# Electronic kit

🔴 Elektronická stavebnice
🔵 Elektronická stavebnica
🔴 Zestaw elektroniczny
🟢 Elektronikus építőkészlet

# BOFFIN IV CODING 1
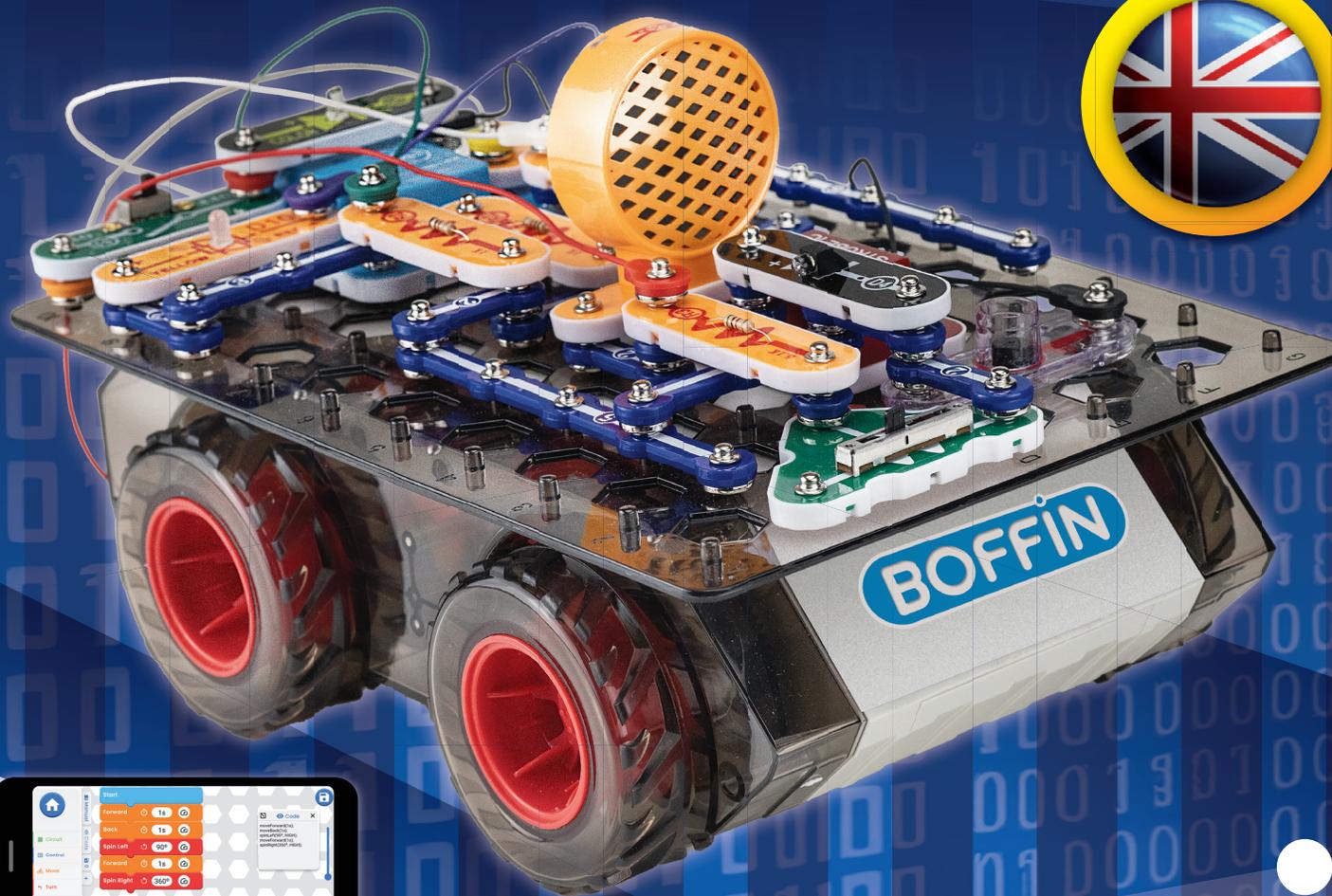
**Learn to programme**
with Boffin kit and app

**Nauč se programovat**
se stavebnicí a aplikací Boffin

**Nauč sa programovať**
so stavebnicou a aplikáciou Boffin

**Naucz się programować**
za pomocą zestawu i aplikacji Boffin

**Tanuljon meg programozni**
a Boffin készlettel és alkalmazással

BOFFIN

8+

Download on the App Store

ANDROID APP ON Google play

# Table of Contents

⚡ **WARNING: SHOCK HAZARD** - Never connect Boffin to electrical outlets in your home in any way!

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

Flash frequency
**WARNING:** This toy produces fl ashes that may trigger epilepsy in sensitised individuals.
Only for use by children aged 8 years and older. Not suitable for children and under 8 years due to small parts which could cause a choking hazard.

**over 8 years**

Conforms to all applicable EU sales requirements.

**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.

# 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.

**Conquest ent. 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 46 to determine which ones need replacing.

⚠ **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.

# How to Use Boffin

Boffin uses components with snaps to build the different electrical and electronic circuits in the projects. Each component has a function: there are switch blocks, light blocks, battery blocks, different length wire blocks, etc. These components have different colors and numbers on them so that you can easily identify them. The components you will be using are marked with color symbols and level numbers, allowing you to easily snap them together to build a circuit.

### For Example:

This is a component with a switch that has the (S1) mark on it.
The colors and appearance may vary, so your component may look a little different, but you can easily recognize them.
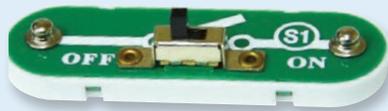
Snap wire blocks are used for making connections, they are blue and come in different wire lengths. This one has the number (2) on it but there are other numbers depending on the length of the wire connection required.

You will also find a 1-snap wire that is used to create a gap or connection between the layers.

Insert six 1.5V AA batteries (not included) into the bottom of the car.

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.

The set includes a black base grid that is used for correct positioning of the individual parts of the circuit. 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 component in the picture there is a black number. This indicates which level the component is on. is located. First, place all the parts on level 1, then on level 2, level 3 - and so on.

Jumper wires are used to connect the circuits to the car's batteries and motors. Connect them to the marked places as instructed in the booklet. The color doesn't matter, you can use whichever one you want. The red and black wires are longer.
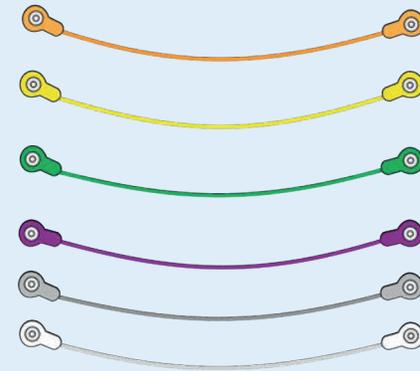
The instruction manual must be retained since it contains important information. This toy contains battery that are non-replaceable.

⚠️ **WARNING:** This toy produces flashes that may trigger epilepsy in sensitised individuals.

⚠️ **WARNING:**
Do not use the car on the road.

⚠️ **WARNING:** Do not operate the car in rain, snow, mud, sand, dirt or on wet floor - you might damage the car.

**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.

# 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 the Boffin app. 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 Boffin app that you will be using is simple and easy to use, making it a great introduction to the world of coding.

## FORM OF CODE YOU WILL BE USING



## OTHER FORMS OF CODE

# Project Listings

**https://boffin.cz/en**

**info@boffin.cz**

6  7  8  9  10

**Bluetooth Connection Light Indicator**

**Placement Level Numbers**

SLIDE S1 SWITCH

2

**CAR REAR**

U33

HORN

W1

2
2
1
2
2
2
1
3
2
1
2
2

Car rear. **Be careful where the front and rear of the car are so you don't crash somewhere! The rear is always where the cable connection plate is.**
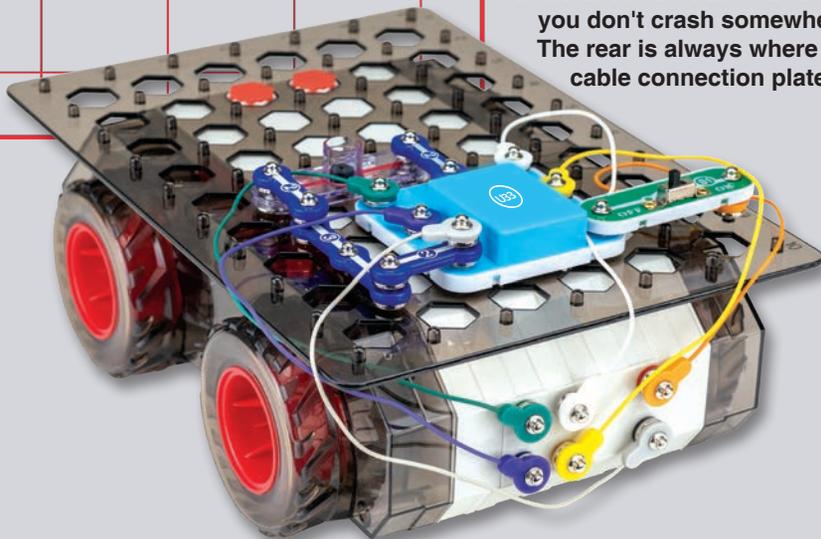


# MEET THE BOFFIN CAR
## (QUICK START - DIVE INTO CODING)

**This is a summarized version of the Boffin app instructions for those already familiar with Boffin and apps and want to just start coding. For more detailed app instructions, see page 40-49. To learn more about the Boffin app see pages 30-39.**

Boffin uses electronic components that snap onto a plastic grid to build different circuits. These components have different colors and numbers on them so that you can easily identify them. Install six (6) "AA" batteries into the bottom of the car body. **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.** Place the base grid on the car body; you may lock it into position by turning the hexagonal alignment posts (shown here), if desired. The base grid should no longer be removable from the car.
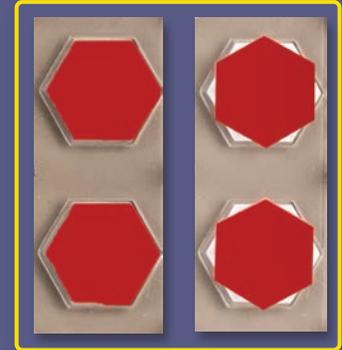
Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Be sure to place the horn (W1) with its (+) side oriented as shown. Connect the colored jumper wires to the rear of the car body as shown (the colors are interchangeable).

1. Turn on the slide switch (S1). A blue light on the component (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 Boffin app; install and open it.

For more detailed app instructions, see page 30-39. To learn more about the Boffin app see pages 40-49.

Google Play Store

App Store

3. Activate location and bluetooth on your phone and open the Boffin app.



Click on the red Bluetooth icon and your phone will pair with the Boffin kit (via part U33).
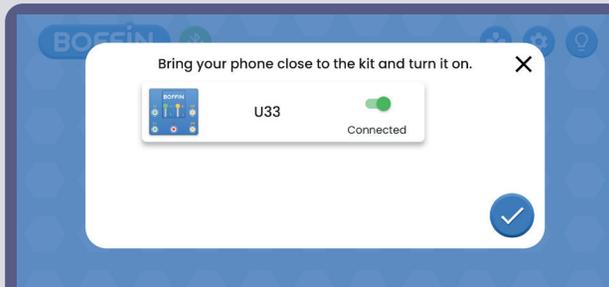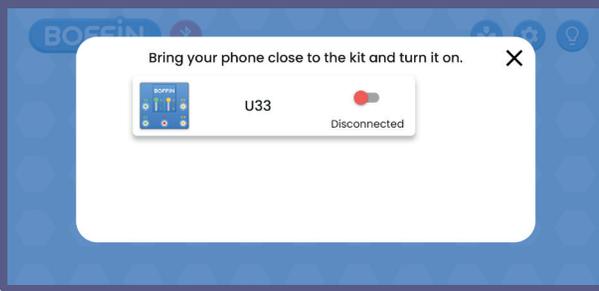


Bring your phone close to the kit and turn it on.

U33    Disconnected

Confirm in the bottom right corner and the pairing is done.



You are now ready to Control or Code.

Bring your phone close to the kit and turn it on.

U33    Connected

4. Go to the main menu (CONTROL-CODE-MANUALS). Click on CONTROL and the control panel (CP) will appear.

### Control Panel
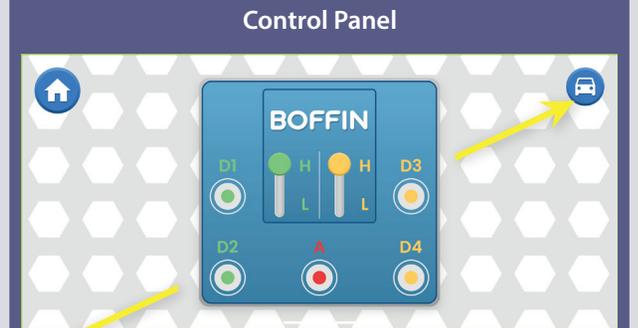


CP has 5 outputs (D1, D2, D3, D4 an A) which are controlled by the app. Outputs D1-D2 and D3-D4 are paired so that each hcontrols a motor in both directions and they can be used to set one of the two levels output voltages, called H (high) and L (low). Output A has a low power output that can control the horn (W1), but cannot control the car's wheel motors. Use the app to control them.

5. The cars are controlled via driving modes, which can be accessed by clicking on the car icon in the right corner (CONTROL - Control Panel - car icon).

6. Under the car icon you will find 3 different driving modes. You can experiment with them and control the Boffin Car with them.

a. Command Drive - the easiest mode, the best to start with.

b. Tank Drive - a two-handed steering control, which allows control of the rear engines.

c. Touch Drive - a responsive controller similar to joystick, which allows touch control movement of the vehicle (touch the center and drag in the direction you want to steer the vehicle).

Steering allows commands such as Forward/Reverse, Left/Right and Left/Right Turn. Output A is available for other functions such as horn.

You can switch between Drive modes with the left and right arrow keys above the controls.

### Command Drive



Output A

Speed
H - high
L - low

### Tank Drive



### Touch Drive
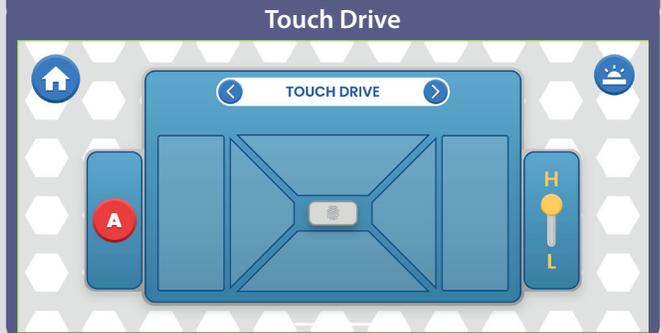
7. Via the main menu of the application menu, open CODE section.

The individual commands are dragged from the list on the left into the programming zone in the middle. You can choose from Outputs/Control/Move/Turn
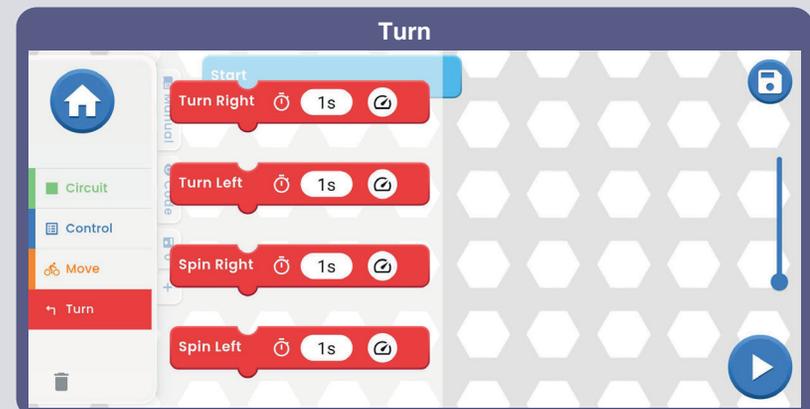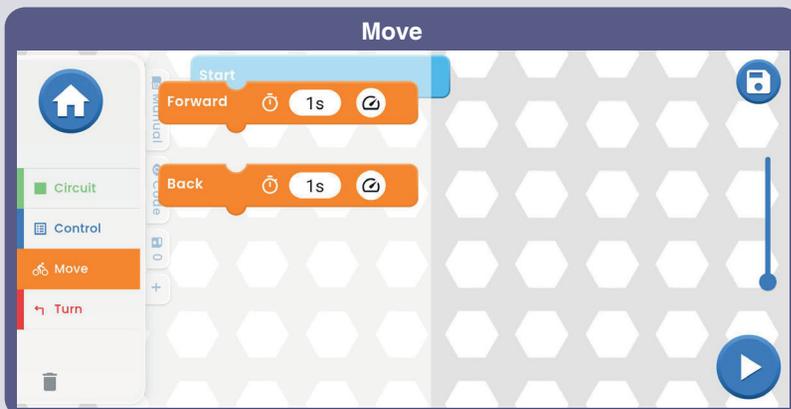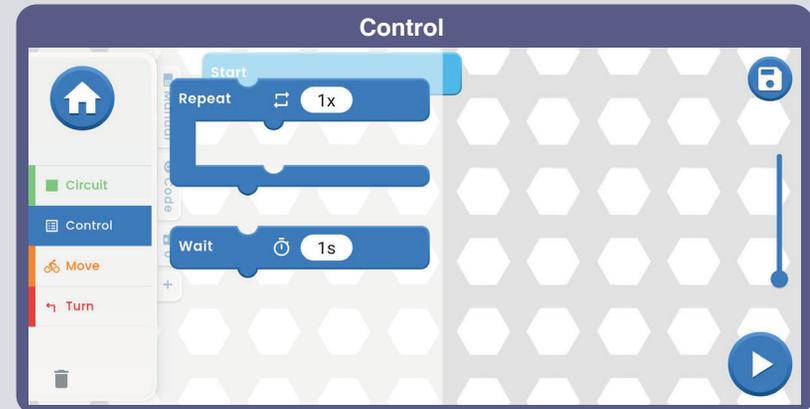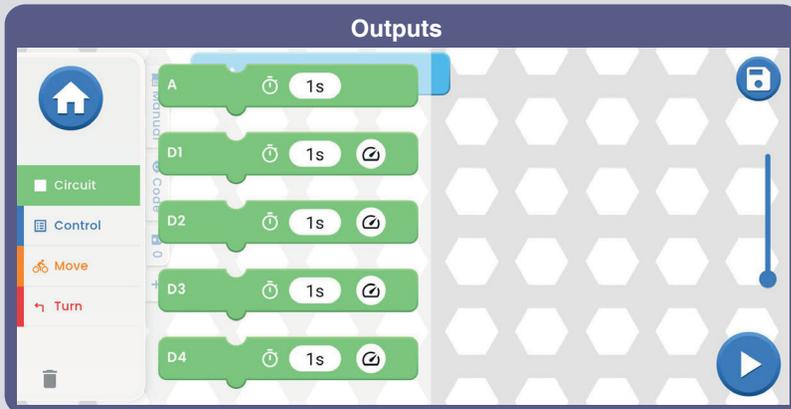
**Start**

| D2 | ⏱ 1s | ⏱ |
| D4 | ⏱ 1s | ⏱ |

Manual

Code

Circuit
Control
Move
Turn

**Code**

```
circuitOn(D2, 1s, HIGH);
circuitOn(D4, 1s, HIGH);
```

**Boffin app screen**

## Outputs

Circuit
Control
Move
Turn

| A | ⏱ 1s | |
| D1 | ⏱ 1s | ⏱ |
| D2 | ⏱ 1s | ⏱ |
| D3 | ⏱ 1s | ⏱ |
| D4 | ⏱ 1s | ⏱ |

## Control

Circuit
Control
Move
Turn

Start
Repeat ⇄ 1x

Wait ⏱ 1s

## Move

Circuit
Control
Move
Turn

Start
Forward ⏱ 1s ⏱
Back ⏱ 1s ⏱

## Turn

Circuit
Control
Move
Turn

Start
Turn Right ⏱ 1s ⏱
Turn Left ⏱ 1s ⏱
Spin Right ⏱ 1s ⏱
Spin Left ⏱ 1s ⏱

Now that you know the basics of the Boffin app, program the U33 controller to drive Boffin Car on routes you select, and sounding the horn at times you select. 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.

