

**Section 1** **8051 Microcontroller Instruction Set**

##### For interrupt response time information, refer to the hardware description chapter.

**Instructions that Affect Flag Settings**[(1)](#_bookmark0)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Instruction** | **Flag** | | | **Instruction** | **Flag** | | |
| **C** | **OV** | **AC** | **C** | **OV** | **AC** |
| ADD | X | X | X | CLR C | O |  |  |
| ADDC | X | X | X | CPL C | X |  |  |
| SUBB | X | X | X | ANL C,bit | X |  |  |
| MUL | O | X |  | ANL C,/bit | X |  |  |
| DIV | O | X |  | ORL C,bit | X |  |  |
| DA | X |  |  | ORL C,/bit | X |  |  |
| RRC | X |  |  | MOV C,bit | X |  |  |
| RLC | X |  |  | CJNE | X |  |  |
| SETB C | 1 |  |  |  |  |  |  |

Note: 1. Operations on SFR byte address 208 or bit addresses 209-215 (that is, the PSW or bits in the PSW) also affect flag settings.

# The Instruction Set and Addressing Modes

|  |  |
| --- | --- |
| **Rn** | Register R7-R0 of the currently selected Register Bank. |
| **direct** | 8-bit internal data location’s address. This could be an Internal Data RAM location (0-127) or a SFR [i.e., I/O port, control register, status register, etc. (128-255)]. |
| **@Ri** | 8-bit internal data RAM location (0-255) addressed indirectly through register R1or R0. |
| **#data** | 8-bit constant included in instruction. |
| **#data 16** | 16-bit constant included in instruction. |
| **addr 16** | 16-bit destination address. Used by LCALL and LJMP. A branch can be anywhere within the 64K byte Program Memory address space. |
| **addr 11** | 11-bit destination address. Used by ACALL and AJMP. The branch will be within the same 2K byte page of program memory as the first byte of the following instruction. |
| **rel** | Signed (two’s complement) 8-bit offset byte. Used by SJMP and all conditional jumps. Range is -128 to +127 bytes relative to first byte of the following instruction. |
| **bit** | Direct Addressed bit in Internal Data RAM or Special Function Register. |

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***Table 1-1.*** Instruction Set Summary



|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | NOP | JBC  bit,rel [3B, 2C] | JB  bit, rel [3B, 2C] | JNB  bit, rel [3B, 2C] | JC  rel [2B, 2C] | JNC  rel [2B, 2C] | JZ  rel [2B, 2C] | JNZ  rel [2B, 2C] |
| 1 | AJMP (P0) [2B, 2C] | ACALL (P0) [2B, 2C] | AJMP (P1) [2B, 2C] | ACALL (P1) [2B, 2C] | AJMP (P2) [2B, 2C] | ACALL (P2) [2B, 2C] | AJMP (P3) [2B, 2C] | ACALL (P3) [2B, 2C] |
| 2 | LJMP  addr16 [3B, 2C] | LCALL  addr16 [3B, 2C] | RET [2C] | RETI [2C] | ORL  dir, A [2B] | ANL  dir, A [2B] | XRL  dir, a [2B] | ORL  C, bit [2B, 2C] |
| 3 | RR A | RRC A | RL A | RLC A | ORL  dir, #data [3B, 2C] | ANL  dir, #data [3B, 2C] | XRL  dir, #data [3B, 2C] | JMP @A + DPTR  [2C] |
| 4 | INC A | DEC A | ADD  A, #data [2B] | ADDC  A, #data [2B] | ORL  A, #data [2B] | ANL  A, #data [2B] | XRL  A, #data [2B] | MOV  A, #data [2B] |
| 5 | INC  dir [2B] | DEC  dir [2B] | ADD  A, dir [2B] | ADDC  A, dir [2B] | ORL  A, dir [2B] | ANL  A, dir [2B] | XRL  A, dir [2B] | MOV  dir, #data [3B, 2C] |
| 6 | INC  @R0 | DEC  @R0 | ADD A, @R0 | ADDC A, @R0 | ORL A, @R0 | ANL A, @R0 | XRL A, @R0 | MOV  @R0, @data [2B] |
| 7 | INC  @R1 | DEC  @R1 | ADD A, @R1 | ADDC A, @R1 | ORL A, @R1 | ANL A, @R1 | XRL A, @R1 | MOV  @R1, #data [2B] |
| 8 | INC R0 | DEC R0 | ADD A, R0 | ADDC A, R0 | ORL A, R0 | ANL A, R0 | XRL A, R0 | MOV  R0, #data [2B] |
| 9 | INC R1 | DEC R1 | ADD A, R1 | ADDC A, R1 | ORL A, R1 | ANL A, R1 | XRL A, R1 | MOV  R1, #data [2B] |
| A | INC R2 | DEC R2 | ADD A, R2 | ADDC A, R2 | ORL A, R2 | ANL A, R2 | XRL A, R2 | MOV  R2, #data [2B] |
| B | INC R3 | DEC R3 | ADD A, R3 | ADDC A, R3 | ORL A, R3 | ANL A, R3 | XRL A, R3 | MOV  R3, #data [2B] |
| C | INC R4 | DEC R4 | ADD A, R4 | ADDC A, R4 | ORL A, R4 | ANL A, R4 | XRL A, R4 | MOV  R4, #data [2B] |
| D | INC R5 | DEC R5 | ADD A, R5 | ADDC A, R5 | ORL A, R5 | ANL A, R5 | XRL A, R5 | MOV  R5, #data [2B] |
| E | INC R6 | DEC R6 | ADD A, R6 | ADDC A, R6 | ORL A, R6 | ANL A, R6 | XRL A, R6 | MOV  R6, #data [2B] |
| F | INC R7 | DEC R7 | ADD A, R7 | ADDC A, R7 | ORL A, R7 | ANL A, R7 | XRL A, R7 | MOV  R7, #data [2B] |

Note: Key: [2B] = 2 Byte, [3B] = 3 Byte, [2C] = 2 Cycle, [4C] = 4 Cycle, Blank = 1 byte/1 cycle

