ELECTRONIC SNAP CIRCUITS®

Projects 306-511

AGE
8 - 108

Project 317

SNAP CIRCUITS®

Instruction Manual

ELENCO®

REV-D Revised 2012 753104

Table of Contents

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.

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.

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.**
5. **If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.**

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 4 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 alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new 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.
- Do not connect batteries or battery holders in parallel.

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.

Review of How To Use It (See page 3 of the Projects 1-101 manual for more details.)

The Snap Circuits® kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

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.

A large clear plastic base grid is included with this kit to help keep the circuit block together. The base has rows labeled A-G and columns labeled 1-10.

Install two (2) "AA" batteries (not included) in the battery holder (B1). The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the L1 lamp socket, and the 6V bulb in the L2 lamp socket.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

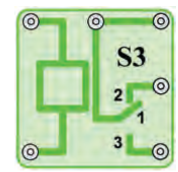
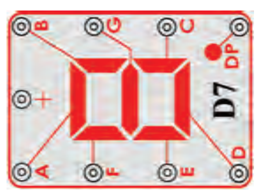
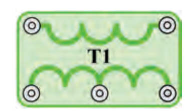
Some circuits use the red and black jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

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.

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

Note: There are additional part lists in your other project manuals. Part designs are subject to change without notice.

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.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 3	2	2-Snap Wire		6SC02	❒ 1	M2	Analog Meter		6SCM2
❒ 1	5	5-Snap Wire		6SC05	❒ 1	Q3	SCR		6SCQ3
❒ 1	D3	Diode 1N4001		6SCD3	❒ 1	S3	Relay		6SCS3
❒ 1	D7	7-Segment LED Display		6SCD7	❒ 1	T1	Transformer		6SCT1
❒ 1	FM	FM Module		6SCFM	❒ 1	U6	Recording Integrated Circuit		6SCU6

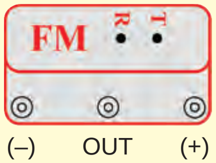
You may order additional / replacement parts at our website: www.snapcircuits.net

MORE About Your New Snap Circuits® Parts (Note: There is additional information in your other project manuals).

Our Student Guides give much more information about your parts, along with a complete lesson in basic electronics. See www.snapcircuits.net/learn.htm or page 62 for more information.

(Part designs are subject to change without notice).

The **FM module (FM)** contains an integrated FM radio circuit. Refer to the figure below for the pinout description.

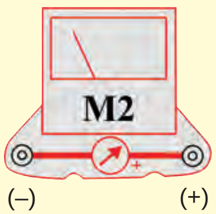


FM Module:

(+) - power from batteries
(–) - power return to batteries
T - tune up
R - reset
OUT - output connection

See project #307 for example of proper connections.

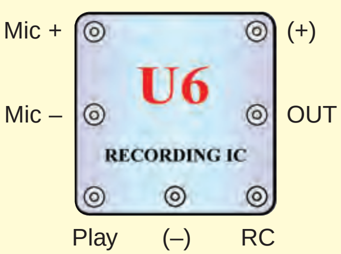
The **meter (M2)** is a very important indicating and measuring device. You'll use it to measure the amount of current or voltage depending on the circuit configuration. Notice the meter has a "+" sign, indicating the positive terminal (+ power from the batteries). The other snap is the negative terminal (– power return to batteries). The meter has a switch to change between scales, indicated as LOW and HIGH (or 10mA and 1A).



Meter:

(+) - power from batteries
(–) - power return to batteries

The **recording IC module (U6)** contains an integrated recording circuit. You can record a message up to five seconds long. There are also three pre-recorded songs. Refer to the figure below for the pinout descriptions.

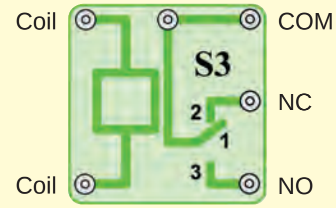


Recording IC Module:

(+) - power from batteries
(–) - power return to batteries
RC - record
Play - play
OUT - output connection
Mic + - microphone input
Mic – - microphone input

See project #308 for example of proper connections.

The **relay (S3)** is an electronic switch with contacts that can be closed or opened. It contains a coil that generates a magnetic field when current flows through it. The magnetic field attracts an iron armature, which switches the contacts (see figure).

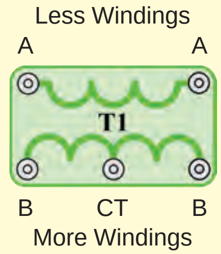


Relay:

Coil - connection to coil
Coil - connection to coil
NC - normally closed contact
NO - normally open contact
COM - Common

See project #341 for example of proper connections.

The **transformer (T1)** consists of two coil windings on one core. One coil is called the Primary (input) and the other the Secondary (output). The purpose of the transformer is to increase the amount of AC voltage applied to the primary. This transformer is a step-up transformer.



Transformer:

A - less windings side
A - less windings side
B - more windings side
B - more windings side
CT - center tap

See project #347 for example of proper connections.

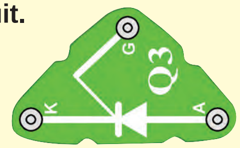
Diode (D3) - Think of a diode as a one-way valve that permits current flow in the direction of the arrow. The anode (arrow) is the positive side, and the cathode (bar) is the negative. The diode conducts or turns on when the voltage at the anode is 0.7V or greater.

Diode:

Anode - (+)
Cathode - (–)

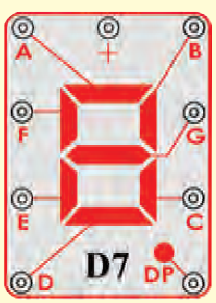
MORE About Your Snap Circuits® Parts (continued)

SCR (Q3) - An SCR is a three-pin (anode, cathode and gate) silicon-controlled rectifier diode. Like a standard diode, it permits current flow in only one direction. It will only conduct in the forward direction when triggered by a short pulse (or steady voltage applied) between the gate and cathode terminals. **A high current may damage this part, so the current must be limited by other components in the circuit.**



SCR:
A - Anode
K - Cathode
G - Gate

The **7-segment display (D7)** is found in many devices today. It contains 7 LED's that have been combined into one case to make a convenient device for displaying numbers and some letters. The display is a common anode version. That means that the positive leg of each LED is connected to a common point which is the snap marked "+". Each LED has a negative leg that is connected to one snap. To make it work you need to connect the "+" snap to positive three volts. Then to make each segment light up, connect the snaps of each LED to ground. In the projects, a resistor is always connected to the "+" snap to limit the current. **A high current may damage this part, so the current must be limited by other components in the circuit.**



7-segment Display:
(+) - power from batteries
A - Segment A
B - Segment B
C - Segment C
D - Segment D
E - Segment E
F - Segment F
G - Segment G
DP - Decimal Point

See project #337 for example of proper connections.

MORE Advanced Troubleshooting (Adult supervision recommended)

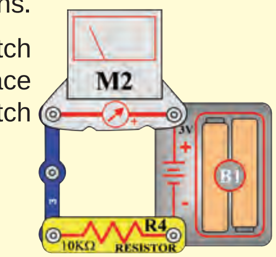
Elenco® is not responsible for parts damaged due to incorrect wiring.

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

1 - 20. Refer to project manuals 1 & 2 (projects #1-101, #102-305) for testing steps 1-20, then continue below.

21. **FM Module (FM):** Build project #307, you should hear FM radio stations.

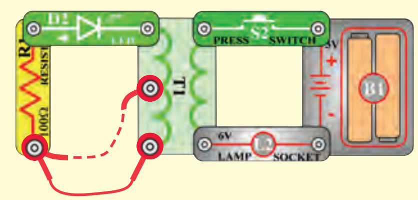
22. **Meter (M2):** Build the mini-circuit shown here and set the meter switch to LOW (or 10mA), the meter (M2) should deflect full scale. Then, replace the 10kΩ resistor (R4) with the 2.5V lamp (L1), and set the meter switch to HIGH (or 1A). The meter should deflect to 1 or higher.



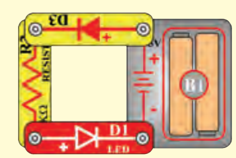
23. **Recording IC (U6):** Build project #308. Make an 8 second recording, then listen to the three prerecorded songs.

24. **Relay (S3):** Build project #341. The red LED (D1) should be on when the slide switch (S1) is on, and the green LED (D2) should be on when the switch is off.

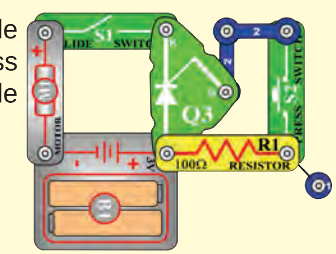
25. **Transformer (T1):** Build the mini-circuit shown here. Pressing the press switch (S2) flashes the green LED (D2). Connect the jumper wire to the CT point. Pressing the press switch flashes the green LED.



26. **Diode (D3):** Build the mini-circuit shown here, the red LED (D1) should light. Reverse the direction of the diode, the LED should not light now.



27. **SCR (Q3):** Build the mini-circuit shown here. Turn on the slide switch (S1) and the motor (M1) should not spin. Press the press switch (S2), the motor should start spinning. Now turn the slide switch off and on, the motor should not spin.



28. **7-Segment Display (D7):** Build project #337. All segments light, displaying the number 8.

MORE DO's 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, lamp, 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 <u>damage components</u> and/or <u>quickly drain your batteries</u>. Only connect the IC's 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 the speaker, lamp, whistle chip, capacitors, IC's (which must be connected properly), motor, microphone, photoresistor, or fixed resistors.

ALWAYS use the **7-segment display**, LED's, transistors, the high frequency IC, the **SCR**, the antenna, and 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 connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.

ALWAYS connect position capacitors so that the "+" side gets the higher voltage.

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.

ALWAYS **connect IC's, the FM module, and the SCR using configurations given in the projects or as per the connection descriptions for the parts.**

NEVER try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).

NEVER use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.

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

NEVER leave a circuit unattended when it is turned on.

NEVER touch the motor when it is spinning at high speed.

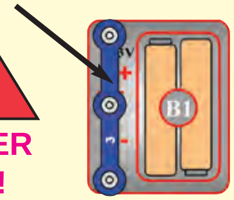
Note: If you have the more advanced Model SC-750, there are additional guidelines in your other project manual.

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.

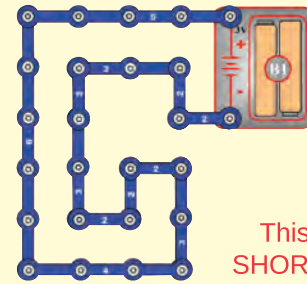
Warning to Snap Rover owners: Do not connect your parts to the Rover body except when using our approved circuits, the Rover body has a higher voltage which could damage your parts.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

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



NEVER DO!

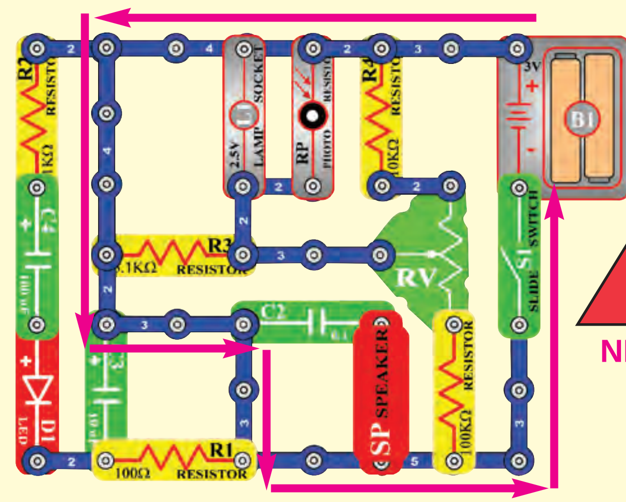


NEVER DO!

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!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.snapcircuits.net/kidkreations.htm**. Send your suggestions to Elenco®.

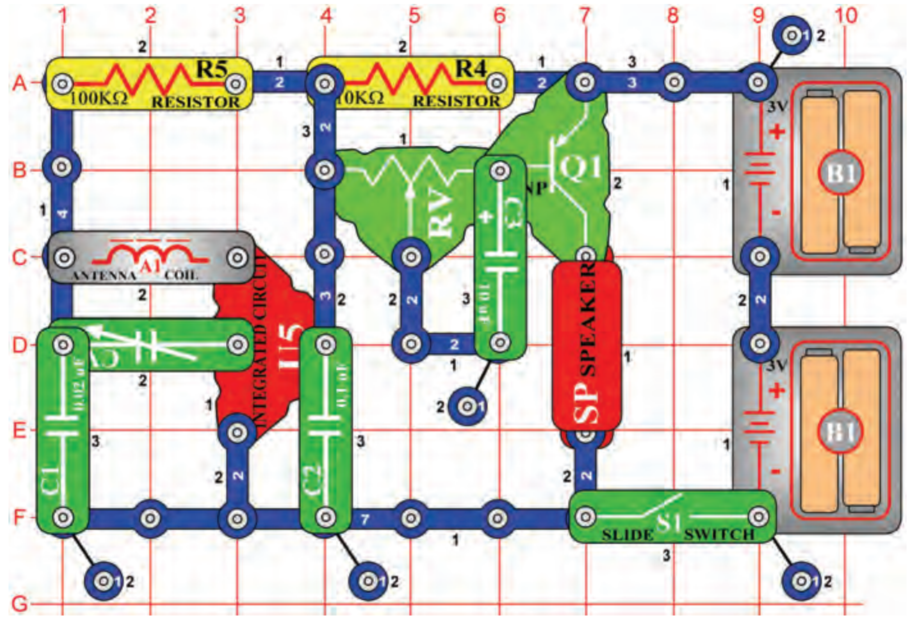
Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.snapcircuits.net/SnapDesigner.doc** or through the **www.snapcircuits.net** web site.

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

Project Listings

Project Listings

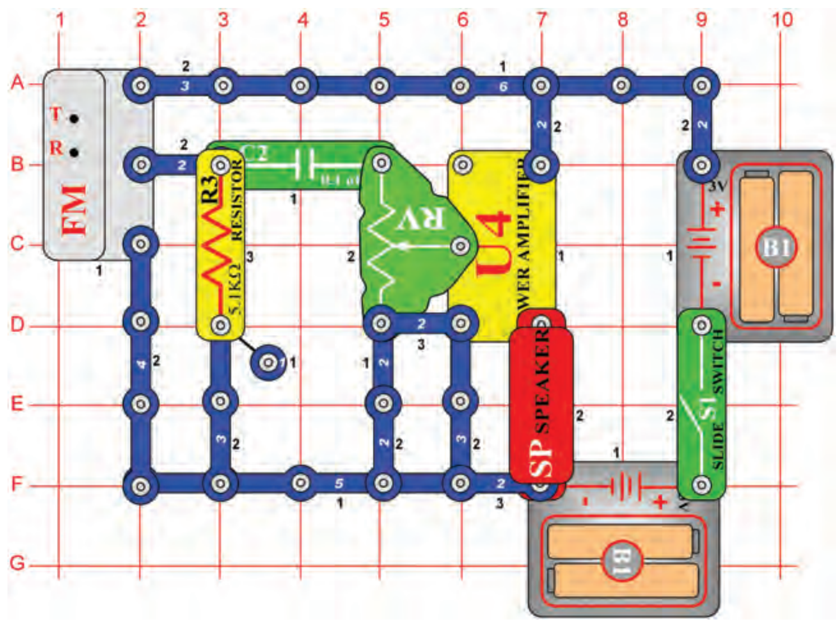
Project #306 AM Radio



OBJECTIVE: To build a one-IC AM radio.

Turn on the slide switch (S1) and adjust the variable capacitor (CV) for a radio station. Make sure you set the variable resistor (RV) control to the left for louder sound.

Project #307 Adjustable Volume FM Radio

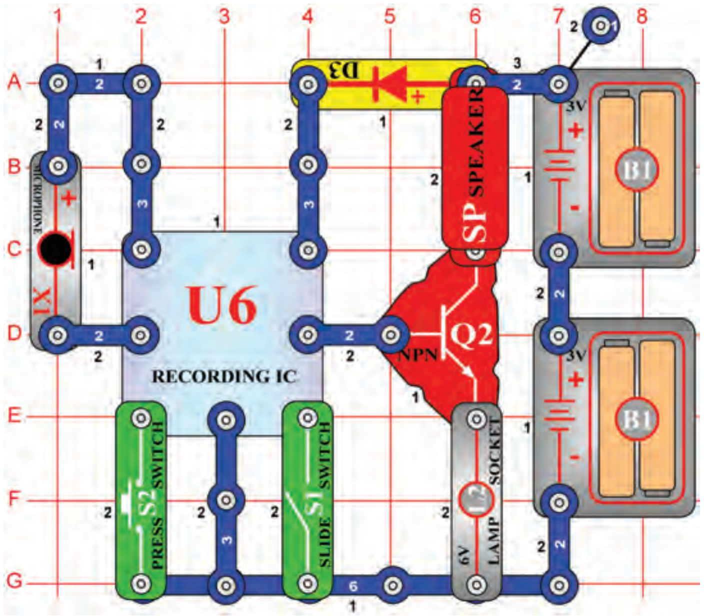


OBJECTIVE: To build a working FM radio with adjustable volume.

Turn on the slide switch (S1) and press the R button. Now press the T button and FM module (FM) scans for a radio station. When a station is found, it locks on to it and you hear it on the speaker (SP). Adjust the volume using the adjustable resistor (RV). The resistor controls the amount of signal into the power amplifier IC (U4). Press the T button again for the next radio station. The module will scan up to 108MHz, the end of the FM band, and stop. You must then press reset (R) to start at 88MHz again.

Project #308 Playback & Record

OBJECTIVE: To demonstrate the capabilities of the recording integrated circuit.



Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs. The lamp (L2) is used to limit current and will not light.

Project #309 Playing Music

OBJECTIVE: To play the three built-in songs on the recording IC.

Use the circuit in project #308. Turn on the slide switch (S1), then press the press switch (S2) to start the first song. When the music stops, press the press switch again to hear the second song. When the second song stops, press the press switch again, the third song plays.

Project #310 Light-Controlled Music

OBJECTIVE: To build a circuit that uses light to control the recording IC.

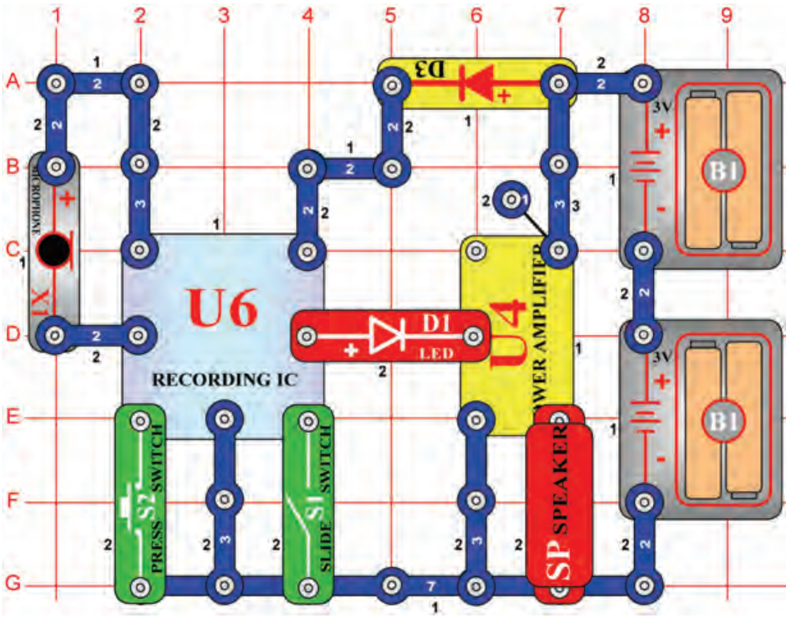
Use the circuit in project #308. Replace the press switch (S2) with the photoresistor (RP), then turn on the slide switch (S1). Turn the music on and off by waving your hand over photoresistor.

Project #311 Touch-Controlled Music

OBJECTIVE: To build a circuit that lets you control the recording IC with your fingers.

Use the circuit in project #308. Place a single snap on base grid point F1. Replace the press switch (S2) with the PNP transistor (Q1, with the arrow on point E2) and then turn on the slide switch (S1). Turn the music on and off by touching points F1 & G2 at the same time. You may need to wet your fingers.

Project #312



Power Playback & Record

OBJECTIVE: To build a circuit that amplifies the recording IC.

Connecting the power amplifier IC (U4) to the output of the recording IC (U6), you can make much louder music than project #308.

Turn on the switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone up to 5 seconds, and then turn open the switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press switch (S2) before the song is over, music will stop. You may press the press switch several times to play all three songs.

Project #313

Power Amplified Playing Music

OBJECTIVE: To amplify the output of the recording IC.

Use the circuit in project #312. Turn on the switch (S1), then press the press switch (S2) to start the first song. When the music stops, press the press switch again to hear the second song. When the second song stops, press the press switch again, the third song plays.

Project #314

Power Light-Controlled Music

OBJECTIVE: Show variations of project #312.

Use the circuit in project #312. Replace the press switch (S2) with the photoresistor (RP), then turn on the switch (S1). Turn the music on and off by waving your hand over photoresistor.

Project #315

Power Touch-Controlled Music

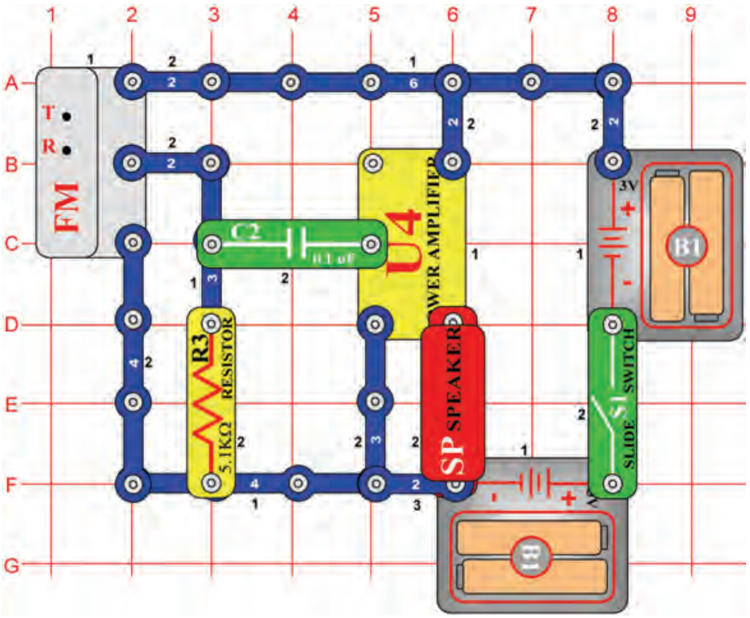
OBJECTIVE: Show variations of project #312.

Use the circuit in project #312. Place a single snap on base grid point F1. Replace the press switch (S2) with the PNP transistor (Q1, with the arrow on point E2) and then turn on the slide switch (S1). Turn the music on and off by touching points F1 & G2 at the same time. You may need to wet your fingers.

Project #316

FM Radio

OBJECTIVE: To build a working FM radio.



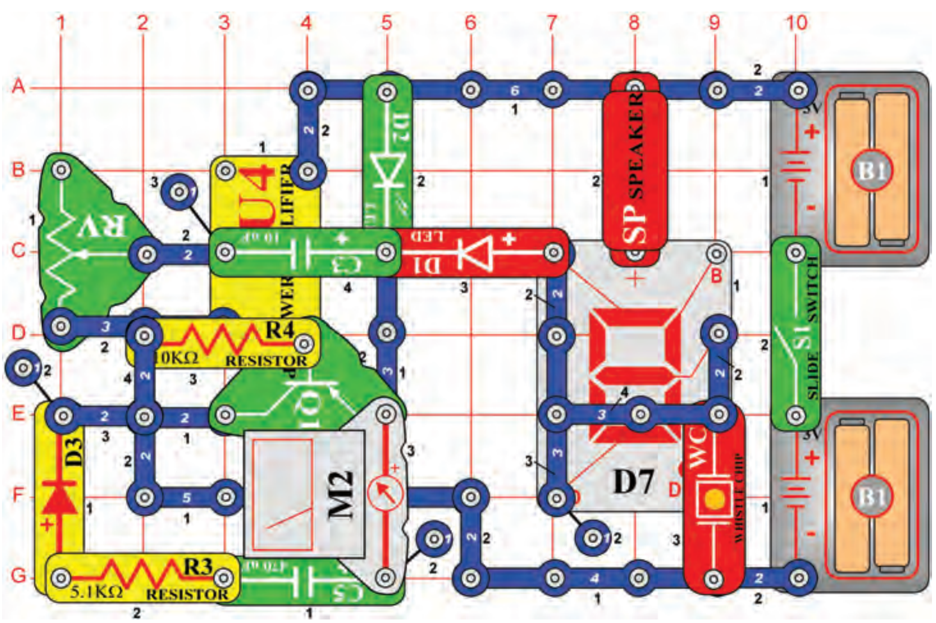
The FM module (FM) contains a scan (T) and a reset (R) button. The R button resets the frequency to 88MHz. This is the beginning of the FM range. Press the T button, the module scans for the next available radio station.

Turn on the slide switch (S1) and press the R button. Now press the T button and the FM module scans for an available radio station. When a station is found, it locks on to it and you hear it on the speaker. Press the T button again for the next radio station. The module will scan up to 108MHz, the end of the FM band, and stop. You must then press the reset (R) button to start at 88MHz again.

Project #317

Mega Circuit

OBJECTIVE: To build a complex circuit.



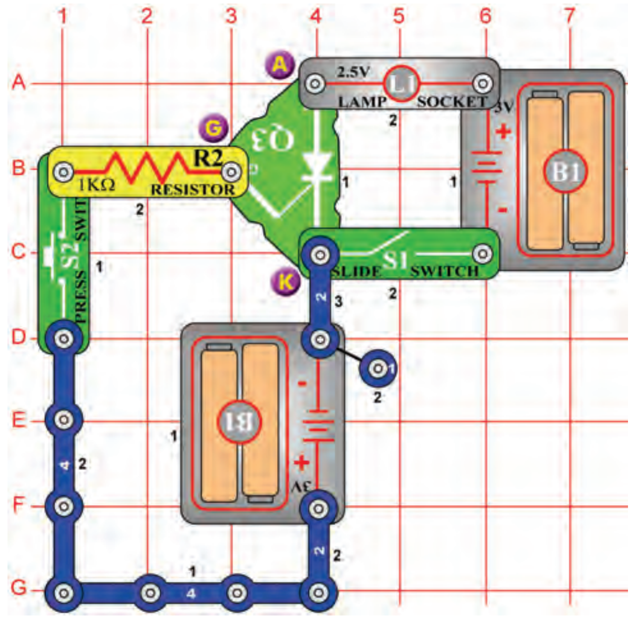
Note that there is a 3-snap wire between RV and U4, partially hidden under R4.

This is an example of using many parts to create an unusual circuit. Set the meter (M2) to the LOW (or 10mA) scale. Turn on the slide switch (S1). As the circuit oscillates, the 7-segment display (D7) flashes the number 5 and the LED's (D1 & D2) flash as well. The meter deflects back and forth and the speaker (SP) sounds a low tone at the same rate. The frequency of the circuit can be changed by adjusting the adjustable resistor (RV).

Next, place the 100Ω resistor (R1) directly over the diode (D3) using a 1-snap. See how this changes the circuit performance.

Project #318 SCR 2.5V Bulb

OBJECTIVE: To learn the principle of an SCR.

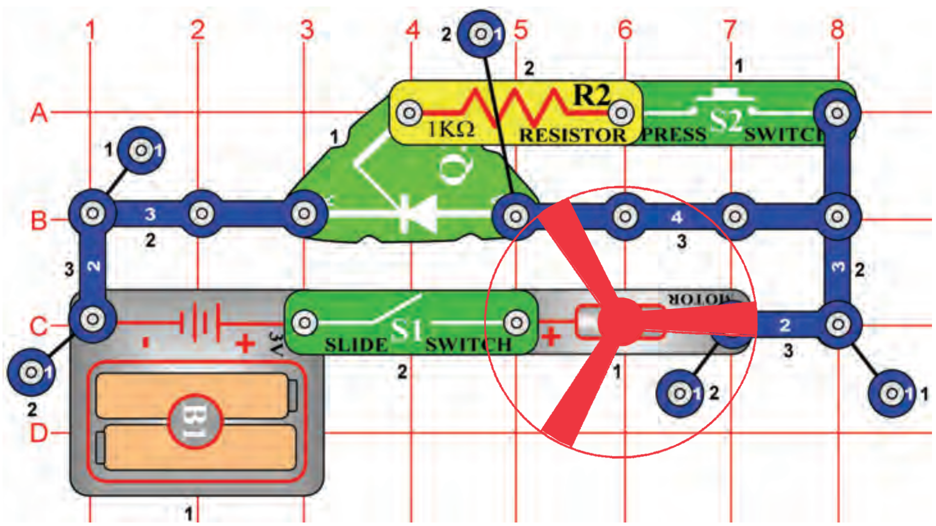


This circuit demonstrates the principle of the SCR (Q3). The SCR can be thought of as an electronic switch with three leads: anode, cathode, and gate. Like a standard diode, it permits current flow in only one direction. It will only conduct in the forward direction when triggered by a short pulse or steady voltage applied between the gate and cathode terminals. One set of batteries powers the lamp, the other is used to trigger the SCR.

Turn on the slide switch (S1) and the bulb (L1) should not light. Now press the press switch (S2); the SCR turns on and lights the bulb. To turn off the bulb you must turn off the slide switch (S1).

Project #319 SCR & Motor

OBJECTIVE: To activate a motor using an SCR.

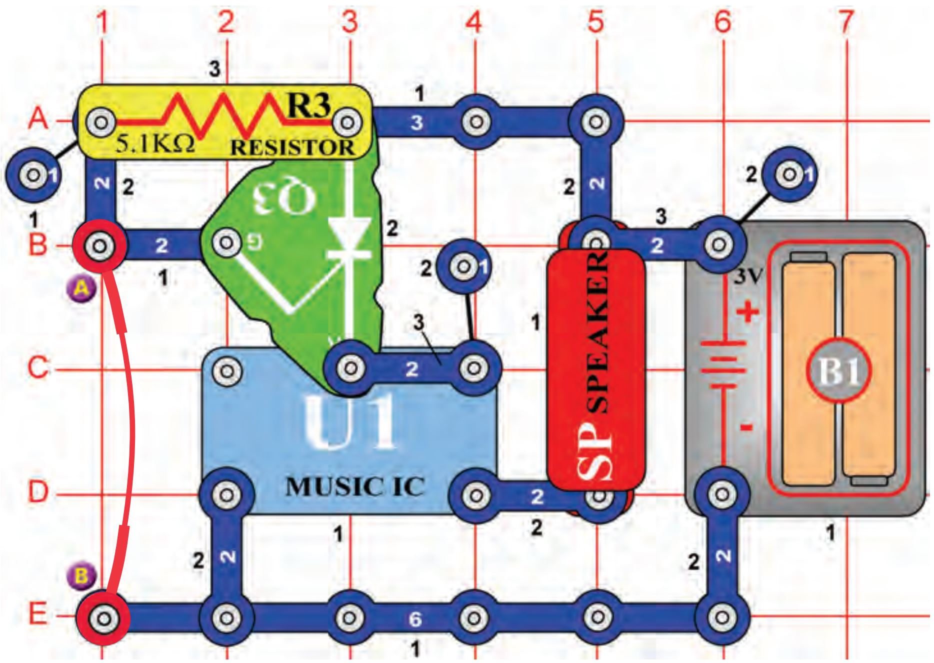


Place the fan onto the motor (M1). In this circuit, the gate is connected to the battery (B1) through the 1KΩ resistor (R2). When the slide switch (S1) is turned on, it triggers the gate, the SCR (Q3) conducts, and the motor spins. The motor continues to spin until the switch is turned off.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #320 Music Alarm

OBJECTIVE: To build a music alarm.



The alarm circuit activates when you remove the jumper wire from points A & B. The jumper wire shorts the SCR's (Q3) gate to ground and the SCR does not conduct. Removing the jumper wire places a voltage on the gate and the SCR conducts. This connects the battery to the music IC (U1) and music is played.

Construct the circuit and you should hear no music. Now remove the jumper wire and the music starts playing.

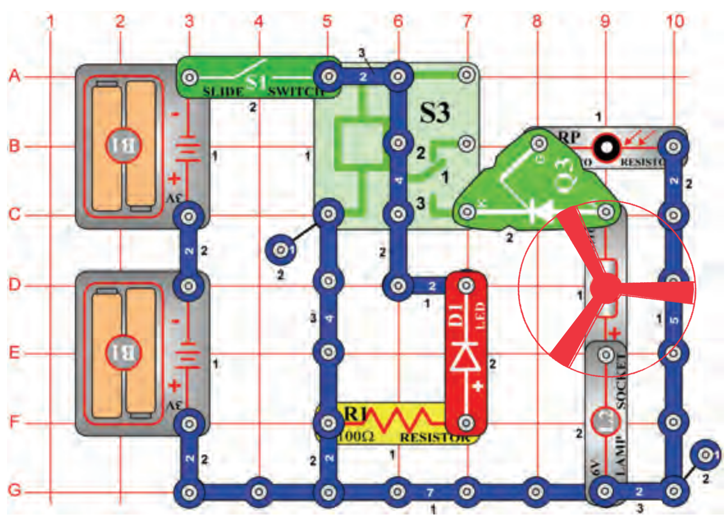
Project #321 Light-Music Alarm

OBJECTIVE: To build a light-music alarm.

Use the circuit in project #320. Replace the resistor R3 with the photoresistor (RP) and remove the jumper wire. Cover the photoresistor with your hand. Now slowly remove your hand. When enough light hits the resistor, the music plays.

Project #322 Light-controlled SCR

OBJECTIVE: To build a circuit that activates a bulb and motor with the amount of light present.



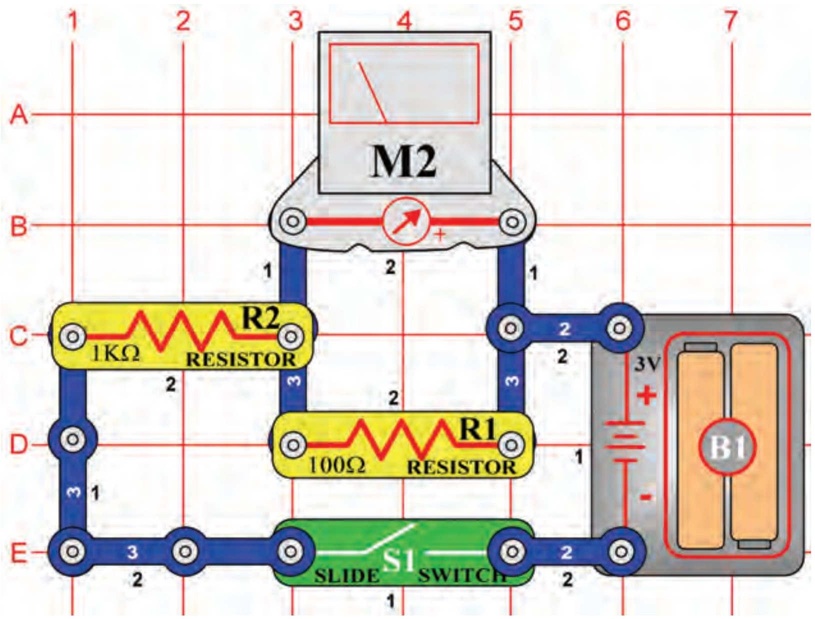
Cover the photoresistor (RP) with your finger. Turn on the switch (S1), and only the LED (D1) lights. The relay (S3) connects the motor (M1) and the bulb (L2) to the batteries, but the motor and bulb are powerless until a voltage is applied to the SCR's gate.

Remove your finger, as light hits the photoresistor, its resistance decreases and a voltage appears on the gate of the SCR (Q3). The SCR conducts and the motor and bulb work now.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #323 — 3mA Meter

OBJECTIVE: To build a 3mA meter circuit.

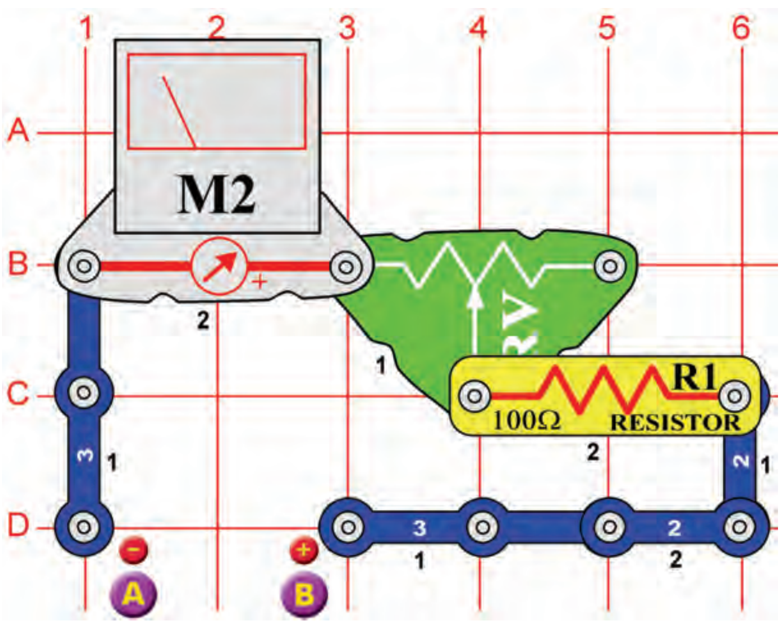


Set the meter (M2) to the LOW (or 10mA) scale. Inside the meter, there is a fixed magnet and a moveable coil around it. As current flows through the coil, it creates a magnetic field. The interaction of the two magnetic fields cause the coil (connected to the pointer) to move (deflect). By itself, the meter can measure 300μA. To increase its range, resistors are connected in parallel or in series to the meter.

Build the circuit shown. Placing the 100Ω resistor (R1) in parallel with the meter increases the range by 10 times to 3mA. More current flows through the resistor than the meter. The lower the resistor value, the wider the range of the meter.

Project #324 — 0-3V Voltmeter

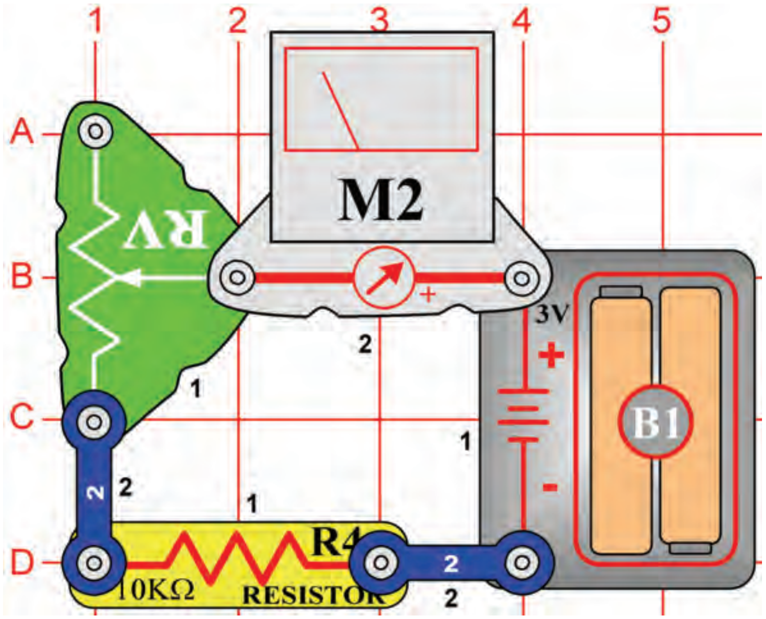
OBJECTIVE: To build a voltmeter.



Build this 0-3V voltmeter circuit. Set the meter (M2) to the LOW (or 10mA) setting. Using new batteries, place the battery holder between points A & B. Adjust the adjustable resistor (RV) so the meter deflects full scale.

Now you can check your other "AA" batteries by inserting them into the battery holder.

Project #325



Function of Adjustable Resistor

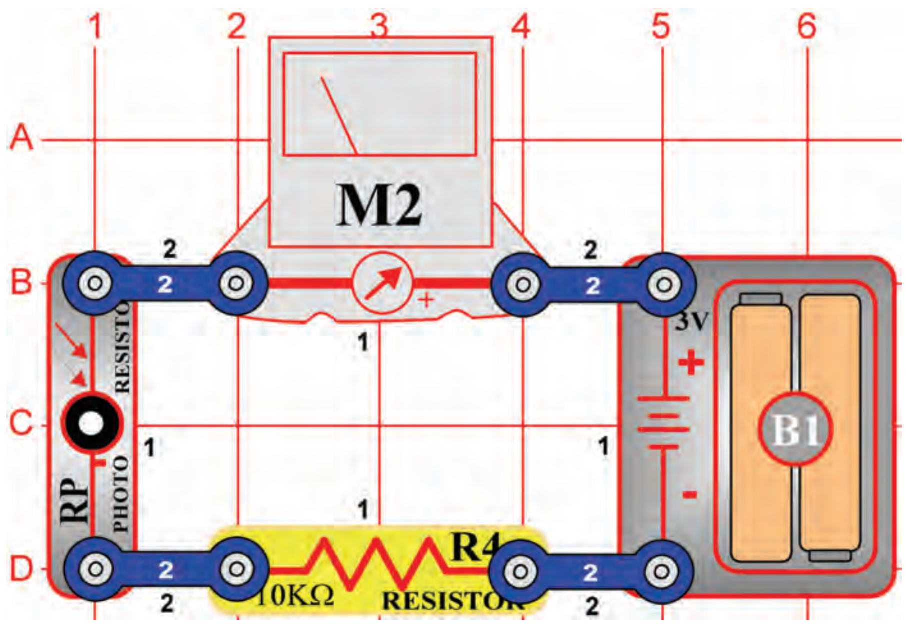
OBJECTIVE: To understand the function of the adjustable resistor.

An adjustable resistor is a normal resistor with an additional arm contact. The arm moves along the resistive material and taps off the desired resistance.

The slider on the adjustable resistor moves the arm contact and sets the resistance between the bottom (point C1) pin and the center pin (point B2). The remaining resistance is between the center and top pin. For example, when the slider is all the way down, there is minimal resistance between the bottom and center pins (usually 0Ω) and maximum resistance between the center and top pins. The resistance between the top (point A1) and bottom (point A3) pins will always be the total resistance, (50kΩ for your part).

Set the meter (M2) to the LOW (or 10mA) scale. Adjust the adjustable resistor (RV) for maximum resistance by setting the slider to the top. The meter only deflects part of the way. As you move the slider down, decreasing the resistance, the meter deflects more.

Project #326



Function of photoresistor

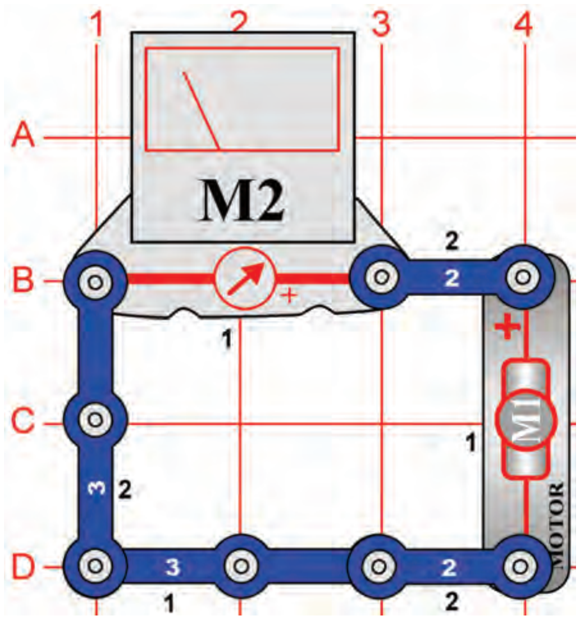
OBJECTIVE: To understand the function of the photoresistor.

Build the circuit shown. Set the meter (M2) to the LOW (or 10mA) scale. The photoresistor (RP) is a light-sensitive resistor. Its value changes from nearly infinite in total darkness to about 1,000Ω when a bright light shines on it.

The meter reading changes as the resistance changes in the circuit. When the lights are on, the meter points to a higher number on the scale. When the lights are OFF, the pointer will point to a lower number on the scale. This means that the resistance of the photoresistor is changing according to the amount of light in the room.

Project #327

Meter Deflect by Motor

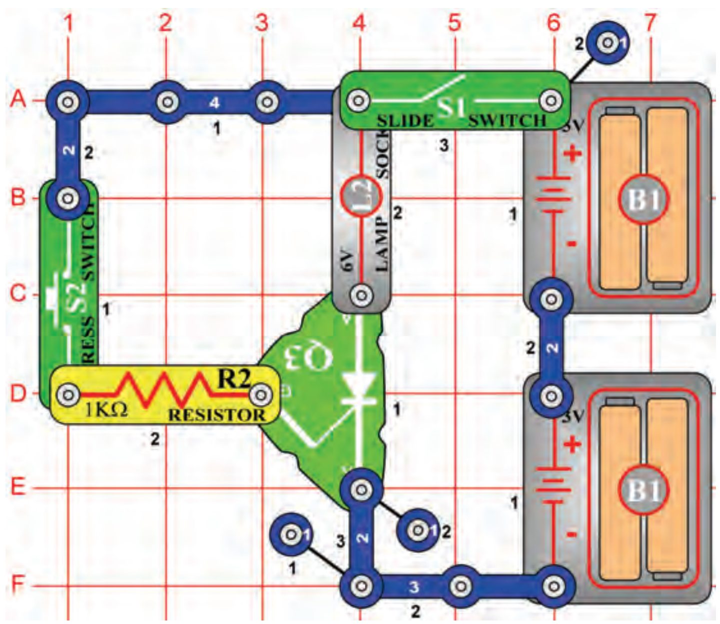


OBJECTIVE: To change the direction of current flow using a motor.

Set the meter (M2) to the LOW (or 10mA) setting. A motor generates a current when it rotates. The rotation of the motor determines the direction current flows. Quickly spin the motor (M1) clockwise with your hand; the meter deflects to the right. Now spin the motor counterclockwise, and the meter deflects to the left.

Project #328

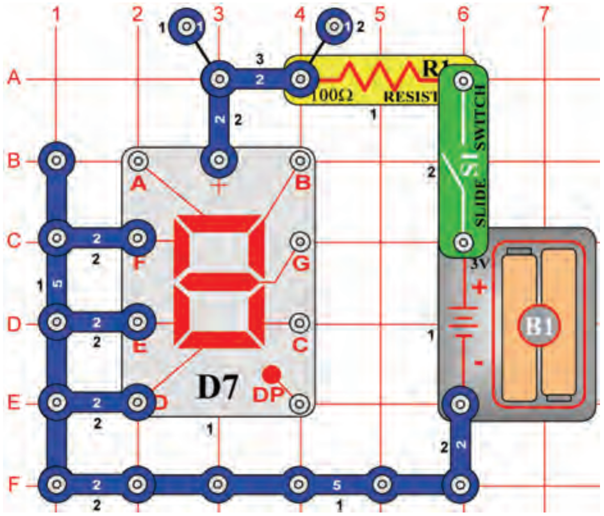
SCR 6V Bulb



OBJECTIVE: To learn the principle of an SCR.

In this circuit, the 6-volt bulb (L2) will not light until the SCR (Q3) is triggered. Turn on the slide switch (S1) and the bulb will not light. Now press the press switch (S2) to light the bulb. The bulb will stay lit until the slide switch is turned off. To protect the SCR, a current limiting 1kΩ resistor (R2) is placed in series with the gate.

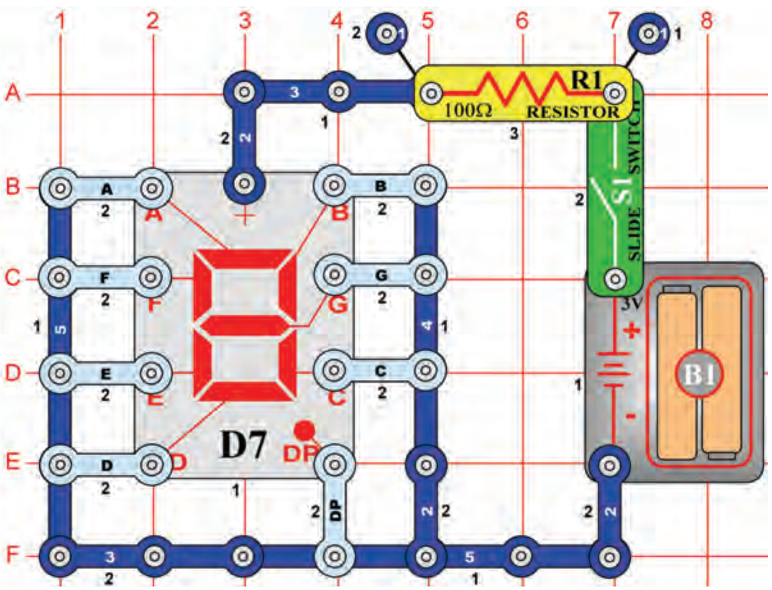
Project #329



Principle of Segment LED

OBJECTIVE: To demonstrate how a seven segment LED works.

The display (D7) is made up of seven segments. Each segment contains an LED connected to an input snap. When the snap is connected to the negative of the battery the segment lights. For example, connect the circuit as shown and the letter "L" lights.



Project #330

Display #1

OBJECTIVE: To configure the seven segment to display the number 1.

Connect B & C to the negative of the battery.

Project #331

Display #2

OBJECTIVE: To configure the seven segment to display the number 2.

Connect A, B, G, E, & D to the negative of the battery.

Project #332

Display #3

OBJECTIVE: To configure the seven segment to display the number 3.

Connect A, B, G, C, & D to the negative of the battery.

Project #333

Display #4

OBJECTIVE: To configure the seven segment to display the number 4.

Connect B, C, F, & G to the negative of the battery.

Project #334

Display #5

OBJECTIVE: *To configure the seven segment to display the number 5.*

Connect A, F, G, C, & D to the negative of the battery.

Project #335

Display #6

OBJECTIVE: *To configure the seven segment to display the number 6.*

Connect A, C, D, E, F, & G to the negative of the battery.

Project #336

Display #7

OBJECTIVE: *To configure the seven segment to display the number 7.*

Connect A, B, & C to the negative of the battery.

Project #337

Display #8

OBJECTIVE: *To configure the seven segment to display the number 8.*

Connect A, B, C, D, E, F & G to the negative of the battery.

Project #338

Display #9

OBJECTIVE: *To configure the seven segment to display the number 9.*

Connect A, B, C, D, F, & G to the negative of the battery.

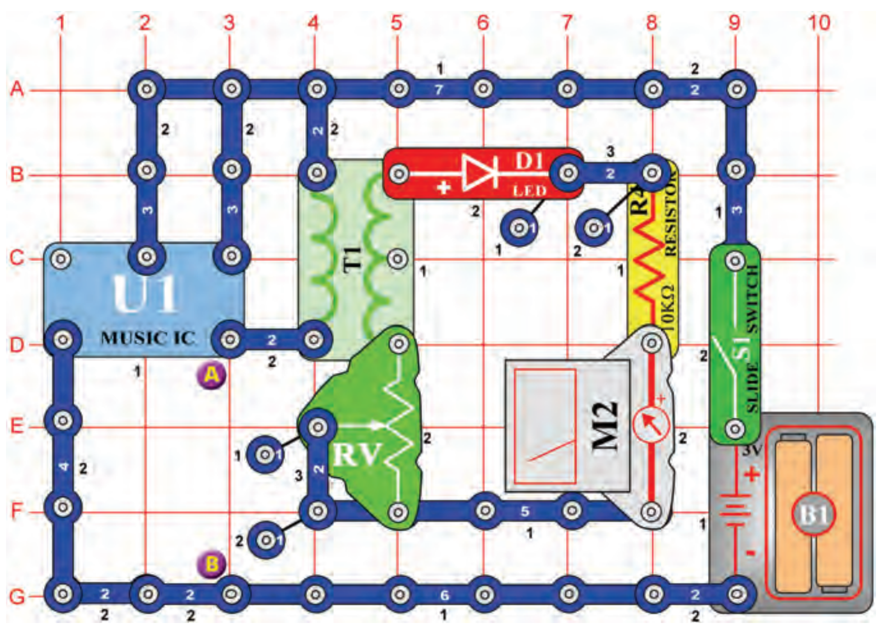
Project #339

Display #0

OBJECTIVE: *To configure the seven segment to display the number 0.*

Connect A, B, C, D, E, & F to the negative of the battery.

Project #340 Music Meter

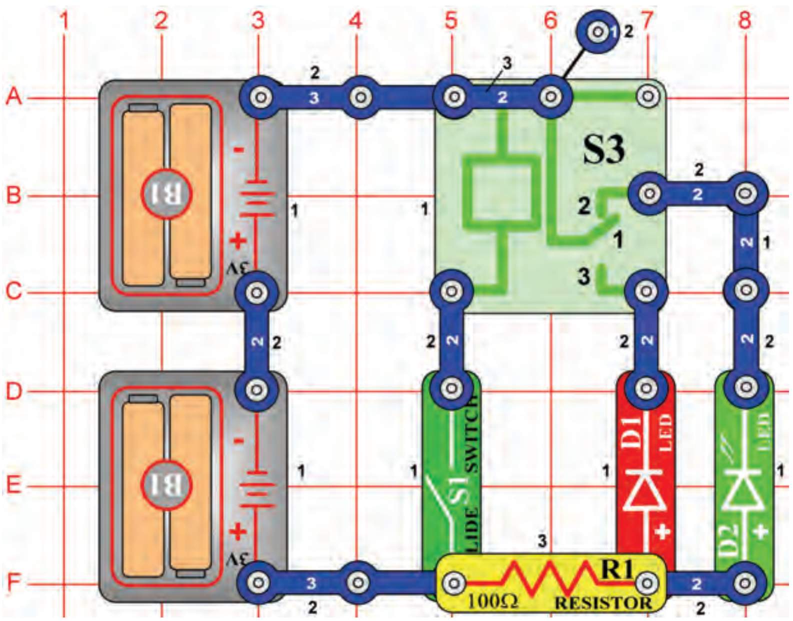


OBJECTIVE: *See and hear the output of the music IC.*

Set the meter (M2) to the LOW (or 10mA) setting. In this circuit, the output of the music IC (U1) is applied to the less windings side of the transformer (T1), which lights the LED (D1) and deflects the meter.

Place the adjustable resistor (RV) to the bottom position and turn on the switch (S1). Adjust the adjustable resistor upwards. This increases the voltage across the LED and meter. The LED brightens and the meter deflects more towards 10. Place the speaker (SP) across points A & B and use a jumper wire to complete the connection. Now you can hear and see the output of the music IC.

Project #341



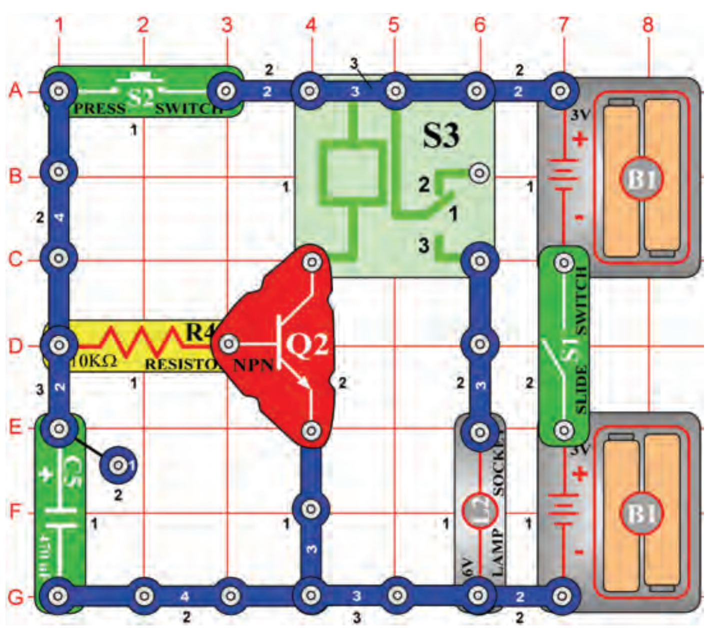
LED & Relay

OBJECTIVE: Turn on and off LED's using a relay.

A relay is an electronic switch with contacts that are opened or closed using voltage. It contains a coil that generates a magnetic field when a current flows through it. The magnetic field attracts an iron armature which switches the contacts. Contact #2 is normally closed, connecting the green LED (D2) and the resistor across the batteries.

With the slide slide switch (S1) turned off, the green LED should light. Now turn on the switch, contact #1 on the relay (S3) will switch to contact #3, lighting the red LED (D1).

Project #342



Manual 7 Second Timer

OBJECTIVE: To build a manual timer using a relay.

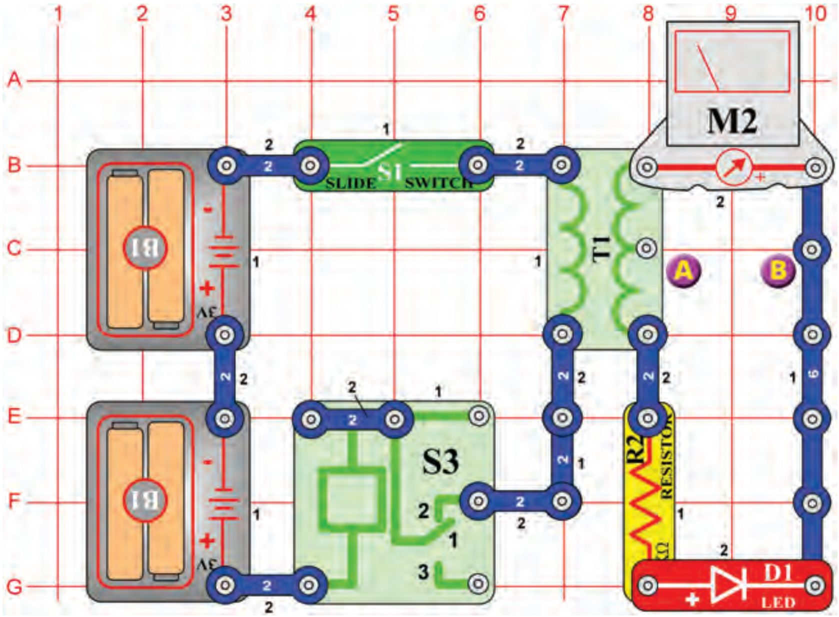
The transistor (Q2) acts as a switch, connecting the relay (S3) to the batteries. As long as there is positive voltage on the transistor's base, the bulb (L2) will light.

Turn on the slide switch (S1) and hold down the press switch (S2). The transistor turns on, capacitor C5 charges up, and the bulb lights. When the press switch is released, the capacitor discharges through the base, keeping the transistor on. The transistor will turn off when the capacitor is almost discharged, about 7 seconds. The relay contacts will switch and the bulb will turn off.

Change the value of the capacitor and see what happens.

☐ Project #343

Half Wave Rectifier Circuit



OBJECTIVE: To build a half wave rectifier circuit.

A rectifier changes an AC voltage into a DC voltage. A diode (D1) is used because it allows current to flow in only one direction, for one polarity of applied voltage. As the contacts open and close, it generates an AC voltage across the transformer (T1). We can measure the DC current from the transformer's output using a resistor (R2), a diode (D1), and a meter (M2). Set the meter to the LOW (or 10mA) scale. Turn on the slide switch (S1), the LED lights as the meter points past the 5 scale.

☐ Project #344

Half Wave Rectifier Circuit (II)

OBJECTIVE: Measure the voltage using the center-tap.

Use the circuit in project #343. Now see what happens if you connect to the center-tap on the side with more windings. Place the meter (M2) across points A & B, then turn on the switch (S1). The needle should deflect less, about half as much as project #343. As you use less windings, the output decreases.

☐ Project #345

LED vs. Diode

OBJECTIVE: To see the voltage difference between an LED and diode.

Use the circuit in project #343. Replace the LED (D1) with the diode (D3) and turn on the switch (S1). The needle deflects higher, because the voltage drop across the diode is less than the voltage drop across the LED.

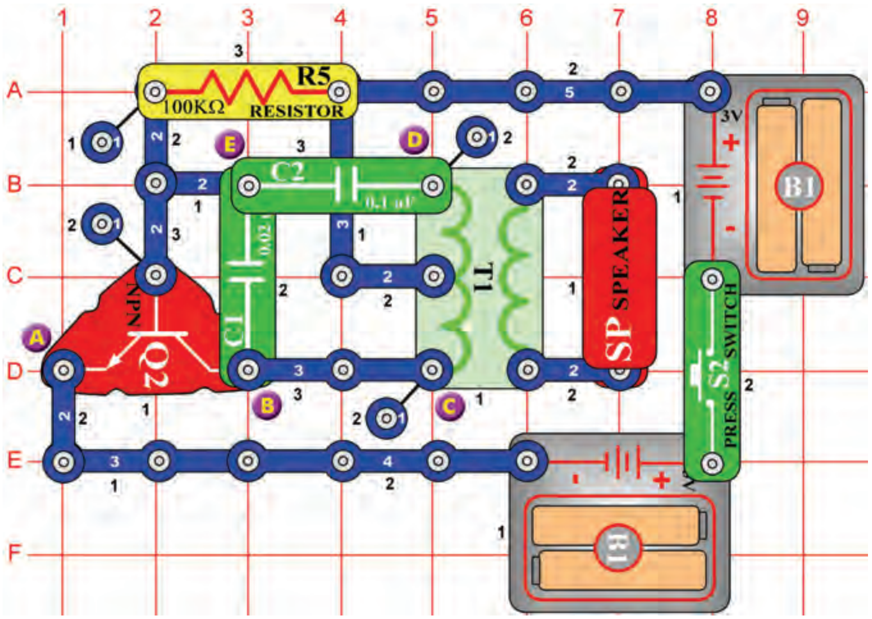
☐ Project #346

Current & Resistance

OBJECTIVE: See how resistance affects current.

Change the 1kΩ (R2) resistor to a 5.1kΩ (R3) and turn on the switch (S1). You will see that increasing the resistance decreases the current through the meter (M2).

Project #347 Telegraph



OBJECTIVE: Making telegraph sounds.

Press the press switch (S2) down. The circuit oscillates and the AC voltage generated from the transformer (T1) drives the speaker (SP). To make a telegraph sound, depress the switch for long and short periods.

Project #348 Mosquito Sound

OBJECTIVE: Use the whistle chip to make a mosquito sound.

Use the circuit in project #347. Remove the speaker (SP). Connect the whistle chip (WC) across points C & D to make a mosquito sound.

Project #349 Mosquito Sound (II)

OBJECTIVE: Show variations of project #347.

Use the circuit in project #347. Connect the whistle chip (WC) across points B & E.

Project #350 Mosquito Sound (III)

OBJECTIVE: Show variations of project #347.

Use the circuit in project #347. Connect the whistle chip (WC) across points E & D (place it beneath capacitor (C2) or use the jumper wires).

Project #351 Touch-Control Mosquito Sound

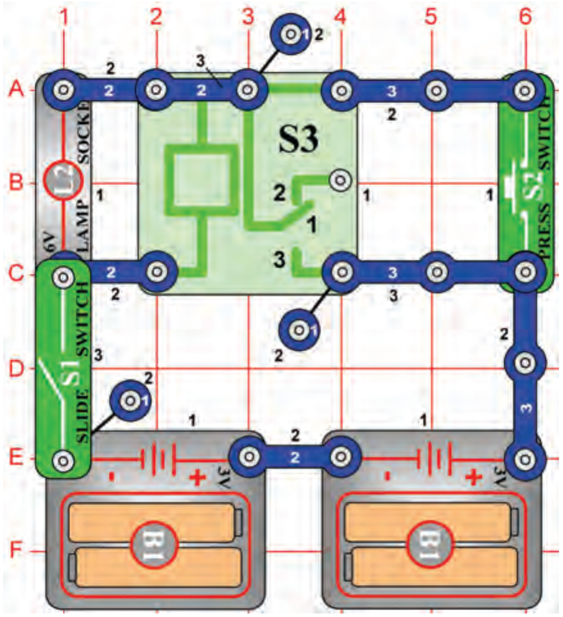
OBJECTIVE: To use the photoresistor to adjust the oscillator sound.

Use the circuit in project #347. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes.

To learn more about how circuits work, visit www.snapcircuits.net or page 62 to find out about our Student Guides.

Project #352 — Bulb & Relay

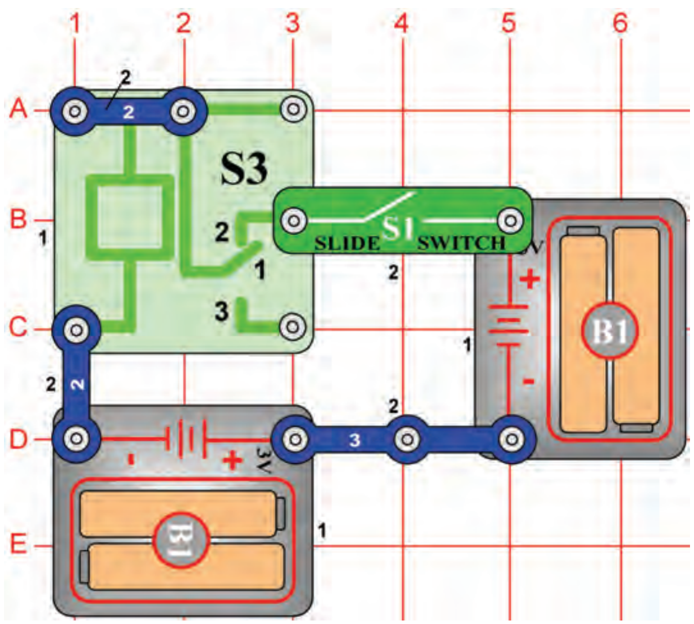
OBJECTIVE: Light a bulb using a relay.



Turn off the slide switch (S1). If you press switch (S2), the lamp (L2) will not light. Turn on the slide switch and press the press switch again; the lamp lights and stays on until the slide switch is turned off. This circuit remembers that the press switch was pressed. Turn the slide switch off and back on again. The lamp will be off until the press switch is pressed, then the lamp will stay on. Computers use memory circuits to remember states like on and off.

Project #353 — Relay Buzzer

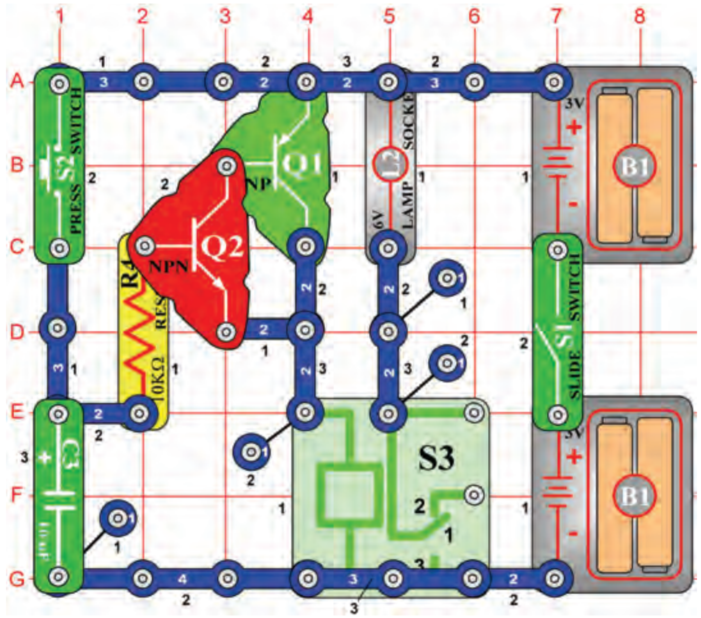
OBJECTIVE: To make a relay buzzer.



When you turn on the switch (S1), you should hear a buzzing sound from the relay (S3). The sound is caused by the relay's contacts opening and closing at a fast rate.

Project #354 Transistor Timer

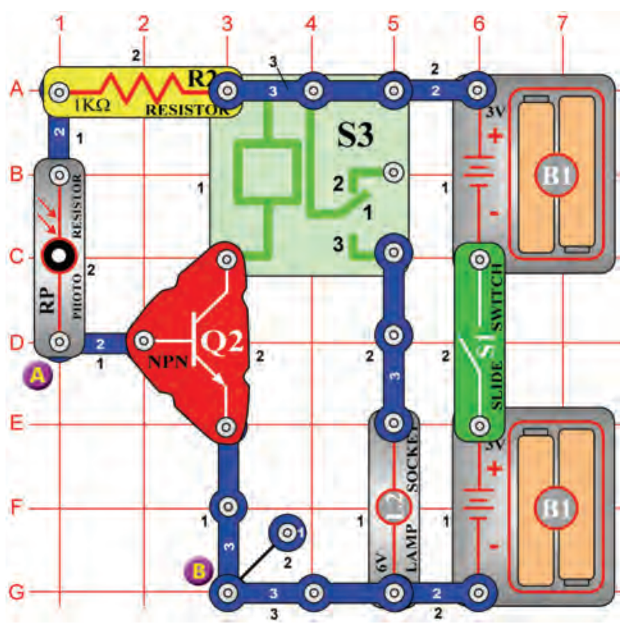
OBJECTIVE: To build a manual timer using a transistor in place of the relay.



This circuit is similar to project #342 except now two transistors are used. Turn on the slide switch (S1) and hold down the press switch (S2). The transistors (Q1 & Q2) turn on, the capacitor (C3) charges up, and the bulb (L2) lights. When the press switch (S2) is released, the capacitor discharges through the base, keeping the transistors on. The transistors will turn off when the capacitor is almost discharged (about 1 minute). The relay (S3) contacts will switch and the bulb will turn off.

Project #355 Light-controlled Relay

OBJECTIVE: To use a photoresistor to control a relay.



Under normal light, the resistance of the photoresistor (RP) is low, allowing a voltage at the base of the transistor (Q2). This turns the transistor on, connecting the relay (S3) across the batteries, and the bulb (L2) lights. If the light decreases, the resistance increases and the voltage to Q2 drops. If the voltage at Q2 decreases enough, the transistor turns off.

Turn on the slide switch (S1) and the bulb lights. Now as you block the light from the photoresistor, the bulb turns off.

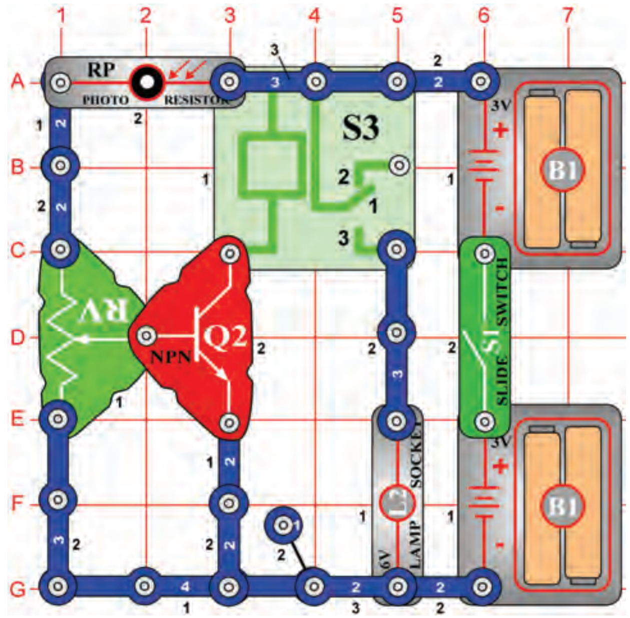
Project #356 Bulb Alert Relay

OBJECTIVE: Make a warning system that lights the bulb.

Replace the photoresistor (RP) with a 10kΩ resistor (R4). Connect the wire to points A & B. As long as the wire is connected, the transistor (Q2) is off and the relay (S3) and bulb (L2) are not powered. Disconnect the wire. The relay contacts will switch and the bulb will light.

Project #357

Adjustable Light Control

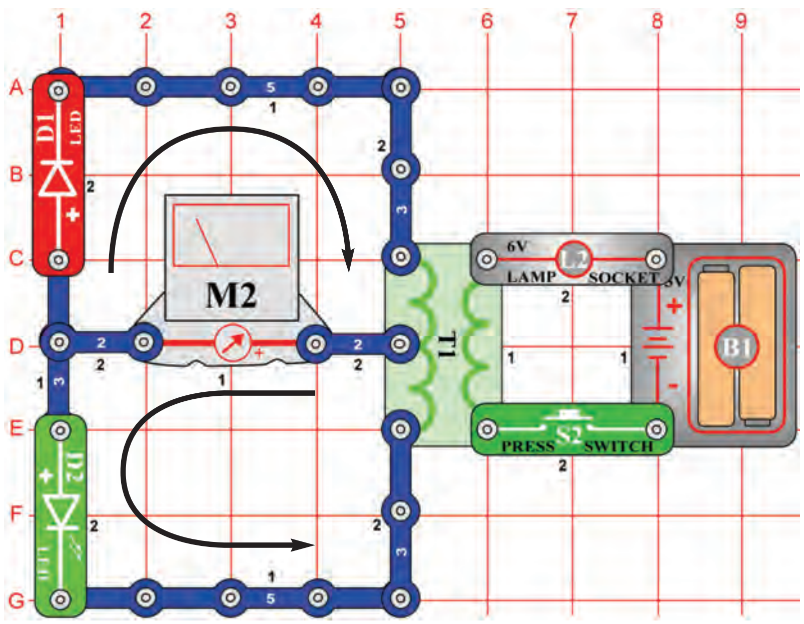


OBJECTIVE: Build an adjustable light-controlled relay.

You can set the amount of light it takes to keep the bulb (L2) on by adjusting the adjustable resistor (RV). Set the adjustable resistor to the top position and turn on the switch. The bulb lights. Cover the photoresistor (RP) and the bulb turns off. Set the adjustable resistor to different positions and then cover the photoresistor. Note that only the top half of the adjustable resistor affects the circuit. If you position it below the middle, the bulb stays off.

Project #358

Meter Deflection



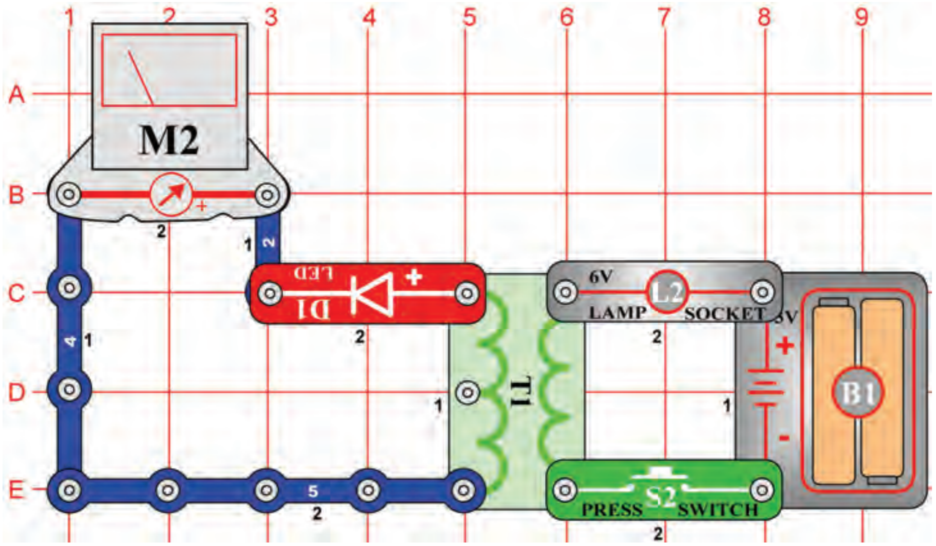
OBJECTIVE: To demonstrate the properties of a transformer.

Set the meter (M2) to the LOW (or 10mA) scale. Pressing the press switch (S2) generates a current on the left side of the transformer (T1). The current lights the LED's (D1 & D2) and deflects the meter. There are two current paths as shown by the arrows. Placing the meter in both current paths always measures each current. The top current is produced when the press switch is pressed and the bottom current is produced when the press switch is released.

Project #359

AC to DC Current

OBJECTIVE: To convert an AC current to DC using an LED.

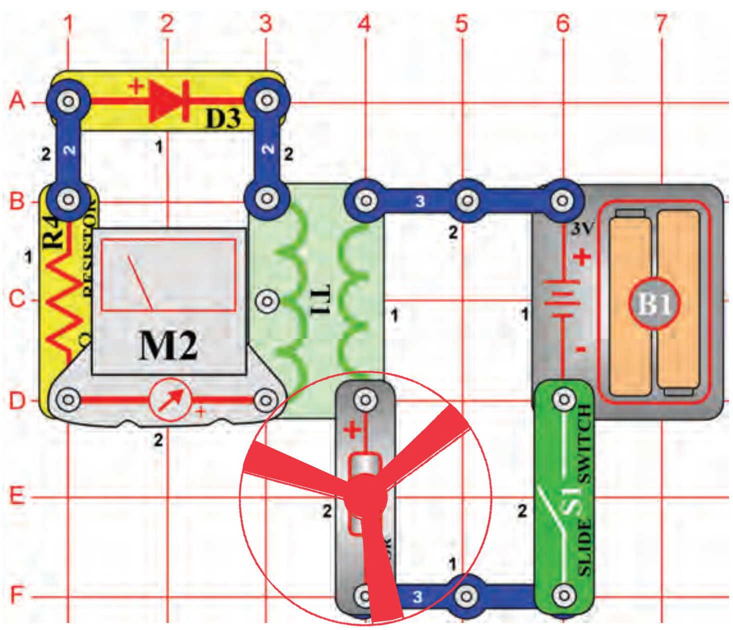


Set the meter (M2) to the LOW (or 10mA) scale. Pressing and releasing the press switch (S2) continuously generates an AC (changing) current. The LED (D1) is used to convert the AC (changing) current to DC (unchanging) current because it only allows the current to flow in one direction. The LED should light as the meter deflects to the right only. Without the LED, the meter would deflect in both directions.

Project #360

Current Meter

OBJECTIVE: To measure the current through a transformer.



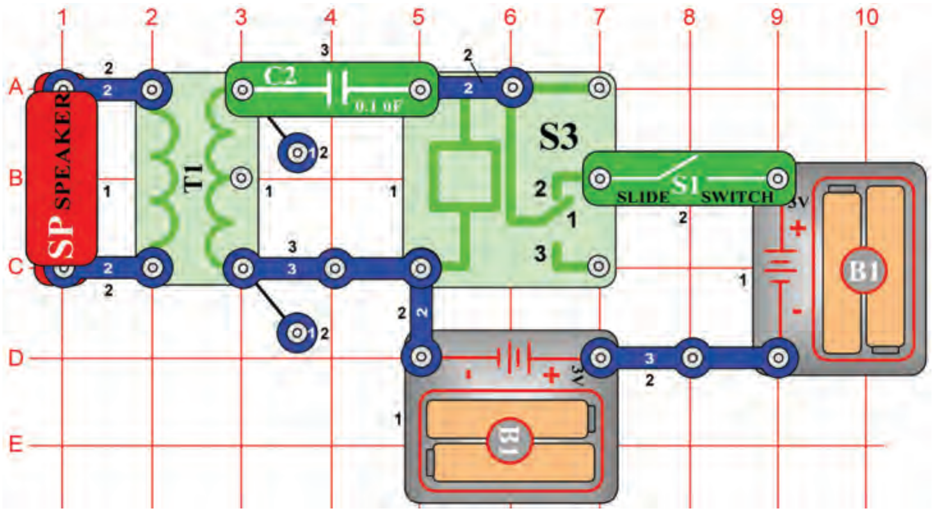
Set the meter (M2) to the LOW (or 10mA) setting. By placing the meter, diode (D3) and current limiting resistor (R4) on the transformer (T1), you can measure the current. Turn on the slide slide switch (S1) and the motor (M1) starts spinning. The current on the right side of the transformer creates a current on the left side using magnetism.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #361

Buzzer, Relay, & Transformer

OBJECTIVE: To use a transformer for a louder buzzer.



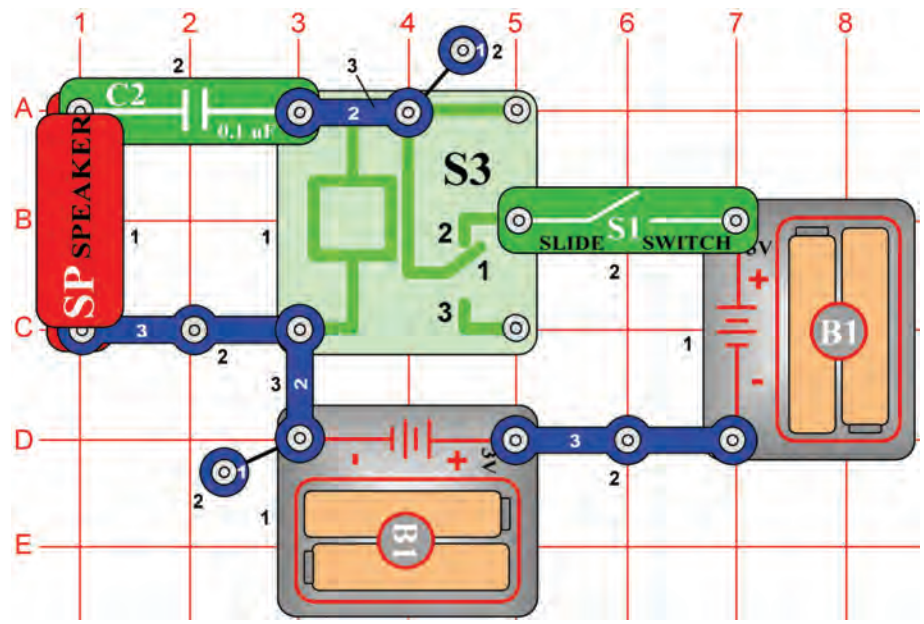
Turn on the switch (S1). The speaker (SP) generates a buzzer sound. As in project #353, the relay (S3) is rapidly switched on and off. This causes an AC voltage on the left side of the transformer (T1). The voltage is stepped-down and applied to the speaker, generating the sound.

To make the sound a little louder, replace the 0.1μF capacitor (C2) with a 3-snap wire.

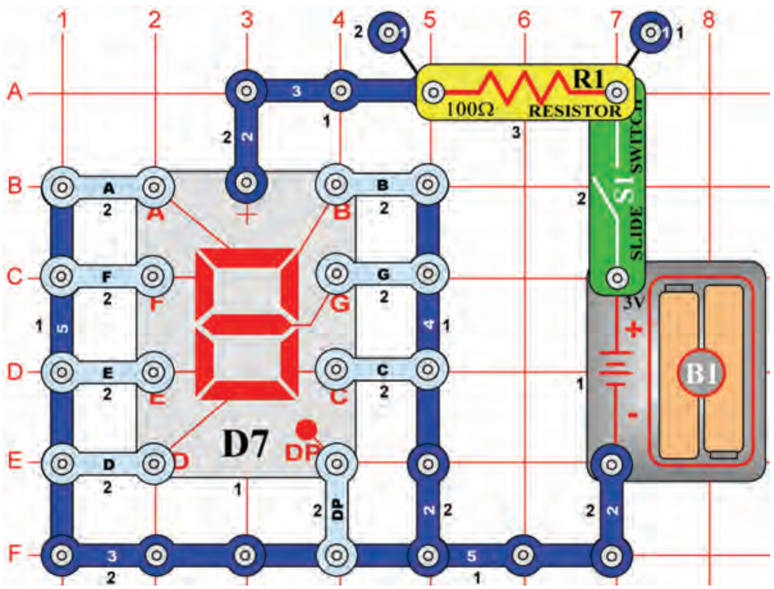
Project #362

Buzzer & Relay

OBJECTIVE: Make a relay buzzer with speaker.



A speaker (SP) and capacitor (C2) are placed across the coil of the relay (S3). When the slide switch (S1) is turned on, the relay's contacts open and close as in project #353. As the capacitor (C2) charges and discharges, the speaker generates a buzzing sound.



Project #363
Display Capital Letter "F"

OBJECTIVE: To configure the seven segment to display the capital letter "F".

Connect A, E, F, & G to the negative of the battery.

Project #364
Display Capital Letter "H"

OBJECTIVE: To configure the seven segment to display the capital letter "H".

Connect B, C, E, F, & G to the negative of the battery.

Project #365
Display Capital Letter "P"

OBJECTIVE: To configure the seven segment to display the capital letter "P".

Connect A, B, E, F, & G to the negative of the battery.

Project #366
Display Capital Letter "S"

OBJECTIVE: To configure the seven segment to display the capital letter "S".

Connect A, F, G, C, & D to the negative of the battery.

Project #367
Display Capital Letter "U"

OBJECTIVE: To configure the seven segment to display the capital letter "U".

Connect B, C, D, E, & F to the negative of the battery.

Project #368
Display Capital Letter "C"

OBJECTIVE: To configure the seven segment to display the capital letter "C".

Connect A, D, E, & F to the negative of the battery.

Project #369
Display Capital Letter "E"

OBJECTIVE: To configure the seven segment to display the capital letter "E".

Connect A, D, E, F, & G to the negative of the battery.

Project #370
Display "."

OBJECTIVE: To configure the seven segment to display the decimal (DP).

Connect DP to the negative of the battery.

Project #371

Display Letter “b”

OBJECTIVE: To configure the seven segment to display the letter “b”.

Connect C, D, E, F, & G to the negative of the battery.

Project #372

Display Letter “c”

OBJECTIVE: To configure the seven segment to display the letter “c”.

Connect A, F, & G to the negative of the battery.

Project #373

Display Letter “d”

OBJECTIVE: To configure the seven segment to display the letter “d”.

Connect B, C, D, E, & G to the negative of the battery.

Project #374

Display Letter “e”

OBJECTIVE: To configure the seven segment to display the letter “e”.

Connect A, B, D, E, F, & G to the negative of the battery.

Project #375

Display Letter “h”

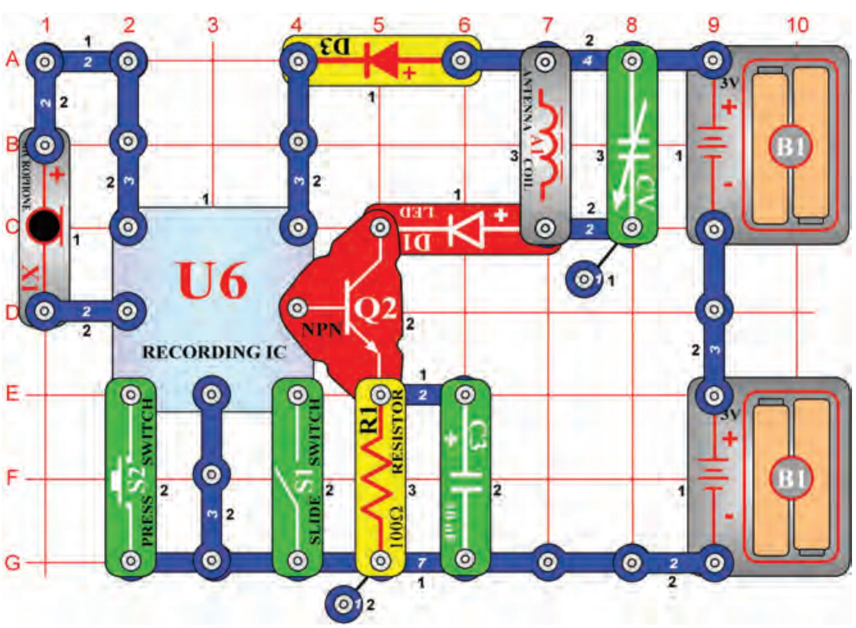
OBJECTIVE: To configure the seven segment to display the letter “h”.

Connect F, E, G, & C to the negative of the battery.

Project #376

Recorded Voice Transmitter

OBJECTIVE: To hear your voice on the radio.

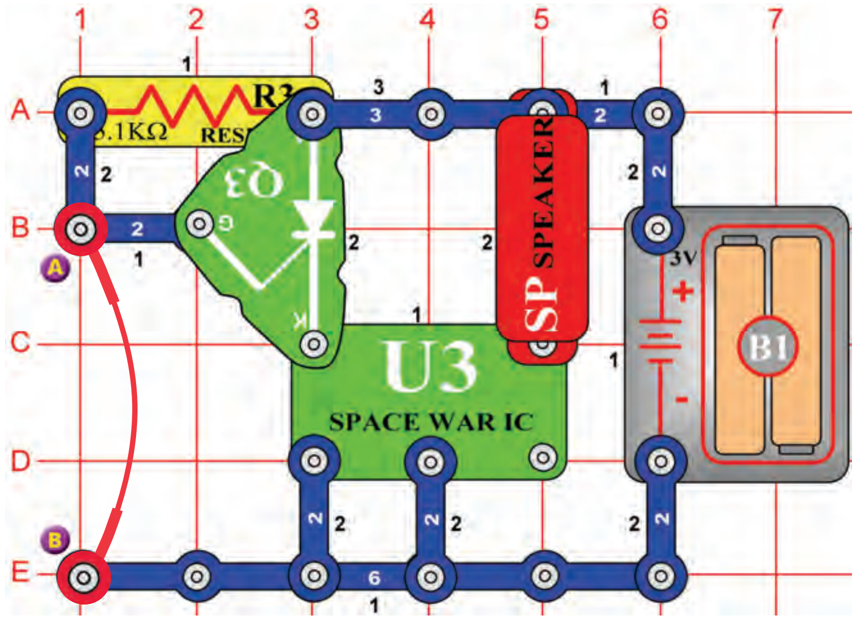


You need an AM radio for this project. Build the circuit shown and place it next to your AM radio. Tune the radio frequency to where no other station is transmitting. Push the press switch (S2); the red LED (D1) should light for a while, indicating that music is being transmitted to your radio. Tune the adjustable capacitor (CV) and the radio volume control until the music sounds best on the radio. Wait until the music stops.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs.

Project #377 — Space War Alarm by SCR



OBJECTIVE: To build an alarm circuit.

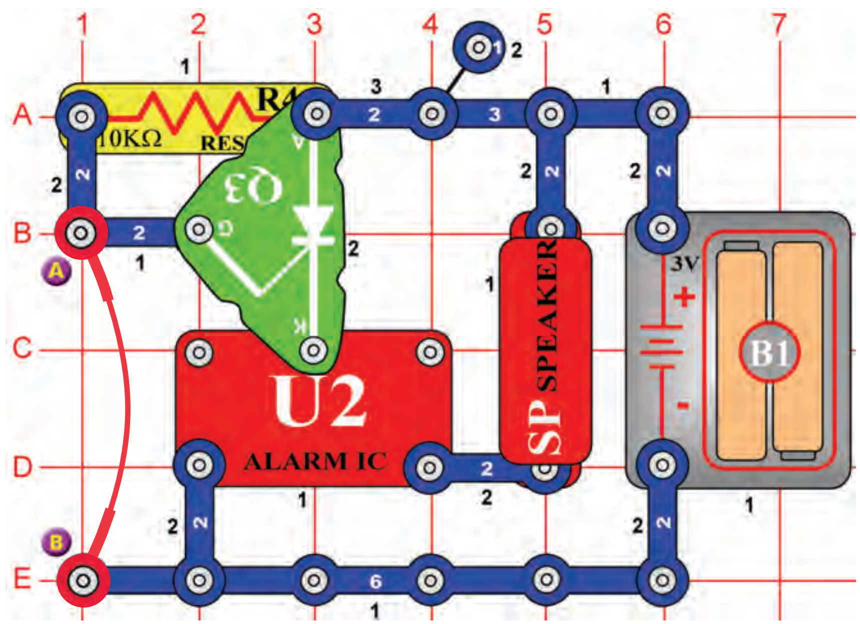
The circuit uses the space war IC (U3) and works the same way as project #320. Remove the jumper wire and a space war sound plays.

Project #378 — Light Space War Alarm

OBJECTIVE: To build an alarm circuit.

Use the circuit in project #377. Replace the resistor (R3) with the photoresistor (RP) and remove the jumper wire. Cover the photoresistor with your hand. Now slowly remove your hand. The music plays when enough light hits the resistor.

Project #379 — Alarm by SCR



OBJECTIVE: To build an alarm circuit.

The circuit uses the alarm IC (U2) and works the same way as project #377. Remove the jumper wire and an alarm IC sounds.

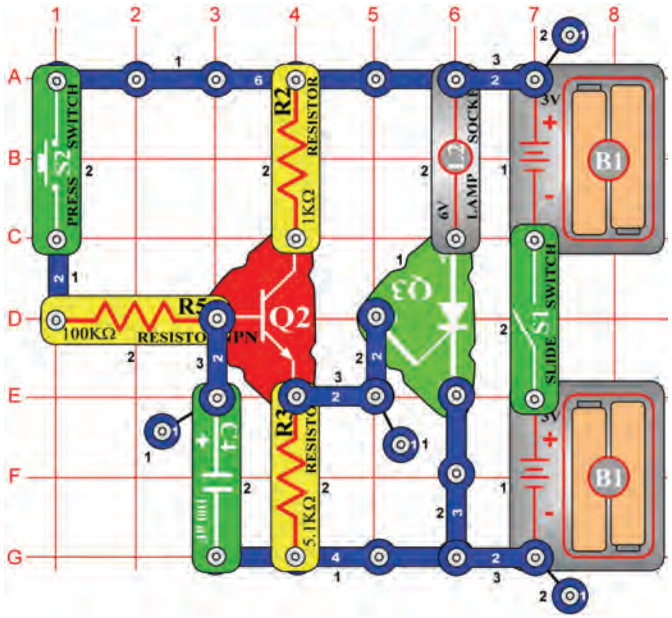
Project #380 — Light & Alarm IC

OBJECTIVE: To build an alarm circuit.

Use the circuit in project #379. Replace the 10kΩ resistor (R4) with the photoresistor (RP) and remove the jumper wire. When enough light strikes the photoresistor, the Alarm IC (U2) plays. Cover the photoresistor with your hand. Now slowly remove it, when enough light hits the resistor, the IC plays.

Project #381 Delay Light

OBJECTIVE: To construct a time delay circuit.



Turn on the slide switch (S1) and the bulb (L2) does not light. Press switch (S2) and slowly the bulb lights.

When the press switch is pressed, current flows to the base of the transistor (Q2) and charges the 100μF capacitor (C4). When the capacitor charges up to more than 1 volt, the transistor (Q2) turns on and triggers the SCR (Q3). The bulb will stay lit until the slide switch is turned off. The values R5 and C4 determine the time it takes until the transistor turns on. The larger the capacitor value, the more time it takes to turn on.

Project #382 Delay Fan

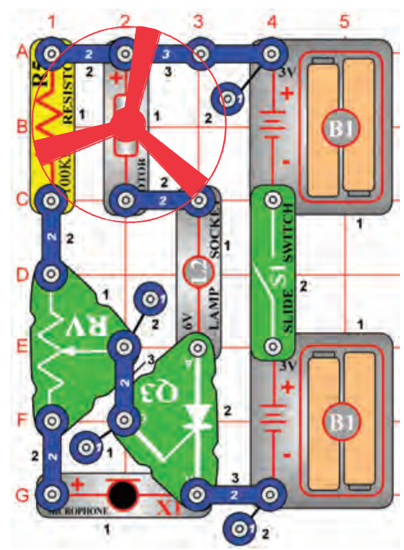
OBJECTIVE: To construct a time delay fan.

Use the circuit in project #381. Replace the lamp (L2) with the motor (M1) and fan, then replace the 3-snap (base grid locations E6-G6) with the lamp (L2). Turn on slide switch (S1) and press down the press switch (S2) to start the motor.

Now replace the 100μF capacitor (C4) with the 470μF capacitor (C5). Turn on slide switch (S1) and press switch (S2). See how long it takes until the motor (M1) spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #383 Sound Activated Fan



OBJECTIVE: To build a sound activated fan.

Build the circuit as shown. Place the fan on the motor (M1). Set the lever on the adjustable resistor (RV) toward towards the 100kΩ resistor (R5). Clap to start the motor.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

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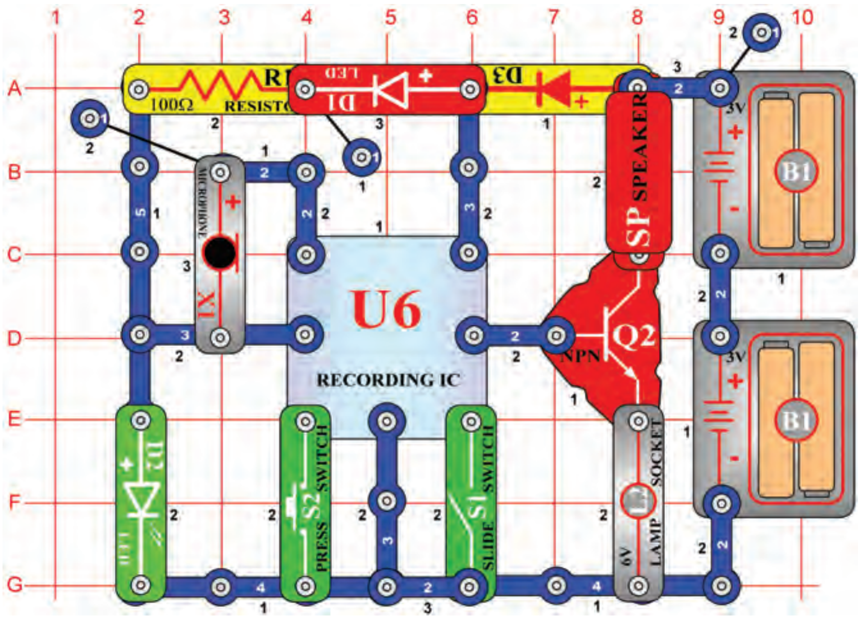
Project #384

Recording LED Indicator

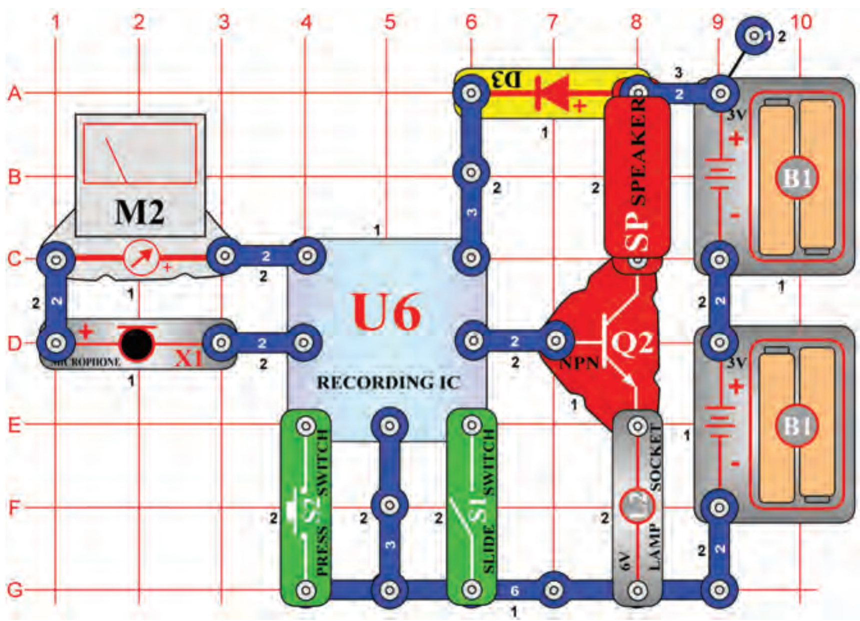


OBJECTIVE: To build a circuit that lights an LED to indicate the recording mode.

