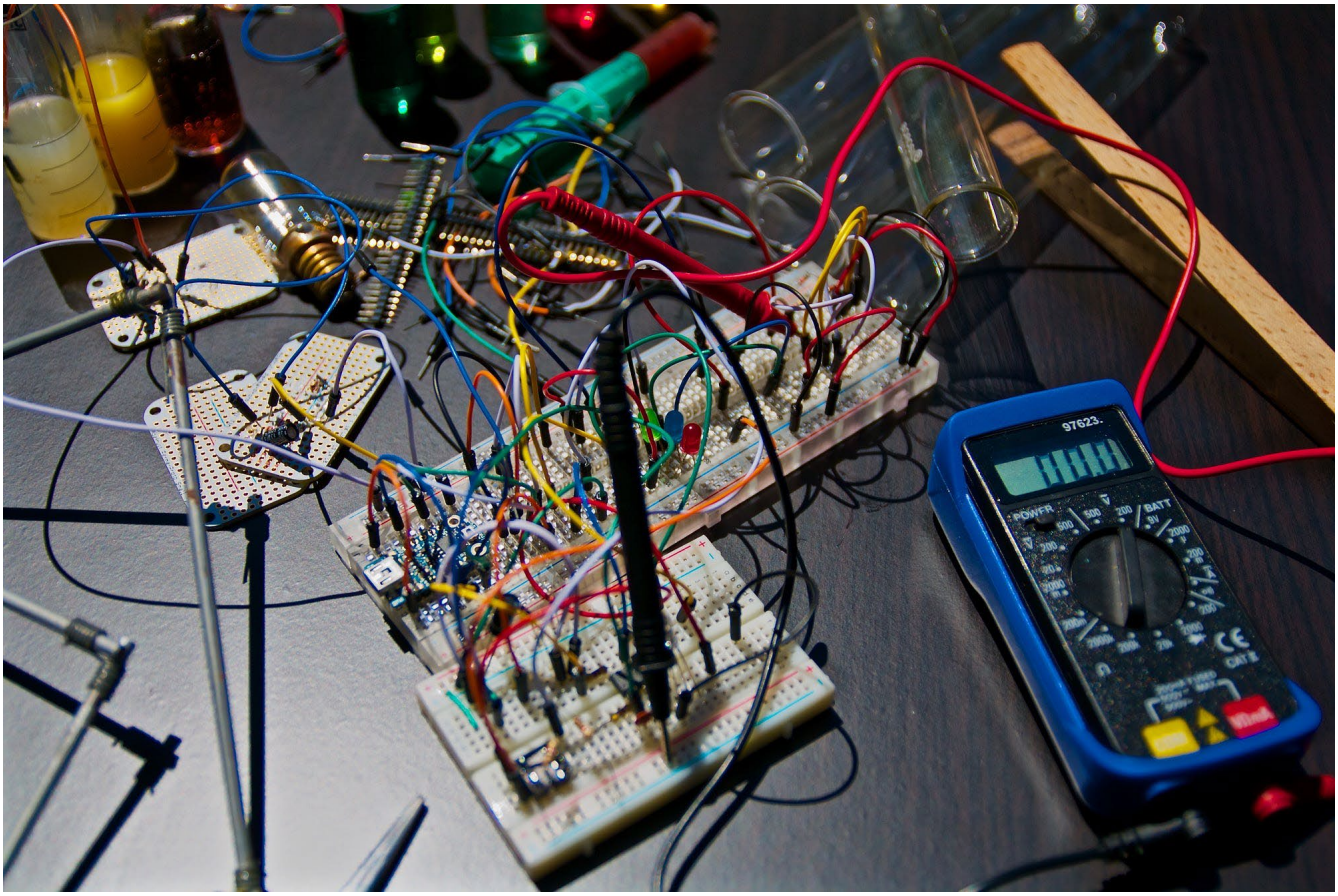
YEAR 12 ELECTRONICS

Circuit Booklet



Circuits you can build to supplement your learning for units 1-3

Contents:

More circuits are available – ask your teacher.

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* Suitable for assessment US18243

Suitable for assessment US18243 in conjunction with one-transistor amplifier or radio boost amplifier

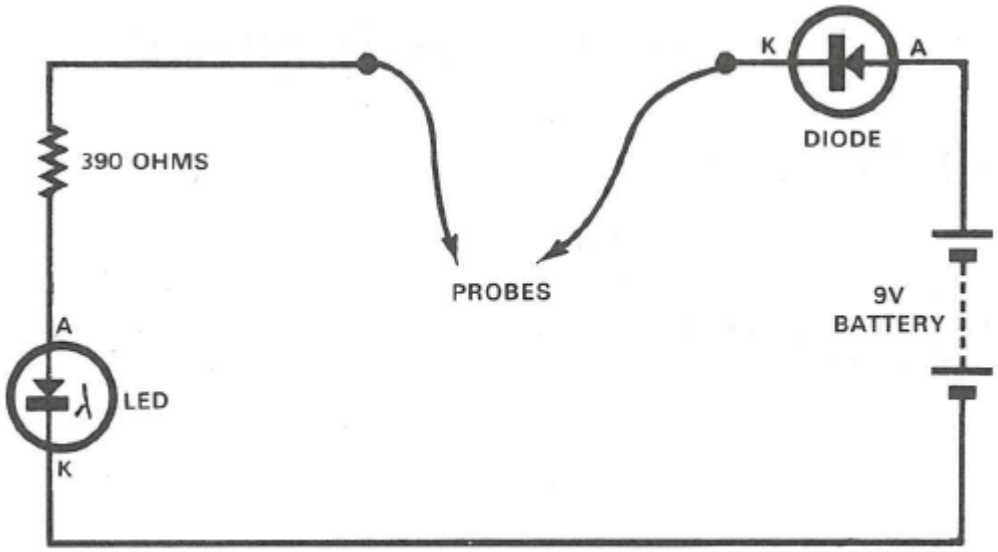
†A schematic is available for a different or more detailed version – ask your teacher if you want to do this for assessment US18243

1. <u>Continuity Indicator</u>

This circuit tests continuity of various objects. You could use it to check what objects conduct electrical current, or to functionally test components.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 330Ω resistor
- 1x Diode (1N4002 or similar)
- 1x LED
- Wire for connections
- Wire for probes



