**Project 151 Clap Sounds**

**OBJECTIVE**: To build a police siren and other sounds that are controlled by clapping your hands.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base grid first. Then, assemble parts marked with a 2.

Turn on the slide switch (S1) and a police siren is heard and then stops, clap your hands and it will play again. Note however that music can be heard faintly in the background of the siren. If clapping does not trigger the sound, tap the whistle chip (WC) with your finger.

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**Project 152 More Clap Sounds**

Modify the last circuit by connecting points X & Y using the black jumper wire. The circuit works the same way but now it sounds like a machine gun.

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**Project 153 More Clap Sounds (II)**

Now remove the connection between X & Y and then make a connection between T & U. The circuit works the same way but now it sounds like a fire engine.

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**Project 154 More Clap Sounds (III)**

Now remove the connection between T & U and then make a connection between U & Z. The circuit works the same way but now it sounds like an ambulance.

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**Project 155 More Clap Sounds (IV)**

Now remove the connections between U & Z and between V & W, then make a connection between T & U. The circuit works the same way but now it sounds like a familiar song but with static.
**Space Battle (II)**

**OBJECTIVE:** To show another way of using the space war integrated circuit.

Turn on the switch and you will hear exciting sounds, as if a space battle is raging!

The motor is used here as a 3-snap wire, and will not spin.

**Project 157 Silent Space Battle**

The preceding circuit is loud and may bother people around you, so replace the speaker (SP) with the LED (D1), position it as in Project 32. Now you have a silent space battle.

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**Project 156**

**OBJECTIVE:** To show how integrated circuits sound can easily be changed to exciting space war sounds.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base grid first. Then, assemble parts marked with a 2.

When you close the slide switch (S1), the integrated circuit (U2) should start sounding a laser gun sound. This integrated circuit is designed to produce different sounds that can easily be changed. You can even switch the sound on and off quickly to add sound effects to your games or recordings.

---

**Project 158**

**OBJECTIVE:** To show how integrated circuits sound can easily be changed to exciting space war sounds.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base grid first. Then, assemble parts marked with a 2.

When you close the slide switch (S1), the integrated circuit (U2) should start sounding a laser gun sound. This integrated circuit is designed to produce different sounds that can easily be changed. You can even switch the sound on and off quickly to add sound effects to your games or recordings.
Project 159

**The Fuse**

**OBJECTIVE:** To show how a fuse is used to break all current paths back to the voltage source.

When you close the slide switch (S1), current flows from the batteries through the slide switch (S1), the lamp (L1), motor (M1), and back to the battery (B1). Pretend the 2-snap wire marked fuse in the drawing on the left is a device that will open the circuit if too much current is taken from the battery. When press switch (S2) is closed, the light is shorted and motor speed increases due to an increase in current to the motor. While still holding press switch (S2) down, remove the 2-snap wire marked fuse and notice how everything stops. Until the fuse is replaced, the open circuit path protects the electronic parts. If fuses did not exist, many parts could get hot and even start fires. Replace the 2-snap wire and the circuit should return to normal.

Many electronic products in your home have a fuse that will open when too much current is drawn. Can you name some?

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

Project 160

**One Direction for LED**

**OBJECTIVE:** To show how electricity can only pass in one direction through an LED.

When you close the slide switch (S1), current should flow from the batteries (B1) through the resistor and then through the LED. When current flows through an LED, it lights up. Since the LED is in backwards, current cannot flow. The LED is like a check valve that lets current flow in only one direction.

In this project, you changed the direction of current through the LED. An electronic component that needs to be connected in one direction is said to have polarity. Other parts like this will be discussed in future projects. Placing the LED in backwards does not harm it because the voltage is not large enough to break down this electronic component.
Objective: To build a circuit that uses your voice to control a light emitting diode.

Build the circuit shown on the left and turn on the slide switch (S1). The LED (D1) may be on for a while and then turn off. Clap or talk loud and the LED will light again and keep flickering for a little while.

Project 162 Voice Control

The preceding circuit probably did not seem too exciting; so replace the LED (D1) with the speaker (SP). You hear a range of exciting sounds. Clap or talk loud and the sounds will resume.

If you find that the sound does not turn off, then vibrations created by the speaker may be activating the whistle chip (WC). Set the speaker on the table near the circuit and connect it to the same locations using the jumper wires to prevent this.

Objective: To build a circuit that uses a motor to activate space war sounds.

Turn it on and wait for any sounds to stop then spin the motor (M1) and the sounds play again.

Do you know why turning the motor makes the sound play? Actually, the DC motor is also a DC generator and when you turn it, the motor generates a voltage that triggers the sound circuits.

Project 164 Motor Space Light

This circuit is loud and may bother other people around you so replace the speaker with the LED (D1), (position it like in Project 32); the circuit operates in the same manner.
**Project 165**

**Light-Controlled Flicker**

**OBJECTIVE:** To make a circuit that uses light to control the blinking of another light.

This circuit does not use the noisy speaker (SP) it uses a nice quiet LED (D1). Turn on the slide switch (S1), the LED flickers. Wait a few seconds, then cover the photoresistor (RP) and the flicker stops. The flicker is controlled by the photoresistor, uncover it and the flicker resumes.

People who are deaf need lights to tell them when a doorbell is ringing. They also use circuits like this to tell them if an alarm has been triggered or an oven is ready.

Can you think of other uses?

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**Project 166**

**More Sound Effects**

**OBJECTIVE:** To investigate the different sound effects available from the alarm integrated circuit.

Build the circuit shown on the left. When you close the slide switch (S1), the integrated circuit (U2) should start sounding an up-down siren. This is just one more sound effect that this integrated circuit is designed to produce. Different sounds that can easily be changed are very important when designing games and toys. Switch the sound on and off quickly and see if you can create even different effects. This mode will create many robotic sounds if switched quickly.
OBJECTIVE: To introduce you to the OR concept of electronic wiring.

Build the circuit shown. Notice that if you turn on the slide switch (S1) OR press the press switch (S2) the LED (D1) lights up. There is no partially lit state here, the diode is either totally on or totally off. While this may seem very simple and boring, it represents an important concept in electronics. Two switches like this may be used to turn on a light in your house, or they might be two sensors at a railroad crossing used to start the ding-ding sound and lower the gate. You could also have more than two switches and the circuit would function the same way.

COMBINATIONS OF AND AND OR CIRCUITS ARE USED TO ADD AND MULTIPLY NUMBERS TOGETHER IN MODERN COMPUTERS. THESE CIRCUITS ARE MADE OF TINY TRANSISTORS IN MASSIVE INTEGRATED CIRCUITS.
**Project 169**

**OBJECTIVE:** To demonstrate the concept of a NOR circuit.

Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the OR circuit in Project 167, you can see the LED lights in the opposite combinations of that circuit. Hence, we refer to it as a NOR circuit (short for “NOT this OR that”). Like the OR and AND, it is an important building block in computers.

