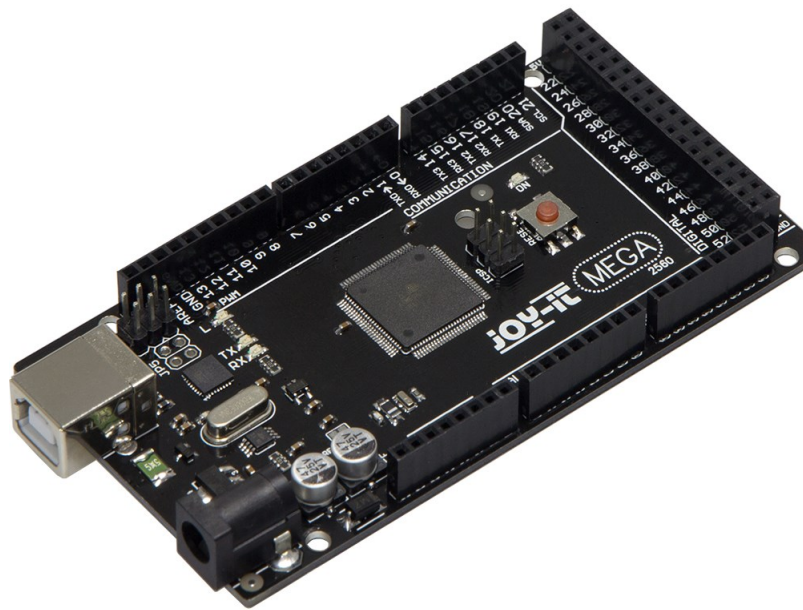


# **JOY-IT**

## Mega2560 R3 Starter Kit



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Dear customer,

thank you for purchasing our product.  
Please find our instructions below.

## 1. General informations & technical data

Our board is a high quality reproduction and fully compatible with the Arduino Mega 2560. We would, however, like to emphasize that this is not an original Arduino.

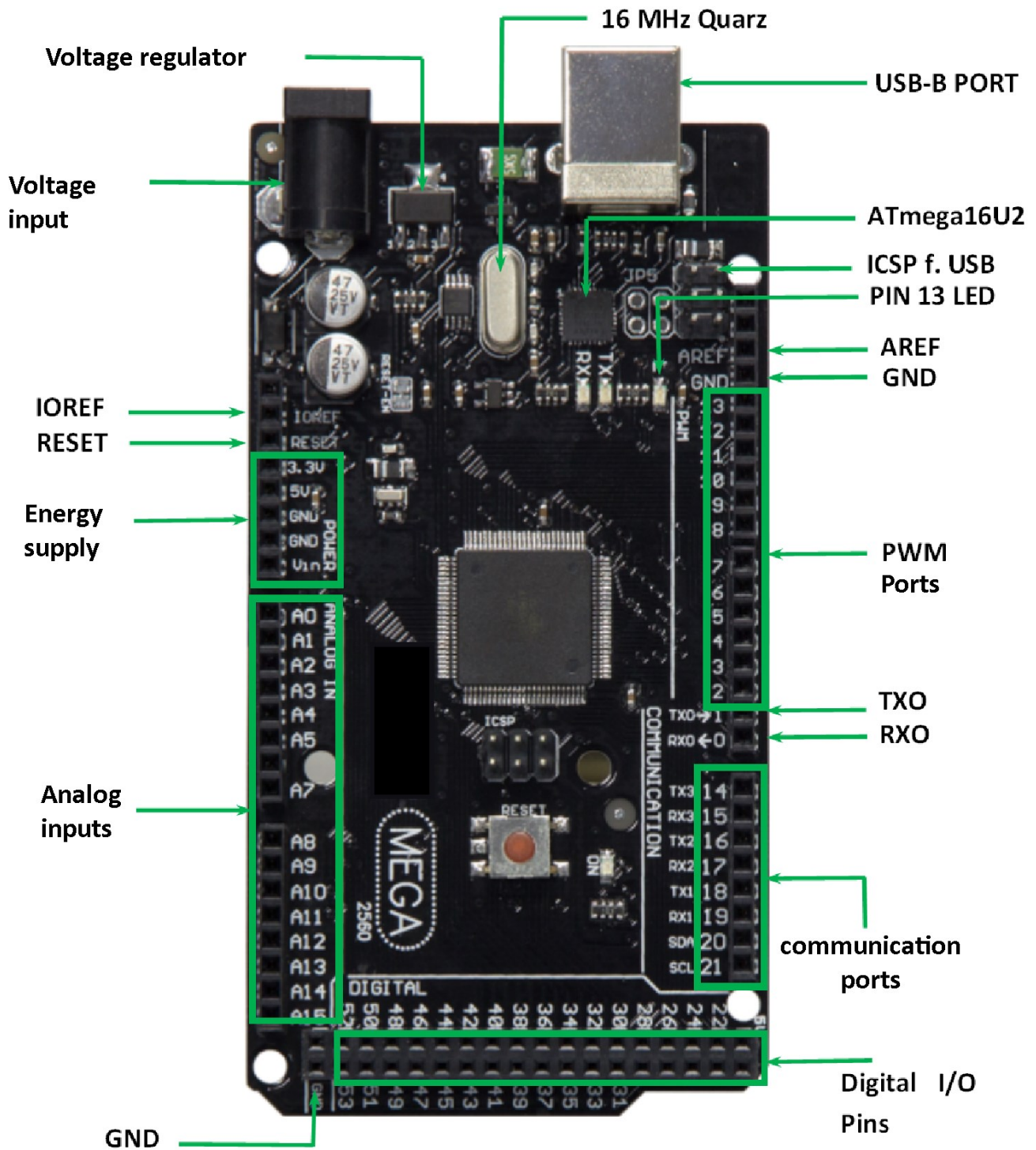
The Mega board is the right microcontrollerboard for everyone who wants to quickly join the programmers world.

This set will lead you to a variety of projects.

Its ATmega2560-Microcontroller offers you enough performance for your ideas and projects. It has a size of 101.52 mm x 53.3 mm and includes 54 digital in- and outputs and 16 analog inputs.

<b>Model</b>	ARD_Mega2560R3
<b>Microcontroller</b>	ATmega2560
<b>Input voltage</b>	7-12V
<b>Input current (max.)</b>	6-20V
<b>Digital IO</b>	54 (14 mit PWM)
<b>Analog IO</b>	16
<b>DC current IO</b>	40mA
<b>DC current 3.3V</b>	50mA
<b>Memory</b>	256kB (8kB für Bootloader)
<b>SRAM</b>	8kB
<b>EEPROM</b>	4kB
<b>Clock Speed</b>	16 MHz
<b>Dimensions</b>	101.52mm x 53.3mm

## 2. Assignment



## 3. Software installation

To start programming your JOY-IT ARD\_Mega2560R3, you need to install the development environment, and, of course, the drivers, on your computer.

The Arduino IDE is best for using with the Mega2560.

It is licensed as open source software under the GPLv2 terms and its concept and design is aiming for beginners.

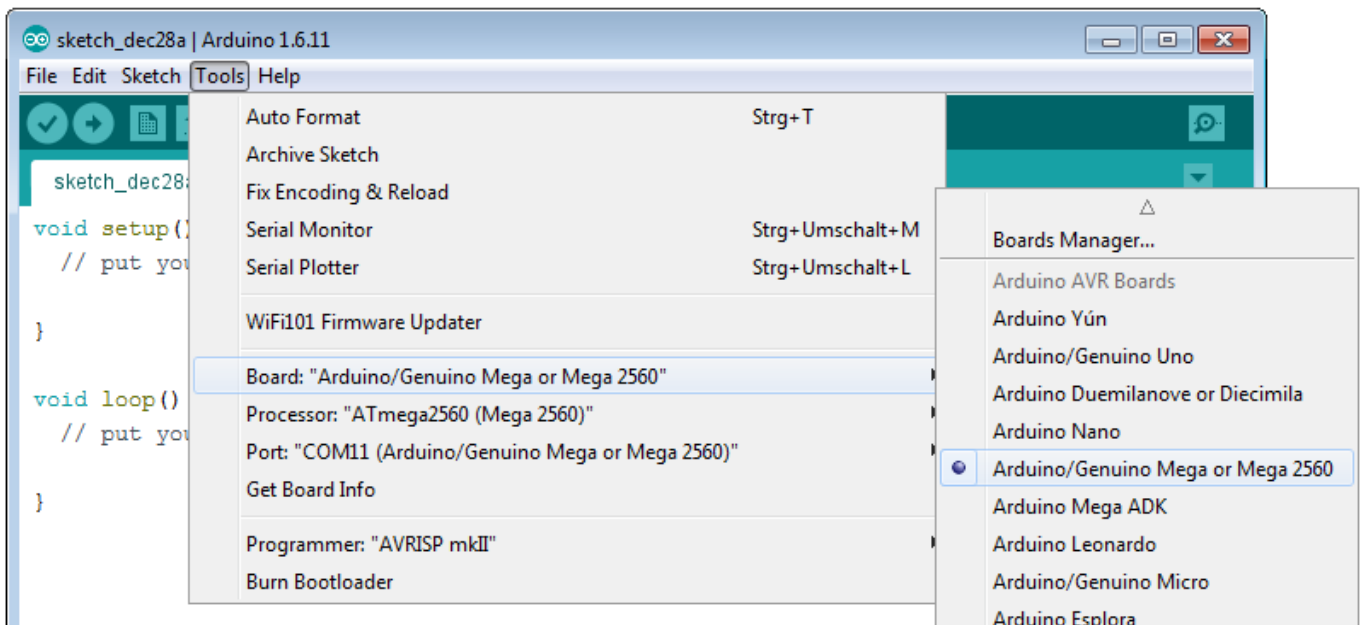
This IDE is completely compatible to our Mega2560R3 board and offers you every driver you need for a quick start.

You can download the software [here](#).

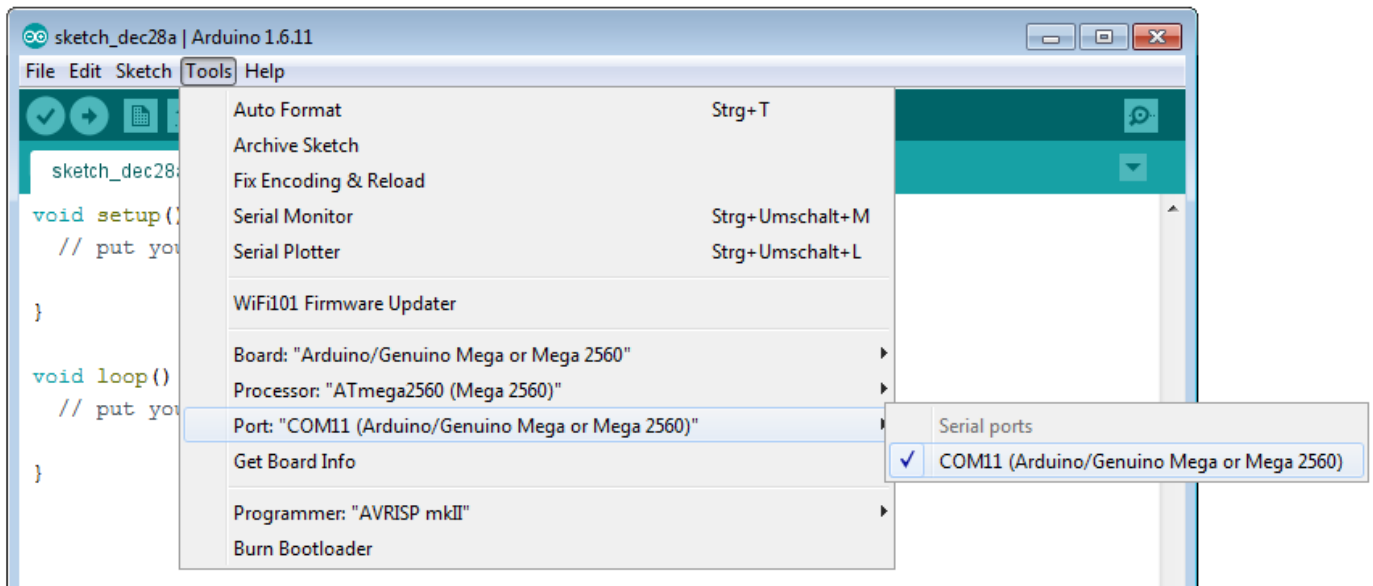
### 3.1 Software setup

After installing the software, you need to choose the right microcontroller-board in the environment. Therefore you need to be aware of two steps:

1. Choose „Arduino/Genuino Mega or Mega 2560“ at [Tools->Board].



2. Choose the right port (marked with Arduino/Genuino Mega or Mega 2560) at [Tools -> Port].



## 4 EU-Declaration of conformity

**Manufacturer** JOY-iT Europe GmbH  
Pascalstr. 8  
47506 Neukirchen-Vluyn

**Article description:** ard\_mega2560R3 /ARD-Set01

**Description:** Microcontroller-Board / Set


**Purpose:** experimental setup / prototyping

The manufacturer, the JOY-IT Europe GmbH, Pascalstr. 8, D-47506 Neukirchen-Vluyn, declares that the product „ard\_Mega2560IP“ is, during operation according to regulations, in compliance with the fundamental requirements of the following guidelines:

2014/ 30/EU (EMV) & 2011/65/EU (Rohs)

The following standards has been applied for assessment:

EN 61326-1: 2013  
electrical equipment for measure-, control- and laboratory devices - EMV requirement part 1 general requirements

<b>Date</b>	<b>Name</b>	<b>Signature</b>	<b>Position</b>
03.03.2017	Yue Yang		Director

## 5 Project examples

### 5.1 Project 1: „Hello World“

We start with an easy one.

You just need the board and an USB cable to start with the „Hello World!“ project.

This is an communication test for your Mega2560 and your computer and a basic project for your first steps in the Arduino world.

Hardware	Amount
Mega2560 board	1
USB cable	1
LED	1

After completing the drivers installation, let's open the Arduino software and write some code, which displays „Hello World“ underneath your code.

Of course you can create some code, which is going to repeat the message automatically.

We can instruct the LED on PIN 13 to blink at first and to output „Hello World“ afterwards.



```

int val; // defines variable "Val"
int ledpin=13; // defines digital interface 13
void setup()
{
  Serial.begin(9600); // sets baudrate to 9600 to comply
                    // with software configurationre

  pinMode(ledpin,OUTPUT); // sets digital PIN 13 to output.
                        // This configuration is requi
                        //red when using I/O ports.}

void loop()
{
  val=Serial.read(); // reads symbols and assigns to „Val“

  if(val=='R') // checks input for the letter „R“

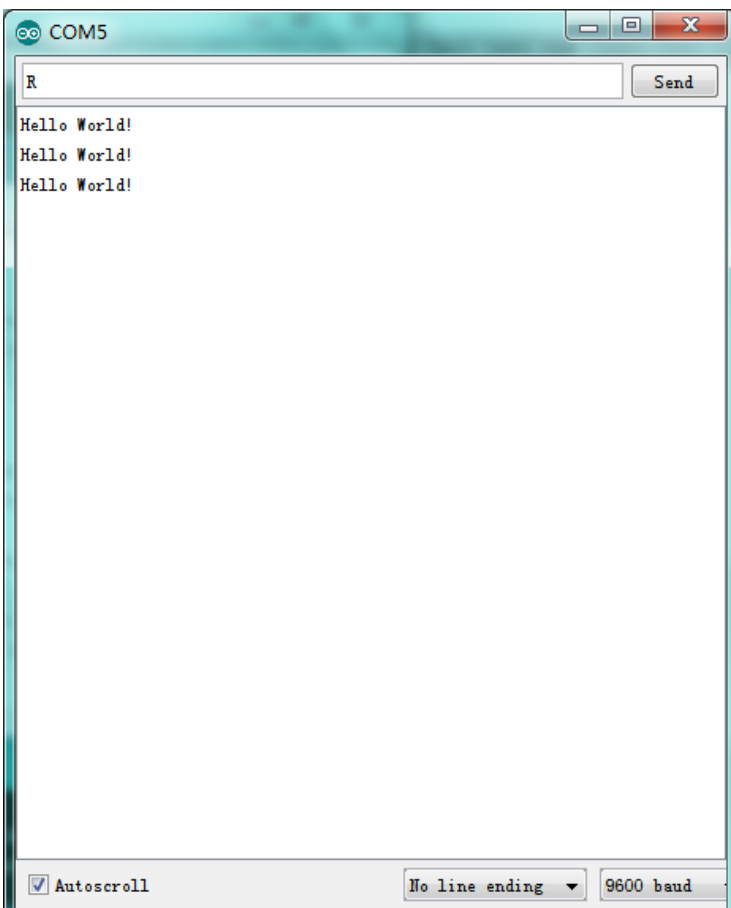
  { // if so, turn on LED at PIN 13
    digitalWrite(ledpin,HIGH);

    delay(500);
    digitalWrite(ledpin,LOW); // turns off LED
    delay(500);
    Serial.println("Hello World!"); // shows "Hello World"
  }
}

```



Open the serial monitor and insert a „R“.  
The LED is going to light up once and you will see „Hello World“ in the serial monitor.



## 5.2 Project 2: flashing LED

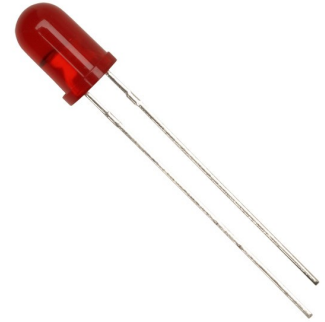
The flashing LED project is quite easy.

We already discovered the LED in the previous project.

This time we will connect the LED to a digital port.

Diesmal werden wir eine LED mit einem der digitalen Pins verbinden.

