are an introduction to your parts and basic circuits without coding. To jump to the other Coding projects skip to projects 10, 12, 13, and 15-18.



ELECTRIC LIGHT

Turn on the slide switch (S1), and the green LED (D2) lights.

Part B: Replace the 1k Ω resistor (R2) with the larger 10k Ω resistor (R4) or the smaller 100 Ω resistor (R1) and see how the LED brightness changes.

Part C: Reverse the position of the LED (so it is backwards) and see how the LED works in reverse.

Part D: Replace the green LED (D2) with the blue LED (D9) and try the above circuits again.

Part E: Replace the LED with the red/yellow LED (D10); try it in both orientations.

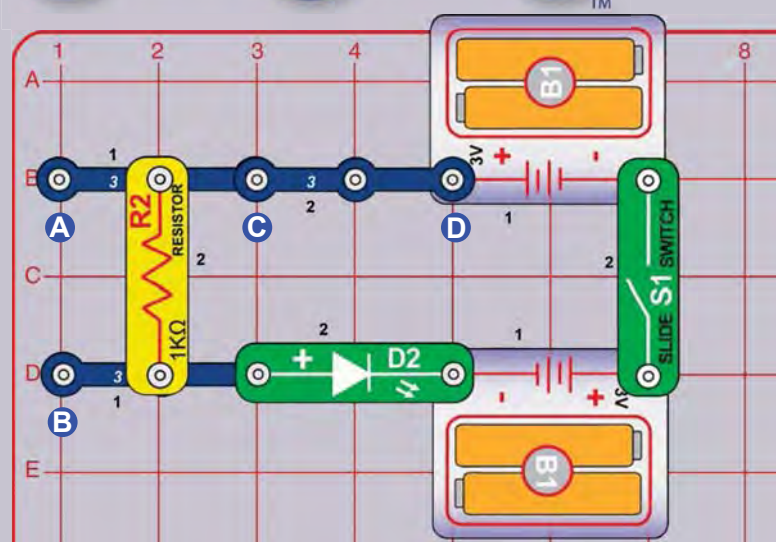
Part F: Reduce the battery voltage by replacing one of the battery holders (B1) with a 3-snap wire and see how the LED brightness changes for any of the above LED-resistor configurations.

When you turn on the slide switch, electricity flows from the batteries through the resistor, then the switch, then the LED, and then back to the batteries. If the switch is off, the flow of electricity is blocked, and the LED won't light.

Resistors "resist" the flow of electricity and are used to control or limit the current in a circuit.

LEDs are like one-way light bulbs that can produce different colors depending on the material used in them.

