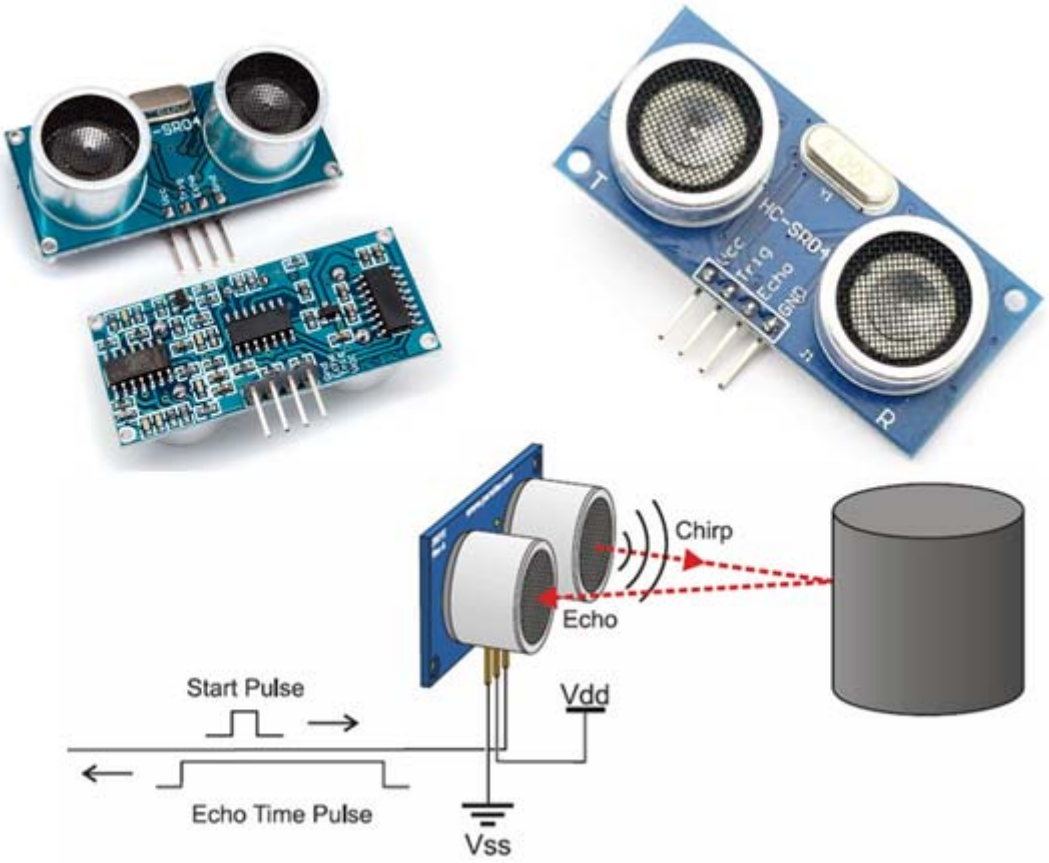
Handson Technology

User Guide

HC-SR04 Ultrasonic Sensor Module User Guide



User Guide: Ultrasonic Sensor V2.0

SKU: MDU-1014

Contents

1. Introduction:

Ultrasonic is an excellent way of figuring out what's in the immediate vicinity of your Arduino. The basics of using ultrasound are like this: you shoot out a sound, wait to hear it echo back, and if you have your timing right, you'll know if anything is out there and how far away it is. This is called echolocation and it's how bats and dolphins find objects in the dark and underwater, though they use lower frequencies than you can use with your Arduino.Figure-1 show the working principal of ultrasonic ranging concept.

