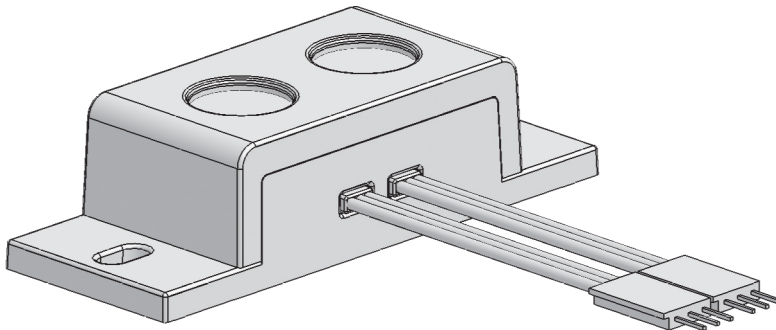


# Ultrasonic Sensor

“Ultrasonic” refers to very high-frequency sound – sound that is higher than the range of human hearing. Sonar, or “Sound Navigation And Ranging,” is an application of ultrasonic sound that uses propagation of these high-frequency sound waves to navigate and detect obstacles. Sonar has a wide variety of applications and a wide variety of users, from submarines avoiding underwater obstacles to hungry bats looking for their dinner!

Ultrasonic Module x 1



#### Limited 90-day Warranty

This product is warranted by VEX Robotics, Inc. against manufacturing defects in material and workmanship under normal use for ninety (90) days from the date of purchase from authorized VEX Robotics dealers. For complete warranty details and exclusions, check with your dealer.

VEX Robotics, Inc.  
1519 IH 30 W  
Greenville, TX 75402

0312

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: Changes or modifications not expressly approved by the manufacturer responsible for compliance could void the user's authority to operate the equipment.

- THIS CLASS B DIGITAL APPARATUS COMPLIES WITH CANADIAN ICES-003.
- CET APPAREIL NUMERIQUE DE LA CLASSE B EST CONFORME A LA NORME NMB-003 DU CANADA.

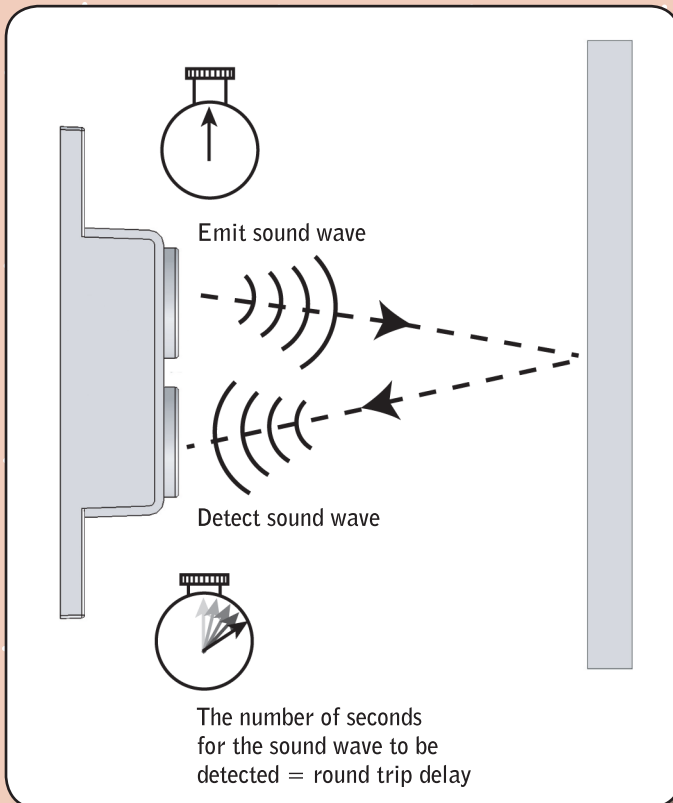
Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

For More Information, and additional Parts & Pieces refer to:  
[www.VEXrobotics.com](http://www.VEXrobotics.com)

### Ultrasonic Sensor, continued

#### 1 Technical Overview

The Ultrasonic Range Finder determines the distance to a reflective surface by emitting high-frequency sound waves and measuring the time it takes for the echo to be picked up by the detector.



The Ultrasonic Range Finder can determine the distance to an object between 3cm and 3m away; closer than 3cm will result in the sound waves echoing back to the sensor before the detector is ready to receive.

The Ultrasonic Range Finder actually consists of two parts: an emitter, which produces a 40kHz sound wave; and a detector, which detects 40kHz sound waves and sends an electrical signal back to the Microcontroller. In order to determine the distance to an object, it is necessary to implement a timing loop in your Microcontroller code to measure the length of time required for the sound wave generated by the emitter to traverse the distance to the object.

The distance to the object can then be calculated with the following formulas:

$$\text{Distance to object} = \frac{1}{2} (\text{speed of sound}) \times (\text{round trip delay})$$

[Note: speed of sound varies with altitude and temperature. At sea level and room temperature, it's approximately 344.2 m/s or 1135 ft/s. It will increase with temperature and decrease with altitude.]