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***Table 1-2.*** Instruction Set Summary (Continued)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 8 | 9 | A | B | C | D | E | F |
| 0 | SJMP REL [2B, 2C] | MOV DPTR,#  data 16 [3B, 2C] | ORL  C, /bit [2B, 2C] | ANL  C, /bit [2B, 2C] | PUSH  dir [2B, 2C] | POP  dir [2B, 2C] | MOVX A, @DPTR [2C] | MOVX @DPTR, A [2C] |
| 1 | AJMP (P4) [2B, 2C] | ACALL (P4) [2B, 2C] | AJMP (P5) [2B, 2C] | ACALL (P5) [2B, 2C] | AJMP (P6) [2B, 2C] | ACALL (P6) [2B, 2C] | AJMP (P7) [2B, 2C] | ACALL (P7) [2B, 2C] |
| 2 | ANL  C, bit [2B, 2C] | MOV  bit, C [2B, 2C] | MOV  C, bit [2B] | CPL  bit [2B] | CLR  bit [2B] | SETB  bit [2B] | MOVX A, @R0 [2C] | MOVX wR0, A [2C] |
| 3 | MOVC A, @A + PC [2C] | MOVC A, @A + DPTR [2C] | INC DPTR [2C] | CPL C | CLR C | SETB C | MOVX A, @RI [2C] | MOVX @RI, A [2C] |
| 4 | DIV AB  [2B, 4C] | SUBB  A, #data [2B] | MUL AB [4C] | CJNE A,  #data, rel [3B, 2C] | SWAP A | DA A | CLR A | CPL A |
| 5 | MOV  dir, dir [3B, 2C] | SUBB  A, dir [2B] |  | CJNE  A, dir, rel [3B, 2C] | XCH  A, dir [2B] | DJNZ  dir, rel [3B, 2C] | MOV  A, dir [2B] | MOV  dir, A [2B] |
| 6 | MOV  dir, @R0 [2B, 2C] | SUBB A, @R0 | MOV  @R0, dir [2B, 2C] | CJNE  @R0, #data, rel [3B, 2C] | XCH A, @R0 | XCHD A, @R0 | MOV A, @R0 | MOV @R0, A |
| 7 | MOV  dir, @R1 [2B, 2C] | SUBB A, @R1 | MOV  @R1, dir [2B, 2C] | CJNE  @R1, #data, rel [3B, 2C] | XCH A, @R1 | XCHD A, @R1 | MOV A, @R1 | MOV @R1, A |
| 8 | MOV  dir, R0 [2B, 2C] | SUBB A, R0 | MOV  R0, dir [2B, 2C] | CJNE  R0, #data, rel [3B, 2C] | XCH A, R0 | DJNZ  R0, rel [2B, 2C] | MOV A, R0 | MOV R0, A |
| 9 | MOV  dir, R1 [2B, 2C] | SUBB A, R1 | MOV  R1, dir [2B, 2C] | CJNE  R1, #data, rel [3B, 2C] | XCH A, R1 | DJNZ  R1, rel [2B, 2C] | MOV A, R1 | MOV R1, A |
| A | MOV  dir, R2 [2B, 2C] | SUBB A, R2 | MOV  R2, dir [2B, 2C] | CJNE  R2, #data, rel [3B, 2C] | XCH A, R2 | DJNZ  R2, rel [2B, 2C] | MOV A, R2 | MOV R2, A |
| B | MOV  dir, R3 [2B, 2C] | SUBB A, R3 | MOV  R3, dir [2B, 2C] | CJNE  R3, #data, rel [3B, 2C] | XCH A, R3 | DJNZ  R3, rel [2B, 2C] | MOV A, R3 | MOV R3, A |
| C | MOV  dir, R4 [2B, 2C] | SUBB A, R4 | MOV  R4, dir [2B, 2C] | CJNE  R4, #data, rel [3B, 2C] | XCH A, R4 | DJNZ  R4, rel [2B, 2C] | MOV A, R4 | MOV R4, A |
| D | MOV  dir, R5 [2B, 2C] | SUBB A, R5 | MOV  R5, dir [2B, 2C] | CJNE  R5, #data, rel [3B, 2C] | XCH A, R5 | DJNZ  R5, rel [2B, 2C] | MOV A, R5 | MOV R5, A |
| E | MOV  dir, R6 [2B, 2C] | SUBB A, R6 | MOV  R6, dir [2B, 2C] | CJNE  R6, #data, rel [3B, 2C] | XCH A, R6 | DJNZ  R6, rel [2B, 2C] | MOV A, R6 | MOV R6. A |
| F | MOV  dir, R7 [2B, 2C] | SUBB A, R7 | MOV  R7, dir [2B, 2C] | CJNE  R7, #data, rel [3B, 2C] | XCH A, R7 | DJNZ  R7, rel [2B, 2C] | MOV A, R7 | MOV R7, A |

Note: Key: [2B] = 2 Byte, [3B] = 3 Byte, [2C] = 2 Cycle, [4C] = 4 Cycle, Blank = 1 byte/1 cycle

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*8051 Microcontroller Instruction Set*