The circuit uses sound (beep) and light (LED) to indicate that you are recording. Build the circuit; the red (D1) and green (D2) LED's should light. Now turn on the slide switch (S1). You hear one beep and the green LED turns off. Speak into the microphone (X1) to record a message. When you turn off the slide switch, or the circuit beeps twice (indicating the recording is finished), the green LED turns on again. Make sure that the slide switch is turned off. Press the press switch to hear your recording followed by a song. The lamp (L2) is used to limit current and will not light.

Project #385

Playback & Record with Meter



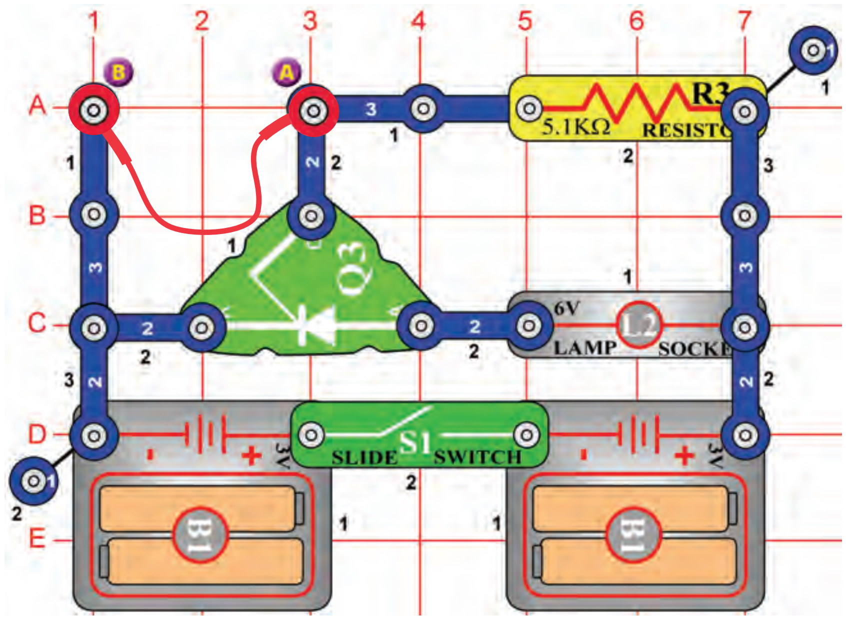
OBJECTIVE: To add a volt meter to the playback and record circuit.

When recording, if the input signal into the microphone (X1) is too high, distortion can occur. To monitor the level, a meter (M2) is placed in series with the microphone.

Set the meter to the LOW (or 10mA) scale. Turn on the slide switch (S1) and the meter defects to the right. As you speak into the microphone, the meter indicates the change in current. Turn the switch off and then on to record again, but this time speak louder. You will find that the louder you speak, the more the meter deflects. The lamp (L2) is used to limit current and will not light.

Project #386 — Alarm Light

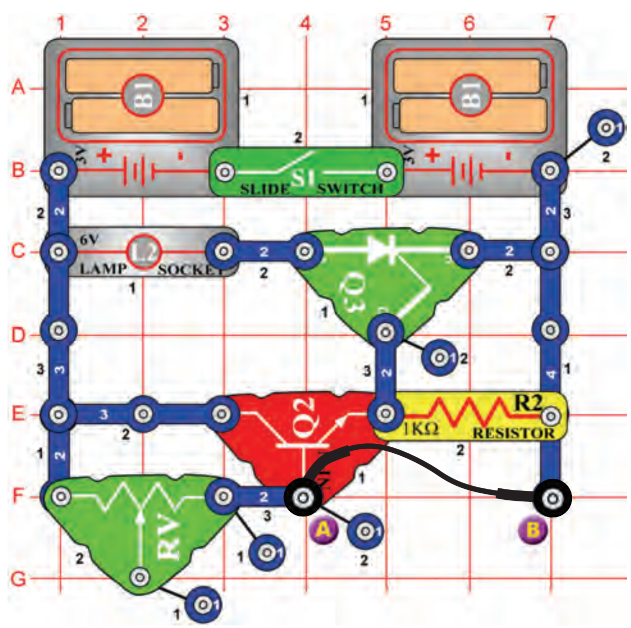
OBJECTIVE: To light a bulb to indicate an open circuit.



This is another example of a alarm that activates when the circuit is broken. Connect the jumper wire across points A & B and then turn on the slide switch (S1). The lamp (L2) will not light until the jumper wire is disconnected. Then the lamp will not turn off. Turn off the switch to turn the lamp off again. This circuit remembers if there was a break in the connection.

Project #387 — Alarm Light (II)

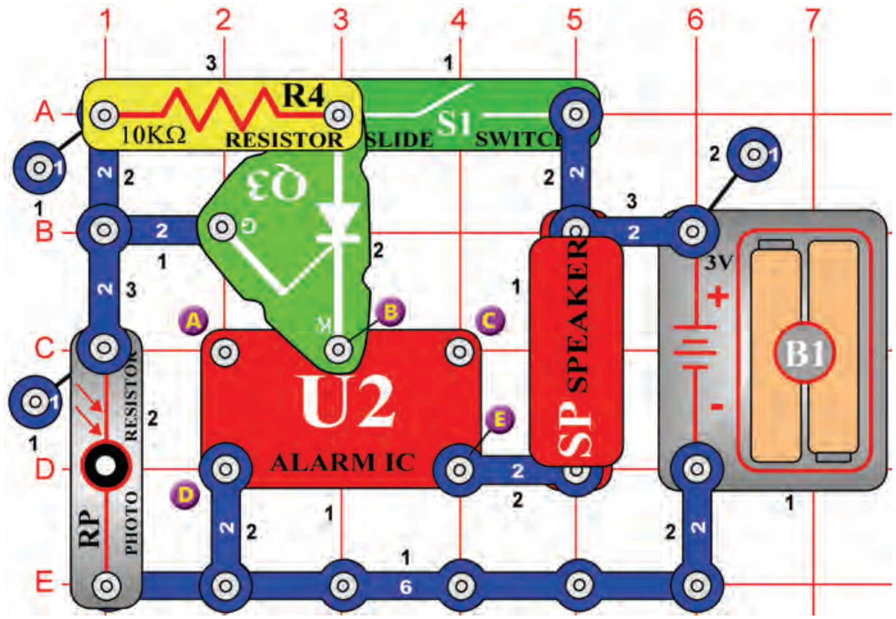
OBJECTIVE: To light a bulb to indicate an open circuit.



This project is similar to project #386, but uses a transistor (Q2). The lamp (L2) will not light until the jumper wire is disconnected. The jumper wire grounds the base of the transistor, keeping it off. Remove the jumper and the voltage on the base rises; turning the transistor and SCR (Q3) on, and lighting the lamp. Note, the adjustable resistor (RV) is used as a fixed value. Once the SCR is triggered, it will light the lamp even if the jumper wire is replaced. Turn the slide switch (S1) off to turn off the lamp.

Project #388 — Night Police Car

OBJECTIVE: To build a night-sensitive police car sound.



As the photoresistor (RP) is exposed to light, its resistance is very low, thereby connecting the gate of the SCR (Q3) to ground. This prevents the SCR from conducting, connecting the alarm IC (U2) to the batteries. The alarm IC remains off until the light is blocked, triggering the SCR. If the light in the room is not bright, the IC may turn on.

Wave your hands over the photoresistor. Block the light with your hand and the speaker (SP) sounds.

Project #389 — Night Machine Gun

OBJECTIVE: To build a night-sensitive machine gun sound.

Use the circuit from project #388. Connect the jumper wire to points B & C for a machine gun sound.

Project #390 — Night Fire Engine

OBJECTIVE: To build a night-sensitive fire engine sound.

Use the circuit from project #388. Connect the jumper wire to points A & B for a fire engine sound.

Project #391 — Night Ambulance

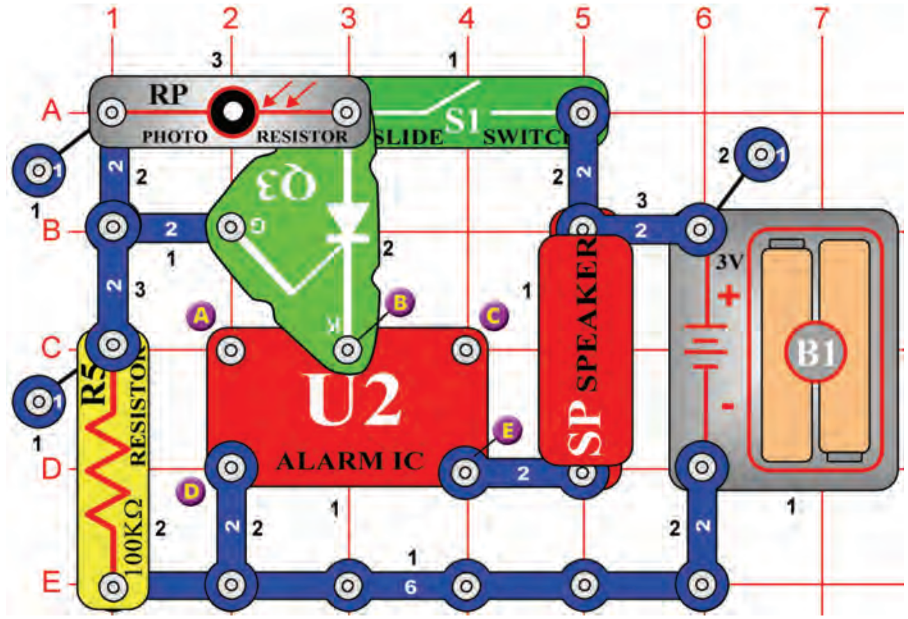
OBJECTIVE: To build a night-sensitive ambulance sound.

Use the circuit from project #388. Connect the jumper wire to points A & D for an ambulance sound.

Project #392

Daytime Light Police Car

OBJECTIVE: To build a light-sensitive police car sound.



As long as the photoresistor (RP) is exposed to light, the alarm IC (U2) outputs a signal to the speaker (SP). Block the light with your hand and the sound will stop.

Project #393

Daytime Light Machine Gun

OBJECTIVE: To build a light-sensitive machine gun sound.

Use the circuit from project #392. Connect the jumper wire to points B & C. The sound of a machine gun will be heard when the room is not dark.

Project #394

Daytime Light Fire Engine

OBJECTIVE: To build a light-sensitive fire engine sound.

Use the circuit from project #392. Connect the jumper wire to points A & B for a fire engine sound, when room is not dark.

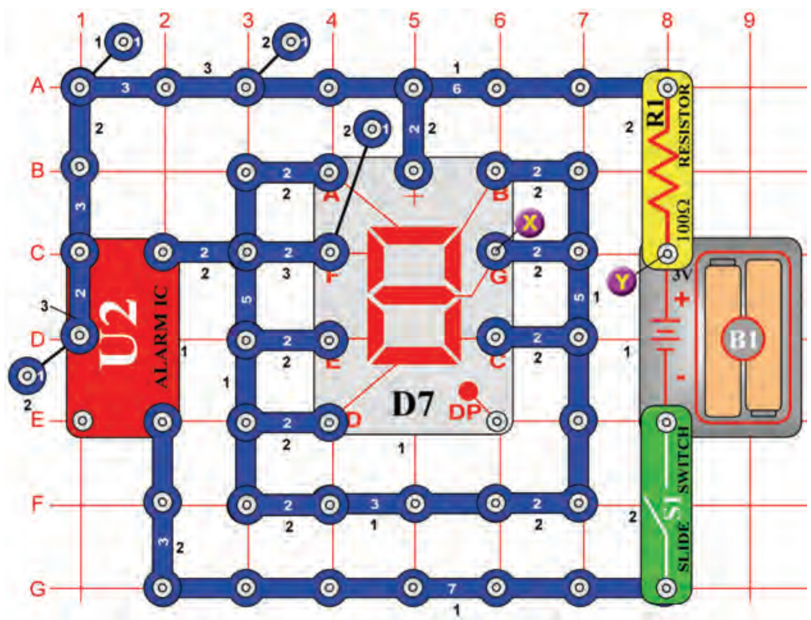
Project #395

Daytime Light Ambulance

OBJECTIVE: To build a light-sensitive ambulance sound.

Use the circuit from project #392. Connect the jumper wire to points A & D for an ambulance sound.

Project #396 — Flashing 8



OBJECTIVE: Use the Alarm IC as a switch to flash the number "8".

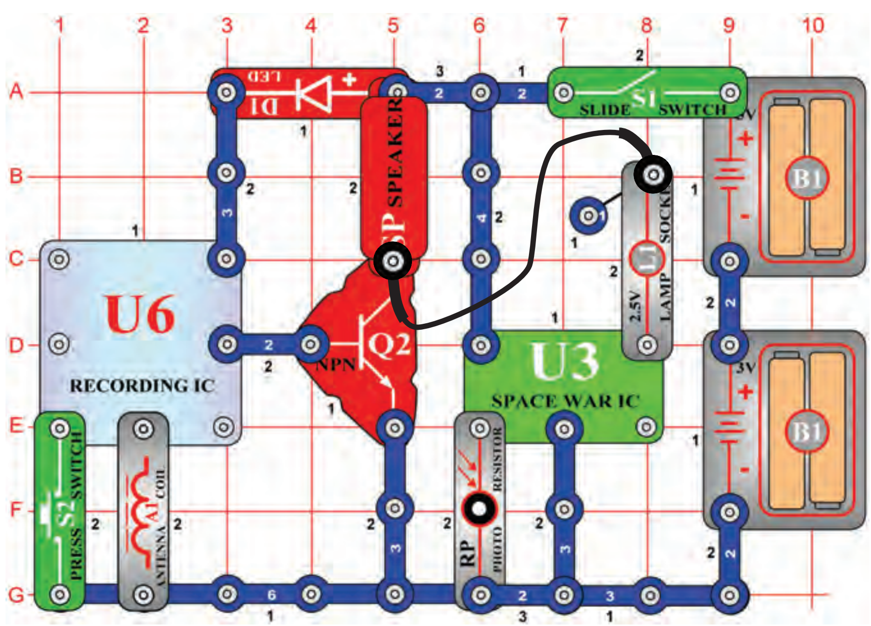
Turn on the slide switch (S1) and the number 8 starts flashing. The segments are powered by connecting them to the IC's (U2) output.

Project #397 — Flashing 8 with Sound

OBJECTIVE: To build a circuit so you can hear and see the 8 flash.

Use the circuit in project #396. Connect the speaker (SP) across points X & Y to see and hear the IC's (U2) output.

Project #398 — Musical Space War



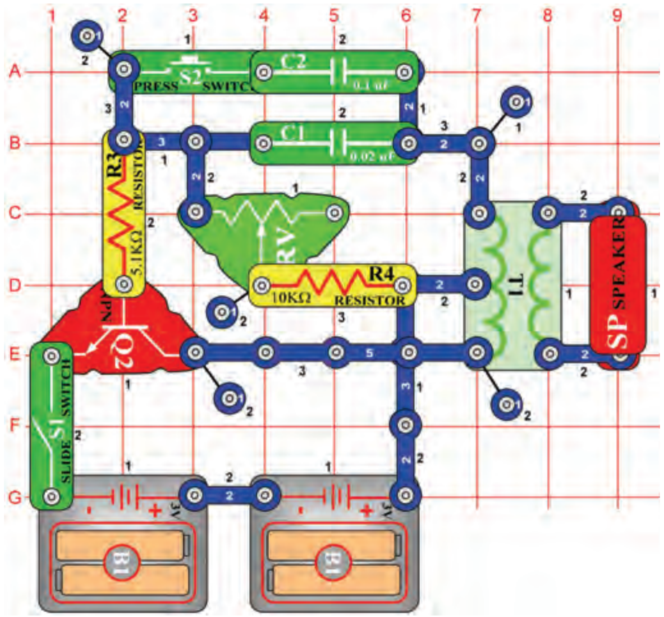
OBJECTIVE: To combine the sound effects of the recorder and space war integrated circuits.

Turn on the slide switch (S1) and you hear space war sounds as the lamp (L1) flashes. If you wave your hand over the photoresistor (RP), the sound changes. If you keep the photoresistor covered, then the sound will stop.

Press the press switch (S2) and you will hear music in addition to any space war sounds that are playing. Press the press switch again to change the music. You will also hear any recording you had made previously with other projects.

Replace the lamp with the 100Ω resistor (R1) to reduce the loudness.

Project #399 Electronic Noisemaker



OBJECTIVE: To make different tones with an oscillator.

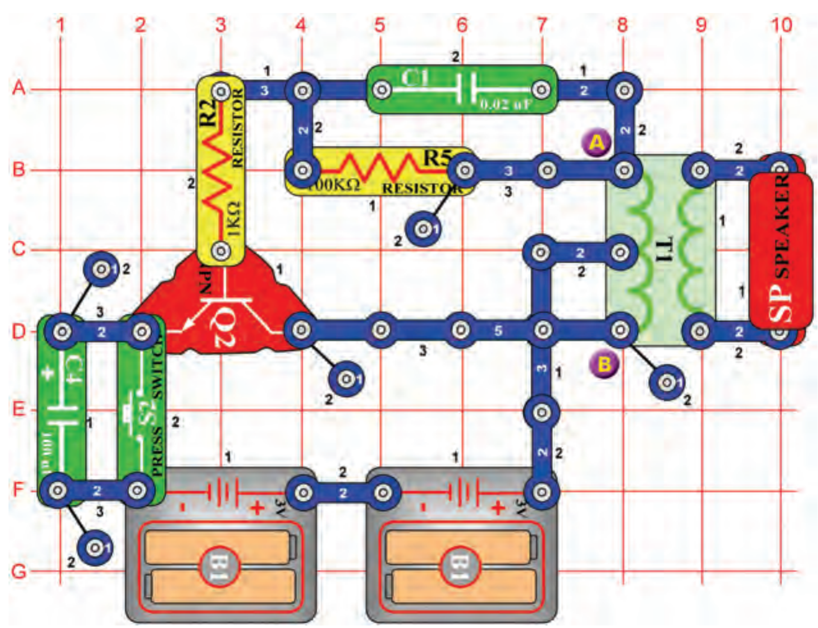
Build the circuit and turn on the slide switch (S1), you hear a high-frequency tone. Press the press switch (S2) and move the adjustable resistor (RV) control around to change to frequency of the tone. Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" on the right) to lower the frequency of the tone.

Project #400 Electronic Noisemaker (II)

OBJECTIVE: To show a variation of project #399.

You can also change the frequency by changing the resistance in the oscillator. Replace the 10KΩ resistor (R4) with the 100KΩ resistor (R5), this can be done with either the 0.1μF (C2) or 10μF (C3) capacitors in the circuit.

Project #401 Bee



OBJECTIVE: To make different sounds with an oscillator.

Build the circuit and press the press switch (S2) a few times, you hear cute sounds like a bumble bee. Replace the 0.02μF capacitor (C1) with 0.1μF capacitor (C2) or 10μF capacitor (C3, "+" on the right) to change the sound.

Project #402 Bee (II)

OBJECTIVE: Show a variation of project #401.

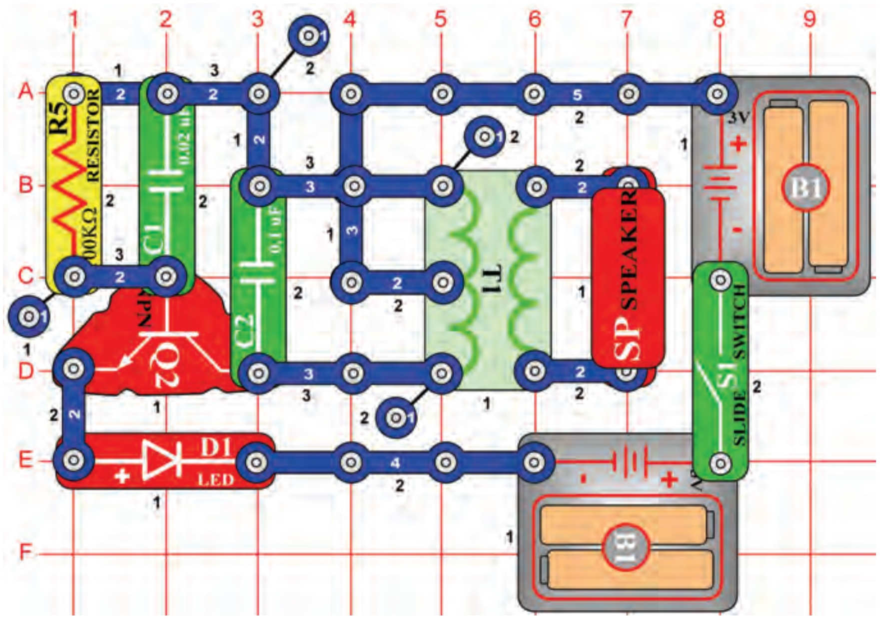
Place the 0.02μF capacitor (C1) back in the circuit. Remove the speaker (S1) from the circuit and place the whistle chip (WC) across the transformer (T1) at points labeled A & B on the circuit layout. Listen to the sounds as you press the press switch (S2). Replace the 0.02μF capacitor (C1) with 0.1μF capacitor (C2) or 10μF capacitor (C3, "+" on the right) to change the sound.

Project #403 Bee (III)

OBJECTIVE: Show a variation of project #401.

Replace the 100μF capacitor (C4) with the 10μF capacitor (C3) or the 470μF capacitor (C5) to change the duration of the sound. Use either the speaker circuit in project #401 or the whistle chip circuit in project #402.

Project #404 — Oscillator Sound



OBJECTIVE: Build an oscillator circuit.

Turn on the slide switch (S1) and the LED (D1) lights as the speaker (SP) emits a tone. The circuit oscillates and generates an AC voltage across the speaker through the transformer (T1).

Project #405 — Oscillator Sound (II)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. In this circuit, you will change the tone by adding more capacitance. Place the whistle chip (WC) on top of capacitor (C1). Turn on the slide switch (S1) and you now hear a lower tone. Adding the more capacitance lowers the oscillating frequency.

Project #406 — Oscillator Sound (III)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Place the whistle chip (WC) in parallel with the capacitor (C2) by placing it on the left side of the transformer (T1). Turn on the slide switch (S1) and you now hear a lower tone.

Project #407 — Oscillator Sound (IV)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Using a 1-snap, place the 10μF capacitor (C3) on top of the 100kΩ resistor (R5), with the “+” side on point A1. Turn on the slide switch (S1) and you should hear a much lower sound then the previous projects.

Project #408 — Oscillator Sound (V)

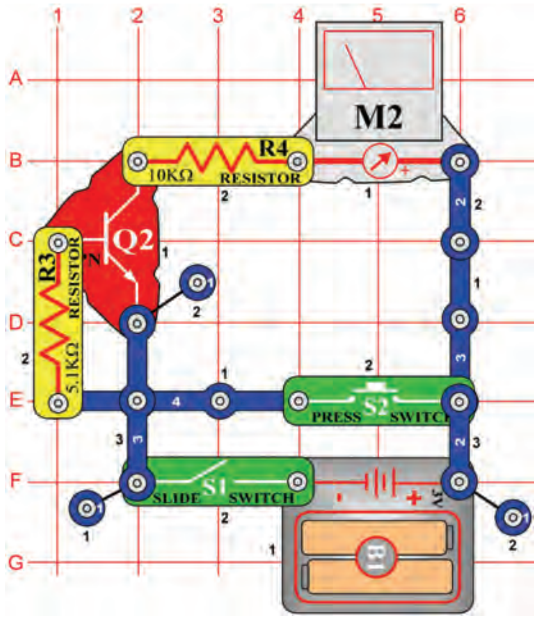
OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the photoresistor. Now, as the resistance changes, so does the oscillator frequency.

Project #409

Transistor Tester

OBJECTIVE: To build a circuit that checks the transistor.

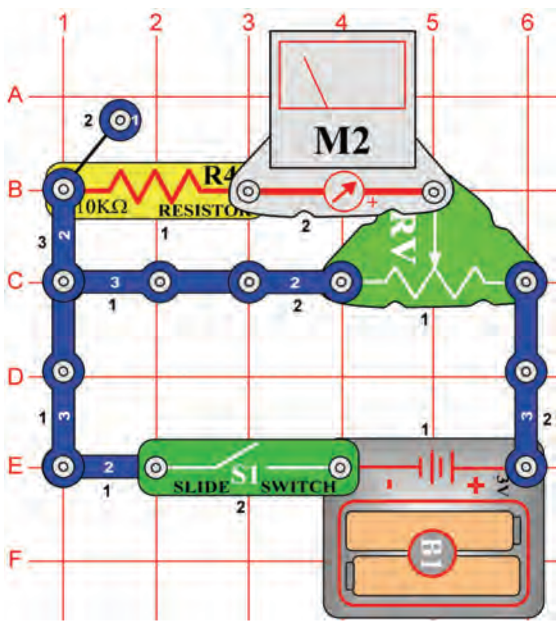


Set the meter (M2) to the LOW (or 10mA) setting. Turn on the switch (S1), the meter does not move. Press the switch (S2), the meter deflects and points to 10. This indicates the transistor (Q2) is GOOD. The meter would only deflect a little or not at all for a BAD transistor.

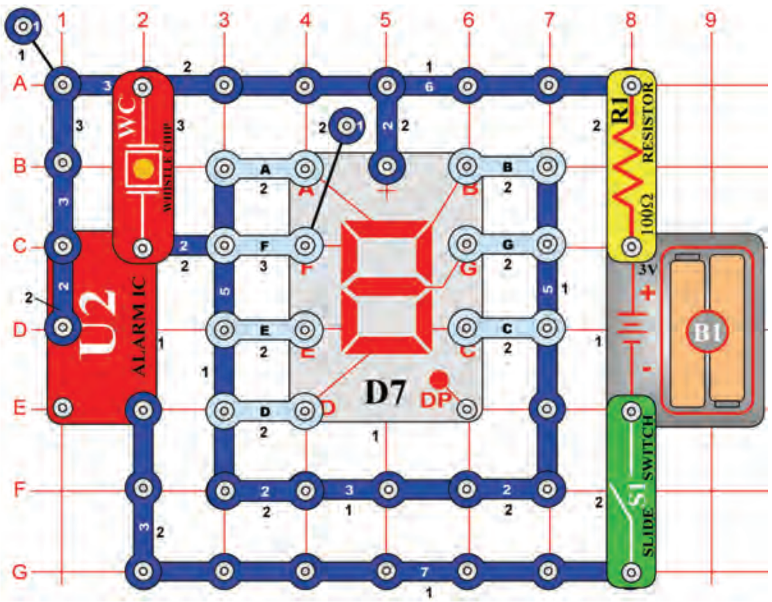
Project #410

Adjustable Voltage Divider

OBJECTIVE: To make an adjustable current path.



Set the meter (M2) to the LOW (or 10mA) setting. This circuit is a simple voltage divider. When the adjustable resistor (RV) is set to the far right, the voltage across the resistors (R4) and (RV) are equal. Adjust resistor (RV) to the left, the meter deflects less, as the voltage decreases.



Project #411

Automatic Display Capital Letter "C"

OBJECTIVE: To construct a flashing display for the capital letter C.

Connect segments A, D, E & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #412

Automatic Display Capital Letter "E"

OBJECTIVE: To construct a flashing display for the capital letter E.

Use the circuit from project #411. Connect A, D, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #413

Automatic Display Capital Letter "F"

OBJECTIVE: To construct a flashing display for the capital letter F.

Use the circuit from project #411. Connect A, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #414

Automatic Display Capital Letter "H"

OBJECTIVE: To construct a flashing display for the capital letter H.

Use the circuit from project #411. Connect B, C, E , F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #415

Automatic Display Capital Letter "P"

OBJECTIVE: To construct a flashing display for the capital letter P.

Use the circuit from project #411. Connect A, B, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #416

Automatic Display Capital Letter "S"

OBJECTIVE: To construct a flashing display for the capital letter S.

Use the circuit from project #411. Connect A, F, G, C, & D to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #417

Automatic Display Capital Letter "U"

OBJECTIVE: To construct a flashing display for the capital letter U.

Use the circuit from project #411. Connect B, C, D, E, & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #418

Automatic Display Capital Letter "L"

OBJECTIVE: To construct a flashing display for the capital letter L.

Use the circuit from project #411. Connect D, E, & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

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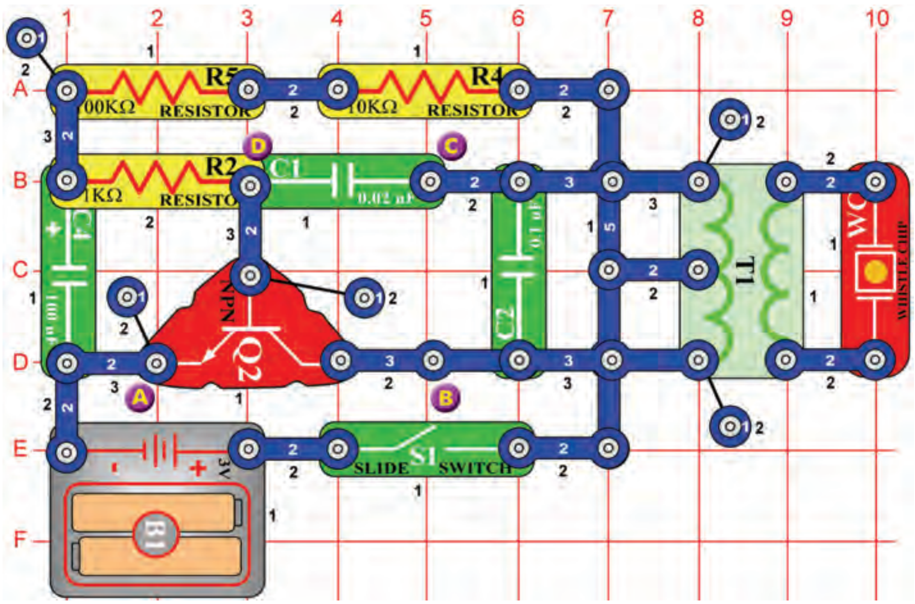


Project #419

Whistle Chip Sounds

OBJECTIVE: To make sounds from the whistle chip.

Turn on the switch (S1). As the circuit oscillates, the plate in the whistle chip vibrates and generates sound.

Project #420

Whistle Chip Sounds (II)

OBJECTIVE: Show variations of project #419.

Connect the whistle chip (WC) across points B & C.

Project #421

Whistle Chip Sounds (III)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419. Connect the whistle chip (WC) across points C & D. You should hear a faster sound.

Project #422

Whistle Chip Sounds (IV)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 10µF capacitor (C3).

Project #423

Whistle Chip Sounds (V)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 470µF capacitor (C5).

Project #424

Whistle Chip Sounds (VI)

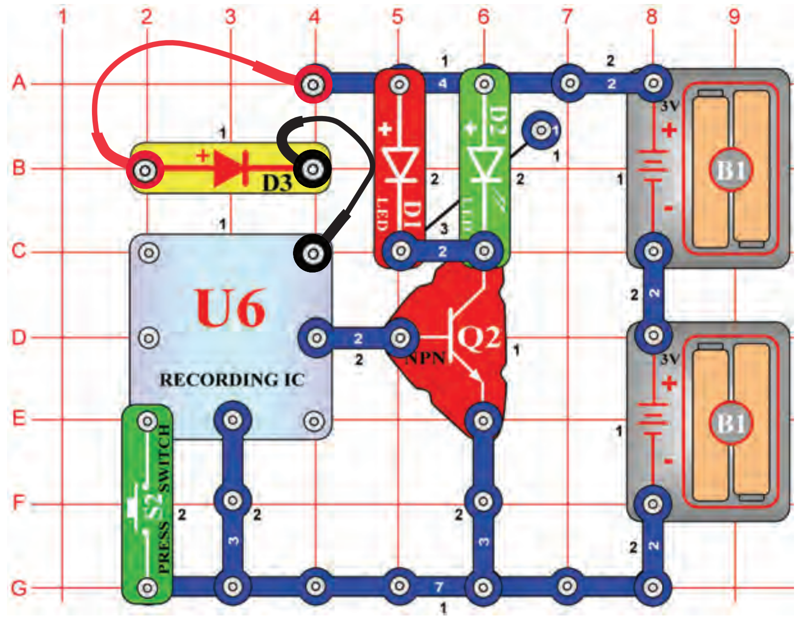
OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 10µF capacitor (C3) and connect the whistle chip across points B & C. You can also connect the whistle chip across points C & D.

Project #425

LED Music

OBJECTIVE: To light the LED's using the recording IC.



The recording IC (U6) lights the LED's (D1 & D2) instead of driving the speaker (SP). Press the press switch (S2) once. The LED's light and then turn off after a while. Press the press switch again and see how long the second song plays. When the second song stops, press the press switch (S2) again to play the third song.

Project #426

Light-controlled LED Time Delay

OBJECTIVE: Show variations of project #425.

Use the circuit in project #425. Replace the press switch (S2) with the photoresistor (RP). Turn the LED's on and off by waving your hand over the photoresistor.

Project #427

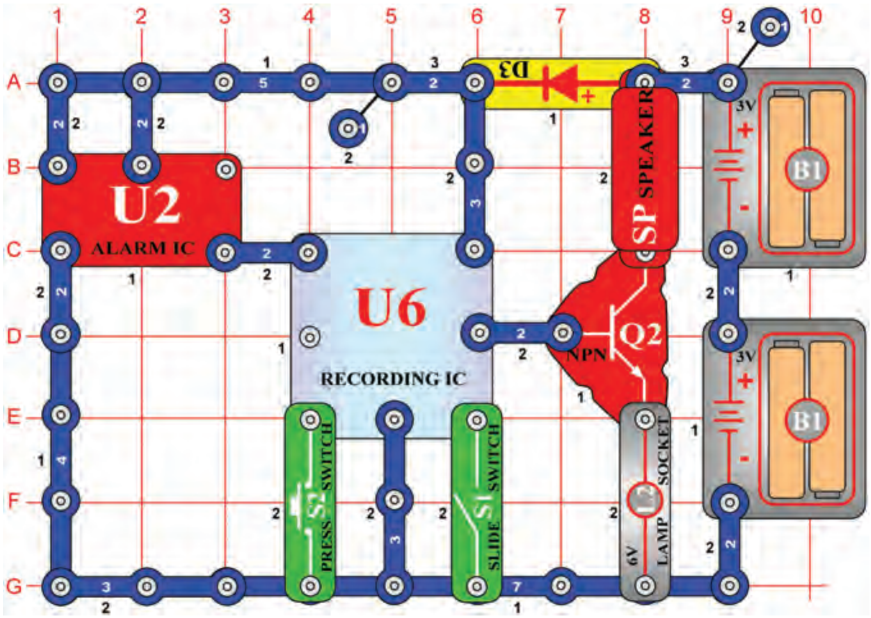
Touch-controlled LED Time Delay

OBJECTIVE: Show variations of project #425.

Use the circuit in project #425. Replace the press switch (S2) with the PNP transistor (Q1, arrow on U6 and a 1-snap on point F1). Turn the LED's on and off by touching grid points F1 & G2 at the same time. You may need to wet your fingers.

Project #428 Alarm Recorder

OBJECTIVE: To record the sound from the alarm IC.



The circuit records the sound from the alarm IC (U2) into the recording IC (U6). Turn on the switch (S1). The first beep indicates that the IC has begun recording. When you hear two beeps, the recording has stopped. Turn off the slide switch (S1) and press the switch (S2). You will hear the recording of the alarm IC before each song is played. The lamp (L2) is used to limit current and will not light.

Project #429 Alarm Recorder (II)

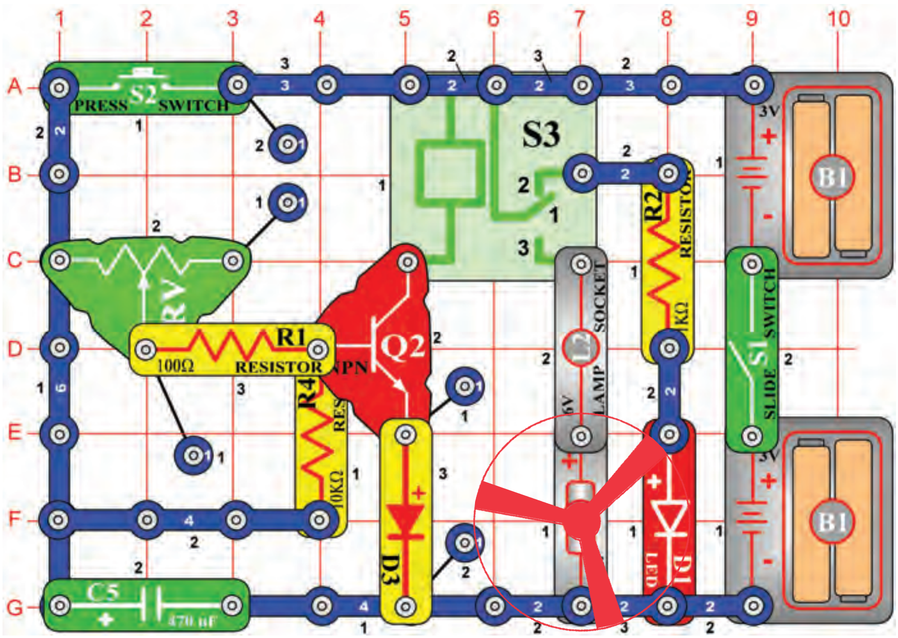
OBJECTIVE: Record the sound from the alarm IC.

Use the circuit in project #428. Remove the 2-snap from A1 to B1. Turn on the switch (S1). The first beep indicates that the IC (U6) has begun recording. When you hear two beeps, turn off the switch (S1), press the switch (S2), and the new recording plays.

Project #430 Machine Gun Recorder

OBJECTIVE: To record the sound of a machine gun.

Use the circuit in project #428. Move the 2-snap from A1 - B1 to 3A - 3B. Turn on the switch (S1). The first beep indicates that the IC (U6) has begun recording. When you hear two beeps, turn off the switch (S1), press the switch (S2), and the machine gun sound plays.



⚠ **WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #431

Time Delay 1-7 Seconds

***OBJECTIVE:** To build a time delay circuit.*

The length of time the motor (M1) runs depends on the position of the adjustable resistor (RV). When the press switch (S2) is pressed, the 470µF capacitor (C5) charges. As the press switch is released, C5 discharges through the resistors R4 and RV, turning the transistor (Q2) on. Transistor Q2 connects the relay (S3) to the batteries, the contacts switch, and the motor (M1) spins. As the voltage decreases, Q2 will turn off and the motor will stop spinning.

Setting RV to the right (large resistance) sets a long discharge time. To the left, a short discharge time.

Turn on the switch (S1), the red LED (D1) lights. Now press and release the switch (S2), the bulb lights and the motor spins.

Project #432

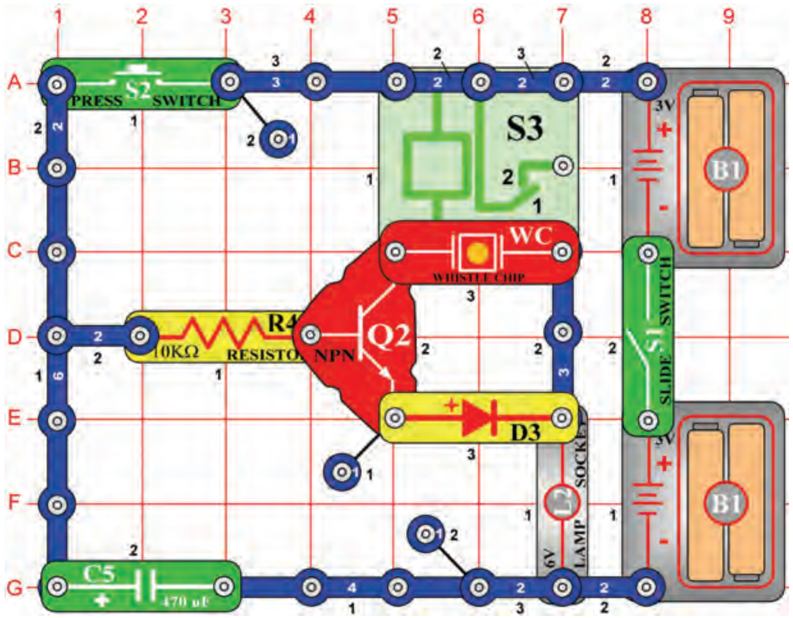
Time Delay

***OBJECTIVE:** To see how the capacitor value affects the time.*

Use the circuit in project #431. Replace the 470µF capacitor (C5) with the 100µF capacitor (C4). Set the adjustable resistor (RV) to the far right, turn on the switch (S1), then press and release the switch (S2). The motor (M1) spins and bulb (L2) lights for about 3 seconds. Adjust the adjustable resistor to the left for a much shorter time.

Project #433 — Manual 7 Second Timer (II)

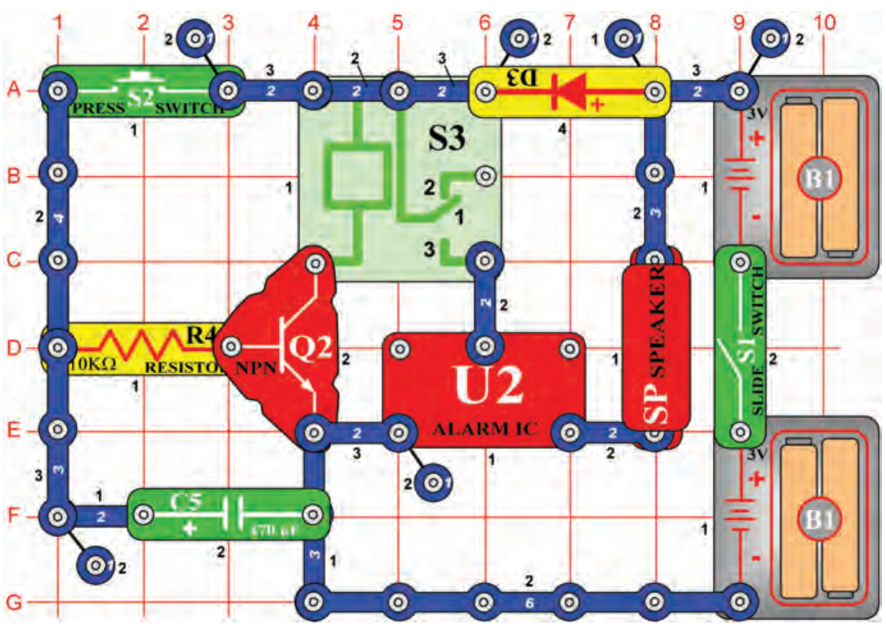
OBJECTIVE: To build a manual timer using a relay and whistle chip.



This circuit is similar to project #431 except now the whistle chip (WC) will also make sound.

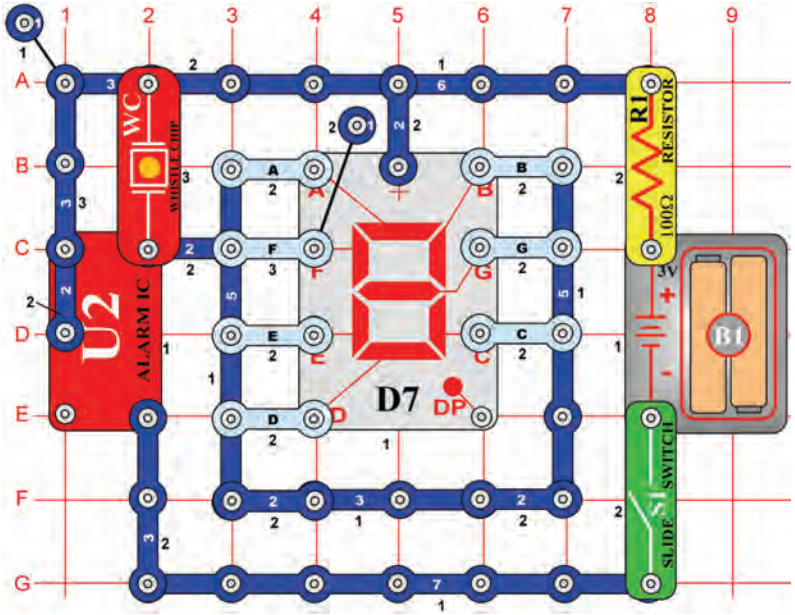
Project #434 — 15 Second Alarm

OBJECTIVE: To build a circuit that sounds the speaker for 15 seconds.



As in project #431, the transistor (Q2) acts as a switch, connecting the relay (S3) and the alarm IC (U2) to the batteries. As long as there is a voltage on the transistor's base, the alarm IC sounds.

Turn on the slide switch (S1) and then press the switch (S2). The transistor turns on, the capacitor (C5) charges up, and the alarm sounds. Release the press switch (S2). As the capacitor discharges, it keeps the transistor on. The transistor will turn off when the capacitor is almost discharged, about 15 seconds. The relay contacts will switch and the alarm will turn off.



Project #435

Flashing "1 & 2"

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers "1 & 2".

Connect segments B & C to the circuit. Turn on the slide switch (S1) and the number "1" should be flashing. Now, connect A, B, G, E, & D to flash the number "2".

Project #436

Flashing "3 & 4"

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers "3 & 4".

Use the circuit in project #435. Connect A, B, G, C, & D to the circuit. Turn on the slide switch (S1) and the number "3" should be flashing. Now, connect C, B, G & F to flash the number "4".

Project #437

Flashing "5 & 6"

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers "5 & 6".

Use the circuit in project #435. Connect A, F, G, C & D to the circuit. Turn on the slide switch (S1) and the number "5" should be flashing. Now, connect A, C, D, E, F & G to flash the number "6".

Project #438

Flashing "7 & 8"

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers "7 & 8".

Use the circuit in project #435. Connect A, B, & C to the circuit. Turn on the slide switch (S1) and the number "7" should be flashing. Now, connect A, B, C, D, E, F & G to flash the number "8".

Project #439

Flashing "9 & 0"

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers "9 & 0".

Use the circuit in project #435. Connect A, B, C, D, F, & G to the circuit. Turn on the switch (S1) and the number "9" should be flashing. Now, connect A, B, C, D, E, & F to flash the number "0".

Project #440

Flashing "b & c"

OBJECTIVE: Use the Alarm IC as a switch to flash the letters "b & c".

Use the circuit in project #435. Connect C, D, E, F & G to the circuit. Turn on the slide switch (S1) and the letter "b" should be flashing. Now, connect A, F & G to flash the letter "c".

Project #441

Flashing "d & e"

OBJECTIVE: Use the Alarm IC as a switch to flash the letters "d & e".

Use the circuit in project #435. Connect B, C, D, E, & G to the circuit. Turn on the slide switch (S1) and the letter "d" should be flashing. Now, connect A, B, D, E, F & G to flash the letter "e".

Project #442

Flashing "h & o"

OBJECTIVE: Use the Alarm IC as a switch to flash the letters "h & o".

Use the circuit in project #435. Connect C, E, F, & G to the circuit. Turn on the slide switch (S1) and the letter "h" should be flashing. Now, connect C, D, E, & G to flash the letter "o".

Project #443

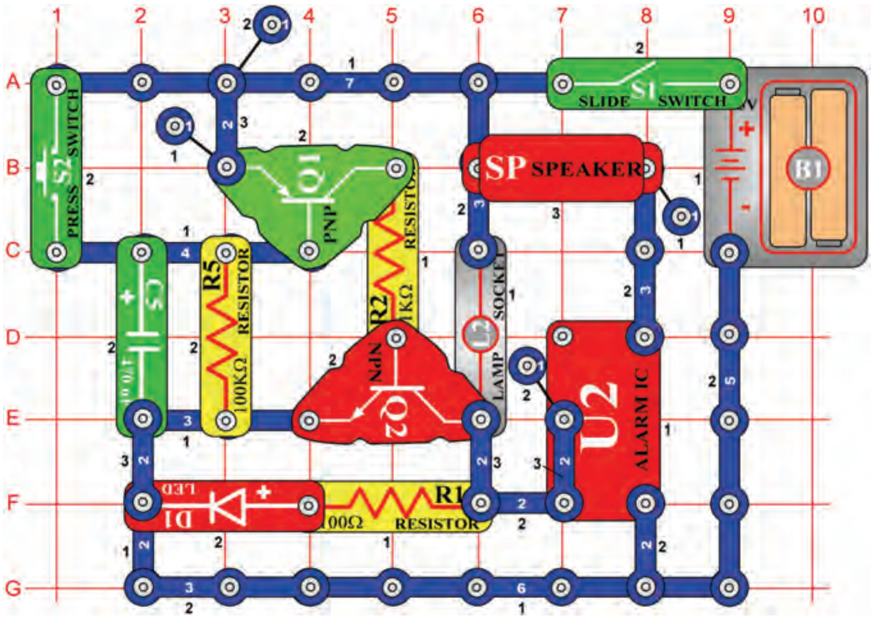
Flashing "A & J"

OBJECTIVE: Use the Alarm IC as a switch to flash the letters "A & J".

Use the circuit in project #435. Connect A, B, C, E, F, & G to the circuit. Turn on the slide switch (S1) and the capital letter "A" should be flashing. Now, connect B, C, & D to flash the capital letter "J".

Project #444 Alarm Timer

OBJECTIVE: To connect the alarm IC to a timer circuit.

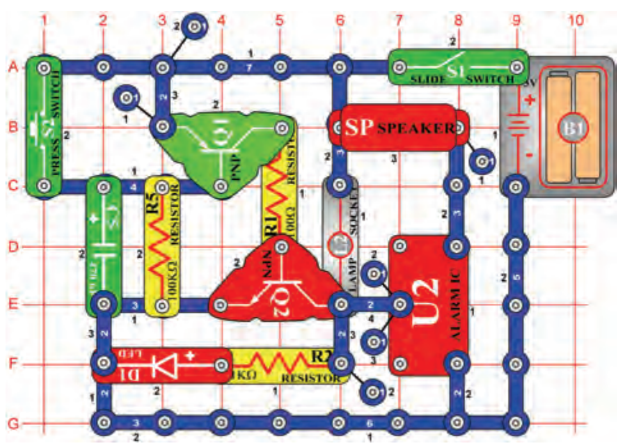


Turn on the slide switch (S1) and the alarm may sound and slowly drift away as the lamp (L2) brightens. Press the press switch (S2) and the alarm sounds at full volume as the LED (D1) lights. Capacitor C5 is also charged. Release the press switch; the alarm IC (U2) still sounds because the voltage from the discharging C5 keeps Q1 and Q2 off. As the capacitor's voltage drops, the LED will turn off and the sound will slowly stop.

Replace resistor R5 and capacitor C5 with different values and see how it affects the circuit.

Project #445 Alarm Timer (II)

OBJECTIVE: To change the time by switching the resistor and capacitor.

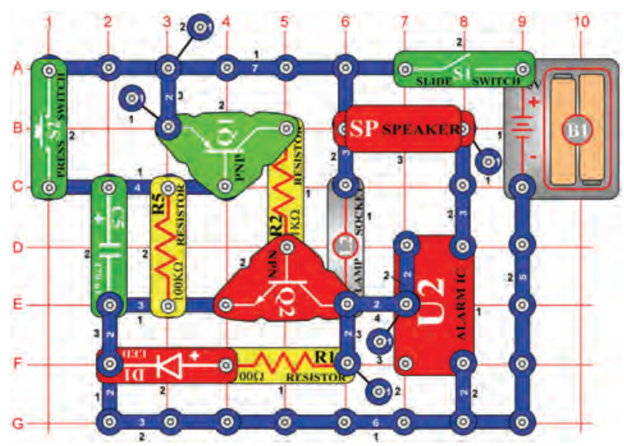


Build this circuit using the following combinations for R5 and C5:

R5 & C3, R4 & C4, and R4 & C5.

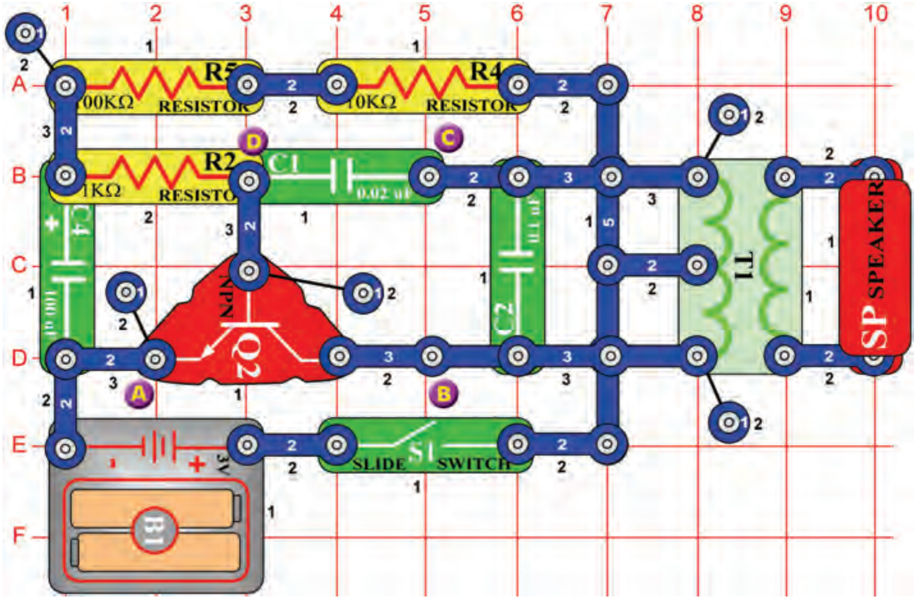
Project #446 Alarm Timer (III)

OBJECTIVE: To modify project #285 for a different sound.



Replace the 1-snap wire from the middle snap on U2 with a 2-snap and connect it to grid location D7 & E7. The circuit now produces a different sound. Change R5 and C5 with the following combinations for R5 and C5:

R5 & C3, R4 & C4, and R4 & C5.



Project #447
Bird Sounds

OBJECTIVE: To create bird sounds.

Turn on the switch (S1). The circuit makes a bird sound.

Project #448
Bird Sounds (II)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Replace the 100μF (C4) capacitor with the 10μF capacitor (C3), the tone should sound like a buzzer. Now use the 470μF capacitor (C5) and hear how the tone gets longer between chirps.

Project #449
Bird Sounds (III)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Using the jumper wires, connect the whistle chip (WC) across points A & B and the sound changes.

Project #450
Bird Sounds (IV)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Connect the whistle chip (WC) across points B & C.

Project #451
Bird Sounds (V)

OBJECTIVE: To create bird sounds.

Using the jumper wires, connect the whistle chip (WC) across points C & D.

Project #452
Touch-Control Bird Sound

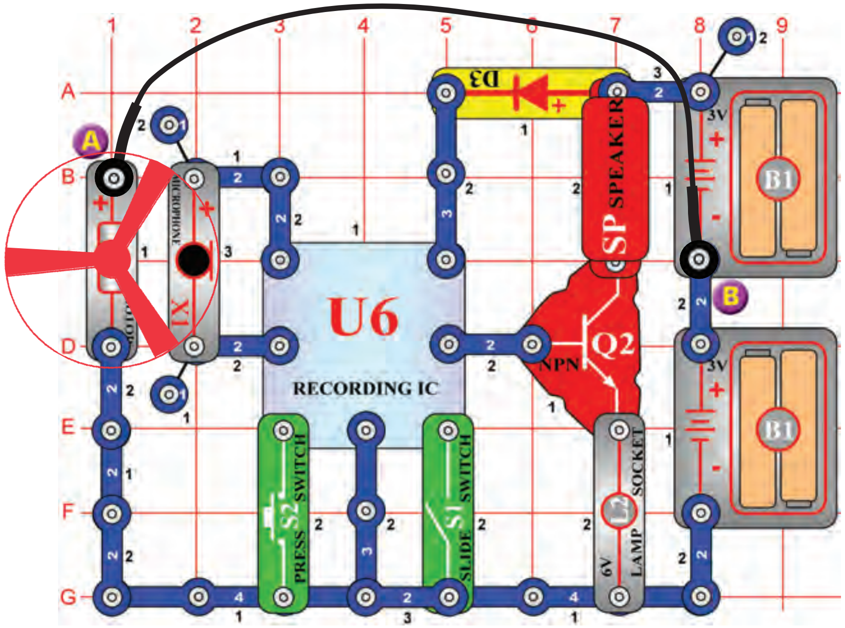
OBJECTIVE: Show variations of project #447.

Use the circuit in project #447. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes. With the photoresistor installed, redo projects #448 - 451.

☐ Project #453

Motor Sound Recording

OBJECTIVE: Build a circuit that records the sound of the motor spinning.



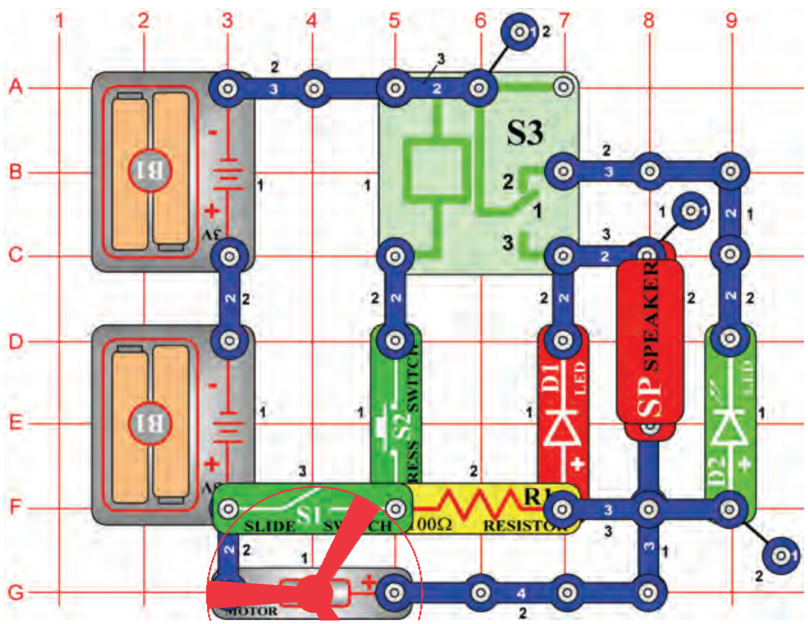
Placing the motor (M1) (with the fan attached) next to the microphone (X1) enables you to record the sound as it spins. Turn off and then turn on the switch (S1). After the two beeps, turn off the slide switch (S1) again. Remove the jumper wire connected across points A & B and press the press switch (S2) to hear the recording. The lamp (L2) is used to limit the current and will not light.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #454

Motor Sound Indicator

OBJECTIVE: To build a circuit that generates sound as a motor is spinning.

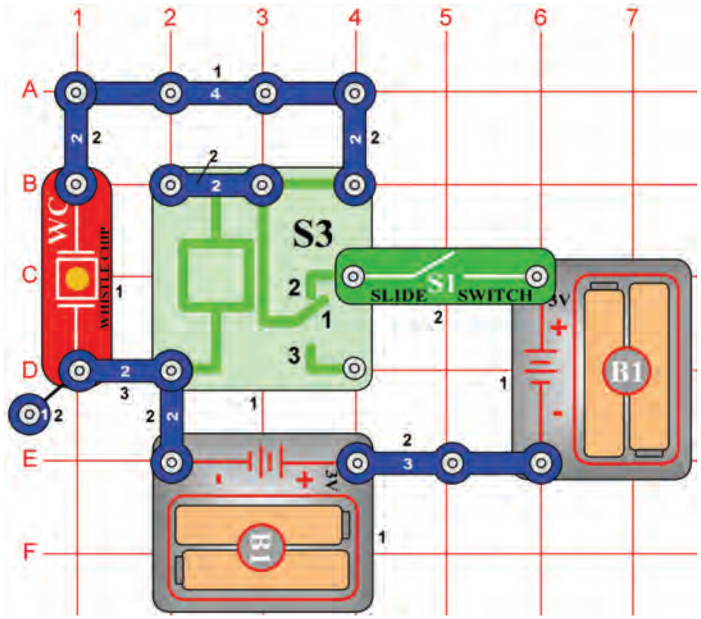


Turn off the switch (S1). There is no power; the LED's and motor are off. Now turn on the switch (S1). Only the green LED (D2) lights, indicating power to the circuit. Press the switch (S2). The motor spins, the red LED (D1) lights, and you hear the motor sound from the speaker (SP).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #455 — Relay & Buzzer

OBJECTIVE: Use the whistle chip and relay to make sound.



Turn on the slide switch (S1) and the relay (S3) opens and closes continuously. This creates an AC voltage across the whistle chip (WC), causing it to vibrate and sound.

Project #456 — Relay & Speaker

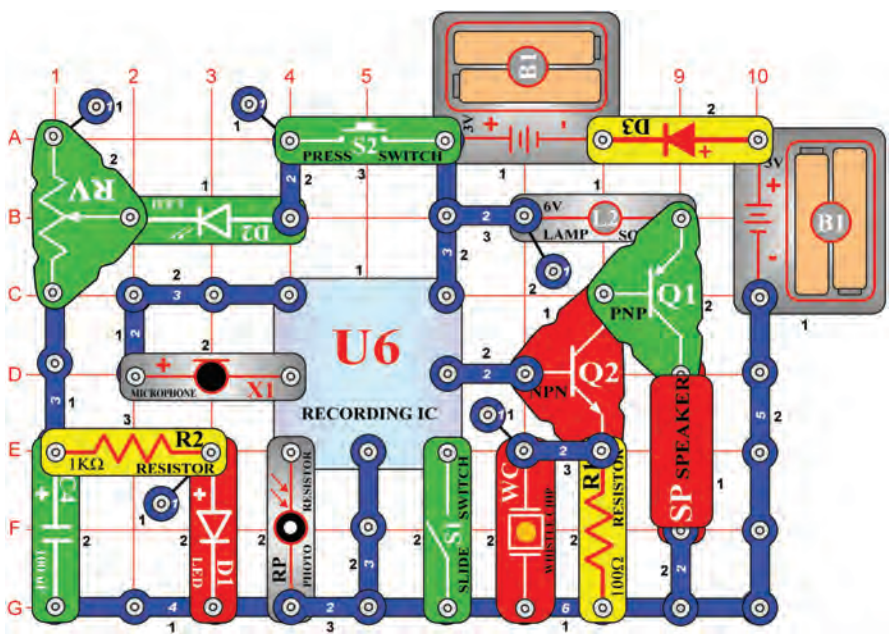
OBJECTIVE: Use the speaker and relay to make sound.

Use the circuit from project #455. Replace the whistle chip (WC) with the speaker (SP). Turn on the slide switch (S1) and now you generate a louder sound using the speaker.

Next, replace the whistle chip (WC) with the 6V lamp (L2). Turn on the slide switch (S1) and the lamp lights.

Project #457 — Electronic Playground

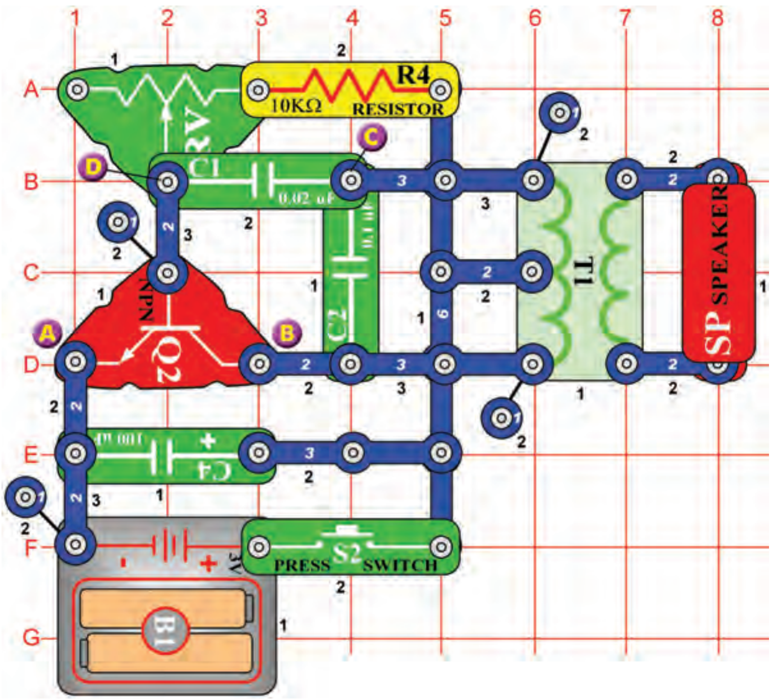
OBJECTIVE: To see how much fun electronics can be.



Uncover the photoresistor (RP) to play a recorded message followed by music, cover it to stop the music.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Set the lever on the adjustable resistor (RV) down (towards the microphone). Push and release the press switch (S2); the green LED (D2) flashes once while the red LED (D1) stays on longer. The LEDs will be brighter if your batteries are new.



Project #458
Electronic Cat

OBJECTIVE: To create the sound of a cat.

Set the adjustable resistor (RV) to the far left. Press and release the switch (S2). You should hear the sound of a cat from the speaker (SP). Now adjust the resistor and hear the different sounds.

Project #459
Electronic Cat (II)

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Connect the whistle chip (WC) across points A & B. Press and release the the switch (S2). You hear sound from the whistle chip and speaker (SP). Adjust the resistor (RV) and hear the different sounds.

Project #460
Electronic Cat (III)

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Using the jumper wires, connect the whistle chip (WC) across points B & C. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #461
Electronic Cat (IV)

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Connect the whistle chip (WC) across points C & D. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #462
Buzzer Cat

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Remove the speaker (SP) and connect the whistle chip (WC) across points A & B. Press and release the press switch (S2) to hear the sounds.

Project #463
Buzzer Cat (II)

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Remove the speaker (SP) and, using the jumper wires, connect the whistle chip (WC) across points B & C. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #464
Buzzer Cat (III)

OBJECTIVE: Show variations of project #458.

Use the circuit in project #458. Remove the speaker (SP) and connect the whistle chip (WC) across points C & D. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

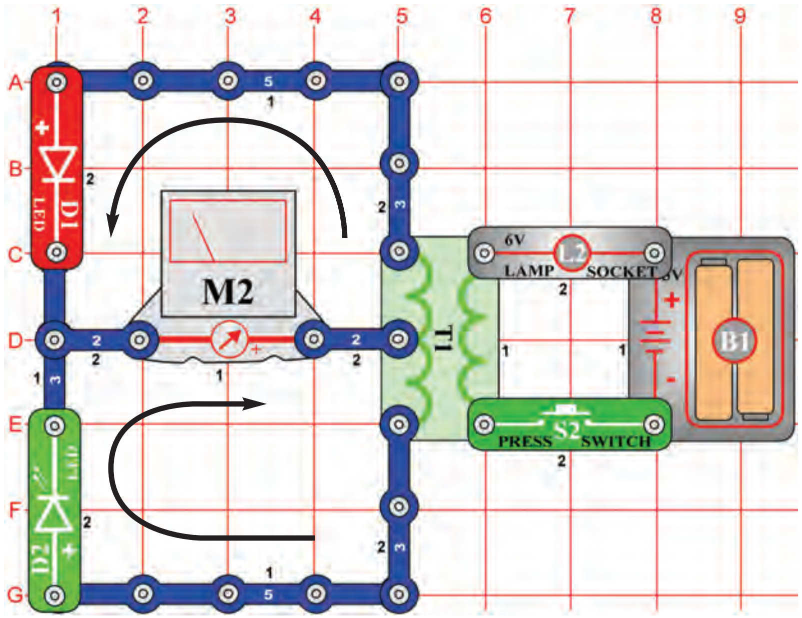
Project #465
Lazy Cat

OBJECTIVE: Show variations of project #458.

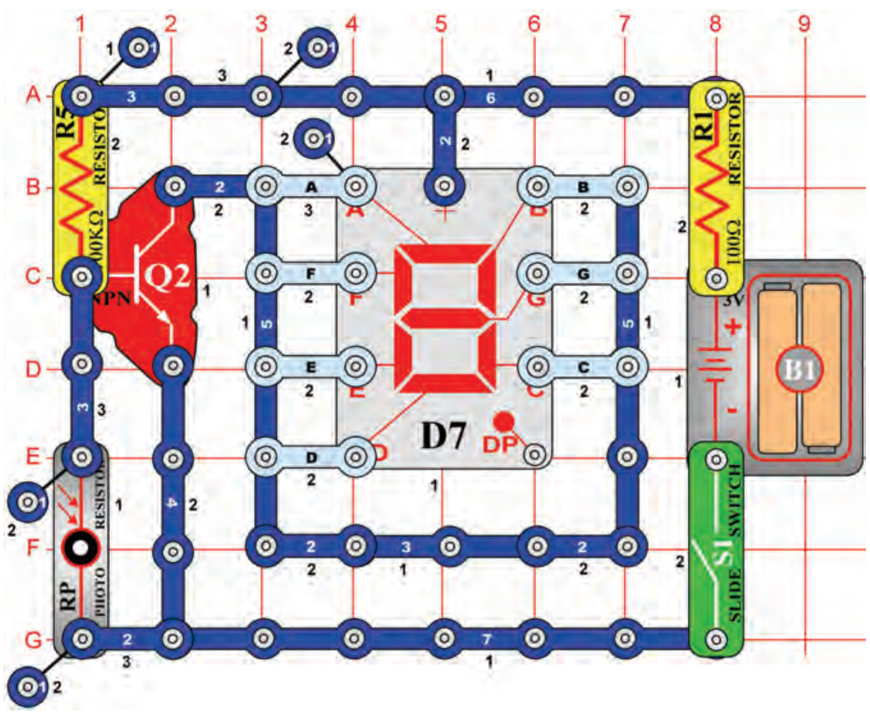
Use the circuit in project #458. Replace the 100μF capacitor (C4) with 470μF (C5). Repeat projects #459-464 and hear 7 different sounds.

Project #466 Meter Deflection (II)

OBJECTIVE: To build change the direction in which current flows.



Compare this circuit to project #358, which has the LED (D1 & D2) positions reversed. This changes the direction that current can flow. Set the meter (M2) to the LOW (or 10mA) scale. Press the press switch (S2) and now the meter deflects to the left.



Project #467 Automatic Display #1

OBJECTIVE: Construct a light-controlled display.

Connect segments B & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 1 lights.

Project #468 Automatic Display #2

OBJECTIVE: Light the number 2 using a light-controlled display.

Use the circuit from project #467. Connect A, B, G, E, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 2 lights.

Project #469

Automatic Display #3

OBJECTIVE: Light the number 3 using a light-controlled display.

Use the circuit from project #467. Connect A, B, G, C, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 3 lights.

Project #470

Automatic Display #4

OBJECTIVE: Light the number 4 using a light-controlled display.

Use the circuit from project #467. Connect B, G, C, & F to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 4 lights.

Project #471

Automatic Display #5

OBJECTIVE: Light the number 5 using a light-controlled display.

Use the circuit from project #467. Connect A, C, F, G, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 5 lights.

Project #472

Automatic Display #6

OBJECTIVE: Light the number 6 using a light-controlled display.

Use the circuit from project #467. Connect A, C, D, E, F, & G to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 6 lights.

Project #473

Automatic Display #7

OBJECTIVE: Light the number 7 using a light-controlled display.

Use the circuit from project #467. Connect A, B, & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 7 lights.

Project #474

Automatic Display #8

OBJECTIVE: Light the number 8 using a light-controlled display.

Use the circuit from project #467. Connect A, B, C, D, E, F & G to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 8 lights.

Project #475

Automatic Display #9

OBJECTIVE: Light the number 9 using a light-controlled display.

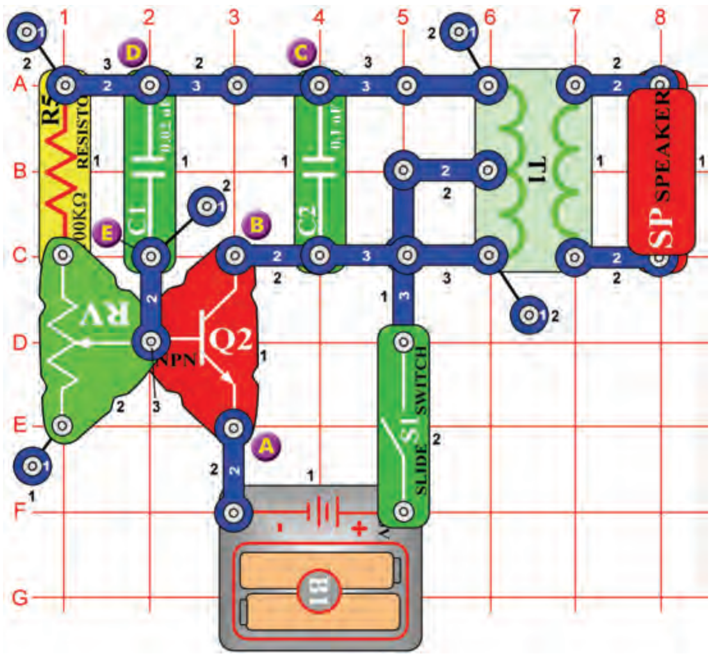
Use the circuit from project #467. Connect A, B, D, F, G, & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 9 lights.

Project #476

Automatic Display #0

OBJECTIVE: Light the number 0 using a light-controlled display.

Use the circuit from project #467. Connect A, B, C, D, E & F to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 0 lights.



Project #477
Variable Oscillator

OBJECTIVE: To change the tone using the adjustable resistor.

Set the adjustable resistor (RV) to the bottom position. Turn on the slide switch (S1) and you should hear sound from the speaker (SP). Adjust the resistor to hear the different sounds.

Project #478
Variable Oscillator (II)

OBJECTIVE: To change the tone using the adjustable resistor.

Use the circuit in project #477. Connect the whistle chip (WC) across points A & B and adjust the resistor (RV). You should hear a higher tone. This is generated by the whistle chip (WC).

Project #479
Variable Oscillator (III)

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Connect the whistle chip (WC) across points B & C and adjust the resistor (RV).

Project #480
Variable Oscillator (IV)

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Connect the whistle chip (WC) across points D & E and adjust the resistor (RV).

Project #481
Photo Variable Resistor

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes. Adjust the resistor (RV) to make more sounds.

Project #482
Variable Whistle Chip Oscillator

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477, remove the speaker (SP). Make three more sounds by placing the whistle chip (WC) across points, A & B, B & C, and D & E.

Project #483
Slow Adjusting Tone

OBJECTIVE: Show variations of project #477.

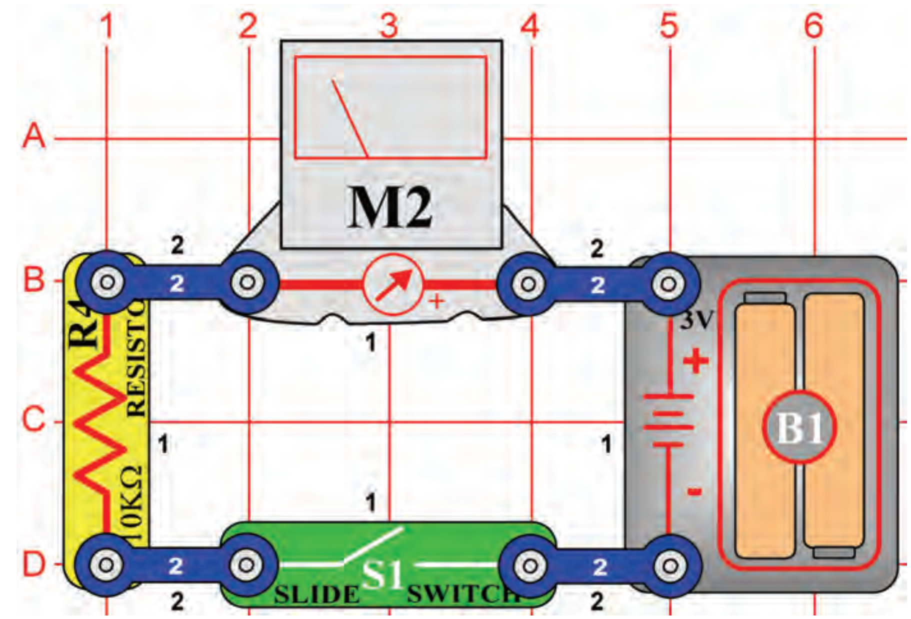
Use the circuit in project #477. Place the 10μF capacitor (C3) (+ towards the top) directly over the .02μF capacitor (C1). A tone is generated once or twice per second, depending on the resistor setting.

Project #484
Slow Adjusting Tone (II)

OBJECTIVE: Show a variation of project #483.

Use the circuit in project #483. Replace the 10μF capacitor (C3) with the 100μF capacitor (C4) and the tone is much slower. To make it even slower, replace the 100μF capacitor (C4) with the 470μF capacitor (C5).

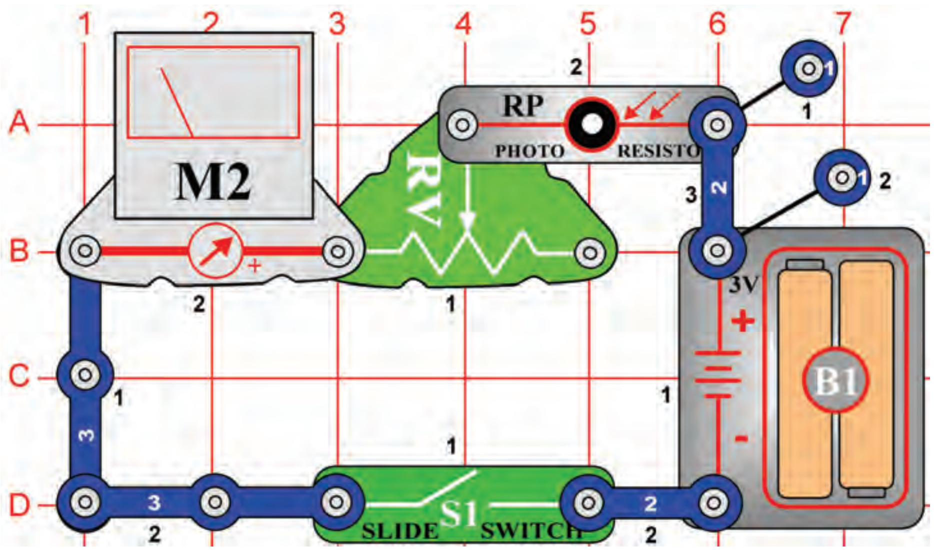
Project #485 Fixed-Current Path



OBJECTIVE: To make a fixed-current path.

Set the meter (M2) to the LOW (or 10mA) setting. The meter indicates the amount of current in the circuit. Turn on the switch (S1), the needle deflects indicating the amount of current. The 10kΩ resistor limits the current, otherwise the meter could be damaged.

Project #486 Simple Illumination Meter

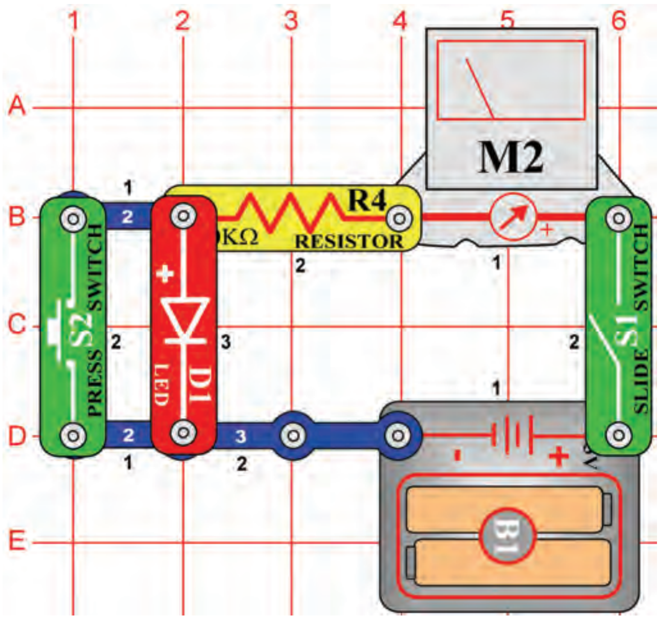


OBJECTIVE: To make a simple light meter.

Set the meter (M2) to the LOW (or 10mA) setting. Using only a few parts, you can make a simple light meter. The amount of light changes the resistance of the photoresistor (RP), which affects the current though the meter. As light increases, the resistance drops and the meter deflects to the right. Decreasing the light, the meter deflects to the left, indicating less current.

Set the adjustable resistor (RV) to the far left and turn on the slide switch (S1). The circuit is now very sensitive to light. Wave your hand over the photoresistor (RP) and the meter deflects to the left, almost to zero. Move the adjustable resistor to the far right and see how less sensitive the circuit is to light now.

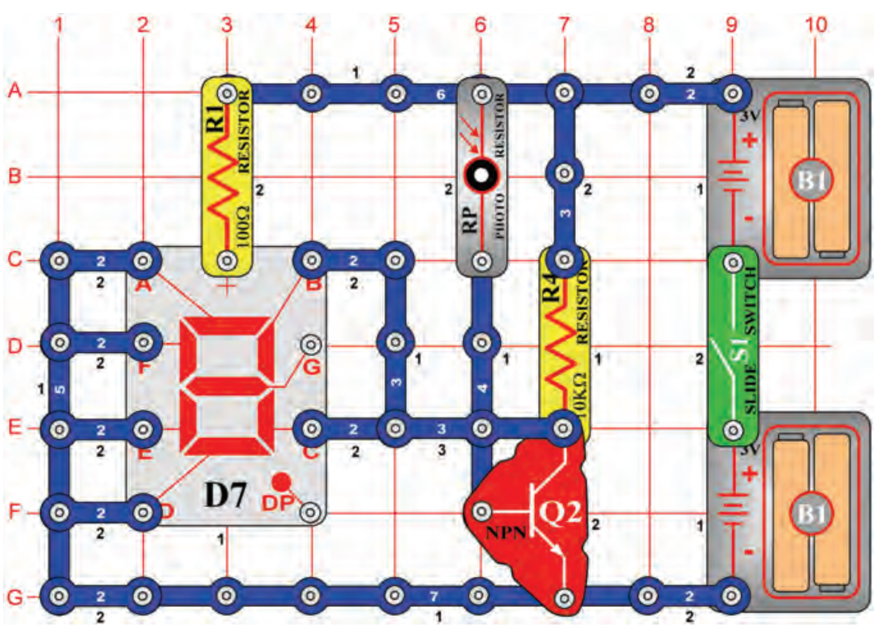
Project #487 LED Voltage Drop



OBJECTIVE: To measure the voltage drop across diodes.

Set the meter (M2) to the LOW (or 10mA) setting. Turn on the slide switch (S1) and the LED (D1) lights as the meter deflects to the middle of the scale. The sum of the voltage drop across each components equals the battery voltage. Bypass the LED by pressing the switch (S2). The voltage across the 10kΩ resistor increases, as shown by the meter deflecting more to the right. Replace the red LED with the green LED (D2) and then the diode (D3), to see the different voltage drops.

Project #488 Open/Closed Door Indicator



OBJECTIVE: To make a circuit that indicates whether a door is open or closed.

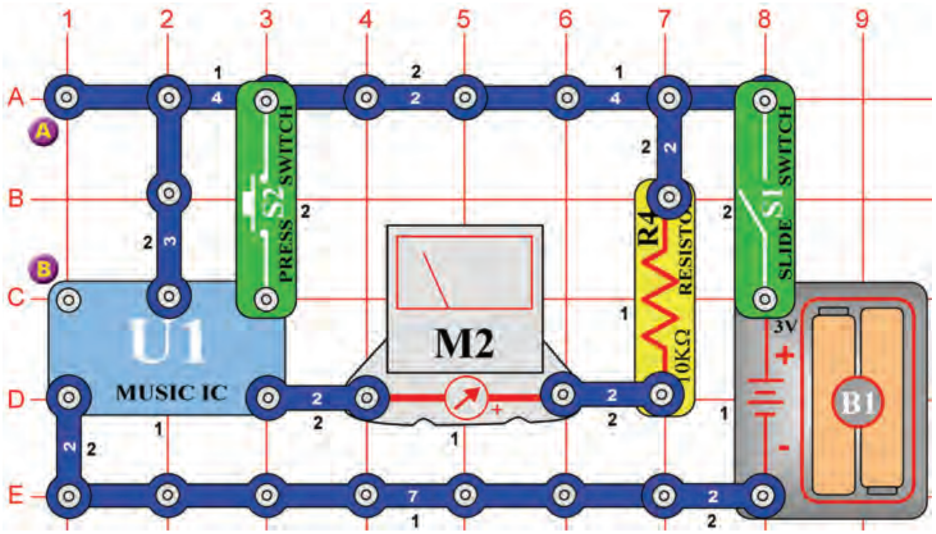
Using the photoresistor (RP) you can build a circuit that indicates if a door is open or closed. When the door is open and light is present, the letter “O” lights. When the door is closed and the room is dark, the letter C lights.

The photoresistor turns the transistor (Q2) on or off, depending on the amount of light in the room. When the transistor is on (light present), segments B & C connect to the (–) side of the batteries and letter “O” lights. When the room is dark, the transistor is off and the letter “C” lights. Segments B & C are connected to the transistor.

Turn the slide switch (S1) on and the letter “O” should light. Cover the photoresistor, simulating closing the door, and the letter “C” lights.

Project #489 Hand-control Meter

OBJECTIVE: To understand music deflection.



Set the meter (M2) to the LOW (or 10mA) setting. Instead of driving a speaker (SP) with the music IC (U1), you can see it by using the meter. Turn on the slide switch (S1) and the meter deflects according to the rhythm of music. After the music stops, hold down the press switch (S2) to make it continue.

Project #490 Light-control Meter

OBJECTIVE: To control the circuit using light.

Use the circuit in project #489. Replace the press switch (S2) with the photoresistor (RP). The music IC (U1) outputs a signal, as long as a light is present on the photoresistor. The photoresistor is like a short, connecting the pin to the battery. When the song repeats, cover the photoresistor with your hand, the resistance goes up, and the music stops.

Project #491 Electric-control Meter

OBJECTIVE: To start the circuit using an electric motor.

Use the circuit in project #489. Place the motor (M1) across points A & B. Turn on the slide switch (S1) and the meter (M2) deflects and swings according to the rhythm of music. When deflection stops, rotate motor to start the music again. The voltage generated by the motor triggers the IC again.

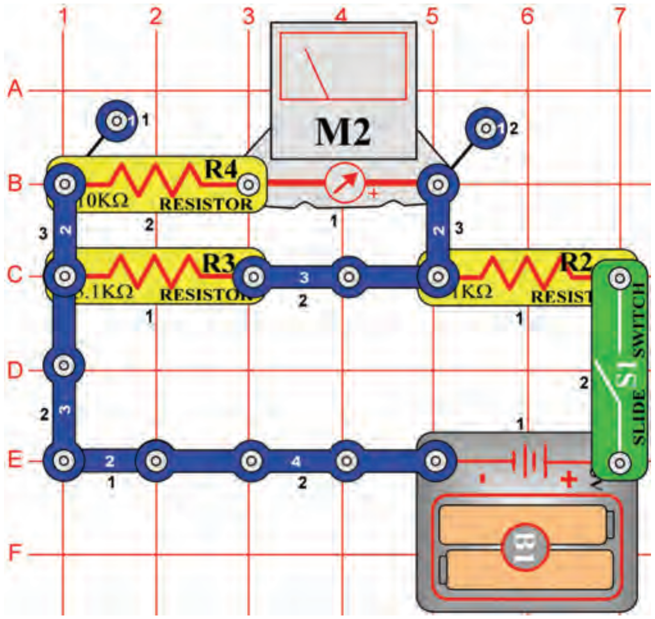
Project #492 Sound-control Meter

OBJECTIVE: To start the circuit by using the whistle chip.

Use the circuit in project #489. Place the whistle chip (WC) across points A & B. Turn on the slide switch (S1) and the meter (M2) deflects and swings according to the rhythm of music. When deflection stops, clap your hands next to the whistle chip, the music plays again. The clapping sound vibrates the plates in the whistle chip, creating the voltage needed to trigger the IC.

Project #493 — Fixed-Voltage Divider

OBJECTIVE: To make a simple voltage divider.

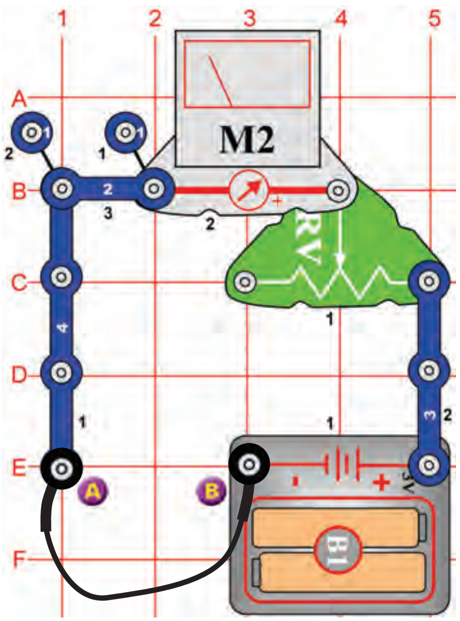


Set the meter (M2) to the LOW (or 10mA) scale. This circuit is a simple voltage divider with parallel load resistors. The voltage across resistors R3 & R4 is the same. The current through both paths are different, due to the resistor values. Since resistor (R3) (5.1kΩ) is half the value of resistor (R4) (10kΩ), twice the current flows through R3.

The lights in a house are an example of this type of circuit. All are connected to the same voltage, but the current is dependent on the wattage of the bulb.

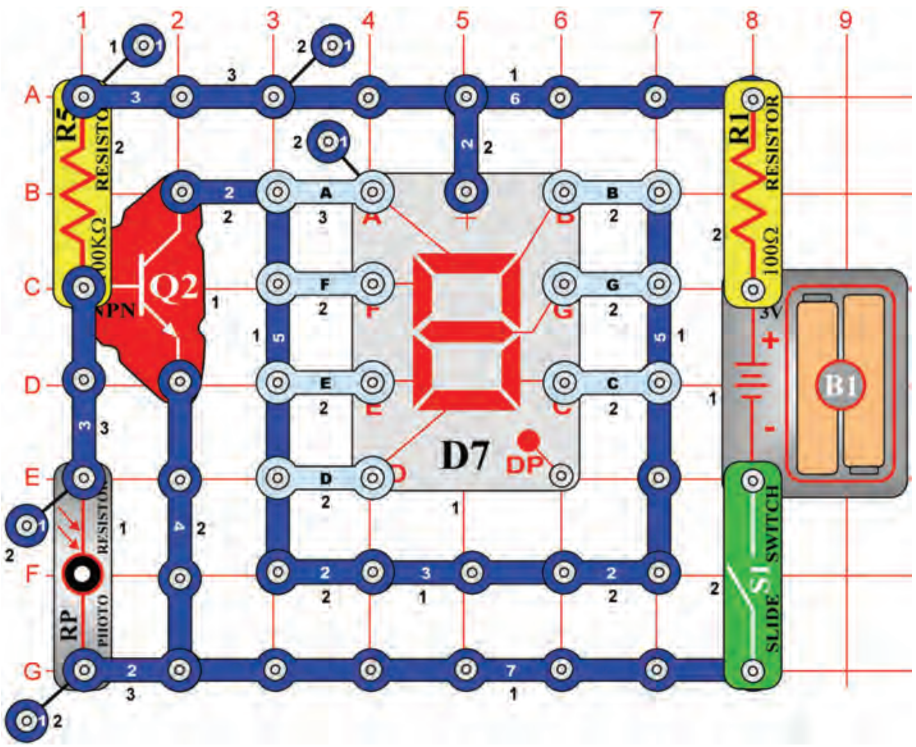
Project #494 — Resistor Measurement

OBJECTIVE: To make a resistor checker.



Set the meter (M2) to the LOW (or 10mA) setting. Connect the jumper wire to points A & B. Adjust the adjustable resistor (RV) so the meter deflects to 10. The resistance between points A & B is zero. Remove the jumper wire and put the 100Ω resistor (R1) across points A & B. The meter deflects to the 10, indicating a low resistance. Now replace resistor (R1) with the other resistors. The meter will display different readings for each resistor.

To learn more about how circuits work, visit www.snapcircuits.net or page 62 to find out about our Student Guides.



Project #495
Automatic Display Letter "b"

OBJECTIVE: To construct a light-controlled display for lower case letters.

Connect C, D, E, F & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "b" lights.

Project #496
Automatic Display Letter "c"

OBJECTIVE: To light the letter "c" using a light-controlled display.

Use the circuit from project #495. Connect E, D, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "c" lights.

Project #497
Automatic Display Letter "d"

OBJECTIVE: To light the letter "d" using a light-controlled display.

Use the circuit from project #495. Connect B, C, D, E, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "d" lights.

Project #498
Automatic Display Letter "e"

OBJECTIVE: To light the letter "e" using a light-controlled display.

Use the circuit from project #495. Connect A, B, D, E, F, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "e" lights.

Project #499
Automatic Display Letter "h"

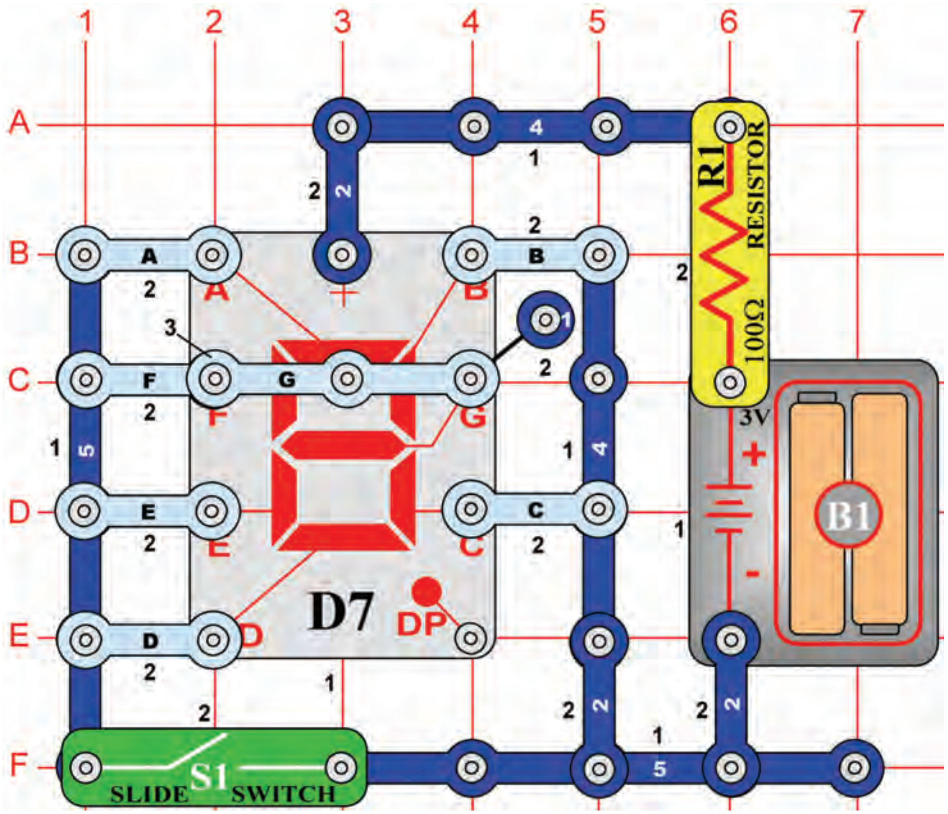
OBJECTIVE: To light the letter "h" using a light-controlled display.

Use the circuit from project #495. Connect F, E, C, & G to the circuit. Turn on the slide switch (S1) the display should be off. Place your hand over the photoresistor (RP), now the letter "h" lights.

Project #500
Automatic Display Letter "o"

OBJECTIVE: To light the letter "o" using a light controlled display.

Use the circuit from project #495. Connect C, D, E, and G to the circuit. Turn on the slide switch (S1) the display should be off. Place your hand over the photoresistor (RP), now the letter "o" lights.



Project #501

Hand-Control Display 1 & 4

OBJECTIVE: Display numbers 1 or 4 using the slide switch.

Connect segments B, C, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 4.

Project #502

Hand-Control Display 1 & 0

OBJECTIVE: Display numbers 1 or 0 using the slide switch.

Connect segments A, B, C, D, E, & F as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 0.

Project #503

Hand-Control Display 1 & 7

OBJECTIVE: Display numbers 1 or 7 using the slide switch.

Connect segments A, B, & C as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 7.

Project #504

Hand-Control Display 1 & 8

OBJECTIVE: Display numbers 1 or 8 using the slide switch.

Connect segments A, B, C, D, E, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 8.

