Home   Download   Resources   About   Contact Rui   More

Complete Guide for Ultrasonic Sensor HC-SR04

Written by Rui Santos - *Download free eBook with Arduino projects here*

Updated: 20/08/2014

This post is all about the Ultrasonic Sensor HC – SR04. I'll explain how it works, show some features and share an Arduino Project example to help you with your projects.

Description

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1" to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

Features

- Power Supply :+5V DC
- Quiescent Current : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1" – 13ft

- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

Sensor
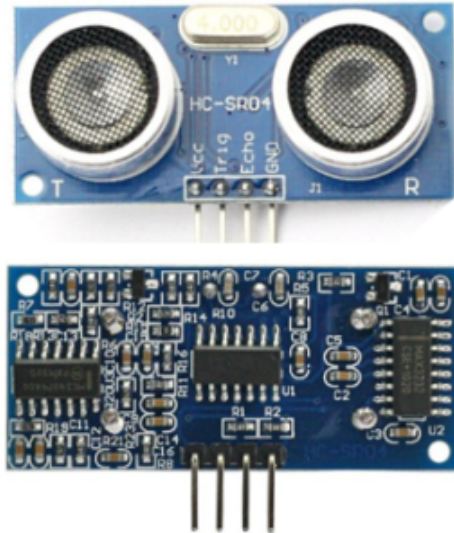
Pins

- VCC: +5VDC
- Trig : Trigger (INPUT)
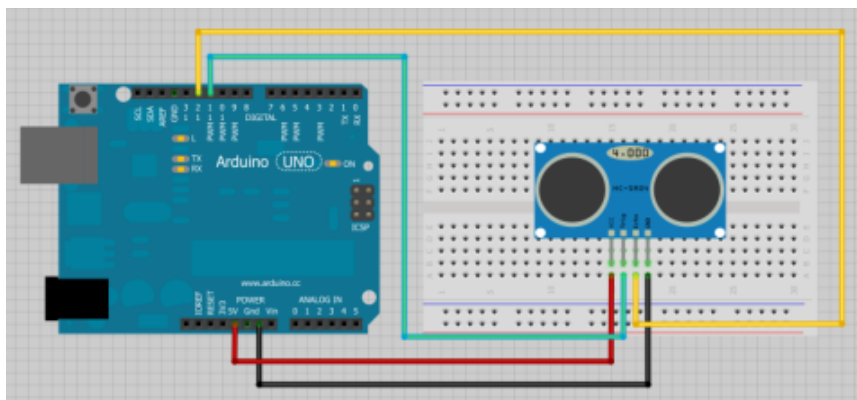- Echo: Echo (OUTPUT)
- GND: GND

Arduino with HC – SR04 Sensor

This sensor is really cool and popular among the Arduino Tinkerers. So I've decided to post a project example using this sensor. In this project the ultrasonic sensor read and write the distance in the serial monitor. It's really simple.

My goal is to help you understand how this sensor works and then you can use this example in your own projects.

Note: There's an Arduino library called NewPing that can make your life easier when using this sensor.

Schematics

Source code

```
/*
 * created by Rui Santos, http://randomnerdtutorials.com
 *
 * Complete Guide for Ultrasonic Sensor HC-SR04
 *
   Ultrasonic sensor Pins:
       VCC: +5VDC
       Trig : Trigger (INPUT) - Pin11
       Echo: Echo (OUTPUT) - Pin 12
       GND: GND
 */

int trigPin = 11;     //Trig - green Jumper
int echoPin = 12;     //Echo - yellow Jumper
long duration, cm, inches;

void setup() {
  //Serial Port begin
  Serial.begin (9600);
  //Define inputs and outputs
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
}

void loop()
{


  // The sensor is triggered by a HIGH pulse of 10 or more microsec
  // Give a short LOW pulse beforehand to ensure a clean HIGH pulse
  digitalWrite(trigPin, LOW);
  delayMicroseconds(5);
```

```
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Read the signal from the sensor: a HIGH pulse whose
  // duration is the time (in microseconds) from the sending
  // of the ping to the reception of its echo off of an object.
  pinMode(echoPin, INPUT);
  duration = pulseIn(echoPin, HIGH);

  // convert the time into a distance
  cm = (duration/2) / 29.1;
  inches = (duration/2) / 74;

  Serial.print(inches);
  Serial.print("in, ");
  Serial.print(cm);
  Serial.print("cm");
  Serial.println();

  delay(250);
}
```