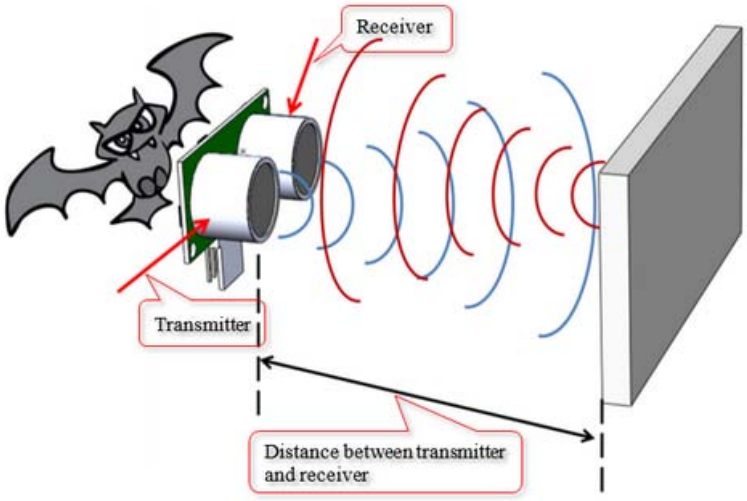


Figure-1

HC-SR04 Ultrasonic Sensor is a very affordable proximity/distance sensor that has been used mainly for object avoidance in various robotics projects. It has also been used in turret applications, water level sensing, and even as a parking sensor.

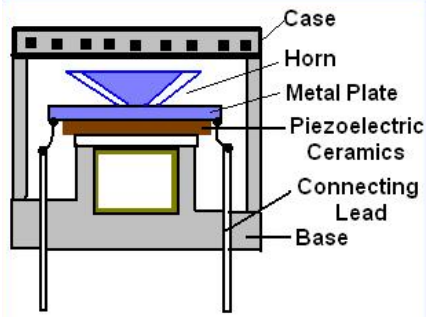
This module is the second generation of the popular HC-SR04 Low Cost Ultrasonic Sensor. Unlike the first generation HC-SR04 that can only operate between 4.8V~5V DC, this new version has wider input voltage range, allow it to work with controller operates on 3.3V.HC-SR04 ultrasonic sensor provides a very low-cost and easy method of distance measurement. It measures distance using sonar, an ultrasonic (well above human hearing) pulse (~40KHz) is transmitted from the unit and distance-to-target is determined by measuring the time required for the echo return. This sensor offers excellent range accuracy and stable readings in an easy-to-use package. An on board 2.54mm pitch pin header allows the sensor to be plugged into a solderless breadboard for easy prototyping.

2. Module Specification

Electrical Parameters	**Value**
Operating Voltage	3.3Vdc ~ 5Vdc
Quiescent Current	<2mA
Operating Current	15mA
Operating Frequency	40KHz
Operating Range & Accuracy	2cm ~ 400cm (1in ~ 13ft) ± 3mm
Sensitivity	-65dB min
Sound Pressure	112dB
Effective Angle	15°
Connector	4-pins header with 2.54mm pitch
Dimension	45mm x 20mm x 15mm
Weight	9g

2.1 Sensor Element Construction

Piezoelectric crystals are used for sensor elements. Piezoelectric crystals will oscillate at high frequencies when electric energy is applied to it. The Piezoelectric crystals will generate electrical signal when ultrasound wave hit the sensor surface in reverse.



Construction of Ultrasonic Sensors

3. Ultrasonic Real Application

3.1 Car Parking Reverse Sensors

The main purpose is the distance range detection, which is widely used parking sensor for car. The sensor is used for calculating the distance, or direction of an object from the time it takes for a sound wave to travel to the object and echo back. The effective detective range is 0.3m ~ 3.0m. Refer to Figure-2.

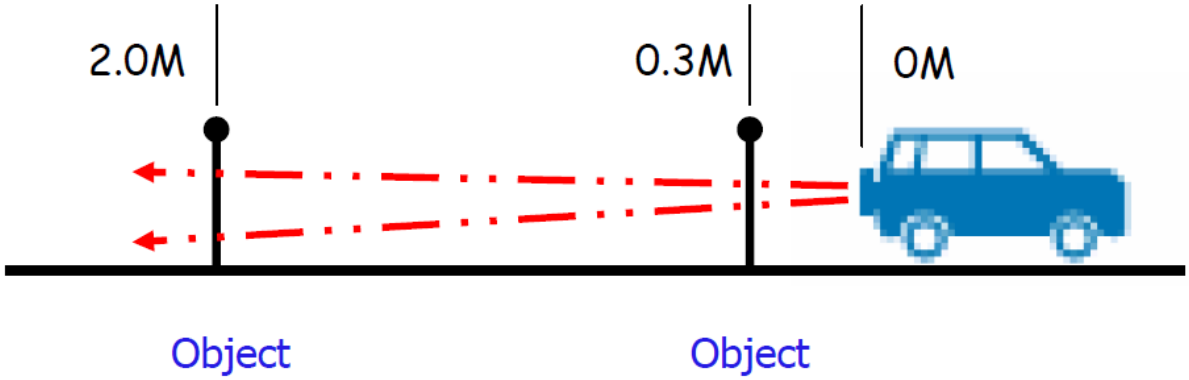
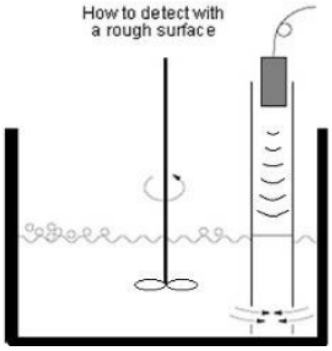