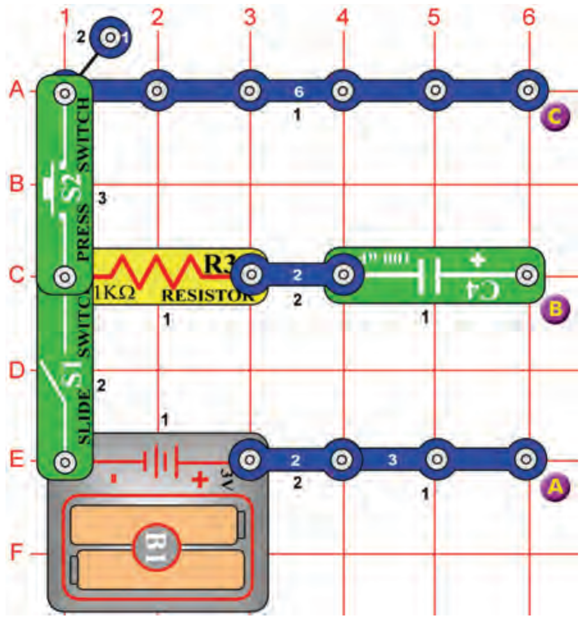
Project #505

Hand-Control Display 1 & 9

OBJECTIVE: Display numbers 1 or 9 using the slide switch.

Connect segments A, B, C, D, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 9.

☐ # Project #506



Monitor Capacitor Charging & Discharging

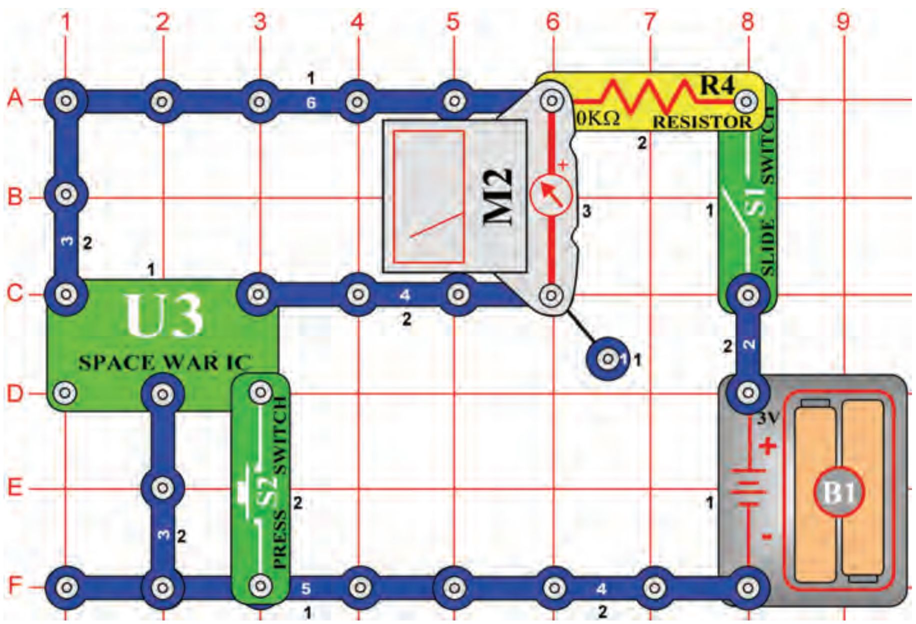
OBJECTIVE: View charging and discharging a capacitor.

Using the meter (M2), we can monitor the charging and discharging of a capacitor. First turn off the switch (S1).

Charging: Connect the meter (M2) to points A & B (positive pole downward). Turn on the switch (S1). The 100μF capacitor (C4) charges and the meter deflects, slowly returning to zero.

Discharging: Connect the meter to points B & C (positive pole downward). Press the switch (S2). The capacitor discharges and the meter deflects, slowly returning to zero.

☐ # Project #507



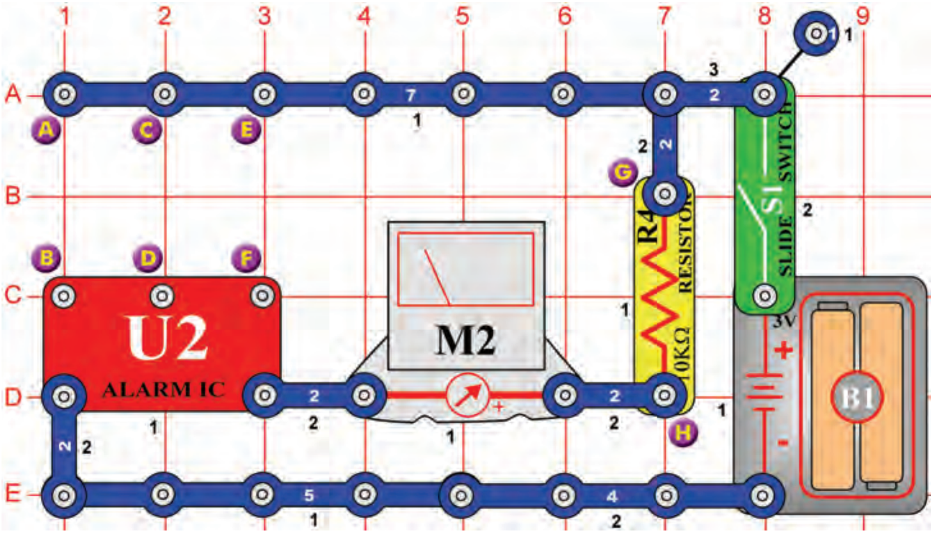
Hand-Control Space Meter

OBJECTIVE: Using the meter with the space war IC.

Set the meter (M2) to the LOW (or 10mA) setting. This is another circuit using the meter to monitor the output of an IC.
Turn on the switch (S1). Press switch (S2) to start the circuit. As the space war IC (U3) outputs a signal, the meter will deflect. When the circuit stops, start it again by pressing switch (S2).

☐ Project #508

Rhythm Swinging Meter



OBJECTIVE: Use the meter with the alarm IC.

Set the meter (M2) to the LOW (or 10mA) setting. Connect 3-snap wires to terminals E & F, and C & D. Turn on the slide switch (S1) and the meter swings rhythmically.

☐ Project #509

Police Car Sound with Whistle Chip

OBJECTIVE: Show variations of project #508.

Use the circuit in project #508. Connect the whistle chip (WC) to points G & H. Connect a 3-wire snap to the terminals C & D and turn on the switch (S1).

☐ Project #510

Fire Engine Sound with Whistle Chip

OBJECTIVE: Show variations of project #508.

Connect 3-wire snaps to terminals C & D and A & B. Connect the whistle chip (WC) across points G & H. You should hear a fire engine sound generated by the alarm IC (U2).

☐ Project #511

Ambulance Sound with Whistle Chip

OBJECTIVE: Show variations of project #508.

Connect a 3-wire snap to terminals C & D. Connect the whistle chip (WC) across points G & H. Connect a jumper wire to terminals B & H. You should hear an ambulance sound generated by the alarm IC (U2).

OTHER SNAP CIRCUITS® PRODUCTS!

For a listing of local toy retailers who carry Snap Circuits®, please visit **www.elenco.com** or call us toll-free at (800) 533-2441. For Snap Circuits® upgrade kits, accessories, additional parts, and more information about your parts, please visit **www.snapcircuits.net**.

Upgrade Kit

Model UC-80

Build 250 Additional Projects

Including:
- Strobe light
- Electromagnetism
- Transistor AM radio
- Rechargeable battery
- Solar batteries
- Mega pulser and flasher
- Paperclip compass

Contains 10 New Parts

Including:
- Solar cell
- Electromagnet
- Vibration switch
- Two-spring socket
- Bag of paperclips

- Plus all experiments contained in the 500-in-1 (SC-500)!
- Includes CI-73 Computer Interface!

Put your circuits in motion!

Deluxe Snap Rover®

Model SCROV-50

Introducing the next generation of the RC Snap Rover®! This version includes a disc launcher, digital voice recorder, and music sounds. Over 50 parts allow you to complete over 40 additional projects.

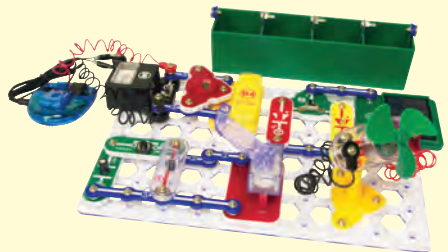
- **Includes 30 parts**
- **Build over 20 projects**
- **Full-color assembly manual**
- **Sound effects**

Snap Circuits® Green

Alternative Energy Kit

Model SCG-125

Learn about energy sources and how to "think green". Build over 125 projects and have loads of fun learning about environmentally-friendly energy and how the electricity in your home works. Includes full-color manual with over 100 pages and separate educational manual. This educational manual will explain all the forms of environmentally-friendly energy including: geothermal, hydrogen fuel cells, wind, solar, tidal, hydro, and others. Contains over 40 parts.



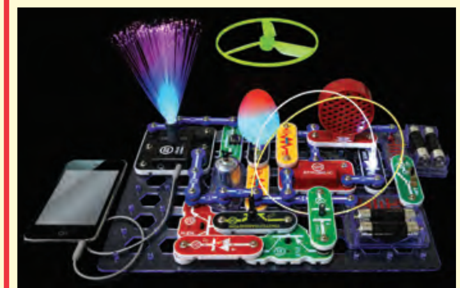
Snap Circuits® LIGHT

Model SCL-175

Build over 175 projects!

Contains over 60 parts

Features:
- Infrared detector
- Strobe light
- Color changing LED
- Glow-in-the-dark fan
- Strobe integrated circuit (IC)
- Fiber optic communication
- Color organ controlled by iPod® or other MP3 player, voice, and fingers.



Motion Detector

Model SCP-03

Whenever somebody walks in front of the Motion Detector, the sound of a laser comes out of the speaker!

Snaptricity

Model SCBE-75

Build Over 75 Projects

Learn how electricity and magnetism can be used to make each other, learn about magnetic fields, how the electricity in your home works, how switches control the electricity to the lights in your home, and how series and parallel circuits affect electricity.

Over 40 parts including: Meter, electromagnet, motor, lamps, switches, fan, compass, and electrodes.

Educational Toy: Projects that relate to electricity in the home and magnetism and how it is used. Build over 75 projects.

If you want to enhance your Snap Circuits® experience and get even smarter, then try

Snap Circuits® Student Guide

Part # 753307

For use with SC-500

Educational Series - teaches Basic Electricity and Electronics in the everyday world using our Learn By Doing® concept!

80 full-color pages, and written with the help of educators.

Custom Storage Case

Model SNAPCASE7

Heavy duty plastic case with 2 custom foam inserts for housing your Snap Circuits® parts. Easy to identify missing components. Also includes a separate small case to hold the smaller loose parts.

(for use with SC-500)

Expansion Parts

AC Power Supply

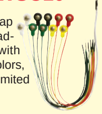
Part # AC-SNAP

Replaces the batteries in Snap Circuits®.

Snap-to-Pin Set

Part # 9JWSC10

Lets you connect Snap Circuits® to a bread-board. 10 wires with reinforced pins, 5 colors, 10" length, and unlimited possibilies!



Two-spring Socket

Part # ?1

Three-spring Socket

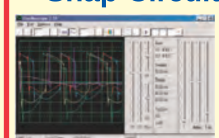
Part # ?Q

Eight-Pin IC Socket

Part # ?U8

Computer Interface for Snap Circuits®

Model CI-73



Sample Screen of Computer Experiment

With this module you will also learn about and use an oscilloscope and spectrum analyzer, as you build over *73 BONUS EXPERIMENTS* using your Windows-based PC. Comes with all of the interface parts you need and the software. Great for introducing electronics through a computer. Works with all versions of our Snap Circuits®.

Acts as a Scope and Allows You to See the Signals in the Circuit.

OTHER FUN ELENCO® PRODUCTS

RC Car Kit

Model FUN-875

Your Turbo King Car will be built from the ground up. You'll learn all about gears, motors, printed circuit boards, and integrated circuits from our detailed assembly and training manual. You will construct each section, explore the circuitry and troubleshoot it.

Titan Tank Kit

Model 21-531N

The Titan Tank is an infrared remote control kit. Its microprocessor provides four different channels that allow up to four Titans to fight each other at the same time. Makes a sound when shooting and when it is hit. The Titan moves using six wheels that can move forward, backward, right and left.

300-in-1 Project Lab

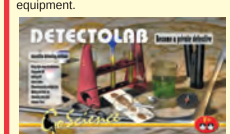
Model MX-908

This lab has everything you need to build 300 exciting electronic projects. It uses spring and breadboard hook-up methods and includes an easy-to-read, illustrated, lab-style manual. Projects include: Transistor Radio, Burglar Alarm, Metal Detector, and much more!

Detectolab

Model EDU-7080

Investigate, analyze, decipher and solve the crime! Over 65 activities with fingerprints, secret messages, chromatography, cipher codes, identity detection and more... Kit includes 30X microscope and necessary lab equipment.



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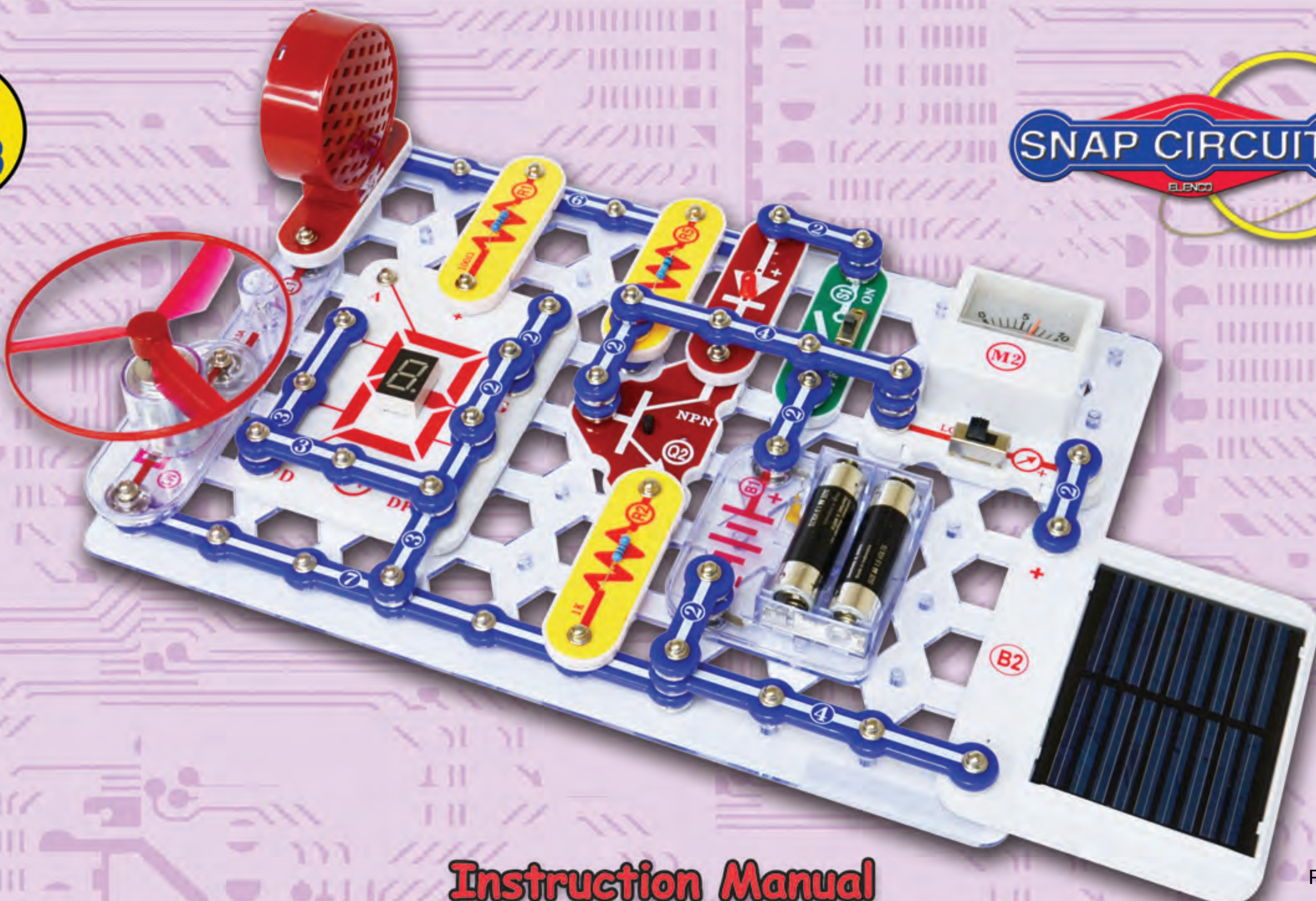
e-mail: elenco@elenco.com

ELECTRONIC SNAP CIRCUITS®

Projects 512-692

AGE 8 - 108



Project 526

Instruction Manual

ELENCO®

REV-E Revised 2012 753292

Table of Contents

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.

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.

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.
5. If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.

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 4 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 alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new 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.
- Do not connect batteries or battery holders in parallel.

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.

Review of How To Use It (See page 3 of the Projects 1-101 manual for more details.)

The Snap Circuits® kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

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.

A large clear plastic base grid is included with this kit to help keep the circuit block together. The base has rows labeled A-G and columns labeled 1-10.

Install two (2) "AA" batteries (not included) in the battery holder (B1). The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the L1 lamp socket, and the 6V bulb in the L2 lamp socket.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

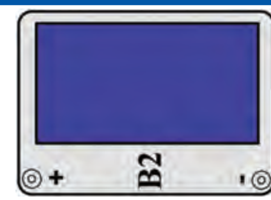
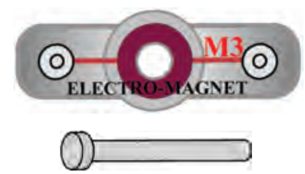
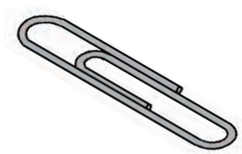
Some circuits use the red and black jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

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.

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

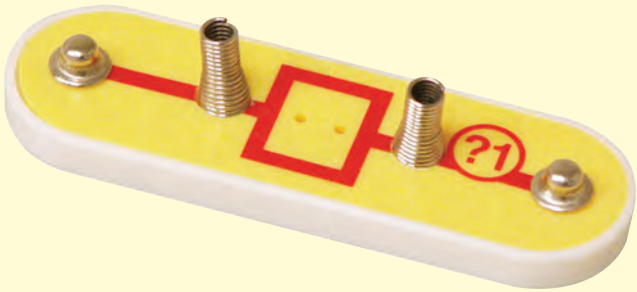
Note: There are additional part lists in your other project manuals. Part designs are subject to change without notice.

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.

Qty.	ID	Name	Symbol	Part #
❐ 1	B2	Solar Cell		6SCB2
❐ 1 ❐ 1	M3	Electromagnet Iron Core Rod		6SCM3 6SCM3B
❐ 1	S4	Vibration Switch		6SCS4
❐ 1		Bag of Paperclips		6SCM3P
❐ 1	?1	Two-spring Socket		6SCPY1

You may order additional / replacement parts at our website: www.snapcircuits.net

About the TWO-SPRING SOCKET (?1)

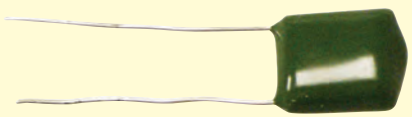


The two-spring socket (?1) just has two springs, and won't do anything by itself. It is not used in any of the experiments. It was included to make it easy to connect other electronic components to your Snap Circuits®. It should only be used by advanced users who are creating their own circuits.

There are many different types of electronic components and basic parts like resistors and capacitors have a wide range of available values. For example, Snap Circuits® includes five fixed-value resistors (100Ω, 1KΩ, 5.1KΩ, 10KΩ, and 100KΩ). This is a very limited choice of values, and difficult to design circuits with. Snap Circuits® also includes a adjustable resistor (RV), but it is difficult to set this part to a particular value. You can place your resistors in series and parallel to make different values (as is done with the 5.1KΩ and 10KΩ in project #166), but this is also difficult with only five values to choose from.

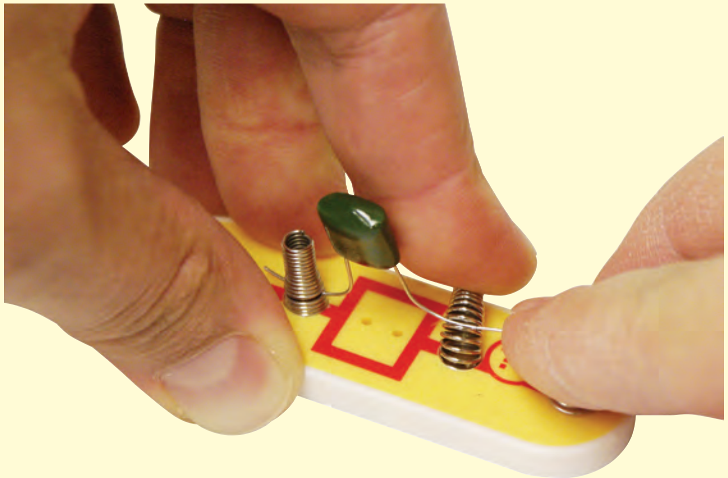
Many customers like to create their own circuits and asked us to include more resistor values with Snap Circuits®. We could have done that, but you would never have enough. And resistors are not very exciting components by themselves. You could try to use your own resistors, but they are difficult to connect since normal electronic parts come with wires on them instead of snaps.

Resistor



Capacitor

The two-spring socket (?1) makes it easy to connect your own resistors (and other parts) to circuits by connecting them between the springs:



Any component with two wires coming from it (called leads) can be connected with the two-spring socket (?1), assuming the leads are long enough. Usually you will connect different values of resistors or capacitors, but other components like LED's, diodes, or coils/inductors can also be used. You can usually find electronic components at any store specializing in electronics.

You can design your own circuits or substitute new parts into the projects in the manuals. For LED's, diodes, or electrolytic capacitors, be sure to connect your parts using the correct polarity or you may damage them. Never exceed the voltage ratings of any parts. Never connect to external voltage sources. ELENCO® IS NOT RESPONSIBLE FOR ANY PARTS DAMAGED BY IMPROPER CIRCUIT DESIGN OR WIRING. **The two-spring socket is only intended for advanced users.**

To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

MORE About Your Snap Circuits® Parts

(Note: There is additional information in your other project manuals).

Our Student Guides give much more information about your parts, along with a complete lesson in basic electronics. See www.snapcircuits.net/learn.htm for more information.

The **solar cell (B2)** contains positively and negatively charged silicon crystals, arranged in layers that cancel each other out. When sunlight shines on it, charged particles in the light unbalance the silicon layers and produce an electrical voltage (about 3V). The maximum current depends on how the type of light and its brightness, but will be much less than a battery can supply. Bright sunlight works best, but incandescent light bulbs also work.

The **electromagnet (M3)** is a large coil of wire, which acts like a magnet when a current flows through it. Placing an iron bar inside increases the magnetic effects. Note that magnets can erase magnetic media like floppy discs.

When shaken, the **vibraton switch (S4)** contains two separate contacts; and a spring is connected to one of them. A vibration causes the spring to move, briefly connecting the two contacts.

The **two-spring socket (?1)** is described on page 3.

A Note on Sun Power

The sun produces heat and light on an immense scale, by transforming Hydrogen gas into Helium gas. This "transformation" is a thermonuclear reaction, similar to the explosion of a Hydrogen bomb. The earth is protected from most of this heat and radiation by being so far away, and by its atmosphere. But even here the sun still has power, since it can spin the motor on your kit and give you sunburn on a hot day.

Nearly all of the energy in any form on the surface of the earth originally came from the sun. Plants get energy for growth from the sun using a process called photosynthesis. People and animals get energy for growth by eating plants (and other animals). Fossil fuels such as oil and coal that power most of our society are the decayed remains of plants from long ago. These fuels exist in large but limited quantity, and are rapidly being consumed. Solar cells will produce electricity as long as the sun is bright, and will have an ever-increasing effect on our lives.

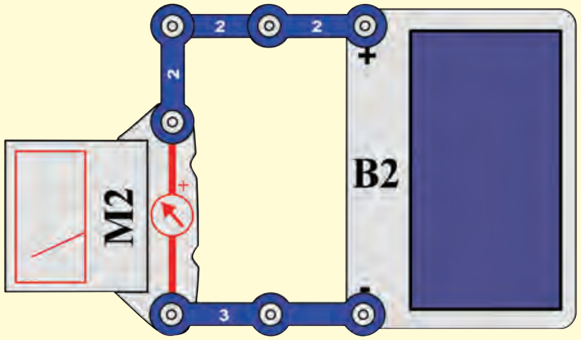
MORE Advanced Troubleshooting (Adult supervision recommended)

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

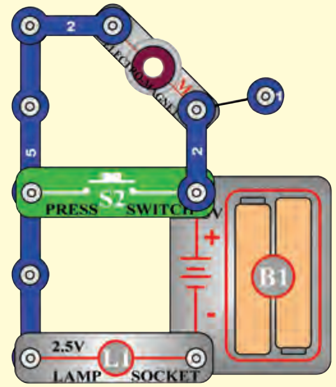
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

1 - 28. Refer to the other project manuals for testing steps 1-28, then continue below.

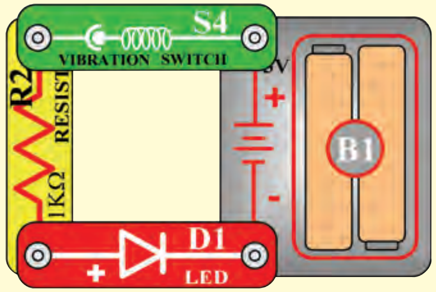
29. **Solar Cell (B2):** Build the mini-circuit shown here and set the meter (M2) to the LOW (or 10mA) setting. Hold the circuit near a lamp and the meter pointer should move.



30. **Electromagnet (M3):** Build the mini-circuit shown here. Lamp (L1) must be dim, and must get brighter when you press the press switch (S2).



31. **Vibration Switch (S4):** Build the mini-circuit shown here and shake the base grid. The LED should go on and off as you shake.



MORE DO's 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, lamp, 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 IC's 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 the speaker, lamp, whistle chip, capacitors, ICs (which must be connected properly), motor, microphone, photo resistor, or fixed resistors.

ALWAYS use the **7-segment display**, LED's, transistors, the high frequency IC, the **SCR**, the antenna, and 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 connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.

ALWAYS connect position capacitors so that the "+" side gets the higher voltage.

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.

ALWAYS **connect ICs, the FM module, and the SCR using configurations given in the projects or as per the connection descriptions for the parts.**

NEVER try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).

NEVER use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.

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

NEVER leave a circuit unattended when it is turned on.

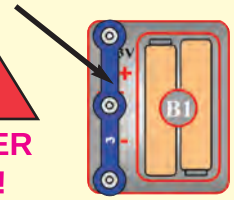
NEVER touch the motor when it is spinning at high speed.

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.

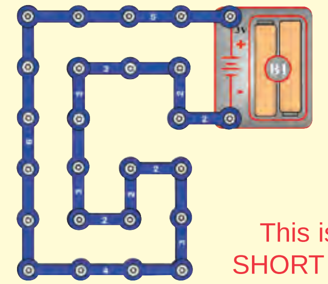
Warning to Snap Rover owners: Do not connect your parts to the Rover body except when using our approved circuits, the Rover body has a higher voltage which could damage your parts.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

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



NEVER DO!

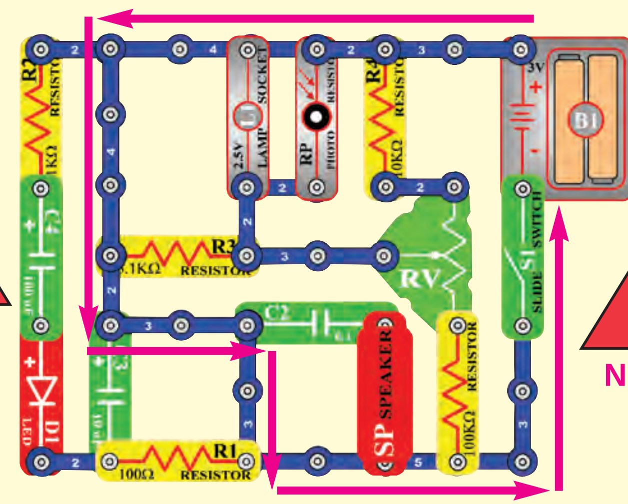


NEVER DO!

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!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.snapcircuits.net/kidkreations.htm**. Send your suggestions to ELENCO®.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.snapcircuits.net/SnapDesigner.doc** or through the **www.snapcircuits.net** web site.

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

Project Listings

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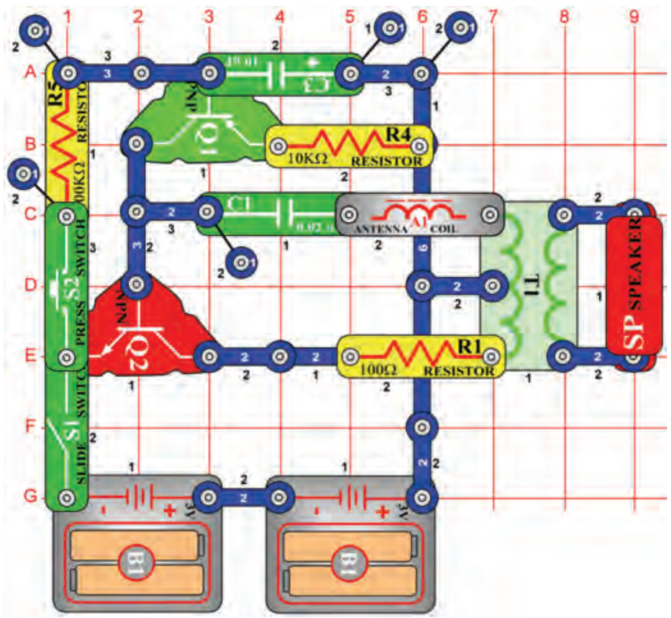
Project Listings

Project #512 Siren

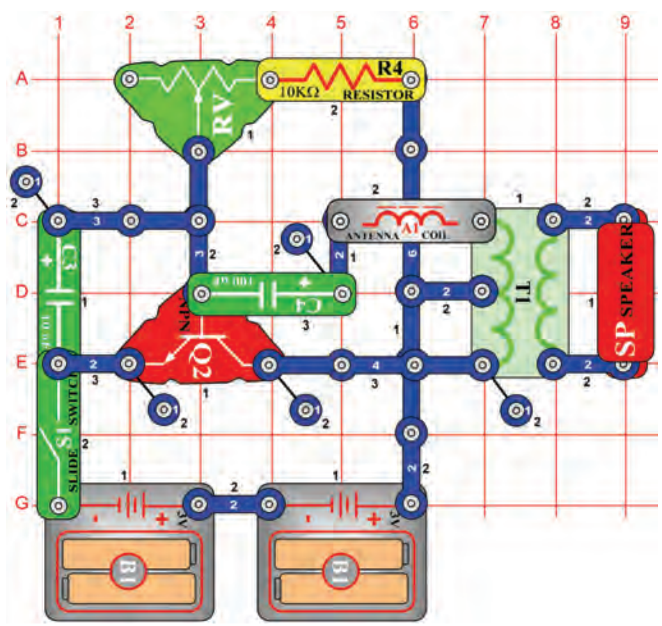
OBJECTIVE: To make a siren that slowly starts up and fades away.



Turn on the slide switch (S1), and then press the press switch (S2) for a few seconds and release. A siren starts up and then slowly fades away as the 10μF capacitor (C3) discharges.

Project #513 Electronic Rain

OBJECTIVE: To make a low-frequency oscillator.



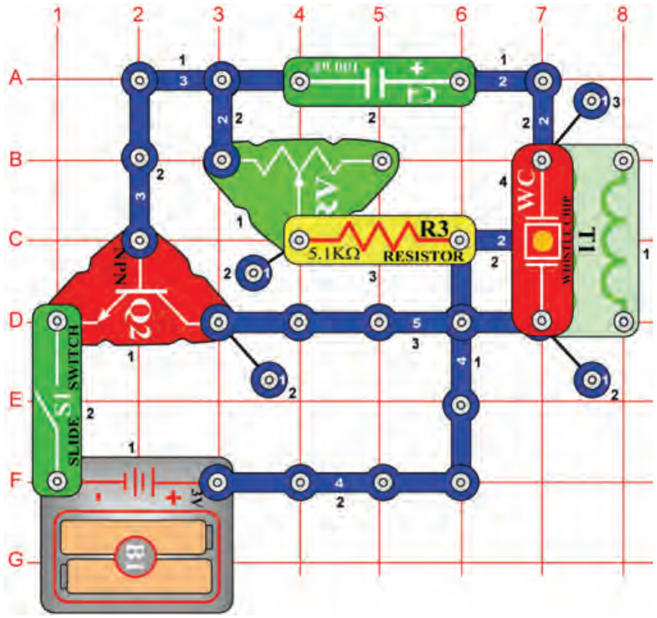
Build the circuit and turn on the slide switch (S1), you hear a sound like raindrops. The adjustable resistor (RV) controls the rain. Turn it to the left to make a drizzle and turn to the right to make the rain come pouring down.

You can replace the 10KΩ resistor (R4) with the 1KΩ (R2) or 5.1KΩ (R3) resistors to speed up the rain.

Project #514

Leaky Faucet

OBJECTIVE: To make a low-frequency oscillator.

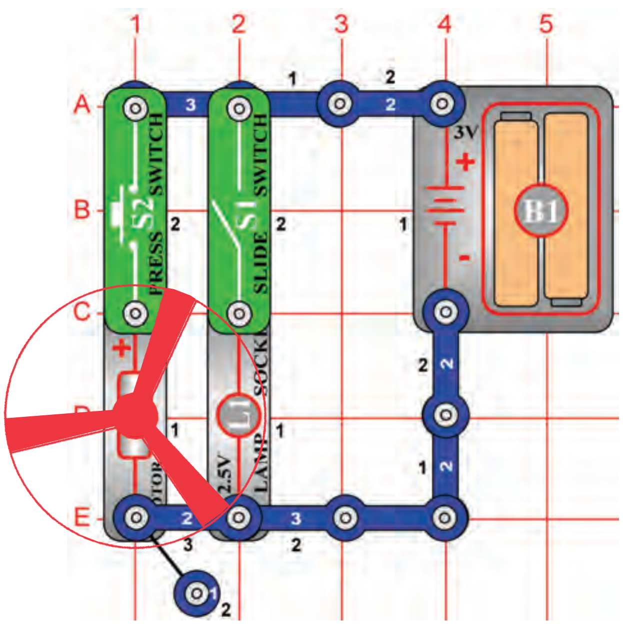


Build the circuit and set the adjustable resistor (RV) control all the way to the right. Turn on the slide switch (S1) and you hear a sound like a faucet dripping. You can speed up the dripping by moving the adjustable resistor control around.

Project #515

Lamp & Fan Independent

OBJECTIVE: To show how switches allow circuits to operate independently even though they have the same power source.



This circuit combines projects #1, #2, and #6 into one circuit.

Build the circuit and place the fan on the motor (M1). Depending on which of the switches (S1 & S2) are on, you can turn on either the lamp (project #1), the motor (project #2), or both together (project #6).

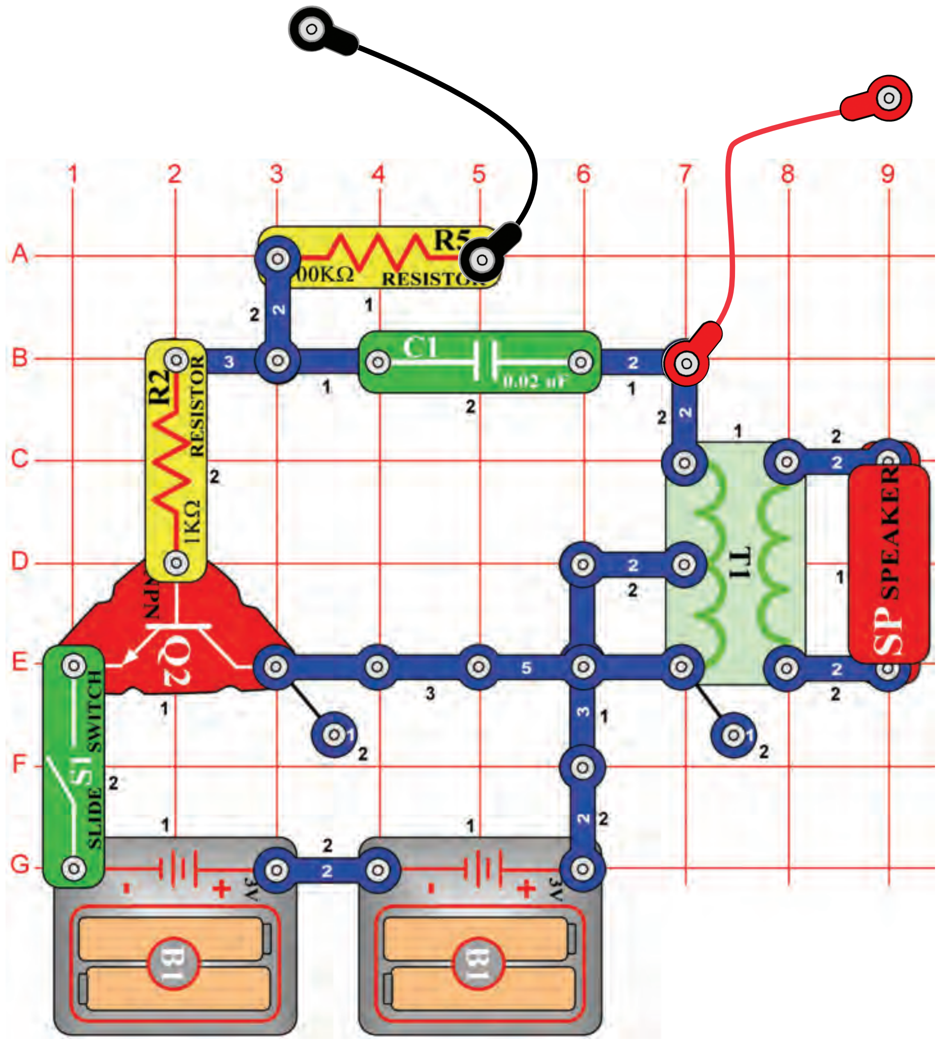
WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

This circuit was suggested by Luke S. of Westborough, MA.

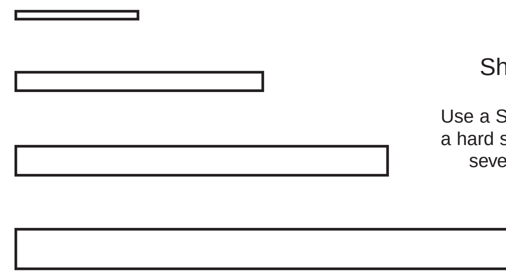
To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

Project #516 Drawing Resistors

OBJECTIVE: To make your own resistors.



You need some more parts to do this experiment, so you're going to draw them. Take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT**, and fill in the 4 rectangles you see below. You will get better results if you **place a hard, flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper) and **fill in each several times** to be sure you have a **thick, even layer of pencil** lead and try to avoid going out of the boundaries.



Shapes to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Actually, your pencils aren't made out of lead anymore (although we still call them "lead pencils"). The "lead" in your pencils is really a form of carbon, the same material that resistors are made of. So the drawings you just made should act just like the resistors in Snap Circuits®.

Build the circuit shown, it is the same basic oscillator circuit you have been using. Touch the the loose ends of the jumper wires to opposite ends of the rectangles you drew, you should hear a sound like an alarm. **Note:** You may get better electrical contact between the wires and the drawings if you wet the metal with a few drops of water or saliva.

Making the drawn resistors longer should increase the resistance while making them wider should reduce the resistance. So all 4 rectangles should produce the same sound, though you will see variations due to how thick and evenly you filled in the rectangles, and exactly where you touch the wires. If your 4 shapes don't sound similar then try improving your drawings.

Be sure to wash your hands after this project.

Project #517 Electronic Kazoo

Use the same circuit as project #516, but draw a new shape. A Kazoo is a musical instrument that is like a one-note flute, and you change the pitch (frequency) of the sound by moving a plunger up and down inside a tube.

As before, take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT** again, and fill in the shape you see below. For best results, **SHARPEN IT again**, **place a hard flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper). **Fill in each several times** to be sure you have a **thick, even layer of pencil** lead, and try to avoid going out of the boundaries. **Where the shape is just a line, draw a thick line and go over it several times.** The black ink in this manual is an insulator just like paper, so you have to write over it with your pencil.

Take one loose wire and touch it to the widest part of this shape, at the upper left. Take the other loose wire and touch it just to the right of the first wire. You should hear a high-pitch sound. How do you think the sound will change as you slide the second wire to the right? Do it, slowly sliding all the way around to the end. The sound changes from high frequency to low frequency, just like a kazoo. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.

Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #518 Electronic Kazoo (II)

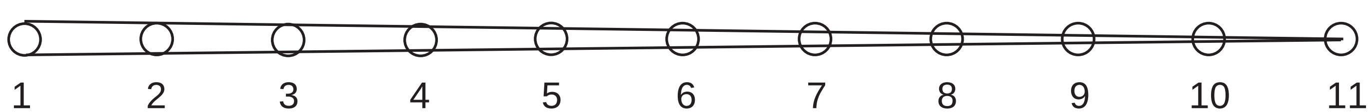
Use the same circuit as project #516, but fill in the new shape shown here.

Take one loose jumper wire and touch it to the left circle. Take the other loose wire and touch it to each of the other circles. The various circles produce different pitches in the sound, like notes. Since the circles are like keys on a piano, you now have an electronic keyboard! See what kind of music you can play with it. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.

Now take one loose wire and touch it to the right circle (#11). Take the other wire and touch it to the circles next to the numbers shown below, in order:

7 - 5 - 1 - 5 - 7 - 7 - 7
5 - 5 - 5
7 - 7 - 7
7 - 5 - 1 - 5 - 7 - 7 - 7 - 7 - 5 - 5 - 7 - 5 - 1

Do you recognize this nursery rhyme? It is "Mary Had a Little Lamb". By now you see that you can draw any shape you like and make electronic sounds with it. Experiment on your own as much as you like. Be sure to wash your hands after this test.



Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #519
Water Resistor

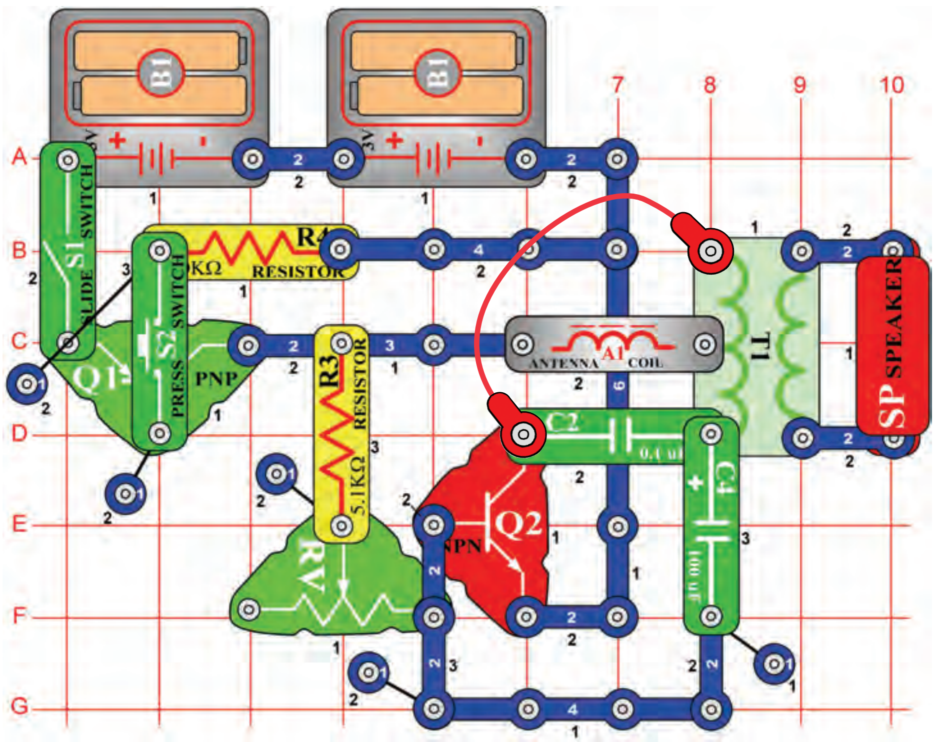
OBJECTIVE: To use water as a resistor.

Use the same circuit as project #516. Take the two loose jumper wires and touch them with your fingers. You should hear a low-frequency sound. Now place the loose jumpers in a cup of water without them touching each other. The sound will have a much higher frequency because drinking water has lower resistance than your body. You can change the sound by adding or removing water from the cup. If you add salt to the water then you will notice the frequency increase, because dissolving salt lowers the resistance of the water.

You can also make a water kazoo. Pour a small amount of water on a table or the floor and spread it with your finger into a long line. Place one of the jumper wires at one end and slide the other along the water. You should get an effect just like the kazoo you drew with the pencil, though the frequency will probably be different.

Project #520
Two-Transistor Oscillator

OBJECTIVE: To make an adjustable low-frequency oscillator.

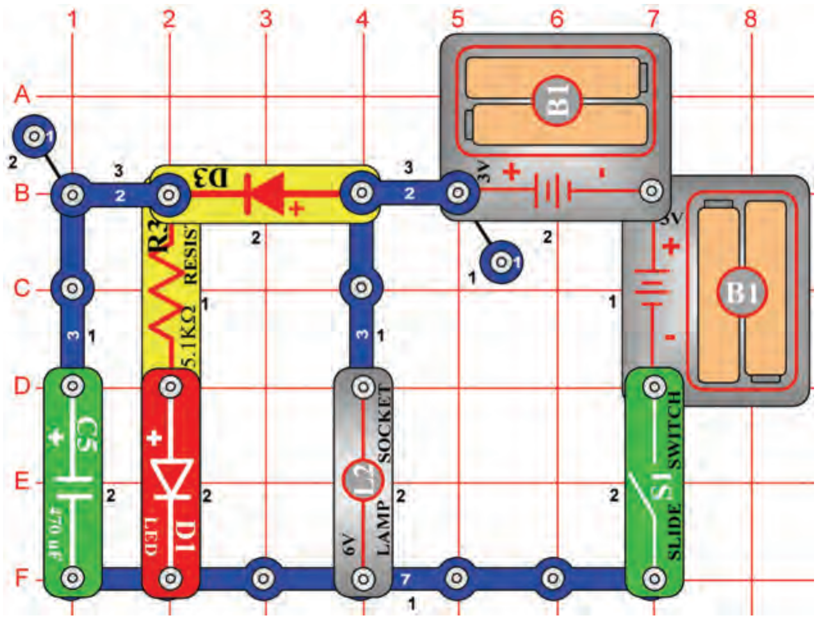


Build the circuit, turn on the slide switch (S1), and then press the press switch (S2). Move the control lever of the adjustable resistor (RV) to change the frequency.

Project #521

Diode

OBJECTIVE: To show how a diode works.



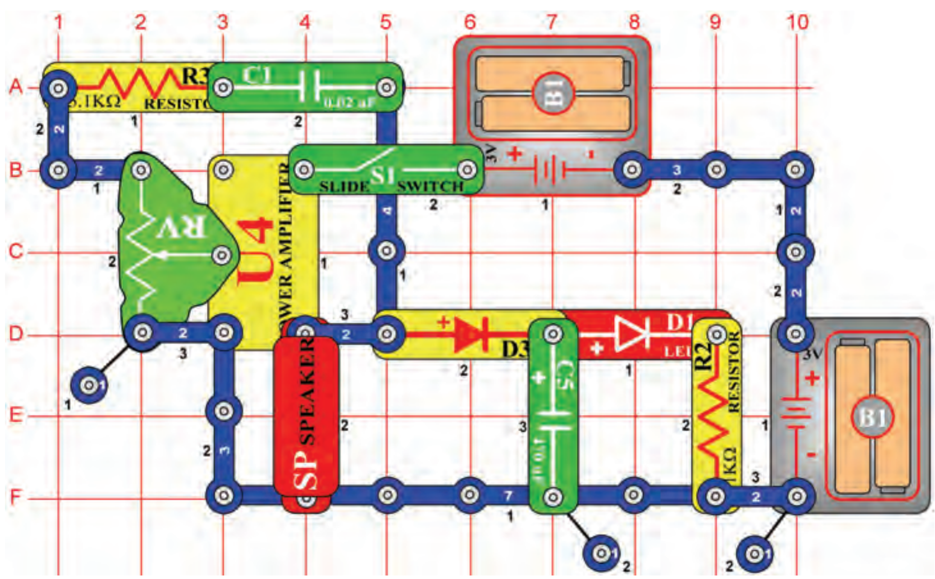
Turn on the slide switch (S1), the lamp (L2) will be bright and the LED (D1) will be lit. The diode (D3) allows the batteries to charge up the 470μF capacitor (C5) and light the LED.

Turn off the slide switch, the lamp will go dark immediately but the LED will stay lit for a few seconds as capacitor C5 discharges through it. The diode isolates the capacitor from the lamp; if you replace the diode with a 3-snap wire then the lamp will drain the capacitor almost instantly.

Project #522

Rectifier

OBJECTIVE: To build a rectifier.



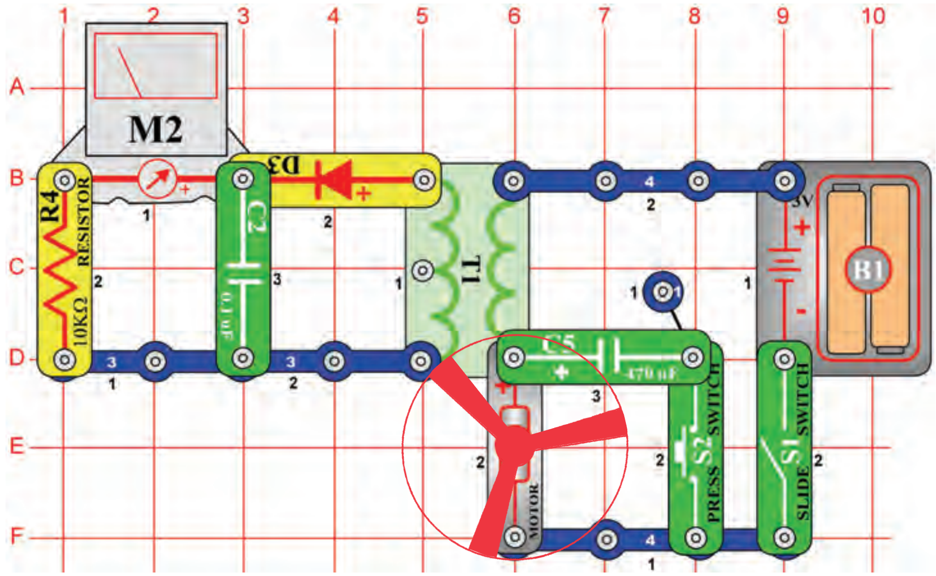
This circuit is based on the Trombone project #238. Turn on the slide switch (S1) and set the adjustable resistor (RV) for mid-range for the best sound. The LED (D1) will also be lit.

The signal from the power amplifier (U4) to the speaker (SP) is a changing (AC) voltage, not the constant (DC) voltage needed to light the LED. The diode (D3) and capacitor (C5) are a rectifier, which converts the AC voltage into a DC voltage.

The diode allows the capacitor to charge up when the power amp voltage is high, but also prevents the capacitor from discharging when the power amp voltage is low. If you replace the diode with a 3-snap or remove the capacitor from the circuit, the LED will not light.

Project #523 Motor Rectifier

OBJECTIVE: To show how what a rectifier does.



Set the meter (M2) to the LOW (or 10mA) scale. Place the fan on the motor (M1) and turn on the slide switch (S1), the meter measures the current on the other side of the transformer (T1).

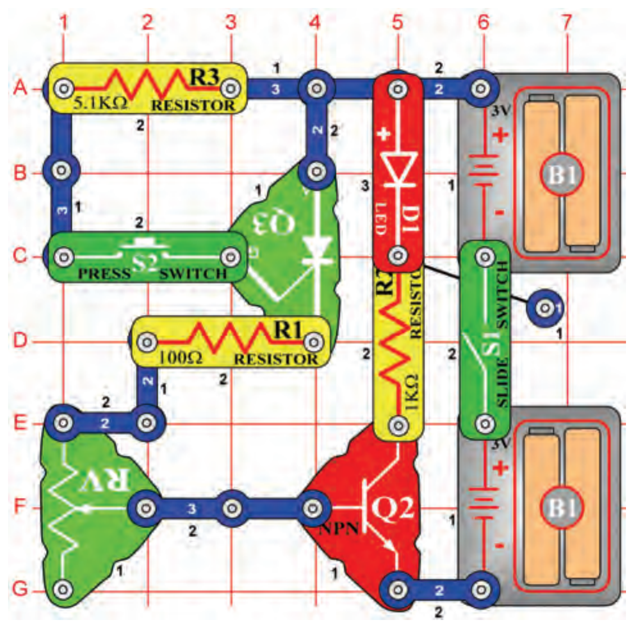
As the DC voltage from the battery (B1) spins the motor, the motor creates an AC ripple in the voltage. This ripple passes through the transformer using magnetism. The diode and 0.1μF capacitor (C2) "rectify" the AC ripple into the DC current that the meter measures.

Holding down the press switch (S2) connects the 470μF capacitor (C5) across the motor. This filters out the AC ripple, so the current through the meter is greatly reduced but the motor speed is not affected.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #524 SCR Shutdown

OBJECTIVE: To show how an SCR works.



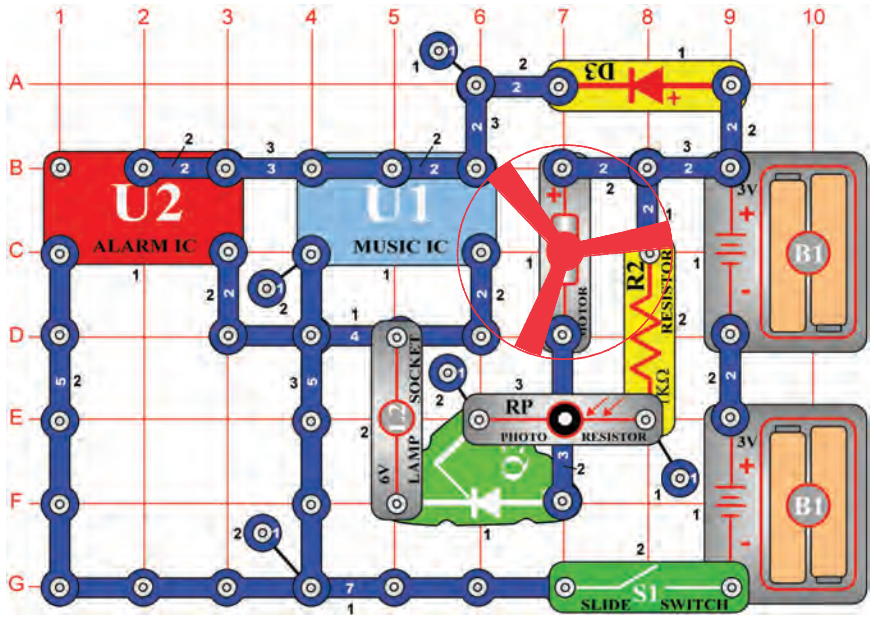
In this circuit the press switch (S2) controls an SCR (Q3), which controls a transistor (Q2), which controls an LED (D1). Set the adjustable resistor (RV) control lever to the top (toward the press switch).

Turn on the slide switch (S1); nothing happens. Press and release the press switch; the SCR, transistor, and LED turn on and stay on. Now move the adjustable resistor control down until the LED turns off. Press and release the press switch again; this time the LED comes on but goes off after you release the press switch.

If the current through an SCR (anode-to-cathode) is above a threshold level, then the SCR stays on. In this circuit you can set the adjustable resistor so that the SCR (and the LED it controls) just barely stays on or shuts off.

Project #525 SCR Motor Control

OBJECTIVE: To show how an SCR is used.



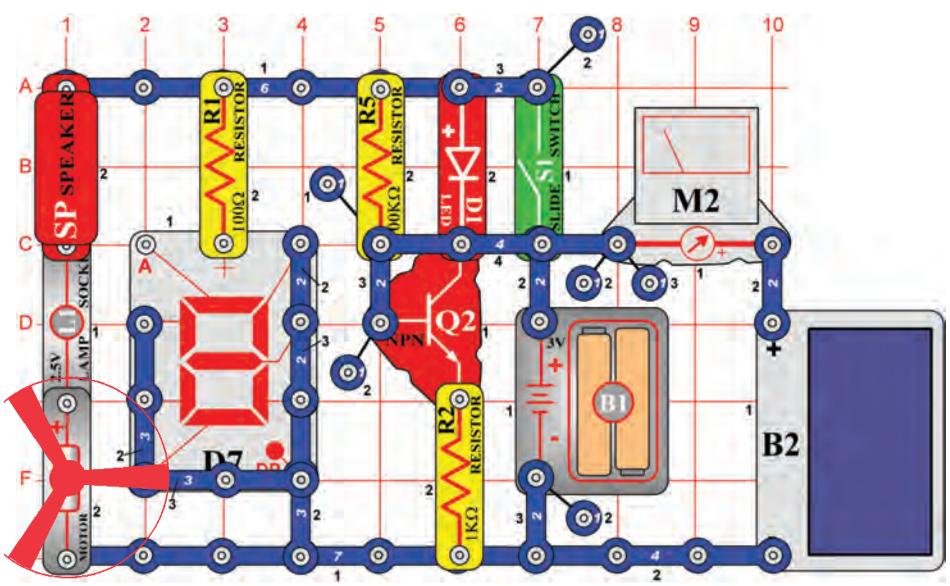
SCR's are often used to control the speed of a motor. The voltage to the gate would be a stream of pulses, and the pulses are made wider to increase the motor speed.

Place the fan on the motor (M1) and turn on the slide switch (S1). The motor spins and the lamp (L2) lights. Wave your hand over the photoresistor (RP) to control how much light shines on it, this will adjust the speed of the motor. By moving your hand in a repetitive motion, you should be able spin the motor at a slow and steady speed.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #526 Output Forms

OBJECTIVE: To show the different types of output from Snap Circuits®.



Set the meter (M2) to the LOW (or 10mA) scale. This circuit uses all six forms of output available in Snap Circuits® - speaker (SP, sound), lamp (L1, light), LED (D1, light), motor (M1, motion), 7-segment display (D7, light), and meter (M2, motion of pointer).

Place the fan on the motor, turn on the slide switch (S1), and shine light on the solar cell (B2). There will be activity from all six forms of output. If the motor does not spin, then give it a push with your finger to start it, or remove the fan.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

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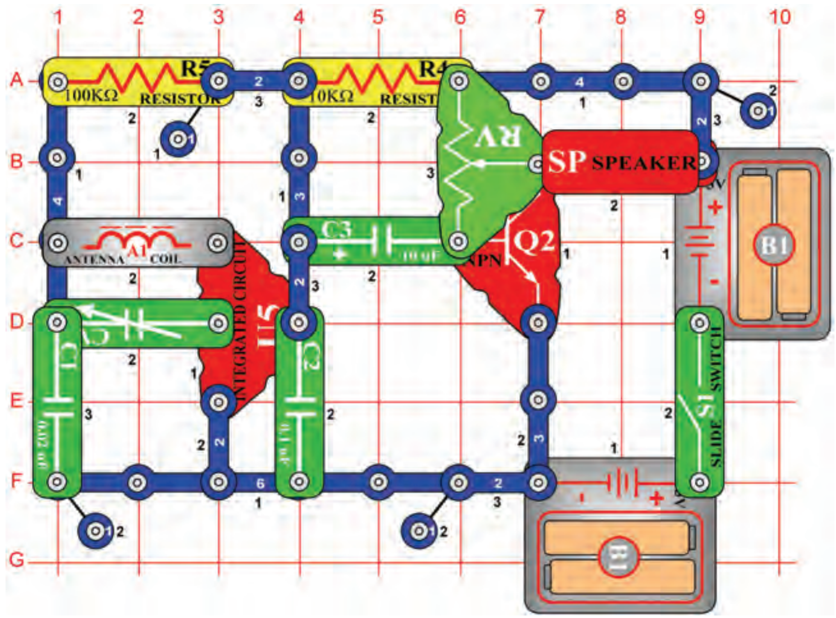
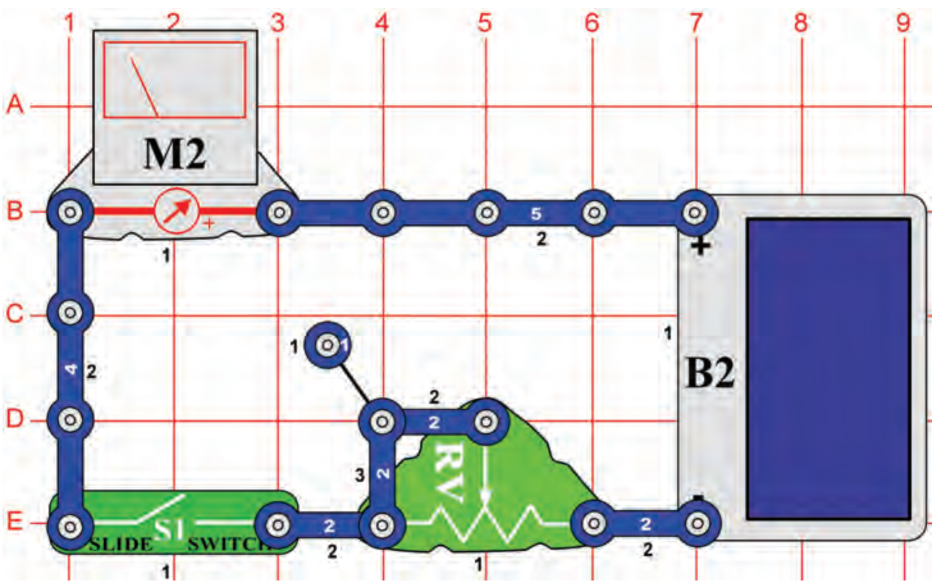
☐ Project #527 Transistor AM Radio



OBJECTIVE: To show the output of an AM radio.

This AM radio circuit uses a transistor (Q2) in the amplifier that drives the speaker (SP). Turn on the slide switch (S1) and adjust the variable capacitor (CV) for a radio station, then adjust the loudness using the adjustable resistor (RV).

☐ Project #528 Adjustable Solar Power Meter



OBJECTIVE: To learn about solar power.

Set the adjustable resistor (RV) for mid-range and the meter (M2) for the LOW (or 10mA) setting. Turn on the slide switch (S1) and let light shine on the solar cell (B2). Move the solar cell around different light sources and adjust the adjustable resistor to change the reading on the meter.

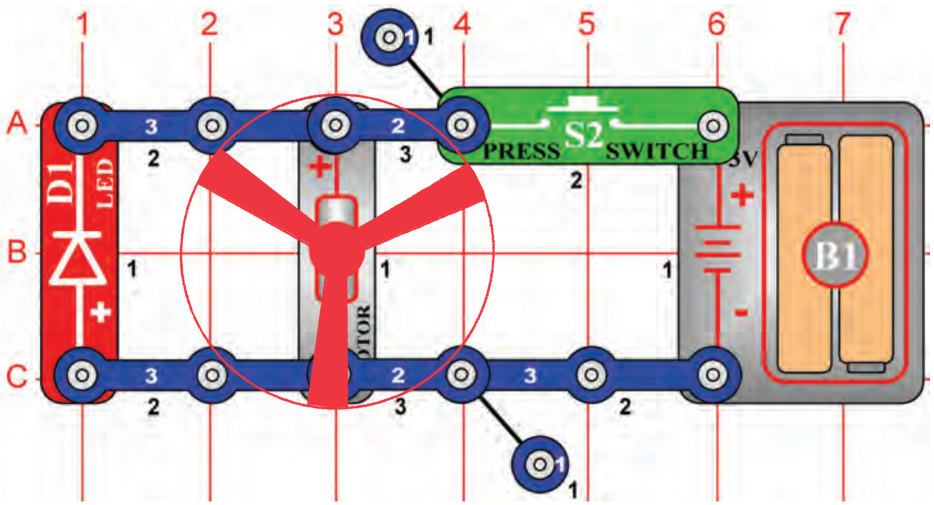
Place your hand to cover half of the solar cell, the meter reading should drop by half. When you reduce the light to the solar cell, the current in the circuit is reduced.

Place a sheet of paper over the solar cell and see how much it changes the reading on the meter. Then add more sheets until the meter reads zero.

Project #529

Fan Blade Storing Energy

OBJECTIVE: To show that the fan blade stores energy.



Place the fan on the motor (M1). Hold down the press switch (S2) for a few seconds and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

Do you know why the LED lights? It lights because the mechanical energy stored in the fan blade makes the motor act like a generator. When the press switch is released, this energy creates a brief current through the LED. If you remove the fan blade from the circuit then the LED will never light, because the motor shaft alone does not store enough mechanical energy.

If you reverse the motor direction, then the LED will light the same way, but the fan may fly off after the LED lights.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

This circuit was suggested by Mike D. of Woodhaven, NY.

Project #530

Antenna Storing Energy

OBJECTIVE: To show that the antenna stores energy.

Modify project #529 by replacing the motor (M1) with the antenna coil (A1). Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B2) are disconnected from the circuit.

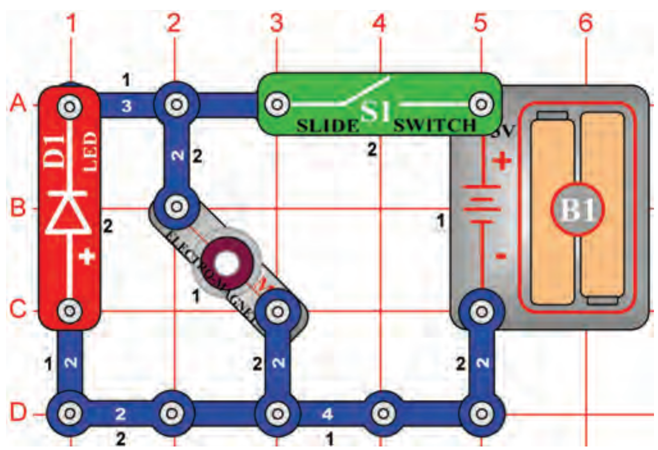
This circuit is different from the Fan Blade Storing Energy project because energy in the antenna coil is stored in a magnetic field. When the press switch is released, this field creates a brief current through the LED.

Note that the energy stored in a magnetic field acts like mechanical momentum, unlike capacitors which store energy as an electrical charge across a material. You can replace the antenna with any of the capacitors but the LED will not light. Energy stored in the magnetic fields of coils was called electrical momentum in the early days of electronics.

Project #531

Electromagnet Storing Energy

OBJECTIVE: To show that the electromagnet stores energy.

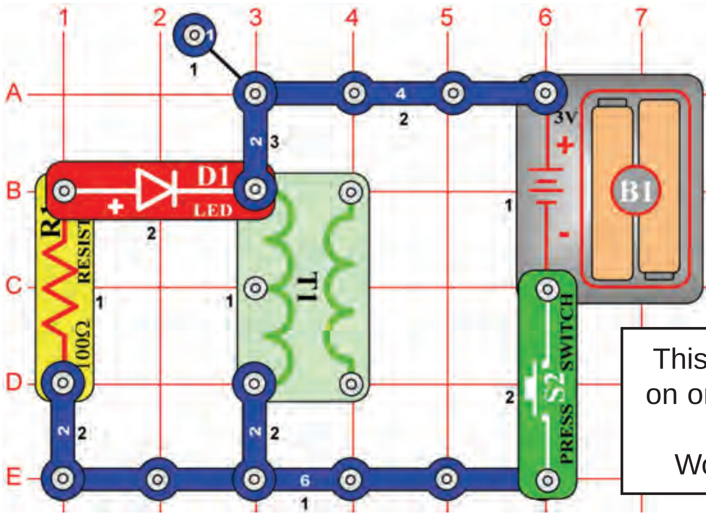


Turn on the slide switch (S1); nothing happens. Turn the switch off; the LED (D1) flashes.

When you turn on the switch, the electromagnet (M3) stores energy from the batteries (B1) into a magnetic field. When you turn off the switch, the magnetic field collapses and the energy from it discharges through the LED.

Project #532 Transformer Storing Energy

OBJECTIVE: To show that the transformer stores electrical energy.



This circuit is based on one suggested by Mike D. of Woodhaven, NY.

Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

This circuit is similar to the Antenna Storing Energy project, and shows how the coils in the transformer (T1) also store energy in magnetic fields. When the press switch is released, this energy creates a brief current through the LED.

Project #533 Relay Storing Energy

OBJECTIVE: To show that the relay stores energy.

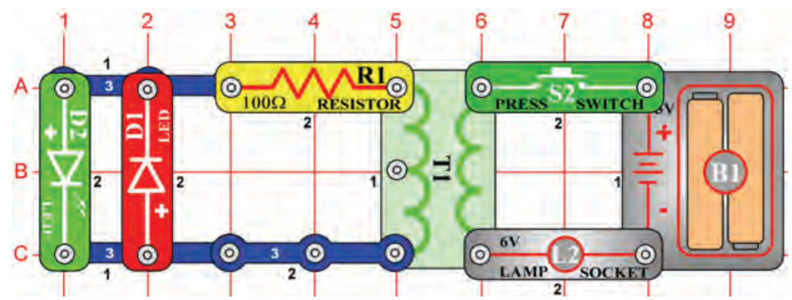
Modify project #532 by replacing the transformer (T1) with the relay (S3), position it with the 3-snap sides to top and right (as in project #341).

Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

The relay has a coil similar to the one in the transformer, and stores energy in the same way.

Project #534 Transformer Lights

OBJECTIVE: To show how the transformer works.



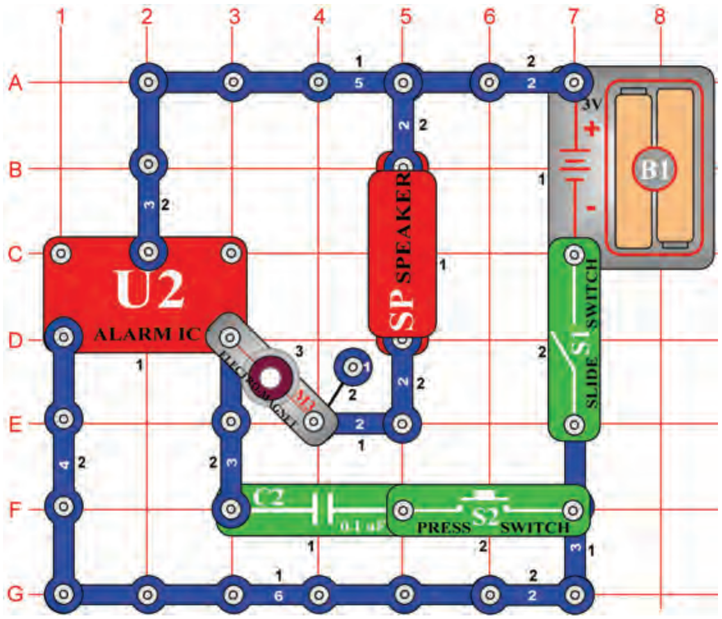
Watch the LED's (D1 & D2) as you press or release the press switch (S2). The red LED (D1) lights briefly just as you press the press switch and the green LED (D2) lights briefly just after you release it, but neither lights while you hold the press switch down. Why?

When you press the press switch, a surge of current from the battery charges a magnetic field in the transformer (T1), which stays constant as the press switch is held down. Charging the magnetic field induces an opposing current on the other side of the transformer, which lights the red LED until the magnetic fields stabilize.

When you release the press switch (removing the current from the battery), the magnetic field discharges. Initially the transformer tries to maintain the magnetic field by inducing a current on the other side, which lights the green LED until the resistor (R1) absorbs the remaining energy.

Note that this project is different from the Antenna Storing Energy project because there is a magnetic connection across the transformer, not an electrical connection.

Project #535 Machine Siren

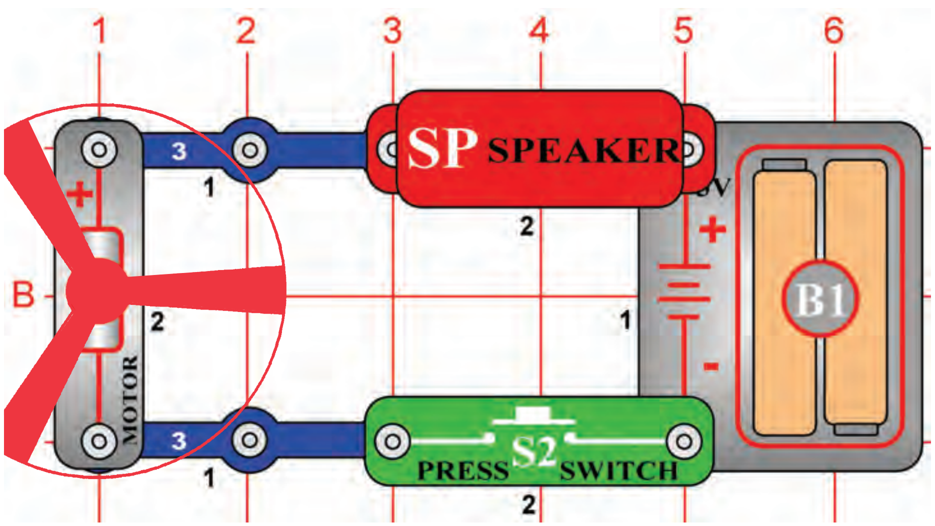


OBJECTIVE: To see how the electromagnet can change the sound from the alarm IC.

Turn on the slide switch (S1), you hear a strange sound from the speaker (SP). Push the press switch (S2) and the sound changes to a high-pitch siren.

The alarm IC (U2) produces a smooth siren sound, but the electromagnet (M3) distorts the siren into the strange sound you hear. Adding the 0.1μF capacitor (C2) counters the electromagnet effects and restores the siren.

Project #536 Hear the Motor



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

OBJECTIVE: To show how a motor works.

Place the fan on the motor (M1). Press the press switch (S2) and listen to the motor. Why does the motor make sound?

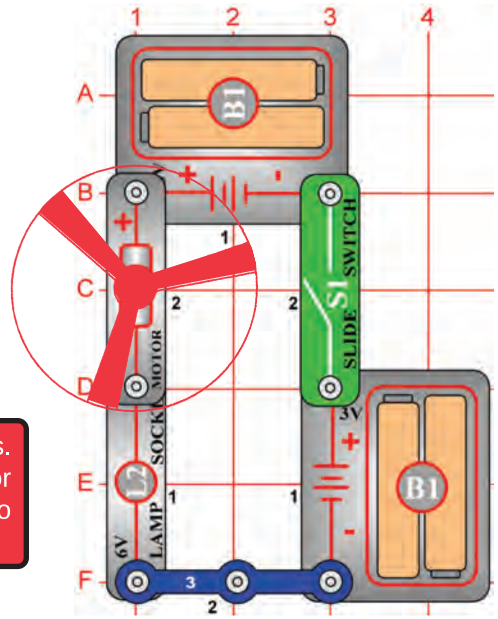
A motor uses magnetism to convert electrical energy into mechanical spinning motion. As the motor shaft spins around it connects/disconnects several sets of electrical contacts to give the best magnetic properties. As these contacts are switched, an electrical disturbance is created, which the speaker converts into sound.

This circuit was suggested by Andrew M. of Cochrane, Alberta, Canada

☐

Project #537 Back EMF

OBJECTIVE: To demonstrate how the motor works.



The voltage produced by a motor when it is spinning is called its *Back Electro-Motive-Force* (Back EMF); this may be thought of as the motor's electrical resistance. The motor's *Front Electro-Motive-Force* is the force it exerts in trying to spin the shaft. This circuit demonstrates how the Back EMF increases and the current decreases as the motor speeds up.

Place the fan on the motor (M1) and turn on the slide switch (S1). The 6V bulb (L2) will be bright, indicating that the Back EMF is low and the current is high.

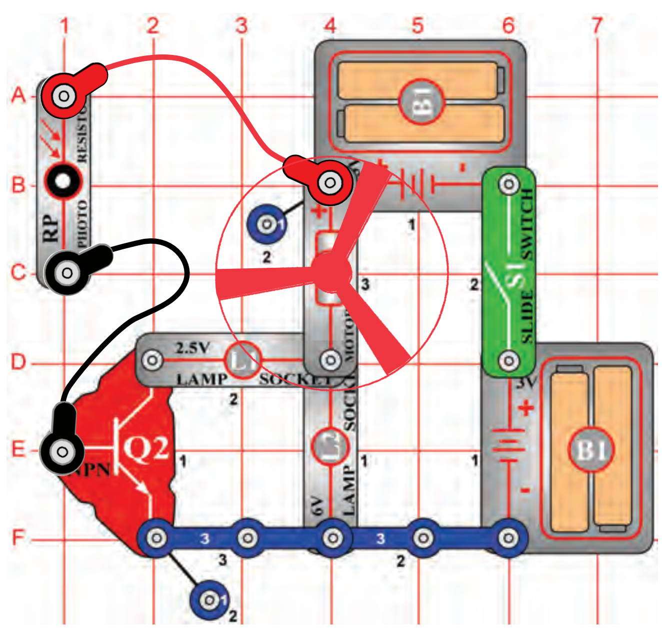
Turn off the slide switch, remove the fan, and turn the slide switch back on. The lamp is bright when the motor starts and the lamp dims as the motor speeds up. Now the Back EMF is high and the current is low. BE CAREFUL NOT TO TOUCH THE MOTOR WHILE IT SPINS.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐

Project #538 Back EMF (II)

OBJECTIVE: To demonstrate how the motor draws more current to exert greater force when spinning slowly.



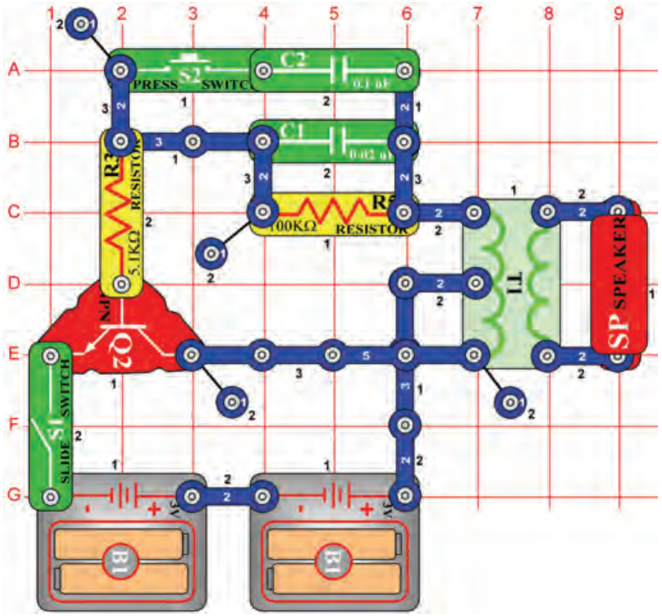
Place the fan on the motor (M1). Connect the photoresistor (RP) with the jumper wires as shown, and hold it next to the 6V lamp (L2) so the light shines on it.

Turn on the slide switch (S1) and watch how the 6V lamp is bright at first, but gets dim as the motor speeds up. By moving the photoresistor (RP) next to or away from the 6V lamp, you should be able to change the motor speed. To slow the motor down even more, cover the photoresistor.

When the photoresistor is held next to the 6V lamp, transistor Q2 (with lamp L1) will try to keep the motor at a constant speed.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #539 Electronic Sound



OBJECTIVE: To make different tones with an oscillator.

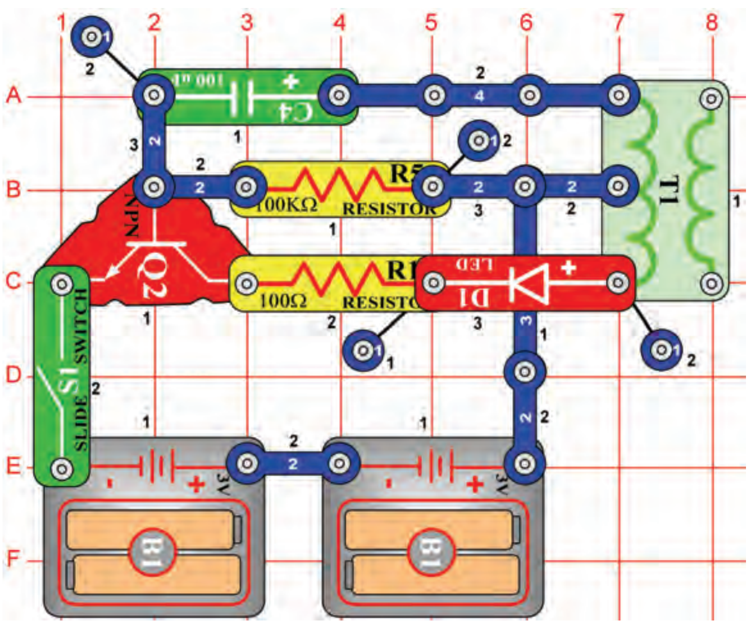
Build the circuit and turn on the slide switch (S1), you hear a high-frequency tone. Press the press switch (S2) to lower the frequency by increasing the capacitance in the oscillator. Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" on the right) to further lower the frequency of the tone.

Project #540 Electronic Sound (II)

OBJECTIVE: To make different tones with an oscillator.

You can also change the frequency by changing the resistance in the oscillator. Replace the 100KΩ resistor (R5) with the 10KΩ resistor (R4), place the 0.1μF capacitor (C2) back in the circuit as before.

Project #541 Lighthouse



OBJECTIVE: To make a blinking light.

Build the circuit and turn on the slide switch (S1), the LED (D1) flashes about once a second.

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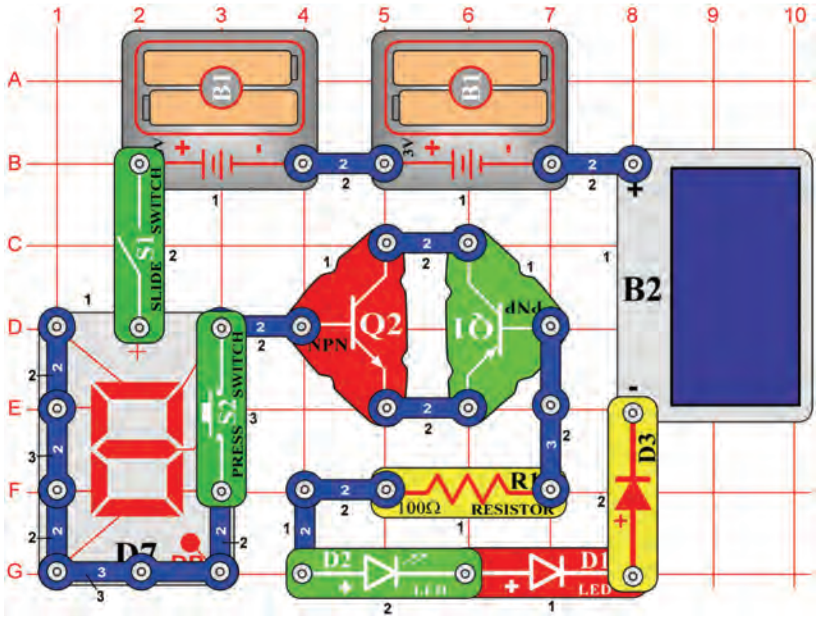
☐ Project #542 Diode Wonderland

OBJECTIVE: To learn more about diodes.



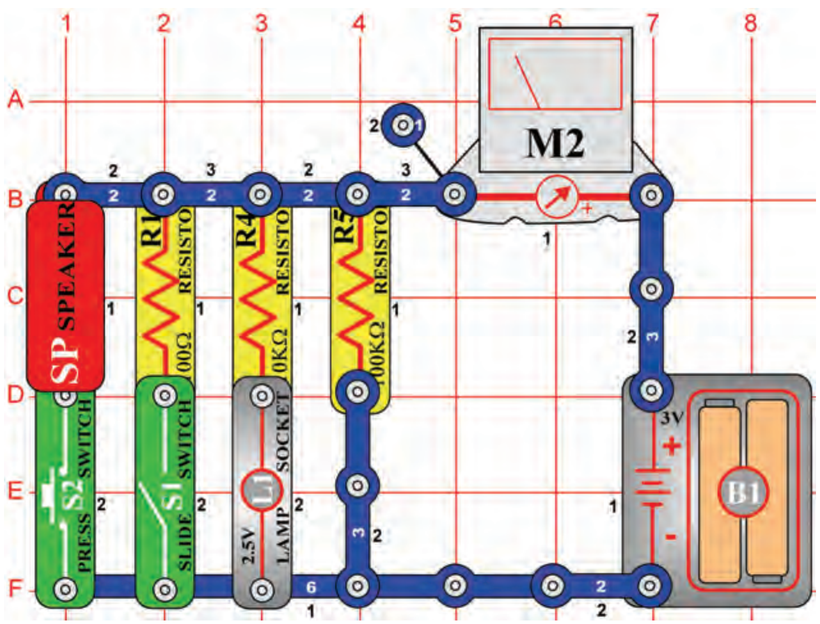
Cover the solar cell (B2) and turn on the slide switch (S1), there should be little or no light from the LED's (results depend on your batteries). Shine a bright light on the solar cell and the red (D1) and green (D2) LED's should be bright, along with one segment of the 7-segment display (D7).

This circuit shows how it takes a lot of voltage to turn on a bunch of diodes connected in a series. Since the transistors (Q1 & Q2) are used as diodes here, there are six diodes total (D1, D2, D3, D7, Q1, and Q2). The voltage from the batteries (B1) alone is not enough to turn them all on at the same time, but the extra voltage produced by the solar cell is enough to make them bright.

Now push the press switch (S2) and D7 will display "0.", but it will be dim unless the light on the solar cell is very bright. With S2 off, all the current through D7 goes through segment B and makes it bright. With S2 on, the current through D7 divides evenly between several segments.

☐ Project #543 Meter Ranges

OBJECTIVE: To show the difference between the low and high current meter ranges.



Use the LOW (or 10mA) setting on the meter (M2), turn off the slide switch (S1), and unscrew the 2.5V bulb (L1). The meter should measure about 2, since the 100KΩ resistor (R5) keeps the current low. Results will vary depending on how good your batteries are.

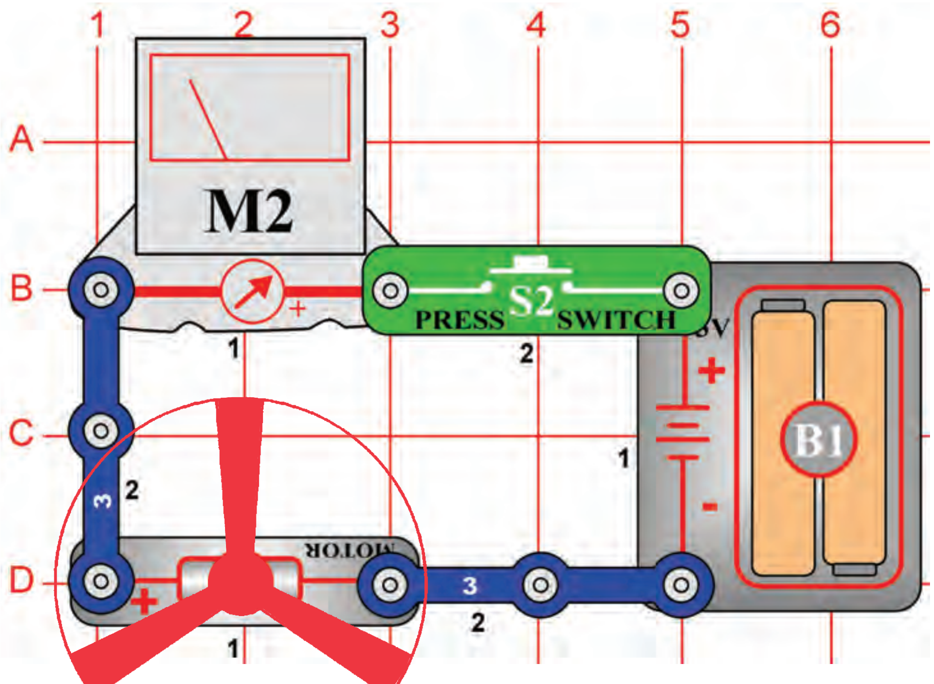
Screw in the 2.5V bulb to add the 10KΩ resistor (R4) to the circuit, now the meter reading will be about 10.

Change the meter to the high-current HIGH (or 1A) setting. Now turn on the slide switch to add the 100Ω resistor to the circuit. The meter should read just above zero.

Now press the switch (S2) to add the speaker (SP) to the circuit. The meter reading will be about 5, since the speaker has only about 8Ω resistance.

Project #544 Motor Current

OBJECTIVE: To measure the motor current.



⚠ **WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Use the HIGH (or 1A) setting on the meter (M2) and place the fan on the motor (M1). Press the press switch (S2), the meter will measure a very high current because it takes a lot of power to spin the fan.

Remove the fan and press the press switch again. The meter reading will be lower since spinning the motor without the fan takes less power.

Project #545 2.5V Lamp Current

OBJECTIVE: To measure the 2.5V lamp current.

Use the circuit from project #544, but replace the motor with the 2.5V lamp (L1). Measure the current using the HIGH (or 1A) setting on the meter.

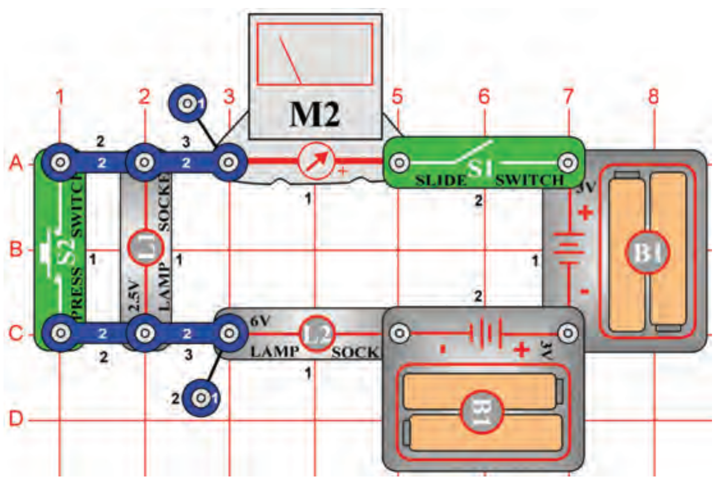
Project #546 6V Lamp Current

OBJECTIVE: To measure the 6V lamp current.

Use the circuit from project #544 but replace the motor with the 6V lamp (L2). Measure the current using the HIGH (or 1A) setting on the meter (M2). Compare the lamp brightness and meter reading to that for the 2.5V lamp (L1).

Project #547 Combined Lamp Circuits

OBJECTIVE: To measure current through the lamps.

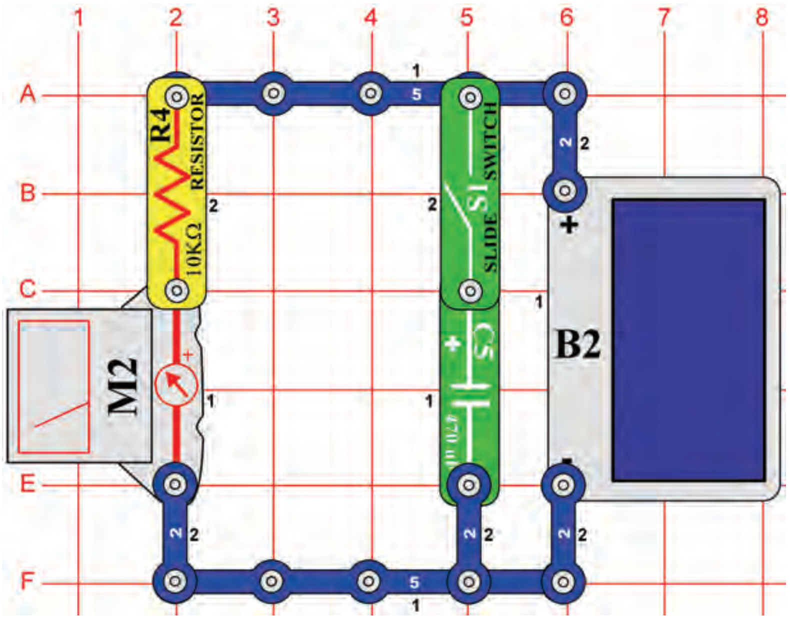


Use the HIGH (or 1A) setting on the meter (M2) and turn on the slide switch (S1). Both lamps are on and the meter measures the current.

Now turn on the press switch (S2) to bypass the 2.5V lamp (L1). The 6V lamp (L2) is brighter now, and the meter measures a higher current.

Project #548 Rechargeable Battery

OBJECTIVE: To show how a capacitor is like a rechargeable battery.

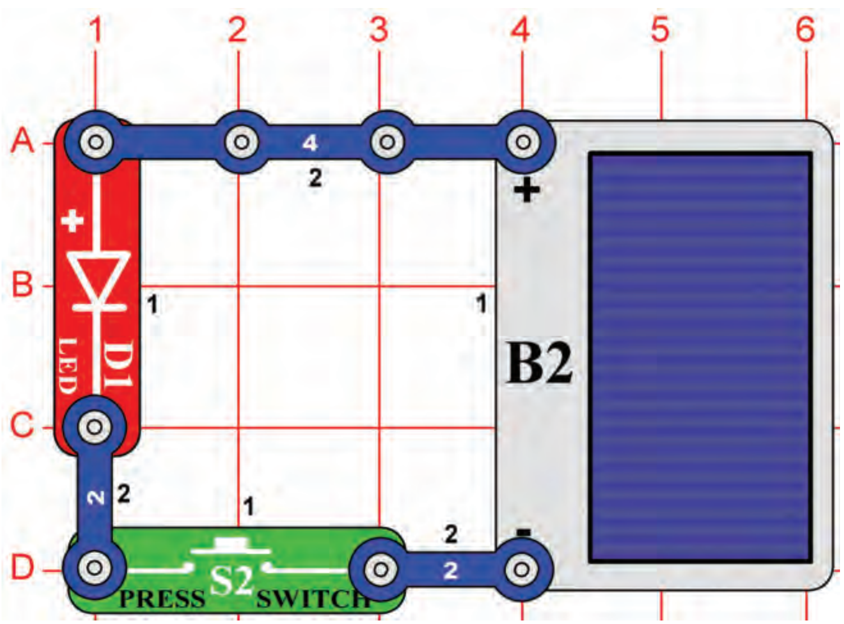


Use the LOW (or 10mA) scale on the meter (M2) and turn the slide switch (S1) off. Vary the current measured on the meter by moving your hand over the solar cell (B2) to block some of the light to it. If you cover the solar cell, then the current immediately drops to zero.

Now turn the slide switch on and watch the meter again as you move your hand over the solar cell. Now the meter current drops slowly if you block the light to the solar cell. The 470μF capacitor (C5) is acting like a rechargeable battery. It keeps a current flowing to the meter when something (such as clouds) blocks light to the solar cell that is powering the circuit.

Project #549 Solar Batteries

OBJECTIVE: To learn about solar power.



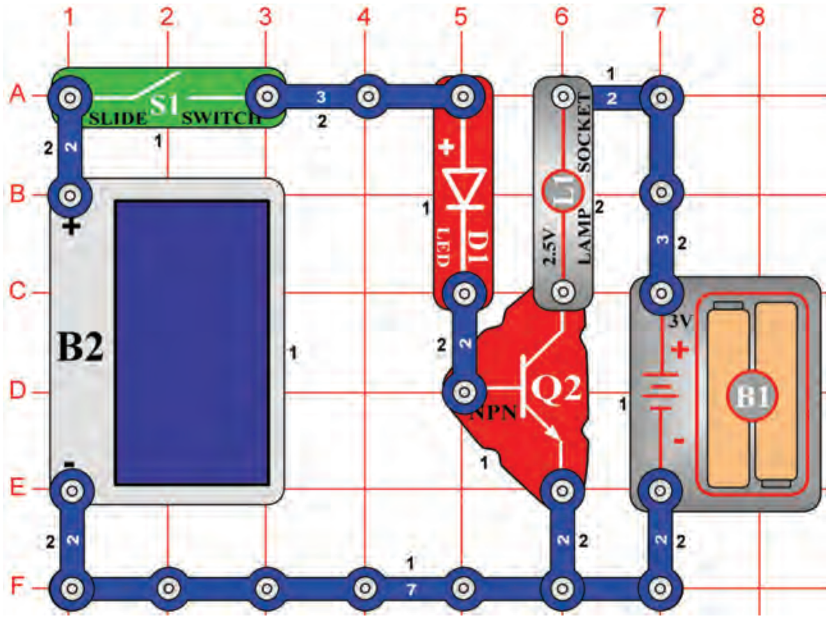
Place this circuit near different types of lights and press the press switch (S2). If the light is bright enough, then the LED (D1) will be lit. Find out what types of light sources make it the brightest.

Solar cells work best with bright sunlight, but incandescent light bulbs (used in house lamps) also work well. Fluorescent lights (the overhead lights in offices and schools) do not work as well with solar cells. Although the voltage produced by your solar cell is 3V just like the batteries, it cannot supply nearly as much current. If you replace the LED with the 2.5V lamp (L1) then it will not light, because the lamp needs a much higher current.

The solar cell (B2) is made from silicon crystals. It uses the energy in sunlight to make an electric current. Solar cells produce electricity that will last as long as the sun is bright. They are pollution-free and never wear out.

Project #550 Solar Control

OBJECTIVE: To learn about solar power.