***Table 1-3.*** AT89 Instruction Set Summary[(1)](#_bookmark1)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mnemonic** | | **Description** | **Byte** | **Oscillator Period** |
| **LOGICAL OPERATIONS** | | | | |
| ANL | A,Rn | AND Register to Accumulator | 1 | 12 |
| ANL | A,direct | AND direct byte to Accumulator | 2 | 12 |
| ANL | A,@Ri | AND indirect RAM to Accumulator | 1 | 12 |
| ANL | A,#data | AND immediate data to Accumulator | 2 | 12 |
| ANL | direct,A | AND Accumulator to direct byte | 2 | 12 |
| ANL | direct,#data | AND immediate data to direct byte | 3 | 24 |
| ORL | A,Rn | OR register to Accumulator | 1 | 12 |
| ORL | A,direct | OR direct byte to Accumulator | 2 | 12 |
| ORL | A,@Ri | OR indirect RAM to Accumulator | 1 | 12 |
| ORL | A,#data | OR immediate data to Accumulator | 2 | 12 |
| ORL | direct,A | OR Accumulator to direct byte | 2 | 12 |
| ORL | direct,#data | OR immediate data to direct byte | 3 | 24 |
| XRL | A,Rn | Exclusive-OR register to Accumulator | 1 | 12 |
| XRL | A,direct | Exclusive-OR direct byte to Accumulator | 2 | 12 |
| XRL | A,@Ri | Exclusive-OR indirect RAM to Accumulator | 1 | 12 |
| XRL | A,#data | Exclusive-OR immediate data to Accumulator | 2 | 12 |
| XRL | direct,A | Exclusive-OR Accumulator to direct byte | 2 | 12 |
| XRL | direct,#data | Exclusive-OR immediate data to direct byte | 3 | 24 |
| CLR | A | Clear Accumulator | 1 | 12 |
| CPL | A | Complement Accumulator | 1 | 12 |
| RL | A | Rotate Accumulator Left | 1 | 12 |
| RLC | A | Rotate Accumulator Left through the Carry | 1 | 12 |
| **LOGICAL OPERATIONS (continued)** | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mnemonic** | | **Description** | **Byte** | **Oscillator Period** |
| **ARITHMETIC OPERATIONS** | | | | |
| ADD | A,Rn | Add register to Accumulator | 1 | 12 |
| ADD | A,direct | Add direct byte to Accumulator | 2 | 12 |
| ADD | A,@Ri | Add indirect RAM to Accumulator | 1 | 12 |
| ADD | A,#data | Add immediate data to Accumulator | 2 | 12 |
| ADDC | A,Rn | Add register to Accumulator with Carry | 1 | 12 |
| ADDC | A,direct | Add direct byte to Accumulator with Carry | 2 | 12 |
| ADDC | A,@Ri | Add indirect RAM to Accumulator with Carry | 1 | 12 |
| ADDC | A,#data | Add immediate data to Acc with Carry | 2 | 12 |
| SUBB | A,Rn | Subtract Register from Acc with borrow | 1 | 12 |
| SUBB | A,direct | Subtract direct byte from Acc with borrow | 2 | 12 |
| SUBB | A,@Ri | Subtract indirect RAM from ACC with borrow | 1 | 12 |
| SUBB | A,#data | Subtract immediate data from Acc with borrow | 2 | 12 |
| INC | A | Increment Accumulator | 1 | 12 |
| INC | Rn | Increment register | 1 | 12 |
| INC | direct | Increment direct byte | 2 | 12 |
| INC | @Ri | Increment direct RAM | 1 | 12 |
| DEC | A | Decrement Accumulator | 1 | 12 |
| DEC | Rn | Decrement Register | 1 | 12 |
| DEC | direct | Decrement direct byte | 2 | 12 |
| DEC | @Ri | Decrement indirect RAM | 1 | 12 |
| INC | DPTR | Increment Data Pointer | 1 | 24 |
| MUL | AB | Multiply A & B | 1 | 48 |
| DIV | AB | Divide A by B | 1 | 48 |
| DA | A | Decimal Adjust Accumulator | 1 | 12 |

Note: 1. All mnemonics copyrighted © Intel Corp., 1980.



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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mnemonic** | | **Description** | **Byte** | **Oscillator Period** |
| RR | A | Rotate Accumulator Right | 1 | 12 |
| RRC | A | Rotate Accumulator Right through the Carry | 1 | 12 |
| SWAP | A | Swap nibbles within the Accumulator | 1 | 12 |
| **DATA TRANSFER** | | | | |
| MOV | A,Rn | Move register to Accumulator | 1 | 12 |
| MOV | A,direct | Move direct byte to Accumulator | 2 | 12 |
| MOV | A,@Ri | Move indirect RAM to Accumulator | 1 | 12 |
| MOV | A,#data | Move immediate data to Accumulator | 2 | 12 |
| MOV | Rn,A | Move Accumulator to register | 1 | 12 |
| MOV | Rn,direct | Move direct byte to register | 2 | 24 |
| MOV | Rn,#data | Move immediate data to register | 2 | 12 |
| MOV | direct,A | Move Accumulator to direct byte | 2 | 12 |
| MOV | direct,Rn | Move register to direct byte | 2 | 24 |
| MOV | direct,direct | Move direct byte to direct | 3 | 24 |
| MOV | direct,@Ri | Move indirect RAM to direct byte | 2 | 24 |
| MOV | direct,#data | Move immediate data to direct byte | 3 | 24 |
| MOV | @Ri,A | Move Accumulator to indirect RAM | 1 | 12 |
| MOV | @Ri,direct | Move direct byte to indirect RAM | 2 | 24 |
| MOV | @Ri,#data | Move immediate data to indirect RAM | 2 | 12 |
| MOV | DPTR,#data16 | Load Data Pointer with a 16-bit constant | 3 | 24 |
| MOVC | A,@A+DPTR | Move Code byte relative to DPTR to Acc | 1 | 24 |
| MOVC | A,@A+PC | Move Code byte relative to PC to Acc | 1 | 24 |
| MOVX | A,@Ri | Move External RAM (8- bit addr) to Acc | 1 | 24 |
| **DATA TRANSFER (continued)** | | | | |
| MOVX | A,@DPTR | Move Exernal RAM (16- bit addr) to Acc | 1 | 24 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mnemonic** | | **Description** | **Byte** | **Oscillator Period** |
| MOVX | @Ri,A | Move Acc to External RAM (8-bit addr) | 1 | 24 |
| MOVX | @DPTR,A | Move Acc to External RAM (16-bit addr) | 1 | 24 |
| PUSH | direct | Push direct byte onto stack | 2 | 24 |
| POP | direct | Pop direct byte from stack | 2 | 24 |
| XCH | A,Rn | Exchange register with Accumulator | 1 | 12 |
| XCH | A,direct | Exchange direct byte with Accumulator | 2 | 12 |
| XCH | A,@Ri | Exchange indirect RAM with Accumulator | 1 | 12 |
| XCHD | A,@Ri | Exchange low-order Digit indirect RAM with Acc | 1 | 12 |
| **BOOLEAN VARIABLE MANIPULATION** | | | | |
| CLR | C | Clear Carry | 1 | 12 |
| CLR | bit | Clear direct bit | 2 | 12 |
| SETB | C | Set Carry | 1 | 12 |
| SETB | bit | Set direct bit | 2 | 12 |
| CPL | C | Complement Carry | 1 | 12 |
| CPL | bit | Complement direct bit | 2 | 12 |
| ANL | C,bit | AND direct bit to CARRY | 2 | 24 |
| ANL | C,/bit | AND complement of direct bit to Carry | 2 | 24 |
| ORL | C,bit | OR direct bit to Carry | 2 | 24 |
| ORL | C,/bit | OR complement of direct bit to Carry | 2 | 24 |
| MOV | C,bit | Move direct bit to Carry | 2 | 12 |
| MOV | bit,C | Move Carry to direct bit | 2 | 24 |
| JC | rel | Jump if Carry is set | 2 | 24 |
| JNC | rel | Jump if Carry not set | 2 | 24 |
| JB | bit,rel | Jump if direct Bit is set | 3 | 24 |
| JNB | bit,rel | Jump if direct Bit is Not set | 3 | 24 |
| JBC | bit,rel | Jump if direct Bit is set & clear bit | 3 | 24 |
| **PROGRAM BRANCHING** | | | | |
| ACAL L | addr11 | Absolute Subroutine Call | 2 | 24 |
| LCALL | addr16 | Long Subroutine Call | 3 | 24 |
| RET |  | Return from Subroutine | 1 | 24 |