**Neither This NOR That**

**Project 170**

**OBJECTIVE:** To demonstrate the concept of a NAND circuit.

Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the AND circuit in Project 168, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a NAND circuit (short for “NOT this AND that”). This circuit can also have more or less than two inputs, though when it only has one input it is referred to as a NOT circuit. Like the OR, AND, and NOR, NAND and NOT are important building blocks in computers.

**Not This AND That**
Reflection Detector

OBJECTIVE: To detect if a mirror is present.

Build the circuit at left. Place it where there won’t be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The lamp (L1) will be bright, but there should be no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now. You have a reflection detector! You can also use a white piece of paper instead of a mirror, since white surfaces reflect light.

Quieter Reflection Detector

OBJECTIVE: To detect a mirror.

Build the circuit at left. Place it where there won’t be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The lamp (L1) will be bright and one song may play, but then there should be no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now. You have a reflection detector! You can also use a white piece of paper instead of a mirror, since white surfaces reflect light.
**Project 173**

**Objectives:**
- To build the circuit used in a toy laser gun with flashing laser light and trigger.

When you press the press switch (S2), the integrated circuit (U2) should start sounding a very loud laser gun sound. The red LED will flash simulating a burst of laser light. You can shoot long repeating laser bursts, or short zaps by tapping the press switch.

**Project 174**

**Objectives:**
- To build a circuit using the space war IC to make exciting sounds.

Build the circuit shown on the left, which uses the Space War integrated circuit (U3).

Set the slide switch (S1) on and the speaker (SP) makes exciting sounds. The output of the IC can control lights, speakers, and other low power devices.

You may replace the speaker with the 2.5V lamp (L1), and the bulb will flicker. You can also use the LED (D1) in place of the lamp (position it with the “+” side towards the 6-snap).
**OBJECTIVE:** To build an electronic spinner.

**Setup:** Cut out the disc on the last page that looks like the one shown here. Using Scotch tape, attach the disc with the printed side up on the top of the fan blade. Place the blade on the motor (M1) as shown to the left and below.

When the press switch (S2) is pressed, the arcs will turn into colored rings with a black background. Notice how the color drops in brightness when it is stretched to make a complete circle.

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**Spinning Rings**

**Project 175**

Use the circuit from Project 175.

**Setup:** Place the spinning rings under a fluorescent light (T12 type only, which is 1.5” diameter) that runs on normal house current. Start the disc spinning and release the press switch (S2). As the speed changes you will notice the white lines first seem to move in one direction then they start moving in another direction. This effect is because the lights are blinking 60 times a second and the changing speed of the motor is acting like a strobe light to catch the motion at certain speeds. To prove this, try the same test with a flashlight. The light from a flashlight is constant and if all other lights are out, you will not see the effect that looks like a helicopter blade in a movie. Some fluorescent lights use an electronic ballast and they also produce a constant light.

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

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**Project 176 Strobe the House Lights**
**Project 177**

**Race Game**

*OBJECTIVE:* Build an electronic game for racing.

Modify Project 176 by adding the pointer as shown on the left. The paper should be cut from the last page and taped high enough on the speaker (SP) so the pointer will stick over the fan (M1) with paper. Bend the pointer at a right angle as shown on the left.

**Setup:** Cut out the grid with four (4) colors from the last page and place it under the base as shown on the left. Each player picks a color (or two colors if only 2 people are playing) and places a single snap on row G. The purple player in column 1, the blue player in column 2, the green player in column 3, and the yellow player in column 4. Spin the wheel by closing the press switch (S2). The first single color wedge that the pointer points to is the first player to start. In some models, you only have three 1-snaps, so use a 2-snap if you have four players.

**The Play:** Each player gets a turn to press the press switch. They release the press switch and when the pointer points to a wedge the players that match the colors on the wedge get to move up one space. If a liner comes up like the one shown on the left then the players on each side of the line get to move up two (2) spaces. The first player to reach the top row (A) wins. If two players reach the top row at the same time they must both drop down to row “D” and play continues.

---

**Project 178**

**Space War Flicker Motor**

*OBJECTIVE:* To run the motor using the space war IC.

Turn on the slide switch (S1) and the motor (M1) spins (you may need to give it a push with your finger to get it started). The sounds from the space war IC (U3) are used to drive the motor. Because the motor uses magnets and a coil of wire similar to a speaker, you may even hear the space war sounds coming faintly from the motor.
**Project 179**

Build the circuit below. It uses both jumper wires as permanent connections. It also uses two 2-snap wires as “shorting bars”.

**Setup:** Player 1 sets the target by placing one shorting bar under the paper on row B, C, or D. Player 2 must NOT know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing their shorting bar at positions X, Y, or Z. In the drawing on the left, Player 1 set up this hole at position “D”. If Player 2 places their shorting bar across “Z” on the first try then they get a hit. They keep guessing until they hit. After each hit, remove the shorting bars and slide the switch off and on to reset the sound. Player 2 then sets the B, C, D side and player 1 tries their luck.

Play multiple rounds and see who gets the best overall score. The winner will be the player who is best at reading their opponent’s mind.
**Project 180**

**Quiet Zone Game**

**OBJECTIVE:** Make and play the electronic game of “Quiet Zone”.

Use the circuit from **Project 66**, but place two 2-snap wires (“shorting bars”) under the paper sheet as shown on left.

**Setup:** Player 1 sets the “Quiet Zone” by placing 2 shorting bars under the paper on row A, B, C, or D, leaving only one open. Player 2 must NOT know where the shorting bars are located under the paper.

Both Player 1 and Player 2 are given 10 points. The object is for Player 2 to guess the location of the “Quiet Zone” by placing their shorting bar at positions X, Y, or Z. In the drawing on the left, Player 1 set up the “Quiet Zone” at position “C”. If Player 2 places their shorting bar across “Z” on the first try, the sounds played mean they have not found the “Quiet Zone” and they lose 1 point. They have three (3) tries to find the zone on each turn. Each time sounds are made, they lose a point.

Player 2 then sets the B, C, D side and player 1 starts searching. Play continues until one player is at zero points and makes sound during that player’s turn.

---

**Project 181**

**Space War Music Combo**

**OBJECTIVE:** To combine the sounds from the space war and music integrated circuits.

Build the circuit shown and add the jumpers to complete it. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to hear all the sound combinations. If the sound is too loud you may replace the speaker (SP) with the whistle chip (WC).
**Thyristor with Motor**

*OBJECTIVE: To make an Thyristor.*

Build the circuit shown and turn on the slide switch (S1). Nothing happens. Push and release the press switch (S2); the red LED (D1) flashes, turning on the PNP and NPN transistors (Q1 & Q2), which turn on the motor (M1) and fan. The motor will continue to run until you turn off the slide switch.

Transistors Q1 and Q2 act as a thyristor bistable switch, conducting electricity when their gate (the left side of Q2) is triggered (by pressing S2), and continuing to conduct until the circuit is turned off.

