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# Design and Development of Microcontroller Based Electronic Queue Control Systems

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**Abstract**

**In this work, low-cost, portable microcontroller based electronic queue control (EQC) systems have been developed for the purpose of controlling queue in banking, hotel reservation counter, ticket counter, insurance company, customer service center etc. The aim of the designed systems is to maintain a queue with order and efficiency. Two different queue control systems have been implemented with slightly different features. In EQC system-1, a general display has been used for displaying token number and service counter number whereas in EQC system-2, each token number has been displayed individually in each service counter with separate displays. In the both systems, each customer has to collect a token and then will be served whenever the token number is displayed. The systems were designed around a 16F72 IC, a low-cost 8-bit PIC microcontroller and entirely software controlled. The control programs have been developed using the PIC assembly language. Finally, the systems have been tested under different conditions to evaluate their performance.**

**Keywords:** Microcontroller, Electronic Queue Control System, Display, PIC assembly language.

## 1. Introduction

In daily life, Customer service orientated companies and institutions frequently face the problem of lengthy queues and unpredictable waiting causing tension and stress among both customers and employees which result in efficiency decline. The solution is a microcontroller based electronic queue management system. It is nothing but a customer service management system that enables the confident treatment of administration, which is often essential; customers do not stand end to end any more. Instead of standing in long queues, customers may sit down and might learn some useful information concerning the services of the company. Any customer-orientated institution, like customer care centers of different telecommunication companies, banks, hospitals, insurance companies, local government offices, post offices, etc. will improve their services providing a more favorable image and text.

There are many manufacturers all over the world which supply electronic equipments to control queue but those equipments are very costly. This work is intended to design low cost equipment
with locally available materials. Here, two different electronic queue control systems with
minor difference in features named i) Electronic Queue Control (EQC) System-1 and ii) Electronic Queue Control (EQC) System-2 have been developed. In the designed systems, four customer service counters can be served at a time in First-In-First-Out (FIFO) basis.

## 2. Overview of the Designed Systems

The service scenario of the proposed systems can be described as follows: Each customer will be given a token when he enters the room. Generally the token is a printed paper containing a number. If the token number that the customer collected is displayed on any service counter screen, then instantly he or she is allowed to get service from that service counter. Otherwise he/she has to wait in customer's waiting seat until the counters display his/her token number. In EQC system-1, a single display for the whole system to show token number and corresponding counter number is used (Fig. 1) but in case of EQC system-2, each service counter has individual screen (Fig. 1) and the display of each service counter indicates which customer will be served from that counter.

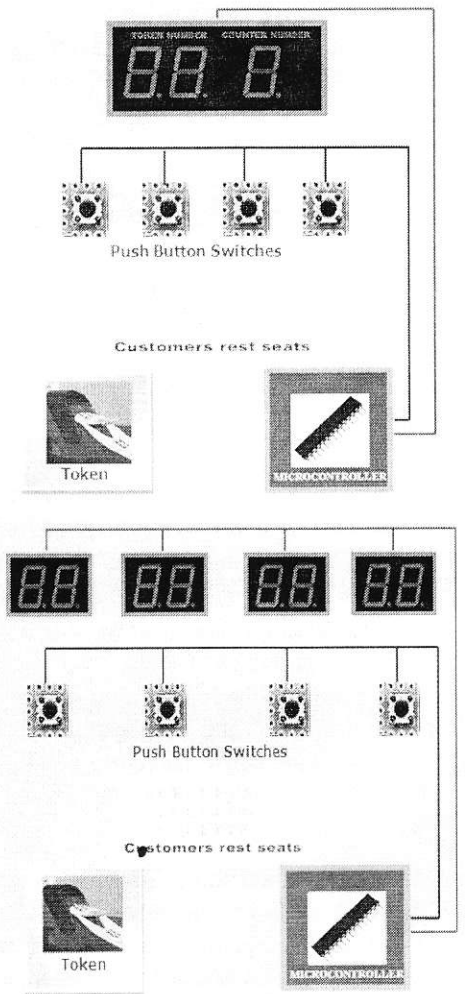


**Fig. 1:** Overview of the EQC System-1(left) and EQC System-2 (right)

## 3. Design and Development of the Systems

The design of electronic queue control systems highly depends on the purpose and place where it will be used. The system design can even become more complex with the addition of new facilities. A simple system may have a display unit, token collection unit, calling unit and control unit and wiring cables.