Source code with NewPing

Below is an example using the NewPing library. Download the library here.

```
/*
 * Posted on http://randomnerdtutorials.com
 * created by http://playground.arduino.cc/Code/NewPing
*/

#include <NewPing.h>

#define TRIGGER_PIN 12
#define ECHO_PIN 11
#define MAX_DISTANCE 200

NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE); // NewPing setu

void setup() {
  Serial.begin(9600);
}
```

```
void loop() {
    delay(50);
    unsigned int uS = sonar.ping_cm();
    Serial.print(uS);
    Serial.println("cm");
}
```

Where to buy?

- Click here to get one.

Check out my book, available for order now! (Paperback or Kindle Edition)

NOTE: "If the HC-SR04 does not receive an echo the
Parallax sensors time out after 36ms and I think 28m
with no return echo the program will hang for 1 seco
You need to use the timeout parameter.

http://arduino.cc/en/Reference/PulseIn
The HC-SR04 barely works to 10 feet giving a total path length of 20 feet and a path time of about
20ms so set the timeout to something above that, say 25 or 30ms.

If you put a resistor, say 2k2 between E and T then only connect to T you can use the HC-SR04
from just one Arduino pin. Look up single pin operation of ultrasonic sensors.

Also if you are using a HC-SR04 with a PicAxe you need to up the clockspeed to at least 8MHz
otherwise they don't see the start of the echo pulse so pulsin never starts. The HC-SR04 works
fine with a BS2." by David Buckley

Thanks to my friend David to leave such an helpful comment!

I hope you found this useful.

Share this post with a friend that also likes electronics!
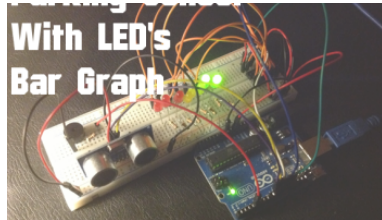
Thanks for reading, you can contact me by leaving a comment. If you like this post probably you
might like my next ones, so please support me by subscribing my blog and my Facebook Page.
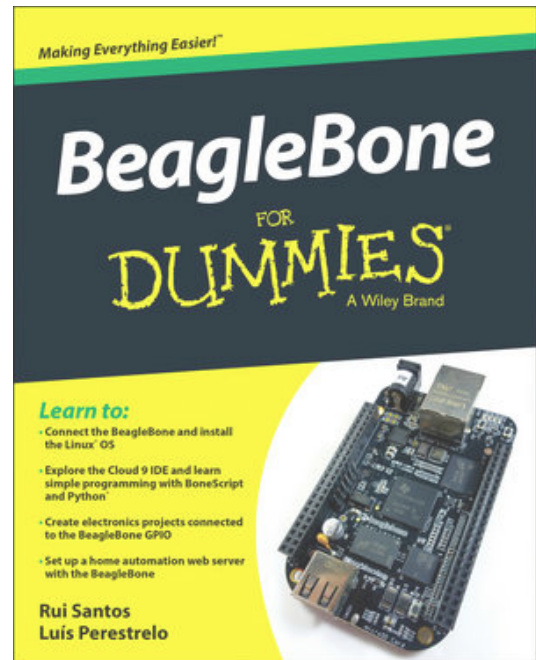
P.S. I've used this sensor in one of my previous project. Make sure you watch that project now: Ultrasonic Sensor with LED's and buzzer
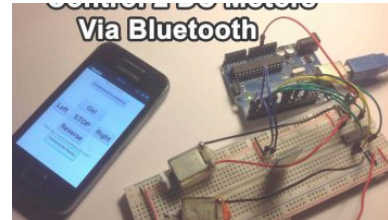
P.P.S. Click here to get one ultrasonic sensor