## The car goes for a drive.

| | | |
|---|---|---|
| Start | | |
| Forward | ⏱ 2s | 🕐 |
| Spin Right | ↻ 90° | 🕐 |
| A | ⏱ 1s | |
| Forward | ⏱ 2s | 🕐 |
| Turn Right | ⏱ 1s | 🕐 |
| A | ⏱ 1s | |
| Forward | ⏱ 1s | 🕐 |
| Back | ⏱ 1s | 🕐 |
| Spin Left | ↻ 270° | 🕐 |
| A | ⏱ 1s | |
| Forward | ⏱ 2s | 🕐 |
| Spin Left | ↻ 180° | 🕐 |
| A | ⏱ 1s | |

Sidebar: Manual · Code · Circuit · Control · Move · Turn

## Extra route

| | | |
|---|---|---|
| Start | | |
| Spin Left | ↻ 360° | 🕐 |
| A | ⏱ 1s | |
| Forward | ⏱ 1s | 🕐 |
| Spin Left | ↻ 90° | 🕐 |
| Spin Right | ↻ 180° | 🕐 |
| Spin Left | ↻ 90° | 🕐 |
| Back | ⏱ 2s | 🕐 |
| Spin Right | ↻ 90° | 🕐 |
| Spin Left | ↻ 180° | 🕐 |
| Spin Right | ↻ 90° | 🕐 |
| Forward | ⏱ 1s | 🕐 |
| Forward | ⏱ 1s | 🕐 |
| A | ⏱ 1s | |

Sidebar: Manual · Code · Circuit · Control · Move · Turn

Limitations of the U33 controller: Controller has only circuit outputs (no inputs), so it cannot make measurements or decisions based on anything happening in your circuit.

Also, the A output on the controller can only supply low currents, so it cannot be used to control the car motors directly.

## CHALLENGES

- Code a route for the Boffin Car.
- Code a "dance" show for the Boffin Car.
- Make Boffin Car spin right for several seconds, then left for several seconds.

## The car goes for a drive and comes back.



Start
Forward — 2s
Spin Left — 1s
Forward — 2s
Spin Right — 1s
A — 1s
Back — 2s
Spin Right — 1s
Back — 2s
A — 1s

```
moveForward(2s);
spinLeft(1s, HIGH);
moveForward(2s);
spinRight(1s, HIGH);
circuitOn(A,1s);
moveBack(2s);
spinRight(1s, HIGH);
moveBack(2s);
circuitOn(A,1s);
```

## The car dances for a moment.

Start
Forward — 1s
Back — 1s
Spin Left — 90°
Forward — 1s
Spin Right — 360°

```
moveForward(1s);
moveBack(1s);
spinLeft(90º, HIGH);
moveForward(1s);
spinRight(360º, HIGH);
```

## Text code for the commands

Start
Forward — 2s
Spin Right — 90°
A — 1s
Forward — 2s
Turn Right — 1s
A — 1s
Forward — 1s
Back — 1s
Spin Left — 270°
A — 1s
Forward — 2s
Spin Left — 180°
A — 1s

After completing the code in the main field and clicking on the code tab, the text code for the commands is displayed, see image.

# CODE 5

Build the circuit shown here and turn on the switch (S1). Open the Boffin app, connect to the U33 controller, and use Control Panel (under Control) to turn on the LEDs (D4, D8, & D10) and horn (W1). See project 1 and pages 30-39 to review how to use the app.
Next, put the app into Code mode and create some code to turn on the LEDs and horn. Experiment with changing parameters for commands, such as the time duration.



**CAR REAR**
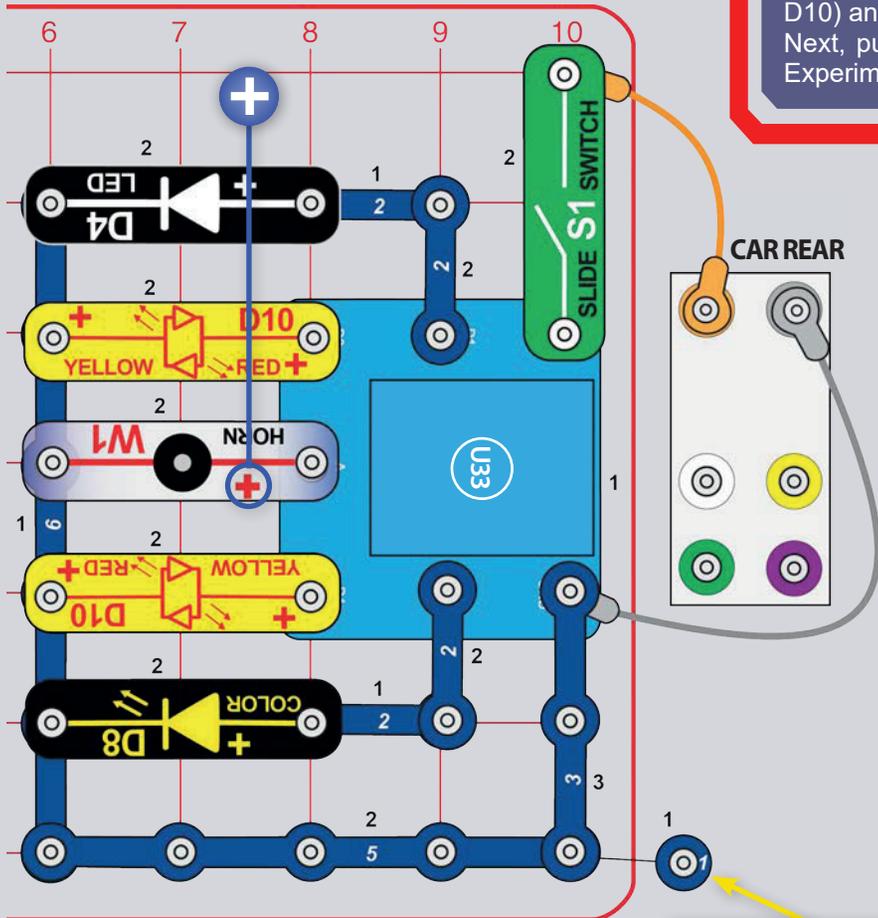
This is a single snap, placed beneath other parts as a spacer.

## CHALLENGES

- Make an LED turn on for several seconds, then off for a much shorter time.
- Make an LED flash every 20 seconds.
- Try to get the lights blinking in a pattern like a beat to a song.

**Boffin app screen: turn on all 4 LEDs and the horn in alternating mode.**



```
circuitOn(D1, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
circuitOn(A,1s);
circuitOn(D4, 1s, HIGH);
circuitOn(D3, 1s, HIGH);
```

| Start | | |
|---|---|---|
| D1 | 1s | |
| D2 | 1s | |
| A | 1s | |
| D4 | 1s | |
| D3 | 1s | |
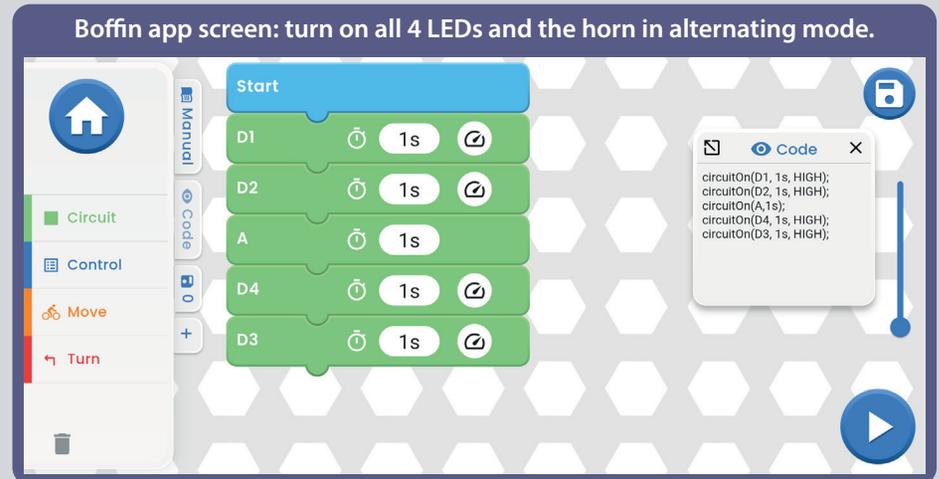
**Turn on the white LED, then the red LED, with low and then high brightness.**



```
circuitOn(D1, 1s, HIGH);
circuitOn(D1, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
```

| Start | | |
|---|---|---|
| D1 | 1s | |
| D1 | 1s | |
| D2 | 1s | |
| D2 | 1s | |
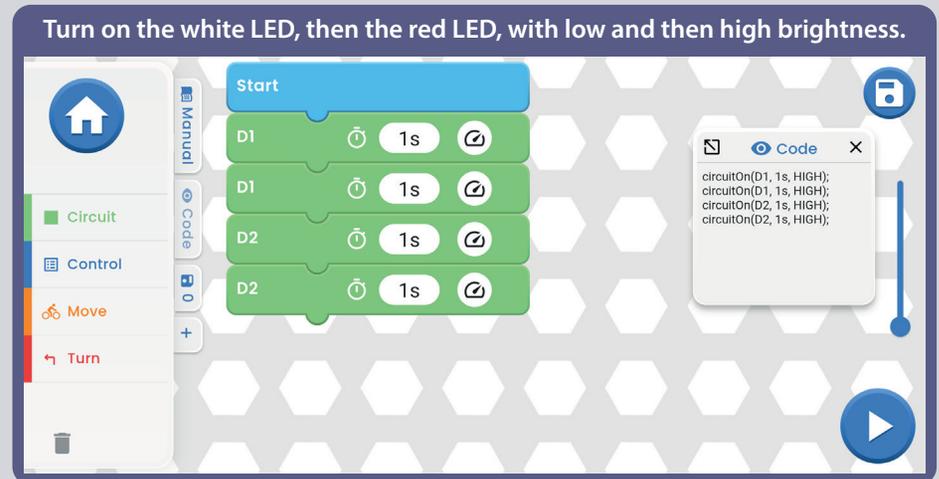
**Turn on all the LEDs and the horn one at a time and then turn them all off at once. You can change the time in the WAIT command as you wish.**



| | |
|---|---|
| Start | |
| D1 | ⊗ ∞ |
| Wait | ⊗ 1s |
| D2 | ⊗ ∞ |
| Wait | ⊗ 1s |
| D4 | ⊗ ∞ |
| Wait | ⊗ 1s |
| D3 | ⊗ ∞ |
| Wait | ⊗ 1s |
| A | ⊗ 1s |
| D1 | ⊗ 0 |
| Wait | ⊗ 1s |
| D2 | ⊗ 0 |
| Wait | ⊗ 1s |
| D4 | ⊗ 0 |
| Wait | ⊗ 1s |
| D3 | ⊗ 0 |
| Wait | ⊗ 1s |
| A | ⊗ 1s |

Circuit
Control
Move
Turn

Manual
Code

**Control panel screen**



BOFFIN

D1   H   H   D3
D2   A   D4

# BOFFIN CAR

Build the circuit shown here and turn on the switch (S1). The white and color LEDs (D4 & D8) are on. Open the Boffin app, connect to the controller (U33), and use on of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around and sound the horn. See project 1 and pages 30-39 to review how to usethe app.

Next, put the app into Code mode and create some code to turn on the LEDs and horn. Experiment with changing parameters for commands, such as the time duration.

CAR REAR
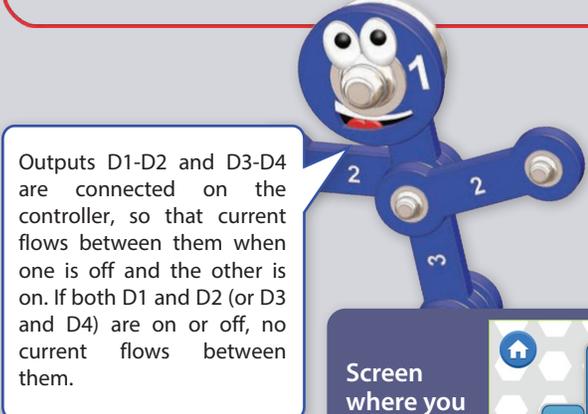
Outputs D1-D2 and D3-D4 are connected on the controller, so that current flows between them when one is off and the other is on. If both D1 and D2 (or D3 and D4) are on or off, no current flows between them.

Screen where you can set the driving mode.

**Control Panel Screen**

BOFFIN

D1 — H H — D3
D2 — A — D4

COMMAND DRIVE

A

H
L

**The car dances for a moment.**

Start
Forward — 1s
Back — 1s
Spin Left — 90º
Forward — 1s
Spin Right — 360º

```
Code
moveForward(1s);
moveBack(1s);
spinLeft(90º, HIGH);
moveForward(1s);
spinRight(360º, HIGH);
```

The car goes for a drive and comes back.

Start
Forward — 2s
Spin Left — 1s
Forward — 2s
Spin Right — 1s
A — 1s
Back — 2s
Spin Right — 1s
Back — 2s
A — 1s

```
Code
moveForward(2s);
spinLeft(1s, HIGH);
moveForward(2s);
spinRight(1s, HIGH);
circuitOn(A,1s);
moveBack(2s);
spinRight(1s, HIGH);
moveBack(2s);
circuitOn(A,1s);
```

# CAR WITH NIGHT LIGHT

Build the circuit shown here and turn on the switch (S1). The white and color LEDs (D4 & D8) are on unless there is bright light on the phototransistor (Q4). Shine a light on the phototransistor or cover it to turn D4 & D8 on or off.

Open the Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around and sound the horn. See project 1 and pages 30-39 to review how to use the app. The D4 & D8 lights turn on whenever the room lighting is not bright.

Next, put the app in Code mode and create some code to drive the car around and sound the horn. Experiment with changing parameters for commands, such as the time duration.

CAR REAR

## Control Panel Screen



Screen where you can set the driving mode.



### Start
| Forward | ⏱ | 1s | |
| Back | ⏱ | 1s | |
| Spin Left | ↺ | 90° | |
| Forward | ⏱ | 1s | |
| Spin Right | ↻ | 360° | |

```
moveForward(1s);
moveBack(1s);
spinLeft(90°, HIGH);
moveForward(1s);
spinRight(360°, HIGH);
```

The car dances for a moment.

The car goes for a drive and comes back.

### Start
| Forward | ⏱ | 2s | |
| Spin Left | ⏱ | 1s | |
| Forward | ⏱ | 2s | |
| Spin Right | ⏱ | 1s | |
| A | ⏱ | 1s | |
| Back | ⏱ | 2s | |
| Spin Right | ⏱ | 1s | |
| Back | ⏱ | 2s | |
| A | ⏱ | 1s | |

```
moveForward(2s);
spinLeft(1s, HIGH);
moveForward(2s);
spinRight(1s, HIGH);
circuitOn(A,1s);
moveBack(2s);
spinRight(1s, HIGH);
moveBack(2s);
circuitOn(A,1s);
```

# SOUND CAR

Build the circuit shown here and turn on the switch (S1). Move the lever on the adjustable resistor (RV) to change the sound.

Open the Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around and sound the horn. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around and hear some sounds. You can use the programs from project 1 or create your own.



