Experiment NO: 02A

Aim:

To interface with 7-segment display using 8051/P89V51RD2 microcontroller.

Objective:

1.To study the working of seven-segment displays.
2.To interface seven-segment display with 8051.

Apparatus / Software Required:

8051 / P89V51RD2 microcontroller kit
Seven-segment display
Keil µVision software (for code development).

Theory :

The 8051's pins are broadly categorized into power and timing, control signals, and I/O ports. **Pins 40 (Vcc) and 20 (GND)** are for power, providing the positive supply voltage and ground, respectively. **Pins 18 (XTAL2) and 19 (XTAL1)** are used to connect an external crystal oscillator, which generates the clock signal for the microcontroller's internal operations.

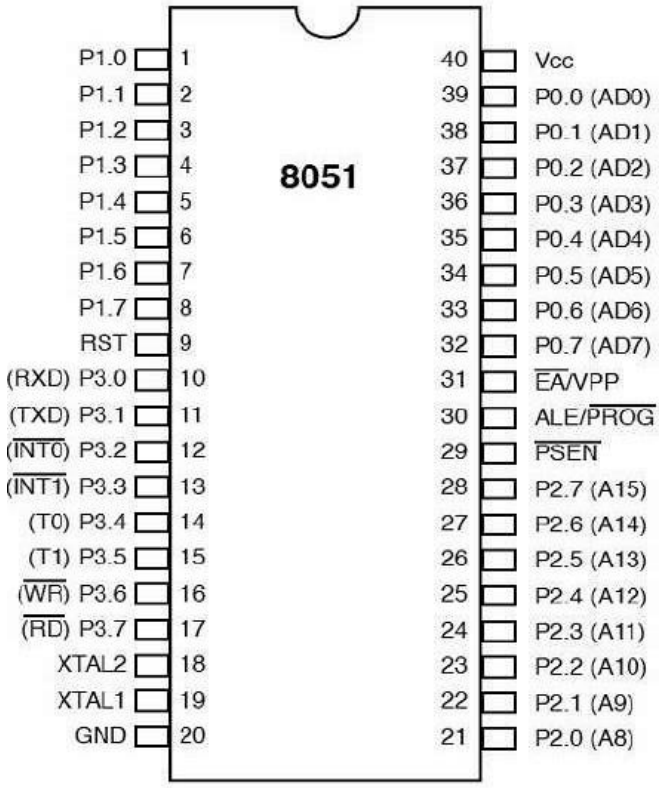


Figure 5.1 Pin Diagram of 8051 Microcontroller

The **control signals** are essential for managing memory and program execution. **Pin 31 (EA/Vpp)** is the External Access Enable pin. When grounded, it forces the 8051 to fetch all instructions from external program memory. When connected to Vcc, it executes instructions from internal program memory until the memory address limit is reached, then automatically switches to external memory. **Pin 30 (ALE/PROG)** stands for Address Latch Enable. It is an output signal that multiplexes the low-order byte of the address from Port 0 during external memory access. **Pin 29 (PSEN)**, or Program Store Enable, is a read strobe signal for external

program memory. **Pins 16 (WR) and 17 (RD)** are write and read strobes for external data memory, respectively.
Pin 9 (RST) is the reset pin; a high pulse on this pin resets the microcontroller.

The 8051 microcontroller is an 8-bit microcontroller developed by Intel in 1980 and has since become one of the most widely used microcontrollers in embedded systems. It is part of the MCS-51 family and is known for its simplicity, reliability, and ease of interfacing with peripheral devices. The 8051 is based on an 8-bit CPU, meaning it can process 8 bits of data at a time, and it has a 16-bit address bus that allows it to address up to 64 KB of external memory. It comes with 4 parallel I/O ports (Port 0 to Port 3), each consisting of 8 pins that can be configured as input or output, enabling direct interfacing with devices such as LEDs, switches, and displays. The microcontroller has an internal 128 bytes of RAM, 4 KB of on-chip ROM (or EPROM/Flash in modern variants) for program storage, and a 16-bit program counter.

The 8051 also includes two 16-bit timers/counters, a serial communication port (UART), and an interrupt system with five interrupt sources, which makes it highly suitable for real-time applications. It operates at a typical clock frequency of 12 MHz, providing sufficient speed for most embedded applications, while its on-chip oscillator reduces the need for external components. The architecture of the 8051 supports both bit-level and byte-level operations, which is useful for controlling hardware at a fine-grained level.

- **7-segment Display:**

A 7-segment display is a form of electronic display device used for displaying decimal numerals. It's a simple, low-cost alternative to more complex displays like dot-matrix or LCD screens. The "seven segments" are actually seven individual LEDs (light-emitting diodes) arranged in a rectangular shape, resembling the number "8." By turning on different combinations of these LEDs, you can form any digit from 0 to 9. Many displays also include a decimal point (DP) as an eighth segment.

