Snap Circuits Sc100

Please note: When placing the battery, please place it so that the connections are to the left. When placing the diode (D1), make sure that the positive end is marked somehow (with a high-raised dot, for example) so that your child knows where the positive end is.

**Project 1**. Electric Light and switch.

Objective: to show how electricity is turned on or off with a switch.

1. Put part 3 on c2-e2.

2. Put L1 at c3-c5. Put b1 at c6-e6. Put s1 at e3-e5.

2. Put part 2 on c2-c3. Put part 2 at c5-c6. Put part 2 at e5-e6. Put part 2 at e2-e3.

When you close the slide switch (S1), current flows from the batteries through the lamp and back to the battery through the switch. The closed switch completes the circuit. In electronics this is called a closed circuit. When the switch is opened, the current can no longer flow back to the battery, so the lamp goes out. In electronics, this is called an open circuit.

**Project 2.** Direct current (DC), motor and switch.

Objective: to show how electricity is used to run a Direct Current (DC) Motor.

When you close the switch S1, current flows from the batteries through the motor, making it rotate. Place the fan blade on the motor shaft and close the slide switch (S1). The motor will rotate, forcing the fan blade to move air past the motor. In this project, you changed electrical power into mechanical power. DC motors are used in all the battery-powered equipment, requiring rotary motion, such as a cordless drill, electric toothbrush and toy trains, that run on batteries, just to name a few. An electric motor is much easier to control than gas or diesel engines.

Do the same steps as in project 1, but put the motor on c3-c5 instead of L1.

**Project 3.** Sound-activated switch.

Objective: to show how sound can turn on an electronic device.

1. Put part 5 at b2-b6. Put B1 at d6-f6. Put part 4 at f2-f5. Put U1 at d2-d4, e2-e4. Put the speaker next to your snap grid/baseboard. Put one jumper cable onto B5 and onto the speaker. Put the other jumper cable onto e4 and the speaker.

2. Put WC at b2-d2. Put part 3 at b3-d3. Put the slide switch (S1) at b6-d6. Put part 2 at f5-f6. Put part 2 at e2-f2.

When you close the slide switch (S1), the music may play for a short time, and then stop. After the music has stopped, clap your hands close to the whistle chip or tap the base with your finger. The music should play again, for a short time, then stop. Blow on the whistle chip, and the music should play. You could connect the speaker using snap wires instead of the jumper wires. But then the speaker may create enough sound vibrations to reactivate the whistle chip.

**Project 4.** Adjusting sound level.

Objective: to show how resistance can lower the sound from the speaker.

1. Put part 5 at b2-b6. Put U1 at d2-d4, e2-e4. Put part 5 at f2-f5. Put SP at c5-e5. Put b1 at d6-f6.

2. Put WC at b2-d2. Put part 3, at b3-d3. Put part 2 at e2-f2. Put S1 at b6-d6. Put part 2 at e4-e5. Put part 2 at f5-f6. Put part 1 at c5.

3. Put R1 c3-c5.

When you close the slide switch (S1), the music may play for a short time and then stop. After the music has stopped, clap your hands close to the whistle chip or tap the base with your finger, the music should play again for a short time, then stop. In this project you changed the amount of current that goes through the speaker and reduced the sound output of the speaker. Resistors are used throughout electronics to limit the amount of current that flows.

**Project 5.** Lamp and fan in series.

Objective: to show how a lamp can indicate when a fan is running.

1. Put L1 at b2-b4. Put motor at b2-e2. Put part 2 at f2-f3. Put B1 at d4-f4.

2. Put 2 at b2-c2. Put part 2 at e2-f2. Put s1 at b4-e4. Put 2 at f3-f4.

Put the fan blade on the motor. When you close the slide switch (S1), the fan will spin and the light should turn on. The fan will take a while to start turning due to inertia. Inertia is the property that tries to keep a body at rest from moving and tries to keep a moving object from stopping. The light helps protect the motor from getting the full voltage when the switch is closed. Part of the voltage goes across the light and the rest goes across the motor. Remove and notice how the light gets dimmer when the motor does not have to spin the fan blade.

**Project 6**. Lamp and fan in parallel.

Objective: to show how an indicator light can be connected without effecting the current in the motor.

1. Put part 4 at b2-b5. Put motor at c2-e2. Put part 3 at f2-f4. Put B1 at d5-f5. Put L1 at c3-e3.

2. Put part 2 at b2-c2. Put part 2 at b3-c3. Put S1 at b5-d5. Put part 2 at e2-f2. Put part 2 at e3-f3. Put part 2 at f4-f5.

Put the blade on the motor. When you close S1, both the fan and the light should turn on. The fan will take a while to start turning due to inertia. In this connection, the lamp does not change the current to the motor. The motor should start a little faster than in project 5. Remove the fan and notice how the light does not change in brightness as the motor picks up speed. It has its own path to the battery.

**Project 7.** Light-emitting Diode (LED).

Objective: to show how a resistor and LED are wired to emit light.

1. Put S1 at b3-b5. Put B1 on c5-e5. Put D1 on f3-f5. Put R1 on c3-e3.

2. Put part 2 on b3-c3. Put part 2 on b5-c5. Put part 2 on e5-f5. Put part 2 on e3-f3.

When you close the S1, current flows from the batteries through the switch through the resistor, through the LED and back to the battery. The closed switch completes the circuit. The resistor limits the current and prevents damage to the LED. NEVER PLACE THE LED DIRECTLY ACROSS THE BATTERY! If no resistor is in the circuit, the battery may push enough current through the LED to damage the semi-conductor that is used to produce the light. LEDs are used in all types of electronic equipment to indicate conditions and pass information to the user of that equipment. Can you think of something that you use every day that has an LED in it?

**Project 8**. One direction for the LED.

Objective: to show how electricity can only pass in one direction through the LED.

Build the circuit in project 7, but put the LED in upside-down. When you close the S1, current should flow from the batteries, 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 for the current through the LED. An electronics, 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.

**Project 9.** Conduction detector.

Objective: to make a circuit that detects the conduction of electricity in different materials.

Rebuild the circuit from project 7, but leave the on-off switch out. When you place a paper clip across the terminals, current flows from the batteries, through the resistor, through the LED and back to the battery. The paper clip completes the circuit and current flows through the LED. Place your fingers across the terminals, and the LED does not light. Your body is too high of a resistance to allow enough current to flow to light the LED. If the voltage, which is electrical pressure, were higher, current could be pushed through your fingers and the LED would light. This detector can be used to see if a material like plastic is a good conductor or a poor conductor.

**Project 10**. Space war alarm combo.

Objective: to combine the sounds from the space war and alarm integrated circuits.

1. Put part U2 at a1-a3 a1-b3. Put SP on a4-c4. Put L1 on a5-c5. Put B1 on a6-c6. Put U3 on c1-c3, d1-d3. Put part 6 on f1-f6. Put part 1 on d6.

2. Put part 2 on a1-a2. Put part 2 on a4-a5. Put part 1 on a6. Put part 1 on c1. Put part 2 on c3-c4. Put part 2 on b3-c3. Put S2 on d1-f1 Put part 3 on d2-f2. Put RP on d3-f3. Put S1 on d6-f6.