CAR REAR
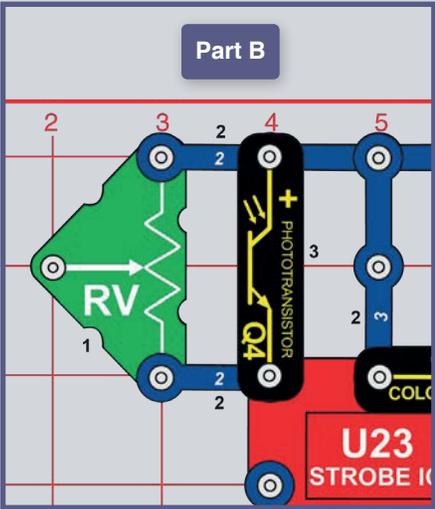
**Part B**



**Part B, Light Controlled Sound:** Re-arrange the adjustable resistor (RV) and add the phototransistor (Q4) as shown. Vary the amount of light shining on the phototransistor to change the sound. Moving the lever on RV will not change the sound, and once the light is dim the sound will not change (RV is used here as a fixed resistor so there is always some sound). Drive the car around between bright and dim areas and see the sound change automatically.
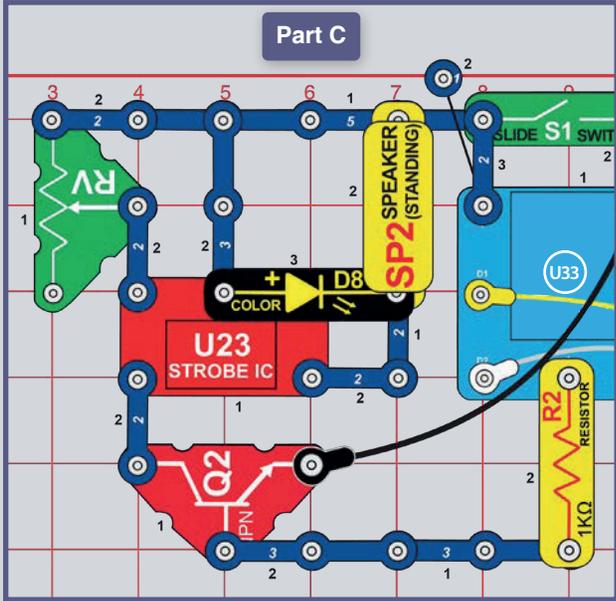
**Part C**



**Part C, Adjustable Controlled Sound:** Return the adjustable resistor (RV) to its original position and add the NPN transistor (Q2) and 1kΩ resistor (R2) as shown. Activate sound by turning on the A output on Control Panel in the Boffin app. The lever on the adjustable resistor changes the sound played. Drive around and turn on the sound when desired.
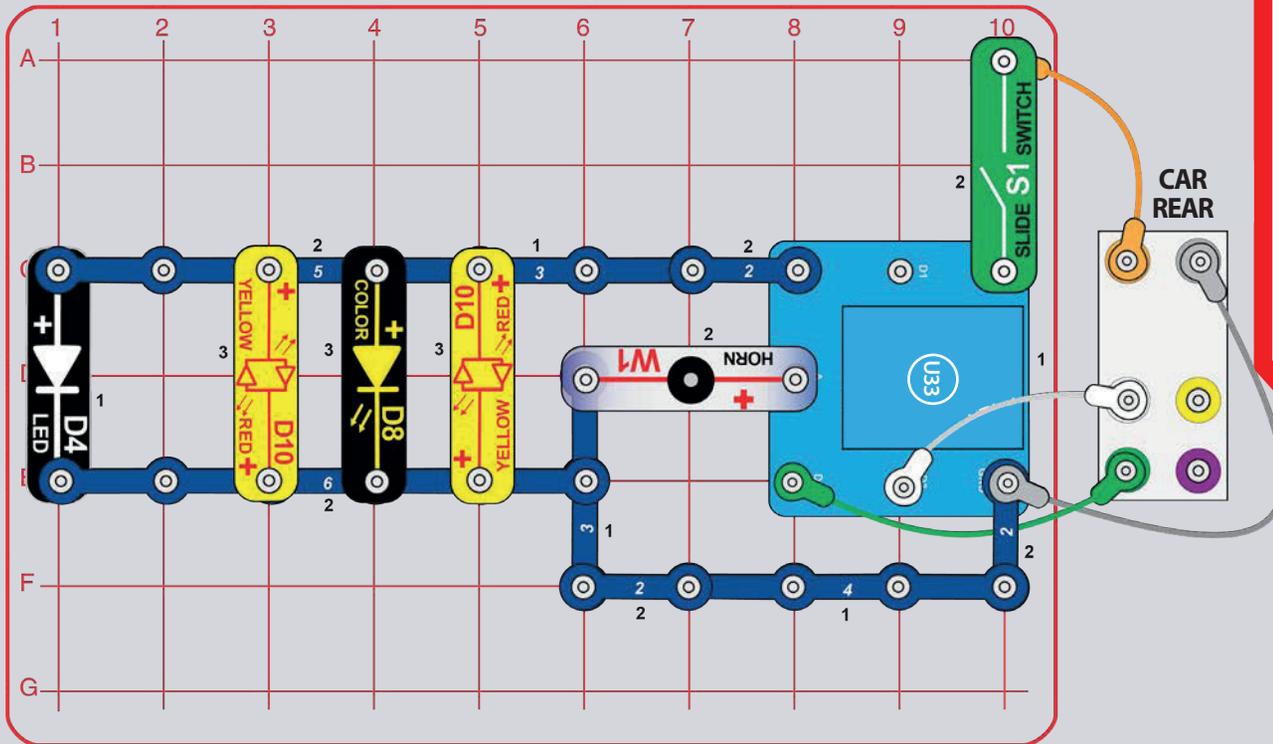
## LIGHT SHOW

Build the circuit shown here and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around and sound the horn. See project 1 and pages 30-39 to review how to use the app. Output D1 on the controller is not used. Next, put the app in Code mode and create some code to turn on the lights sequentially like a light show.

### Control Panel Screen



COMMAND DRIVE

### Boffin app screen: car light show



```
circuitOn(D2, 1s, HIGH);
circuitOn(D3, 1s, HIGH);
circuitOn(D4, 1s, HIGH);
circuitOn(A,1s);
```
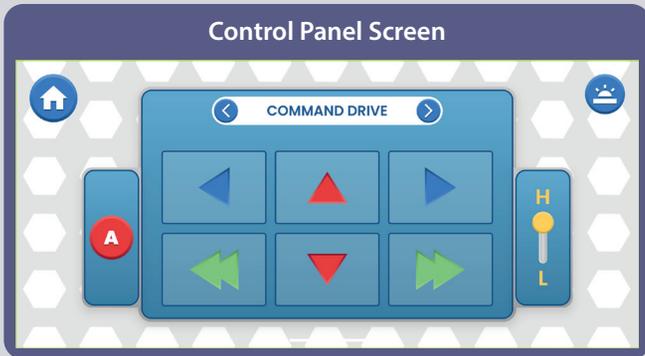
### CHALLENGES

- Make the LEDs light up in different patterns.
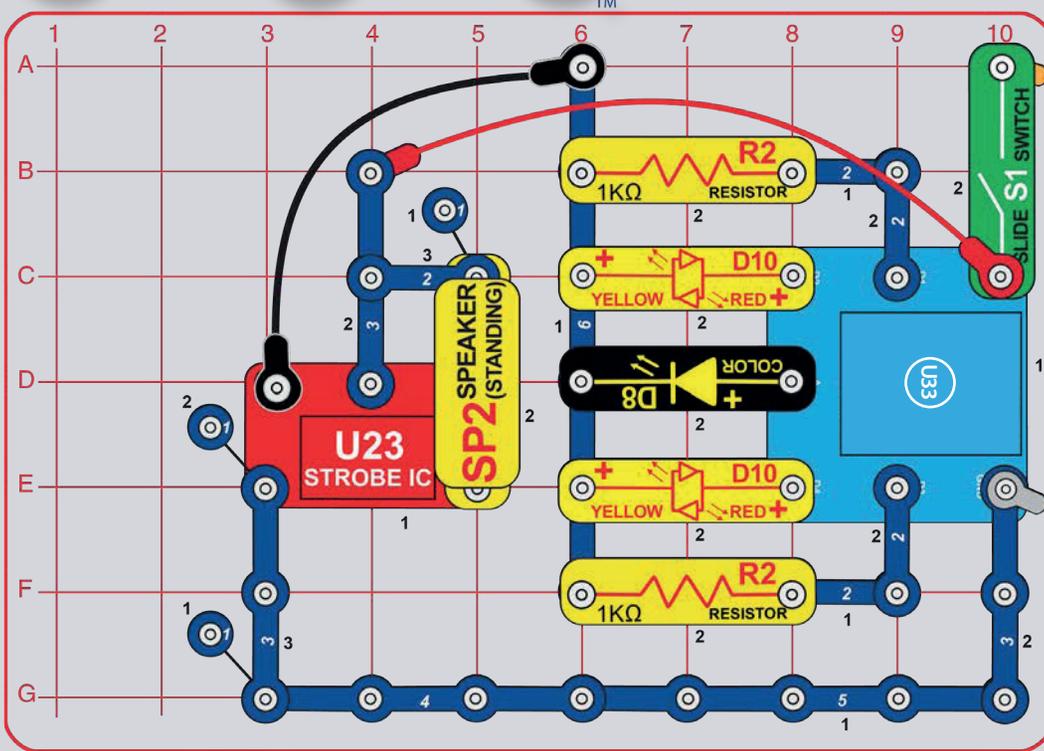
# ELECTRONIC KEYBOARD

Build the circuit shown here and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and and use Control Panel to hear different sounds by activating any of the D1-D4 or A outputs. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to turn on the sounds in a sequence, see images.
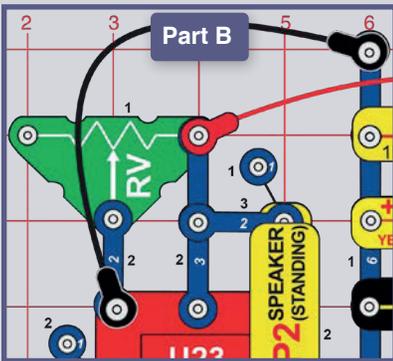
**Part B:** Add the adjustable resistor (RV) and re-arrange the connections near it as shown. The circuit works the same but the sounds are higher in pitch.

The A output on the controller produces a changing sound as the color LED (D8) changes colors.

Tone Changer

## CHALLENGES

- See if you can play a familiar song on this "keyboard".

## Control Panel Screen

BOFFIN

D1  H  H  D3
D2  A  D4

PROJECT    8™

## Boffin app screen: Key tones

Manual | Code | 0 | +

| Start | | | |
| D1 | ⏱ | 1s | ⏲ |
| D2 | ⏱ | 1s | ⏲ |
| A | ⏱ | 2s | ⏲ |
| D3 | ⏱ | 1s | ⏲ |
| D4 | ⏱ | 1s | ⏲ |

■ Circuit
▤ Control
🚲 Move
↩ Turn

👁 Code  ✕

```
circuitOn(D1, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
circuitOn(A,2s);
circuitOn(D3, 1s, HIGH);
circuitOn(D4, 1s, HIGH);
```
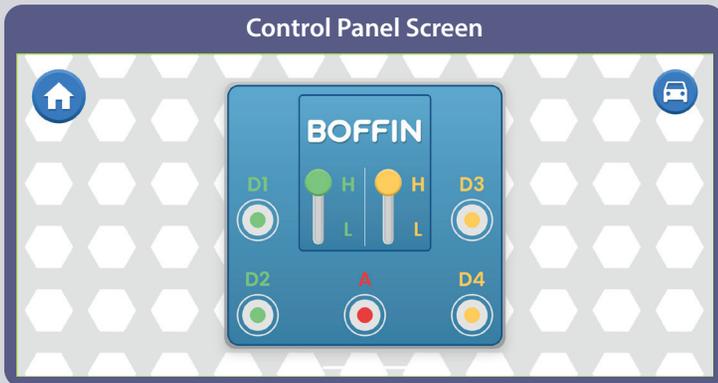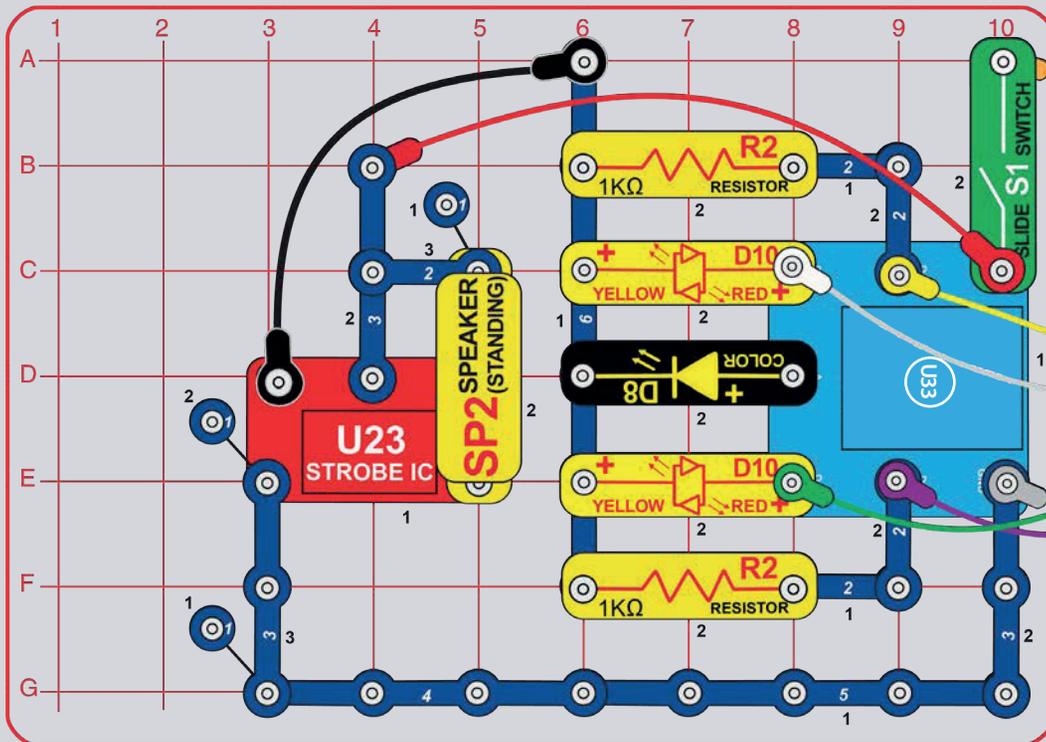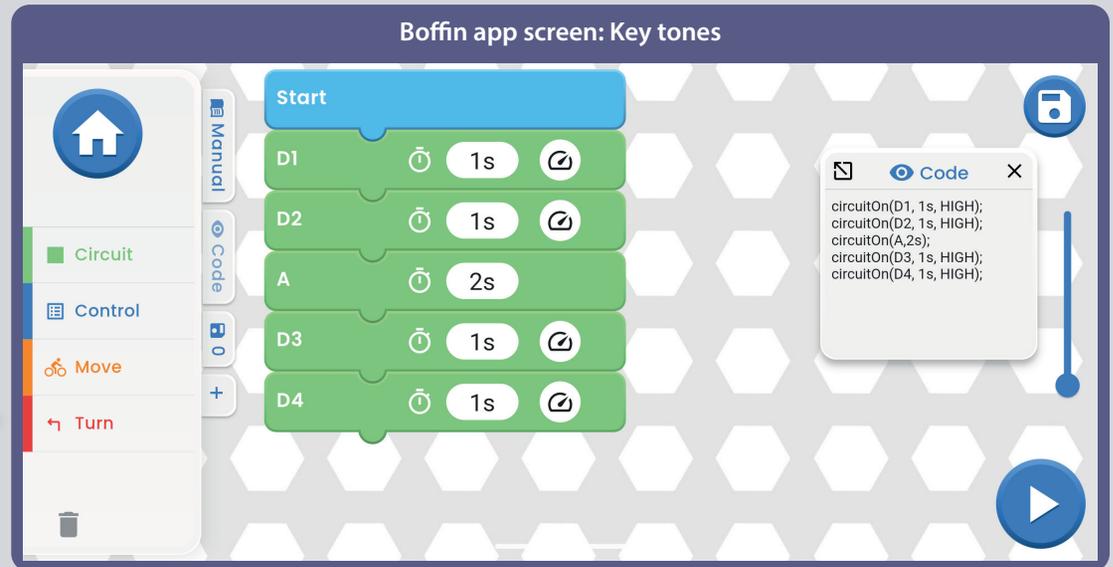


# MOBILE ELECTRONIC KEYBOARD

Use the preceding circuit but add the white, yellow, green and purple jumper wires to connect the motors in the car body. Turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the Drive Control modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around while activating different tones. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around while activating different tones. You can use the programs from project 1 or create your own.
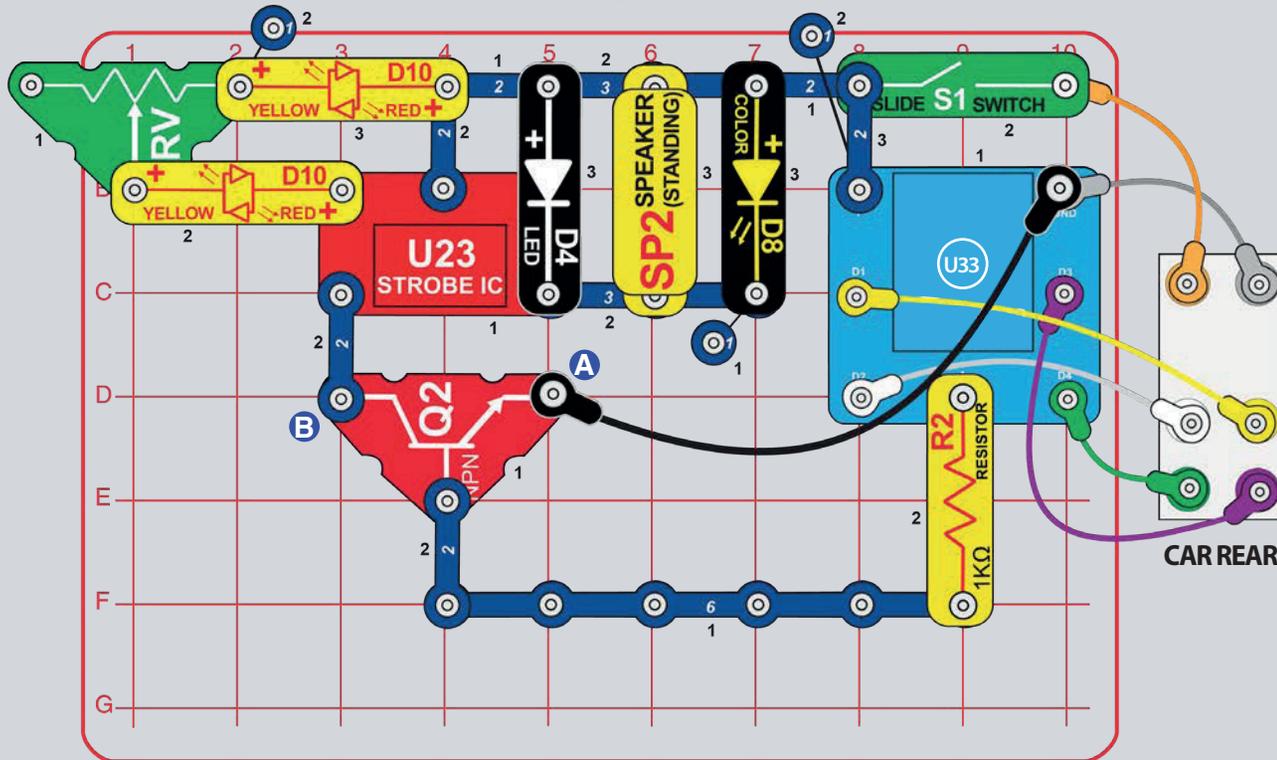
# STROBE LIGHT

Build the circuit shown, set the lever on the adjustable resistor (RV) to the left, and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around, while using output A control to activate a strobe light and beeping. See project 1 and pages 30-39 to review how to use the app.