Questions (answer in your book)

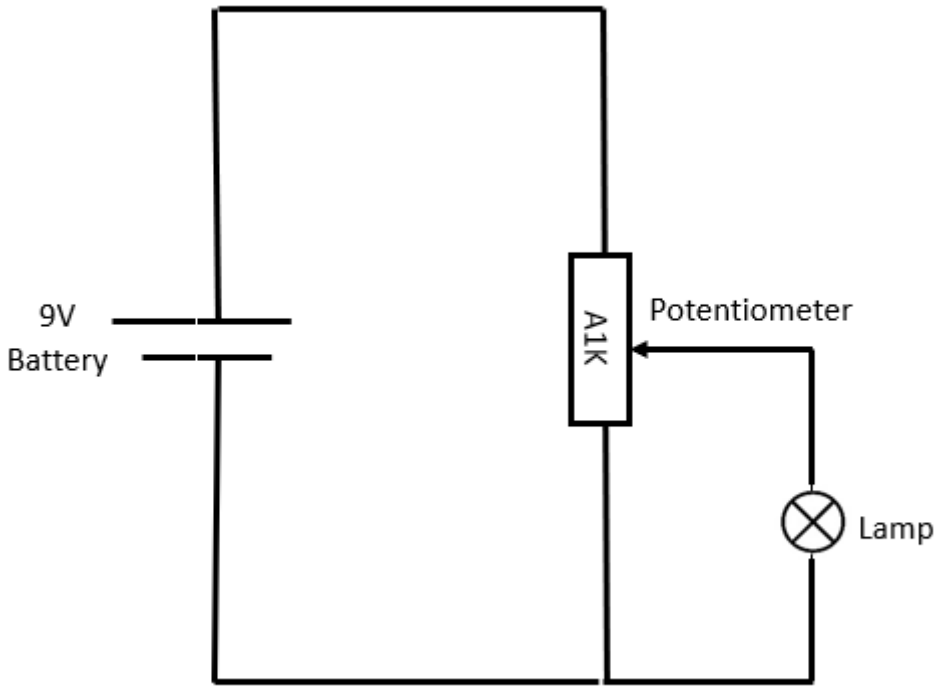
1. Write a brief summary of what this circuit demonstrates.
2. What is the purpose of the diode?
3. What is the purpose of the LED?
4. What is the purpose of the resistor?

2. Dimmable Lamp

This circuit demonstrates the operation of a dimmer switch

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x lamp
- 1x A1k potentiometer
- Wire for connections



Questions (answer in your book)

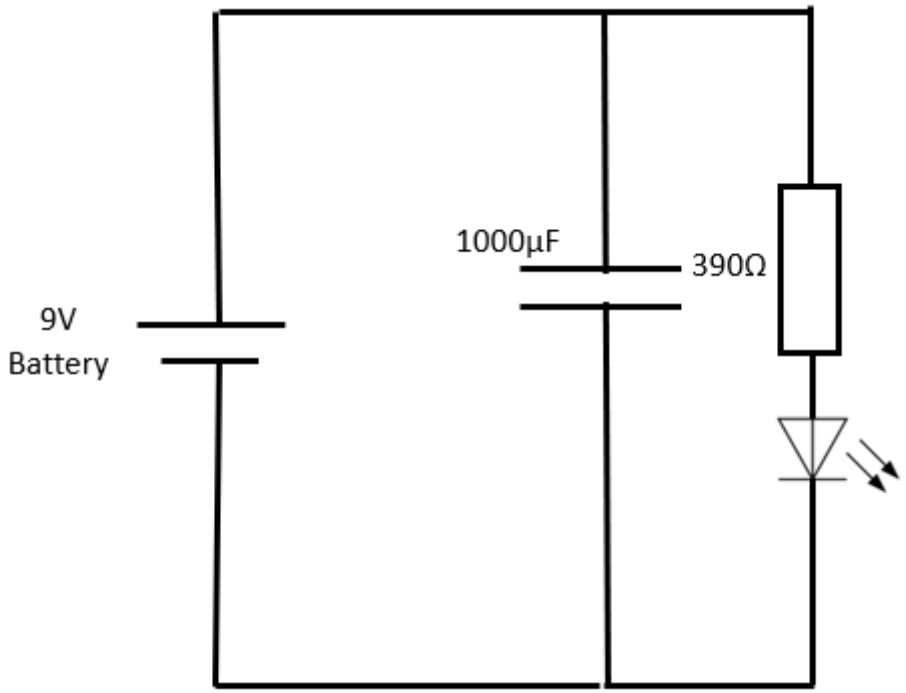
1. Write a brief summary of what this circuit demonstrates.
2. Describe how the voltage across the lamp changes as you turn the potentiometer. What is the range of voltages?
3. How does the potentiometer work to control the voltage across the lamp?

3. <u>Fading LED</u>

This circuit gives a very basic demonstration of how a capacitor operates. Observe the LED when the battery is disconnected.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x LED
- 1x 390Ω resistor
- 1x 1000µF capacitor
- Wire for connections



Questions (answer in your book)

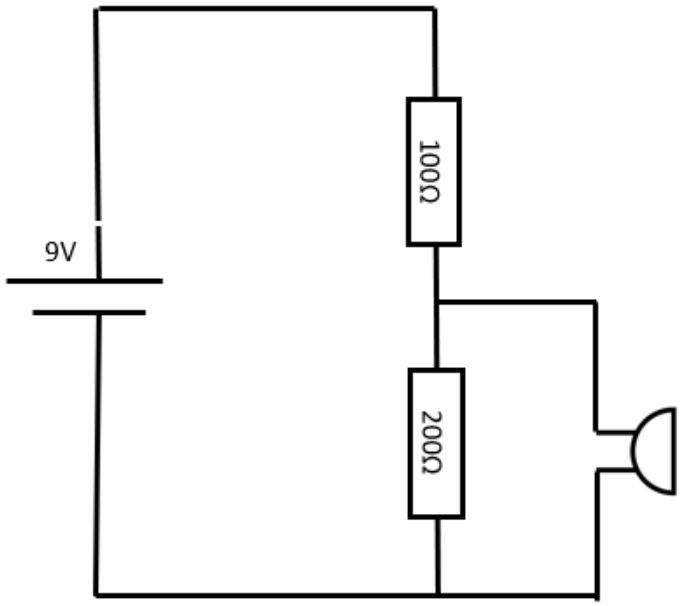
1. Write a brief summary of what this circuit demonstrates.
2. Describe the LED after the battery is disconnected. Explain how this happens.
3. What is the function of the resistor?
4. Explore and describe the impact of using a capacitor with a lower capacitance.

