ELE2303 Embedded Systems Design (changes V1.01, V1.02)

Assignment 2 – Washing Machine Controller - Stage 2

Description	Marks out of	Wtg (%)	Due date
WMC – Stage 2	200	20	**9/06/17**

Purpose

This assessment is intended to evaluate the student's capability in **using hardware and designing software** for microcontroller unit (MCU), **altering/adding to existing interface routines** (from Assignment 1) and writing a **state-based main program to operate the Washing Machine Controller (WMC) as a functional unit**.

Grading of this assessment

This task will be assessed against the course objectives **2, 3, 6 and 7**. This assessment will be graded (F, C, B, A, HD) using a checklist marking scheme against criteria such as: **appropriate use of hardware and interface routines**; **state-based software design**; implementation of software to meet a specification; quality of documentation including organisation of ideas and format; spelling, grammar and punctuation. *Note - this course is a communications benchmark course, hence marks will be awarded for the quality of documentation.*

Assignment Requirements

This assessment requires students to meet the requirements of the specification below, **alter interface routines (if necessary) to match specified hardware**, **write and test C programs** to operate the **WMC** and then **document the software** as a proposed design.

Software is to be written in C using the MPLABX IDE. You must utilise a project for your program which may include one or more C source files. The **testing is to be completed** using the PICSimLab simulator.

There is NO requirement to assemble any hardware, or layout a PCB for this assignment. The circuit design for the hardware may be drawn using electronics CAD software, OR neatly hand-drawn and scanned, for inclusion in the documentation. The interface for the application can be successfully tested on the PICSimLab simulator.

NOTE on testing – the time periods specified in minutes for the machine wash cycles are to be reduced to seconds for testing.

A recorded demonstration of the software under-going testing must be submitted with the documentation.

Each student is required to submit:

1. A **report in Microsoft WORD format (with tracked changes enabled)** which includes:
   - **a brief introduction** (150 – 200 words) outlining the design requirements based on the specification.
   - **A state diagram** (preferably a single A3 or A4 page) detailing the controller software design.
   - **A brief description of the state-based control program** (300 – 400 words) **explaining the main program** and how they meet the specification.
   - **A brief description of any <u>modified or additional</u> routines** (as needed up to 200 words) explaining how they meet the specification.
   - **a brief analysis of the testing of the software** (200 – 300 words) explaining what is working and isn't working.
   - **A Zoom recording** showing the compilation in MPLABX and testing of the functionality of the program on the PICSimLab simulator, with commentary by the student.
   - **copy of the C source code** showing the whole program. (as an appendix to the report)

   The document should be formatted as a report and must include:

   - a title page showing the student name and number
   - numbered sections with appropriate sub-headings
   - grammatically correct English, complete sentences in paragraphs
   - clearly drawn diagrams including figure numbers and captions (may be a separate file)
   - the assignment name and page number in the header of the document
   - the student's name and student number in the footer of the document

2. A **copy of the project directory (**example **myproject.X)** saved as a ZIP file. Make sure all the files in the directory are included.

Notes on academic integrity

This is an individual assessment. **Students must complete and submit their own work and documentation.** Students may discuss concepts and methods of implementation with others, but **it is forbidden to share circuits and source code, copy another student's work or submit work prepared for you by another person**. Student may discuss how to solve the problem, but must come up with their own work. Circuits or programs should NOT be copied (ie. scanned or cut and paste) from the internet or other sources.

For this sort of assessment two or more students submitting the same circuit or program may be considered as plagiarism or collusion. There are also several ways that each part of a program may be implemented, so two 'independently' written programs are highly unlikely to be identical. "Working together on the assignment" should not result in exactly the same design or program. Re-using assignment work from past years is also not allowed and easily identified. Students are also warned that paying someone else to do your assignment is considered a serious breach of the academic integrity policy. This too is very easy to identify!