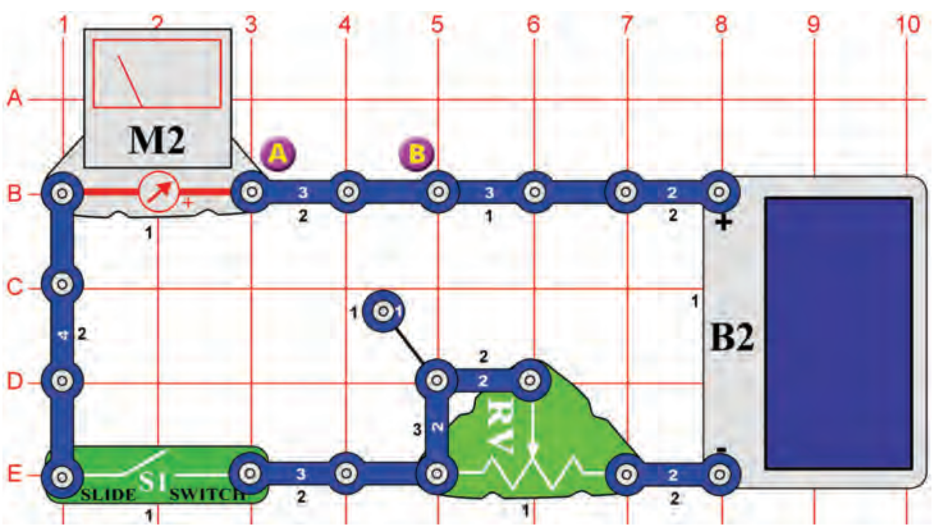
Build the circuit and turn on the slide switch (S1). If there is sunlight on the solar cell (B2), then the LED (D1) and lamp (L1) will be on.

This circuit uses the solar cell to light the LED and to control the lamp. The solar cell does not produce enough power to run the lamp directly. You can replace the lamp with the motor (M1, “+” side on top) and fan; the motor will spin if there is sunlight on the solar cell.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #551 Solar Resistance Meter

OBJECTIVE: To test the resistance of your components.



Place the circuit near a bright light and set the adjustable resistor (RV) so that the meter (M2) reads “10” on the LOW (or 10mA) setting. Now replace the 3-snap between points A & B with another component to test, such as a resistor, capacitor, motor, photoresistor, or lamp. The 100μF (C4) or 470μF (C5) capacitors will give a high reading that slowly drops to zero.

You can also use the two-spring socket (?1) and place your own components between its springs to test them.

Project #552 Solar Diode Tester

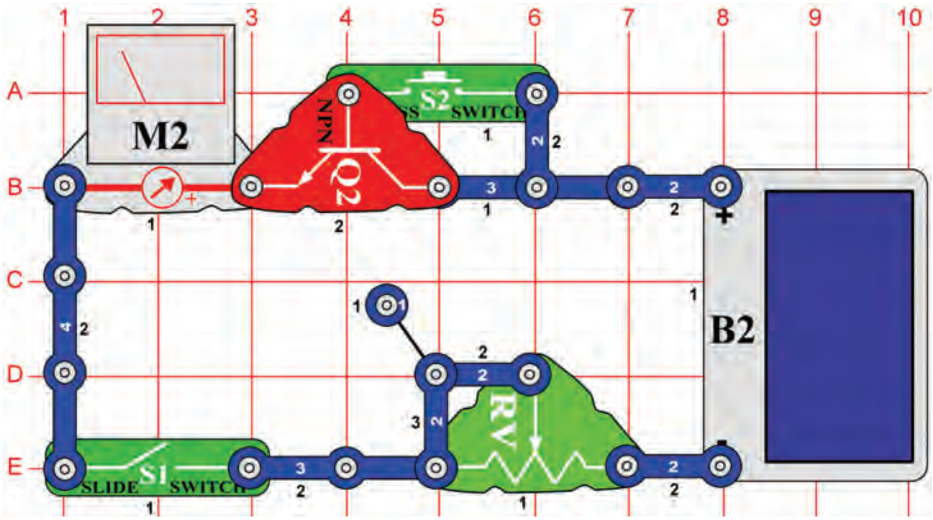
OBJECTIVE: To learn about solar power.

Use the same circuit to test the red and green LED’s (D1 & D2), and the diode (D3). The diode will give a higher meter reading than the LED’s, and all three will block current in one direction.

Project #553

Solar NPN Transistor Tester

OBJECTIVE: To test your NPN transistor.



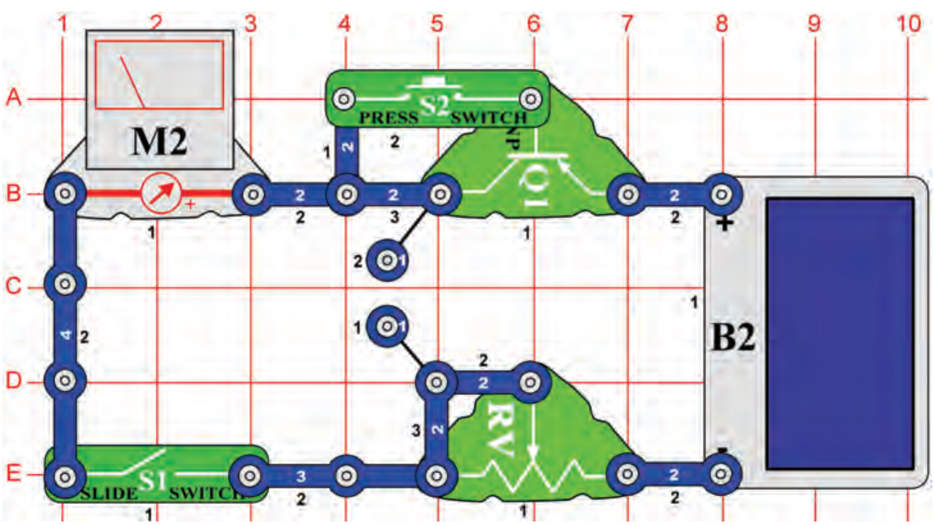
This circuit is just like the one in project #551, but tests the NPN transistor (Q2). The meter will read zero unless both switches (S1 & S2) are on, then the adjustable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter (M2) reading will be higher with the transistor.

You can replace the NPN transistor with the SCR (Q3), it works the same way in this circuit.

Project #554

Solar PNP Transistor Tester

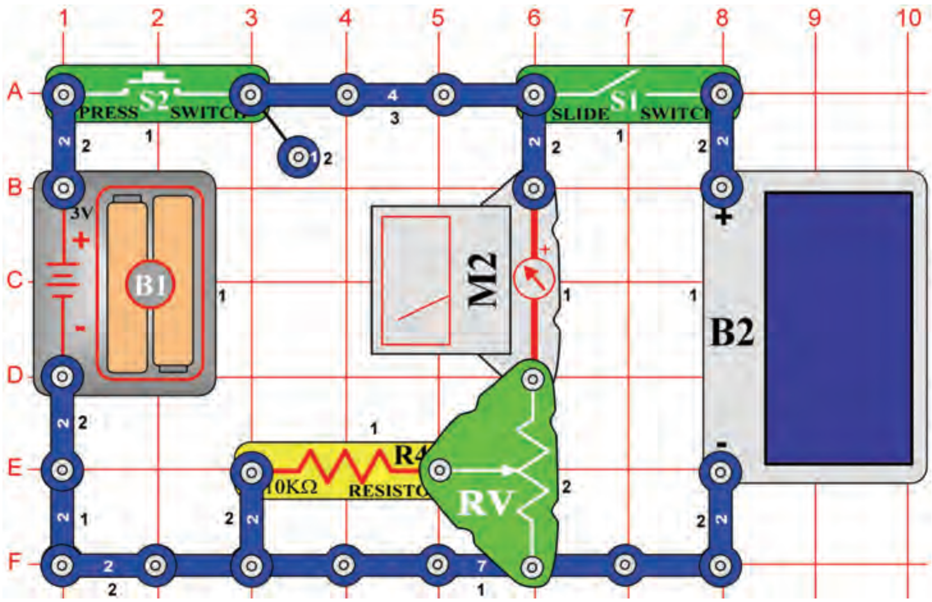
OBJECTIVE: To test your PNP transistor.



This circuit is just like the one in project #551, but tests the PNP transistor (Q1). The meter (M2) will read zero unless both switches (S1 & S2) are on, then the adjustable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter reading will be higher with the transistor.

Project #555 Solar Cell vs. Battery

***OBJECTIVE:** To compare the voltage of the solar cell to the battery.*

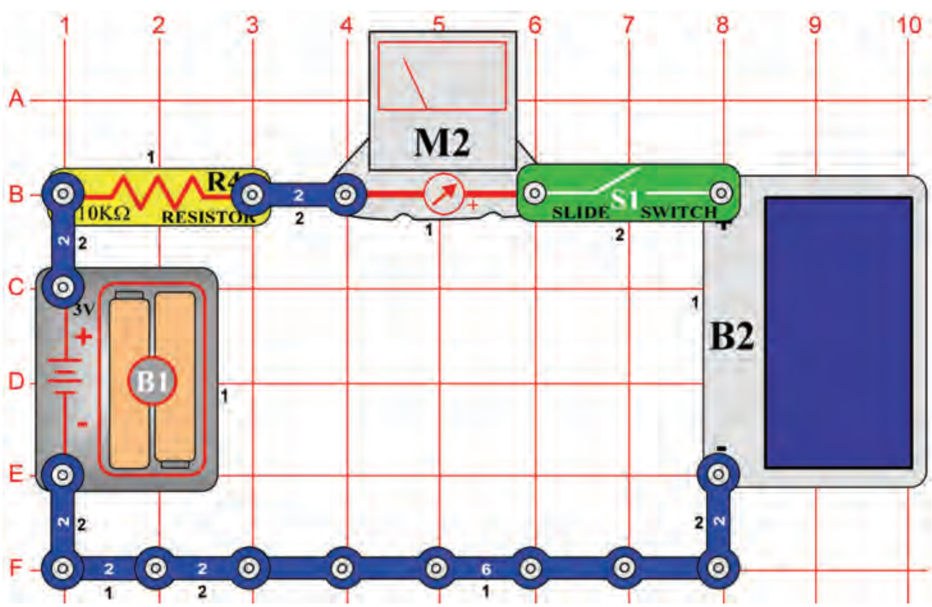


Set the meter (M2) to the LOW (or 10mA) scale. Press the press switch (S2) and set the adjustable resistor (RV) so that the meter reads “5”, then release it.

Now turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). Since the voltage from the batteries (B1) is 3V, if the meter reads higher than “5”, then the solar cell voltage is greater than 3V. If the solar cell voltage is greater and you have rechargeable batteries (in B1), then turning on both switches at the same time will use the solar cell to recharge your batteries.

Project #556 Solar Cell vs. Battery (II)

***OBJECTIVE:** To compare the voltage of the solar cell to the battery.*



Set the meter (M2) to the LOW (or 10mA) scale. Turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). If the meter reads zero, then the battery voltage is higher than the voltage produced by the solar cell.

If the meter reads greater than zero, then the solar cell voltage is higher. If the batteries are rechargeable then the solar cell will recharge them until the voltages are equal.

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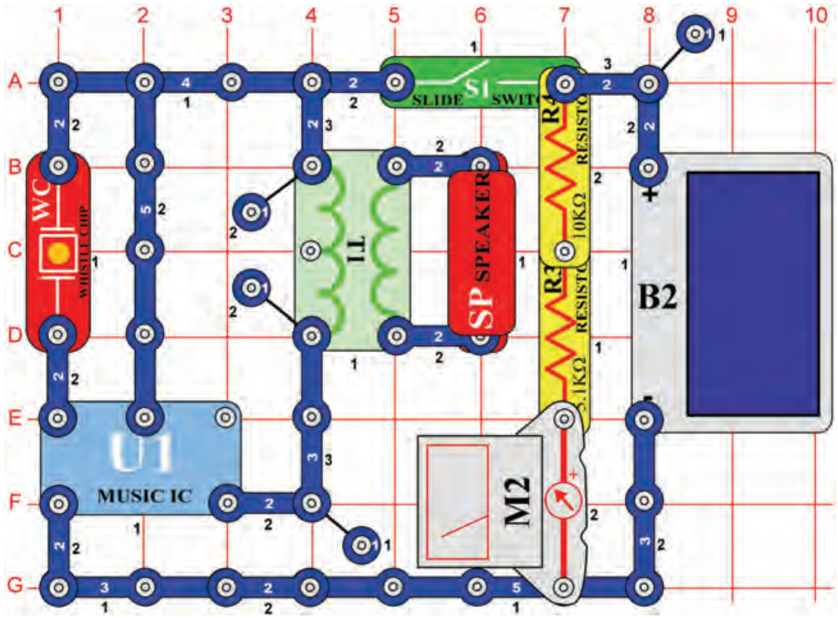
Project #557

Solar Music

OBJECTIVE: To use the sun to make music.



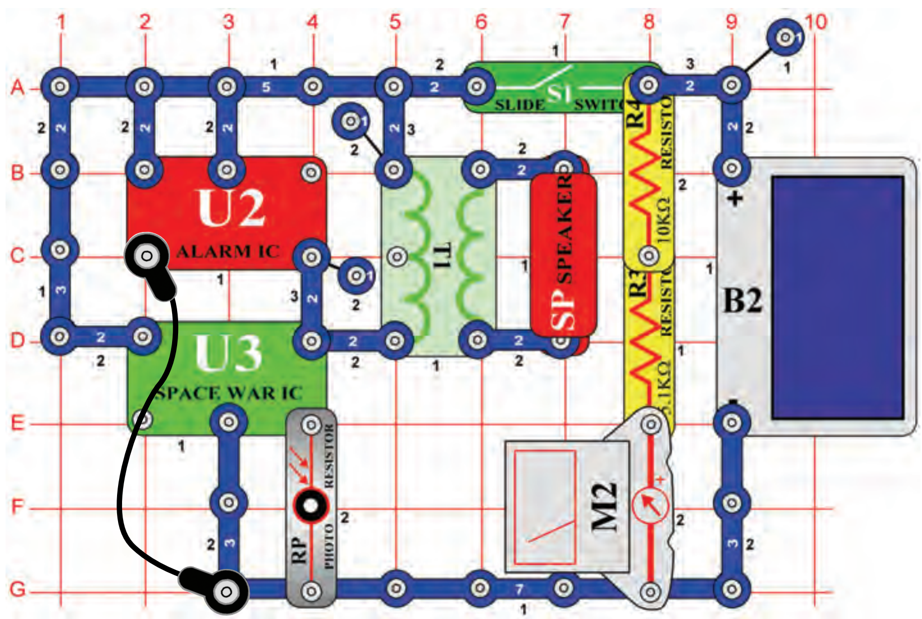
Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 7 or higher. Now turn on the slide switch and listen to the music. When it stops, clap your hands and it should resume.

The meter is used to measure if the solar cell can supply enough current to operate the music IC (U1).

Project #558

Solar Sounds Combo

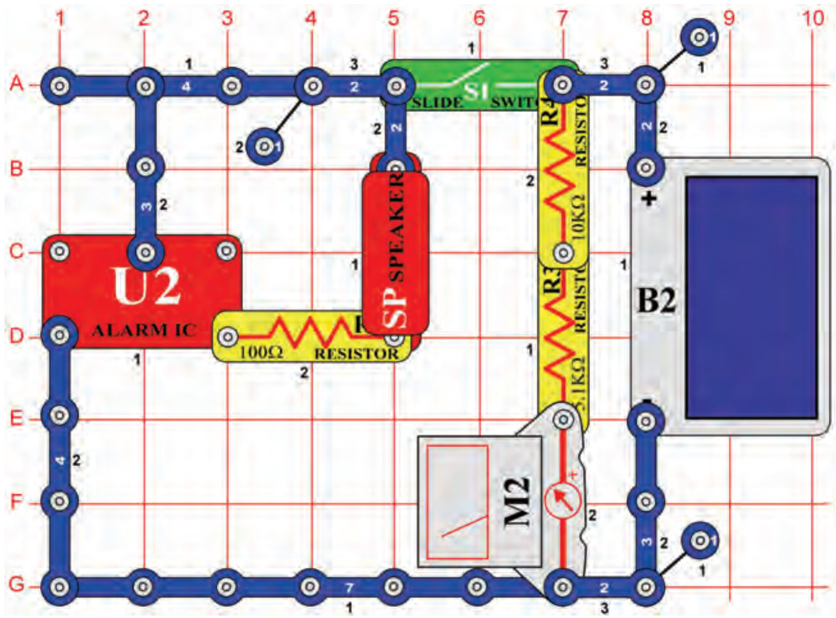
OBJECTIVE: To use the sun to make sounds.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to sounds from the alarm (U2) and space war (U3) IC's. Wave your hand over the photoresistor (RP) to change the sounds.

The meter is used to measure if the solar cell can supply enough current to operate the alarm and space war IC's. This project needs more light than project #557, since two IC's are used here.

Project #559 Solar Alarm

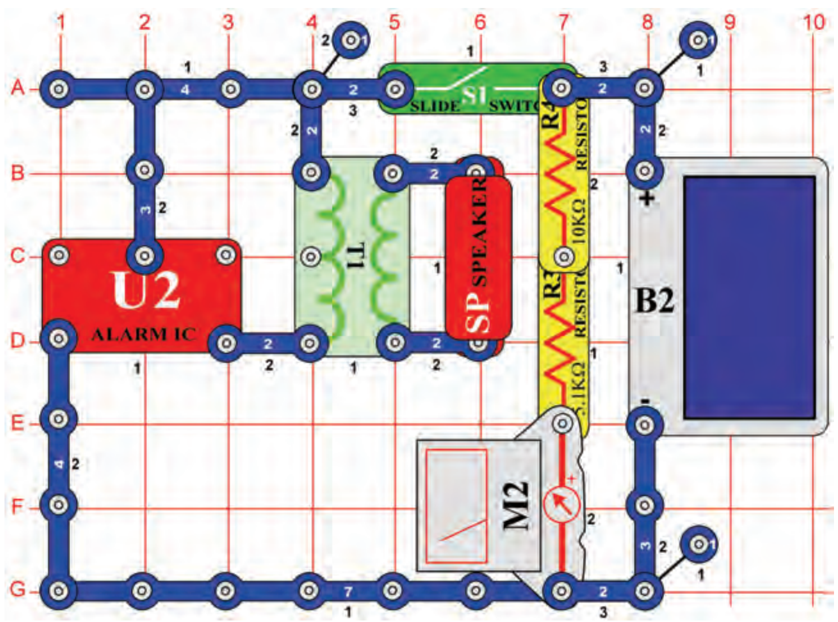


OBJECTIVE: To use the sun to make alarm sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have a bright light on the solar cell (B2) so the meter reads 10 or higher. Now turn on the slide switch and listen to the sound.

The meter is used to measure if the solar cell can supply enough current to operate the alarm IC (U2). Some types of light are better than others, but bright sunlight is best.

Project #560 Better Solar Alarm



OBJECTIVE: To use the sun to make alarm sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the sound.

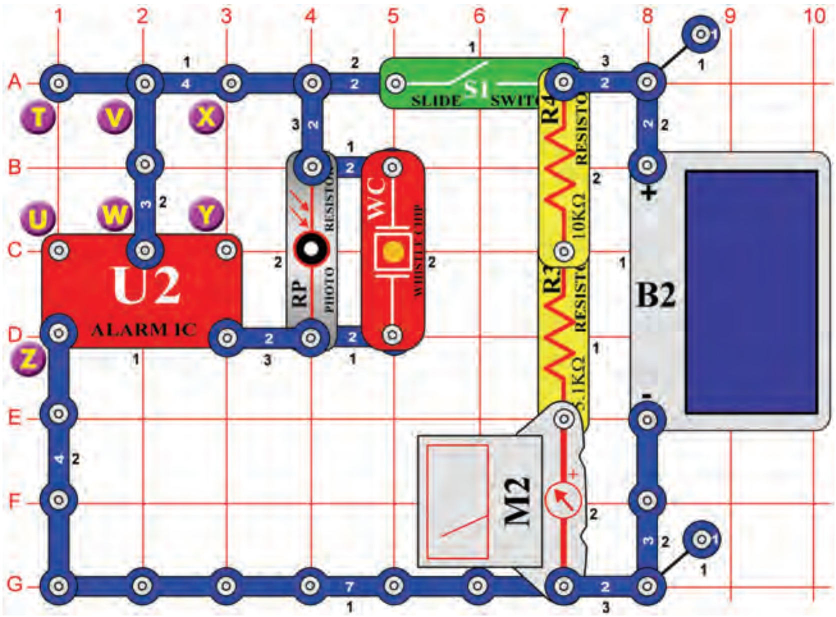
This circuit uses the transformer (T1) to boost the current to the speaker (SP), allowing it to operate with less power from the solar cell. Compare how much light it needs to project #559, which doesn't have a transformer.

You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #561

Photo Solar Alarm

OBJECTIVE: To use the sun to make alarm sounds.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 6 or higher. Now turn on the slide switch and listen to the alarm. Cover the photoresistor (RP) to stop the alarm.

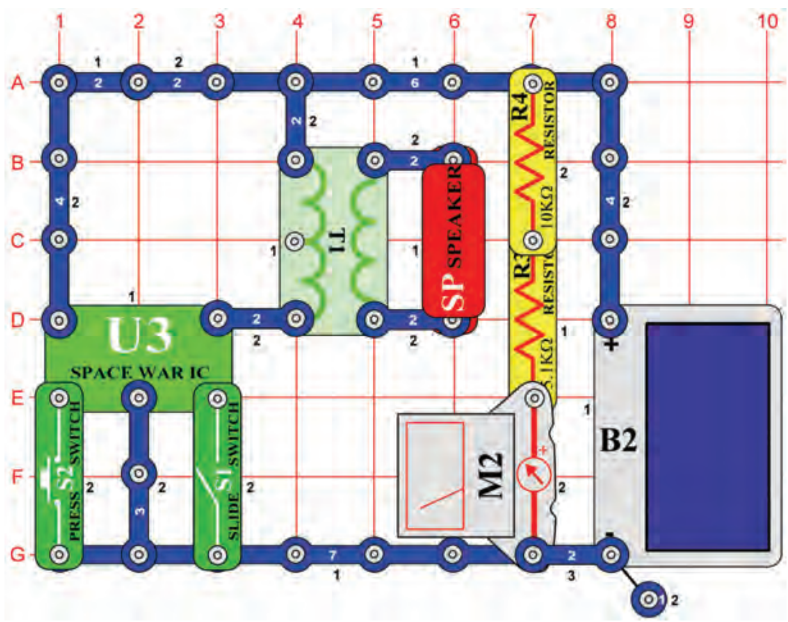
The whistle chip (WC) needs less power to make noise than the speaker (SP), so this circuit can operate with less light on the solar cell than projects #559 and #560. But the sound from the circuits with the speaker is louder and clearer.

You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #562

Solar Space War

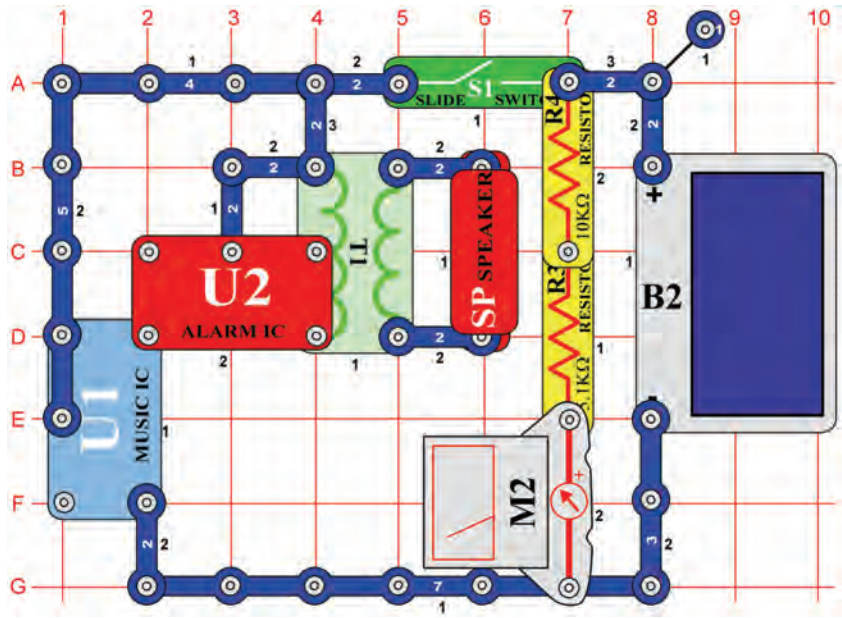
OBJECTIVE: To use the sun to make space war sounds.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the space war sounds.

Project #563

Solar Music Alarm Combo



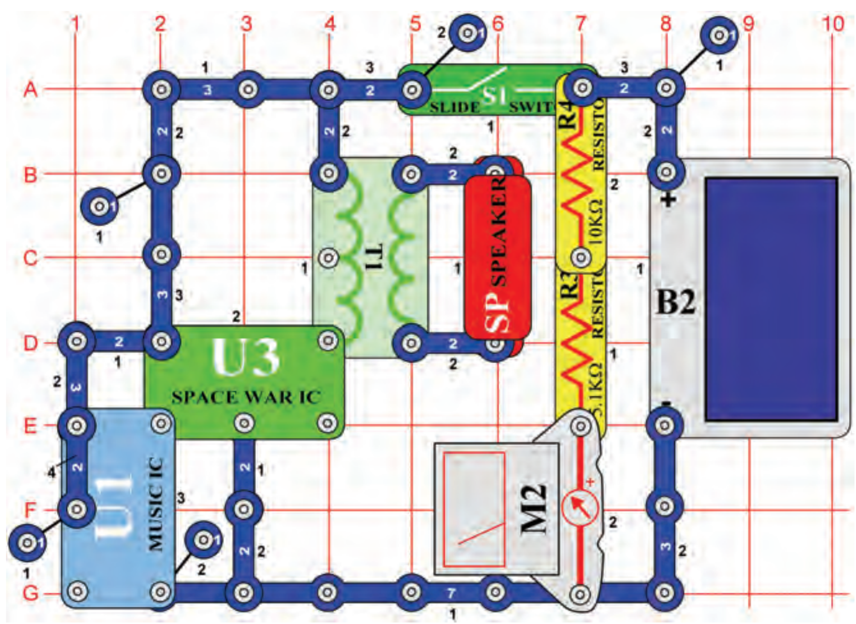
OBJECTIVE: To use the sun to make a combination of sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the music.

The meter is used to measure if the solar cell can supply enough current to operate the ICs (U1 & U2).

Project #564

Solar Music Space War Combo



OBJECTIVE: To use the sun to make a combination of sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the music.

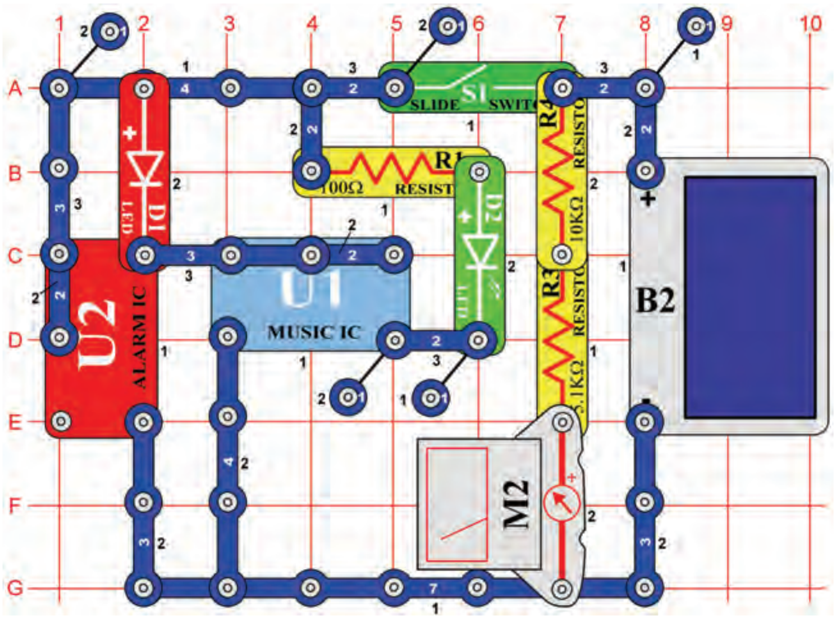
Project #565

Solar Music Space War Combo (II)

OBJECTIVE: To use the sun to make a combination of sounds.

Use the circuit from project #564 but replace the speaker (SP) with the whistle chip (WC). Now the light on the solar cell (B2) doesn't have to be as bright for this circuit to work. You can also modify this circuit by replacing the music IC (U1) with the alarm IC (U2).

Project #566 Solar Periodic Lights



OBJECTIVE: To use the sun to flash lights in a repeating pattern.

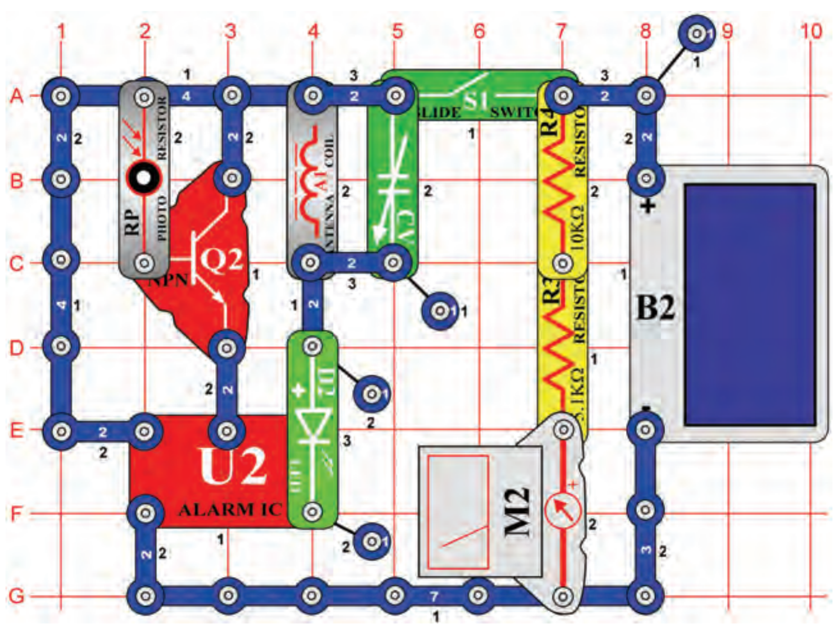
Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and the LED's (D1 & D2) will alternate being on and off.

Project #567 Solar Periodic Lights (II)

OBJECTIVE: To use the sun to flash lights in a repeating pattern.

Use the circuit in project #566, except remove the 3-snap between the music (U1) and alarm (U2) IC's (base grid locations C2-C4) and add a 2-snap between the music IC and the 100Ω resistor (R1) (base grid B4-C4). The circuit works the same way but the LED flashing patterns are different.

Project #568 Solar AM Radio Transmitter



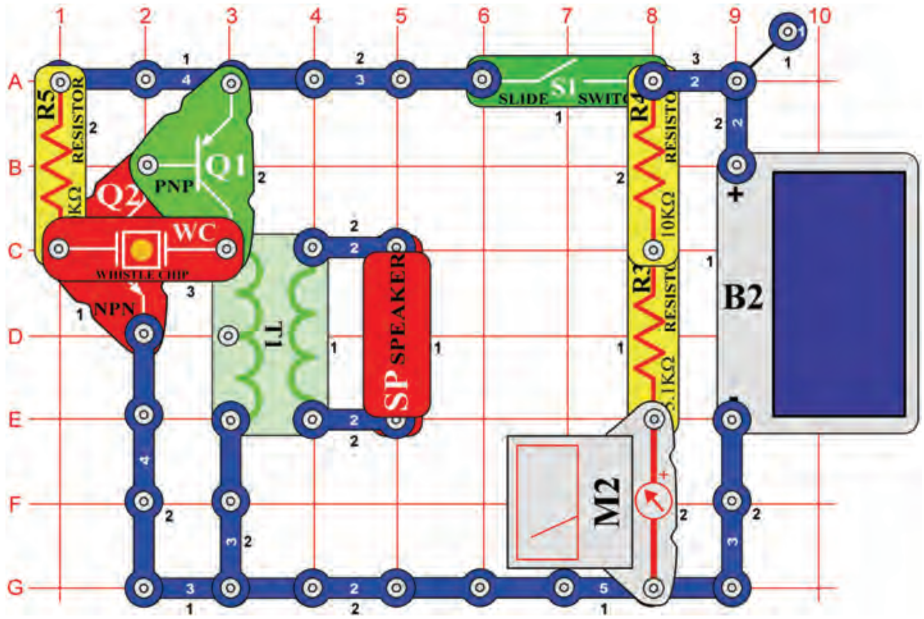
OBJECTIVE: To use the sun to power an AM radio transmitter.

You need an AM radio for this project. Place it next to your circuit and tune the frequency to where no other station is transmitting.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Turn on the slide switch and adjust the variable capacitor (CV) for the best sound on the radio. Cover the photoresistor (RP) to change the sound pattern.

Project #569 — Low Light Noisemaker

OBJECTIVE: To build a sun-powered oscillator circuit.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have light on the solar cell (B2) for the meter to read at least 5 but less than 10.

Turn on the slide switch and it should make a whining sound, adjust the amount of light to the solar cell to change the frequency of the sound. Use a brighter light or partially cover the solar cell if there is no sound at all.

Project #570 — Low Light Noisemaker (II)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #569 but replace the whistle chip (WC) with the 0.1μF capacitor (C2) to lower the frequency of the sound. The circuit works the same way.

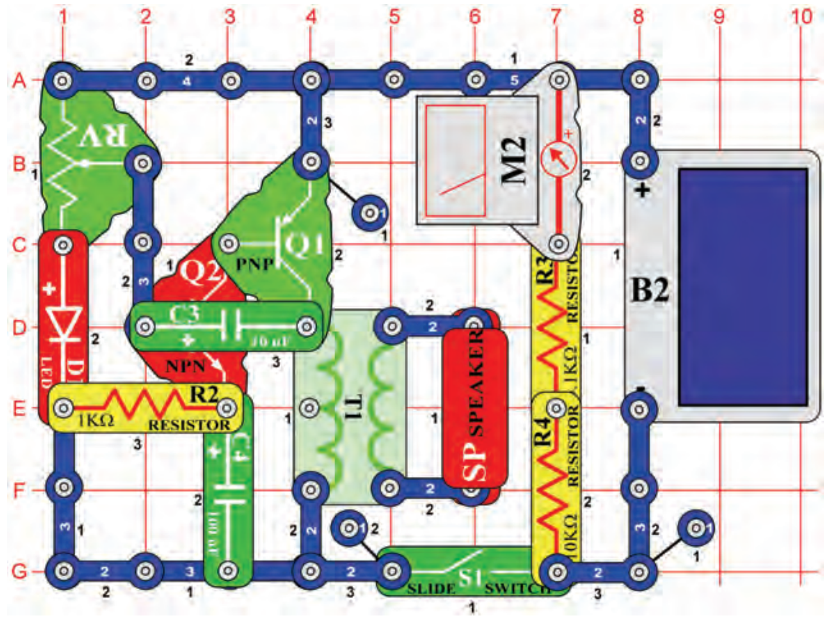
Project #571 — Low Light Noisemaker (III)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #569 but replace the whistle chip (WC) with the 10μF capacitor (C3, “+” on the right) to lower the frequency of the sound. The circuit works the same way but you hear a ticking sound instead of a whining sound.

Project #572 Solar Oscillator

OBJECTIVE: To build a sun-powered oscillator circuit.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and adjust the adjustable resistor (RV).

You will hear a clicking sound like raindrops or a whine, depending upon how much light there is.

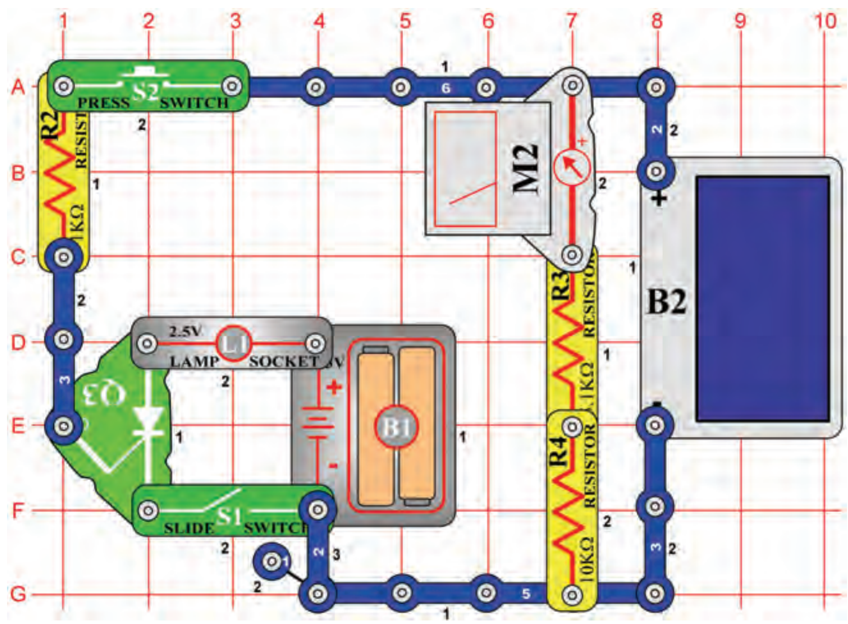
Project #573 Solar Oscillator (II)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #572 but replace the 10μF capacitor (C3) with the 0.02μF or 0.1μF capacitors (C1 & C2) to make the sound a high-pitch whine.

Project #574 Daylight SCR Lamp

OBJECTIVE: To learn the principle of an SCR.



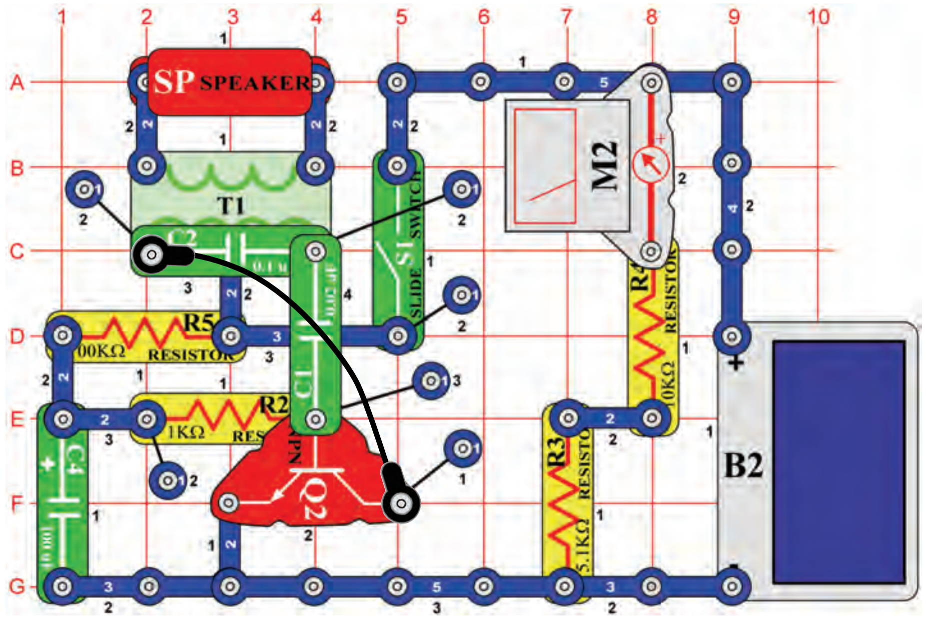
Set the meter (M2) to the LOW (or 10mA) scale. Make sure you have enough light on the solar cell (B2) for the meter to read 3 or higher.

Turn on the slide switch (S1), the lamp (L1) stays off. Push the press switch (S2) and the SCR (Q3) turns on the lamp and keeps it on. You must turn off the slide switch to turn off the lamp.

The SCR is a controlled diode. It lets current flow in one direction, and only after a voltage pulse is applied to its control pin. This circuit has the control pin connected to the press switch and solar cell, so you can't turn it on if the room is dark.

Project #575 — Solar Bird Sounds

OBJECTIVE: To build a sun-powered oscillator circuit.

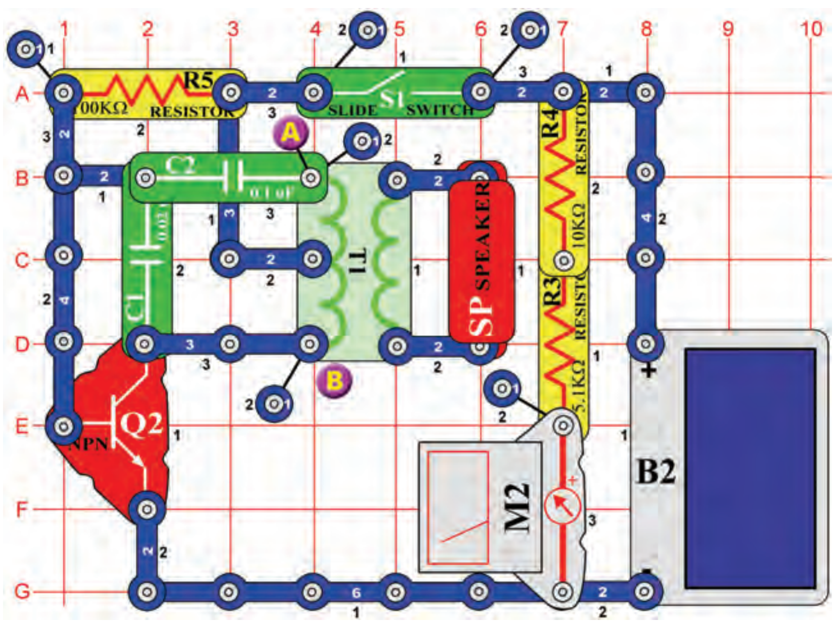


Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to the sound.

For variations on this circuit, replace the 100µF capacitor (C4) with the 10µF capacitor (C3) or replace the speaker (SP) with the whistle chip (WC).

Project #576 — Solar Bird Sounds (II)

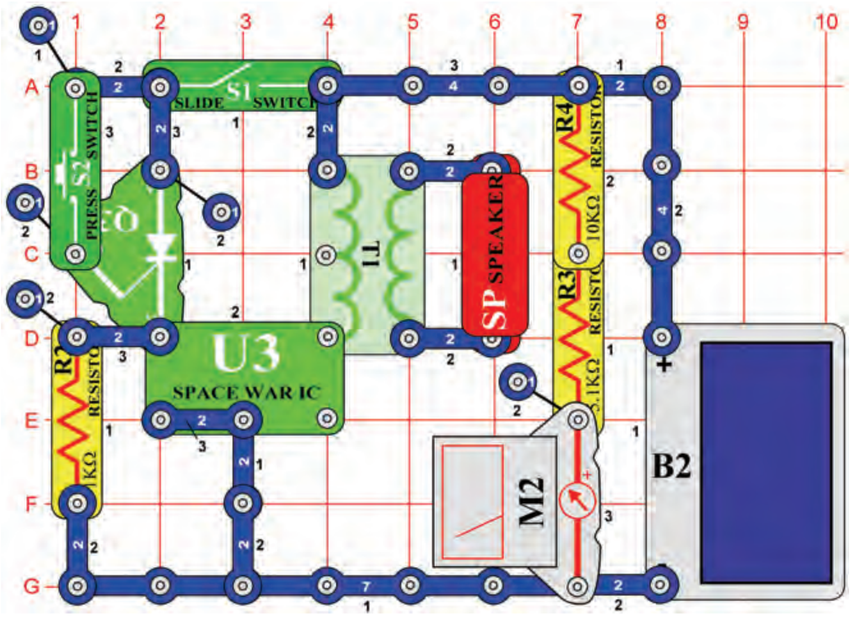
OBJECTIVE: To build a sun-powered oscillator circuit.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to the sound.

For variations on this circuit, install the whistle chip (WC) above the 0.02µF capacitor (C1), or install it across points A & B and remove the speaker (SP).

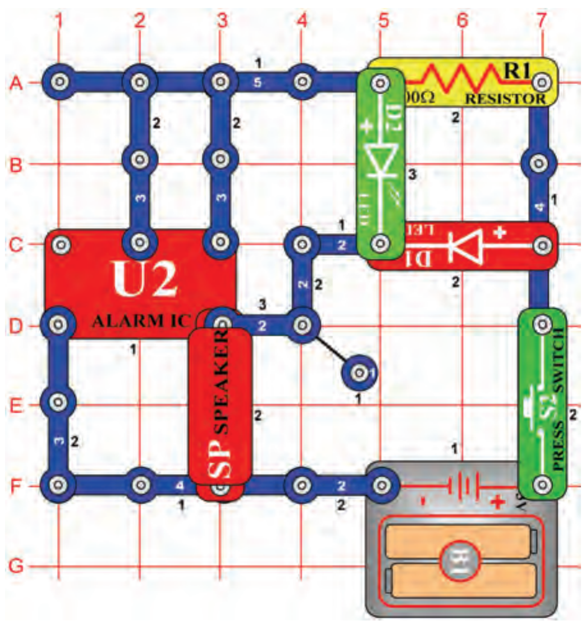
Project #577 SCR Solar Bomb Sounds



OBJECTIVE: To learn the principle of an SCR.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Turn on the slide switch now; nothing happens. Press the press switch (S2) and you hear an explosion of sounds, which continues until you turn off the slide switch.

Project #578 Flashing Laser LED's with Sound



OBJECTIVE: To build a laser sounding circuit.

When you press the press switch (S2), the integrated circuit (U2) should sound like a laser gun. The red (D1) and green (D2) LED's will flash simulating a burst of light. You can shoot long repeating laser bursts or short zaps by tapping the press switch.

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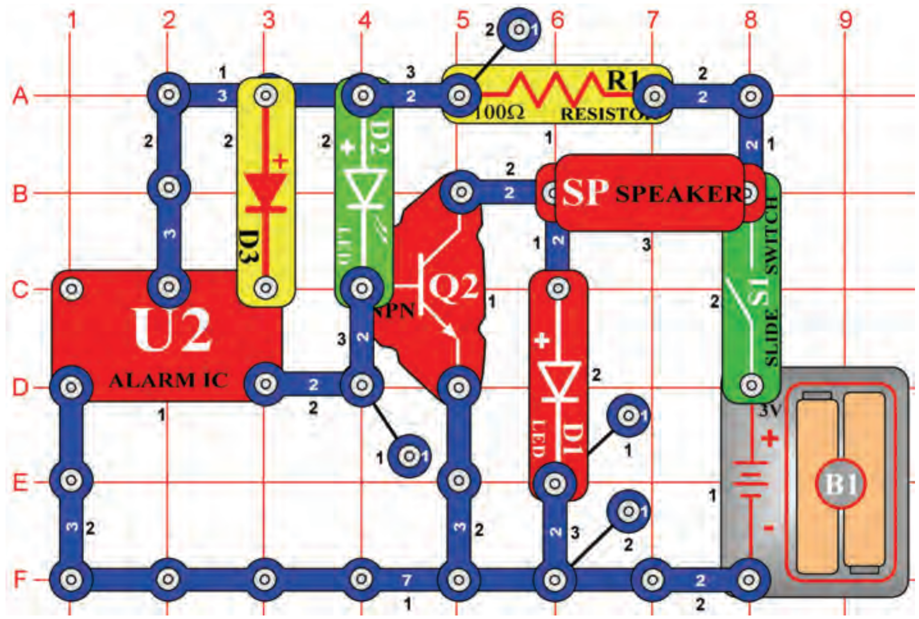
Project #579

U2 with Transistor Amplifier



OBJECTIVE: To combine U2 with an amplifier.

Turn the slide switch (S1) on and the LED's (D1 & D2) flash as the speaker (SP) sounds. The output pulses from U2 turns transistor Q2 on and off rapidly. As the transistor turns on, the speaker shorts to ground and a current flows through it. The current flow through the speaker causes it to produce a sound. The LED's show the pulsing signal from U2 that is turning Q2 on and off.

Project #580

U2 with Transistor Amplifier (II)

OBJECTIVE: To combine U2 with an amplifier.

Using project #579, remove the diode (D3) to create a different sound.

Project #581

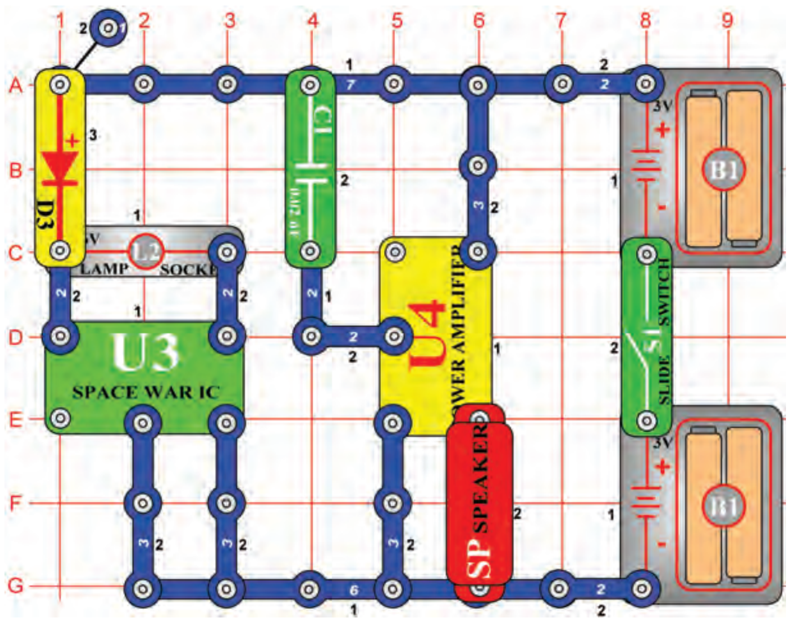
U1 with Transistor Amplifier (III)

OBJECTIVE: To combine U1 with an amplifier.

Using the project #579, replace U2 with U1. The circuit will now play music.

Project #582 — Loud Sounds

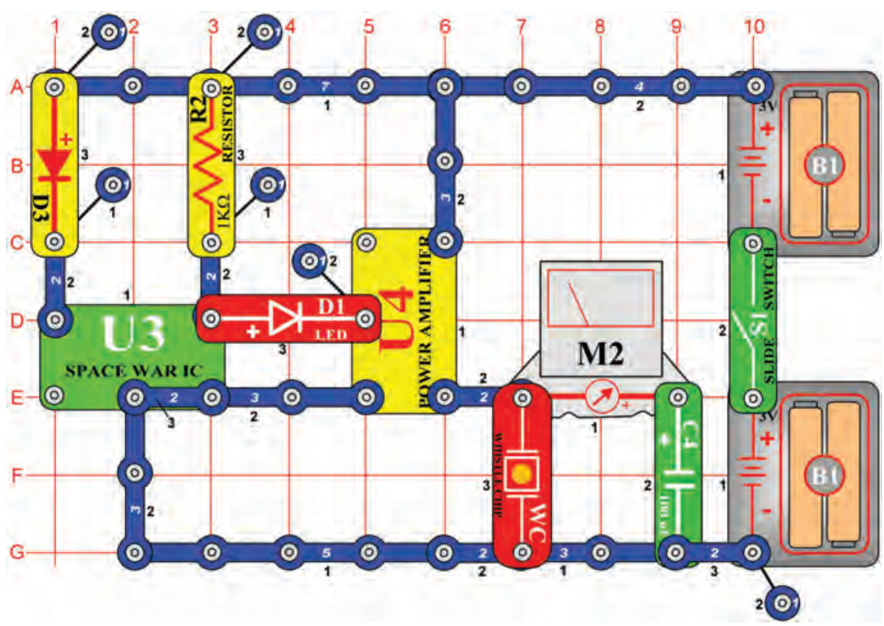
OBJECTIVE: To create a sound circuit.



Turn the slide switch (S1) on and you should hear a tone from the speaker (SP).

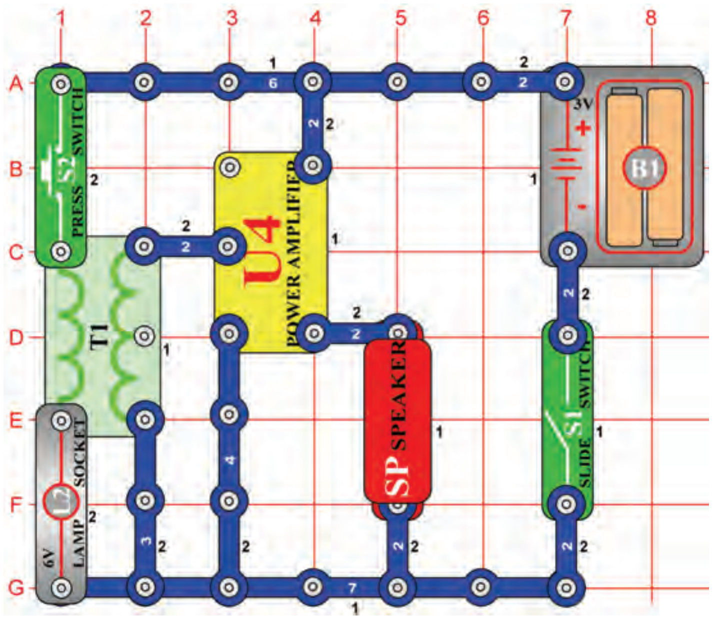
Project #583 — Swinging Meter with Sound

OBJECTIVE: To see and hear the output from the Space War



Set the meter (M2) to the LOW (or 10mA) scale. In this project, you will see and hear the output from the space war IC (U3). The power amplifier IC (U4) amplifies the signal from U3 in order to drive the whistle chip (WC) and meter. Turn on the slide switch (S1). The meter deflects back and forth, as the LED (D1) flashes and the whistle chip sounds. Replace the whistle chip with the speaker (SP) for a louder sound. Note that the meter will deflect very little now. Almost all the signal is across the speaker due to its low resistance.

Project #584



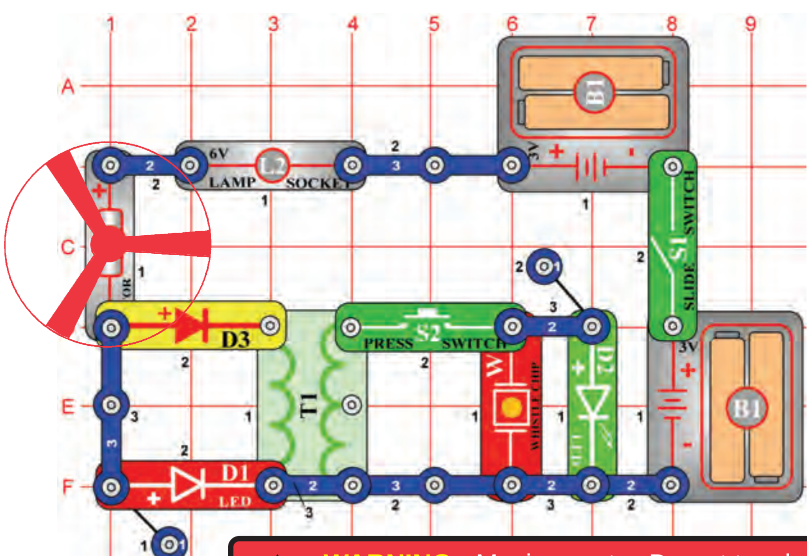
Motor Sound Using Transformer

OBJECTIVE: To create a sound circuit.

Turn the slide switch (S1) on and then rapidly turn on and off the press switch (S2). This causes a magnetic field to expand and collapse in the transformer (T1). The small voltage generated is then amplified by the power amplifier IC (U4) and the speaker (SP) sounds. Replace switch S2 with the motor (M1, leave the fan off) and you can hear how fast the motor spins. To hear the sound better, connect the speaker to the circuit using the red and black jumper wires (instead of the 2-snaps) and hold it next to your ear.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #585



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Motor Sound with LED

OBJECTIVE: To create a sound circuit.

In this project, you will drive the whistle chip (WC) and LED's using the motor (M1) and transformer (T1). Turn the slide switch (S1) on. The motor begins spinning and the red LED (D1) lights. Now press the press switch (S2), the voltage generated from the transformer is now across the whistle chip and green LED (D2). The whistle chip sounds as the green LED lights.

Project #586

Motor Sound with LED (II)

OBJECTIVE: To create a sound circuit.

Modify project #585 by replacing the 6V lamp (L2) with the speaker (SP). Now the speaker (SP) will also output sound.

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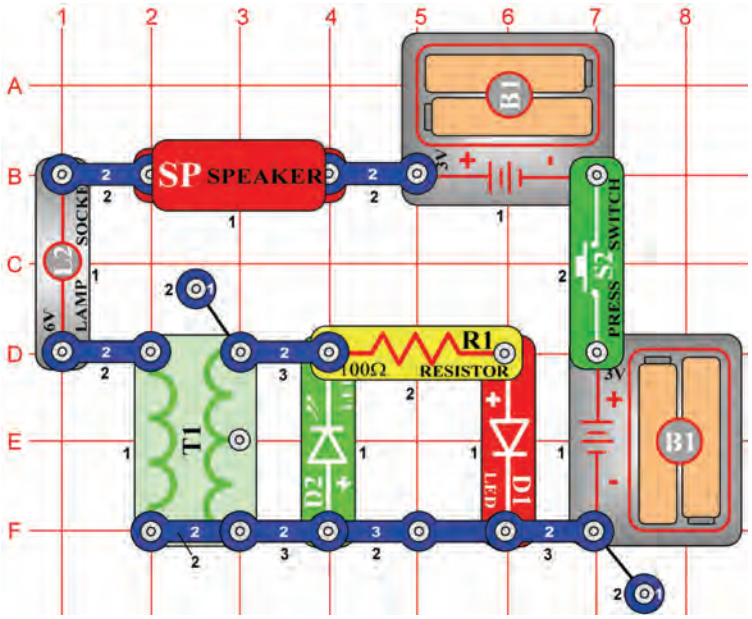
Project #587 — AC & DC Current

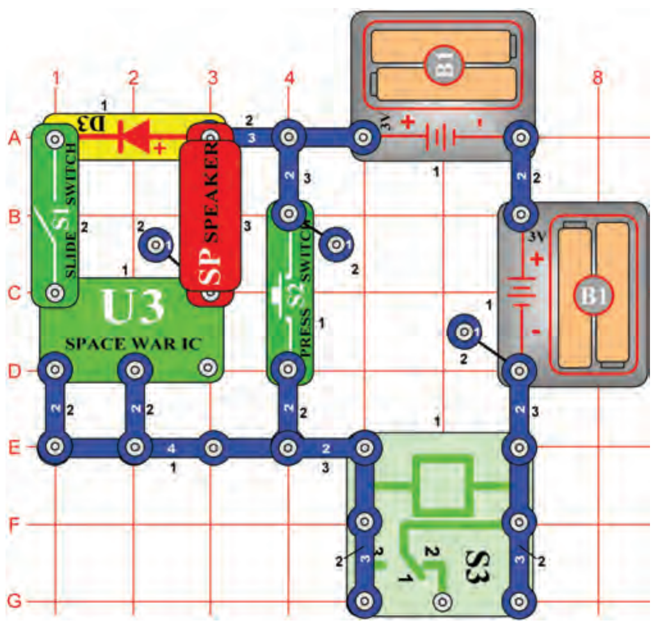
OBJECTIVE: Using AC and DC current.



This circuit creates an AC & DC current. Press the press switch (S2) a few times and the LED's flash back and forth. Turning the switch on and off causes the magnetic field in the transformer (T1) to expand (green LED D2 lights) and collapse (red LED D1 lights) and current flows in two directions. Hold the switch down and the green LED flashes once. Replace the 6V lamp (L2) with the motor (M1). Press the press switch, the red LED flickers and the speaker sounds, due to the small current change from the motor spinning.

Project #588 — Noisemaker

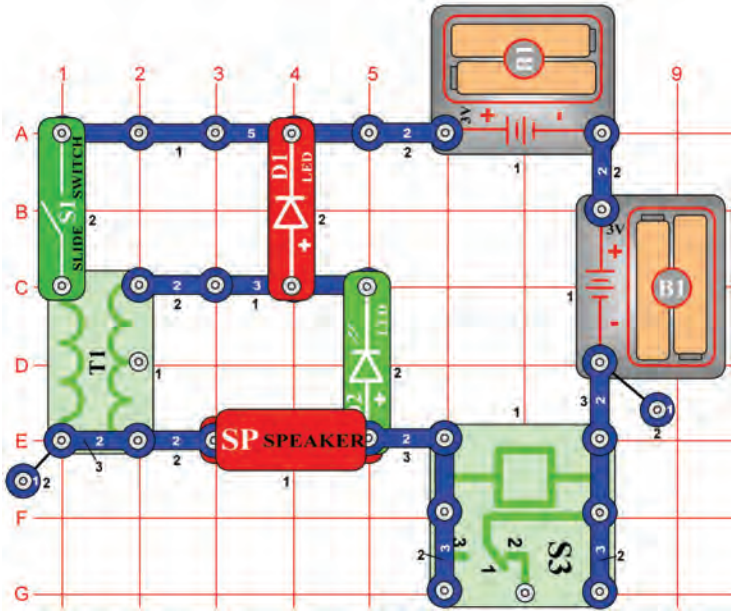
OBJECTIVE: To create a sound circuit.



Turn on the slide switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the press switch (S2). The tone is higher because the relay's contacts are opening and closing faster.

Project #589 AC Voltage

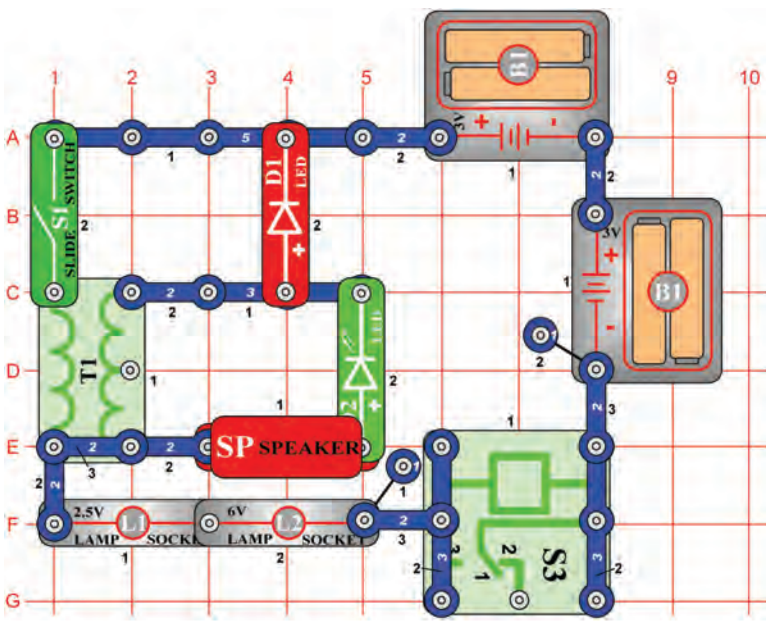
OBJECTIVE: To use AC voltage.



Turn the slide switch (S1) on. The LED's (D1 & D2) flash so fast that they appear to be on, and the speaker (SP) sounds. As in other projects, the relay's (S3) contacts open and close rapidly. This causes the magnetic field in the transformer (T1) to expand and collapse, creating an AC voltage lighting the LED's.

Project #590 AC Voltage (II)

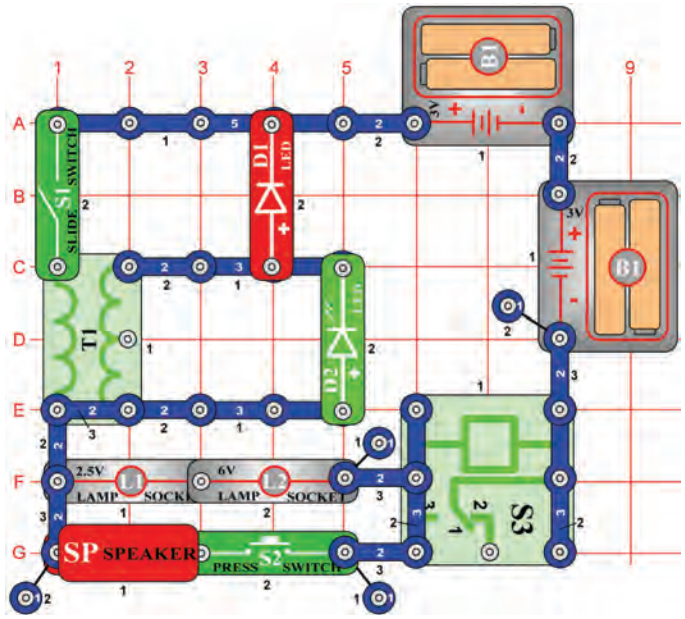
OBJECTIVE: To use AC voltage.



You can modify project #589 by adding two light bulbs (L1 & L2). When the slide switch (S1) is turned on, the relay (S3) sounds and the light bulbs and LED's (D1 & D2) flash.

Project #591 — AC Voltage (III)

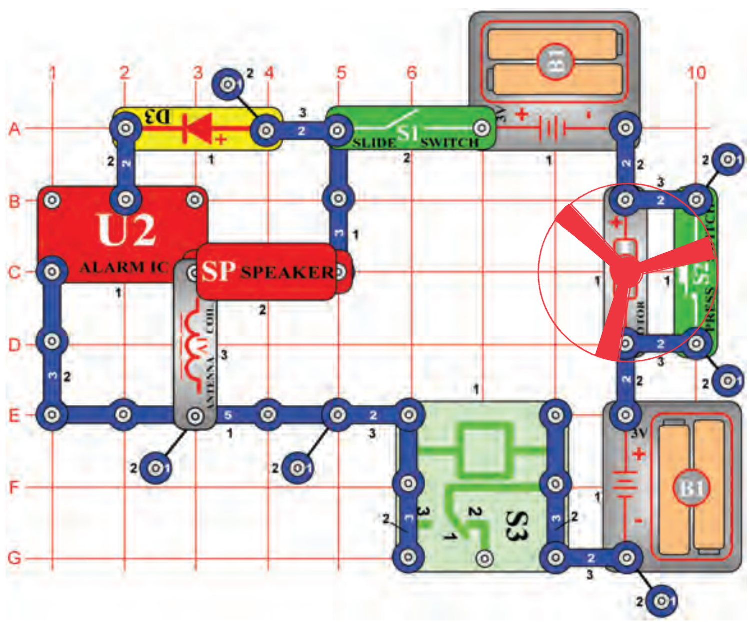
OBJECTIVE: To use AC voltage.



This project is similar to project #589. When the slide switch (S1) is turned on, the relay (S3) sounds and the light bulbs (L1 & L2) and LED's (D1 & D2) flash. Now when the press switch (S2) is pressed, the speaker (SP) also sounds.

Project #592 — Noisemaker (II)

OBJECTIVE: To create a sound circuit.



Turn on the slide switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the press switch (S2). The tone changes because the relay's contacts are opening and closing faster.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

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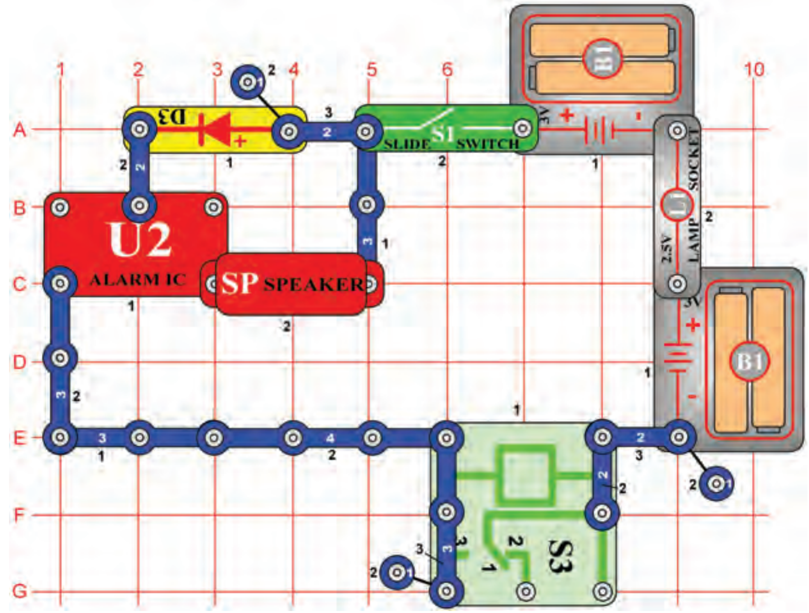
☐ Project #593 Noisemaker (III)

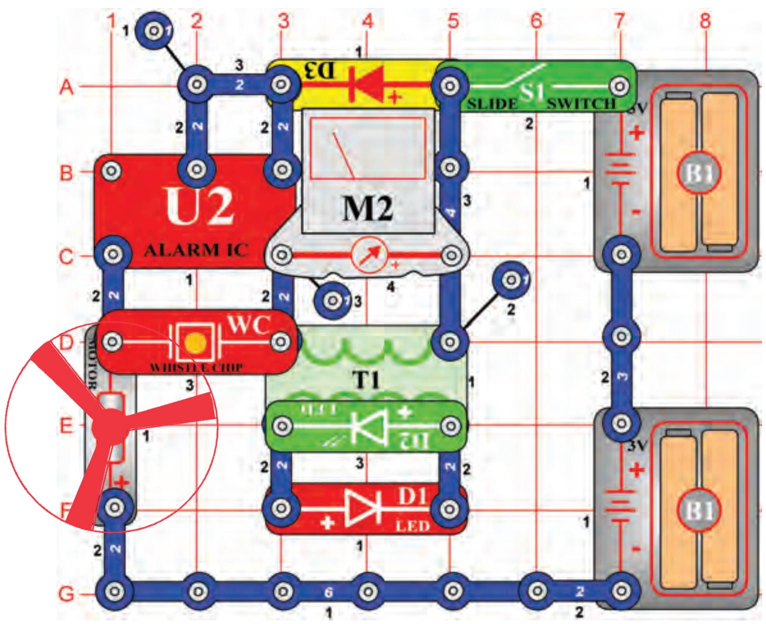
OBJECTIVE: To create a sound circuit.



Turn the slide switch (S1) on and the speaker (SP) sounds as if a motor is spinning and an alarm is running. The relay's (S3) contacts rapidly open and close the battery connection to the circuit causing the alarm IC (U2) sound to be different.

☐ Project #594 Pulsing Motor

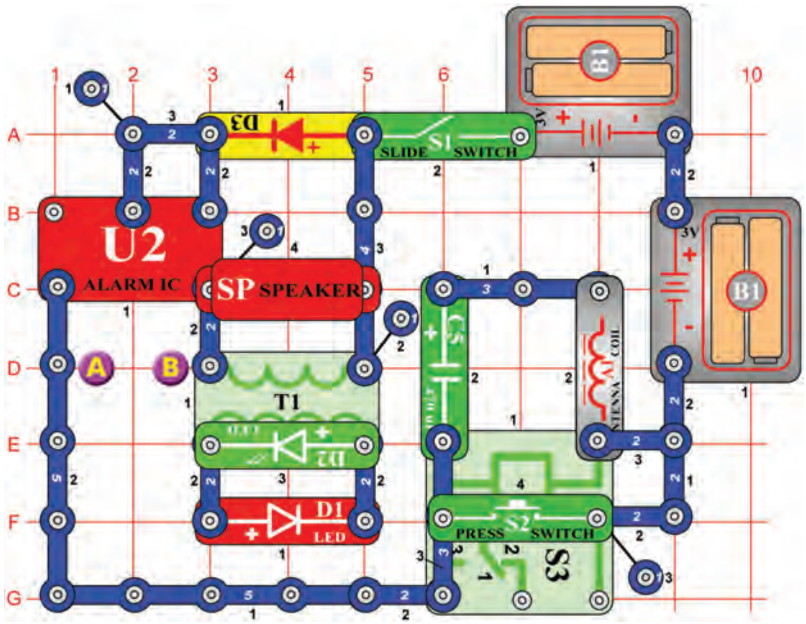
OBJECTIVE: To create a pulsing motor circuit.



Set the meter (M2) to the LOW scale. Turn on the slide switch (S1) and now you have a pulsing motor and LED's circuit. Replace the meter with the 470µF capacitor (C5, "+" on right) to change the rate the LED's (D1 & D2) flash.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #595 Noisemaker (IV)



OBJECTIVE: To create a sound circuit.

In this project, you'll see and hear the output of the alarm IC (U2). Turn on the slide switch (S1), the LED's (D1 & D2) flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the press switch (S2) and see what happens when you remove the relay from the circuit.

Project #596 Noisemaker (V)

OBJECTIVE: To create a sound circuit.

Modify the sound of project #595 by adding capacitor C4 across points A & B (+ of C4 on right).

Project #597 Noisemaker (VI)

OBJECTIVE: To create a sound circuit.

Modify project #596 by replacing the capacitor C4 with the motor (M1, position it with the "+" on the left and don't place the fan on it). Turn on the slide switch (S1), the LED's flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the press switch (S2) removing the relay from the circuit, providing a constant connection to the battery (B1). The motor speeds up and the sound from the speaker is not distorted.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #598 Noisemaker (VII)

OBJECTIVE: To create a sound circuit.

Modify project #597 replacing the speaker (SP) with the whistle chip (WC) and placing the fan onto the motor (M1). Turn on the slide switch (S1) and the fan spins, lights flash, and the relay (S3) chatters. Now try to launch the fan by pressing the press switch (S2) down for about five seconds and releasing it.

Project #599 Noisemaker (VIII)

OBJECTIVE: To create a sound circuit.

Modify project #598 by removing the motor (M1). Turn on the slide switch (S1) and press the press switch (S2) to hear the new sound.

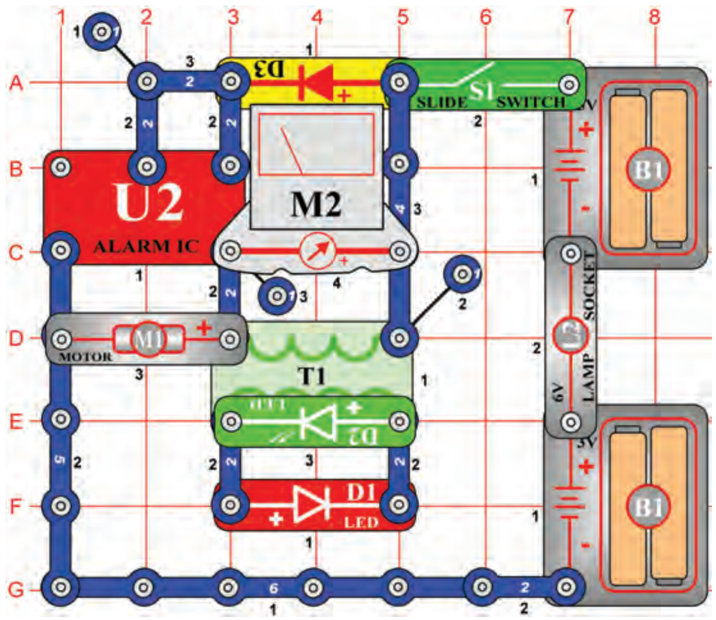
Project #600 Noisemaker (IX)

OBJECTIVE: To create a sound circuit.

Modify the sound of project #599 by replacing the whistle chip (WC) with the meter (M2, "+" towards right), use the LOW (or 10mA) meter setting. Turn on the slide switch (S1) and as the LED's flash the meter deflects.

Project #601 Alarm Power

OBJECTIVE: To create a sound circuit.



In this project, the alarm IC (U2) powers the motor (M1), meter (M2) and LED's (D1 & D2). Leave the fan off of the motor. Set the meter to the LOW (or 10mA) position and turn on the slide switch (S1). The circuit pulses the meter, motor, and LED's.

WARNING: Moving parts. Do not touch the motor during operation.

Project #602 Alarm Power (II)

OBJECTIVE: To create a sound circuit.

Remove the motor (M1) from the circuit and now the circuit pulses around 1Hz.

Project #603 Night Sounds

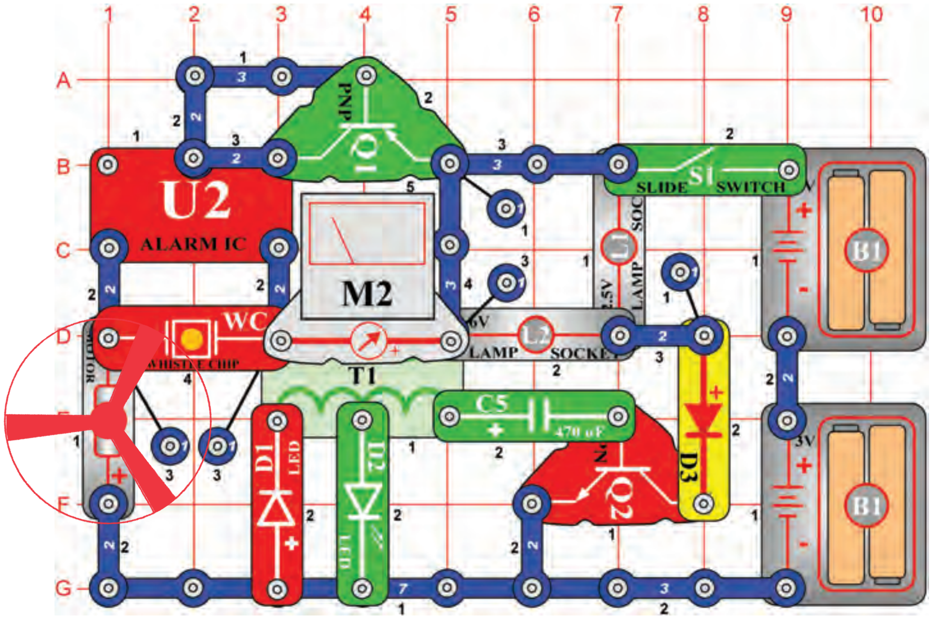
OBJECTIVE: To hear the sounds of the night.

Simulate the sound of a forest at night by replacing the motor (M1) in project #601 with the whistle chip (WC).

Project #604

Mega Pulser & Flasher

OBJECTIVE: To power other devices using the alarm IC.



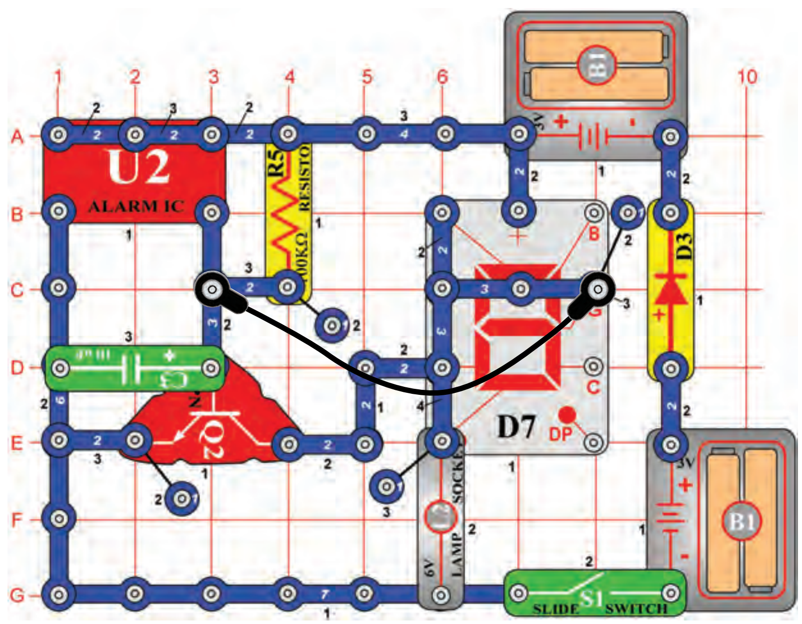
In this circuit, you will power many devices using the alarm IC (U2). Set the meter (M2) to LOW (or 10mA) and turn on the slide switch (S1). The LED's (D1 & D2) and bulbs (L1 & L2) flash, the meter deflects, the whistle chip (WC) sounds, and the motor (M1) spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #605

"E" & "S" Blinker

OBJECTIVE: To use the alarm IC to flash between "E" & "S".

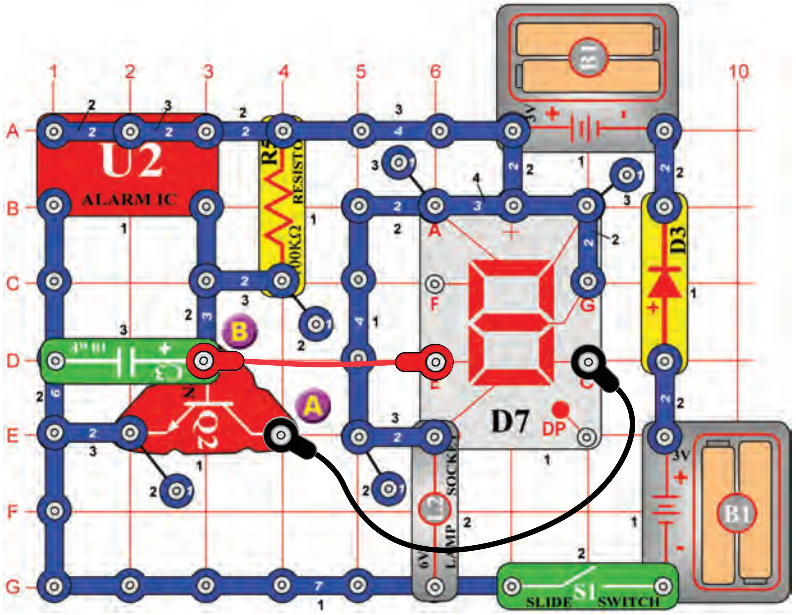


This circuit alternately displays letters "E" and "S" by switching segments "E" and "C" on and off. Segments A, D, F, and G are connected to ground so they are always lit. Segment "C" is connected to the base of Q2 and output of U2. The segment "E" is connected to the collector of Q2. When the output of U2 is low, segment "C" is on and "E" is off. When the U2's output is high, the transistor (Q2) turns on and segment "C" turns off. When the transistor connects the "E" segment to ground the segment lights, displaying the letter "S".

☐ **Project #606**

"2" & "3" Blinker

OBJECTIVE: To use the alarm IC to flash between "2" & "3".

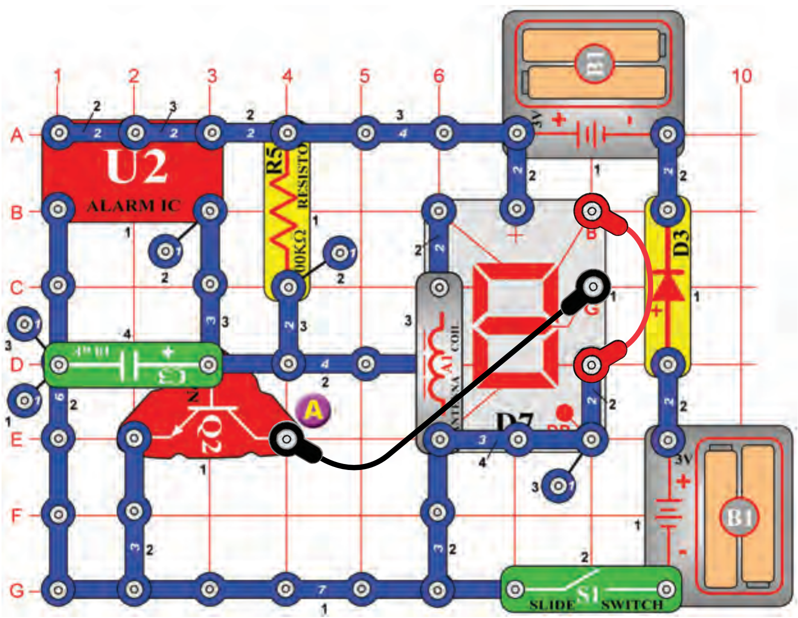


The circuit switches between numbers "2" & "3" on the display.
Place jumpers from point A to segment C and point B to segment E.

☐ **Project #607**

"9" & "0" Blinker

OBJECTIVE: To use the alarm IC to flash between "9" & "0".

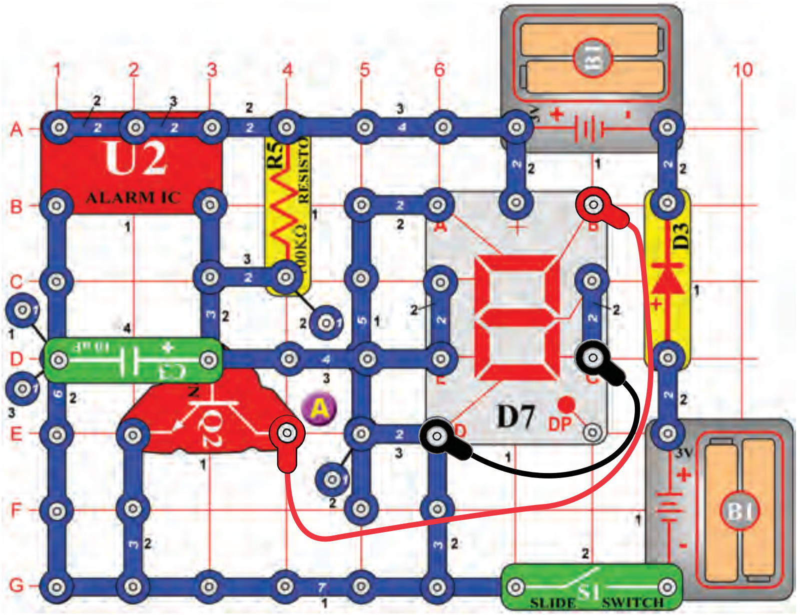


The circuit switches between numbers "9" and "0" on the display.
Place a jumper from point A to segment G and segment B to segment C.

Project #608

"3" & "6" Blinker

OBJECTIVE: To use the alarm IC to flash between "3" & "6".

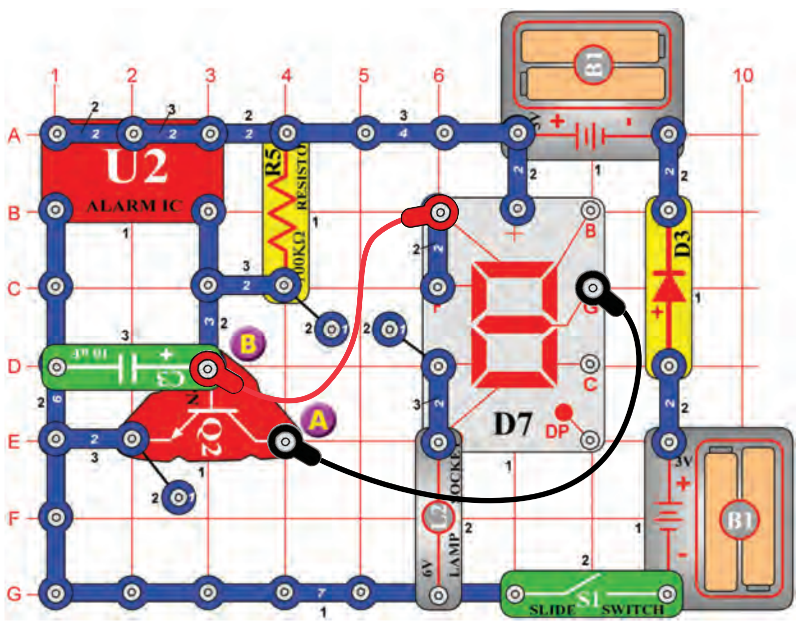


The circuit switches between numbers "3" & "6" on the display. Place a jumper from segment C to segment D and segment B to point A.

Project #609

"c" & "C" Blinker

OBJECTIVE: To use the alarm IC to flash between "c" & "C".

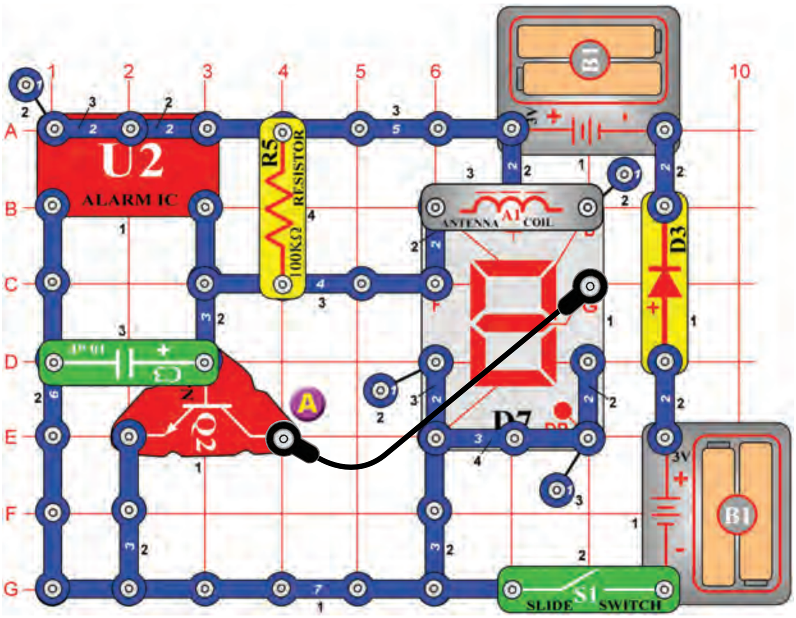


The circuit switches between letters "c" & "C" on the display. Place a jumper from point A to segment G and point B to segment A.

Project #610

“O” & “o” Blinker

OBJECTIVE: To use the alarm IC to flash between “O” & “o”.

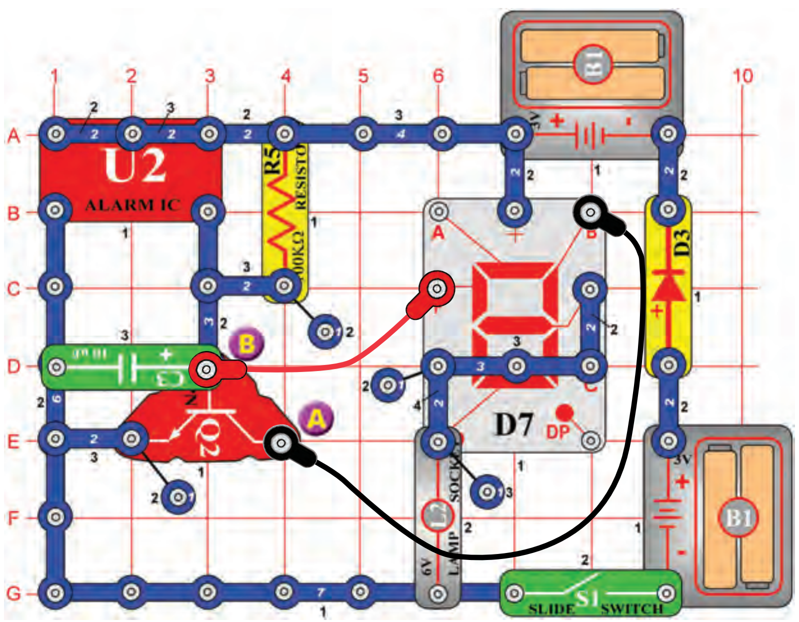


The circuit switches between upper case “O” and lower case “o”. Place a jumper from point A to segment G. The DP segment will also light.

Project #611

“b” & “d” Blinker

OBJECTIVE: To use the alarm IC to flash between “b” & “d”.

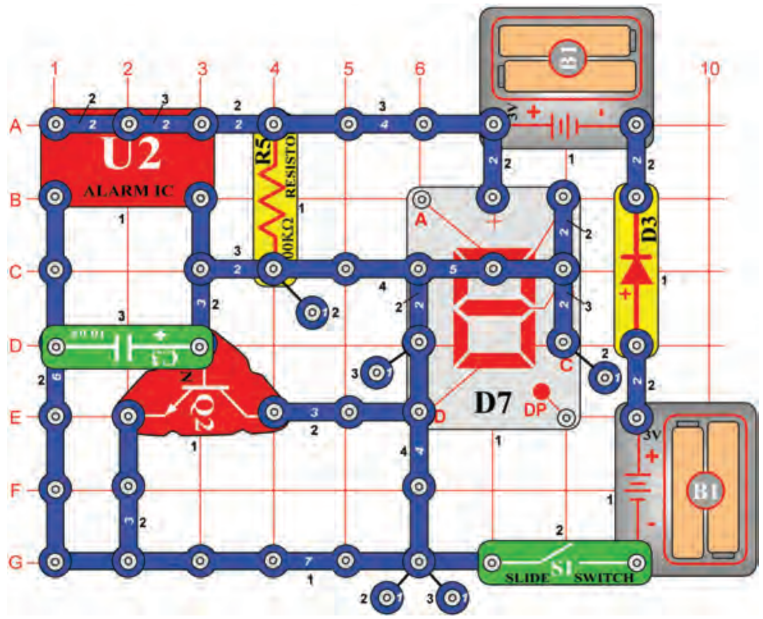


The circuit switches between letters “b” & “d” on the display. Place a jumper from point A to segment B and point B to segment F.

☐ **Project #612**

"H" & "L" Blinker

OBJECTIVE: To use the alarm IC to flash between "H" & "L".

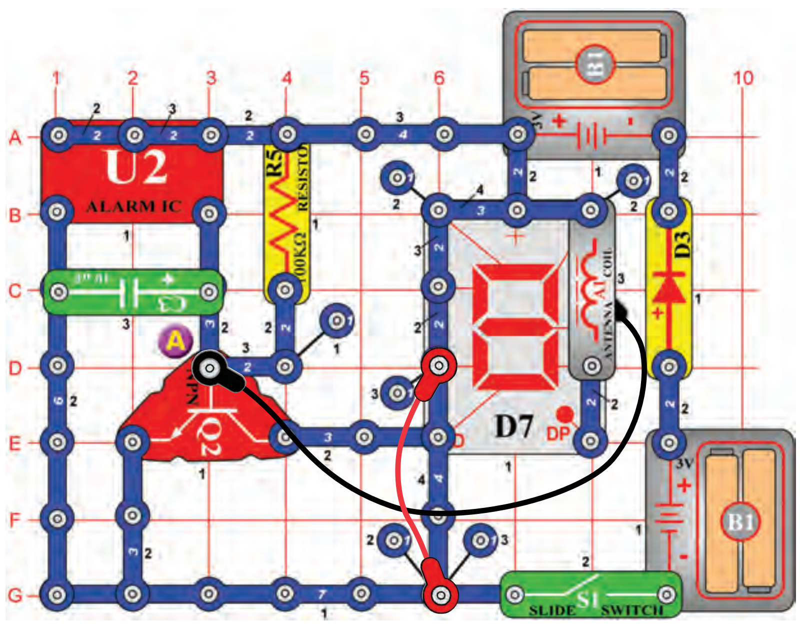


The circuit switches between letters "H" & "L" on the display.

☐ **Project #613**

"A" & "O" Blinker

OBJECTIVE: To use the alarm IC to flash between "A" & "O".

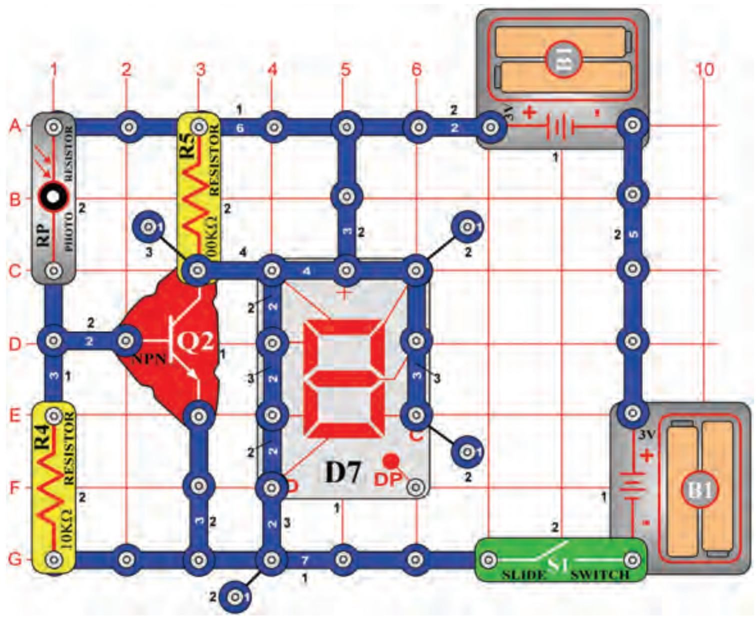


The circuit switches between letters "A" & "O" on the display. Place a jumper from point A to segment G. The DP segment will also light.

Project #614

Open & Closed Indicator

OBJECTIVE: To construct a circuit that indicates if a door is open or closed using light.

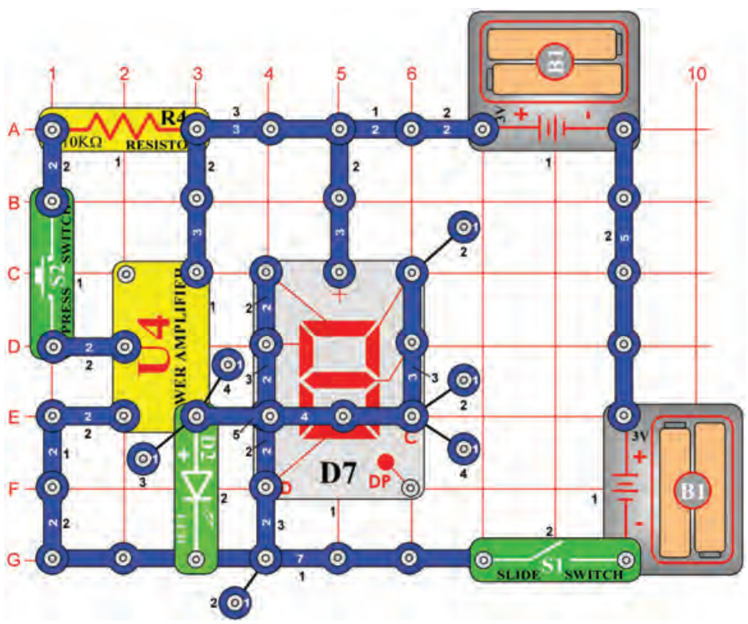


Switching from letters "O" to "C" requires turning off segments B & C. Turn on the slide switch (S1), the display lights an "O" indicating an open door. Cover the photoresistor (RP) with your hand (closed door) and the letter "C" lights. The photoresistor turns Q2 on and off depending on the amount of light. When Q2 is on (light on RP) the voltage at the collector is low, lighting segments B & C. Covering the RP turns Q2 off and the collector voltage is high now. Segments B & C turn off and the letter "C" lights.

Project #615

Open & Closed Indicator (II)

OBJECTIVE: To construct a circuit that indicates if a switch is open or closed using U4.



As in project #614, the display will light an "O" or "C" indicating if the press switch (S2) is on or off. Turn on the slide switch (S1), the LED (D2) and letter "O" lights. With no input to U4 the LED lights and the voltage decreases enough so segments B & C light. Press the press switch S2, the LED turns off and the letter "C" lights. The voltage at U4's output increased enough turning the segments off.

