



***UNIVERSITY OF JORDAN***

***Embedded Systems Lab***

***Vending Machine***



***Preferred Group Size***

***Grading***

***Project Due Date***

**(4)** Four is the allowed group size.

**(20)** 20 marks is the project weight.

**(22<sup>nd</sup>/23<sup>rd</sup>)** The deadline for the project is Tuesday/Wednesday, August 22<sup>nd</sup>/23<sup>rd</sup> 2017.

## Project Description

In this project you are required to implement a simple vending machine. There will be two PICs in the design. PIC\_1 is responsible for the following:

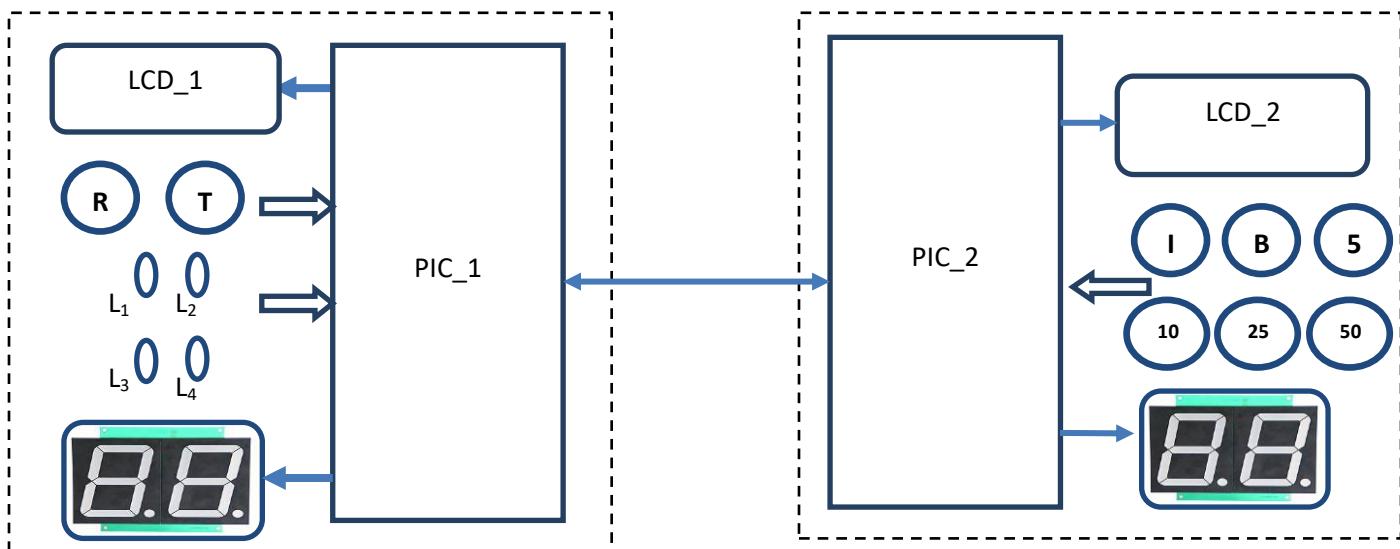
- Displaying the different types in the vending machine using an LCD (minimum 4 types).
- Keeping track of the quantity available for each type, alerting the vending machine company when there are no more items of a certain type using LEDs, and controlling Refills.
- Receiving pricing and purchasing requests from PIC\_2.
- Displaying the price of the item chosen by the buyer using a 7-segment display.
- Sending the appropriate purchasing reply message to PIC\_2.
- Displaying the total amount of money in the machine using a 7-segment display.

On the other hand, PIC\_2 is responsible for the following:

- Allowing the buyer to check the price of an item by sending a pricing request to PIC\_1.
- Collecting the money from the buyer and sending the total to PIC\_1 (i.e. purchasing request).
- Implementing the 90 seconds timer of pricing and purchasing requests and displaying it on the 7-segment display.
- Receiving PIC\_1 purchasing reply messages and displaying them using an LCD.
- Displaying the change (i.e. remainder money) using a 7-segment display.

## Hardware Layout

As mentioned above, this project requires two PIC microcontrollers. Each PIC performs specific functions and has different input and output devices connected to it. The two PICs are connected as in the following figure:



PIC\_1 is connected to 2 push buttons (R and T), 4 LEDs (L<sub>1</sub>, L<sub>2</sub>, L<sub>3</sub>, and L<sub>4</sub>), LCD\_1 and 2-digit 7-segment display. PIC\_2 is connected to 6 push buttons (I, B, 5, 10, 25, and 50), LCD\_2 and 2-digit 7-segment display. Notice that the two PICs are connected to each other as well.

## Functionality

The functionality of the vending machine is best described by explaining the functionality of each PIC. PIC\_1 displays the different types available in the vending machine on LCD\_1. There should be at least 4 types displayed with a unique CG-RAM shape for each type (e.g. chocolate bar, Juice, water...etc.). PIC\_1 also keeps track of the quantity of each type (e.g. 5 chocolate bars, 3 Juices...etc.). Hence, each time an item of a certain type is purchased, the quantity of that type is decremented by 1. Similarly, each time a certain type is refilled, the quantity of that type should be incremented according to the amount of the refill. Each type is associated with a LED and when the quantity of the type is Zero, the LED is turned ON to alert the vending machine company that Refill is required. The Refill process is achieved through the push button “R” connected to PIC\_1. When the “R” button is pressed, types with Zero quantities are refilled with a certain amount (e.g. 9).

