Addressing modes of 8051

In this section, we will see different addressing modes of the 8051 microcontrollers. In 8051 there are 1-byte, 2-byte instructions and very few 3-byte instructions are present. The opcodes are 8-bit long. As the opcodes are 8-bit data, there are 256 possibilities. Among 256, 255 opcodes are implemented.

The clock frequency is 12MHz, so 64 instruction types are executed in just 1 μs. The Multiplication and Division operations take 4 μs to execute.

In 8051 There are six types of addressing modes.

- Immediate Addressing Mode
- Register Addressing Mode
- Direct Addressing Mode
- Register Indirect Addressing Mode
- Indexed Addressing Mode
- Implied Addressing Mode

1. Immediate addressing mode

In this Immediate Addressing Mode, the data is provided in the instruction itself. The data is provided immediately after the opcode. These are some examples of Immediate Addressing Mode.

```
MOVA, #0AFH;
MOVDPTR, #FE00H;
```

In these instructions, the # symbol is used for immediate data. In the last instruction, there is DPTR. The DPTR stands for Data Pointer. Using this, it points the external data memory location. In the first instruction, the immediate data is AFH, but one 0 is added at the beginning. So when the data is starting with A to F, the data should be preceded by 0.

2. Register addressing mode

In the register addressing mode the source or destination data should be present in a register (**R0 to R7**). These are some examples of Register Addressing Mode.

```
MOVA, R5;
MOVR2, #45H;
MOVR0, A;
```

Register Banks in 8051

A total of 32 bytes of RAM are set aside for the register banks and the stack. These 32 bytes are divided into four register banks in which each bank has 8 registers, R0–R7. RAM locations from 0 to 7 are set aside for bank 0 of R0–R7 where R0 is RAM location 0, R1 is RAM location 1, R2 is location 2, and so on, until the memory location 7, which belongs to R7 of bank 0.

The second bank of registers R0–R7 starts at RAM location 08 and goes to locations OFH. The third bank of R0–R7 starts at memory location 10H and goes to location to 17H. Finally, RAM locations 18H to 1FH are set aside for the fourth bank of R0–R7.

In 8051, there is no instruction like **MOVR5, R7**. But we can get the same result by using this instruction **MOV R5, 07H**, or by using **MOV 05H, R7**. But these two instructions will work when the selected register bank is **RB0**. To use another register bank and to get the same effect, we have to add the starting address of that register bank with the register number. For an example, if the RB2 is selected, and we want to access R5, then the address will be (10H + 05H = 15H), so the instruction will look like this **MOV 15H, R7**. Here 10H is the starting address of Register Bank 2.

3. Direct Addressing Mode

In the Direct Addressing Mode, the source or destination address is specified by using 8-bit data in the instruction. Only the internal data memory can be used in this mode. Here some of the examples of direct Addressing Mode.

```
MOV80H, R6;
MOVR2, 45H;
MOVR0, 05H;
```

The first instruction will send the content of register R6 to port P0 **(Address of Port 0 is 80H).** The second one is for getting content from 45H to R2. The third one is used to get data from Register R5 (When register bank RB0 is selected) to register ~~R5.~~ R0

4. Register indirect addressing Mode

In this mode, the source or destination address is given in the register. By using register indirect addressing mode, the internal or external addresses can be accessed. **The R0 and R1 are used for 8-bit addresses**, and DPTR is used for 16-bit addresses, no other registers can be used for addressing purposes. Let us see some examples of this mode.

```
MOV0E5H, @R0;
```

In the instructions, the @ symbol is used for register indirect addressing. In the instruction, it is showing that the R0 register is used. If the content of R0 is 40H, then that instruction will take the data which is located at location 40H of the internal RAM.

5. Indexed addressing mode

In the indexed addressing mode, the source memory can only be accessed from program memory. **The destination operand is always the register A**. These are some examples of Indexed addressing mode.

```
MOVA, @A+PC;
MOVA, @A+DPTR;
```

. For the first instruction, let us consider A holds 30H. And the PC value is 1125H. The contents of program memory location 1155H (30H + 1125H) are moved to register A.

6. Implied Addressing Mode

In the implied addressing mode, there will be a single operand. These types of instruction can work on specific registers only. These types of instructions are also known as register specific instruction. Here are some examples of Implied Addressing Mode.

```
RLA;
SWAPA;
```

These are 1- byte instruction. The first one is used to rotate the A register content to the Left. The second one is used to swap the nibbles in A.