PROJECT 3



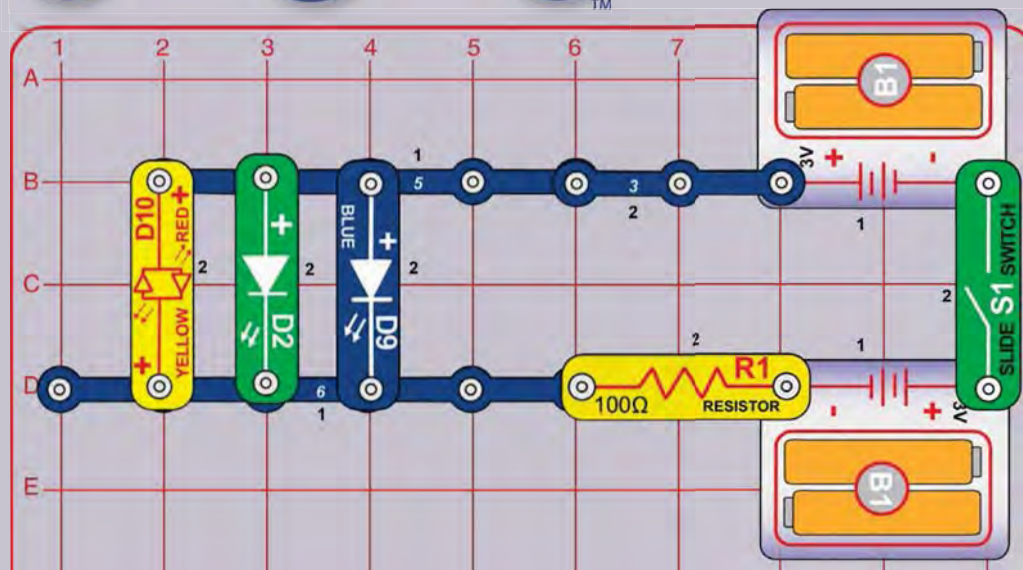
SERIES & PARALLEL CIRCUITS

Build the circuit as shown and turn on the slide switch (S1); the green LED (D2) lights. Now place the larger 10kΩ resistor (R4) or the smaller 100Ω resistor (R1) between the points labeled A & B, so it is next to (and in parallel with) the 1kΩ resistor (R2), and see how the LED brightness changes.

Part B: Use the original circuit but replace the 3-snap wire at points C & D with 10kΩ resistor (R4) or the 100Ω resistor (R1), placing that resistor in series with the 1kΩ resistor (R2). Notice how the resistors combine to affect the LED brightness.

Part C: Use the original circuit but replace the 3-snap wire at points C & D with another LED (D2, D9, or D10, "+" on right, D10 in either orientation). Compare the LED brightness two LEDs are in series. You can also replace the 1kΩ resistor (R2) with the larger 10kΩ resistor (R4) or the smaller 100Ω resistor (R1) and see how the LED brightness changes.

PROJECT 4



LED COMPARISON

Build the circuit as shown and turn on the slide switch (S1); the three LEDs (D10, D2, & D9) light. Now replace the 100Ω resistor (R1) with the larger 1kΩ resistor (R2) and then the much larger 10kΩ resistor (R4) and see how the brightness changes on each LED.

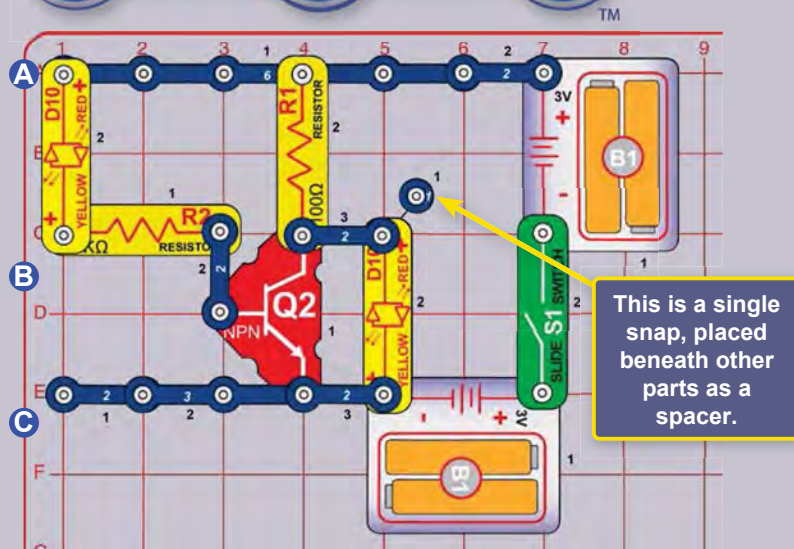
Try the red/yellow LED (D10) in both red and yellow orientations. Your set includes a second green LED and red/yellow LED, so you can experiment with different LEDs and have up to five at once (add two more to the right of the blue LED).

Electricity flows through an LED if the voltage exceeds a turn-on threshold (about 1.5V for red, about 2.0V for green, and about 3.0V for blue). The resistor limits the voltage/current through all the LEDs, but the blue LED is affected the most because of its higher turn-on level.



PROJECT

5



TRANSISTOR INVERTER

Build the circuit as shown, and turn on the slide switch (S1). The left LED is on and the right one is off.