This is what we need:

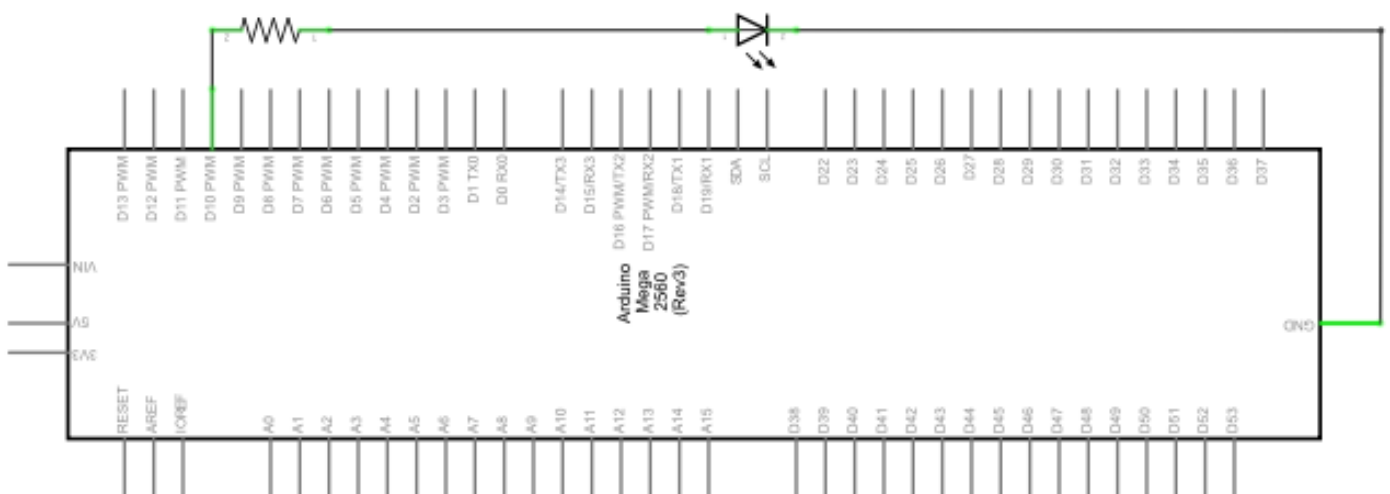


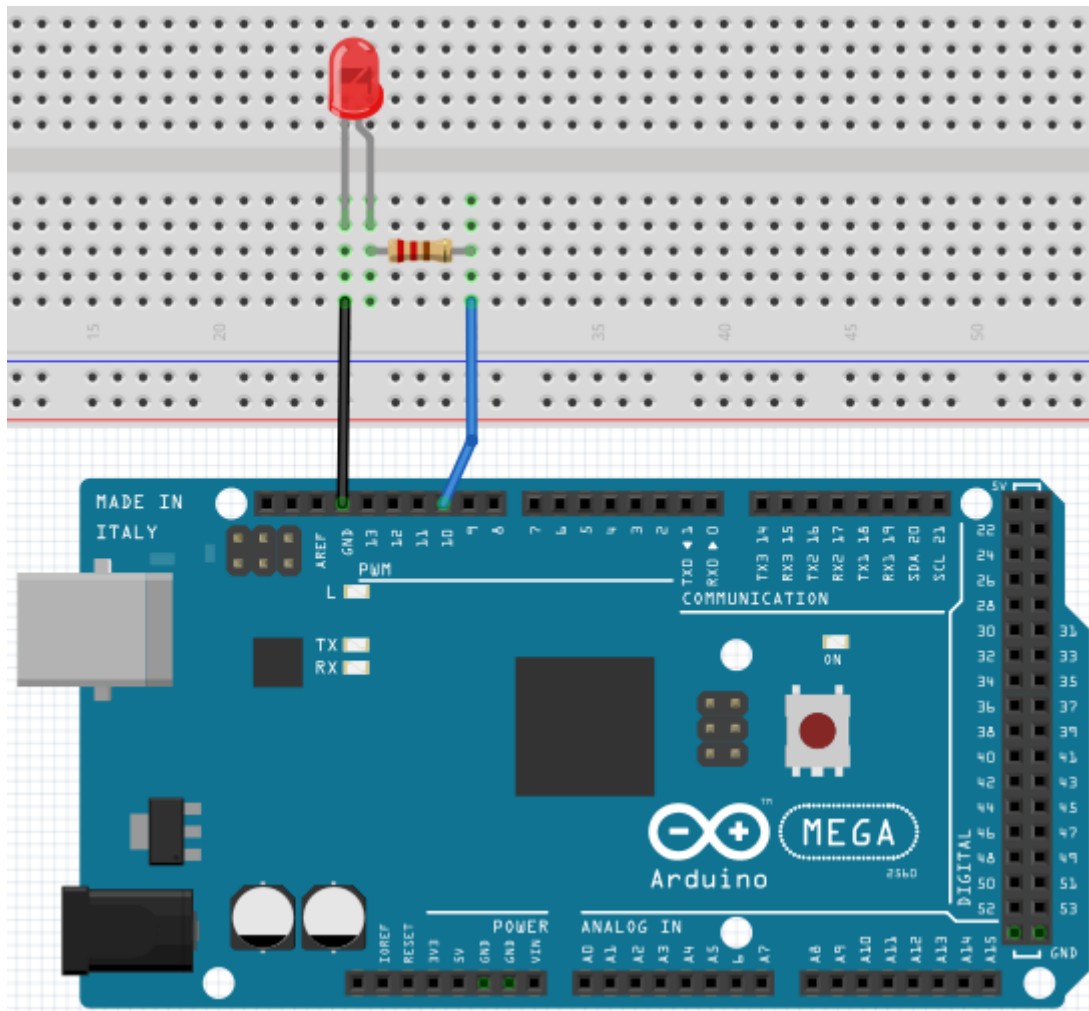
Hardware	Amount
Mega2560 board	1
USB cable	1
Red M5 LED	1
220Ω resistor	1
Breadboard	1
Breadboard cable	2

Just connect the components as seen in the circuit diagram below.

We are going to use digital pin 10.

Connect the LED to a 220 Ohm resistor to avoid damage by higher currents.





```

int ledPin = 10; // Defines digital PIN 10.

void setup()
{
  pinMode(ledPin, OUTPUT); // Defines PIN with connected LED as
                           // 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
}

```

Nach dem Runterladen dieses Programms, wirst du im Experiment die an Pin 10 verbundene LED sich, mit einem Intervall von ca. einer Sekunde, Ein- und Ausschalten sehen.

## 5.3 Project 3: PWM Lightcontrol

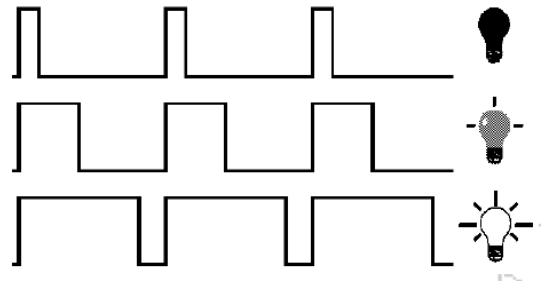
PWM, short for Pulse Width Modulation, is a technique, used to translate analog signals into digital signals.

A computer is not able to output an analog voltage.

Er kann nur Digitalspannung ausgeben mit Werten wie 0V oder 5V.

Therefore, a high-resolution counter is used, to code an analog signal level, by modulating the occupancy rate of PWM.

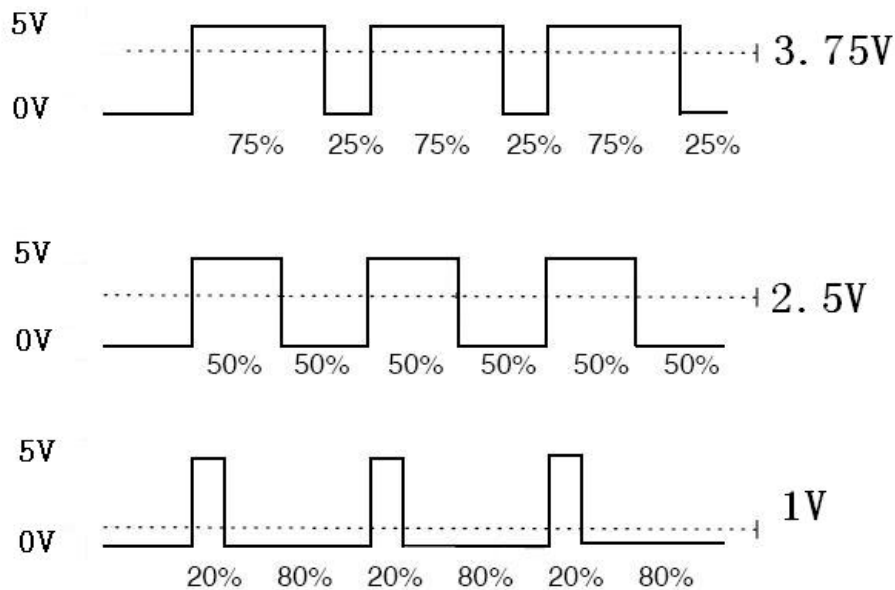
The voltage and current is led by repeated pulse sequences to the component.



Every analog value can be decoded by PWM, if the bandwidth is appropriated.

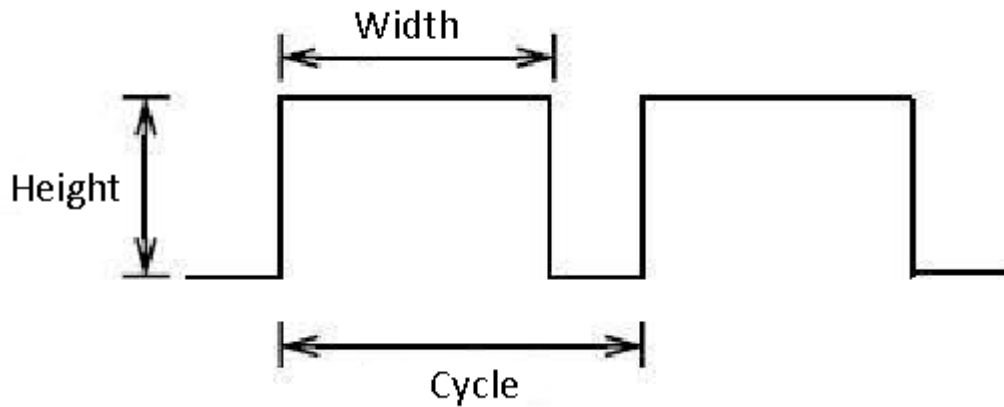
The value of the outputvoltage is calculated with the duration of the on and off conditions.

Voltage = (ON duration / pulse duration) \* maximum voltage



PWM has many uses: control of lightintensity, control of motor speed etc.

The three basic parameters of PWM:



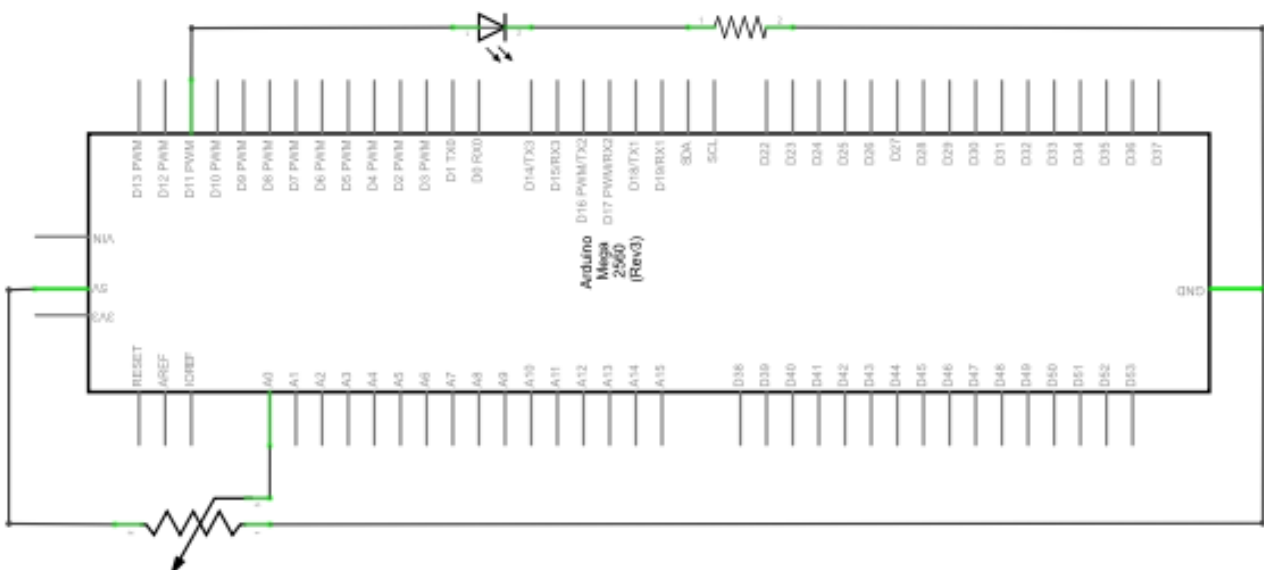
1. Die amplitude of the pulse width (minimum/maximum)
2. Pulsefrequency
3. Voltage level

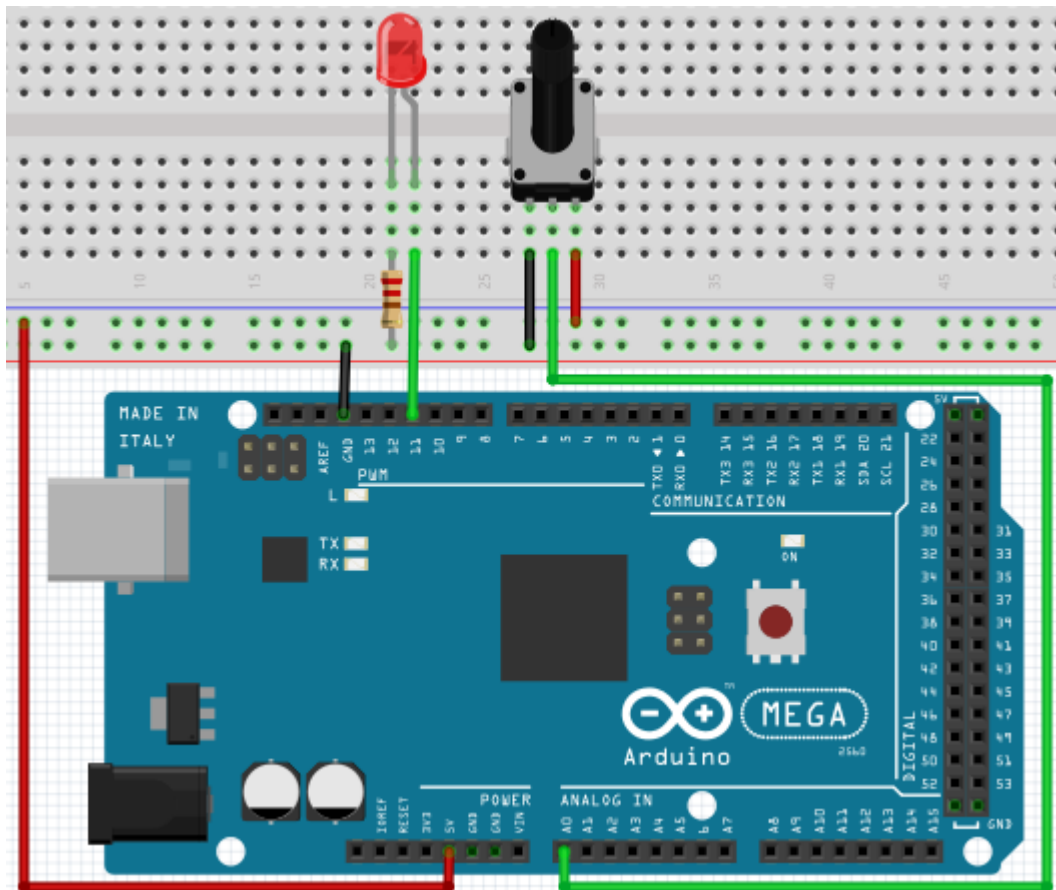
The Mega2560 has 6 interfaces, supporting PWM: digital PIN 3, 5, 6, 9, 10 and 11.

Hardware	Amount
Mega2560 Platine	1
USB Kabel	1
Rote M5 LED	1
Variabler Widerstand	1
220Ω Widerstand	1
Breadboard	1
Breadboard Überbrückungskabel	6

In a previous project, we used a digital signal to control a LED.

Now we are going to use a potentiometer to adjust the brightness of the LED.





While creating this program, we will make use of the analog writing function. In this experiment, we are going to read the analog value of the potentiometer and assign this value to the PWM port, to notice a change of LED brightness. The last part will be to show the analog value on the screen.

```

int potpin=0; // initialises analog PIN 0
int ledpin=11; // initialises digital PIN 11 (PWM output)

int val=0; // saves the value of the sensor
void setup()
{
    pinMode(ledpin,OUTPUT); // sets digital PIN 11 to output
    Serial.begin(9600); // sets baudrate to 9600
}

void loop()
{
    val=analogRead(potpin); // reads analog value and assigns it to „Val“
    Serial.println(val); // shows „Val“ value
    analogWrite(ledpin,val/4); // turns on LED and assigns brightness
    //(maximum PWM output is 255)
    delay(10); // waits 0,01 seconds
}

```

After transferring the code, we can notice the value changing by moving the potentiometer. We can also notice the brightness of the LED changing.

The screenshot shows the Arduino IDE interface. The main window displays the code from the previous block, with some comments in German. The code is:
 

```

int potpin=0; // initialize analog pin 0
int ledpin=11; // initialize digital pin 11 (PWM output)
int val=0; // Temporarily store variables' value from the sensor
void setup()
{
    pinMode(ledpin, OUTPUT); // define digital pin 11 as "output"
    Serial.begin(9600); // set baud rate at 9600
    // attention: for analog ports, they are automatically set up as "input"
}
void loop()
{
    val=analogRead(potpin); // read the analog value from the sensor and assign it
    Serial.println(val); // display value of val
    analogWrite(ledpin, val/4); // turn on LED and set up brightness (maximum output
    delay(10); // wait for 0.01 second
}

```

 Below the code editor, a status bar indicates "Done uploading." and provides memory usage information: "Global variables use 190 bytes (2%) of dynamic memory, leaving 8,002 bytes for local variables. Maximum is 8,192 bytes." The bottom status bar shows "16 Arduino Mega or Mega 2560, ATmega2560 (Mega 2560) on COM5".



## 5.4. Projekt 4: Traffic lights

We already discovered the flashing LED project.

