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Model # : SEN - 0903

"ECHO"

Ultrasonic Distance Sensor

(PWM o/p)

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This "ECHO" Ultrasonic Distance Sensor from Rhydolabz is an amazing product that provides very short (2CM) to long-range (4M) detection and ranging. The sensor provides precise, stable non-contact distance measurements from 2cm to 4 meters with very high accuracy. Its compact size, higher range and easy usability make it a handy sensor for distance measurement and mapping. The board can easily be interfaced to microcontrollers where the triggering and measurement can be done using one I/O pin. The sensor transmits an ultrasonic wave and produces an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to target can easily be calculated.

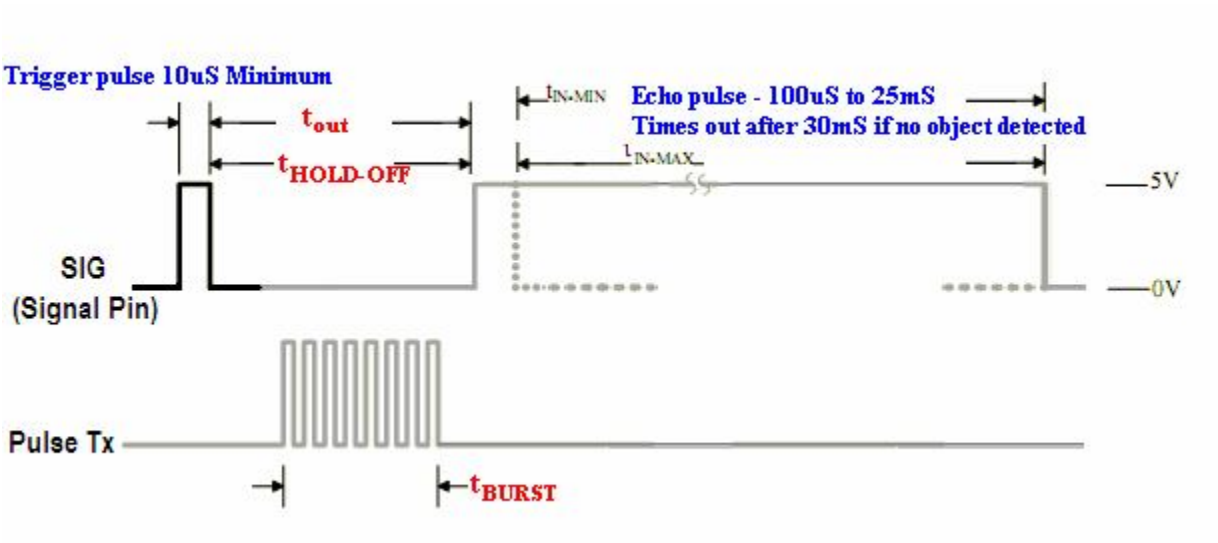
ECHO SENSOR FEATURES

- Professional EMI/RFI Complaint PCB Layout Design for Noise Reduction
- Range : 2 cm to 4 m
- Accurate and Stable range data
- Data loss in Error zone eliminated
- Modulation at 40 KHz
- Mounting holes provided on the circuit board
- Triggered externally by supplying a pulse to the signal pin
- 5V DC Supply voltage
- Current - < 20mA
- Bidirectional TTL pulse interface on a single I/O pin can communicate with 5 V TTL or 3.3V CMOS microcontrollers
- Echo pulse: positive TTL pulse, 87 µs minimum to 30 ms maximum(PWM)
- On Board Burst LED Indicator shows measurement in progress
- 3-pin header makes it easy to connect using a servo extension cable, no soldering required

PIN DEFINITION

PIN	PIN NAME	DETAILS
VCC	Power Supply	Power Supply Input (+5V)
GND	Ground	Ground Level of Power supply
SIGNAL	Signal I/O	This pin reads the trigger pulse from the host microcontroller and returns the pulse based on the distance.

