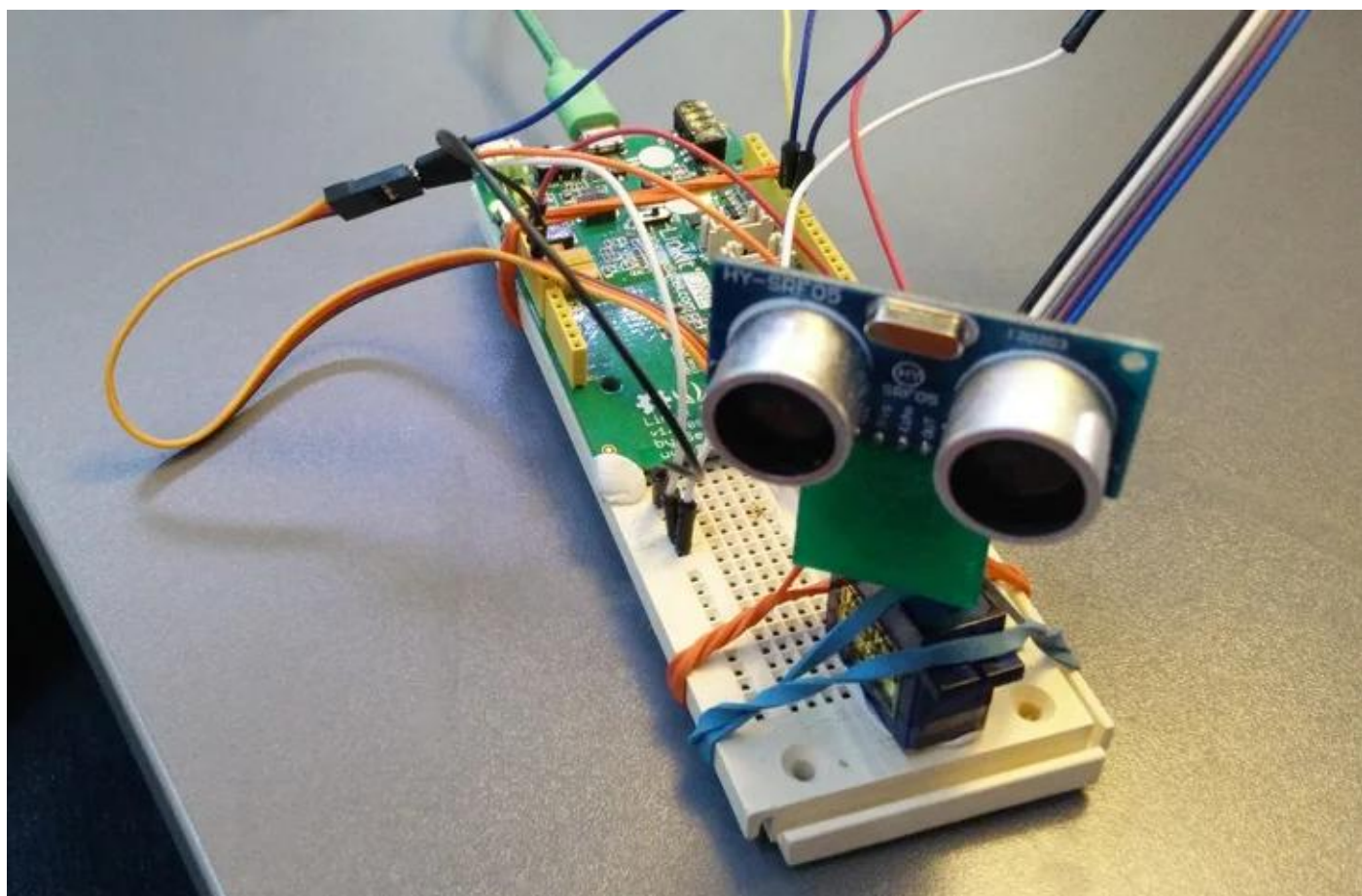
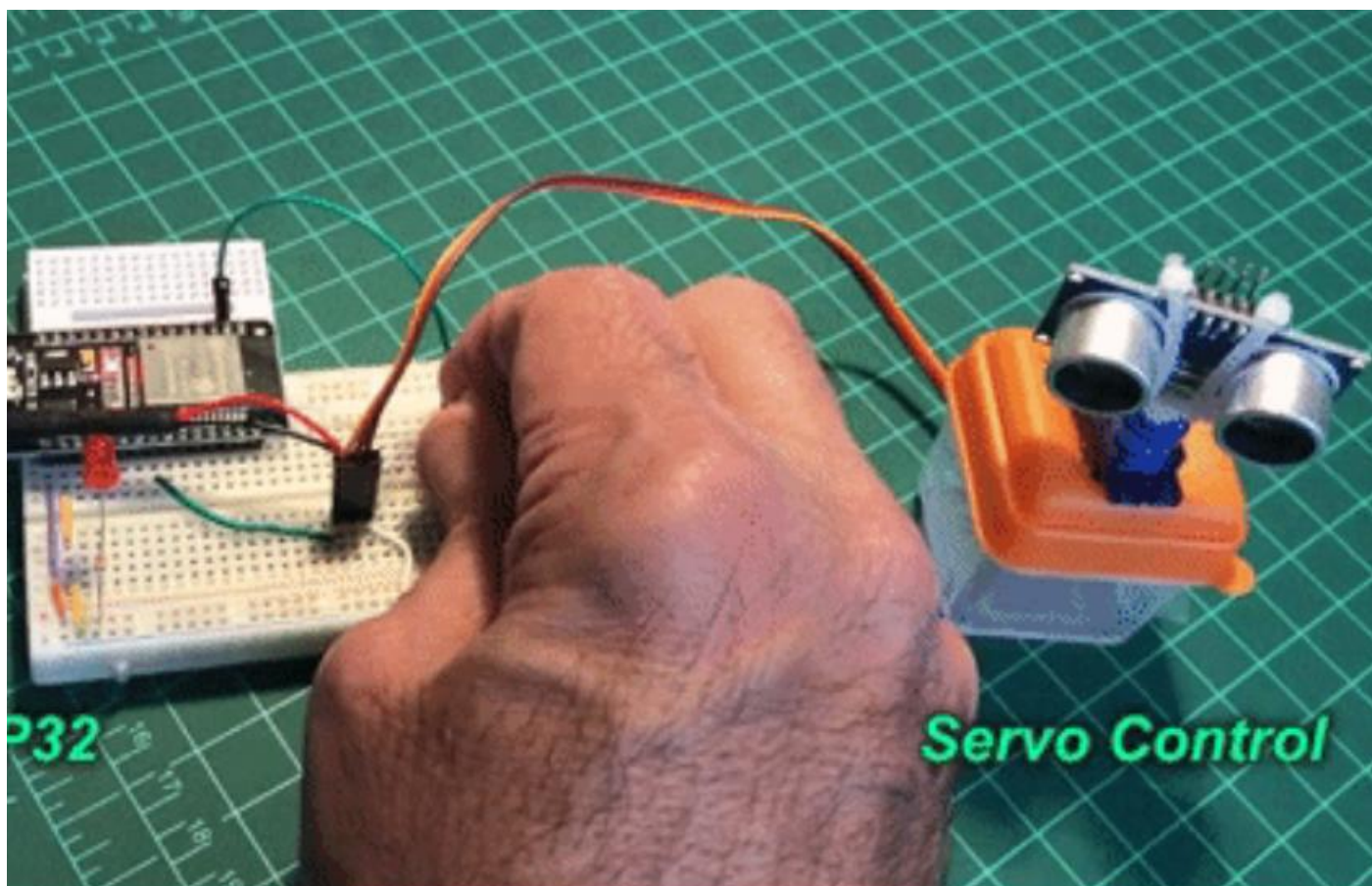