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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mnemonic** | | **Description** | **Byte** | **Oscillator Period** |
| RETI |  | Return from interrupt | 1 | 24 |
| AJMP | addr11 | Absolute Jump | 2 | 24 |
| LJMP | addr16 | Long Jump | 3 | 24 |
| SJMP | rel | Short Jump (relative addr) | 2 | 24 |
| JMP | @A+DPTR | Jump indirect relative to the DPTR | 1 | 24 |
| JZ | rel | Jump if Accumulator is Zero | 2 | 24 |
| JNZ | rel | Jump if Accumulator is Not Zero | 2 | 24 |
| CJNE | A,direct,rel | Compare direct byte to Acc and Jump if Not Equal | 3 | 24 |
| CJNE | A,#data,rel | Compare immediate to Acc and Jump if Not Equal | 3 | 24 |
| CJNE | Rn,#data,rel | Compare immediate to register and Jump if Not Equal | 3 | 24 |
| CJNE | @Ri,#data,rel | Compare immediate to indirect and Jump if Not Equal | 3 | 24 |
| DJNZ | Rn,rel | Decrement register and Jump if Not Zero | 2 | 24 |
| DJNZ | direct,rel | Decrement direct byte and Jump if Not Zero | 3 | 24 |
| NOP |  | No Operation | 1 | 12 |



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***Table 1-4.*** Instruction Opcodes in Hexadecimal Order

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| 00 | 1 | NOP |  |
| 01 | 2 | AJMP | code addr |
| 02 | 3 | LJMP | code addr |
| 03 | 1 | RR | A |
| 04 | 1 | INC | A |
| 05 | 2 | INC | data addr |
| 06 | 1 | INC | @R0 |
| 07 | 1 | INC | @R1 |
| 08 | 1 | INC | R0 |
| 09 | 1 | INC | R1 |
| 0A | 1 | INC | R2 |
| 0B | 1 | INC | R3 |
| 0C | 1 | INC | R4 |
| 0D | 1 | INC | R5 |
| 0E | 1 | INC | R6 |
| 0F | 1 | INC | R7 |
| 10 | 3 | JBC | bit addr,code addr |
| 11 | 2 | ACALL | code addr |
| 12 | 3 | LCALL | code addr |
| 13 | 1 | RRC | A |
| 14 | 1 | DEC | A |
| 15 | 2 | DEC | data addr |
| 16 | 1 | DEC | @R0 |
| 17 | 1 | DEC | @R1 |
| 18 | 1 | DEC | R0 |
| 19 | 1 | DEC | R1 |
| 1A | 1 | DEC | R2 |
| 1B | 1 | DEC | R3 |
| 1C | 1 | DEC | R4 |
| 1D | 1 | DEC | R5 |
| 1E | 1 | DEC | R6 |
| 1F | 1 | DEC | R7 |
| 20 | 3 | JB | bit addr,code addr |
| 21 | 2 | AJMP | code addr |
| 22 | 1 | RET |  |
| 23 | 1 | RL | A |
| 24 | 2 | ADD | A,#data |
| 25 | 2 | ADD | A,data addr |

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| 26 | 1 | ADD | A,@R0 |
| 27 | 1 | ADD | A,@R1 |
| 28 | 1 | ADD | A,R0 |
| 29 | 1 | ADD | A,R1 |
| 2A | 1 | ADD | A,R2 |
| 2B | 1 | ADD | A,R3 |
| 2C | 1 | ADD | A,R4 |
| 2D | 1 | ADD | A,R5 |
| 2E | 1 | ADD | A,R6 |
| 2F | 1 | ADD | A,R7 |
| 30 | 3 | JNB | bit addr,code addr |
| 31 | 2 | ACALL | code addr |
| 32 | 1 | RETI |  |
| 33 | 1 | RLC | A |
| 34 | 2 | ADDC | A,#data |
| 35 | 2 | ADDC | A,data addr |
| 36 | 1 | ADDC | A,@R0 |
| 37 | 1 | ADDC | A,@R1 |
| 38 | 1 | ADDC | A,R0 |
| 39 | 1 | ADDC | A,R1 |
| 3A | 1 | ADDC | A,R2 |
| 3B | 1 | ADDC | A,R3 |
| 3C | 1 | ADDC | A,R4 |
| 3D | 1 | ADDC | A,R5 |
| 3E | 1 | ADDC | A,R6 |
| 3F | 1 | ADDC | A,R7 |
| 40 | 2 | JC | code addr |
| 41 | 2 | AJMP | code addr |
| 42 | 2 | ORL | data addr,A |
| 43 | 3 | ORL | data addr,#data |
| 44 | 2 | ORL | A,#data |
| 45 | 2 | ORL | A,data addr |
| 46 | 1 | ORL | A,@R0 |
| 47 | 1 | ORL | A,@R1 |
| 48 | 1 | ORL | A,R0 |
| 49 | 1 | ORL | A,R1 |
| 4A | 1 | ORL | A,R2 |