3. Put part 3 on a1-c1. Put part 3 at a2-a4. Put part 2 on a5-a6. Put part 2 on c4-c5. Put one jumper cable on b1-f1, and the other on c6-d6.

Turn it on, press the switch (S2) several times and wave your hand over the photo resistor, (RP), to hear all the sound combinations. If the sound is too loud, you may replace the speaker (SP) with the whistle chip (WC).

**Project 11**. Flying saucer.

Objective: to make a circuit that launches the fan blade, to simulate a flying saucer.

Re-build the circuit from project 2, but reverse the polarity on the motor, so that the negative on the motor goes to the positive on the battery. When you close the slide switch (S1), the motor will slowly increase in speed. When the motor has reached maximum rotation, turn the slide switch (S1) off. The fan blade should rise and float through the air like a flying saucer. Be careful not to look directly down on the fan blade when it is spinning. The air is being blown down through the blade, and the motor rotation locks the fan on the shaft. When the motor is turned off, the blade unlocks from the shaft and is free to act as a propeller and fly through the air. If speed of rotation is too slow, the fan will remain on the motor shaft, because it does not have enough lift to propel it. The motor will spin faster when both batteries are new.

**Project 12**. Decreasing saucer lift.

Objective: to show how voltage affects speed of a DC motor and can decrease the lift of the saucer.

Change the circuit in project 11 by adding the lamp (L1) instead of part 3 on c2-e2. When you place the lamp in series with any electronic device, it will draw less current, because it adds resistance. In this case, the lamp in series reduces the current through the motor, and that reduces the top speed of the motor. Close the slide switch (S1) and wait until the fan reaches maximum speed. Open the switch and observe the difference in the height due to the lamp. In most cases, it may not even launch.

**Project 13.** Two-speed fan.

Objective: to show how switches can increase or decrease the speed of an electric fan.

1. Put motor on b2-b4. Put S2 on c2-e2. Put part 2 on f2-f3. Put B1 on d4-e4. Put L1 on c3-e3.

2. Put part 2 on b2-c2. Put part 2 on e2-f2. Put part 2 on f3-f4. Put S1 on b4-d4. Put part 1 on c3. Put part 1 on e3.

3. Put part 2 on c2-c3. Put part 2 on e2-e3.

When you close the slide switch (S1), current flows from the batteries through the slide switch (S1), motor (M1), the lamp (L1) and back to the battery (B1). When the press switch (S2) is closed, the lamp is shorted, and motor speed increases. The principle of removing resistance to increase motor speeds is only one way of changing the speed of the motor. Commercial fans do not use this method because it would produce heat in the resistor, and fans are used to cool circuits by moving air over them. Commercial fans change the amount of voltage that is applied to the motor using a transformer or other electronic device.

**Project 14**. The fuse.

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

Use the circuit built in project 13. 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. Pretend the part 2, from f3-f4 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 part 2 f3-f4, (the 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 part 2, 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?

**Project 15.** Musical Doorbell.

Objective: to show how an integrated circuit can be used as a musical doorbell.

1. Part 5 on a1-a5. Part U1 on c1-c3, d1-d3. Part 4 on e1-e4. Part B1 on c5-e5. Part SP on b4-d4.

2. Part S2 on a1-c1. Part 2 on d1-e1. Part 3 at a2-c2. Part 2 at d3-d4. Part 1 at b4. Part S1 on a5-c5. Part 2 on e4-e5.

3. Part R1 on b2-b4.

Each time you press the S2, the song will play again and stop. Even if you let go of the S2, the integrated circuit keeps the song playing until it has reached the end of the song. Musical integrated circuits are used to entertain young children in many of the toys and chairs made to hold infants. If the music is replaced with words, the child can also learn while he is entertained. Because of great advances in miniaturization, many songs are stored in a circuit no bigger than a pinhead.

**Project 16**. Momentary alarm.

Objective: show how integrated circuits can also create loud alarm sounds in case of emergencies.

Build the same circuit as in project 15, but remove R1, and put S2 on a3-c3.

When you close S1, the music integrated circuit U1 may start playing one song and then stop. The song will be much louder than in the previous project because it is now being used as an alarm. Each time you press S2 after the song stops playing, the song will play again, but only while you hold the button down.

**Project 17.** Alarm circuit.

Objective: to show how an integrated circuit can be used to make real alarm sounds.

Do as above (project 16), but don't use 2, and replace part U1 with part U2. When you close S1, the integrated circuit should start sounding a very loud alarm sound. This integrated circuit is designed to sweep through all the frequencies, so even hard-of-hearing people can be warned by the alarm. If the alarm sound was passed through an amplifier and installed into a police car, it would also serve as a good police siren.

**Project 18.** Laser gun.

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

Same as above (project 17), but put R1 on d3-d5 and put part 3 on a3-c3.

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

**Project 19.** Space war.

Objective: to introduce you to the space war integrated circuit and the sounds it can make.

1. Part 5 on a1-a5. Part U3 on c1-c3 d1-d3. Part 4 on f1-f4. B1 on c4-c6.

2. Part 2 on a1-c1. Part SP on a3-c3. Part 3 on a4-c4. Part S2 on d1-f1. Part 3 on d2-f2. Part S1 on d3-f3. Part 2 on e4-f4.

Activate it by flipping the switch or pressing the key, do both several times and in combination. You will hear an exciting range of sounds as if a space war is raging! Like the other integrated circuits, the space war IC is a super-miniaturized electronic circuit that can play a variety of cool sounds stored in it, by using just a few extra components. In movie studios technicians are paid to insert these sounds at the precise instant a gun is fired. Try making your sound occur at the same time as an object hits the floor. It is not as easy as it sounds.

**Project 20**. Light switch.

Objective: to show how light can control a circuit using a photo resistor.

Use the circuit from project 19, but replace the slide switch (S1) with the photo resistor (RP). The circuit immediately makes noise. Try turning it off. If you experiment, then you can see that the only ways to turn it off are to cover the photo resistor, or to turn off the lights in the room (if the room is otherwise dark). Since light is used to turn on the circuit, you might say it is a "Light Switch". The photo resistor contains material that changes its resistance when it is exposed to light. The more light the RP receives, the less resistance it produces. Parts like this are used in a number of ways that affect our lives. For example, you may have streetlights in your neighborhood that turn on when it starts getting dark, and turn off in the morning.

**Project 21**. Paper space war.

Objective: to give a more dramatic demonstration of using the RP.

Use project 20. Find a piece of white paper that has a lot of large black or dark areas on it, and slowly slide it over the RP. You should hear the sound pattern constantly changing, as the white and dark areas of the paper control the light to the photosensitive resistance. You can also try the pattern printed in the project (a pattern similar to the piano keyboard: white-black, white- black, etc. but the black areas are of uneven widths) or something similar to it.

**Project 22.** Light police siren.

Objective: to build a police siren that is controlled by light.

1. Part 6 on a1-a6. Part 5 on e1-e5. U1 on c1-c3 d1-d3. U2 on c4-c6 d4-d6. Part 4 on a8-d8. B1 on e6-e8 g6-g8.

2. Part 3 on a2-c2. RP on a3-c3. Part 3 on a5-c5. S1 on a6-a8. Part 2 on d1-e1. Part 2 on d3-d4. SP on d6-d8. Part 2 on e5-e6. Part 1 on e8.