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**Thyristor with Light**

Replace the motor (M1) with the lamp (L1). The circuit works the same way.

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**Quiet Water Alarm**

*OBJECTIVE: To sound an alarm when water is detected.*

Sometimes you want a water alarm that can be heard but is not loud enough to be annoying or distracting, so let’s make one. We’ll also put a light on it that could be seen in a noisy room, in a real application you could use a powerful light that would be easily seen.

Build the circuit shown but initially leave the jumper wires outside the cup. Turn on the slide switch (S1); nothing happens. Place the jumper wires into a cup of water and an alarm sounds and the light comes on.
Project 185

Light-Controlled Lamp

OBJECTIVE: To turn a lamp on and off using light.

Cover the unit, turn the slide switch (S1) on, and notice that the lamp (L1) is off after a few seconds. Place the unit near a light and the lamp turns on. Cover the photoresistor (RP) and place it in the light again. The lamp will not turn on. The resistance of the photoresistor decreases as the light increases. The low resistance acts like a wire connecting point C to the positive (+) side of the battery (B1).

Project 186 Voice-Controlled Lamp

Remove the photoresistor (RP) and connect the whistle chip (WC) across points A & B. Turn the slide switch (S1) on and clap your hands or talk loud near the whistle chip (WC), the lamp will light. The whistle chip has a piezocrystal between the two metal plates. The sound causes the plates to vibrate and produce a small voltage. The voltage then activates the music IC (U1) and turns the lamp on.

Project 187 Motor-Controlled Lamp

Remove the whistle chip (WC) and connect the motor (M1) across points A & B. Turn the slide switch (S1) on and turn the shaft of the motor and the lamp (L1) will light. As the motor turns, it produces a voltage. This is because there is a magnet and a coil inside the motor. When the axis turns the magnetic field will change and generate a small current in the coil and a voltage across its terminals. The voltage then activates the music IC (U1).
**Project 188**

**Light-Controlled LED**

OBJECTIVE: To control an LED using light.

Cover the unit, turn the slide switch (S1) on, and notice that the LED (D1) is on for a few seconds and then goes off. Place the unit near a light and the LED will light. Cover the photoresistor (RP) and place it near the light again. The LED will not turn on. The resistance of the photoresistor decreases as the light increases.

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**Project 189 Sound-Controlled Time Delay LED**

Connect the whistle chip (WC) to points A1 and C1 on the base grid, then remove the photoresistor (RP). Turn the slide switch (S1) on and clap your hands or talk loud near the whistle chip, the LED (D1) will light. The whistle chip has a piezocrystal between the two metal plates. The sound causes the plates to vibrate and produce a small voltage. The voltage then activates the music IC (U1).

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**Project 190 Motor-Controlled Time Delay LED**

Remove the whistle chip (WC) and connect the motor (M1) across points A1 and C1 on the base grid. Turn the slide switch (S1) on and turn the shaft of the motor and the LED (D1) will light. As the motor turns, it produces a voltage. There is a magnet and a coil inside the motor. When the axis turns, the magnetic field will change and generate a small current across its terminals. The voltage then activates the music IC (U1).
Project 191
Lamp, Speaker & Fan in Parallel

OBJECTIVE: To show the power drop of components connected in parallel.

Leave the fan off the motor (M1). Turn on the slide switch (S1), the motor spins and the lamp (L1) turns on. Place the fan on the motor and press the press switch. The lamp is not as bright now, because it takes more power from the batteries (B1) to spin the motor with the fan on it, which leaves less battery power available to light the lamp. If you have weak batteries, the difference in lamp brightness will be more obvious because weaker batteries don’t have as much power to supply.

The speaker (SP) is being used as a low-value resistance here to make the above effects more apparent.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
OBJECTIVE: To draw an alarm activator.

Build the circuit shown and connect the two jumpers to it, leave the loose ends of the jumpers unconnected for now. There is one more part you need and you are going to draw it. Take a pencil (No. 2 lead is best but other types will also work), SHARPEN IT, and fill in the shape below. You will get better results if you place a hard, flat surface directly beneath this page while you are drawing. Press hard (but don’t rip the paper), and fill in the shape several times to be sure you have a thick, even layer of pencil lead.

Turn on the slide switch (S1) and take the loose ends of the jumpers, press them to the shape and move them around over the drawing. If you don’t hear any sound then move the ends closer together and move over the drawing, add another layer of pencil lead, or put a drop of water on the jumper ends to get better contact.

Project 193 Pencil Alarm Variants

Remove the jumper connected to point Y (as shown in the drawing) and connect it to point X instead. Touch the loose ends to the pencil drawing again, the sound is different now.

Next connect a 2-snap wire between points X & Y connect the jumper to either point. Touch the loose ends to the pencil drawing again, you hear a different sound.

Now remove the 2-snap wire between X & Y and connect it between X & Z, connect the jumpers to W & Y. Touch the loose ends to the pencil drawing again, you hear yet another sound.

Now you can draw your own shapes and see what kinds of sounds you can make.
Music Alarm Combo

OBJECTIVE: To combine the sounds from the music and alarm integrated circuits.

Build the circuit shown and add the jumper to complete it. Turn it on and you will hear a siren and music together. Press the press switch (S2) and the siren changes to a fire engine sound. After a few seconds, covering the photoresistor (RP) will stop the music (but the siren continues). The motor (M1) is used here as a 3-snap wire and will not spin.

Bomb Sound

OBJECTIVE: Build a circuit that sounds like a bomb dropping.

Turn the slide switch (S1) on and you hear the sound of a bomb dropping and then exploding. The LED (D1) lights and then flashes as the bomb explodes. This is one sound generated from the space war IC (U3).

Project 196 Bomb Sound (II)

Replace the slide switch (S1) with the motor (M1). Turn the shaft on the motor and now it sounds like a bunch of bombs dropping.
**Project 197 Light-Controlled LED (II)**

OBJECTIVE: Build a circuit that turns an LED on and off if there is light present.

When there is light on the photoresistor (RP), the LED (D1) will flicker. Shield the photoresistor from the light, the LED should turn off.

---

**Project 198 Touch Light**

Replace the photoresistor (RP) with the whistle chip (WC). Tap on the whistle chip and the LED (D1) flickers. Tap again and the LED may flicker for a longer time. See how long the LED will stay on.

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**Project 199 Touch Sound**

Replace the LED (D1) with the speaker (SP). Now you can hear the different sound as you tap on the whistle chip (WC).
**Space War Flicker LED**

*OBJECTIVE: Flash an LED using the space war IC.*

Build the circuit shown on the left. The circuit uses the alarm (U2) and space war (U3) ICs to flash the LED (D1). Turn the slide switch (S1) on and the LED starts flashing.

---

**Music AND Gate**

*OBJECTIVE: To build an AND gate.*

You will only hear music if you turn on the slide switch (S1) AND press the press switch (S2). This is referred to as an AND gate in electronics. This concept is important in computer logic.

