00273

THE OPEN UNIVERSITY OF SRI LANKA

Faculty of Engineering Technology
Department of Electrical & Computer Engineering
Diploma in Technology – Level 04

FINAL EXAMINATION – (2009/2010)

ECX4236 – Microprocessors and Interfacing

CLOSED BOOK EXAM

Time Allowed: **3 hours**

Date: 25th March 2010 **Time: 1400 – 1700 hours**

INSTRUCTIONS TO CANDIDATES

1. This question paper contains one question in **SECTION A** and three questions in **SECTION B** on 6 pages.
2. Answer **ALL** parts in **SECTION A**.
3. Answer any **TWO** questions from **SECTION B**.

NOTE:

1. When you have to write any Assembly Language Program for your answer, you need to provide appropriate comments where necessary. **Full marks will only be given to correct programs, with comments**.

2. Refer **data sheet of the 8051 microcontroller (given separately)**, when you answer the questions in this paper.

Continued...

SECTION A:
Answer ALL questions

Question 01

Digital Fare Meter (DFM)

The following description is about the *Digital Fare Meter (DFM)* and you are to analyze and design the requirements for the DFM according to the 8051 microcontroller specifications.

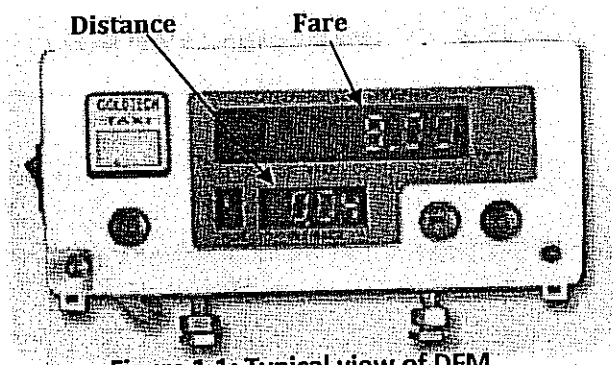


Figure 1.1: Typical view of DFM

A typical view of the *DFM* is given in figure 1.1. The Idea of designing the *DFM* is to be used for calculating the fare for a journey of a three-wheeler according to the distance travelled and waiting time of the journey. *Reading the wheel rotation*, *fare calculation* and *display* are the important parts of the system that you need to consider while answering the questions given below

Design Parameters

1. Each value, specifically the total fare in rupees and the distance travelled in kilometers are indicated by two 3-digits display panels on the DFM, constructed by seven segment displays.
2. Assume maximum distance of a journey = 30km
3. Two switching options are available between *day fare* and *night fare*.
4. There are 3 switching modes: running mode, waiting mode and stop mode.
5. Daily trip statistics for owner's use. (i.e. store total fare and total kilometers in external memory)
6. Operation of the DFM should be simple with minimum number of keys.
7. Crystal frequency of the 8051 microcontroller = 12MHz.

Distance and Fare Calculation

The distance traveled by the three-wheeler and the corresponding fare can be obtained from the following method.

Distance calculation
The wheel diameter = 28 cm.
Assume maximum allowable speed of the three-wheeler = 44 km/h

Fare calculation for a journey (round up to nearest hundred meters)
Day Fare = (a*b*10) + c
Night Fare = Day Fare*2
Where ***a*** = Total Kilometers for a Journey, ***b*** = fare for 0.1 km = Rs 3/=, ***c*** = waiting charge Rs 20/= per hour (round up to the nearest 30 minutes)

State all other assumptions (if any) clearly, when answering the questions.

(i) Draw the external view of the system (i.e. a diagram that shows the inputs and the outputs). [05 Marks]

(ii) Identify the sub units/sub modules of the system and draw the interconnected block diagram of the system using the central controller. [05 Marks]

(iii) Draw a flowchart to represent the algorithm for *Reading the wheel rotation, fare calculation and display* operations of the system. [20 Marks]

(iv) Write an Assembly Language Program for the system. [30 Marks]
(Clearly show *Reading the wheel rotation, fare calculation* and *display* assembly routines with comments)

(v) Write an entity declaration of the system in HDL (Hardware Description Language) or pseudo-code/Structured-English. [04 Marks]

SECTION B:
Answer any TWO questions

State your assumptions (if any) clearly.

Question 02

(i) In a certain experiment, a student has the crystal frequency as 11.0592MHz and (s)he set the variable baud rate to 4800. Find out the timer values of the 8051 microcontroller for the experiment.

[06 Marks]

(ii) Write an Assembly Language Program to send a block of external RAM (XRAM) data located at 0040H – 0080H to a PC through serial communication of the 8051 microcontroller. Use 9200bps, 8 data bits, 1 start bit, 1 stop bit and no parity bits for the communication. Use *serial interrupt* facility available in the 8051 microcontroller. (Assume that the PC will receive data without any error)

[12 Marks]

Question 03

Figure 3.1 depicts the waveform of quadrature outputs of the quadrature encoder of a DC motor. Channel "A" connected to T0 pin and channel "B" connected to T1 pin of the 8051 microcontroller. Table 3.1 and table 3.2 depict gray coding of quadrature outputs as follows.