4. Voltage Divider for Buzzer

A voltage divider is a two-resistor system that splits a voltage in a pre-calculated way to provide the required voltage.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x Buzzer
- 1x 100Ω resistor
- 1x 200Ω resistor
- Wire for connections



Questions (answer in your book)

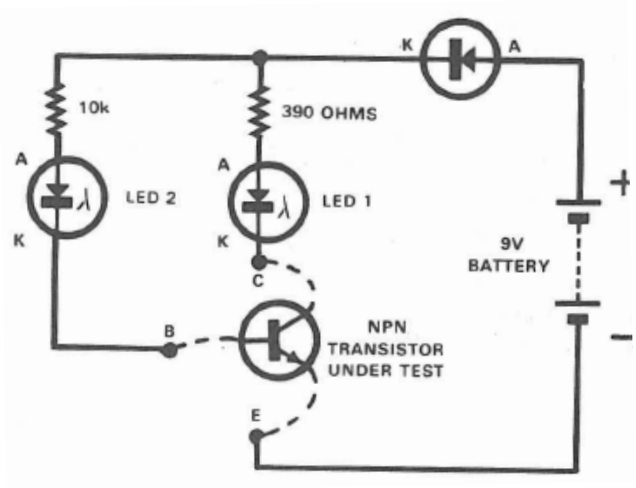
1. Write a brief summary of what this circuit demonstrates.
2. What is the voltage rating on the buzzer (what voltage is it supposed to run at?)
3. Measure the voltage across the buzzer to check it is working at the correct voltage.
4. What happens if you switch the resistors around?

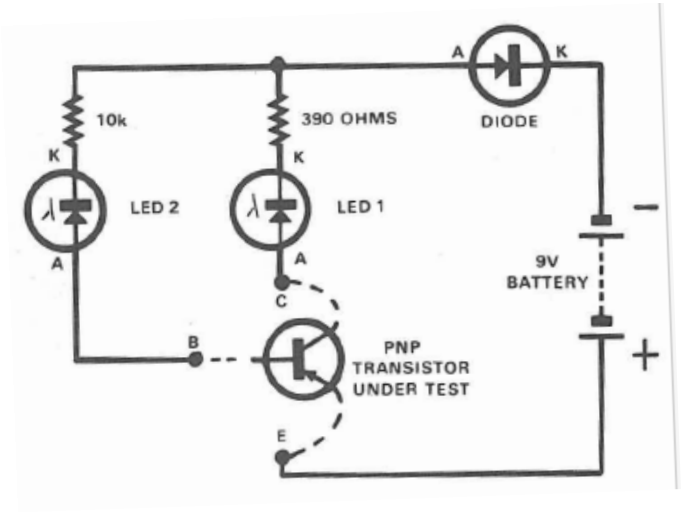
5. Transistor Tester

This circuit checks whether a transistor is working or not; it is also useful for learning about the different types of transistors and how to connect them. Start by building the NPN version.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 1x 10kΩ resistor
- 2x LED
- 1x Diode (1N4002 or similar)
- 1x NPN transistor (BC548 or similar)
- 1x PNP transistor (BC558 or similar)
- Wire for connections





Questions (answer in your book)

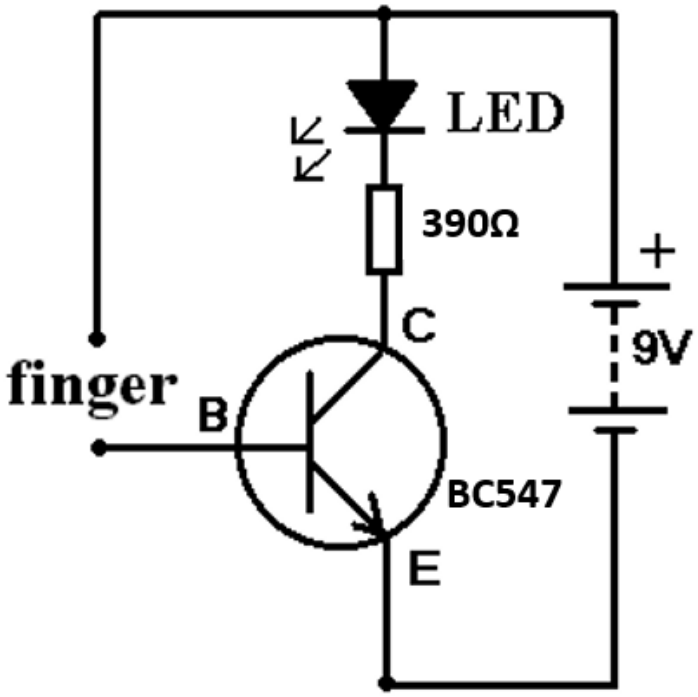
1. Write a brief summary of what this circuit demonstrates.
2. Check that both lights are on. What is the base-emitter voltage V_{BE}? (Measure the voltage between B and E).
3. If you remove the base pin (B) of the transistor, *both* lights should go off. Check that this happens – otherwise the transistor is faulty
4. Repeat for the PNP resistor. Note that the polar component are all switched around. What is different about how a PNP transistor is connected?

