

# Laboratory 4

(Due date: November 7th)

## OBJECTIVES

- ✓ Learn how to interface with an external component
- ✓ Learn how to use input capture to measure an input digital waveform
- ✓ Learn how to output compare to output a digital waveform
- ✓ Learn how to use an existing C library

## FIRST ACTIVITY (100/100)

- You will be designing a program to interface with the HC-SR04 ultrasonic rangefinder. Below is a picture from its datasheet explaining its operation. **All signals shown are 0 to 5V.**

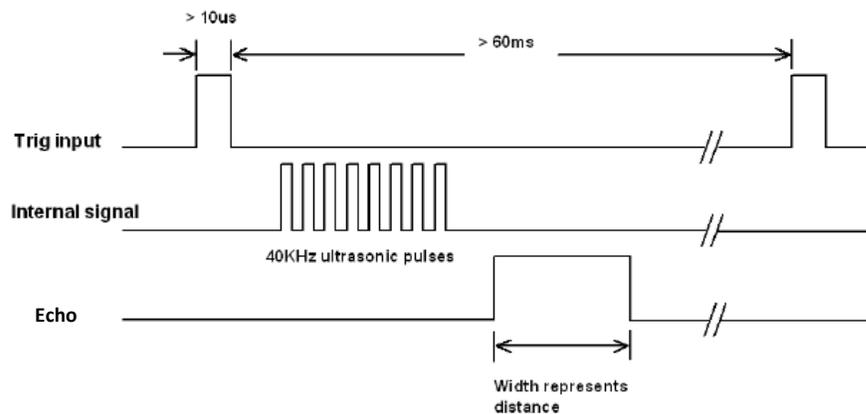
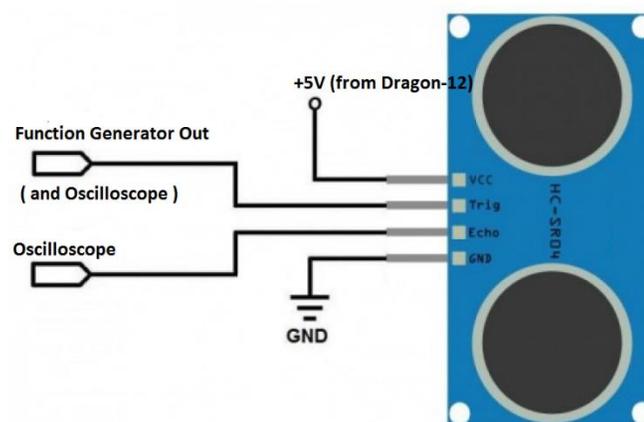


Fig. 1

A trigger input with a pulse width longer than 10 us starts a measurement. This sends 40KHz sound waves out the rangefinder. The distance is measured internally on the component and output on the echo output. The width of the echo pulse corresponds to a distance using the following equation:

$$\text{dist(cm)} = \text{echo\_width(uS)} / 58$$

- Use the pulse mode of the function generator to generate the trigger signal (you will need to specify Period, Ampl, Offset, and Width). Use the oscilloscope to verify you have setup the trigger correctly.
- When you have a working trigger signal, wire up the rangefinder to the Dragon-12 as shown in **Fig. 2**. Use the measurement functionality of the oscilloscope to measure the two widths. Use the oscilloscope to verify that the ultrasonic rangefinder works similar **Fig. 1** (you could have a bad one!). Capture an image from the oscilloscope similar to **Fig. 1**.



### FIRST ACTIVITY (CONT.)

- Create a new project (**lab4**). Add the given file timers.h to the project.
- In this project you will write a program in C (and maybe some assembly) to read distances from the ultrasonic sensor
  - Use the HCS12's output compare functionality to generate the trigger pulse
  - Use the HCS12's input capture functionality to measure the width of the echo pulse
  - Output the measured distance the on LEDs like a progress bar
    - (ie. 0xFF =really far, 0x3F far, 0x0F=sorta close, 0x07 = close, 0x00 = really close)
- **Demonstrate that your code works to the TA and submit the working code and oscilloscope capture to the Moodle Submission page**

TA signature: \_\_\_\_\_

Date: \_\_\_\_\_

### EXTRA CREDIT ACTIVITY (20/100)

- Use the rangefinder as an instrument by outputting different musical notes on the Dragon-12 speaker based on the measured distance.
- **Demonstrate that your code works to the TA and submit the added code to the Moodle Submission page**

TA signature: \_\_\_\_\_

Date: \_\_\_\_\_

### HINTS

- timers.h contains most of the functions required to interface with the input capture and output compare functions of the HCS12
- Output capture 7 can make other output captures have more complicated outputs
- The output button of the function generator turns on the output
- Easiest way to make a progress bar is using a bunch of if else if statements
- Pin 5 on Port T connects to the Speaker