Project #616

Vibration Indicator

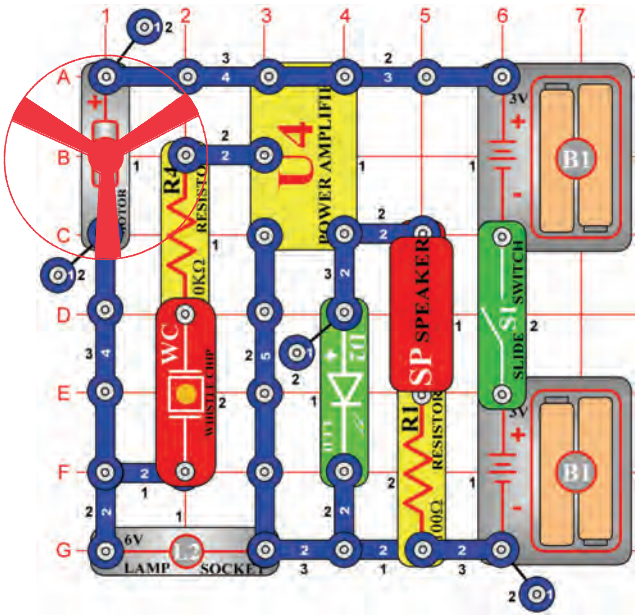
OBJECTIVE: To construct a circuit that indicates vibration.

Modify project #615 by replacing the press switch (S2) with the whistle chip (WC). As you tap the whistle chip, U4's output voltage changes, lighting the LED (D2) and changing the display from "C" to "O".

Project #617

Vibration Sounder

OBJECTIVE: To construct a circuit that indicates vibration.



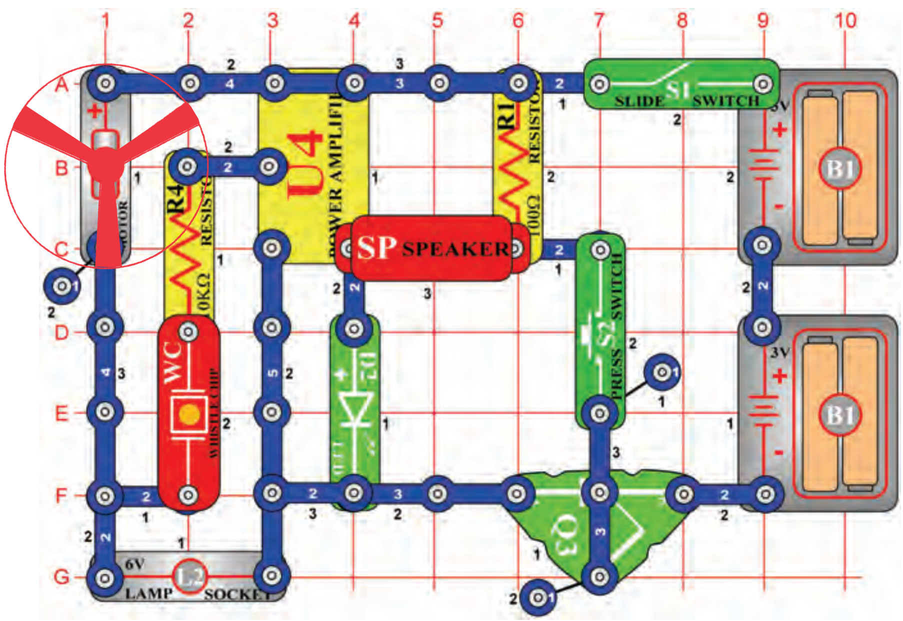
As the motor (M1) spins, it generates an AC voltage amplified by U4. The output from U4 lights the LED (D2) and makes noise from the speaker (SP). With the fan not installed, turn on the slide switch (S1) and you hear the high tone of the spinning motor. Now, install the fan and hear the difference.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #618

SCR Noise Circuit

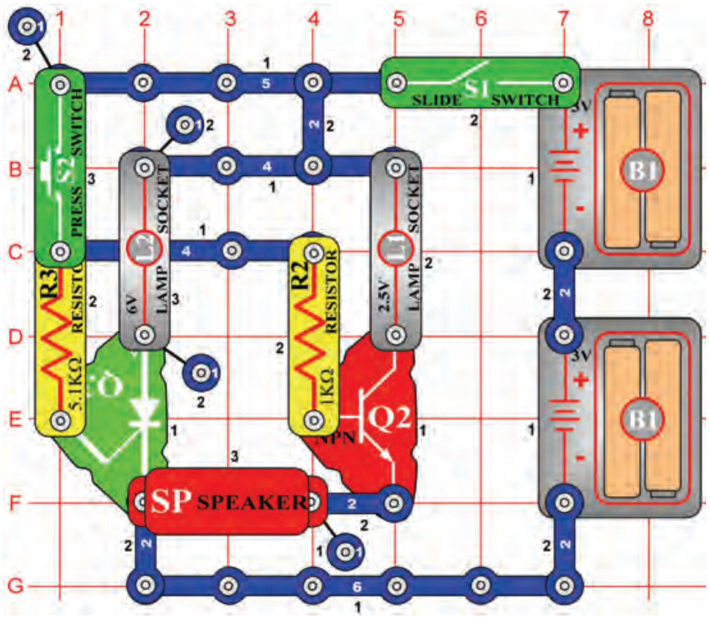
OBJECTIVE: To use the SCR to start a circuit.



Turn on the slide switch (S1) and nothing happens. The SCR (Q3) connects the circuit to the batteries and, until the SCR's gate goes high, the circuit is off. Press the press switch (S2) and the motor (M1) spins and the LED (D2) and bulb (L2) light. Increase the sound from the speaker (SP) by pressing the press switch.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #619

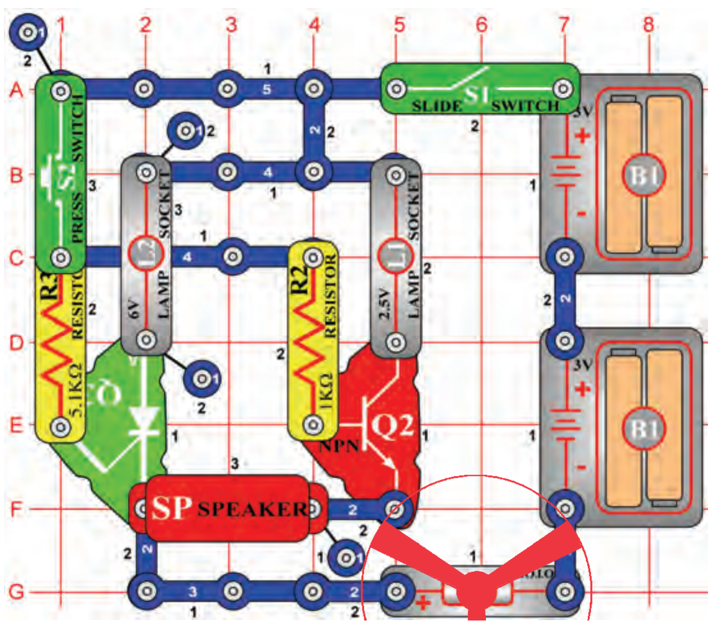


SCR & Transistor Switch

OBJECTIVE: Control bulbs L1 & L2 with an SCR and transistor.

Turn the slide switch (S1) on and then press the press switch (S2), both bulbs (L1 & L2) light, but only L2 stays on when S2 is released. To stay on, the transistor (Q2) requires a continuous voltage but the SCR only needs a pulse. The speaker (SP) may not make any sound.

Project #620



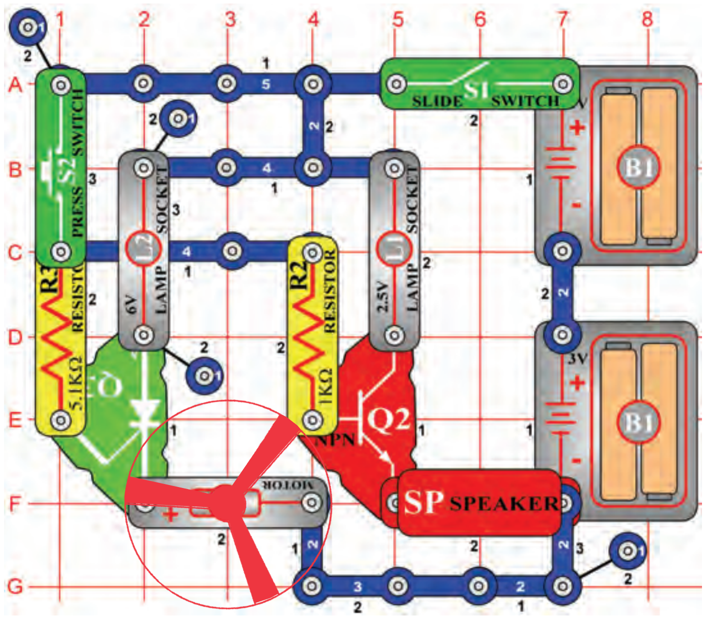
Two-speed Motor

OBJECTIVE: Increase the speed of a motor using an SCR and transistor.

If you turn on either switch (S1 or S2) alone, nothing happens. But if you turn on the slide switch (S1) and then press the press switch (S2), the lamps (L1 & L2) light and the motor (M1) spins. The SCR (Q3) keeps the 6V lamp (L2) on and the motor spinning after you release the press switch. If you hold the press switch down, then the 2.5V lamp (L1) stays on and the motor spins faster.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #621 Two-speed Motor (II)

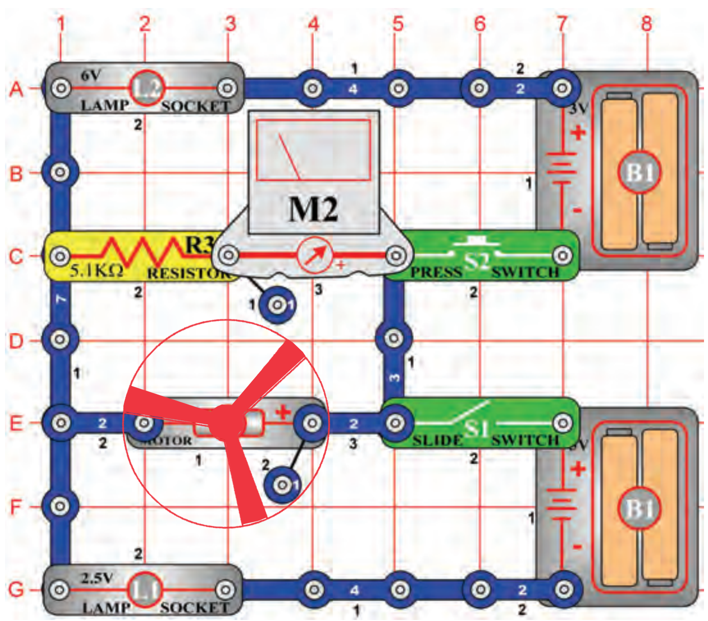


OBJECTIVE: To decrease the speed of a motor using an SCR and transistor.

Instead of increasing the motor's speed as in project #620, pressing the press switch (S2) decreases the speed. In this circuit, the transistor (Q2) is in parallel with the SCR (Q3). Pressing S2 turns on Q2 and the voltage across the motor (M1) decreases.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #622 Current Flow



OBJECTIVE: To show the effects of current flow.

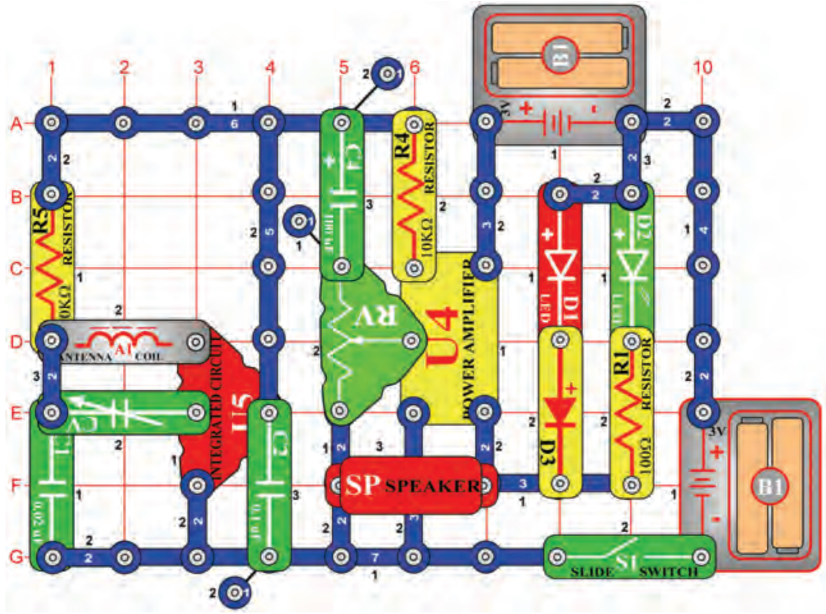
Set the meter (M2) to the LOW (or 10mA) position. Turning on the slide switch (S1) connects the motor (M1), meter and 2.5V lamp (L1) to the lower battery (B1) pack. The motor rotates clockwise and the meter deflects right. Now turn off the slide switch and press the press switch (S2). Now, current from the upper battery causes the motor to rotate in the opposite direction. If you place the batteries in series by turning on the slide switch and then pressing the press switch, only the bulbs (L1 & L2) light.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #623

AM Radio with Power LED's

OBJECTIVE: To build an AM radio with LED's.

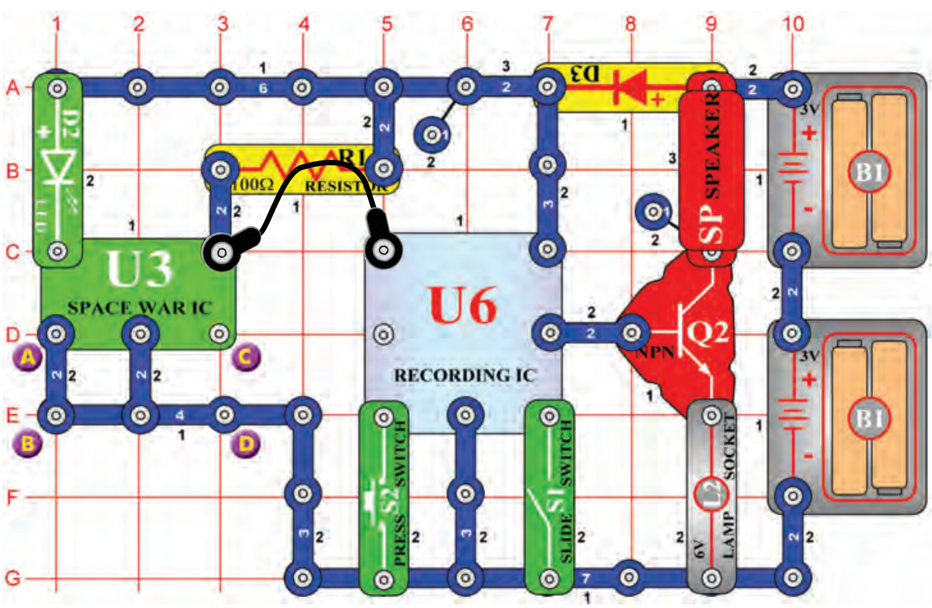


Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. Tune the radio by adjusting the variable capacitor (CV). The LED's (D1 & D2) flicker as the sound is heard.

Project #624

Space War IC Recording

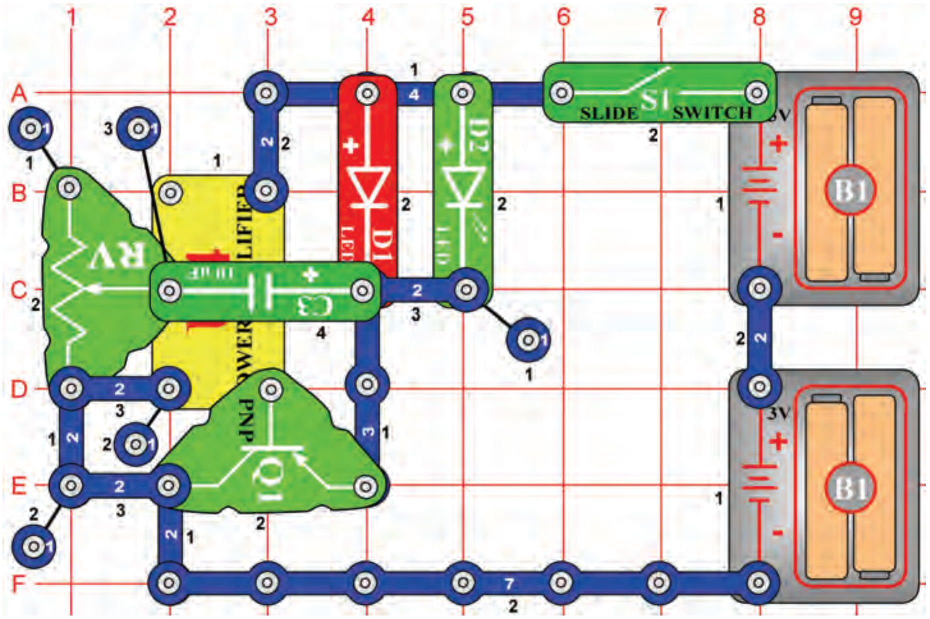
OBJECTIVE: To record the sounds from the space war IC.



The circuit records the sounds from the space war IC (U3) into the recording IC (U6). Turn on the slide switch (S1) and the first beep indicates that the IC has begun recording. When you hear two beeps, the recording has stopped. Turn off the slide switch and press the press switch (S2). You will hear the recording of the space war IC before each song is played. The lamp (L2) is used to limit current and will not light.

Place the 2-snap from points A & B onto C & D. Now record a different sound from U3.

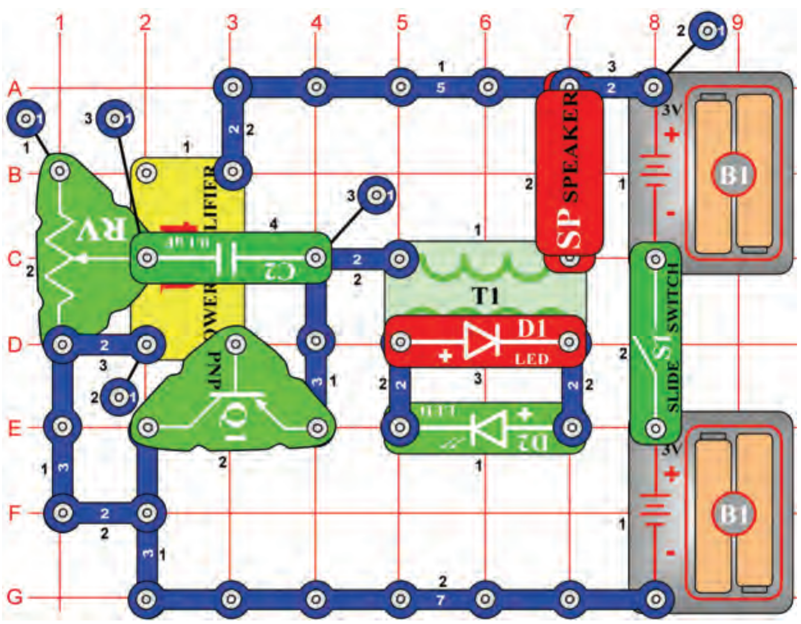
Project #625 LED Flasher



OBJECTIVE: To construct an LED flasher.

Set the adjustable resistor (RV) to the top position and then turn on the slide switch (S1). The LED's (D1 & D2) flash at a rate of once per second. As you adjust RV's knob down, the LED's flash faster. When RV is at the bottom, the LED's turn off.

Project #626 LED Flasher with Sound



OBJECTIVE: To construct an LED flasher with sound.

You can modify project #625 by adding a transformer (T1) to drive a speaker (SP). Set the adjustable resistor (RV) to the top position and turn on the slide switch (S1). The speaker sounds as the LED (D2) flashes several times per second. Increase the rate by moving RV's knob down.

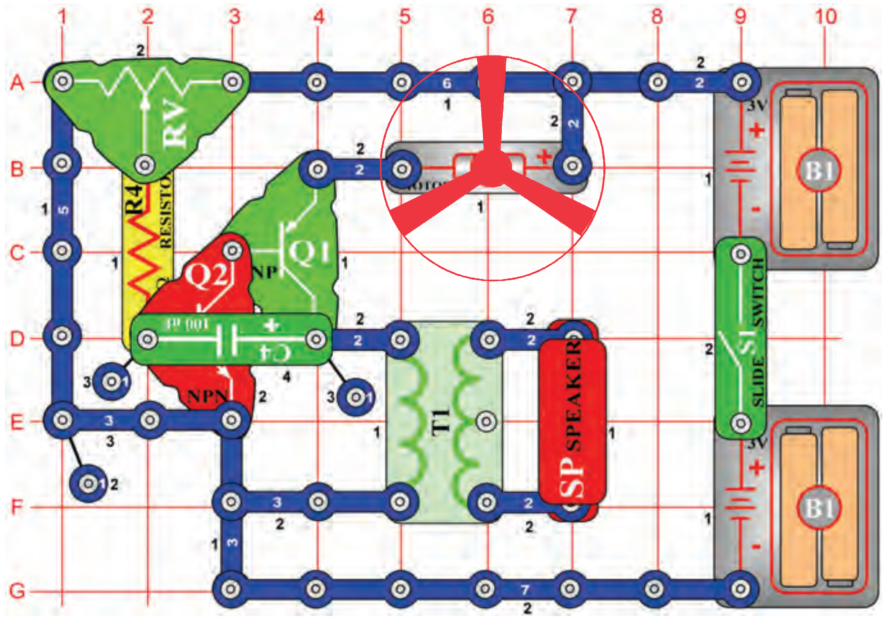
Project #627 LED Flasher with Sound (II)

OBJECTIVE: To construct an LED flasher with sound.

Modify the frequency by replacing the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" side on the right).

Project #628 Stepper Motor

OBJECTIVE: To build a variable stepper motor.

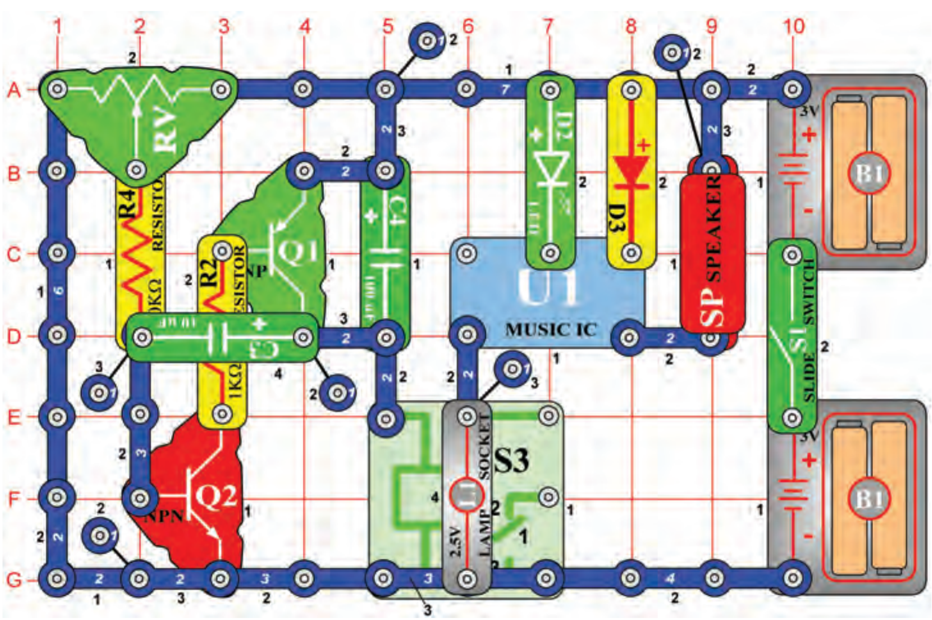


Adjust the adjustable resistor (RV) to the middle position and turn on the slide switch (S1). As the circuit oscillates, the motor (M1) moves a short distance as the speaker (SP) sounds. Adjust the adjustable resistor to different positions seeing how it affects the motor and speaker.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #629 Crazy Music IC

OBJECTIVE: To change the sound of the music IC.



Set the adjustable resistor (RV) to the far left position and turn the slide switch (S1) on. The relay's (S3) contacts open and close shorting U1 to ground, causing the sound level to change.

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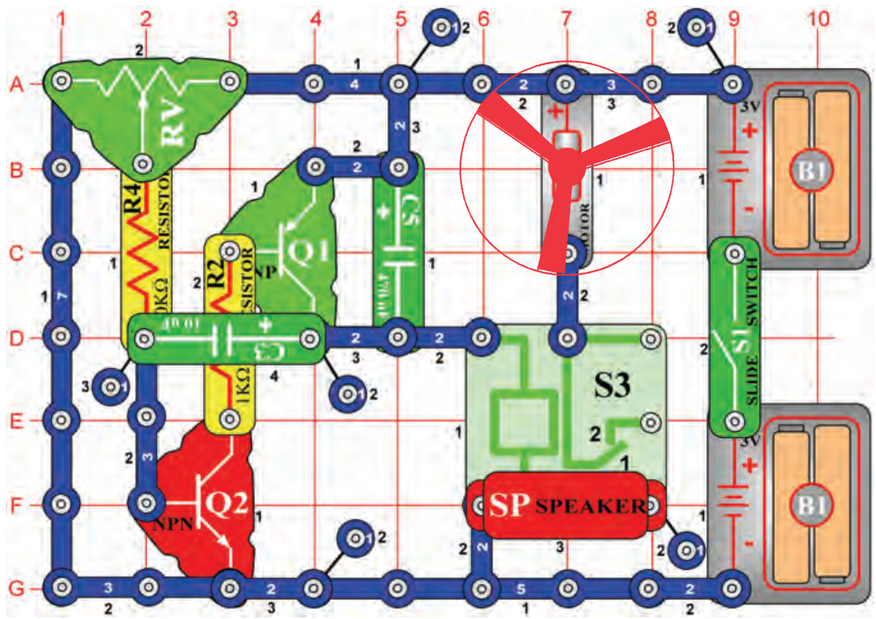
Project #630

Stepper Motor w/ Sound

OBJECTIVE: To add sound to a stepper motor circuit.



Set the adjustable resistor (RV) to the middle position. Turn the slide switch (S1) on and the motor (M1) pulses on and off as the speaker (SP) sounds. As the circuit oscillates, the relay's (S3) contacts open and close shorting the motor and speaker to ground. See how much you can adjust the adjustable resistor before the motor turns off or continuously spins.

Project #631

Stepper Motor w/ Light

OBJECTIVE: To add light to a stepper motor circuit.

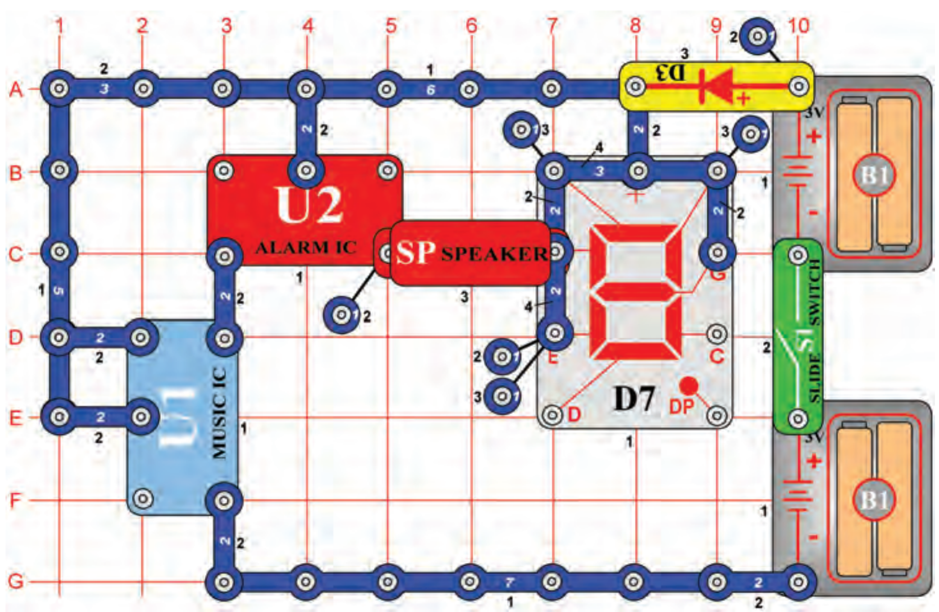
Modify project #630 by removing the speaker (SP) and replacing it with the lamp (L1). Now when you turn the slide switch (S1) on, the lamp lights as the motor spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #632

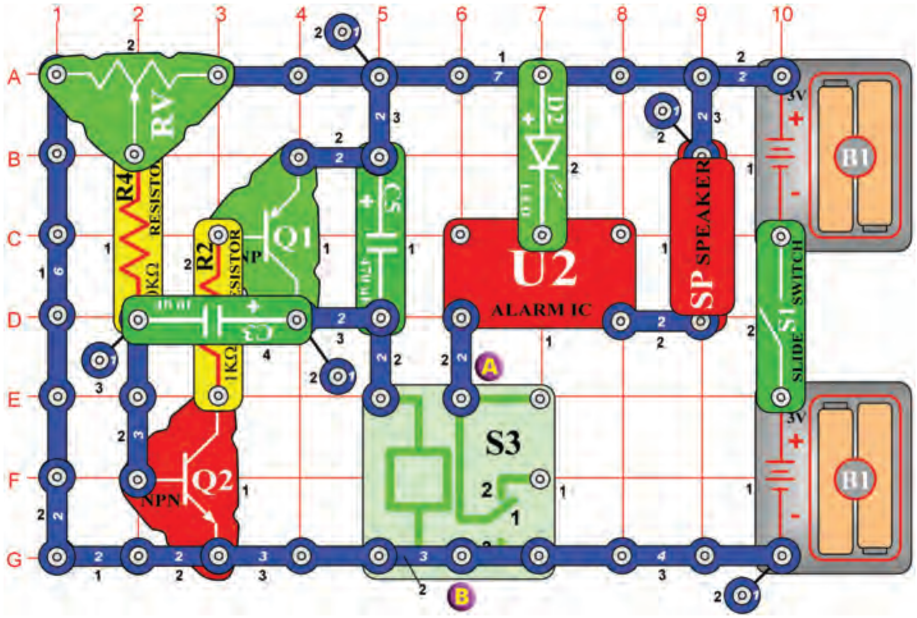
Police Siren with Display

OBJECTIVE: To display the letter "P" as the alarm IC sounds.



Turn the slide switch (S1) on and the speaker (SP) sounds as the letter "P" lights. You also hear the music IC (U1) playing in the background. The alarm IC (U2) plays as long as the music IC is on since U2 is connected to U1's output. After 20 seconds, the circuit turns off for 5 seconds and then starts again.

Project #633 Oscillator Alarm



OBJECTIVE: To control the alarm IC with an oscillator circuit.

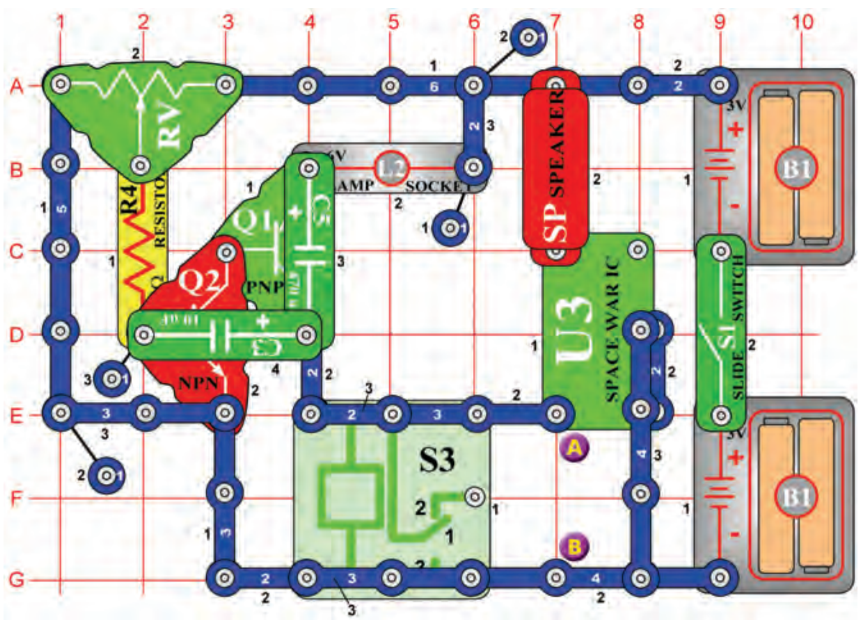
Set the adjustable resistor (RV) to the far left and turn the slide switch (S1) on. The speaker (SP) sounds only once. Slowly move the adjustable resistor to the right, the speaker momentarily sounds. As you move the adjustable resistor to the right, the alarm is on continuously. The adjustable resistor controls the frequency of the oscillator circuit (C3, C5, Q1, Q2) by adjusting the voltage at Q2's base. The relay (S3) switches the alarm IC (U2) on and off.

Project #634 Oscillator Alarm (II)

OBJECTIVE: To control the alarm IC with an oscillator circuit.

Using a single snap, connect the red LED (D1, "+" side on point A) across points A & B. Turn the slide switch (S1) on and the circuit has a different sound now.

Project #635 Tapping U3



OBJECTIVE: To control the space war IC with an oscillator circuit.

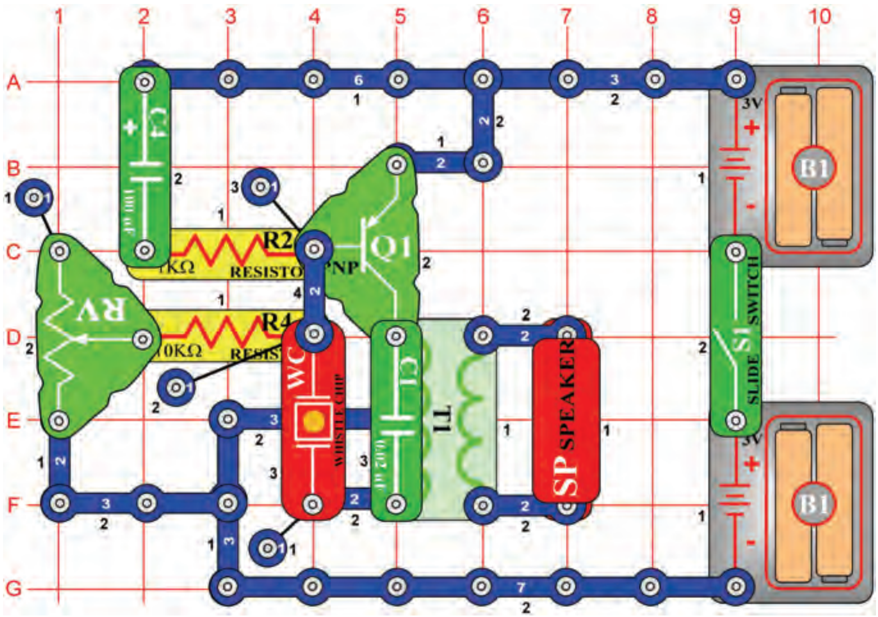
Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. This is another example using the oscillator that switches the power on and off creating sound. Alter the sound by adjusting the adjustable resistor.

Project #636 Tapping U3 (II)

OBJECTIVE: To control the space war IC with an oscillator circuit.

Connect the motor (M1) across points A & B. Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. Now you hear random noise and static from the speaker (SP). The motor causes the random static and noise from the speaker.

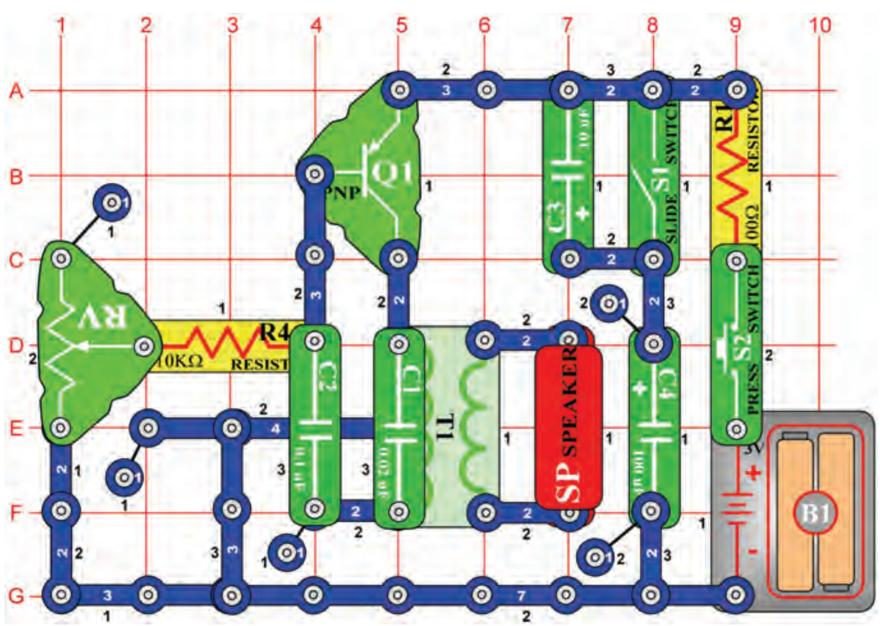
Project #637 Adjustable Beeper



OBJECTIVE: To build a simple oscillator that beeps.

Turn the slide switch (S1) on and this simple oscillator circuit outputs a beep from the speaker (SP). Change the frequency by adjusting the adjustable resistor (RV).

Project #638 Electronic Meow



OBJECTIVE: To create the sound of a cat's meow.

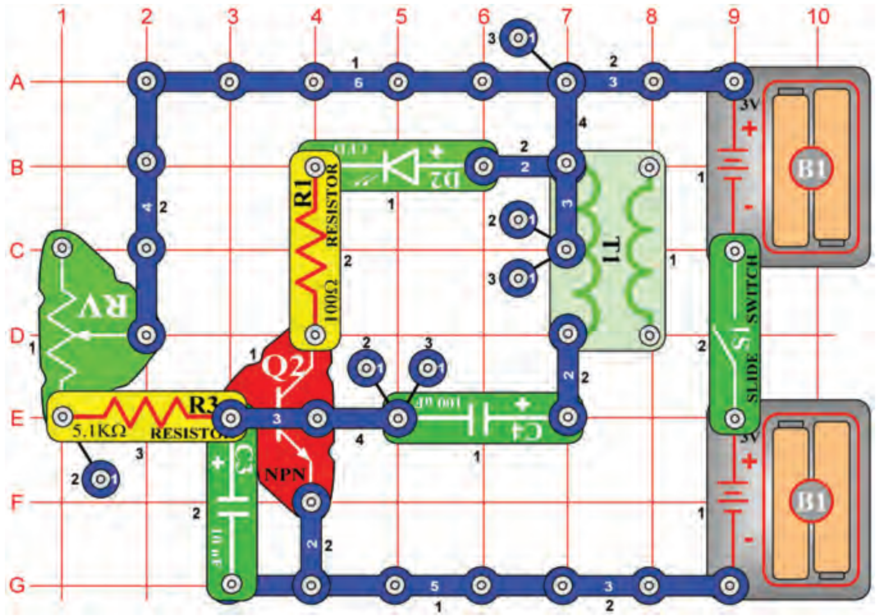
Turn off the slide switch (S1) and then press and release the press switch (S2). You hear a "cat's meow" from the speaker (SP). Now turn the slide switch (S1) on and the sound is lower and lasts longer. Adjust the adjustable resistor (RV) while the sound is fading away.

Project #639 Electronic Meow (II)

OBJECTIVE: To add the photoresistor to project #638.

Replace the 10KΩ resistor (R4) with the photoresistor (RP). Wave your hand over photoresistor as you press down on the press switch (S2).

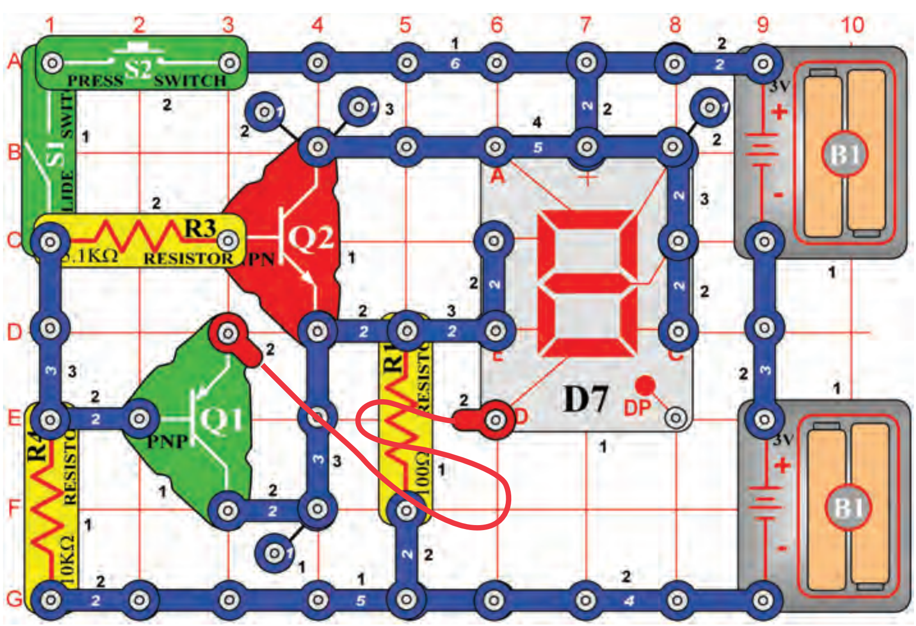
Project #640 Strobe Light



OBJECTIVE: To construct an LED strobe light.

This is an example of how a large strobe light works. Turn the slide switch (S1) on and the LED (D2) flashes at a certain frequency. Adjust the frequency by adjusting the adjustable resistor (RV). Now add sound by replacing the 100Ω resistor (R1) with the speaker (SP). Each time the LED lights, the speaker sounds.

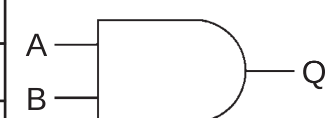
Project #641 AND Gate



OBJECTIVE: To demonstrate the operations of the AND gate.

In digital electronics, there are two states, 0 & 1. The **AND gate** performs a logical "and" operation on two inputs, A & B. If A **AND** B are both 1, then Q should be 1. The logic table below shows the state of "Q" with different inputs and the symbol for it in circuit diagrams.

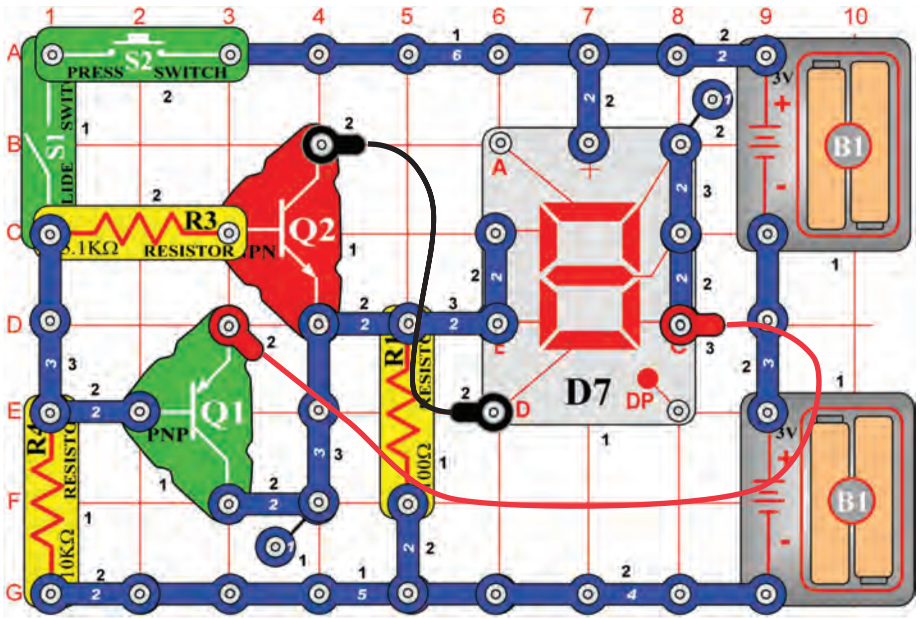
A	B	Q	D7
0	0	0	"L"
1	0	0	"L"
0	1	0	"L"
1	1	1	"H"



AND Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

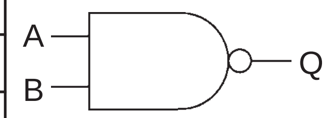
Project #642 — NAND Gate



OBJECTIVE: To demonstrate the operations of the NAND gate.

The NAND gate works the opposite of the AND as shown in the logic chart.

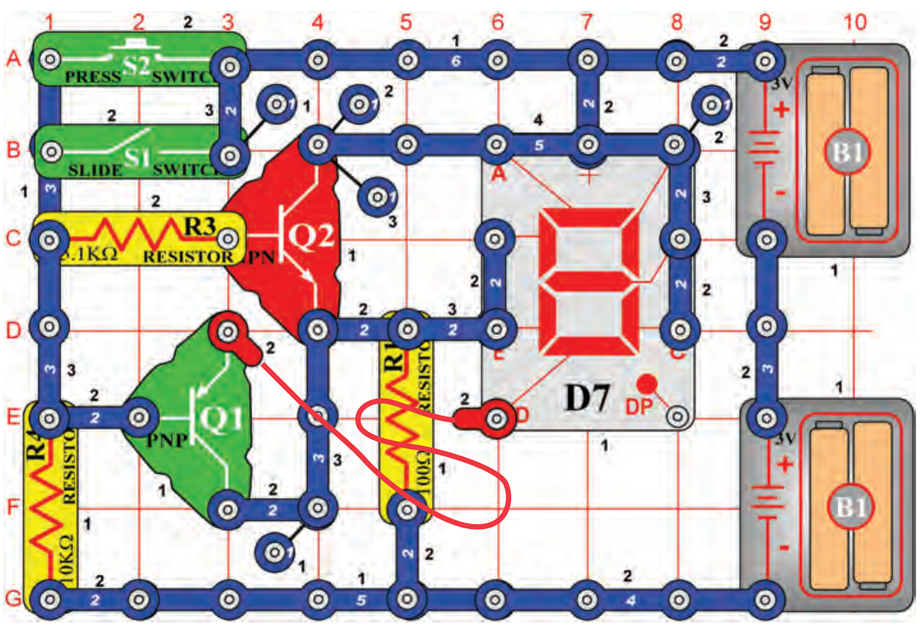
A	B	Q	D7
0	0	1	"H"
1	0	1	"H"
0	1	1	"H"
1	1	0	"L"



NAND Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

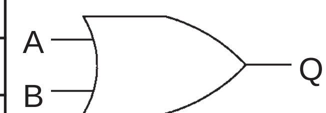
Project #643 — OR Gate



OBJECTIVE: To demonstrate the operations of the OR gate.

The basic idea of an OR gate is: If A OR B is 1 (or both are 1), then Q is 1.

A	B	Q	D7
0	0	0	"L"
1	0	1	"H"
0	1	1	"H"
1	1	1	"H"

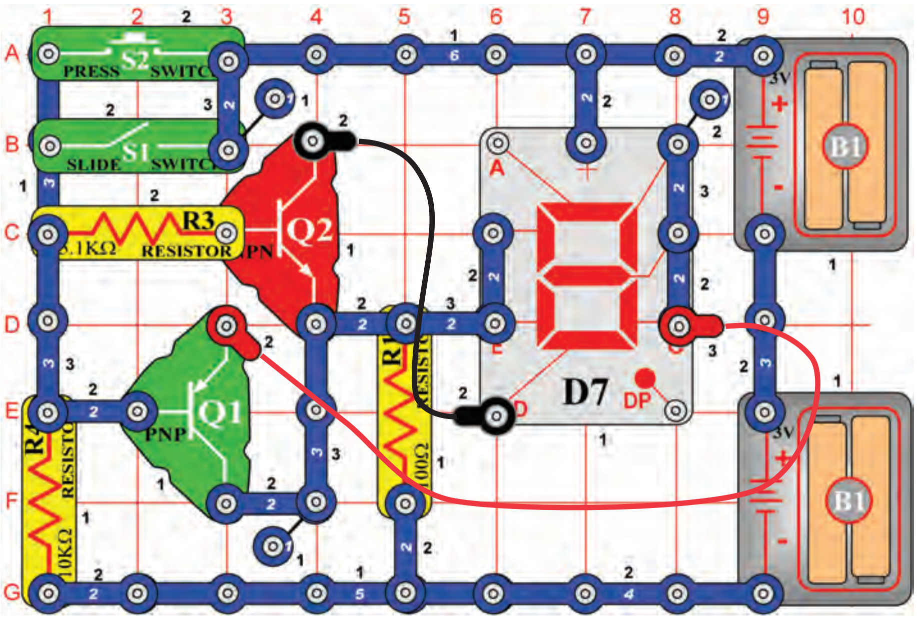


OR Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

Project #644

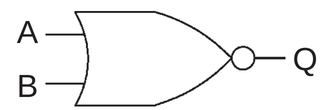
NOR Gate



OBJECTIVE: To demonstrate the operations of the NOR gate.

The NOR gate works the opposite of the OR. In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

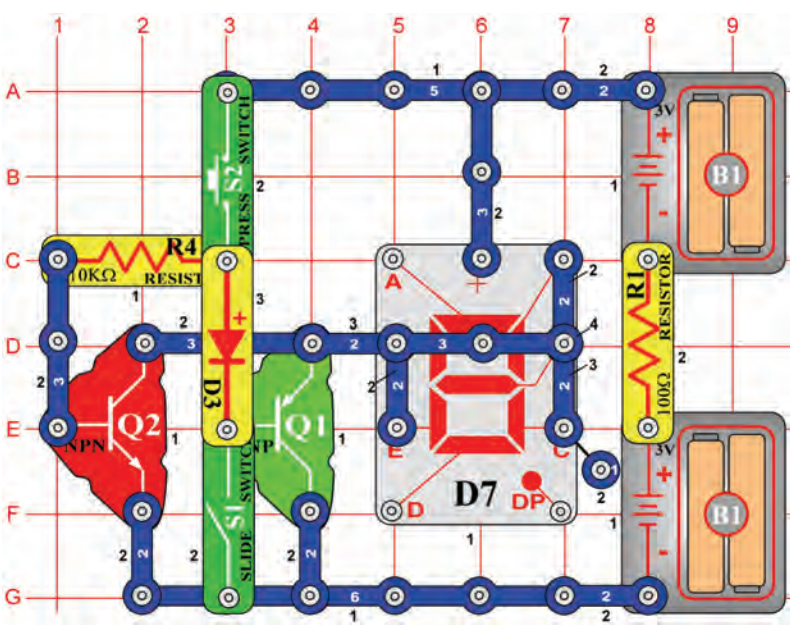
A	B	Q	D7
0	0	1	"H"
1	0	0	"L"
0	1	0	"L"
1	1	0	"L"



NOR Gate

Project #645

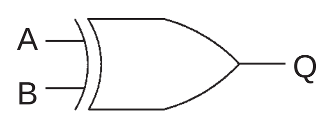
XOR Gate



OBJECTIVE: To demonstrate the operations of the "exclusive or" XOR gate.

In an XOR gate the output "Q" is only high when inputs "A" or "B" is set high (1).
Using the chart, set the switches (S1 & S2) to the different states. The display (D7) lights the letter "H" only when either switch is turned on.

A	B	Q	D7
0	0	0	–
1	0	1	"H"
0	1	1	"H"
1	1	0	–



XOR Gate

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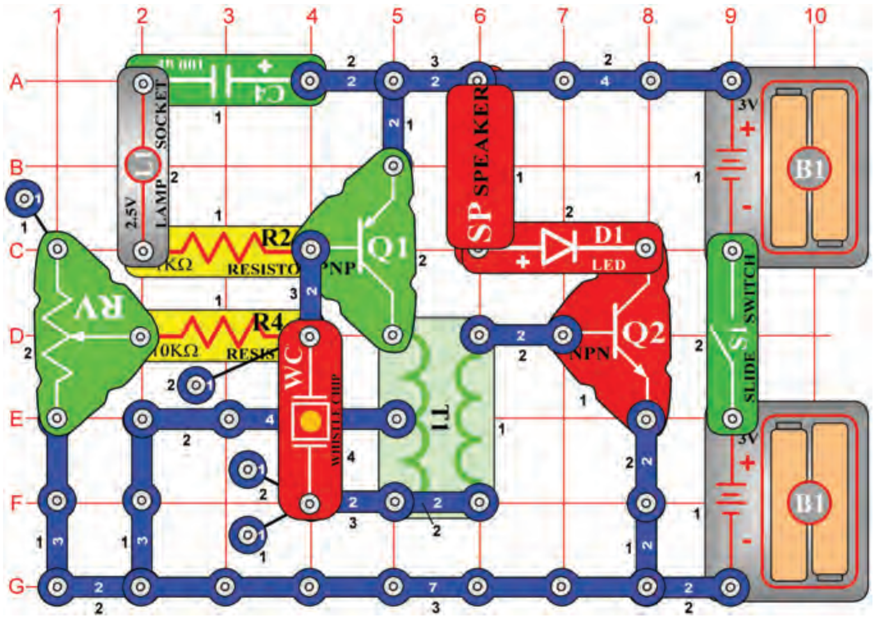
☐ Project #646 High Pitch Oscillator



OBJECTIVE: To build a high pitch oscillator.

Set the adjustable resistor (RV) to the top position and then turn the slide switch (S1) on. You hear a high pitch sound and the LED (D1) flashes at the same rate. Change the oscillator frequency by adjusting RV.

☐ Project #647 Low Pitch Oscillator

OBJECTIVE: To modify project #646.

Replace the whistle chip (WC) with the 0.1µF capacitor (C2). Turn the slide switch (S1) on and now the circuit oscillates at a lower frequency.

☐ Project #648 Low Pitch Oscillator (II)

OBJECTIVE: To modify project #646.

Replace the 0.1µF capacitor (C2) with the 10µF capacitor (C3) placing the "+" sign towards the top. Turn the slide switch (S1) on; now the circuit oscillates at a lower frequency.

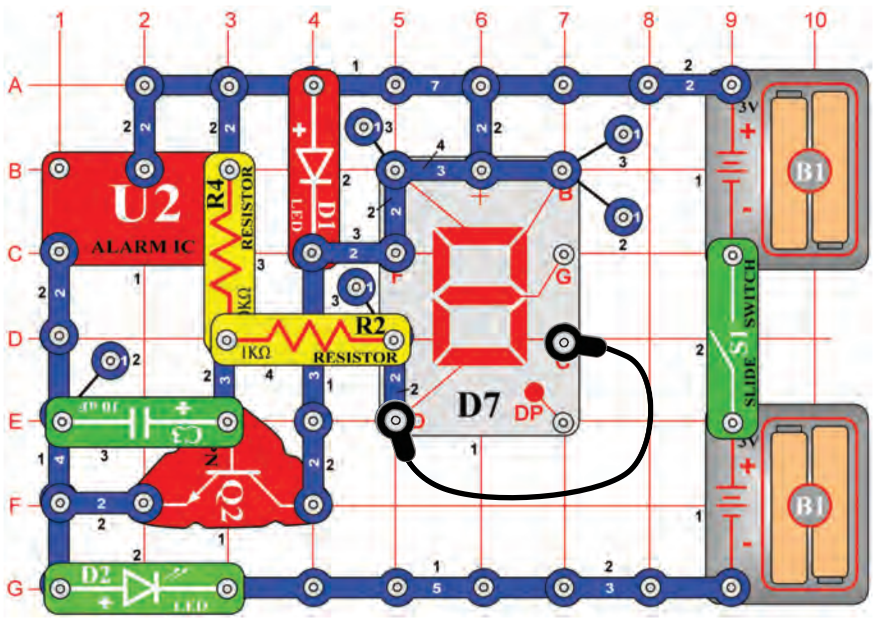
☐ Project #649 Low Pitch Oscillator (III)

OBJECTIVE: To modify project #646.

Replace the 10µF capacitor (C3) with the 470µF capacitor (C5) placing the "+" sign towards the top. Turn the slide switch (S1) on and the circuit oscillates at a lower frequency now.

Project #650 — Segment Jumper

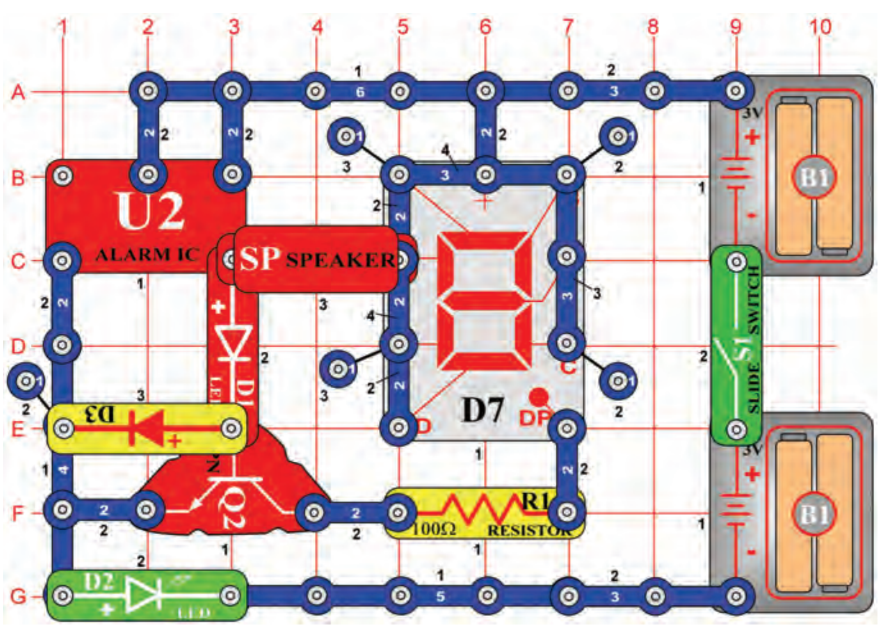
OBJECTIVE: To use the alarm IC with the 7-segment display.



Turn the slide switch (S1) on; segments A, B, and F light and then segments C, D, and E. The two groups of segments are connected to different voltages. As the voltage changes from high to low, the segments toggle back and forth.

Project #651 — DP & Zero Flasher

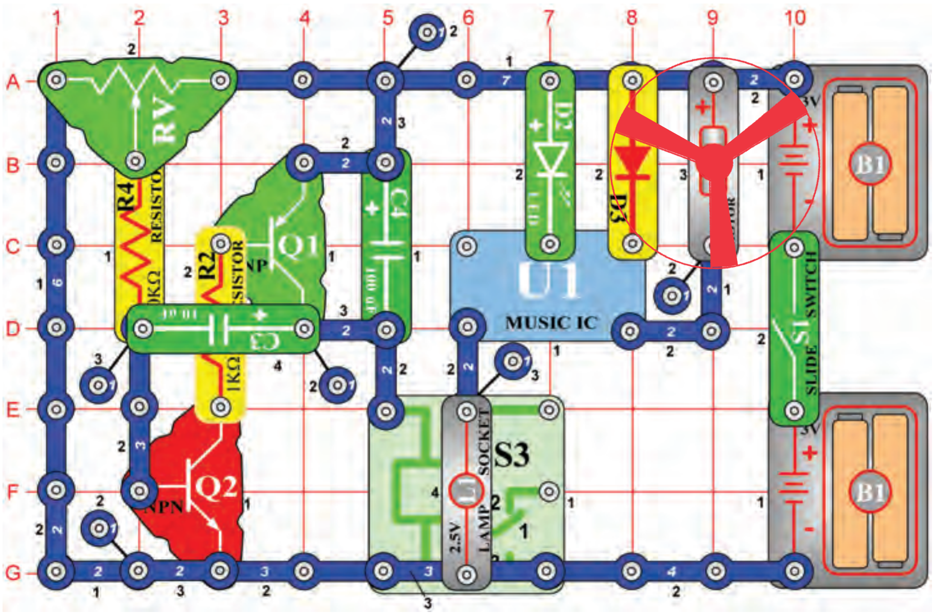
OBJECTIVE: To use the alarm IC with the 7-segment display.



As in project #650, we use the alarm IC (U2) to flash segments and LED's. Turn the slide switch (S1) on and the number "0" and the green LED (D2) flash as the speaker (SP) sounds. When they turn off, the DP segment lights.

Project #652

Stepper Motor with Lamp & LED's



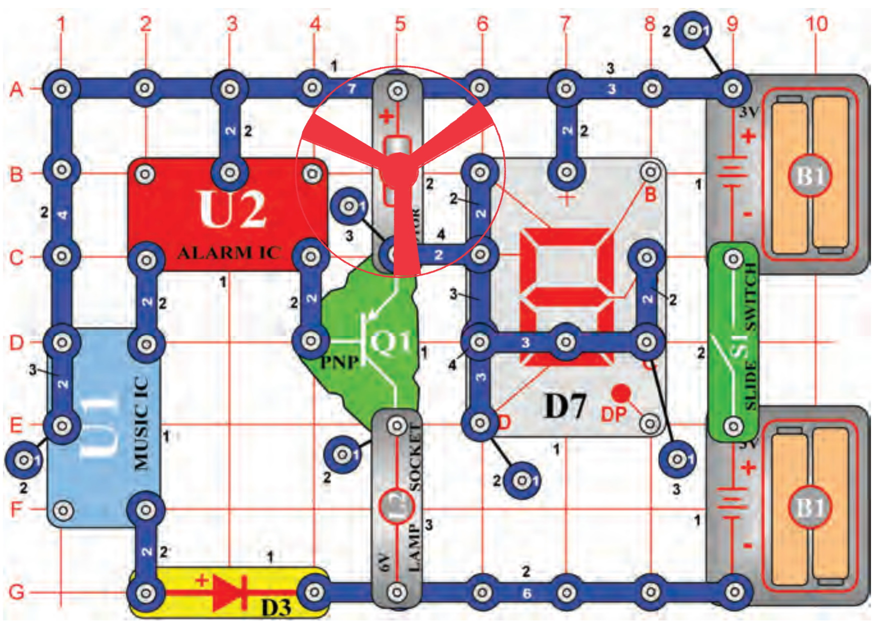
OBJECTIVE: To add LED's to a stepper motor circuit.

Set the adjustable resistor (RV) to the middle position. Turn the slide switch (S1) on, the motor spins, the bulb lights, and then turn off as the green LED lights.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #653

IC Start & Stop



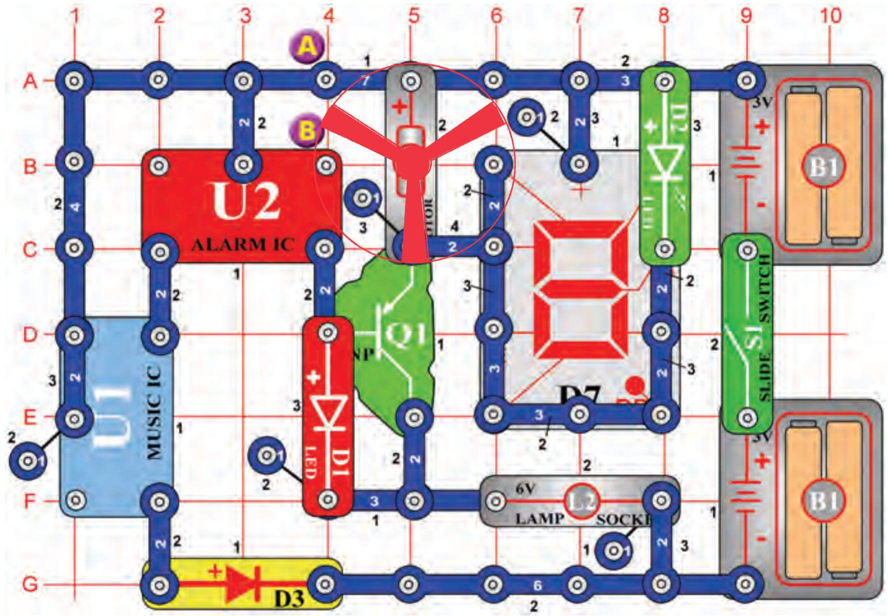
OBJECTIVE: To drive the motor and display with two IC modules.

Turn the slide switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights the letter "S" and then turns off.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #654 IC Motor Speed

OBJECTIVE: To modify project #653 so the motor slows down.



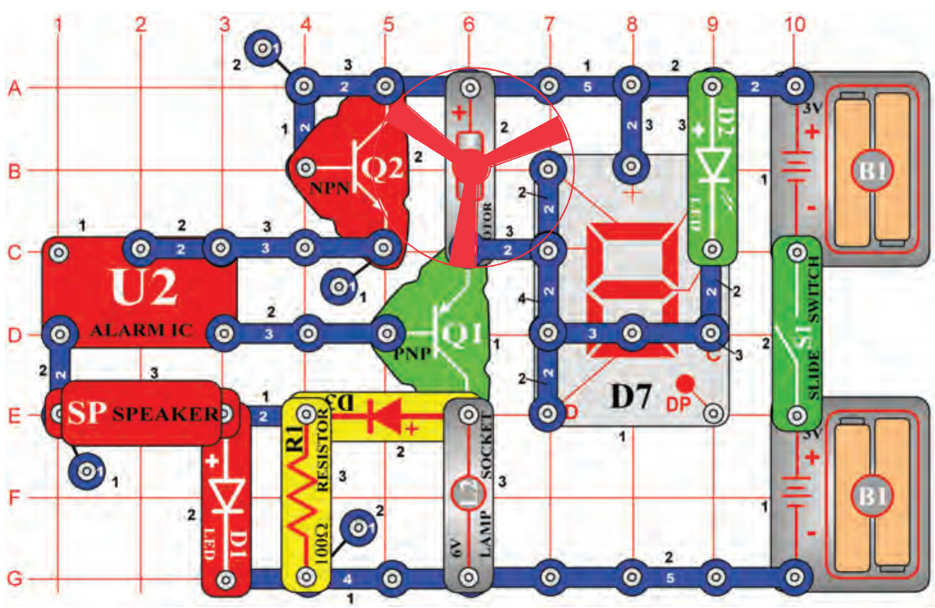
Turn the slide switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights. Instead of turning off as in project #653, the motor slows down and the red LED (D1) lights.

Modify the circuit by placing a jumper wire across points A & B. Now the circuit pulses and then runs continuously for a short time.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #655 Sound & Light Flasher

OBJECTIVE: To use the alarm IC to drive the motor, speaker, LED and bulb.



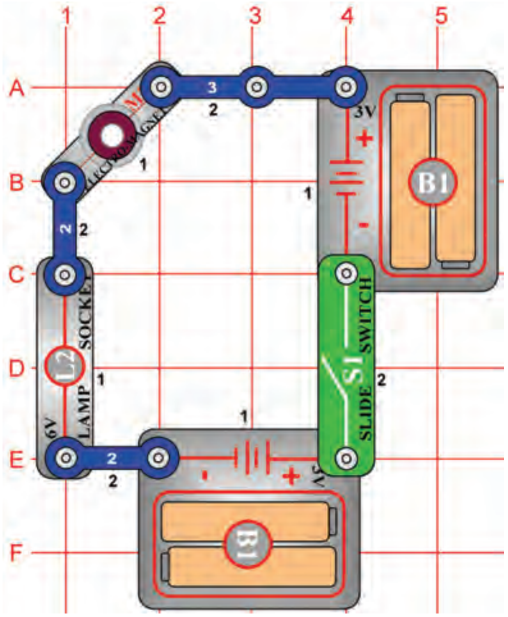
Turn the slide switch (S1) on and the speaker (SP) outputs the sounds from the alarm IC (U2). The IC also drives the transistor (Q1) causing the motor (M1) to spin and lights to flash.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #656

Electromagnet Delayer

OBJECTIVE: To learn about the electromagnet.



Build the circuit and turn it on. After a delay of about 2 seconds, the lamp (L2) will light, but be dim. Replace your batteries if it does not light at all.

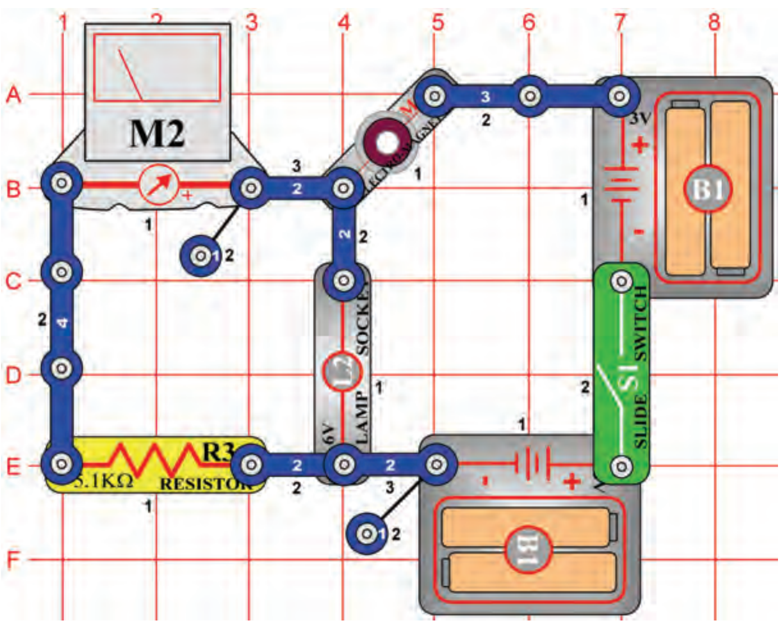
Why does the electromagnet (M3) delay the lamp turn-on? The electromagnet (M3) contains a large coil of wire, and the batteries have to fill the coil with electricity before the lamp can turn on. This is like using a long hose to water your garden - when you turn on the water it takes a few seconds before water comes out the other end.

Once the lamp is on, the resistance of the wire in the coil keeps the lamp from getting bright. You can replace the 6V lamp with the 2.5V lamp (L1), because the coil will protect it from the full battery voltage.

Project #657

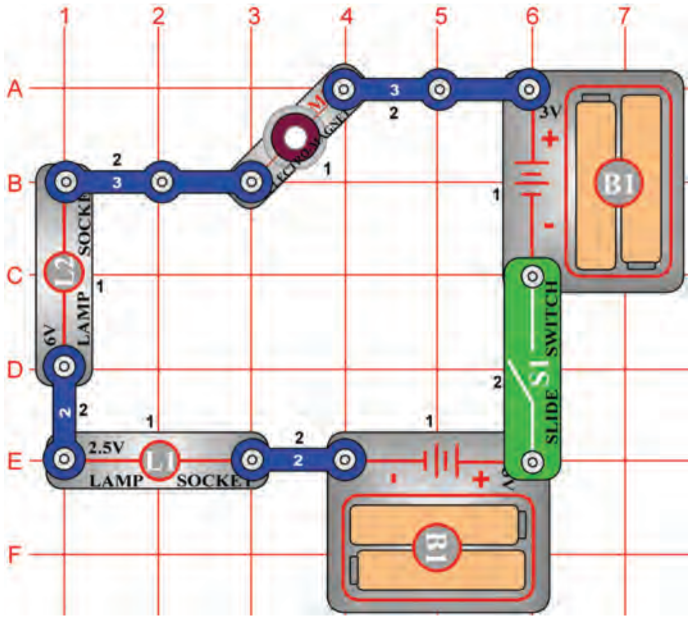
Electromagnet Delayer (II)

OBJECTIVE: To learn about the electromagnet.



Use the LOW (or 10mA) setting on the meter (M2) and turn on the slide switch (S1). The meter shows how the current slowly rises. After a delay of about 2 seconds, the lamp (L2) will light but be dim.

Project #658



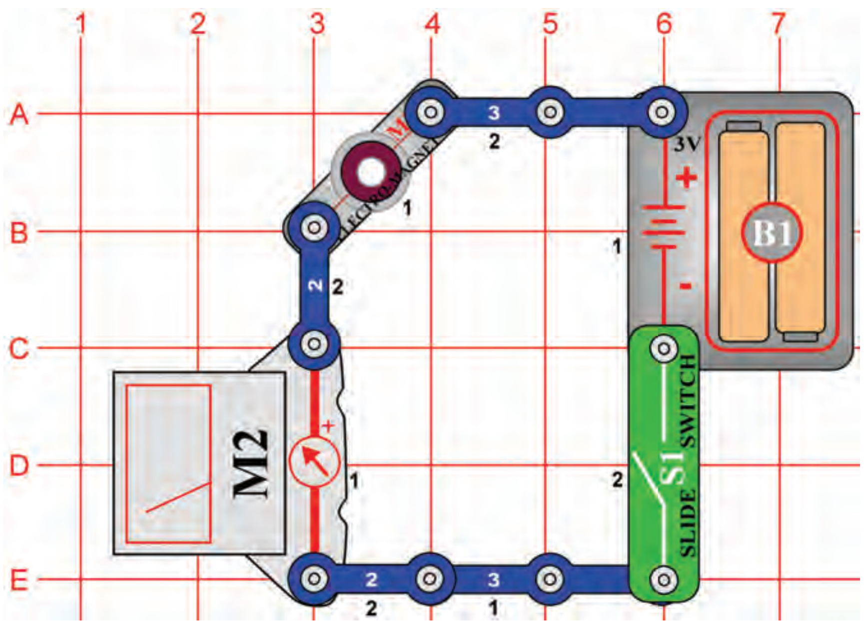
Two-Lamp Electromagnet Delayer

OBJECTIVE: To learn about the electromagnet.

Build the circuit and turn it on. First the 2.5V lamp (L1) turns on, and then the 6V lamp (L2) turns on. Both may be dim, replace your batteries if they do not light at all.

The electromagnet (M3) stores energy, and the batteries must fill it up before the lamps become bright. The smaller bulb turns on sooner because it needs less current to light.

Project #659



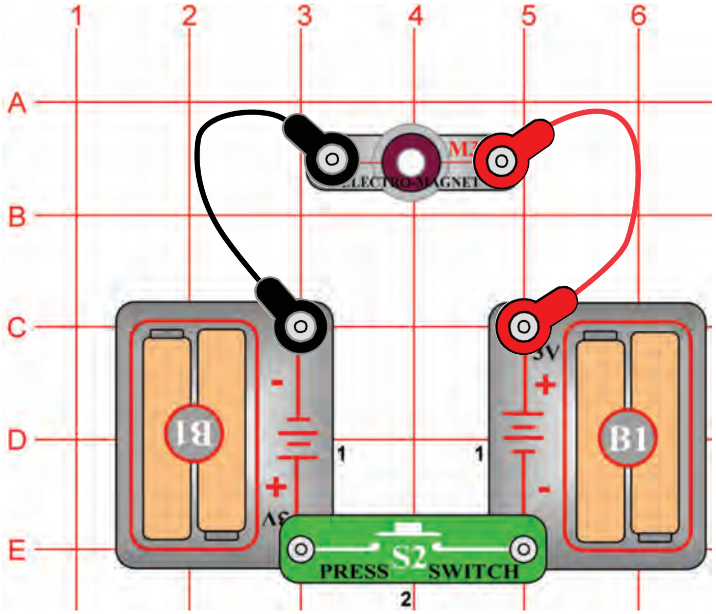
Electromagnet Current

OBJECTIVE: To measure the electromagnet current.

Use the HIGH (or 1A) setting on the meter (M2) to measure the electromagnet (M3) current. Compare the meter reading to that for the motor and lamp current in projects #544-546. Insert the iron core rod into the electromagnet and see if it changes the meter reading.

Project #660 Electromagnetism

OBJECTIVE: To learn how electricity and magnetism are related.



Put the iron core rod into the electromagnet (M3). Press the press switch (S2) and place the electromagnet (M3) near some iron objects like a refrigerator or a hammer, it will be attracted to them. You can use it to pick up iron objects, such as nails.

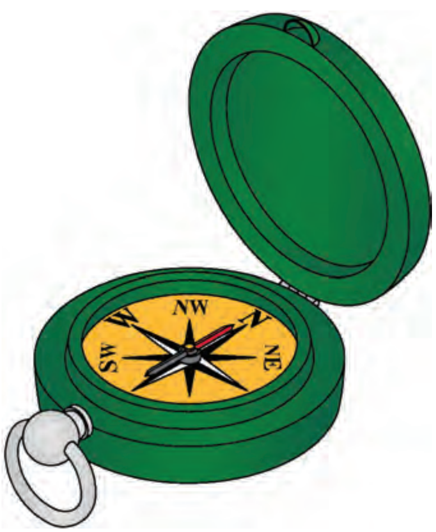
Electricity and magnetism are closely related, and an electric current flowing in a coil of wire has a magnetic field just like a normal magnet. Placing an iron rod through the coil magnifies this magnetic field. Notice that when the electromagnet is attracted to an iron object, its attraction is strongest at the ends of the iron core rod. If you remove the iron core rod from the electromagnet then its magnetic properties are greatly reduced – try this:

If you place the electromagnet upside down under a large object like a table, you can suspend it there. Be careful though, since it will fall when you release the press switch.

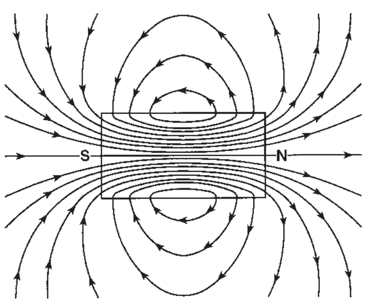
You can use this circuit to see which things are made of iron. Other metals like copper or aluminum will not be attracted to the electromagnet.

Project #661 Electromagnetism & Compass

OBJECTIVE: To learn how electricity and magnetism are related.



Compass



Magnetic Field

You need a compass for this project (not included). Use the circuit from project #660, with the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

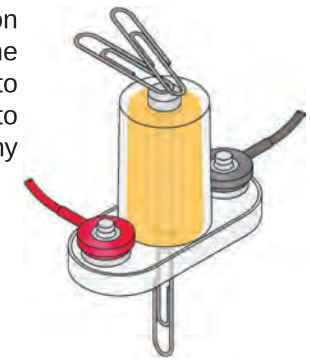
Turn on the slide switch and move the compass around near the edges of the electromagnet, it will point toward ends of the iron core rod. By slowly moving the compass around the electromagnet, you can see the flow of its magnetic field.

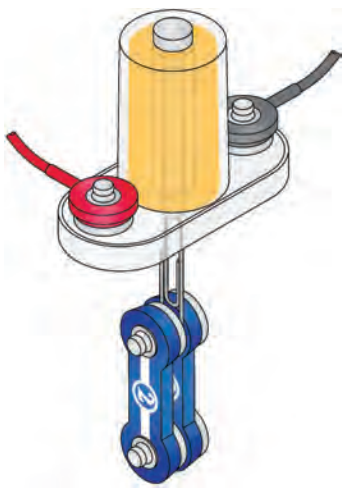
The earth has a similar magnetic field, due to its iron core. A compass points north because it is attracted to this magnetic field. The electromagnet creates its own magnetic field, and attracts the compass in a similar way.

☐ Project #662 Electromagnetism & Paperclips

OBJECTIVE: To learn how electricity and magnetism are related.

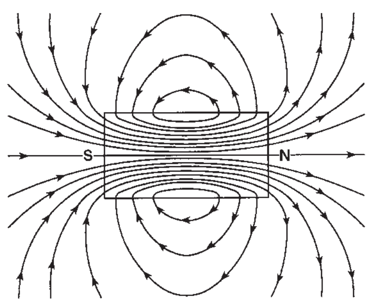
Use the circuit from project #660, with the iron core rod in the electromagnet (M3). Press the press switch (S2) and use the electromagnet to pick up some paperclips, they will be attracted to both ends of the iron core rod. See how many paperclips you can lift at once.

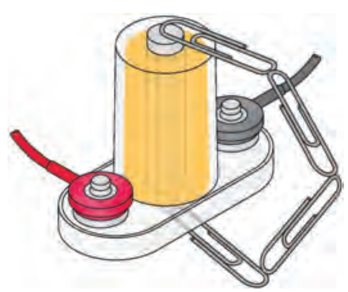




Snap two 2-snaps around a paperclip and lift them with the electromagnet, as shown here on the left.

The magnetic field created by the electromagnet occurs in a loop, and is strongest in the iron core rod in the middle. You can see this loop with some paperclips:



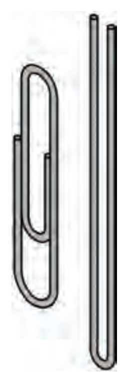


You can also use the paperclip to lift the iron core rod up from the electromagnet.

See what other small objects you can pick up. You can only pick up things made of iron, not just any metal.

☐ Project #663 Electromagnet Suction

OBJECTIVE: To show how electricity can lift things using magnetism.



An electric current flowing in a coil of wire has a magnetic field, which tries to suck iron objects into its center. You can see this using the circuit from project #660.

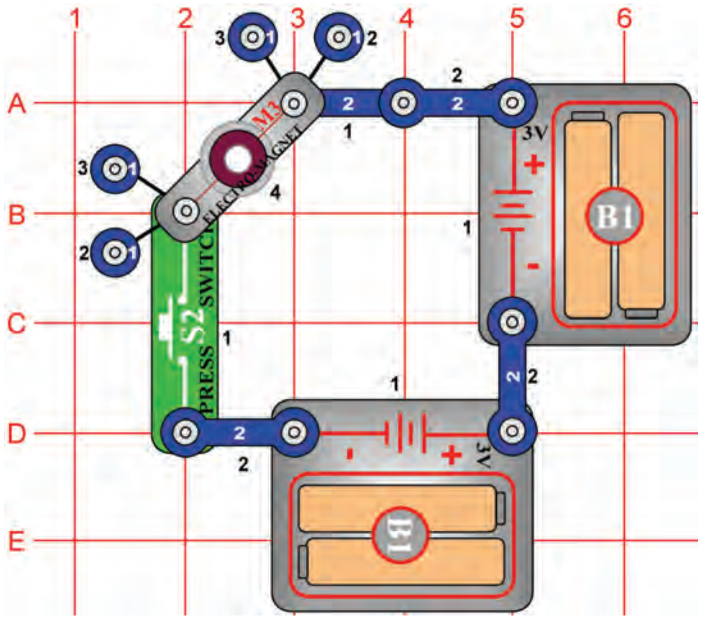
Lay the electromagnet (M3) on its side with the iron core rod sticking out about half way, and press the press switch (S2). The iron rod gets sucked into the center.

A lighter iron object will show this better. Take a paperclip and straighten it out, then bend it in half.

Place the bent paperclip next to the electromagnet and turn on the switch to see it get sucked in. Gently pull it out to feel how much suction the electromagnet has.

Try sucking up other thin iron objects, like nails.

Project #664

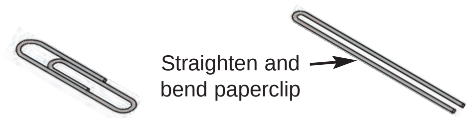


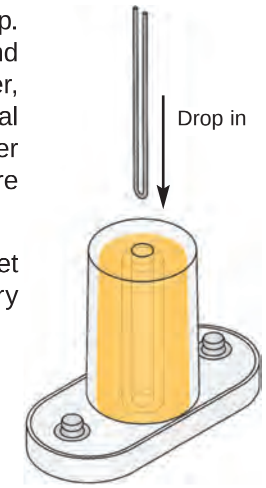
Electromagnet Tower

***OBJECTIVE:** To show how electricity can lift things using magnetism.*

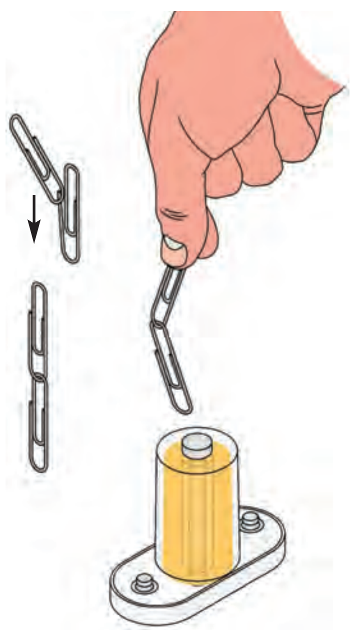
This circuit gives a dramatic demonstration of how the electromagnet (M3) can suck up a paperclip. Take a paperclip and straighten it out, then bend it in half. Drop it into the electromagnet center, and then press the press switch (S2) several times. The paperclip gets sucked into the center of the electromagnet and stays suspended there until you release the press switch.

Add two more 1-snaps under the electromagnet to make it higher, and try this again. Then try sucking up other thin iron objects, like nails.





Project #665



Paperclip Compass

***OBJECTIVE:** To learn how electricity and magnetism are related.*

Use the circuit from project #664, but place the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

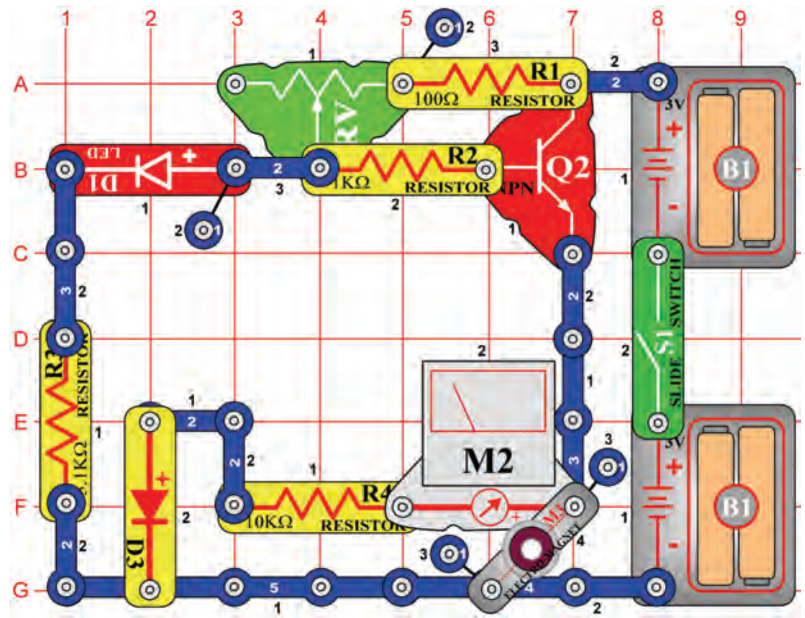
Slide two paperclips together, using their loops.

Turn on the switch and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod, and will point towards it just like a compass.

Project #666

Adjustable Paperclip Suspension

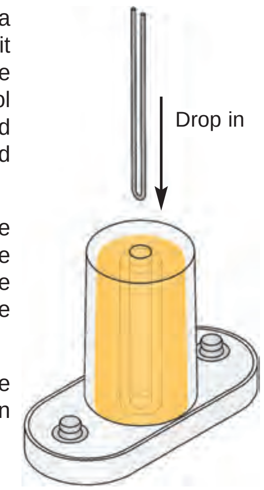
OBJECTIVE: To show how electricity can lift things using magnetism.

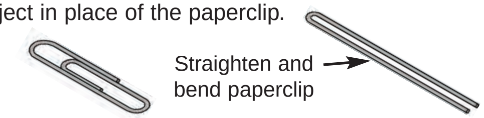


Use the LOW (or 10mA) setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and drop it into the electromagnet (M3) center. Turn on the slide switch (S1) and set the adjustable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now very slowly move the adjustable resistor lever to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. When the current is at zero, the paperclip is resting on the table.

Add two more 1-snaps under the electromagnet to make it higher, and try this again. Or try using a different iron object in place of the paperclip.

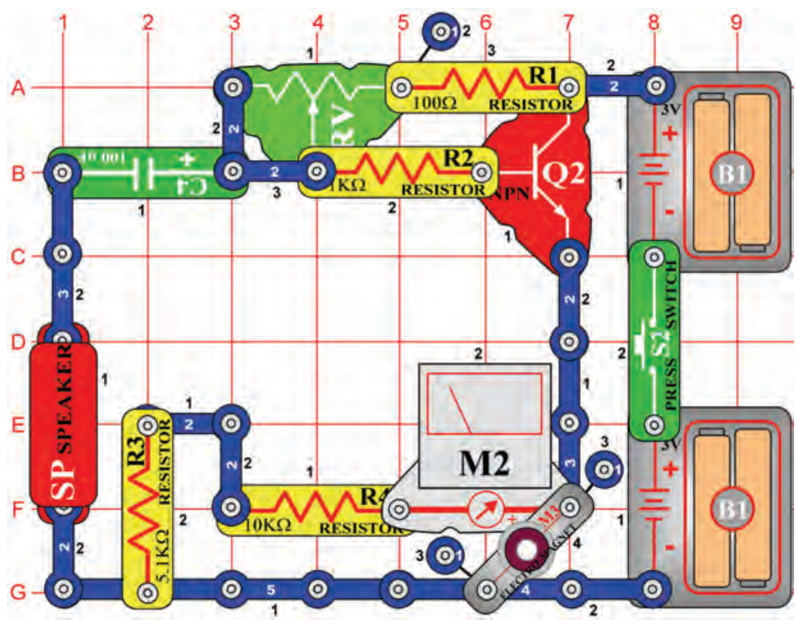




Project #667

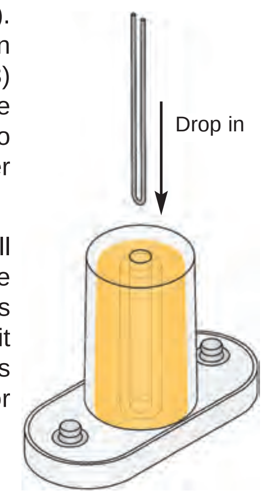
Adjustable Paperclip w/ Delay

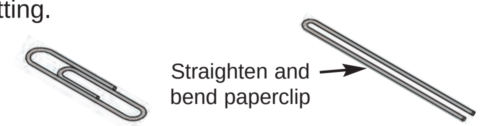
OBJECTIVE: To show how electricity can lift things using magnetism.



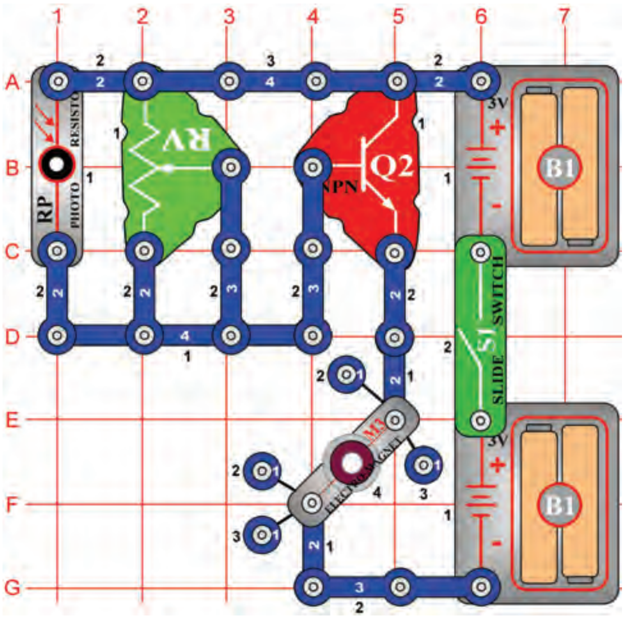
Use the LOW (or 10mA) setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the press switch (S2) and set the adjustable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

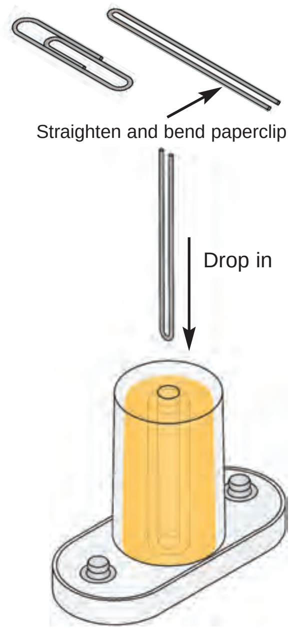
Now quickly slide the adjustable resistor lever all the way to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. This circuit is similar to project #666, but the capacitor delays the effect of changing the adjustable resistor setting.





Project #668





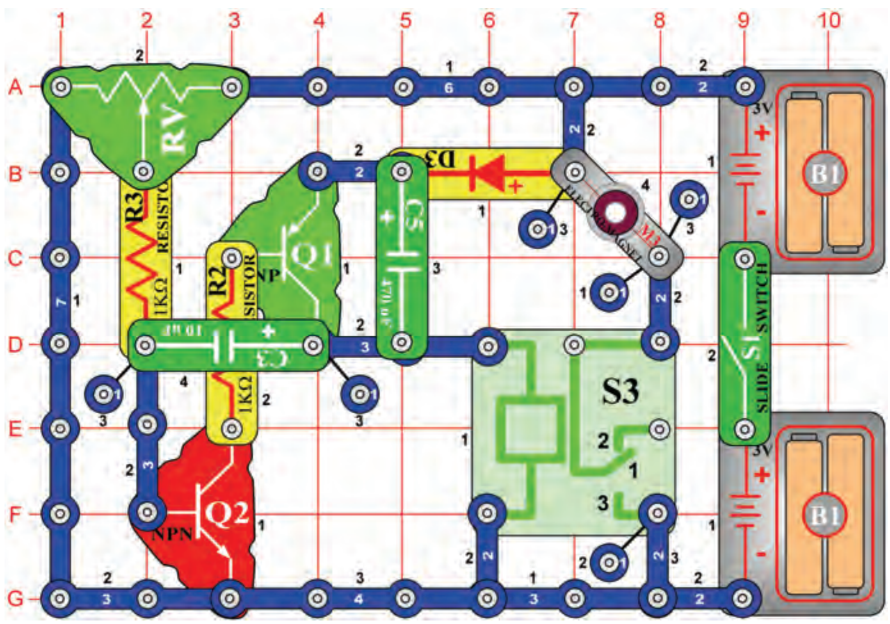
Photoresistor Paperclip Suspension

***OBJECTIVE:** To show how electricity can lift things using magnetism.*

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), the paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now move the adjustable resistor (RV) control lever around while waving your hand over the photoresistor (RP). Depending on the adjustable resistor setting, sometimes covering the photoresistor causes the paperclip to fall and sometimes it doesn't. You can also adjust the light to set the paperclip to different heights.

Project #669

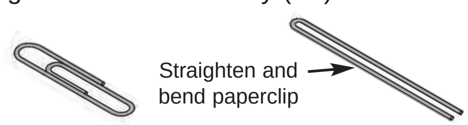


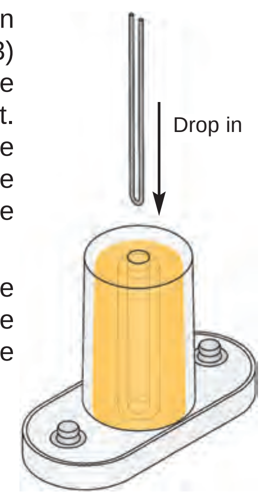
Paperclip Oscillator

***OBJECTIVE:** To show how electricity can lift things using magnetism.*

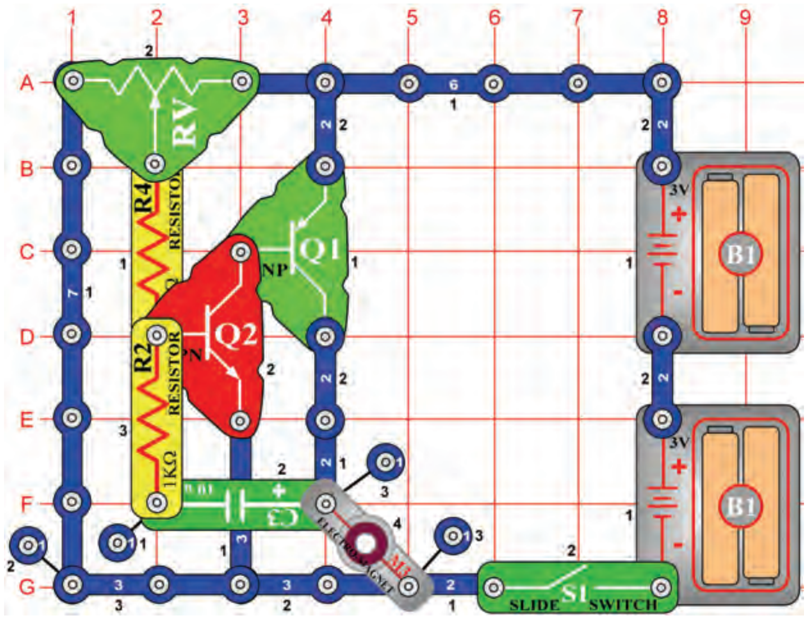
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. There will be a clicking sound from the relay (S3).





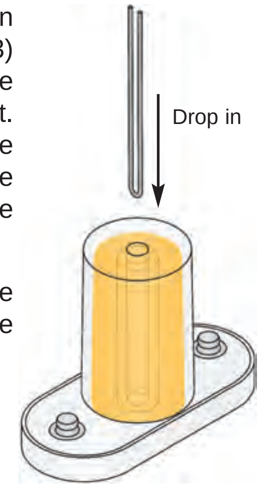
Project #670 Paperclip Oscillator (II)

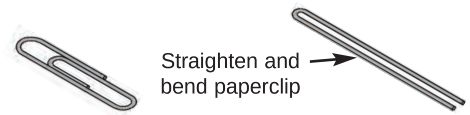


OBJECTIVE: To show how electricity can lift things using magnetism.

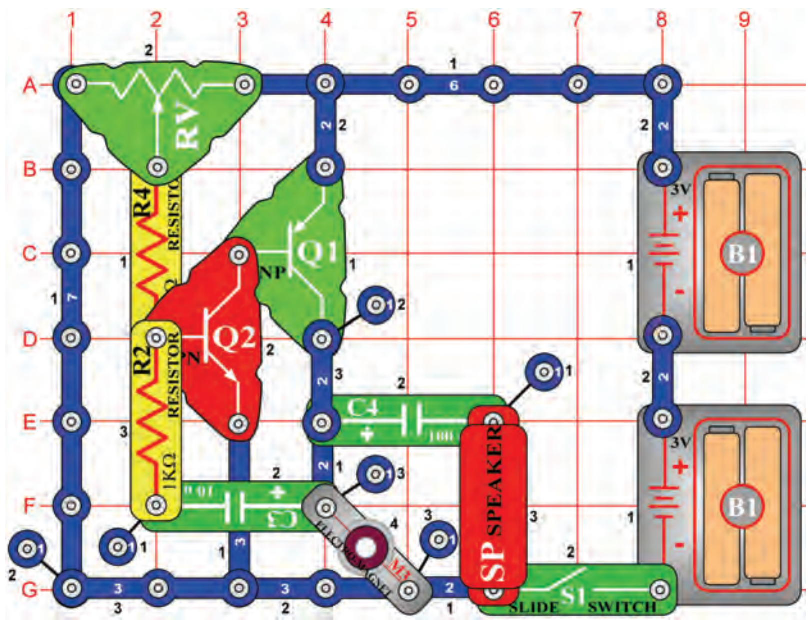
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down.