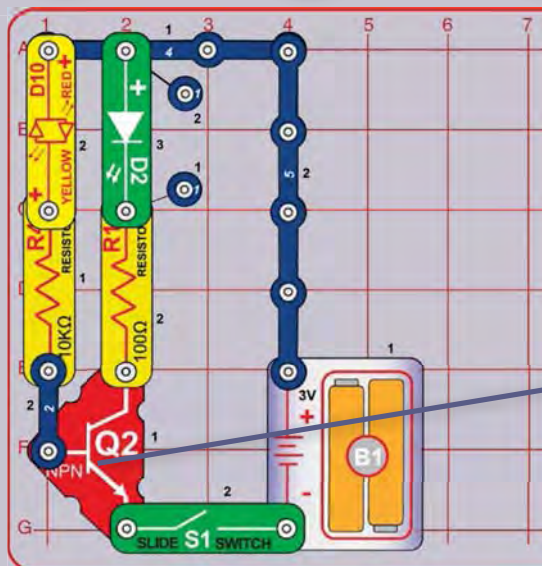
Now remove the left LED (which is across points labeled A & B) and place it across the points labeled B & C (positioned in either direction), or leave it disconnected (which is functionally the same as connecting across points B & C). Now the left LED is off and the right one is on.

Notice that the two LEDs are opposites - when one is on, the other is off.

Transistors like your NPN transistor (Q2) use a small current to control a larger current and are used in switching and amplifier circuits. In this circuit a small current flows into Q2 through R2, controlling a larger current into Q2 through R1. This control allows the right LED to be opposite of the left LED or inverted. The transistor will later be used to invert a voltage in coding project 15.