Students suspected of having colluded, copied another's work (with or without permission) or suspected of having paid a ghost writer to prepare their work will be required to clearly demonstrate they have prepared the work. Submission of the report with tracked changes enabled is intended to help protect the honest student, so failing to follow this instruction will focus attention on your submission. **Students must prepare their report in MS Word format with the track changes feature enabled.** (If you are unsure how to do this – ASK NOW in the forum)

The System Specification

Outline of the task

You have been requested by your Senior Engineer to complete the design of the Washing Machine Controller (WMC). He advises you that **a specific hardware design has been chosen with some minor changes/additions** and a circuit board is being constructed. In the mean time you will need to design and write the main program for the controller and modify (as required) any of your existing interface routines to match the chosen hardware configuration. (shown in Figure 1)

Stage 2 of the project (this assignment) thus requires you to:

(a) **modify existing interface routines** (as necessary) **to match the specific hardware design**
(b) **write a main program** and any additional routines you need, to meet the operational requirements specified on the next few pages
(c) **test the operation** of the controller (*simulate it*)
(d) **prepare a report** detailing your **software** solution for the Washing Machine Controller.

Hardware Requirements

The requirements are as the same as assignment 1, with the addition of a DOOR switch (0 = open), a door lock SOLENOID (1 = lock), a DISPENSE control (1 = trigger), a SPIN SPEED selection for the motor (1 = spin, 0 = normal) and the requirement that the configuration of the chosen design uses ports as depicted in the **block diagram** in Figure 1. No STOP or SPIN LEDs are now required. The BACK button has been renamed to STOP.