6. <u>Transistor As a Switch #1</u>

This circuit demonstrates how a transistor can be switched on and off by a very small current. When you have finished, don't dismantle your circuit, as only a small modification is needed to build circuit 7.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 1x LED
- 1x NPN transistor (BC547 or similar)
- Wire for connections



Questions (answer in your book)

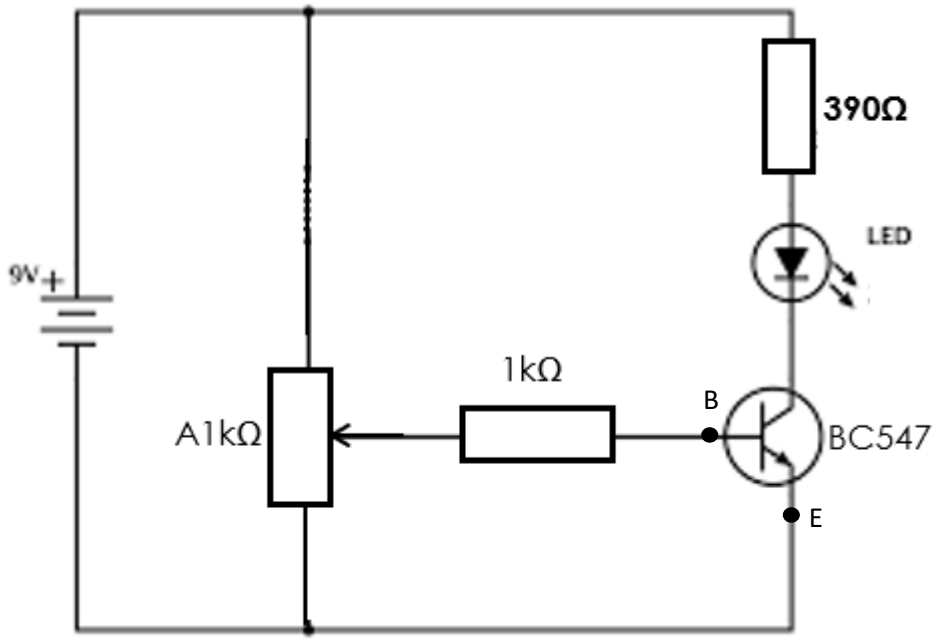
1. Write a brief summary of what this circuit demonstrates.
2. Explain why joining the gap with your finger makes the LED light up
3. Try joining the finger gap using one hand on each side. Make a chain of people holding hands. How many people can you have in a chain and still make the LED go? What does this tell you about the kind of base currents needed to switch the transistor on?

7. <u>Transistor As a Switch #2</u>

This circuit further demonstrates properties of transistors when used as a switch.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 1x 1kΩ resistor
- 1x LED
- 1x NPN transistor (BC547 or similar)
- 1x A1k Potentiometer
- Wire for connections



Questions (answer in your book)

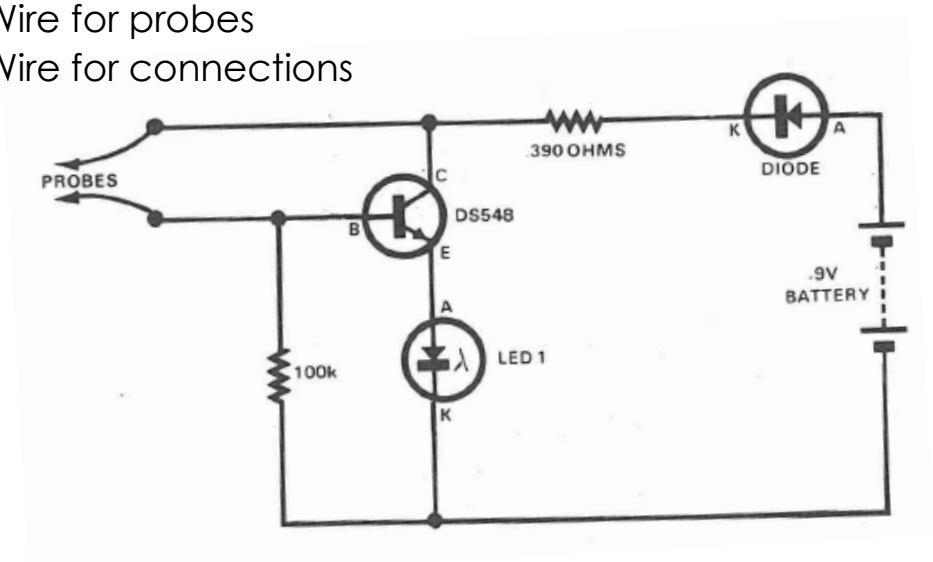
1. Write a brief summary of what this circuit demonstrates.
2. Describe what happens when you turn the potentiometer through its complete range
3. Measure the voltage across the base and the emitter (V_{BE}) when the LED first turns on, and when the LED first reaches its maximum brightness.

8. <u>Moisture Indicator</u>

This circuit is designed to monitor soil for house plants. It is also a good introduction to how a transistor's switching ability can be used to respond to environmental changes. Keep this circuit after you are finished – much of it is the same as circuit 9

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 1x 100kΩ resistor
- 1x Green LED
- 1x NPN transistor (BC548 or similar)
- 1x Diode (1N4002 or similar)
- Wire for probes
- Wire for connections



Questions (answer in your book)

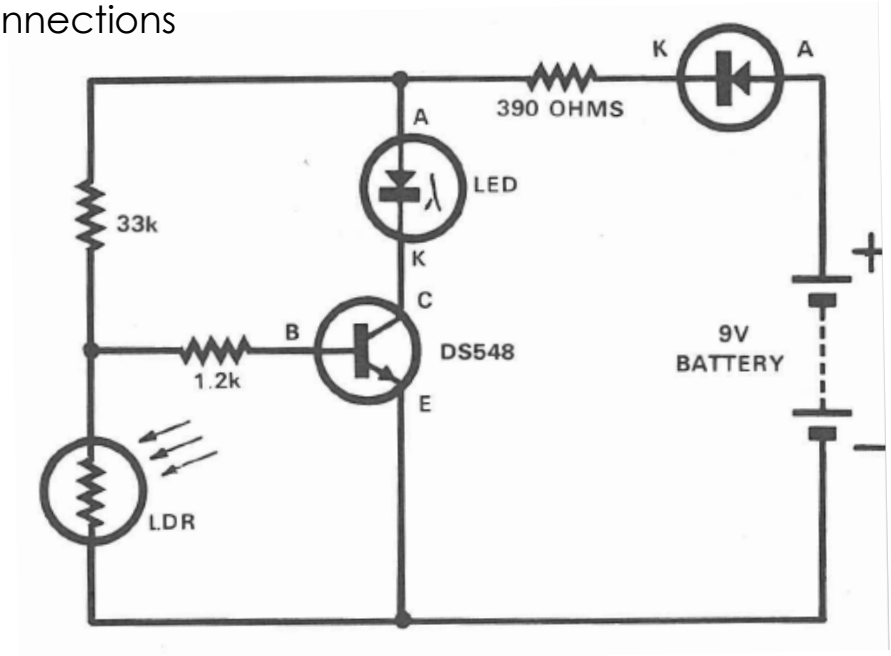
1. Write a brief summary of what this circuit demonstrates.
2. Test this circuit *either* by slowly adding water to soil *or* adding salt to a saltwater solution. Describe what you observe.
3. If the soil is very dry, then the resistance between the probes will be very high. What will this mean for the base current?
4. What is the purpose of the 100kΩ resistor?
5. Green means good. If you wanted a red LED to come on when the soil got too dry, can you work out what you'd have to do to this circuit? Give it a try!