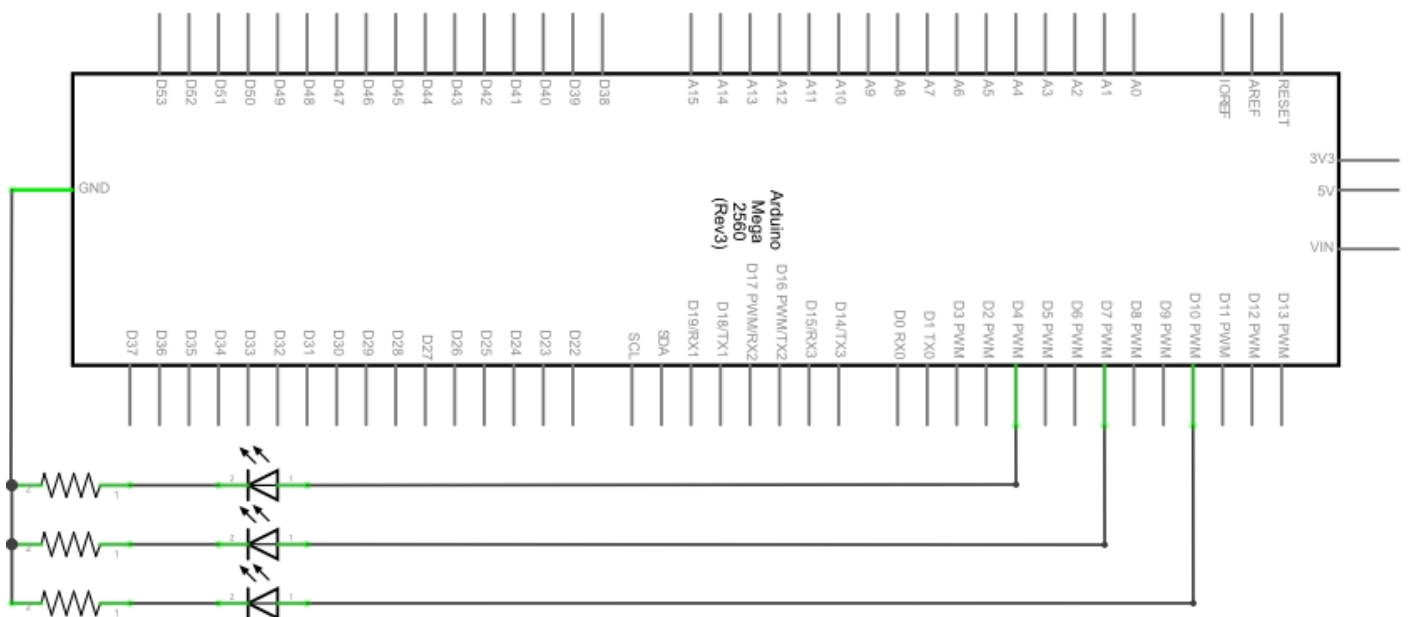
Now it is time to do a more complicated experiment:

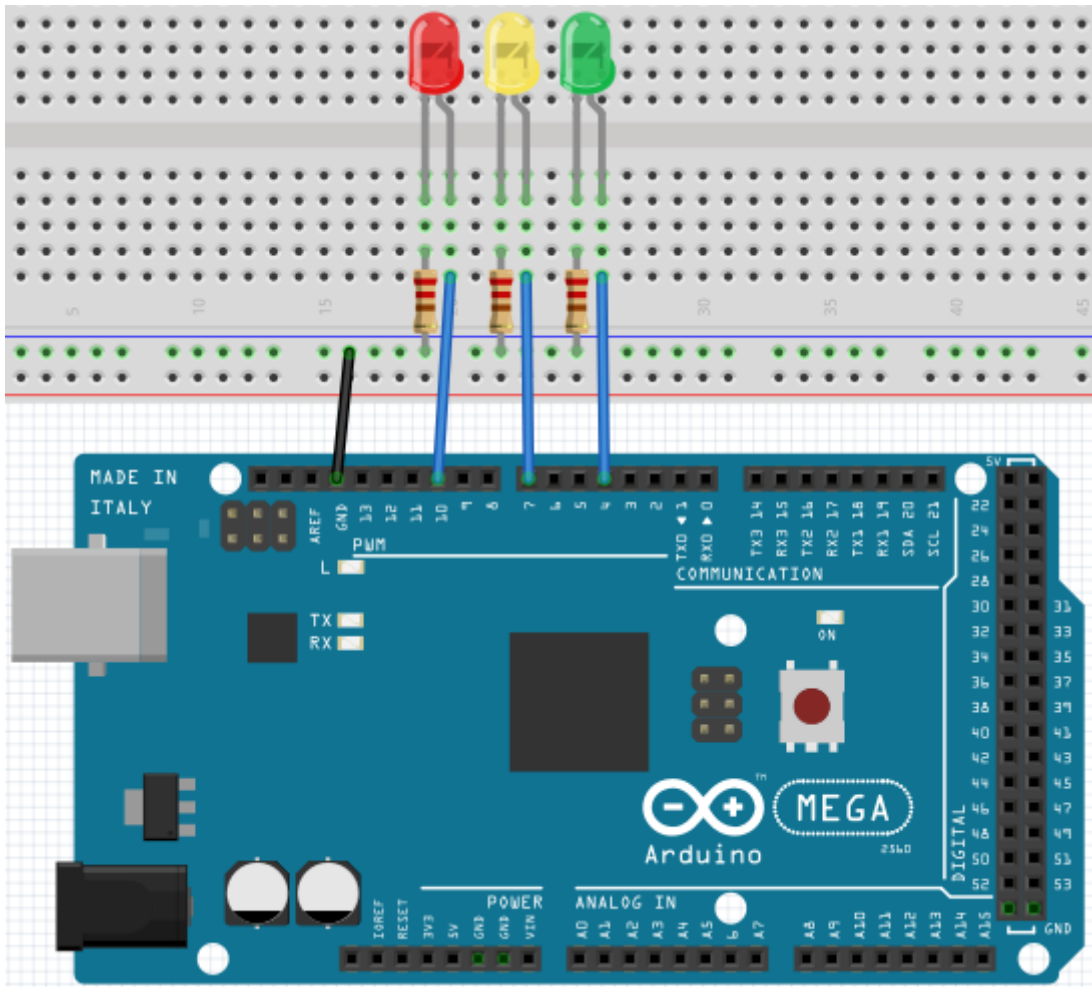
Traffic lights

During this experiment we will use three LEDs with different colors.



Hardware	Amount
Mega2560 board	1
USB cable	1
Red M5 LED	1
Yellow M5 LED	1
Green M5 LED	1
220Ω resistor	3
Breadboard	1
Breadboard cable	4





Because this is a simulation of traffic lights, the lighting duration should be as long as real traffic lights. Therefore we are going to use the Arduinos delayfunction, to control the delay.

```

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 red LED PIN to output
pinMode(yellowled, OUTPUT); // sets yellow LED PIN to output
pinMode(greenled, OUTPUT); // sets green LED PIN to output
}

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

```

You can watch the traffic lights, after the transfer is complete.

The green light is going to light up for five seconds.

The yellow light then flashes three times.

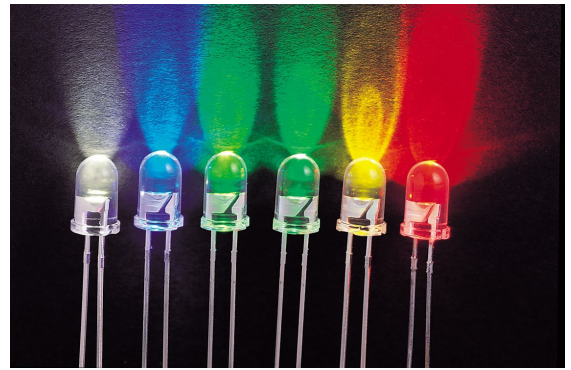
The green light will then light up for another five seconds.

Then the yellow light will flash three times again.

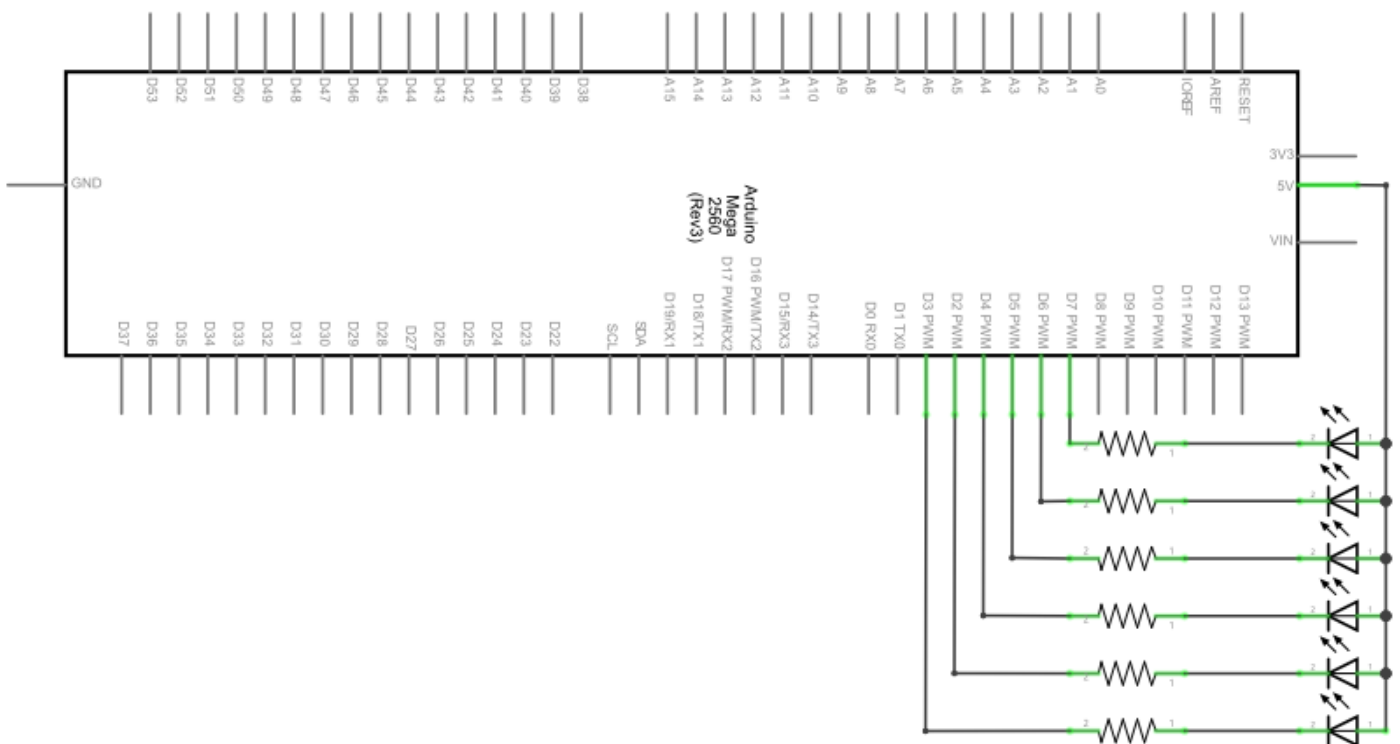
In the end the red light will light up for three seconds and completes the cycle.

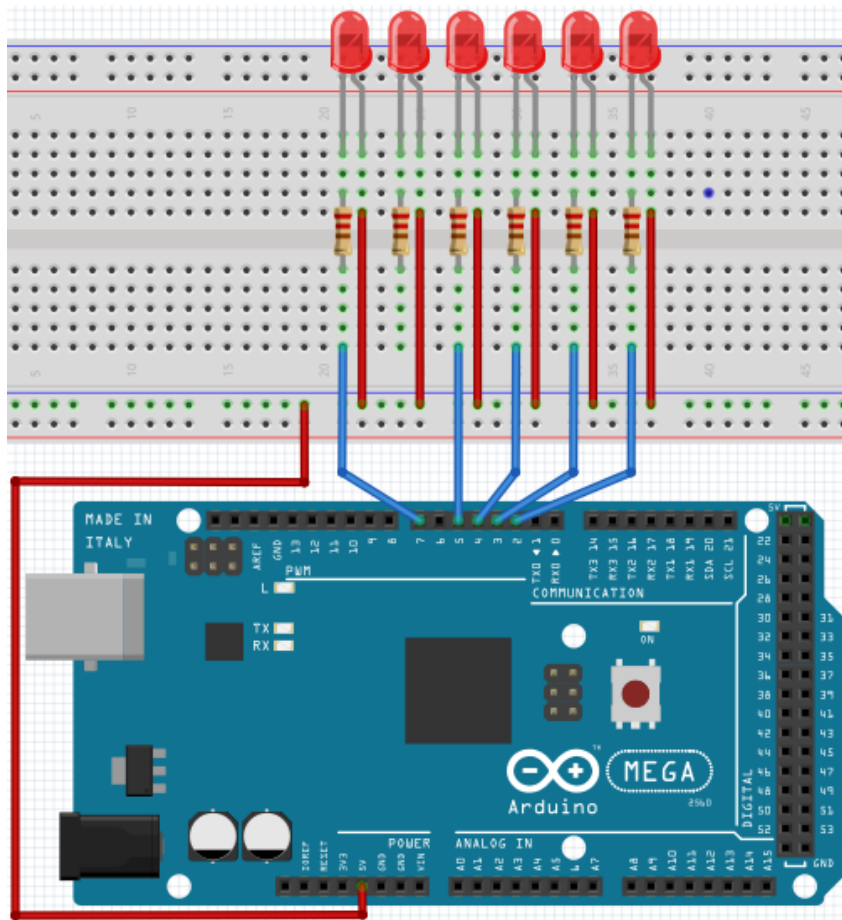
## 5.5 Project 5: LED Chase-Effect

We often see billboards with colorful LEDs. These are always changing to form different effects. This experiment will simulate this effect.



Hardware	Amount
Mega2560 board	1
USB cable	1
LED	6
220Ω resistor	6
Breadboard	1
Breadboard cable	12





```

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); // sets I/O PIN to „low“, turns on LEDs
                          // one after the other die LEDs
    delay(200);           // delay
  }
  for (int i = BASE; i < (BASE + NUM); i ++)
  {
    digitalWrite(i, HIGH); // sets I/O PIN to „high“,
                           // turns off LEDs one after the other
    delay(200);           // delay
  }
}

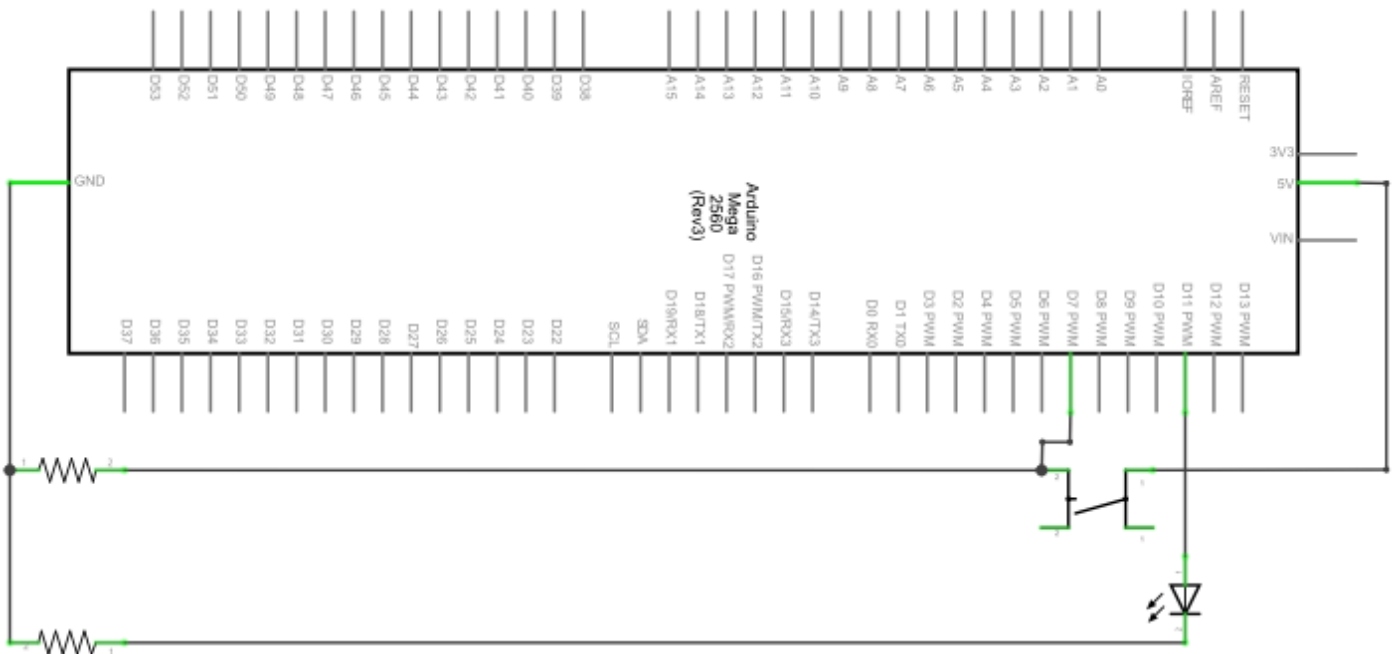
```

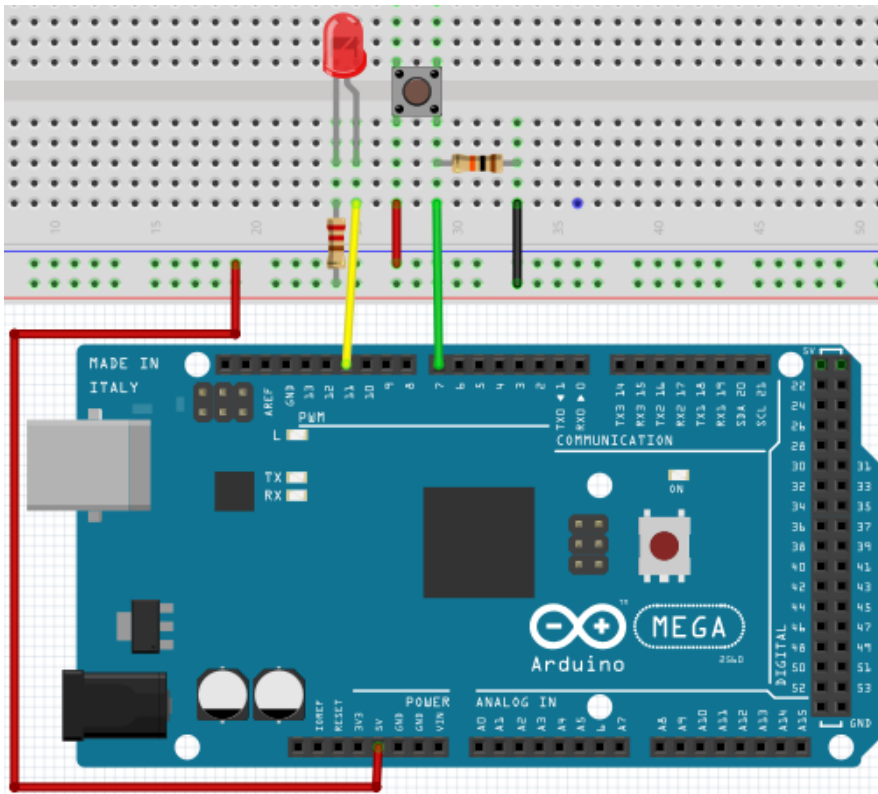
## 5.6 Project 6: button-controlled LED

I/O Port is the interface for input and output. Until now we have just used the output. In this project we will try to use the input to read the value of the connected component. We will use a button and a LED with the input and output to give a better understanding of the I/O function. Buttons have a digital value. If the button is pressed, the circuit is closed and gets in a conductive state.



