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1. GENERAL INFORMATION

Dear customer,
Thank you very much for choosing our product. In the following, we will show you what has to be observed during commissioning and use.

Should you encounter any unexpected problems during use, please feel free to contact us.

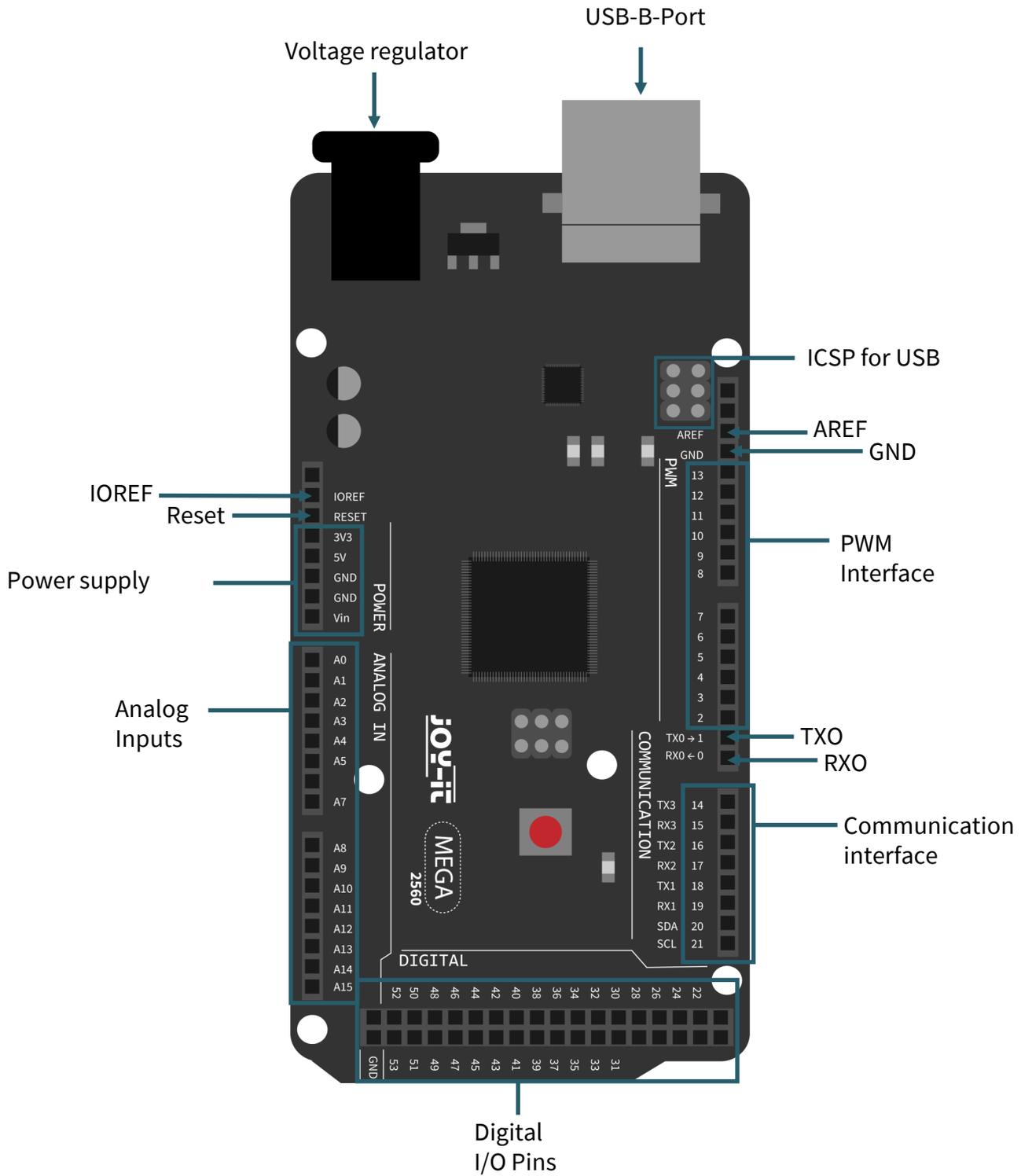
Technical data

Our board is a high-quality replica and compatible to the Arduino Mega 2560 but it is explicitly not an original Arduino.

The Mega 2560 is the right microcontroller board for those who want to get into the programming world quickly and easily as possible. This set guides you through a variety of projects. Its ATmega2560 microcontroller offers you enough power for your ideas and projects. It measures 101.52 x 53.3 mm and has with 54 digital inputs and outputs and 16 analog inputs many possibilities to connect.

Model	ard_Mega2560R3
Microcontroller	ATmega2560
Input voltage	7 - 12 V
Maximum input voltage	6 - 20 V
Digital IO	54 (14 with PWM)
Analog IO	16
DC current IO	40 mA
DC current 3,3 V	50 mA
Memory	256 kB (8 kB for Bootloader)
SRAM	8 kB
EEPROM	4 kB
Clock Speed	16 MHz
Dimensions	101.52 x 53.3 mm

Pin assignment



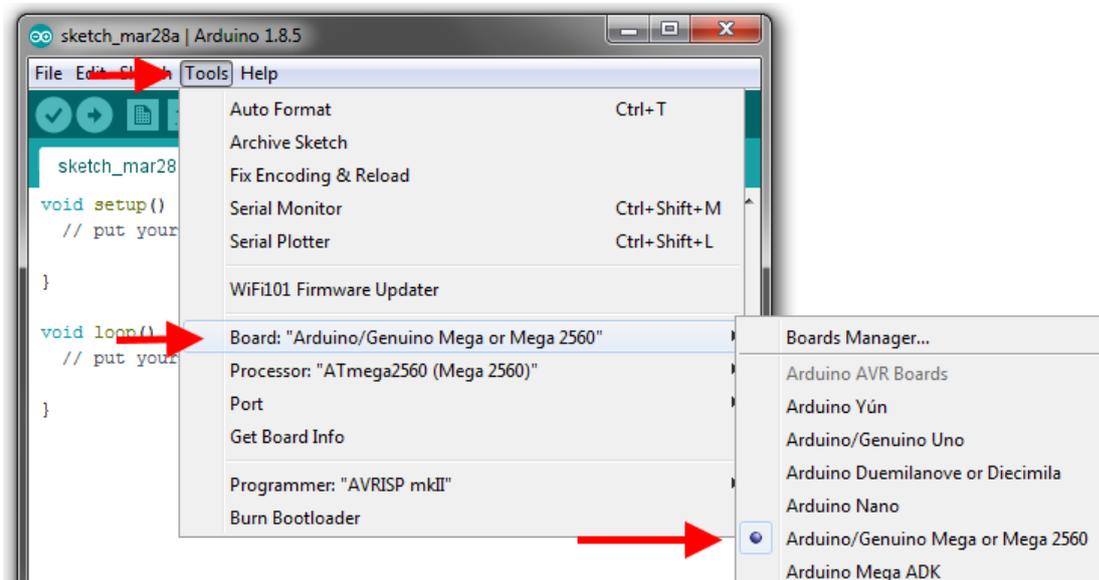
3. SOFTWARE INSTALLATION

In order to start programming the Joy-IT ard_Mega2560R3, a development environment and the drivers for the corresponding operating system must first be installed on the computer.

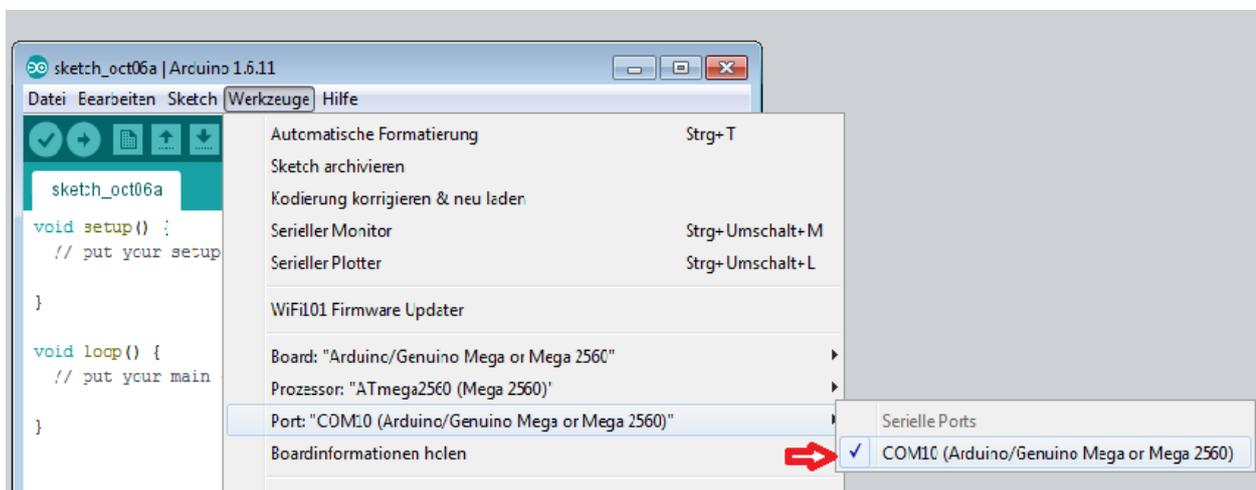
The Arduino IDE (which you can download [here](#)), which is available as an OpenSource software under the GPLv2 and published by the Arduino manufacturer. It is aimed at beginners from concept and structure. It is fully compatible with the Joy-IT ard_Mega2560R3 and contains the programming environment as well as the necessary drivers to get started right away.

After installing the software, the corresponding microcontroller board must be set up in the programming environment. To do this, follow the following two steps:

1. Under **Tools** → **Board** muss **Arduino/Genuino Mega or Mega 2560** must be selected.



2. Under **Tools** → **Port** then select the port which is marked with **Arduino/Genuino Mega or Mega 2560**.



4. RESISTORS

In this set there are three different resistors 220 Ω , 1 k Ω and 10 k Ω . On resistors there is a colour coding which can be used to calculate or detect the resistance if it cannot be measured with a multimeter. In this chapter you will learn how to calculate this resistance in order to better perform the following lessons, because you need to be able to identify the different resistances in order to correctly reproduce the set-ups.

First you have to measure the number of rings on the resistor, because resistors can have four or five rings. In this set, the resistors have 5 rings, which give you a more accurate indication of the resistance value than with 4 rings.

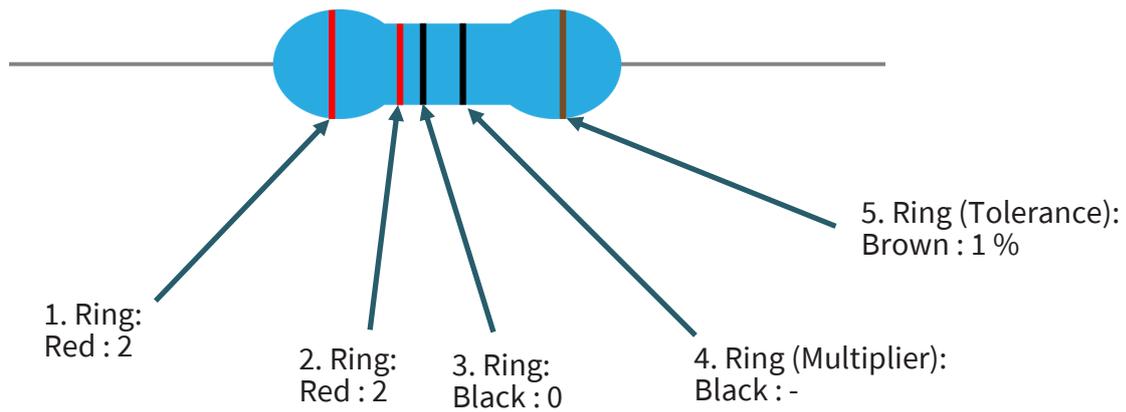
Now you have to determine which ring is the first one. This first ring can be identified by the fact that it is further away from the end of the body than the last ring.

You can now calculate the resistance value with a formula. If there are 5 rings, the first 3 rings serve as resistance counters and the fourth as multiplier, which calculates the total resistance value. The fifth ring is the tolerance ring, which calculates the deviation of resistance value. With four rings, the third ring is omitted as a resistance counter and then serves as a multiplier. The fourth ring is then the tolerance ring.

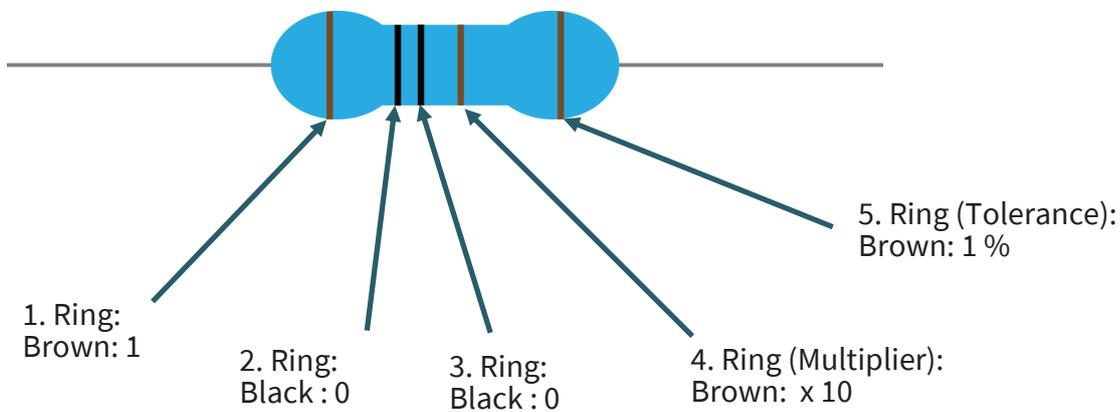
The rings have a specific colour code, where each colour has a certain value. In the following, you see the colour table for 5 rings:

Ring colour	1. Ring	2. Ring	3. Ring	4. Ring (Multiplier)	5. Ring (Tolerance)
Black	0	0	0	-	-
Brown	1	1	1	x 10	1 %
Red	2	2	2	x 100	2 %
Orange	3	3	3	x 1.000	-
Yellow	4	4	4	x 10.000	-
Green	5	5	5	x 100.000	0,5 %
Blue	6	6	6	x 1.000.000	0,25 %
Purple	7	7	7	x 10.000.000	0,1 %
Grey	8	8	8	-	-
White	9	9	9	-	-
Gold	-	-	-	x 0,1	5 %
Silver	-	-	-	x 0,01	10 %

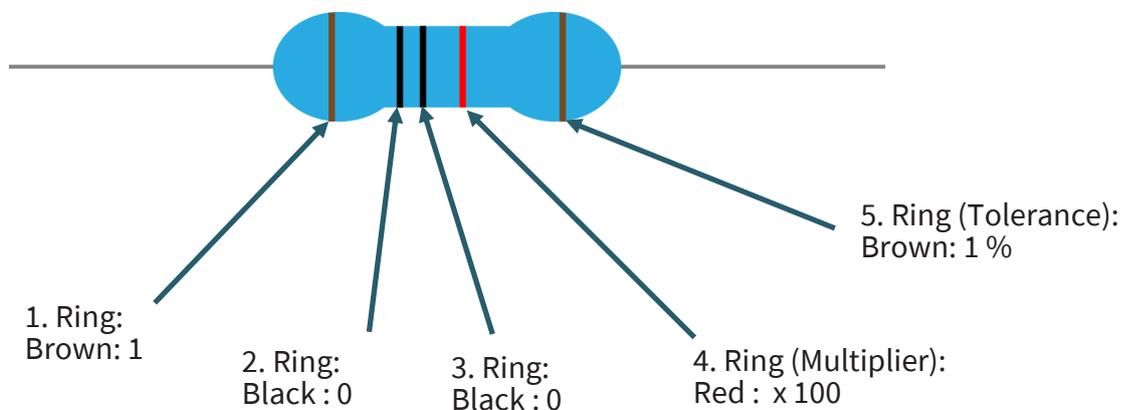
If we now look at our resistances, we can quickly calculate their value. Let's start with the 220 Ω resistance



Due to the fact that the multiplier has no value, the resistance can be determined on 220 Ω with a tolerance of 1%, which this resistance can vary.



The first three rings give the first value of 100, which is calculated by means of the multiplier (x 10) to the resistance value of 1000 Ω . This can also be converted to 1 k Ω . So this has resistor a resistance value of 1 k Ω with a tolerance of 1 %.



The first three rings result again in the first value of 100. By means of the multiplier of x 100 the resistance value of 10.000 Ω is obtained, which can be converted into 10 k Ω . Also this resistor has again a tolerance of 1 %.

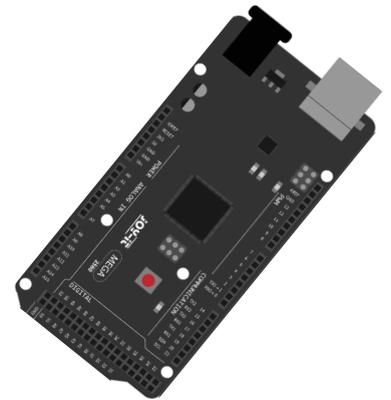
Hello world!

HELLO WORLD!

Lesson 1 : Hello world

We start with something simple. For this project you only need the board and a USB cable to start the lesson. This is a communication test for your Mega2560 and your PC, and a basic project for your first try in the Arduino world!

Once the installation of the drivers is complete, open the Arduino software and write a code that will allow the Mega2560 to display *Hello World!* under your instructions. Of course, you can also write a code that will allow the Mega2560 to display *Hello World!* repeatedly without prompting. A simple *if()* statement will do this. We can instruct the LED on pin 13 to blink first and then display Hello World! after the Arduino gets the command to do so.

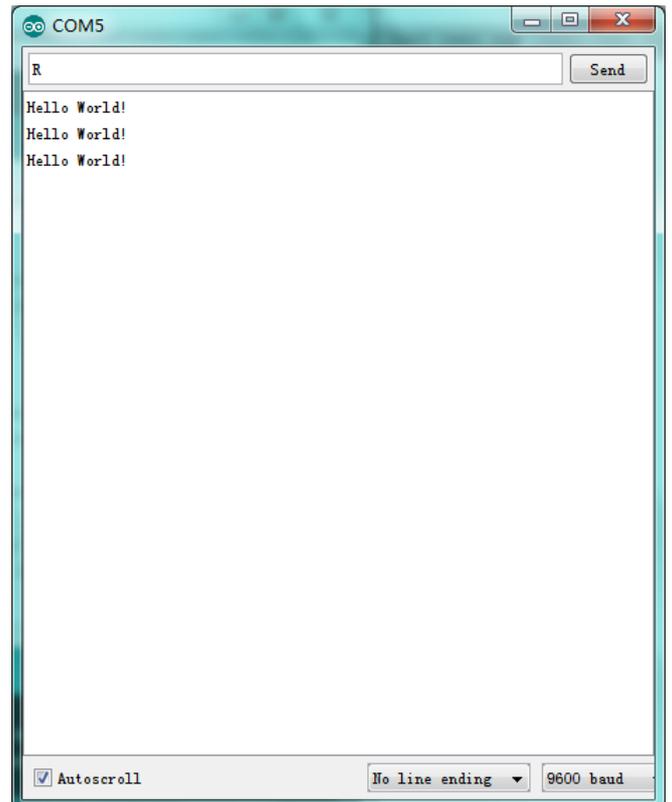


```
int val; // defines the variable "Val"
int ledpin=13; // defines the digital interface 13

void setup() {
  Serial.begin(9600);
  // sets the baudrate to 9600 to fit the software configuration
  pinMode(ledpin,OUTPUT); // sets the digital pin 13 to output
}

void loop() {
  val=Serial.read();
  if(val=='R') { // checks if the character is a R.
    // if so:
    digitalWrite(ledpin,HIGH); // turns on LED
    delay(500);
    digitalWrite(ledpin,LOW); // turns off LED
    delay(500);
    Serial.println("Hello World!"); // Shows „Hello World!“.
  }
}
```

Click on the serial monitor and add **R** , then the LED on the board will light up and your PC will receive the information *Hello World!* from the Arduino.



Lesson 2: Flashing LED

In the Hello World! program we have already encountered the LED. This time we will connect an LED with one of the digital pins. The following parts are needed:

1x Mega2560 board

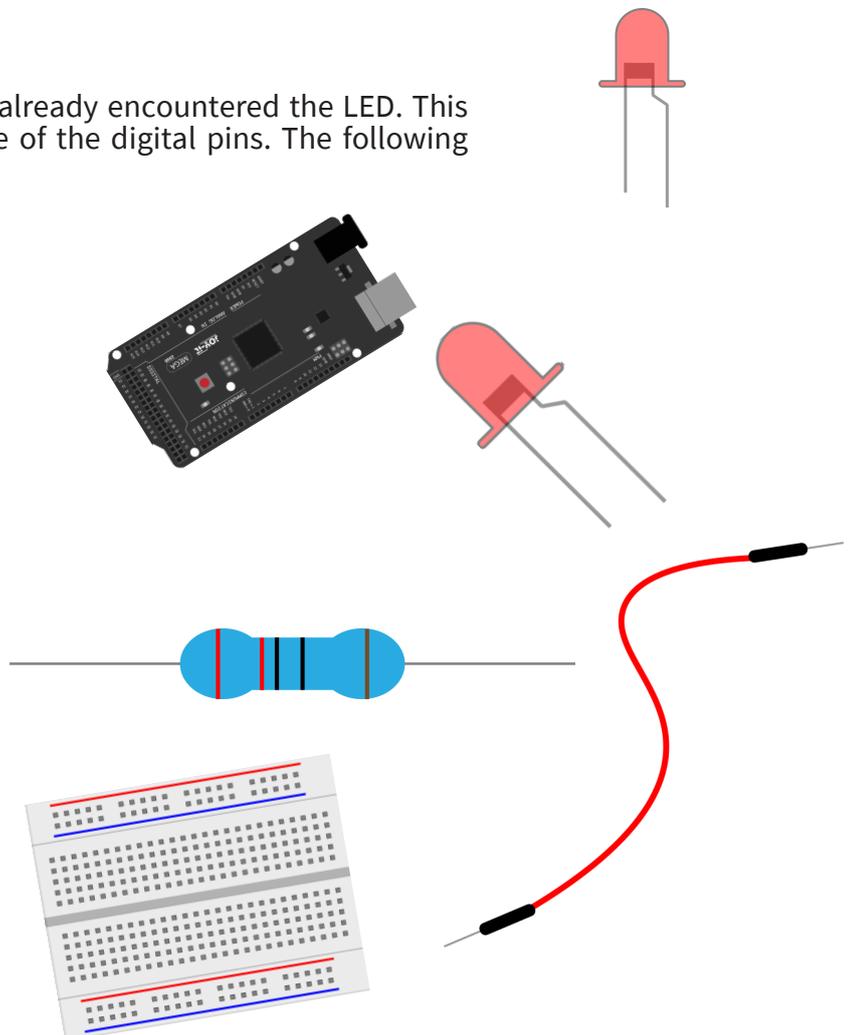
1x USB cable

1x Red M5 LED

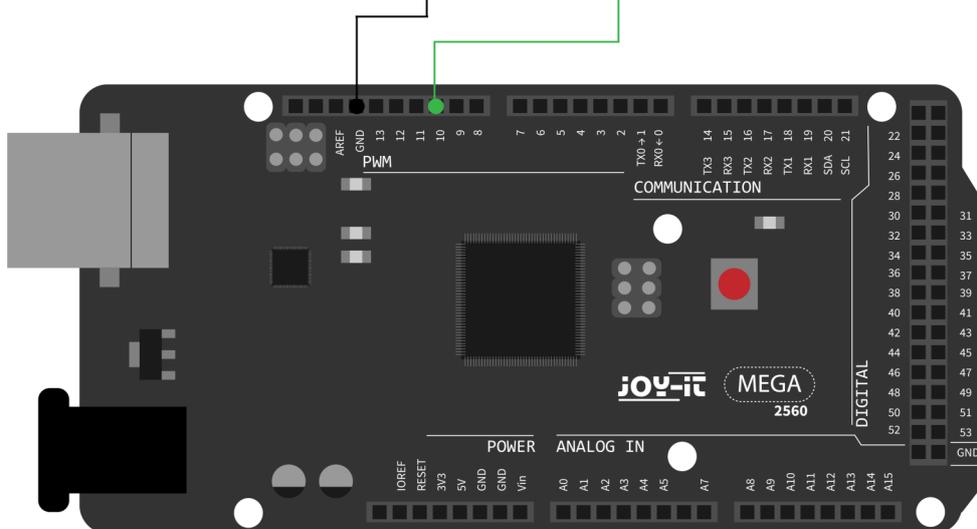
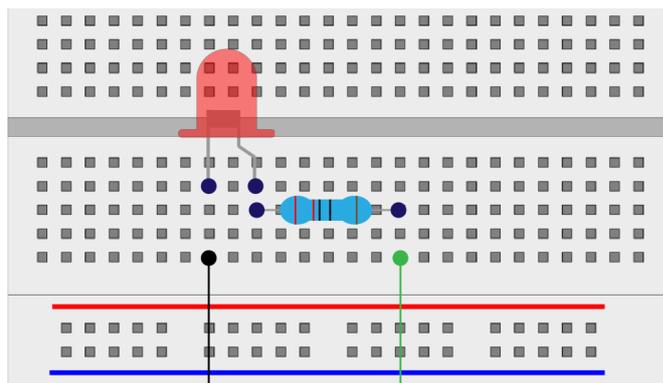
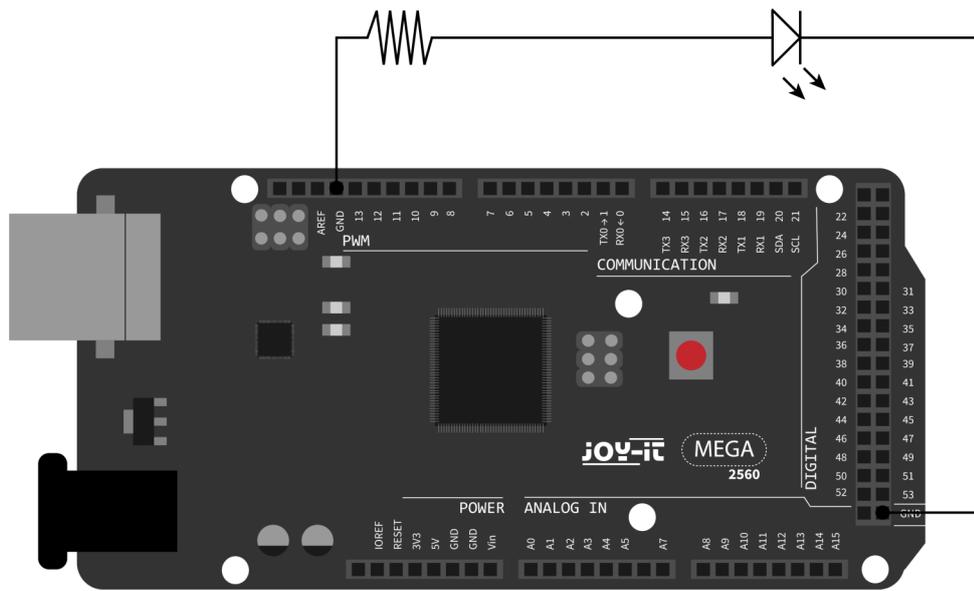
1x 220 Ω resistor