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|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| 4B | 1 | ORL | A,R3 |
| 4C | 1 | ORL | A,R4 |
| 4D | 1 | ORL | A,R5 |
| 4E | 1 | ORL | A,R6 |
| 4F | 1 | ORL | A,R7 |
| 50 | 2 | JNC | code addr |
| 51 | 2 | ACALL | code addr |
| 52 | 2 | ANL | data addr,A |
| 53 | 3 | ANL | data addr,#data |
| 54 | 2 | ANL | A,#data |
| 55 | 2 | ANL | A,data addr |
| 56 | 1 | ANL | A,@R0 |
| 57 | 1 | ANL | A,@R1 |
| 58 | 1 | ANL | A,R0 |
| 59 | 1 | ANL | A,R1 |
| 5A | 1 | ANL | A,R2 |
| 5B | 1 | ANL | A,R3 |
| 5C | 1 | ANL | A,R4 |
| 5D | 1 | ANL | A,R5 |
| 5E | 1 | ANL | A,R6 |
| 5F | 1 | ANL | A,R7 |
| 60 | 2 | JZ | code addr |
| 61 | 2 | AJMP | code addr |
| 62 | 2 | XRL | data addr,A |
| 63 | 3 | XRL | data addr,#data |
| 64 | 2 | XRL | A,#data |
| 65 | 2 | XRL | A,data addr |
| 66 | 1 | XRL | A,@R0 |
| 67 | 1 | XRL | A,@R1 |
| 68 | 1 | XRL | A,R0 |
| 69 | 1 | XRL | A,R1 |
| 6A | 1 | XRL | A,R2 |
| 6B | 1 | XRL | A,R3 |
| 6C | 1 | XRL | A,R4 |
| 6D | 1 | XRL | A,R5 |
| 6E | 1 | XRL | A,R6 |
| 6F | 1 | XRL | A,R7 |
| 70 | 2 | JNZ | code addr |

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| 71 | 2 | ACALL | code addr |
| 72 | 2 | ORL | C,bit addr |
| 73 | 1 | JMP | @A+DPTR |
| 74 | 2 | MOV | A,#data |
| 75 | 3 | MOV | data addr,#data |
| 76 | 2 | MOV | @R0,#data |
| 77 | 2 | MOV | @R1,#data |
| 78 | 2 | MOV | R0,#data |
| 79 | 2 | MOV | R1,#data |
| 7A | 2 | MOV | R2,#data |
| 7B | 2 | MOV | R3,#data |
| 7C | 2 | MOV | R4,#data |
| 7D | 2 | MOV | R5,#data |
| 7E | 2 | MOV | R6,#data |
| 7F | 2 | MOV | R7,#data |
| 80 | 2 | SJMP | code addr |
| 81 | 2 | AJMP | code addr |
| 82 | 2 | ANL | C,bit addr |
| 83 | 1 | MOVC | A,@A+PC |
| 84 | 1 | DIV | AB |
| 85 | 3 | MOV | data addr,data addr |
| 86 | 2 | MOV | data addr,@R0 |
| 87 | 2 | MOV | data addr,@R1 |
| 88 | 2 | MOV | data addr,R0 |
| 89 | 2 | MOV | data addr,R1 |
| 8A | 2 | MOV | data addr,R2 |
| 8B | 2 | MOV | data addr,R3 |
| 8C | 2 | MOV | data addr,R4 |
| 8D | 2 | MOV | data addr,R5 |
| 8E | 2 | MOV | data addr,R6 |
| 8F | 2 | MOV | data addr,R7 |
| 90 | 3 | MOV | DPTR,#data |
| 91 | 2 | ACALL | code addr |
| 92 | 2 | MOV | bit addr,C |
| 93 | 1 | MOVC | A,@A+DPTR |
| 94 | 2 | SUBB | A,#data |
| 95 | 2 | SUBB | A,data addr |
| 96 | 1 | SUBB | A,@R0 |



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*8051 Microcontroller Instruction Set*

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| 97 | 1 | SUBB | A,@R1 |
| 98 | 1 | SUBB | A,R0 |
| 99 | 1 | SUBB | A,R1 |
| 9A | 1 | SUBB | A,R2 |
| 9B | 1 | SUBB | A,R3 |
| 9C | 1 | SUBB | A,R4 |
| 9D | 1 | SUBB | A,R5 |
| 9E | 1 | SUBB | A,R6 |
| 9F | 1 | SUBB | A,R7 |
| A0 | 2 | ORL | C,/bit addr |
| A1 | 2 | AJMP | code addr |
| A2 | 2 | MOV | C,bit addr |
| A3 | 1 | INC | DPTR |
| A4 | 1 | MUL | AB |
| A5 |  | reserved |  |
| A6 | 2 | MOV | @R0,data addr |
| A7 | 2 | MOV | @R1,data addr |
| A8 | 2 | MOV | R0,data addr |
| A9 | 2 | MOV | R1,data addr |
| AA | 2 | MOV | R2,data addr |
| AB | 2 | MOV | R3,data addr |
| AC | 2 | MOV | R4,data addr |
| AD | 2 | MOV | R5,data addr |
| AE | 2 | MOV | R6,data addr |
| AF | 2 | MOV | R7,data addr |
| B0 | 2 | ANL | C,/bit addr |
| B1 | 2 | ACALL | code addr |
| B2 | 2 | CPL | bit addr |
| B3 | 1 | CPL | C |
| B4 | 3 | CJNE | A,#data,code addr |
| B5 | 3 | CJNE | A,data addr,code addr |
| B6 | 3 | CJNE | @R0,#data,code addr |
| B7 | 3 | CJNE | @R1,#data,code addr |
| B8 | 3 | CJNE | R0,#data,code addr |
| B9 | 3 | CJNE | R1,#data,code addr |
| BA | 3 | CJNE | R2,#data,code addr |
| BB | 3 | CJNE | R3,#data,code addr |
| BC | 3 | CJNE | R4,#data,code addr |