PROJECT

6



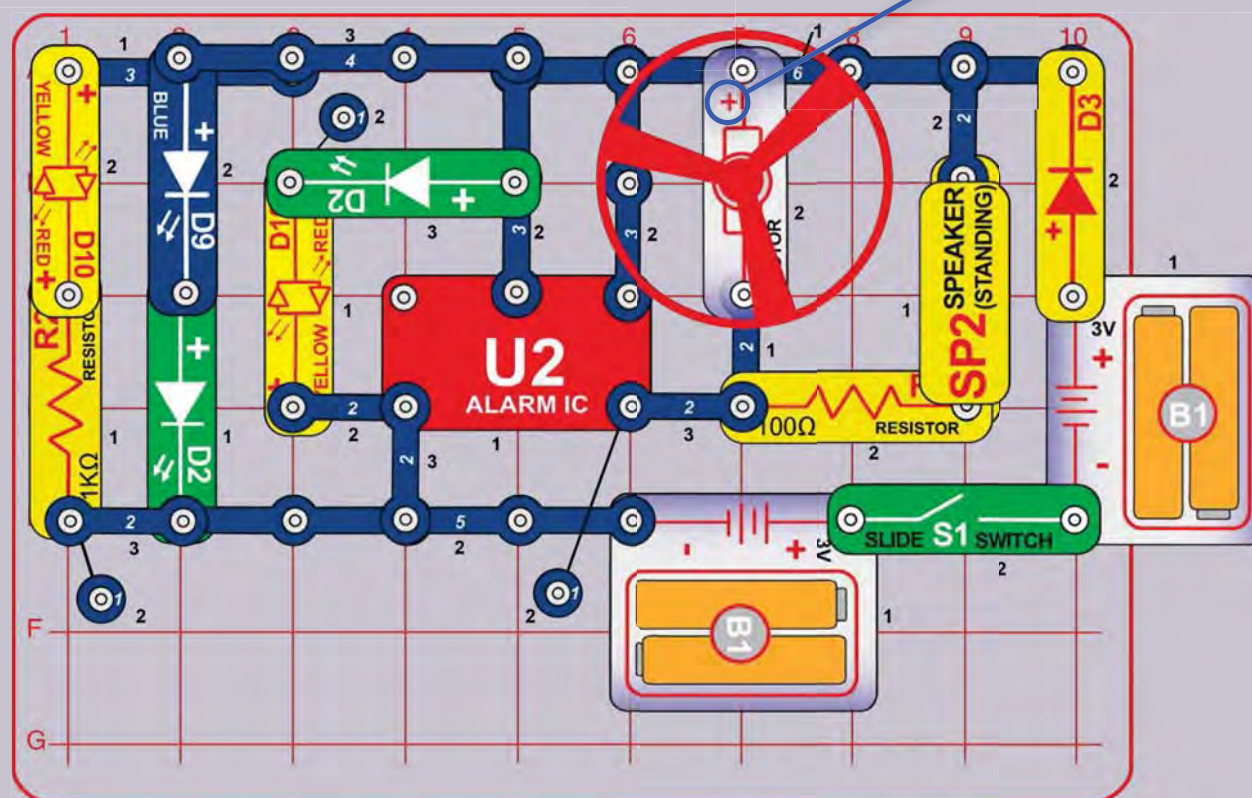
TRANSISTOR CURRENTS

Build the circuit as shown, and turn on the slide switch (S1). The red/yellow LED (D10) is dim and the green LED (D2) is bright. Try removing each LED and see if the other still lights.

A small current flowing into the left connection of the NPN transistor controls a larger current flowing into the top connection. Both currents exit out of the bottom connection.

PROJECT

7



FUN CIRCUIT

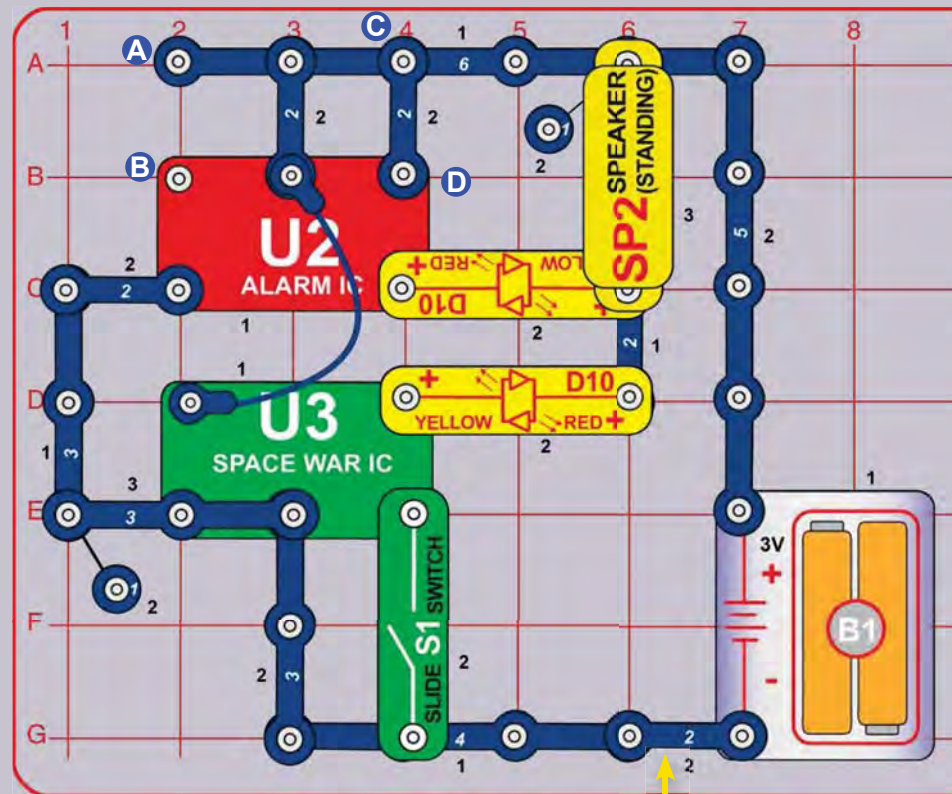
Build the circuit as shown and turn on the slide switch (S1). Lights shine, the motor (M1) spins, and a machine gun sound is heard.