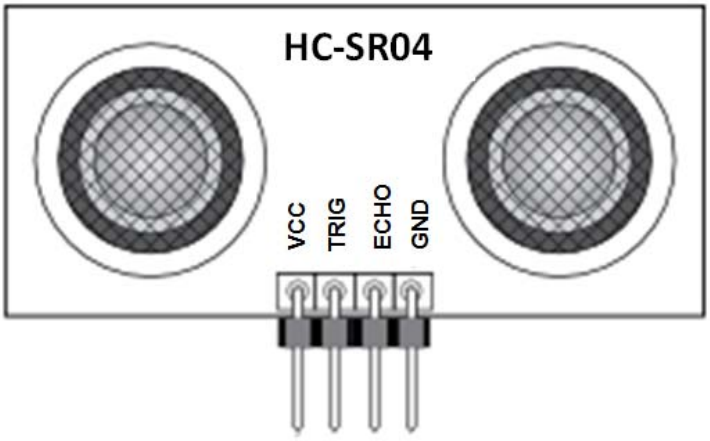
Figure-2.

3.2 Liquid Level Detection

Ultrasonic sensors are widely used for liquid level detection. In such cases, place a pipe on top of the sensor head as shown Figure-3. By detecting the liquid level inside the pipe, a wavy surface or bubbles which can disturb stable reading can be prevented.

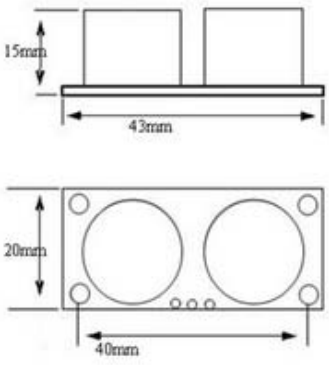


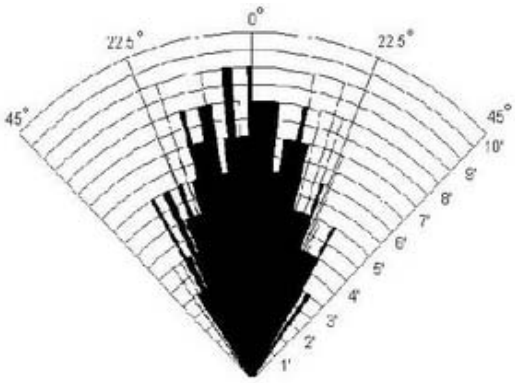
4. Hardware Information



VCC	3.3v ~ 5V
TRIG	Triggering Input Pin. 10uS TTL Pulses
ECHO	TTL Logic Output Pin. Proportional to distance
GND	Ground Pin

4.1 Mechanical Dimension





Practical test of performance,
Best in 30 degree angle

4.2 Timing Diagram

The timing diagram, Figure-4 is shown below. You only need to supply a short 10uS pulse to “Trigger Input” pin to start the ranging. The module will send out 8-cycles burst of ultrasound at 40KHz and raise its “Echo”

pin, refer to Figure-5. The echo is a distance object that is pulse width and the range in proportion. You can calculate the range through the time interval between sending trigger signal and receiving echo signal.