PIC\_1 receives two kinds of requests from PIC\_2: pricing requests and purchasing requests. When a pricing request is received, PIC\_1 displays the price of the type selected by the buyer on the 2-digit 7-segment display connected to it. The price is for each type can be any multiple of 5 value between 1 and 99 Fils (i.e. 5, 10, 15, ..., 95). When a purchasing request is received, PIC\_1 checks if there is an item available from the selected type. If no item is available, PIC\_1 sends a reply message to PIC\_2 to indicate that the selected item is not available and ask the buyer to collect his money. If the item is available, PIC\_1 sends a reply message to PIC\_2 to ask the buyer to collect his item and change. PIC\_1 should also send the amount of the remainder money (i.e. change) to PIC\_2.

The last functionality of PIC\_1 is to keep track of total amount of money available in the vending machine and display that amount on the 2-digit 7-segment display rounded to the nearest JD when the “T” push button is pressed. For example, when the amount of money available in the vending machine is 14.25 JD and the “T” button is pressed, the amount 14 is displayed on the 7-segement display connected to PIC\_1.

PIC\_2 allows the buyer to check the price of an item by sending a pricing request to PIC\_1. This can be done by pressing “I” button connected to PIC\_2. When the buyer presses the “I” button for the 1<sup>st</sup> time, the number 1 should appear on LCD\_2 to indicate that the buyer is interested in an item of type 1. When the buyer presses the “I” button for the 2<sup>nd</sup> time, the type number displayed on LCD\_2 is incremented by 1 to indicate that the buyer is interested in an item of type 2 and so on. Notice that if there are 4 types in the vending machine and the current type number displayed on LCD\_2 is 4, the type number should roll-back to 1 if the buyer presses the “I” button one more time. After selecting the desired type, the buyer should press the button “B” to send the pricing request to PIC\_1. As discussed above, when PIC\_1 receives the pricing request it displays the price of the desired price on the 2-digit 7-segement display connected to it.

In addition, PIC\_2 collects money from the buyer and sends purchasing requests to PIC\_1. To deposit a certain amount of money in the vending machine, the buyer needs to push a combination of the buttons: “5”, “10”, “25”, “50”. For example, if the buyer wants to deposit the amount of 35 Fils, he can push “5”

one time and “10” three times. Alternatively, the buyer can push “25” one time and “10” one time. Every time the buyer pushes one of the four buttons, the total amount of money deposited in the vending machine should be updated and displayed on LCD\_2. In order to send a purchasing request to PIC\_1, the buyer needs to select a type using the “I” button as described above and then deposit enough money in the vending machine and finally press the “B” button. PIC\_1 handles purchasing requests by sending appropriate messages to PIC\_2 along with the amount of any change available. Consecutively, PIC\_2 displays the reply message on LCD\_2 and the amount of the change on the 2-digit 7-segment display connected to it.

Once the user initiates a pricing or a purchasing request by pressing the “I” button for the 1<sup>st</sup> time, a 90 seconds timer is set on. The value of the timer is displayed on the 7-segment display connected to PIC\_2. When the user completes the request by pressing the “B” button, the timer is terminated. If the timer goes off (i.e. reaches 0) before the user completes the request, the request is cancelled (i.e. LCD\_2 is cleared).

**Every group should add an extra feature to the vending machine. For example, one group can add the possibility of the buyer depositing insufficient amount of money to buy a certain item and handle it appropriately.**

## **Important Notes**

- Start as early as possible on your project, though the project description sounds simple, there is inherent complexity in both hardware and software aspects, so do not underestimate the time it needs, you will have many problems along the way which you will have to resolve!
- Never think of buying a model or commissioning someone to do it for you, not only will you get a zero in the project, but also your act will be considered as a direct violation to JU laws and your actions shall be reported as cheating in the final exam!
- **Code sharing between groups is NOT allowed and leads to 0 points.**
- If you acquire a **part** of your software from a book, website, etc ... kindly reference it properly, else it will be considered as plagiarism.
- You are only allowed to base your project on PIC16877a or PIC1684a.
- All programming must be done in **PIC ASSEMBLY** language only; using high level languages in the project will get you a Zero.
- Your submitted work must be professional:
  - Hardware: you are submitting a product, all electrical and electronic components must be hidden from the user, only user-accessed components are visible, hide the wiring, be neat. ***Still, the instructor should be easily able to examine the internal components at the time of discussion when required!***
  - Software: your work should be fully documented, all inputs/outputs should be listed, and each subroutine/macro should be fully documented! Use functional comments! Refer to the last section in experiment 2 regarding documentation.
- You should submit two types of flowcharts:
  1. An abstract general flowchart of the whole program.
  2. A flowchart for each of your subroutines/macros (except codes taken from lab experiments).

- Students are not allowed to move between groups once they are formed, so choose your group carefully from the beginning! ***We are not responsible if your colleagues in the group chose to drop the class, we will not allow you to join another group!***
- Divide the work such that each student is responsible for a specific task, **YET EVERY** student is required to answer for **ANY QUESTIONS** in relation to any submitted work of the project.

## **Report Guidelines**

You should submit a hard copy of your report and it should contain the following parts:

- Introduction
- Requirements and subsystems description along with their respective flowcharts (as described above in the notes section)
- Circuit diagram of your hardware (use Proteus to draw the circuit)
- Snap shots of the actual hardware implementation with a brief description
- The contribution of each student in the project
- Major obstacles faced during the design process

**Good Luck and Have Fun Building the Project**