Hardware	Amount
Mega2560 board	1
USB cable	1
LED	1
220Ω resistor	1
10kΩ resisotr	1
Button	1
Breadboard	1
Breadboard cable	5





By pressing the button, the LED will light up.  
In this program, an if query is used.

```

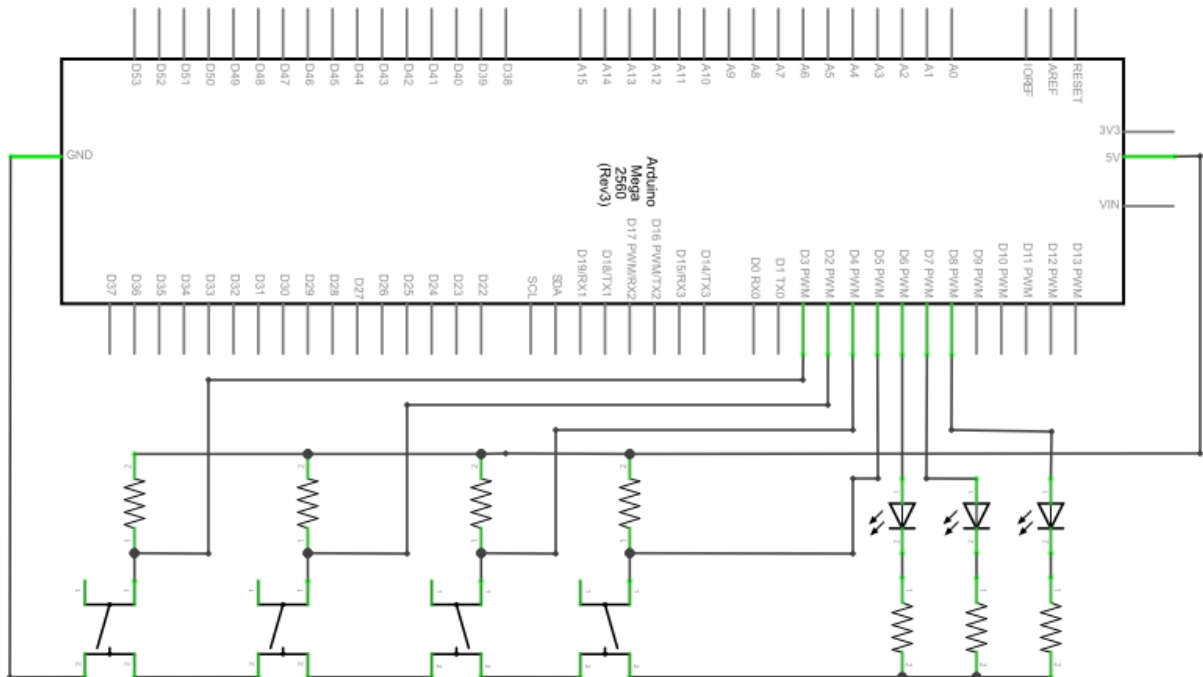
int ledpin=11;           // initialises PIN 11
int inpin=7;             // initialises PIN 7
int val;                 // defines „Val”
void setup()
{
  pinMode(ledpin,OUTPUT); // sets LED PIN to „OUTPUT”
  pinMode(inpin,INPUT);   // sets button PIN to „INPUT”
}
void loop()
{
  val=digitalRead(inpin); // reads value of PIN 7
                          // assigns to „Val”
  if(val==LOW)            // checks if button is pressed
                          // if so, LED lights up
  { digitalWrite(ledpin,LOW);}
  else
  { digitalWrite(ledpin,HIGH);}
}

```

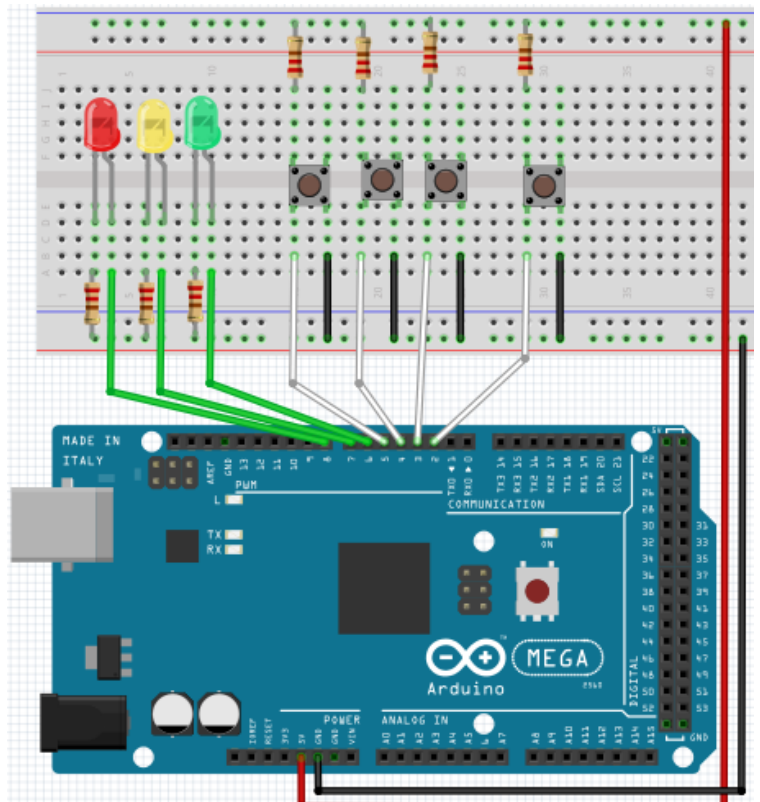
If the button is pressed, the LED will light up.  
Otherwise it will stay off.

## 5.7 Project 7: Responder experiment

In this program are three buttons and one reset button which will control the three LEDs with 7 digital I/O PINs.



Hardware	Amount
Mega2560 board	1
USB cable	1
Red M5 LED	1
Yellow M5 LED	1
Green M5 LED	1
220Ω resistor	7
Buttons	4
Breadboard	1
Breadboard cable	13





```

int redled=8; // sets red LED to „Output“
int yellowled=7; // sets yellow LED to „Output“
int greenled=6; // sets green LED to „Output“
int redpin=5; // initialises PIN for red button
int yellowpin=4; // initialises PIN for yellow button
int greenpin=3; // initialises PIN for green button
int restpin=2; // initialises PIN for reset button
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() //reads the buttons repetitive
{
    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 the red LED is
// on. Ends the circle 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 the yellow LED
                                // is on. Ends the circle 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 the green LED
                                // is on. Ends the circle when the reset
                                // button is pressed.
{
  while(digitalRead(restpin)==1)
  {
    digitalWrite(redled,LOW);
    digitalWrite(greenled,HIGH);
    digitalWrite(yellowled,LOW);
  }
  clear_led();
}
void clear_led()                 // turns all LEDs off
{
  digitalWrite(redled,LOW);
  digitalWrite(greenled,LOW);
  digitalWrite(yellowled,LOW);
}

```

Achten Sie bitte darauf, dass Sie beide Code-Teile in ihrem Sketch des Arduino-Programms zusammenfügen.

Wenn eine Taste betätigt wird, schaltet sich die entsprechende LED ein.

Wird die Reset-Taste betätigt, schaltet sich die entsprechende LED wieder aus.

## 5.8 Project 8: Active buzzer

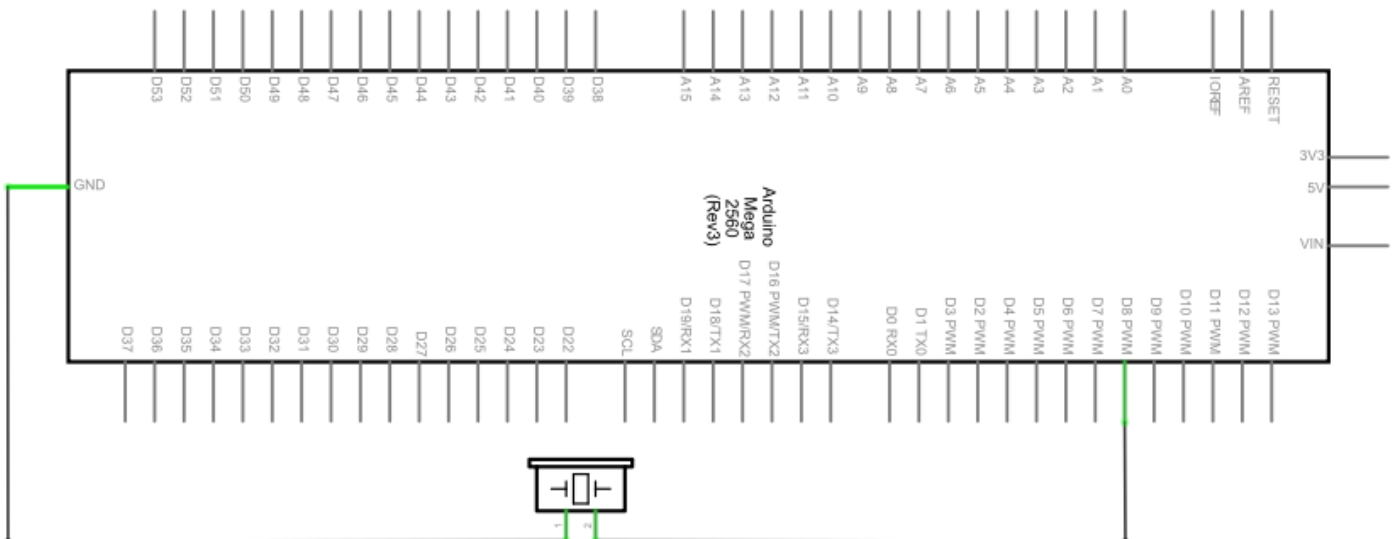
Active buzzers are used in computers, printers, alarm clocks, toys etc. to emit a sound.

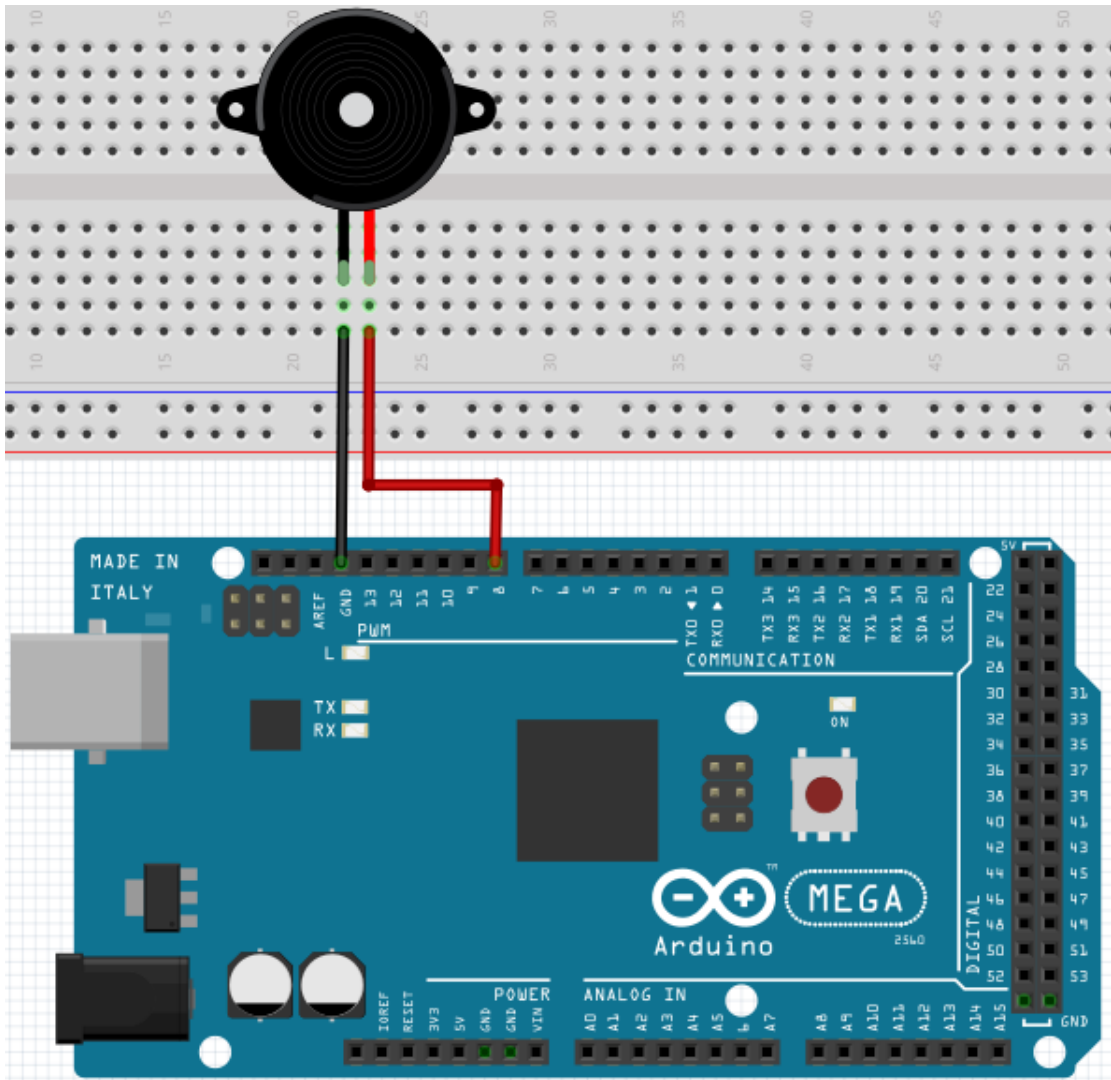
It has an inner vibration source.

Connected to a 5V-Power-supply, it can buzz repeatedly.



Hardware	Amount
Mega2560 board	1
USB cable	1
Buzzer	1
Breadboard	1
Breadboard cable	2





```
int buzzer=8;           // initialises digital I/O PIN
                        // to control the buzzer

void setup()
{
  pinMode(buzzer,OUTPUT);    // sets pinmode to Output
}

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

Das Projekt ist nach dem Übertragen des Programms abgeschlossen.  
Der Summer summt.

## 5.9 Project 9: Passive buzzer

With the Mega2560, many interactive projects are possible.

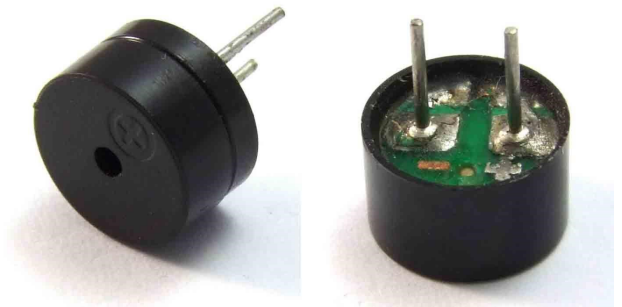
The previous projects mainly dealt with LEDs but an often used project is the acoustic-optic display.

Therefore, a passive buzzer is used which is, unlike the active buzzer, not able to activate itself.

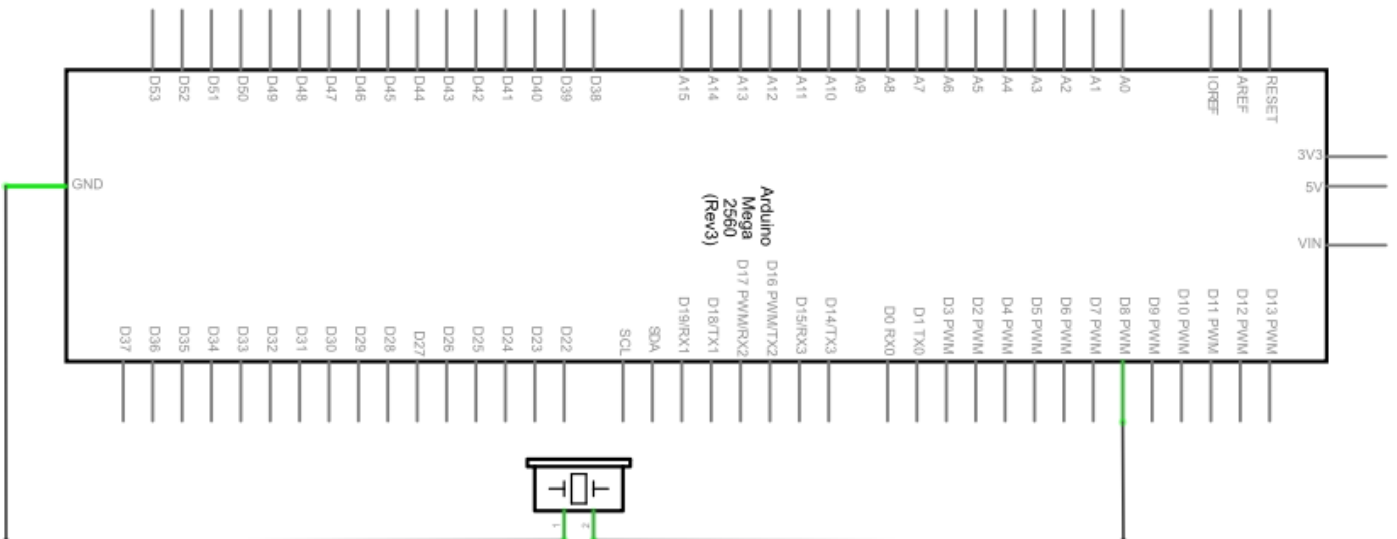
The activation occurs over a pulse frequency.

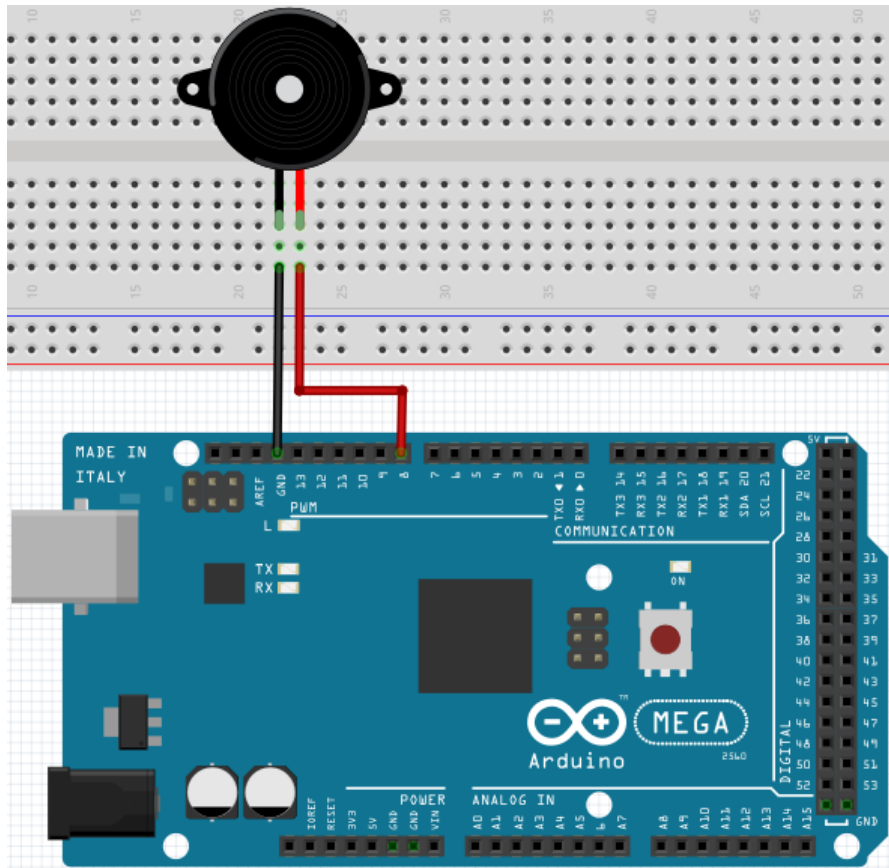
Different frequencies result in different sounds.

You can use this to play the melody of a song.



Hardware	Amount
Mega2560 board	1
USB cable	1
Passive buzzer	1
Breadboard	1
Breadboard cable	2