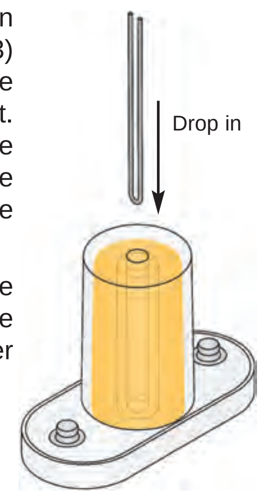
Project #671 Paperclip Oscillator (III)

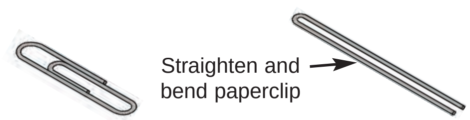


OBJECTIVE: To show how electricity can lift things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. The speaker (SP) makes a clicking sound.

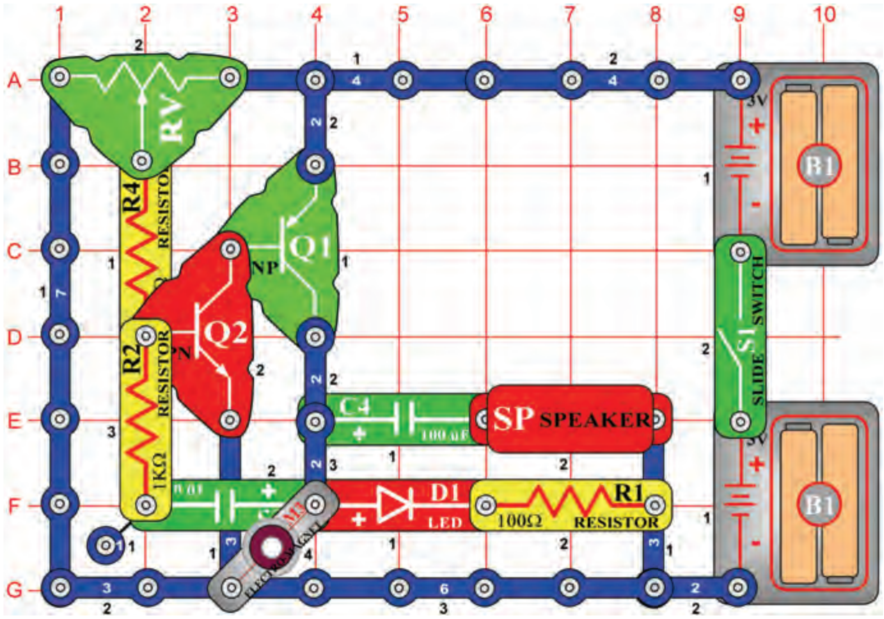




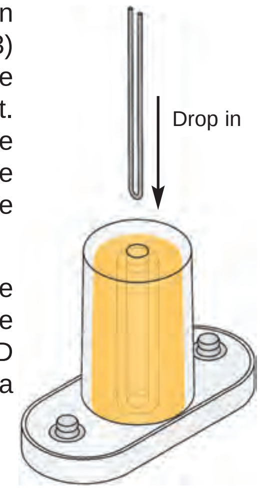
To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

☐ Project #672 Paperclip Oscillator (IV)

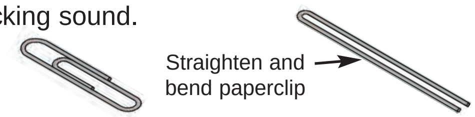
***OBJECTIVE:** To show how electricity can lift things using magnetism.*



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.



Now for the fun part: slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. The LED (D1) flashes and the speaker (SP) makes a clicking sound.



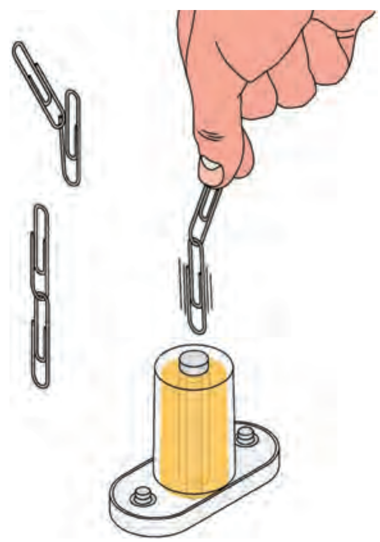
☐ Project #673 Paperclip Oscillator (V)

***OBJECTIVE:** To show how electricity can lift things using magnetism.*

Use the circuit from project #672, but replace the 100μF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). The circuit works the same way, but the lamp flashes like a strobe light.

☐ Project #674 Oscillating Compass

***OBJECTIVE:** To learn how electricity and magnetism are related.*



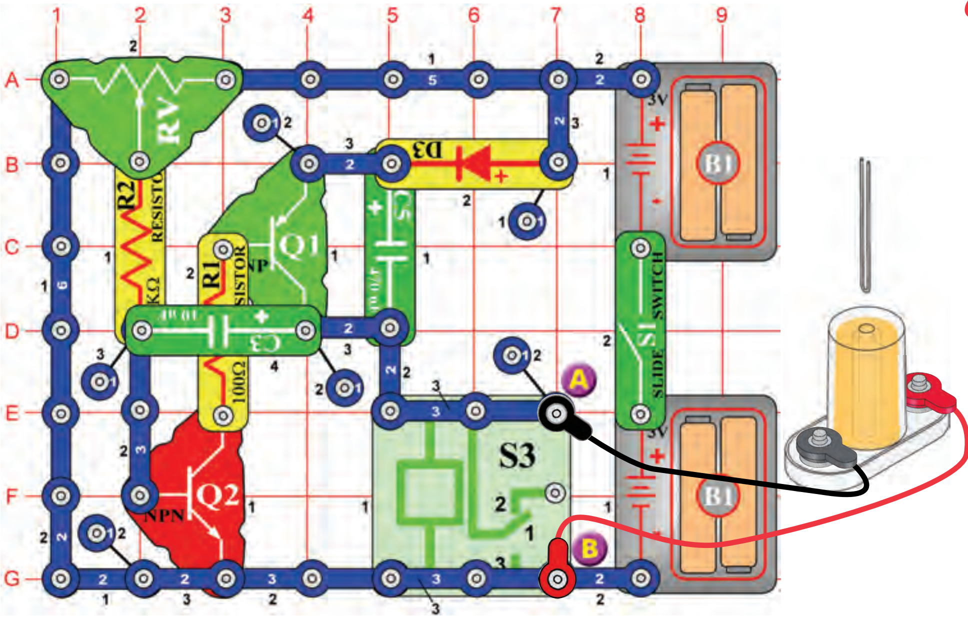
Use the circuit from project #672, but replace the 100μF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). Place the iron core rod in the electromagnet (M3) and don't use the bent paperclip. Slide two paperclips together, using their loops.

Turn on the slide switch (S1) and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod. Notice that the lower paperclip is vibrating, due to the changing magnetic field from this oscillator circuit. Compare this circuit to project #665 (Paperclip Compass).

Project #675

High Frequency Vibrator

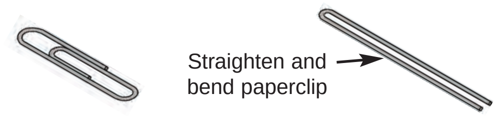
OBJECTIVE: To show how electricity can lift things using magnetism.



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3).

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paperclip bounce.

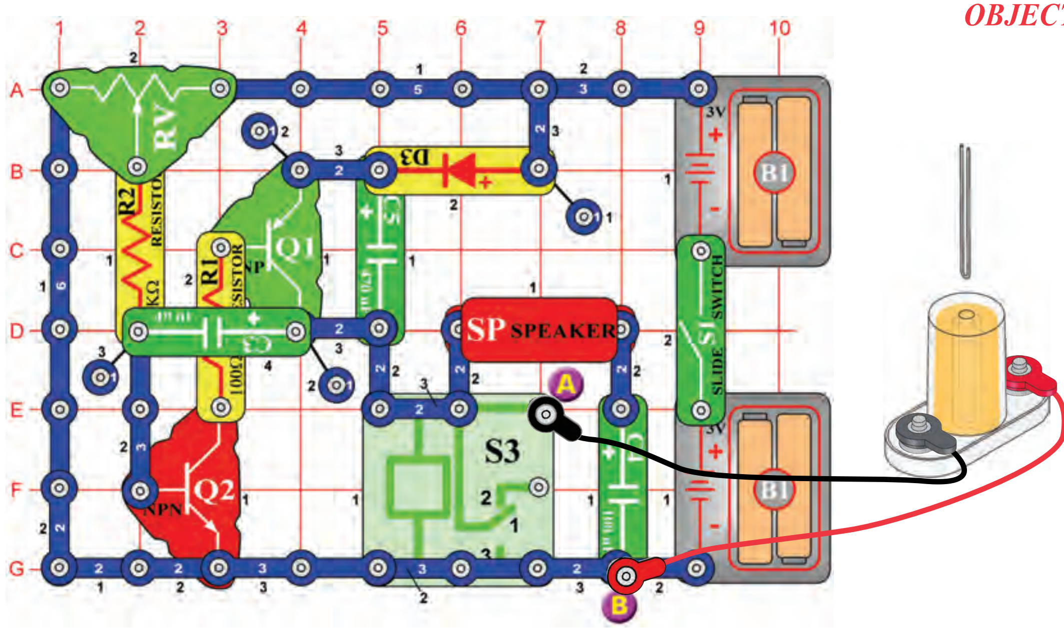
Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



Project #676

High Frequency Vibrator (II)

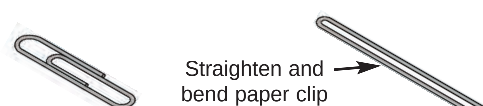
OBJECTIVE: To show how electricity can lift things using magnetism.



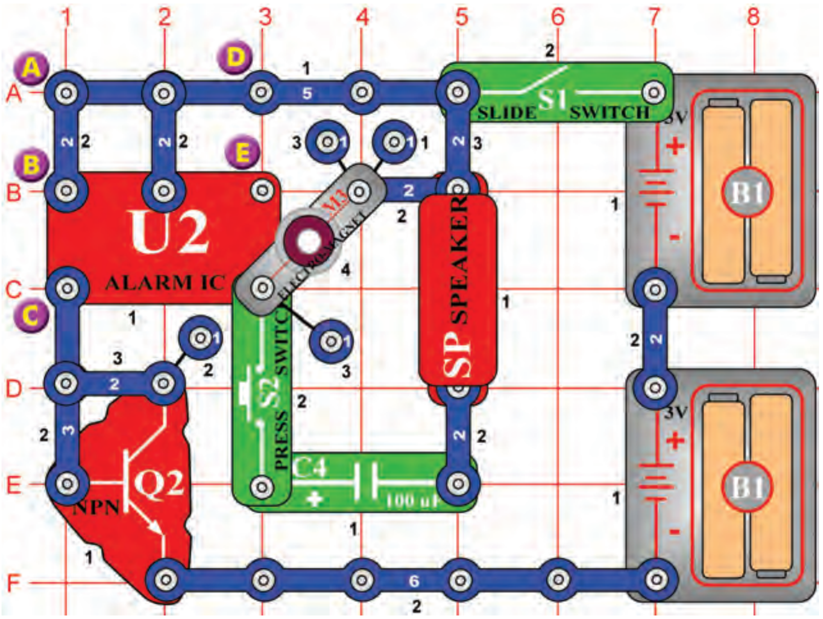
Take a paper clip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3) and speaker (SP).

Adjust the electromagnet height and resistor control lever until the paper clip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paper clip bounce.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



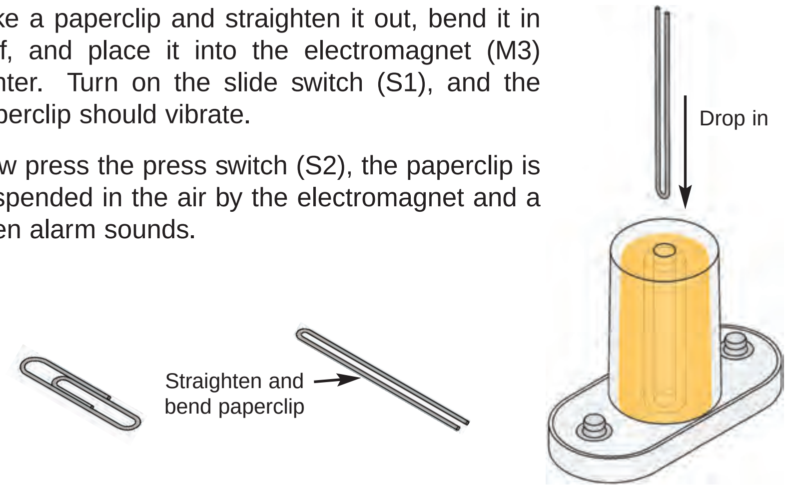
Project #677 Siren Paperclip Vibrator



OBJECTIVE: To show how electricity can move things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

Now press the press switch (S2), the paperclip is suspended in the air by the electromagnet and a siren alarm sounds.



Project #678 Alarm Paperclip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

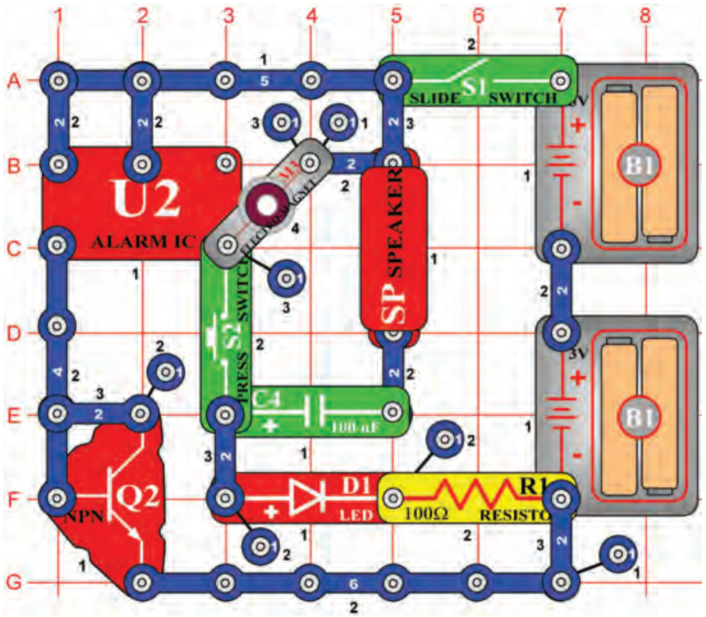
Use the circuit from project #677, remove the connection between points A & B and make a connection between points B & C (using a spacer on point B). The sound and vibration are different now. Compare the vibration height and frequency to project #677.

Project #679 Machine Gun Paperclip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

Now remove the connection between points B & C and make a connection between points D & E. The sound and vibration are different now. Compare the vibration height and frequency to projects #677 and #678.

Project #680 — Alarm Vibrator w/ LED

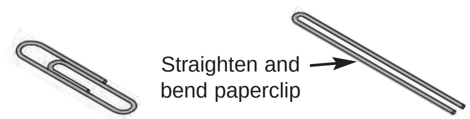


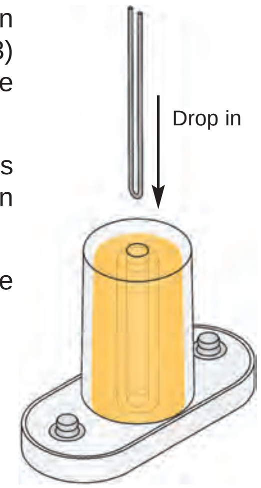
OBJECTIVE: To show how electricity can move things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate and LED (D1) flashes.

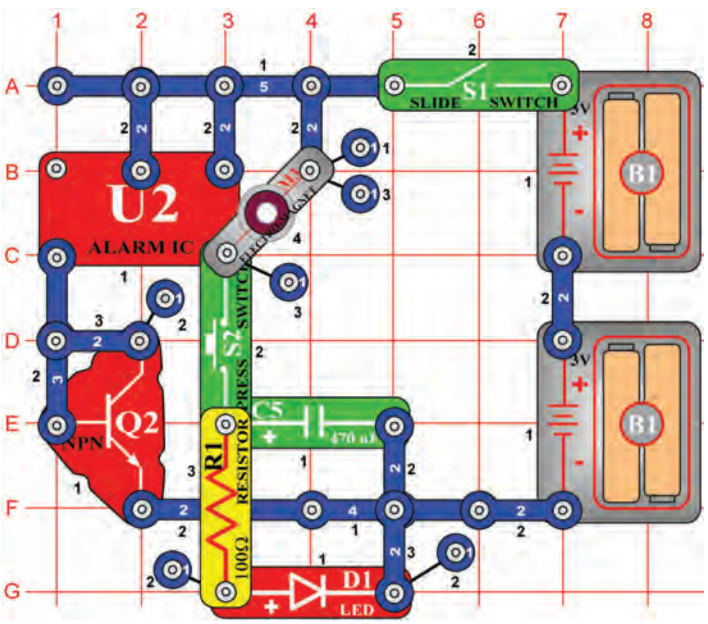
Now press the press switch (S2), the paperclip is sucked up by the electromagnet and a siren alarm sounds.

You can replace the speaker (SP) with the whistle chip (WC) to change the sound.





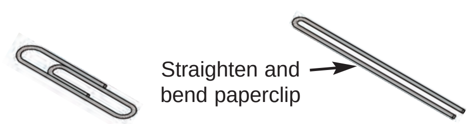
Project #681 — Alarm Vibrator w/ LED (II)

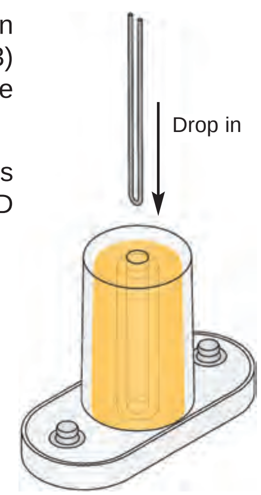


OBJECTIVE: To show how electricity can move things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

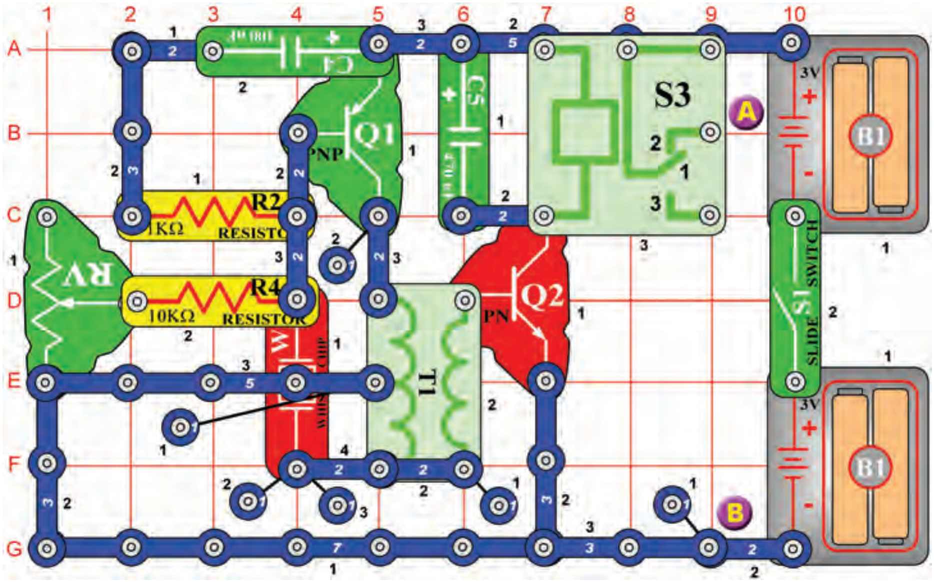
Now press the press switch (S2), the paperclip is sucked up by the electromagnet and the LED (D1) flashes.





Project #682 Relay-Whistle Vibrator

OBJECTIVE: To show how electricity can lift things using magnetism.

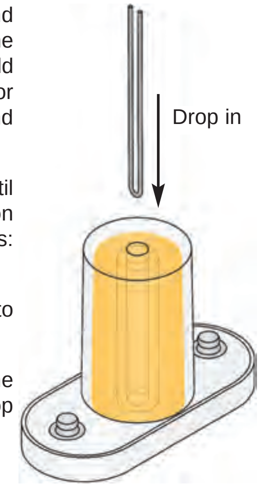


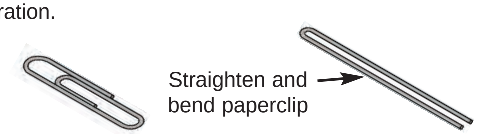
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. The vibration pattern may seem complex because it is due to two sources: the whistle chip and the relay.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.

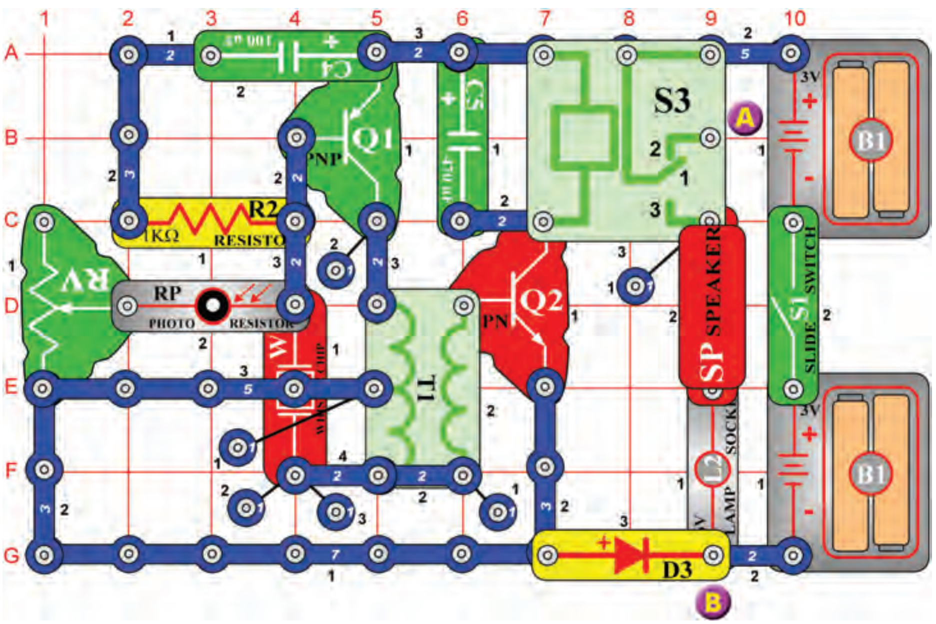
You can also replace the 10KΩ resistor (R4) with the photoresistor (RP). Waving your hand over it will start or stop the vibration.





Project #683 Relay-Whistle Photo Vibrator

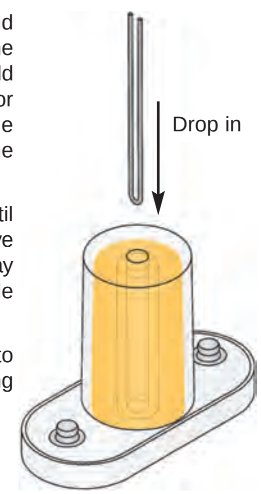
OBJECTIVE: To show how electricity can lift things using magnetism.

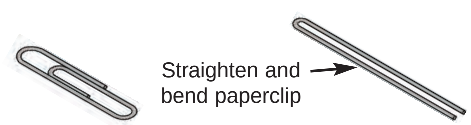


Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly without covering the photoresistor (RP), you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

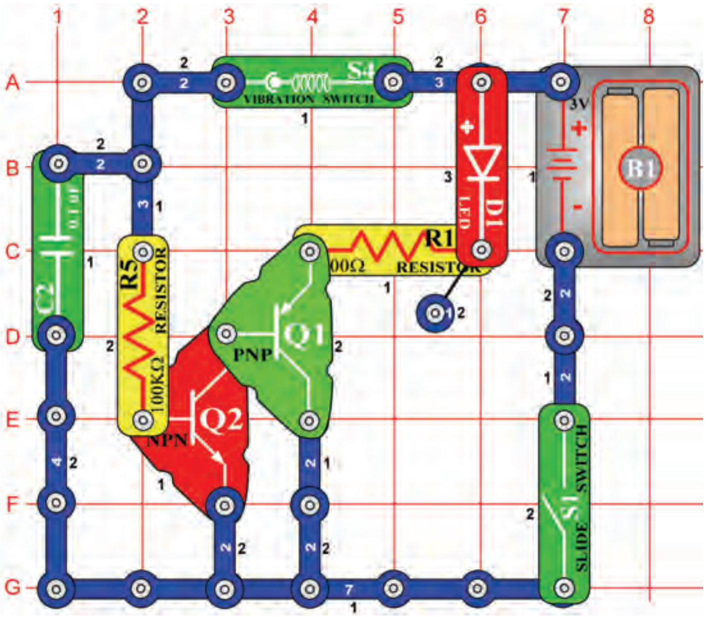
Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. Then wave your hand over the photoresistor. The vibration pattern may seem complex because it is due to three sources: the whistle chip, the relay, and the photoresistor.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration. Covering the photoresistor stops the vibration.





Project #684 — Vibration LED

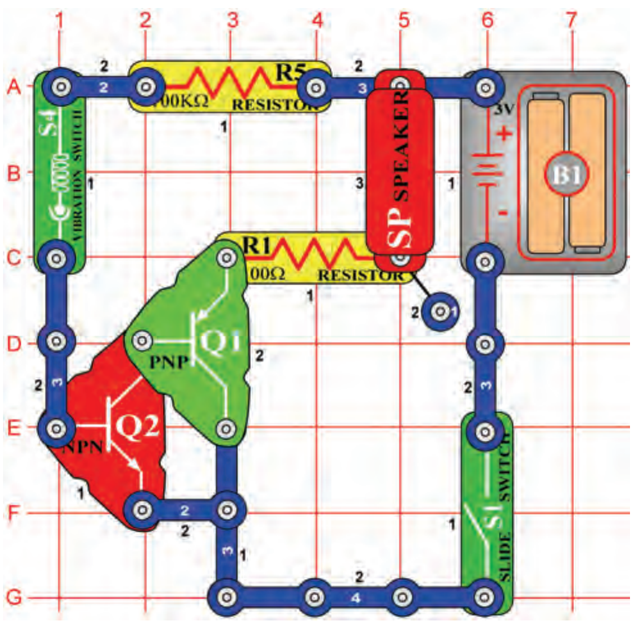


OBJECTIVE: Introduction to the vibration switch.

The vibration switch (S4) contains two separate contacts; a spring is connected to one of the contacts. A vibration causes the spring to move briefly shorting the two contacts. This simple circuit demonstrates how the vibration switch works. Build the circuit and the LED (D1) does not light. Tap the vibration switch or table and the LED lights for every tap.

The 100KΩ resistor (R5) limits the current to protect the vibration switch while the transistors allow the vibration switch to control a large current.

Project #685 — Vibration Speaker



OBJECTIVE: To create sound with a tap of your finger.

Build the circuit and turn on the slide switch (S1). When you tap on the vibration switch (S4), the speaker (SP) sounds. Listen closely because the sound may not be very loud.

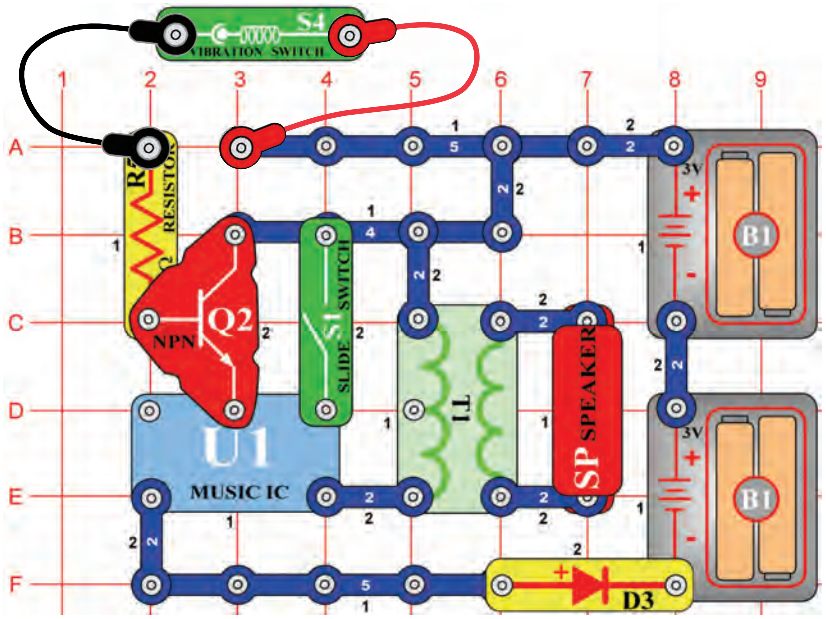
Project #686 — Measure the Vibration as You Tap the Switch

OBJECTIVE: To use the meter with the vibration switch.

Modify project #685 by replacing the speaker (SP) with the meter (M2). Place it with the "+" side towards R5 and use the LOW (or 10mA) setting. Tap the vibration switch (S4) and the meter deflects to the right. Tap harder on the switch; the switch closes longer and the meter deflects more to the right.

☐ Project #687 Shaky Birthday Song

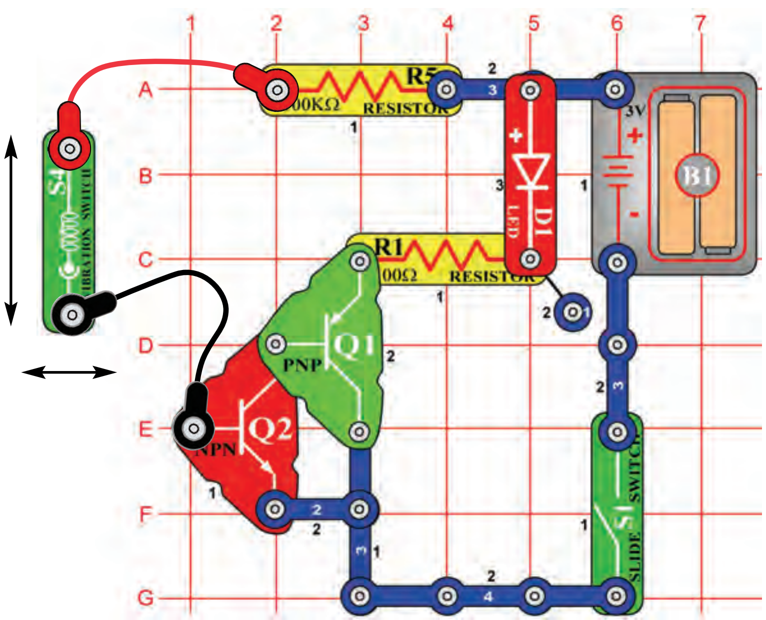
OBJECTIVE: To turn the music IC on and off using the vibration switch.



Connect the vibration switch (S4) to the circuit using the red and black jumpers. Hold the vibration switch steady in your hand and the music should not play. Now move your hand, the music should briefly play. If you continuously shake the switch, the music keeps playing. Turn the slide switch (S1) on and the music plays. Change the sound by shaking the vibration switch.

☐ Project #688 Vibration Detector

OBJECTIVE: To show the effects of horizontal and vertical direction.

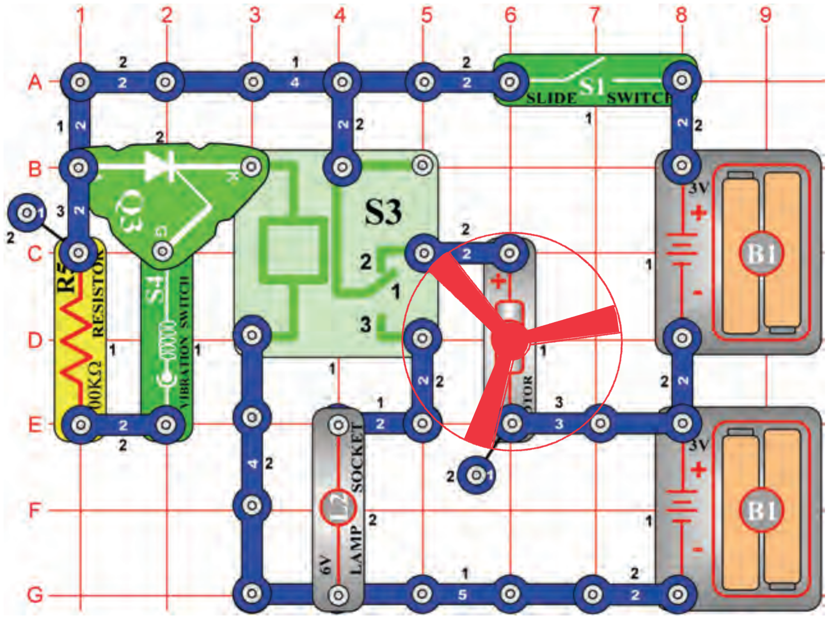


Connect the vibration switch (S4) to the circuit using the black and red jumper wires. Place the switch horizontally on the table. Rapidly move the switch from left to right and notice that the LED (D1) does not light. There is not enough force to expand the internal spring to turn on the switch. Now move the switch up and down and see that the LED easily lights. It requires less force to move the spring back and forth.

You can replace the LED (D1) with the meter (M2), place it with the "+" side towards R5 and use the LOW (or 10mA) setting. The meter deflects more when you move the vibration switch up and down.

Project #689 — Out of Balance

OBJECTIVE: To build an out of balance turn off circuit.



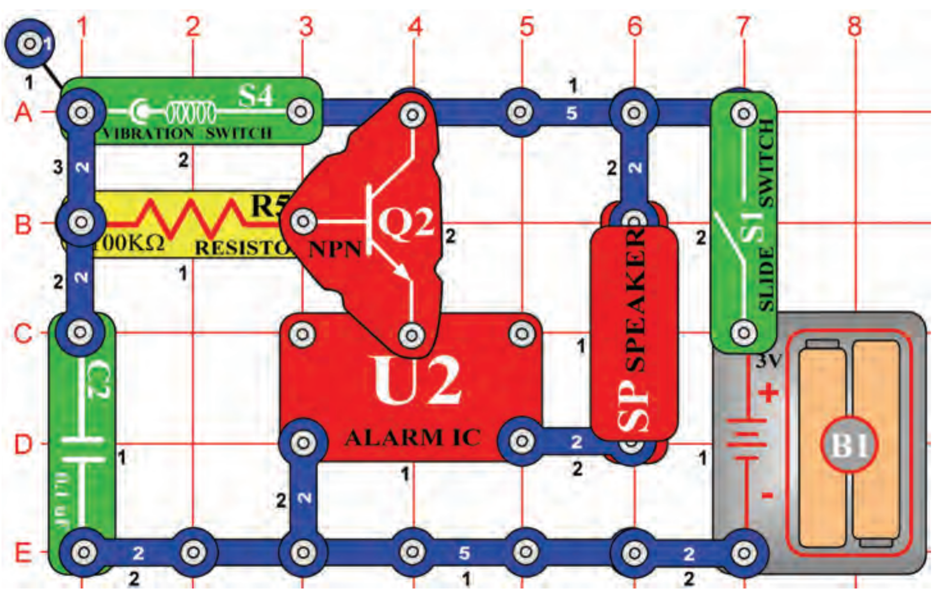
The vibration switch (S4) triggers the SCR (Q3) connecting the relay's (S3) coil to the battery (B1). The relay's contacts switch, turning the motor (M1) off, and lighting the lamp (L2). The lamp will stay lit until the slide switch (S1) is turned off.

Turn the slide switch on; the motor starts to spin. If the motor generates enough vibration, the switch will trigger the SCR, turning off the motor and lighting the lamp. If the motor keeps spinning, tap on the table to trigger the vibration switch.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #690 — Vibration Alarm

OBJECTIVE: To sound an alarm when something is shaken.

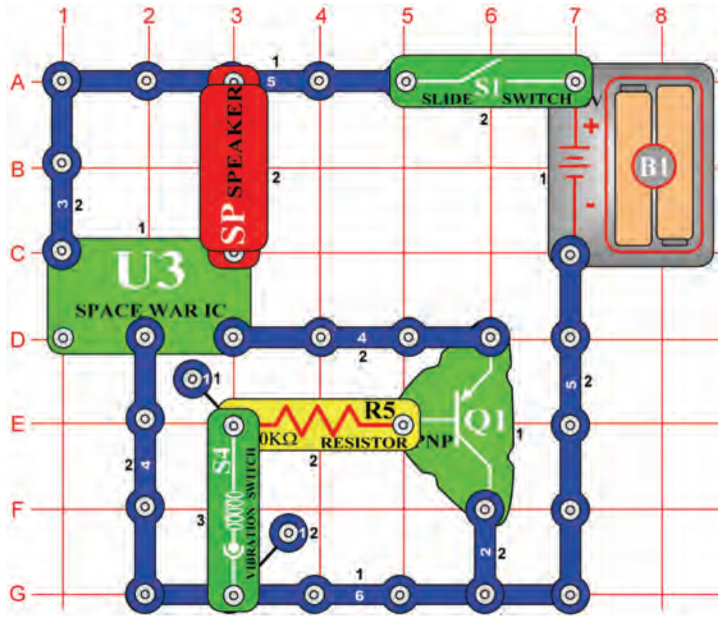


Turn on the slide switch (S1) and shake the circuit or bang on the table; an alarm will sound. Try banging on the table in a regular pattern, and see if you can make the alarm sound continuously.

Project #691

Vibration Space War

OBJECTIVE: To make sounds when something is shaken.



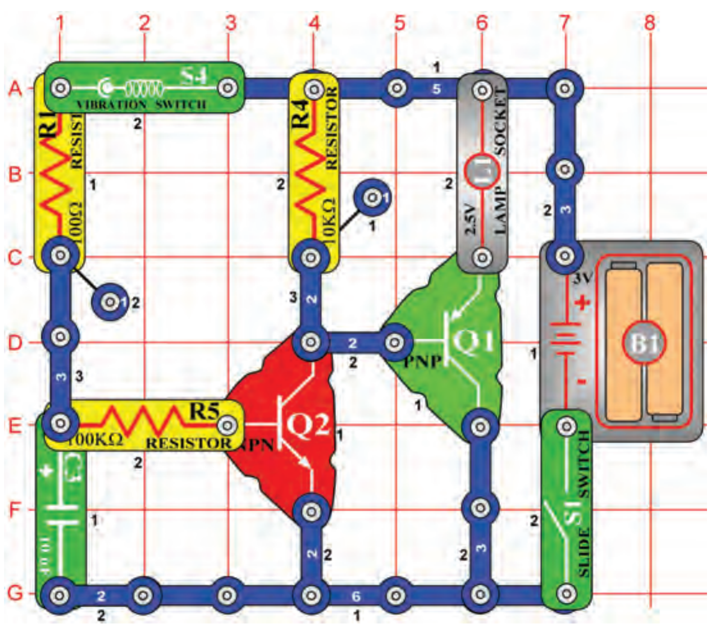
Turn on the slide switch (S1) and shake the circuit or bang on the table, you will hear different sounds. Try banging on the table in a regular pattern, and see if you can make the sounds continuous.

When the vibration switch (S4) is shaken, the circuit plays out one of eight sounds.

Project #692

Vibration Light

OBJECTIVE: To build a lamp that stays on for a while.



Turn on the slide switch (S1) and shake the base grid or bang on the table. The lamp (L1) turns on when there is vibration, and stays on for a few seconds.

OTHER FUN ELENCO® PRODUCTS!

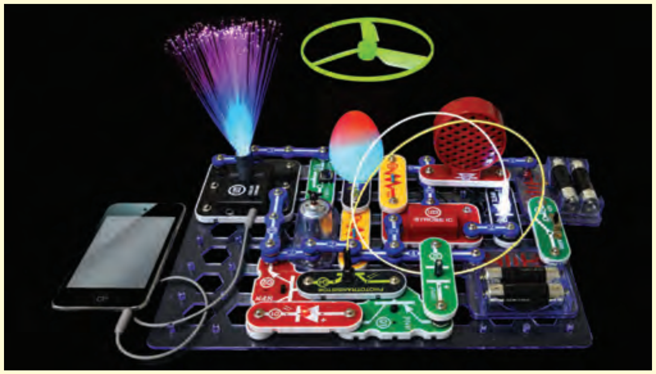
For a listing of local toy retailers who carry Snap Circuits®, please visit **www.elenco.com** or call us toll-free at (800) 533-2441. For Snap Circuits® upgrade kits, accessories, additional parts, and more information about your parts, please visit **www.snapcircuits.net**.

Snap Circuits® LIGHT

Model SCL-175

Build over 175 projects! **Contains over 60 parts**

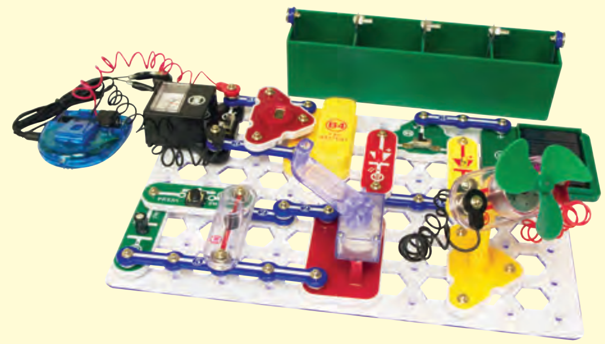
- Infrared detector
- Strobe light
- Color changing LED
- Glow-in-the-dark fan
- Strobe integrated circuit (IC)
- Fiber optic communication
- Color organ controlled by iPod® or other MP3 player, voice, and fingers.



Snap Circuits® Green

Alternative Energy Kit Model SCG-125

Learn about energy sources and how to “think green”. Build over 125 projects and have loads of fun learning about environmentally-friendly energy and how the electricity in your home works. Includes full-color manual with over 100 pages and separate educational manual. This educational manual will explain all the forms of environmentally-friendly energy including: geothermal, hydrogen fuel cells, wind, solar, tidal, hydro, and others. Contains over 40 parts.



If you want to enhance your Snap Circuits® experience and get even smarter, then try

Snap Circuits® Student Guide

Part # 753307

For use with SC-750

Educational Series - teaches Basic Electricity and Electronics in the everyday world using our Learn By Doing® concept! 80 full-color pages, and written with the help of educators.

Snaptricity Model SCBE-75

Build Over 75 Projects

Learn how electricity and magnetism can be used to make each other, learn about magnetic fields, how the electricity in your home works, how switches control the electricity to the lights in your home, and how series and parallel circuits affect electricity.

Over 40 parts including: Meter, electromagnet, motor, lamps, switches, fan, compass, and electrodes.

Educational Toy: Projects that relate to electricity in the home and magnetism and how it is used. Build over 75 projects.

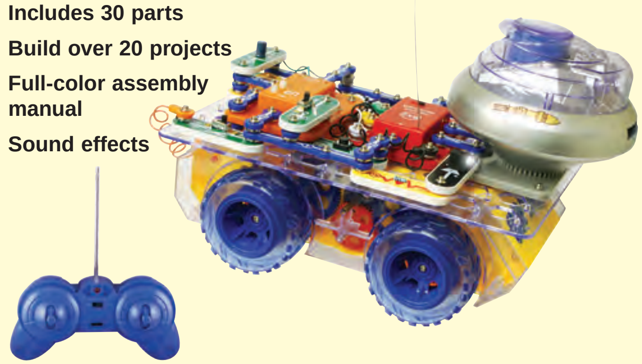
Put your circuits in motion!

Deluxe Snap Rover®

Model SCROV-50

Introducing the next generation of the RC Snap Rover®! This version includes a disc launcher, digital voice recorder, and music sounds. Over 50 parts allow you to complete over 40 additional projects.

- **Includes 30 parts**
- **Build over 20 projects**
- **Full-color assembly manual**
- **Sound effects**



Custom Storage Case

Model SNAPCASE7

Heavy duty plastic case with 2 custom foam inserts for housing your Snap Circuits® parts. Easy to identify missing components. Also includes a separate small case to hold the smaller loose parts.

(for use with SC-750)

AC Power Supply

Part # AC-SNAP

Replaces the batteries in Snap Circuits®.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from:

www.snapcircuits.net/SnapDesigner.doc

or through the **www.snapcircuits.net** web site.

OTHER FUN ELENCO® PRODUCTS!

Project Labs *No Soldering Required*

500-in-1 Electronic Project Lab
Model MX-909

Everything you need to build 500 exciting electronic projects. Learn the basics of electronics and put your knowledge to work creating projects that explore amplifiers, analog and digital circuits plus learn how to read schematic diagrams. Includes built-in breadboard for easy wiring and connection of components and an LCD (liquid crystal display) which indicates the information for the experiment in progress. Includes breadboard and spring hook-up methods.

Weather
Model EDU-7074

Over 30 fascinating activities all about weather and climate. Build your own barometer, weather vane, rain gauge, and hydrometer. Observe the weather traits and see how they'll affect tomorrow's weather. Make a rainbow, produce clouds, lightning, rain, and even a thunderstorm! Requires one (1) 9V battery.

Warning: This product contains uninflated balloons.

Chemistry 60
Model EDU-7075

Beginning chemistry set includes 60 fun activities with no chemicals. Activities include three-dimensional bubbles, basic chemistry, crystal growing, physics, magnetism, optics, growing plants, slime & gook, science tricks, and chromatography.

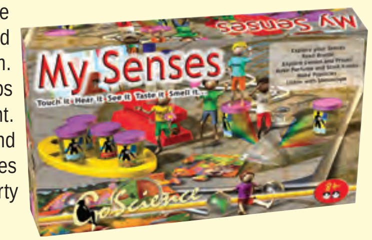
Warning: This product contains magnets.

Detectolab
Model EDU-7080

Investigate, analyze, decipher and solve the crime!
Over 65 activities with fingerprints, secret messages, chromatography, cipher codes, identity detection and more. Kit includes 30X microscope and necessary lab equipment.
Requires two (2) "AA" batteries.

My Senses
Model EDU-7086

This kit is part of our Body Awareness Science Series, exploring the five senses: sight, hearing, smell, taste, and touch. Perform over 50 fascinating experiments. Use a genuine stethoscope, make a telescope with real lenses and create rainbows with a prism. Prepare perfume and stink bombs with chemistry lab equipment. Learn how to read and send messages in Braille. Also includes many activities suitable for party games.



Educational Kits *No Soldering Required*

Radio-Controlled Race Car
Model FUN-875

The purpose of this project is to expand your understanding of basic transmitters, receivers and electronic switching theories. Your Turbo King Car will be built from the ground up. You'll learn all about gears, motors, printed circuit boards, and integrated circuits from our detailed assembly and training manual. You will construct each section, explore the circuitry and troubleshoot it.

Requires 1 9V and 4 "AA" batteries.

Solar Deluxe Educational Kit
Model SK-40

By solar power, harness the power of the sun with this environment-friendly D.I.Y. kit!

You can do a series of do-it-yourself experiments to acquire the basic knowledge of solar energy.

You can learn how to make an electrical circuit, make a solar circuit, how to increase voltage and current, and how to use solar power to produce energy for a radio, calculator, battery charger, and more!

ELENCO®
150 Carpenter Avenue
Wheeling, IL 60090
(847) 541-3800
Website: www.elenco.com
e-mail: elenco@elenco.com

ELECTRONIC SNAP CIRCUITS™

With Computer Interface   Model CI-73

Experiments PC1 - PC73

SNAP CIRCUITS®

Instruction Manual

Elenco® Electronics, Inc.

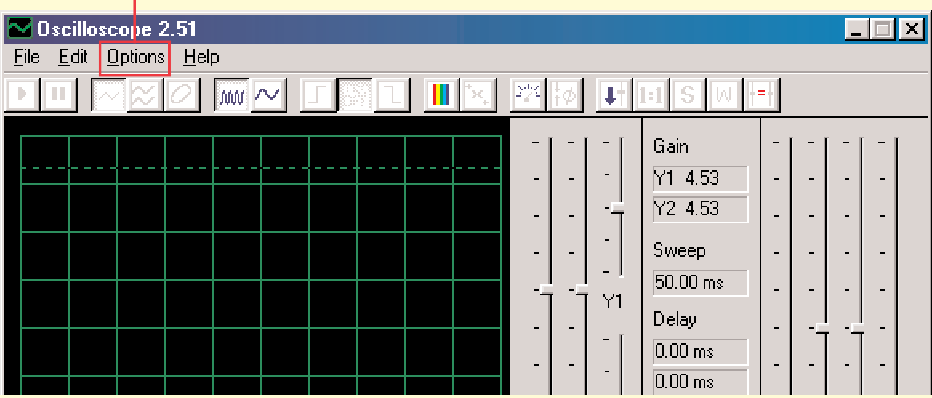
REV-B Revised 2005 753293

CI-73 - READ THIS FIRST

The CI-73 is a set of 73 Snap Circuits with special software that allows you to “see” the electrical signals in the circuits, just like electronics engineers do using oscilloscopes and spectrum analyzers.

Requirements for your computer:

1. Windows® 95 or later.
2. A working microphone input port.



INSTRUCTIONS:

1. Insert the CI-73 CD into your computer. The Snap Circuits menu comes up automatically, with an electronic copy of this manual. Select **Run Winscope Now**. <u>Connect the plug end of the probe to the microphone input on the back of your personal computer.</u>

   If the Snap Circuits menu does not appear automatically: Click <Start> - <Run> - <Browse>, then select CI-73 in your CD drive, then select AutorunPro and click <OK>.

   If Windows asks you how to open the file (or if you have Acrobat® Reader™ 3.0 or older), then you need to install Acrobat® Reader™: Click <Start> - <Run> - <Browse>, then select CI-73 in your CD drive, then select Acrobat® Installer and click <OK>. Follow the instructions to install, and then re-insert the CI-73 CD into your computer.

2. Change the default settings for Winscope by selecting <Options>. Then select <Timing> and change Sampling to 44100 and press <OK>. Then select <Options> again, then <Colors> - <Y1 Trace> and pick a bright color like pink. Then select <Options>, then <Save Setup> to save these settings as your default.

3. Follow the instructions through project PC3 before moving on to any other circuits, since the main features of the software are demonstrated.

If you have any questions contact:

Elenco® Electronics, Inc.
150 Carpenter Avenue
Wheeling, IL 60090
(847) 541-3800
Website: www.elenco.com • e-mail: elenco@elenco.com

WARNING:

SHOCK HAZARD - **<u>NEVER</u>** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

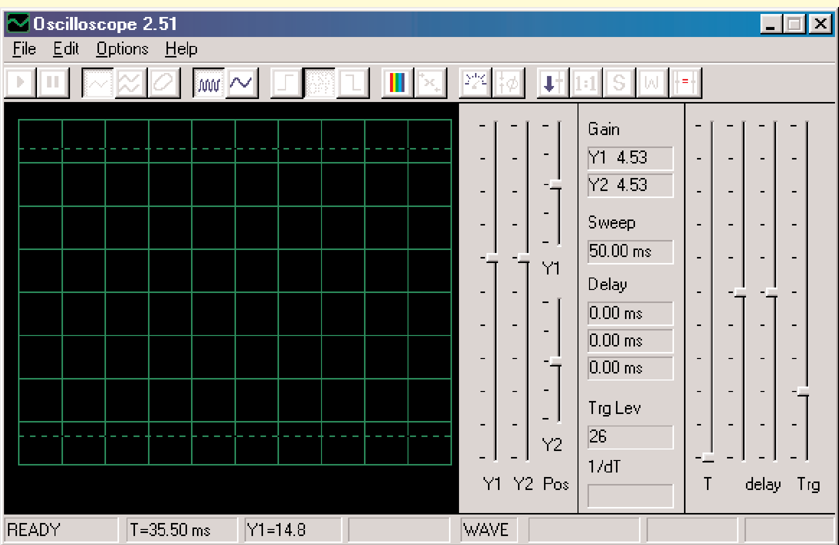
Looking at Electronic Signals using the WINSCOPE Software

Electronic engineers use specialized test equipment to “see” electronic signals and make performance measurements. They use an oscilloscope to look at the shape of the signal and use a spectrum analyzer to look at its frequency content. This equipment is specialized and usually very expensive.

The Winscope software simulates this equipment using your personal computer. The **PC-interface cable** can be connected across any 2 points in your circuit to look at the signal.

WARNING:
SHOCK HAZARD - **NEVER** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

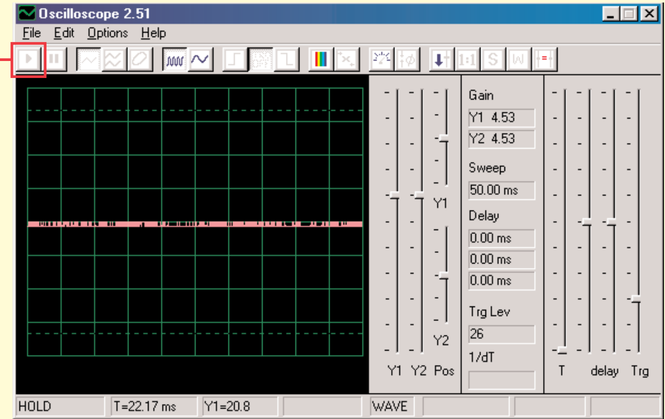
It is usually connected to the output of a circuit, as in the circuits shown for the CI-73. **Connect the plug end of the probe to the microphone input (pink plug) on the back of your personal computer.** Run the Winscope application (from the CI-73 menu). It will come up in Hold mode looking like this:



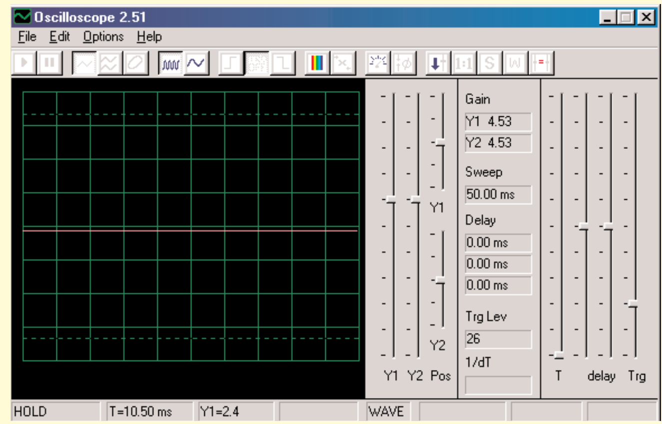
Click on the **On-Line button** to turn it on. You should now get one of the following 2 pictures, depending on whether your microphone input is properly turned on:

On-Line button

Example A



Example B

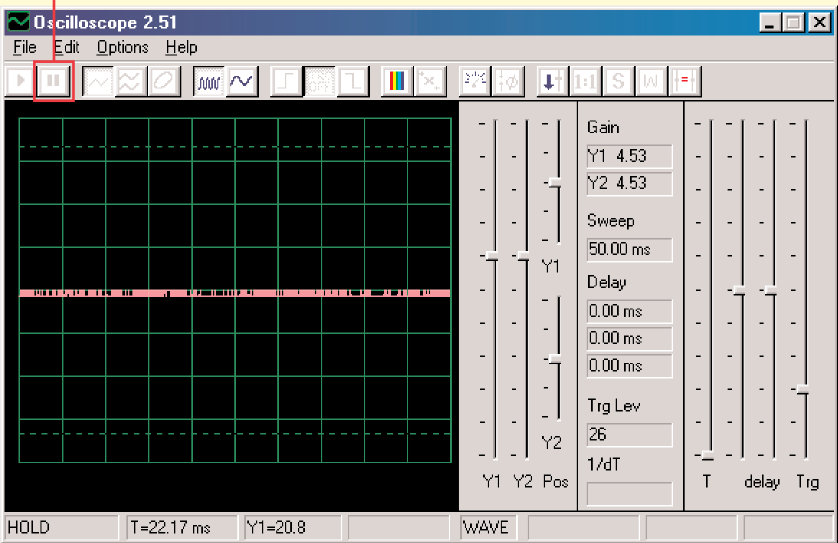


If you get the picture shown in Example B, then your microphone input is not properly turned on. Go to the “Turning On Your Microphone Input” section to turn it on. There may also be other sound card controls on your computer that you need to set. When your input is properly configured, you will get a picture like Example A above. Touch the red and black “alligator” clips on the PC-interface cable to each other and you should see the random pattern on the Winscope screen change as you do so. You are now ready to proceed with the first CI-73 experiment or you may investigate the Winscope software on your own.

Looking at Electronic Signals using the WINSCOPE Software (continued)

You may freeze a waveform on the screen by clicking on the **Hold mode button** (just to the right of the On-Line button).

Hold mode button



WARNING: **Do not "save setup" in Winscope.** Many of the buttons on Winscope control features that this manual will not be using. If you accidentally place the Winscope software into an unknown mode, you may always close and re-start Winscope. Doing so will reset all settings to those described in this booklet unless you have done a "save setup".

PROJECTS PC1-PC3 SHOW HOW TO USE THE MAIN FUNCTIONS OF WINSCOPE SO DO THEM FIRST!

NOTES:

1. **It is recommended that you disable or turn down the volume to the speakers on your computer. CI-73's use of the microphone input port will also channel the same signal to the speakers, and the result can be distracting.**
2. **It is recommended that you become familiar with the Snap Circuits parts and assembly methods before building any of the circuits in this manual.**

Turning On Your Microphone

(For Windows® 98 or XP, other Windows® versions may be slightly different.)

If you don't get any signal from the PC-interface cable then your microphone may be disabled on your computer. To turn it on, follow these instructions which begin by pressing the <Start> button on the lower-left corner:

1. Select <Start> - <Programs> - <Accessories> - <Entertainment> (or <Multimedia>) - <Volume Control>.
2. Select <Options>.
3. Select <Properties>.
4. Select <Recording> in the "Adjust Volume For" box.
5. In the "Show the Following Controls" box, check <Microphone>.
6. Select <OK>.
7. In the "Microphone - Volume" box, check <Select> and set volume to about 40% of max.

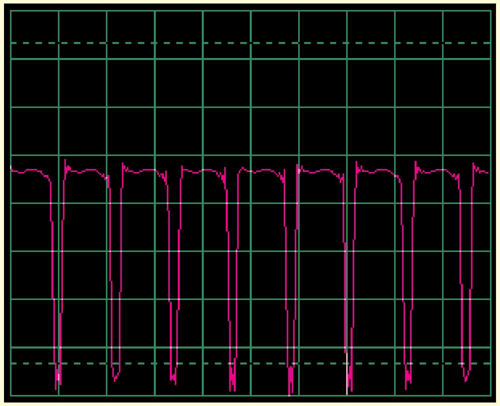
Your microphone should now be turned on.

Looking at Electronic Signals using the WINSCOPE Software (continued)

IMPORTANT NOTE: The designs for the microphone input port vary throughout the computer industry. Hence you may get waveforms different from those shown in your manual even though the circuit is actually performing the same way. Here are some types of differences:

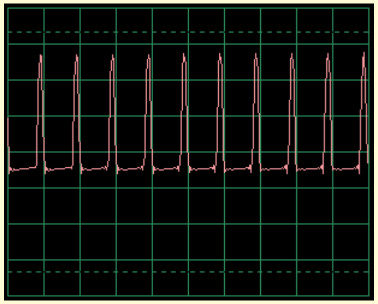
A. The gain of your microphone input may be significantly different from that indicated on pages 8-10 (and similarly for the other circuits). Page 4 describes how to turn on the microphone input and adjust its volume to about 40% of max, you may want to adjust this volume higher or lower so that your results better match those shown. Note that having the volume set too high may "clip off" the top or bottom portion of a waveform.

B. The oscilloscope waveforms shown on your display may appear upside down ("inverted") from those shown throughout this document. For example the waveform shown on the top of page 10 would look like this:

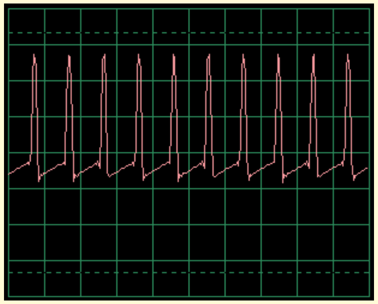


If this is the case then swap the connections of the red and black clips of the Winscope probe in all circuits.

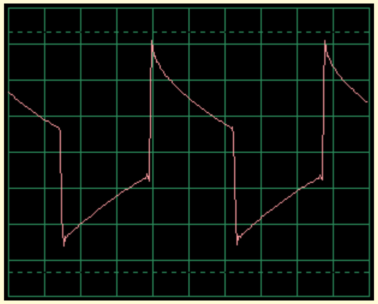
C. The shape of waveforms may appear distorted for some circuits, due to protection circuitry that acts as a filter. For example:



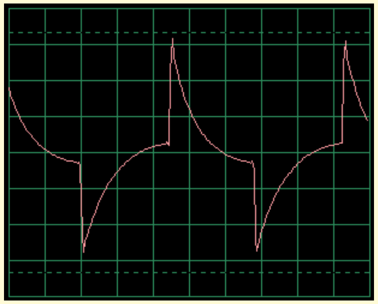
This waveform . . .



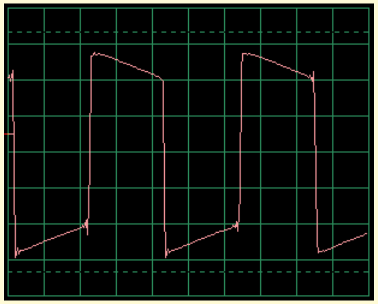
might look like this.



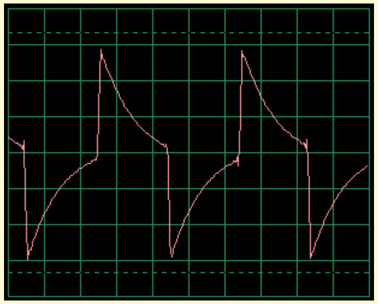
And this waveform . . .



might look like this.



And this waveform . . .



might look like this.

Contact Elenco® Electronics if you have any questions about this.

Limitations of WINSCOPE and Its Interface

By using the microphone audio input and the flexible processing power of the personal computer, we have created an inexpensive and easy-to-use way of looking at electronic signals. However, no electronic oscilloscope or spectrum analyzer ever made works on all electronic signals, and similarly Winscope has limitations. The projects in this booklet were written to minimize those limitations.

Winscope can only measure changing signals (AC voltages, >20 Hz frequency) and cannot measure fixed voltages (DC voltages, such as a battery), due to the design of the microphone input. Fixed voltages are not very exciting to look at anyway. Slow-changing or transient signals (such as when you first turn on power to a circuit) will be displayed in a distorted form.

Winscope works best on signals up to about 5kHz, since its sampling rate is limited to 44kHz. If you attempt to measure higher frequency signals, then you will get wrong results due to undersampling. This is a narrow range but it covers human voice and most (but not all) music. AM and FM radio frequencies cannot be measured. Every measurement you make will have some amount of random "chatter" superimposed on the signal of interest. This chatter is due to the limited sampling rate and from the PC-interface cable picking up energy from other electronic instruments in the vicinity (including room lights and your computer), hence it cannot be avoided.

Using WINSCOPE's Full Capabilities

Winscope has 2 input channels that can be displayed at the same time. This is commonly done by electronic engineers using an oscilloscope, to show the relationship of one (or more) signals to another. However, use of this requires a second microphone input, which most computers do not have. If the sound card in your computer has this then you may use all of Winscope features for 2 channels, which include X-Y and correlate modes. Use of these Winscope capabilities is beyond the introductory level of this product, use the Help menu in Winscope for information about using these features.

WARNING:
SHOCK HAZARD - **NEVER** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

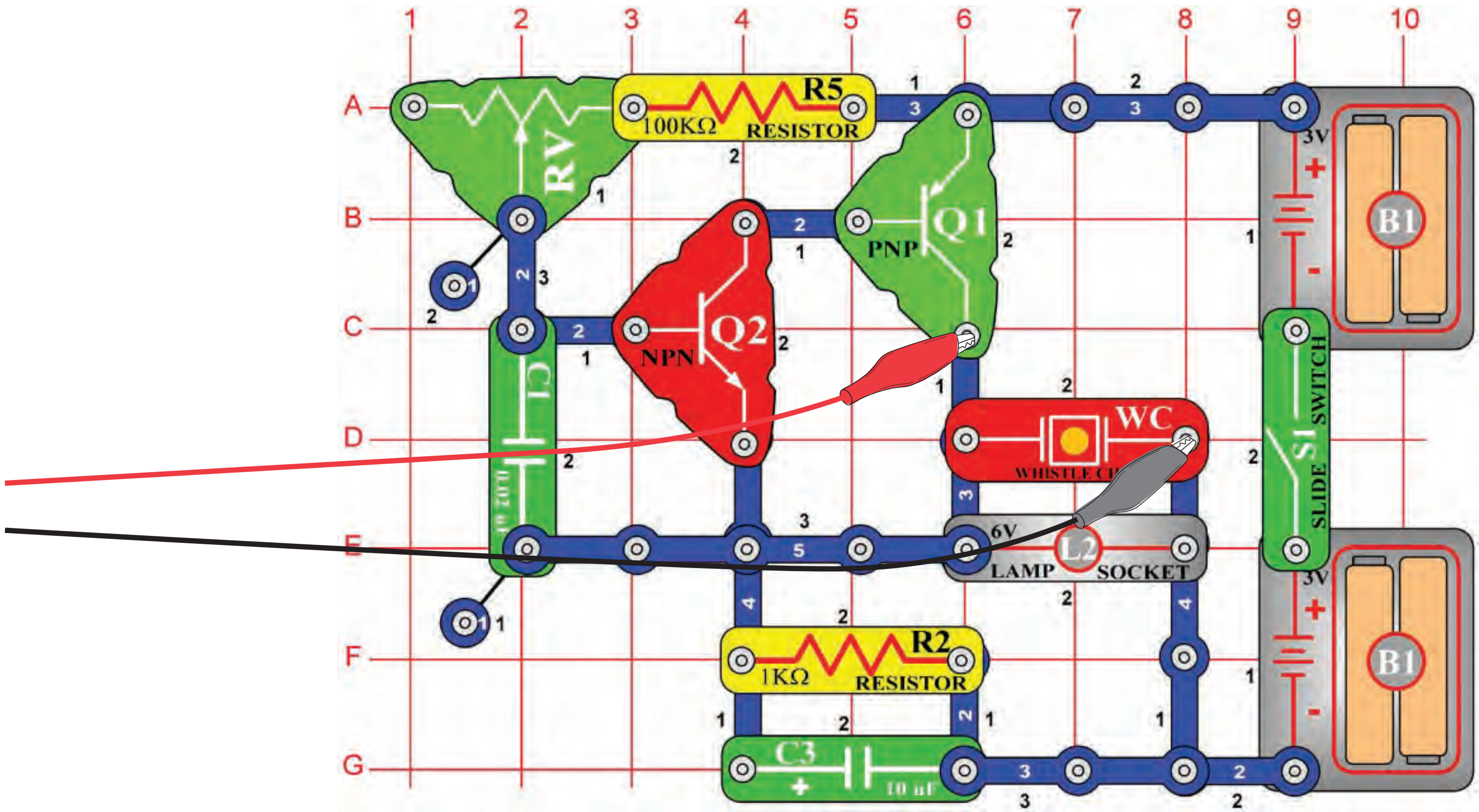
Exporting Graphs from WINSCOPE

To make a copy of the Winscope display screen, hold down the Alt button and press the PrtScn button on your computer when Winscope is the active window. You can then paste it into word processing programs such as Microsoft Word.

Project Listings

☐ Project #PC1 Pitch PC

OBJECTIVE: To look at the output signal from a transistor oscillator while changing the pitch of the sound.

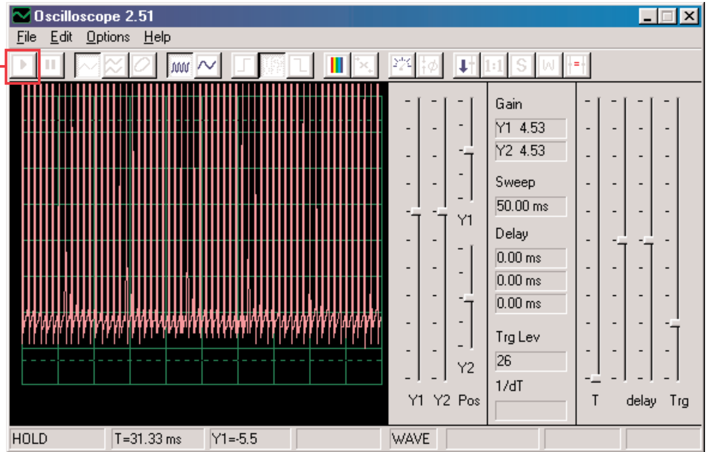


You will now be introduced to the Winscope features, and thereby become familiar with oscilloscopes and spectrum analyzers, and see some of the most important concepts in electronics. It is recommended that you already be familiar with the Snap Circuits parts and assembly methods from the other manuals.

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer. Turn on the slide switch (S1) and vary the adjustable resistor (RV). The frequency or pitch of the sound is changed. Run the Winscope software and be sure your microphone input is configured properly, as described earlier.

Click on the **On-Line button** if Winscope is currently in Hold mode and you should get a picture similar to this one:

On-Line button

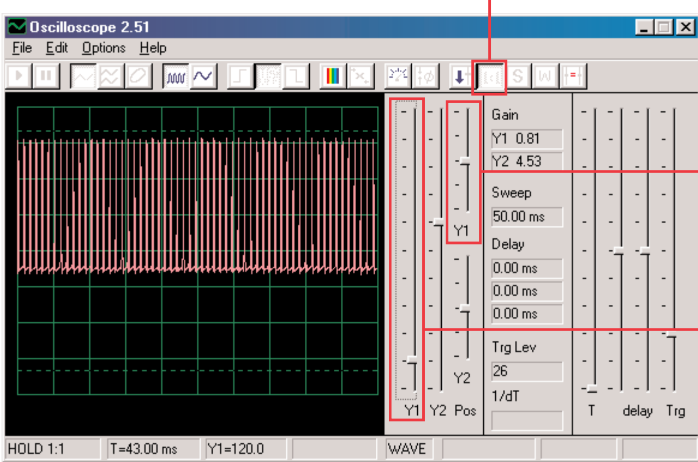


The waveform peak is off the top of the screen because the scope gain (amplification) is set too high. You may adjust this gain by moving the **Y1 gain control** around (try it).

Similarly, you may adjust the position of the waveform on the screen by moving the **Y1 position control** around (try it).

Now click on the **1:1 button** to set the gain to x1 and disable the Y1 controls. You should now have a picture similar to this one:

1:1 button



Y1 position control

Y1 gain control

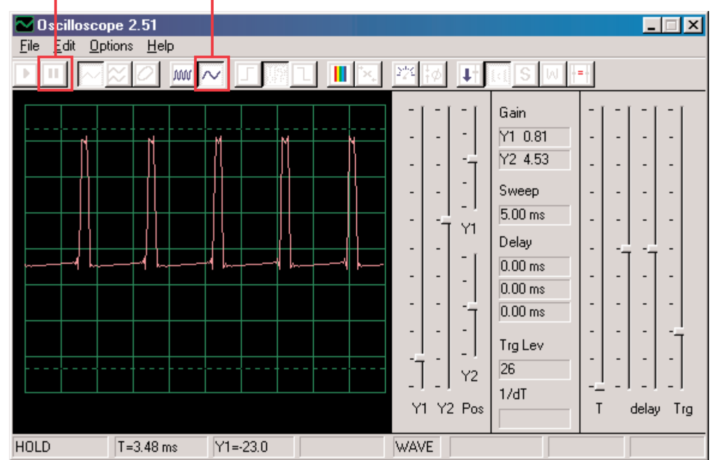
Note that your picture may not exactly match this picture due to variances in the microphone input gain between computers, which is beyond software control. You may want to adjust the volume control of your microphone input to compensate, see note A on page 4 for more details. You may also disable 1:1 mode by clicking on its button again and then adjust the gain using the Y1 control.

The gain and position control features just described enable electronic engineers and technicians to "see" the amplitude (voltage level) of a signal. By adjusting the settings on an oscilloscope, they can look at both very large and very small voltage waveforms.

Move the adjustable resistor control (snap part RV) and watch how it changes the waveform on the computer screen. Now click on the **0.5ms/div button** to change the time scale on the display. (The button to the left of it is for 5ms/div, the default.) Move the adjustable resistor control around again. You may click on the **Hold button** to freeze the waveform on the screen, then click on On-Line to re-start.

Hold button

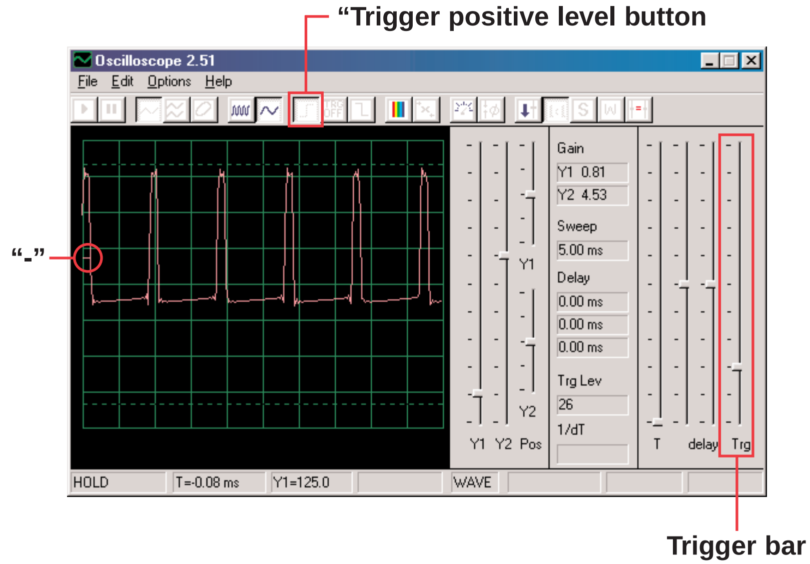
0.5ms/div button



With the time scale at 0.5ms/div and the adjustable resistor set for middle position, you should now have a picture similar to this one.

Your picture may appear different due to variations in the microphone input designs between computers. Although this is beyond software control, in some cases you may be able to compensate externally. See notes B and C on page 4 for details.

Notice that the waveform seems to be randomly dancing across the screen, making it hard to study. We can fix this. Click on the **“trigger positive level” button** and make sure the **trigger bar** is in the position shown here. Notice that a small **“-”** appears on the left of the display as you do so.

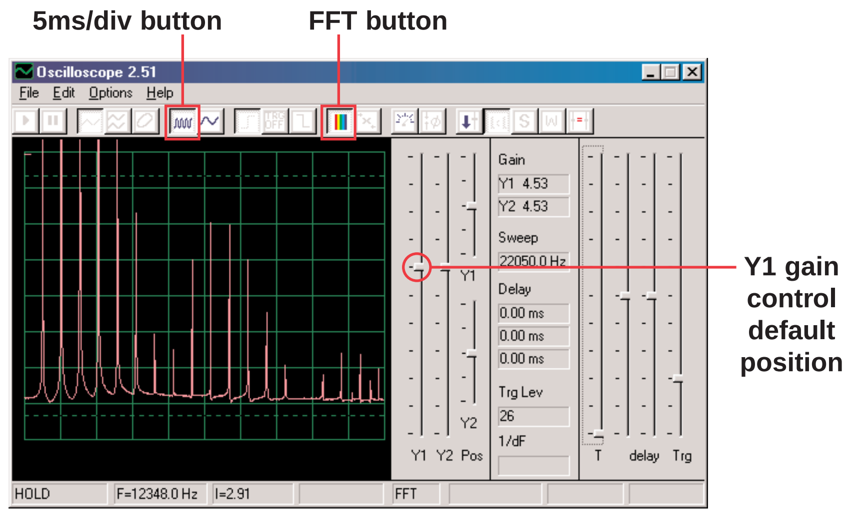


The small slash “-” represents the trigger voltage, when the signal reaches this voltage level it activates the display. This makes it easy to observe a stream of pulses like you have now, and also to record a single (non-repeating) pulse.

Move the adjustable resistor control (snap part RV) and watch how it changes the waveform on the computer screen. Now you can see how changing the adjustable resistor changes the time between the pulses, which changes the tone of the sound you hear.

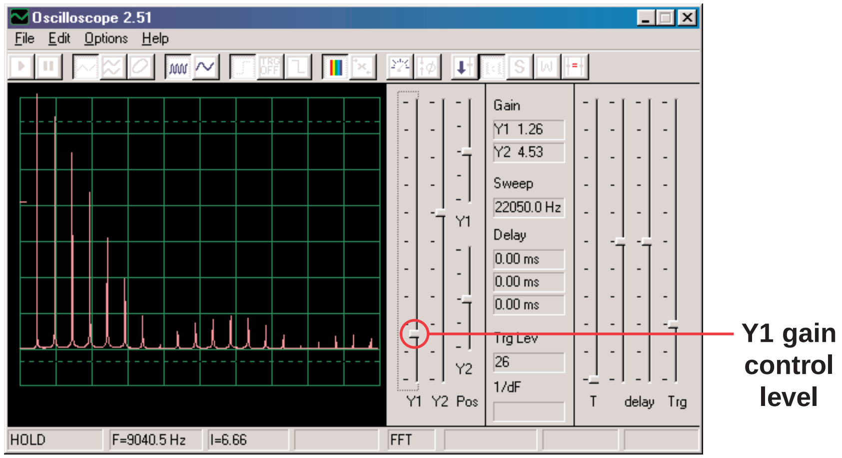
The waveform you see here is the voltage across the speaker, the peaks of the pulses occur when the transistors turn on and provide current to the speaker. Changing the amplitude of the peaks changes the loudness of the sound, changing their separation changes the tone or “pitch” of the sound. The time scale and trigger control features just described enable electronic engineers and technicians to see the relationship between parts of a waveform on their oscilloscope.

Now its time to look at your electronic signal in a different way. The oscilloscope features you have been using show you voltage (amplitude) vs. ***time***, now you will see voltage vs. ***frequency***. Engineers use expensive instruments called spectrum analyzers to do this, but Winscope uses a mathematical transformation called an FFT to do this. Set the Y1 gain control back to its **default position** for now. Click on the **5ms/div button** to display a wider range, then click on the **FFT button**. Your display should be similar to this:



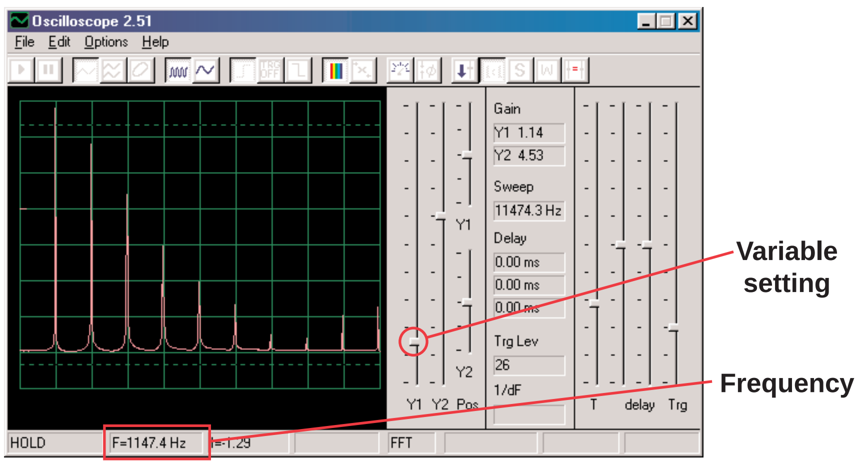
You are seeing the frequency spectrum of your signal, up to 22kHz. Notice that most of the energy is at the low frequencies (below 7kHz), and there is very little as you go higher.

The 1:1 gain mode does not apply to the FFT screen, so move the **Y1 gain control** down to here so you can see the peak energy at the low frequencies.



Move the adjustable resistor control (snap part RV) and watch how it changes the frequencies on the display.

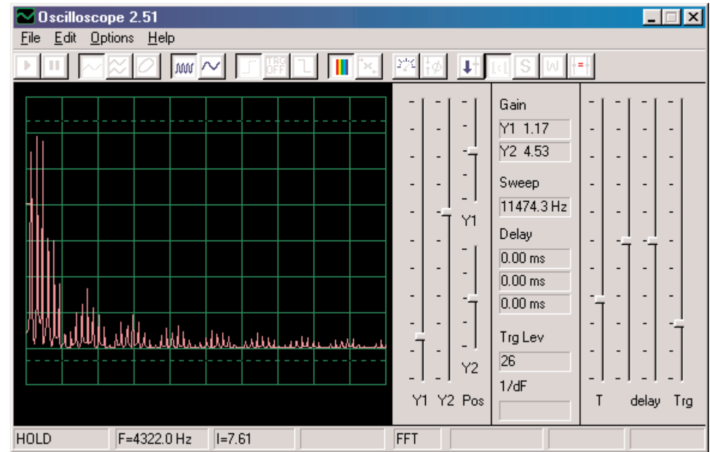
Set the adjustable resistor control (snap part RV) to mid-range. In addition to the 5ms/div and 0.5ms/div settings for the horizontal scale, there is also a **variable setting**. See if you can set it so that all the signal peaks line up with the grid lines, as shown.



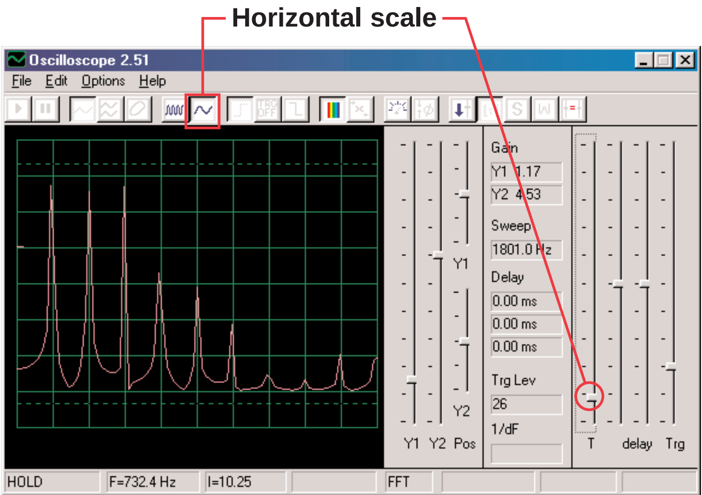
As you can see, all the peaks are equally spaced in frequency. Move your computer mouse directly over the first peak, the software displays the **frequency** you are pointing at. Move the mouse to the other peaks and you see they are multiples of the first frequency.

Now you can see that the tone you hear is actually a range of related frequencies combined together. The first peak is considered to be the main signal (and it is usually but not always the highest), the energy at all the other peaks determine the waveform of the signal you see on an oscilloscope.

Now modify your circuit by placing the 0.1μF capacitor (C2) on top of the 0.02μF capacitor (C1). By increasing circuit capacitance, you lower the oscillation frequency and your display should now look something like this:

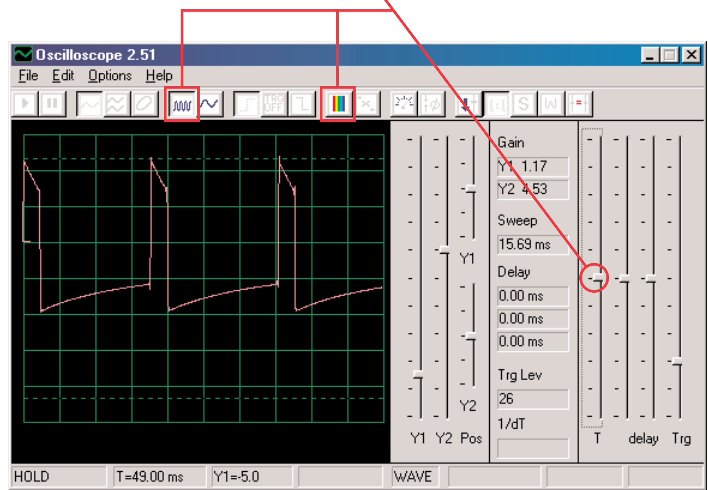


Now adjust the **horizontal scale** so the peaks line up with the gridlines as they did before.



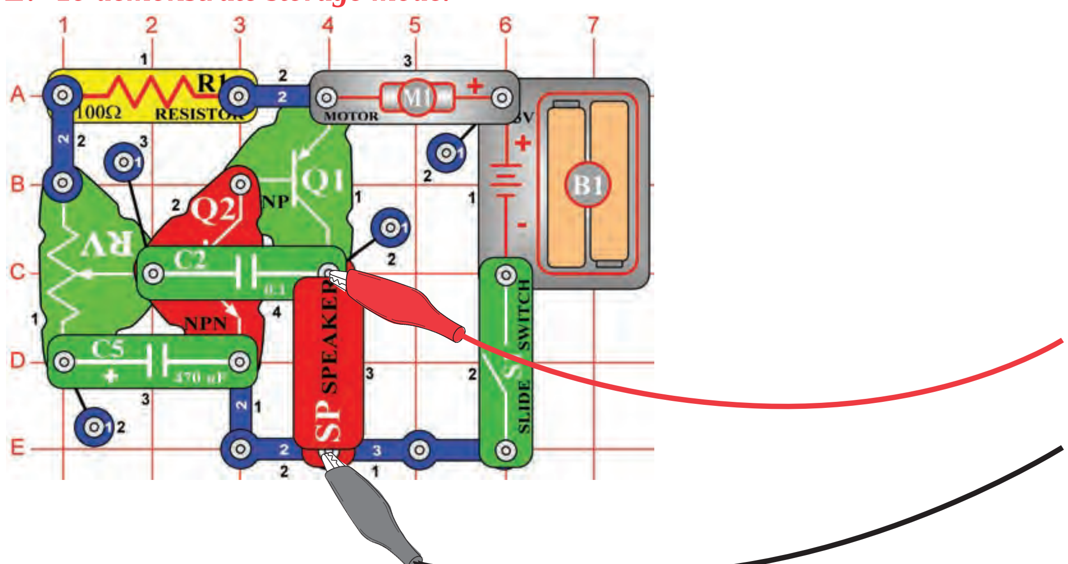
Notice that all the peaks went down in frequency by a corresponding amount and many changed in amplitude, that is why your ears hear a different sound. Notice also that in this case the left-most frequency peak no longer is the highest in voltage (your results may vary).

Now you can click on the FFT box to return to oscilloscope mode and look at the waveform with the 0.1μF capacitor in the circuit. You can observe it with the same settings as before for comparison, but these settings usually work best:



☐ Project #PC2 Screaming Fan PC

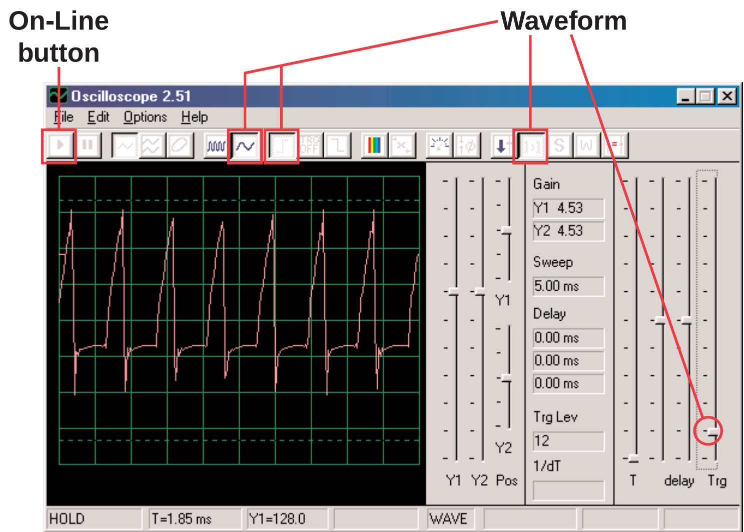
OBJECTIVE: To demonstrate storage mode.



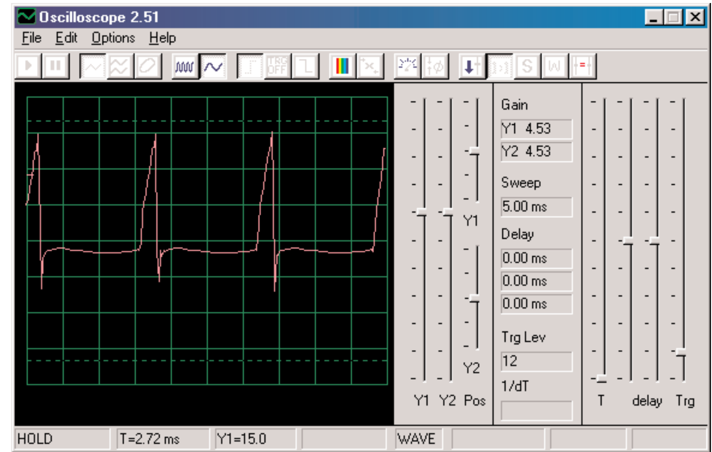
WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.

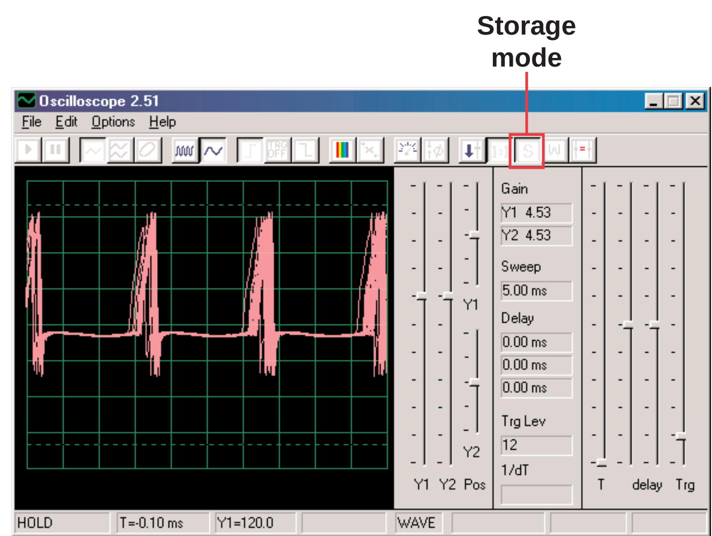
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the settings shown below, and move the lever on the adjustable resistor (snap part RV) around to change **the waveform** and the sound. A sample waveform is shown here, but the pattern and shape of the pulses depends on the adjustable resistor setting.



Winscope has a mode that can display multiple scans at the same time, called **Storage mode**. Set the adjustable resistor lever to a low-middle position, place Winscope in this mode, and watch the results.

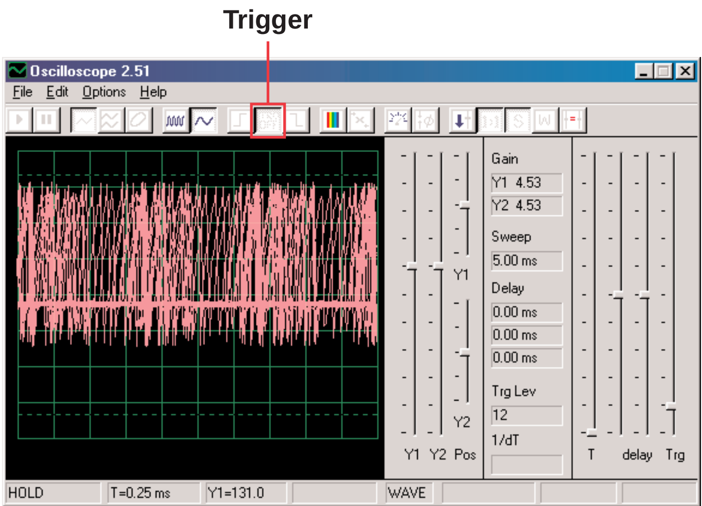


Without Storage Mode



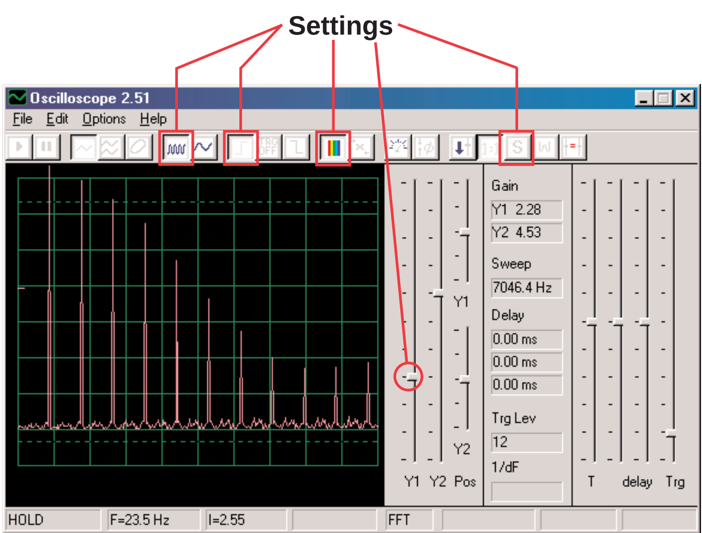
With Storage Mode

What you see here is the effect of timing variations on the trigger used for synchronization. Turn off the **trigger** and you will see how much variation there is without using the trigger:



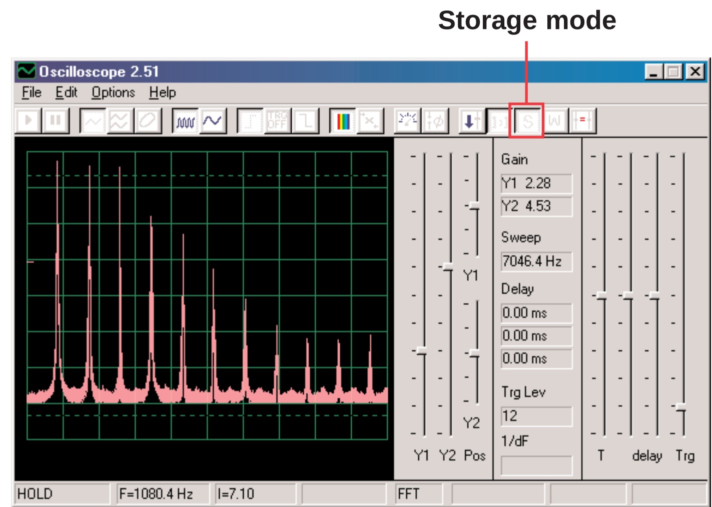
You can use Storage mode on any of the other circuit waveforms if desired.

Now turn off storage mode and turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



Moving the adjustable resistor lever will change the spectrum shown.

You can also use **storage mode** when in FFT mode, so turn it on now.

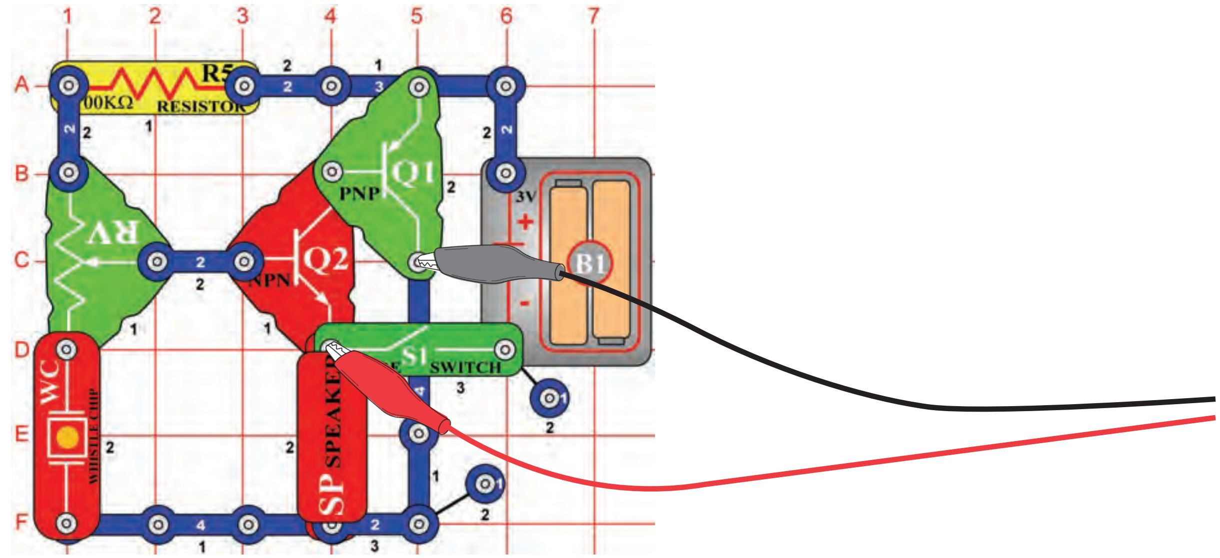


In this way you can show the peak energy achieved at each frequency. But this is only useful on a stable waveform, so if you move the adjustable resistor lever now the signal will fill the screen as the peaks move across the display.