Move the lever on RV to the right to increase the rate of the strobe and sound. Moving RV's lever all the way to the right makes the strobe LEDs (D4 & D8) on continuously and makes the sound into a continuous tone.

Next, put the app in Code mode and create some code to drive the car around and activate the strobe light and sound. You can use the programs from project 1 or create your own.

**Part B:** Move the end of the black jumper wire from the point labeled A to point B. Now the strobe light and sound are on whenever the switch (S1) is on, instead of being activated by the controller.

**Part C:** Use the original or Part B circuit but re-arrange the speaker and LEDs at the output of the strobe IC (Integrated Circuit, U23) as shown. Now the strobe light is not as bright and the sound is not as loud. You can replace the color LED with the white LED if desired.

**CHALLENGES**

- Make the lights flash in short bursts.

18

## PROJECT 10



5   6   7   8   9   10

**CAR REAR**
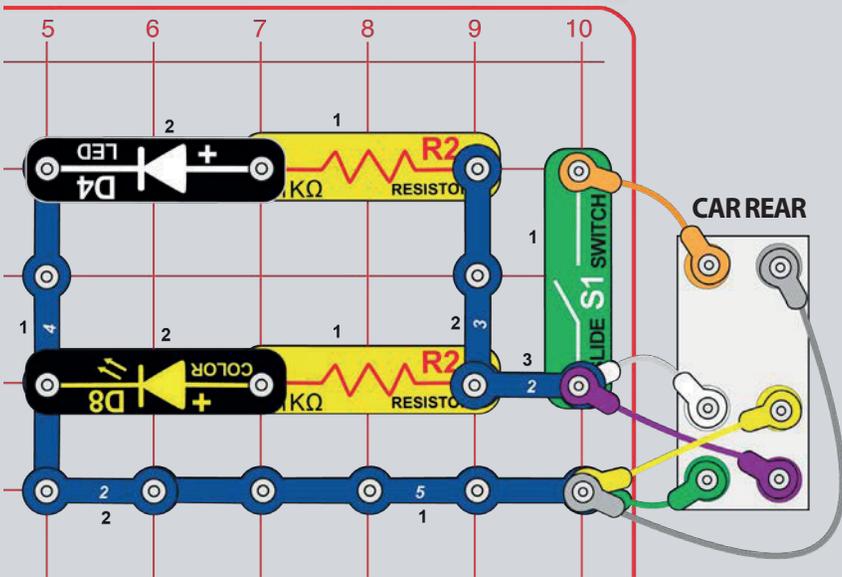
### LIGHTHOUSE

Build the circuit shown, place it in the middle of a dimly lit room, and turn on the switch (S1). The light will shine around the room as the car spins.

---

## PROJECT 11



**CAR REAR**
**(upside down)**

Notice that the smaller gears are spinning faster than the larger gears and wheels. The smallest gears (on the motor) are actually spinning 128 times faster than the wheels. See page 44 for more information about the gears.
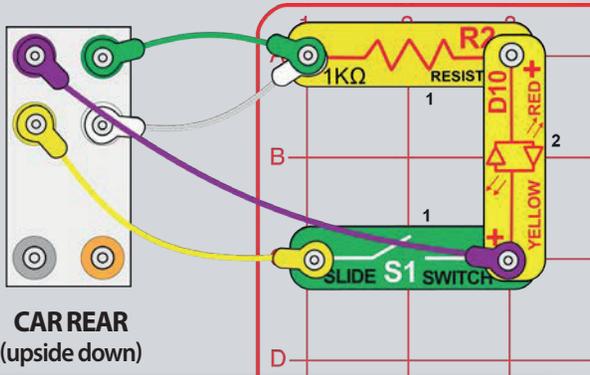
### GENERATOR

**WARNING:** Do not use excessive force to spin the wheels at abnormally high speeds. This may burn out the motors or LEDs.

Flip the car body so it is upside down and connect the jumper wires to the body and circuit as shown. Turn off the slide switch (S1) for the time being. Spin the right wheels with your hands. The red/yellow LED (D10) should light. Now turn on the slide switch (S1) and spin the right wheels again. The wheels now take more effort to spin, and cause the left wheels to also spin.

Spinning the right wheels makes all the inter-connected gears spin, and spins the shaft on the right motor. The spinning motor shaft creates electricity using magnetism (opposite to how electricity through the motor spins the shaft), which powers the LED. With the switch on, the electricity created in the right motor also powers the left motor, which spins the left wheels. The wheels are harder to spin now because magnetic fields in both motors must be overcome. No batteries are used.

7 8 9 10

CAR REAR

SLIDE S1 SWITCH

PHOTOTRANSISTOR Q4

D10
YELLOW — RED

# LED FUN

**Part A:** Build the circuit shown and turn on the slide switch (S1). Vary the amount of light shining on the phototransistor (Q4) to change the brightness of the red/yellow LED (D10). You may want to hold the circuit near a bright light or flashlight and then partially block the light with your hand.

You can replace the phototransistor with a 5.1kΩ resistor (R3) to compare the phototransistor's resistance to it.

**Part B:** With the phototransistor in the circuit, dim the room lights so the LED is off. Take a TV/stereo/DVD infrared remote control from your home then point it directly into the phototransistor, and press any button to turn on the LED. (Infrared light is light, so can change the phototransistor's resistance just like visible light does.)

**Part C**

SLIDE S1 SWITCH

CAR REAR

RV

D10
YELLOW — RED
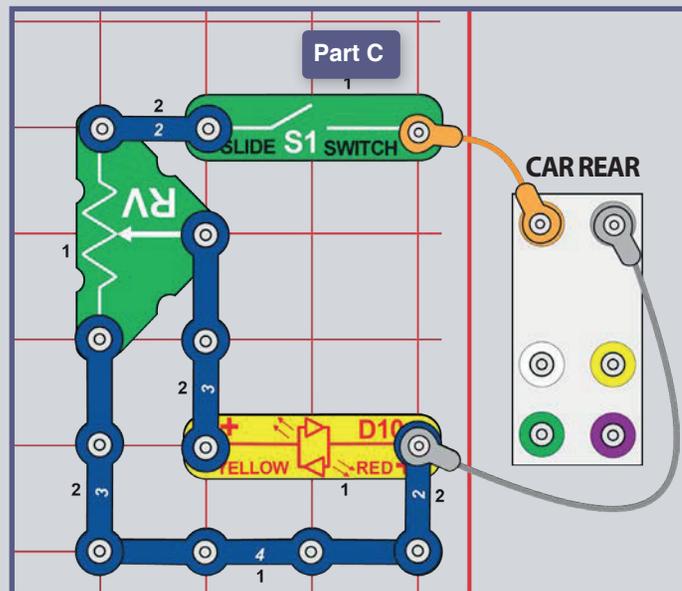
**Part C:** Re-arrange the circuit and add the adjustable resistor (RV) as shown here. Move the lever on RV to vary the LED brightness. (RV is a 50kΩ resistor, with a center tap that is adjustable from 200Ω to 50kΩ.)

**Part D**

SLIDE S

RV

C4
100μF
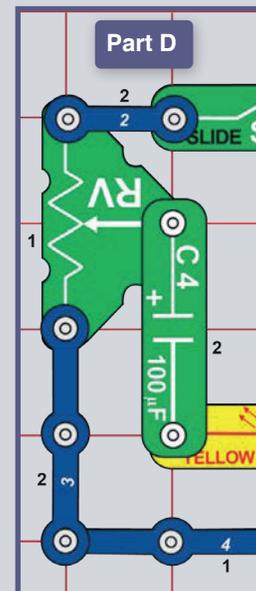
YELLOW

**Part D:** Replace a 3-snap wire with the 100mF capacitor (C4). Move the lever on RV back and forth several times. (Moving RV's lever changes the voltage to the capacitor and LED, making the capacitor charge up and discharge. The LED is yellow when the capacitor is charging and red when the capacitor is discharging.)
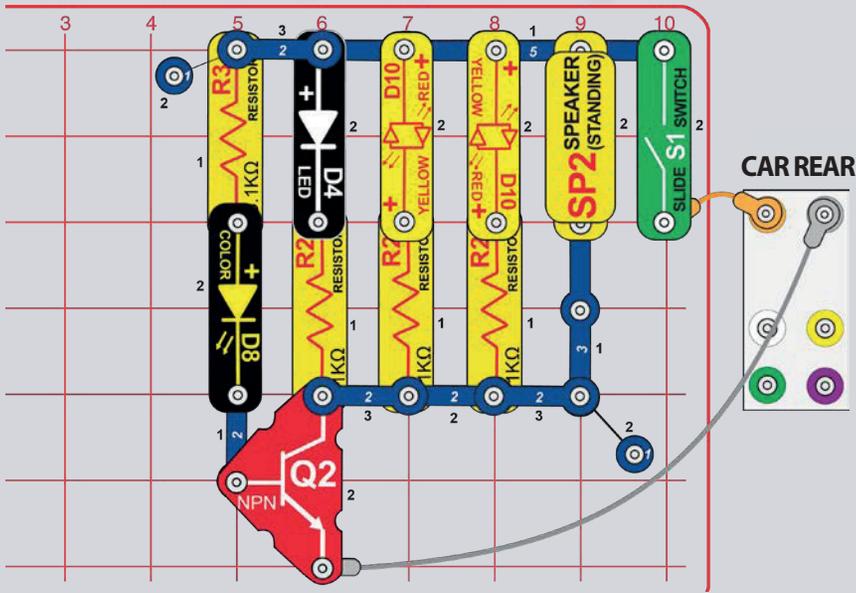
# FUNKY LIGHT & SOUND

Build the circuit and turn on the slide switch (S1). The white & red/yellow LEDs (D4 & D10) flash and the speaker (SP2) makes sound in sync with the color LED (D8) as it changes.

**CAR REAR**

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 D8 and R2, controlling a larger current into Q2 through D4, both D10s, and SP2. This control allows the color LED to control the other LEDs and the speaker.
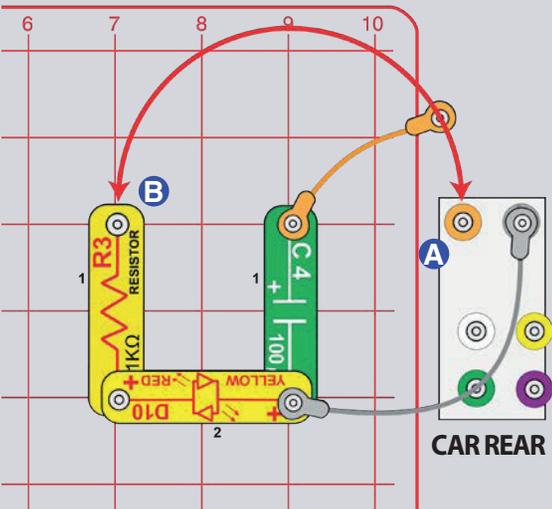
# ELECTRICITY TANK

Build the circuit and connect the jumper wires, leaving one end of the orange jumper off as shown. Touch the loose end of the orange jumper to point A on the car rear for a moment. This fills up the 100mF capacitor (C4) with electricity.

Now move the orange jumper from point A to point B on the 5.1kΩ resistor (R3). The red/yellow LED (D10) lights red for a few seconds using the electricity stored in the capacitor. Move the orange jumper back to point A to refill with electricity, and then to point B several times.

If you replace the 5.1kΩ resistor (R3) with the 1kΩ resistor (R2) then the LED will turn off faster but be brighter.

**CAR REAR**

Notice that a capacitor is not very efficient at storing electricity - compare how long the capacitor kept the LED lit for with how your batteries run all of your projects! That is because capacitors store electrical energy while a battery stores chemical energy.

**PROJECT 15**
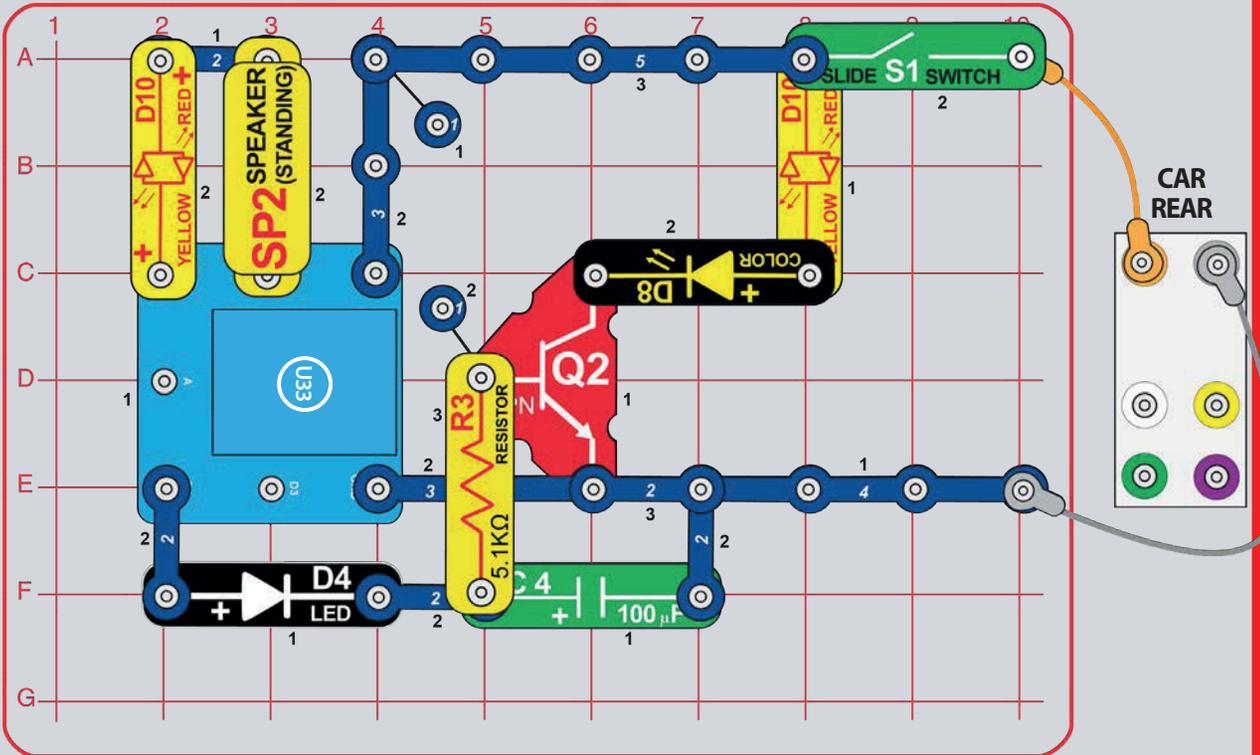
# FADING LIGHTS AND BEEPER

Build the circuit shown here and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use the Control Panel to turn the output D4 on and off. See project 1 and pages 30-39 to review how to use the app.

Turning on output D4 turns on the white LED (D4), charges the 100mF capacitor (C4), and turns on the color LED (D8) and a red LED (D10). Turning off output D4 turns off the white LED and lets the capacitor slowly discharge into the 5.1kΩ resistor (R3) and NPN transistor (Q2), which slowly turns off the color and red LEDs.

Next, put the app in Code mode and control the output D4 using the Control Panel in the app.

Variants:

- Speed up the color LED fading rate by replacing the 5.1kΩ resistor (R3) with 1kΩ resistor (R2)
- Remove the 100µF capacitor (C4) and compare how quickly the color LED turns off.

**CAR REAR**

**Part B, Beeper:** Now use Control panel to turn the controller outputs D1 & D2 on and off. Next, put the app in Code mode and control the controller outputs D1 & D2 repeatedly using the app.

```
circuitOn(D2, 1s, HIGH);
circuitOn(D4, 1s, HIGH);
```

**Beep & flash. Run this program continuously.**

BOFFIN

D1 H H D3

D2 A D4

Boffin app screen: Fading Lights, run continuously.