```

int buzzer=8;
void setup()
{
    pinMode(buzzer,OUTPUT);    // sets buzzer Pin to output.
}
void loop()
{
    unsigned char i,j;        // defines variable
    while(1)
    {
        for(i=0;i<80;i++)    // emits frequencysound
        {
            digitalWrite(buzzer,HIGH);    // Sound
            delay(1);                    // 1ms delay
            digitalWrite(buzzer,LOW);    // No sound
            delay(1);                    // 1ms delay
        }
        for(i=0;i<100;i++)    // emits frequencysound
        {
            digitalWrite(buzzer,HIGH);    // Sound
            digitalWrite(buzzer,LOW);    // No Sound
            delay(2);                    // 2ms delay
        }
    }
}

```

## 5.10 Project 10: Reading analog values

This project is about the analog interfaces of the Mega2560.

An **analogRead()** command can the value of the interface.

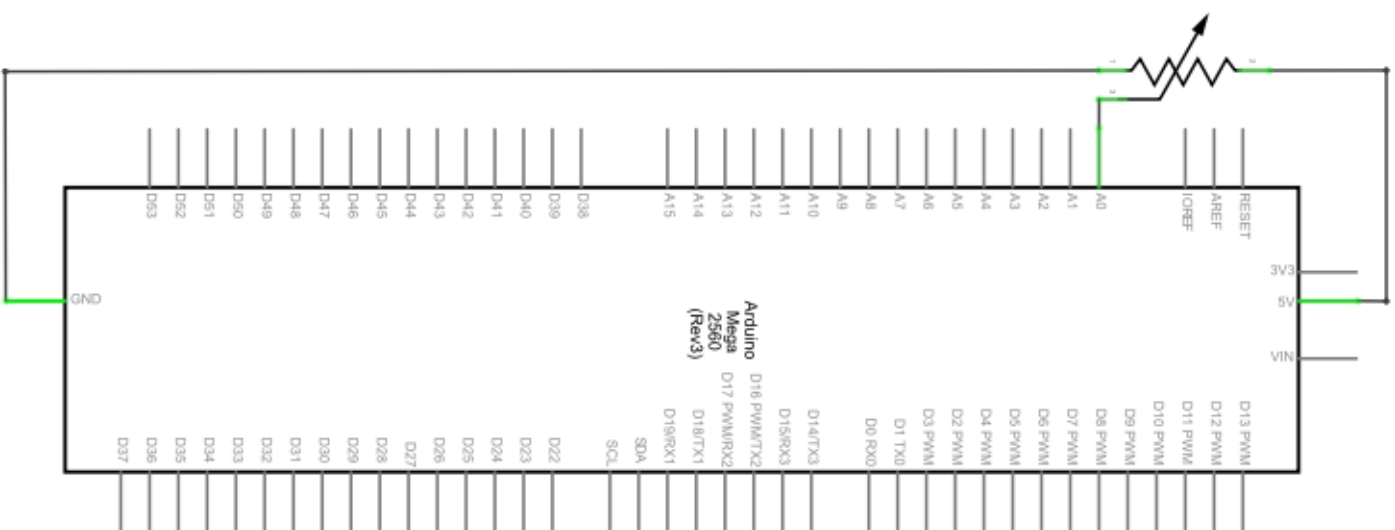
Because of the Analog-Digital-Converter of the Mega2560, the read-out values are between 0 and 1023.

To be able to read the values, it is important to take care of the right baudrate.

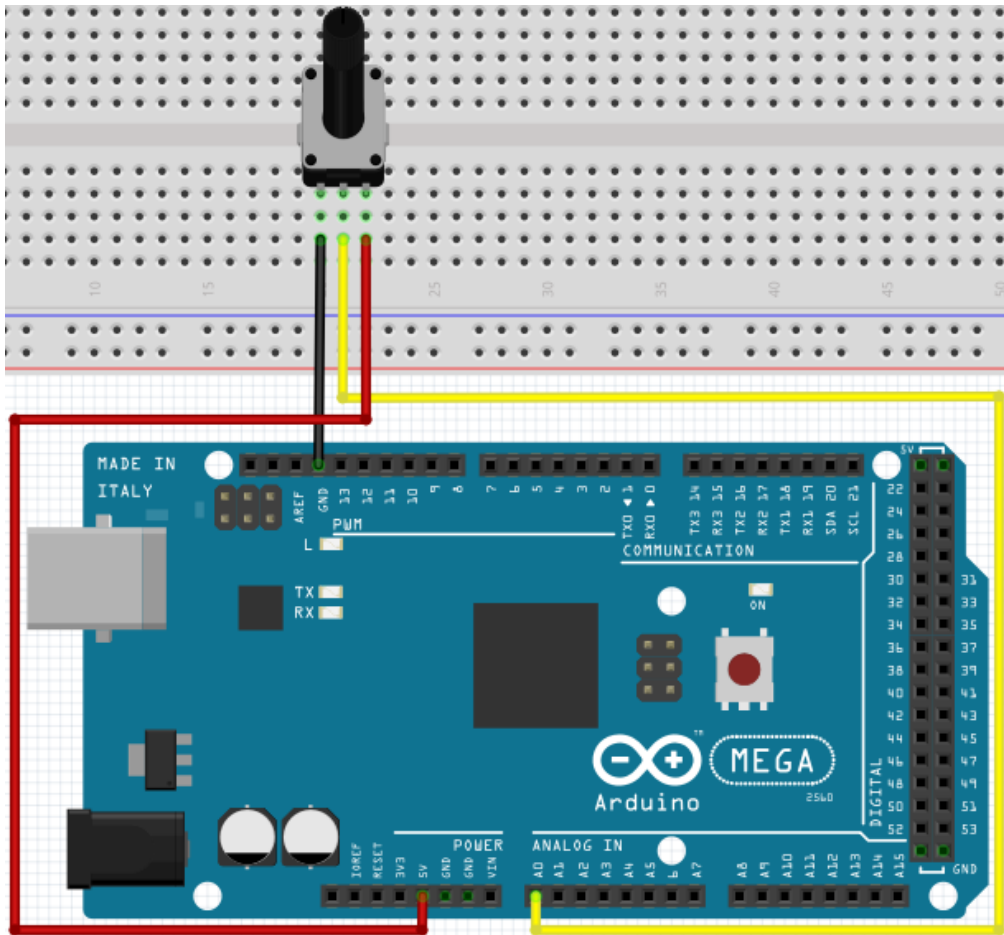
The baudrate of the computer has to meet the requirements of the device.

If you open the serial monitor in your Arduino program, you can configure the baudrate in the bottom right corner.

Here we are going to convert the adjustes value of a potentiometer to an analog value and display it on the screen.



Hardware	Amount
Mega2560 board	1
USB cable	1
Potentiometer	1
Breadboard	1
Breadboard cable	3



```

int potpin=0; // initialises analog PIN 0
int ledpin=13; // initialises digital PIN 13
int val=0; // defines „Val“
void setup()
{
    pinMode(ledpin,OUTPUT); // sets digital PIN to „Output“
    Serial.begin(9600); // sets Baudrate to 9600
}
void loop()
{
    digitalWrite(ledpin,HIGH); // turns on LED
    delay(50); // waits 0,05 seconds
    digitalWrite(ledpin,LOW); // turns off
    delay(50); // waits 0,05 seconds
    val=analogRead(potpin); // reads Analogvalue

    Serial.println(val); // Shows Analogvalue(saved in „Val“)
}

```

The read out values are displayed in the serial monitor.



## 5.11 Project 11: Light dependent resistor

A light dependent resistor is a resistor which is changing its value by the incoming light.

It is based on the photoelectric effect of semiconductors.

If the incoming light is intensive, it reduces its power of resistance.

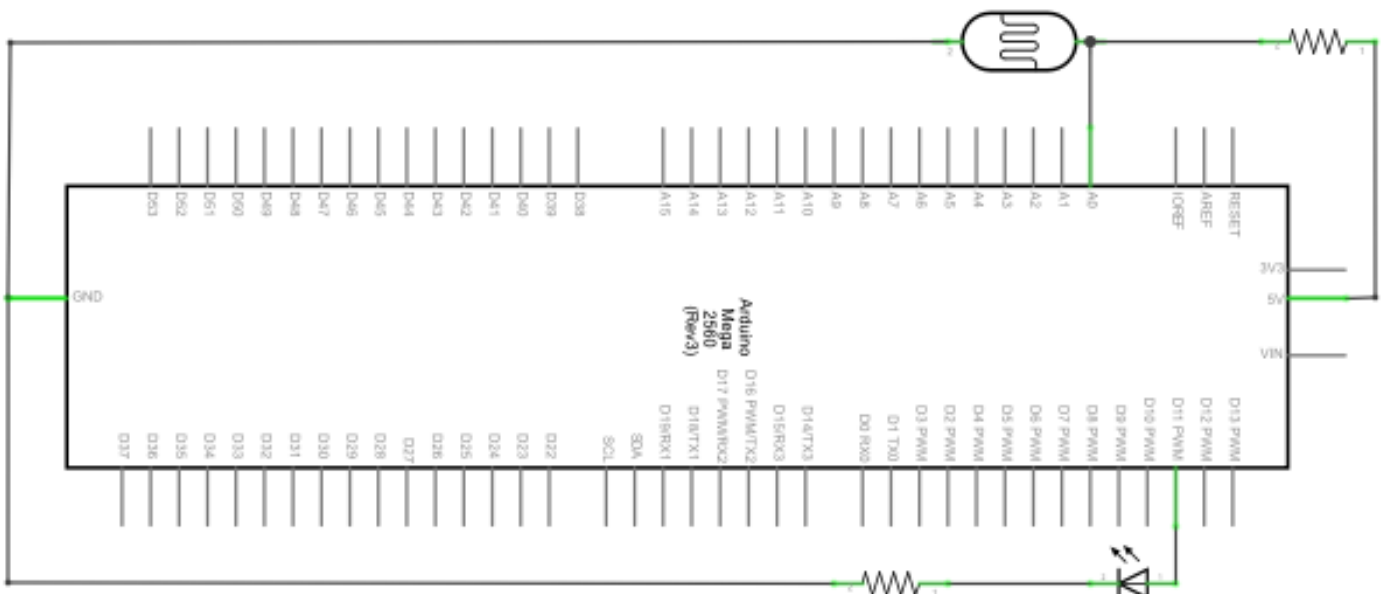
If the incoming light is low, it raises its power of resistance.

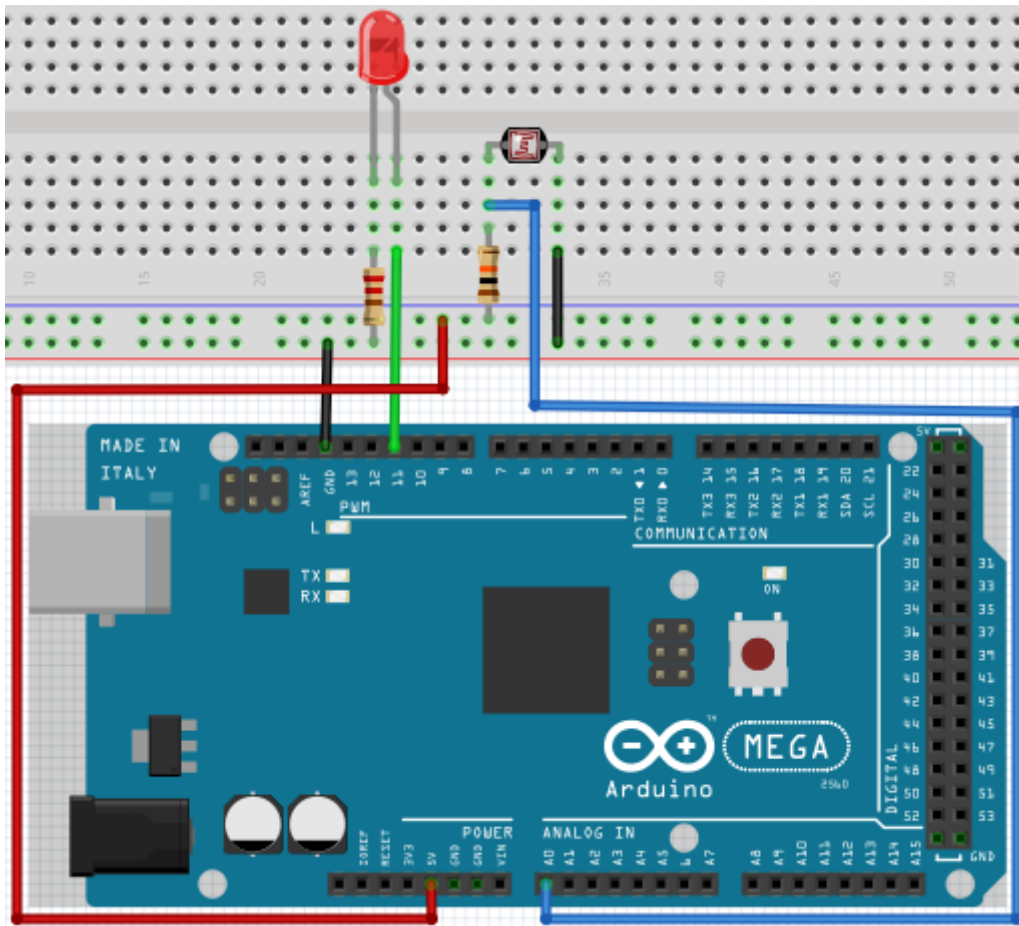
Light dependent resistors are usually used for light measurement, light control and for photovoltaic-conversion.

We will use this effect to control the light intensity of a LED.



Hardware	Amount
Mega2560 board	1
USB cable	1
Red M5 LED	1
Light dependent resistor	1
220Ω resistor	1
10kΩ resistor	1
Breadboard	1
Breadboard cable	5





```

int potpin=0;           // initialises analog PIN 0 an
int ledpin=11;         // initialises digital PIN 11. Ausgang
int val=0;             // initialises variable „Val“
void setup()
{
  pinMode(ledpin,OUTPUT); // sets Pin 11 to output
  Serial.begin(9600);     // sets baudrate to „9600“
}
void loop()
{
  val=analogRead(potpin); // reads analog value of the sensor
  Serial.println(val);     // shows analog value in „Val“
  analogWrite(ledpin,val); // turns on LED and sets brightness
  delay(10);              // waits 0,01 seconds
}

```

## 5.12 Project 12: Flamesensor

The Flamesensor (infrared receiving triode) is specially used by robots to find flamesources.

This sensor has a high sensitivity to flames because infrared rays are very sensitive to fire.

It has a specially build Infared-Receiverpipe to detect fire and convert the light of the flames to a signal.

These signals are processed by the central processor.



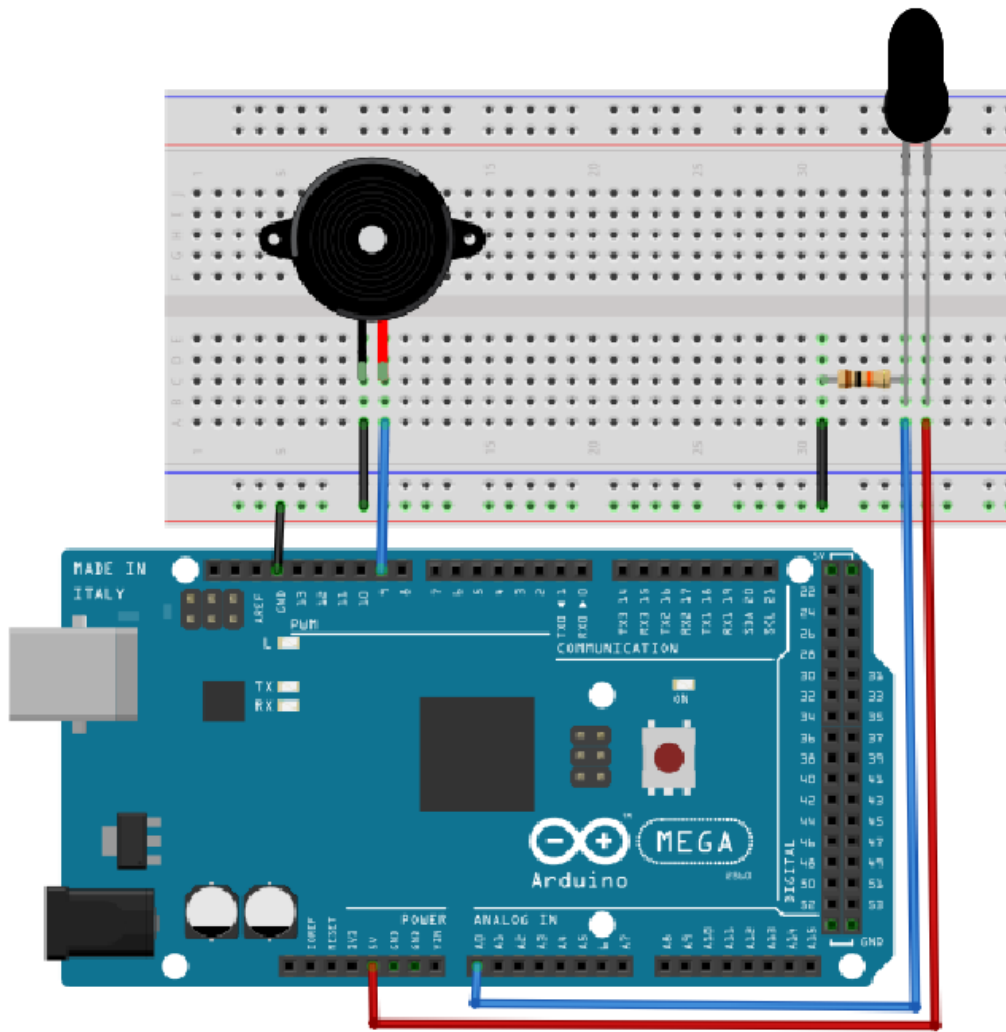
If the sensor is approaching a fire, the analog voltage is changing.

If no fire is close, the voltage is by roughly 0.3V.

If a fire is close, the voltage is at 1V.

The higher the voltage, the closer the fire.

Hardware	Amount
Mega2560 board	1
USB cable	1
Flamesensor	1
Buzzer	1
10kΩ Resistor	1
Breadboard	1
Breadboard cable	6