Related

Arduino - Ultrasonic Sensor with LEDs and buzzer
In "Arduino"

Arduino vs Raspberry Pi vs BeagleBone vs PCDuino
In "Random Articles"

Arduino - Control 2 DC Motors Via Bluetooth (Perfect To Build a Robot)
In "Arduino"

Comments

Robert L. Pendergast says
November 17, 2013 at 1:32 pm

Hi, Thanks for your interesting and informative projects.

Reply

Rui Santos says
November 17, 2013 at 2:21 pm

Thanks Robert for your feedback.

I'm really glad you found this information useful!

Thanks again,

Rui Santos

Reply

Abdul Irfan says
November 17, 2013 at 5:25 pm

Hi, this is to me really helpful. Now I able to understand better how HC-SC04 work.. Hopefully you will keep on sharing this valuable knowledge.

Thank you very much ^_^

Reply

Rui Santos says
November 17, 2013 at 9:46 pm

Thanks Abdul!

I'll try my best to create content every week.

See you in the next project,

Rui Santos

Reply

imam says
November 18, 2013 at 3:49 am

make simple if use NewPing library.

the code like this .

#include

```
#define TRIGGER_PIN 12
#define ECHO_PIN 11
#define MAX_DISTANCE 200

NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE); // NewPing setup of pins and
maximum distance.

void setup() {
Serial.begin(9600);
}

void loop() {
delay(50);
unsigned int uS = sonar.ping_cm();
Serial.print(uS);
Serial.println("cm");
}
```

resource : http://playground.arduino.cc/Code/NewPing

Reply

Rui Santos says
November 18, 2013 at 10:40 am

yeah I've mentioned that library in the notes.

It's a really nice library specially when your working with robotics and using this sensor.

Thanks for sharing Iman!

Reply

Rui Santos says
November 25, 2013 at 9:40 pm

I've added that example to my blog post!
Thanks for sharing!

Have a nice day,
Rui

Reply

raj says
December 14, 2013 at 10:15 am

hi rui , can we become friends , i am interested in robotics can u guide me , i m waiting………..

Reply

Rui Santos says
December 15, 2013 at 11:56 am

Hi raj!

Sure go over to facebook and connect with me.
https://www.facebook.com/RandomNerdTutorials

All the best,
Rui

Reply

David says
November 18, 2013 at 6:31 pm

Unfortunately you missed out the one thing that gives people trouble.
If the HC-SR04 does not receive an echo then the output never goes low.
Devantec and Parallax sensors time out after 36ms and I think 28ms respectively. If you use Pulsin as above then with no return echo the program will hang for 1 second which is the default timeout for Pulsin. You need to use the timeout parameter.
http://arduino.cc/en/Reference/PulseIn
The HC-SR04 barely works to 10 feet giving a total path length of 20 feet and a path time of about 20ms so set the timeout to something above that, say 25 or 30ms.
If you put a resistor, say 2k2 between E and T then only connect to T you can use the HC-SR04 from just one Arduino pin. Look up single pin operation of ultrasonic sensors.
Also if you are using a HC-SR04 with a PicAxe you need to up the clockspeed to at least 8MHz otherwise they don't see the start of the echo pulse so pulsin never starts. The HC-SR04 works fine with a BS2.

Reply

Rui Santos says
November 19, 2013 at 10:44 pm

Hi David,

I totally forgot that and some problems I wasn't aware of.

Next weekend I'll try to update this post and add all those notes.

Thanks for such a detailed comment and for improving my content!

thanks again,

Rui santos

Reply

Rui Santos says
November 25, 2013 at 9:33 pm

Hi David,

I've added your comment to my blog post.

You really explained well some stuff that I wasn't aware of.