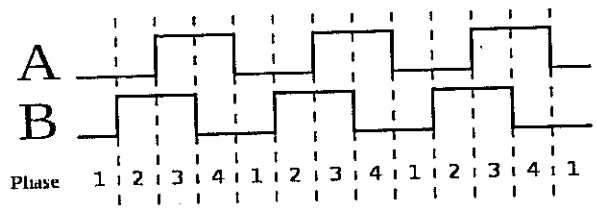


Figure 3.1: Two square waves in quadrature (clockwise rotation)

Table 3.1: Gray coding for clockwise rotation

Gray coding for clockwise rotation		
Phase	**A**	**B**
1	0	0
2	0	1
3	1	1
4	1	0

Table 3.2: Gray coding for counter-clockwise rot

Gray coding for counter-clockwise rotation		
Phase	**A**	**B**
1	1	0
2	1	1
3	0	1
4	0	0

(i) Draw a flow chart to identify rotational direction (whether the clockwise or counter-clockwise) of the encoder *using 8051 counters*. If the motor rotates in the clockwise direction then clear the bit 0 of port 2 (P2.0). If the motor rotates in the counter-clockwise direction then clear the bit 1 of port 2 (P2.1). Else clear the bit 3 of port 2 (P2.3).

[08 Marks]

(ii) Write an assembly language program to implement the algorithm given in Q3(i) algorithm

[10 Marks]

Question 04

Figure 4.1 depicts the timing diagram of a sonar sensor (SRF05) which can be used to measure distance using ultrasound.

It uses a single pin for both trigger and echo signals to save valuable pins on 8051 microcontroller (MCU). This pin of the sonar sensor is connected to INT0 (P3.2) pin of the MCU to obtain distance of an object from base point.

If MCU sends a 10 microsecond trigger pulse to the sonar sensor then it will send 8 cycles of sonic burst to detect object and then it will send back an echo pulse to the MCU along the same pin (INT0) as shown in figure 4.1 below

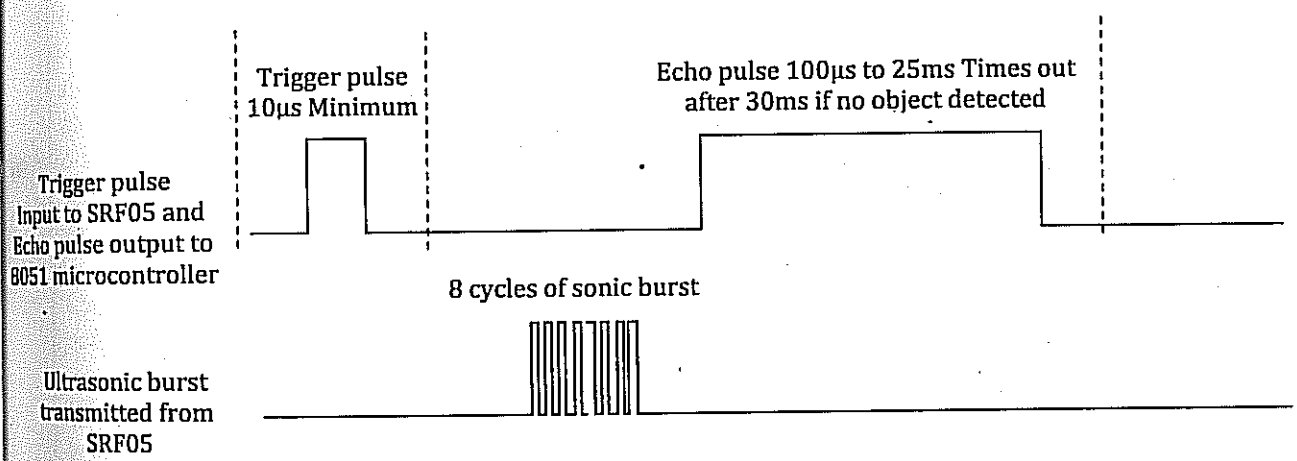


Figure 4.1: Timing Diagram

The distance (s) can be computed as, $s = \frac{ut}{2}$ where **u** = speed of the sound = 340 m/s at 20^0C and **t** = width of measured echo pulse in seconds. For the particular experiment, timer0 can be used to measure echo time (**t**), Assume that TMOD value is 09H and crystal frequency XTAL = 12MHz.