```

int flame=0; // selects analog PIN 0 for sensor
int Beep=9; // selects digital PIN9 for buzzer
int val=0; // initialises variable
void setup()
{
  pinMode(Beep,OUTPUT); // sets buzzer PIN to „output“
  pinMode(flame,INPUT); // sets flame sensor PIN to „input“
  Serial.begin(9600); // sets baudrate to „9600“
}
void loop()
{
  val=analogRead(flame); // reads the sensors analog value
  Serial.println(val); // prints the value
  if(val>=600) // buzzer beeps if value over 600
  {
    digitalWrite(Beep,HIGH);
  }else
  {
    digitalWrite(Beep,LOW);
  }
  delay(500);
}

```

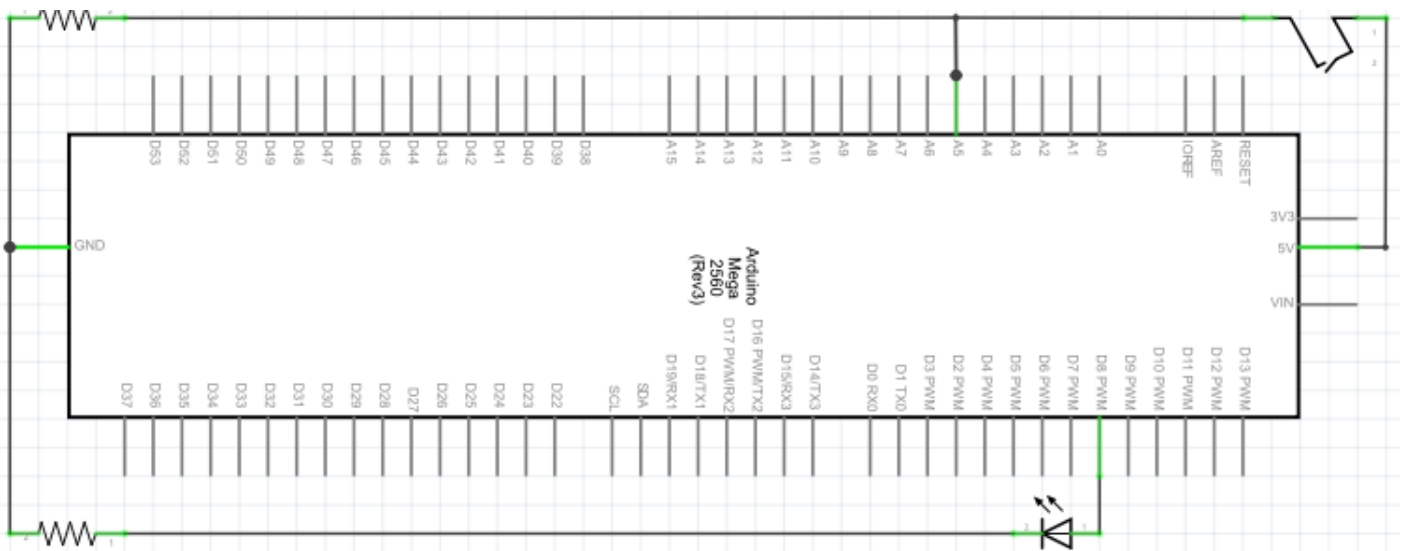
## 5.13 Project 13: Tilt switch

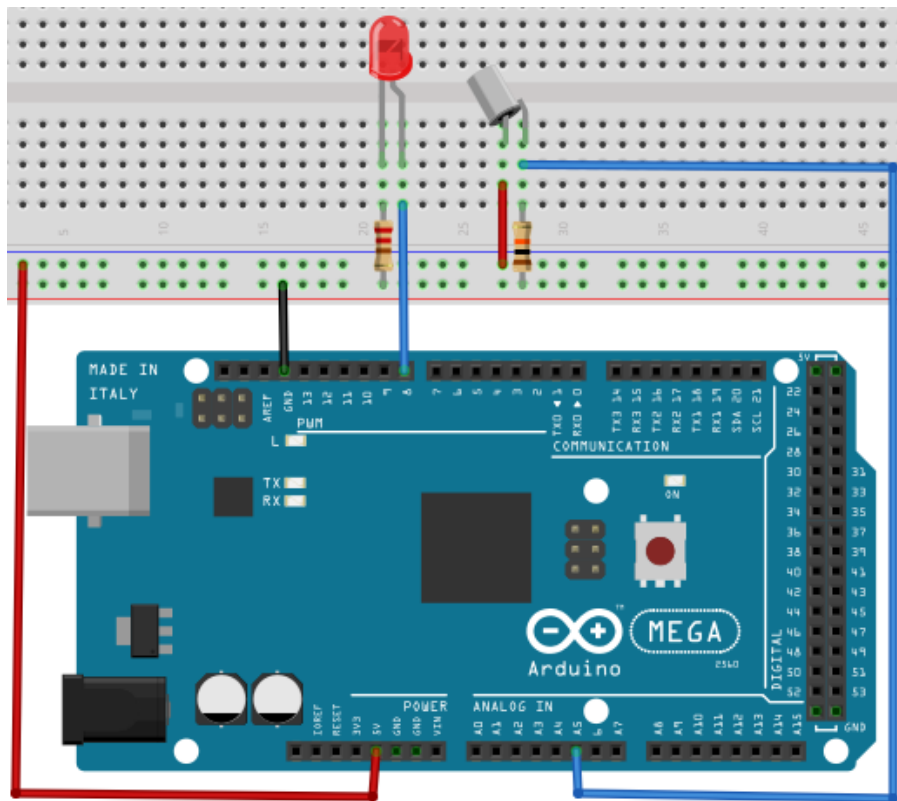
We are going to use the tilt switch to control the on and off switch of a LED. The switch is on if the tilt switch is below a horizontal position.

We can use the voltage value of the analog port, on which the tilt switch is connected to, to measure the position of the switch.



Hardware	Amount
Mega2560 board	1
USB cable	1
Tilt switch	1
Red M5 LED	1
220Ω Resistor	1
Breadboard	1
Breadboard cable	5





```

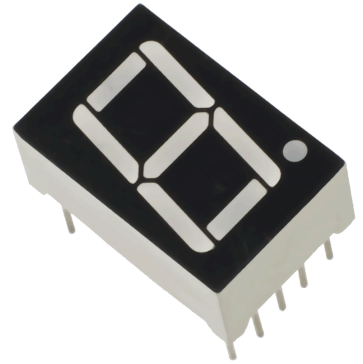
void setup()
{
    pinMode(8,OUTPUT);           // sets digital PIN 8 to „output“
}
void loop()
{
    int i;                       // defines variable i
    while(1)
    {
        i=analogRead(5);        // reads the voltage value on analog PIN 5
        if(i>512)               // if higher then 512 (= 2.5V)
        {
            digitalWrite(8,LOW); // turn on LED
        }
        else                    // otherwise
        {
            digitalWrite(8,HIGH); // turn off LED
        }
    }
}

```

Wird das Breadboard bis zu einem bestimmten Grad geneigt, so schaltet sich die LED ein. Falls es keine Neigung gibt, bleibt die LED aus.

## 5.14 Project 14: 1-digit LED segment display

The LED segment displays are very common displays for numeric informations. They are often used in electric ovens, washing machines, water-temperature displays and electric clocks.



The LED segment display is a semi-conductor and a light emitting devie. Its base-unit is a LED:

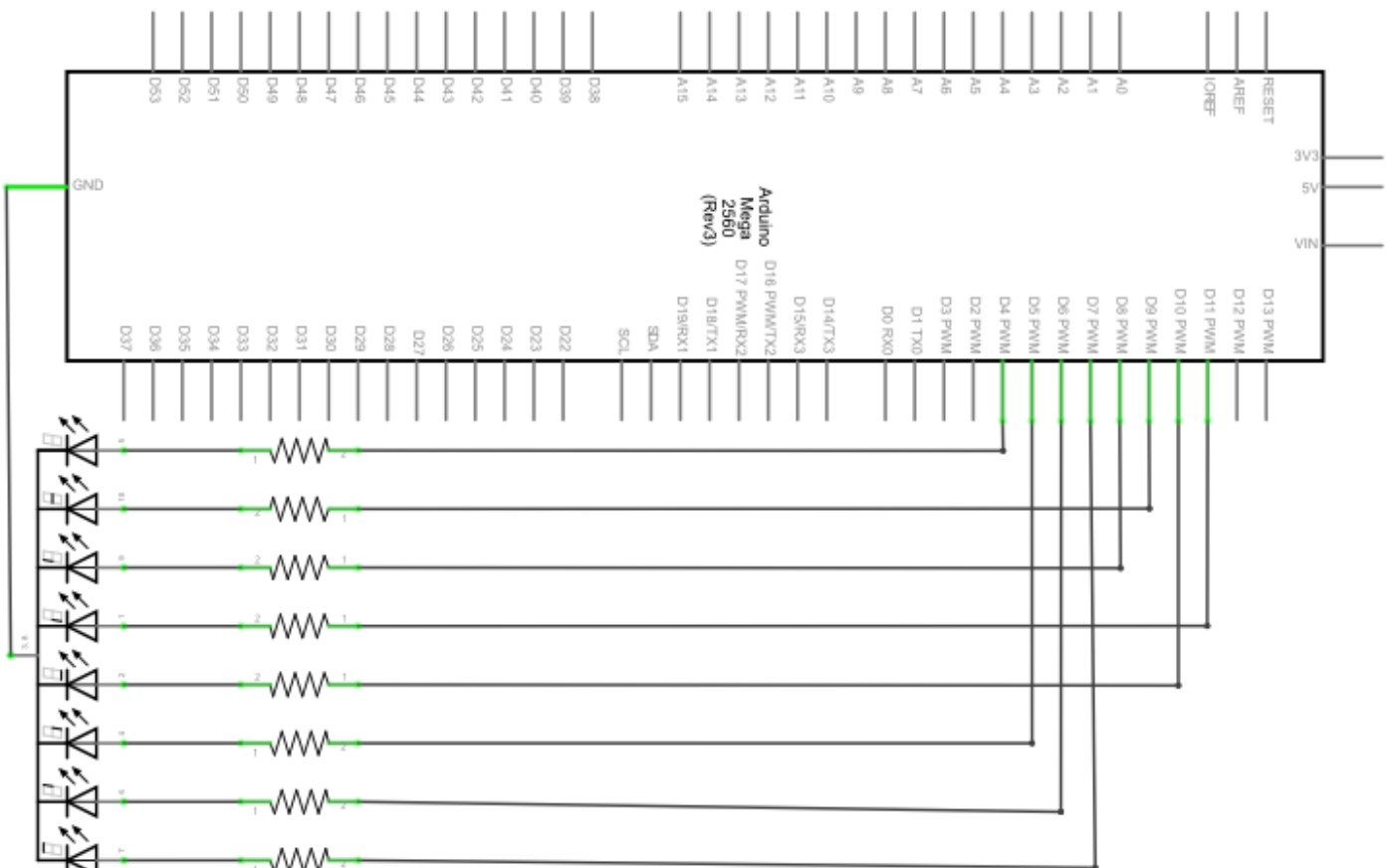
The segment display can be devided in a 7-segement and a 8-segment display. The 8-segment display contains one more LED-unit (for the decimal dot).

Depending on the wiring, the displays can also be devided in displays with common anode and common cathode.

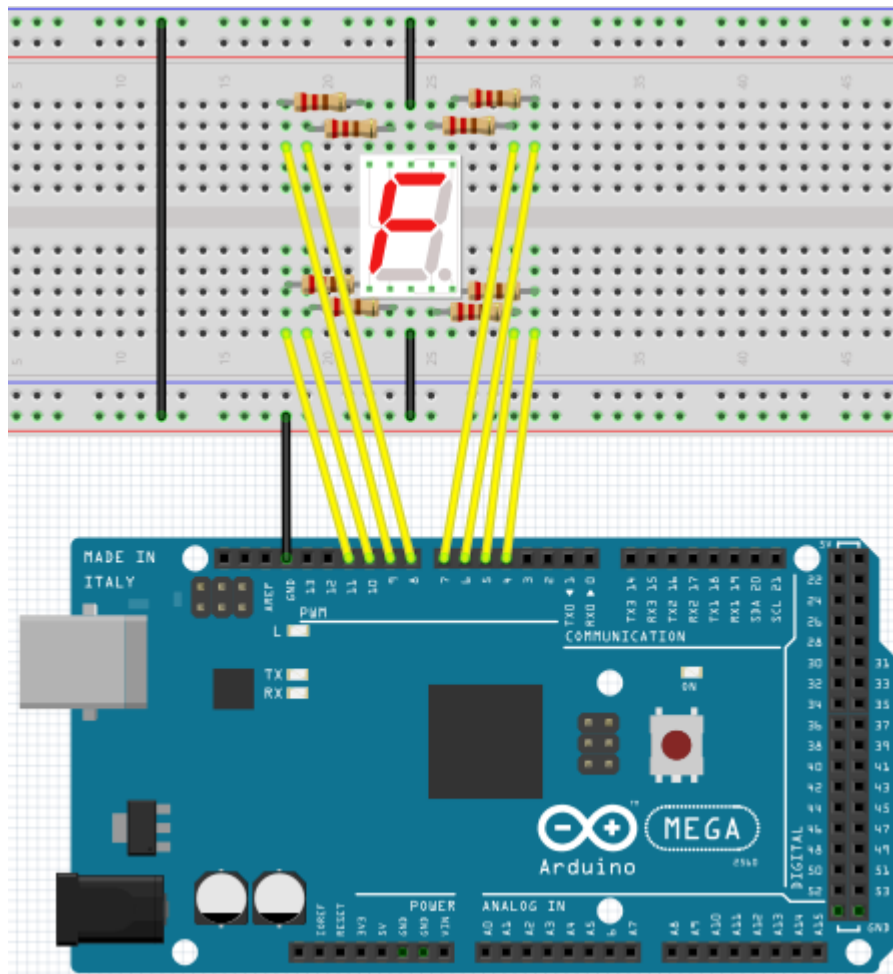
The display with common anode combines every anodes to one common anode (COM).

If you are using a display with a common anode, the common anode (COM) has to be connected to +5V. If the cathode-level of a segment is low, the segment is activated.

If you are using a display with a common cathode, the common cathode (COM) has to be connected to GND.



Hardware	Amount
Mega2560 board	1
USB cable	1
8-Segment display	1
220Ω Resistor	8
Breadboard	1
Breadboard cabel	12





