# Distance to Sound 290 Datasheet

Part #DTS290 Authors: Luke Jones & Gabby Macdonald

## Description

Lightweight and compact, DTS290 provides frequency varying audio feedback based on its distance from an object. The DTS290 accurately responds to distances between 3 and 120 cm, with the frequency of the corresponding output being between 7.35 Hz and 0.390 Hz. The DTS290 is durable and easy to use, great for times where an audible output is preferred.

## Applications

The DTS290 can be used in many applications, from being used as a car parking proximity sensor to a motion detector or to measure distances. It is suitable for use both indoors and outdoors, further diversifying its practical applications.

## Principles of Operation

The DTS290 outputs a sound (beep) at a frequency related to how far an object is to the sensor. This sensor detects changes in distance with an ultrasonic sensor which is connected to an Arduino that sends a signal through a speaker to produce sound.

The DTS detects distance by utilizing the ultrasonic waves produced by the Ultrasonic sensor, similar to the sonar used in submarines. It sends a 40KHz ultrasonic wave through the transmitter and measures the time taken for the reflected wave to return to the receiver. This time is used to calculate the distance between the object and the sensor in the equation below,

$$d = \frac{v \times t}{2} \quad (1)$$

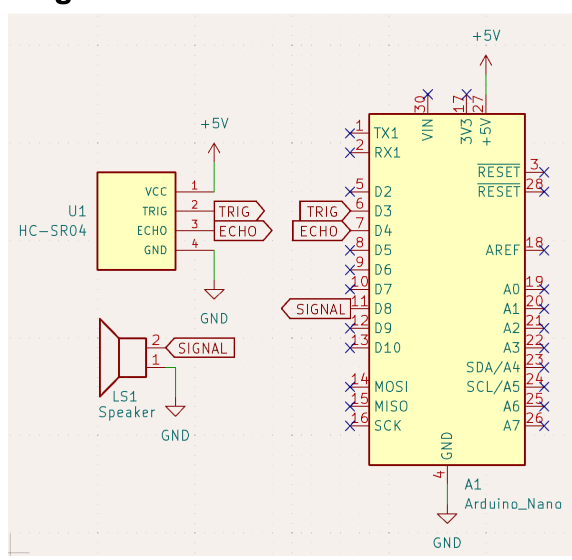
where d is distance, t is duration and v is the speed of sound. Equation 1 involves dividing everything by two because the duration is measuring the time it takes for the sound wave to travel there and back.

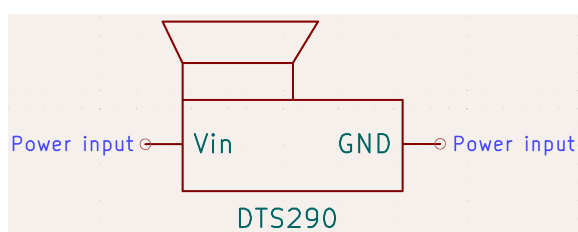
The software of the sensor then does calculations for the period of the beeps. This gives the relationship between distance and the beep period in milliseconds to be:

$$T = 20d \times \left(1 + \frac{1}{v}\right) + 50 \quad (2)$$

where T is the period, d is the distance (cm) and v (cm/ms) is the speed of sound.

## Equivalent Circuit & Connection Diagram



### Absolute Maximum Ratings

| Parameter | Limit | Units | Notes |
|---|---|---|---|
| Max Operating Voltage | 5.5 | V | From HCSR04 datasheet. Connect GND before $V_{DD}$. |
| Min Operating Voltage | 4.5 | V | Smallest working voltage. |
| Max Current Draw | 20 | mA | Combined from components datasheets. |
| Max Sensor Range | 400 | cm | Largest distance from the datasheet |
| Min Sensor Range | 2 | cm | Smallest distance from the datasheet |

### Electrical Characteristics

| Parameter | Conditions | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| Operating distance range | Object held as close or far as possible before it stops beeping | 2 | - | 140 | cm |
| Max frequency | At minimum distance | 7.30 | 7.35 | 7.41 | Hz |
| Min frequency | At max distance | - | 0.390 | - | Hz |
| Field of view | Averaged out, from different distances | 20 | 30 | 35 | degrees |
| Speaker frequency | The note frequency the speaker plays | - | 262 | - | Hz |