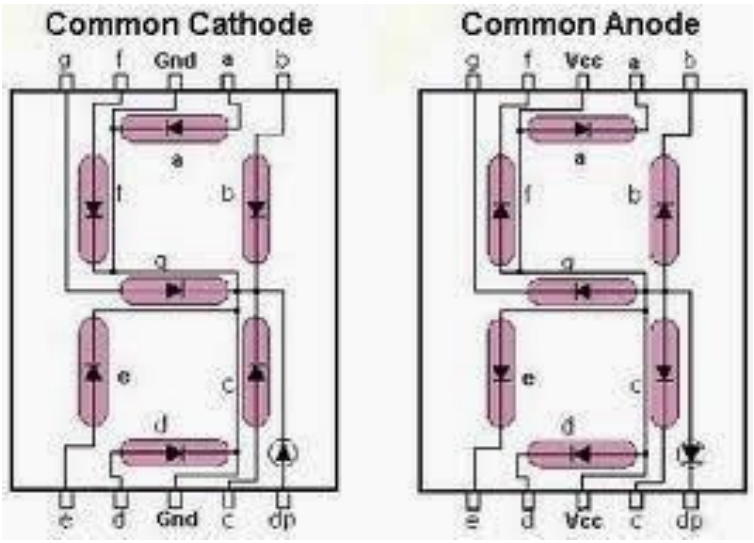


Figure 5.2 Internal Diagram of Seven Segment Display

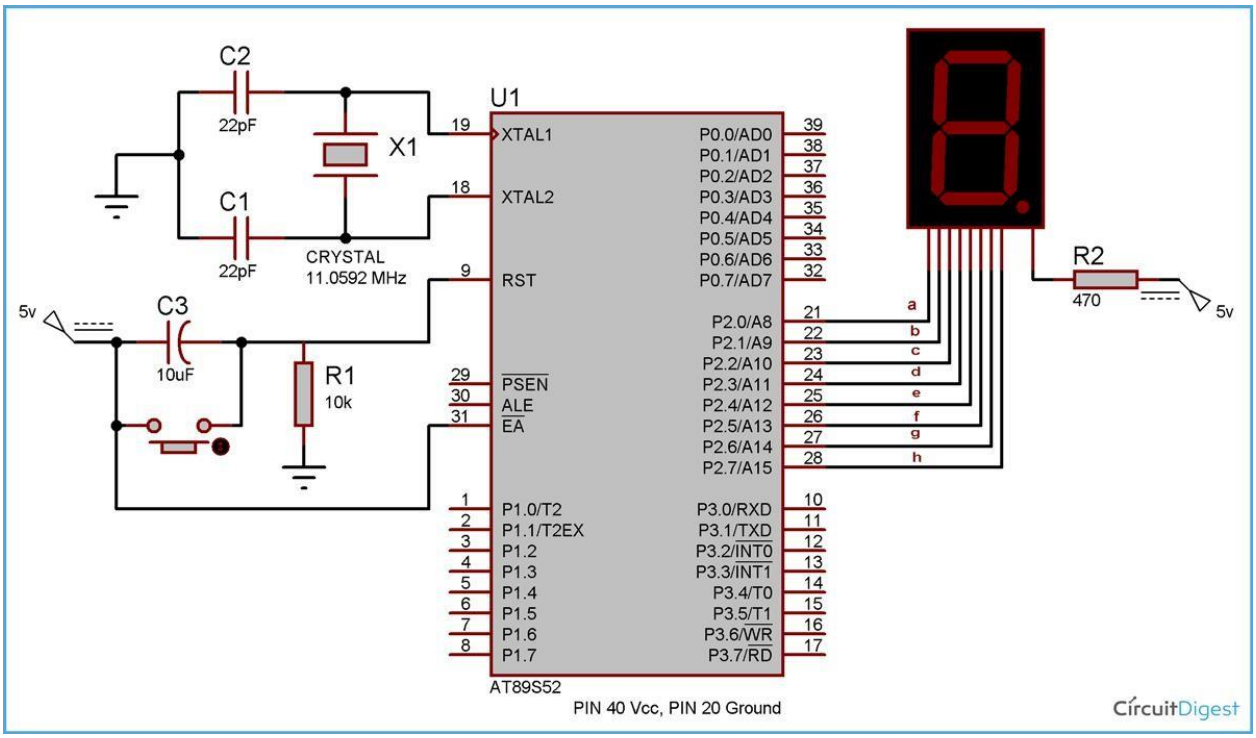
Working Principle

At its core, a 7-segment display works by the principle of **electroluminescence**, where an LED emits light when an electric current passes through it. The segments are labeled 'a' through 'g' for easy identification. To display a number, you simply provide power to the specific segments that form that number. For example, to display the number "1," you would activate segments 'b' and 'c' while keeping the others off.

A 7-segment display is an electronic display device composed of seven LEDs (segments) arranged to form numerical digits and some characters. The two main types are the common anode and common cathode, and the choice between them depends on the control logic and power supply of the circuit.