Manual

Code

Circuit

Control

Move

Turn

Start

D4 ⏱ 1s ⚙

Wait ⏱ 10s

Code

```
circuitOn(D4, 1s, HIGH);
wait(10s);
```
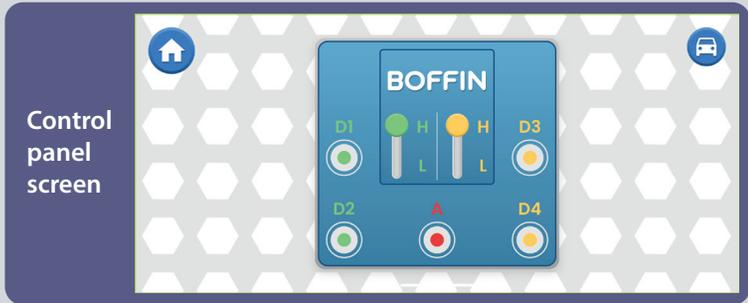
Belongs to project 15

## PROJECT 16



1  2  3  4  5  6  7  8  9  10

SLIDE S1 SWITCH

CAR REAR

R2 RESISTOR

RV

PHOTOTRANSISTOR Q4

Q2 NPN

D4 LED

COLOR D8

HORN W1

U33
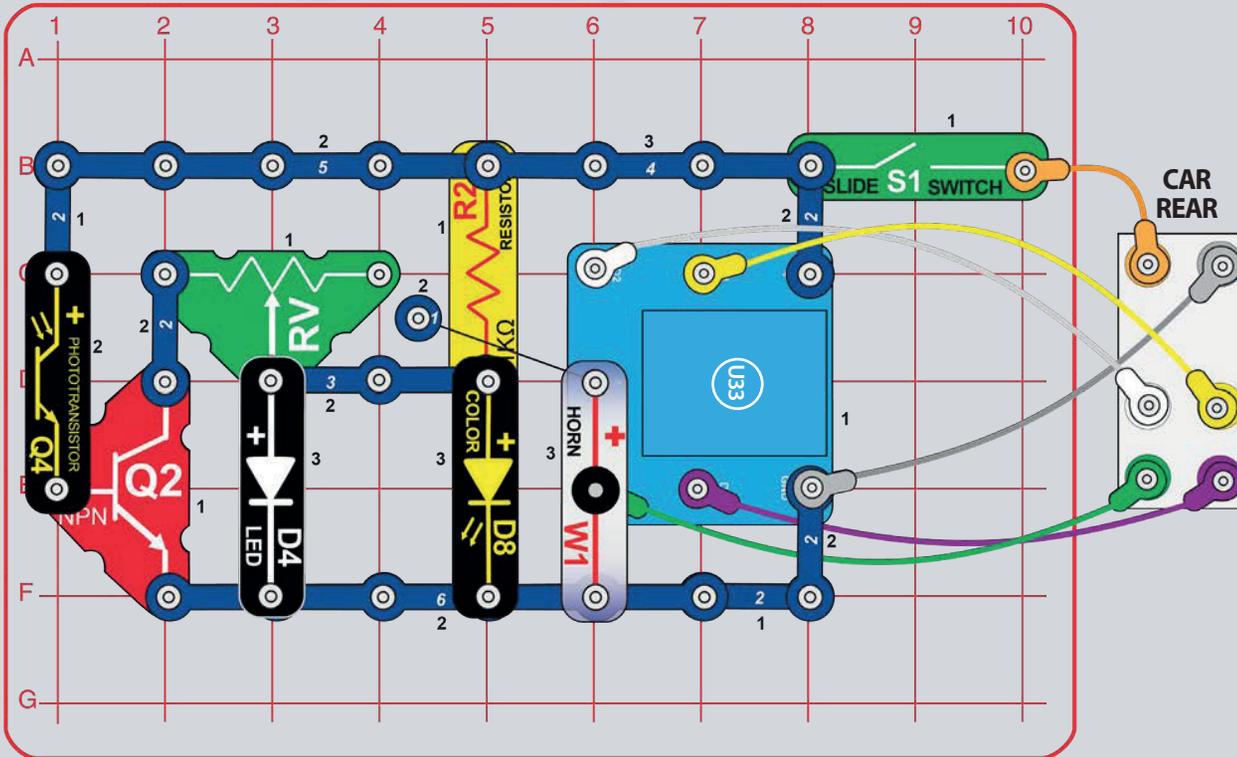
# AUTOMATIC LIGHT

Build the circuit shown and turn on the switch (S1). Set the lever on the adjustable resistor (RV) to the left. If the room lighting is dim then the white and color LEDs (D4 & D8) will be on, otherwise they will be off. Vary the amount of light shining on the phototransistor (Q4) to turn the LEDs on and off. Move the lever on RV a little to the right to make the LEDs come on more easily.

Open the Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around, while using output A control to change the sound. The white & color LEDs will come on if the room lighting is dim, to help the car find its way. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around and change the sound. You can use the programs from project 1 or create your own.

## CHALLENGES

- Make the car follow a route or do a dance.
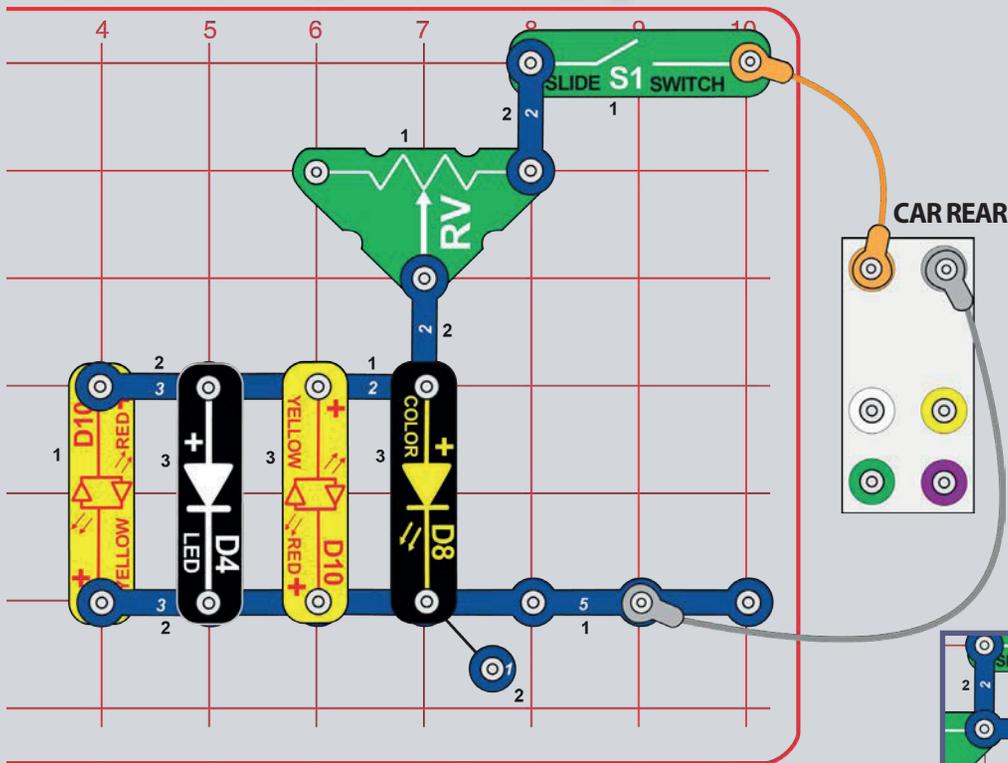
# LIGHT THEM UP

Build the circuit shown here and turn on the switch (S1). Move the lever on the adjustable resistor (RV) to the right to increase the brightness of the LEDs. If you move the lever slowly as it nears the right side, you can see that some LED colors come on before others.

**CAR REAR**
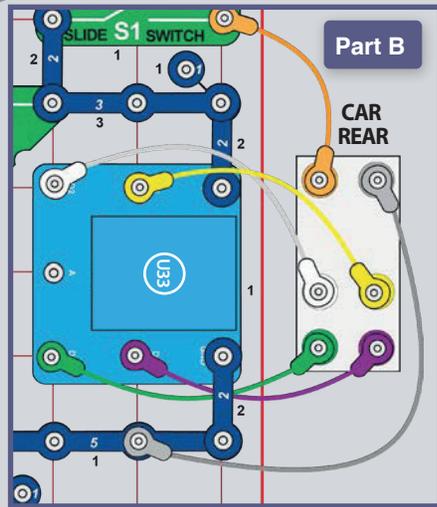
**Part B**

**Part B, Light Controlled Sound:** Add the SC Controller (U33) and other connecting parts to the circuit as shown. Turn on the switch. Open Boffin app, connect to the controller (U33), and use one of the drive modes (TANK, COMMANDER, TOUCH DRIVE) to drive the car around with the LEDs on. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around. You can use the programs from project 1 or create your own.

In LEDs, red & yellow are easily to produce than white or blue, so red & yellow come on sooner.
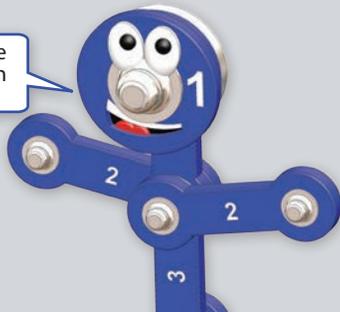
PROJECT 18
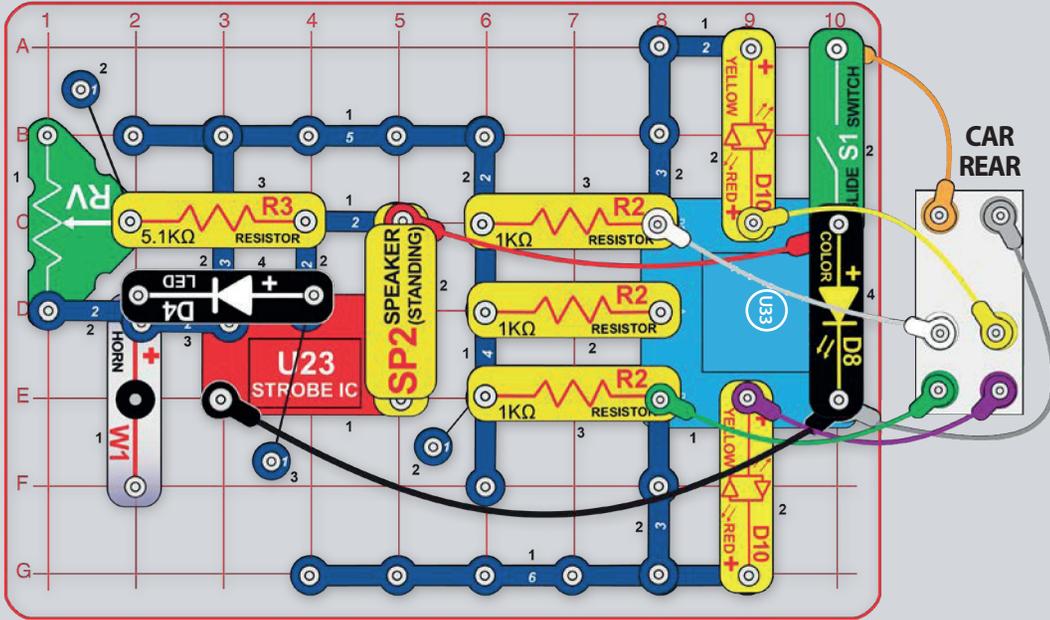
## SILENT CIRCUIT

Build the circuit shown here and turn on the switch (S1). Move the lever on the adjustable resistor (RV) to change the sound. Open the Boffin app, connect to the controller, and use one of the drive modes to drive the car around and to change the sound. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around while changing the sound. Experiment with changing parameters for commands, such as the time duration.

The horn (W1) will not make sound, it is only used here as a spacer.

CAR REAR

**The car does a short dance.**

```
moveForward(1s);
moveBack(1s);
spinLeft(90º, HIGH);
moveForward(1s);
spinRight(360º, HIGH);
```

**The car goes on a journey and returns.**

```
moveForward(2s);
spinLeft(1s, HIGH);
moveForward(2s);
spinRight(1s, HIGH);
circuitOn(A,1s);
moveBack(2s);
spinRight(1s, HIGH);
moveBack(2s);
circuitOn(A,1s);
```

### CHALLENGES

- Make your own dance or route for the car.

BOFFIN

D1   H   H   D3
L    L

D2   A   D4

Drive modes (TANK, COMMANDER, TOUCH DRIVE)

TOUCH DRIVE

A

H
L
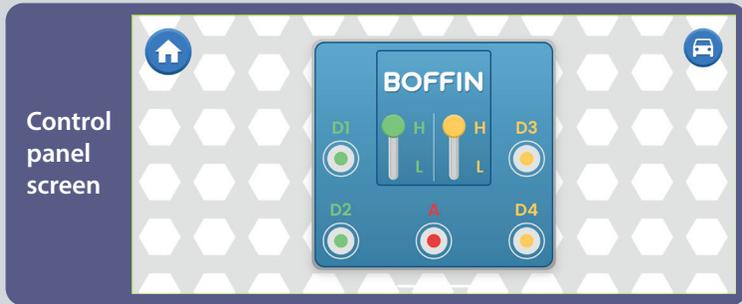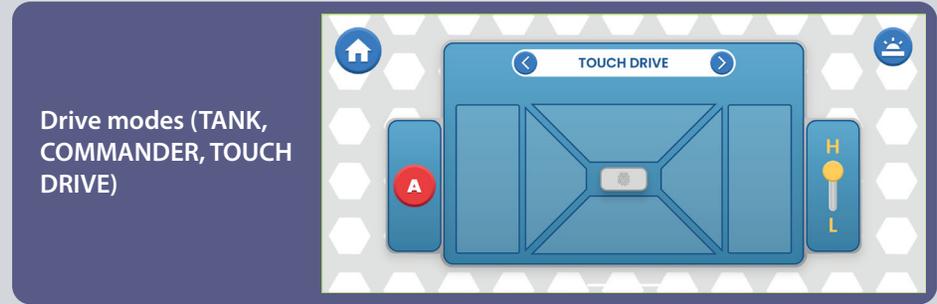
Belongs to project 18

**PROJECT 19** ™



SLIDE S1 SWITCH

COLOR D8

U23 STROBE IC

SP2 SPEAKER (STANDING)

U33

Q2 NPN

R2 RESISTOR 1kΩ

A

B

CAR REAR

# FUNKY SOUND CAR

Build the circuit shown and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes to drive the car around, while using output A control to activate a funky sound. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around and activate the funky sound. You can use the programs from project 1 or create your own.

**Part B:** Move the end of the black jumper wire from the point labeled A to point B. Now the strobe light and sound are on whenever the switch (S1) is on, instead of being activated by the controller.

If the sound seems too loud then replace the 3-snap wire between U23 and SP2 with the red/yellow LED (D10) or the 1kΩ resistor (R2).

## CHALLENGES

- Make the car follow a route or do a dance.
- Make the car follow a short zig-zag route.

CAR REAR

# CRAZY SOUND CAR

Build the circuit shown and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes to drive the car around, while using output A control to change the sound. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around and change the sound. You can use the programs from project 1 or create your own.

**Part B:** Replace the 5.1kΩ resistor (R3) with the 1kΩ resistor (R2). The sound is different now.

If the sound seems too loud then replace the 3-snap wire between U23 and SP2 with the red/yellow LED (D10) or the 1kΩ resistor (R2).

## CHALLENGES

- Make the car follow a route, making a sound after every turn.

# CRAZY KEYBOARD

Build the circuit shown here and turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes to drive the car around and hear different sounds by activating any of the D1-D4 or A outputs. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to turn on the sounds in a sequence.

**CAR REAR**

**Control panel screen**

The NPN transistor (Q2) is only connected in two places. Q2 is used here as a one-way diode to isolate some of the circuits from each other.

## CHALLENGES

- Make an interesting sequence of sounds.

## Keyboard tones

| Start | | |
|---|---|---|
| D1 | Ō | 1s | ⊘ |
| D2 | Ō | 1s | ⊘ |
| A | Ō | 2s | |
| D3 | Ō | 1s | ⊘ |
| D4 | Ō | 1s | ⊘ |

**Circuit**
**Control**
**Move**
**Turn**

**Code** ✕
```
circuitOn(D1, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
circuitOn(A,2s);
circuitOn(D3, 1s, HIGH);
circuitOn(D4, 1s, HIGH);
```

Belongs to project 21

## Tone Changer

| Start | | |
|---|---|---|
| D1 | Ō | ∞ | ⊘ |
| Wait | Ō | 1s | |
| D2 | Ō | ∞ | ⊘ |
| Wait | Ō | 1s | |
| D4 | Ō | ∞ | ⊘ |
| Wait | Ō | 1s | |
| D3 | Ō | ∞ | ⊘ |
| Wait | Ō | 1s | |
| A | Ō | 1s | |
| D1 | Ō | 0 | ⊘ |
| Wait | Ō | 1s | |
| D2 | Ō | 0 | ⊘ |
| Wait | Ō | 1s | |
| D4 | Ō | 0 | ⊘ |
| Wait | Ō | 1s | |
| D3 | Ō | 0 | ⊘ |
| Wait | Ō | 1s | |
| A | Ō | 1s | |

**Circuit**
**Control**
**Move**
**Turn**

## PROJECT 22

CAR REAR



D10 RED
D10 RED
U33
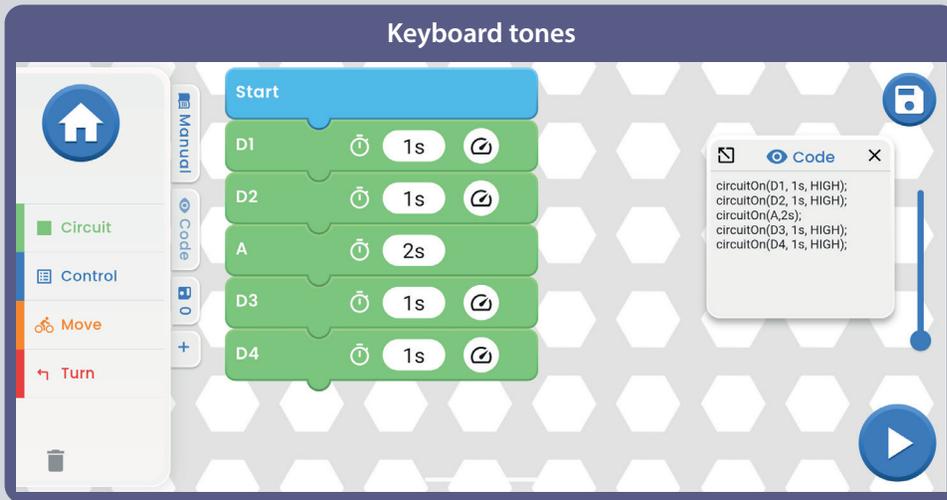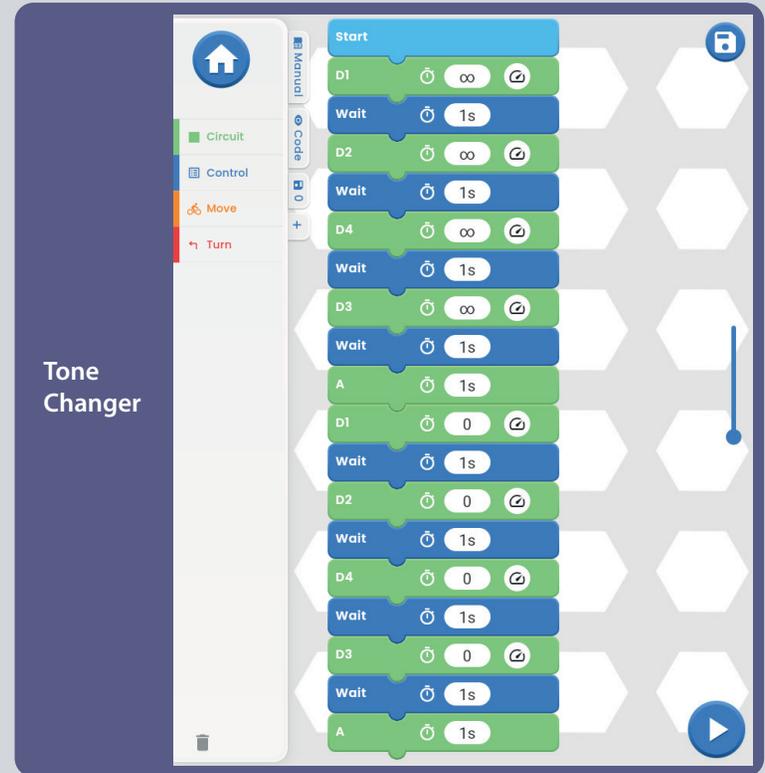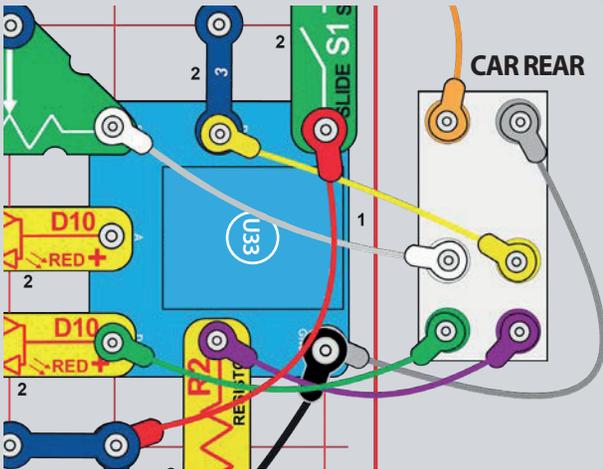
### CHALLENGES

- Make your own dance or route for the car.