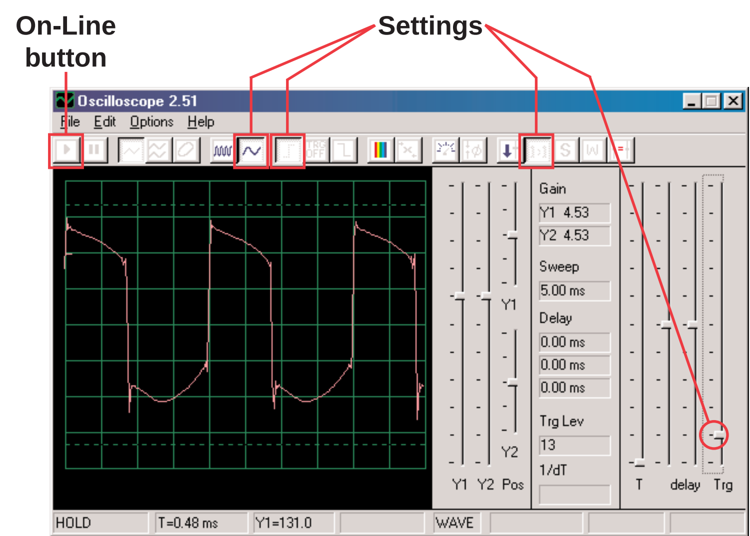
Most oscilloscopes and spectrum analyzers have a storage mode like this of some form.

Project #PC3 Hissing Foghorn PC

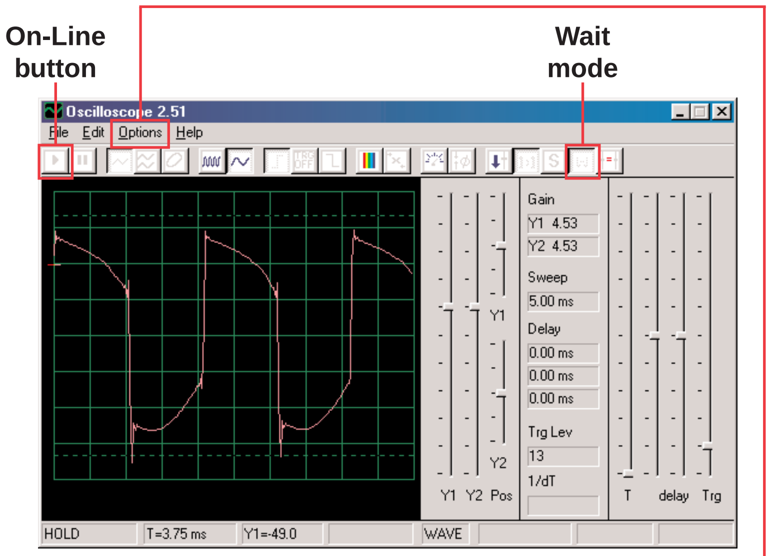
OBJECTIVE: To demonstrate wait mode with multiple colors.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown on the right, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown here, but the pattern and shape of the pulses depends on the adjustable resistor setting.



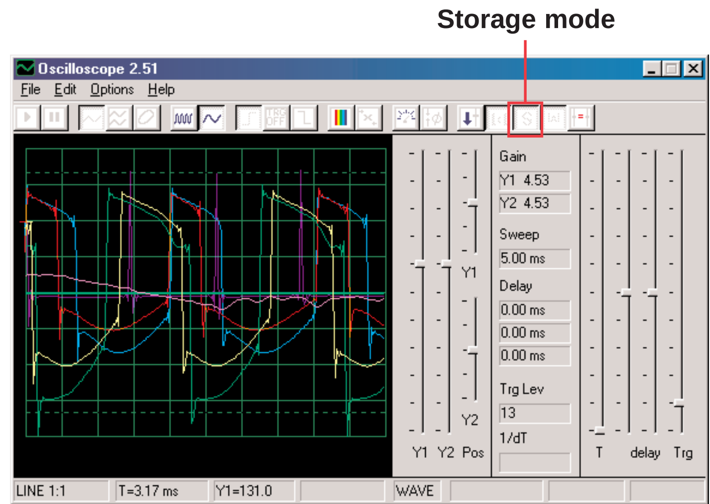
Place Winscope in **Wait mode** by clicking on the button for it, then slowly press the **On-Line button** several times. Now turn off the slide switch (snap part S1) and press On-Line again. Then turn the switch back on. You see that in Wait mode Winscope scans ("waits") until it sees a waveform that exceeds the trigger level you set, then stops. With a strong signal it will make one scan and then stop, whereas if no signal is present it keeps scanning until it finds one. You could use this to sense when someone has turned on the circuit.



You can change the color of the waveform: select **<Options>**, then select <Colors>, then select <Y1 Trace>. Now select the color you like and click <OK>.

Now we will combine the wait and storage modes to display several waveforms that this circuit can create. You should have the circuit on with the adjustable resistor at mid-range and Winscope in Wait mode. Now turn on **Storage mode**. Now change the color of the Y1 trace. Move the adjustable resistor control lever a little, then press On-Line once to record another waveform. Now change the color of Y1 again. Move the resistance control again and press On-Line once. Change the Y1 color, adjust the resistance and press On-Line. Change the Y1 color, adjust the resistance and press On-Line. Do this several more times if you like. Note that at some resistance settings there may be no waveform to trigger on, move the resistance control until it does.

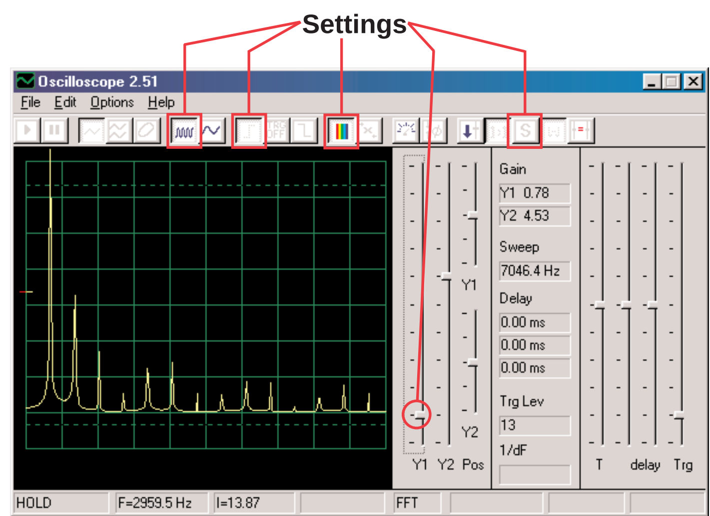
Now your display should look something like this:



Now you see the range of waveforms this circuit can create, all at the same time. Engineers often do this to compare signals during analysis.

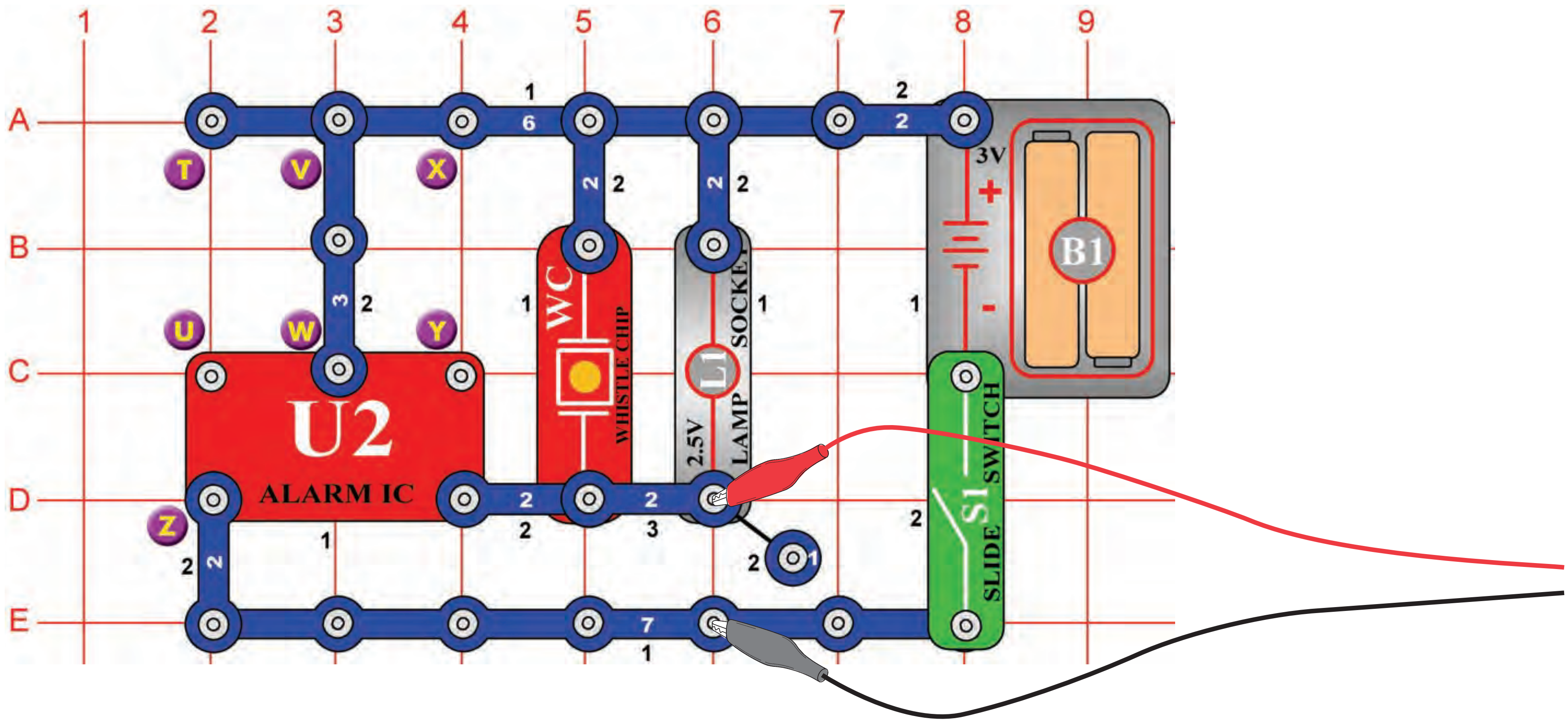
You can use Wait mode and different colors like this on the other circuits if you like.

Now turn off storage mode and turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. Wait mode does not apply in FFT mode, so it has no effect here. Moving the adjustable resistor lever will change the spectrum shown.



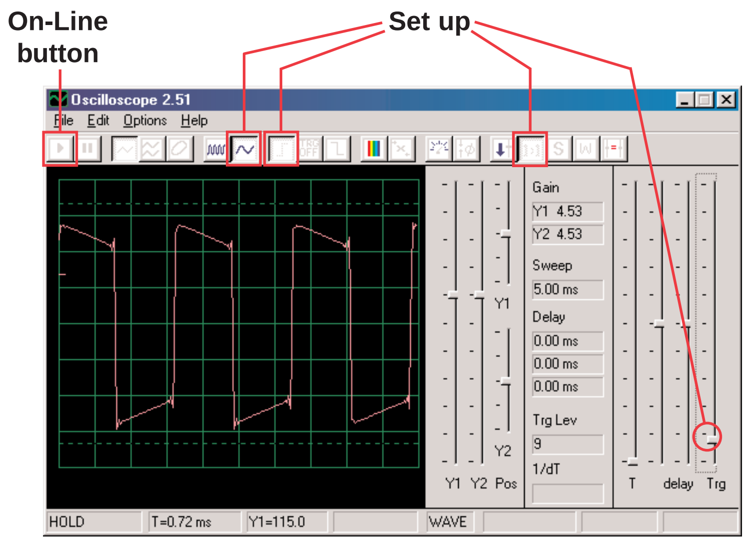
Project #PC4 Light & Sounds PC

OBJECTIVE: To look at the output signal from a circuit that makes alarm sounds.



Build the circuit and connect the Winscope PC-interface cable as shown, the cable should still be connected to the microphone input on your computer.

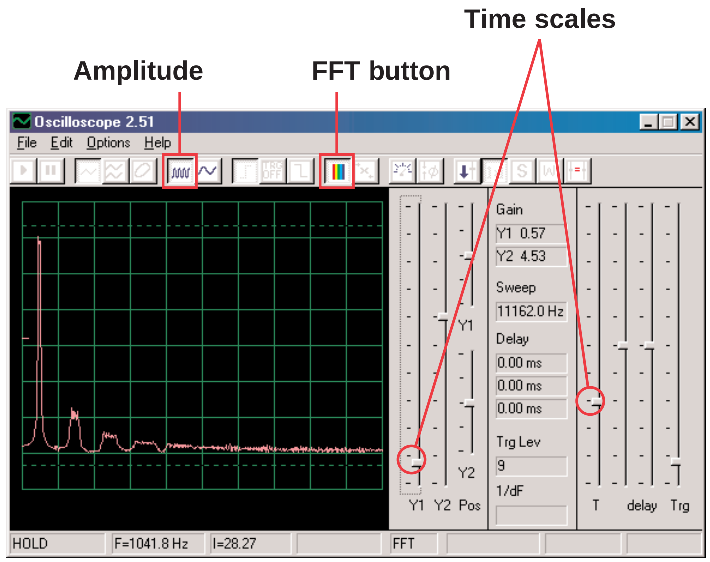
If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to **set it up** as shown here, and turn on the switch (snap part S1). Click on the **On-Line button** to activate.



You should see a waveform similar to that shown here, but it will be constantly changing. This is because the siren sound you hear is not a continuous tone but instead is constantly changing. Note the differences in the waveshape for this circuit compared to the circuit in Project PC1.

Your picture may appear different due to variations in the microphone input designs between computers. See the notes on page 4 for details.

Click on the **FFT button** to look at the frequency spectrum. Also set the **amplitude** and **time scales** (really amplitude and frequency scales in FFT mode) to be as shown here.



You should see a fuzzy spectrum similar to that shown here, but it will be constantly changing. This is because the siren sound you hear is not a continuous tone but instead is constantly changing frequency, and it spends more time at some frequencies than at others. Note the differences in the spectrum for this circuit compared to the circuit in Project PC1.

☐ Project #PC5

Light & Sounds PC (II)

Modify the circuit for project PC4 by connecting points X and Y on the snap diagram. Now the sound is a machine gun, it shuts off between bursts.

Look at the waveform and frequency spectrum using the same settings as for project PC4, and compare them to those for the siren.

☐ Project #PC6

Light & Sounds PC (III)

Modify the circuit by removing the connection between X and Y and then make a connection between T and U. It makes a fire engine sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. The waveform slowly rises and falls in pitch, and gives a clear spectrum that slowly rises and falls in frequency.

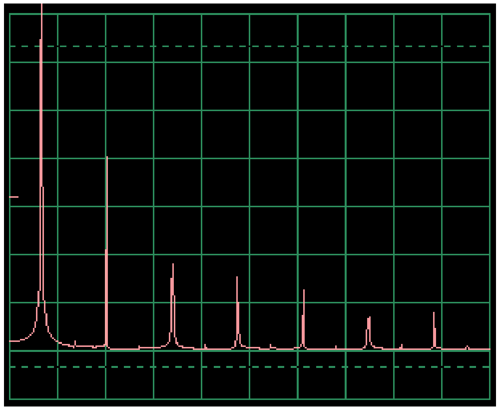
☐ Project #PC7

Light & Sounds PC (IV)

Remove the connection between T and U and then make a connection between U and Z. It makes an ambulance sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. It alternates between two frequencies.

Sample Frequency Spectrum



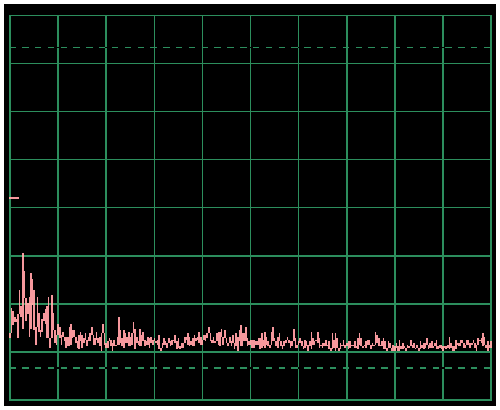
☐ Project #PC8

Light & Sounds PC (V)

Remove the connections between U and Z and between V and W, then make a connection between T and U. It makes a water faucet sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. This sound is different from the others and seems to have little or no pattern.

Sample Frequency Spectrum



Project #PC9

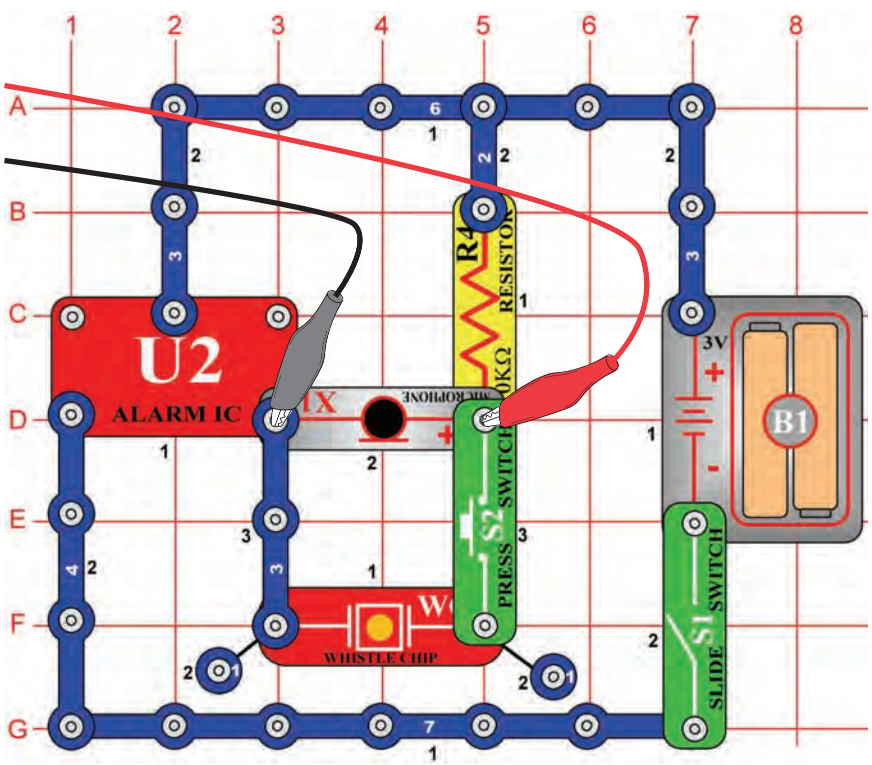
Light & Sounds PC (VI)

Look at the waveform in oscilloscope mode using the same settings as earlier in PC4. Replace the whistle chip with the speaker and remove the lamp. Compare the waveform you see now with that from the whistle chip. The amplitude of the waveforms are similar but yet the sound from the speaker is much louder, since the speaker is drawing more current.

Project #PC10

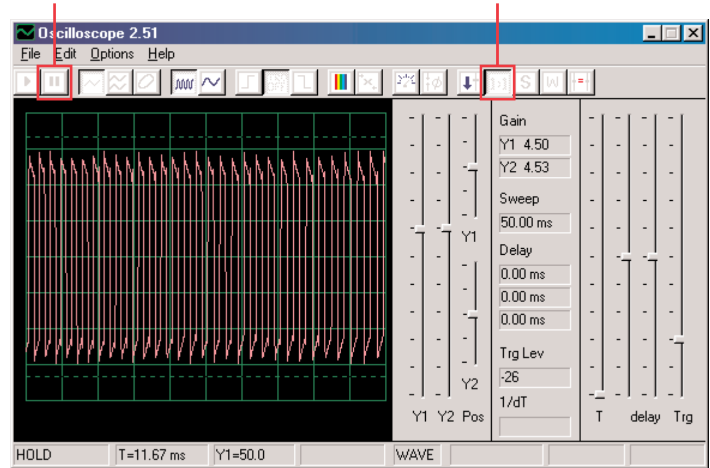
Modulation

OBJECTIVE: To demonstrate AM and FM modulation.

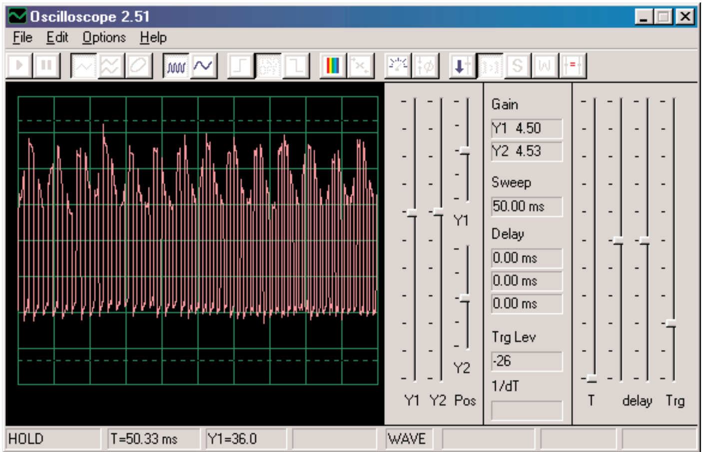


Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). If you press the key (snap part S2) then you will hear a siren sound, but it will not be very loud. Click on the **1:1 button** to set the gain automatically, then talk or hum into the microphone (snap part X1) and observe how the waveform changes. You may freeze the waveform by pressing the **Hold button** if desired.

Hold button **1:1 button**

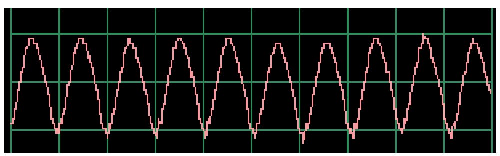


When you are quiet you just get a stream of pulses with roughly equal height and width, as shown at left.

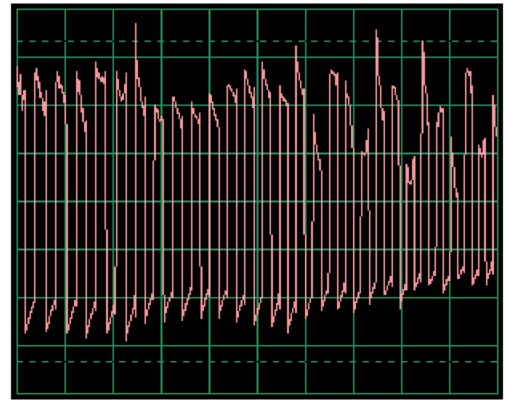


The waveform shown here is from humming into the microphone, notice how the tops of the pulses show a regular pattern of dips now.

Look ahead to the Microphone project PC14 on page ??, and note the waveform shown there for humming into the microphone:



Notice that you can see roughly the same pattern in the peaks of the waveform at left. If you hum at a similar tone and at a similar distance from the microphone, you will get similar results.



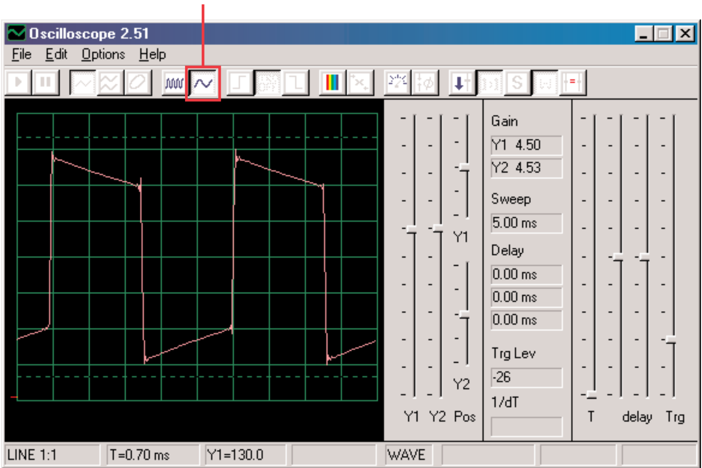
If you talk into the microphone now you will get different patterns depending on what words you say, how loudly you say them, and your distance from the microphone. Words produce a more “random” pattern than humming, but less random than blowing into the microphone. The waveform at left is an example of talking into the microphone. Observe the waveforms you get and compare with what you get in project PC14.

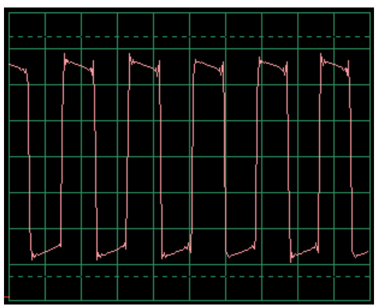
And so you see that your voice is being superimposed onto the peaks of the stream of pulses, this is called **Amplitude Modulation** or **AM**. At AM radio stations music or voice is superimposed on a high frequency waveform (similar to the pulse stream here), filtered, amplified, and transmitted. Doing this allows the music to be transmitted over great distances.

You can place Winscope into FFT mode to view the frequency spectrum if you like, but it will be confusing to look at.

You probably noticed that the width of the pulses in the pulse stream is constantly changing, that is because there is actually a second type of modulation occurring here. Press the key again and you hear a siren. A siren is not a stable tone but rather is constantly changing in frequency. Change the **time scale** to 0.5ms/div and observe the range of waveforms:

Time scale



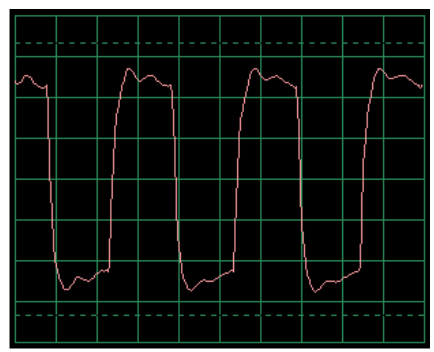


The width of the pulses (or frequency of the signal) is slowly being changed, at a regular and repetitive rate. This is an example of **Frequency Modulation**, or **FM**. In AM you use a controlling signal (voice or music) to vary the amplitude of a second signal, in FM you use the controlling signal to vary the frequency of the other signal. In this circuit the output frequency from the alarm IC is being controlled by a signal created inside the alarm IC, but it could have been controlled by humming like you did for the AM (you don't have the parts needed to do this).

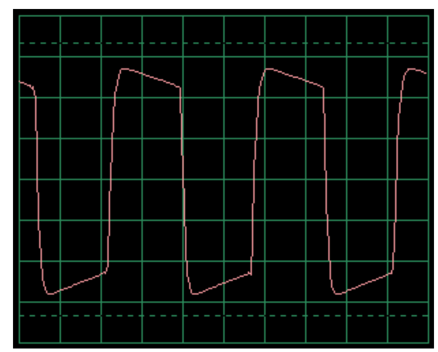
Look back at the Light & Sounds project PC4 on page 16. It shows several different ways of configuring the alarm IC to make different sounds, all of these are examples of frequency modulation using different controlling signals created within the alarm IC. It also shows examples of the frequency spectrum.

☐ Project #PC11
Filtering

With the same circuit as PC10 and the same settings as shown at the end of PC10, look at the waveform again and then press the key. Notice how the pulses become more "rounded" when the key is pressed. The whistle chip (snap part WC) has capacitance that filters or smoothes the output signal. Now replace the whistle chip with the 0.02μF capacitor (snap part C1) and it should look similar though you won't hear any sound. You can also look at the frequency spectrum in FFT mode like in the other projects.



Typical waveform using whistle chip

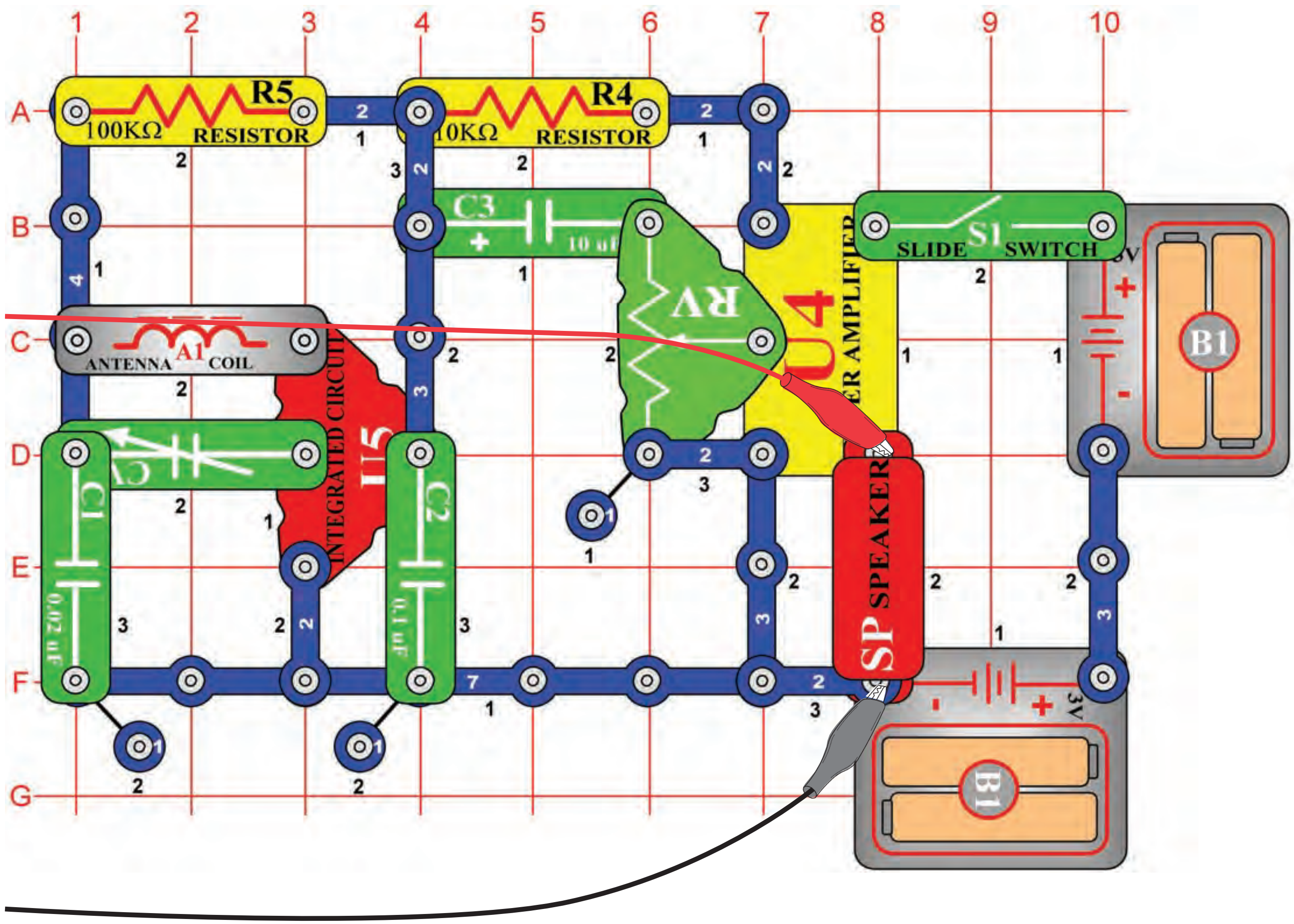


Typical waveform using 0.02μF capacitor

☐

Project #PC12
AM Radio PC

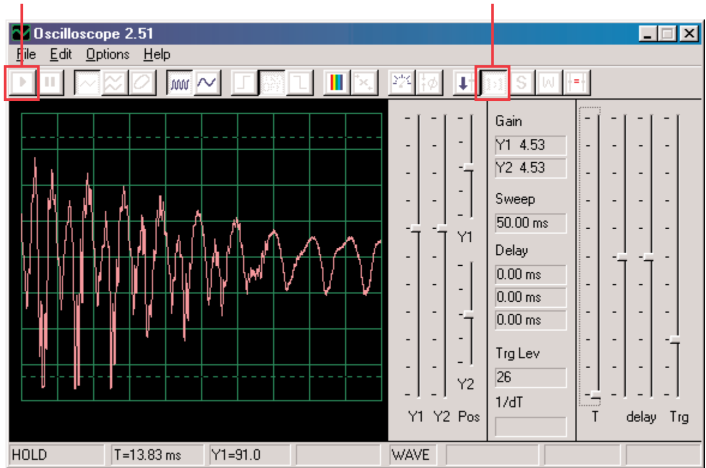
OBJECTIVE: To look at the output signal from an AM radio.



Build the circuit shown and connect the PC-interface cable to the microphone input on your computer. Turn on the slide switch (snap part S1), tune the variable capacitor (snap part CV) to a local radio station that gives good reception, and set the adjustable resistor (snap part RV) to a comfortable volume. The integrated circuit (snap part U5) detects and amplifies the AM radio waves all around you. The power amplifier IC (snap part U4) drives the speaker (snap part SP) to complete the circuit.

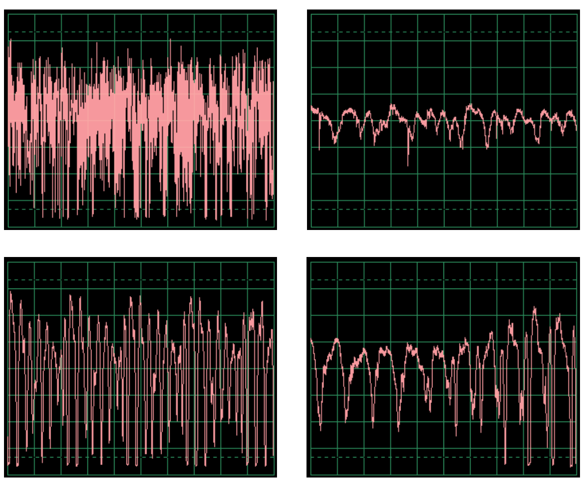
In this project you will study the audio signal at the radio's output to the speaker. The actual AM radio transmission is at high frequencies that cannot be viewed using Winscope.

If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to set the scale to **1:1 mode**. Click on the **On-Line button** to activate.

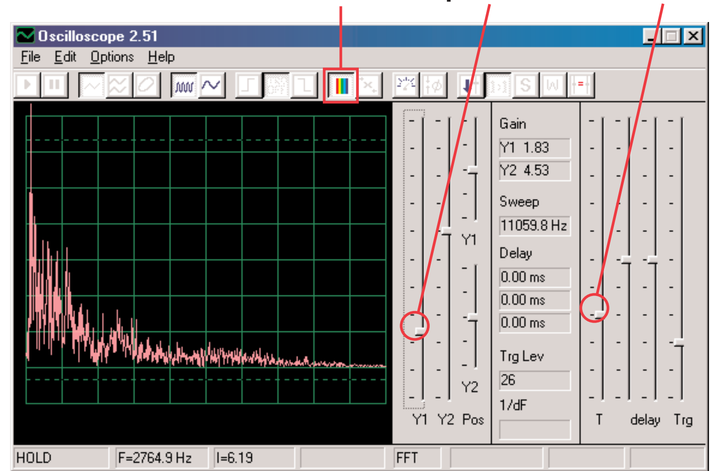


You should see a waveform similar to that shown here, but it will be constantly changing as the music or talking you hear is changing. Try tuning the adjustable capacitor (snap part CV) to different radio stations and compare the waveforms.

This shows you what talking or music look like in electrical form. Every word that every person says looks different, though there are many patterns. The waveform will be fuzzier if there is lots of static on the station. Here are some other examples of talking and music using the same settings above:

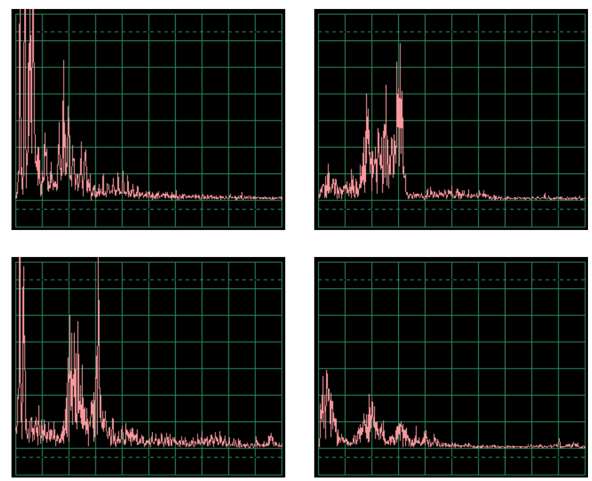


Click on the **FFT button** to look at the frequency spectrum. Set the **time scale** (really frequency scale in FFT mode) and **amplitude scale** to be as shown here.



You should see a spectrum similar to that shown here, but it will be constantly changing as the music or talking you hear is changing. Try tuning the adjustable capacitor (snap part CV) to different radio stations and compare the waveforms.

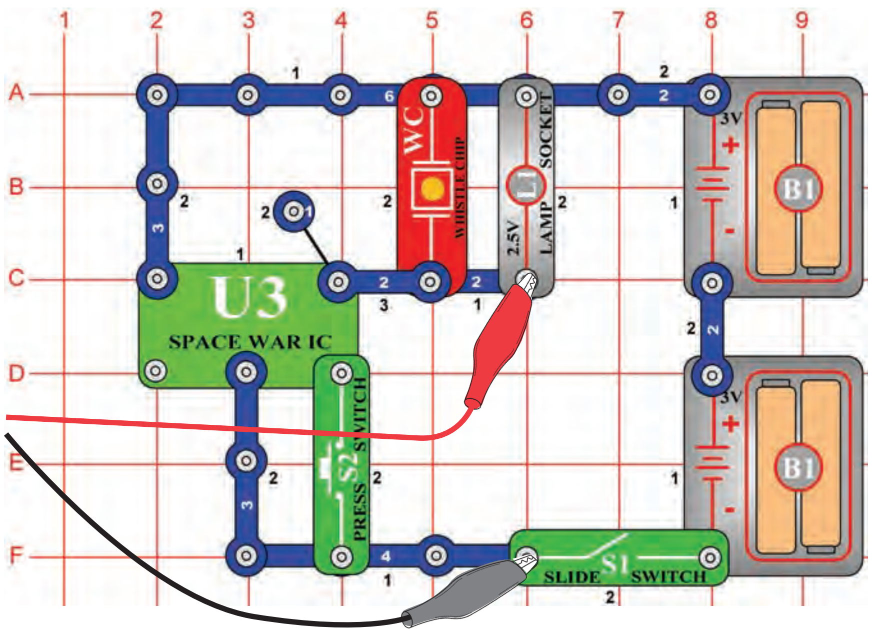
This shows you the frequency spectrum of talking or music. Every word that every person says looks different, though there are many patterns. The spectrum will be fuzzier if there is lots of static on the station. Here are some other examples of talking and music using the same settings above:



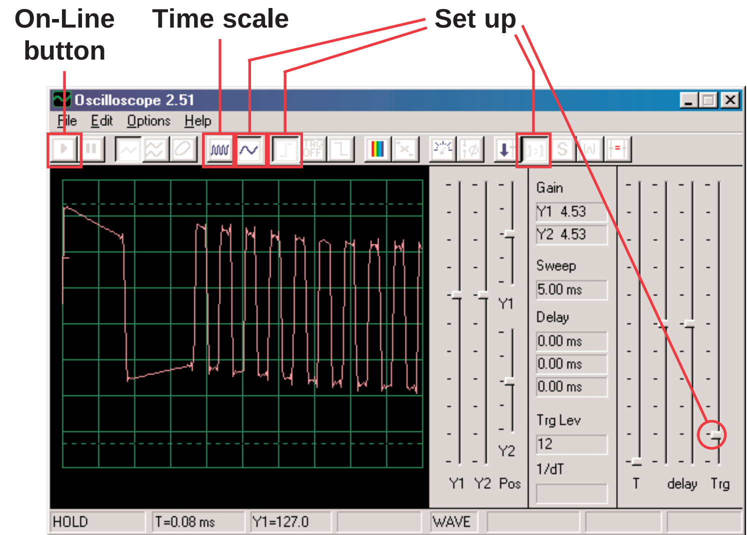
☐ Project #PC13
Space War PC

OBJECTIVE: To look at the output signal from a circuit that makes space war sounds.

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer.

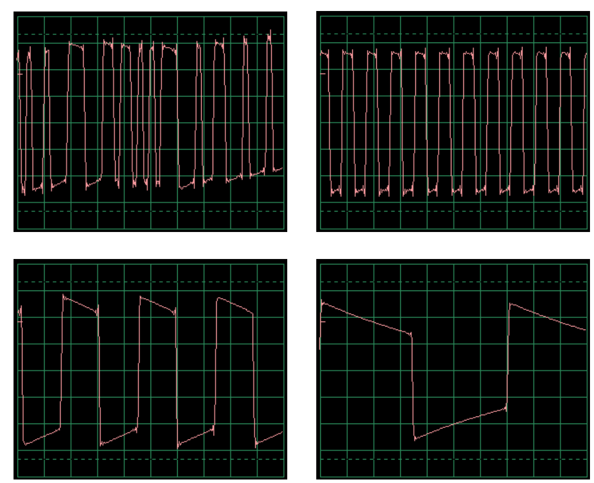


If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to **set it up** as shown here, and turn on the switch (snap part S1). Click on the **On-Line button** to activate.

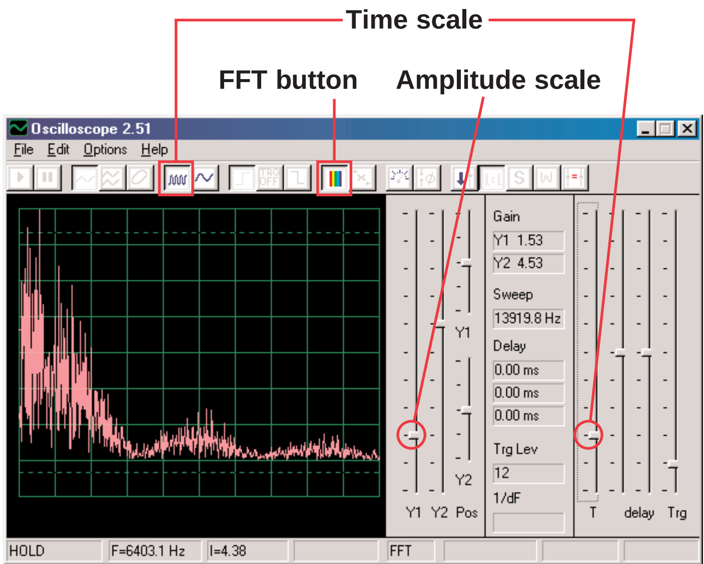


Press the press switch (snap part S2) several times to step through the eight different sounds from the space war integrated circuit. Hold it down for a few seconds each time so you can see the waveform representing the sound you hear.

It is also interesting to switch to the **5ms/div time scale** setting to see more of the waveform at one time. Here are some example waveforms using the same settings as above:

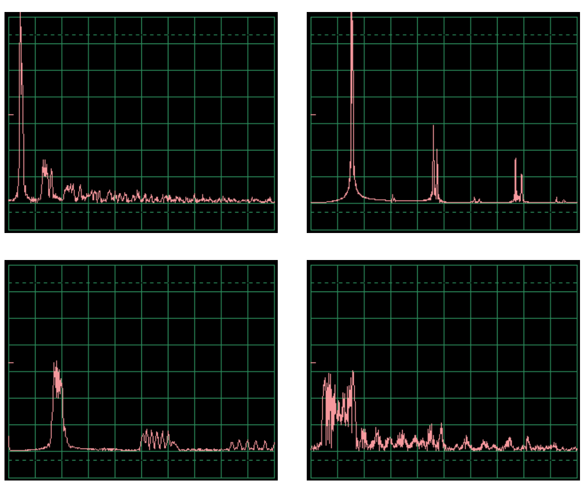


Click on the **FFT button** to look at the frequency spectrum for these signals. For best viewing set the **amplitude** and **time scales** (really amplitude and frequency scales in FFT mode) to be as shown here.



Press the press switch (snap part S2) several times to step through the eight different sounds from the space war integrated circuit. Hold it down for a few seconds each time so you can see the frequency spectrum representing the sound you hear.

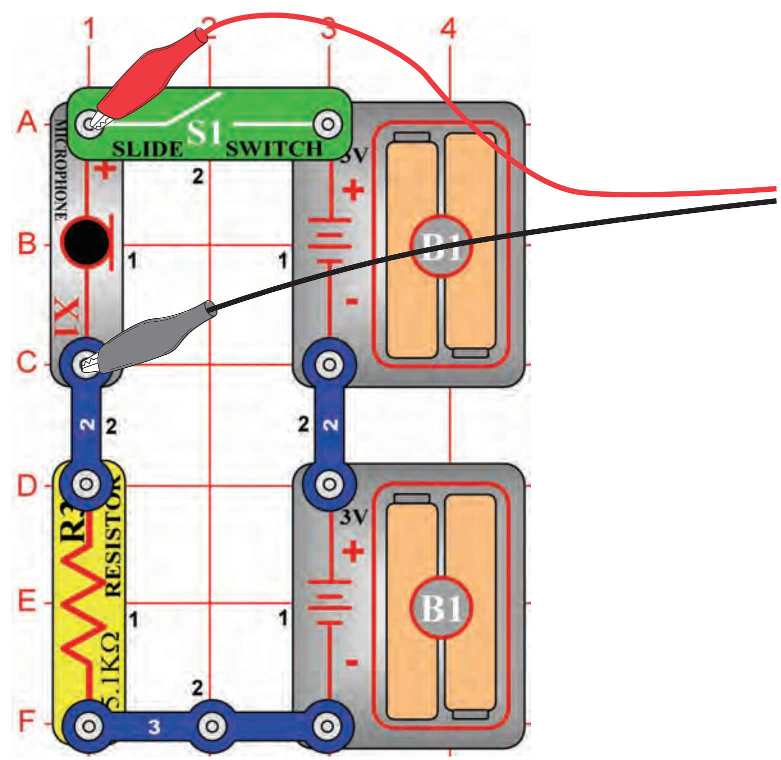
Here are sample spectrums from some of the other sounds using the same settings as above:



Project #PC14 Microphone

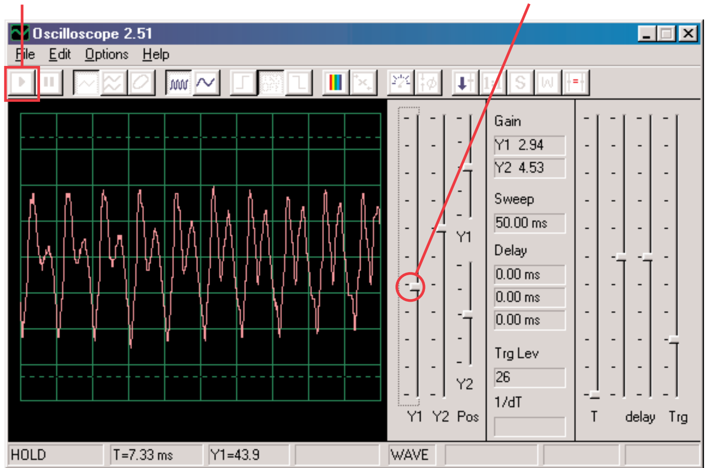
***OBJECTIVE:** To see what your voice looks like in electrical form.*

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer.



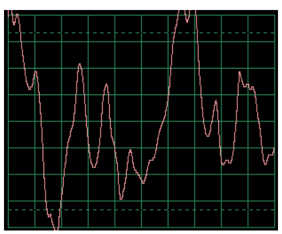
If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate Winscope, and turn on the switch (snap part S1).

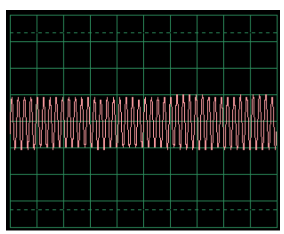
On-Line button **Y1 gain control**

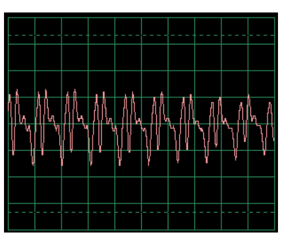


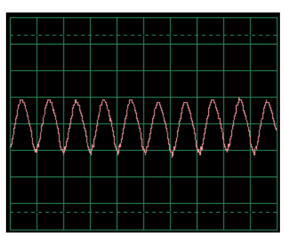
Talk into the microphone (snap part X1) and see what your voice looks like after the microphone converts it to electrical energy. Adjust the **Y1 gain control** to get the best view of it, since the amplitude is greater if you talk louder or are closer to the microphone. Notice how the waveform is different depending on which words or tones you say.

Here are some example waveforms using the same settings as above. Try not to blow on the microphone while you talk into it.


Blowing into microphone

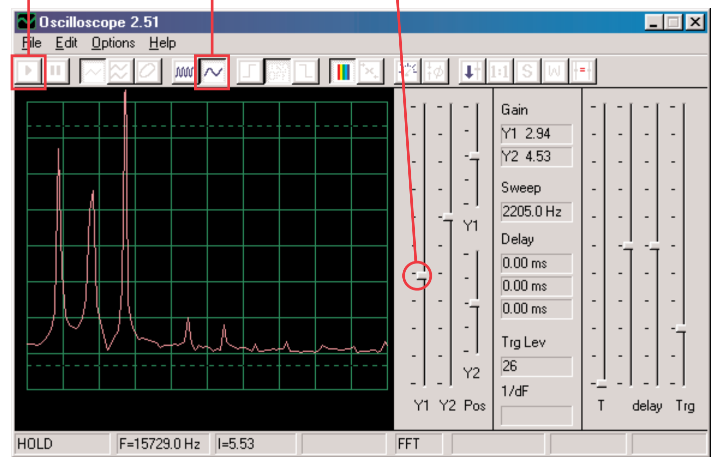

Whistling into microphone


Ahhhhhh sound


Humming into microphone

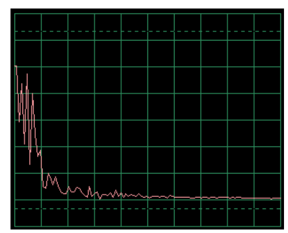
Click on the **FFT button** to look at the frequency spectrum for these signals. Try the **amplitude** and **time scales** shown here to start, but your best settings will depend on what sounds you make, how loud you speak, and how close you are to the microphone.

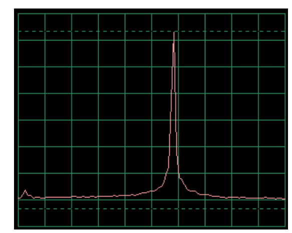
On-Line button **Amplitude and time scales**

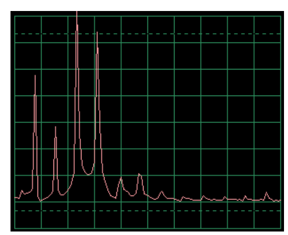


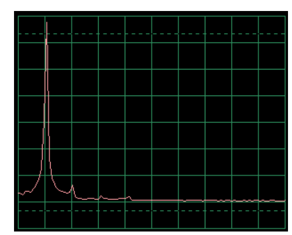
Notice that most women have higher-frequency voices than most men, and so their frequency peaks are further to the right on your display.

Here are some example waveforms using the same settings as above:


Blowing into microphone


Whistling into microphone


Ahhhhhh sound

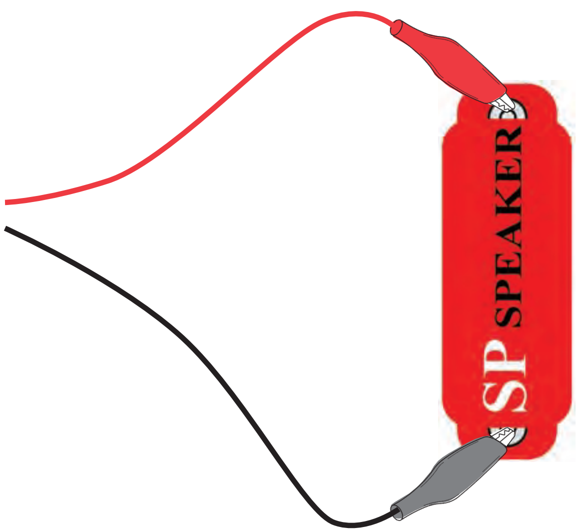

Humming into microphone

The above frequency spectrum pictures correspond directly to the waveform pictures on the preceding page. Notice that the spectrums for the hum and whistle have only a single big peak. Smooth, well-rounded, and repetitive waveforms (in oscilloscope mode) have nearly all of their energy at a specific frequency like for the hum. “Square” or “rectangular” looking waveforms (like in Project PC1) and most music have a series of mathematically-related peaks, while “random” waveforms (like from blowing into the microphone or several people talking at the same time) have a frequency “blob” instead of distinct peaks.

☐ Project #PC15

Speaker Microphone

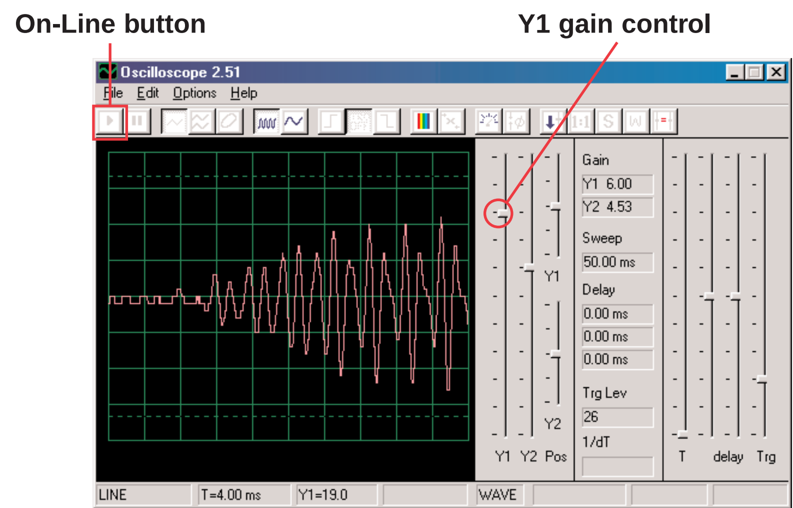
OBJECTIVE: To see what your voice looks like in electrical form.



A speaker uses electrical energy to create mechanical vibrations. These vibrations create variations in air pressure, called sound waves, which travel across the room. You “hear” sound when your ears feel these air pressure variations. But if air pressure variations reach the speaker from another source, they will cause it to vibrate too. This, in turn, causes the speaker to create a small electrical signal just like a microphone does (though not very efficiently, since speakers were not designed to be microphones).

Connect the PC-interface cable directly onto the speaker as shown; no other parts are needed here. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate.

Hold the speaker next to your mouth and talk into it to see what your voice looks like after the speaker converts it to electrical energy. Adjust the **Y1 gain control** to get the best view of it.



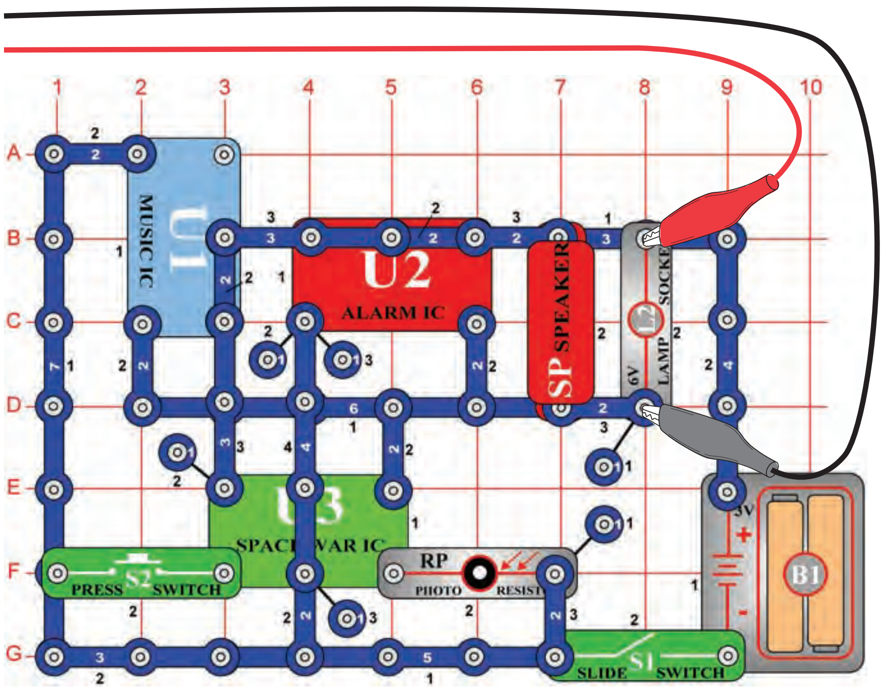
Notice that you need to set the gain control higher here than in the preceding project using the microphone, since speakers were not designed to be used in the same way.

You may switch to FFT mode and view the frequency spectrum in the same manner as for the microphone project PC14.

☐ Project #PC16

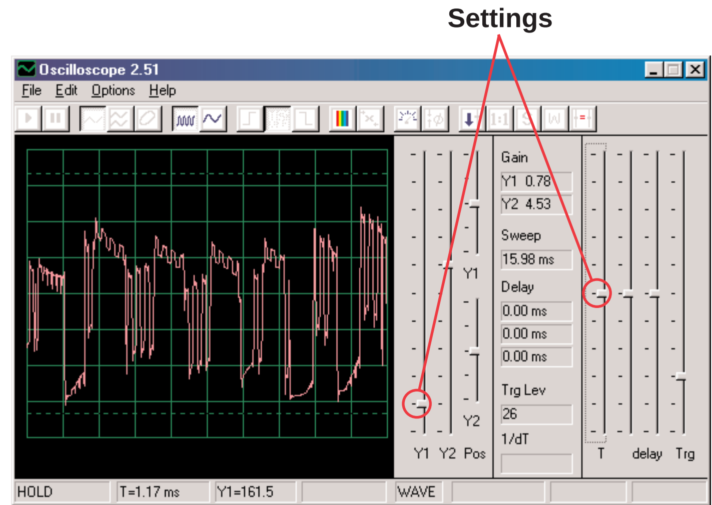
Symphony of Sounds PC

OBJECTIVE: To see the waveforms for a complex signal.

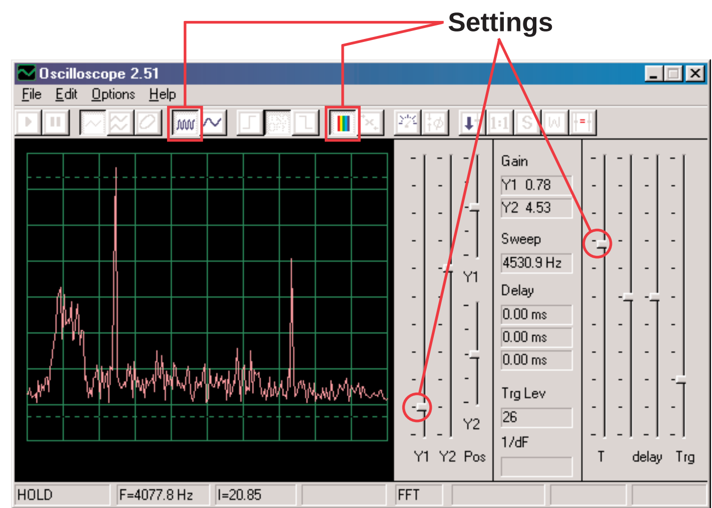


The Symphony of Sounds project combines waveforms from the Music, Alarm, and Space War integrated circuits. Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). Press the press switch (S2) and wave your hand over the photosensitive resistor (RP).

Due to the combination of sounds, the waveform is complex. Set Winscope to the **settings** shown, or as you prefer.



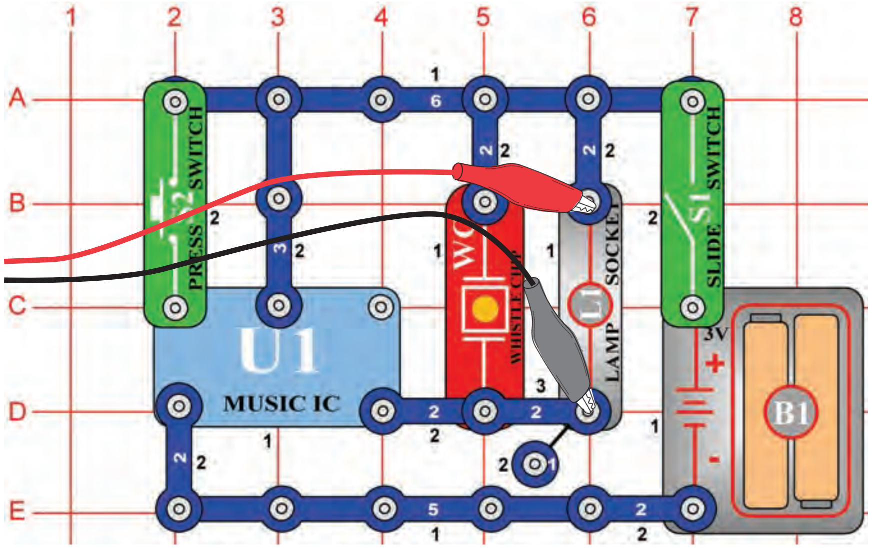
Click on the FFT button to look at the frequency spectrum for the signal. Try the **settings** shown here, or as you prefer.



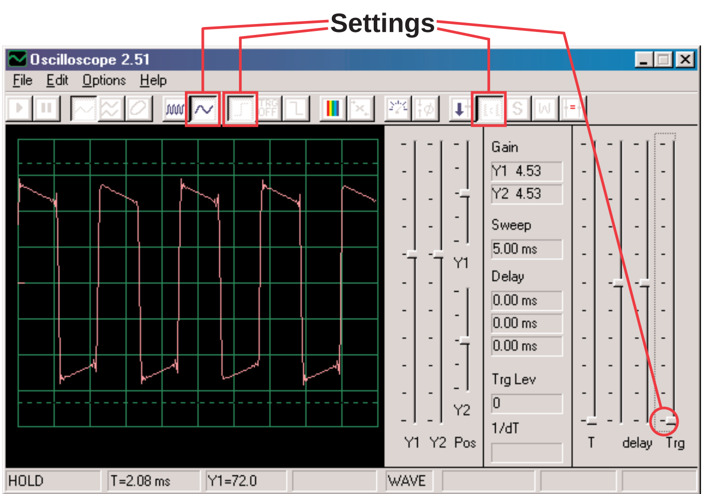
Project #PC17

Doorbell PC

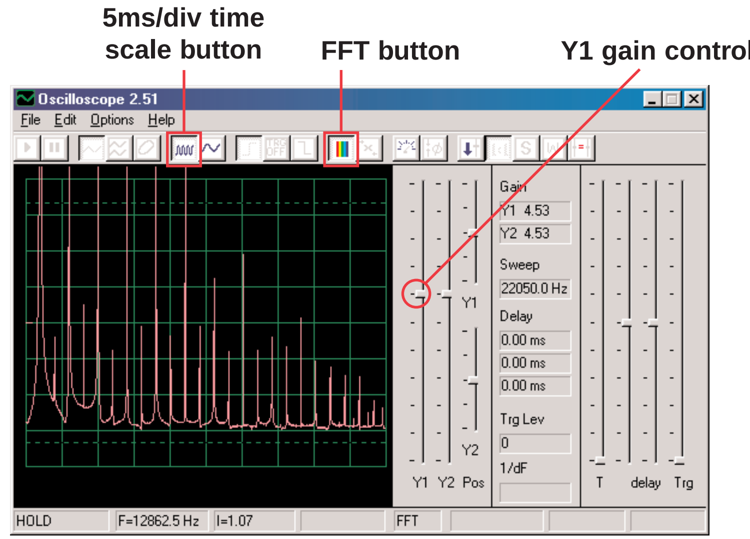
OBJECTIVE: To look at the output of a musical circuit.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Try the **settings** shown here. When the music stops, press the press switch (part S2) and it will resume.



Click on the **5ms/div time scale button** and on the **FFT button** to look at the frequency spectrum for the signal. The Y1 gain control is set for high gain now, so the higher peaks are off the screen but lots of the lower peaks are visible.

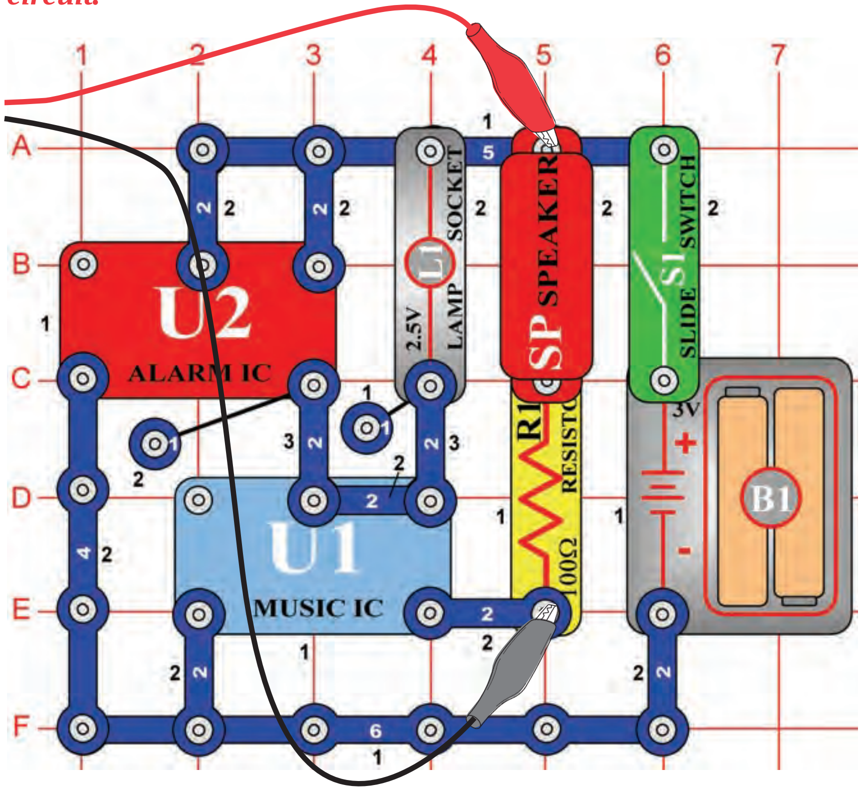


Note that the sound is music and the oscilloscope waveform has a "square" shape, as a result the frequency spectrum has a lot of peaks with equal spacing.

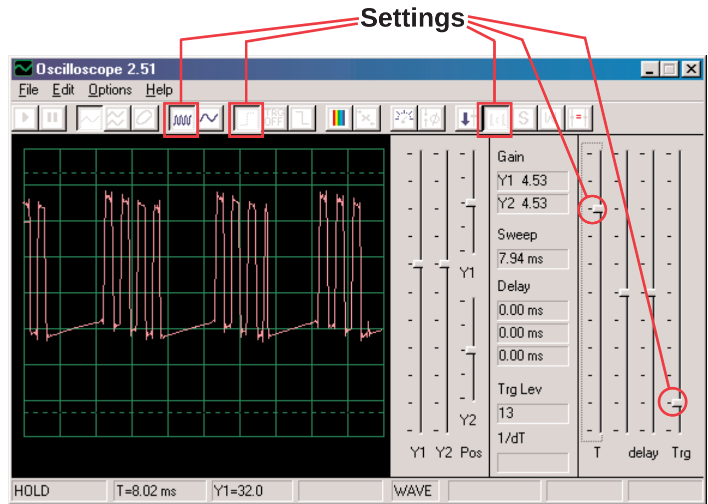
Now adjust the **gain** lower until you see the higher peaks.

Project #PC18
Periodic Sounds PC

OBJECTIVE: To look at the output of an alternately changing circuit.



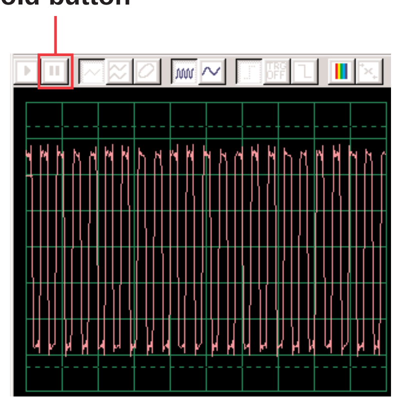
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Try the **settings** shown here.



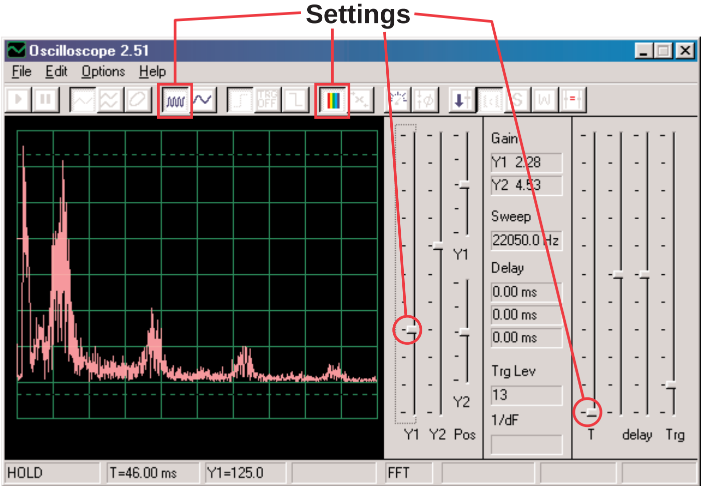
The oscilloscope display alternates between 2 waveforms, the one shown here and the one on the next page. This one shows some pulses followed by a flat signal, then more pulses, then flat, then pulses, then flat . . .

This is the second oscilloscope waveform, using the same settings. It is a continuous series of pulses. You can use the **Hold button** to freeze the display for easier viewing.

Hold button

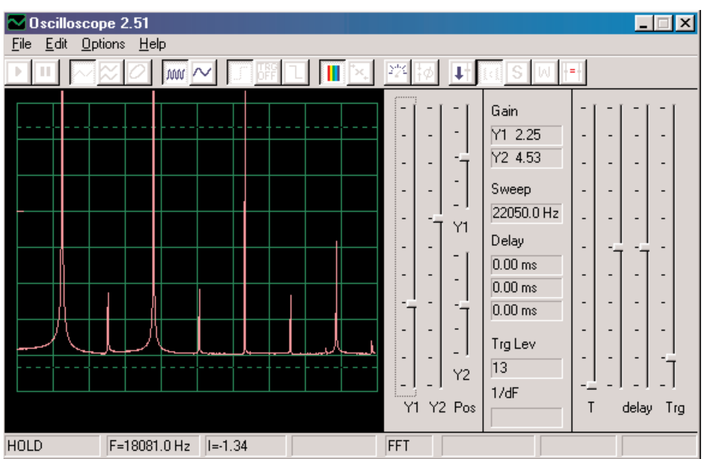


Now change to FFT mode to look at the frequency spectrums corresponding to the 2 waveforms above. Try the **settings** shown here.



This is the spectrum for the oscilloscope waveform shown on the preceding page, which alternates between pulses and flat. Because of the transition between pulses and flat, the spectrum is the irregular shape shown here.

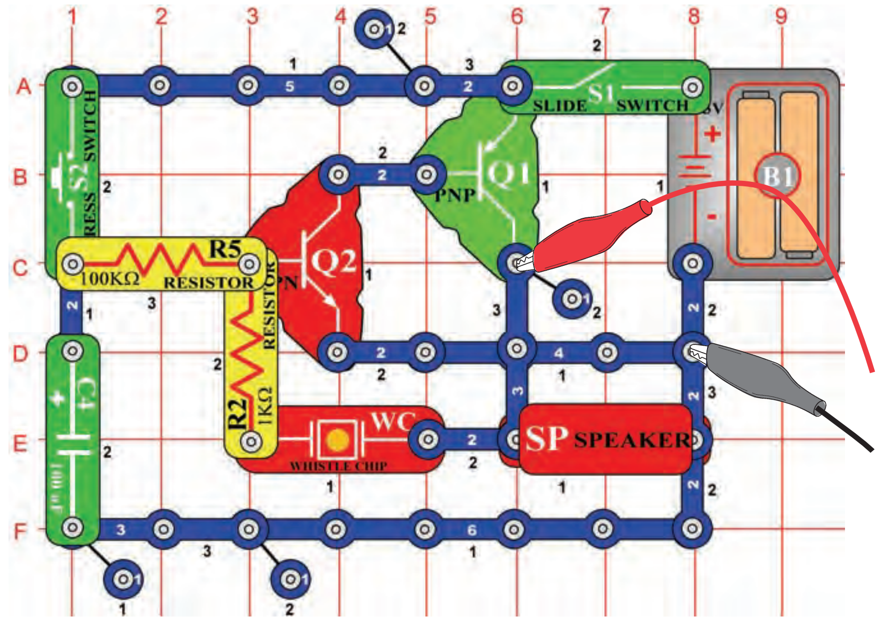
This is the spectrum for the oscilloscope waveform shown at the top of this page, which has a continuous series of pulses. There are only pulses there, with no transition between pulses and flat. Hence the frequency spectrum is very "clean", with the energy concentrated at a few tall peaks instead of being spread out like in the other spectrum display.



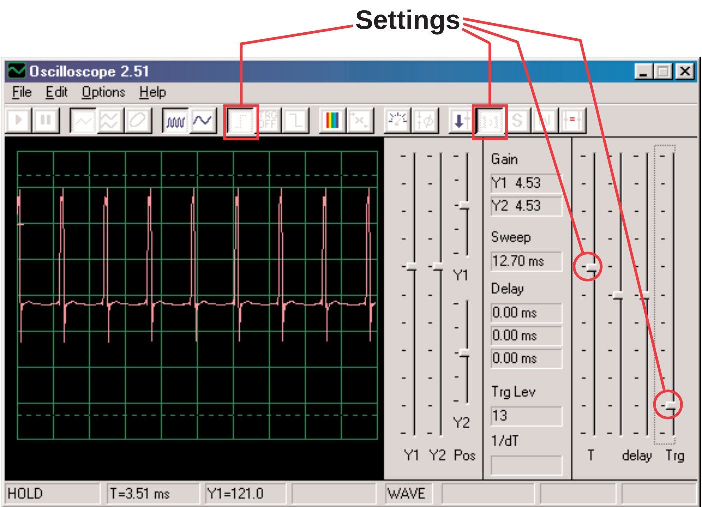
☐ Project #PC19

Lasting Doorbell PC

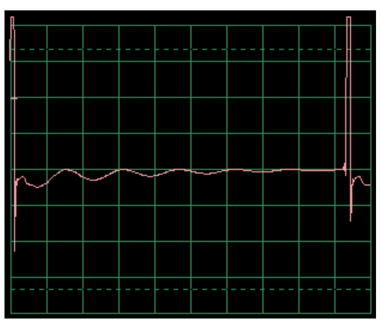
***OBJECTIVE:** To look at the output of an alternately changing circuit.*



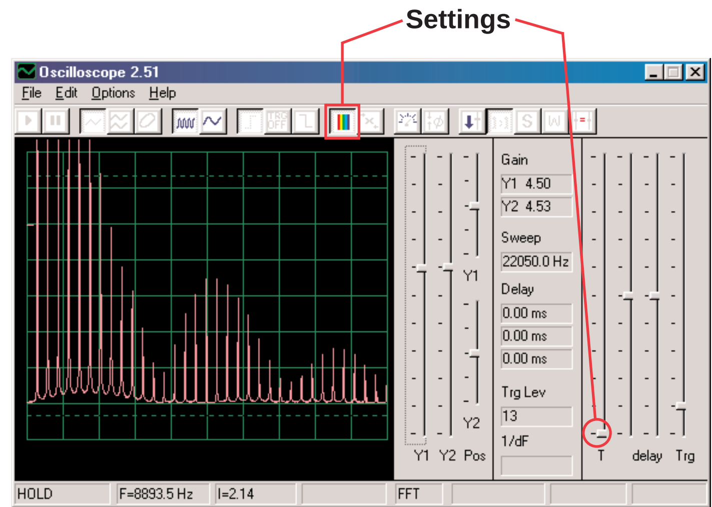
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, turn on the switch (snap part S1), and press the press switch (part S2). Try the **settings** shown here.



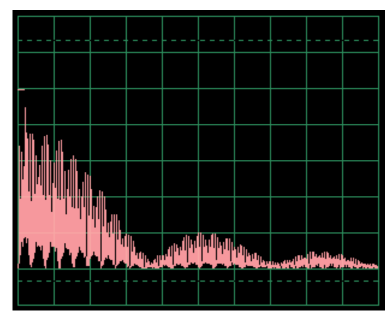
The waveform at left shows the signal just after pressing the press switch, the waveform below uses the same settings and shows the waveform just before the sound stops. You see the pulses slowly spread out as the tone of the sound changes.



Now change to FFT mode to look at the frequency spectrum as the sound fades away. Try the **settings** shown here.



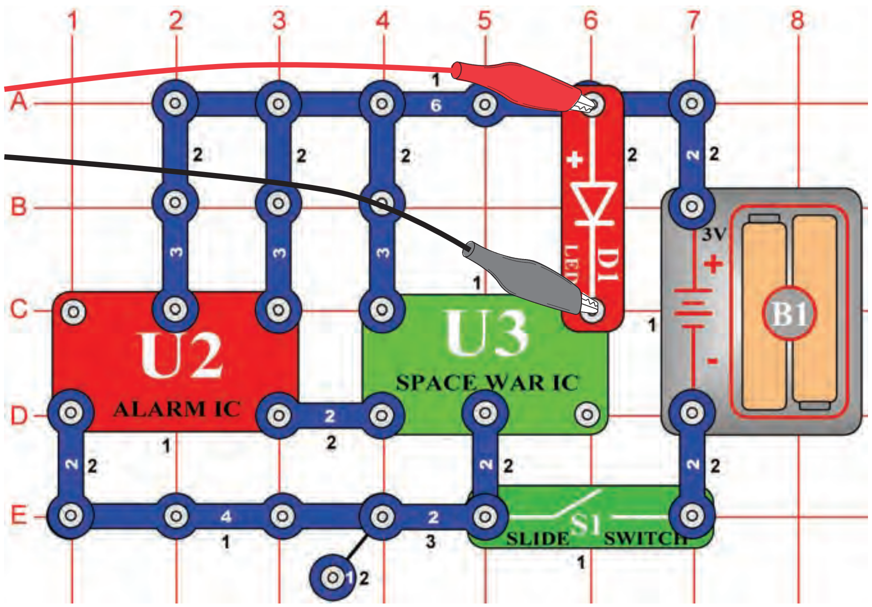
The spectrum at left is for just after pressing the press switch. The spectrum below uses the same settings and shows the spectrum just before the sound stops. The frequencies and amplitude slowly get lower as the sound fades away.



☐ Project #PC20

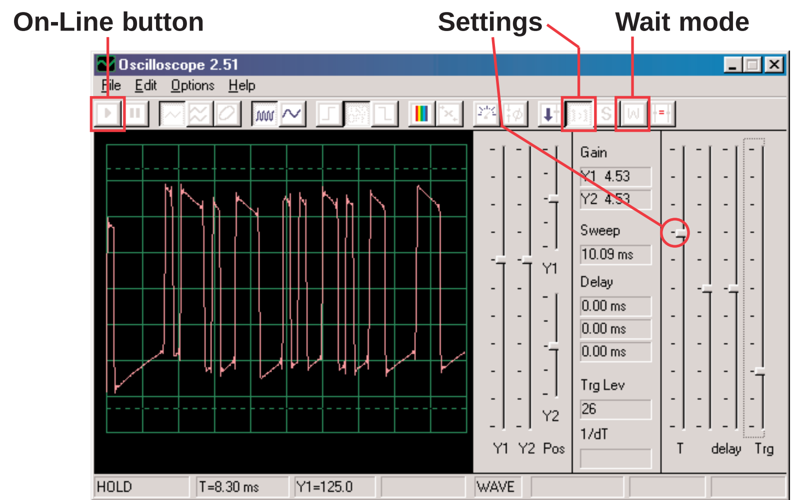
Space War Flicker PC

OBJECTIVE: To continuously show the patterns created by the space war IC.



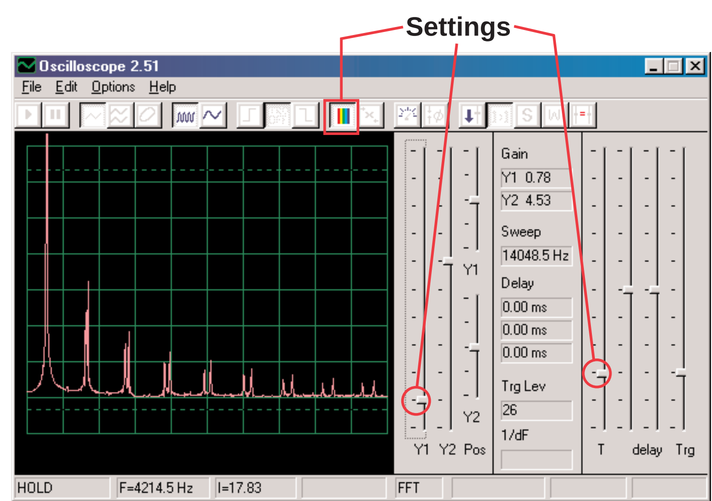
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings.

Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown below. The signal from the alarm IC (snap part U2) causes the space war IC (part U3) to step through the 8 different patterns it can create. A sample waveform is shown here.



You can also activate **Wait mode** and press the On-Line button several times to view one scan of the signal at a time, instead of seeing continuous scans.

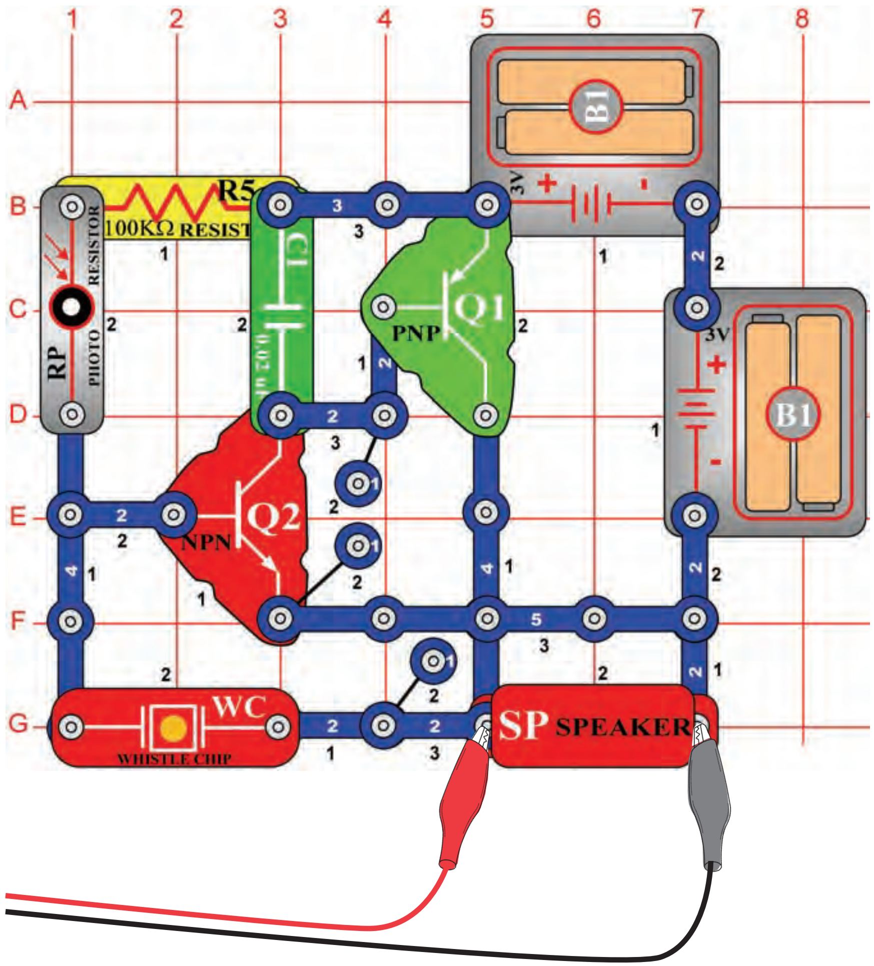
Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. You can see the spectrums for the different patterns produced by the space war IC, a sample is shown here.



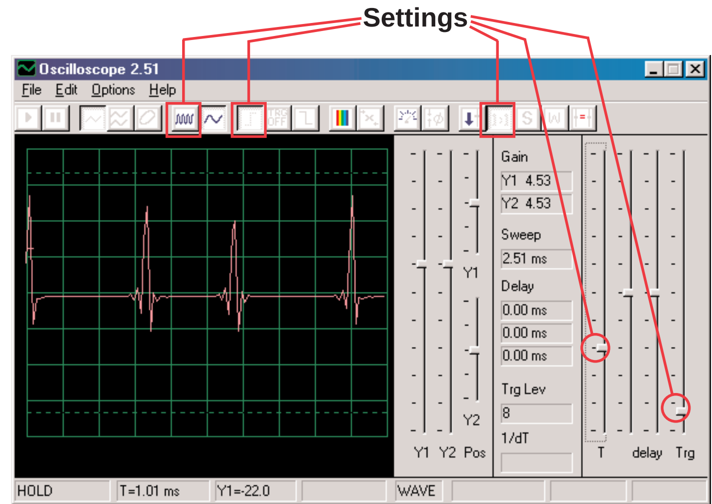
☐ Project #PC21

Buzzing in the Dark PC

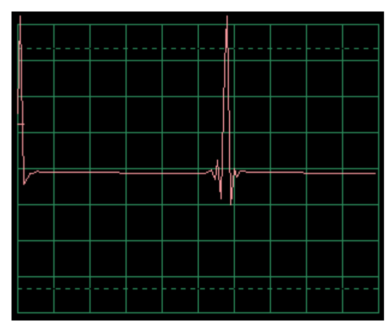
OBJECTIVE: To build a circuit that buzzes.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Set Winscope to the **settings** shown below and click on the On-Line button to activate. A sample waveform is shown here.

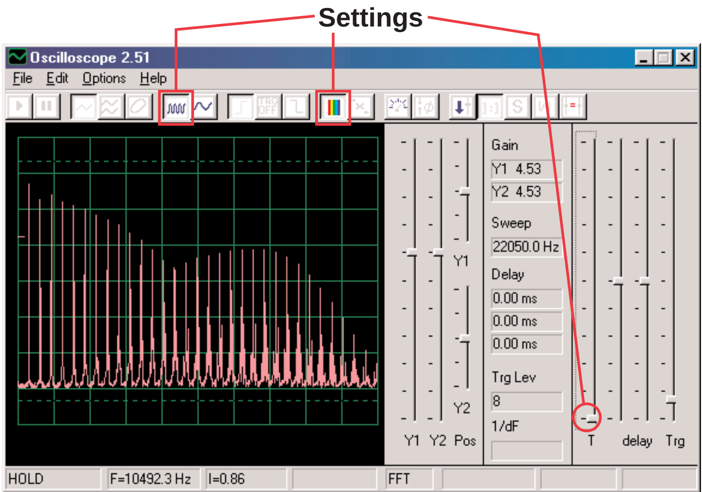


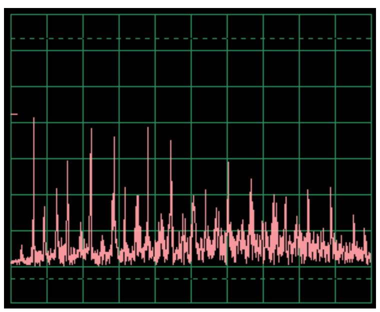
The actual waveform will vary depending on how much light is shining on the photoresistor (snap part RP). If you cover the photoresistor then the circuit shuts off.



The waveform above is weak and erratic, so replace the 0.02μF capacitor (snap part C1) with the 0.1μF capacitor. A sample of the new waveform is at left, with the same settings. It is lower in frequency but higher in amplitude.

Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



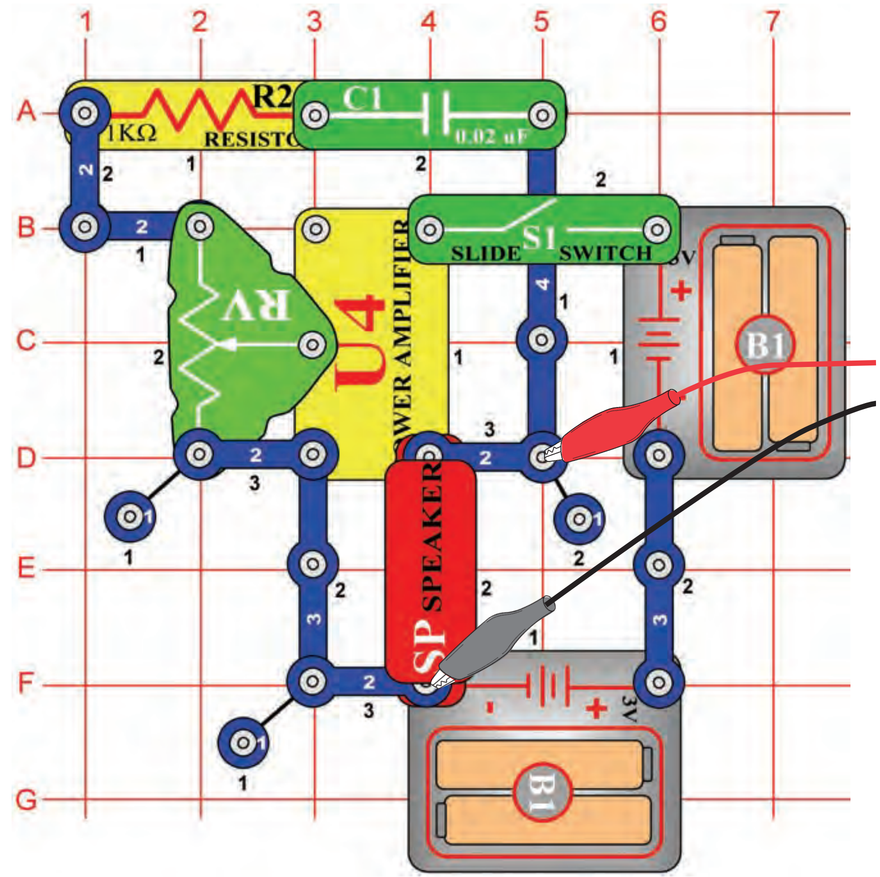


Now put the 0.02μF capacitor back in place of the 0.1μF capacitor to compare its spectrum. A sample is on the left, with the same Winscope settings as above. As with the oscilloscope mode, its spectrum is weaker and more erratic.

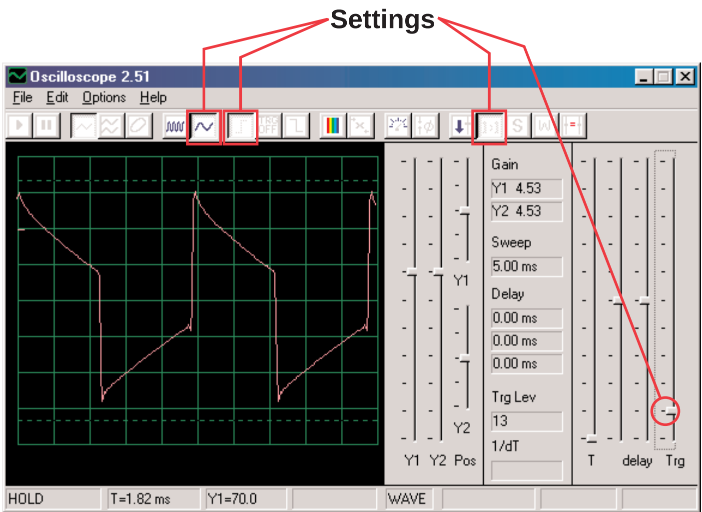
☐ Project #PC22

Trombone PC

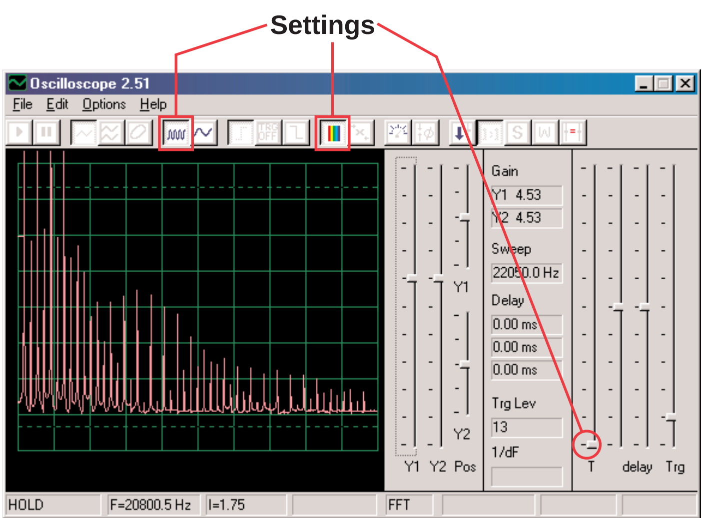
OBJECTIVE: To build a circuit that sounds like a trombone.



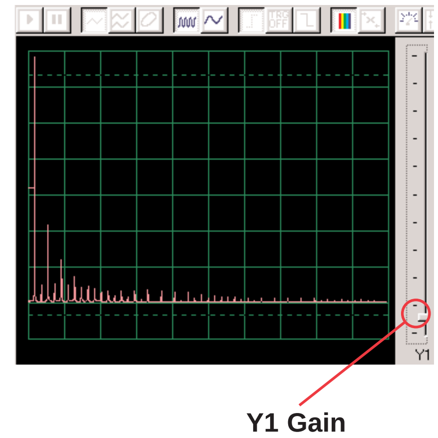
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown below, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown here.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



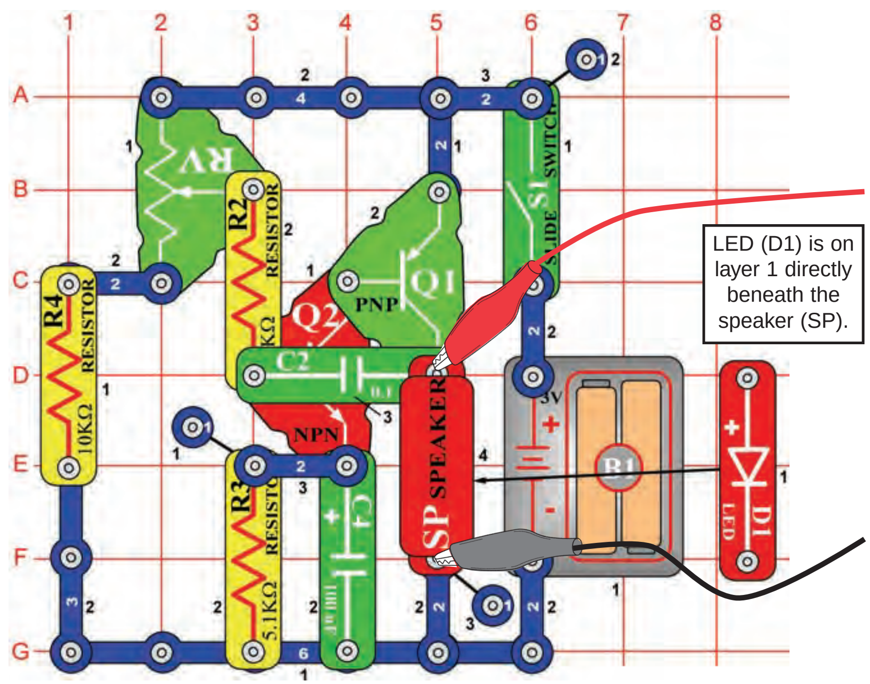
Note that in the above display the Y1 Gain is set high to show the low energy levels of the higher frequency components of the signal, even though the stronger peaks of the lower frequency components are off the top of the display. This can be deceiving. Now change the **Y1 Gain** so that the highest peak can be seen, this is shown on the right. Now you see how the main signal frequency dominates the others.



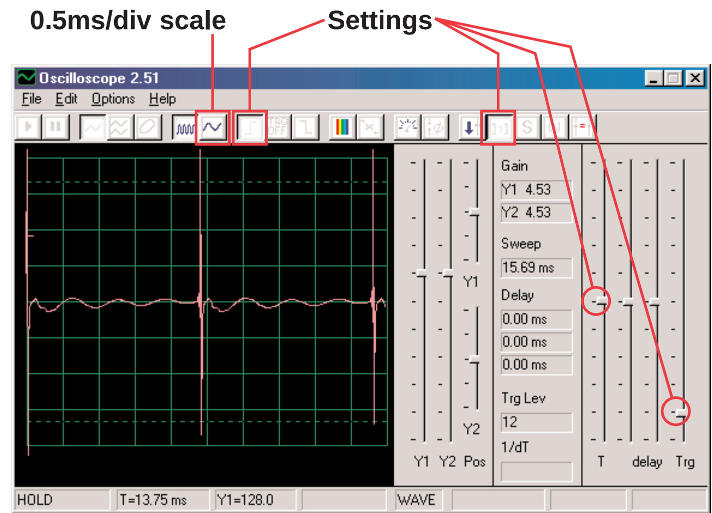
Project #PC23

Sound Pulse Oscillator PC

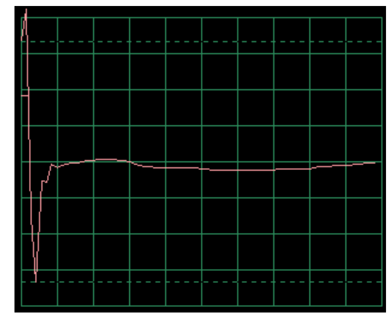
OBJECTIVE: To build a pulse oscillator.



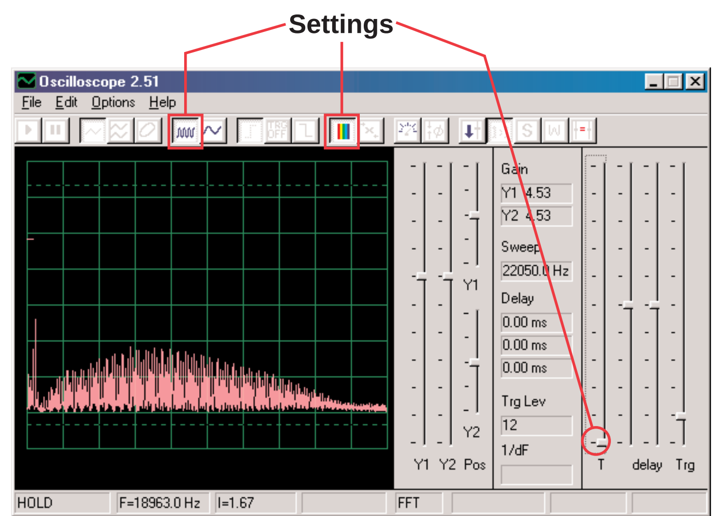
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Set Winscope to the **settings** shown on the upper right, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown on the upper right.