I hope you don't mind.

Thanks for your expertise.

Have a nice day,

Rui

Reply

Andreas Dunker says
November 19, 2013 at 8:42 am

Hi,

very cool guide. Thanks for that! If you want to see a "real life example", please have look on my blog: danimathblog.wordpress.com/tag/spider/

best regards

Andreas

Reply

Rui Santos says
November 19, 2013 at 10:46 pm

Hi Andreas,
Thanks for taking the time to leave a comment and for sharing an awesome project!
All the best,
Rui Santos

Reply

Rodrigo says
November 24, 2013 at 2:07 am

Fala amigo, beleza?
Testando seu codigo esbarrei em um problema, quanto mais proximo um objeto do sensor, mais rapido o programa faz seu loop, achei isso muito estranho pois na ultima linha o "delayMicroseconds(300)" define basicamente que o loop sera dado a cada 300milisegundos (logico um pouco mais pq tem outros pequenos delays e tem o tempo de processamento), mas nao sei pq o loop fica mt acelerado, acho que ate a baixo de 300milisegundos.
Como o meu programa depende desse tempo, basicamente é um buzzer que almenta a frequencia de apitos com a proximidade de um objeto, nao funcionou com seu codigo. Porem usando a biblioteca NewPing, e usando como base o codigo exemplo que o Imam postou esse erro foi resolvido. Sabe me explicar o porque?

Reply

Rui Santos says
November 25, 2013 at 8:55 pm

Olá Rodrigo,
realmente é um erro um pouco estranho. Eu vou testar isso agora mesmo e tentar resolver.

assim que consiga resolver altero este post.
Pode sempre usar a biblioteca NewPing. É mesmo muito boa e simplifica imenso o nosso

trabalho.

Obrigado por notar esse erro.

Abraço,
Rui

Reply

Rui Santos says
November 25, 2013 at 9:24 pm

Olá Rodrigo,
já resolvi o problema esqueci-me de fazer low ao trigPin no inicio do loop:

digitalWrite(trigPin, LOW);
delayMicroseconds(5);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);

E isso estava a fazer com que o sensor se comporta-se de uma forma estranha. Já está
resolvido.
Obrigado!

Abraço,
Rui

Reply

Paul says
December 22, 2013 at 12:48 pm

is it possible that arduino uno can accomodate 4 ultrasonic sensors?

Reply

Rui Santos says
December 26, 2013 at 12:05 am

yes the Arduino can easily accomodate 4 ultrasonic sensors.

Each sensor only requires 2 digitals pins. (4 ultrasonic sensors * 2 digital pins = 8)

so you still have some pins left.

But you need to right a good code so they don't conflict with each other!

Reply

Gokul says
March 12, 2014 at 5:15 pm

I glad of your work, but i want to know the internal working of the module. It consist of 3 ICs . I want to know the Working of them. Can you help me?

Reply

Ali says
April 29, 2014 at 7:05 am

Hi . and thanks for this article .

i have a question about the sensor . after one trigger does it continue to measure the distance ,

i mean if we want it to measure the distance for some time , do we need to send the trigger signal continuously?

Reply

Rui Santos says
May 3, 2014 at 2:22 pm

Hi Ali,

I'm not sure if this answer is exactly what you're asking…

when you send the trigger after a few seconds you need to read that signal with the echo

to see how much time it took the ultrasonic wave to touch the nearest object.

So that means you need to keep repeating that process over and over again to measure

the distance…

Reply

gomer says
August 30, 2014 at 2:57 pm

I have six of these…
before connecting to the micro controller, all of them put 5v on trig at power on. is this the
correct behavior?
I understand that the micro controller is to put 5v on trig for 10us to trigger the pulse… can
you explain how it can be correct to put 5v on trig as instructed, when 5v is already on trig on
power up (without connecting to anything)?

nice job with this write up… thanks

Reply

Rui Santos says
September 1, 2014 at 9:56 am

The microcontroller puts 5V on the trigPin when you turn the digital pin of your Arduino
to HIGH.