3. Part 2 on d8-e8.

Cover RP and turn on S1. A police siren with music is heard for a while and stops, then you can control it by covering or uncovering the RP.

Projects 23-26 modify Project 22.

**Project 23**. More loud sounds.

Objective: to show variations of the circuit in project 22.

Connect a6 and c6. By connecting these points, the circuit works the same way, but now it sounds like a machine gun.

**Project 24**. More loud sounds.

Objective: to show variations of the circuit in project 22.

Remove the connection between a6-c6 and make a connection between a4-c4. The circuit works the same but now it sounds like a fire engine.

**Project 25.** More loud sounds.

Objective: to show variations of the circuit in project 22.

Remove the previous connection and then make a connection between c4-d4. The circuit works the same way but how sounds like an ambulance.

**Project 26.** More loud sounds.

Objective: to show variations of the circuit in project 22.

Remove the previous connection and part 3 from a5-c5. Then make a connection between a4--c4. The circuit works the same way, but now it sounds like a familiar song but with static.

**Project 27.** Clap sounds.

Objective: to build a police siren and other sounds that are controlled by clapping your hands.

1. Part 6 on a1-a6. Part 4 on a7-a10. U1 on c1-c3 d1-d3. U2 on c4-c6, d4-d6. SP on b8-d8. S1 on b9-d9. Part 5 on e1-e5. B1 on e7-e9, g7-g9.

2. WC on a1-c1. Part 3 on a2-c2. Part 3 on a5-c5. Part 2 on a6-a7. Part 2 on a8-b8. Part 2 on a9-b9. Part 2 on d1-e1. Part 2 on d3-d4. R1 on d6-d8. Part 2 on d9-e9. Part 3 on e5-e7.

Turn on S1, and a police siren is heard and 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 with your finger.

**Project 28.** More clap sounds.

Objective: to show how ICs can do many jobs.

Modify the last circuit by connecting a6 and c6. The circuit works the same way, but now it sounds like a machine gun.

**Project 29**. More clap sounds.

Objective: to show how ICs can do many jobs.

Remove the connection from project 28 and make a connection between a4-c4. The circuit works the same way, but now it sounds like a fire engine.

**Project 30.** More clap sounds.

Objective: to show how ICs can do many jobs.

Remove the last connection and make a connection between c4-d4. It sounds like an ambulance.

**Project 31.** More clap sounds.

Objective: to show how ICs can do many jobs.

Remove the last connection and also a5-c5. Make a connection between a4-c4. Now it sounds like a familiar song, but with static.

**Project 32.** Voice light diode.

Objective: to build a circuit that uses your voice to control a light-emitting diode.

1. Part 6 on a1-a6. Part 1 on a7. U1 on c1-c3, d1-d3. U3 on c4-c6, d4-c6. Part 5 on e1-e5. B1 on c7-e7, c9-e9.

2. Part 1 on d5. WC on a1-c1. Part 3 on a2-c2. Part 3 on a4-c4. D1 on a6-c6. Part 3 on a7-c7. Part 2 on d1-e1. Part 2 on d3-d4. Part 1 on d5. S1 on e5-e7.

3. Part 2 on a6-a7. Part 2 on d5-e5.

Turn on the switch. The LED (D1) may be on for a while, and then turn off. Clap or talk loudly, and the diode will light again and keep flickering for a little while.

**Project 33**. Voice control.

Objective: to use your voice to control sounds.

The preceeding circuit probably did not seem too exciting; so replace the diode (D1) with the speaker (SP). You hear a range of exciting sounds. Clap or talk loudly 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. Set the speaker on the table near the circuit and connect it to the same locations using the jumper wires to prevent this.

**Project 34.** Motor space sounds.

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

Use the circuit from project 33, but replace part WC (the whistle chip) with part M1 (the motor). Turn it on and wait for any sounds to stop. Then spin the motor 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 circuit.

**Project 35.** Motor space light.

Objective: to build a circuit that uses a motor to activate a light diode.

This circuit is loud, it 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 36**. Space battle II.

Objective: to show another way of using the space war integrated circuit.

1. Part 6, on a1-a6. Part 1 on a7. U2 on c1-c3, d1-d3. U3 on c4-c6, d4-d6. B1 on c7-e7, c9-e9. Part 5 on e1-e5.

2. Part M1 on a2-c2. Part 3 on a3-c3. Part 2 on a4-c4. SP on a6-c6. Part 2 on a7-c7. Part 2 on D1-e1. Part 2 on d3-d4. Part 1 on d5. S1 on e5-e7.

3. Part 2 on a6-a7. Part 2 on d5-e5.

This circuit is based on the space war (project 19). Turn on the switch, and you will hear exciting sounds, as if a space battle is raging. The motor is used here as a part 3, and will not spin.

**Project 37.** Silent space battle.

Objective: to show another way of using the space war part.

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

**Project 38**. Periodic sounds.

Objective: to build a circuit with light and sound that change and repeat.

1. Part 5 on a2-a6. U2 on b1-b3, c1-c3. U1 on c4-e4, c5-e5. B1 on c6-e6, c8-e8. Part 6 on f1-f6.

2. Part 2 on a2-b2. Part 2 on a3-b3. L1 on a4-c4. SP on a5-c5. S1 on a6-c6. part 1 on c3. Part 4 on c1-f1. Part 1 on d4. Part 2 on e5-f5. Part 2 on e6-f6.

3. Part 1 on c3. Part 2 on c4-d4.

4. Part 2 on c3-c4.

Turn it on. The lamp alternates between being on and off, while the speaker alternates between two musical tones. Like someone is flipping a switch, but at a very consistent rate. Periodic signals like this are very important in electronics.

**Project 39.** Blinking double flashlight.

Objective: to build a circuit with two lights that alternate.

In project 38, replace the speaker SP with an LED (D1). Position it as in project 32. The lamp alternates between being on and off, while the LED alternates between being dimmer and brighter.

**Project 40.** Motor-controlled sounds.

Objective: to show how motion can trigger electronic circuits.

1. Part 6 on a1-a6. Part 4 on a7-a10. U1 on c1-d1, c3-d3. U2 on c4-d4, c6-d6. SP on b8-d8. S1 on b9-d9. Part 5 on e1-e5. B1 on e7-e9, f7-f9.

2. M1 on a1-c1. Part 3 on a2-c2. Part 2 on a6-a7. Part 2 on a5-c5. Part 2 on a8-b8. Part 2 on a9-b9. Part 2 on d1-e1. Part 2 on d3-d4. R1 on d6-d8. Part 3 on e5-e7. Part 2 on d9-e9.

This circuit is controlled by spinning the motor with your hands. Turn on the switch. A police siren is heard and then stops. Spin the motor and it will play again. Note, however, that music can be faintly heard in the background of the siren.

**Project 41.** More motor sounds.

Objective: to show how motion can trigger electronic circuits.

Modify that last circuit by connecting a6-c6. The circuit works the same, but now it sounds like a machine gun.

**Project 42.** More motor sounds.

Objective: to show how motion can trigger electronic circuits.

