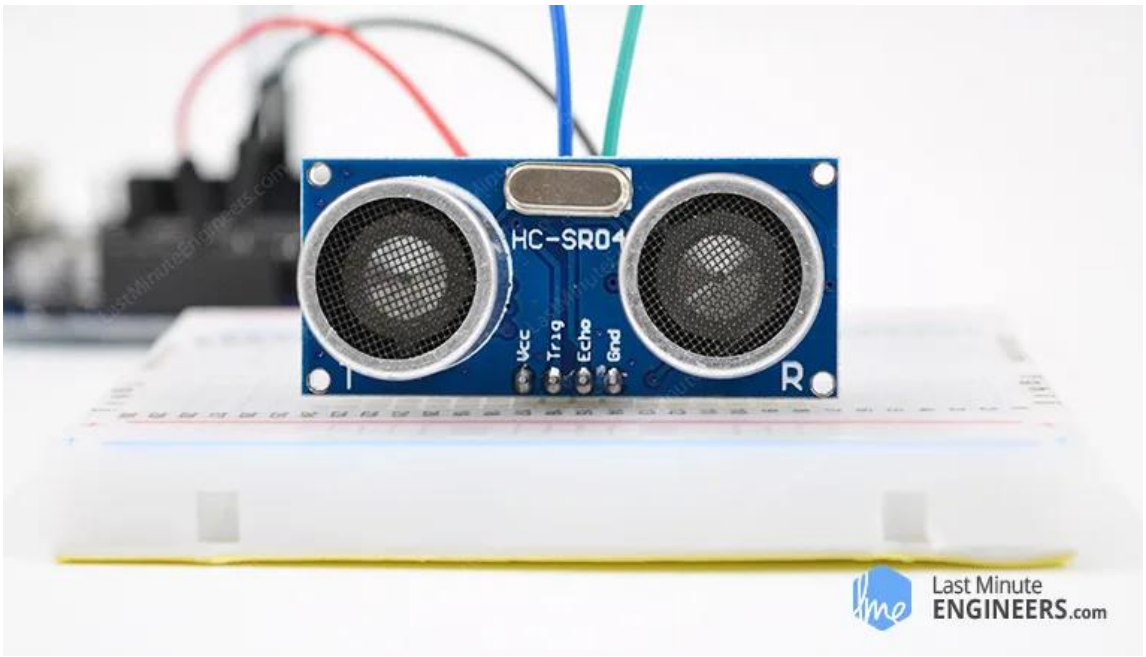
ULTRASONIC SENSOR



Whether you're building a robot that needs to avoid obstacles, an automatic door that opens when someone approaches, a parking assistant that helps you park your car without hitting the wall, or even a smart measuring device to replace your tape measure, the HC-SR04 is a fun and useful tool to add to your projects!

This sensor is popular among hobbyists and makers for several good reasons. It uses very little power, making it perfect for battery-powered projects. It's also affordable—you can usually find these sensors for just a few dollars. Best of all, it's super easy to connect to an Arduino or other microcontrollers.

In this tutorial, we'll explore how the HC-SR04 sensor works, how to connect it to an Arduino, and how to write a simple program to measure distances with it.

So, let's get started and give your next Arduino project bat-like powers!

HC-SR04 HARDWARE OVERVIEW

The HC-SR04 ultrasonic distance sensor consists of two ultrasonic transducers working together. One acts as a transmitter, changing electrical signals into 40 kHz ultrasonic sound pulses. The other works as a receiver, listening for these pulses after they bounce back from an object.

When the receiver detects these returning sound waves, it creates an output signal. The length of this signal is directly related to how far away the object is. By measuring this signal length, your Arduino can calculate the exact distance to the object.

This sensor is perfect for measuring distances without touching anything! It can detect objects between 2 cm and 400 cm away (about 13 feet) with impressive accuracy of about 3 millimeters.

Since the sensor runs on 5 volts, you can easily connect it directly to an Arduino or any other microcontroller that uses 5V logic. This makes it a simple and versatile component to add to all kinds of projects!

TECHNICAL SPECIFICATIONS

Here are the specifications:

Operating Voltage	DC 5V
Operating Current	15mA
Operating Frequency	40KHz
Max Range	4m
Min Range	2cm
Ranging Accuracy	3mm
Measuring Angle	15 degree
Trigger Input Signal	10µS TTL pulse
Dimension	45 x 20 x 15mm

HC-SR04 ULTRASONIC SENSOR PINOUT

Now, let's take a closer look at the pinout of the HC-SR04 Ultrasonic Sensor and what each pin does:

VCC is the power pin for the sensor. You can connect this to the 5V output from your Arduino.