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| BD | 3 | CJNE | R5,#data,code addr |
| BE | 3 | CJNE | R6,#data,code addr |
| BF | 3 | CJNE | R7,#data,code addr |
| C0 | 2 | PUSH | data addr |
| C1 | 2 | AJMP | code addr |
| C2 | 2 | CLR | bit addr |
| C3 | 1 | CLR | C |
| C4 | 1 | SWAP | A |
| C5 | 2 | XCH | A,data addr |
| C6 | 1 | XCH | A,@R0 |
| C7 | 1 | XCH | A,@R1 |
| C8 | 1 | XCH | A,R0 |
| C9 | 1 | XCH | A,R1 |
| CA | 1 | XCH | A,R2 |
| CB | 1 | XCH | A,R3 |
| CC | 1 | XCH | A,R4 |
| CD | 1 | XCH | A,R5 |
| CE | 1 | XCH | A,R6 |
| CF | 1 | XCH | A,R7 |
| D0 | 2 | POP | data addr |
| D1 | 2 | ACALL | code addr |
| D2 | 2 | SETB | bit addr |
| D3 | 1 | SETB | C |
| D4 | 1 | DA | A |
| D5 | 3 | DJNZ | data addr,code addr |
| D6 | 1 | XCHD | A,@R0 |
| D7 | 1 | XCHD | A,@R1 |
| D8 | 2 | DJNZ | R0,code addr |
| D9 | 2 | DJNZ | R1,code addr |
| DA | 2 | DJNZ | R2,code addr |
| DB | 2 | DJNZ | R3,code addr |
| DC | 2 | DJNZ | R4,code addr |
| DD | 2 | DJNZ | R5,code addr |
| DE | 2 | DJNZ | R6,code addr |
| DF | 2 | DJNZ | R7,code addr |
| E0 | 1 | MOVX | A,@DPTR |
| E1 | 2 | AJMP | code addr |
| E2 | 1 | MOVX | A,@R0 |



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*8051 Microcontroller Instruction Set*

|  |  |  |  |
| --- | --- | --- | --- |
| **Hex Code** | **Number of Bytes** | **Mnemonic** | **Operands** |
| E3 | 1 | MOVX | A,@R1 |
| E4 | 1 | CLR | A |
| E5 | 2 | MOV | A,data addr |
| E6 | 1 | MOV | A,@R0 |
| E7 | 1 | MOV | A,@R1 |
| E8 | 1 | MOV | A,R0 |
| E9 | 1 | MOV | A,R1 |
| EA | 1 | MOV | A,R2 |
| EB | 1 | MOV | A,R3 |
| EC | 1 | MOV | A,R4 |
| ED | 1 | MOV | A,R5 |
| EE | 1 | MOV | A,R6 |
| EF | 1 | MOV | A,R7 |
| F0 | 1 | MOVX | @DPTR,A |
| F1 | 2 | ACALL | code addr |
| F2 | 1 | MOVX | @R0,A |
| F3 | 1 | MOVX | @R1,A |
| F4 | 1 | CPL | A |
| F5 | 2 | MOV | data addr,A |
| F6 | 1 | MOV | @R0,A |
| F7 | 1 | MOV | @R1,A |
| F8 | 1 | MOV | R0,A |
| F9 | 1 | MOV | R1,A |
| FA | 1 | MOV | R2,A |
| FB | 1 | MOV | R3,A |
| FC | 1 | MOV | R4,A |
| FD | 1 | MOV | R5,A |
| FE | 1 | MOV | R6,A |
| FF | 1 | MOV | R7,A |



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# 1.1 Instruction Definitions

**ACALL addr11**

**Function:** Absolute Call

**Description:** ACALL unconditionally calls a subroutine located at the indicated address. The instruction increments the PC twice to obtain the address of the following instruction, then pushes the 16-bit result onto the stack (low-order byte first) and increments the Stack Pointer twice. The destination address is obtained by successively concatenating the five high-order bits of the incremented PC, opcode bits 7 through 5, and the second byte of the instruction. The subroutine called must therefore start within the same 2 K block of the program memory as the first byte of the instruction following ACALL. No flags are affected.

**Example:** Initially SP equals 07H. The label SUBRTN is at program memory location 0345 H. After executing the following instruction,

ACALL SUBRTN

at location 0123H, SP contains 09H, internal RAM locations 08H and 09H will contain 25H and 01H, respectively, and the PC contains 0345H.

###### Bytes: 2

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a10 | a9 | a8 | 1 | 0 | 0 | 0 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a7 | a6 | a5 | a4 | a3 | a2 | a1 | a0 |

**Encoding:**

**Operation:** ACALL

(PC)  (PC) + 2

(SP)  (SP) + 1 ((SP))  (PC7-0) (SP)  (SP) + 1 ((SP))  (PC15-8)

(PC10-0)  page address

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**ADD A,<src-byte>**

**Function:** Add

**Description:** ADD adds the byte variable indicated to the Accumulator, leaving the result in the Accumulator. The carry and auxiliary-carry flags are set, respectively, if there is a carry-out from bit 7 or bit 3, and cleared otherwise. When adding unsigned integers, the carry flag indicates an overflow occurred.

OV is set if there is a carry-out of bit 6 but not out of bit 7, or a carry-out of bit 7 but not bit 6; otherwise, OV is cleared. When adding signed integers, OV indicates a negative number produced as the sum of two positive operands, or a positive sum from two negative operands.

Four source operand addressing modes are allowed: register, direct, register-indirect, or immediate.

**Example:** The Accumulator holds 0C3H (1100001lB), and register 0 holds 0AAH (10101010B). The following instruction,

ADD A,R0

leaves 6DH (01101101B) in the Accumulator with the AC flag cleared and both the carry flag and OV set to 1.