### 3.1 Design and Development - EQC System-1

The system design comprises both hardware & software design and development stages.

#### 3.1.1 Hardware design

The hardware design process is divided into three subsections like Switch Debouching Section, Display Section, and Control Section.

*Switch Debouching Section*

To avoid the effect of mechanical jittering of push button switches, we use monostable multivibrator (MV) which will generate a constant short duration pulse to be transmitted to the microcontroller regardless of how long the operators press the switch. CD4047BE Astable/ Monostable multivibrator IC has been used here as the monostable multivibrator [2] (Fig. 2). Two external resistor (R) and capacitor (C) set the defined short pulse period. In our case, time period is only one (1) second. The schematic diagram of switch debouching circuits for EQC system-1 is shown in Fig. 3 where each arrow indicates output of MV which is individually connected to 4 pins of PORTA of the microcontroller [3].

*Display section*

This section consists of following units 1. BCD (Binary Coded Decimal) counters. 2. Decoder/Driver unit, 3. LED Seven Segment Display Units

**BCD Counter:** This section is designed as a MOD-99 counter by cascading two DM74LS90 decade and binary counter ICs [5]. The CLK input of the first counter IC is connected to MCU but second counter IC is clocked by the MSB ($Q_D$) of first counter IC [1] (Fig 4). When a button is pressed, the MCU generates a pulse that increases the content of the counter. This counter unit orders the token number of the customers and displays it on 7-segment display. The determination of the corresponding counter number where the customer is being served will be recognized by the microcontroller.

**Decoder Unit:** For common anode Seven Segment Display, DM74LS47N BCD to Seven Segment Decoder has been used. The DM74LS47 accepts four lines of BCD input data, generates their complements internally and decodes the data with seven gates outputs to drive indicator segments directly [1].

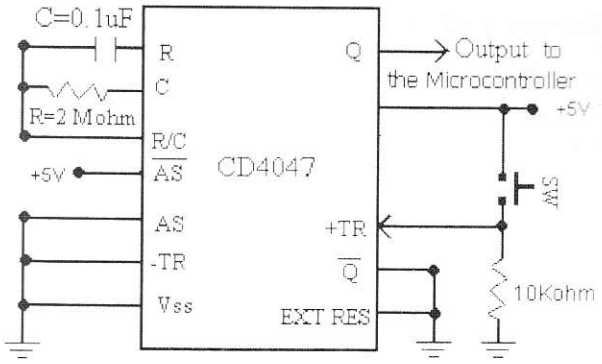


**Fig. 2:** Monostable Multivibrator (MV) as a Switch Debouching Circuit (SDC).

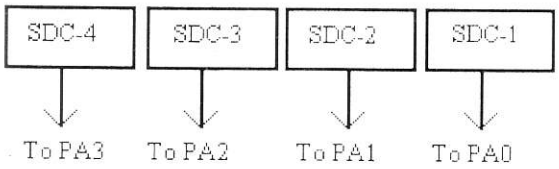


**Fig. 3:** The Switch Debouching Circuits for EQC System-1

**LED 7-Segment Display Units:** Each 7 segment display comprises seven Light Emitting Diodes (LEDs) and anode or cathodes of the LEDs are common. Common anode type 7-Segment Display is used in this work because of active low DM74LS47N BCD to Seven Segment Decoder.

*Control Section*

The purpose of this section is to control the whole EQC System-1. Each customer servicing counter has a single push button switch and the outputs of switch debouching circuits are connected to PORTA of the microcontroller. First four pins (RB0 to RB3) of PORTB are configured as output which is used to display the service counter number. Whenever a switch is pressed, RB4 pin of PORTB sends a pulse to MOD-99 counter to increase the token number. A buzzer is also connected to RB5 pin of PORTB (not shown in Fig. 4) to alert about the change of token number. The successful control is achieved by loading a program to the program memory of the microcontroller [3] [4] [5].