1x Breadboard

2x Jumper cable



We follow the following wiring diagram. Here we use the digital pin 10. We connect the LED with a 220 Ω resistor to avoid damage due to excessive current.



```

int ledPin = 10; // defines Digital Pin 10.

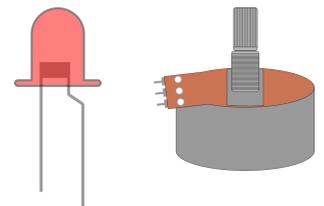
void setup() {
  pinMode(ledPin, OUTPUT); // defines pin to output
}
void loop() {
  digitalWrite(ledPin, HIGH); // turns on Led
  delay(1000); // waits a second
  digitalWrite(ledPin, LOW); // turns off Led
  delay(1000); // waits a second
}

```

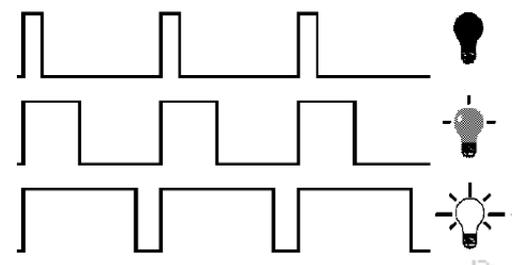
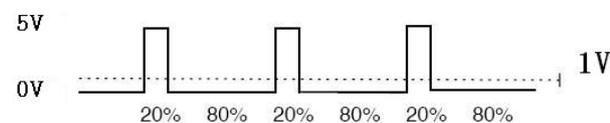
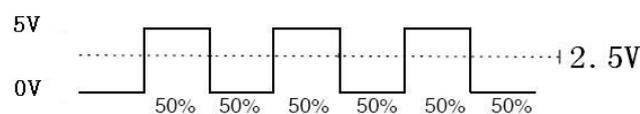
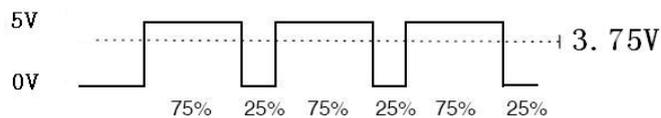
After uploading the program you will see the LED which is connected to pin 10, light up every second.

Lesson 3: PWM light control

PWM (short for Pulse Width Modulation) is a technique used to encode analog signal levels into digital ones. A computer is not capable of outputting analog voltage. It can only output digital voltage with values like 0 V or 5 V. Therefore a high resolution counter is used to output a specific analog signal level by encoding the utilization level by modulating PWM. The PWM signal is also digitized, because to each time the power supply is either 5 V (on) or 0 V (off).



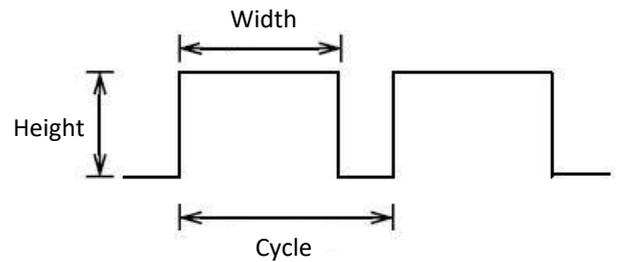
The voltage or current is supplied to the analog load (the device that consumes the energy) by repeated pulse sequences, by constantly switching between the on and off states. The value of the output voltage is determined by the on and off states.



$$\text{Voltage} = \frac{\text{ON - duration}}{\text{Pulse duration}} * \text{maximal voltage}$$

There are many applications for PWM: regulation of lamp brightness, regulation of motor speed, etc. .

These are the three basic parameters of PWM:

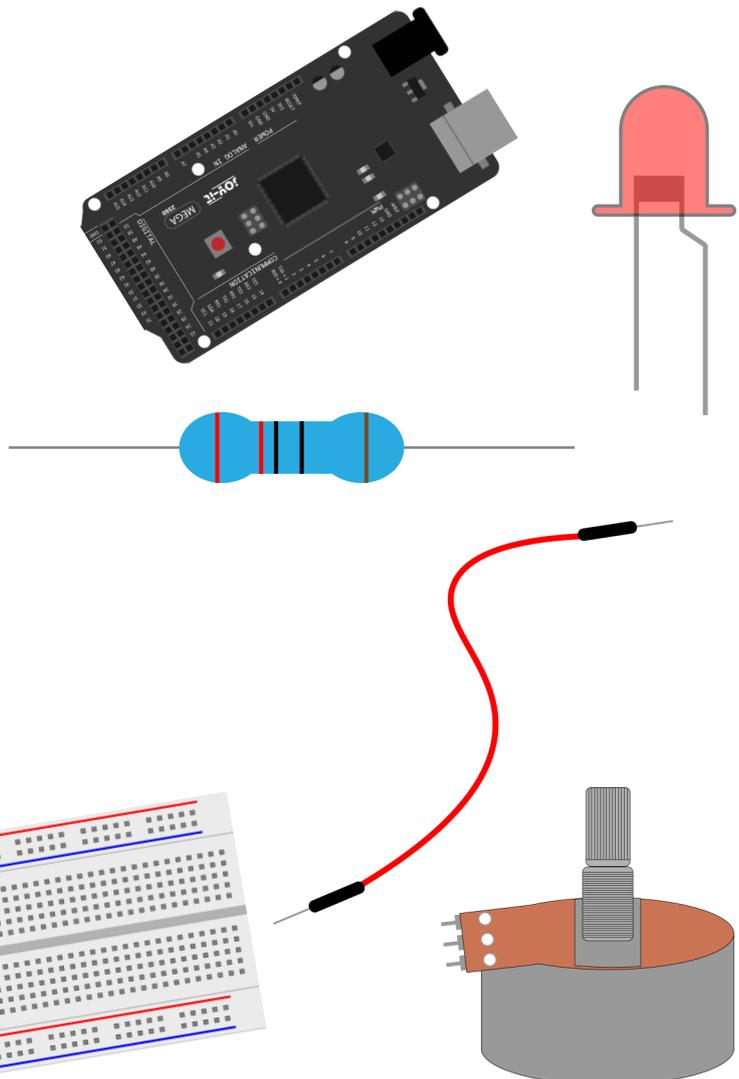


1. The amplitude of the pulse width (minimum / maximum)
2. The pulse period (The mutual pulse rate in one second)
3. The voltage level (like: 0 - 5 V)

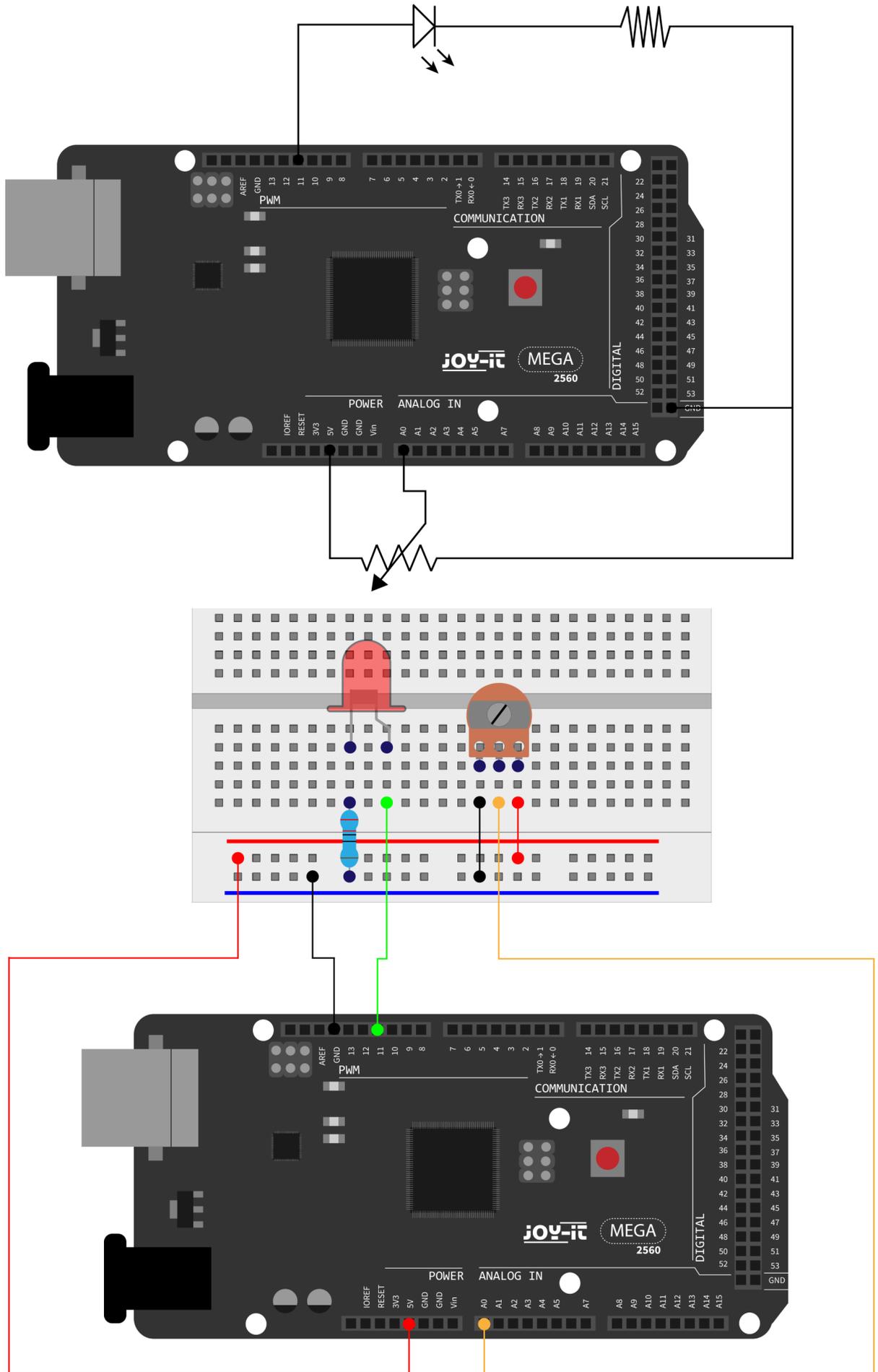
There are 6 PWM interfaces on the Mega2560: digital pins 3, 5, 6, 9, 10 and 11.

In previous experiments we have got to know the key-controlled LED, where we used a digital signal to generate a digital pin. Now we will use a potentiometer to control the brightness of the LED. We need for this:

- 1x Mega2560 board
- 1x USB cable
- 1x Red M5 LED
- 1x 220 Ω resistor
- 1x Breadboard
- 6x Jumper cable
- 1x Potentiometer



The input of the potentiometer is analog, so we connect it to the analog port. We connect the LED to the PWM port. A other PWM signal can regulate the brightness of the LED.



```

int potpin = 0; // Initialises analog Pin 0
int ledpin = 11; // Initialises digital Pin 11 (PWM Output)
int val = 0; // Saves the Sensors Value

void setup() {
  pinMode(ledpin,OUTPUT); // defines digital Pin 11 to „Output“
  Serial.begin(9600); // Sets Baudrate to 9600
}

void loop() {
  val = analogRead(potpin);
  // reads the Analog-Value of the sensor and assigns it to „Val“
  Serial.println(val); // shows the value of „Val“
  analogWrite(ledpin,val/4);
  // turns on the LED and sets the brightness (Max. Value: 255)
  delay(10); // Waits 0,01 Seconds
}

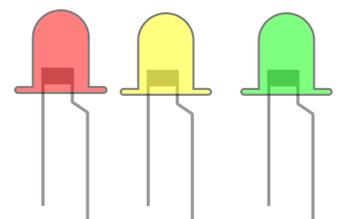
```

After transmission of the program and when moving the potentiometer, we can observe changes in the displayed values. We can also see an obvious change in LED brightness.

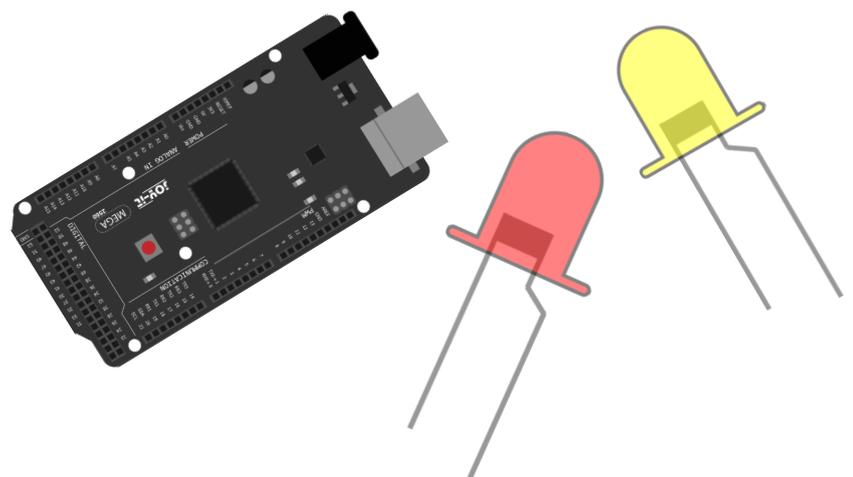
Lesson 4: Traffic lights

In the previous program we did the flashing LED experiment with only one LED. Now it is time to do a more complicated experiment: Traffic lights.

Actually these two experiments are very similar. In this experiment we will use 3 LEDs with different colors, while in the last one only one LED was used. We need for this:



- 1x Mega2560 board
- 1x USB cable
- 1x Red M5 LED
- 1x Yellow M5 LED

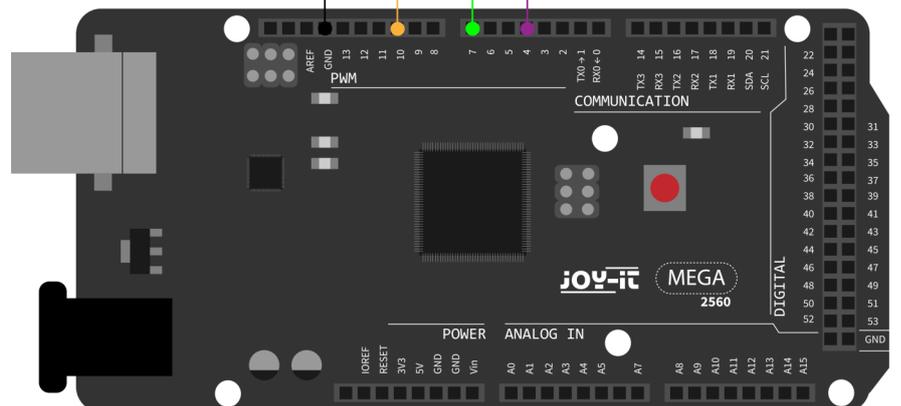
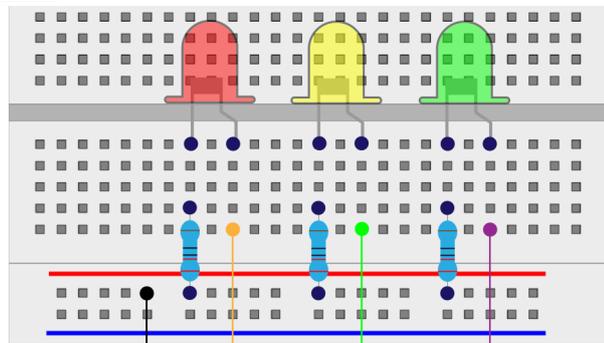
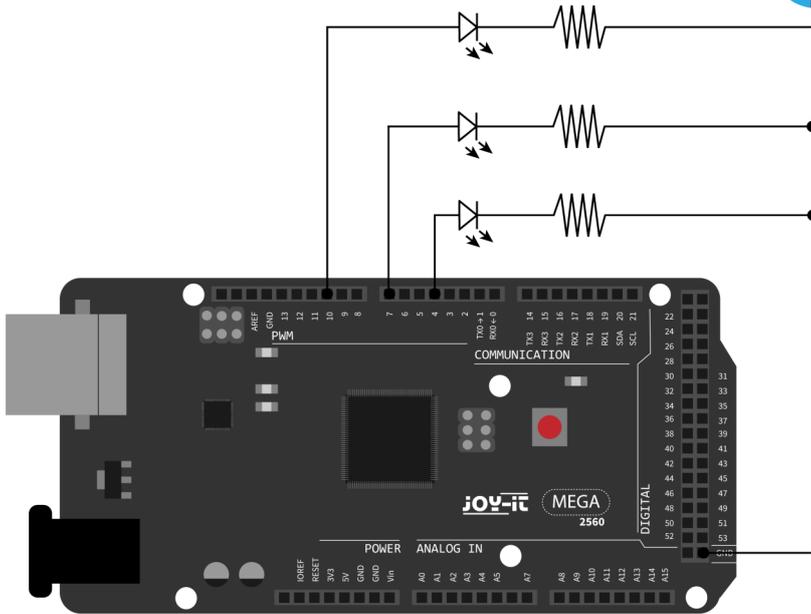
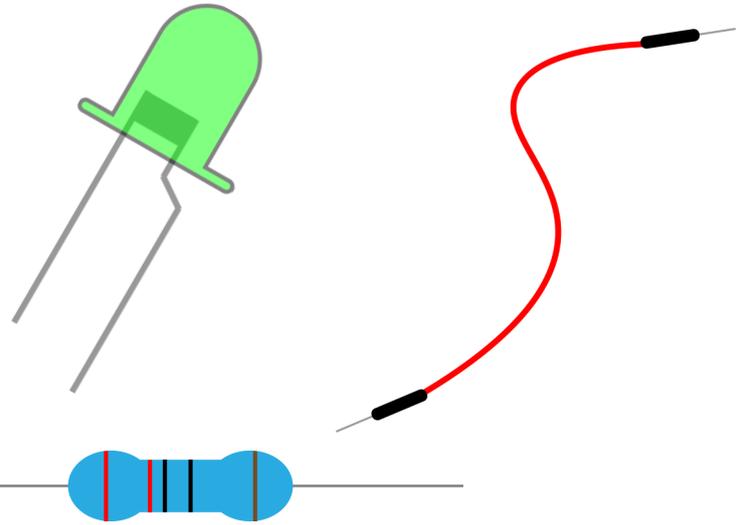


1x Green M5 LED

3x 220 Ω resistor

1x Breadboard

4x Jumper cable



Since this is a situation of traffic lights, the lighting time of each individual LED should be exactly the same as in a real traffic light. In this program we will use the Arduino delay function to control the delay time.

```
int redled =10; // Initialises digital Pin 8
int yellowled =7; // Initialises digital Pin 7
int greenled =4; // Initialises digital Pin 4

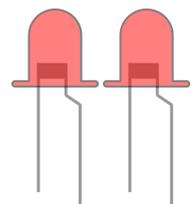
void setup() {
  pinMode(redled, OUTPUT); // Sets Pin with red LED to „Output“
  pinMode(yellowled, OUTPUT); // Sets Pin with yellow to „Output“
  pinMode(greenled, OUTPUT); // Sets Pin with green LED to „Output“
}

void loop() {
  digitalWrite(greenled, HIGH); // turns on green leed
  delay(5000); // Waits 5 Seconds
  digitalWrite(greenled, LOW); // turns off green LED
  for(int i=0;i<3;i++) { // flashes 3x
    delay(500);
    digitalWrite(yellowled, HIGH); // turns on the yellow LED
    delay(500);
    digitalWrite(yellowled, LOW); // turns on the yellow LED
  }
  delay(500);
  digitalWrite(redled, HIGH); // turns on the red LED
  delay(5000);
  digitalWrite(redled, LOW); // turns on the red LED
}
```

Once the file has been uploaded, the traffic lights are visible. The green light will stay on for 5 seconds and then turn off. Then the yellow light will flash 3 times and then the red light for 5 seconds, so that a circuit is formed.