Remove the last connection and make a connection between a4-c4. Now it sounds like a fire engine.

**Project 43.** More motor sounds.

Objective: to show how motion can trigger electronic circuits.

Remove the last connection and make a connection between c4-d4. Now it sounds like an ambulance.

**Project 44.** More motor sounds.

Objective: to show how motion can trigger electronic circuits.

Remove the last connection and part 2 from a5-c5. Connect a4-c4. It sounds like a familiar song, but with static.

**Project 45**. Light controlled flicker.

Objective: to make a circuit that uses light to control the blinking of another light.

1. Part 6 on a1-a6. Part 4 on a8-d8. U1 on c1-d1, c3-d3. U2 on c4-d4, c6-d6. Part 5 on e1-e5. B1 on e6-e8.

2. Part 3 on a2-c2. RP on a3-c3. Part 3 on a5-c5. Part 1 on c6. Part 2 on d3-d4. Part d1 on d6-d8. Part 2 on e5-e6. Put S1 on a6-a8. Part 1 on e8.

3. Put part 3 on a6-c6. Put part 2 on d8-e8.

This circuit does not use a noisy speaker, it uses a nice quiet LED. Turn on the switch. The LED flickers. Wait a few seconds, then cover the photo resistor, and the flicker stops. The flicker is controled by the photo resistor; uncover it, and the flicker resumes. People that 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?

**Project 46**. More sound effects.

Objective: to investigate the different sound effects available from the alarm integrated circuit.

1. Part 6 on a1-a6. U2 on c1-c3, d1-d3. Part 5 on e1-e5. SP on b5-e5. B1 on c6-e6, c8-e8.

2. Part 2 on a5-b5. Part 3 on a1-c1. Part 3 on a2-c2. S1 on a6-c6. Part 2 on d1-e1. Part 2 on e5-e6. R1 on d3-d5.

When you close the slide switch (S1), the integrated circuit 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 more different sound effects. This mode will create many robotic sounds if switched quickly.

**Project 47.** This OR that.

Objective: to introduce you to the OR concept of electronic wiring.

1.R1 on a1-c1. S1 on a2-a4. S2 on b2-b4. D1 on c2-c4. B1 on a5-c5, a7-c7.

2. Part 2 on a1-a2. Part 2 on a4-a5. Part 1 on b2. Part 1 on b4. Part 2 on c1-c2. Part 2 on c4-c5.

3. Part 2 on a2-b2. Part 2 on a4-b4.

Notice that if you turn on the slide switch (S1), OR press the press switch (S2), the LED 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 importnat 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 rail-road 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.

**Project 48.** This AND that.

Objective: to introduce you to digital circuits.

1. R1 on a1-a3. B1 at a5-c5, a7-c7. S1 on c1-c3.

2. D1 on a1-c1. Part 3 on a3-a5. S2 on c3-c5.

Notice that if you turn on S1 and press the S2, the LED lights up. Once again, there is no partially lit state here, the LED is either totally on or totally off. Two switches may be used to turn on the same light in your house, the room switch, and the master switch, in the electrical box. 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 49.** Neither this NOR that.

Objective: to demonstrate the concept of a NOR circuit.

1. S1 on a1-c1. S2 on a2-c2. D1 on a3-c3. B1 on a5-c5, a7-c7.

2. Part 2 on a1-a2. R1 on a3-a5. Part 2 on c1-c2. Part 3 on c3-c5.

3. Part 2 on a2-a3. Part 2 on c2-c3.

Test the combinations of S1 and S2. If you compare it to the OR circuit in Project 47, you can see the LED lights in the opposite combinations of that circuit. Hence, we refer to this as a NOR circuit (short for "not this or that"). Like the OR and AND, it is an important building block in computers.

**Project 50.** NOT this AND that.

Objective: to demonstrate the concept of a NAND circuit.

1. S1 on a1-c1. D1 on a3-c3. B1 on a5-c5, a7-c7.

2. R1 on a3-a5. Part 1 on a1. Part 1 on c1. Part 3 on c3-c5.

3. S2 on a1-a3. Part 3 on c1-c3.

Test the combinations of S1 and S2. If you compare it to the AND circuit in Project 48, you can see the LED 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 reffered to as a NOT circuit. Like the OR, AND, and NOR, NAND and NOT are important building blocks in computers.

**Project 51.** Reflection detector.

Objective: to detect if a mirror is present.

1. L1 on a1-c1. RP on a2-c2. S1 on a4-a6. U2 on d1-d3, e1-e3. Part 5 on f1-f5. Put b1 on d6-f6, d8-f8. SP on c4-e4.

2. Part 2 on a1-a2. Part 1 on c1. Part 2 on c2-d2. Part 4 on a6-d6. Part 2 on f5-f6. Part 3 on a4-c4. Part 2 on e3-e4.

3. Part 3 on a2-a4. Part 3 on c1-e1.

Place the circuit where there won't be any room light hitting the RP, and then turn it on. The 2.5V lamp (L1) should be bright, but there should little to no sound. Take a small mirror and hold it over the lamp and RP. You should hear sound now. You have a reflection detector! The more light gets reflected like this, the louder the sound. You can try holding the mirror at different angles and distances and see how the sound changes. You can also hold a white piece of paper over L1 and the photo resistor, since white surfaces reflect light.

**Project 52.** Quieter reflection detector.

Objective: to detect a mirror.

1. L1 on a1-c1. RP on a2-c2. Part 6 on a3-a8. WC on c4-e4. D1 on c6-e6. U2 on d1-d3, e1-e3. Part 5 on f1-f5. B1 on d7-f7, d9-f9.

2. Part 2 on a1-a2. Part 1 on a3. Part 3 on a4-c4. Part 3 on a6-c6. Part 4 on a7-d7. Part 1 on c1. Part 2 on c2-d2. R1 on e4-e6. Part 2 on e1-f1. Part 1 on e3. S1 on f5-f7.

3. Part 2 on a2-a3. Part 3 on c1-e1. Part 2 on e3-e4.

Let's modify the reflection detector circuit so it is not so loud and annoying. We'll also put a lamp on it so that it can be seen in a noisy room. Build the circuit. Place it somewhere where there won't be any room light hitting RP and then turn it on. The 2.5V lamp will be bright, but there should be little or no sound. Take a small mirror and hold it over the lamp and RP. You should hear sound now, as the mirror reflects light from the lamp onto the RP. The more light gets reflected like this, the louder the sound. You can also hold a piece of white paper over the circuit, since white surfaces reflect light.

**Project 53**: Flashing laser light with sound.

Objective: to build a circuit used in a toy with laser gun, with flashing laser light and trigger.

1. Part 6 on a2-a8. U2 on c1-c3 d1-d3. SP on b4-d4. D1 on b6-d6. Part 5 on e1-e5. B1 on c7-e7.

2. Part 2 on a2-c2. Part 3 on a3-c3. Part 2 on a4-b4. Part 2 on a6-b6. S2 on a7-c7. Part 2 on d1-e1. Part 2 on d3-d4. Part 1 on d6. Part 3 on e5-e7.

3. R1 on d4-d6.

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

**Project 54:** Space war flicker.

Objective: to build a circuit using the space war IC to make exciting sounds.