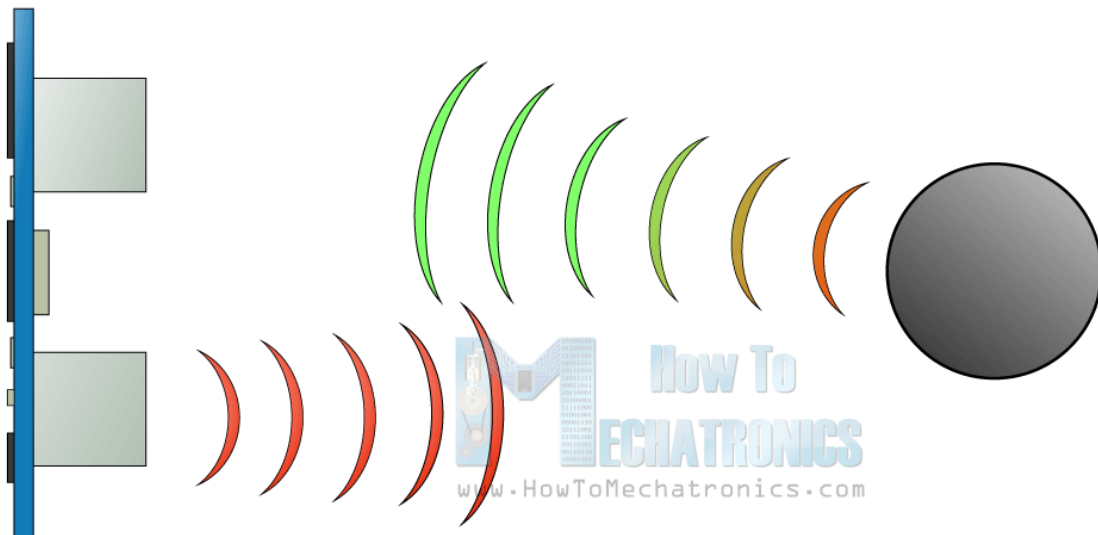