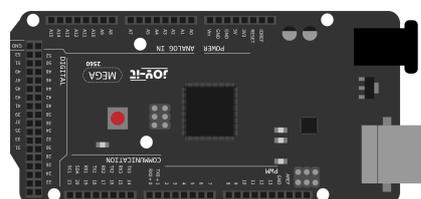
Lesson 5: LED hunting effect

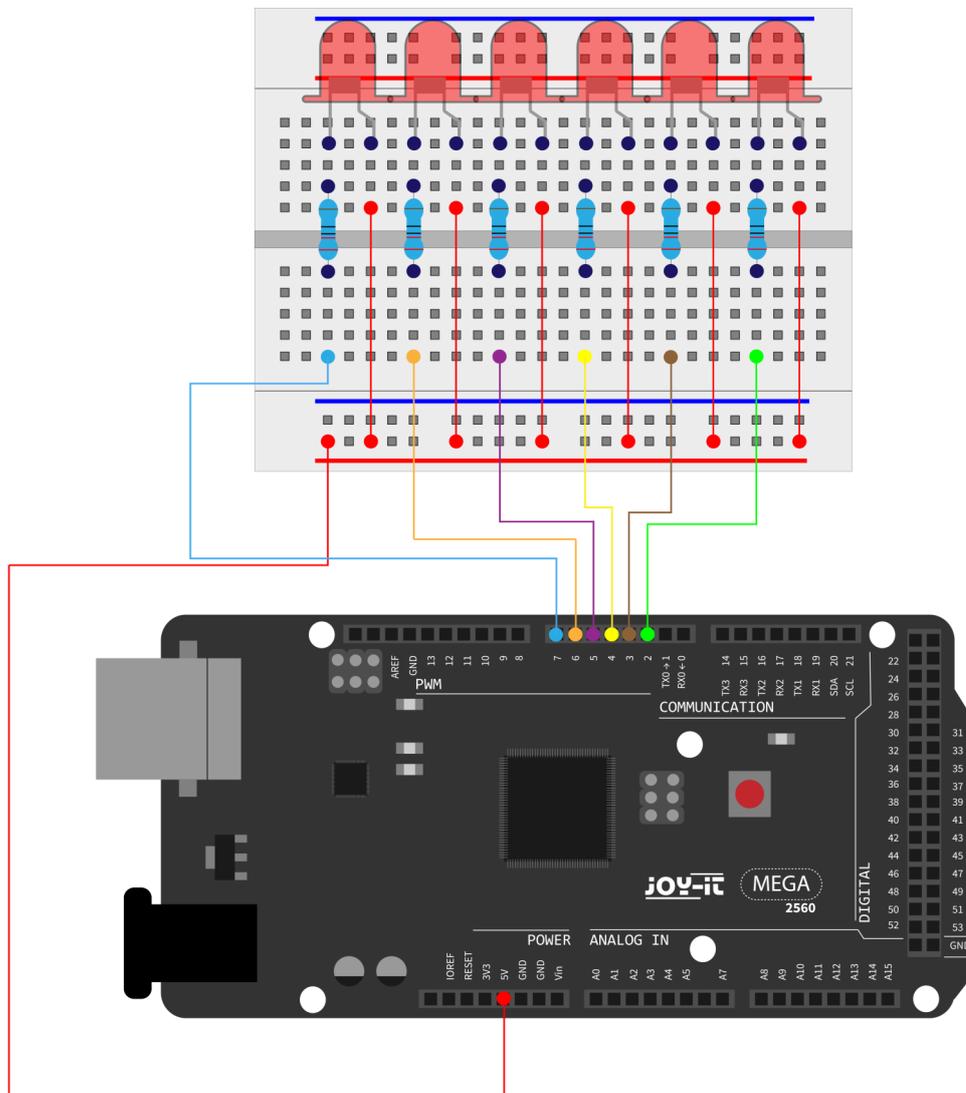
We often see billboards, which are equipped with coloured LEDs. These change constantly to create different effects. In this experiment, a program is created which simulates the LED hunting effect. This is needed:



1x Mega2560 board

1x USB cable





```

int BASE = 2 ; // The I/O pin for the first LED
int NUM = 6; // Amount of LEDs

void setup() {
  for (int i = BASE; i < (BASE + NUM); i ++){
    pinMode(i, OUTPUT); // Set I/O pins as output
  }
}

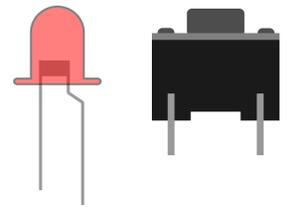
void loop() {
  for (int i = BASE; i < (BASE + NUM); i ++){
    digitalWrite(i, LOW); // Sets I/O pins to "Low"
    // switches on the LEDs one after the other
    delay(200); // delay
  }
  for (int i = BASE; i < (BASE + NUM); i ++){
    digitalWrite(i, HIGH); // Sets I/O pins to "high"
    // switches off the LEDs one after the other
    delay(200); // delay
  }
}

```

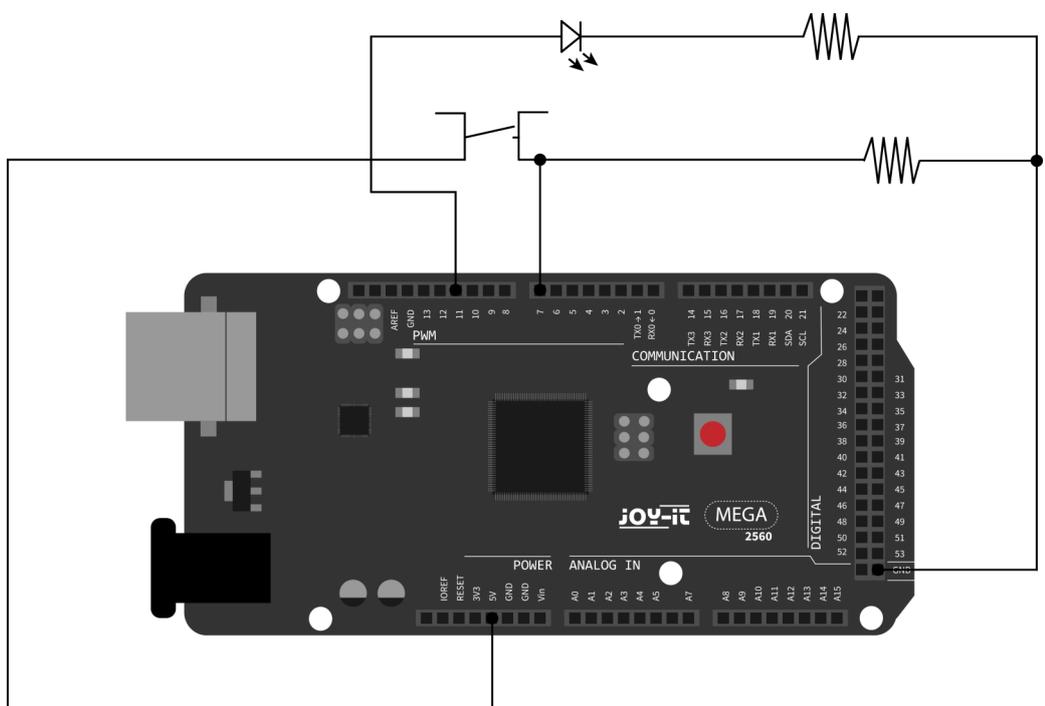
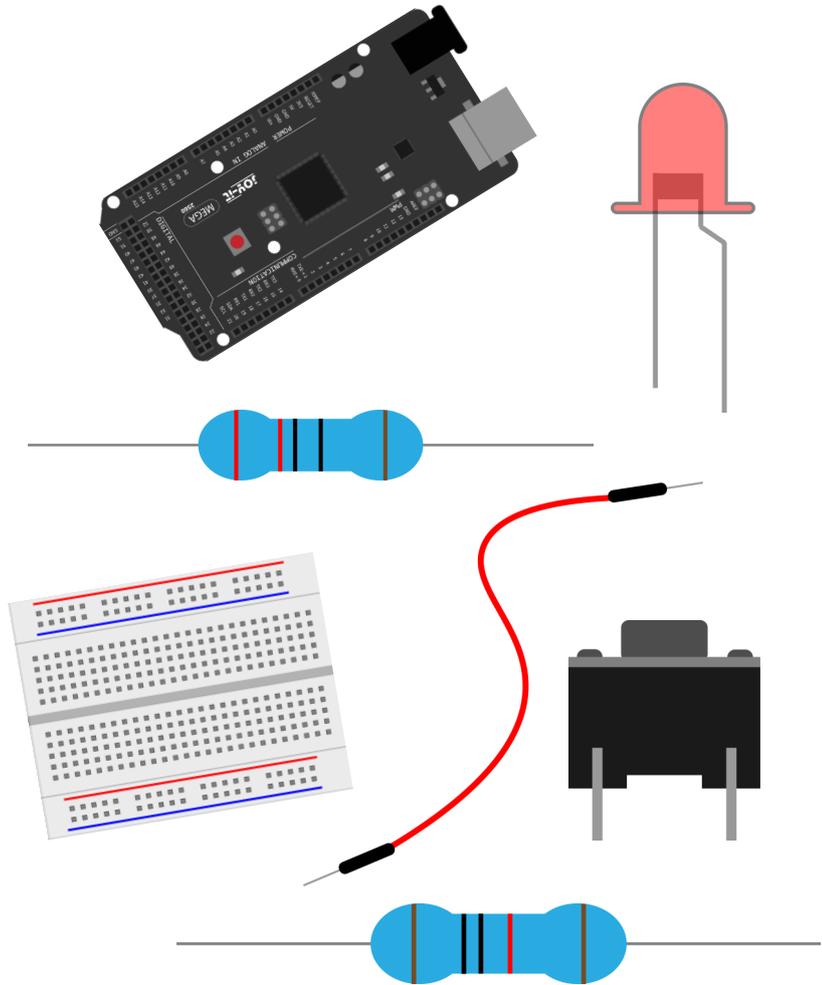
Lesson 6: Key-controlled LED

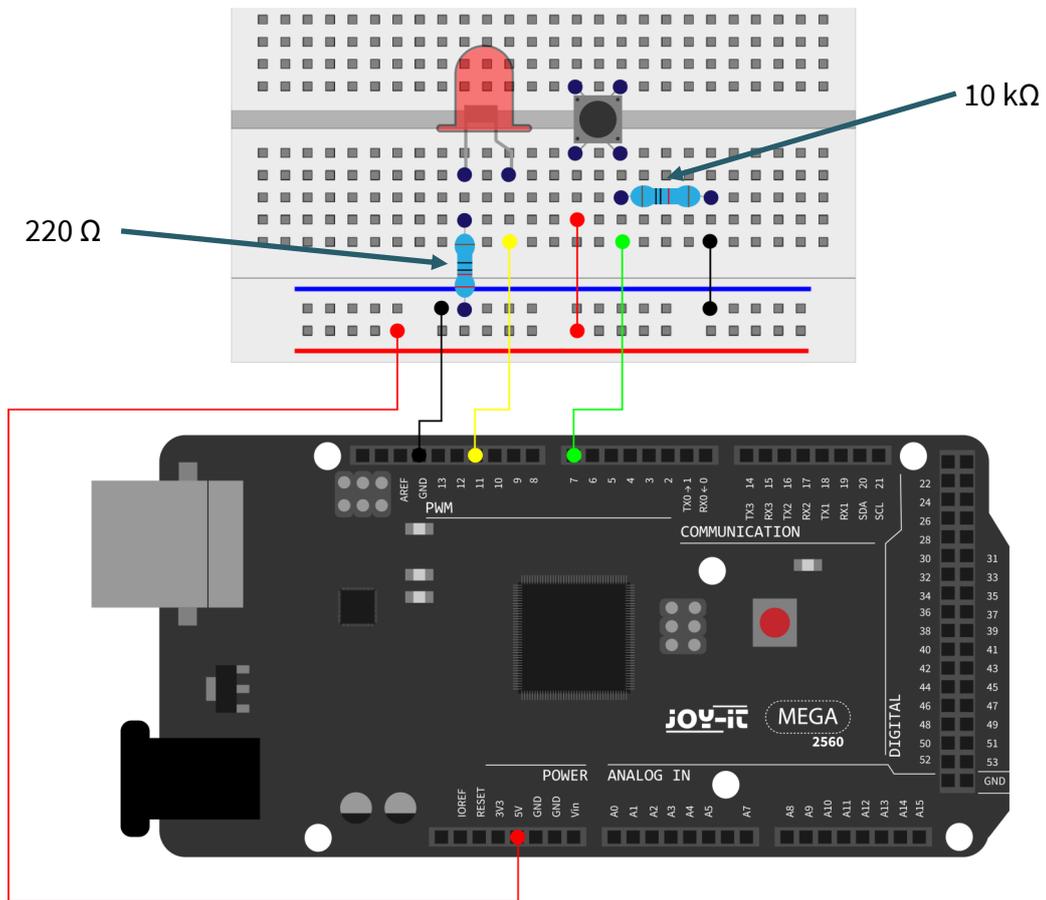
I/O-Port is an interface, which can be used as input and output. So far, we've only used it as the output. In this experiment we will try to use the input to read the output value of the connected device. We will use a key as input and a LED as output to get a better understanding of the I/O functions. Key switches, which many people probably know, have a switching value (digital value). When the switch is pressed, the circuit closes and is in a conducting state.

For this we need:



- 1x Mega2560 board
- 1x USB cable
- 1x Red M5 LED
- 1x 220 Ω resistor
- 1x 10 kΩ resistor
- 1x Key switch
- 1x Breadboard
- 6x Jumper cable





```

int BASE = 2 ; // I/O Pin for the first LED
int NUM = 6; // Amount of LEDs

void setup() {
  for (int i = BASE; i < (BASE + NUM); i ++ ) {
    pinMode(i, OUTPUT); // Sets I/O Pins to output
  }
}

void loop() {
  for (int i = BASE; i < (BASE + NUM); i ++ ) {
    digitalWrite(i, LOW); // Set I/O Pin to „Low“
    // turns on leds one by one
    delay(200); // delay
  }
  for (int i = BASE; i < (BASE + NUM); i ++ ) {
    digitalWrite(i, HIGH); // Sets I/O Pin to „high“
    // turns off led one by one
    delay(200); // delay
  }
}

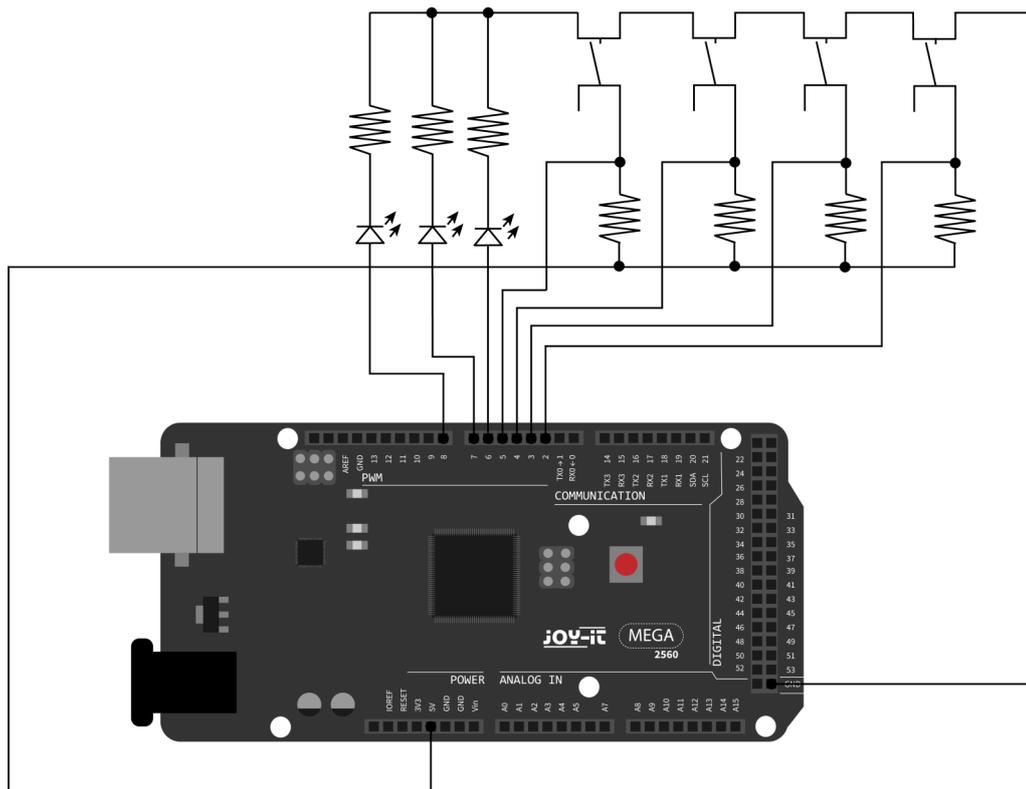
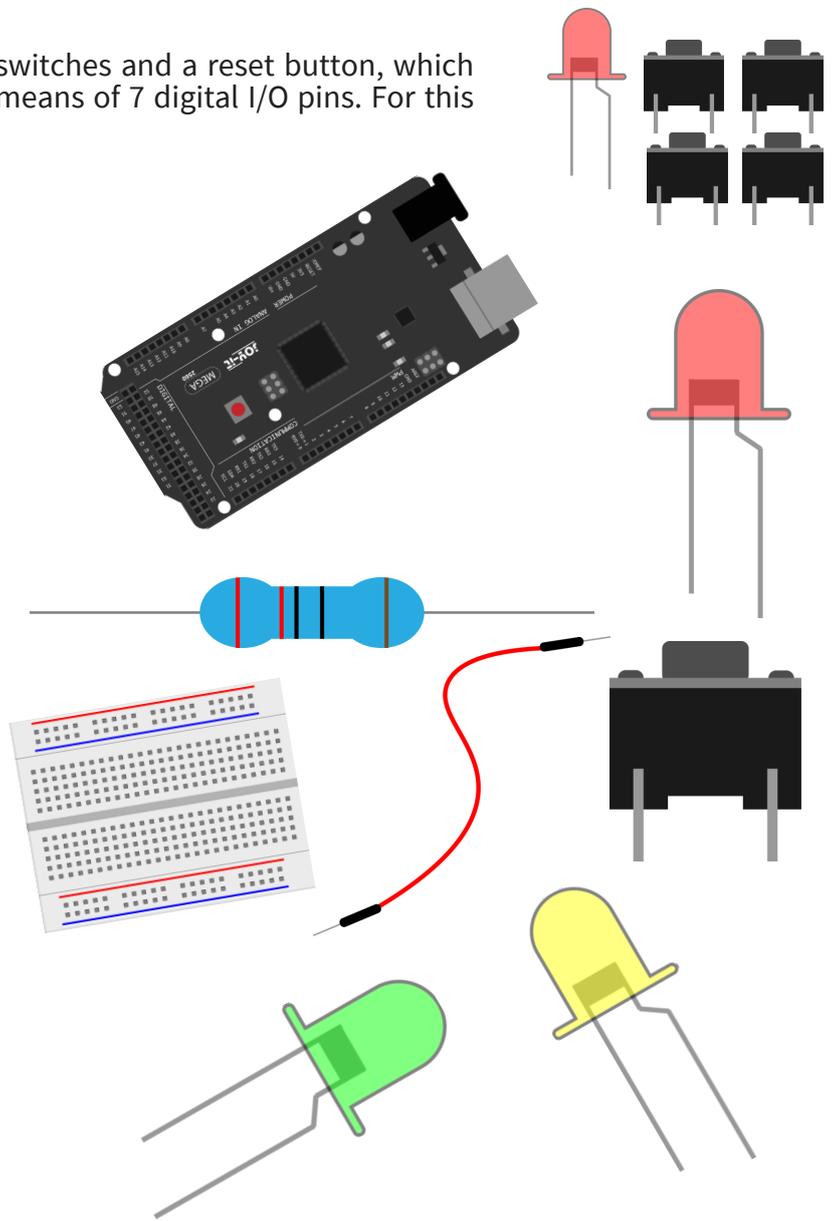
```

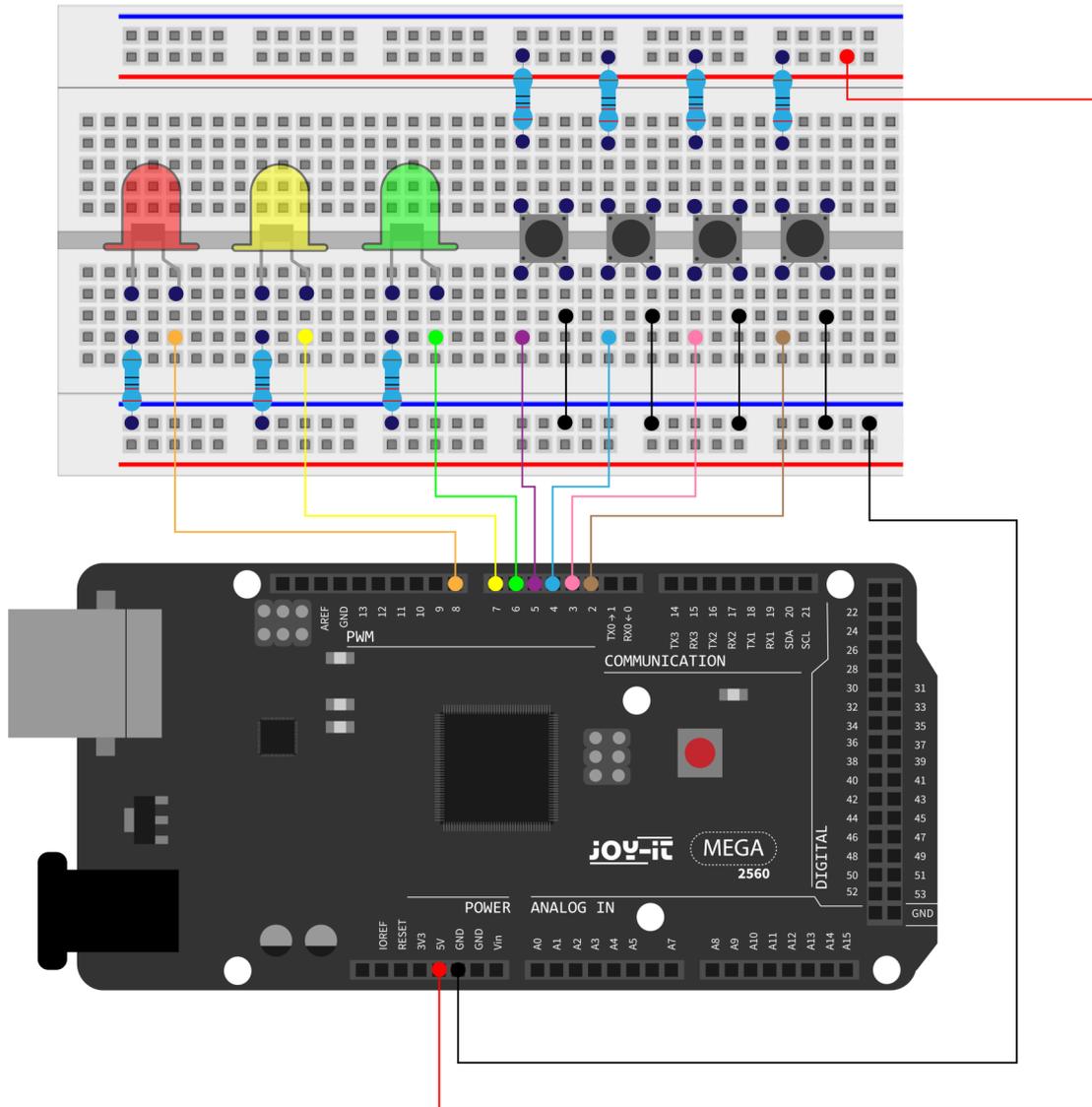
When the key is pressed, the LED is on, otherwise it remains off. The simple principle of this experiment is often used in a variety of circuits and electrical devices.

Lesson 7: Responder experiment

In this lesson there are three button switches and a reset button, which control the 3 corresponding LEDs by means of 7 digital I/O pins. For this you need:

- 1x Mega2560 board
- 1x USB cable
- 7x 220 Ω Widerstand
- 1x Red M5 LED
- 1x Yellow M5 LED
- 1x Green M5 LED
- 4x Key switch
- 1x Breadboard
- 13x Jumper cable





```

int redled=8; // Pin for red LED
int yellowled=7; // Pin for yellow LED
int greenled=6; // Pin for green LED
int redpin=5; // Pin for red key
int yellowpin=4; // Pin for yellow key
int greenpin=3; // Pin for green key
int restpin=2; // Pin for reset pin
int red;
int yellow;
int green;

void setup() {
  pinMode(redled,OUTPUT);
  pinMode(yellowled,OUTPUT);
  pinMode(greenled,OUTPUT);
  pinMode(redpin,INPUT);
  pinMode(yellowpin,INPUT);
  pinMode(greenpin,INPUT);
}

```

```

void loop(){ //Repeatedly reads the pins of the keys
  red = digitalRead(redpin);
  yellow = digitalRead(yellowpin);
  green = digitalRead(greenpin);
  if(red==LOW)RED_YES();
  if(yellow==LOW)YELLOW_YES();
  if(green==LOW)GREEN_YES();
}

void RED_YES(){// Executes the code until red LED is on
// ends the cycle when the reset button is pressed
  while(digitalRead(restpin)==1){
    digitalWrite(redled,HIGH);
    digitalWrite(greenled,LOW);
    digitalWrite(yellowled,LOW);
  }
  clear_led();
}

void YELLOW_YES(){// Executes the code until yellow LED is on
// ends the cycle when the reset button is pressed
  while(digitalRead(restpin)==1){
    digitalWrite(redled,LOW);
    digitalWrite(greenled,LOW);
    digitalWrite(yellowled,HIGH);
  }
  clear_led();
}

void GREEN_YES() // Executes the code until green LED is on
// ends the cycle when the reset button is pressed
{
  while(digitalRead(restpin)==1){
    digitalWrite(redled,LOW);
    digitalWrite(greenled,HIGH);
    digitalWrite(yellowled,LOW);
  }
  clear_led();
}

void clear_led(){ // all LEDs off
digitalWrite(redled,LOW);
digitalWrite(greenled,LOW);
digitalWrite(yellowled,LOW);
}

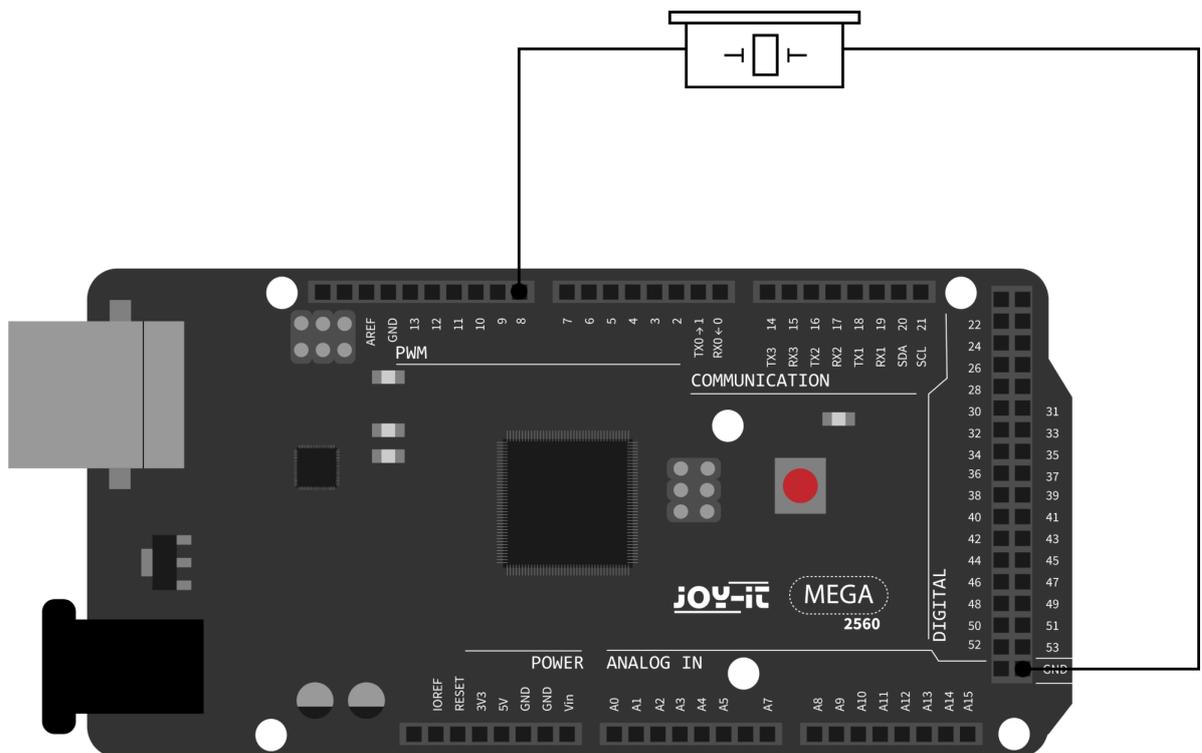
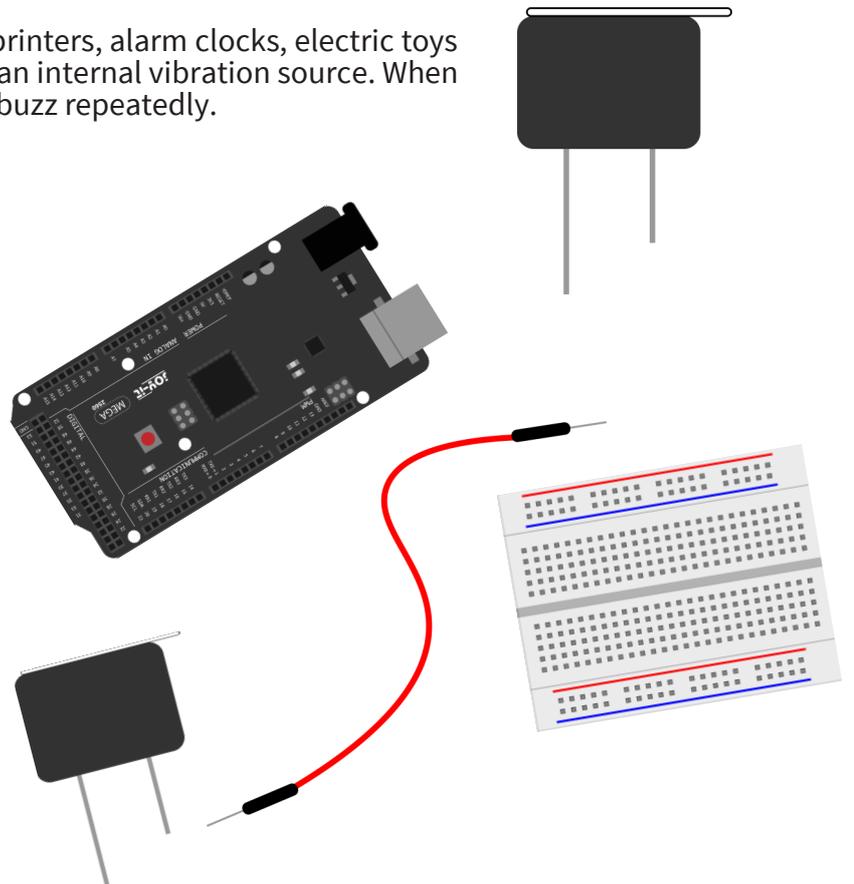
```