If you swap the locations of the 100Ω resistor (R1) and 1kΩ resistor (R2) then the red/yellow LED (D10) will be brighter and the sound will not be as loud.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor. Fan may not rise until switch is released. Eye protection is recommended for this circuit.

Why do the LEDs flicker? When the fan starts to spin, the battery voltage drops a little due to the added load of driving the motor and speaker. If you remove the motor from the circuit then the LED flicker will be much less and there would be no LED flicker at all, if you removed the motor and the speaker.



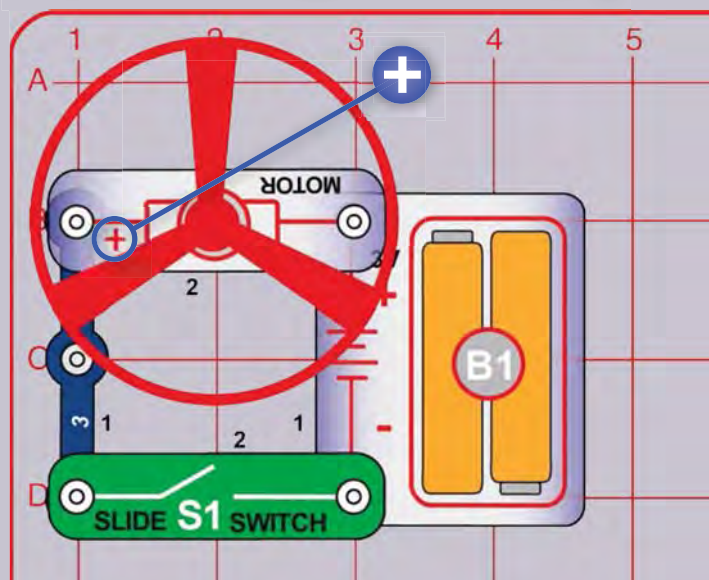


Connect this part last

DOUBLE SOUNDS

Build the circuit as shown, but connect the 2-snap wire at bottom last. The sound starts immediately. Turn the slide switch (S1) on and off several times to add space war sounds.

Change the sound by removing the 2-snap wire at points C & D or moving it to points A & B.



FLYING SAUCER

Build the circuit as shown. Turn on the slide switch (S1) until the motor reaches full speed, then turn it off. The fan blade should rise and float through the air like a flying saucer. Be careful not to look directly down on fan blade when it is spinning.

If the fan doesn't fly off, then turn the switch on and off several times rapidly when it is at full speed. You may need to have new alkaline batteries for the fan to fly.

Part B: "Super Flying Saucer": Replace the 3-snap wire with another battery holder (B1). The fan will spin faster and fly higher, making it easy to lose your fan. Elenco® Electronics Inc. is not responsible for lost or broken fans! You may purchase replacement fans at www.elenco.com/replacement-parts.

Part C: "Fan": Use either of the preceding circuits but reverse the position of the motor (M1), so its "+" is on the right. Now it acts like a fan, but does not fly.

NOTE: See project 10 to launch the fan using coding, and see how much more control coding gives you.