#### ADD A,Rn

###### Bytes: 1

**Cycles:** 1

**Encoding: Operation:**

**ADD A,direct**

**Bytes: Cycles: Encoding: Operation:**

**ADD A,@Ri**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 1 | r | r | r |

ADD

(A)  (A) + (Rn)

2

1

### 

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |

direct address

ADD

1.  (A) + (direct)

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** ADD

(A)  (A) + ((Ri))

**ADD A,#data**

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** ADD

* 1.  (A) + #data

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# ADDC A, <src-byte>

**Function:** Add with Carry

**Description:** ADDC simultaneously adds the byte variable indicated, the carry flag and the Accumulator contents, leaving the result in the Accumulator. The carry and auxiliary-carry flags are set respectively, if there is a carry-out from bit 7 or bit 3, and cleared otherwise. When adding unsigned integers, the carry flag indicates an overflow occurred.

OV is set if there is a carry-out of bit 6 but not out of bit 7, or a carry-out of bit 7 but not out of bit 6; otherwise OV is cleared. When adding signed integers, OV indicates a negative number produced as the sum of two positive operands or a positive sum from two negative operands.

Four source operand addressing modes are allowed: register, direct, register-indirect, or immediate.

**Example:** The Accumulator holds 0C3H (11000011B) and register 0 holds 0AAH (10101010B) with the carry flag set. The following instruction,

ADDC A,R0

leaves 6EH (01101110B) in the Accumulator with AC cleared and both the Carry flag and OV set to 1.

#### ADDC A,Rn

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** ADDC

(A)  (A) + (C) + (Rn)

#### ADDC A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** ADDC

(A)  (A) + (C) + (direct)

#### ADDC A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** ADDC

(A)  (A) + (C) + ((Ri))

#### ADDC A,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** ADDC

(A)  (A) + (C) + #data

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**AJMP addr11**

**Function:** Absolute Jump

**Description:** AJMP transfers program execution to the indicated address, which is formed at run-time by concatenating the high-order five bits of the PC (after incrementing the PC twice), opcode bits 7 through 5, and the second byte of the instruction. The destination must therfore be within the same 2 K block of program memory as the first byte of the instruction following AJMP.

**Example:** The label JMPADR is at program memory location 0123H. The following instruction, AJMP JMPADR

is at location 0345H and loads the PC with 0123H.

###### Bytes: 2

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a10 | a9 | a8 | 0 | 0 | 0 | 0 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a7 | a6 | a5 | a4 | a3 | a2 | a1 | a0 |

**Encoding:**

**Operation:** AJMP

(PC)  (PC) + 2

(PC10-0)  page address

# ANL <dest-byte>,<src-byte>

**Function:** Logical-AND for byte variables

**Description:** ANL performs the bitwise logical-AND operation between the variables indicated and stores the results in the destination variable. No flags are affected.

The two operands allow six addressing mode combinations. When the destination is the Accumulator, the source can use register, direct, register-indirect, or immediate addressing; when the destination is a direct address, the source can be the Accumulator or immediate data.

Note: When this instruction is used to modify an output port, the value used as the original port data will be read from the output data latch, *not* the input pins.

**Example:** If the Accumulator holds 0C3H (1100001lB), and register 0 holds 55H (01010101B), then the following instruction,

ANL A,R0

leaves 41H (01000001B) in the Accumulator.

When the destination is a directly addressed byte, this instruction clears combinations of bits in any RAM location or hardware register. The mask byte determining the pattern of bits to be cleared would either be a constant contained in the instruction or a value computed in the Accumulator at run-time. The following instruction,

ANL P1,#01110011B

clears bits 7, 3, and 2 of output port 1.

#### ANL A,Rn

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** ANL



(A)  (A) (Rn)

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#### ANL A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** ANL



(A)  (A) (direct)

#### ANL A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** ANL



(A)  (A) ((Ri))

#### ANL A,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** ANL



(A)  (A) #data

#### ANL direct,A

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** ANL



(direct)  (direct) (A)

#### ANL direct,#data

###### Bytes: 3

**Cycles:** 2

immediate data

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** ANL



(direct)  (direct) #data

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**ANL C,<src-bit>**

**Function:** Logical-AND for bit variables

**Description:** If the Boolean value of the source bit is a logical 0, then ANL C clears the carry flag; otherwise, this instruction leaves the carry flag in its current state. A slash ( / ) preceding the operand in the assembly language indicates that the logical complement of the addressed bit is used as the source value, *but the source bit itself is not affected*. No other flags are affected.

Only direct addressing is allowed for the source operand.

**Example:** Set the carry flag if, and only if, P1.0 = 1, ACC.7 = 1, and OV = 0: MOV C,P1.0 ;LOAD CARRY WITH INPUT PIN STATE ANL C,ACC.7 ;AND CARRY WITH ACCUM. BIT 7

ANL C,/OV ;AND WITH INVERSE OF OVERFLOW FLAG

#### ANL C,bit

###### Bytes: 2

**Cycles:** 2

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** ANL



(C)  (C) (bit)

#### ANL C,/bit

###### Bytes: 2

**Cycles:** 2

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** ANL



(C)  (C) (bit)

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# CJNE <dest-byte>,<src-byte>, rel

**Function:** Compare and Jump if Not Equal.

**Description:** CJNE compares the magnitudes of the first two operands and branches if their values are not equal. The branch destination is computed by adding the signed relative-displacement in the last instruction byte to the PC, after incrementing the PC to the start of the next instruction. The carry flag is set if the unsigned integer value of

<dest-byte> is less than the unsigned integer value of <src-byte>; otherwise, the carry is cleared. Neither operand is affected.

The first two operands allow four addressing mode combinations: the Accumulator may be compared with any directly addressed byte or immediate data, and any indirect RAM location or working register can be compared with an immediate constant.

**Example:** The Accumulator contains 34H. Register 7 contains 56H. The first instruction in the sequence,

|  |  |  |  |
| --- | --- | --- | --- |
|  | CJNE | R7, # 60H, NOT\_EQ |  |
| ; | . . . | . . . . . | ;R7 = 60H. |
| NOT\_EQ: | JC | REQ\_LOW | ;IF R7 < 60H. |
| ; | . . . | . . . . . | ;R7 > 60H. |

sets the carry flag and branches to the instruction at label NOT\_EQ. By testing the carry flag, this instruction determines whether R7 is greater or less than 60H.

