4 INTRODUCTION TO MICROCONTROLLER

Introduction

8051 is one of the first and most popular microcontrollers also known as MCS-51. Intel introduced it in the year 1981. Initially, it came out as an N-type metal-oxide-semiconductor (NMOS) based microcontroller, but later versions were based on complementary metal-oxide-semiconductor (CMOS) technology. These microcontrollers were named 80C51, where C in the name tells that it is based on CMOS technology. It is an 8-bit microcontroller which means the data bus is 8-bit. Therefore, it can process 8 bits at a time. It is used in a wide variety of embedded systems like robotics, remote controls, the automotive industry, telecom applications, power tools, etc.

FEATURES OF 8051 MICROCONTROLLER

An 8051 microcontroller comes bundled with the following features –

- 4KB bytes on-chip program memory (ROM)
- 128 bytes on-chip data memory (RAM)
- Four register banks
- 128 user defined software flags
- 8-bit bidirectional data bus
- 16-bit unidirectional address bus
- 32 general purpose registers each of 8-bit
- 16 bit Timers (usually 2, but may have more or less)
- Three internal and two external Interrupts
- Four 8-bit ports,(short model have two 8-bit ports)
- 16-bit program counter and data pointer

APPLICATIONS OF MICROCONTROLLER

1. Most personal computer keyboards are implemented with a microcontroller. It replaces scanning, debounce matrix decoding and serial transmission circuits.
2. Generally in low cost products, such as toys, electric drills, microwave ovens, VCRs microcontrollers are used.
3. Microcontrollers are used as machine tools, chemical processors and in medical instruments.
4. It also controls mechanism of electronic systems, music system, home security system, etc.

In this chapter we will study a brief overview of 8051 microcontrollers.

ARCHITECTURE 8051

The 8051 is a second generation 8–bit microcontroller. The first Intel's 8–bit microcontroller was the 8048. The 8051 provide a more powerful architecture, a more powerful instruction set, a full serial port.

Main Features of 8051 Microcontroller

1) An 8 bit ALU

2) 4K × 8 ROM (OR EPROM)
3) 128 × 8 RAM
4) Dual 16 bit timer event counter
5) 32 I/O lines
6) Addresses of 64 Kbytes of program memory
7) Addresses of 64 Kbytes of data memory
8) Powerful 111 instruction set
9) Full featured serial port
10) Up to 12 MHz. clock
11) Two external interrupts

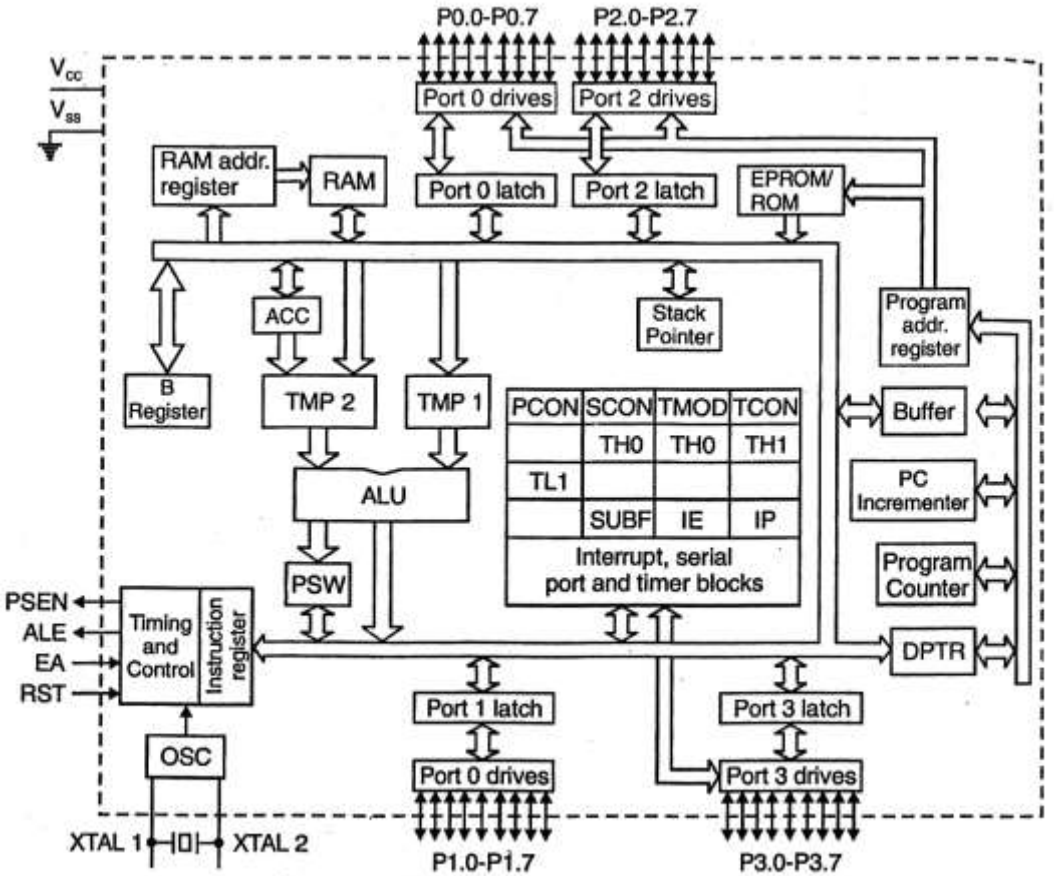

Fig. An architectural block diagram of 8051

Architecture of 8051

There are 32 pins needed by the four 8-bit bi-directional I/O ports. Eight additional pins provide power and allow to connect to a clock crystal and also provide timing and control signals.