9. Light/ Dark Indicator

This circuit responds to changes in light level, and indicates when the light levels pass a certain threshold. Like the last circuit, it shows how a transistor can be used to respond to environmental changes.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 1x 100kΩ resistor
- 1x Green LED
- 1x NPN transistor (BC548 or similar)
- 1x Diode (1N4002 or similar)
- Wire for probes
- Wire for connections



Questions (answer in your book)

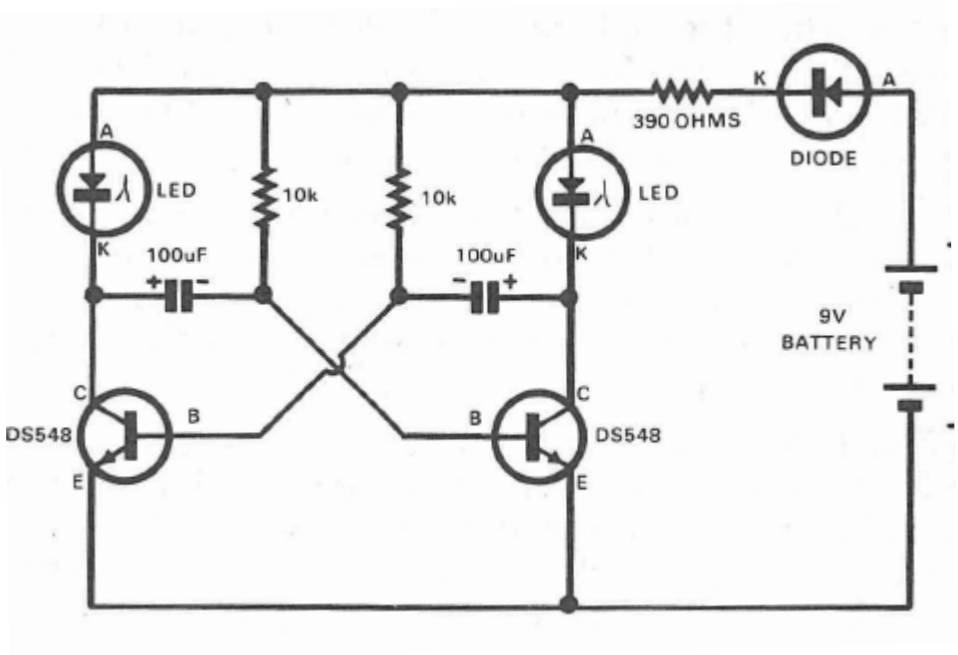
1. Write a brief summary of what this circuit demonstrates.
2. Explain how the LDR functions in this circuit.
3. What is the purpose of the transistor?
4. What is the purpose of the 33kΩ resistor?
5. Can you think of a useful purpose for a circuit like this?
6. What could you change so that the circuit responds to temperature changes instead of light? Try it!

10. Flasher

This circuit Uses capacitors and transistors to make two LEDs flash alternately. Do not dismantle it after use – it is similar to circuit 11

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 2x 10kΩ resistor
- 2x LED
- 2x NPN transistor (BC548 or similar)
- 2x 100µF electrolytic Capacitor
- 1x Diode (1N4002 or similar)
- Wire for connections



Questions (answer in your book)

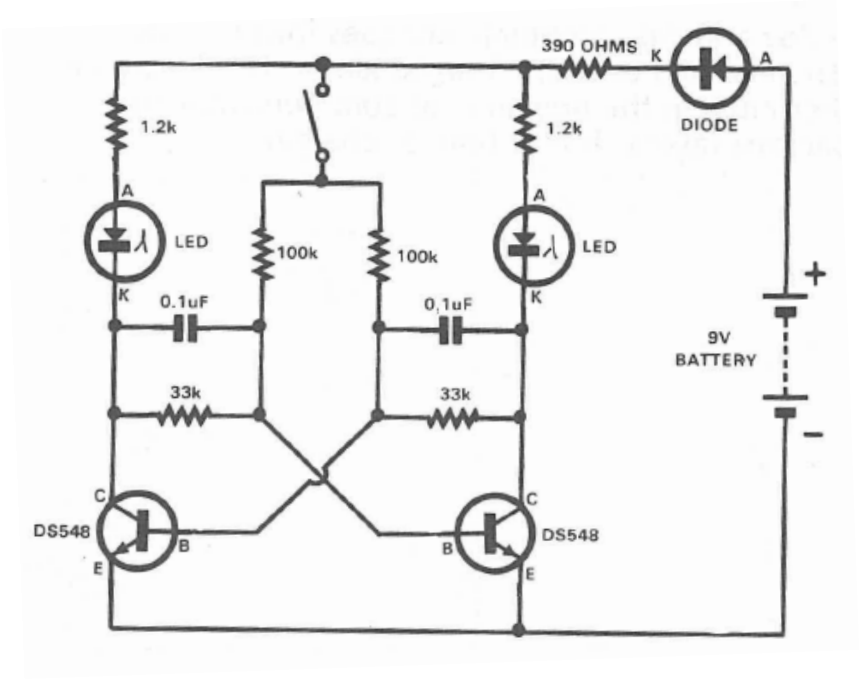
1. Write a brief summary of what this circuit demonstrates.
2. Explain how the LEDs are switched on and off.
3. What is the purpose of the capacitors?
4. What is the purpose of the 10kΩ resistor?