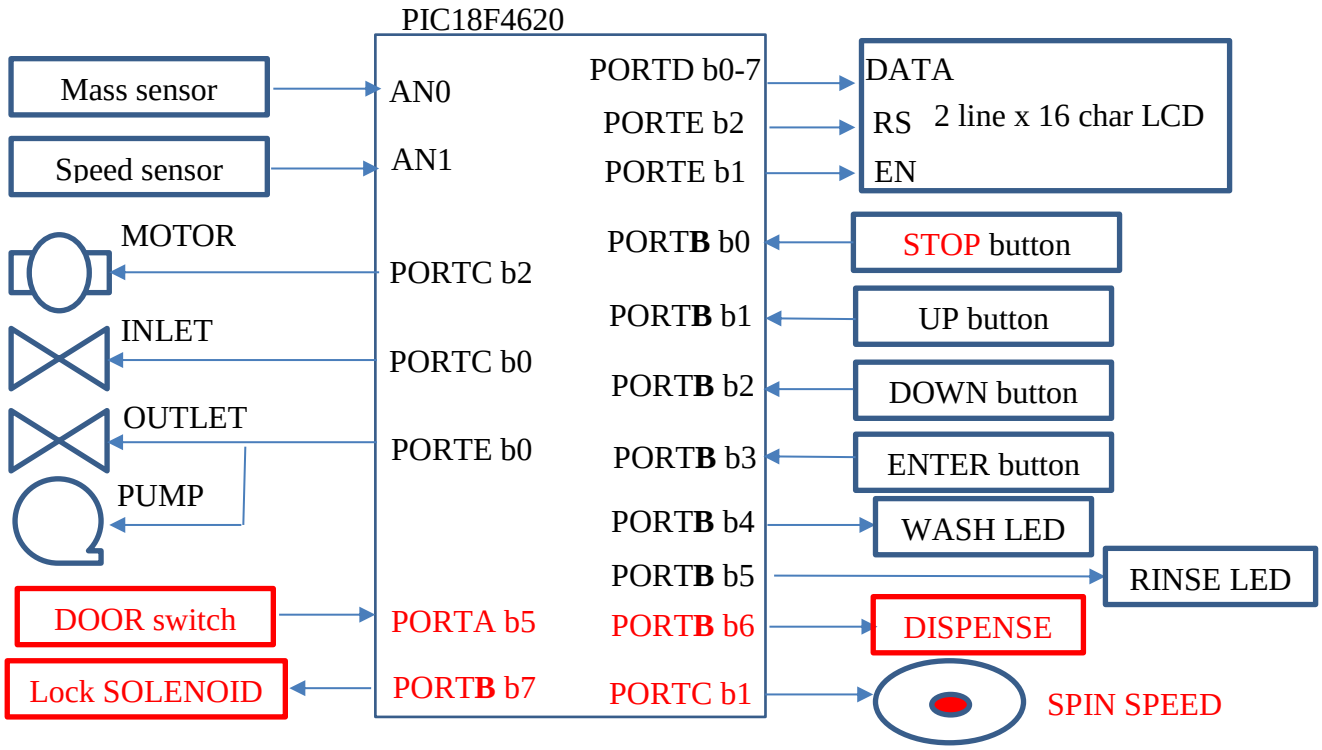

Figure 1. Hardware configuration block diagram

Software Requirements

The requirements for the **interface routines** are the same as assignment 1, with the exception that they may need to be modified to match the hardware configuration specified above. (This will also ensure that tests conducted using the PICsimlab simulator, will be the same for all students.)

Part 10. Re-write the **main** C program that initialises the PIC as required for the hardware, then runs in an endless loop to operate the Washing Machine Controller as below:

Operational requirements

R1. The washing machine mechanism is to operate in four distinct modes: STOP, WASH, RINSE and SPIN. Only 2 LEDs are now used to indicate the modes of WASH and RINSE at the appropriate time. STOP mode is indicated with NO LEDs on. SPIN mode is evident by the sound. (Via the buzzer on the PICsimab) Generally the steps in each mode are:

Wash - Fill the machine to a certain mass, dispense any chemicals, rotate the drum with the motor for a certain amount of time and drain the water via the outlet & pump

Rinse - Fill the machine to a certain mass, rotate the drum with the motor for a certain amount of **time** and drain the water via the outlet & pump

Spin - Spin the drum rapidly for a certain amount of time with the outlet & pump on so most remaining water is removed by the centrifugal force. Spin Speed is achieved with the motor on and the SPIN SPEED output on.

R2. The washing machine has 3 different wash cycles called NORMAL, DELICATE and QUICK. The selection for the various washing **cycles** are to be made via the UP and DOWN buttons and started by the ENTER button, but this must only be selectable during the STOP mode.

The three wash cycles are to be as follows:

Normal – fill until total clothes (up to 5kg) + water = 7.5 kg, dispense (2 second pulse), wash (45 minutes), rinse (10 minutes), spin (5 minutes)

Delicate – fill until total clothes (up to 3kg) + water = 5 kg, dispense (2 second pulse), wash (12 minutes), rinse (3 minutes), dispense (2 second pulse), (added 12/5) wash (12 minutes), rinse (3 minutes), spin (3 minutes)

Quick – fill until total clothes (up to 3kg) + water = 5 kg, dispense (2 second pulse), wash (20 minutes), rinse (5 minutes), spin (3 minutes)

Specification continued

R3. The STOP button is required to stop the machine at any time, cancel the cycle and drain the water via the outlet and pump for 1 minute.

R4. The LCD is to be used to prompt the user for selection of the cycle, to show the name of the cycle and to indicate the approximate time remaining in the cycle (in minutes).

R5. The DOOR switch (active low) and door LOCK (active high) must be used to detect if the door is open or closed and lock it closed during any cycle.

R6. If the mass of clothes placed in the drum exceeds the limit for each type of cycle an appropriate message is to be shown to the user.

NOTES-

The Speed measurement and control is NOT required for this implementation of the Washing Machine Controller.

The time periods specified in minutes for the machine wash cycles are to be reduced to seconds for testing.

Due to the coarse resolution of the sliders on the PICsimlab analog inputs, you are to test for an 'approximate' mass of 5 or 7.5 kg. Raise the slider slowly as if water was filling the drum until the required mass is just exceeded.

End of specification