# Ultrasonic SENSOR

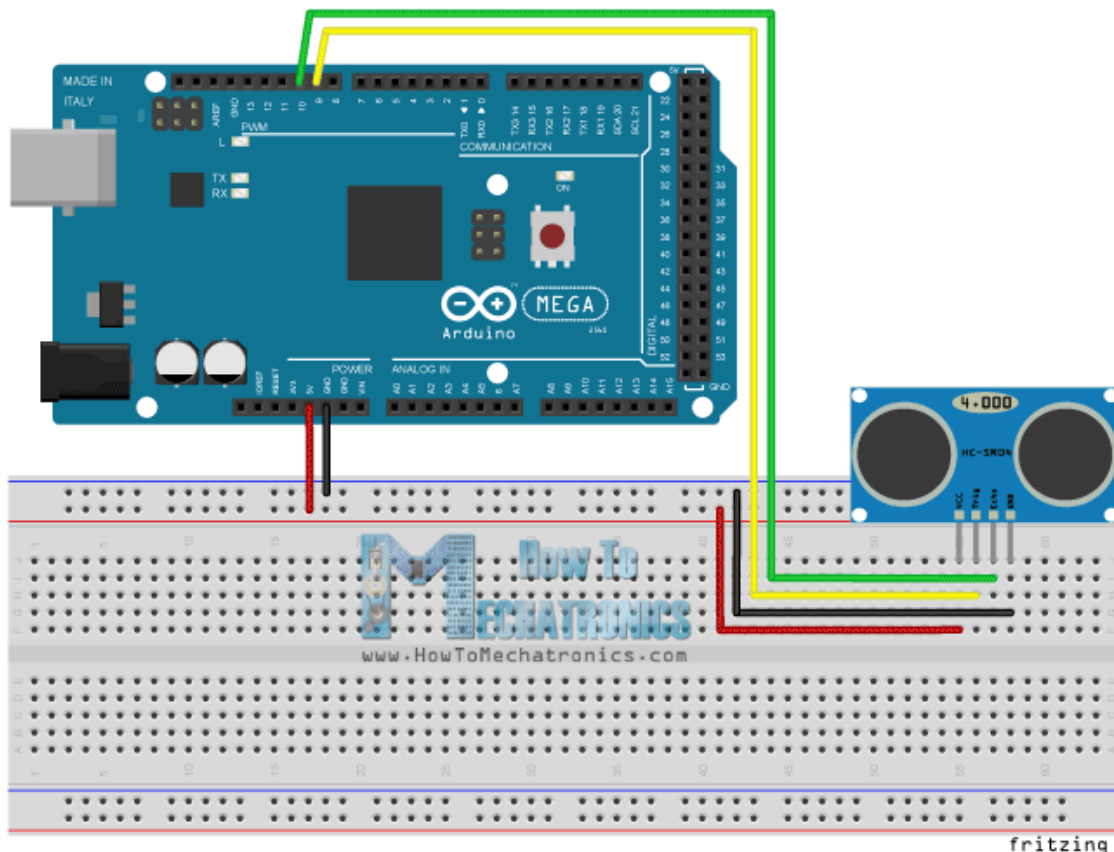


## How It Works – Ultrasonic Sensor

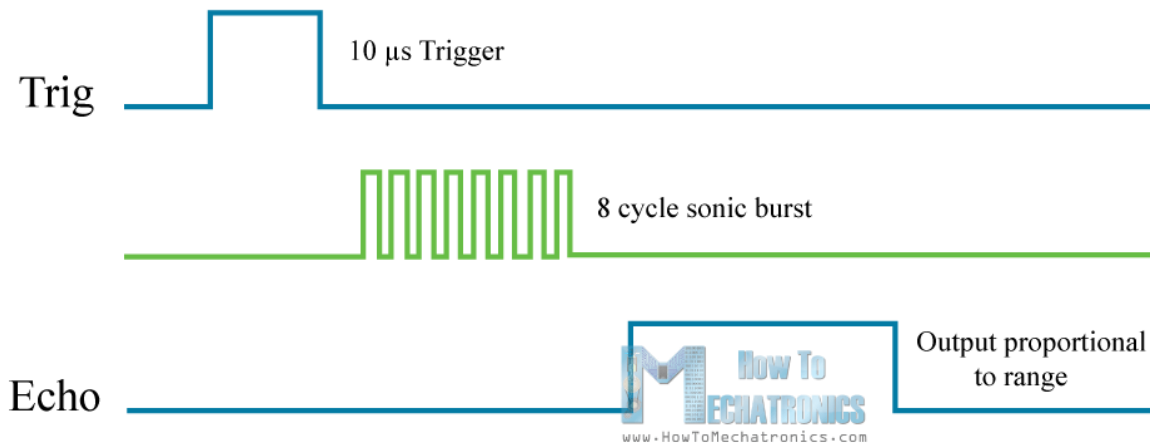
It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance.



The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board.