11. Decision Maker

Ask a question with a simple yes/ no answer and release the button – the circuit will decide for you!

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 390Ω resistor
- 2x 1.2kΩ resistor
- 2x 33kΩ resistor
- 2x LED (one red, one green)
- 2x NPN transistor (BC548 or similar)
- 2x 0.1µF electrolytic Capacitor
- 1x Diode (1N4002 or similar)
- 1 Push Switch
- Wire for connections



Questions (answer in your book)

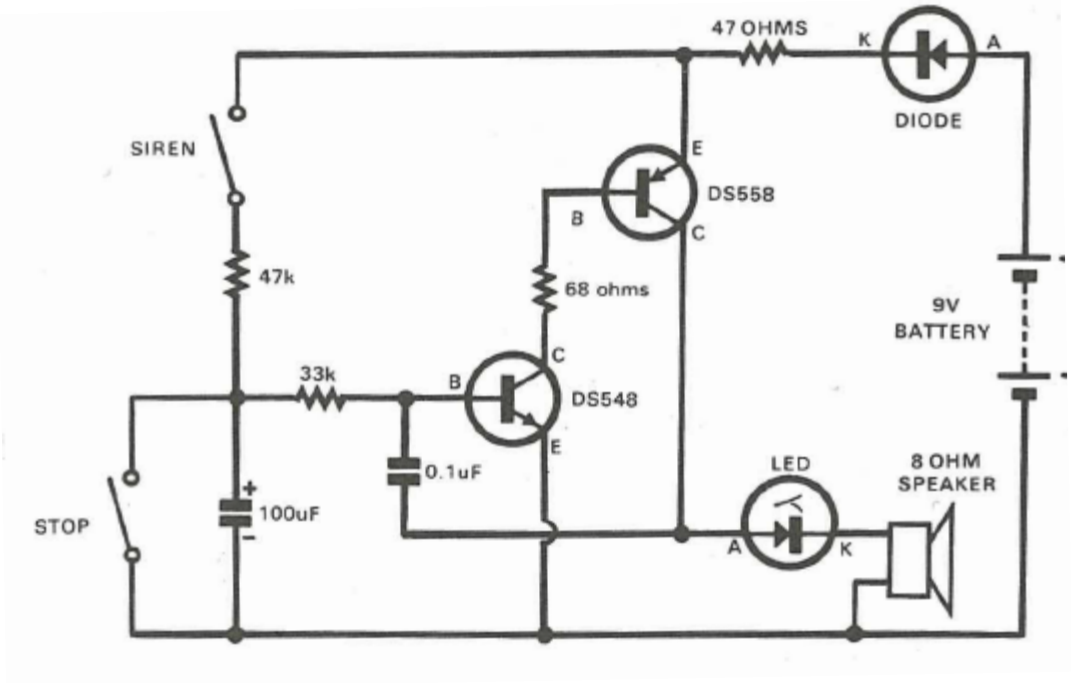
1. One change from circuit 10 is the different values for the capacitors. What effect does this have?
2. Why does it seem as though the lights aren't flashing?
3. Why can one LED stay on even when the switch is opened?

12. <u>Electronics Siren</u>

This circuit mimics the slow rise and fall of an emergency siren. It is another variation on the theme of the previous two circuits, which use transistors and capacitors.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 47Ω resistor
- 1x 47kΩ resistor
- 1x 33kΩ resistor
- 1x 68Ω resistor
- 1x LED
- 1x NPN transistor (BC548 or similar)
- 1x PNP transistor (BC558 or similar)
- 1x 0.1µF electrolytic Capacitor
- 1x 100µF electrolytic Capacitor
- 1x Diode (1N4002 or similar)
- 2x Push Switch
- 1x 8Ω speaker
- Wire for connections



Questions (answer in your book)

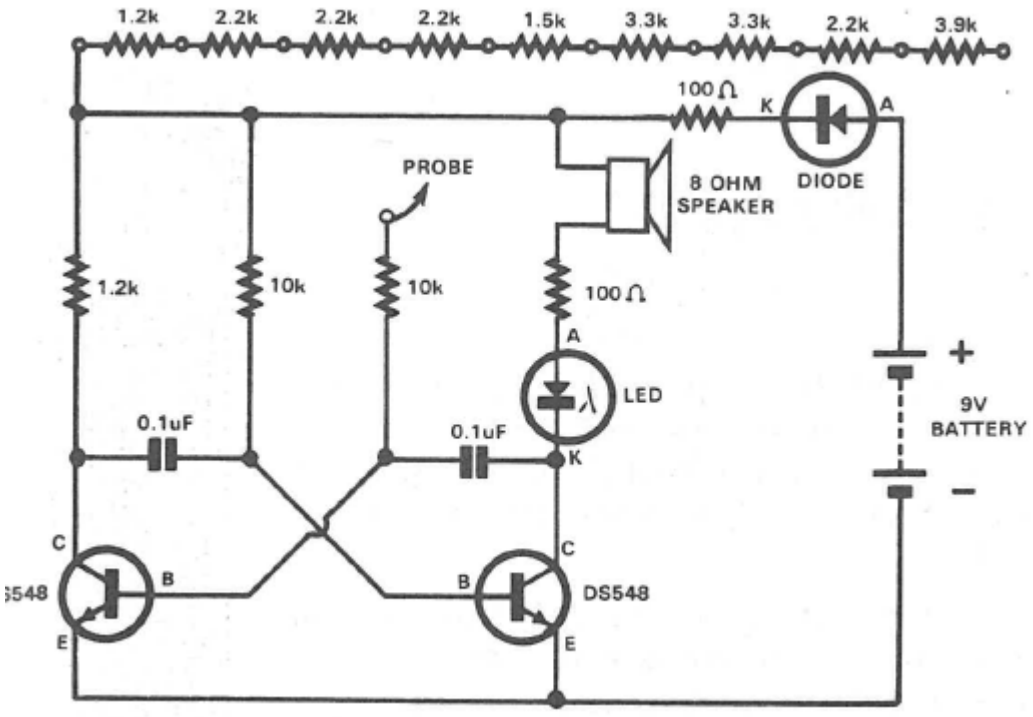
1. There are two different capacitors. What one is responsible for the high pitch sound, and what is responsible for the slow rise and fall?
2. Can you explain how the capacitors cause these effects?
3. How does the stop switch work?