Therefore

$$\text{Distance in feet} = 567.5 \text{ ft/s} \times (\text{round trip delay})$$

or

$$\text{Distance in meters} = 172.1 \text{ m/s} \times (\text{round trip delay})$$

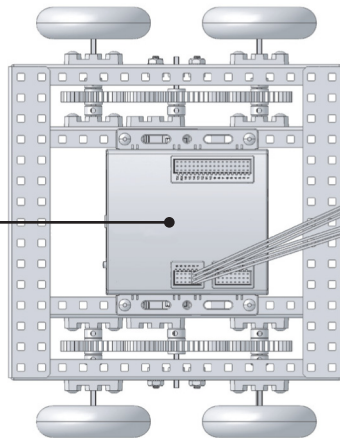
accessories

## Ultrasonic Sensor, continued

### 1 Technical Overview

The steps your robot's program will have to follow in order to calculate the distance to an object are:

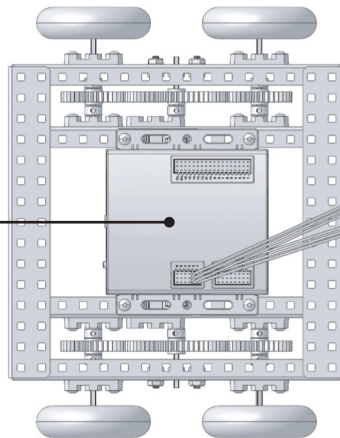
**1. The VEX Microcontroller** sends a "start" signal to the Ultrasonic Range Finder.



**2. The Ultrasonic Range Finder** generates a 250 microsecond ultrasonic pulse.

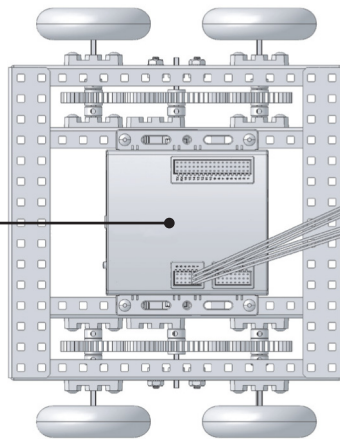


**4. A timing loop** on the Microcontroller begins, counting the seconds. This will be the "round trip delay" in the distance equation.



**3. The Ultrasonic Range Finder** sets its output signal to +5V, thus sending a "high" signal to the Microcontroller. In digital terms, this is a "1".

**7. The VEX Microcontroller** exits the timing loop and uses the round trip delay to calculate the distance to the object.



**5. The Ultrasonic Range Finder** picks up the echo from the 250 microsecond pulse.

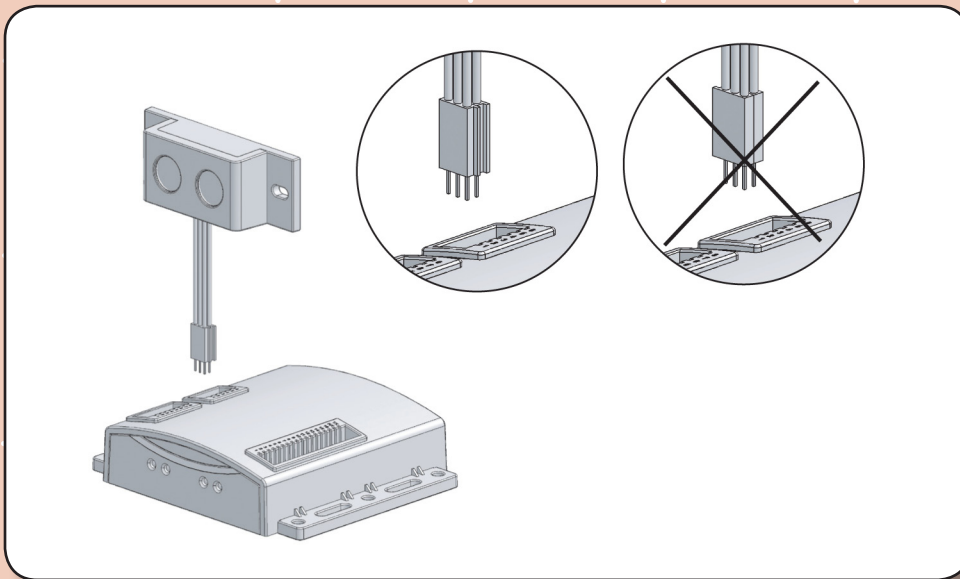


**6. The Ultrasonic Range Finder** sets its output signal to 0V, thus sending a "low" signal to the Microcontroller. In digital terms, this is a "0".

### Ultrasonic Sensor, continued

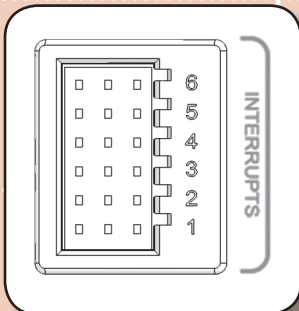
#### 2 Connecting the Ultrasonic Range Finder to the Microcontroller

The ultrasonic module has two three-pin connectors that will each plug into an interrupt port on the VEX Microcontroller. These can be adjacent ports, but do not have to be. The connector labelled "INPUT" is the trigger output of the VEX Microcontroller; the ultrasonic module receives a start signal from the VEX Microcontroller on this line. The connector labelled "OUTPUT" is the echo response from the ultrasonic detector; this is the line through which the VEX Microcontroller receives output from the detector, indicating that it has picked up an echo.



#### 3 Reprogramming the Microcontroller to enable the Ultrasonic Range Finder to generate a "ping"

Start by plugging the "INPUT" and "OUTPUT" connectors into any two ports in the Interrupts bank on the VEX Microcontroller.



In order for your robot to be able to read the sensor, you will have to reprogram the Microcontroller. Consult the supplier of your programming software, for more information or refer to [www.VEXrobotics.com](http://www.VEXrobotics.com).