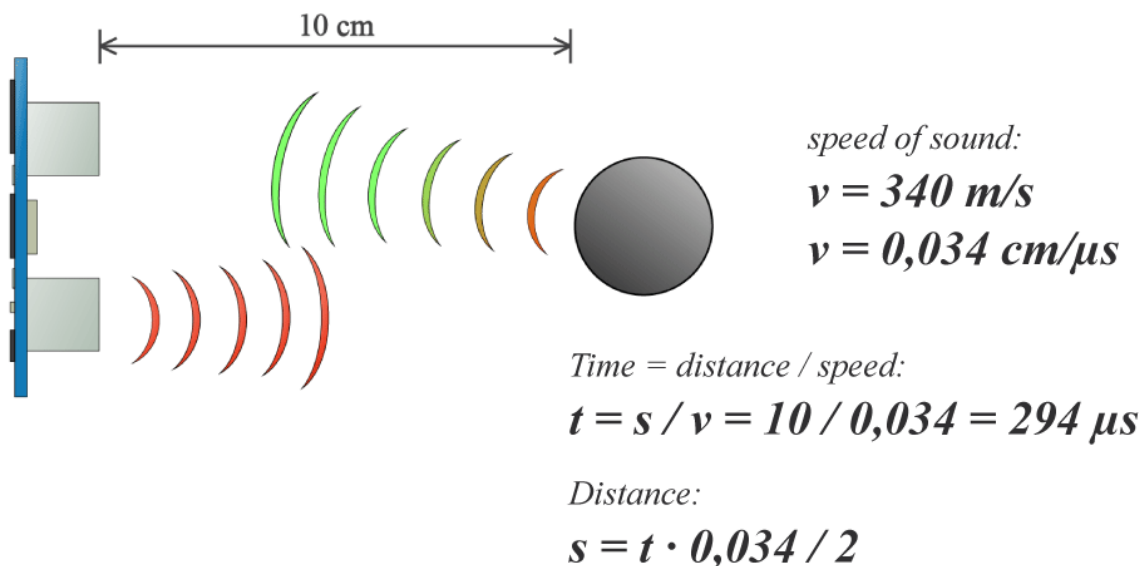


In order to generate the ultrasound you need to set the Trig on a High State for 10  $\mu$ s. That will send out an 8 cycle sonic burst which will travel at the speed sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds the sound wave traveled.



For example, if the object is 10 cm away from the sensor, and the speed of the sound is 340 m/s or 0.034 cm/ $\mu$ s the sound wave will need to travel about 294  $\mu$ s. But what you will get from the Echo pin will be double that number because the sound wave needs to travel forward and bounce backward.

So in order to get the distance in cm we need to multiply the received travel time value from the echo pin by 0.034 and divide it by 2.



## Arduino and HC-SR04 Ultrasonic Sensor Code

First you have to define the Trig and Echo pins. In this case they are the pins number 9 and 10 on the Arduino Board and they are named trigPin and echoPin. Then you need a Long variable, named "duration" for the travel time that you will get from the sensor and an integer variable for the distance.

```
// defines pins numbers
```

```
const int trigPin = 9;
const int echoPin = 10;
// defines variables
long duration;
int distance;
```

In the setup you have to define the trigPin as an output and the echoPin as an Input and also start the serial communication for showing the results on the serial monitor.

```
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
}
```

In the loop first you have to make sure that the trigPin is clear so you have to set that pin on a LOW State for just 2  $\mu$ s. Now for generating the Ultra sound wave we have to set the trigPin on HIGH State for 10  $\mu$ s. Using the `pulseIn()` function you have to read the travel time and put that value into the variable "duration". This function has 2 parameters, the first one is the name of the echo pin and for the second one you can write either HIGH or LOW.

```
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
```

In this case, HIGH means that the `pulseIn()` function will wait for the pin to go HIGH caused by the bounced sound wave and it will start timing, then it will wait for the pin to go LOW when the sound wave will end which will stop the timing. At the end the function will return the length of the pulse in microseconds.

For getting the distance we will multiply the duration by 0.034 and divide it by 2 as we explained this equation previously.

```
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);
```

At the end we will print the value of the distance on the Serial Monitor.

The complete code:

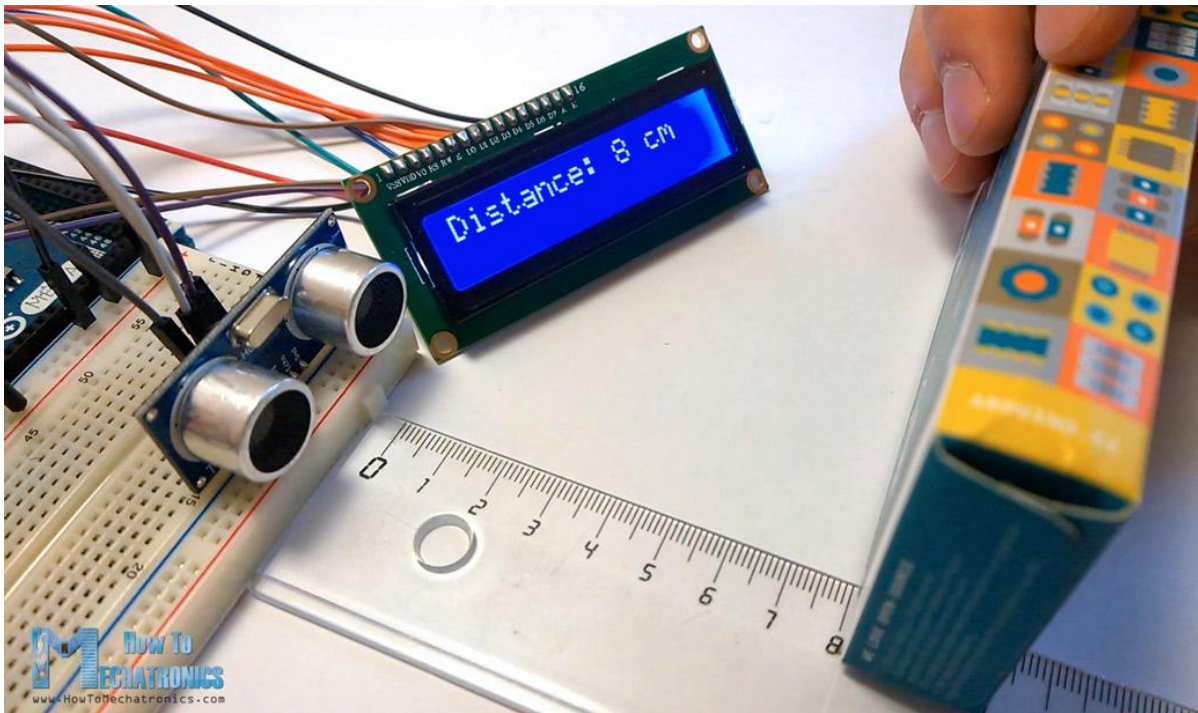
```

// Ultrasonic Sensor HC-SR04 and Arduino Tutorial
// defines pins numbers
const int trigPin = 9;
const int echoPin = 10;
// defines variables
long duration;