#### 3.1.2 Software Design

This section is developed with the help of a program flowchart shown in Fig. 9.

### 3.2 Design and Development - EQC System-2

#### 3.2.1 Hardware Design

This section is also divided into three subsections: Switches and switches Debouching Section, Display Section and Control Section

*Switch and Switch Debouching Section*

This section is similar to the EQC System-1 exception is that the output from each switch debouching circuit is tied

to PB0 interrupt pin through a signal diode 2N4148. Here, pin PB0 identifies a token change call from all counter but pins PA0-PA3 identify the individual service counter number.

*Display Section*

Two 7-segment displays have been used for displaying token number for each counter i.e., eight 7-segment displays have been used for four service counters. All the 7-segmnets are multiplexed and driven by PB1-PB7 pins of the microcontroller. Thus the counter and the decoder/drivers can be eliminated.

*Control Section*

Each customer servicing counter has a single push button switch and the outputs of switch debouching circuits are connected to PORTA (PA3-PA0) and the signals are ANDed through 2N4148 signal diodes (D1-D4) to PB0 pin of the microcontroller. PB1-PB7 of PORTB is configured as output which is used to send data to the multiplexed 7-segment displays of the service counter. The cathodes of the 7-segment displays have been controlled by PC0-PC7 pins of the PIC.

Whenever a switch is pressed, an interrupt is generated to PB0 pin of PORTB and the microcontroller scans which pin of PA0-PA3 has been pressed to identify the counter number where been pressed to identify the counter number where the token number is to be increased. A buzzer is also connected to PA5 pin of PORTA (not shown in Fig. 6) to alert about the change of token number [3] [4] [5].

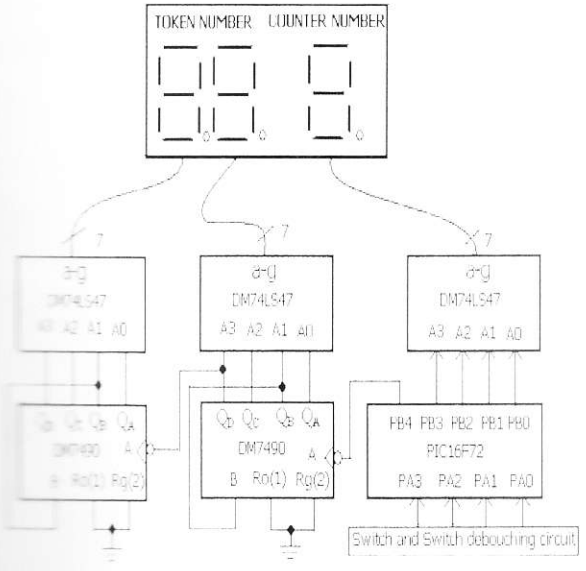


Fig. 4: Complete Circuit Diagram of EQC System-1

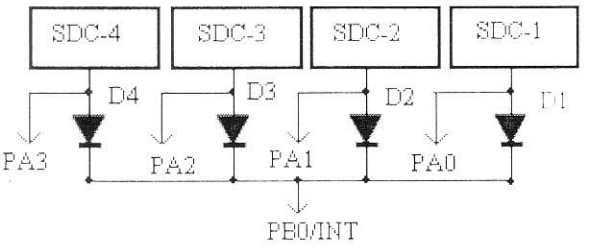


Fig. 5: Switch Debouching Circuits for EQC System-2

### 3.2.2 Software Design

The program flowchart is given in Appendix (Fig. 9 &10 (a), (b)).