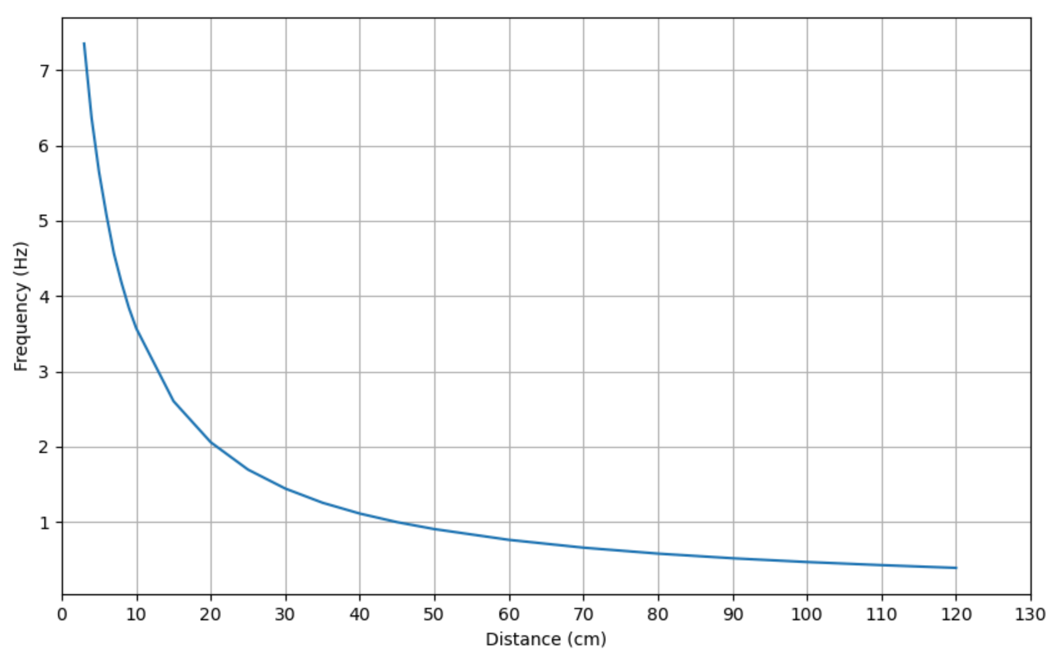



Figure 1: Change in beep frequency (Hz) due to distance (cm)

## Commentary

The DTS290 was characterised by taking measurements of both the input property, distance, and output property, frequency (period). This was done by using a program to track the period of the beeps, and a tape measure for distance. An object with a large surface area was used for the sensor to detect. This way the tape measure can be used to track the distance between said objects.

The measurements for the characteristic were in steps of 1 cm for the smaller distances (3-10), 5 cm between distances from 10 cm to 50 cm, and lastly in steps of 10 cm between 50 cm and 120 cm. The minimum distance range in these calculations is 3 as getting any closer makes the measurements inaccurate even if the operating minimum is 2 cm. Same goes for the maximum of 120; larger distances of around 140 could be measured, but weren't accurate enough to be included in the characteristic.

These measurements were important to plot the characteristic curve in Fig. 3 which resulted in an exponential-decay relationship. The equation of this relationship was obtained directly from the software calculation as it is accurate (using $f = 1/T$).

The program software handled the frequency measurements. This was done by measuring the time it takes for each beep to sound. Then it's as simple as inverting to get the frequency. This was used to plot the sensor characteristic in Fig 1.

The field of view is important so that users will know the angles where their readings might not be as accurate. It was measured using a protractor, placed perpendicular to the base of the ultrasonic sensor with their centers in line. An object was then moved across the sensor's field of view at a certain distance. Once the sensor started outputting false measurements or none at all, the angle was measured. These angles were measured in each direction horizontally and vertically (sensor was rotated by 90 degrees to test it vertically). This was tested at multiple distances, then averaged out to give the value in the table. A plot for this was excluded because the sensor suddenly stops working past the edge of the field of view due to the behaviour of the incident and reflected waveforms.

The speaker pitch was chosen in software. This is important if the user is concerned with the pitch of the sensor, as certain values may be undesirable.

The maximum voltage and current draw values, along with the others in the absolute maximum table, were taken from the datasheet of the weakest component, and have been included to prevent the user from misusing their DTS290.

The maximums and minimums of the frequency range and other such characteristics were found experimentally, with typical values given. These values are given so the user knows what to expect from an off the shelf model, it also provides a basis for the user to work upon.