int distance;
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
}
void loop() {
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);
}

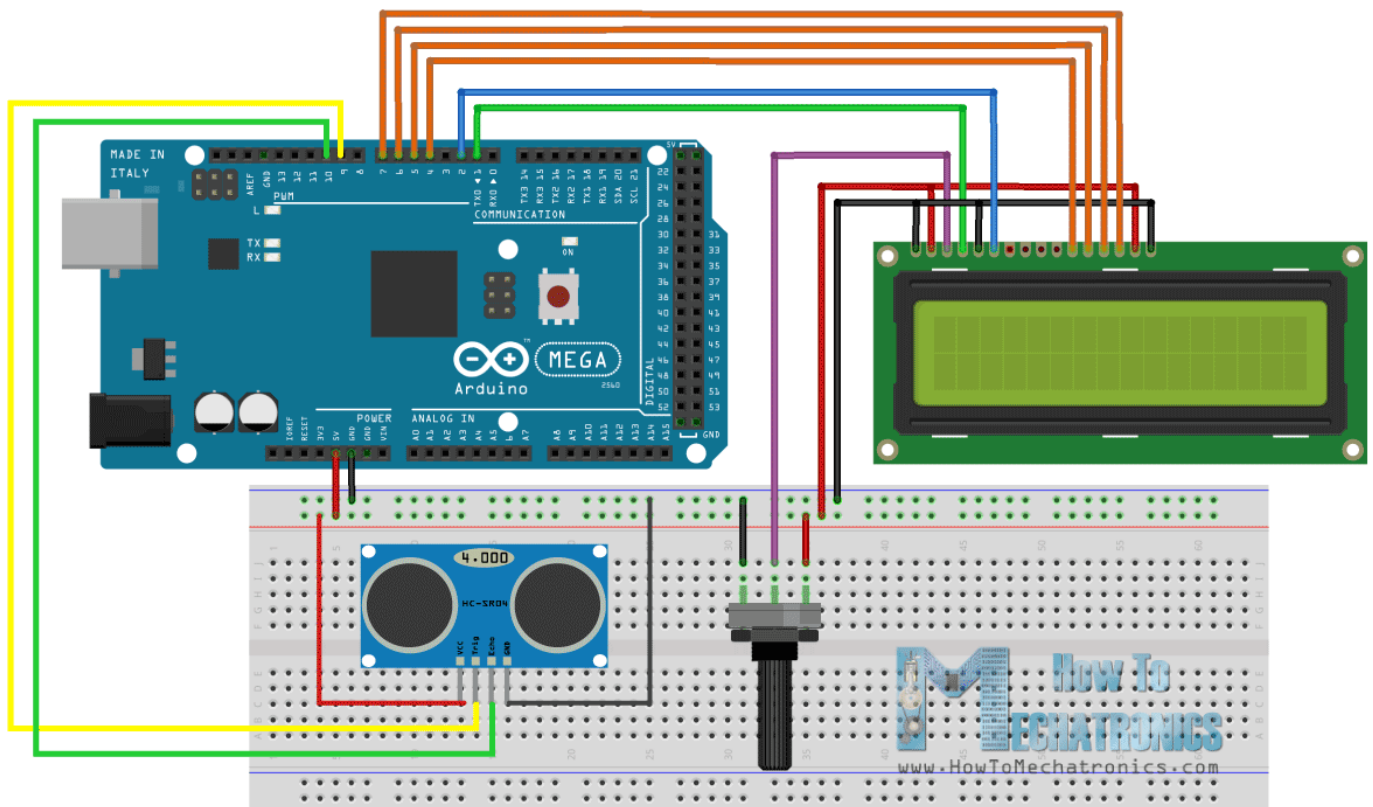
```