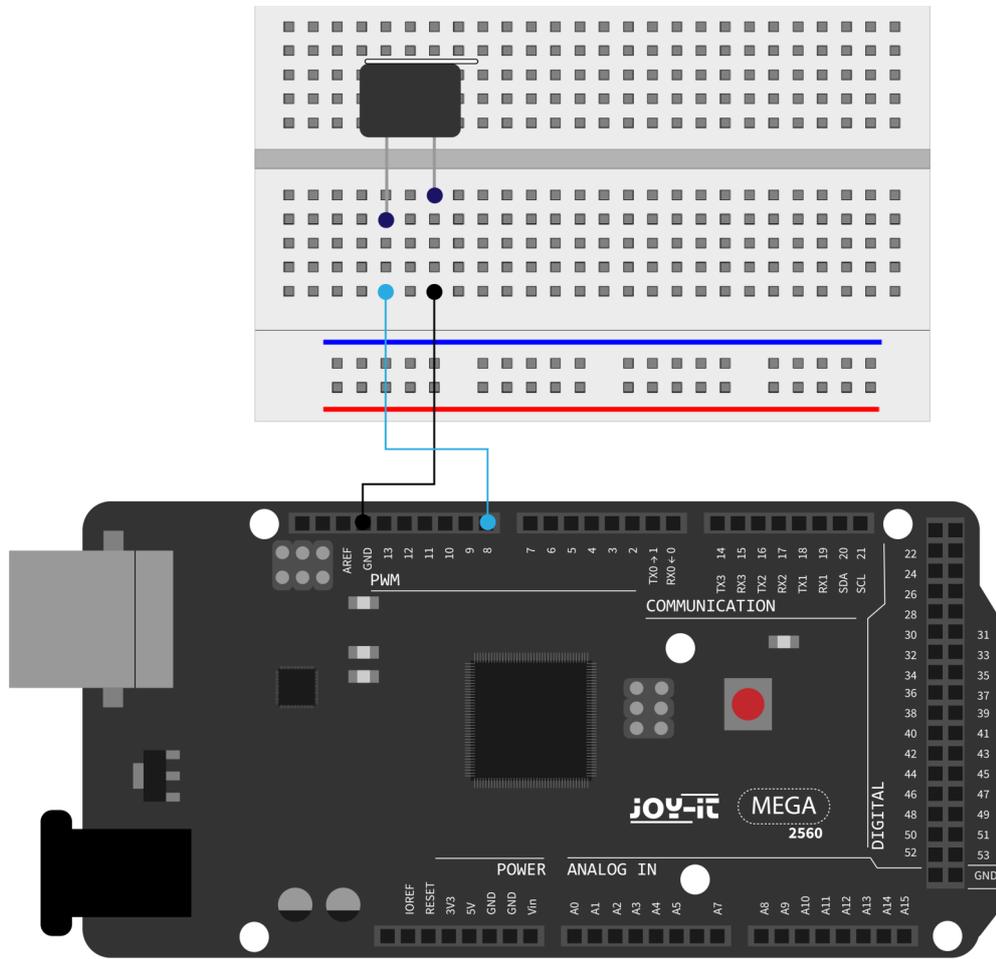
Make sure you add both pieces of code in your sketch to the Arduino IDE. When a button is pressed, the corresponding LED is switched on. When the reset button is pressed, the corresponding LED is switched off again.

Lesson 8: Active buzzer

Active buzzers are used in computers, printers, alarm clocks, electric toys etc. as a noise-emitting element. It has an internal vibration source. When connected to a 5V power supply, it can buzz repeatedly. This is required:

- 1x Mega2560 board
- 1x USB cable
- 1x Active buzzer (with sticker)
- 1x Breadboard
- 2x Jumper cable





```
int buzzer=8;
// Initialize digital I/O pin, which controls the buzzer

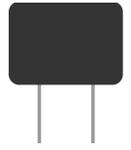
void setup() {
  pinMode(buzzer,OUTPUT); // set pin as "output"
}

void loop() {
  digitalWrite(buzzer, HIGH); // makes noises
}
```

The project is completed after the transfer of the program. If the buzzer is supplied with power after the transfer, it will be making noises.

Lesson 9: Passive buzzer

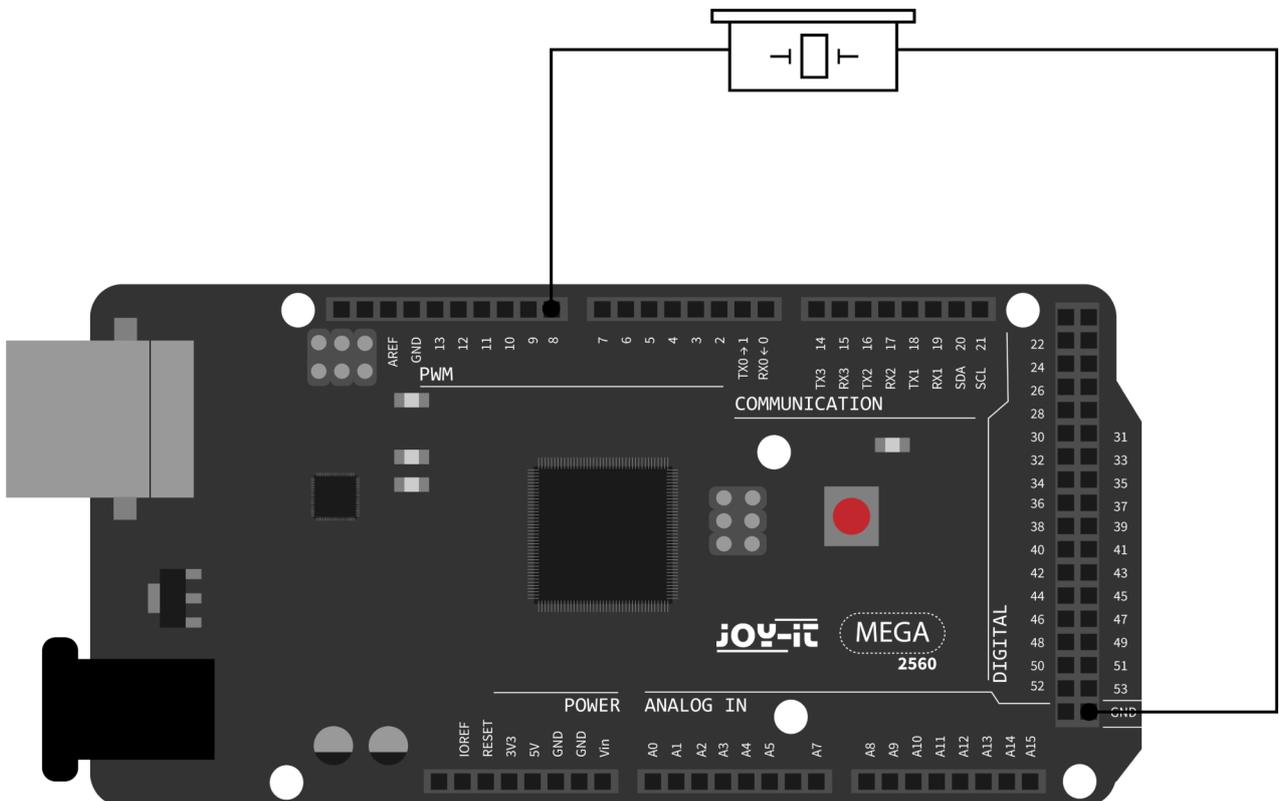
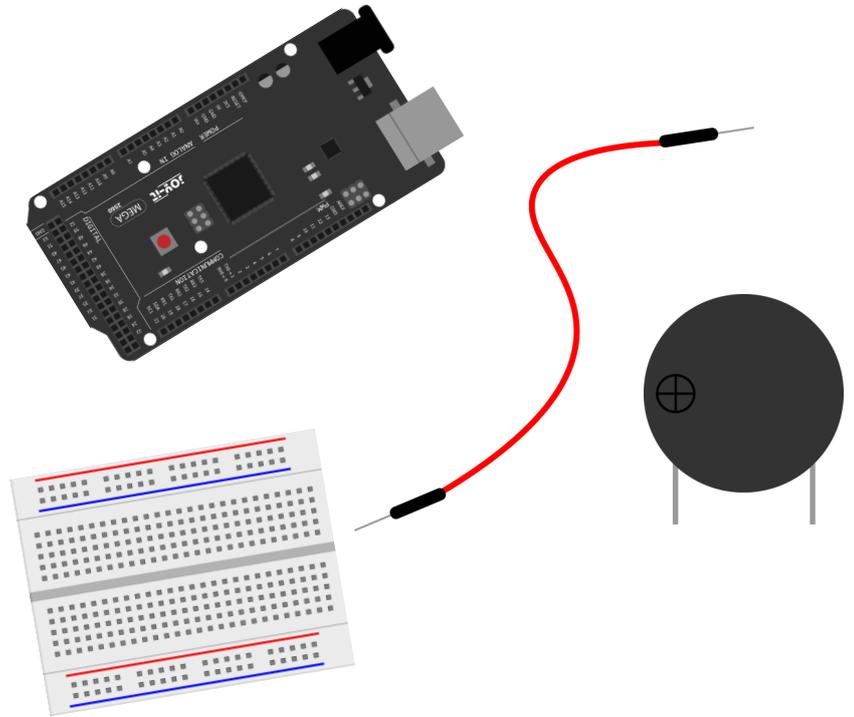
With the Mega2560 many interactive projects are possible. The previous projects have mainly dealt with LEDs, but a frequently used project is the acoustic-optical display. For this a passive buzzer is used, which, in contrast to the active buzzer, cannot activate itself.

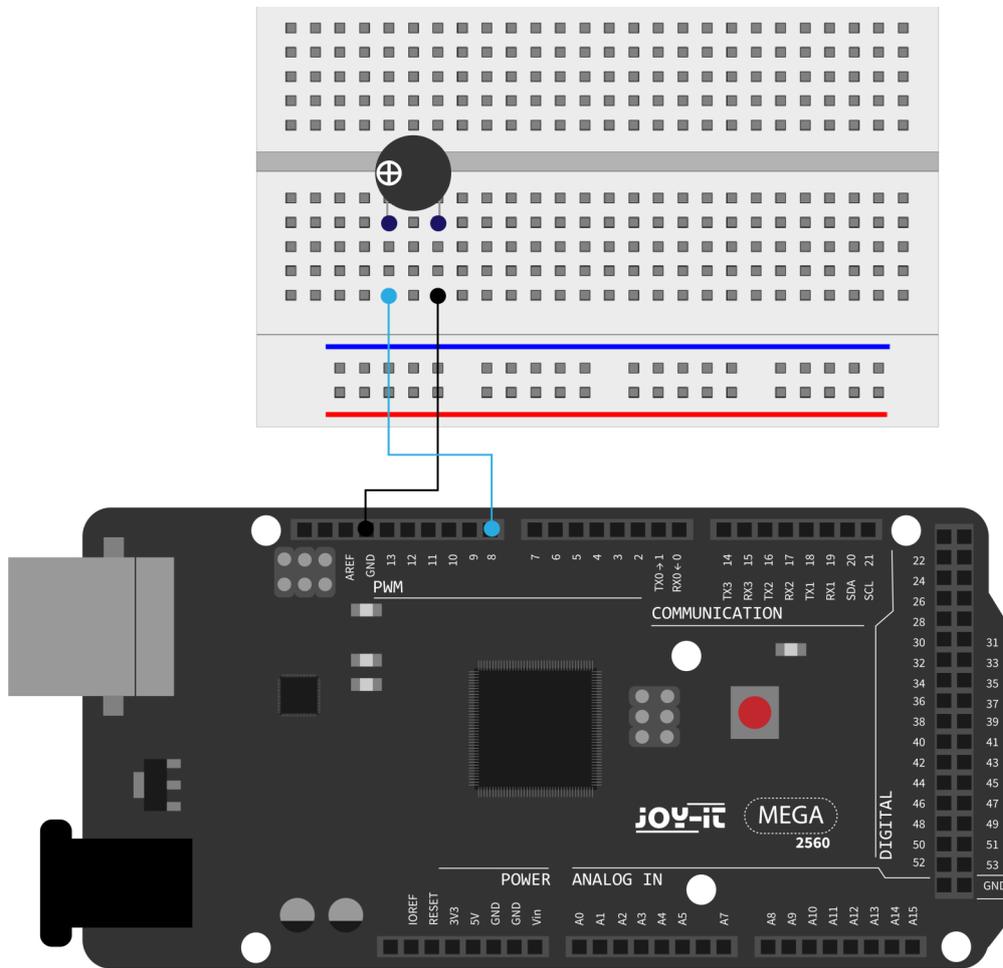


The activation is done by a pulse frequency. Different frequencies result in different tones of the buzzer. This can be used, for example, to reproduce the melody of a song.

This is required:

- 1x Mega2560 board
- 1x USB cable
- 1x Passive buzzer (without sticker)
- 1x Breadboard
- 2x Jumper cable





```

int buzzer=8; // I/O pin for buzzer

void setup() {
  pinMode(buzzer,OUTPUT); // sets pin as output
}

void loop() {
  unsigned char i,j; // defines variable
  while(1){
    for(i=0;i<80;i++) { // makes frequency sound
      digitalWrite(buzzer,HIGH); // sound
      delay(1); // 1ms delay
      digitalWrite(buzzer,LOW); // no sound
      delay(1); // 1ms delay
    }
    for(i=0;i<100;i++) { // makes frequency sound
      digitalWrite(buzzer,HIGH); // sound
      digitalWrite(buzzer,LOW); // no sound
      delay(2); // 2ms delay
    }
  }
}

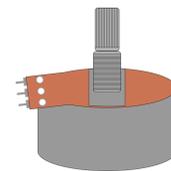
```

Lesson 10: Reading the analog value

This project deals with the analog interfaces of the Mega2560. An `analogRead()` command can read the value of the interface. Due to the analog-to-digital conversion of the Mega2560 the read values are between 0 and 1023.

To be able to read out the values, it is important to ensure the correct baud rate (here: 9600). The baud rate of the computer should correspond to the baud rate of the device. If you open the serial monitor of the Arduino IDE, you can configure the baud rate in the lower right corner.

In this project, the set resistance value of a potentiometer is converted to an analog signal and is then displayed on the screen.



This is required:

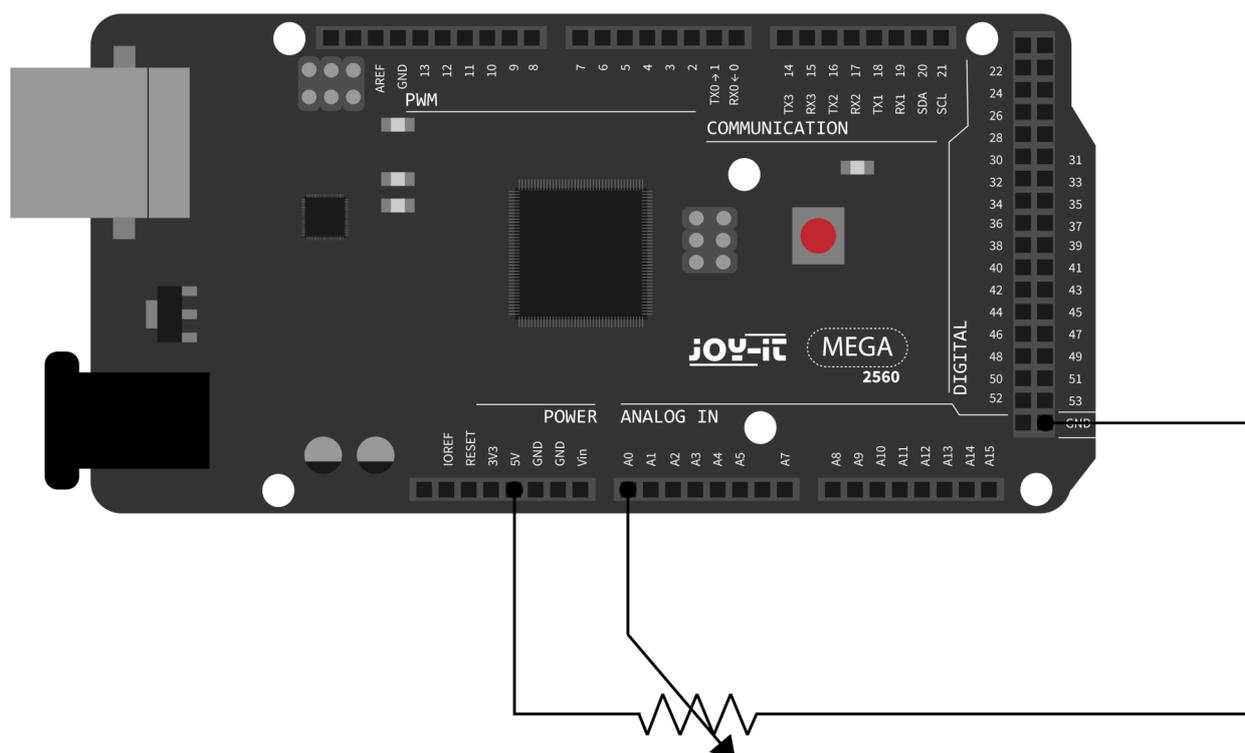
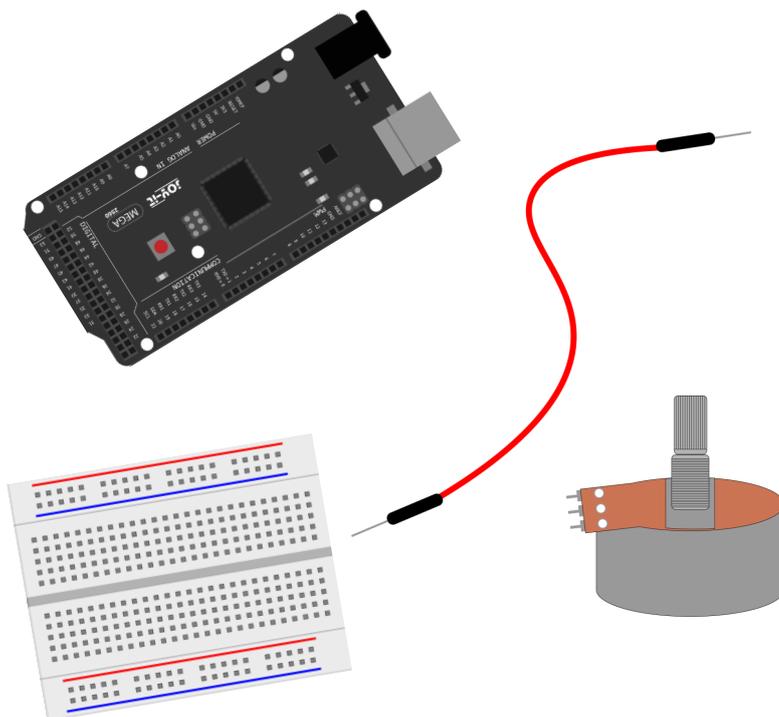
1x Mega2560 board

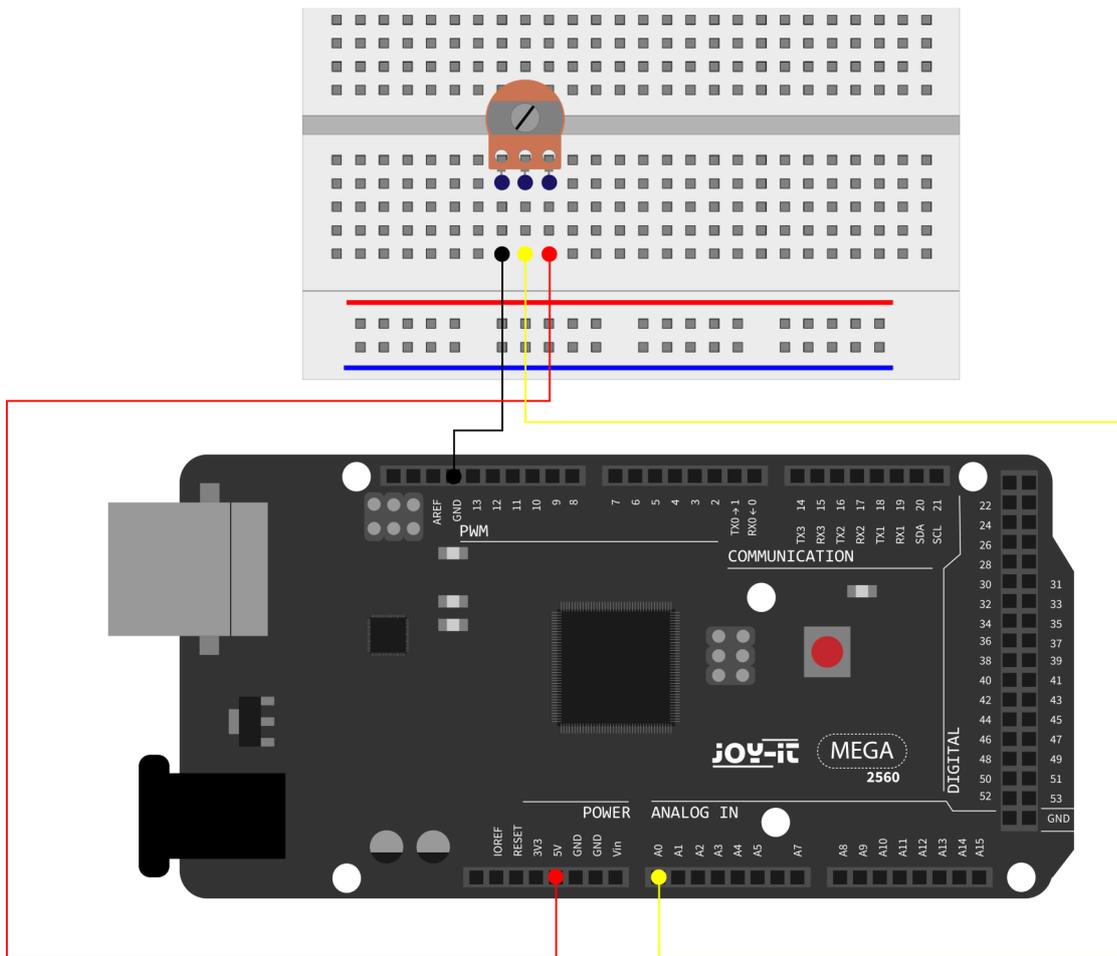
1x USB cable

1x Potentiometer

1x Breadboard

3x Jumper cable





```

int potpin=0; // sets pin for potentiometer to analog 0
int ledpin=13; // sets pin for led for pin 13
int val=0; // defines val

void setup() {
  pinMode(ledpin,OUTPUT); // sets led pin as output
  Serial.begin(9600); // sets baudrate to 9600
}

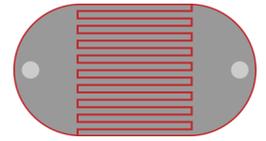
void loop() {
  digitalWrite(ledpin,HIGH); // turns led on pin 13 on
  delay(50); // waits 0.05 seconds
  digitalWrite(ledpin,LOW); // turns led on pin 13 off
  delay(500); // waits 0.05 seconds
  val=analogRead(potpin); // reads analog value and assigns it to val
  Serial.println(val); // displays val
}

```

The read out values are displayed on the serial monitor.