13. <u>Music Maker</u>

This is a rudimentary version of an electronic keyboard. The schematic for a full keyboard is also available. Touch the probe between the resistors to create different notes.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 2x 100Ω resistor
- 2x 1.2kΩ resistor
- 1x 1.5kΩ resistor
- 4x 2.2kΩ resistor
- 2x 3.3kΩ resistor
- 1x 3.9kΩ resistor
- 2x 10kΩ resistor
- 1x LED
- 2x NPN transistor (BC548 or similar)
- 2x 0.1µF electrolytic Capacitor
- 1x Diode (1N4002 or similar)
- 1x 8Ω speaker
- Wire for connections
- Wire for probe



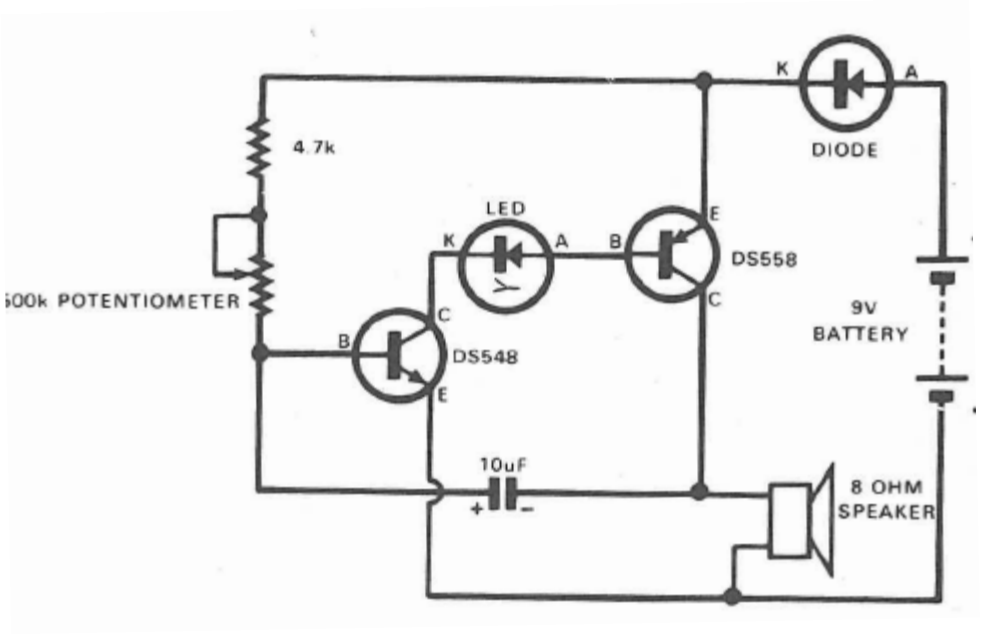
No questions for this circuit

14. <u>Sound Effects Generator</u>

By adjusting the potentiometer, this circuit can generate a wide range of sound effects, from the "put put" of a motor, to water drops on a tin roof, to a hospital heartbeat monitor or a grandfather clock.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 4.7kΩ resistor
- 1x500k potentiometer
- 1x LED
- 1x 10µF electrolytic Capacitor
- 1x PNP transistor (BC558 or similar)
- 1x NPN transistor (BC548 or similar)
- 1x Diode (1N4002 or similar)
- 1x 8Ω speaker
- Wire for connections



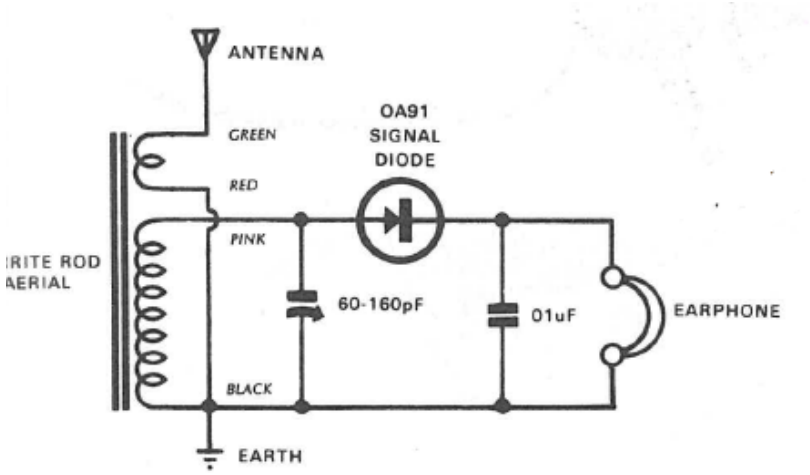
No questions for this circuit

15. A: Crystal Set

This circuit lets you pick up radio signals and hear them in an earpiece. Don't dismantle this when you are finished – it can be connected to an amplifier to improve performance.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 0.1µF electrolytic Capacitor
- 1x Tuning Capacitor
- 1x Signal Diode
- 1x Ferrite rod Aerial
- 1x Earphone
- Wire for connections
- Wire for Antenna

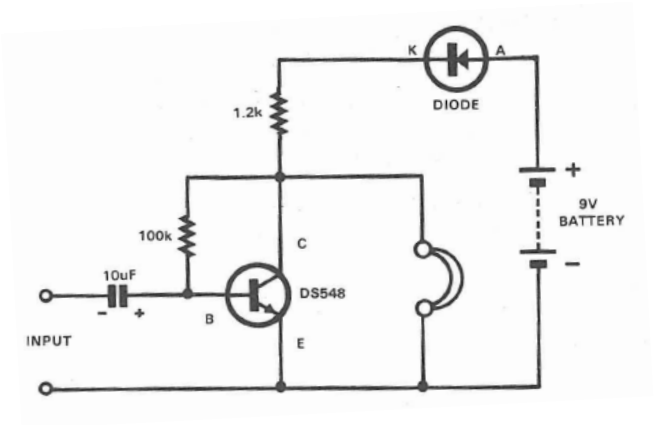


15. B: One Transistor Amplifier

This circuit demonstrates the amplification function of transistors. Connect it to your crystal set between the earpiece and the rest of the circuit.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 1.2kΩ resistor
- 1x 100kΩ resistor
- 1x 10µF electrolytic Capacitor
- 1x NPN transistor (BC548 or similar)
- 1x Diode (1N4002 or similar)
- 1x Earphone
- Wire for connections