```

// sets the IO PIN for every segment
int a=7; // digital PIN 7 for segment a
int b=6; // digital PIN 6 for segment b
int c=5; // digital PIN 5 for segment c
int d=10; // digital PIN 10 for segment d
int e=11; // digital PIN 11 for segment e
int f=8; // digital PIN 8 for segment f
int g=9; // digital PIN 9 for segment g
int dp=4; // digital PIN 4 for segment dp
void digital_0(void) // displays number 5
{
    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) // displays number 1
{
    unsigned char j;
    digitalWrite(c,HIGH); // sets level for PIN 5 to "high"
    digitalWrite(b,HIGH); // turns off 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) // displays 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)          // displays 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)          // displays 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)          // displays 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)          // displays 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)          // displays 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);
}

```

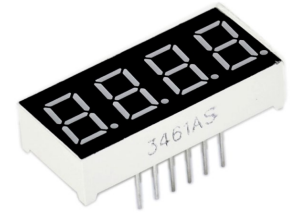
```

void digital_8(void)          // displays number 8
{
    unsigned char j;
    for(j=5;j<=11;j++)
        digitalWrite(j,HIGH);
        digitalWrite(dp,LOW);
}
void digital_9(void)        // displays 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;                    // declares a Variable
    for(i=4;i<=11;i++)
        pinMode(i,OUTPUT);    // sets PIN 4-11 to "output"
}
void loop()
{
    while(1)
    {
        digital_0();          // displays number 0
        delay(1000);          // waits a second
        digital_1();          // displays number 1
        delay(1000);          // waits a second
        digital_2();          // displays number 2
        delay(1000);          // waits a second
        digital_3();          // displays number 3
        delay(1000);          // waits a second
        digital_4();          // displays number 4
        delay(1000);          // waits a second
        digital_5();          // displays number 5
        delay(1000);          // waits a second
        digital_6();          // displays number 6
        delay(1000);          // waits a second
        digital_7();          // displays number 7
        delay(1000);          // waits a second
        digital_8();          // displays number 8
        delay(1000);          // waits a second
        digital_9();          // displays number 9
        delay(1000);          // waits a second
    }
}

```

## 5.15 Project 15: 4-digit LED segment display

In this project we will use a 4-digit 7-segment LED display. Current limiting resistors are essential for LED displays.

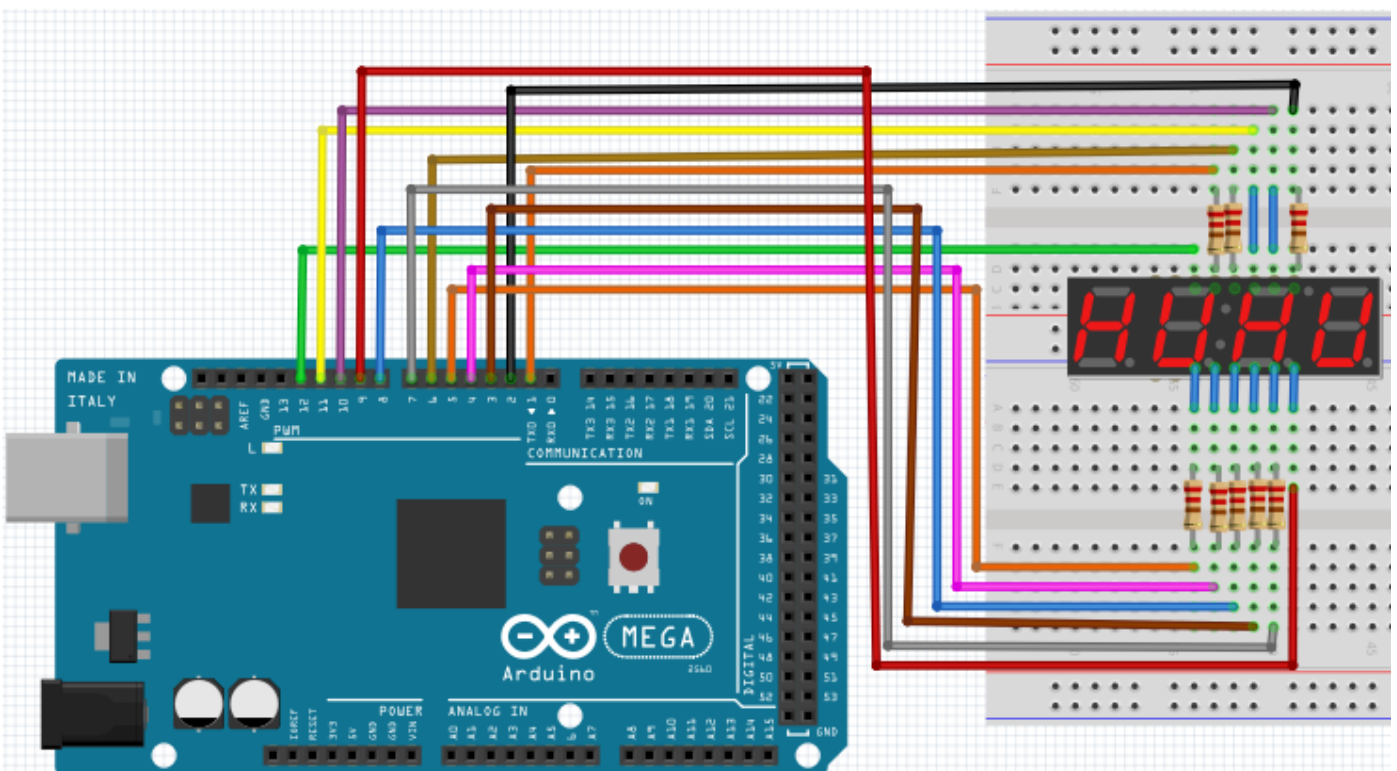


There are two ways of wiring the resistors.

You can either connect one resistor to every anode (4 resistors connected to anode d1-d4) or you can connect one resistor to every PIN.

The first way is needing less resistors but can not keep a constant display brightness.

Hardware	Amount
Mega2560 board	1
USB cable	1
4 digit 7-segment display	1
220Ω Resistor	8
Breadboard	1
Breadboard cable	12



```

// PIN 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;

// PIN for cathode
int d4 = 9;
int d3 = 10;
int d2 = 11;
int d1 = 12;

// sets variable
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 WeiXuan(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 screen
{
    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) // pics 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)
{
    WeiXuan(x);
    pickNumber(Number);
    delay(1);
    Clear() ;                // clears screen
}
```

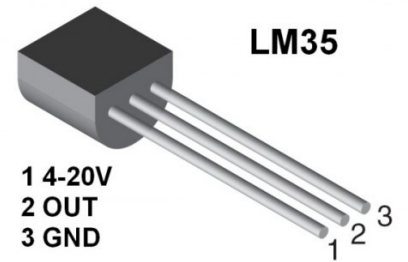
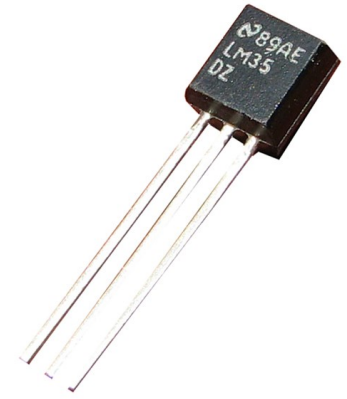
If the code above is fully transferred to the Mega2560, the display is showing "1234".

## 5.16 Project 16: LM35 Temperature-sensor

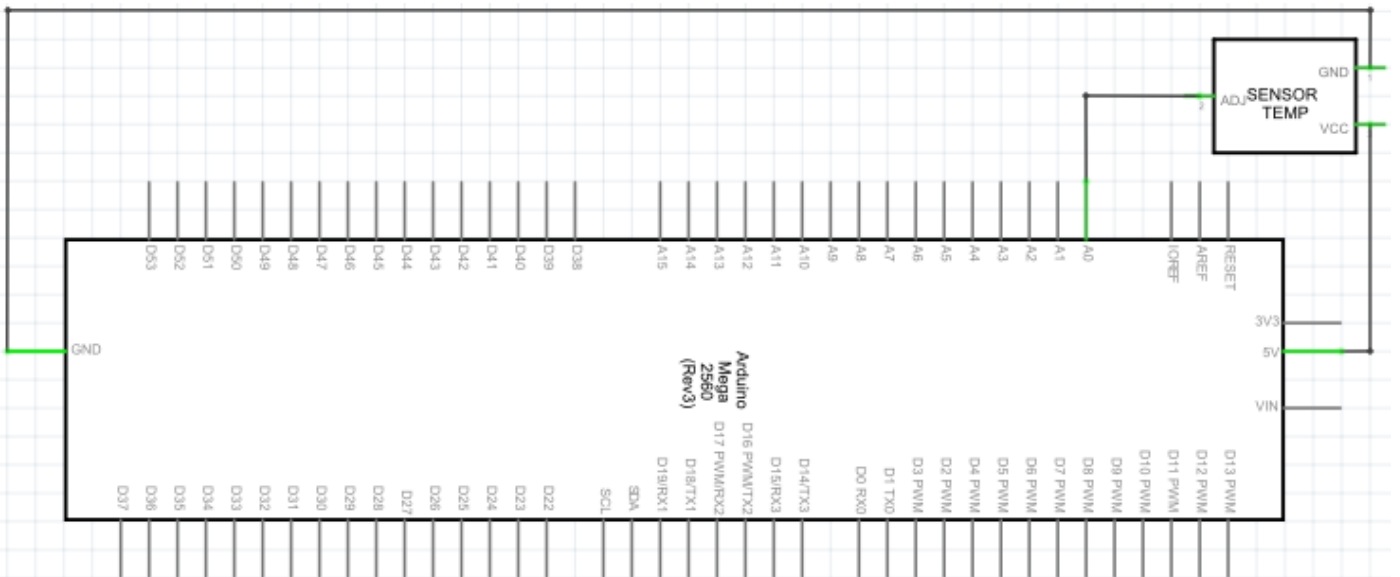
The LM35 is an easy to use temperature sensor.

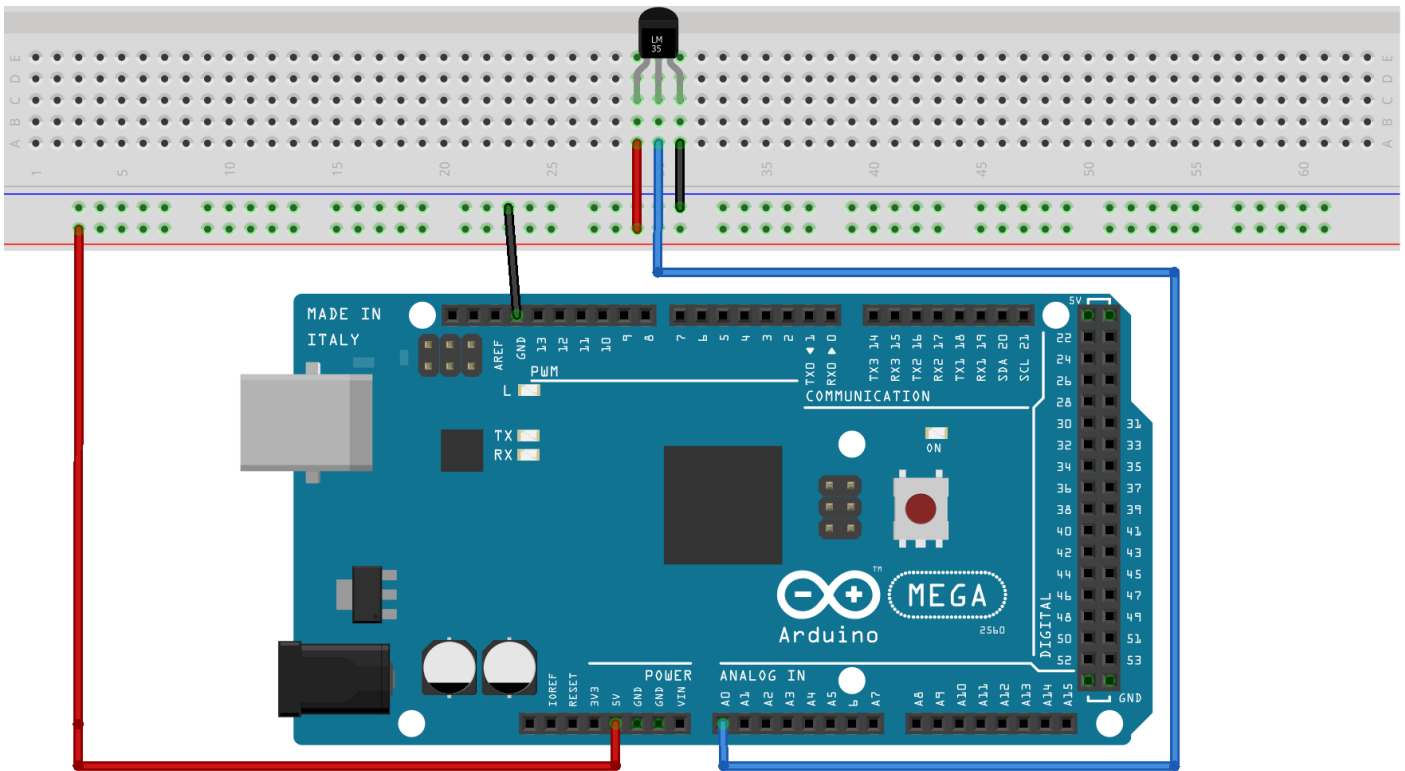
You don't need any other hardware.

The only difficulty is in writing the code which is calculating the readed analog values into celsius temperatures.



Hardware	Amount
Mega2560 board	1
USB cable	1
LM35	1
Breadboard	1
Breadboard cable	5





```

int potPin = 0; // initialises port A0 for sensor

void setup()
{
  Serial.begin(9600); // sets baudrate to "9600"
}
void loop()
{
  int val; // defines variable
  int dat; // defines variable
  val=analogRead(0); // reads analog value from sensor
  dat=(125*val)>>8; // temperature-calculation
  Serial.print("Temp:"); // output starts with "Temp:"
  Serial.print(dat); // prints "dat"-value
  Serial.println(" C"); // prints letter „C“
  delay(500); // waits 0,5 seconds
}

```

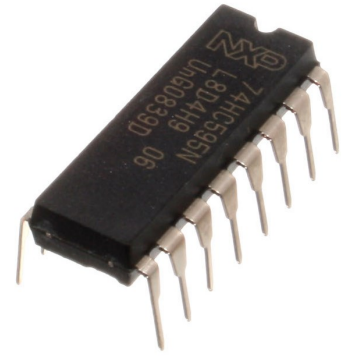
You can now monitor the temperature in the serial monitor.

## 5.17 Project 17: 74HC595

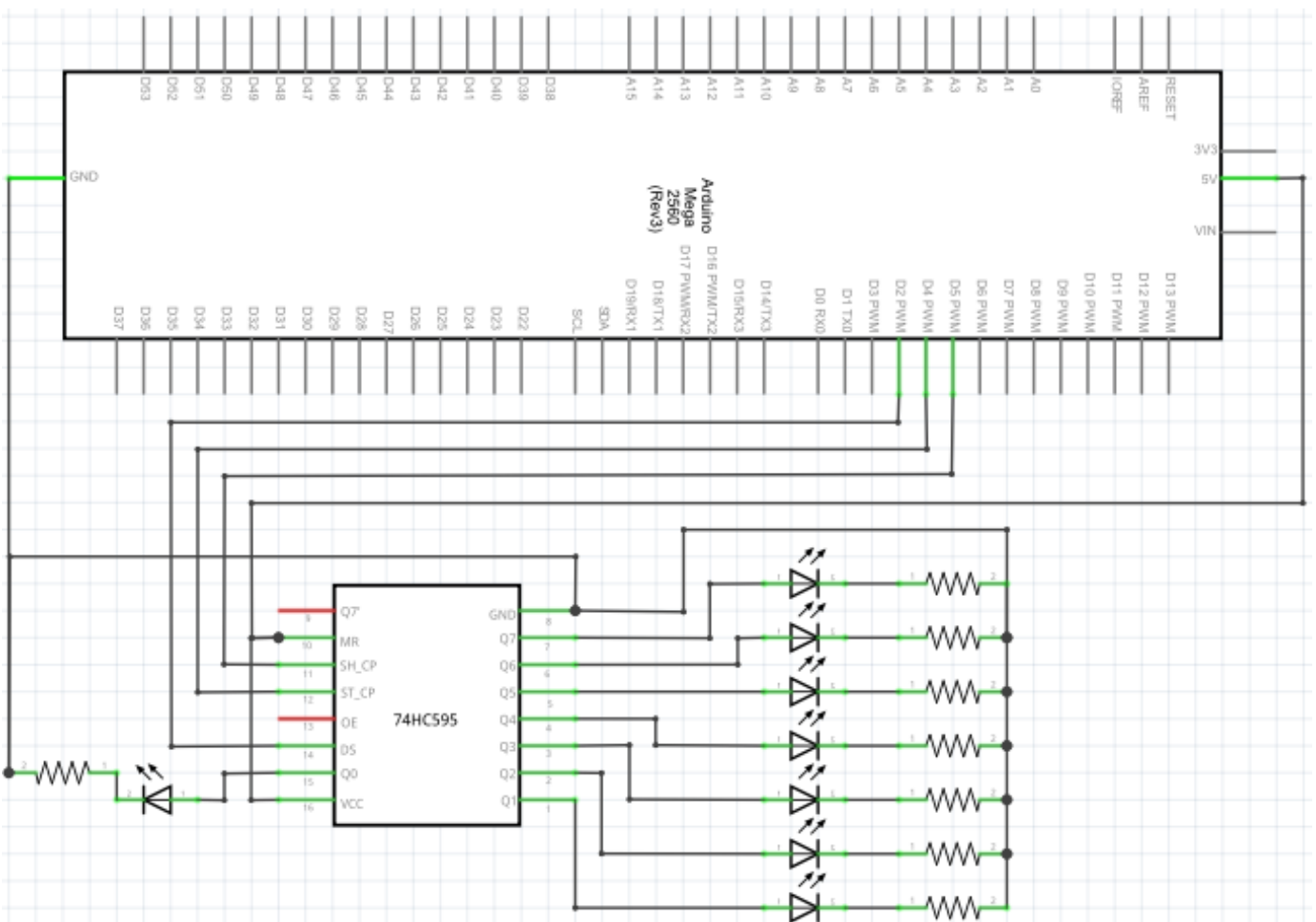
The 74HC595 is a combination of a 8-digit shift register, flag and equipped with a tri-state output.

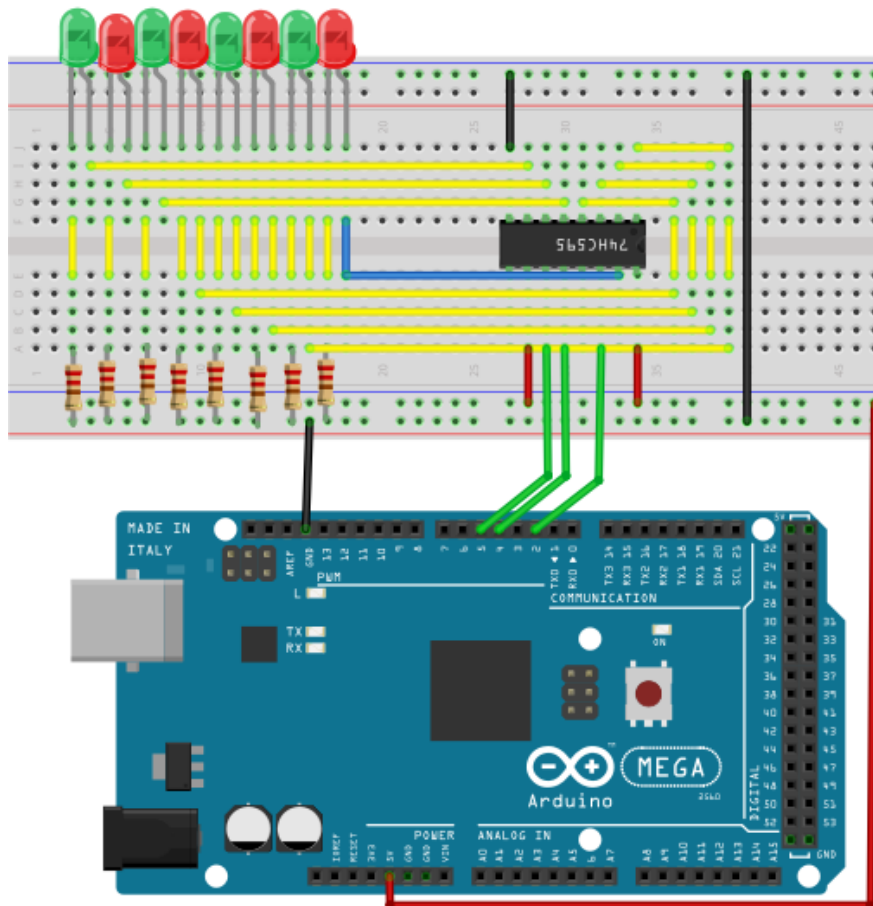
We will use the 74HC595 to operate 8 LEDs in a resource-saving way.

The needed I/O ports are reduced from 8 to 3 ports



Hardware	Amount
Mega2560 board	1
USB cable	1
74HC595 Chip	1
Red M5 LED	4
Green M5 LED	4
220Ω Resistor	8
Breadboard	1
Breadboard cable	37





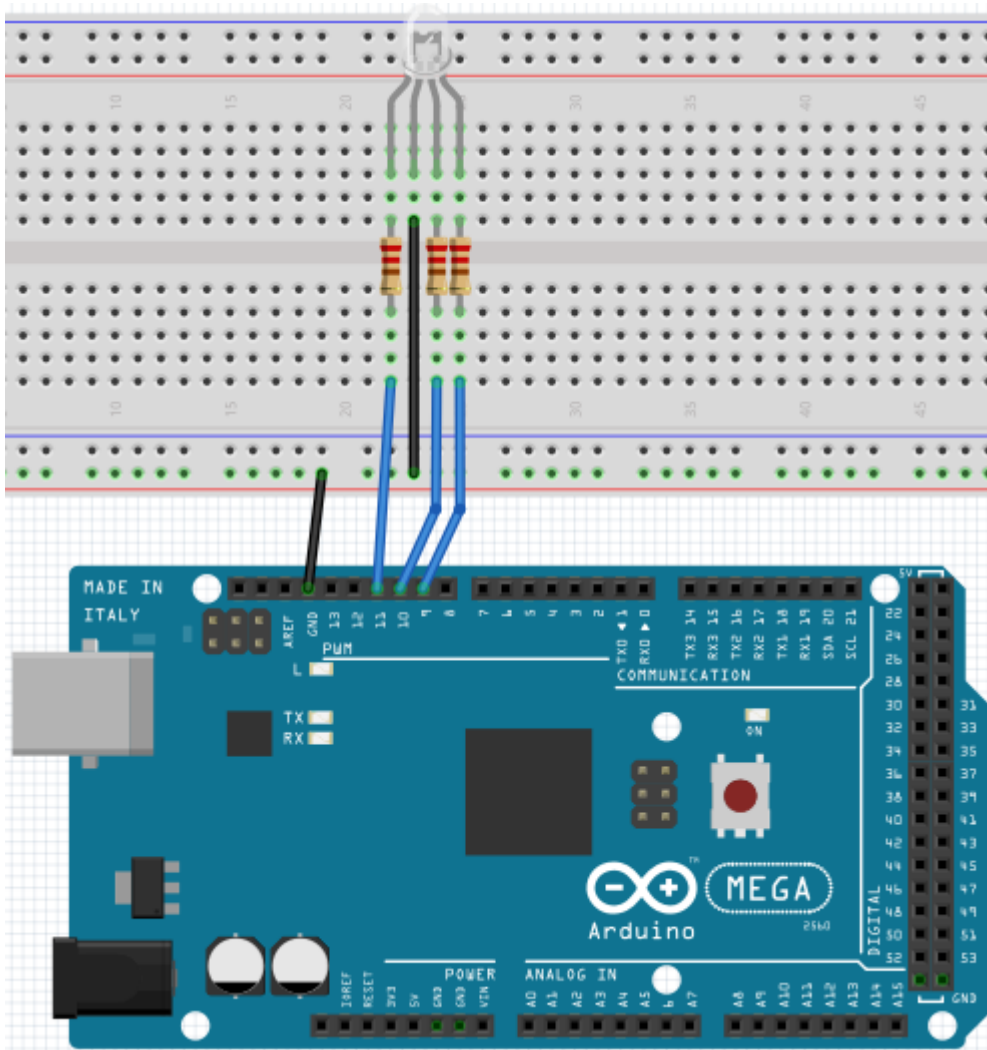
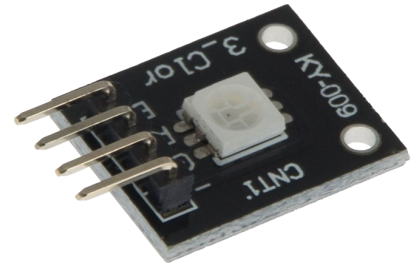
```