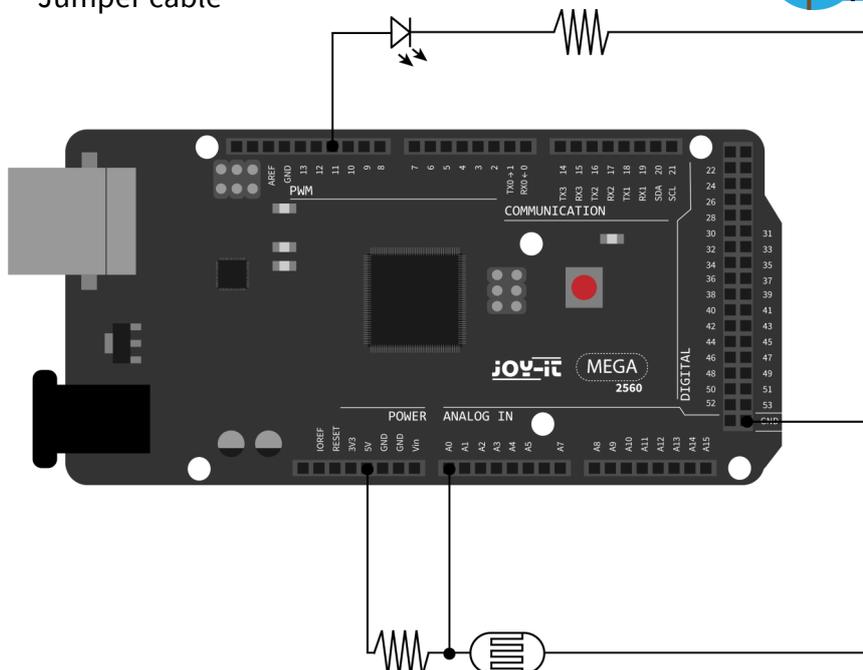
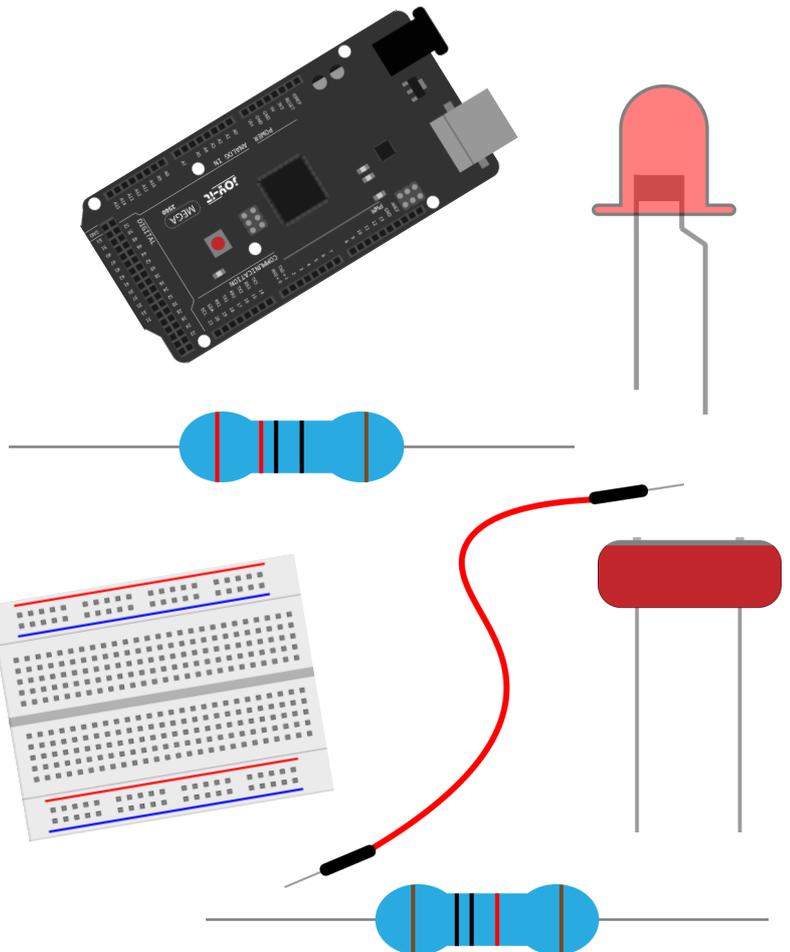
Lesson 11: Photo resistor

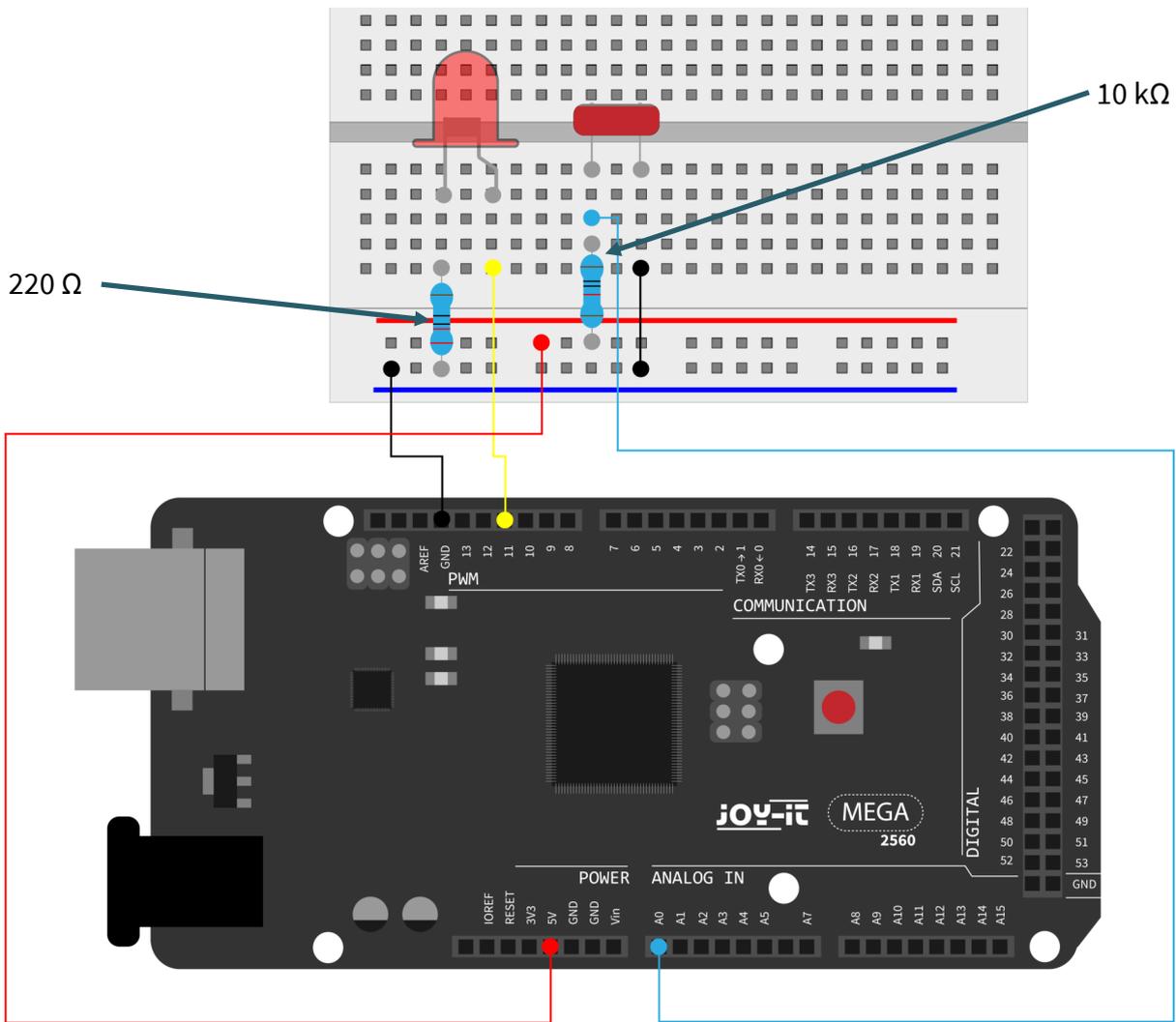
A photoresistor is a resistor whose resistance varies depending on the incident light intensity. It is based on the photoelectric effect of semiconductors. When the incident light is intense, the resistivity is reduced. If the incident light is weak, the resistance increases. Photo resistors are normally used for light measurement, light control and photovoltaic conversion (converting the change of light into a change of electricity). They are used in various light control circuits for example as optical switches. In this project this effect is used to adjust an LED to the current light intensity.



For this is needed:

- 1x Mega2560 board
- 1x USB cable
- 1x Red M5 LED
- 1x 220 Ω resistor
- 1x 10 k Ω resistor
- 1x Photo resistor
- 1x Breadboard
- 5x Jumper cable





```

int potpin=0; // Initialises analog Pin 0
int ledpin=11; // Initialises digital Pin 11
// output which regulates the led brightness
int val=0; // Initialises Variable „Val“

void setup() {
  pinMode(ledpin,OUTPUT); // Set Pin 11 to output
  Serial.begin(9600); // Set Baudrate to „9600“
}

void loop() {
  val=analogRead(potpin);
  // reads the sensors values and assigns it to val
  Serial.println(val); // shows the values of val
  analogWrite(ledpin,val); // turns on the led and sets the brightness
  delay(10); // Waits 0,01 Seconds
}

```

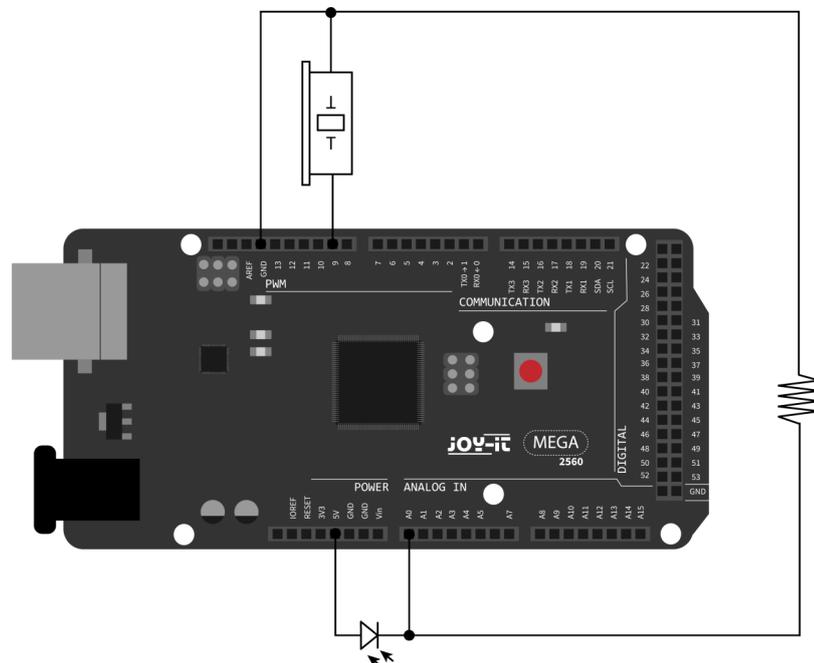
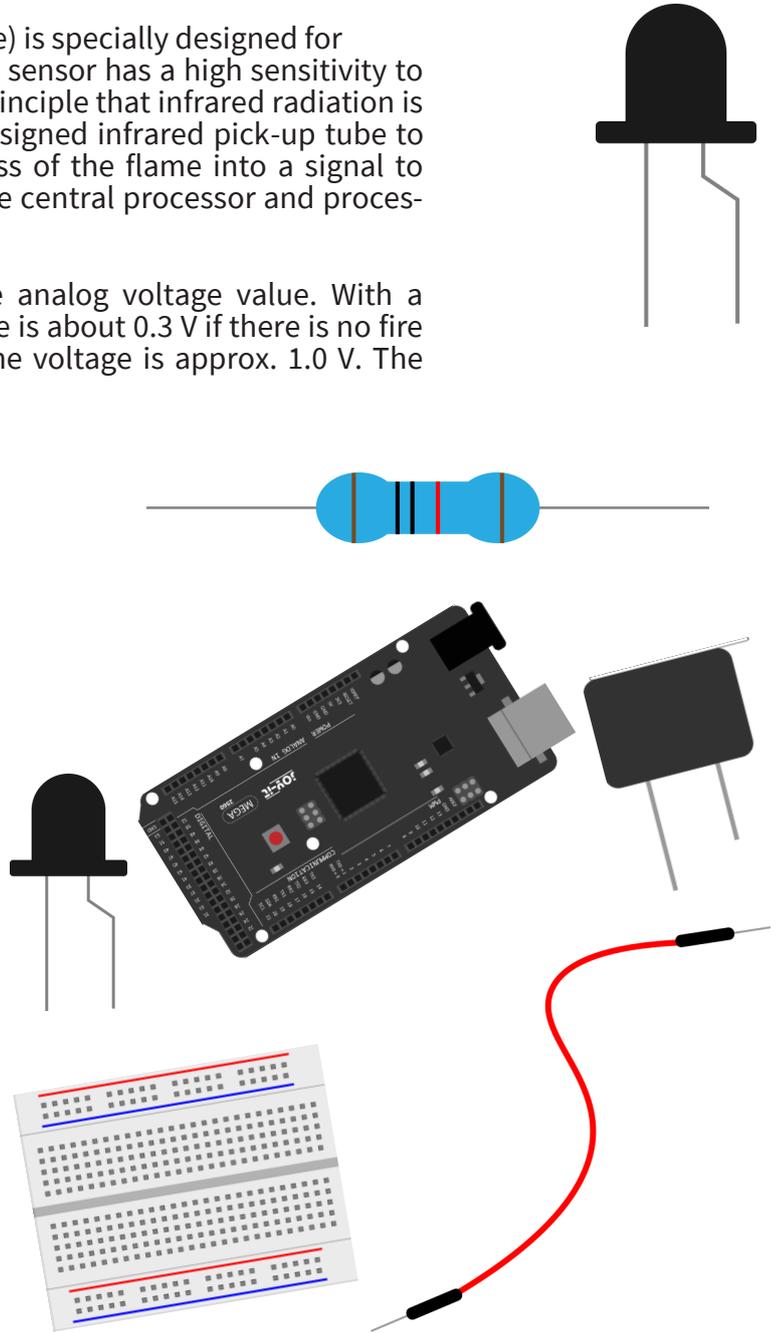
Lesson 12: Flame sensor

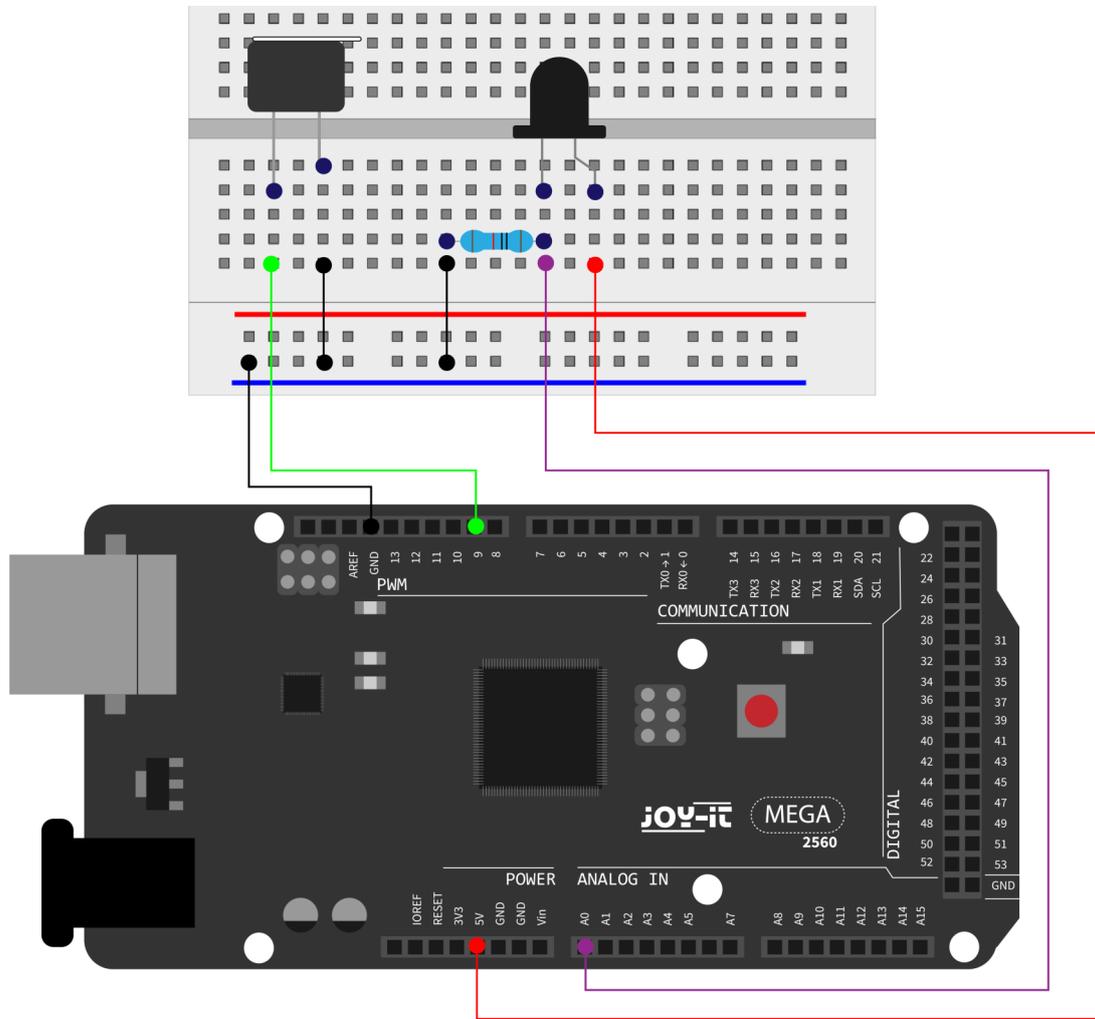
The flame sensor (infrared receiving triode) is specially designed for robots used to find sources of flame. This sensor has a high sensitivity to flames. The flame sensor is built on the principle that infrared radiation is very sensitive to fire. It has a specially designed infrared pick-up tube to detect fire, then to convert the brightness of the flame into a signal to convert. These signals are then sent to the central processor and processed accordingly.

When the sensor approaches a fire, the analog voltage value. With a multimeter you can check that the voltage is about 0.3 V if there is no fire nearby. If there is a fire in the vicinity, the voltage is approx. 1.0 V. The higher the voltage, the closer the fire.

For this project is required:

- 1x Mega2560 board
- 1x USB cable
- 1x Flame sensor
- 1x Active buzzer (with sticker)
- 1x 10 kΩ resistor
- 1x Breadboard
- 6x Jumper cable





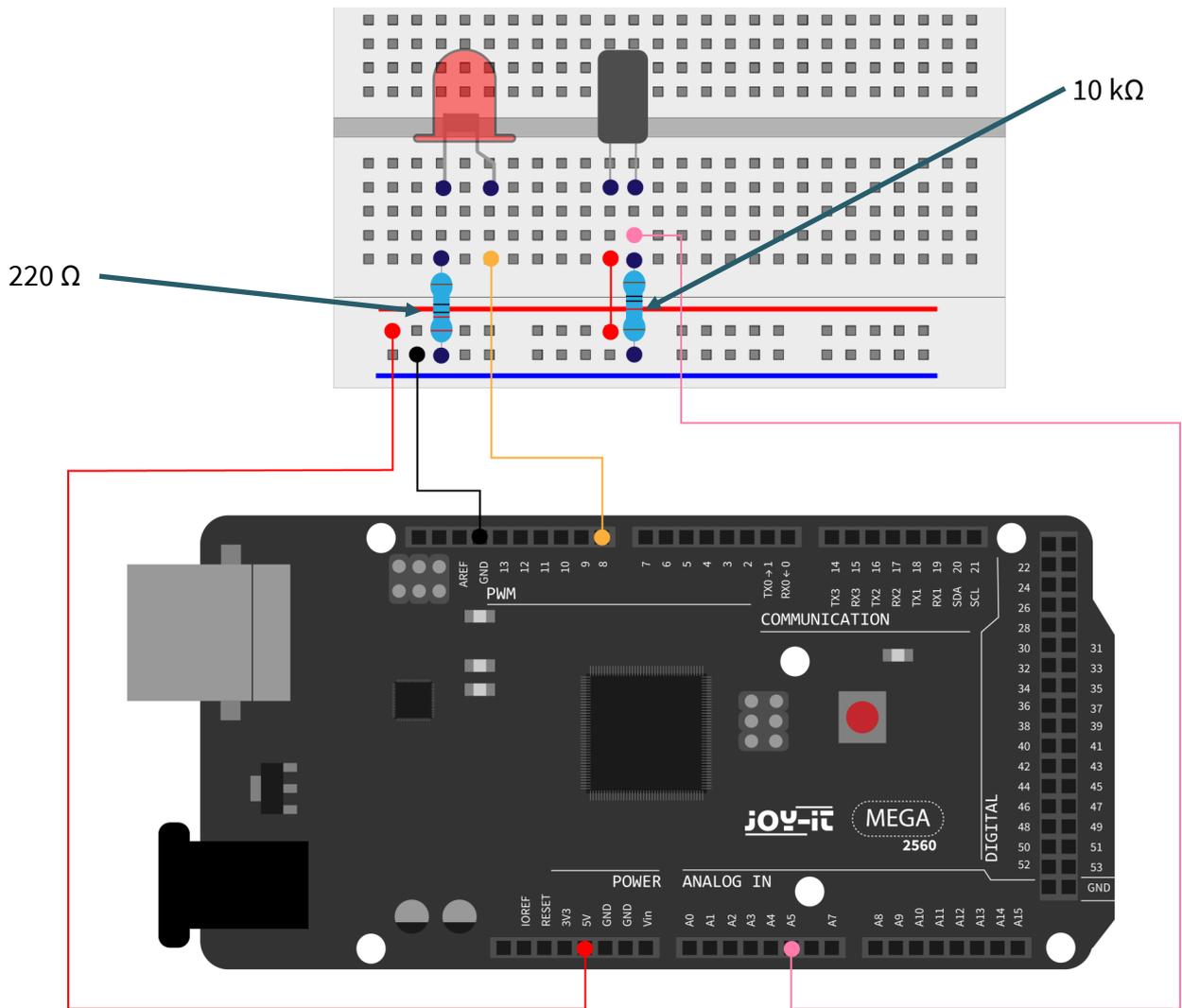
```

int flame=0; // analog pin 0 for sensor
int Beep=9; // digital pin 9 for buzzer
int val=0; // defines variable val

void setup() {
  pinMode(Beep,OUTPUT); // sets buzzer pin as output
  pinMode(flame,INPUT); // sets sensor pin as input
  Serial.begin(9600); // sets baudrate to 9600
}

void loop() {
  val=analogRead(flame); // reads the analog values of sensor
  Serial.println(val); // prints analog values
  if(val>=10) { // buzzer makes noises if value if over 10
    // if necessary must be adjusted to the values of the sensor
    digitalWrite(Beep,HIGH);
  }
  else{
    digitalWrite(Beep,LOW);
  }
  delay(500);
}

```

```

void setup() {
  pinMode(8,OUTPUT); // sets pin 8 as output
}

void loop() {
  int i; // defines variable i
  while(1) {
    i=analogRead(5); // reads voltage value from pin 5
    if(i>512) { // if bigger than 512 (2.5 V)
      digitalWrite(8,LOW); // switch LED on
    }
    else {
      digitalWrite(8,HIGH); // switch LED off
    }
  }
}