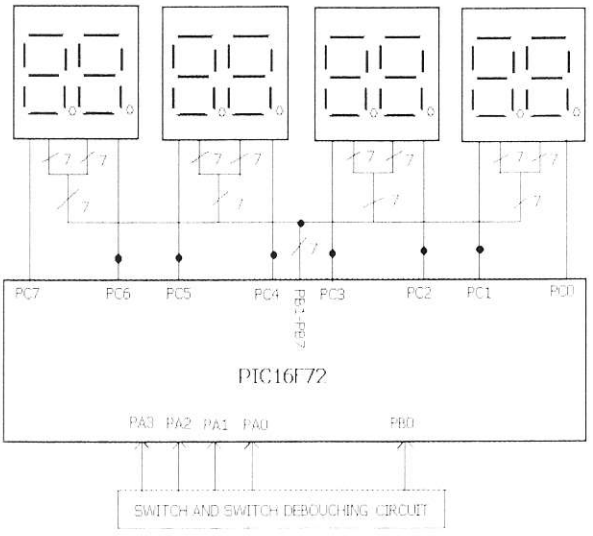


Fig. 6: Circuit Diagram of EQC System-2

## 4. Result

Both the systems have been implemented in assembly language [3] and built using MPLAB assembler [3] and finally downloaded to PIC microcontroller using PICALLW software [6] [7].
Snapshots of both systems are shown in Fig. 7 and 8.

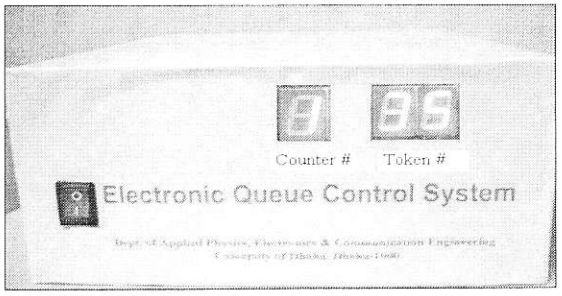


Fig. 7: EQC System-1

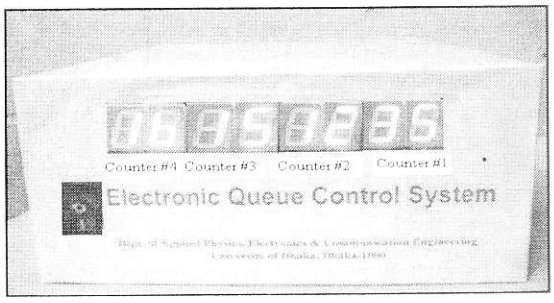


Fig. 8: EQC System-2

## 5. Discussion

This electronic queue control system may seem to be simple in design but in our daily-life it has wide area of applications. Quick and efficient queue management can be ensured through this system. Although it is a very basic arrangement for crowd control, it can be improved to reliable and more secure system with various facilities such as announcing, direction pointing etc. In EQC system-2 using multiplexing technique, individual token number has been displayed to individual display hanging on each service counter avoiding the necessity of using any decoder circuits. But there may be a problem for the customers as they have to look at all the displays of the service counters to know which counter is going to serve him/her. In case of EQC system-1 there is no such problem but there is no way to keep track of last displayed token number. Till then both systems are used in different companies, offices, customer care centers and banks.