Formula: uS / 58 = centimeters or uS / 148 =inch

or: the range = high level time * sound velocity (340m/s) / 2;

Suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

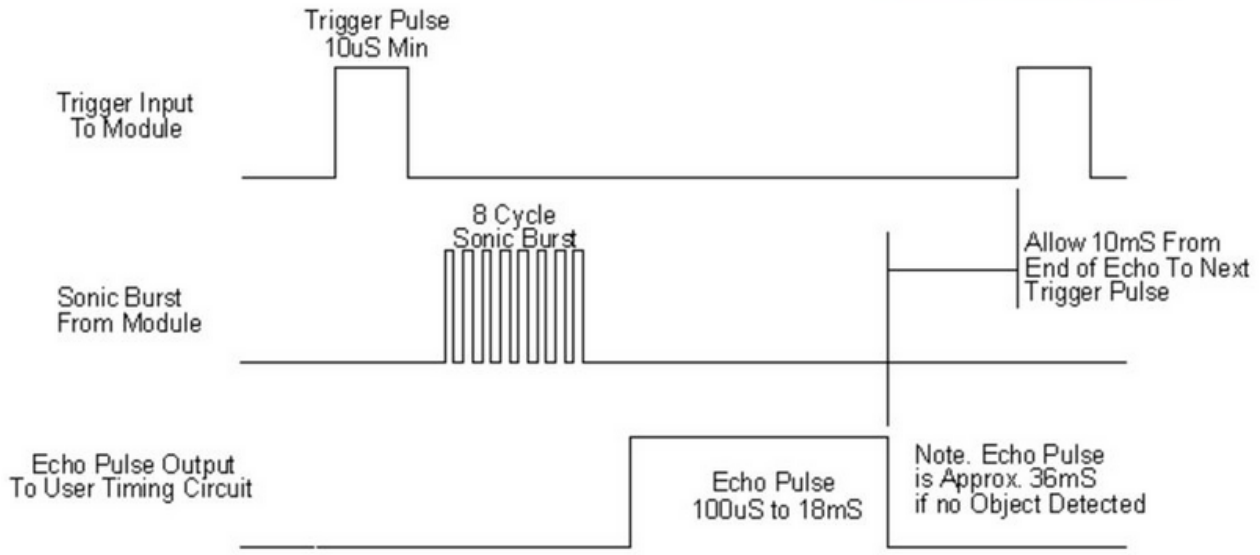


Figure-4: Timing Diagram

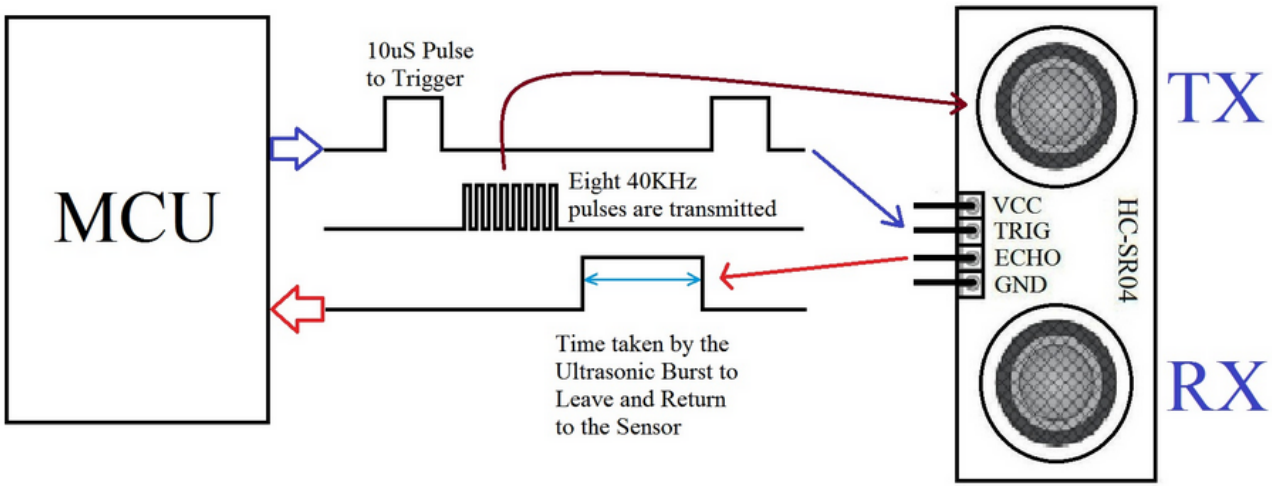


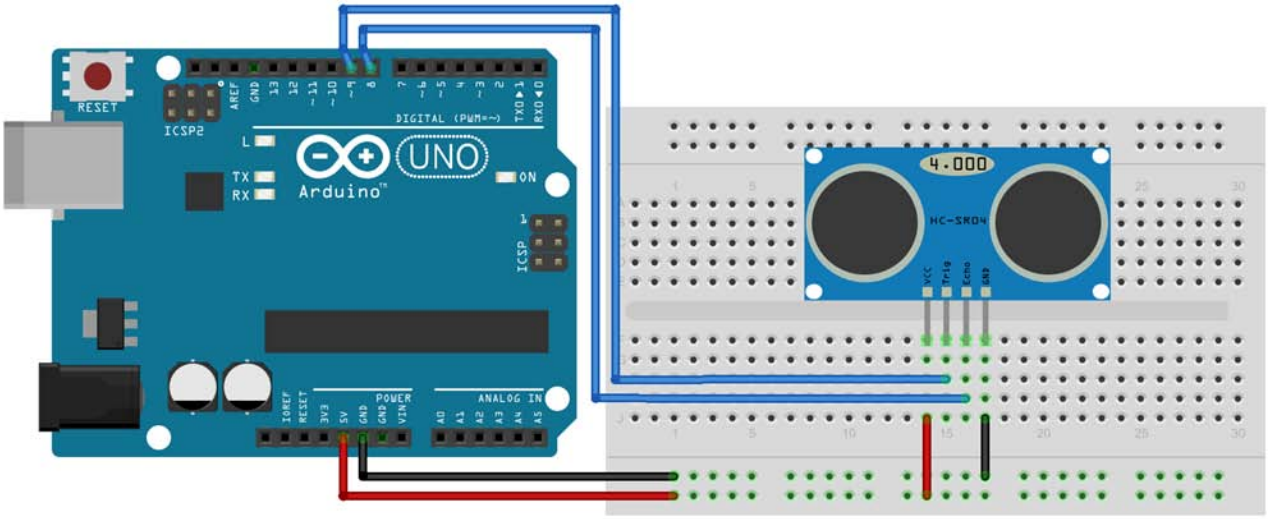
Figure-5: Microcontroller Interfacing

Please make sure the surface of object to be detected should have at least 0.5m^{2}areafor better performance.

5. Interfacing to Arduino Boards

5.1 Arduino Uno Connection Schematic.

Connect the circuit as shown below using Arduino Uno controller board:



5.2 Arduino Sketch.

Copy and paste the below sketch into Arduino IDE and upload to Arduino Uno Board:

```
/*============================================================================
//  Author      : Handson Technology
//  Project     : HC-SR04 Ultrasonic Sensor with Arduino Uno
//  Description : HC-SR04 Distance Measure with Arduino and display
//                on Serial Monitor.
//  LiquidCrystal Library - Special Chars
//  Source-Code : HC-SR04.ino
//============================================================================
*/

int trig=9;
int echo=8;
int duration;
float distance;
float meter;
void setup()
{
  Serial.begin(9600);
  pinMode(trig, OUTPUT);
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  pinMode(echo, INPUT);
  delay(6000);
  Serial.println("Distance:");
}
void loop()
{
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
```