# MOBILE CRAZY KEYBOARD

Use the preceding circuit but add the white, yellow, green and purple jumper wires to connect the motors in the car body. Turn on the switch (S1). Open the Boffin app, connect to the controller (U33), and use one of the drive modes to drive the car around while activating different tones. See project 1 and pages 30-39 to review how to use the app.

Next, put the app in Code mode and create some code to drive the car around while activating different tones. You can use the programs from project 1 or create your own.

# HOW TO DOWNLOAD AND USE THE BOFFIN APP

Bluetooth Connection
Light Indicator

U33

+    GND

D1    D3

D2    A    D4

## MEET THE CONTROLLER

The controller module (U33) has 5 outputs (D1, D2, D3, D4, and A) that are controlled through Bluetooth using an Boffin app on your device. 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 - 5V) and L (Lower - 3V). Output A has low power and cannot control most motors.

The controller can be controlled from the Boffin app on your Bluetooth device in two ways:
1. Control panel (remote control in real-time).
2. Boffin app (simple graphical coding).

**U33 CONTROLLER:**

| | |
|---|---|
| **(+)** | - power input from batteries |
| **GND** | - power return to batteries |
| **D1** | - output connection for a motor, paired with D2, higher & lower levels |
| **D2** | - output connection for a motor, paired with D1, higher & lower levels |
| **A** | - output connection for low current uses, 4V output level |
| **D3** | - output connection for a motor, paired with D4, higher & lower levels |
| **D4** | - output connection for a motor, paired with D3, higher & lower levels |

## BOFFIN APP INSTRUCTIONS

Google Play Store          App Store

Go to the App Store or Google Play Store on your device. The most recent version of the Boffin app is available on iOS and Android, and may also be available on other devices. Visit www.boffin.cz/en for more information.

Search for 'Boffin'. Look for a page like the one shown here. Download the app, install it, and open it. Contact Conquest ent. if you have any problems (www.boffin.cz/en, info@boffin.cz).

# CONNECT TO THE BOFFIN APP

Build any project from this booklet and turn on the switch (S1) that is needed to turn on the controller (U33). Activate the position on your phone and Bluetooth as well and open the Boffin app.



Make sure Bluetooth is turned on your device; If it's off, the app should prompt you to turn it on. Confirm in the bottom right corner and the pairing is done.



You are now ready to Control or Code.

Click on the red bluetooth icon and your phone will pair with the Boffin kit (via part U33).
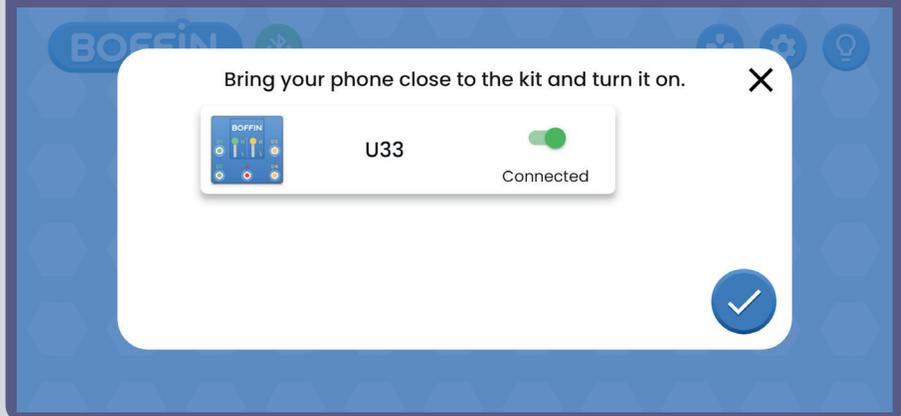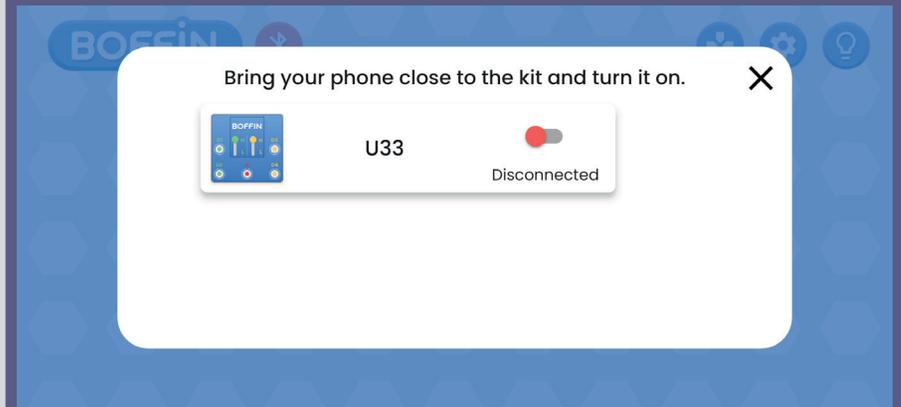


**Note:** If you are connecting for the first time, your U33 driver will named SCCSCC or SCC.

**To disconnect:** Turn off the S1 switch or click the green Bluetooth icon on your phone and confirm Disconnect. This will disconnect your device from the U33 controller and someone else can connect.

**To reconnect:** Switch on your U33 controller using the S1 switch. Return to the app and click on the red bluetooth icon.

# CONTROL

The easiest way to use your driver U33 is through the Control Panel, which can be found in the main menu under CONTROL and which serves as a remote control for the Boffin car.



1. You should have the Boffin app running on your device, the project built and the U33 driver connected.

2. Select CONTROL from the main menu and the Control Panel in basic settings.



3. You can click on the icon at the top right and the first of the drive modes will appear. Drive modes are described on the following pages (37).



4. Control panel in the basic settings is used for switching the LEDs on and off (by clicking on D1, D2, D3, D4 and A).

- 5 outputs for controlling your circuits: D1, D2, D3, D4 and A. Simply press the button to turn on/off the circuit output. Use these to turn the LEDs in your circuit on and off.

- D1-D4 have Higher and Lower Voltage Level Controls (typically 5V and 3V but varies depending on your battery voltage). Select Higher (H) or Lower (L) voltage to change the output voltage level. D1 & D2, and D3 & D4, are paired and must always be the same voltage level (H or L). Use H and L to change the brightness of LEDs in your circuit that are turned on.

- The A output is 4V but can only supply low currents, so it cannot be used to control the motor (M1) directly.

- You can Control & Code circuit paths independently or together. You can turn on all 5 circuit outputs (controlling 5 LEDs in this circuit) at a time or turn them on/off individually.

# CREATE WITH BOFFIN

The Boffin app uses Scratch-like drag and drop coding to make it easy to program the controller. You can turn on lights, sounds, or motors, in any order or for different durations.

1. The Boffin app should be open on your device and your controller module should be connected to it as described earlier.

2. From the main menu, tap the Code button to get to the main screen with first command BEGINNING. With the Boffin appyou can program sequences of actions for your controller and see them in action. Turn your device sideways – the app will always be locked in landscape mode.

### Outputs

### Move

### Control

### Turn

---
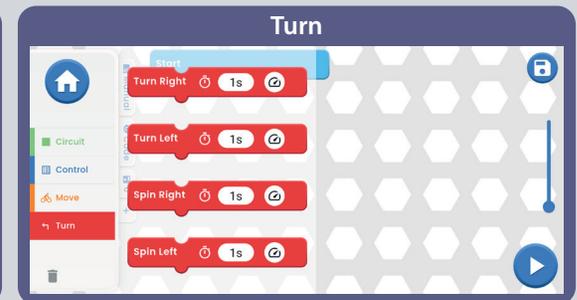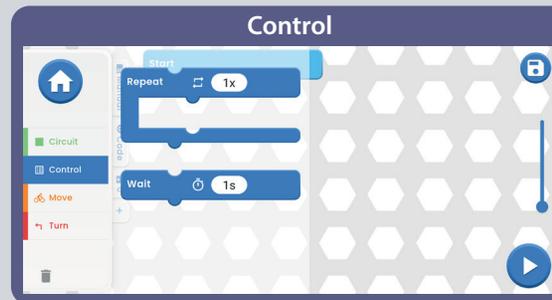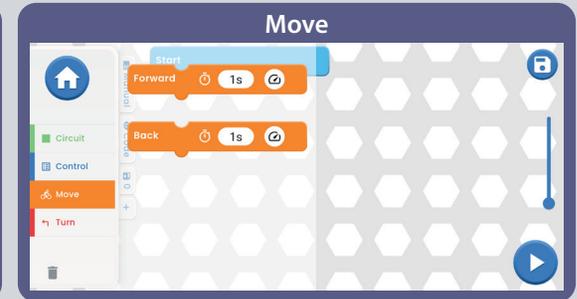
**Bookmarks:**

**Manual** - offer of all Boffin manuals. When you click on it, a small window with a "+" will open. Click on the "+" and select manual from the list. Manuals are downloaded from www.boffin.cz/en, so it may take a while. Confirm the blue arrow and the manual will open in a small window. You can scroll through the manual or enlarge the window in the upper left corner. Working in the window is not so comfortable as it is with printed manual.
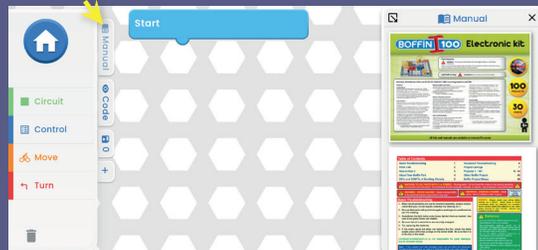
**Code** - the text code for the commands which you created in the main field under BEGINNING.

```
circuitOn(D1, 1s, HIGH);
circuitOn(D2, 1s, HIGH);
circuitOn(A, 1s);
circuitOn(D4, 1s, HIGH);
circuitOn(D3, 1s, HIGH);
```

**Trash bin (command dragged towards the bin gets deleted)**

**Save** - a list of all saved projects

Project1
Projekt2
Projekt3

**"+"** - open a new project
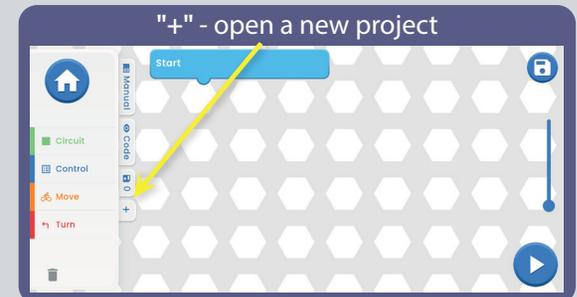
# EDITING & SAVING BOFFIN



**Boffin app screen**

Main field - choose a command from the left menu OUTPUTS/CONTROL/MOVE/TURN and drag it under the command BEGINNING. Command will snap to it. For example D1 from OUTPUTS see picture.

Follow this procedure for all commands.
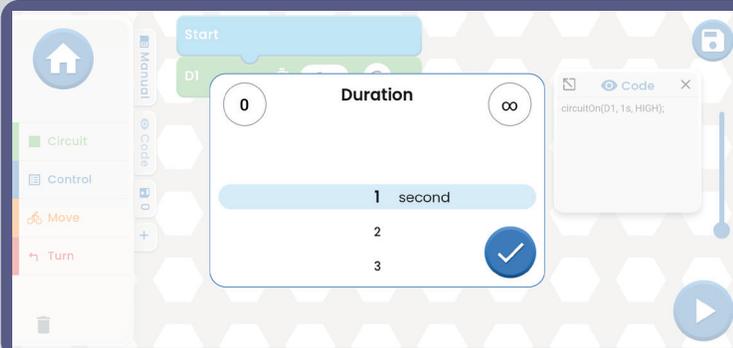


You can adjust the time and intensity on the D1 command by clicking on

Time is in the range 1-999 seconds or you can use the 0 and ∞ button. Intensity is either Low or High.



Try adding more commands from the left menu. If you enter more commands than the screen size, you can simply scroll through the commands (just swipe your finger around the screen NEXT to the commands, not on them) or use ZOOM.



When you enter a command from TURN and click on the 1s time, a window will open where you can set not only the time, but also the degrees of turning (by clicking on Degrees or Time). The degrees are selectable from 0 to 360°.
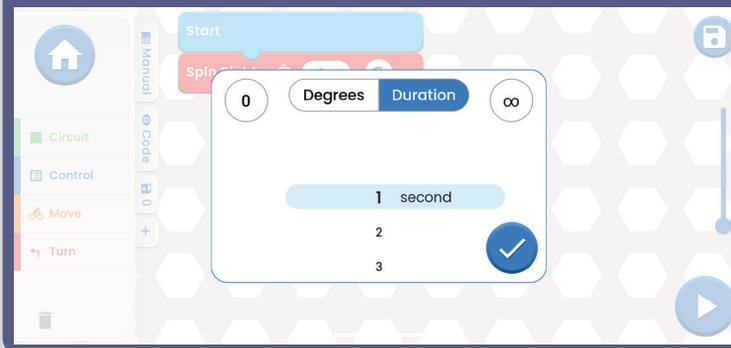


**TIPS:** Inserting a command between commands - Click or example on OUTPUTS, hold down with your finger D2, point it between two commands where you want D2 to be inserted. Then you just drop D2.

**TIPS:** Removing a command, that is inserted between other commands. Hold the command with your finger and pull it aside. The command will be detached and you you can drag it towards trash bin, which is on the bottom left.

## To save your programs

You can save the code at any time by clicking on the icon in the top right corner save icon. Just enter the project name and confirm with the green arrow.



**Note:** To program commands, you must be connected to U33 driver.

**Tips:** Select a command and change the voltage (H/L) of the U33 driver and the time for each command.

H (high = 5V) and L (low = 3V) output voltage levels apply only to outputs D1 to D4, not to output A.

Once you've completed the code (you have all the commands in it) and saved it, click the START button in the bottom right corner.
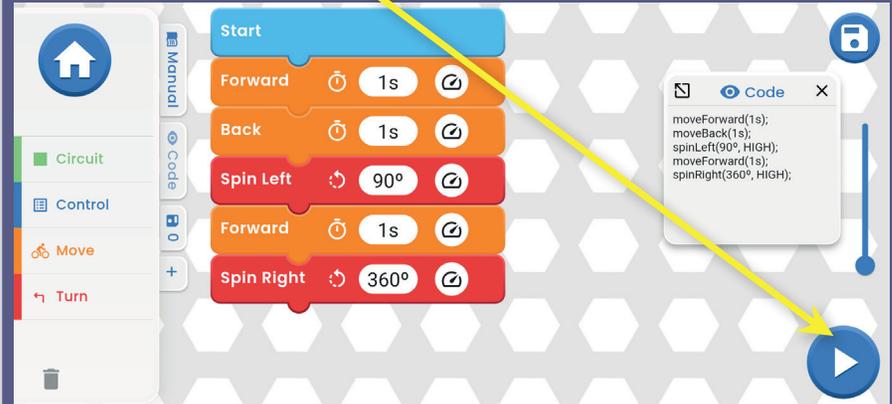


The whole code will run (lights will flash on the project on the kit, the car will drive, etc.). The kit will do exactly what you coded. In case you want to stop the code, just click on the blue square. To let you know what command is currently being executed, a black box will mark the command in the app and start counting down the time you set on the command.

# INDIVIDUAL COMMANDS

**Outputs A - D1 - D2 - D3 - D4.** The duration can be set for all of them.D1/D2/D3/D4 - the intensity (H/L, High/Low) can also be set.



