

**Project #4**  
**16F877A PICMicro programming under MPLAB**  
**Due: July 12, 2024**

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## Interfacing a 16F877A controller to ultrasonic sensors SFR04

We would like to build a hardware board that interfaces a 16F877A controller to 24 ultrasonic modules SFR04. The ultrasonic modules have 4 pins where 2 of them are for power (Vcc, Gnd) and the other 2 pins are called trigger and echo pins (see Figure 1). The SFR04 module is easy to use as only 2 pins need to be connected to the 16F877A to get to read the distance of objects facing the ultrasonic modules.

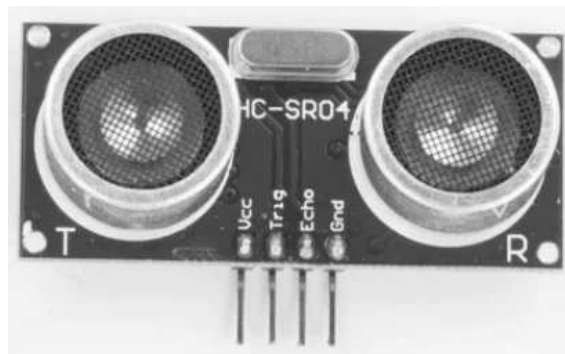


Figure 1: Ultrasonic module SFR04

To read a distance of objects with respect to an ultrasonic module, the following steps need to be executed:

- Make the trigger pin low.
- Wait for 2 microseconds.
- Make the trigger pin high.
- Wait for 10 microseconds.
- Make the trigger pin low.
- Wait for the echo pulse to go high.

Since the number of SFR04 ultrasonic modules exceeds the number of available pins on the controller 16F877A, we'll use 3 decoders 74LS138 ( $3 \times 8$  decoders) and 3 multiplexers 74LS151 (8 inputs, 3 selection lines, 1 output) to help with the SFR04 interfacing. The idea is to use the decoders for the trigger pulses of the modules and the multiplexers for the echo signals.

The hardware board should behave as follows:

1. When the system is powered up, the first line of the LCD should display the message 'Welcome to' and the second line of the LCD should display the message 'SFR04 Modules'.

The above message blinks 3 times with a 0.5 second delay between blinks.

2. When step (1) above is done, the 16F877A controller will trigger the SFR04 modules one by one and keep in the  $16 \times 2$  LCD display the top 4 distances (2 readings on the first row, 2 readings on the second row as shown below):

US-05:	US-13:
US-23:	US-17:

In the above LCD drawing, I assume the highest distance readings relate to modules 05, 13, 23 and 17 consecutively. The display is sorted with the highest distance on the first row. Thus the distance reading of module 05 is the highest and that of module 17 is the lowest among the highest 4 readings.

Once the 16F877A controller reads the distance value from an SFR04 ultrasonic module, it pauses for a second before moving to the next SFR04 ultrasonic module. Thus, the whole cycle requires 24 seconds to read the 24 ultrasonic sensors' distances. Once the last SFR04 has been reached, go back to the first SFR04 and the same sequence goes on forever.

## What you should do

- Use Proteus application to build the schematic for the whole system (including the  $16 \times 2$  character LCD, SFR04 modules, etc).
- Use the interrupt pins of PortB as input for the echo signals from the SFR04 modules. That should allow you to use the interrupt capability of the controller 16F877A. You can choose not to use the interrupt capability if you wish.
- Use PortD of the 16F877A controller to connect the character LCD in 4-bit mode. Remember to pull up the RS pin of the LCD using a  $4.7K\Omega$  resistor.
- Add a 4MHZ oscillator (with  $2 \times 15pF$  capacitors) and a  $10K\Omega$  pull-up resistor to the MCLR pin.
- Build the PIC assembly code that implements the behavior described above under MPLAB IDE.
- Assemble the project and make sure you get a successful build. Use the simulator if you wish to make sure the behavior is correct.
- Send the zipped folder that contains the MPLAB code for the project before the deadline. If the deadline is reached and you are still having problems with your code, just send it as is!