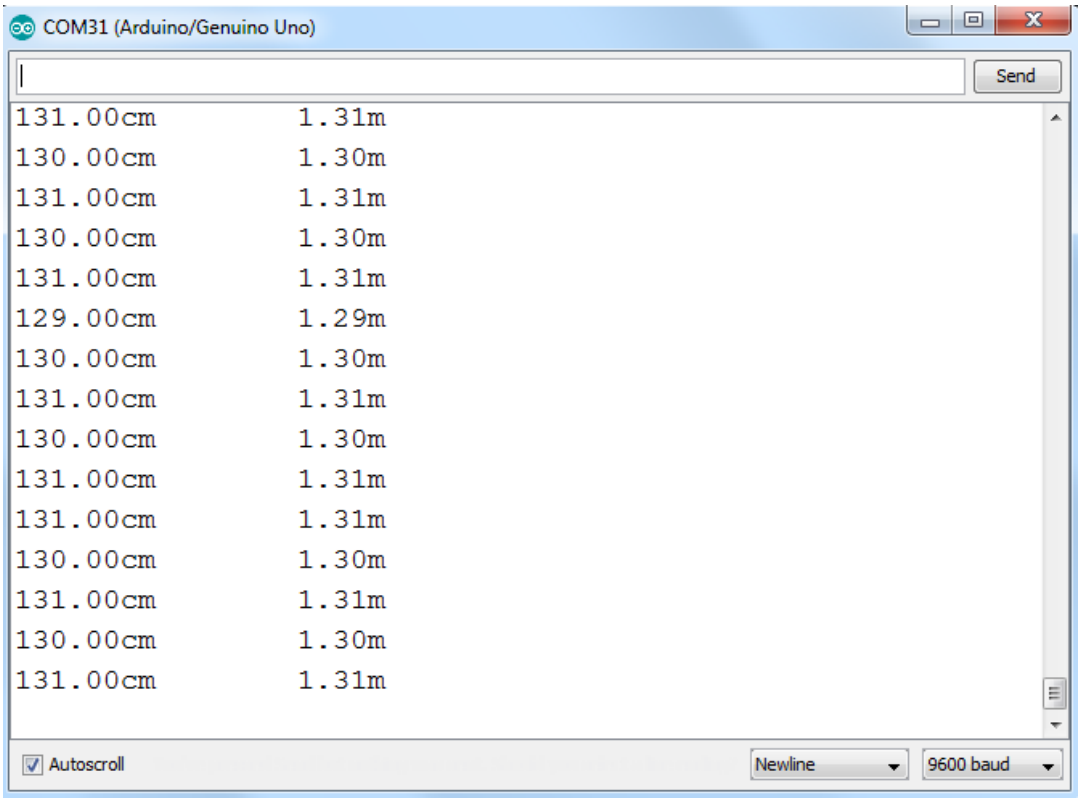
```
  digitalWrite(trig, LOW);
  duration = pulseIn(echo, HIGH);

  if(duration>=38000){
      Serial.print("Out range");
      }

  else{
      distance = duration/58;
      Serial.print(distance);
      Serial.print("cm");
      meter=distance/100;
      Serial.print("\t");
      Serial.print(meter);
      Serial.println("m");
      }
  delay(1000);
}
```

Open up the Serial Monitor with baud rate of 9600.

Facing the sensor toward some obstacle like wall or cardboard, you should see the distance measurement data displayed as below screen. The distance is display in cm and m unit.



5.3 Code Anatomy

In the first part of sketch we declare the variables used and define which pins are used to connect to the Ultrasonic Module. In the setup function first we initialize the Serial communication with the command ***Serial.begin(9600)***, after we define the trig as output and the echo as input through the function ***pinMode***, finally we set the trig at LOW level with the command ***digitalWrite***.

In the loop block we set the trig to HIGH and after 10 micro-second we set it again to the LOW level.

We read the time between transmitting and receiving signal with the function ***pulseIn(Echo,HIGH)*** and we place it in the duration variable. After we check this value, if it is greater or equal than 38000 micro-second on Serial monitor we view this phrase: out range; else we see the measure of distance expressed in centimeter and meter.

We calculate the distance dividing duration by 58.

Calculation of the distance:

distance = speed of sound * duration

the speed of sound is 343,4 m/s or 0,0343 cm/microsecond to the Temperature of 20°C.

distance = 0,0343 * duration

we divide for 2 because the duration is the time spent from ultrasonic signal to sending and returning:

distance = 0,0343 * duration/2

but:

0,0343/2 = 0,01715 = 1/58,31

then:

distance = duration/58,31

approximate:

distance = duration/58

6. HandsOn Technology Products Quality Commitments

HandsOn Technology wishes to be perceived as simple and affordable by our customers. However the joy over a low price is never greater than the disappointment over poor quality products. All our parts are original genuine parts with proper data specifications from manufacturers. This is to ensure you always get the high quality genuine original part as stated in our products information.

6.1 WARRANTY

- Product warranty is valid for 6 months.
- Warranty only applies to manufacturing defect.
- Damaged caused by misuse is not cover under warranty.
- Warranty does not cover freight cost for both ways.