```

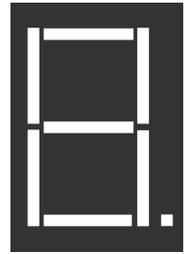
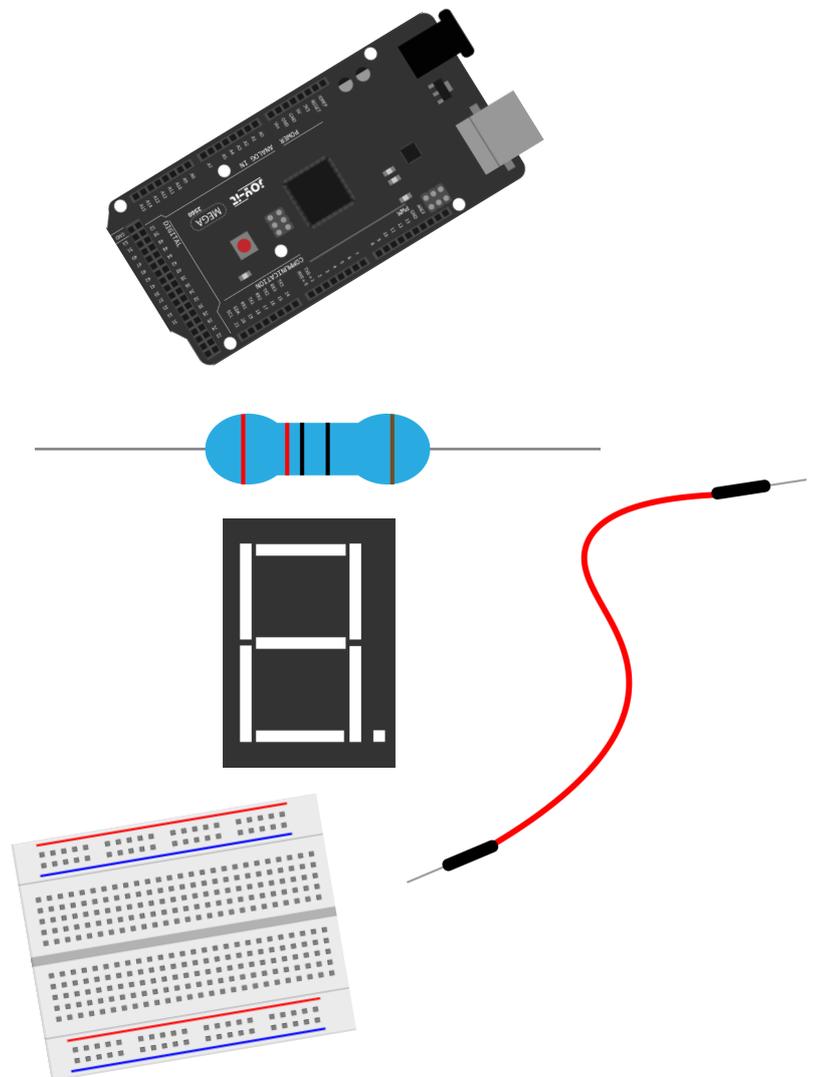
Lesson 14: 1-digit LED segment display

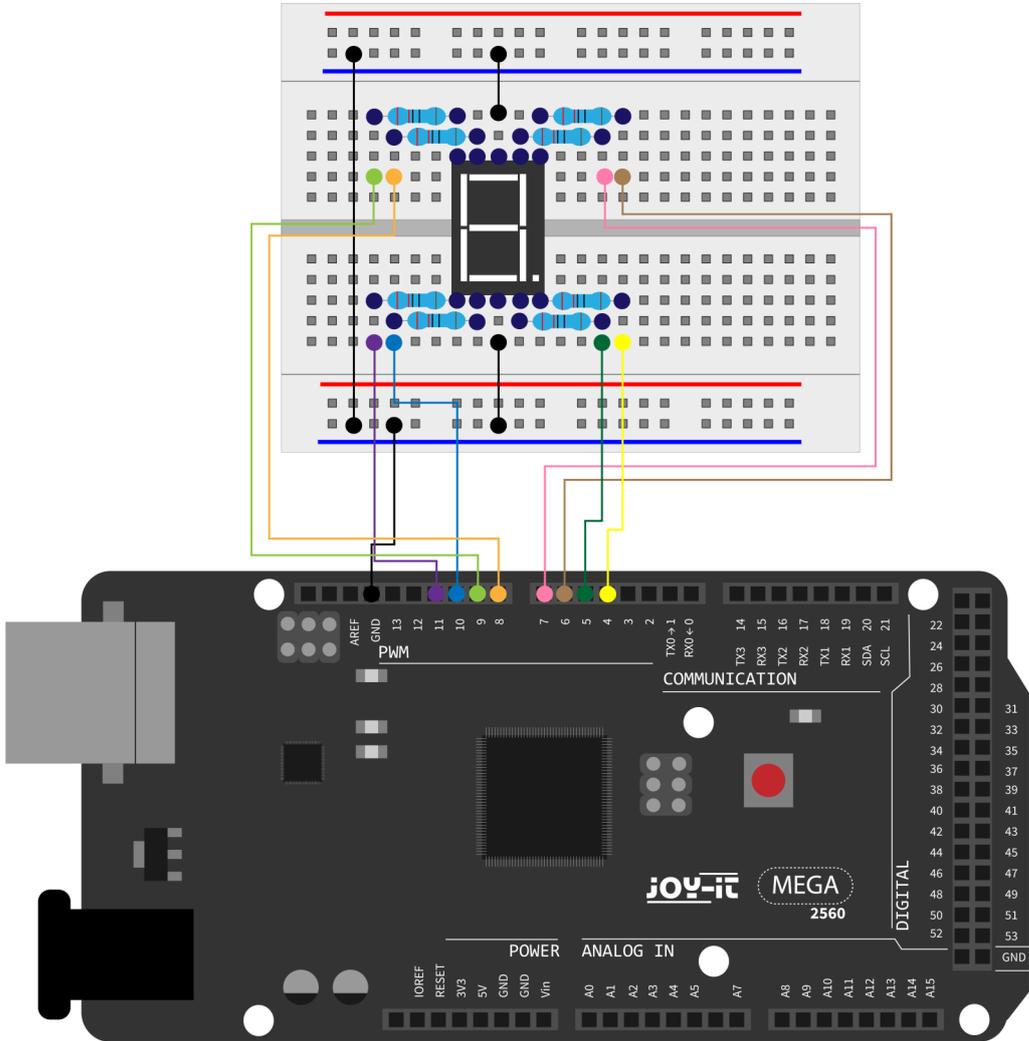
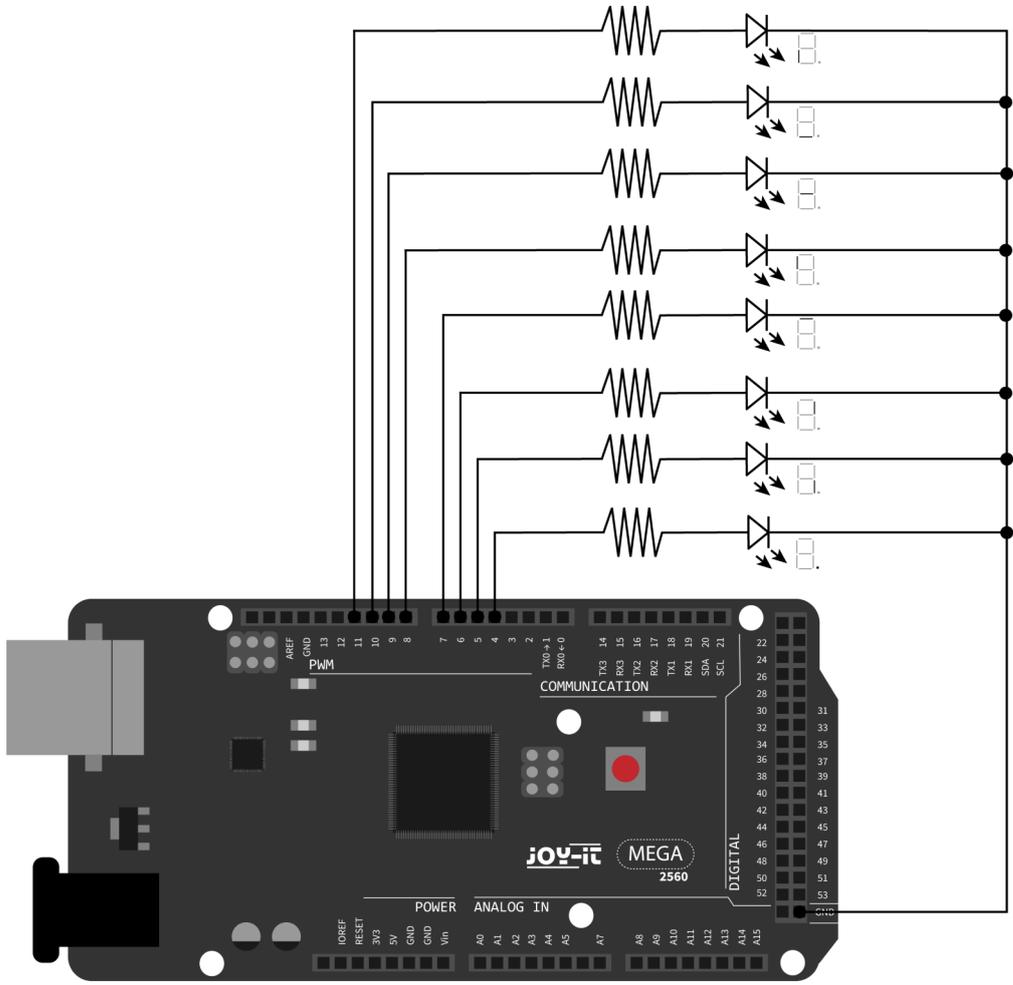
LED segment displays are widely used for displaying numerical information. They are often used for displays of electromagnetic ovens, fully automatic washing machines, water temperature displays, electronic watches, etc. The LED segment display is a semiconductor and light emitting device. Its basic unit is an LED.

Depending on the wiring of the LED units, the LED segment display can be divided into displays with common anode and displays with common cathode. The common anode display combines all anodes of the LED units into a common anode (COM). For the common anode display, the common anode (COM) must be connected to + 5 V. If the cathode level of a segment is low, the segment is on. If the cathode level of a segment is high, the segment is off. For common cathode display, the common cathode (COM) must be connected to GND. If the anode level of a segment is high, the segment is on. If the anode level of a segment is low, the segment is off.

For the following project is required:

1x	Mega2560 board
1x	USB cable
1x	1-digit 7-segment display
8x	220 Ω resistor
1x	Breadboard
12x	Jumper cable





```

// sets I/O pin for every segment
int a=7; // sets pin 7 for segments a
int b=6; // sets pin 6 for segments b
int c=5; // sets pin 5 for segments c
int d=10; // sets pin 10 for segments d
int e=11; // sets pin 11 for segments e
int f=8; // sets pin 8 for segments f
int g=9; // sets pin 9 for segments g
int dp=4; // sets pin 4 for segments dp

void digital_0(void) { // shows number 0
    unsigned char j;
    digitalWrite(a,HIGH);
    digitalWrite(b,HIGH);
    digitalWrite(c,HIGH);
    digitalWrite(d,HIGH);
    digitalWrite(e,HIGH);
    digitalWrite(f,HIGH);
    digitalWrite(g,LOW);
    digitalWrite(dp,LOW);
}

void digital_1(void) { // shows number 1
    unsigned char j;
    digitalWrite(c,HIGH); // sets pin 5 high
    digitalWrite(b,HIGH); // turns on segment b
    for(j=7;j<=11;j++) // turns off other segments
        digitalWrite(j,LOW);
    digitalWrite(dp,LOW); // turns off segment dp
}

void digital_2(void) { // shows number 2
    unsigned char j;
    digitalWrite(b,HIGH);
    digitalWrite(a,HIGH);
    for(j=9;j<=11;j++)
        digitalWrite(j,HIGH);
    digitalWrite(dp,LOW);
    digitalWrite(c,LOW);
    digitalWrite(f,LOW);
}

```

```
void digital_3(void) { // shows number 3
    digitalWrite(g,HIGH);
    digitalWrite(a,HIGH);
    digitalWrite(b,HIGH);
    digitalWrite(c,HIGH);
    digitalWrite(d,HIGH);
    digitalWrite(dp,LOW);
    digitalWrite(f,LOW);
    digitalWrite(e,LOW);
}
```

```
void digital_4(void) { // shows number 4
    digitalWrite(c,HIGH);
    digitalWrite(b,HIGH);
    digitalWrite(f,HIGH);
    digitalWrite(g,HIGH);
    digitalWrite(dp,LOW);
    digitalWrite(a,LOW);
    digitalWrite(e,LOW);
    digitalWrite(d,LOW);
}
```

```
void digital_5(void) { // shows number 5
    unsigned char j;
    digitalWrite(a,HIGH);
    digitalWrite(b, LOW);
    digitalWrite(c,HIGH);
    digitalWrite(d,HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f,HIGH);
    digitalWrite(g,HIGH);
    digitalWrite(dp,LOW);
}
```

```
void digital_6(void) { // shows number 6
    unsigned char j;
    for(j=7;j<=11;j++)
        digitalWrite(j,HIGH);
    digitalWrite(c,HIGH);
    digitalWrite(dp,LOW);
    digitalWrite(b,LOW);
}
```

```

void digital_7(void) { // shows number 7
    unsigned char j;
    for(j=5;j<=7;j++)
        digitalWrite(j,HIGH);
    digitalWrite(dp,LOW);
    for(j=8;j<=11;j++)
        digitalWrite(j,LOW);
}

void digital_8(void) { // shows number 8
    unsigned char j;
    for(j=5;j<=11;j++)
        digitalWrite(j,HIGH);
    digitalWrite(dp,LOW);
}

void digital_9(void) { // shows number 9
    unsigned char j;
    digitalWrite(a,HIGH);
    digitalWrite(b,HIGH);
    digitalWrite(c,HIGH);
    digitalWrite(d,HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f,HIGH);
    digitalWrite(g,HIGH);
    digitalWrite(dp,LOW);
}

void setup() {
    int i; // defines variable i
    for(i=4;i<=11;i++)
        pinMode(i,OUTPUT); // sets pin 5 to 11 as output
}

void loop() {
    while(1){
        digital_0(); // shows number 0
        delay(1000); // waits 1 second
        digital_1(); // shows number 1
        delay(1000); // waits 1 second
        digital_2(); // shows number 2
        delay(1000); // waits 1 second
        digital_3(); // shows number 3
        delay(1000); // waits 1 second
        digital_4(); // shows number 4
    }
}

```

```

    delay(1000); // waits 1 second
    digital_5(); // shows number 5
    delay(1000); // waits 1 second
    digital_6(); // shows number 6
    delay(1000); // waits 1 second
    digital_7(); // shows number 7
    delay(1000); // waits 1 second
    digital_8(); // shows number 8
    delay(1000); // waits 1 second
    digital_9(); // shows number 9
    delay(1000); // waits 1 second
  }
}

```

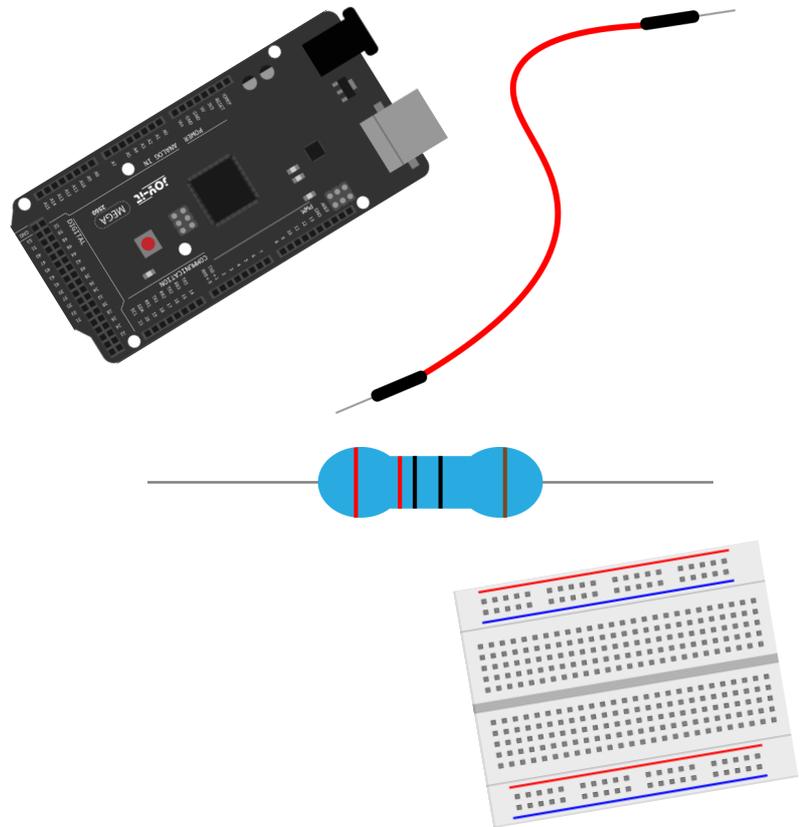
Lesson 15: 4-digits LED segment display

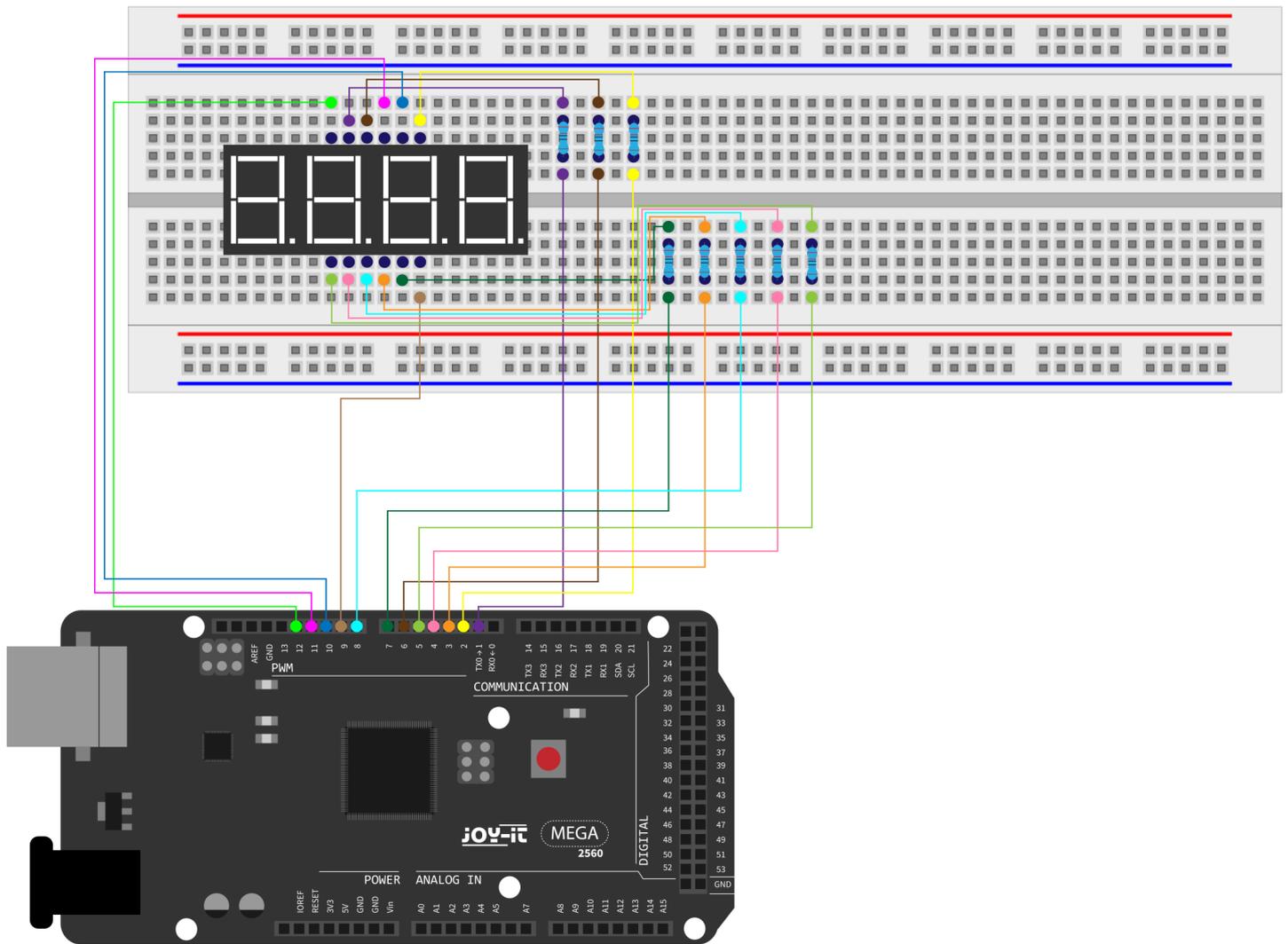
In this project a 4-digit 7-segment display is operated. Current limiting resistors are indispensable for LED displays. There are two wiring methods for current limiting the d1-d4 anode. One advantage of this method is that it needs less resistors and only 4 pieces. But this method can not get a constant brightness. The second method is to connect a resistor to each pin.



For the first method is required:

- 1x Mega2560 board
- 1x USB cable
- 1x 4-digits 7-segment display
- 8x 220 Ω resistor
- 1x Breadboard
- 20x Jumper caple





```
// pins for anode
```

```
int a = 1;
int b = 2;
int c = 3;
int d = 4;
int e = 5;
int f = 6;
int g = 7;
int dp = 8;
```

```
// pins for cathode
```

```
int d4 = 9;
int d3 = 10;
int d2 = 11;
int d1 = 12;
```

```
// sets variables
```

```
long n = 1230;
int x = 100;
int del = 55;
```

```

void setup() {
  pinMode(d1, OUTPUT);
  pinMode(d2, OUTPUT);
  pinMode(d3, OUTPUT);
  pinMode(d4, OUTPUT);
  pinMode(a, OUTPUT);
  pinMode(b, OUTPUT);
  pinMode(c, OUTPUT);
  pinMode(d, OUTPUT);
  pinMode(e, OUTPUT);
  pinMode(f, OUTPUT);
  pinMode(g, OUTPUT);
  pinMode(dp, OUTPUT);
}

void loop() {
  Display(1, 1);
  Display(2, 2);
  Display(3, 3);
  Display(4, 4);
}

void position(unsigned char n){
  switch(n) {
    case 1:
      digitalWrite(d1,LOW);
      digitalWrite(d2, HIGH);
      digitalWrite(d3, HIGH);
      digitalWrite(d4, HIGH);
      break;
    case 2:
      digitalWrite(d1, HIGH);
      digitalWrite(d2, LOW);
      digitalWrite(d3, HIGH);
      digitalWrite(d4, HIGH);
      break;
    case 3:
      digitalWrite(d1,HIGH);
      digitalWrite(d2, HIGH);
      digitalWrite(d3, LOW);
      digitalWrite(d4, HIGH);
      break;
  }
}

```

```

    case 4:
        digitalWrite(d1, HIGH);
        digitalWrite(d2, HIGH);
        digitalWrite(d3, HIGH);
        digitalWrite(d4, LOW);
        break;
    default :
        digitalWrite(d1, HIGH);
        digitalWrite(d2, HIGH);
        digitalWrite(d3, HIGH);
        digitalWrite(d4, HIGH);
        break;
}
}

void Num_0() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, LOW);
    digitalWrite(dp, LOW);
}

void Num_1() {
    digitalWrite(a, LOW);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
    digitalWrite(dp, LOW);
}

void Num_2() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, LOW);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, LOW);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}

```

```
void Num_3() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}
```

```
void Num_4() {
    digitalWrite(a, LOW);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}
```

```
void Num_5() {
    digitalWrite(a, HIGH);
    digitalWrite(b, LOW);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}
```

```
void Num_6() {
    digitalWrite(a, HIGH);
    digitalWrite(b, LOW);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}
```

```
void Num_7() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
    digitalWrite(dp, LOW);
}

void Num_8() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, HIGH);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}

void Num_9() {
    digitalWrite(a, HIGH);
    digitalWrite(b, HIGH);
    digitalWrite(c, HIGH);
    digitalWrite(d, HIGH);
    digitalWrite(e, LOW);
    digitalWrite(f, HIGH);
    digitalWrite(g, HIGH);
    digitalWrite(dp, LOW);
}

void Clear() { // clears display
    digitalWrite(a, LOW);
    digitalWrite(b, LOW);
    digitalWrite(c, LOW);
    digitalWrite(d, LOW);
    digitalWrite(e, LOW);
    digitalWrite(f, LOW);
    digitalWrite(g, LOW);
    digitalWrite(dp, LOW);
}
```

```
void pickNumber(unsigned char n) { // chooses number
    switch(n) {
        case 0:
            Num_0();
            break;
        case 1:
            Num_1();
            break;
        case 2:
            Num_2();
            break;
        case 3:
            Num_3();
            break;
        case 4:
            Num_4();
            break;
        case 5:
            Num_5();
            break;
        case 6:
            Num_6();
            break;
        case 7:
            Num_7();
            break;
        case 8:
            Num_8();
            break;
        case 9:
            Num_9();
            break;
        default:
            Clear();
            break;
    }
}
```

```
void Display(unsigned char x, unsigned char Number) {
    position(x);
    pickNumber(Number);
    delay(1);
    Clear() ; // clears display
}
```