**Example:** If condition X AND condition Y are true, then execute instruction Z.
**Project 202**

**Noisier Water Space War**

*OBJECTIVE: To use water to control the space war integrated circuit.*

Add the press switch (S2) to the preceding circuit to make it look like the one at left. There will be sound if the press switch is pressed or the jumper wires are in the water.

Pressing the press switch or pulling the wires out of the water changes the sound played.

**Project 203 Light/Water Space War**

Replace the speaker (SP) with the LED (D1, “+” on top). Putting the jumper wires in the water OR pressing the press switch (S2) will cause the LED to be bright.
Project 204

OBJECTIVE: To build a middle-frequency oscillator.

Build the circuit; as the name suggests this circuit is similar to that in Project 206. Turn it on, you hear a middle-frequency sound.

Project 205 More Tone Generator (II)

Place the 0.02\(\mu\)F capacitor (C1) or the 0.1\(\mu\)F capacitor (C2) on top of the whistle chip (WC). The sound is different now because the added capacitance has lowered the frequency. The LEDs appear to be on, but are actually blinking at a very fast rate.

Project 206 More Tone Generator (II)

Now place the 10\(\mu\)F capacitor (C3) on top of the whistle chip (WC). You hear a clicking sound as the LEDs blink about once a second.
**Project 207**

**Spacey Fan**

**OBJECTIVE:** To build a fan with sound that is activated by light.

Place the fan onto the motor (M1). Sounds are heard if light shines on the photoresistor (RP) OR if you press the press switch (S2), the fan may start to spin, but will only get to high speed if you do BOTH. Try various combinations of shining light and holding down the press switch.

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

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**Project 208**

**Two-Transistor Light Alarm**

**OBJECTIVE:** To compare transistor circuits.

This light alarm circuit uses two transistors (Q1 & Q2) and both sets of batteries. Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the lamp (L2) turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

**Project 209**

**PNP Collector**

**OBJECTIVE:** To demonstrate adjusting the gain of a transistor circuit.

Build the circuit and vary the lamp (L2) brightness with the adjustable resistor (RV), it will be off for most of the resistor’s range. The point on the PNP (Q1) that the lamp is connected to (point E3 on the base grid) is called the collector, hence the name for this project.

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

---

**Project 210**

**PNP Emmitter**

**OBJECTIVE:** To compare transistor circuits.

Compare this circuit to that in Project 128. The maximum lamp (L2) brightness is less here because the lamp resistance reduces the emitter-base current, which contacts the emitter-collector current (as per Project 128). The point on the PNP (Q1) that the lamp is now connected to (grid point C3) is called the emitter.
OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in Project 209, it is the NPN transistor (Q2) version and works the same way. Which circuit makes the lamp (L2) brighter? (They are about the same because both transistors are made from the same materials).

OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in Project 210. It is the NPN transistor (Q2) version and works the same way. The same principles apply here as in projects 209-211, so you should expect it to be less bright than 211 but as bright as 210.

OBJECTIVE: To compare transistor circuits.

Place the motor with the positive (+) side touching the NPN and put the fan on it. The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

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

OBJECTIVE: To compare transistor circuits.

Place the motor with the positive (+) side to the right and put the fan on it. Compare the fan speed to that in Project 213. Just as the lamp was dimmer in the emitter configuration, the motor is not as fast now.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
Project 215

**OBJECTIVE:** To make a circuit that buzzes when the lights are off.

This circuit makes a high-frequency screaming sound when light shines on the photoresistor (RP), and makes a buzzing sound when you shield the photoresistor.

**Project 216 Touch Buzzer**

Remove the photoresistor (RP) from the circuit in Project 215 and instead touch your fingers across where it used to be (points B1 and D1 on the grid) to hear a cute buzzing sound.

The circuit works because of the resistance in your body. If you put back the photoresistor and partially cover it, you should be able to make the same resistance your body did, and get the same sound.

**Project 217 High Frequency Touch Buzzer**

Replace the speaker (SP) with the 6V lamp (L2). Now touching your fingers between B1 and D1 creates a quieter but more pleasant buzzing sound.

**Project 218 High Frequency Water Buzzer**

Now connect two (2) jumpers to points B1 and D1 (that you were touching with your fingers) and place the loose ends into a cup of water. The sound will not be much different now, because your body is mostly water and so the circuit resistance has not changed much.

**Project 219 Mosquito**

Place the photoresistor (RP) into the circuit in Project 218 across where you were connecting the jumpers (points B1 and D1 on the grid, and as shown in Project 215). Now the buzz sounds like a mosquito.
OBJECTIVE: To build a radio music alarm.

You need an AM radio for this project. Build the circuit on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting. Then, tune the adjustable capacitor (CV) until your music sounds best on the radio. Now connect a jumper wire between X and Y on the drawing, the music stops. If you remove the jumper now, the music will play indicating your alarm wire has been triggered. You could use a longer wire and wrap it around a bike, and use it as a burglar alarm!

Remove the jumper wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play music as long as there is light in the room.

Put the 100kΩ resistor back in as before and instead connect the photoresistor between X & Y (you also need a 1-snap and a 2-snap wire to do this). Now your radio plays music when it is dark.

Replace the music IC (U1) with the alarm IC (U2). Now your radio plays the sound of a machine gun when it is dark.

Remove the jumper wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play the machine gun sound as long as there is light in the room.
Project 226

OBJECTIVE: To combine sounds from the integrated circuits.

Build the circuit shown and add the two (2) jumper wires to complete it. Note that in one place two (2) single snaps are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun! Do you know why the antenna (A1) is used in this circuit? It is being used as just a 3-snap wire, because it acts like an ordinary wire in low frequency circuits such as this. Without it, you don’t have enough parts to build this complex circuit.

Project 227 Police Car Symphony (II)

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project 228

Ambulance Symphony

OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Modify the circuit from Project 226 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

Project 229 More Clap Sounds (III)

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).
**Project 230**

**Static Symphony**

*OBJECTIVE: To combine sounds from the integrated circuits.*

Build the circuit shown. Note that in some places parts are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

**Project 231 Static Symphony (II)**

For a variation on the preceding circuit, you can replace the 6V lamp (L2) with the LED (D1), with the positive (+) side up, or the motor (M1) (do not place the fan on it).

**Project 232**

**Standard Transistor Circuit**

*OBJECTIVE: To save some electricity for later use.*

Turn on the slide switch (S1) and move the adjustable resistor (RV) control lever across its range. When the lever is all the way down the LED (D1) will be off, as you move the lever up it will come on and reach full brightness.

This circuit is considered the standard transistor configuration for amplifiers. The adjustable resistor control will normally be set so that the LED is at half brightness, since this minimizes distortion of the signal being amplified.
OBJECTIVE: To show how water conducts electricity.