## Appendix

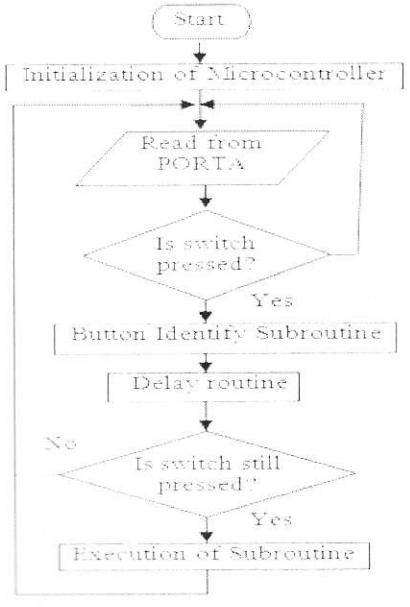


Fig. 9: Flow code for EQC system-1

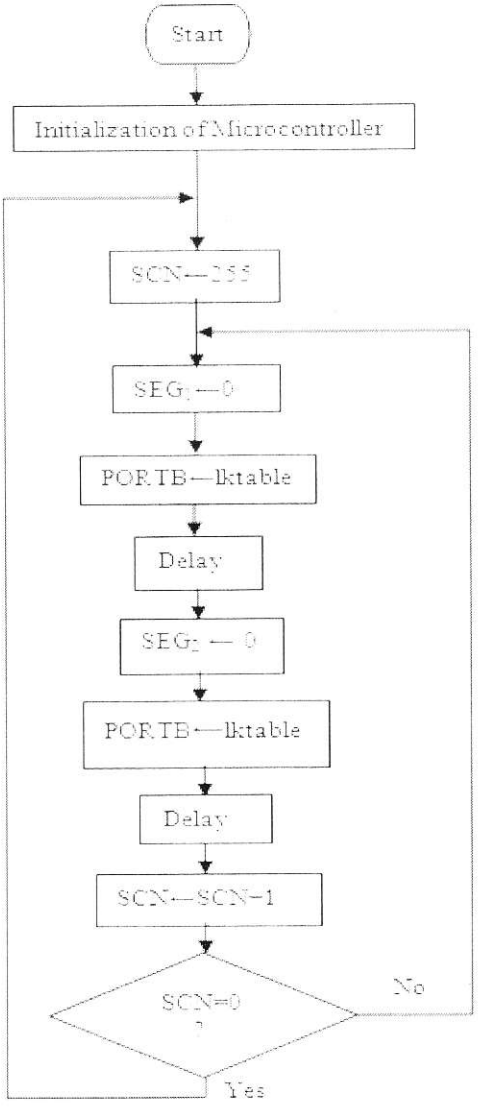


Fig. 10(a): Flow code for EQC system-2(part)

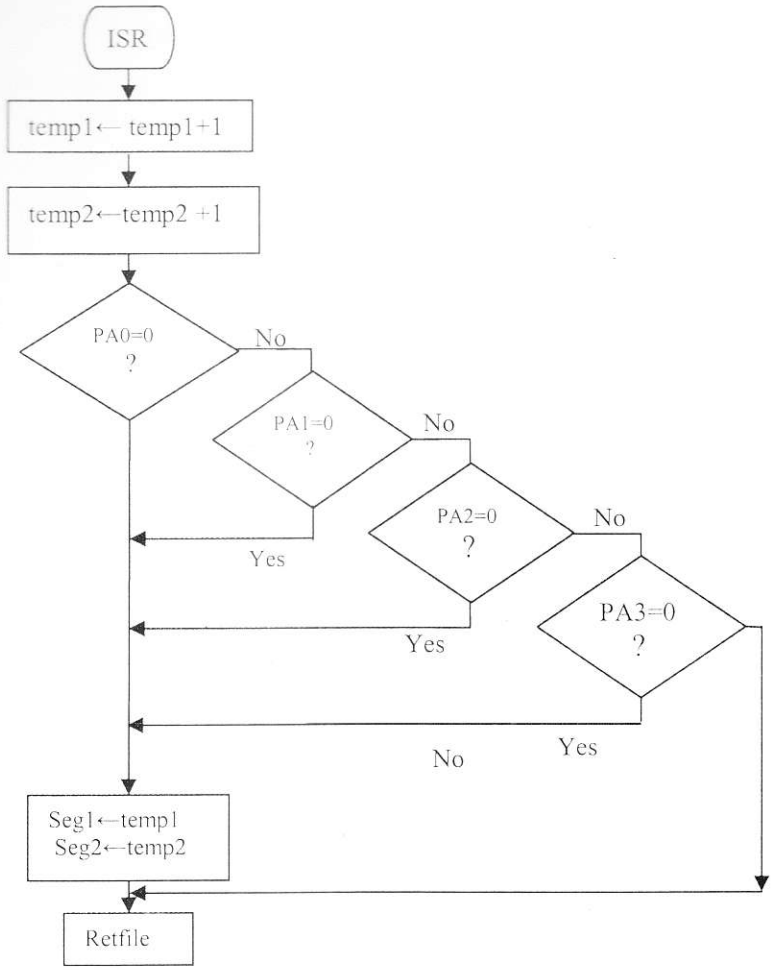


**Fig. 10 (b):** Flow code for EQC system-2

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