COMMUNICATION PROTOCOL

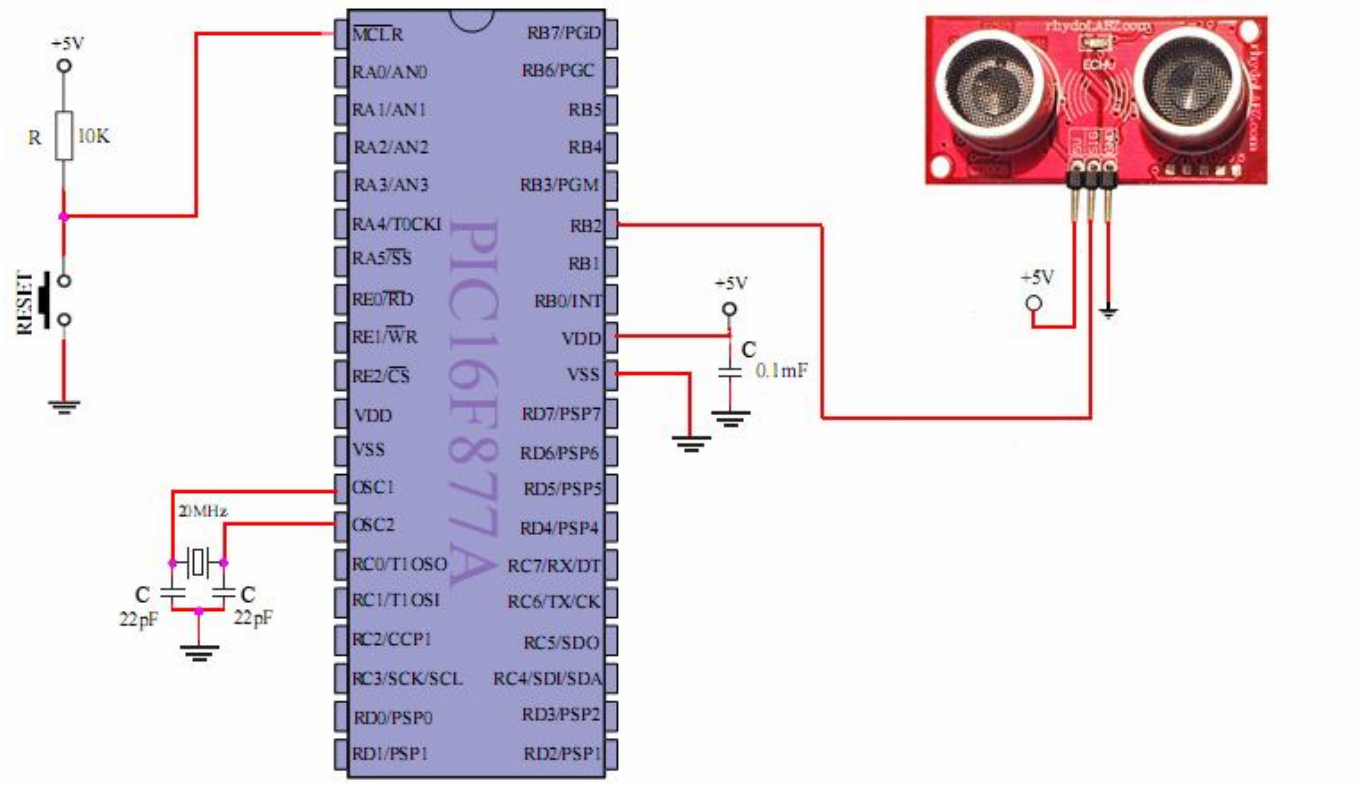


Under control of a host microcontroller (trigger pulse), the ECHO sensor emits a short 40 kHz (ultrasonic) wave. This burst travels through the air, hits an object and then bounces back to the sensor. The ECHO sensor provides an output pulse to the host (through its signal pin) when the echo is detected; hence the distance to the target can be measured from the width of this pulse.

	Host Device	Input Trigger Pulse	t_{OUT}	10 us(min & typical) 100us max
	ECHO Sensor	Echo Holdoff	$t_{HOLDOFF}$	700 us
		Burst Frequency	t_{BURST}	200us @ 40KHz
		Echo Return Pulse Minimum	t_{IN-MIN}	87us
		Echo Return Pulse Maximum	t_{IN-MAX}	30ms
		Delay before next measurement		32ms

INTERFACING '*ECHO*' SENSOR

Interfacing the ECHO Sensor with PIC 16F877 microcontroller



FINDING THE DISTANCE

The figure above depicts the interfacing of an ECHO sensor to PIC16F877A.