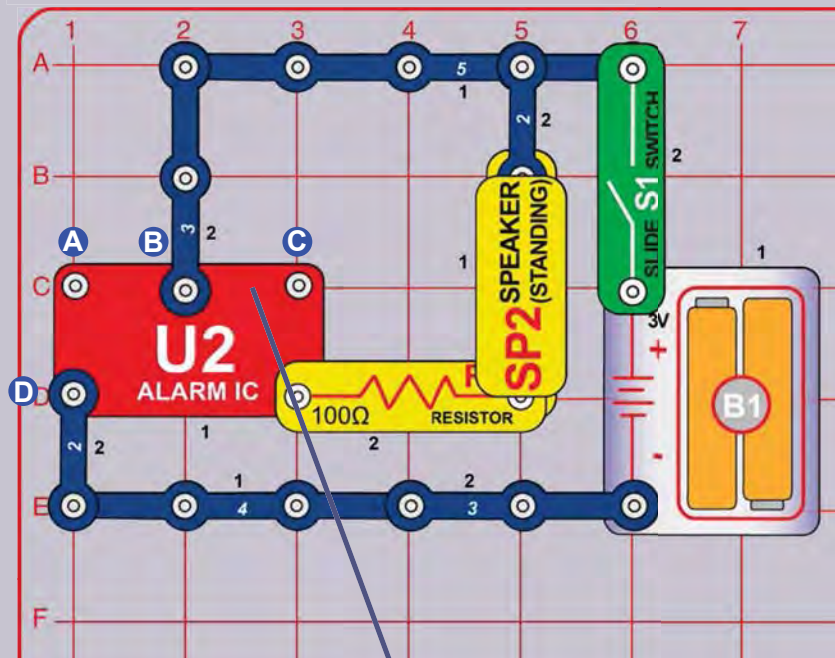
⚠ WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor. Fan may not rise until switch is released. Eye protection is recommended for this circuit.

The air is being blown down through the blade and the motor rotation locks the fan on the shaft. When the motor is turned off, the blade unlocks from the shaft and is free to act as a propeller and fly through the air. If speed of rotation is too slow, the fan will remain on the motor shaft because it does not have enough lift to propel it.

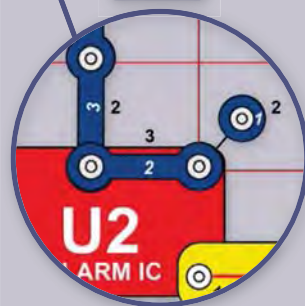
In part C ("Fan"), the fan is blowing air upward; place your hand a short distance above the motor and you should be able to feel it.

In this project electrical power was changed into mechanical power. Motors like this one are used in battery powered equipment requiring rotary motion, such as a cordless drill, electric toothbrush, and toys. An electric motor is much easier to control than gas or diesel engines.





Part B



SIRENS

Turn on the slide switch (S1), siren sounds.

Part B: Add a connection between the points marked B & C using a 1-snap wire and a 2-snap wire (or you can use the red jumper wire). Now it sounds like a machine gun.

Part C: Remove the connection between B & C, and add a connection between A & B. Now it sounds like a fire engine.

Part D: Remove the connection between A & B, and add a connection between A & D. Now it sounds like a European siren.