Build the circuit at left and connect the two jumpers to it, but leave the loose ends of the jumpers lying on the table initially. Turn on the slide switch (S1) - the LED (D1) will be dark because the air separating the jumpers has very high resistance. Touch the loose jumper ends to each other and the LED will be bright, because with a direct connection there is no resistance separating the jumpers.

Now take the loose ends of the jumpers and place them in a cup of water, without letting them touch each other. The LED should be dimly lit, indicating you have detected water!

For this experiment, your LED brightness may vary depending upon your local water supply. Pure water (like distilled water) has very high resistance, but drinking water has impurities mixed in that increase electrical conduction.

OBJECTIVE: To show how adding salt to water changes water’s electrical characteristics.

Place the jumpers in a cup of water as in the preceding project; the LED (D1) should be dimly lit. Slowly add salt to the water and see how the LED brightness changes, mix it a little so it dissolves. It will slowly become very bright as you add more salt. You can use this bright LED condition as a saltwater detector! You can then reduce the LED brightness by adding more water to dilute the salt.

Take another cup of water and try adding other household substances like sugar to see if they increase the LED brightness as the salt did.
**Project 235**
**PNP Light Control**

*OBJECTIVE: To compare transistor circuits.*

Turn on the slide switch (S1), the brightness of the LED (D1) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current through the PNP (Q1). This is similar to the NPN (Q2) circuit in Project 85.

**Project 236**
**PNP Dark Control**

*OBJECTIVE: To compare transistor circuits.*

Turn on the slide switch (S1), the brightness of the LED (D1) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, so more current gets to the 100kΩ resistor (R5) from the photoresistor path and less from the PNP-diode path. This is similar to the NPN circuit in Project 86.

**Project 237**
**Current Equalizing**

*OBJECTIVE: To compare types of circuits.*

In this circuit the LEDs (D1 & D2) will have the same brightness, but the lamp (L1) will be off. When connected in series, all components will have equal electric current through them. The lamp is off because it requires a higher current through the circuit to turn on than the LEDs do.

**Project 238**
**Battery Polarity Tester**

*OBJECTIVE: To test the polarity of a battery.*

Use this circuit to check the polarity of a battery. Connect your battery to X & Y on the drawing using the jumper cables (your 3V battery pack (B1) can also be snapped on directly instead). If the positive (+) side of your battery is connected to X, then the red LED (D1) will be on, if the negative (−) side is connected to X then the green LED (D2) will be on.
**Project 239 Blow Off a Doorbell**

OBJECTIVE: To turn off a circuit by blowing on it.

Build the circuit and turn it on; music plays. Since it is loud and annoying, try to shut it off by blowing into the microphone (X1). Blowing hard into the microphone stops the music, and then it starts again.

**Project 240 Blow Off a Candle**

Replace the speaker (SP) with the 6V lamp (L2). Blowing hard into the microphone (X1) turns off the light briefly.

**Project 241 Blow On a Doorbell**

OBJECTIVE: To turn on a circuit by blowing on it.

Build the circuit and turn it on, music plays for a few moments and then stops. Blow into the microphone (X1) and it plays; it plays as long as you keep blowing.

**Project 242 Blow On a Candle**

Replace the speaker (SP) with the 6V lamp (L2). Blowing into the microphone (X1) turns on the light, and then it goes off again.
Project 243

**Light Alarm**

*OBJECTIVE: To build a transistor light alarm.*

Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the light turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

**Project 244 Brighter Light Alarm**

Modify the preceding circuit by replacing the LED (D1) with the 2.5V lamp (L1) and replacing the 5.1kΩ resistor (R3) with the 100Ω resistor (R1). It works the same way but is brighter now.

Project 245

**Lazy Fan**

*OBJECTIVE: To build a fan that doesn't work well.*

Press the press switch (S2) and the fan will be on for a few turns. Wait a few moments and press again, and the fan will make a few more turns.

**Project 246 Laser Light**

Replace the motor (M1) with the 6V lamp (L2). Now pressing the press switch (S2) creates a blast of light like a laser.

**WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
**Project 247**

**Water Alarm**

**OBJECTIVE:** To sound an alarm when water is detected, tone will vary with salt content.

Build the circuit at left and connect the two (2) jumpers to it, place the loose ends of the jumpers into an empty cup (without them touching each other). Press the press switch (S2) - nothing happens. Add some water to the cup and an alarm will sound. Add salt to the water and the tone changes.

You can also test different liquids and see what tone they produce.

**Project 248**

**Flooding Alarm**

**OBJECTIVE:** To sound an alarm when water is detected.

Build the circuit on the left and connect the two (2) jumpers to it, place the loose ends of the jumpers into an empty cup (without them touching each other). Turn on the slide switch (S1) - nothing happens. This circuit is designed to detect water and there is none in the cup. Add some water to the cup - an alarm sounds!

You can use longer jumper wires and hang them near your basement floor or next to your sump pump to give a warning if your basement is being flooded. Note that if the loose jumper ends accidentally touch then you will have a false alarm.
**Project 249**

**Motor & Lamp by Light**

**OBJECTIVE:** To control a motor using light.

Turn the slide switch (S1) on, the motor (M1) spins and the lamp (L2) lights. As you move your hand over the photoresistor (RP), the motor slows. Now place finger onto the photoresistor to block the light. The motor slows down. In a few seconds, the motor speeds up again.

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

---

**Project 250**

**Lamp Brightness Control**

**OBJECTIVE:** To use a transistor combination to control a lamp.

Here is a combination with two transistors. This combination increases the amplifying power. By changing the resistance, the current at the base of the transistor is also changed. With this amplifying ability of the combination, there is a greater change of current to the lamp (L1). This changes the brightness.

---

**Project 251 Electric Fan**

Use the preceding circuit. Replace the lamp (L1) with the motor (M1) and install the fan. By controlling the adjustable resistor (RV), the speed of the fan changes. Now you can make your own speed changing electric fan.

**WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
**Project 252**

OBJECTIVE: To learn about the most important component in electronics.

When you place one or more fingers across the two snaps marked X & Y you will notice the LED (D1) turns on. The two transistors are being used to amplify the very tiny current going through your body to turn on the LED. Transistors are actually electrical current amplifiers. The PNP transistor (Q1) has the arrow pointing into the transistor body. The NPN transistor (Q2) has the arrow pointing out of the transistor body. The PNP amplifies the current from your fingers first, then the NPN amplifies it more to turn on the LED.

**Project 253 Pressure Meter**

Use the preceding circuit. When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in Project 252. Repeat this process, but this time press very lightly on the two snaps marked X & Y. Notice how the brightness of the LED is dependent on the amount of pressure you use. Pressing hard makes the LED bright while pressing very gently makes it dim or even flash. This is due to what technicians call “contact resistance”. Even switches made to turn your lights on and off have some resistance in them. When large currents flow, this resistance will drop the voltage and produce the undesirable side effect of heat.

