Digital Clock

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Course: Embedded System Design
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Introduction

- A **digital clock** is a type of clock that displays the time digitally (i.e. in numerals or other symbols), as opposed to an analogue clock, where the time is indicated by the positions of rotating hands.(Figure 1)
- To represent the time, most digital clocks use a seven-segment LED, VFD, or LCD for each of four digits. They generally also include other elements to indicate whether the time is AM or PM, whether or not an alarm is set, and so on.
- Because they run on electricity, digital clocks often need to be reset whenever the power is cut off, even for a very brief period of time. This is a particular problem with alarm clocks that have no "battery" backup, because a power outage during the night usually prevents the clock from triggering the alarm in the morning.
- To reduce the problem, many devices designed to operate on household electricity incorporate a battery backup to maintain the time during power outages and during times of disconnection from the power supply.
- More recently, some devices incorporate a method for automatically setting the time, such as using a broadcast radio time signal from an atomic clock, getting the time from an existing satellite television or computer connection, or by being set at the factory and then maintaining the time from then on with a quartz movement powered by an internal rechargeable battery.
- Digital clocks are often associated with electronic drives, but the "digital" description refers only to the display, not to the drive mechanism. Both analogue and digital clocks can be driven either mechanically or electronically

Figure 1: A Basic Digital Clock

Design

The following is a very specific design of a digital clock (Figure 2). While preparing for the exam you can describe a generalized system (Figure 4) unless asked for specific components.

The basic components are:

- **Microcontroller**
- **A display**
- **A keyboard or keypad**
- **Power supply**
- **Oscillator**

The following components are used in this digital clock with some specifications:

1. A display device to display the current time. Here a 16 character 2-line display is used for displaying the current.

   Specifications:
   - Display the time in DAY HH:MM:SS format on the first line.
   - Display the message 'Have A Nice Day! ' on the second line.
   - This design uses a Hitachi HD44780 compatible LCD with 8051 microcontroller as per-the following interface details:

     - Data Bus: Port P2
     - Register Select Control.line (RS): Port Pin P1.4
     - Read/Write Control Signal (RW): Port Pin PI.5
     - LCD Enable (E):P1.6
     - The Backlight of the LCD should be always ON
     - The various signals connected to the LCD display:

       - power supply pins (i.e. Vcc and GND)
       - VEE pin (for intensity adjustment of LCD backlight)
       - data pins (D0-D7)- connected to p2.0- P2.7 of microcontroller
       - RS - To indicate a command or data to LCD connected to p1.4 of microcontroller
       - RW - To indicate read or write operation to LCD connected to p1.5 of microcontroller
       - EN or E -To enable pin to indicate latching of command or data connected to p1.6 of microcontroller

2. A microcontroller.

   Specifications:

- Use AT89C51/52 or AT89S8252 microcontroller.
- This microcontroller is compatible with the industry-standard 80C51 and 80C52 instruction set and pinout.
- Use a crystal Oscillator with frequency 12.00 MHz. This will provide accurate timing of 1 microsecond/machine cycle.
- The delay can be accordingly adjusted to give 1μsec; after which the seconds counts. can be incremented. Once the seconds counter reaches 60, it should be reset to 0 and the minutes counter should be incremented. Also once the minutes counter reaches 60, it should be reset to zero and the hours counter should be incremented. Finally if the hours counter reaches 24, it should also be reset to zero. Thus the crystal is a very important component for timer or digital clock.

3. A keyboard for input.

   Specifications:

   - A 2 x 2 matrix key board (4 keys) is interfaced to Port PI of the microcontroller. The key details are:
     - MENU key --connected to Row 0, and Column 0 of the matrix;
     - ESC key connected to Row 0, and Column 1 of the matrix;
     - UP key connected to Row 1, and Column 0 of the matrix;
     - DOWN key connected to Row 1, and Column 1 of the matrix.
   - The Rows 0, 1 and columns 0, 1 of matrix keyboard are interfaced to Port pins P1.0, Pl.l, PI.2 and PI.3 respectively. **(Recall we studied this type of a keyboard interface program in lab experiment)**

4. The power supply is implemented using a transformer followed by a rectifier and finally a regulator.

   Specification:

   - The *LM7805* is a voltage regulator that outputs +5 volts is used

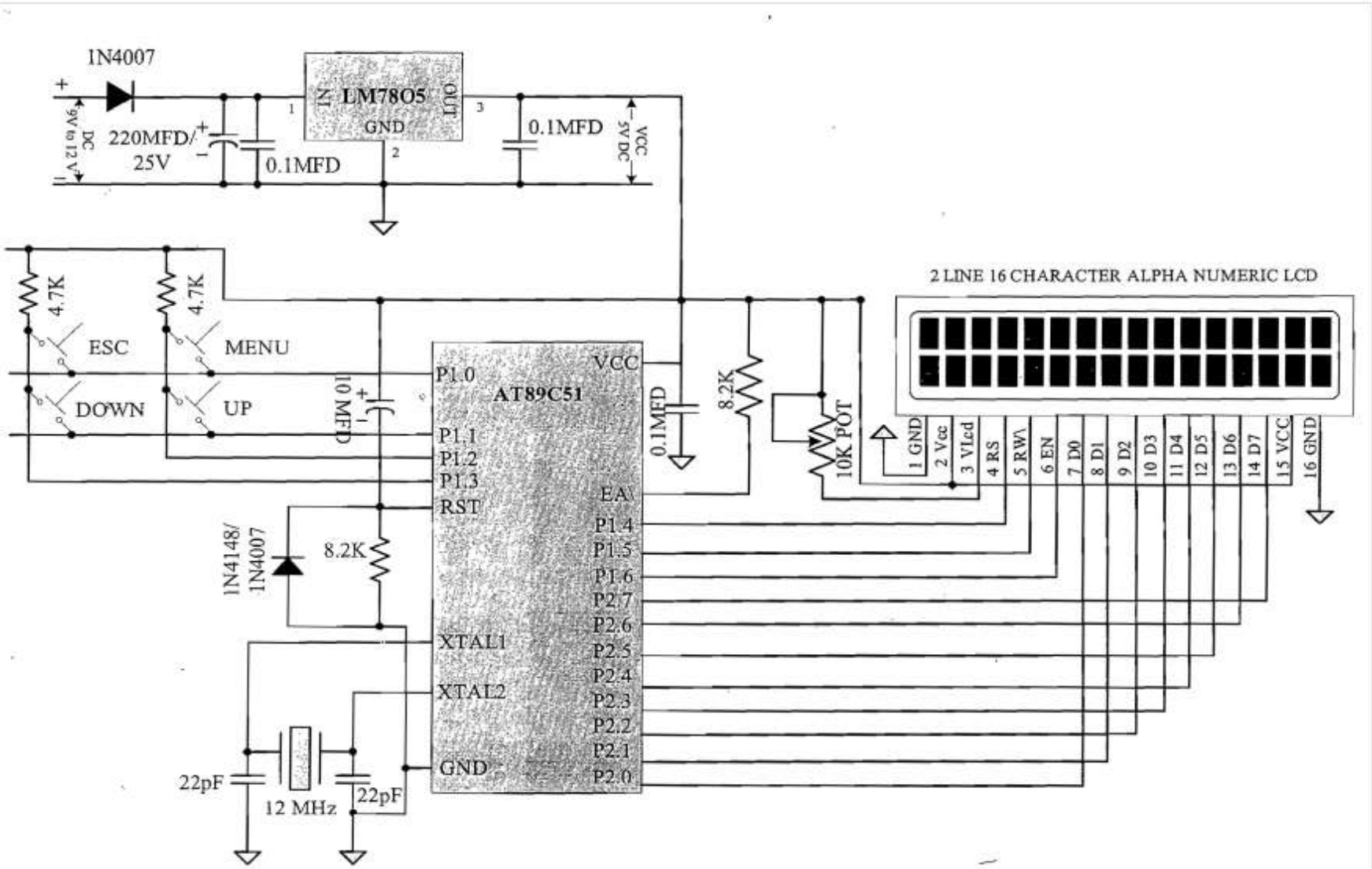

Figure 1: **Circuit diagram for Digital Clock implementation using *8051***

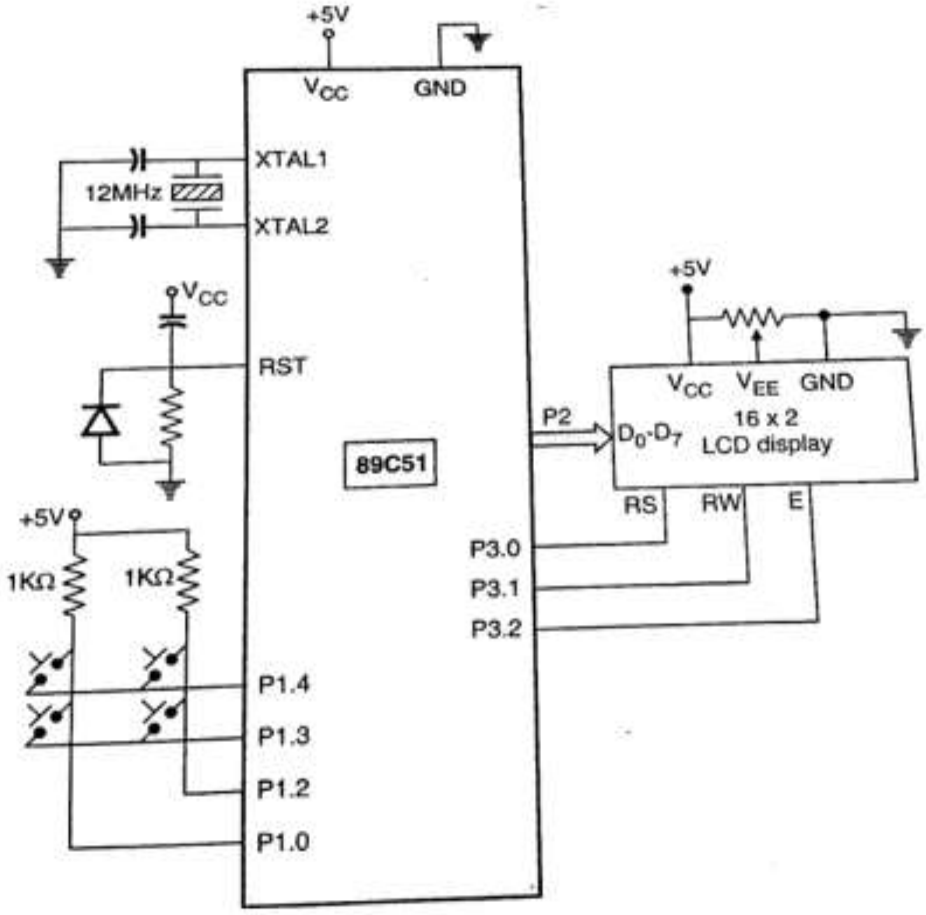