The standard functions, which make up a microprocessor, are in the center of the diagram. It includes the ALU, accumulator, stack pointer, a block of registers and a general purpose registers. All of these devices are connected to 8051 internal 8-bit data bus.

Each I/O port is also connected to the 8 bit internal data bus through a series of register. These registers hold data during I/O transfers and control I/O ports. It is also having ROM and RAM.

8051 Memory Register Map

Generally 8051 addresses two memory spaces. It uses one memory space for storing programs and the other for storing variable data. The program memory space is a read only memory space. You can read program instructions from this space but the processor cannot write data or read data from these memory locations. The 8051 internal ROM is in program memory space. All instructions fetches are from program memory space.

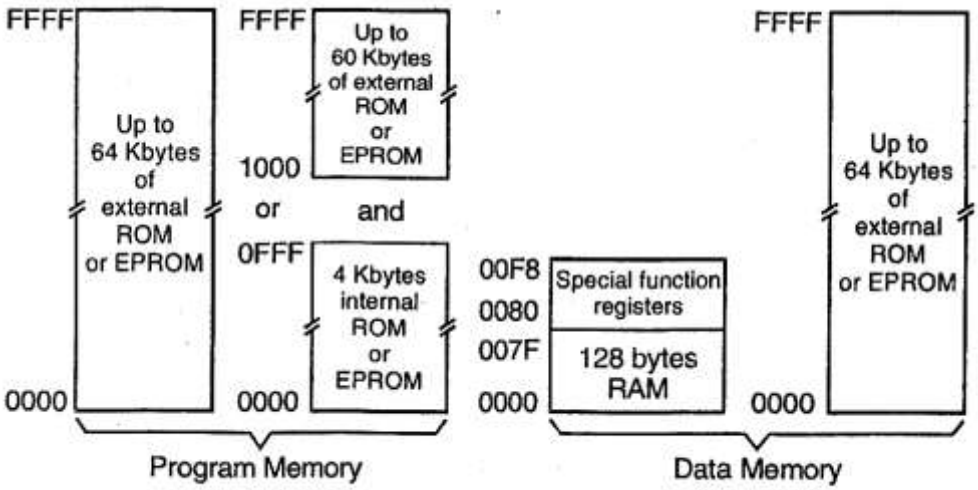

Fig. Memory Map of 8051

The data memory space is read-write memory space. The processor can read data from this memory space and can write data to this memory space. But it cannot execute program instructions from this memory space. The 8051 internal RAM is in this memory space.

The 128 bytes of internal RAM provide general read-write data storage. Part of this memory space is often referred to as general purpose registers.

The 8051 also has 22 special function registers which are not part of 128 bytes of internal RAM. They occupy memory space from 80H to F8H.

If more program memory is needed the internal 4 Kbytes memory can be expanded by an additional 60 Kbytes. So 8051 has now a full 64 Kbytes program memory space. If 8051 pin is connected to ground, it does not use the internal 4 K ROM. If user needs more RAM, external data memory can be added. It is of 64 Kbytes. Generally 8051 operates with separate program memory and data memory space but in some applications it is desirable to have these work as common memory. In that case 8051 has 64 Kbytes of total external memory.

In this configuration 8051 can input a block of data through serial communication port, load data into memory and then execute that data as a program. This is called downloaded program.

COMPARISON WITH MICRPROCESSOR

	Microprocessor 8085	Microcontroller 8051
a)	It is an 8–bit μp.	It is a 8–bit microcontroller.
b)	Address bus is 16–bit, hence can access 64 KB memory.	Address bus is 16–bit, hence can access 64 KB memory
c)	It provides seven 8–bit registers –A, B, H…	It provides 34 8–bit registers–A, Band 32 general purpose registers.
d)	8 – bit of data bus but ports are not available.	It has four ports P0–P3 for I/O
e)	Flag register is 8–bit and contains Five flags	Flag register is 8–bit and contains Nine flags.
f)	Peripheral chips are required	Peripheral chips are not required

Exercise

Select the correct alternative and rewrite the following.