**Project 254 Resistance Meter**

Use the circuit from Project 252 shown above

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in Project 252. In this project, you will place different resistors across R & Z and see how bright the LED glows. Do not snap them in; just press them up against the snaps labeled R & Z in the diagram above.

First, place the 100kΩ resistor (R5) across the R & Z snaps and note the brightness of the LED. Next, press the 5.1kΩ resistor (R3) across R & Z. Notice how the LED gets brighter when the resistance is less. This is because the NPN amplifier (Q2) gets more current at its input when the resistance is lower. The PNP amplifier (Q1) is not used in this test.
**Morse Code Generator**

**OBJECTIVE:** To make a Morse code generator and learn to generate code.

When you press down on the press switch (S2) you will hear a tone. By pressing and releasing the press switch you can generate long and short tones called Morse code. For International code, a short tone is represented by a “+”, and a long tone by a “–”. See the chart below for letter or number followed by code.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Morse Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>+ –</td>
</tr>
<tr>
<td>B</td>
<td>– + + +</td>
</tr>
<tr>
<td>C</td>
<td>– + – +</td>
</tr>
<tr>
<td>D</td>
<td>– + +</td>
</tr>
<tr>
<td>E</td>
<td>+</td>
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<tr>
<td>F</td>
<td>+ + – +</td>
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<td>G</td>
<td>– – +</td>
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<td>H</td>
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<td>N</td>
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<td>O</td>
<td>– – –</td>
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<td>Q</td>
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<td>– – – – +</td>
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<td>0</td>
<td>– – – – –</td>
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</tbody>
</table>

Use the circuit from **Project 255** shown above. Replace the speaker with a 100Ω resistor (R1) so you can practice generating the Morse code without the loud speaker. Have someone transmit code and watch the LED. Tell them the letter or number after each is generated. When you have learned code, replace the speaker.

**Project 256 LED Code Teacher**

Use the circuit from **Project 255** shown above. Replace the speaker with a 100Ω resistor (R1) so you can practice generating the Morse code without the loud speaker. Have someone transmit code and watch the LED. Tell them the letter or number after each is generated. When you have learned code, replace the speaker.

**Project 257 Ghost Shriek Machine**

Use the circuit from **Project 255** shown above, but change the 1kΩ resistor (R2) to a 10kΩ resistor (R4), and 0.1mF capacitor (C2) to the whistle chip (WC). While holding the press switch (S2) down, adjust both the adjustable resistor (RV) and the whistle chip for a ghost like sound. At certain settings, sound may stop or get very faint.

**Project 258 LED Code Speaker**

Use the circuit from **Project 255** shown above. Try and find a person that already knows the Morse code to send you a message with both sound and LED flashing. Try in a dark room first so LED (D1) is easier to see. Morse code is still used by many amateur radio operators to send messages around the world.

**Project 259 Dog Whistle**

Use the circuit from **Project 255** shown above, but change the 1kΩ resistor (R2) to the 100Ω resistor (R1). While holding down the press switch (S2), move the slider on the adjustable resistor (RV) around. When the slider is near the 100Ω resistor you won’t hear any sound, but the circuit is still working. This oscillator circuit is making sound waves at a frequency too high for your ears to hear. But your dog may hear it, because dogs can hear higher frequencies than people can.
OBJECTIVE: To make an electronic game of mind reading.

Build the circuit shown on the left. It uses two (2) 2-snap wires as shorting bars.

Setup: Player 1 sets up by placing one shorting bar under the paper on row A, B, C, or D. Player 2 must NOT know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left, Player 1 set up at position “D”. If Player 2 places his shorting bar across “Z” on the first try, then he guessed correctly and marks a 1 on the score card sheet under that round number. If it takes three tries, then he gets a three. Player 2 then sets the A, B, C, D side and Player 1 tries his luck. Each player records his score for each round. When all 18 rounds have been played, the player with the lowest score wins. Additional players can play. Use the score card below to determine the winner.

<table>
<thead>
<tr>
<th>Round #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>16</th>
<th>17</th>
<th>18</th>
<th>Total</th>
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<td>Player 1</td>
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<td>Player 2</td>
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<td>Player 3</td>
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<td>Player 4</td>
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</table>
**Project 261**

**Enhanced Quiet Zone Game**

**OBJECTIVE:** Make and play the electronic game of “Quiet Zone”.

Use the circuit from Project 260, but place three (3) 2-snap wires (“shorting bars”) under paper as shown on left.

**Setup:** Player 1 sets the “Quiet Zone” by placing three (3) shorting bars under the paper on row A, B, C, or D, leaving only one open. Player 2 must NOT know where the shorting bars are located under the paper.

Both Player 1 and Player 2 are given 10 points. The object is for Player 2 to guess the location of the “Quiet Zone” by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left Player 1 set up the “Quiet Zone” at position “C”. If Player 2 places his shorting bar across “Z” on the first try, the sounds played mean he has not found the “Quiet Zone” and he loses 1 point. He has 3 tries to find the zone on each turn. Each time sounds are made he loses a point.

Player 2 then sets the A, B, C, D side and Player 1 starts searching. Play continues until one player is at zero points and makes sound during that players turn.

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**Project 262**

**Space War Amplifier**

**OBJECTIVE:** To amplify sounds from the space war integrated circuit.

Build the circuit, turn on the slide switch (S1), and press the press switch (S2) several times. You will hear loud space war sounds, since the sound from the space war IC (U3) is amplified by the power amplifier IC (U4).

Nearly all toys that make sound use a power amplifier of some sort.
**Objective:** To combine sounds from the music, alarm, and space war integrated circuits.

Build the circuit shown and add the jumper to complete it. Note that in two places two single snaps are stacked on top of each other. Also, note that there is a 2-snap wire on layer 2 that does not connect with a 4-snap wire that runs over it on layer 4 (both touch the music IC, U1). Turn it on and press the press switch (S2) several times and wave your hand over the photosensor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

**Project 264 Fire Engine Symphony (II)**

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Can you guess why the jumper is used in this circuit? It is being used as just a 6-snap wire, because without it you don’t have enough parts to build this complex circuit.

**Project 265 Vibration or Sound Indicator**

**Objective:** To build a circuit that is activated by vibration or sound.

Turn on the slide switch (S1), the war sounds start playing and the LED (D1) flashes. When all of the sounds are played, the circuit stops. Clap your hands next to the whistle chip (WC) or tap on it. Any loud sound or vibration causes the whistle chip to produce a small voltage, which activates the circuit. You can repeat a sound by holding down the press switch (S2) while it is playing.
**Project 266**

**Space Battle**

*OBJECTIVE: To make space battle sounds.*

Build the circuit shown on the left. Activate the circuit by turning on the slide switch (S1) or pressing the press switch (S2), do both several times and in combination. You will hear exciting sounds and see flashing lights, as if a space battle is raging!