Trig (Trigger) is a signal input pin. When you want the sensor to measure distance, you pull this pin HIGH for 10 microseconds. When this pin receives that signal, the sensor responds by sending out 8 pulses of ultrasonic sound waves at 40 kHz.

Echo is a signal output pin. After the sensor sends out sound waves, this pin goes HIGH. The sensor then waits for those waves to bounce off an object and return. During this waiting period, the Echo pin stays HIGH. As soon as the sound waves bounce back and reach the sensor, the Echo pin goes LOW. The amount of time the Echo pin stays HIGH directly relates to how far away the object is. By measuring this time, your Arduino can calculate the exact distance to the object.

GND is the ground connection. Make sure to connect this to the ground pin of your Arduino to complete the electrical circuit.

CALCULATING THE DISTANCE

The width (duration) of the received pulse is what we use to figure out the distance to the object. We can calculate this using the distance-speed-time equation you might remember from science class.

Distance = Speed x Time

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Let's look at an example: Say we have an object somewhere in front of the sensor, and we receive a pulse that lasts 500 microseconds (µs) on the echo pin. Here's how we calculate the distance:

Distance = Speed × Time

We know the time value is 500 µs, and the speed is the speed of sound, which is 340 meters per second.

To make our math easier, let's convert the speed of sound from meters per second (m/s) to centimeters per microsecond (cm/µs), which comes out to be 0.034 cm/µs. Now, let's put this value into the equation.

Distance = 0.034 cm/µs × 500 µs

But wait! There's one more important step. The pulse duration represents the round-trip time – the time it took for sound to travel to the object AND back to the sensor. So to get the actual distance, we need to divide by 2:

Distance = (0.034 cm/µs × 500 µs) ÷ 2

Distance = 8.5 cm

This means the object is 8.5 centimeters away from our sensor.

WIRING AN HC-SR04 SENSOR TO AN ARDUINO

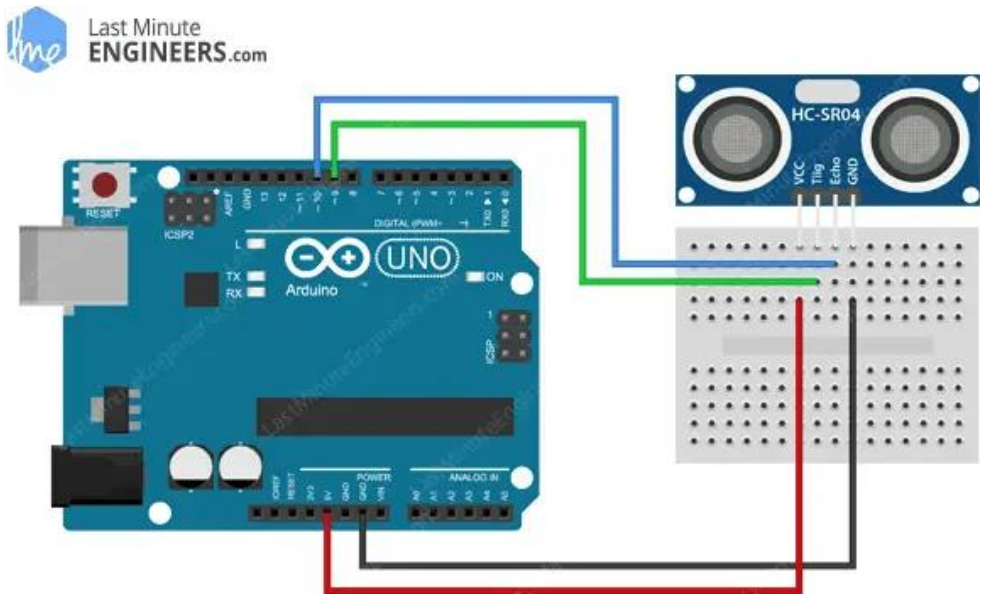
Now that we fully understand how the HC-SR04 ultrasonic sensor works, let's connect it to our Arduino!

Connecting the HC-SR04 to your Arduino is super simple. First, place the sensor on your breadboard. Connect the VCC pin to the 5V pin on the Arduino, and the GND pin to the ground pin. Next, connect the Trig pin to digital pin #9 on your Arduino, and the Echo pin to digital pin #10.