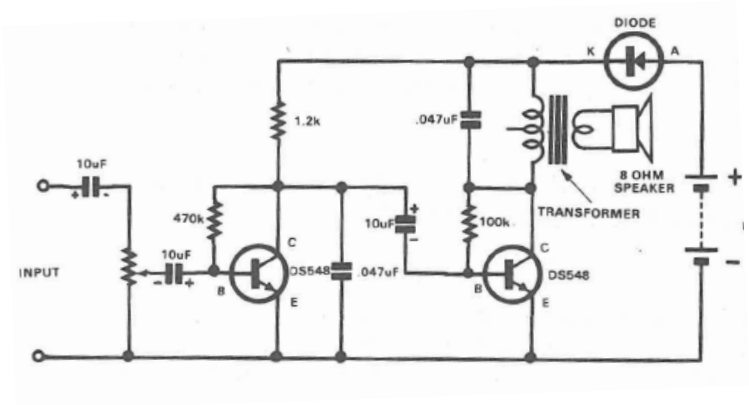
Questions (answer in your book)

1. What is the purpose of this circuit?
2. What is the purpose of the transistor of this circuit?
3. What lead of the transistor does the input current flow into?

15. C: Two transistor amplifier

Similar to the previous circuit, this circuit amplifiers more by using an extra transistor. It can be used with the crystal set so that a speaker can be used instead of the earpiece. An alternative schematic for a two-transistor amplifier is available as well.

You will need:

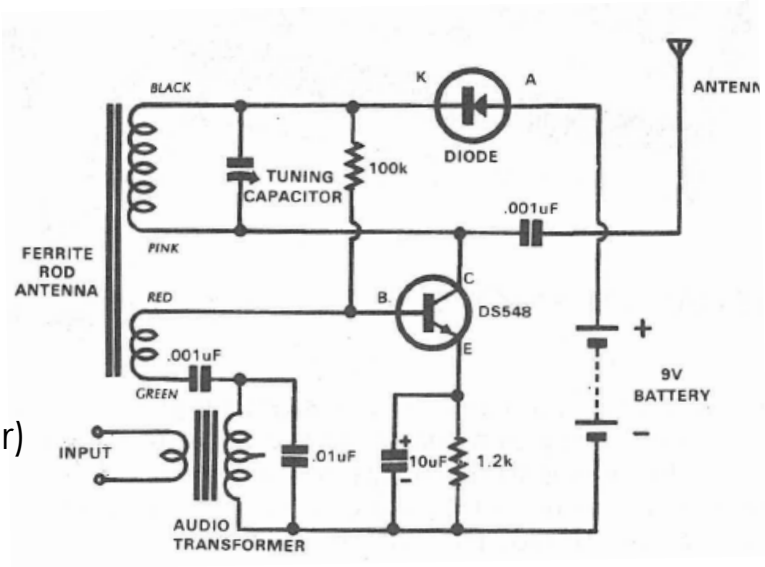


- 1x 9V battery
- 1x 9V battery snap
- 1x 1.2kΩ resistor
- 1x 100kΩ resistor
- 1x 470kΩ resistor
- 1x 500kΩ potentiometer
- 1x 47nF green capacitor
- 1x 47nF ceramic capacitor
- 3x 10µF electrolytic capacitors
- 1x Diode (1N4002 or similar)
- 2x NPN transistor (BC548 or similar)
- 1x 8Ω speaker
- 1x 8Ω to 1kΩ transformer
- Wire for connections

D: Voice/ Morse Code Transmitter

This circuit used a radio tuning circuit to broadcast at a specific frequency, which can be picked up by radio receiver circuits.

You will need:



- 1x 9V battery
- 1x 9V battery snap
- 1x 1.2kΩ resistor
- 1x 100kΩ resistor
- 1x 10nF ceramic capacitor
- 2x 1nF ceramic capacitor
- 1x 60 to 160pF tuning capacitor
- 1x Diode (1N4002 or similar)
- 1x NPN transistor (BC548 or similar)
- 1x 8Ω to 1kΩ transformer
- 1x Ferrite rod aerial
- Wire for connections
- Wire for antenna

15. E: CB Radio Receiver

This receiver covers the 'short wave' section of radio frequencies between 11 and 35MHz. This includes emergency calls, amateur radio operators and world-wide short-wave broadcasts.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 1.2kΩ resistor
- 1x 47kΩ resistor
- 1x 10nF ceramic capacitor
- 1x 1nF ceramic capacitor
- 1x 10pF ceramic capacitor
- 1x 60 to 160pF tuning capacitor
- 1x Diode (1N4002 or similar)
- 1x Signal Diode (1N60 or similar)
- 1x NPN transistor (BC548 or similar)
- Wire for connections
- Wire for antenna
- Pencil and wire for tuner coil

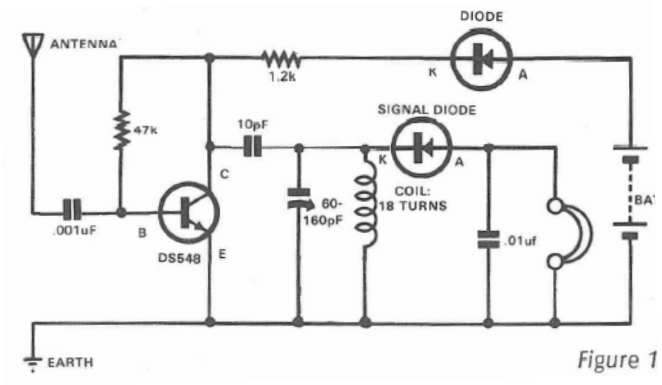


Figure 1

15. F: Radio Boost Amplifier

This can be added to any receiver to improve reception.

You will need:

- 1x 9V battery
- 1x 9V battery snap
- 1x 1.2kΩ resistor
- 1x 47kΩ resistor
- 1x 1nF ceramic capacitor
- 1x 10pF ceramic capacitor
- 1x Diode (1N4002 or similar)
- 1x NPN transistor (BC548 or similar)
- Wire for connections
- Wire for antenna