**Project 267 Space Battle (II)**

Replace the slide switch (S1) with the photoresistor (RP). Now covering and uncovering the photoresistor will change the sound.

**Project 268**

**Multi-Speed Light Fan**

*OBJECTIVE: To vary the speed of a fan activated by light.*

Build the circuit shown on the left, with the fan on the motor (M1). This circuit is activated by light on the photoresistor, (RP) though the fan will barely turn at all. Press the press switch (S2) and the fan will spin. If you hold the press switch down, the fan will spin faster. If you cover the photoresistor, the fan will stop unless the press switch is pressed.

**Project 269 Light & Finger Light**

In the circuit at left, replace the motor (M1) with the 2.5V lamp (L1). Vary the brightness of the lamp by covering the photoresistor (RP) and holding down the press switch (S2) in various combinations. Notice that pressing the press switch when the photoresistor is covered still turns on the lamp, while in Project 250, doing this would turn off the motor.

**WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
**Project 270**

**OBJECTIVE:** To change the speed of a tune.

Build the circuit shown and turn on the slide switch \((S1)\); a tune plays. Push the press switch \((S2)\) to make the tune play a little faster.

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**Project 271**

**Light Dimmer**

**OBJECTIVE:** To build a light dimmer.

Press the press switch \((S2)\) to complete the current’s path flow. You might expect the LED \((D1)\) to light instantly but it doesn’t. The charging current flows into the 100\(\mu\)F capacitor \((C4)\) first. As the capacitor charges, the charging current decreases, input current to the PNP transistor \((Q1)\) increases. So current begins to flow to the LED and the LED gradually brightens.

Now release the press switch. The capacitor begins to discharge, sending input current to the transistor. As the capacitor discharges, the input current reduces to zero and gradually turns off the LED and the transistor.
**Fan Modulator**

**OBJECTIVE:** To modulate the brightness of an LED.

Using the fan outline as a guide, cut a 3” circle out of a piece of paper. Then, cut a small triangle in it as shown. Tape the circle onto the fan and then place it onto the motor (M1). Set the adjustable resistor (RV) to the center position and turn the slide switch (S1) on. Press the press switch (S2), the fan spins and the lamp (L1) lights. As the triangle opening moves over the photoresistor (RP), more light strikes it. The brightness of the LED changes, or is modulated. As in AM or FM radio, modulation uses one signal to modify the amplitude or frequency of another signal.

**Motion Detector (II)**

**OBJECTIVE:** To build a motion detector that senses an objects movement.

Turn the slide switch (S1) on and move the adjustable resistor (RV) control all the way up. The brightness of the LED (D1) is at maximum. Now, move the adjustable resistor control down until the LED goes out. Set the control up a little and the LED lights dimly.

Move your hand from side to side over the photoresistor (RP). As your hand blocks the light, the LED goes out.

The amount of light changes the resistance of the photoresistor and the current flow to the base of the NPN transistor (Q2). The transistor acts like a switch. Its base current is supplied through the photoresistor. As the base current changes, so does the current flow through the LED. With no base current, the LED goes out.
**Project 274**

**Motor Rotation**

*OBJECTIVE:* To show how voltage polarity affects a DC motor.

Place the fan onto the motor (M1). Press the press switch (S2). The fan rotates clockwise. When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Release the press switch and turn on the slide switch (S1). Now the fan spins the other way. The positive (+) side of the battery is connected to the negative (–) side of the motor. The polarity on the motor determines which way it rotates.

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

**Project 275**

**Motor Delay Fan**

*OBJECTIVE:* To build a circuit that controls how long the fan is on.

Place the fan onto the motor (M1) and set the adjustable resistor (RV) control to the far right. Turn the slide switch (S1) on and then press the press switch (S2) once. The motor will spin and then stop. Now set the resistor control to the far left and press the press switch again. The time the fan spins is much less now. When the press switch is pressed, the current flows through the circuit and the fan spins. The 100 μF capacitor (C4) charges up also. When the press switch is released, the capacitor discharges and supplies the current to keep the transistors (Q1 & Q2) on. The transistor acts like a switch connecting the fan to the battery. When the capacitor fully discharges, the transistors turn off and the motor stops. The adjustable resistor controls how fast the capacitor discharges. The more resistance, the longer the discharge time.

**Project 276 Motor Delay Fan (II)**

Use the preceding circuit. Connect a single snap under the positive (+) side of the 470 μF capacitor (C5) and then connect it over the top of the 100 μF capacitor (C4). Turn the slide switch (S1) on and press the press switch (S2). Notice that the fan spins longer now. When capacitors are in parallel, the values are added, so now you have 570 μF. The time it takes to discharge the capacitors is longer now, so the fan keeps spinning.

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

**OBJECTIVE:** To build a high pitch bell.

Build the circuit shown and push the press switch (S2). The circuit starts to oscillate. This generates the sound of a high pitch bell.

**Project 278 Steamboat Whistle**

Use the preceding circuit but connect the 0.02\(\mu\)F capacitor (C1) across the whistle chip (WC). Push the press switch (S2). The circuit now generates the sound of a steamboat.

**Project 279 Steamship**

Use the preceding circuit but replace the 0.02\(\mu\)F capacitor (C1) with the 0.1\(\mu\)F capacitor (C2). Push the press switch (S2). The circuit now generates the sound of a steamship.

**Project 280 Dot-Dot-Dot**

Use the preceding circuit but replace the 0.1\(\mu\)F capacitor (C2) with the 10\(\mu\)F capacitor (C3). Push the press switch (S2). The circuit now generates a beeping sound.

**Light NOR Gate**

**OBJECTIVE:** To build a NOR gate.

Build the circuit on the left. You will find that the lamp (L1) is on when neither the slide switch (S1) NOR the press switch (S2) are on. This is referred to as an NOR gate in electronics and is important in computer logic.

**Example:** If neither condition X NOR condition Y are true, then execute instruction Z.
OBJECTIVE: To build a noise activated alarm.

Turn the slide switch (S1) on and wait for the sound to stop. Place the circuit into a room you want guarded. If a thief comes into the room and makes a loud noise, the speaker (SP) will sound again. If you find that the sound does not turn off, then vibrations created by the speaker may be activating the whistle chip. Set the speaker on the table near the circuit and connect it to the same locations using the jumper wires to prevent this.

Replace the whistle chip (WC) with the motor (M1). Wind a piece of string around the axis of the motor so when you pull it the axes spins. Connect the other end of the string to a door or window. Turn the slide switch (S1) on and wait for the sound to stop. If a thief comes in through the door or window the string pulls and the axes spins. This will activate the sound.

Use the circuit from Project 282 shown above. Connect a photoresistor (RP) across points A & B and cover it or turn off the lights. Turn the slide switch (S1) on and wait for the sound to stop. At night, when the thief comes in and turns on the light, the speaker (SP) makes the sound of a machine gun.
**Pressure Alarm**

*OBJECTIVE:* To build a pressure alarm circuit.