As per the figure, the signal I/O pin of the ECHO sensor is to be connected to RB2 (Pin<35>) of the HOST controller. Pin RB2 of your host controller has to be configured to both input and output accordingly to the function. It is your host controller that has to trigger the functioning of an ECHO senor. At this time the pin RB2 of the host controller has to be configured as output so that it can give (o/p) a trigger signal to the sensor. The trigger pulse should be of range 10µsec - 100µsec, typical value is 10µsec.

After triggering the sensor, pin RB2 has to be configured as input so that your host controller switches to the receiving mode. Any pin configured as input should be provided with either pull-up or pull-down voltages so that it isn't affected by small static field variations. But here no external pull-ups or pull-downs are required since, the signal I/O pin of the ECHO sensor which is to be connected to pin RB2 has been **provided with pull-down on-board.**

In the receiving mode, the host controller has to wait for the **Low to High** transition in the **SIG pin**. When a transition is detected**,** the host controller should start counting the time. The host controller can use a timer or any other programming logic to calculate the time. The counting **should terminate** when the next **High to Low** transition is detected. The time gap between transitions will vary (**PWM)** with respect to the distance to the target. The obtained value (pulse-width) in µSeconds represents the echo time and further calibrations of this data gives you the obstacle distance. ie, **the echo time** in micro-seconds **divided by 58 (at 30° C)** gives you the obstacle distance **in centimeters** and the same divided by **148 (at 30° C)** gives the distance **in inches**. **i.e Echo time in µsec /58 = distance in cm** and **Echo time in µsec /148= distance in inches.** The calculated distance can be either displayed in an LCD or transmitted to your PC.

Calculations to be performed by your HOST microcontroller

- Speed of ultrasonic wave is 347 m/s equivalent to 0 .0347cm/µsec (**Temperature dependent**)

  Timer count multiplied with 200nsec (0.2µsec), internal clock period gives the echo time (say, Et).

- As per the eqn: **Speed = distance/time => echo distance (Ed) = echo speed(Ev) *echo time(Et)**

  ie, **distance (Ed) = 0.0347cm per µsec (Ev) * Et µsec**

  The obtained distance will be twice the actual distance since it gives the to and fro distance of the object as per the to and fro time equated to the equation: **(ie, Et stands for 2Et).**

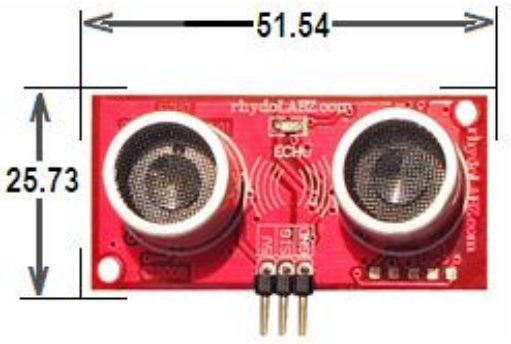
  Thus the **obtained distance divided by 2** gives **actual distance** of the obstacle. ie, **Actual distance = Ed/2**

As per the above illustration your equation is,

Ed = Ev * (Et/2) implies Et = 2 * Ed /Ev equivalent to **Et = (2/0.0347) * Ed**

Implies **Et = 58 * Ed** equivalent to **Ed (in cm)= Et(in µsec)/58**

DIMENSIONS (mm)