1. _____ is a microcontroller chip.
(i) 8085 (ii) 80286 (iii) 8051 (iv) Pentium
1. (iii) 8051

2. 8051 has _____ RAM.
(i) 128 bytes (ii) 64K bytes (iii) 1K bytes (iv) None of these
2. (i) 128 bytes

3. The 8051 microcontroller has instruction set of _____ instructions.
(i) 99 (ii) 111 (iii) 120 (iv) 110
3. (ii) 111

4. 8051 has clock upto _____ frequency.
(i) 12 MHz (ii) 4 MHz (iii) 9 MHz (iv) 6 MHz
4. (i) 12 MHz

5. The 8051 is a _____ generation microcontroller.
(i) First (ii) Second (iii) Third (iv) Fourth
5. (ii) Second

6. The 8051 microcontroller has an ALU of _____ bit capacity.
(i) 8 (ii) 16 (iii) 32 (iv) 64
6. (i) 8

7. _____ is not a characteristics feature of 8051 microcontroller.
(i) 4 kbyte of internal RAM (ii) 4 kbyte of internal ROM
(iii) 4 parallel bi–directional I/O port (iv) Full featured serial port.
7. (i) 4 kbyte of internal RAM

8. _____IC consists of internal RAM.
(i) 8080 (ii) 8085 (iii) 8051 (iv) 8086
8. (iii) 8051

9. 8051 Microcontroller IC have _____ number of 8 bit I/O ports.
(i) 1 (ii) 2 (iii) 4 (iv) 8
9. (iii) 4

10. 8051 micro–controller has instruction set of _____
(i) 99 (ii) 111 (iii) 120 (iv) 110
10. (ii) 111

11. Intel 8051 has clock upto _____ frequency.
(i) 12 MHz (ii) 4 MHz (iii) 9 MHz (iv) 6MHz
11. (i) 12 MHz

12. Among following _____ is the latest 8–bit single chip microcontroller.
(i) 8048 (ii) 8051 (iii) 8096 (iv) 8044
12. (ii) 8051

13. In 8051 size of internal ROM is _____.
(i) 4KB (ii) 2KB (iii) 8KB (iv) 16 KB
13. (i) 4KB

14. The 8051 internal ROM is _____.
(i) Found in the Data Memory Space.
(ii) Used to store variable program data
(iii) 4 kBytes of ROM in the Program Memory Space
(iv) All of the
14. (iii) 4 kBytes of ROM in the Program Memory Space

15. Which of the following is not a part of an 8051 Single–chip Microprocessor?
(i) A 4–kbyte ROM (ii) Dual Serial Port
(iii) A 128–byte RAM (iv) Four 8–bit parallel I/O ports
15. (ii) Dual Serial Port

16. The additional feature of 8051 Microcontroller over 8085 Microprocessor is that, it has additional _____.
(i) Internal RAM only (ii) Internal ROM only
(iii) 16 bit ALU (iv) Both Internal RAM and ROM
16. (iv) Both Internal RAM and ROM

17. Internal program memory of 8052 Microcontroller is _____
(i) 4 k byte (ii) 8 k byte (iii) 256 k byte (iv) 64 k byte
17. (ii) 8 k byte

18. In case of 8051 Microcontroller Chip, there are _____ external interrupts.
(i) 3 (ii) 2 (iii) 4 (iv) 5
18. (ii) 2

19. In 8051, 22 special function registers occupy memory space from _____
(i) 08H to F8H (ii) 80H to F8H (iii) 80 to 8FH (iv) None of these
19. (ii) 80H to F8H

20. Micro–controller 8051 have _____. External Interrupts.
(i) 1 (ii) 2 (iii) 3 (iv) 4
20. (ii) 2

21. _____ is a characteristics feature of 8051 Micro–controller.
(i) Four 8 bit I/O Ports (ii) Two 8 bit I/O Ports
(iii) 4kB RAM (iv) Four External Interrupts
21. (iv) Four External Interrupts

22. Micro–controller 8052 has _____ external interrupts.
(i) 2 (ii) 3 (iii) 4 (iv) 5
22. (ii) 3

23. Micro–controller 8050 has _____ bytes of RAM
(i) 64 (ii) 128 (iii) 256 (iv) 32
23. (iii) 256

24. Internal Data memory of 8051 microcontroller is _____.
(i) 128 bytes (ii) 128 k bytes (iii) 256 bytes (iv) 4 k bytes
24. (i) 128 bytes

25. _____ is not a micro–controller.
(i) 8052 (ii) 8032 (iii) Pentium (iv) 8051
25. (iii) Pentium

26. 8051 _____ Bit Micro–Controller.
(i) 8 (ii) 4 (iii) 16 (iv) 32
26. (i) 8

27. _____ is a Micro–Controller.
(i) 8086 (ii) 8051 (iii) 8088 (iv) 80286
27. (ii) 8051

28. Intel 8051 Microcontroller has _____RAM.
(i) 128×8 (ii) $4K \times 8$ (iii) 64×8 (iv) $8K \times 8$
28. (i) 128×8

29. The instruction set of intel 8051 micro–controller contains total ____ instruction.
(i) 111 (ii) 72 (iii) 74 (iv) 100
29. (i) 111

30. The 8081 Micro–controller has instruction set of _____ instructions.
(i) 101 (ii) 110 (iii) 99 (iv) 111
30. (iv) 111

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