int data = 2;           // sets PIN 14 of the 74HC595 to datainput
int clock = 5;         // sets PIN 11 of the 74HC595 to clock PIN
int latch = 4;        // sets PIN 12 of the 74HC595 to 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);           // lock
}

```

## 5.18 Project 18: RGB LED

This diode is controlled by PWM signals and contains a three-coloured system to display colors. The component can be connected directly to the ports of the Mega2560.



```

int redpin = 11;           // selects PIN for red LED
int bluepin =10;          // selects PIN for blue LED
int greenpin =9;          // selects PIN 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);
}

```

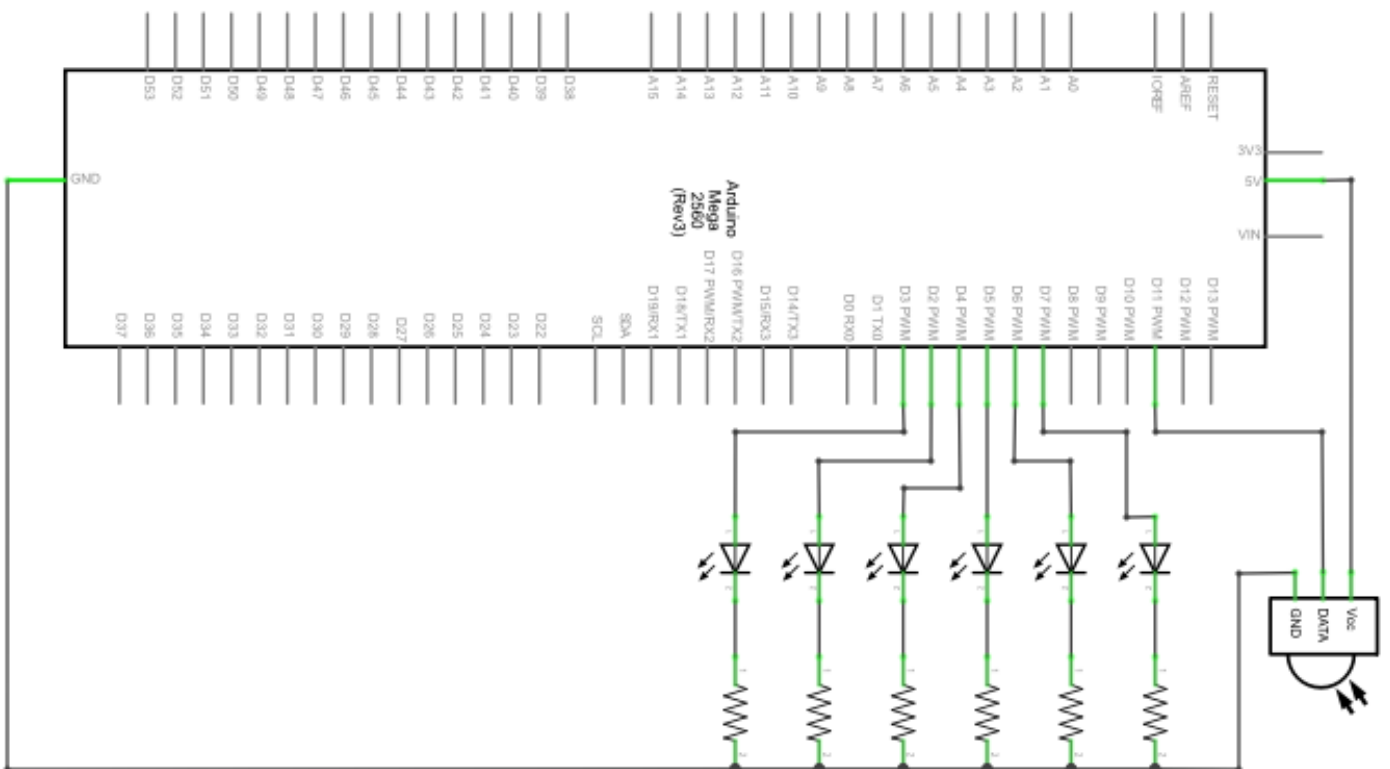


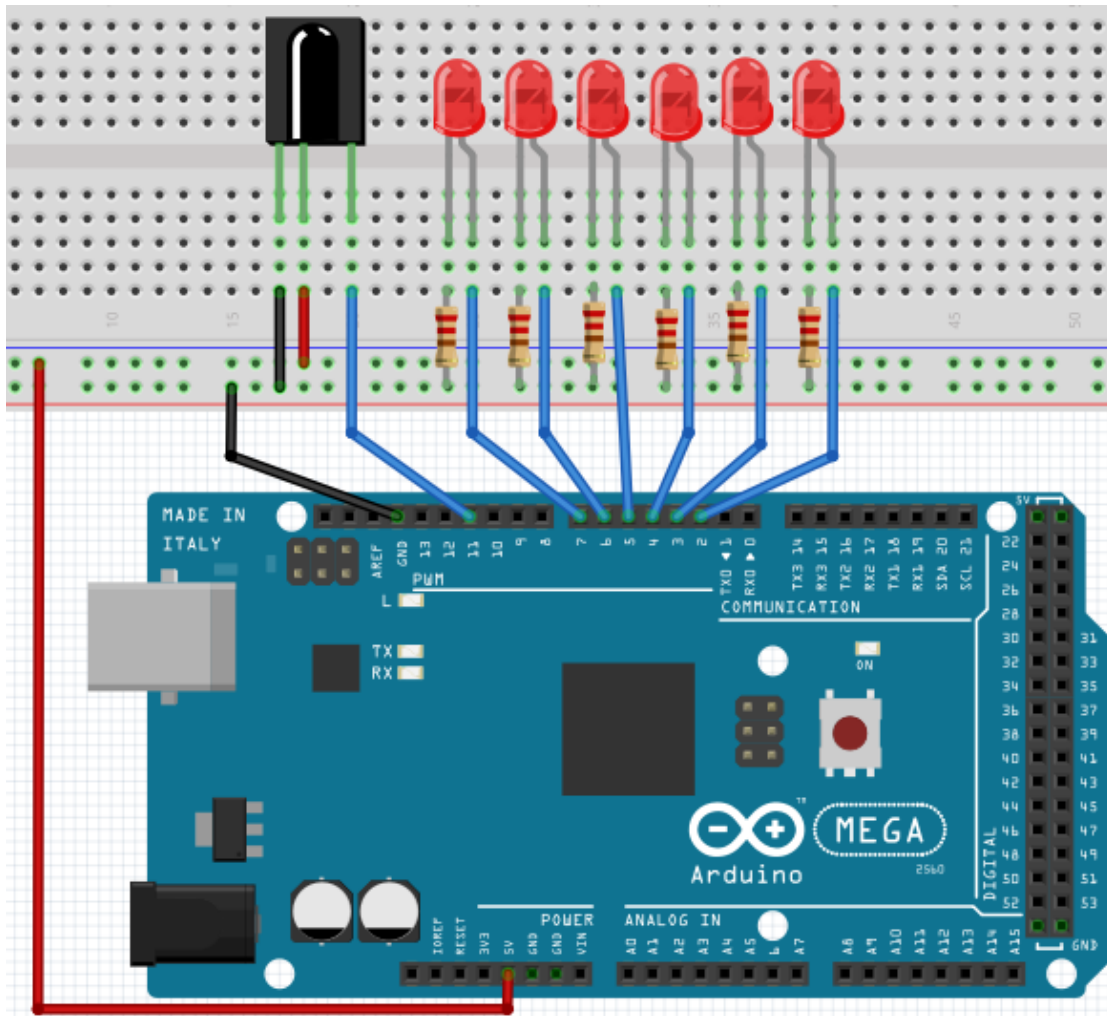
## 5.19 Project 19: Infrared remote-control

The IR-receiver converts the incoming light-signal into a low electric signal. To decode the remote-controls code it is necessary to know the coding method. The NEC-protocol is being used in this project.



Hardware	Amount
Mega2560 board	1
USB cable	1
Infrared-receiver	1
Infrared remote-control	1
Red M5 LED	6
220Ω Resistor	6
Breadboard	1
Breadboard cable	11





Before transferring the code to the Mega2560, please install the **IRremote** library from the Arduino Library Manager.  
Otherwise the project is not going to work.

```

#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 = 0x00FFB047;
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)");
}
Serial.print("Raw (");
Serial.print(count, DEC);
Serial.print("): ");

for (int i = 0; i < count; i++)
{
  if ((i % 2) == 1) {
    Serial.print(results->rawbuf[i]*USECPERTICK, DEC);
  }
  else
  {
    Serial.print(-(int)results->rawbuf[i]*USECPERTICK, DEC);
  }
  Serial.print(" ");
}
Serial.println("");
}

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();
  }
}

```

## 5.20 Project 20: 8x8 LED Matrix

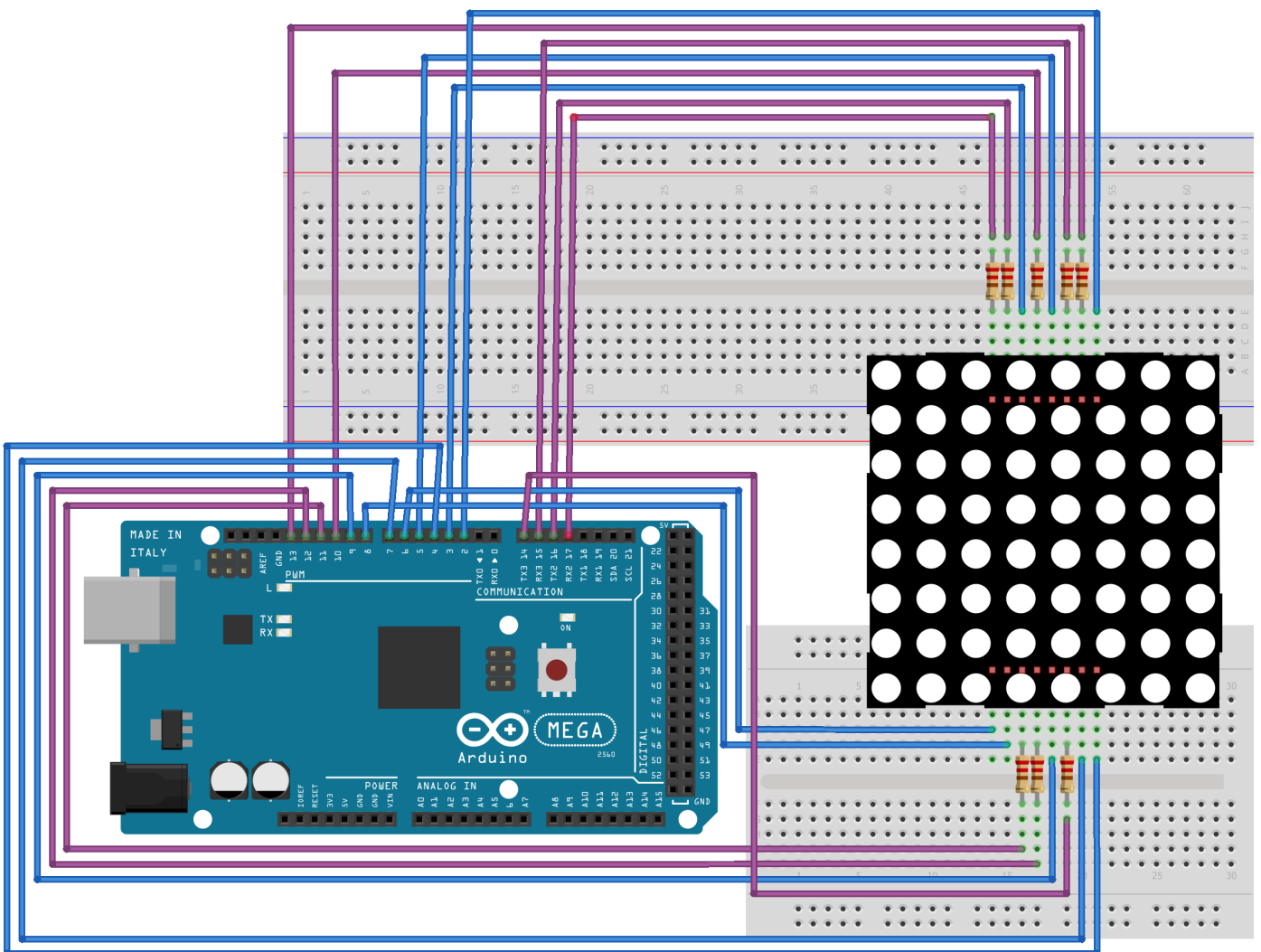
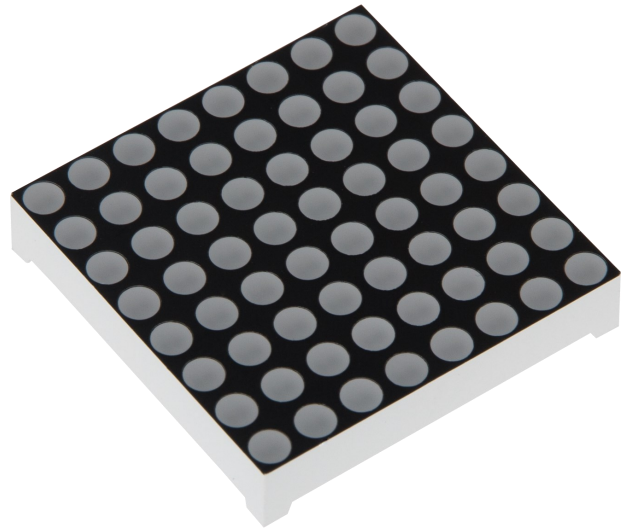
A 8x8 LED matrix contains 64 LEDs.

Every single LED is placed in the intersection of row and column.

The LED will light up if the level of the row is 1 and the level of the column is 0.

For example:

If you want to turn on the first LED, you have to turn PIN 9 to HIGH and PIN 13 to LOW.



```

// setting up array to save the letters of 0

unsigned char Text[]={0x00,0x1c,0x22,0x22,0x22,0x22,0x22,0x1c};
void Draw_point(unsigned char x,unsigned char y)
// show-dot function
{
    clear_();
    digitalWrite(x+2, HIGH);
    digitalWrite(y+10, LOW);
    delay(1);
}
void show_num(void)    // Show-function calls show-dot 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);
}

```