1. Part 6 at a2-a7. U2 at c1-c3 d1-d3. U3 c4-c6 d4-d6. B1 on b7-d7 b9-d9. Part 4 on e1-e4. S1 on e5-e7.

2. Part 3 on a2-c2. Part 3 on a3-c3. Part 3 at a4-c4. SP on a6-c6. Part 2 on a7-b7. Part 2 on d1-e1. Part 2 on d3-d4. Part 1 on e5. Part 2 on d5-e5. Part 2 on d7-e7.

3. Part 2 on e4-e5.

The circuit uses the Space War Integrated Circuit. Set the switch on, and the speaker makes exciting sounds. The output of the IC can control lights, speakers and other low-power devices. You can replace the speaker (SP) with the lamp (L1) and hte bulb will flicker. You can also use the LED (D1) in place of the lamp.

**Project 55:** Spinning rings.

Objective: to build an electronic spinner.

1. Part 3 on a5-a7. M1 on b5-d5. B1 on a8-c8. S2 on d6-d8.

2. Part 2 on a5-b5. Part 2 on a7-a8. Part 2 on d5-d6. Part 2 on c8-d8.

Set up: cut out the disk on page 46. (The disk is divided into 8 sectors, the radius of each sector a different color. The colors are: pink, green, pale-blue, yellow.) Using scotch tape, attach the disk with the printed side up on top of the fan blade. Place the blade on the motor. 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.

**Project 56:** Strobe the house lights.

Objective: to use the spinner to see strobed effects due to 60 cycles.

Use the circuit from project 55. Set-up: Place the spinning rings under a fluorescent light that runs on normal house current. Start the disk 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 happens 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 spots. 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.

**Project 57:** Race game.

Objective: to build an electronic game for racing.

Modify project 56 by putting the speaker on e5-g5. Then add a pointer (the pointer looks like a rectangle with a triangle attached to it). Cut the pointer from the last page and tape it to the speaker. It should be taped high enough, so the pointer will stick over the fan with the paper. Bend the pointer at a right angle.

Set-up: Cut out the grid. (On page 46, there is a grid, which goes from a1-a4 to g1-g4. It has 4 different-colored parallel vertical lines: 1- purple, 2 - blue, 3 - green and 4 - yellow) and place it under the base. Each player picks a color (or two colors if only two people are playing) and place a part 1 on row G, each in his color. 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.

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 of the player's color, he moves up one space. If a liner (the line between the wedges) comes up, then the players on each side of the line get to move up two 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 58**: Using parts as conductors.

Objective: to show that motors and lamps may sometimes be used as ordinary conductors. 1. Part 1 on a1. Part 6 on a4-a10. Part S1 on a10-c10. Part 5 on a1-g1. U1 on c3-c5, d3-d5. U2 on c6-c8 d6-d8. Part 2 on d10-e10. Part 4 on e3-e7. B1 on e7-e9. M1 (upside-down) on g3-g4.

2. L1 on a1-c1. WC on a3-c3. Part 3 on a4-c4. Part 3 on a7-c7. RP on a8-c8. Part 1 on a10. Part 1 on c10. Part 2 on d3-e3. Part 2 on d5-d6. SP on d8-d10. Part 2 on e6-e7. Part 2 on e9-e10. D1 on g1-g3. R1 on e5-g5.

3. S2 on a1-a3. Part 3 on a8-a10. Part 2 on c10-d10.

Turn on the switch and tap the whistle chip (WC); it makes a machine gun sound, with music in the background. Thoroughly cover the photo resistor with your hand, and the sound becomes a siren. After a while the sound will stop; tap the whistle chip, and it resumes. Press the press switch (S2) and the LED (D1) lights, but the lamp does not light and the motor does not spin. Electricity is flowing through the lamp and motor, but not enough to turn them on, so in this circuit they're acting like part 3.

**Project 59**: Spin draw.

Objective: to produce circular artistic drawings.

This is the same set-up as project 57.

Set-up: Cut out a circular piece of thin cardboard, from the back of an old spiral note-book or notepad. Use the fan blade as a guide to draw a circle on the cardboard. Cut out the circle and tape it to the fan blade. Do the same thing with a piece of white paper, but tape it lightly on top of the cardboard.

Drawing: get some thin and thick markers. Spin the paper by pressing and holding press switch (S2) down. Press the marker on the paper to form rings. To make spiral drawings, release press switch (S2) and as the motor approaches a slow speed, move the marker from the inside outward quickly. Change the colors often and avoid using too much black to get hypnotic effects. Another method is to make colorful shapes on the disk, then spin the disk and watch them blend into each other. When certain speeds are reached under fluorescend lights, the strobe principle shown in another project will product strange effects and backward movement. Make a wheel with different colored spokes to see this strange effect. Adding more spokes and removing spokes will give different effects at different motor speeds.

**Project 60**: Space war flicker motor.

Objective: to run the motor using the space war IC.

1. Part 5 on a2-a6. U2 on c1-c3 d1-d3. U3 at c4-c6, d4-c6. Part 4 at b5-b8. part 6 at e1-e6. B1 at c8-c10 e8-e10.

2. Part 3 on a2-c3. Part 3 on a3-c3. Part 3 on a4-c4. Part 2 on a5-b5. Part 1 on b8. M1 on c6-c8. Part 2 on d1-e1. Part 2 on d3-d4. Part 2 on d5-e5. S1 on e6-e8.

3. Part 2 on b8-c8.

Turn on the switch, and the motor spins (you may need to give it a push with your finger to get it started). The sounds from the IC are used to drive the motor.

**Project 61**: light-controlled sounds.

Objective: to give a more dramatic demonstration of using the photo-sensitive resistance.

1. Part 5 on a1-a5. WC on b4-d4. RP on b5-d5. Battery on b6-d6. U2 on c1-c3, d1-d3. Part 6 on f1-f6.

2. Part 3 on a2-c2. Part 2 on a4-b4. Part 2 on a5-b5. Part 1 on b6. Part 2 on d4-d5. Part 3 on d1-f1. Part 1 on d3. S1 on d6-f6.

3. Part 2 on b5-b6. Part 2 on d3-d4.

Turn on the slide switch (S1), and police siren is heard. The loudness of the sound depends on how much light reaches the photo resistor. Try partially shielding it or placing it near very bright light and compare the sound.

**Project 62:** Light-controlled sounds II.

Objective: to show a variation of the circuit in project 61.

Modify the last circuit by connecting a3 and c3. The circuit works the same way, but now it sounds like a machine gun.

**Project 63**: Light-controlled sounds III.

Objective: to show a variation of the circuit in project 61. Remove the connection from a3-c3 and make a connection between a1 and c1. The circuit works the same, but now it sounds like a fire-engine.

**Project 64**: Light-controlled sounds IV.

Objective: to show a variation of the circuit in project 61.

Remove the connection between a1-c1 and make a connection between c1 and d1, the circuit now sounds like an ambulance.

**Project 65:** Light-controlled sounds V.

Objective: to show a variation of the circuit in project 61.

Remove the connection between c1 and d1 and remove the connection between a2 and c2. Then make a connection between a1-c1. Now it sounds like a computer.