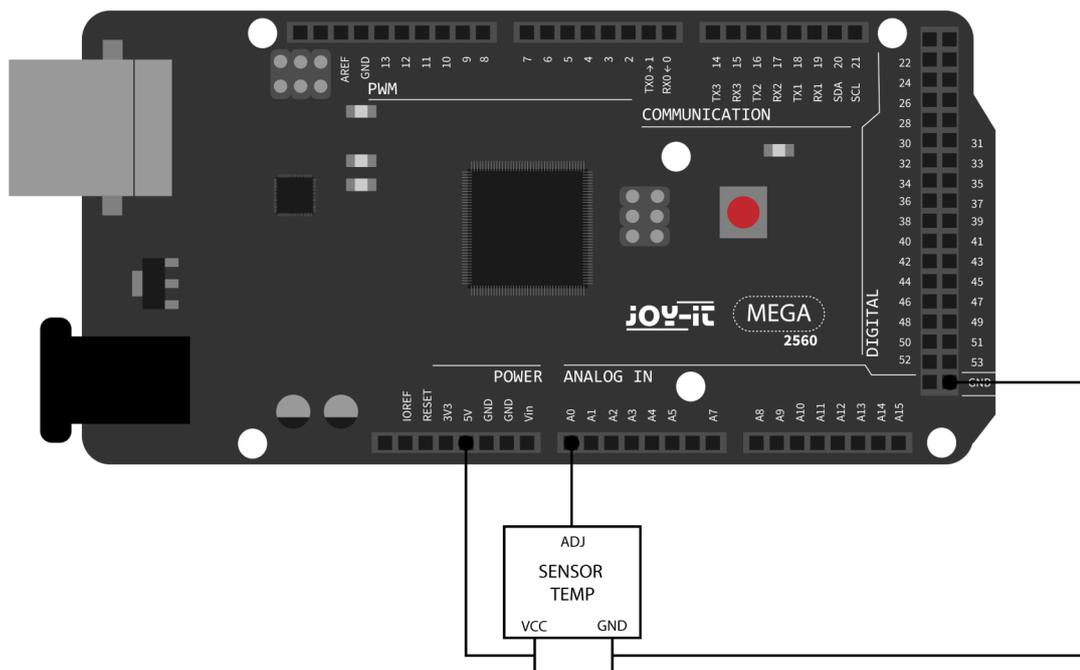
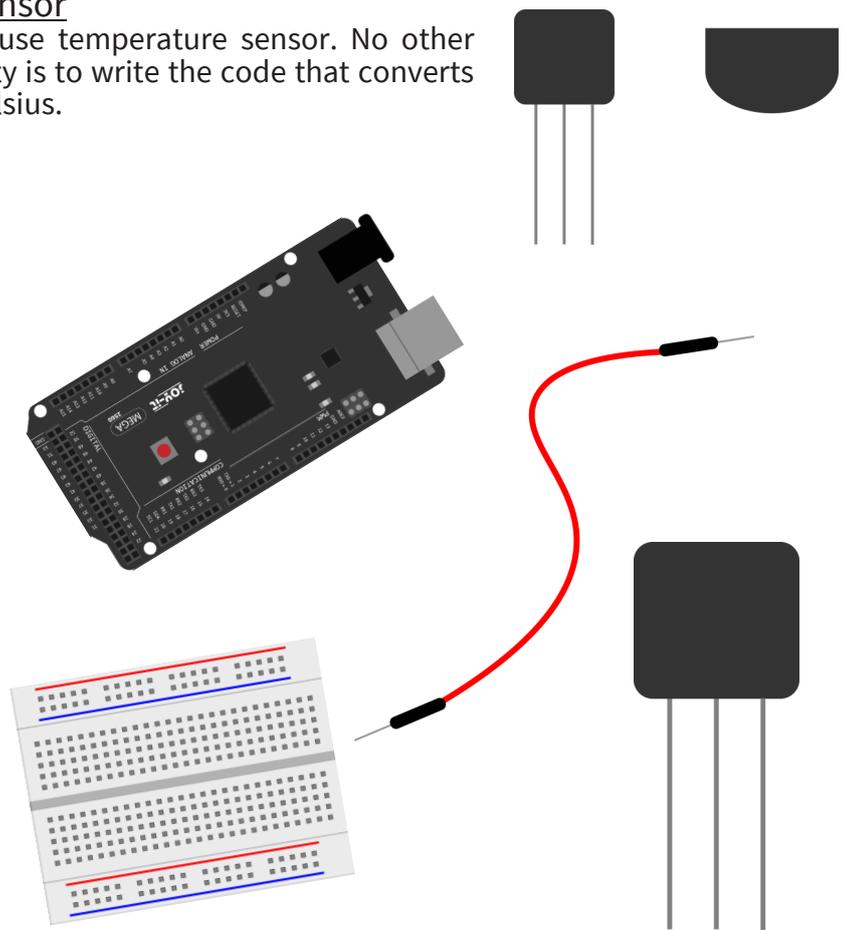
If the above code is transferred completely to the Mega2560, the display shows 1234.

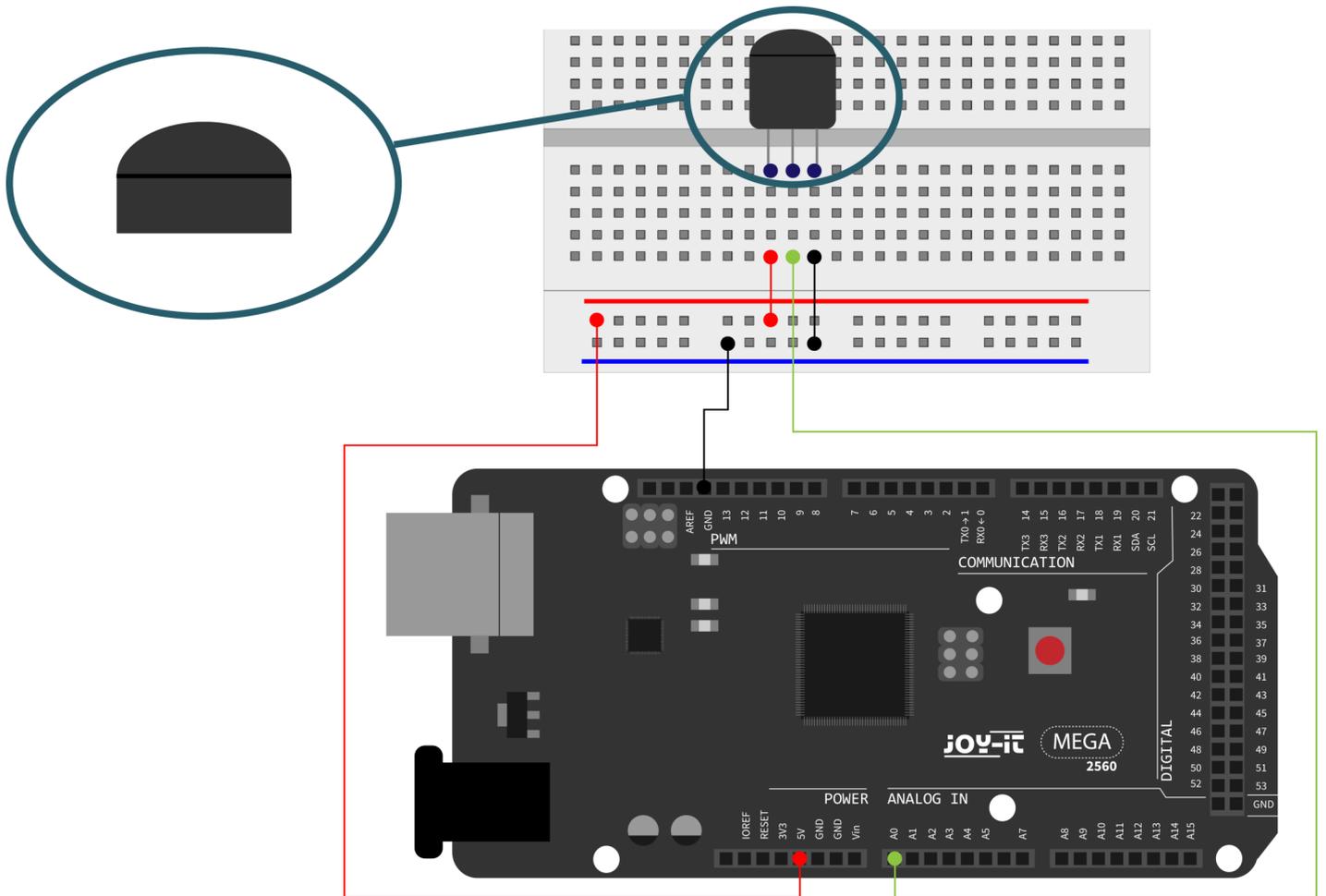
Lektion 16: LM35 temperature sensor

The LM35 is a popular and easy to use temperature sensor. No other hardware is needed. The only difficulty is to write the code that converts the analog values that it reads into Celsius.

You need:

- 1x Mega2560 board
- 1x USB cable
- 1x LM35
- 1x Breadboard
- 5x Jumper cable





```

int potPin = 0; // sets sensor to analog pin 0

void setup() {
  Serial.begin(9600); // sets baudrate to 9600
}

void loop() {
  int val; // defines variable val
  int dat; // defines variable dat
  val=analogRead(0); // reads the analog value from sensor
  dat=(125*val)>>8; // Temperature calculation formula
  Serial.print("Temp:"); // output begins with Temp:
  Serial.print(dat); // prints the calculated temperature
  Serial.println(" *C"); // displays "*C"
  delay(500); // waits 0.5 seconds
}

```

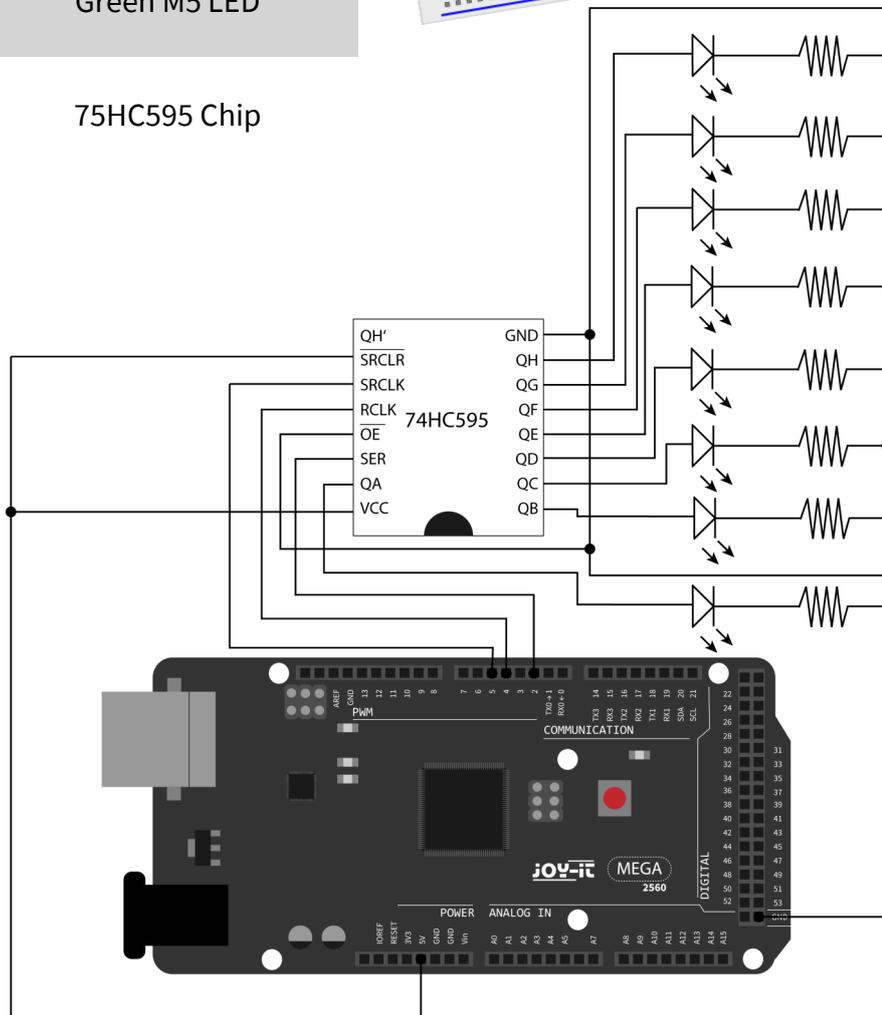
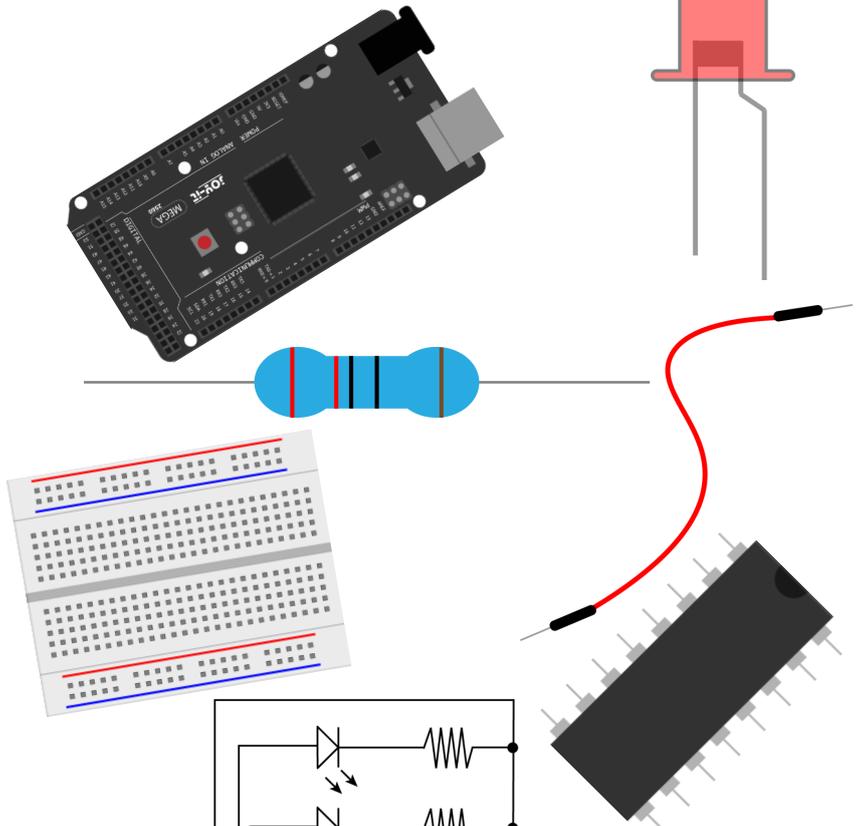
On the serial monitor the temperature output can be monitored.

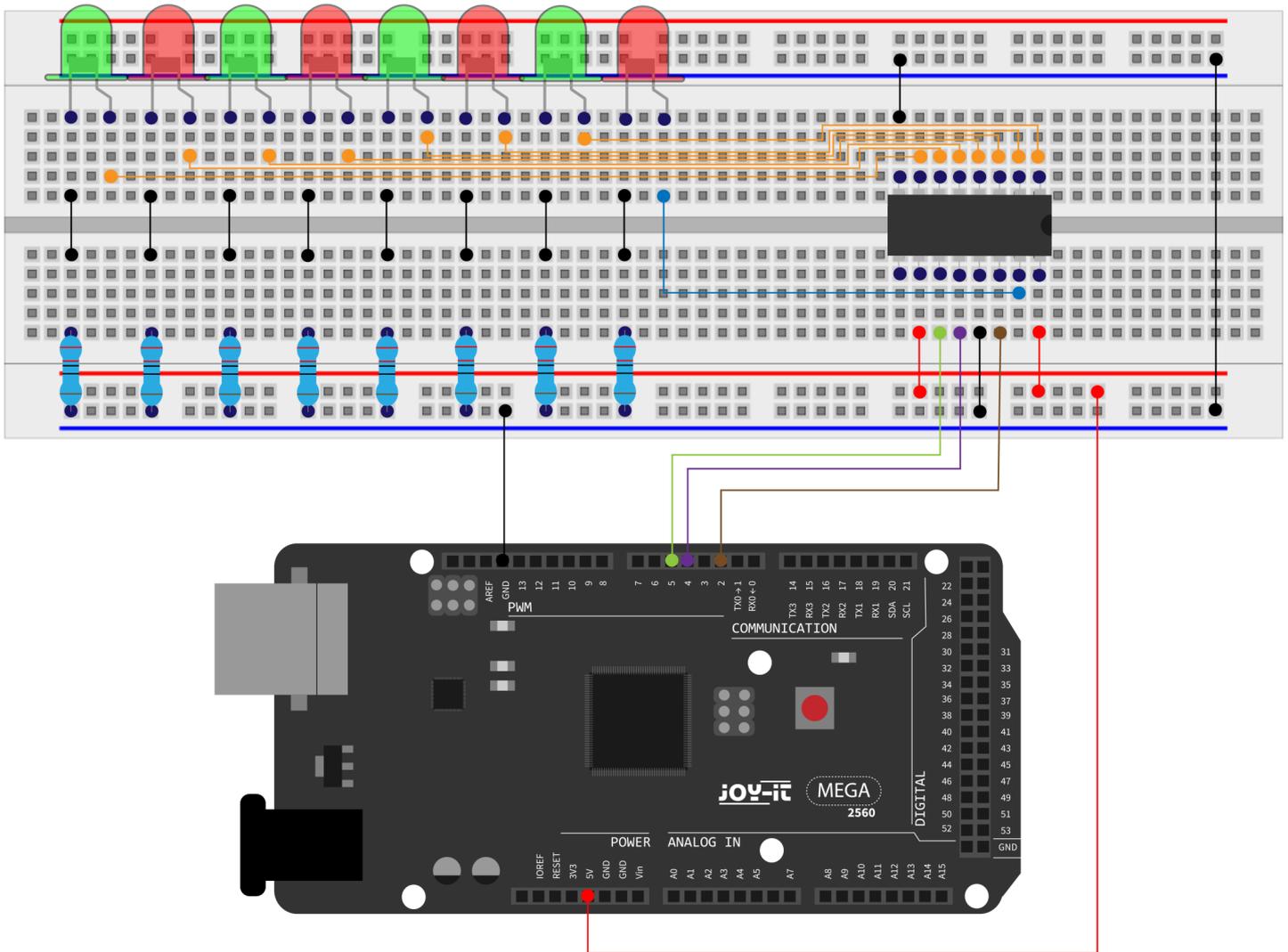
Lektion 17: 74HC595 Shift register

The 74HC595 is a combination of an 8-digit shift register and flags. It is equipped with a tri-state output. In this project the 74HC595 is used to use 8 LEDs to save resources. The required I/O ports are reduced from 8 to 3 ports.

You need:

- 1x Mega2560 board
- 1x USB cable
- 4x Red M5 LED
- 8x 220 Ω resistor
- 1x Breadboard
- 24x Jumper cable
- 4x Green M5 LED
- 1x 75HC595 Chip





```

int data = 2; // sets pin 14 as data pin
int clock = 5; // sets pin 11 as clock pin
int latch = 4; // sets pin 12 as output
int ledState = 0;
const int ON = HIGH;
const int OFF = LOW;

void setup() {
  pinMode(data, OUTPUT);
  pinMode(clock, OUTPUT);
  pinMode(latch, OUTPUT);
}

void loop() {
  for(int i = 0; i < 256; i++) {
    updateLEDs(i);
    delay(500);
  }
}

```

```
void updateLEDs(int value) {
  digitalWrite(latch, LOW);
  shiftOut(data, clock, MSBFIRST, ~value);
  digitalWrite(latch, HIGH); // Interlock
}
```

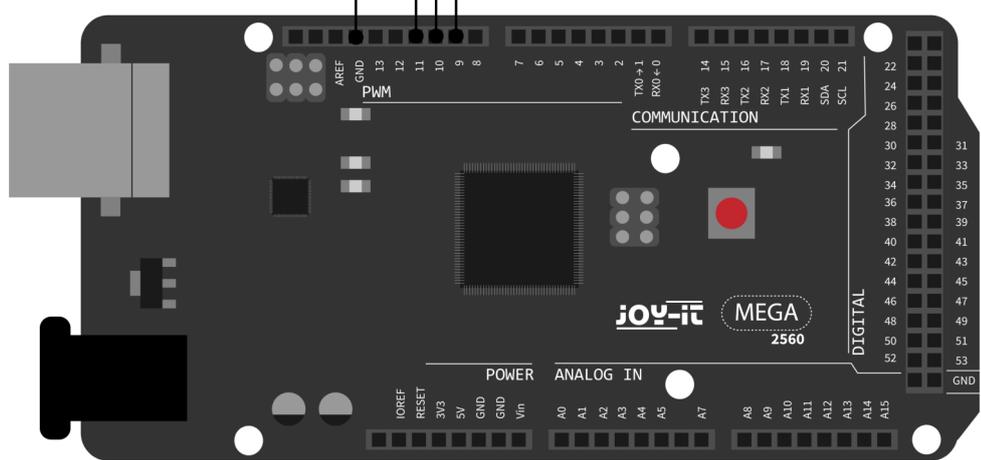
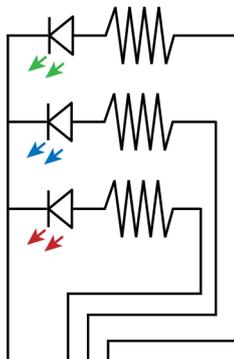
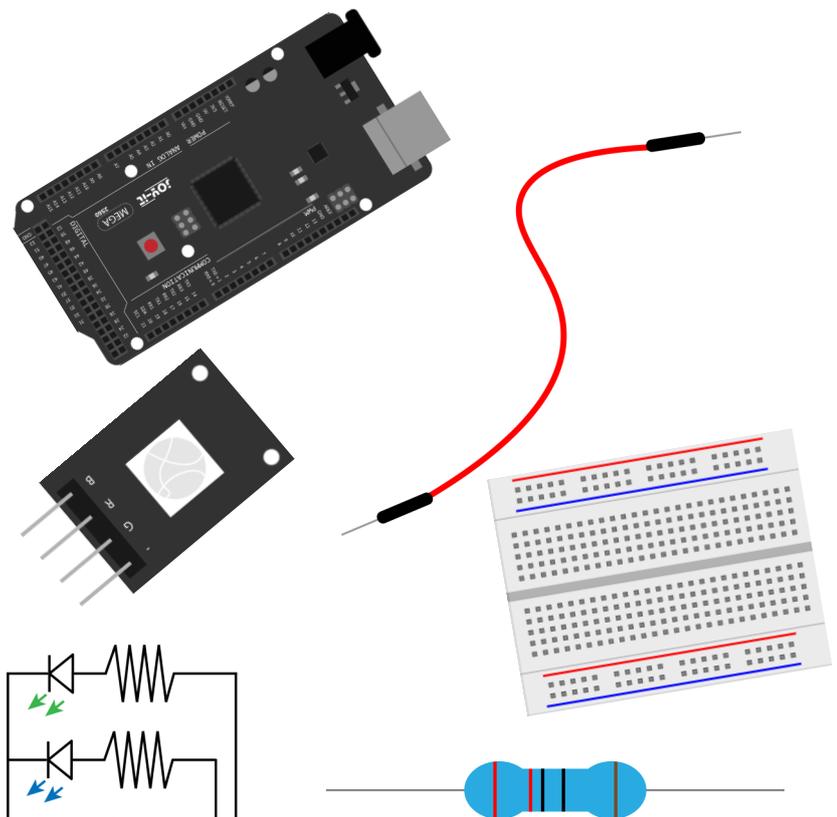
Lesson 18: RGB-LED

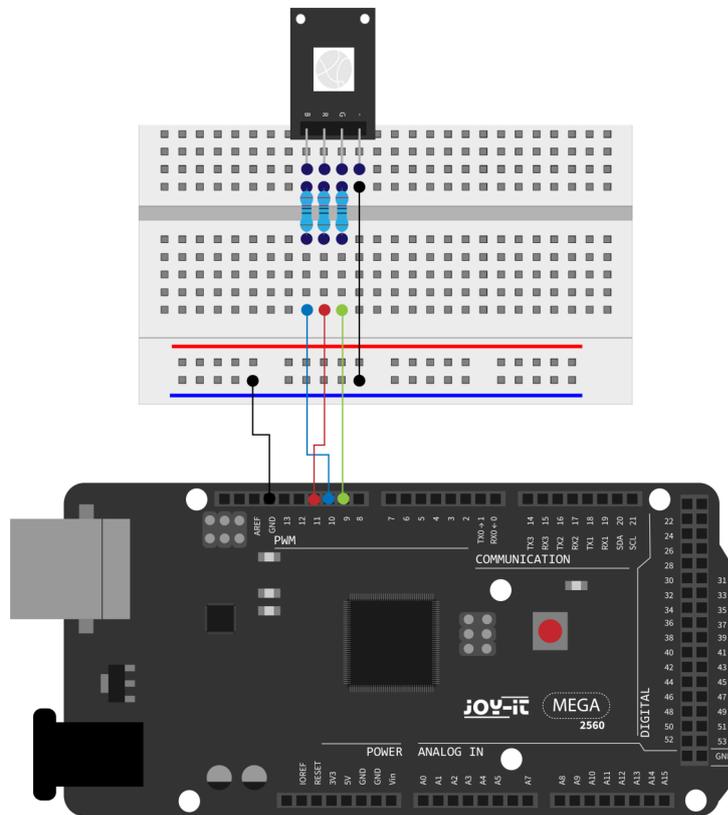
This diode is controlled by PWM signals and has a three-color system for displaying colors. The component can be connected directly to the Mega2560 interfaces.