You can also change to the **0.5ms/div scale** to take a closer look at one of the pulses, shown on the right:



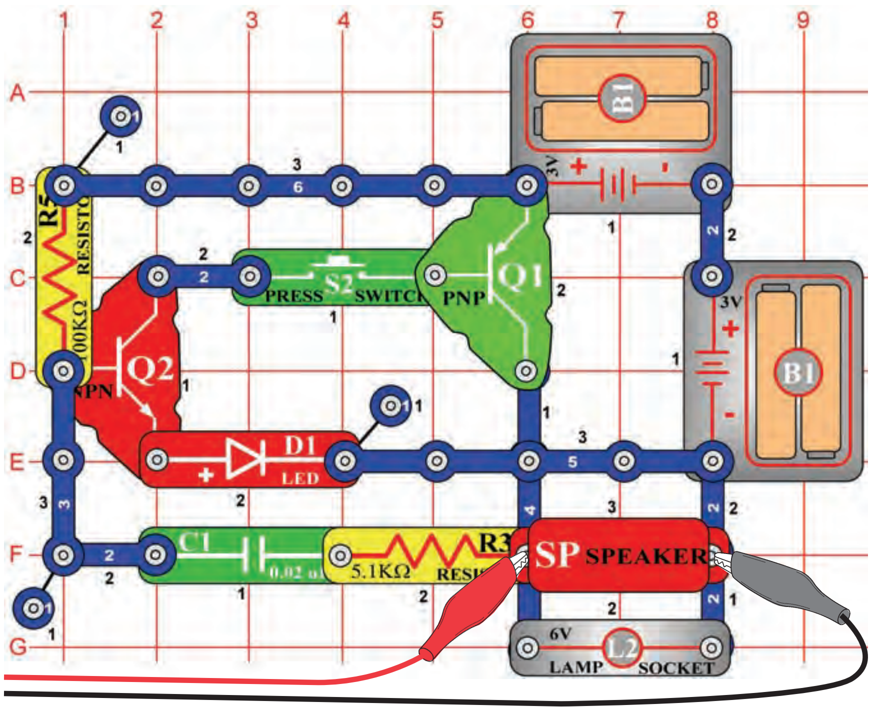
Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



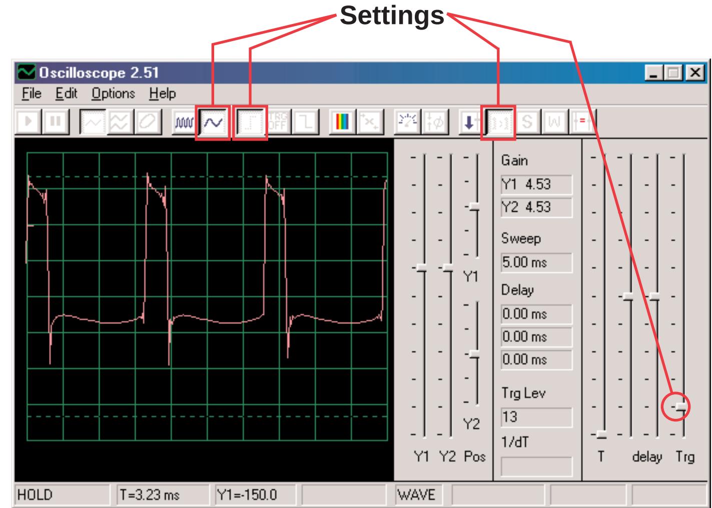
☐ # Project #PC24

High Pitch Bell PC

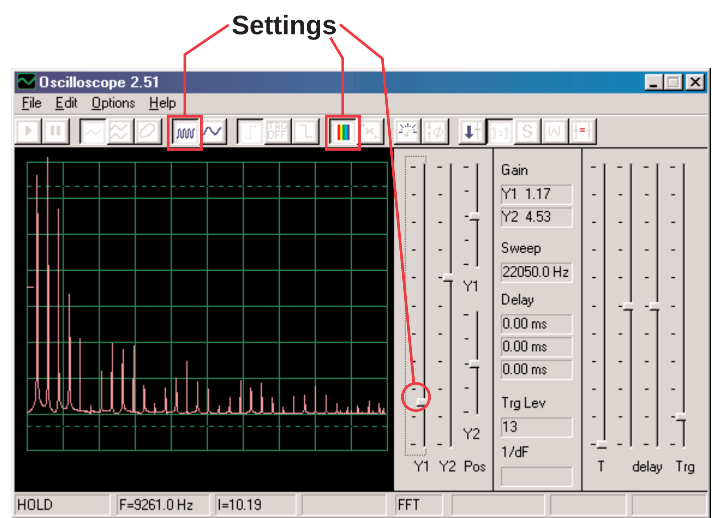
OBJECTIVE: To build a high pitch bell.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and hold down the press switch (snap part S2). Set Winscope to the **settings** shown on the upper right. A sample waveform is shown on the upper right.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.

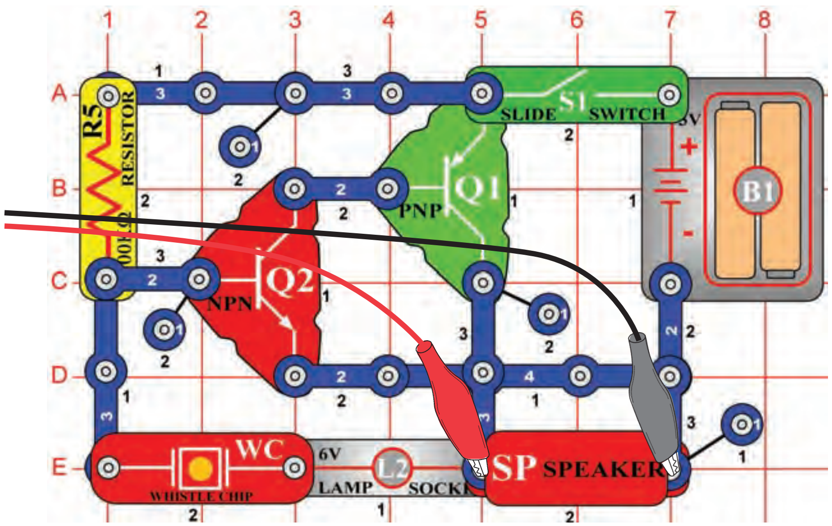


You can change some of the Winscope settings around to view the waveform and spectrum in different ways if desired. You can also place the 0.02μF capacitor on top of the whistle chip to lower the frequency.

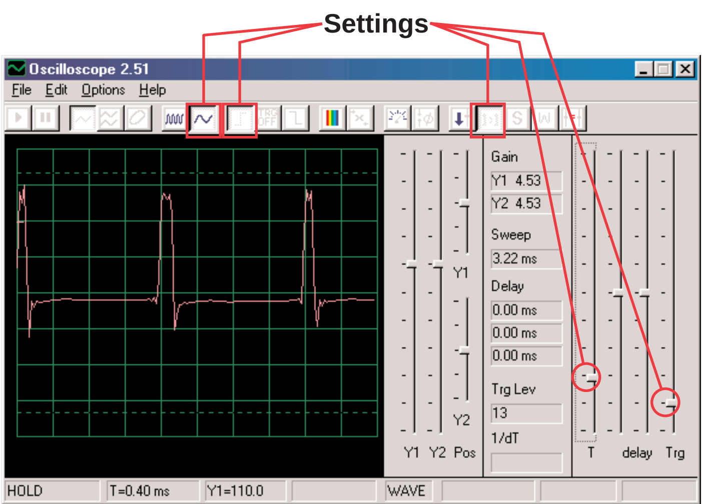
☐ Project #PC25

Tone Generator PC

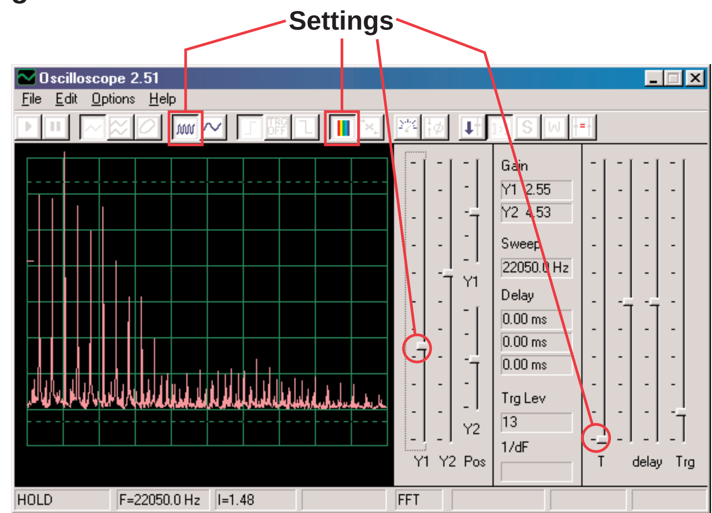
***OBJECTIVE:** To build a high frequency oscillator.*



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch. Set Winscope to the **settings** shown below. A sample waveform is shown here.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



☐ Project #PC26

Tone Generator PC (II)

Modify the circuit for project PC25 by placing the 0.02μF capacitor (C1) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC19, the frequency is lower now.

☐ Project #PC27

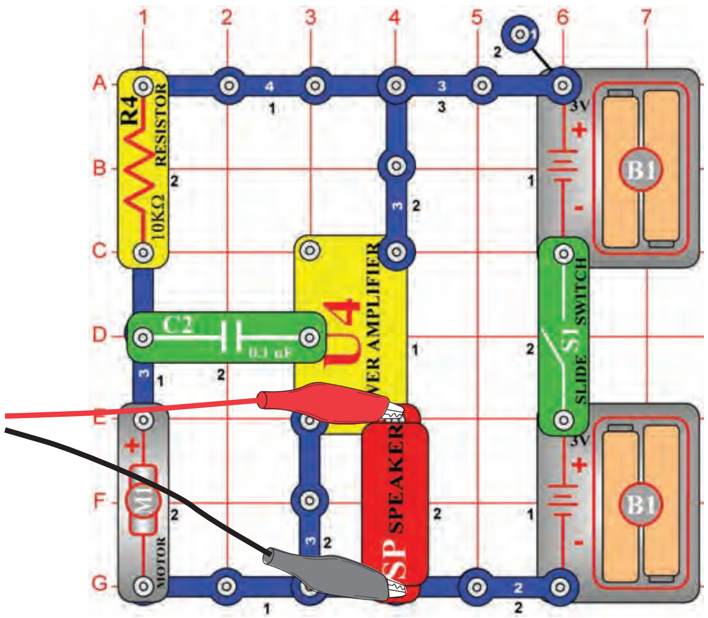
Tone Generator PC (III)

Modify the circuit for project PC25 by placing the 0.1μF capacitor (C2) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC19, but you may want to change the time scale since the frequency is much lower now.

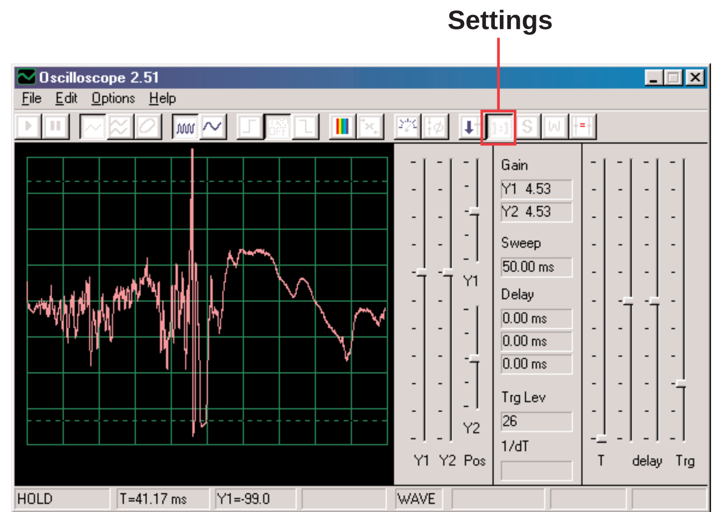
☐ Project #PC28

Old-Style Typewriter PC

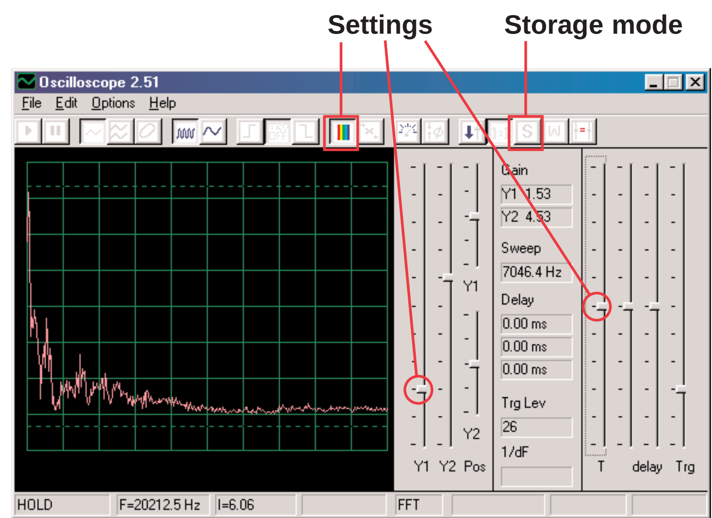
OBJECTIVE: To build a circuit that sounds like a typewriter.



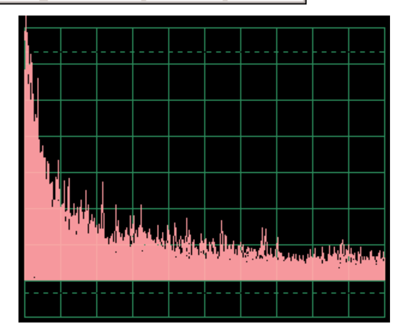
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch. Set Winscope to the **settings** shown on the upper right. Turn the motor (snap part M1) slowly with your fingers and watch the waveforms generated. They are very erratic and unpredictable. A sample is shown on the upper right.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



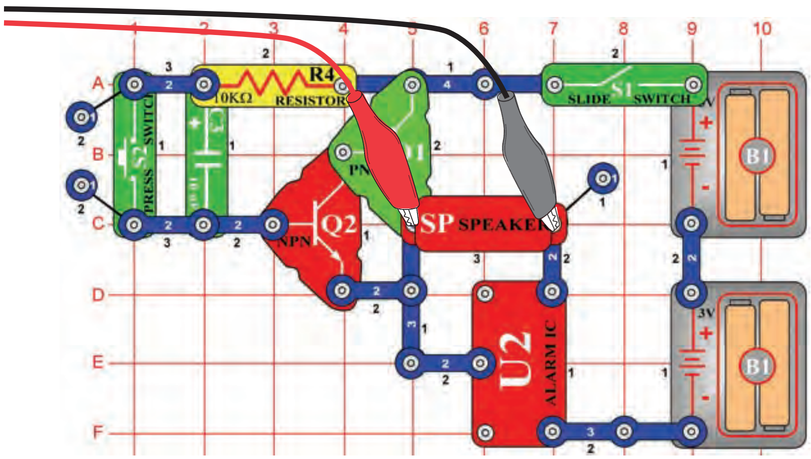
You can also turn on **Storage mode** to see the peaks recorded as you turn the motor, a sample of this is at right.



☐ Project #PC29

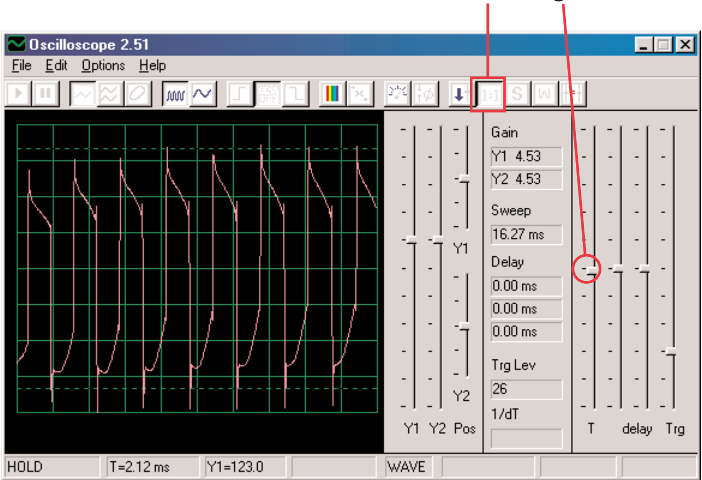
Transistor Fading Siren PC

OBJECTIVE: To build a siren that slowly fades away.



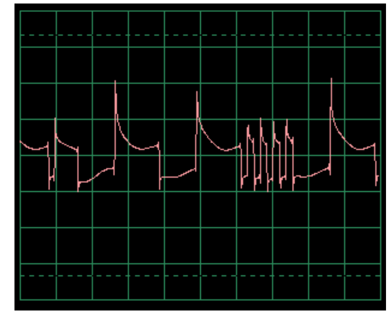
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Set Winscope to the **settings** shown on the right. Click on the On-Line button to activate, turn on the switch, and press the press switch (snap part S2). You hear a siren that slowly fades away.

Settings



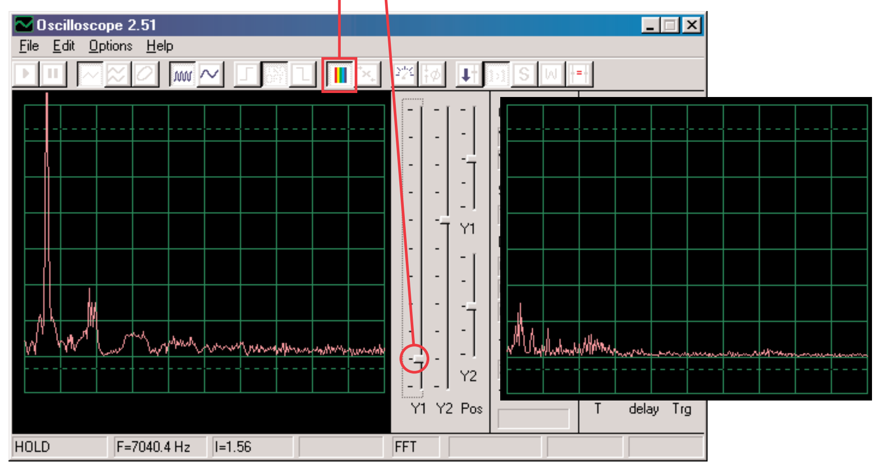
This display shows the siren just after pressing the press switch.

This display (at the same settings) shows the siren when it has almost faded out. The waveform has become weak and sometimes erratic.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. The display on the left shows the signal just after pressing the press switch and on the right shows it just before it fades out.

Settings



☐ Project #PC30

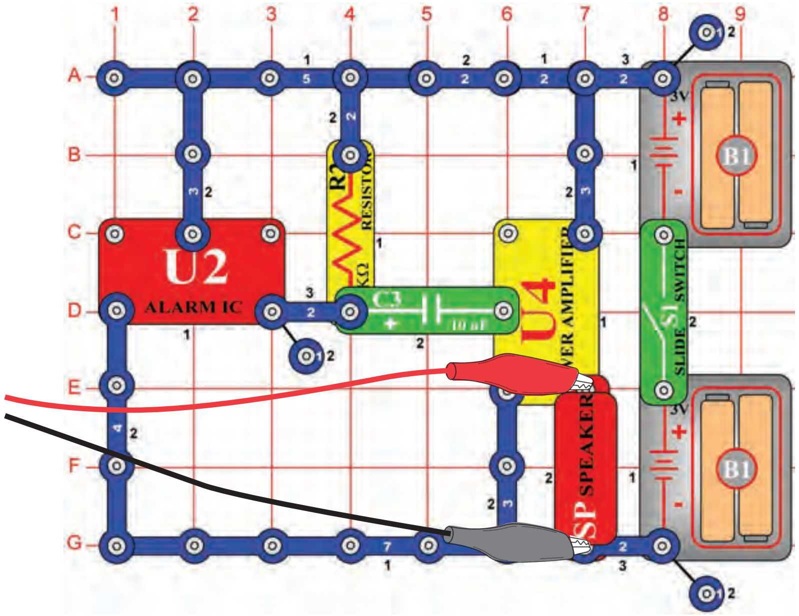
Fading Doorbell PC

Modify the circuit in PC29 by replacing the alarm IC (U2) with the music IC (U1), use a 1-snap and a 2-snap to make a connection across D6-E6 on top of the music IC. The music slowly fades away and stops. Use the same settings as in PC29 to view the waveform and frequency spectrum.

☐ Project #PC31

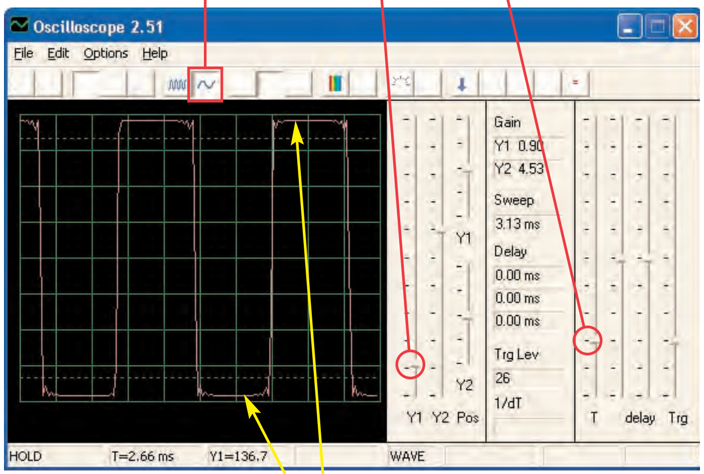
Police Siren Amplifier PC

OBJECTIVE: To show the output of an amplifier.



Build the circuit shown and set Winscope to the **settings** shown below. The siren sound is very loud. In most cases the waveform will have **flat edges** on the top and bottom, indicating the voltage is too high for the microphone input stage on your computer and is being distorted. You may sometimes correct for this if you like by reducing the volume control of your microphone input (see p. 3), but it is recommended that you return the volume to the normal level before doing other projects.

Settings



Flat edges

You may also make different alarm sounds by connecting the alarm IC using the configurations shown in projects #23-26.

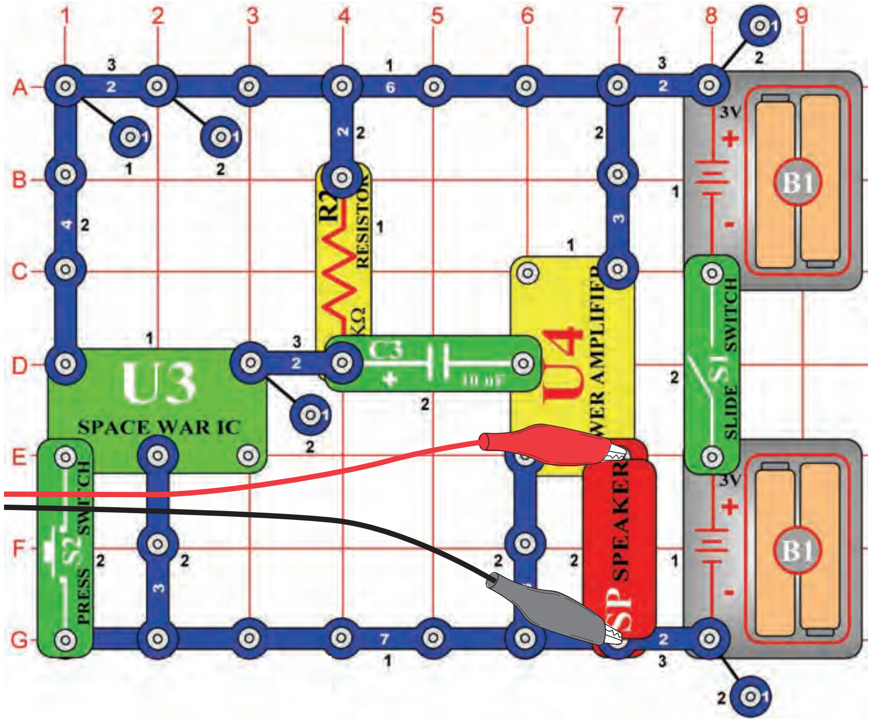
☐ Project #PC32

Music Amplifier PC

Modify the circuit in PC31 by replacing the alarm IC (U2) with the music IC (U1). Use the same settings as in PC31 to view the waveform, you may also use the FFT button to view the frequency spectrum.

☐ Project #PC33

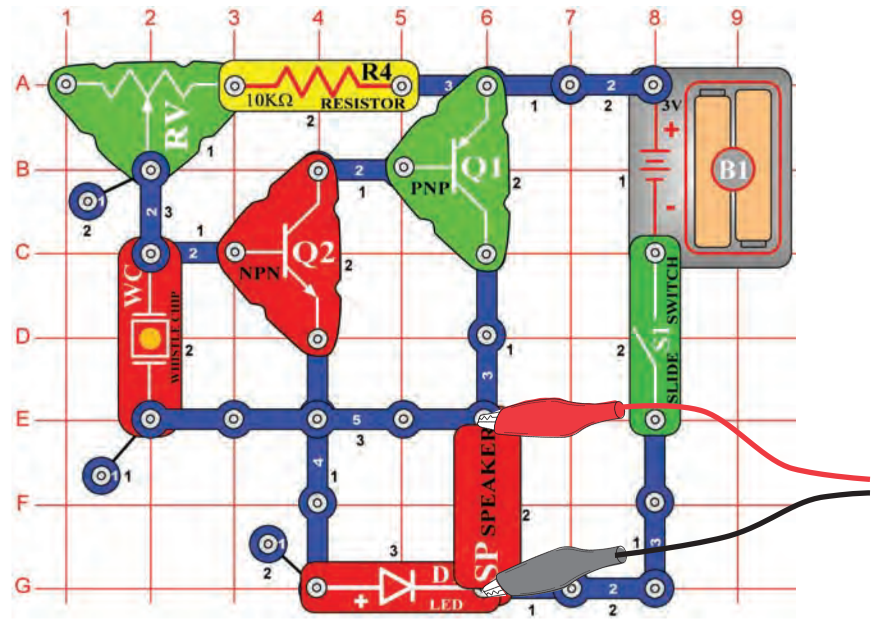
Space War Amplifier PC



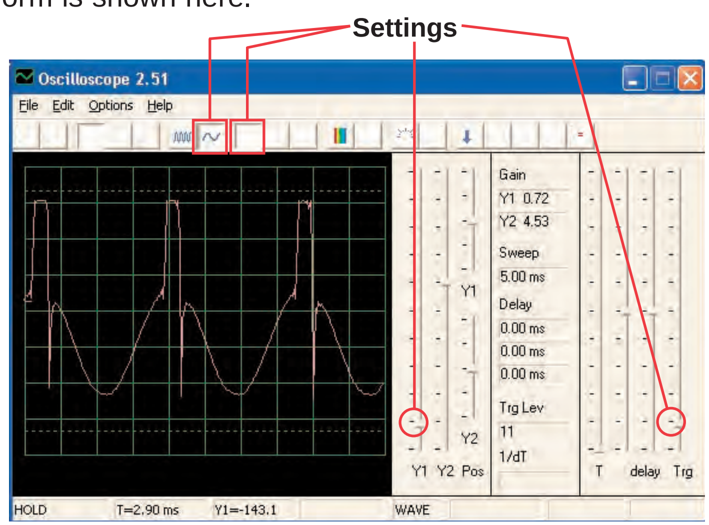
Build the circuit shown and use the same settings as in PC31 to view the waveform. Press the switch (S2) to change the sounds and waveform.

☐ Project #PC34

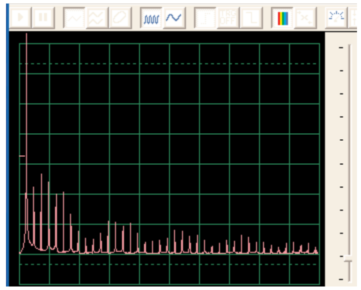
Adjustable Tone Generator PC



Build the circuit shown, and try the **settings** below. Move the adjustable resistor lever to change the frequency. A sample waveform is shown here.



Try these settings to see the spectrum:



Project #PC35

Adjustable Tone Generator PC (II)

Modify the circuit for project PC34 by placing the 0.02μF capacitor (C1) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC34, the frequency is lower now.

Project #PC36

Adjustable Tone Generator PC (III)

Modify the circuit for project PC34 by placing the 0.1μF capacitor (C2) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC34, but you may want to change the time scale since the frequency is much lower now.

Project #PC37

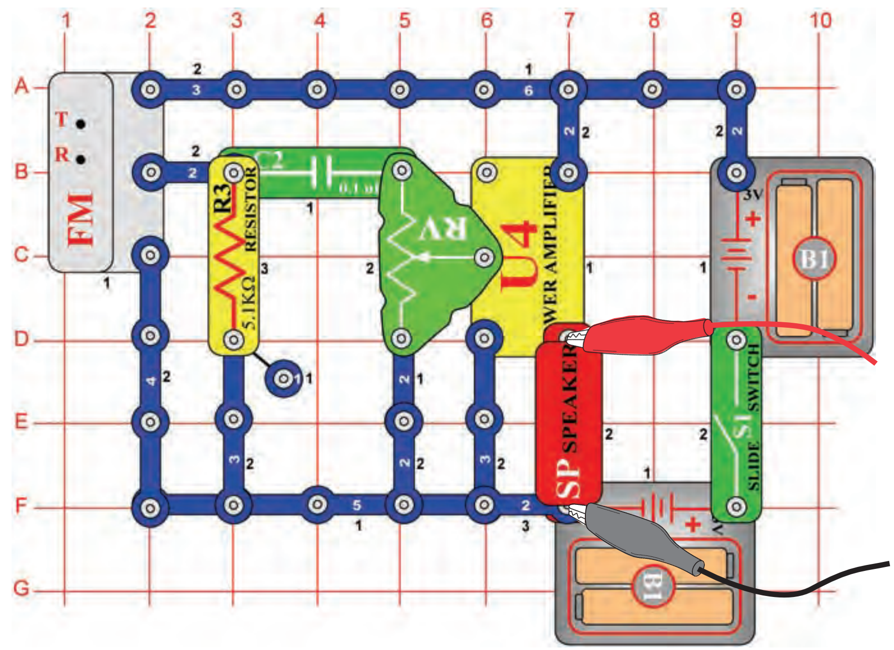
Adjustable Tone Generator PC (IV)

Modify the circuit for project PC34 by replacing the 10KΩ (R4) resistor with the photoresistor (RP). Look at the waveform and frequency spectrum using the same settings as for project PC34, and wave your hand over the photoresistor to change the sound and pattern. There will not always be sound.

Project #PC38

Adjustable FM Radio PC

OBJECTIVE: To show the output of an FM Radio.



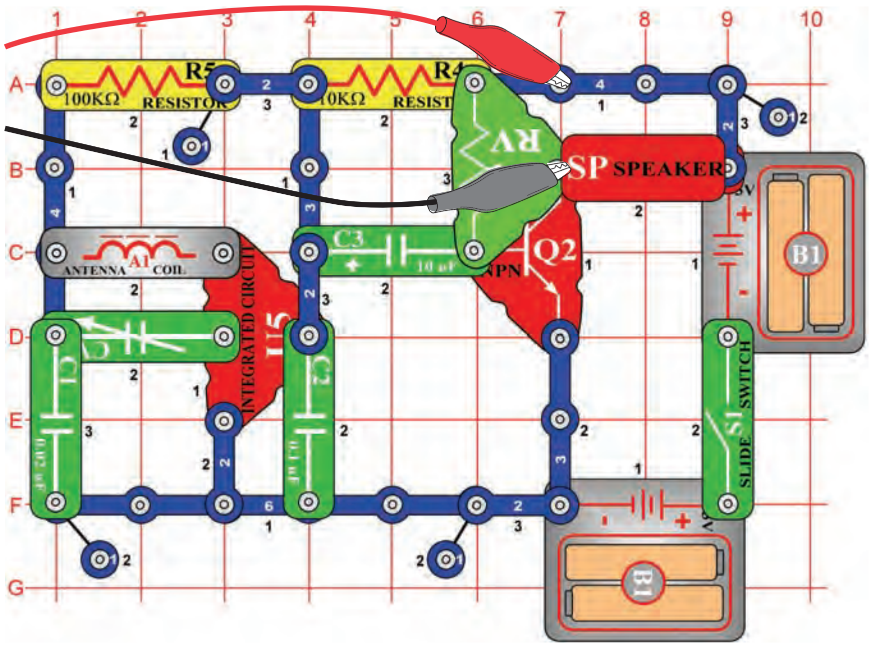
Turn on the slide switch (S1) and press the R button. Now press the T button and the FM module scans for a radio station. When a station is found, it locks on to it and you hear it on the speaker. Press the T button again for the next radio station.

Connect the PC-interface cable as shown. Set up Winscope as desired or use the same Winscope settings to view the waveform and frequency spectrum as for project PC12 (AM radio), since the output signal to the speaker is music or talking just like in PC12. (AM and FM radio transmit the same types of information using different modulation methods.) Adjust the volume using the adjustable resistor (RV) so that all of the waveform is shown on the Winscope screen.

Project #PC39

Transistor AM Radio PC (II)

***OBJECTIVE:** To show the output of an AM Radio.*

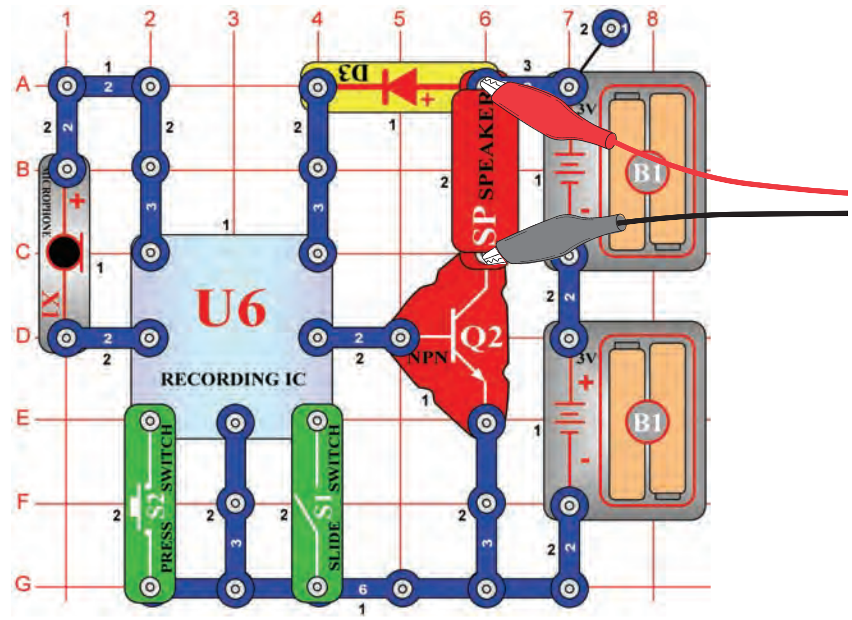


Turn on the switch and adjust the variable capacitor (CV) for a radio station, then adjust the loudness using the adjustable resistor (RV). Use the same Winscope settings as for project PC12 (AM radio) to view the waveform and frequency spectrum. The waveform will be different from that in projects PC12 and PC38, because those circuits use the power amplifier IC (U4) instead of the NPN transistor for amplification.

Project #PC40

Playback & Record PC

***OBJECTIVE:** To show the waveforms for music and your voice.*

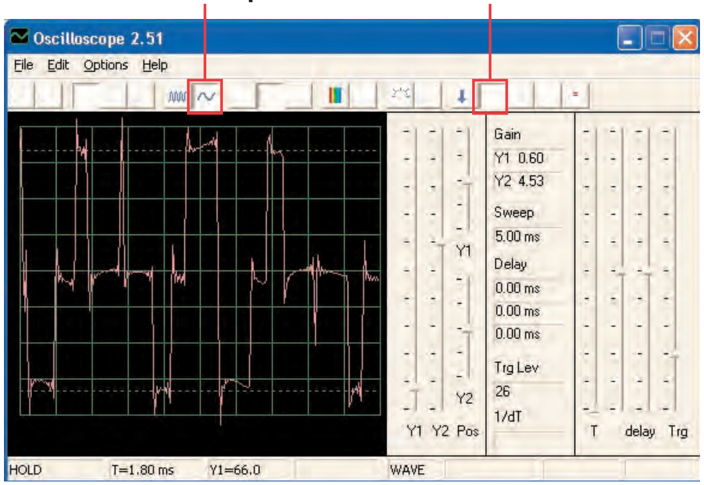


Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, the music will stop. You may press the press switch several times to play all three songs.

Use Winscope to view the waveform and frequency spectrum when playing back your recording and music. A **sample music waveform** is shown here.

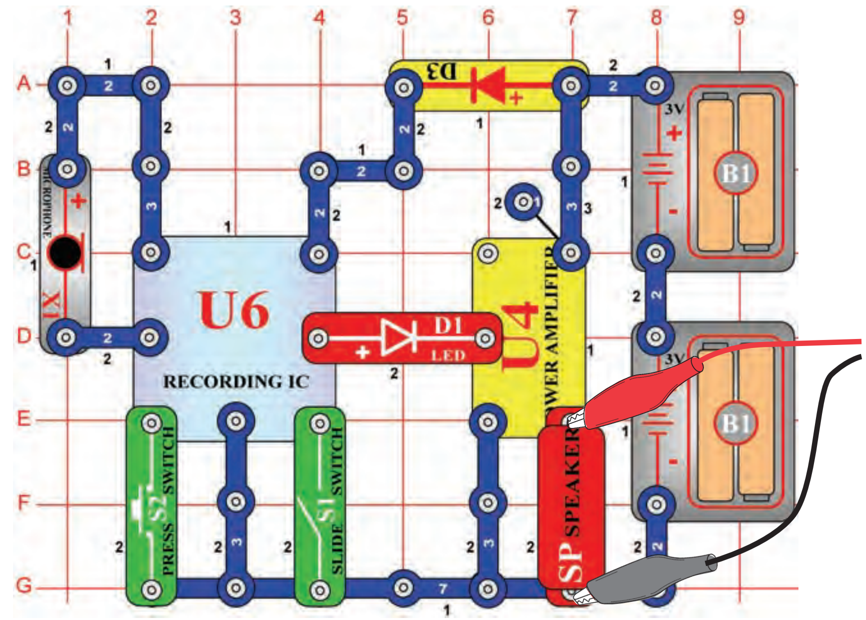
Sample music waveform



Project #PC41

Power Amplifier Playing Music IC

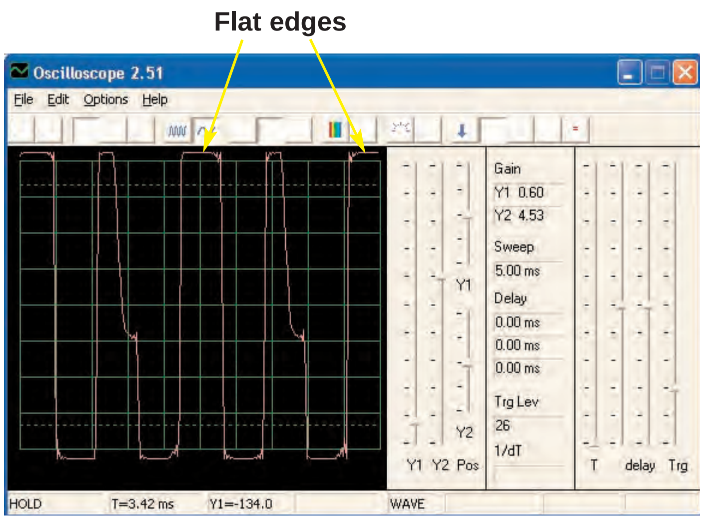
OBJECTIVE: To show how high amplification can distort music.



Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the switch S2 for playback. It plays the recording you made followed by one of three songs. If you press the press switch (S2) before the song is over, the music will stop. You may press the press switch several times to play all three songs.

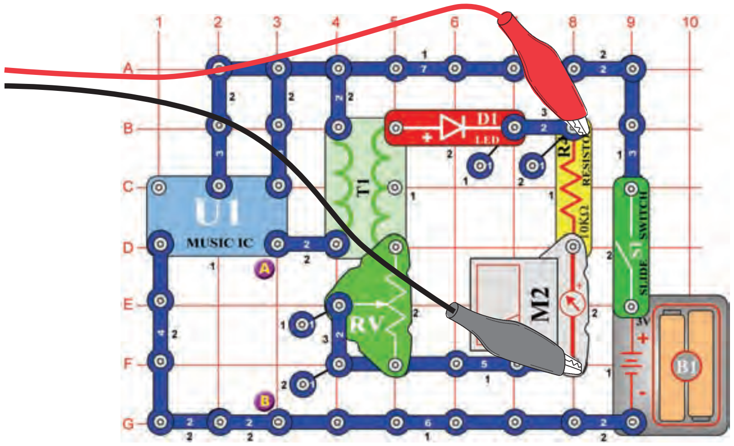
This recorder IC circuit works the same as in project PC40 except that the power amplifer IC (U4) used here makes the sound much louder than in project PC40. If viewed with the same Winscope settings as in PC40, then the waveform appears as shown below. The output from the recorder IC has not changed, but the **flat edges** at the top and bottom of the waveform indicate that the higher amplification is distorting the sound.



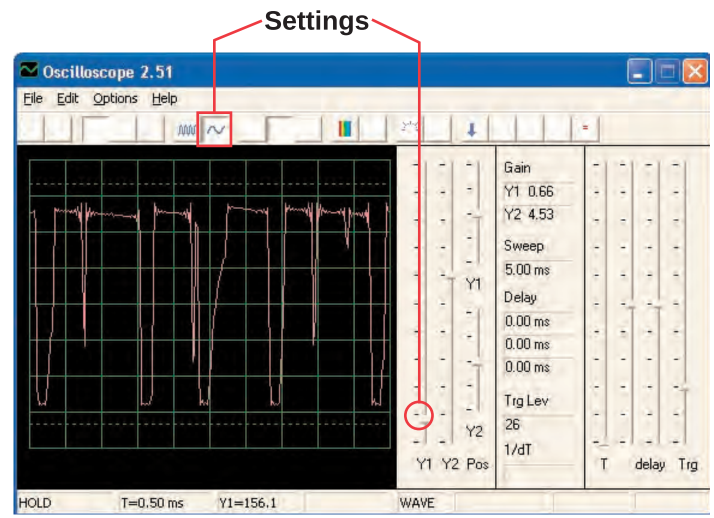
Project #PC42

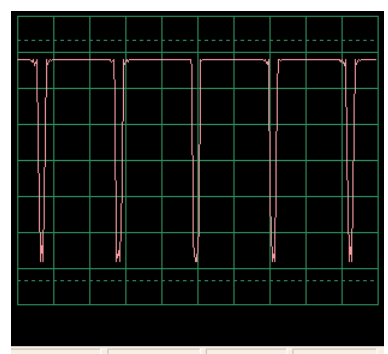
Music Meter PC

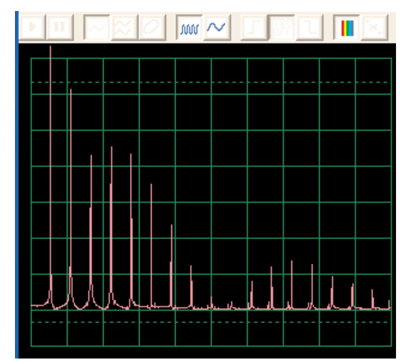
OBJECTIVE: To show how high amplification can distort music.



Use the LOW (or 10mA) setting on the meter (M2). Set the adjustable resistor (RV) to the bottom position and turn on the slide switch (S1), you will see a waveform like that shown below. Set the adjustable resistor to the top, and the waveform looks like that shown on the bottom left, due to lower resistance in the circuit. A sample frequency spectrum is also shown on the bottom right.



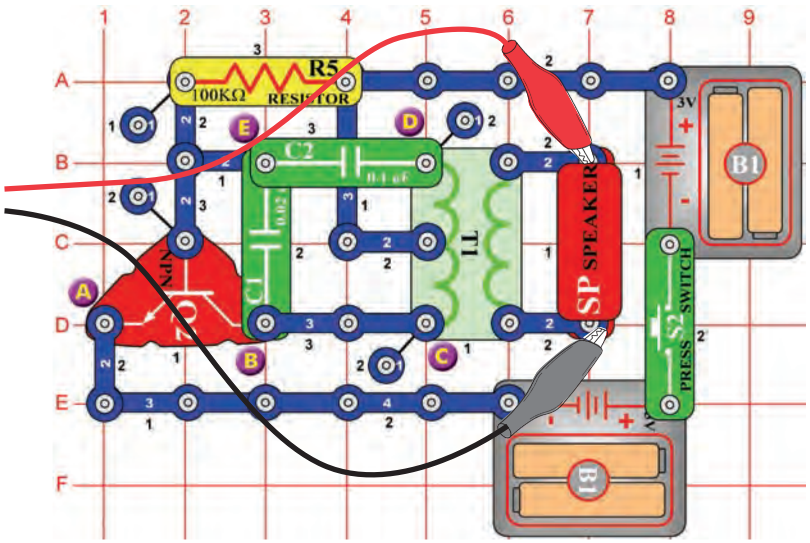




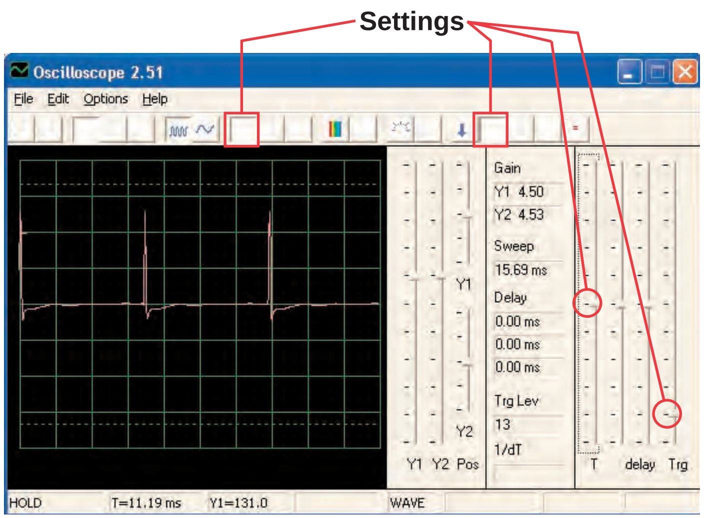
Project #PC43

Oscillation Sounds PC

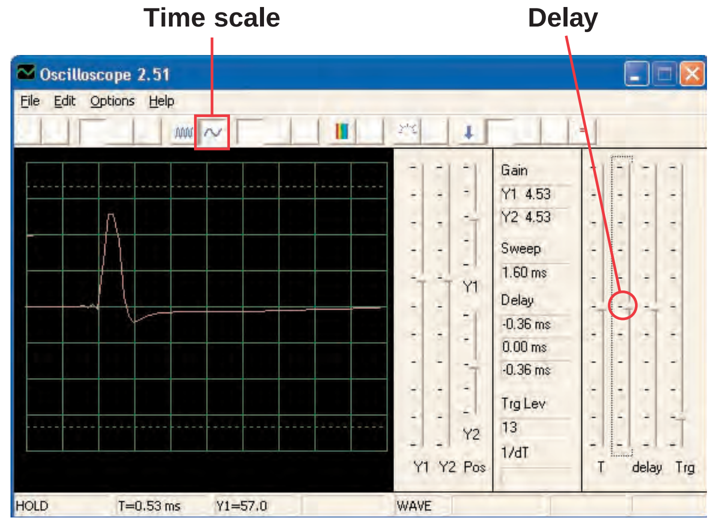
OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown here. This circuit produces a series of pulses (shown below), representing when the transistor is activated.



You may look at a pulse close-up by changing the **time scale** and slightly adjusting the **delay**, as shown.

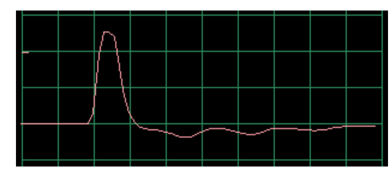


You may look at the frequency spectrum on your own if desired.

Project #PC44

Oscillation Sounds PC (II)

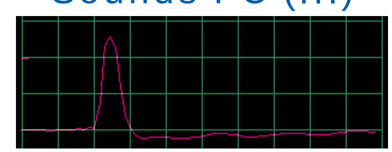
Using the circuit from PC43, connect the whistle chip across points C & D. Notice how the shape of the pulse has changed from that shown in PC43 (using the same settings):



Project #PC45

Oscillation Sounds PC (III)

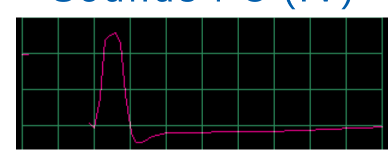
Using the circuit from PC43, connect the whistle chip across points B & E. Notice how the shape of the pulse has changed.



Project #PC46

Oscillation Sounds PC (IV)

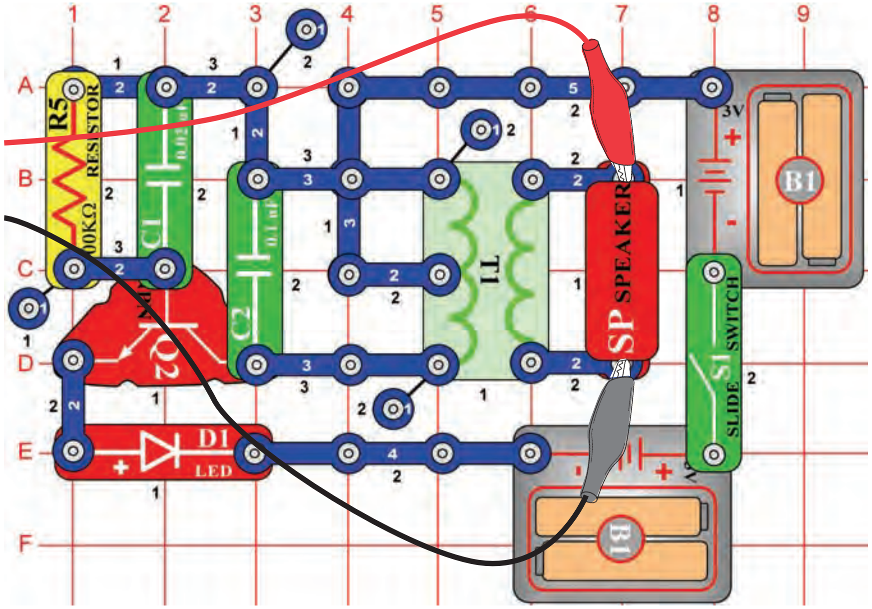
Using the circuit from PC43, install the whistle chip under capacitor C2. Notice how the shape of the pulse has changed.



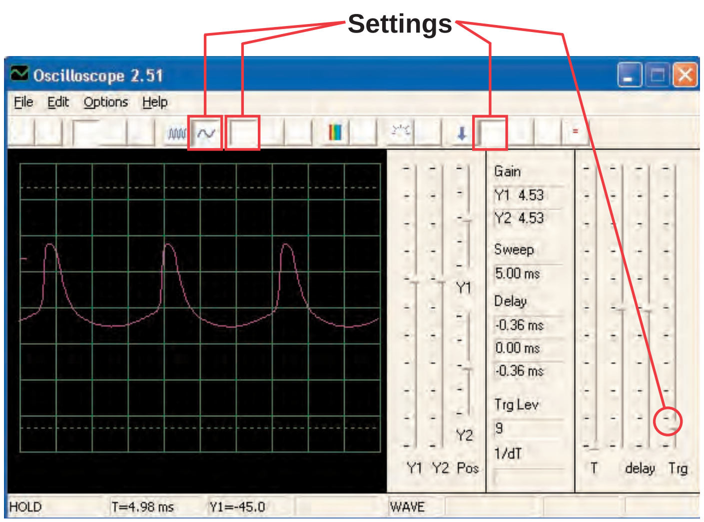
Project #PC47

Oscillator Sounds PC

***OBJECTIVE:** To view the output of an oscillator circuit.*



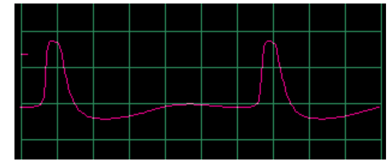
Build the circuit and try the **settings** shown.



Project #PC48

Oscillation Sounds PC (II)

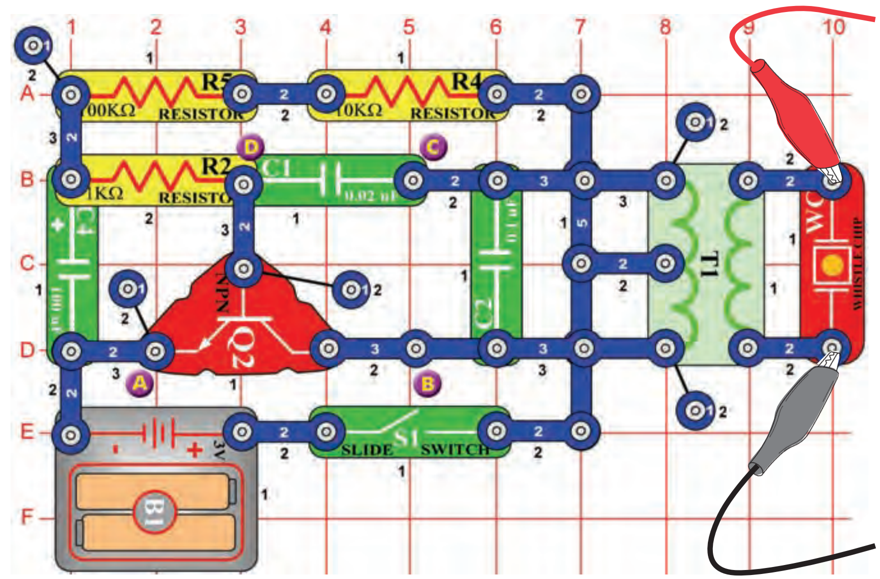
Using the circuit from PC47, install the whistle chip on top of capacitor C1. Notice how the spacing between the pulses has changed.



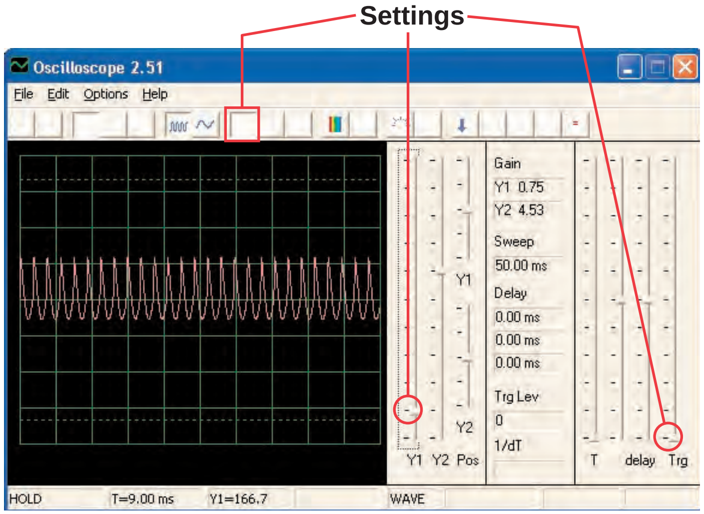
Project #PC49

Whistle Chip Sounds PC

***OBJECTIVE:** To view the output of an oscillator circuit.*

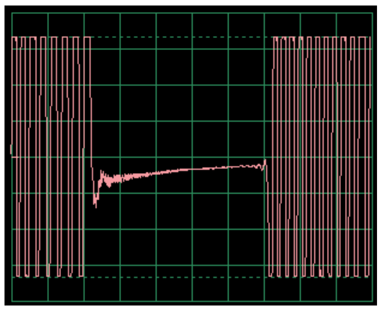


Build the circuit and try the **settings** shown. You may try other settings to zoom in or look at the frequency spectrum.



Project #PC50

Whistle Chip Sounds PC (II)



Connect the whistle chip (with the PC-interface cable still connected across it) across points B & C. The circuit oscillates in short intervals.

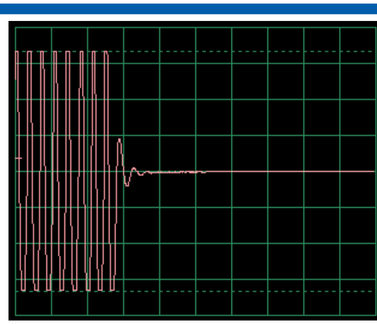
Project #PC51

Whistle Chip Sounds PC (III)

Connect the whistle chip (with PC cable) across points C & D using a 1-snap, the sound and waveforms are different.

Project #PC52

Whistle Chip Sounds PC (IV)

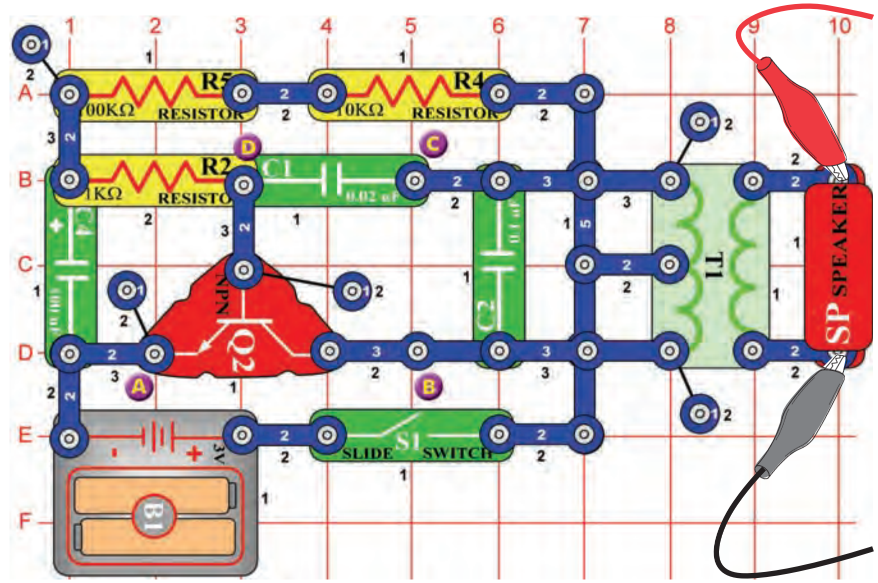


Place the 470μF capacitor C5 on top of the 100μF capacitor C4, and connect the whistle chip across points A & B. The circuit oscillates in 2-second intervals.

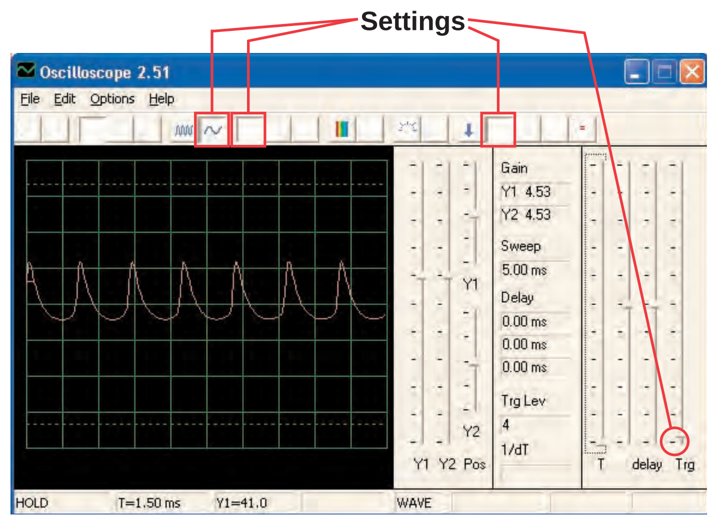
Project #PC53

Bird Sounds PC

OBJECTIVE: To view the output of an oscillator circuit.

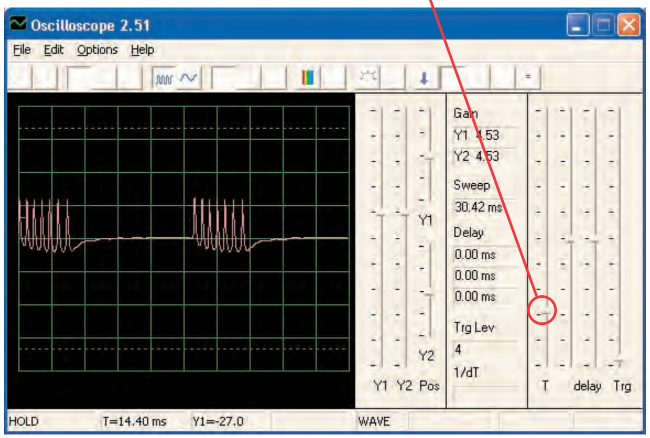


Build the circuit and try the **settings** shown. The oscillator activates about once-a-second, sounding like a bird chirping. You may look at the frequency spectrum if you like.



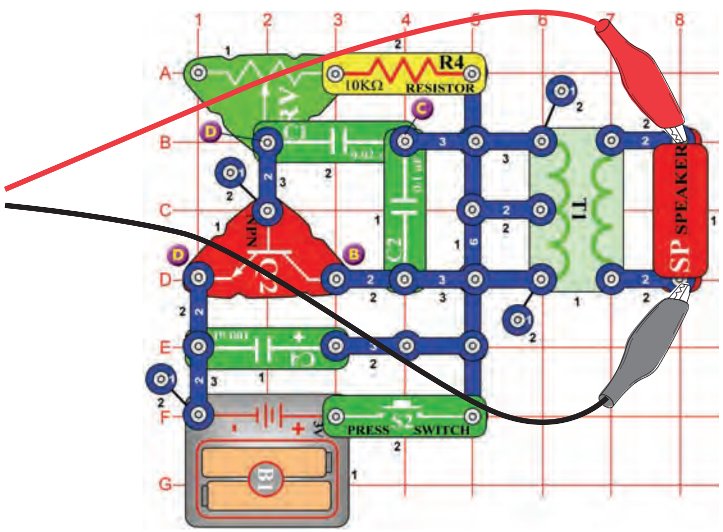
Project #PC54 Bird Sounds PC (II)

Replace the 100μF capacitor (C4) with the 10μF capacitor (C3). The frequency of the oscillator is the same as before (and so the pulses look the same), but the oscillator activates in shorter intervals (so the bursts of pulses are shorter but closer together). You could use the 470μF capacitor to increase the oscillation interval.

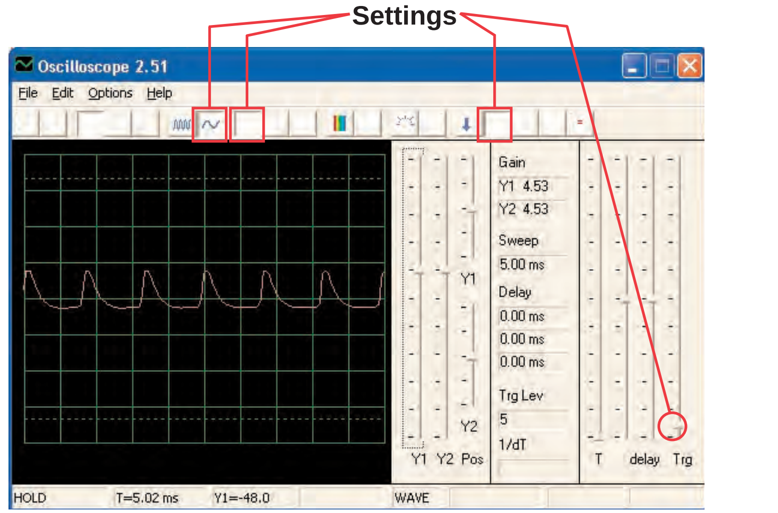


Project #PC55 Electronic Cat PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Start with the adjustable resistor set to the left but then adjust to change the tone. The signal dies out after you release the switch.

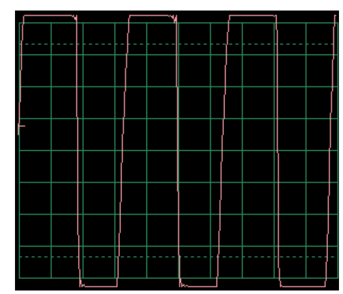


Project #PC56 Electronic Cat PC (II)

Connect the whistle chip across points A & B, then B & C, then C & D and observe how the waveform changes as the sound changes.

Project #PC57 Electronic Cat PC (III)

Remove the speaker. Connect the PC interface cable across the whistle chip and install the whistle chip across points A & B, then B & C, then C & D and observe how the waveform changes as the sound changes. Try different settings of the adjustable resistor. The waveform for B & C is shown.



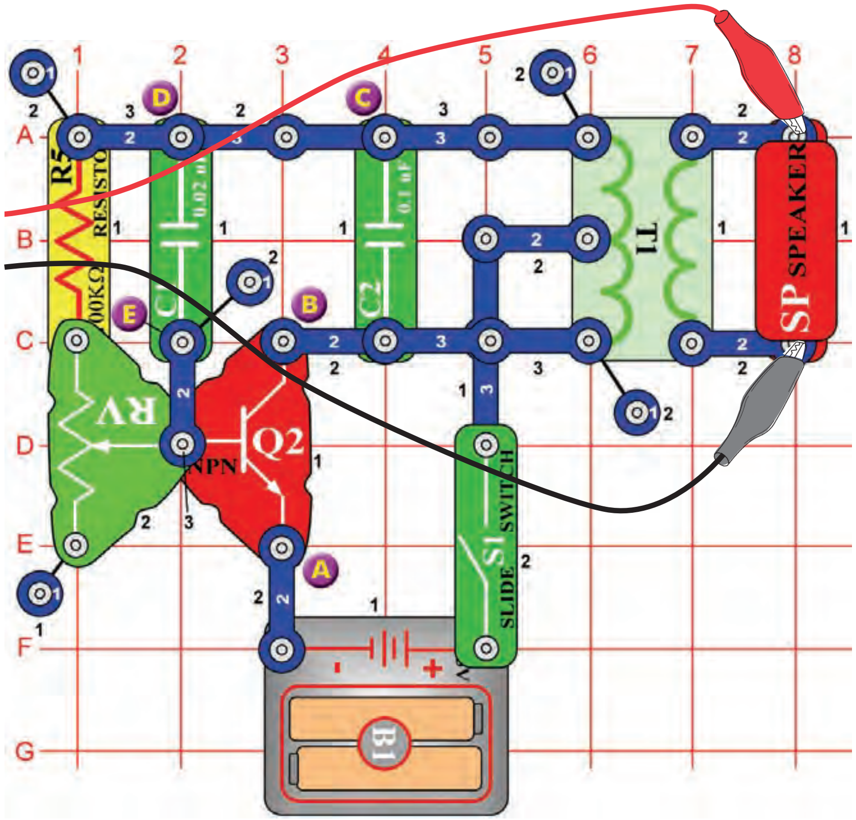
Project #PC58 Electronic Cat PC (IV)

Replace the 100μF capacitor with the 470μF capacitor and repeat projects PC55-PC57. The signal dies out at a much slower rate now, making it easier to observe. You can also use FFT mode to view the frequency spectrum as desired.

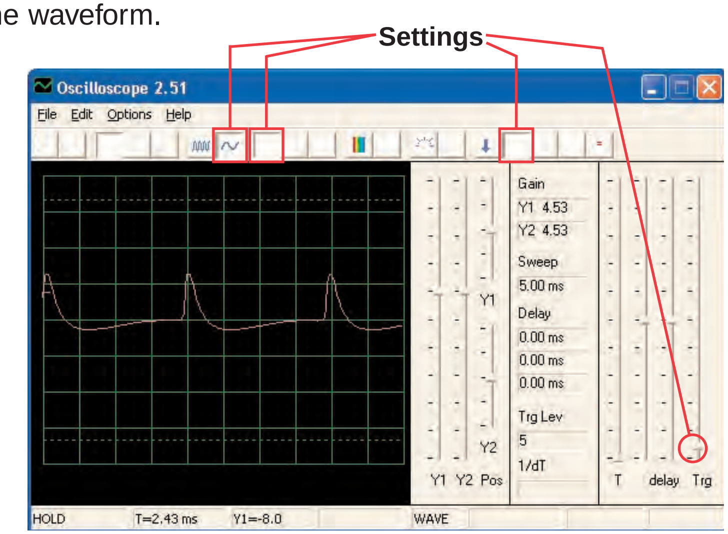
Project #PC59

Variable Oscillator PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Move the adjustable resistor lever to change the pitch of the sound and pulse separation in the waveform.



Project #PC60

Variable Oscillator PC (II)

Connect the whistle chip across points A & B, then B & C, then D & E and observe how the waveform changes as the sound changes. Sometimes the speaker sound and waveform are unchanged, but the whistle chip itself makes new sound.

Project #PC61

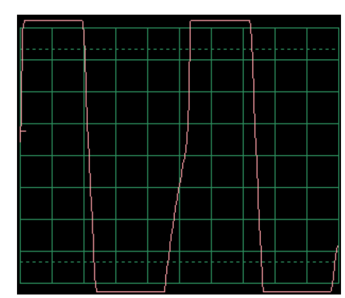
Variable Oscillator PC (III)

Replace the 100KΩ resistor R5 with the photoresistor RP, wave your hand or a piece of paper over it and observe how the sound and waveform change.

Project #PC62

Variable Oscillator PC (IV)

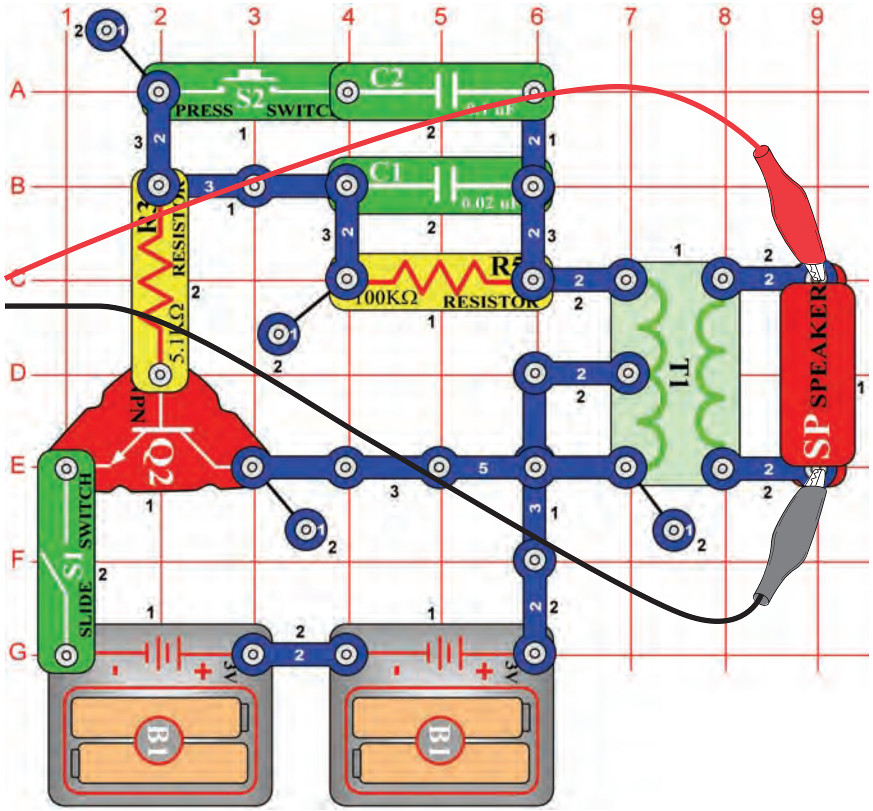
Remove the speaker. Connect the PC interface cable across the whistle chip and install the whistle chip across points A & B, then B & C, then D & E and observe how the waveform changes as the sound changes. Try different settings of the adjustable resistor. The waveform for A & B is shown.



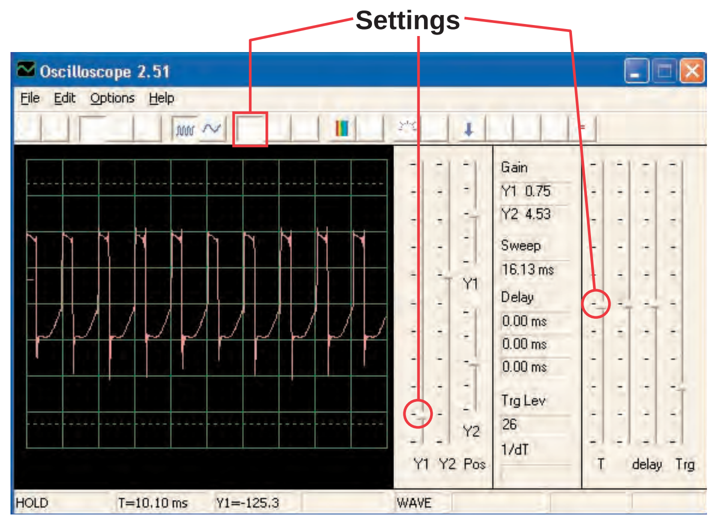
Project #PC63

Electronic Sound PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Press the press switch to lower the frequency of the signal by increasing the capacitance in the oscillator. You can replace the 0.1μF capacitor C2 with the 10μF capacitor C3 (“+” on the right) to further lower the frequency of the tone. You may try other settings to zoom in or look at the frequency spectrum.



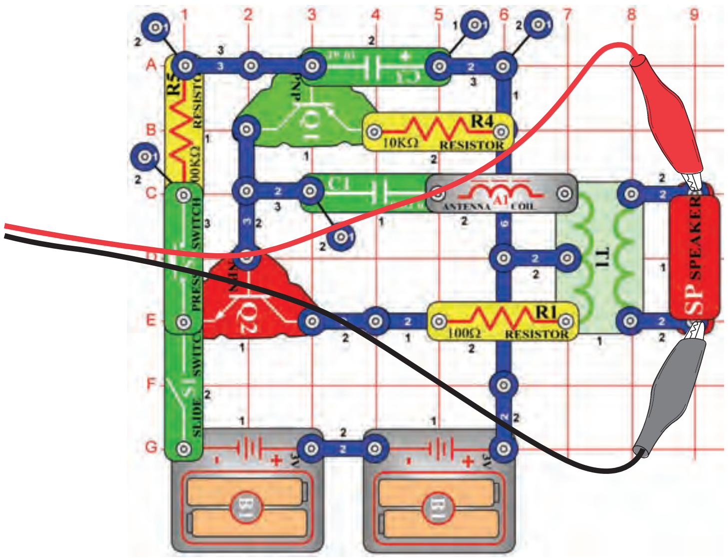
Project #PC64

Electronic Sound PC (II)

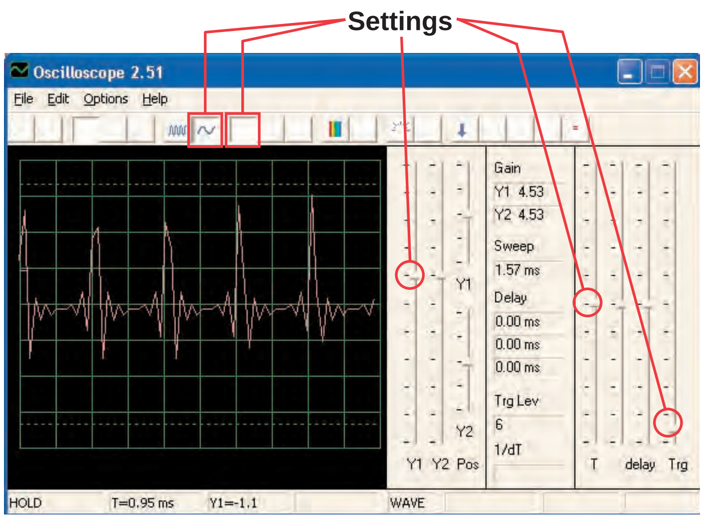
Replace the 100KΩ resistor R5 with the 10KΩ resistor R4, place the 0.1μF capacitor back in the circuit as before. Now you change the frequency by changing the resistance in the oscillator.

☐ Project #PC65
Siren PC

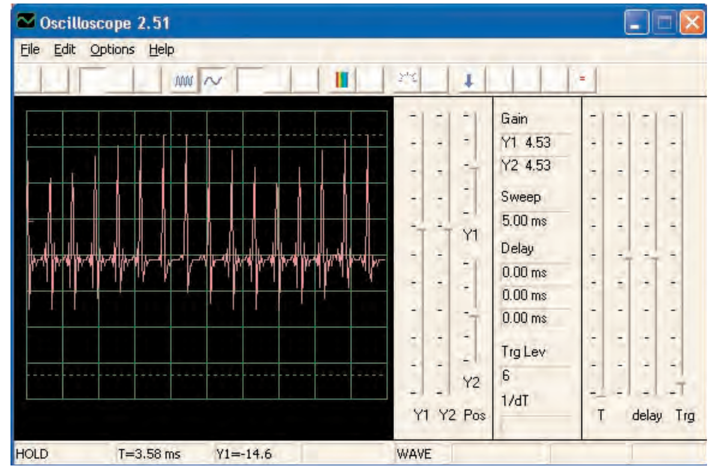
OBJECTIVE: To view the output of a fading siren circuit.



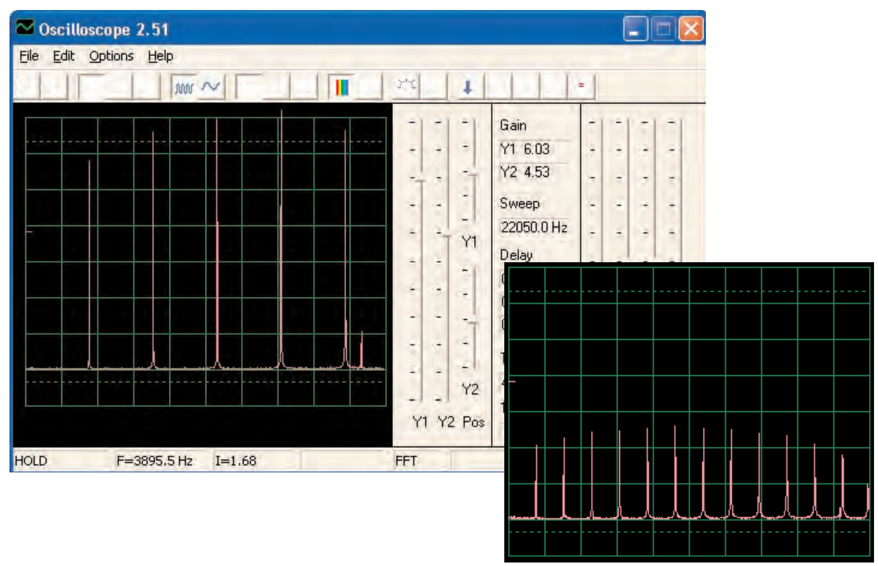
Build the circuit and try the **settings** shown. Flip on the slide switch and press the press switch for a few seconds and release. View the waveform as a siren starts up and then slowly fades away.



Note: Although the amplitude of the pulses appears to be varying across the screen (the wider time scale shown below shows this better), this is an illusion caused by the way Winscope measures the signal. The amplitude of the pulses is not really varying.



Winscope makes measurements using a 44kHz sampling rate, which is fast enough to measure the frequency of this signal (varying from 1-5kHz). However these pulses have much of their energy spread among higher frequencies that approach the sampling rate (see the sample spectrum plots at right), where the amplitude measurement becomes increasingly inaccurate.

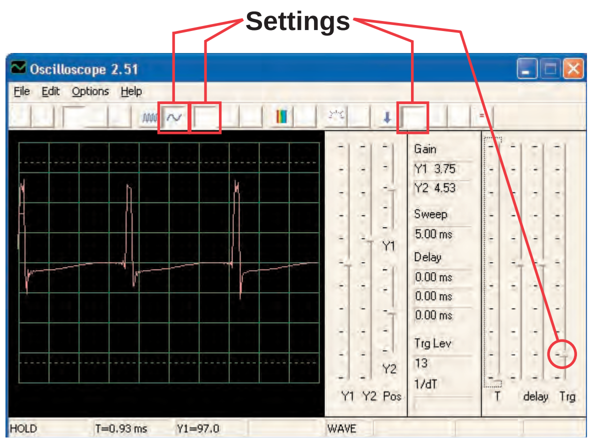


☐ Project #PC66

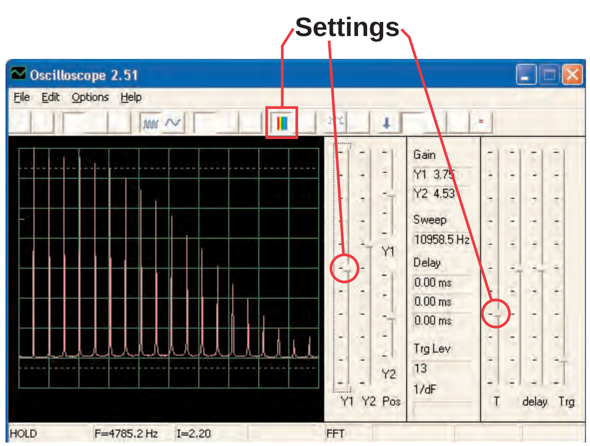
Drawing Resistors PC

OBJECTIVE: To draw your own resistors.

Use the circuit from the Drawing Resistors project #516, but connect the PC-interface cable across the speaker. Use a pencil to draw the shapes shown in projects #516-518, as per the directions given in those projects. Use Winscope to see how the waveforms and frequency spectrums vary as you move the jumper wires across the shapes to change the sounds. A sample is shown here.



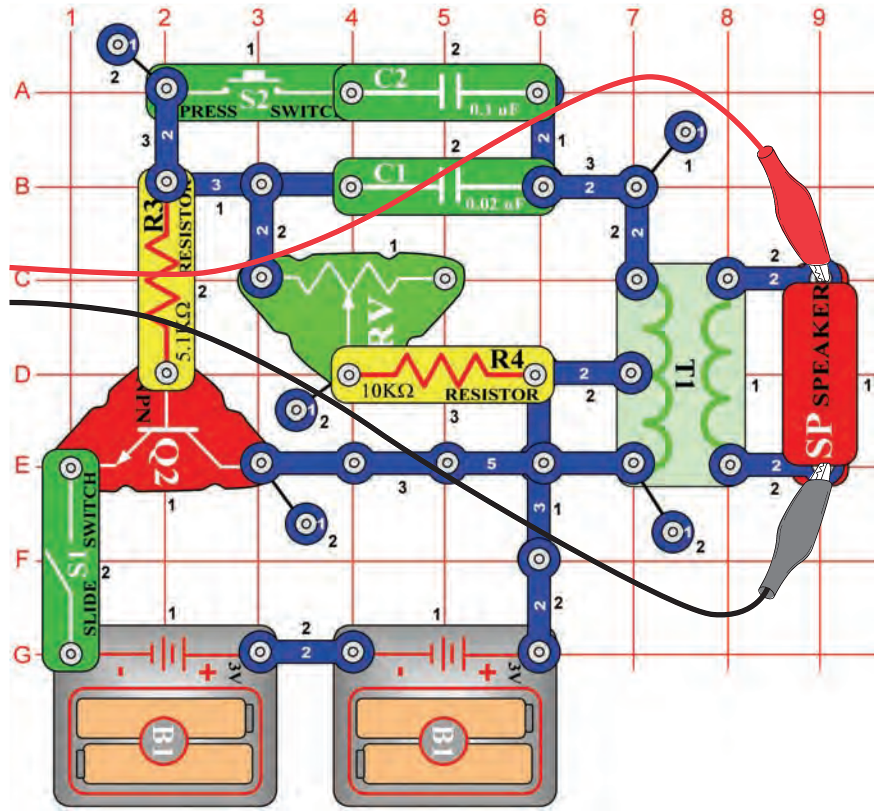
Next, place the loose ends of the jumper wires into a cup of water, as per project #519. The waveforms and frequency spectrum you see will be similar to the resistors you drew, just as the sounds are similar.



☐ Project #PC67

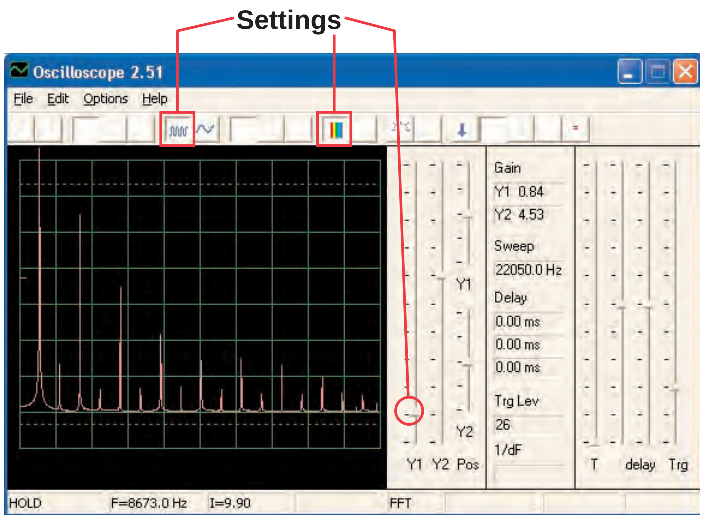
Electronic Noisemaker PC

OBJECTIVE: To view the output of an oscillator circuit.

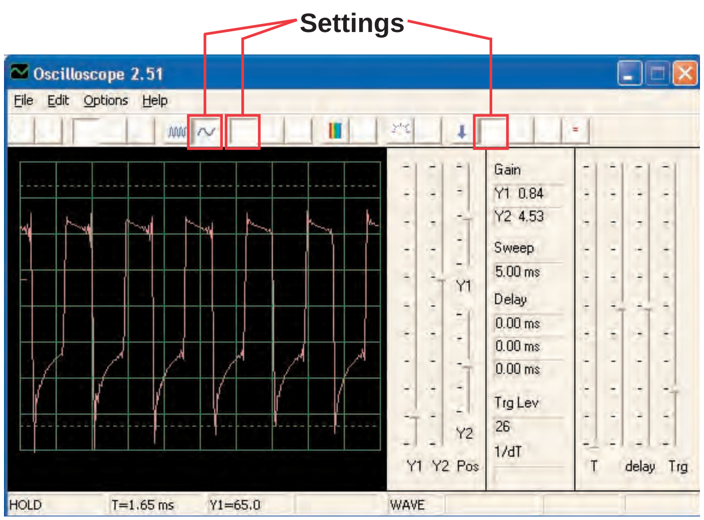


Build the circuit and try the settings shown. Flip on the slide switch and press the press switch a few times while moving the adjustable resistor control around. View the waveform and frequency spectrum.

Sample frequency spectrum:



Sample waveform:



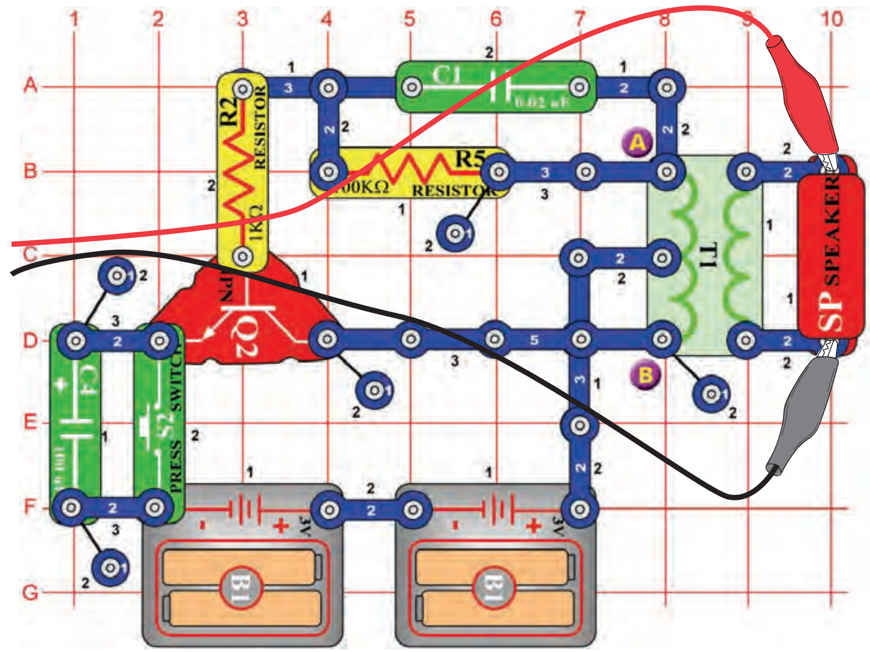
You can replace the 0.1μF capacitor C2 with the 10μF capacitor C3 ("+" on the right) to change the sound.

Project #PC68 Electronic Noisemaker PC (II)

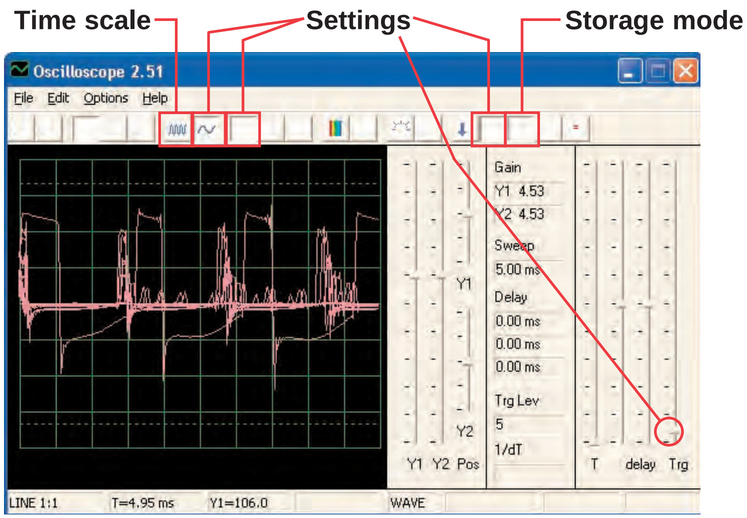
Replace the 10KΩ resistor R4 with the 100KΩ resistor R5. Now you change the frequency by changing the resistance in the oscillator.

Project #PC69 Bee PC

OBJECTIVE: *To view the output of an oscillator circuit.*



Build the circuit and press the press switch a few times, you hear cute sounds like a bumble bee. Use Winscope to see how the waveform fades away after you release the switch, and try **storage mode** as shown here.



You may replace the 0.02μF capacitor C1 with 0.1μF capacitor C2 or 10μF capacitor C3 ("+" on the right) to change the sound, but you may want to change the **time scale**.
You may also replace the 100μF capacitor C4 with the 10μF capacitor C3 or the 470μF capacitor C5 to change the duration of the sound.

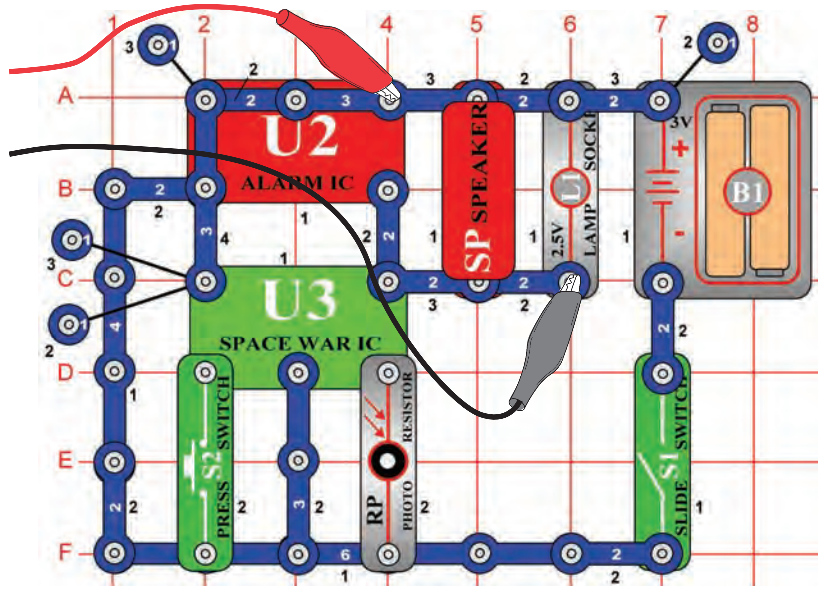
Project #PC70 Bee PC (II)

Remove the speaker from the circuit and place the whistle chip (WC) across the transformer at points labeled A & B on the circuit layout, connect the PC-interface cable across the whistle chip. Listen to the sounds and view the waveforms as you press the press switch. Replace the 0.02μF capacitor C1 with 0.1μF capacitor C2 or 10μF capacitor C3 ("+" on the right) to change the sound, or replace the 100μF capacitor C4 with the 10μF capacitor C3 ("+" on the right) or the 470μF capacitor C5 to change the duration.

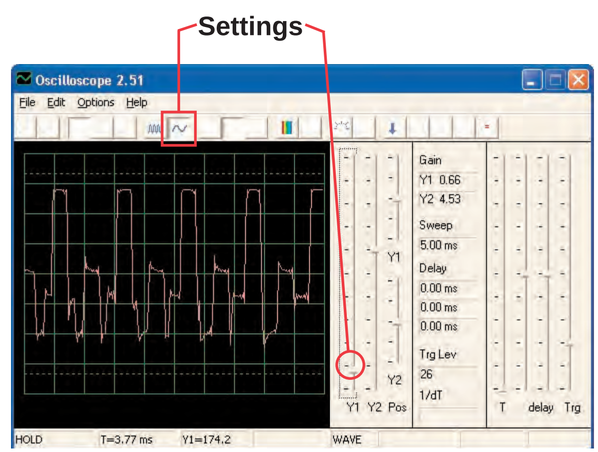
Project #PC71

Space War Alarm Combo PC

OBJECTIVE: To view the output of the combined outputs from the space war and alarm integrated circuits.



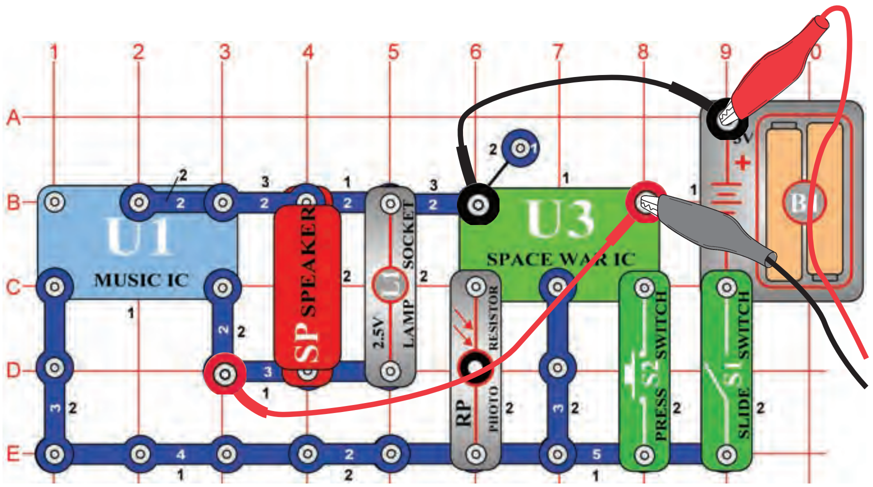
Build the circuit and try the settings shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to view all the sound combinations. You may also use FFT mode to view the frequency spectrum.



Project #PC72

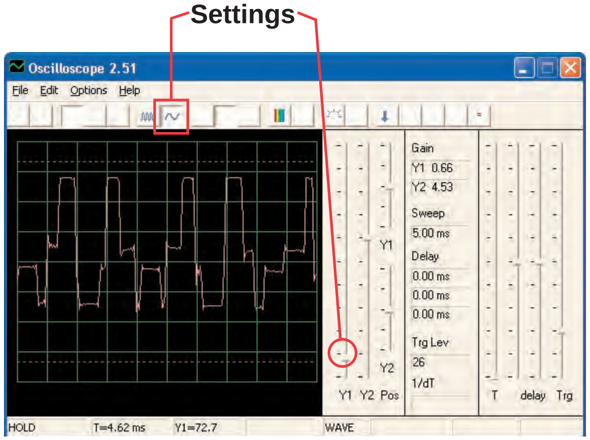
Space War Music Combo PC

OBJECTIVE: To view the output of the combined outputs from the space war and music integrated circuits.



Build the circuit and try the **settings** shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to view all the sound combinations. Compare the waveform and spectrum to the alarm IC combo circuit.

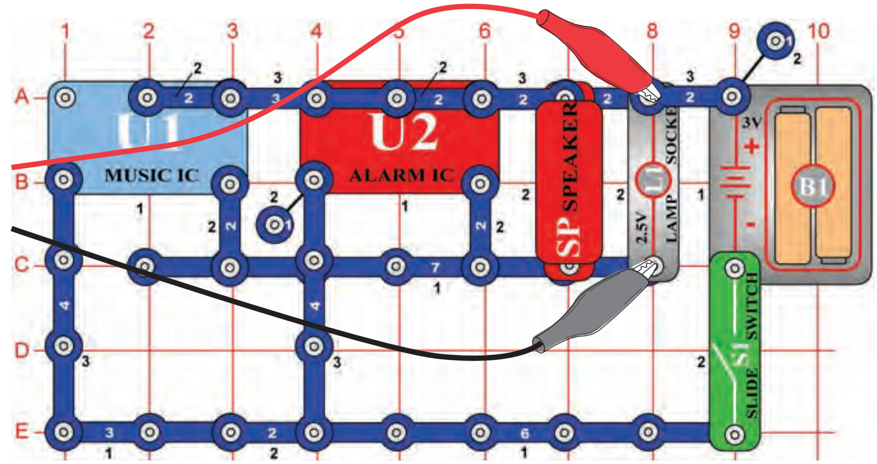
Settings



Project #PC73

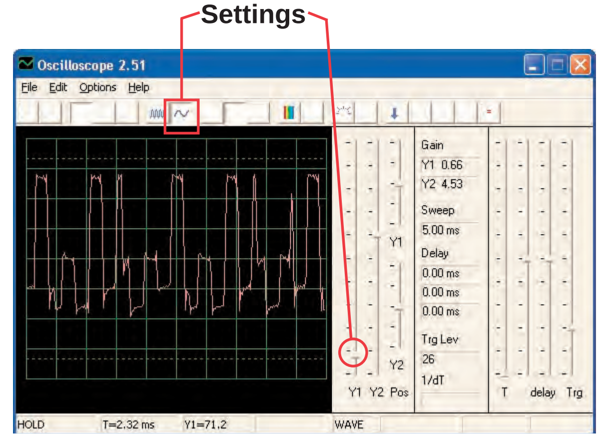
Sound Mixer PC

OBJECTIVE: To view the output of the music and alarm integrated circuits.



Build the circuit and try the **settings** shown. Turn it on and view the waveforms.

Settings



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