**Project 66:** Electronic bombing game.

Objective: to make an electornic bombing game.

1. Part 6 on a1-f1. Part 3 on b2-b4. Part 3 on c2-c4. Part 3 on d2-d4. Part 5 on a5-e5. Part 1 on a7. Part 1 on b7. Part 2 on a7-b7. Part 4 on b6-b9. U3 on d6-d8, e6-e8. B1 on c9-e9.

2. R1 on a5-a7. Part 2 on d1-d2 (this is a shorting bar for B, D, or D.) Part 2 on e5-e6. S1 on b6-d6. SP on b8-d8. Part 2 on b9-c9. Jumper wire on e1-e7. Jumper wire on f1-e9.

This circuit uses both jumper wires as permanent connections. It also uses two parts two as "shorting bars". Use a paper sheet to hide the position of the shorting bar. Put the sheet of paper with its left upper-corner above and to the left of a1, top right corner, above and to the right of a3, left-bottom corner below and to the left of d1, and the bottom right corner below and to the right of d3.

Set-up: Player one sets the target by placing one shorting bar under the paper on row B, C, or D. Player two must not know where the shorting bar is located under the paper. The object is for player two to guess the location by placing his shorting bar as position b4, d4, or d4. In the following exmaple: Player 1 set up a sorting bar on d1-d2. If player 2 places his shorting bar across d4 on the first try, he gets a hit. He keeps guessing until he hits. 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 one tries his luck. Play multiple rounds and see who gets the best overall score. The winner will be the player who is best at reading his opponent's mind.

**Project 67**: Quiet zone game.

Objective: to make and play the electronic game of Quiet Zone.

Use the circuit form project 66, but place two parts 2 (sorting bars) under the paper sheet, one at b1-b2, and the other at d1-d2.

Set-up: Player 1 sets the quiet zone by placing two 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 b4, c4, and d4. In the example, player 1 sets up the quiet zone at position "c". If player 2 places his shorting bar across d4 on the first try, the sounds played mean that he has not found the quiet zone and he loses one point. He has three tries to find the zone on each turn. Each time sounds are made, he looses a point. Player 2 then sets up the b, c, d side and player 1 starts searching. Play continues until player 1 is at zero points, and makes sound during his turn.

**Project 68**: Space war music combo.

Objective: to combine the sounds from the space-war and music integrated circuits.

1. Part 2 on b4-b5. U3 on b6-b8, c6-c8. B1 at a9-c9. U1 at b1-b3, c1-c3. Part 3 on c3-c5. Part 4 at e1-e5. Part 5 on e5-e9.

2. Part 2 on b2-b3. Part 1 on b9. Part 3 on c1-e1. Part 2 on c33-d3. SP on b4-d4. L1 on b5-d5. S2 on c6-e6. Part 3 on c7-e7. RP on c8-e8. S1 on c9-e9. Part 2 on e4-e5.

3. Part 2 on b3-b4. Part 2 on b5-b6. Jumper wire on b6-a9. Put the other jumper wire on d3-b8.

Turn it on, press the press switch (S2) several times and wave your hand over the photo resistor to hear all the sound combinations. If the sound is too loud, you may replace the speaker (SP) with the whistle chip (WC).

**Project 69**: Space war siren.

Objective: to combine effects from the space war and alarm integrated circuits.

1. Part 6 on a1-a6. U3 on c1-c3, d1-d3. U2 on c4-c5 e4-e5. B1 on c6-e6. Part 5 on f1-f5.

2. Part 2 on a1-c1. L1 on a3-c3. Sp on a5-c5. S1 on a6-c6. S2 on d1-f1. Part 3 on d2-f2. R1 on d3-f3. Part 2 on e5-f5. Part 1 on e6.

3. Part 2 on c3-c4. Part 2 on e5-e6. Turn on the slide switch (S1) press and hold the press switch (S2) for more sound effects.

**Project 70**: Quiet water alarm.

Objective: to sound an alarm when water is detected.

1. Part 6 on a2-a7. U2 on c1-c3 d1-d3. WC on b4-d4. D1 (upside-down) on b6-d6. B1 on c7-e7. Part 5 on e1-e5.

2. Part 2 on a4-b4. Part 2 on a6-b6. S1 on a7-c7. Part 2 on D1-e1. Part 1 on d3. R1 on d4-d6. Part 3 on e5-e7.

3. Part 2 on d3-d4.

Sometimes you want a water alarm that can be heard but is not loud enough to be annoying to be 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. Turn on the switch. Nothing happens. Place one jumper wire on a2 and place another on c2. Put the loose ends of the wires in a cup of water. An alarm sounds and the light comes on.

**Project 71**: Light-controlled lamp.

Objective: to turn a lamp on and off using light.

1. U1 on c1-c3, d1-d3. L1 on b4-d4. B1 on c5-e5. Part 4 on e1-e4.

2. Part 3 on a2-c2. RP on a3-c3. Part 2 on a4-b4. S11 on a5-c5. Part 2 on d1-e1. Part 2 on d3-d4. Part 2 on e4-e5.

Cover the unit then switch on, and notice that the lamp is off. Place the unit near a light and the lamp tusn on. Cover the photo resistor and place itin the light again. The lamp will not turn on. The resistance of the photo resistor decreases as the light increases. The low resistance acts like a wire connecting point c to the positive side of the battery.

**Project 72:** Voice-controlled lamp.

Objective: to turn al amp on and off using the voltage generated from a photo resistor.

Use the circuit from project 71. Remove the photo resistor RP, and connect the whistle chip (WC) across points a and b (please note, the manual we used does not have these points. I assume that the WC should be placed in the same place as the RP.) Turn the switch on and clap your hands or talk loudly near the whistle chip. The lamp will light. The WC has a piezo-crystal between the two metal plates. The sound causes the plates to vibrate and produce a small voltage. The voltage then activates the music IC and turns the lamp on.

**Project 73:** Motor-controlled lamp.

Objective: to turn a lamp on or off using the voltage that a motor generates.

Use the circuit from project 72. Remove the WC and connect the M1 across points a and b. (sample place as 2c). Turn the switch on, turn the shaft of the motor, and the lamp 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 across its terminals. The voltage then activates the music IC.

**Project 74:** Light-controlled LED.

Objective: to control and LED using light.

1. Part 5 on a1-a5. U1 on c1-c3, d1-d3. D1 upside-down at b4-d4. B1 at c5-e5. Part 4 on e1-e4.

2. Part 3 on a2-c2. RP on a3-c3. Part 2 on a4-b4. S1 at a5-c5. Part 2 on d1-e1. Part 2 on d3-d4. Part 2 on e4-e5.

Cover the unit, turn the switch on and notice that the LED is off. Place the unit near a light, and the LED will light. Cover the RP and plkace it near the light again. The LED will not turn on. The resistance of the photo resistor decreases as the light increases.

**Project 75**: Sound-controlled time-delay LED.

Objective: To control the LED using sound.

Use the circuit from project 74, remove the RP and connect the WC to points a1-c1. Turn the switch on and clap your hands or talk loudly near the WC, and the LED will light. The WC has a piezocrystal between the two metal plates. The sound causes the plates to vibrate, the voltage then activates the music IC.