When you do this digitalWrite(trigPin, HIGH);
The trigPin of your ultrasonic sensor receives 5V.

Reply

David says
September 1, 2014 at 12:27 pm

Input pins when not connected to anything are said to float and because the input
impedance of them is high they can be affected by stray electrostatic voltages on
anything, including your fingers. Hence voltage on them can be at an illegal value between
the thresholds for logic 0 and logic 1 which can cause the internal circuitry to fail or lock
up or generally do bad things. To avoid this a lot of input pins have either pull-up or pull-
down resistors connected to them so that when the pin is not connected it will be in a
known state.
The Trig pin has a 10K pull up resistor connected between it and Vcc, on mine you can see
the tiny surface mount 103 resistor on the back of the board by the header pins. So when
the board is powered and no circuitry is connected to Trig the voltage on it will be at Vcc.
The control computer must first set the pin to logic zero and then, when it wants to

trigger the HC-04, set the pin to high for 10us before setting it low again.

Reply

lorenzo says
September 17, 2014 at 3:12 pm

I have a problem… I also have the "OUT" pin…
how can I program arduino ?

Reply

A. Rakesh Kumar says
September 17, 2014 at 5:28 pm

Thank you man!!

Reply

Rui Santos says
October 9, 2014 at 11:16 am

You're welcome!

Reply

Abdo says
September 28, 2014 at 11:18 pm

Thanks for this article .

Is there any way to make sure sensor is working or not?

Reply

Rui Santos says
October 9, 2014 at 11:09 am

You can see what's happening with the sensor with an Oscilloscope.
But if you followed my tutorial and it's not working for you, your ultrasonic sensor might be damaged.

Reply

Abdo says
October 9, 2014 at 11:20 am

Thanks for reply. Yes it seems my ultrasonic sensor is not working.

I had change it and everything gone well.

Reply

Rui Santos says
October 9, 2014 at 11:24 am

Awesome Abdo!
I'm glad it's now working for you

Reply

David says
October 9, 2014 at 11:32 am

The sensors are cheap enough so the easy way to see if a sensor is working is to try another one. I have used maybe 20 of them without any problems until the other day when one stopped working. I swapped it and the replacement worked. Nothing was obviously wrong with the bad sensor but if I held it, it started working again so I resoldered the joints on the two transducer cans and the connector and now it works again.

Reply

Sidd says
March 14, 2015 at 3:42 pm

thanx a lot for this info. But I need your help,I am expecting reading from sensors in millimeters. Is it possible to have??
Please give me a solution

Reply

Rui Santos says
March 15, 2015 at 11:48 am

Hi Sidd,
You can simply change my code to do the conversion to millimeters by multiplying the centimeters output.

Reply

Trackbacks

Distance sensors | Fabricio Ferreira says:
March 26, 2014 at 4:36 am
[…] colleagues that were using Ultrasonic distance sensors, we borrowed it, did some tests (based on a tutorial) and found out it is way more precise and has a much wider range than the previous option. So, we […]

Leave a Reply

Your email address will not be published. Required fields are marked *

Name *

Email *

Website

Comment

You may use these HTML tags and attributes: `<a href="" title=""> <abbr title=""> <acronym title=""> <b> <blockquote cite=""> <cite> <code class="" title="" data-url=""> <del datetime=""> <em> <i> <q cite=""> <strike> <strong> <pre class="" title="" data-url=""> <span class="" title="" data-url="">`

POST COMMENT

☐ Notify me of follow-up comments by email.

☐ Notify me of new posts by email.

Advertisement

Connect with Rui

Facebook

Facebook Page

GitHub

LinkedIn

Twitter

YouTube

Like Our Facebook Page!

Random Nerd Tutorials

Like

6,918 people like Random Nerd Tutorials.

About | Contact Rui | Terms and Conditions | Home Automation Server

Copyright © 2015 - Random Nerd Tutorials