A **common cathode** seven-segment display (CC SSD) is a widely used electronic display device for representing numerical digits and some alphabets. It consists of seven Light Emitting Diodes (LEDs) arranged in a specific pattern to form the shape of the number eight, with each LED segment labeled as **a, b, c, d, e, f, and g**. In a common cathode configuration, the cathode (negative terminal) of all seven LEDs is connected together internally and brought out to one or more common pins. This common cathode pin is usually connected to ground (logic 0). To display a number or character, individual segments are illuminated by applying a logic HIGH (positive voltage, typically +5V) to the corresponding anode terminal of each segment. For example, to display the digit "2," segments a, b, g, e, and d are activated, while the others remain off. The advantage of a common cathode display is that it is simple to interface with microcontrollers like the **8051**, as the microcontroller can directly provide HIGH signals to the desired segment pins to form numbers.
These displays are commonly used in digital clocks, calculators, counters, measuring instruments, and embedded systems due to their low cost, easy availability, and straightforward operation.

- **Interfacing Diagram (Common Cathode)**

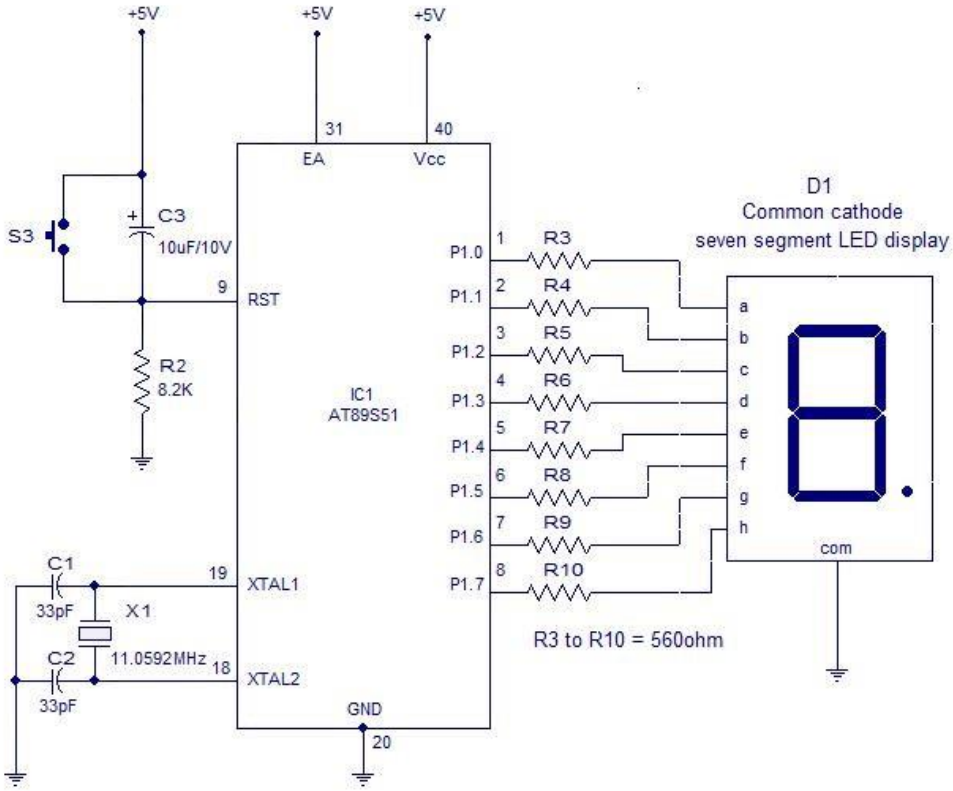


A **common anode** seven-segment display (CA SSD) is another popular type of display device used to show numerical digits and limited alphabets, but it works on the opposite principle of the common cathode display. In this configuration, the anodes (positive terminals) of all seven LEDs are internally connected together and brought out to one or more common pins, which are then connected to a positive supply voltage (typically +5V). To light up a particular segment, its cathode (negative terminal) must be connected to ground through the controlling device. In other words, unlike the common cathode type that requires a logic HIGH to glow, the common anode display requires a logic LOW (0) at the segment pin to turn ON that LED. For example, to display the digit "3," the microcontroller drives segments a, b, c, d, and g LOW, while keeping the remaining pins HIGH.

The operation of the common anode display makes it more suitable for current sinking microcontrollers or driver ICs. When interfacing with the 8051 microcontroller, the common anode pin is tied to Vcc, and each segment pin is connected to the 8051 port pins through current-limiting resistors. To turn ON a segment, the microcontroller outputs a LOW signal, while a HIGH signal keeps it OFF. Just like in common cathode, a lookup table is prepared in the program memory that contains the segment codes for digits 0–9 and characters A–F (in case of hexadecimal displays). For multi-digit applications, the multiplexing method is again used, where all segments of the displays are connected together, and the common anodes are controlled individually via transistors or port pins. The microcontroller switches between digits rapidly, giving the illusion of continuous display to the human eye.

Because of this logic inversion (active LOW), programmers must take care to store complemented codes in the lookup table for common anode displays. Despite this small difference, common anode seven-segment displays are just as widely used in digital clocks, counters, calculators, and embedded applications due to their reliability, simple design, and cost-effectiveness.

- **Interfacing Diagram (Common Anode)**



Algorithm :

Main Program:

1. Start
2. Initialize Port2 of 8051 as output port
3. Send hex codes for digits 0–9 sequentially to seven-segment display
4. Provide delay between digits
5. Repeat the process continuously

Conclusion:

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