**Control REPEAT** - is used to make the commands inserted into REPEAT execute multiple times in a loop (the number of times depends on your choice). WAIT specifies how long to pause. To interrupt the repeat, press the blue square on the bottom right.
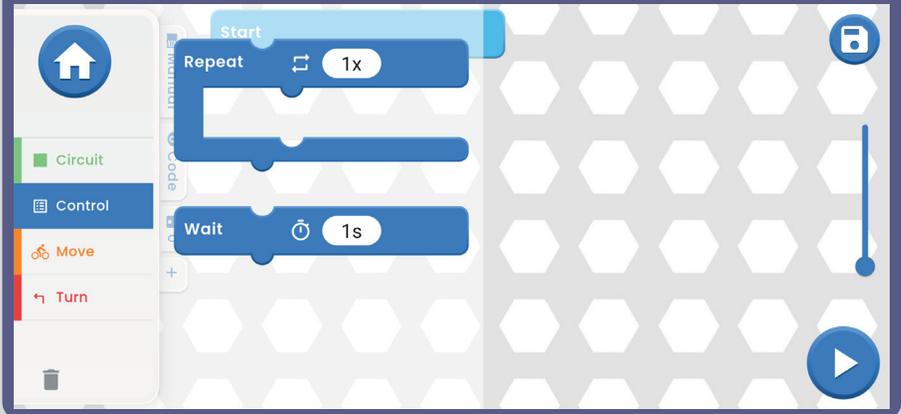


**Move - FORWARD/BACKWARD** For both commands the duration and intensity can be set (H/L, High/Low).
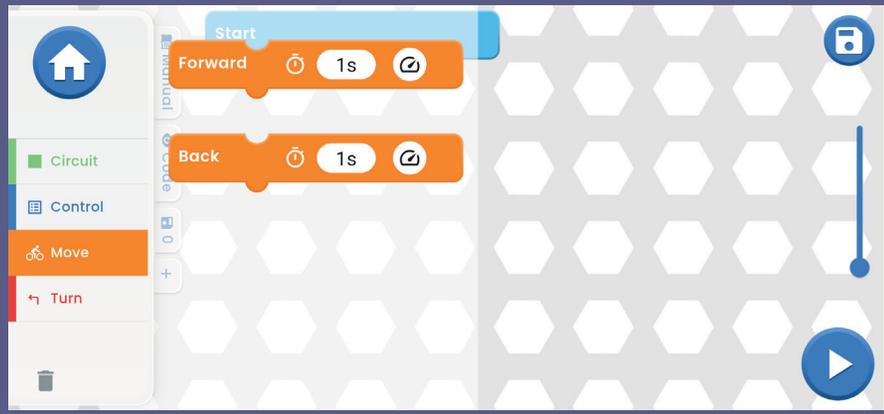


**Turn** - TURN RIGHT/TURN LEFT/SPIN RIGHT/SPIN LEFT. For all commands the duration and intensity can be set (H/L, High/Low).

# DRIVE MODES

Main menu - CONTROL - Control panel and car icon in the top right corner.

Click on to open the first driving mode - COMMAND DRIVE.

**Command Drive** - the easiest mode, best for getting started. Red Arrows - Forward/Reverse, Blue Arrows Right/Left, Green Arrows Turn right/turn left.
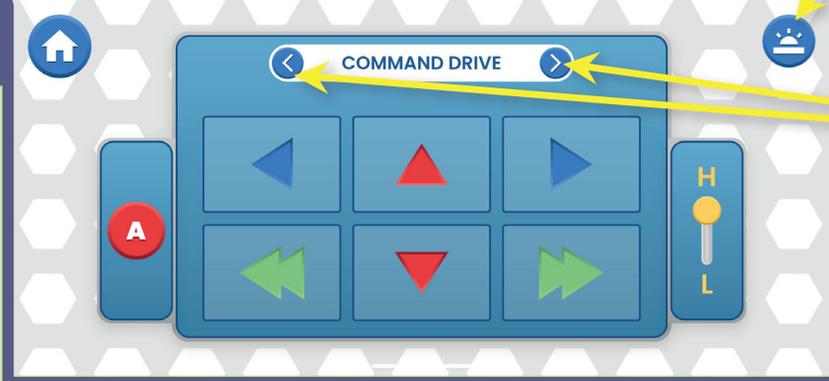
**Top right button:** Back to the CP (Control panel).

You can switch between Drive modes with the left and right arrow keys above the controls.

**Tank Drive** - a two-handed steering control that makes it possible to control the rear engines. Top arrows - press at once = drive forward. Lower arrows - press separately = turn Right/Left.

**Touch Drive** - a sensitive joystick-like controller that allows you to touch to control the movement of the vehicle (touch the center and pull in the direction you want to steer the vehicle). Put your finger forward on the white button and move it where you want to go.
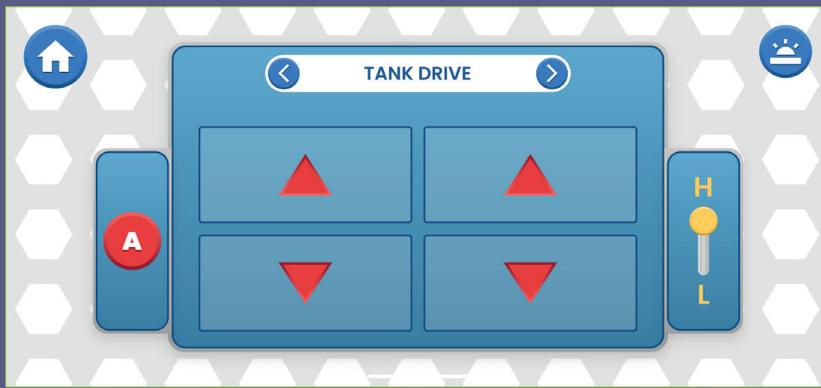
For all 3 modes you can control the speed (H/L, High/Low) and output A (this can be a light or horn depending on the project you build).
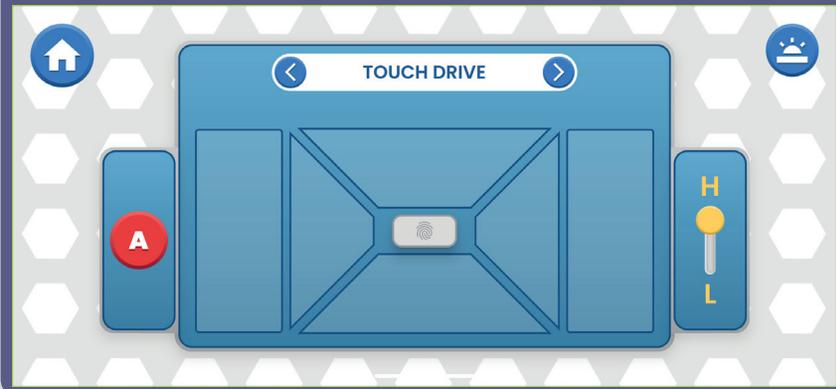
**VEHICLE CONTROL WITH THE CONTROLLER (U33):** Vehicle commands assume that D1-D2 outputs on the controller are connected to a vehicle's left motor (motor "+" or forward to D1), and that the D3-D4 outputs on the controller are connected to a vehicle's right motor (motor "+" or forward to D3). The A output on the controller is free to be used for sound, a light, or other functions.

# APP SETTINGS AND TIPS

**Settings** - click in the main menu on the icon SETTINGS.



In the settings you can turn the sound ON/OFF, change the language, read the privacy policy and general terms and conditions.



## Tips



You can pick between three different possibilities in this app.



Here you can control the LEDs on your kit. Just press the diode button.



Or use the panel to control the toy car.
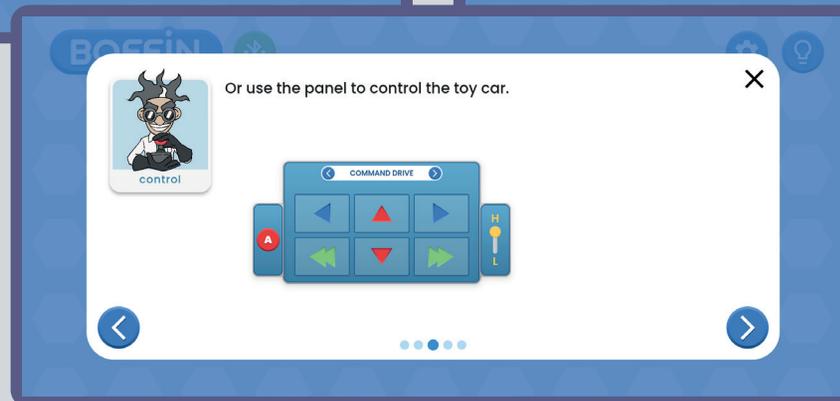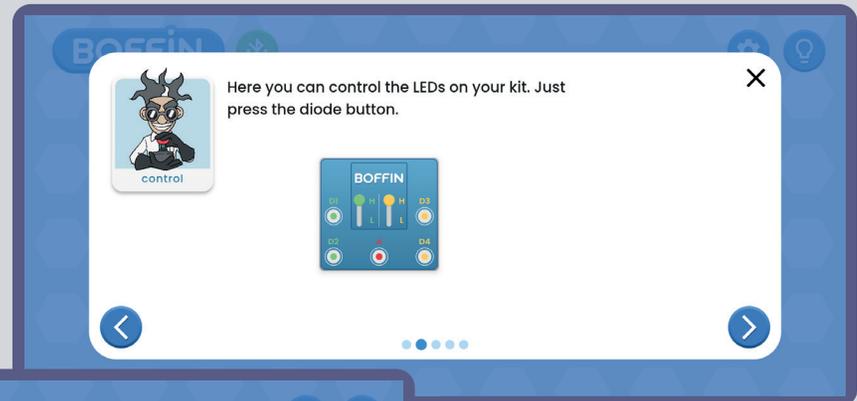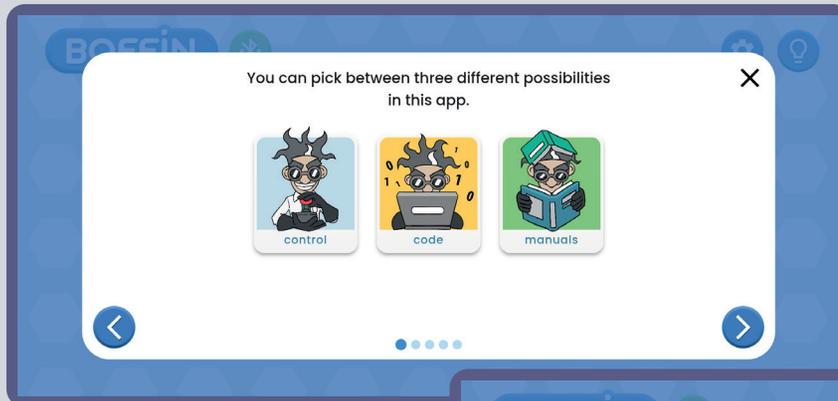
**D1** — Turn on D1 output (similar for D2, D3, D4) for the time duration shown and at the voltage level (H or L) shown.

**A** — Turn on A output for the time duration shown.

**REPEAT** — Set up a group of commands to be executed for the specified number of times (1-100).

**WAIT** — Wait for the time duration shown before executing any more commands. Time units are roughly 0.1 seconds (varies widely, due to processing and Bluetooth delays). Value can be set from 1 to 100.
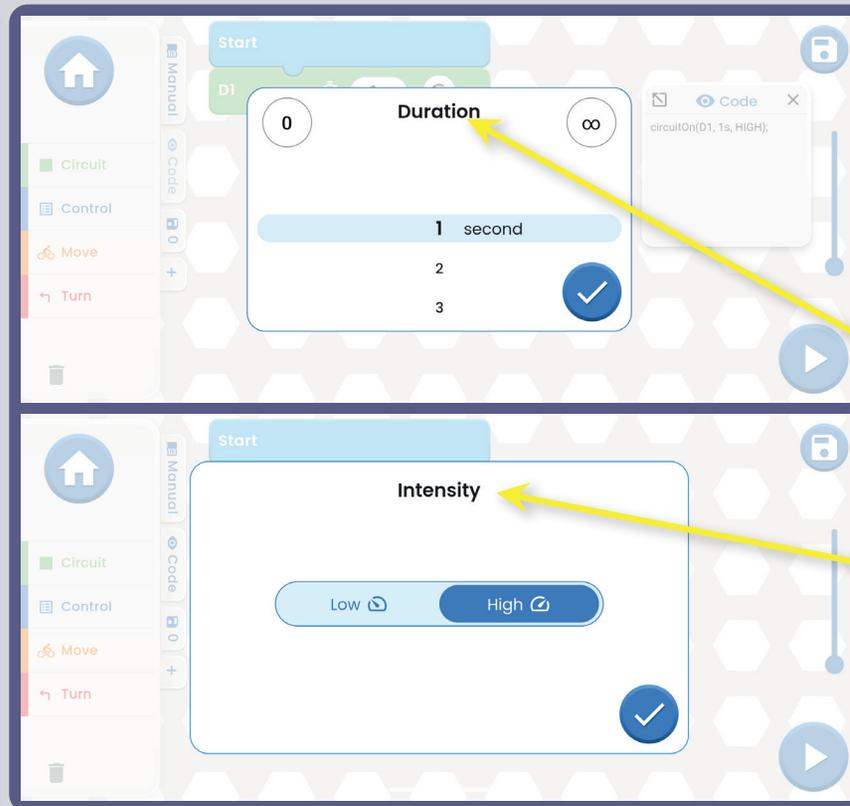
On the D1 command you can adjust the time and intensity.

The time is between 1-999 seconds or you can use the 0 and ∞ button.

The intensity is either Low or High.

**NOTE:** Turning on D1-D4 and A for a set time means the program will turn that output on, wait for that duration, then turn that output off before moving on to the next command. Set the duration to ∞ to turn an output on and leave it on (while the program performs other commands), then later set the duration to 0 if you want to turn it off later in the program.

**Important:** If any parts are missing or damaged, DO NOT RETURN TO RETAILER. Contact us at: info@boffin.cz.
You may order replacement parts at www.toy.cz

| Qty. | ID | Name | Symbol | Part | Qty. | ID | Name | Symbol | Part |
|---|---|---|---|---|---|---|---|---|---|
| ❏ 3 | 1 | 1 - Snap Wire | | 6SC01 | ❏ 1 | | Jumper Wire, Green | | 6SCJ3C |
| ❏ 6 | 2 | 2 - Snap Wire | | 6SC02 | ❏ 1 | | Jumper Wire, Purple | | 6SCJ3D |
| ❏ 3 | 3 | 3 - Snap Wire | | 6SC03 | ❏ 1 | | Jumper Wire, Gray | | 6SCJ3E |
| ❏ 1 | 4 | 4 - Snap Wire | | 6SC04 | ❏ 1 | | Jumper Wire, White | | 6SCJ3F |
| ❏ 1 | 5 | 5 - Snap Wire | | 6SC05 | ❏ 1 | Q2 | NPN transistor | | 6SCQ2 |
| ❏ 1 | 6 | 6 - Snap Wire | | 6SC06 | ❏ 1 | Q4 | Phototransistor | | 6SCQ4 |
| ❏ 1 | | Base Grid (11.0" x 7.7") | | 6SCBGBK | ❏ 3 | R2 | 1kΩ Resistor | | 6SCR2 |
| ❏ 1 | C4 | 100µF Capacitor | | 6SCC4 | ❏ 1 | R3 | 5.1kΩ Resistor | | 6SCR3 |
| ❏ 1 | D4 | White LED 90º | | 6SCD4 | ❏ 1 | | Car | | 6SCRB2 |
| ❏ 1 | D8 | Color LED | | 6SCD8 | ❏ 1 | RV | Adjustable Resistor | | 6SCRV |
| ❏ 2 | D10 | Red/Yellow Bi-Color LED | | 6SCD10 | ❏ 1 | S1 | Slide Switch | | 6SCS1 |
| ❏ 1 | | Jumper Wire, Black | | 6SCJ1 | ❏ 1 | SP2 | Speaker | | 6SCSP2 |
| ❏ 1 | | Jumper Wire, Red | | 6SCJ2 | ❏ 1 | U23 | Strobe IC | | 6SCU23 |
| ❏ 1 | | Jumper Wire, Orange | | 6SCJ3A | ❏ 1 | U33 | SC Controller | | 6SCU33 |
| ❏ 1 | | Jumper Wire, Yellow | | 6SCJ3B | ❏ 1 | W1 | Horn | | 6SCW1 |

# 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** (kΩ, 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**
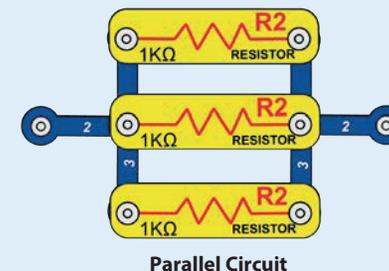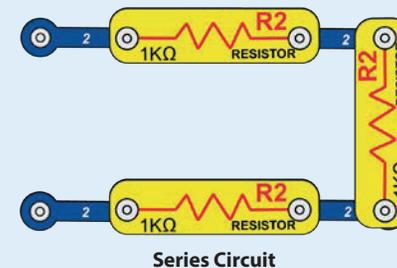


**Parallel Circuit**

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.

# About Your Boffin 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.
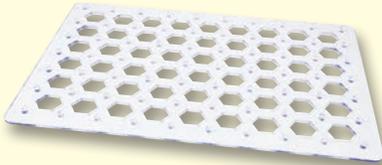
## SNAP WIRES & JUMPER WIRES

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 colored **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 in the car body 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.

**Batteries in the Boffin car**

## SWITCHES

The **slide switches (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.
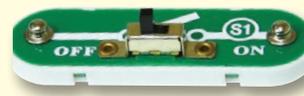
**Slide Switch (S1)**

## TRANSISTORS

The **NPN transistor (Q2)** 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.

The **phototransistor (Q4)** is a transistor that uses light to control electric current.

**NPN  Transistor (Q2)**

## 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.

**Speaker (SP2)**

# About Your Boffin Parts

## LEDs

**The white, color, and red/yellow LEDs (D4, D8, & 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 about 1.5V for red and yellow, about 2.0V for green, and about 3.0V for blue and white; 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 Boffin kit LEDs have internal resistors to protect against incorrect wiring).

**White, Color, & Red/Yellow LEDs (D4, D8, & D10)**

## RESISTORS

Resistors "resist" the flow of electricity and are used to control or limit the current in a circuit. This set includes **1kΩ (R2) and 5.1kΩ (R3) resistors** ("k" symbolizes 1,000, so R2 is really 1,000Ω). 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.