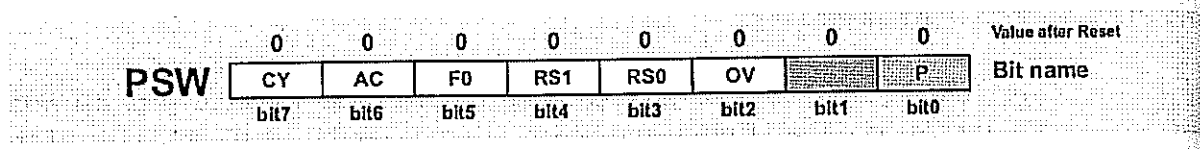
(i) Draw Timer0 *configuration diagram* to measure the echo pulse with TMOD values.

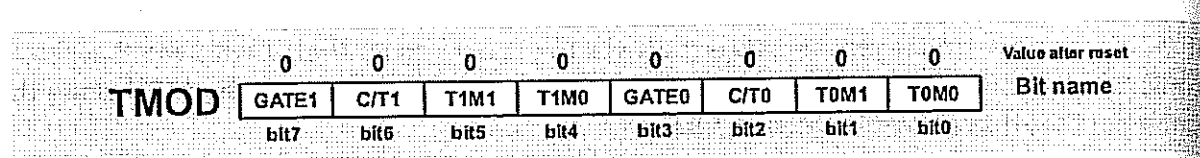
[06 Marks]

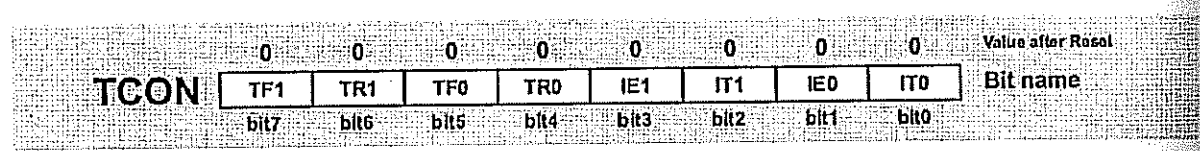
(ii) Write an assembly language program to compute the distance above using Timer0 with given settings. Store the result in internal RAM location 20H.

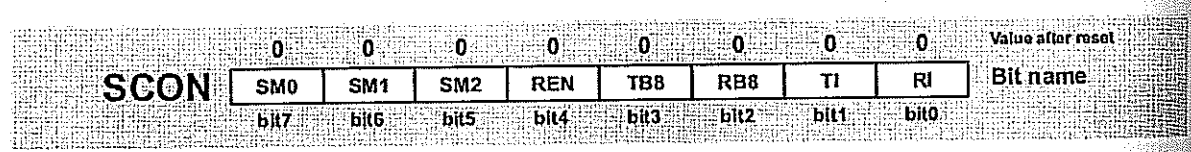
[12 Marks]

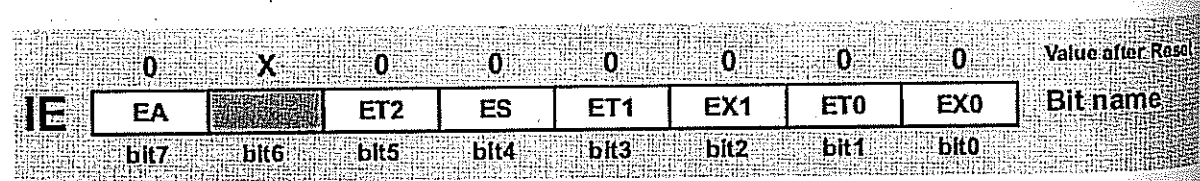
References: 8051 SFR Registers (from http://www.mikroe.com/en/books/8051book/ch2/)

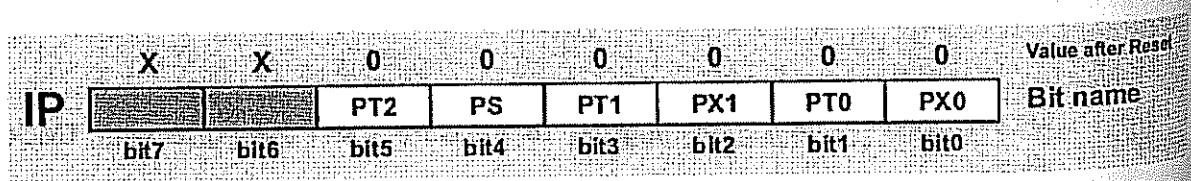


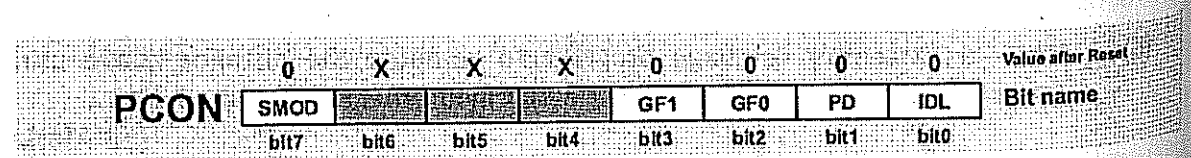












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