It is required:



- 1x Mega2560 board
- 1x USB cable
- 1x RGB-LED
- 1x Breadboard
- 5x Jumper cable
- 3x 220 Ω resistor





```
int redpin = 11; // sets pin 11 for red LED
int bluepin =10; // sets pin 10 for blue LED
int greenpin =9; // sets pin 9 for green LED
int val;

void setup() {
  pinMode(redpin, OUTPUT);
  pinMode(bluepin, OUTPUT);
  pinMode(greenpin, OUTPUT);
  Serial.begin(9600);
}

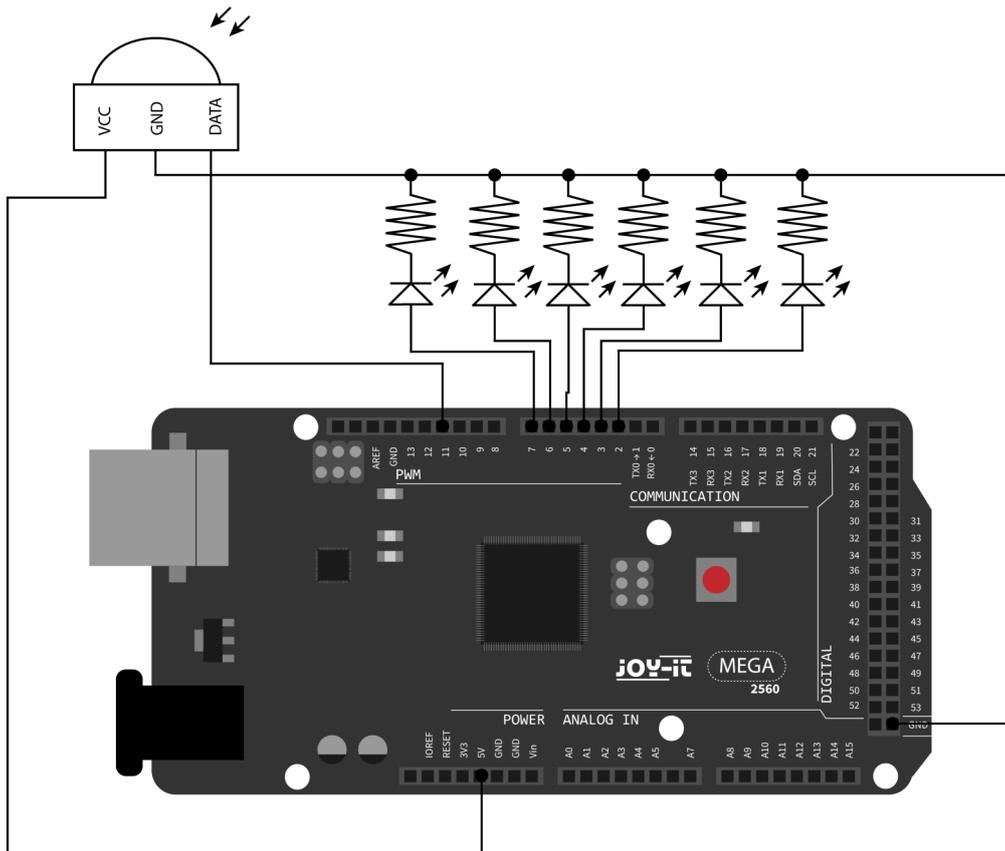
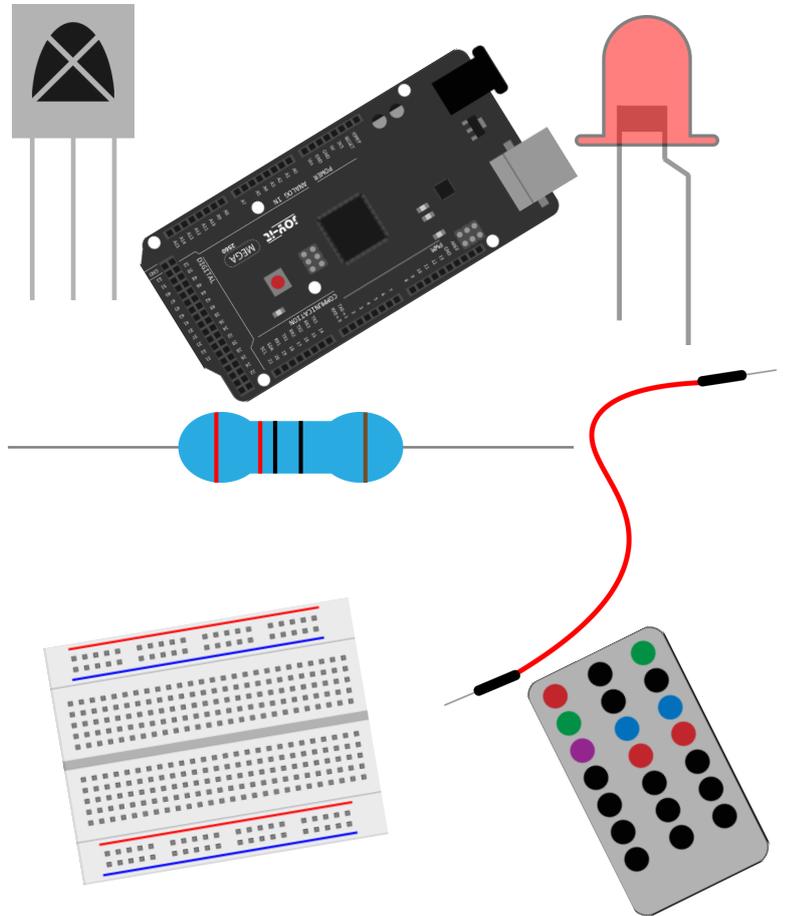
void loop() {
  for(val=255; val>0; val--) {
    analogWrite(11, val);
    analogWrite(10, 255-val);
    analogWrite(9, 128-val);
    delay(1);
  }
  for(val=0; val<255; val++) {
    analogWrite(11, val);
    analogWrite(10, 255-val);
    analogWrite(9, 128-val);
    delay(1);
  }
  Serial.println(val, DEC);
}
```

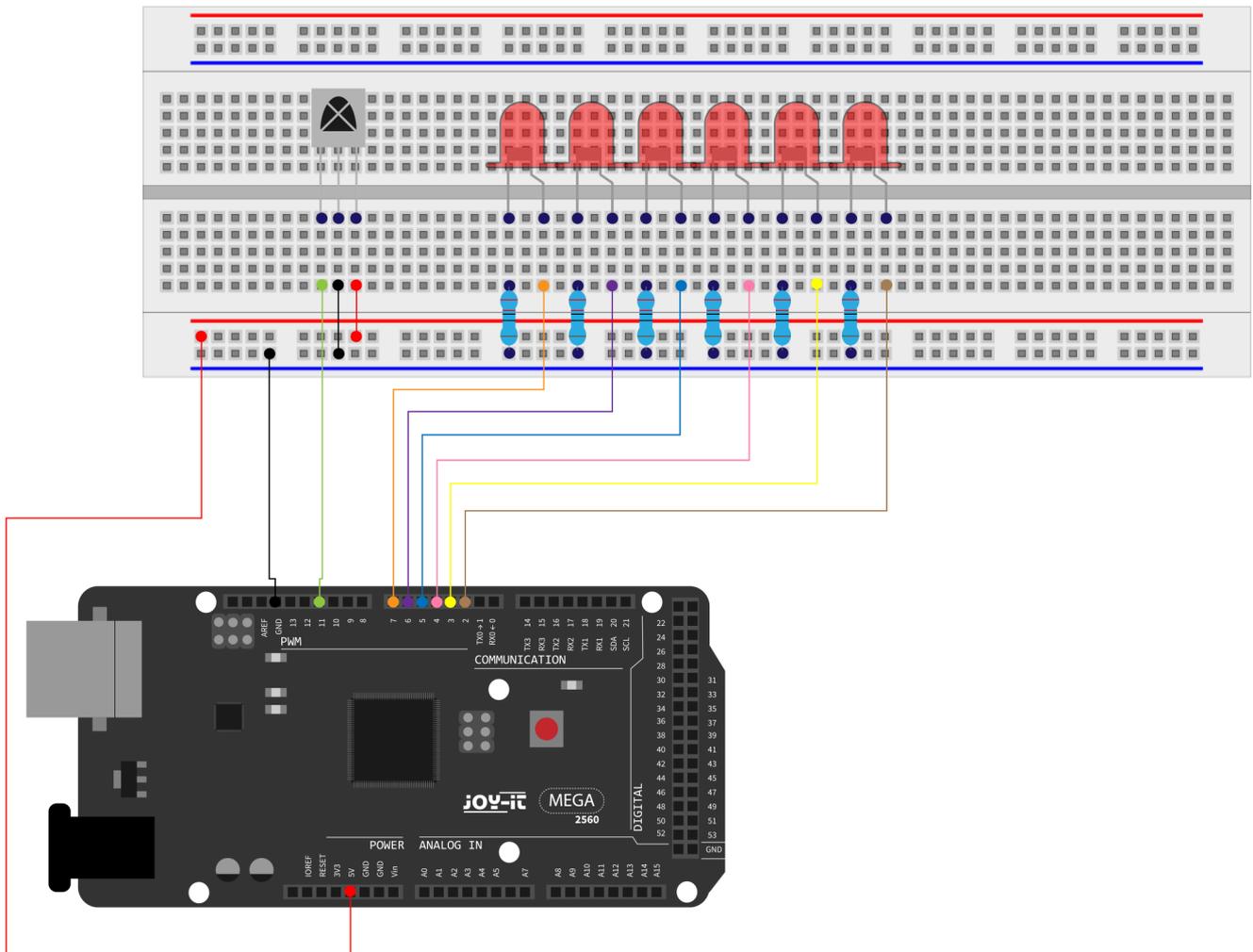
Lesson 19: Infrared remote control

The IR receiver converts the incoming light signal into a weak electrical signal. To decode the code of a remote control, it is necessary to know the coding method. In this project the NEC protocol is used for this purpose.

For this you need:

- 1x Mega2560 Platine
- 1x USB-Kabel
- 6x M5 LED
- 6x 220 Ω Widerstand
- 1x Breadboard
- 11x Überbrückungskabel
- 1x Infrarot-Empfänger
- 1x Infrarot-Fernbedienung





The following code requires the library *IRremote* which you can download in the Arduino IDE at **Sketch** → **Include Library** → **Manage libraries...**. There you can manage the libraries you have created using the search bar to find and install this library. Restart your IDE afterwards.

The following code will receive a signal via infrared, decode and output to the serial monitor. If you use the supplied remote control, the pressed button on the remote control will also be outputted correctly. Please note that if you use a different remote control, the wrong keys will be displayed or none. The remote control can also be used to control the 6 LEDs, i.e. switch them on and off.

```
#include <IRremote.h>
int RECV_PIN = 11;
int LED1 = 2;
int LED2 = 3;
int LED3 = 4;
int LED4 = 5;
int LED5 = 6;
int LED6 = 7;
long on1 = 0x00FFA25D;
long off1 = 0x00FFE01F;
```

```

long on2 = 0x00FF629D;
long off2 = 0x00FFA857;
long on3 = 0x00FFE21D;
long off3 = 0x00FF906F;
long on4 = 0x00FF22DD;
long off4 = 0x00FF6897;
long on5 = 0x00FF02FD;
long off5 = 0x00FF9867;
long on6 = 0x00FFC23D;
long off6 = 0x00FFB04F;
IRrecv irrecv(RECV_PIN);
decode_results results;

void dump(decode_results *results) {
    int count = results->rawlen;
    if (results->decode_type == UNKNOWN){
        Serial.println("Could not decode message");
    }
    else {
        if (results->decode_type == NEC){
            Serial.print("Decoded NEC: ");
        }
        else if (results->decode_type == SONY) {
            Serial.print("Decoded SONY: ");
        }
        else if (results->decode_type == RC5) {
            Serial.print("Decoded RC5: ");
        }
        else if (results->decode_type == RC6) {
            Serial.print("Decoded RC6: ");
        }
        Serial.print(results->value, HEX);
        Serial.print(" (");
        Serial.print(results->bits, DEC);
        Serial.println(" bits)");

        if(results->value == 0xFFA25D)
            Serial.println("Button: Power");
        else if(results->value == 0xFF629D)
            Serial.println("Button: Mode");
        else if(results->value == 0xFFE21D)
            Serial.println("Button: Mute");
        else if(results->value == 0xFF22DD)
            Serial.println("Button: Play/Stop");
        else if(results->value == 0xFF02FD)
            Serial.println("Button: <<");
    }
}

```

```

else if(results->value == 0xFFC23D)
    Serial.println("Button: >>");
else if(results->value == 0xFFE01F)
    Serial.println("Button: EQ");
else if(results->value == 0xFFA857)
    Serial.println("Button: -");
else if(results->value == 0xFF906F)
    Serial.println("Button: +");
else if(results->value == 0xFF6897)
    Serial.println("Button: 0");
else if(results->value == 0xFF9867)
    Serial.println("Button: Reload");
else if(results->value == 0xFFB04F)
    Serial.println("Button: U/SD");
else if(results->value == 0xFF30CF)
    Serial.println("Button: 1");
else if(results->value == 0xFF18E7)
    Serial.println("Button: 2");
else if(results->value == 0xFF7A85)
    Serial.println("Button: 3");
else if(results->value == 0xFF10EF)
    Serial.println("Button: 4");
else if(results->value == 0xFF38C7)
    Serial.println("Button: 5");
else if(results->value == 0xFF5AA5)
    Serial.println("Button: 6");
else if(results->value == 0xFF42BD)
    Serial.println("Button: 7");
else if(results->value == 0xFF4AB5)
    Serial.println("Button: 8");
else if(results->value == 0xFF52AD)
    Serial.println("Button: 9");
    }
}
void setup() {
pinMode(RECV_PIN, INPUT);
    pinMode(LED1, OUTPUT);
    pinMode(LED2, OUTPUT);
    pinMode(LED3, OUTPUT);
    pinMode(LED4, OUTPUT);
    pinMode(LED5, OUTPUT);
    pinMode(LED6, OUTPUT);
    pinMode(13, OUTPUT);
    Serial.begin(9600);
    irrecv.enableIRIn(); // Start the receiver
}

```

```
int on = 0;
unsigned long last = millis();
void loop() {
  if (irrecv.decode(&results)){
    if (millis() - last > 250){
      on = !on; // digitalWrite(8, on ? HIGH : LOW);
      digitalWrite(13, on ? HIGH : LOW);
      dump(&results);
    }

    if (results.value == on1 )
      digitalWrite(LED1, HIGH);
    if (results.value == off1 )
      digitalWrite(LED1, LOW);
    if (results.value == on2 )
      digitalWrite(LED2, HIGH);
    if (results.value == off2 )
      digitalWrite(LED2, LOW);
    if (results.value == on3 )
      digitalWrite(LED3, HIGH);
    if (results.value == off3 )
      digitalWrite(LED3, LOW);
    if (results.value == on4 )
      digitalWrite(LED4, HIGH);
    if (results.value == off4 )
      digitalWrite(LED4, LOW);
    if (results.value == on5 )
      digitalWrite(LED5, HIGH);
    if (results.value == off5 )
      digitalWrite(LED5, LOW);
    if (results.value == on6 )
      digitalWrite(LED6, HIGH);
    if (results.value == off6 )
      digitalWrite(LED6, LOW);
    last = millis();
    irrecv.resume();
  }
}
```

Lesson 20: 8x8 LED-Matrix

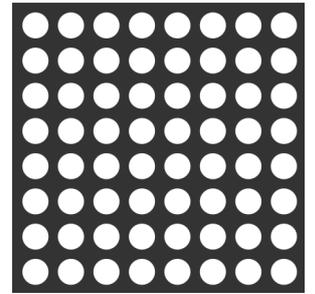
The 8 x 8 LED matrix consists of 64 LEDs. Each LED is placed at the intersection of row and column. If the level for a row is 1 and the level of the corresponding column is 0, the LED will turn on at its intersection.

Example:

If you want to switch on the first LED, set pin 9 to "HIGHLEVEL" and pin 13 to "LOWLEVEL".

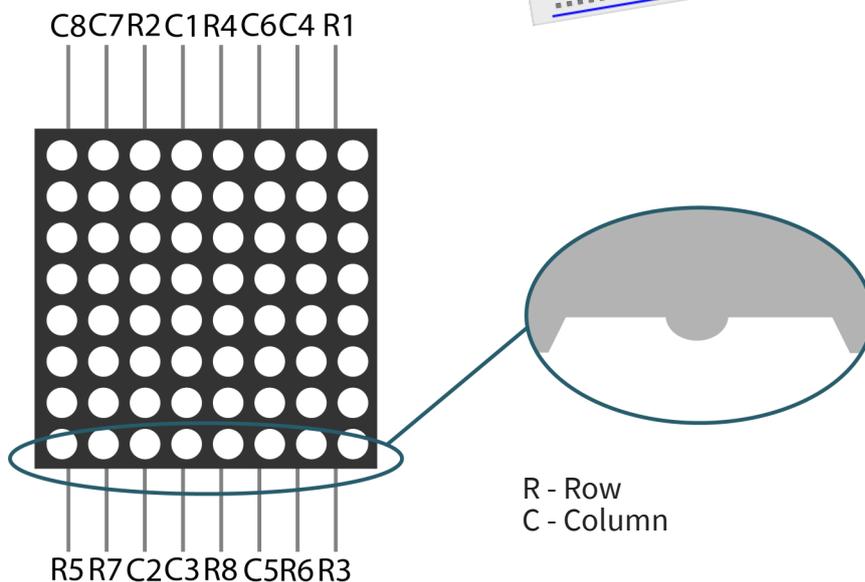
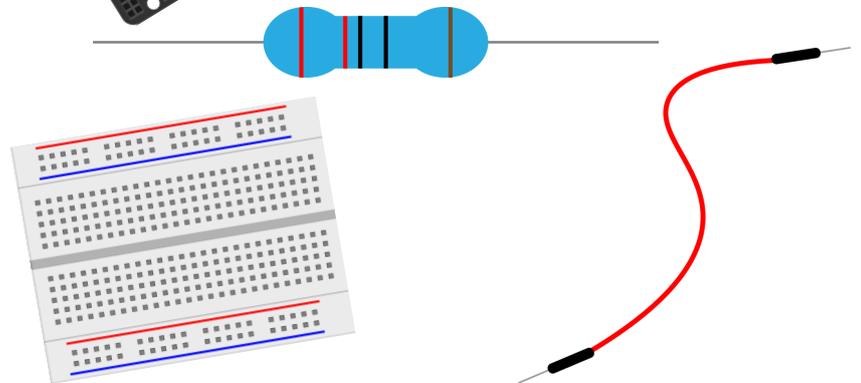
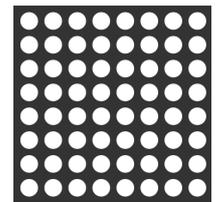
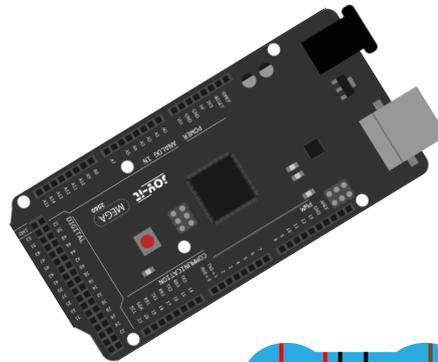
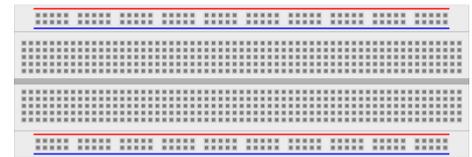
If you want to switch on the first row, set pin 9 to "HIGHLEVEL" and pins 13, 3, 4, 10, 11, 15 and 16 to "LOWLEVEL".

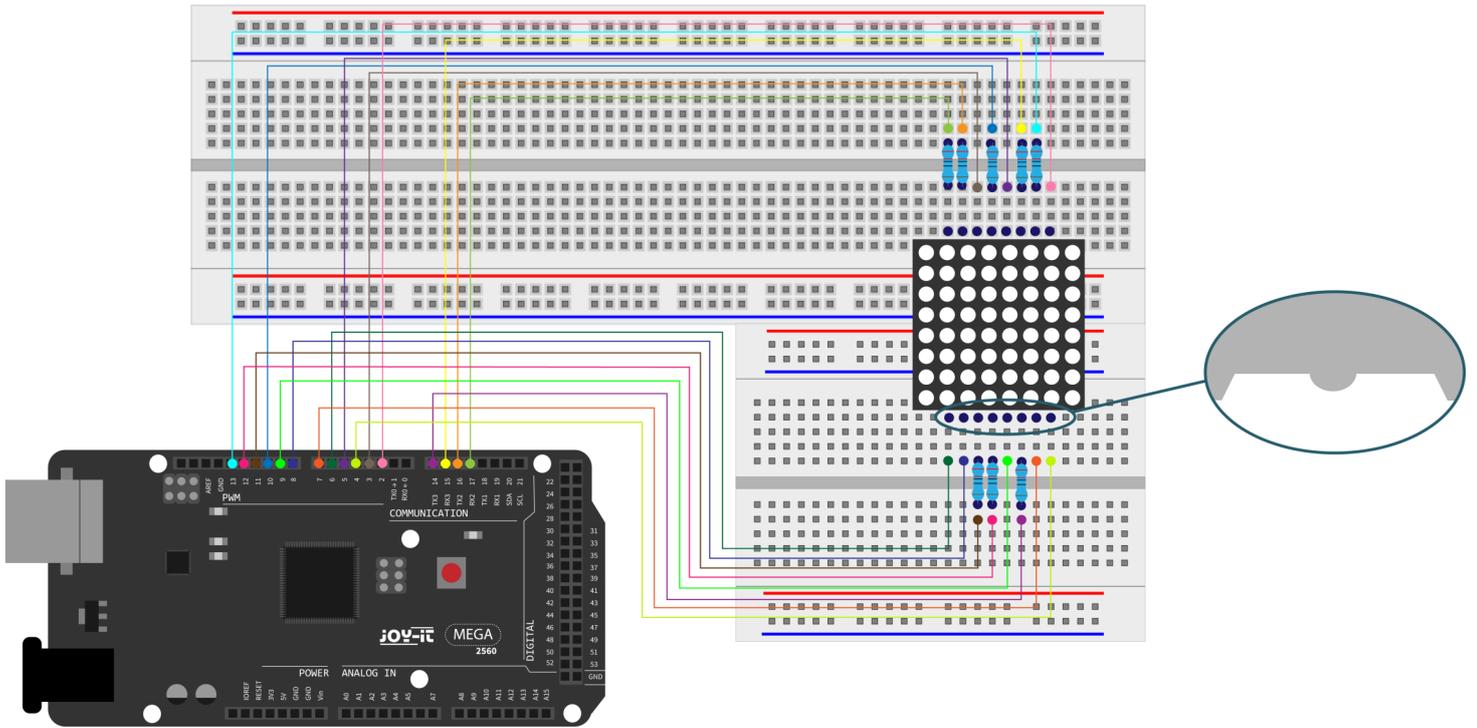
To switch on the first column, set pin 13 to "LOWLEVEL" and pins 9, 14, 8, 12, 1, 7, 2, 5 to "HIGHLEVEL".



You need for the following code:

- 1x Mega2560 board
- 1x USB cable
- 6x LED matrix
- 8x 220 Ω resistor
- 2x Breadboard
- 16x Jumper cable





Make sure that the LED matrix is connected properly. Under the matrix there is a bulge (picture) where you can compare the position of your matrix with the matrix on the picture.

```
// Set an array to store letters from 0
unsigned char Text[]={0x00,0x1c,0x22,0x22,0x22,0x22,0x22,0x1c};

void Draw_point(unsigned char x,unsigned char y) { // draw-point function
  clear_();
  digitalWrite(x+2, HIGH);
  digitalWrite(y+10, LOW);
  delay(1);
}

void show_num(void) { // display function, calls draw-point function
  unsigned char i,j,data;
  for(i=0;i<8;i++) {
    data=Text[i];
    for(j=0;j<8;j++) {
      if(data & 0x01)
        Draw_point(j,i);
      data>>=1;
    }
  }
}
```

```
void setup(){
    int i = 0 ;
    for(i=2;i<18;i++) {
        pinMode(i, OUTPUT);
    }
    clear_();
}

void loop() {
    show_num();
}

void clear_(void) { // clears screen
    for(int i=2;i<10;i++)
        digitalWrite(i, LOW);
    for(int i=0;i<8;i++)
        digitalWrite(i+10, HIGH);
}
```

6. OTHER INFORMATION

Our information and take-back obligations according to the Electrical and Electronic Equipment Act (ElektroG)



Symbol on electrical and electronic equipment:

This crossed-out dustbin means that electrical and electronic appliances do not belong in the household waste. You must return the old appliances to a collection point.

Before handing over waste batteries and accumulators that are not enclosed by waste equipment must be separated from it.

Return options:

As an end user, you can return your old device (which essentially fulfils the same function as the new device purchased from us) free of charge for disposal when you purchase a new device.

Small appliances with no external dimensions greater than 25 cm can be disposed of in normal household quantities independently of the purchase of a new appliance.

Possibility of return at our company location during opening hours:

Simac GmbH, Pascalstr. 8, D-47506 Neukirchen-Vluyn, Germany

Possibility of return in your area:

We will send you a parcel stamp with which you can return the device to us free of charge. Please contact us by e-mail at Service@joy-it.net or by telephone.

Information on packaging:

If you do not have suitable packaging material or do not wish to use your own, please contact us and we will send you suitable packaging.

7. SUPPORT

If there are still any issues pending or problems arising after your purchase, we will support you by e-mail, telephone and with our ticket support system.

E-Mail: service@joy-it.net

Ticket system: <http://support.joy-it.net>

Telephone: +49 (0)2845 98469-66 (10-17 o'clock)

For further information please visit our website:

www.joy-it.net