PRACTICAL CONSIDERATION FOR USE

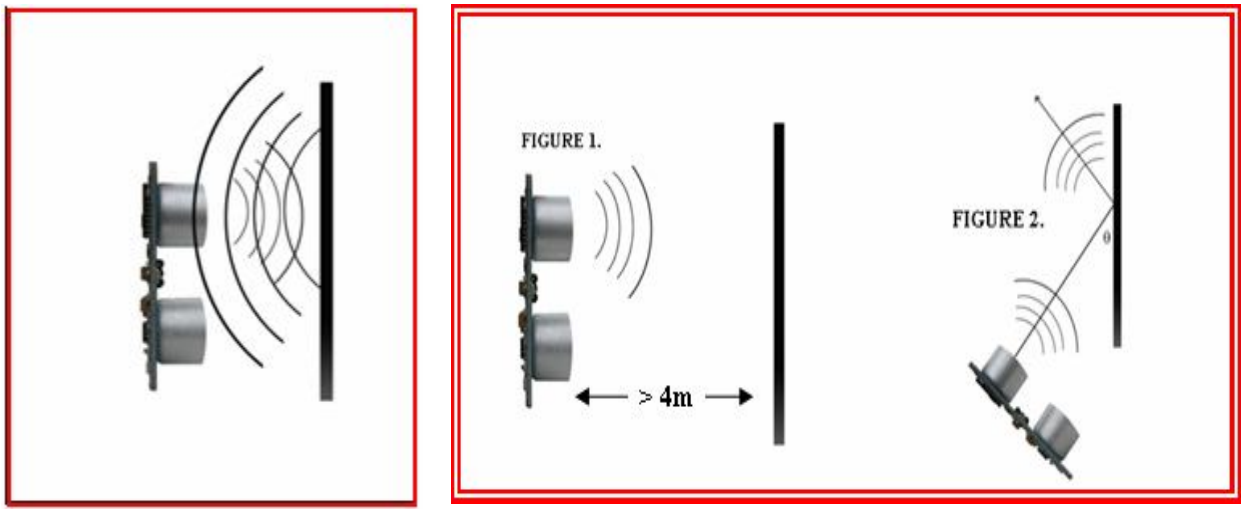
Object Positioning

The ECHO sensor cannot accurately measure the distance to an object that:

- Is more than 4 meters away, Fig 1
- That has its reflective surface at a shallow angle so that sound will not be reflected back towards the sensor (Angle θ < 90°), Fig 2. or
- Is too small to reflect enough sound back to the sensor.

In addition, if your ECHO sensor is mounted low on your device, you may detect sound reflecting off the floor.

Ideal Case Of Positioning ***Error Case***



Target Object Material

In addition, objects that absorb sound or have a soft or irregular surface, such as a stuffed animal, may not reflect enough sound to be detected accurately. The ECHO sensor will detect the surface of water; however it is not rated for outdoor use or continual use in a wet environment. Condensation on its transducers may affect performance and lifespan of the device.

Air Temperature

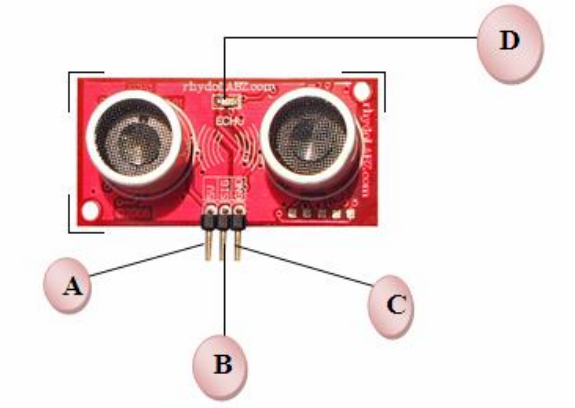
Temperature has an effect on the speed of sound in air that is measured by the ECHO sensor. If the temperature (degree Celsius) is known, the formula is

C_air = 331.5 + (0.6 * Tc)m/s

The percent error over the sensor's operating range of 0 to 70 ° C is significant, in the magnitude of 11 to 12 percent. The use of conversion constants to account for air temperature may be incorporated into your program.

BOARD SPECIFICATION

- VCC -- Power supply input marked 'A'
  5V supply has to be provided for its reliable performance
- SIG -- Signal pin marked 'B'
  This pin is used for output PWM to the host controller
- GND -- Ground level of Power supply marked 'C'
- The marking 'D' points to the Burst LED Indicator that shows measurement in progress.



TECHNICAL SUPPORT

If you are experiencing a problem that is not described in this manual, please contact us. Our phone lines are open from 9:00 AM – 5.00 PM (*Indian Standard Time*) Monday through Saturday excluding holidays. Email can be sent to *support@rhydolabz.com*

LIMITATIONS AND WARRANTEES

This product is intended for personal or lab experimental purpose and in no case should be used where it harmfully effect human and nature. No liability will be accepted by the publisher for any consequence of its use. Use of the product software and or hardware is with the understanding that any outcome whatsoever is at the users own risk. All products are tested for their best performance before shipping, still rhydoLABZ is offering One year Free service warranty (Components cost + Shipping cost will be charged from Customer)

DISCLAIMER

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