**Project 76**: Motor-controlled time-delay LED.

Objective: to control an LEDd using a motor.

Use the circuit from project 75. Remove the wc and connect the M1 to points a1-c1. Turn the switch on and turn the shaft of the motor, and the LED 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.

**Project 77:** Space war flicker LED.

Objective: to flash an LED using the Space war IC.

1. Part 6 on a2-a7. U2 on c1-c3 d1-d3. U3 on c4-c6, d4-d6. B1 on b7-d7. Part 4 on e1-e4. S1 on e5-e7.

2. Part 2 on a2-c2. Part 2 on a3-c3. Part 2 on a4-c4. D1 upside-down on a6-c6. Part 2 on a7-b7. Part 2 on d1-e1. Part 2 on d3-d4. Part 1 on e4. Part 2 on d5-e5. Part 2 on d7-e7.

3. Part 2 on e4-e5.

The circuit uses the alarm and space war ICs to flash the LED (D1). Turn the switch on and the LED starts flashing.

**Project 78:** Music AND gate.

Objective: to build an AND gate.

1. Part 4 on a2-a5. SP on b4-d4. B1 on b5-d5. U1 on c1-c3, d1-d3. S1 on e1-e3. Part 1 on e5.

2. Part 3 on a2-c2. Part 3 on a3-c3. Part 2 on a4-b4. Part 2 on a5-b5. Part 2 on d1-e1. Part 2 on d3-d4. S2 on e3-e5. Part 1 on d5.

3. Part 2 on d5-e5.

You will only hear music if you turn on the slide switch (S1) AND press the press switch (S2). This is refered to as an AND gate in electornics. This concept is important in computer logic. Example: If condition x AND condition y are true, then execute instruction z.

**Project 79**: Flash and tone.

Objective: to build a circuit that flashes light and play sounds.

1. Part 5 on a2-a6. U2 on b1-b3, c1-c3. U1 on c4-c5, e4-e5. B1 on b6-d6. Part 1 on d2. Part 6 on f1-f6.

2. Part 2 on a2-a3. Part 2 on a3-b3. L1 on a4-c4. SP on a5-c5. Part 2 on a6-b6. Part 4 on c1-f1. Part 1 on c3. D1 upside-down at d2-d4. Part 2 at e5-f5. S1 at d6-f6. Part 1 on f2.

3. Part 2 on c3-c4. Part 3 on d2-f2.

Turn the switch on, and the lamp and LED start flashing. The LED will flash at a much faster rate than the lamp. You hear two different tones driving LED and lamp. ICs can be connected to control many different devices at the same time.

Project 80: Lamp, speaker, and fan in parallel.

Objective: To show the power drop of components connected in paralel.

1. Part 6 on a1-a6. M1 on b1-d1. L1 on b2-d2. Sp on b3-d3. B1 at c6-e6. Part 4 on e1-e4.

2. Part 2 on a1-b1. Part 2 on a2-b2. Part 3 on a3-b3. S2 on a6-c6. Part 2 on d1-e1. Part 2 on d2-e2. Part 2 on d3-e3. Part 3 on e4-e6.

Leave the fan off the motor when you press the press switch (S2). The motor spins and the lamp turns on. Observe how bright the lamp is. Place the fan on the motor and press the press switch again. The lamp is not as bright now because it takes more power from the batteries to spin the motor with the fan on it, which leaves less batter 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 is being used as a low-value resistance here, to make the above effects more apparent. If you remove it, then the lamp brightness will increase slightly.

**Project 81:** Pencil alarm.

Objective: to draw an alarm activator.

1. Part 1 on a1-a5. U2 on c1-c3, d1-d3. SP on b4-d4. B1 on c5-e5. Part 4 on a1-a4.

2. Part 2 on a4-b4. S1 on a5-c5. Part 2 on d1-e1. Part 2 on d3-d4. Part 2 on e4-e5.

Connect the jumper wires - one to a1, and leave the loose end - and the other wire to c2, and leave the lose end. There is one part you need, and you're going to draw it. Take a pencil (number 2 lead is best, but other types will also work.) SHARPEN IT, and fill in the shape below. (The shape in the print manual that you should shade is a rectangle.) Shade it heavily so there's lots of pencil lead in it. Turn on the switch and take the loose ends of the jumpers, press them to the rectangle 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 82**: Pencil aram variants.

Objective: to draw an alarm activator.

Remove the jumper connected to c2 and connect it to c1 instead. Touch the loose ends of the pencil drawing again; the sound is different now. Next connect part 2 between c1-c2. Connect the jumper to either c1 or c2. Touch the loose ends to the pencil drawing again. You hear a different sound. Now remove the part 2 from c1-c2 and connect it between c1 and d1. Connect the jumpers to and a1-c2. Touch the loose ends to the pencil drawing again - you hear yet another sound. Now you can draw your own shapes and see what other kinds of sounds you can make.

**Project 83**: Fun with the alarm IC.

Objective: to show some new ways of using the alarm IC.

1. Part 6 on a3-a8. S1 on a10-c10. L1 on c1-e1. U1 on c3-c5, d3-d5. U2 on c6-c8, d6-d8. Part 2 on d10-e10. R1 on g3-g5. Part 4 on e2-e6. B1 on e7-e9, g7-g9.

2. WC on a3-c3. Part 3 on a4-c4. S2 on a6-c6 Part 3 on a7-c7. Rp on a8-c8 Part 1 pm a10. Part 1 on c10. Part 2 on d3-e3. Part 2 on d5-d6. Sp on d8-d10. Part 1 on e1. Part 2 on e6-e7. Part 2 on e9-e10. D1 on e5-g5.

3. Part 3 on a8-a10. Part 2 on c10-d10. M1 upside-down on e1-e3.

Place the fan on the motor. Turn on the switch, and tap the WC - it makes a machine-gun sound with music in the background. Thoroughly cover the RP with your hand, and the sound becoms a siren. Now press the press switch (S2), and the sound becomes that of an ambulance. Uncover the photo resistor, and the sound remains that of a machine gun, whether the press switch (S2) is pressed or not. After a while the sound will stop. Tap the whistle chip and it resumes. Connect the jumper wires, one on c1-a3, and the other on a5-g3. Tap the whistle chip to resume the sound. The lamp L1 and the LED (D1) are lit, and the motor spins. The sound continues but it may become distorted, as the motor speeds up. The motor draws a lot of power from the bateries, and this may reduce the voltage to the music and alarm ICs, distorting the sound.

**Project 84**: Touch motor.

Objective: to built a circuit that spins a motor when you touch it with your finger.

1. Part 5 on a2-a6. U2 on b1-b3, c1-c3. U1 on c4-c5, e4-e5. B1 on b6-d6. Part 6 on f1-f6.

2. Part 2 on a2-b2. Part 2 on a3-b3. L1 on a4-c4. M1 on a5-c5. Part 2 on a6-b6. Part 4 on c1-f1. Part 1 on c3. Part 2 on e5-f5. S1 on d6-f6.

3. Part 2 on c3-c4.

Place the fan on the motor. Turn the switch on, and the lamp starts flashing. Place your figner on e4 - the motor should start spinning. The finger activated the music IC that powers the motor. Remove your finger, and the motor will stop after a while.