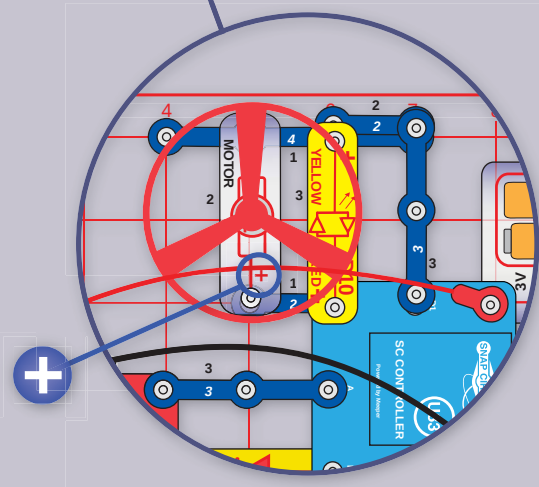
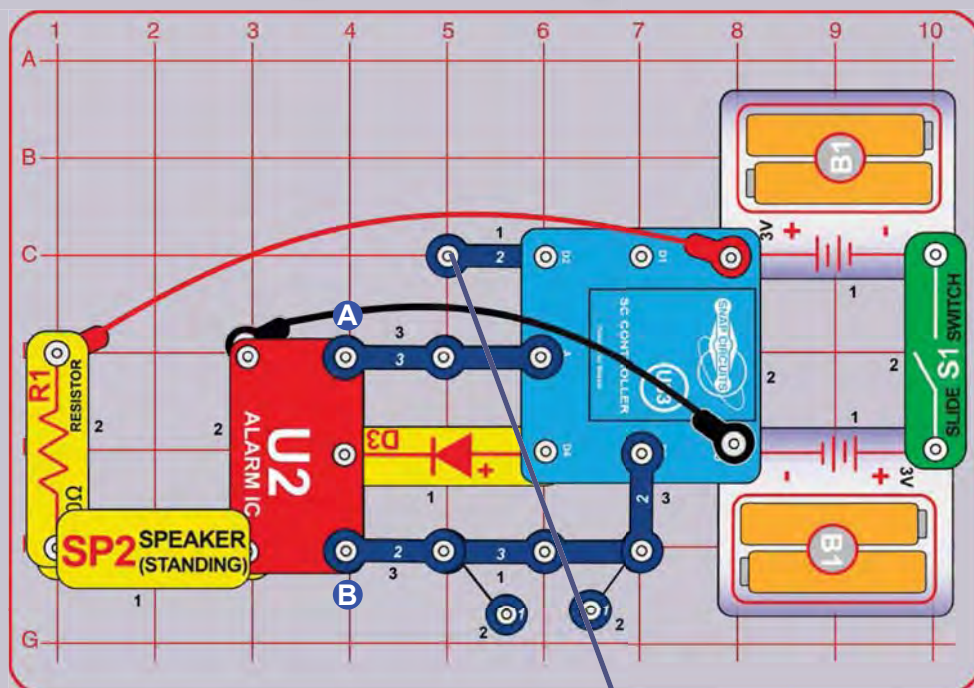
Part E: For any of the above circuits replace the 100Ω resistor (R1) with a 3-snap wire to make the sound louder, or with the 1kΩ resistor (R2) to make the sound softer.

Part F: Use the part B circuit but replace the 100Ω resistor (R1) with the red/yellow LED (D10, in either direction) or the green LED (D2, “+” on right). Now the LED is blinking as the machine gun sounds.

NOTE: See projects 12-13 to control the alarm IC using coding, and see how much more control coding gives you.

The lower-right snap of the alarm IC (U2) is like an electrical gate, opening and closing quickly to let small bursts of electric current flow in. The bursts of electric current also flow through the speaker (which produces sound). The alarm IC produces the different siren sounds by adjusting the pattern of current bursts through the speaker.





SIRENS CODING

Build the circuit shown here and turn on the switch (S1). Open the Snap Circuits® Coding app, connect to the SC Controller (U33), and use Circuit Control mode to activate sirens by turning on output D4, outputs A & D4, or outputs D3 & D4. See project 1 and pages 34–42 to review how to use the app.

Next, put the app in BOTCode™ mode and create some code to sound different sirens. Experiment with changing parameters for commands, such as the time duration.

The alarm IC (U2) can produce four siren sounds, as shown in project 4. Those sirens can be produced by controlling the SC Coder outputs as follows:

- Siren 1. D4 on, A and D3 off.
- Siren 2. D4 and A on, D3 off.
- Siren 3. D4 and D3 on, A off.
- Siren 4. D4 on, and change the circuit by removing the snap wires from points labeled A and B on the alarm IC.

You can make the sound louder by replacing the 100Ω resistor (R1) with a 2-snap wire, or make the sound softer by replacing R1 with the 1kΩ resistor (R2) or an LED (“+” on top).

Part B: Add the motor (M1), fan, and red/yellow LED (D10).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor. Fan may not rise until switch is released. Eye protection is recommended for this circuit.



NOTE: If your batteries are weak then turning on the motor(M1)/fan may reset the SC Controller (making the blue Bluetooth light start flashing instead of staying on); if this happens then replace your batteries.

CODING CHALLENGE

- Play a siren for different durations using the same program.
- Turn motor forwards and then backwards.

The diode (D3) blocks electricity from flowing from the A or D3 outputs (when they are turned on) on the SC Controller through the alarm IC, and back into the D4 output (when it is turned off) on the SC Controller. The alarm IC would not operate properly if that happened.