Connect two jumper wires to the whistle chip (WC) as shown. Set the control of the adjustable resistor (RV) to the far left and turn on the switch. There is no sound from the speaker (SP) and the LED (D1) is off. Tap the center of the whistle chip. The speaker sounds and the LED lights. The whistle chip has a piezocrystal between the two metal plates. The sound causes the plates to vibrate and produce a small voltage. The voltage is amplified by the power amplifier IC (U4), which drive the speaker and LED.

Place a small object in the center of the whistle chip. When you remove the object the speaker and LED are activated. In alarm systems, a siren would sound to indicate the object has been removed.

**Project 286 Power Microphone**

Use the preceding circuit but replace the whistle chip with the microphone (X1, “+” to black jumper wire), and hold it away from the speaker (SP). Set the control of the adjustable resistor (RV) to the far left. Turn on the slide switch (S1) and talk into the microphone. You now hear your voice on the speaker. The sound waves from your voice vibrate the microphone and produce a voltage. The voltage is amplified by the power amplifier IC (U4) and your voice is heard on the speaker.
Objectives:

**Project 287**

Objectives: To build a circuit that uses a programmed sound integrated circuit (IC).

Build the circuit shown on the left, which uses the space war integrated circuit (U3). Turn the slide switch (S1) on. A space war sound plays, and the LED (D1) flashes. If there is no light on the photoresistor (RP) then the sound will stop after a while.

You also make sounds by pressing the press switch (S2). See how many sounds are programmed into the space war sound IC.

**Project 288**

Objectives: To connect two sound ICs together.

In the circuit, the outputs from the alarm (U2) and music (U1) ICs are connected together. The sounds from both ICs are played at the same time.

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**Space War Sounds with LED**

**Sound Mixer**
Electric Fan Stopped by Light

OBJECTIVE: To show how light can control a motor.

Turn on the slide switch (S1) and set the adjustable resistor (RV) control so the motor (M1) just starts spinning. Slowly cover the photoresistor (RP) and the motor spins faster. By placing more light over the photoresistor, the motor slows.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

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

Motor & Lamp

OBJECTIVE: To control large currents with a small one.

Place the fan on the motor (M1). Turn on the slide switch (S1) and the motor spins. The transistors are like two switches connected in series. A small current turns on the NPN transistor (Q2), which turns on the PNP transistor (Q1). The large current used to spin the motor now flows through the PNP. The combination allows a small current to control a much larger one.

Press the press switch (S2) and the lamp (L2) lights and slows the motor. When the lamp lights, the voltage across the motor decreases and slows it down.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

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

**OBJECTIVE:** To build a circuit to indicate if you have mail.

Turn on the slide switch (S1). If there is light on the photoresistor (RP) the red LED (D1) will not light. Place your finger over the photoresistor and now the red LED lights. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED (D2) inside the mailbox facing each other. Place the red LED outside the mailbox. When there is mail, the light is blocked from the photoresistor and the red LED turns on.

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**AM Radio (II)**

**OBJECTIVE:** To build a complete, working AM radio.

When you close the slide switch (S1), the integrated circuit (U5) should detect and amplify the AM radio waves. The signal is then amplified using the power amplifier (U4), which drives the speaker (SP). Tune the variable capacitor (CV) to the desirable station.
Mail Notifying Electronic Bell

OBJECTIVE: To build a circuit to indicate if you have mail by sounding a tone.

Turn on the slide switch (S1). If there is enough light on the photoresistor (RP), the speaker (SP) will not make any sound. Place your finger over the photoresistor and now the speaker sounds. The sound will stay on until you turn off the slide switch. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED inside the mailbox facing each other. When there is mail, the light is blocked from the photoresistor and the speaker turns on. The sound may be better if you replace the 0.02 µF capacitor (C1) with the 0.1 µF capacitor (C2).

Replace the speaker (SP) with the lamp (L2). When there is mail, the light is blocked from the photoresistor (RP) and the lamp lights. The lamp may not be very bright.

Twice-Amplified Oscillator

OBJECTIVE: To build an oscillating circuit.

The tone you hear is the frequency of the oscillator. Install different values of capacitors in place of the 0.1 µF capacitor (C2) to change the frequency.

Replace the speaker (SP) with a red LED (D1, the “+” sign on top). Now you see the frequency of the oscillator. Install different values of capacitors to change the frequency.
**OBJECTIVE:** To amplify sounds from the music integrated circuit.

Build the circuit and turn on the slide switch (S1). You will hear loud music, since the sound from the music IC (U1) is amplified by the power amplifier IC (U4). All radios and stereos use a power amplifier.

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**Music Amplifier**

**Project 297**

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**OBJECTIVE:** To amplify sounds from the music integrated circuit.

Build the circuit and turn on the slide switch (S1). You will hear loud music, since the sound from the music IC (U1) is amplified by the power amplifier IC (U4). All radios and stereos use a power amplifier.

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**Police Siren Amplifier**

**Project 298**

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**OBJECTIVE:** To amplify sounds from the music integrated circuit.

Build the circuit and turn on the slide switch (S1). You will hear a very loud siren, since the sound from the alarm IC (U2) is amplified by the power amplifier IC (U4). Sirens on police cars use a similar circuit, with an IC to create the sound and a power amplifier to make it very loud.
**Project 299**

**OBJECTIVE:** To build a siren that slowly fades away.

Turn on the slide switch (S1), then press and release the press switch (S2). You hear a siren that slowly fades away and eventually goes off. You can modify this circuit to make machine gun or ambulance sound instead like in the other projects. You can also replace the 10μF capacitor (C3) with the 100μF (C4) or 0.1μF (C2) to greatly slow down or speed up the fading.

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

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**Project 300 Fading Doorbell**

Replace the alarm IC (U2) with the music IC (U1). The circuit has a doorbell sound that plays and stops.

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**Project 301 Adjustable Time Delay Lamp (II)**

**OBJECTIVE:** To build a lamp that stays on for a while.

Be sure to use the 2.5V lamp (L1) for this circuit. Turn on the switch and press the press switch (S2). The lamp stays on for a few seconds after you release the press switch. You can change the delay time with the adjustable resistor (RV).

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**Project 302 Adjustable Time Delay Fan (II)**

Replace the lamp (L1) with the motor (M1), be sure to put on the fan. Turn on the switch and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).
Project 303

Blowing Space War Sounds

**OBJECTIVE:** To change space war sounds by blowing.

Turn on the slide switch (S1) and you will hear explosion sounds and the lamp is on or flashing. Blow into the microphone (X1) and you can change the sound pattern.

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Project 304

Adjustable Time Delay Lamp

**OBJECTIVE:** To build a lamp that stays on for a while.

Turn on the slide switch (S1) and press the press switch (S2). The lamps stay on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

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Project 305 Adjustable Time Delay Fan

Replace the lamp (L1) with the motor (M1), be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

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