**Project 85**: Touch light.

Objective: to build a cirucit that lights an LED. Use the circuit in project 84, replace the motor with the LED (d1), positive side on top. Turn the switch on when the lamp light, the LED flickers. When the lamp is off, the LED is on.

**Project 86**: Music alarm combo.

Objective: to combine the sounds from the music an d alarm integrated circuits.

1. Part 6 on a2-a7. U1 on c1-dc3, d1-d3. U2 on c4-c6, d4-d6. SP on b7-d7. L1 on b8-d8. B1 on b9-d9. Part 5 on f1-f5. Part 4 on f6-f9.

2. M1 on a2-c2. RP a3-c3. S2 on a4-c4. Part 3 on a5-c5. Part 1 on a7. Part 2 on b7-b8. Part 1 on b9. Part 2 on d6-d7. Part 3 on d1-f1. Part 2 on d4-f4. Part 1 on d8. S1 on d9-f9. Part 2 on f5-f6.

3. Part 2 on a7-b7. Part 2 on b8-b9. Part 2 on d7-d8.

Put a jumper wire on d3-d6. Turn it on, and you will hear a siren and music together. Press the press switch (S2), and the sire changes to a fire engine sound. The music will stop if you cover the photo resistor. The motor is used here as a part 3 and will not spin.

**Project 86:** Bomb sound.

Objective: to build a circuit that sounds like a bomb dropping.

1. Part 5 on a1-a5. U3 on c1-c3, d1-d3. B1 on c5-e5. Part 3 on e1-e3.

2. Part 3 on a1-c1. SP on a3-c3. Part 3 on a5-c5. Part 2 on d1-e1. Part 2 on d2-e2. S1 on e3-e5.

3. D1 upside-down on c3-c5. Turn the switch on, and you hear the sound of a bomb dropping and then exploding. The LED lights and then flashes as the bomb explodes. This is one sound generated from the space war IC.

**Project 88:** Bomb sound I.

Objective: to build a circuit that sounds like a bomb dropping.

Using the circuit from project 87, but replace the switch with the motor (M1). Turn the shaft on the motor, and now it sounds like a bunch of bombs dropping.

**Project 89**: Light-controlled LED II.

Objective:to build a circuit that turns the LED on or off if there is light present.

1. Part 5 on a1-a5. U3 on c1-c3, d1-d3. B1 on c5-e5. Part 4 on f2-f5.

2. Part 3 on a1-c1. D1 upside-down, on a3-c3. Part 3 on a5-c5. Part 3 on d2-f2. Rp on d3-f3. Part 2 on e5-f5.

When there is light on, the photo resistor, the LED will flicker. Shield the photo resistor from the light - the LED should turn off.

**Project 90**: Touch light.

Objective: to build a circuit that turns the LED on or off using the whistle chip.

Use the circuit from project 89, but replace the photo resistor with the whistle chip (WC). Tap on the whistle chip, and the LED flickers. Tap again, and the LED may flicker for a longer time. See how long the LED will stay on.

**Project 91**: Touch sound.

Objective: to build a circuit that plays a sound when you tap on the whistle chip.

Use the circuit from project 90, but replace the LED with the speaker SP. Now you can hear different sounds as you tap on the whistle chip.

**Project 92:** Water space war.

Objective: to use water to control the space war integrated circuit.

1. Part 5 on a1-a5. U3 on c1-c3, d1-d3. B1 on c4-e4. Part 4 on f1-f4.

2. Part 3 on a1-c1. SP on a3-c3. Part 3 on a4-c4. Part 3 on d2-f2. Part 2 on e4-f4.

Put one jumper wire on d1, leaving the other end loose, and put the other jumper wire on f1, leaving its other end loose. Put the loose ends in a cup of water. There will be sound as long as the wires are in the water. Placing the wires out of, and then back into, the water, will change the sound played. There are eight different sounds.

**Project 93**: Water space war II.

Objective: to use water to control the space war integrated circuit. Use the circuit from project 92. Move the jumpers wires from d1, and f1, to d3, and f3, and try it again. Does it work the same way? See if you can get the same 8 sounds.

**Project 94**: Human space war.

Objective: To use your body to control the space war IC.

Use the circuit from project 93, but instead of placing the jumper wires in the water to control the circuit, touch the metal in the jumper with your fingers. Letting go and touching them again will change the sound just as pulling the wires out of the water did.

**Project 95:** Noisier water space war.

Objective: to use water to control the space war integrated circuit.

1. Part 5 on a1-a5. U3 on c1-c3, d1-d3. B1 on c4-e4. Part 4 on f1-f4.

2. Part 3 on a1-c1. SP on a3-c3. Part 3 on a4-c4. S2 on d1-f1. Part 3 on d2-f2. Part 2 on e4-f4. Put the jumpers, one on d3, and the other on f3, leaving their ends loose. Put the other ends of the wires in a cup of water. There will be sound if the press switch (S2) is pressed, or if the jumper wires are in the water. Pressing the press switch or pulling the wires out of the water changes the sound played. If you prefer, you can just touch the jumper wire metal with your fingers, instead of putting the jumpers in the water.

**Project 96**: Light/water space war.

Objective: to use water to control the space war integrated circuit.

Use the circuit from project 95, but replace the speaker (SP) with the LED (D1), putting the jumper wires in the water OR pressing the press switch, will cause the diode to be bright.

**Project 97**: OR/AND Space war light.

Objective: to control the space war integrated circuit.

Use the circuit from project 96. Replace the LED (D1) with the lamp (L1). Putting the jumper wires in the water OR pressing the press switch (S2) will cause the lamp to be dimly lit. Putting the wires in the water AND pressing the press switch at the same time will cause the lamp to be much brighter.

**Project 98:** Simple water alarm.

Objective: to sound an larm when water is detected.

1. Part 5 on a1-a5. Sp on b4-d4. B1 on d5-e5. U2 on d1-c3, d1-d3. Part 44 on e1-e4.

2. Part 2 on a4-b4, s1, on a5-c5. Part 2 on d1-e1. Part 2 on d3-d4. Part 2 on e4-e5. Put one jumper wire on a2, and the other on c2, leaving their other ends loose.

Initially leave the jumper wires outside the cup of water. Turn on the switch - nothing happens. Place the jumper wires into a cup of water, and the alarm sounds. You could use longer wires and lay them on your basement floor, if you basement floods during a storm - then this circuit would sound an alarm.

**Project 99:** SImple saltwater alarm.

Objective: to detect salt water.

Add salt to the water, and the tone of the alarm is louder and faster, telling you that salt is in the water you detected. Also try holding the jumper wires with your fingers to see if your body can set off the alarm.

**Project 100.** Ambulance water alarm.

Objective: to show a variation of the circuit in project 98.

Modify the project in project 98, by making a connection between c1 and d1. The water alarm works the same way, but now it sounds like an ambulance.

**Project 101**: Ambulance contact alarm.

Objective: to show a variation of the circuit in proejct 98.

The same circuit also detects if the jumper wires get touched together, so connect them to each other.Tthe tone of the sound is now different. Therefore this circuit will tell you if there is water between the jumper wires, or if the wires are touching each other.