## Arduino Ultrasonic Sensor and LCD Display Example

Here's another example how to use the ultrasonic sensor with Arduino and display the results on an LCD.



You can connect the ultrasonic sensor and the LDC as following:



The code measuring the distance is pretty much the same as the basic example. Here, instead of printing the results on the serial monitor we print them on the LCD. If you need more [details how to use and connect an LCD with Arduino](#) you can check my particular tutorial for it.

// Ultrasonic Sensor HC-SR04 and Arduino Tutorial

**#include <LiquidCrystal.h> // includes the LiquidCrystal Library**

LiquidCrystal lcd(1, 2, 4, 5, 6, 7); // Creates an LCD object. Parameters: (rs, enable, d4, d5, d6, d7)

const int trigPin = 9;

const int echoPin = 10;

long duration;

int distanceCm, distanceInch;

void setup() {

lcd.begin(16,2); // Initializes the interface to the LCD screen, and specifies the dimensions (width and height) of the display

pinMode(trigPin, OUTPUT);

pinMode(echoPin, INPUT);

}

void loop() {

digitalWrite(trigPin, LOW);

delayMicroseconds(2);

digitalWrite(trigPin, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin, LOW);

duration = pulseIn(echoPin, HIGH);

distanceCm = duration\*0.034/2;

distanceInch = duration\*0.0133/2;

lcd.setCursor(0,0); // Sets the location at which subsequent text written to the LCD will be displayed

lcd.print("Distance: "); // Prints string "Distance" on the LCD

lcd.print(distanceCm); // Prints the distance value from the sensor

lcd.print(" cm");

delay(10);

lcd.setCursor(0,1);

lcd.print("Distance: ");

lcd.print(distanceInch);

lcd.print(" inch");

delay(10);

}