Here's a quick reference table for the pin connections:

HC-SR04 Sensor	Arduino
VCC	5V
Trig	9
Echo	10
GND	GND

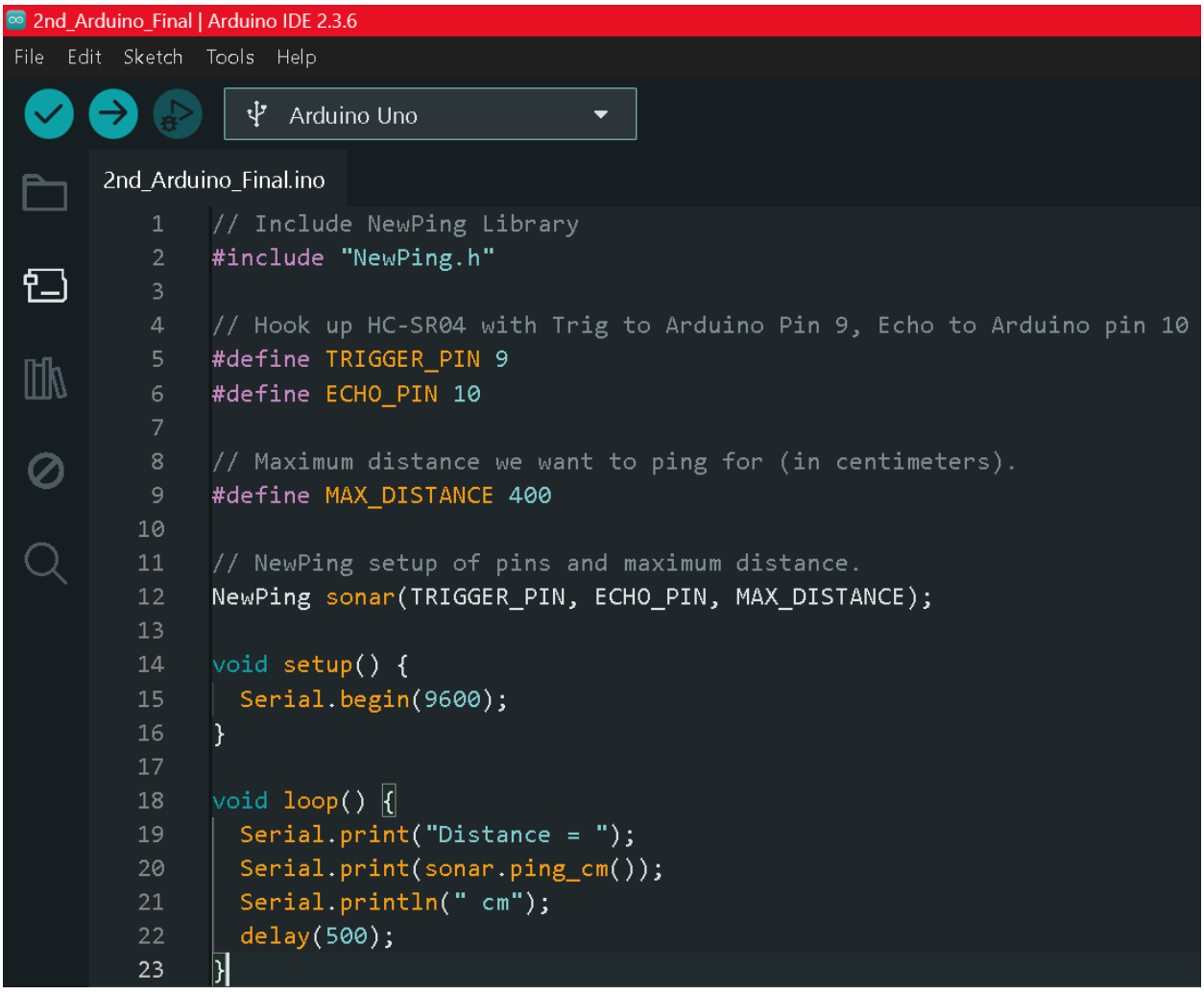
Once you've made all these connections, your setup should look something like the image shown below.



CODE

Let's try a simple program that uses the HC-SR04 ultrasonic sensor to measure the distance to objects and display the results in centimeters on the Arduino's serial monitor every half-second.

Before we break it down step by step, go ahead and upload the code to your Arduino and see it in action.



Once the code is uploaded to your Arduino, open the serial monitor and set the baud rate to 9600 bps. Now, point the sensor at different objects around you—like your desk, a wall, or even your hand—and watch as the measured distances update in real time.

REFERENCE:

https://lastminuteengineers.com/arduino-sr04-ultrasonic-sensor-tutorial/