**Resistors (R2 & R3)**

The **adjustable resistor (RV)** is a 50kΩ resistor but with a center tap that can be adjusted between 200Ω and 50kΩ.

**Adjustable Resistor (RV)**

## HORN

The **horn (W1)** 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.

**Horn (W1)**

## CAPACITORS

The **100µF capacitor (C4)** can store electrical pressure (voltage) for periods of time. This storage ability allows it to block stable voltage signals and pass changing ones. Capacitors are used for filtering, delay/timing, and oscillator circuits.

**Capacitor (C4)**

## ELECTRONIC MODULES

The strobe IC (U23) contains resistors, capacitors, and transistors that are needed to make a strobe light circuit.

(+)

CTL    NC

(–)    OUT

**U23 STROBE IC**
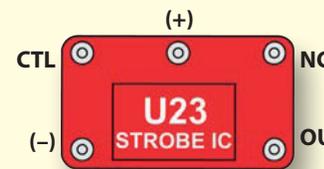
**Connections:**
**(+) - power from batteries**
**(–) - power return to batteries**
**OUT - output connection**
**CTL - strobe speed control**
**NC - not used**
See project 5 for example of proper connections.

The **controller (U33)** lets you control Boffin parts using Bluetooth. Its functions and use are described in project 1 and page 30.

# About Your Boffin Parts

## MOTORS

The motors (in the car body) convert electricity into mechanical motion. Electricity is closely related to magnetism, and an electric current flowing in a wire has a magnetic field similar to that of a very, very tiny magnet. Inside the motor is a coil of wire with many loops wrapped around metal plates. 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 coil, it magnetizes the metal plates and they repel from the magnet on the motor shell - spinning the shaft. A small gear is on the end of the shaft and spins with it.

**Car body:**

(+) - power from batteries
(−) - power return to batteries
L+ - left forward motor drive
L- - left backward motor drive
R+ - right forward motor drive
R- - right backward motor drive

R−    L−         (+)

R+    L+         (−)
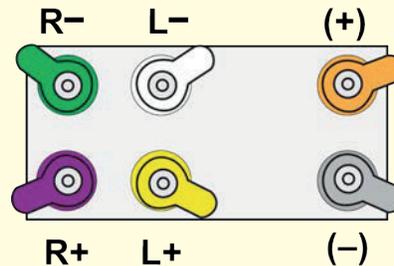
> ⚠ **WARNING:** Only connect this part as shown in the projects!

**Car Drive Mechanism:**

The small gear on the Motor drives a larger gear, which drives a larger gear, which drives two larger gears (one on each side), which drive larger gears. The last, largest gears are fixed on shafts that are attached to the front and back wheels, making them move. Note that interlocking gears spin in opposite directions. Also notice that in the sets of interlocking gears between the Motor and the gears on the wheel shafts, the number of "teeth" is increased each time (40-8, 44-8, 64-44, and 64-20), for 128:1 gear ratio overall. This means the Motor must rotate 128 times to rotate the wheels once. The reason for this is that if the Motor were to drive the wheels directly then the auto would be so fast that it would be impossible to control. Using the gears to reduce the speed also makes the wheels move with much greater force, preventing the auto from getting stuck in rough terrain and allowing it to carry heavy loads uphill.

## GEARS

Motor **gear** Spins 128 times faster than wheels

Wheel shaft

*(Part designs are subject to change without notice)*

44
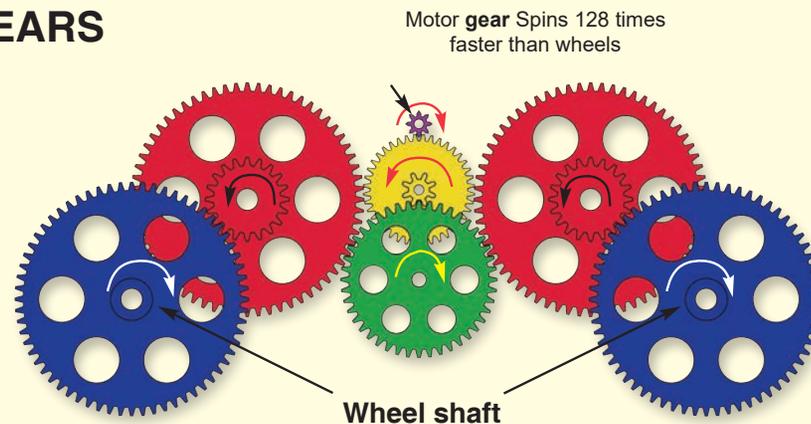
# Guidelines For Classrooms or Home Schooling

This product is a tool for opening the exciting worlds of coding & electronics. Following the experiments concept, coding & electronics will be easy for students to understand by using Boffin to learn about circuits and the Boffin 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 7 hours to do this book. 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.

## 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 Boffin components into the workspace.
  - Teacher instruction about the specific projects to be performed during that session.
  - Building and testing the circuits.
  - Loading the Boffin and connecting to a controller circuit.
  - Performing experiments (and teacher verification if desired).
  - Dismantling the circuits and returning Boffin 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 46 at the beginning of each session.

# 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 modules using configurations given in the projects, incorrectly doing so may damage them. **ConQuest ent. 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 motor, resistor, IC, or 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* connect the strobe IC using configurations given in the projects.

*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 Boffin Users:** Do not connect additional voltage sources from other sets, or you may damage your parts. Do not connect parts from other Boffin sets with the car body unless you are familiar with the limitations of those parts, the car body uses higher voltage which could damage those parts. Contact ConQuest Entertainment in case of questions at info@boffin.cz.

## Examples of SHORT CIRCUITS - NEVER DO THESE!!!

(+)

! NEVER DO!

Placing a jumper wire directly across the battery snaps is a SHORT CIRCUIT.

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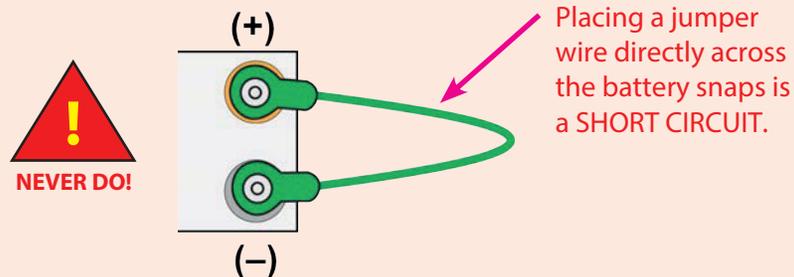
When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.

! NEVER DO!

! NEVER DO!

! NEVER DO!
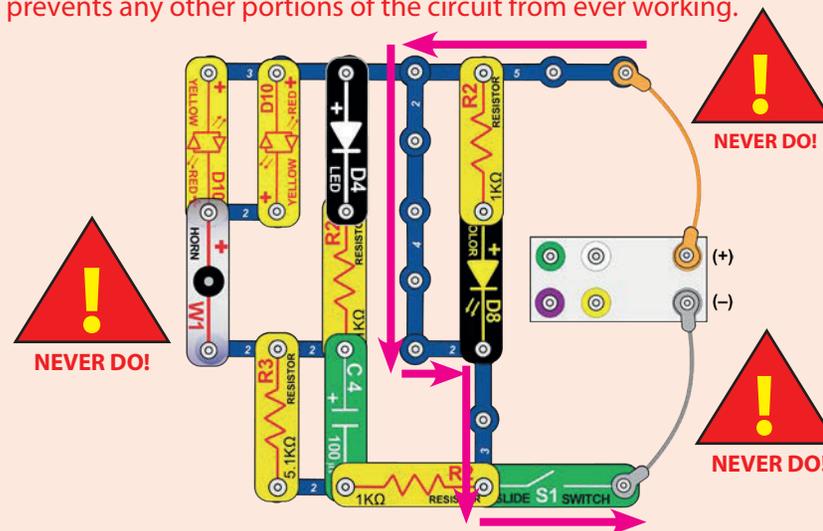


You are encouraged to tell us about new circuits and structures you create.

If they are unique, we will post them with your name and state on our website at: www.boffin.cz/en.

**WARNING: SHOCK HAZARD** - Never connect Boffin to the electrical outlets in your home in any way!

# Advanced Troubleshooting (Adult supervision recommended)

**ConQuest ent. 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. Car body and jumper wires:** Flip the car body upside down and make sure the wheel mechanisms are clean. Install batteries in the car body and connect jumper wires to the auto rear as shown; two wheels should move. Replace the orange and gray jumper wires with each of the other colors to see if any of the jumpers are damaged. If the wheels don't move for any combination of wires, then the car body is damaged. Remove the gray wire; four LEDs on the side should light. Now move the jumper wires to test the other two wheels, if they don't move then the car body is damaged. Remove the gray wire; four LEDs on the side should light.
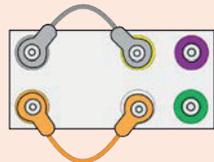
CAR REAR (upside down)
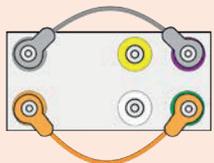
CAR REAR (upside down)

**2. LEDs (D4, D8, & D10) and horn (W1):** With the car body still upside down, connect the white LED (D4) as shown ("+" on left), it should light or it is damaged. Replace D4 with D8 and test it in the same way. Replace D8 with each D10 and test in both directions, D10 should be red or yellow depending on its direction. Replace D10 with W1 ("+" on left), it should make sound.

CAR REAR (upside down)

**3. Snap wires:** With the car body still upside down, connect each of the blue snap wires (including the 1-snaps) between the red/yellow LED (D10) and orange jumper wire as shown, test them one at a time. The LED should light or the snap wire is damaged.
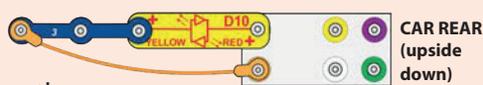
CAR REAR (upside down)

**4. 1kW & 5.1kW. resistors (R2 & R3) and slide switch (S1):** Use the preceding circuit but replace the 3-snap wire with S1, when LED should be on when the switch is on and off when the switch is off. Replace the switch with R3, the LED should light but be dimmer. Replace R3 with each R2 (one at a time), the LED should be slightly brighter than with R3.

**5. NPN transistor (Q2):** Use this mini circuit, the red/yellow LED (D10) should only be on when the switch (S1) is on, or the transistor is broken.

CAR REAR
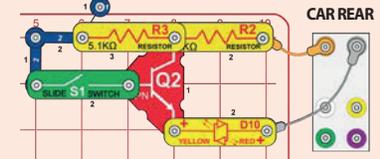
**6. Phototransistor (Q4), adjustable resistor (RV), and phototransistor (Q4):** Use the circuit from project 12 (part A); the LED should be on when there is bright light on Q4, or Q4 is broken. Next, use part C; the lever on RV should be able to make the LED bright and off, or RV is broken. Next, use part D; as you move the lever on RV the LED should change brightness more slowly than in part C, or C4 is broken.

**7. Strobe IC (23) and speaker (SP2):** Use this mini circuit, the LED should be flashing quickly or U23 is broken (the lever on RV is not used here). Place SP2 directly over the LED (on level 3), you should hear a buzzing sound or the SP2 is broken.

CAR REAR
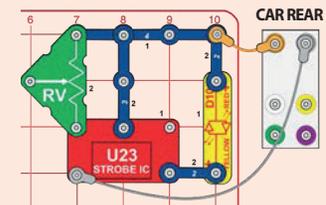
**8. Controller (U33):** Build project 1, the blue (Bluetooth) light on the controller should be blinking when the switch (S1) is turned on. Connect the controller to the App and use the CONTROL - CONTROL PANEL to drive the car around and sound the horn (W1) as described in project 1.

**Boffin app Note:** If you are using previously entered code then you may need to reassign commands to make that code work, as per page 36.

# ADDITIONAL U33 MODULS

## Login to multiple U33s (max 15):

When you click on the bluetooth icon, the app will display all U33s that are within range. Click on Disconnected and the U33 will connect to your app.
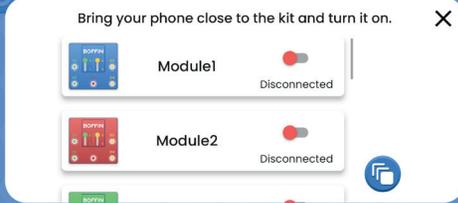


Confirm this step. If you click on Disconnected and there is not another U33 controller in range - nothing happens.
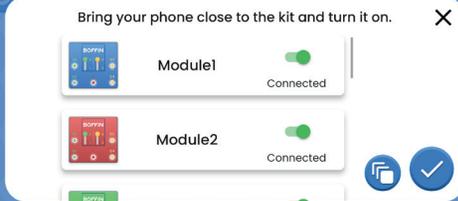


## Login to multiple U33s - different view:





## Change the color of U33:

You can change the colour of individual U33s. Click on the U33 module icon to open a selection bar colors. Confirm your selection with a check mark.



This is what the Control Panel looks like when there are multiple U33s (right icon).



Click on the icon to see all U33s.



## Renaming U33:

You can rename individual U33s. Click on U33 name and the keyboard will open. Confirm the new name.

## CREATE YOUR OWN CHALLENGES

*For Example:*

- Code a route for the car using blocks or cones to make obstacles in your path.
- Code a route to another room of your house and have the car bring a note to your family member.
- Make an obstacle course and time your route. Play with friends and see who has the best time.
- Code the car to "park" under a chair or table.
- Pretend the car is on a mission on the moon – have him code an exploration route, then send a light signal to basecamp.
- Play Simon Says: Have the car mimic someone's route or path.

## NOTES

**Build your own projects and send them to us at info@boffin.cz**

# Electronic kit

**Boffin START 1**

**Boffin START 2**

**Boffin I 100**

**Boffin I 300**

**Boffin I 500**

**Boffin I 750**

**Boffin II Light**

**Boffin II 3D**

**Boffin II Green Energy**

**Boffin III Bricks**

# Components set up

R2 1KΩ RESISTOR
R2 1KΩ RESISTOR
R2 1KΩ RESISTOR
R3 5.1KΩ RESISTOR
SLIDE S1 SWITCH
C 4 100 μF
+ PHOTOTRANSISTOR Q4
+ HORN W1

+ COLOR D8
+ YELLOW RED D10 +
+ YELLOW RED D10 +
Q2 NPN
RV
U23 STROBE IC

U33
+ GND
D1 D3
D2 A D4

+ D4 LED
SP2 SPEAKER
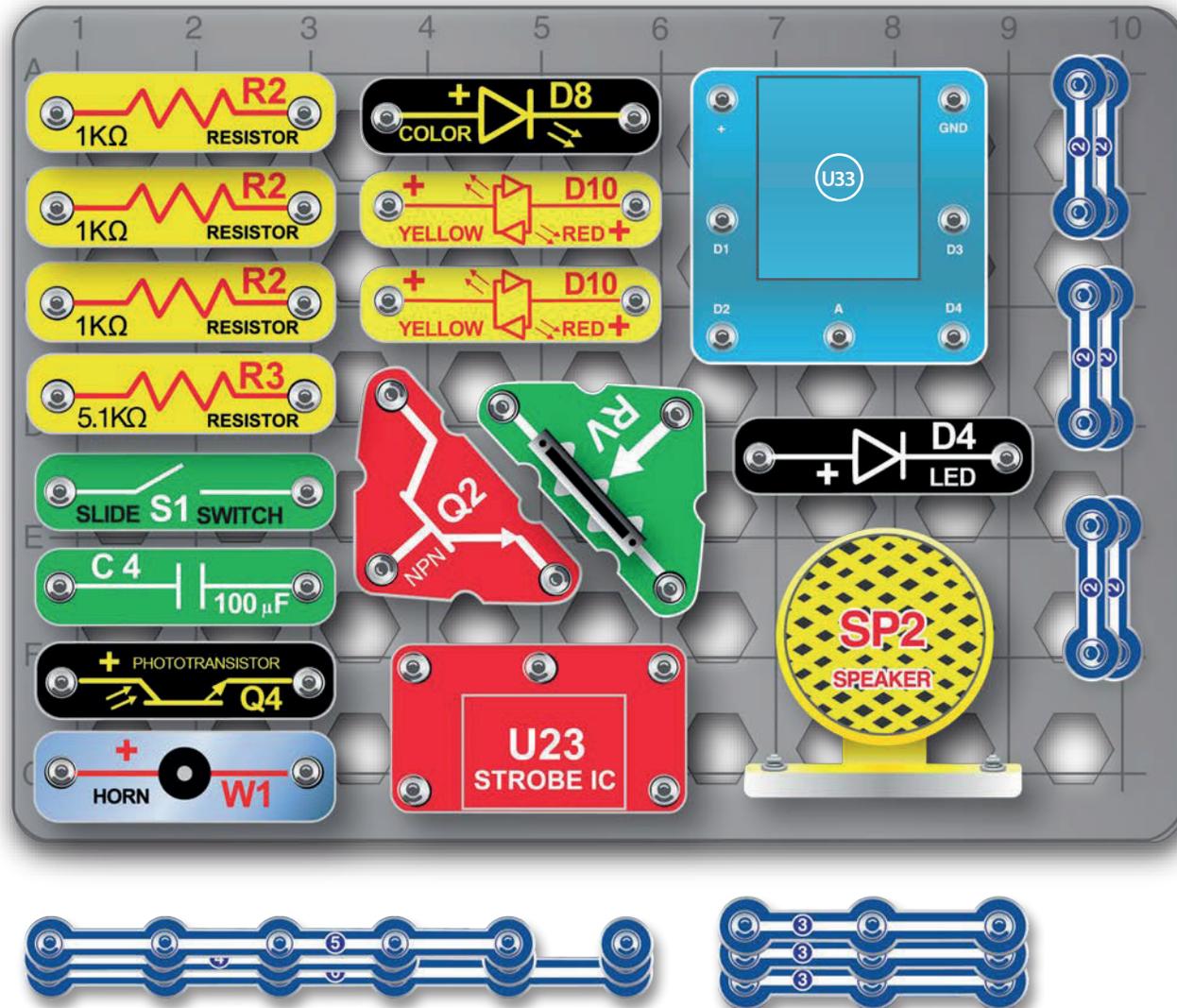
Not responsible for typographical errors. Colors, styles and case quantities are subject to change without notice.