Figure 3: A simplified Circuit diagram of a digital clock (the data lines are consolidated together and power supply is not shown)

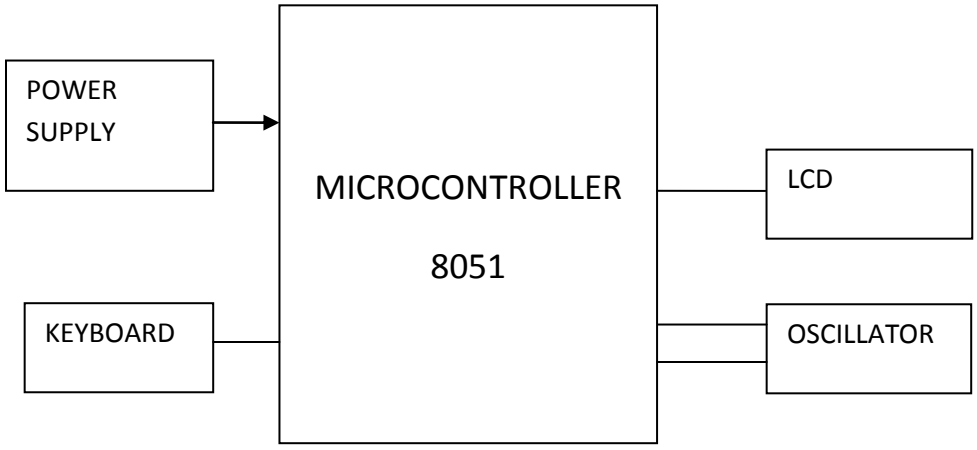

Figure 4: A generalized block diagram of a digital clock