If the data being presented to Port 1 is also 34H, then the following instruction,

WAIT: CJNE A, P1,WAIT

clears the carry flag and continues with the next instruction in sequence, since the Accumulator does equal the data read from P1. (If some other value was being input on P1, the program loops at this point until the P1 data changes to 34H.)

#### CJNE A,direct,rel

###### Bytes: 3

**Cycles:** 2

rel. address

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** (PC)  (PC) + 3

IF (A) < > (*direct*) THEN

(PC)  (PC) + *relative offset*

IF (A) < (*direct*) THEN

(C)  1

ELSE

(C)  0

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#### CJNE A,#data,rel

###### Bytes: 3

**Cycles:** 2

rel. address

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** (PC)  (PC) + 3

IF (A) < > *data*

THEN

(PC)  (PC) + *relative offset*

IF (A) < *data*

THEN

(C)  1 ELSE

(C)  0

#### CJNE Rn,#data,rel

###### Bytes: 3

**Cycles:** 2

rel. address

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** (PC)  (PC) + 3

IF (Rn) < > *data*

THEN

(PC)  (PC) + *relative offset*

IF (Rn) < *data*

THEN

(C)  1 ELSE

(C)  0

#### CJNE @Ri,data,rel

###### Bytes: 3

**Cycles:** 2

rel. address

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** (PC)  (PC) + 3

IF ((Ri)) < > *data*

THEN

(PC)  (PC) + *relative offset*

IF ((Ri)) < *data*

THEN

(C)  1 ELSE

(C)  0

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# CLR A

**Function:** Clear Accumulator

**Description:** CLR A clears the Accumulator (all bits set to 0). No flags are affected

**Example:** The Accumulator contains 5CH (01011100B). The following instruction,CLR Aleaves the Accumulator set to 00H (00000000B).

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** CLR

(A)  0

# CLR bit

**Function:** Clear bit

**Description:** CLR bit clears the indicated bit (reset to 0). No other flags are affected. CLR can operate on the carry flag or any directly addressable bit.

**Example:** Port 1 has previously been written with 5DH (01011101B). The following instruction,CLR P1.2 leaves the port set to 59H (01011001B).

#### CLR C

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** CLR

(C)  0

#### CLR bit

###### Bytes: 2

**Cycles:** 1

**Encoding: Operation:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

bit address

CLR

(bit)  0

#### 19



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**CPL A**

**Function:** Complement Accumulator

**Description:** CPLA logically complements each bit of the Accumulator (one’s complement). Bits which previously contained a 1 are changed to a 0 and vice-versa. No flags are affected.

**Example:** The Accumulator contains 5CH (01011100B). The following instruction, CPL A

leaves the Accumulator set to 0A3H (10100011B).

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** CPL

(A)  (A)

# CPL bit

**Function:** Complement bit

**Description:** CPL bit complements the bit variable specified. A bit that had been a 1 is changed to 0 and vice-versa. No other flags are affected. CLR can operate on the carry or any directly addressable bit.

Note: When this instruction is used to modify an output pin, the value used as the original data is read from the output data latch, *not* the input pin.

**Example:** Port 1 has previously been written with 5BH (01011101B). The following instruction sequence,CPL P1.1CPL P1.2 leaves the port set to 5BH (01011011B).

#### CPL C

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** CPL

(C)  (C)

#### CPL bit

###### Bytes: 2

**Cycles:** 1

**Encoding: Operation:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |

bit address

CPL

(bit)  (bit)

#### 20

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# DA A

**Function:** Decimal-adjust Accumulator for Addition

**Description:** DA A adjusts the eight-bit value in the Accumulator resulting from the earlier addition of two variables (each in packed-BCD format), producing two four-bit digits. Any ADD or ADDC instruction may have been used to perform the addition.

If Accumulator bits 3 through 0 are greater than nine (xxxx1010-xxxx1111), or if the AC flag is one, six is added to the Accumulator producing the proper BCD digit in the low-order nibble. This internal addition sets the carry flag if a carry-out of the low-order four-bit field propagates through all high-order bits, but it does not clear the carry flag otherwise.

If the carry flag is now set, or if the four high-order bits now exceed nine (1010xxxx-1111xxxx), these high-order bits are incremented by six, producing the proper BCD digit in the high-order nibble. Again, this sets the carry flag if there is a carry-out of the high-order bits, but does not clear the carry. The carry flag thus indicates if the sum of the original two BCD variables is greater than 100, allowing multiple precision decimal addition. OV is not affected.

All of this occurs during the one instruction cycle. Essentially, this instruction performs the decimal conversion by adding 00H, 06H, 60H, or 66H to the Accumulator, depending on initial Accumulator and PSW conditions.

Note: DA A *cannot* simply convert a hexadecimal number in the Accumulator to BCD notation, nor does DAA apply to decimal subtraction.

**Example:** The Accumulator holds the value 56H (01010110B), representing the packed BCD digits of the decimal number

56. Register 3 contains the value 67H (01100111B), representing the packed BCD digits of the decimal number

67. The carry flag is set. The following instruction sequence ADDC A,R3

DA A

first performs a standard two’s-complement binary addition, resulting in the value 0BEH (10111110) in the Accumulator. The carry and auxiliary carry flags are cleared.

The Decimal Adjust instruction then alters the Accumulator to the value 24H (00100100B), indicating the packed BCD digits of the decimal number 24, the low-order two digits of the decimal sum of 56, 67, and the carry-in. The carry flag is set by the Decimal Adjust instruction, indicating that a decimal overflow occurred. The true sum of 56, 67, and 1 is 124.

BCD variables can be incremented or decremented by adding 01H or 99H. If the Accumulator initially holds 30H (representing the digits of 30 decimal), then the following instruction sequence,

ADD A, # 99H

DA A

leaves the carry set and 29H in the Accumulator, since 30 + 99 = 129. The low-order byte of the sum can be interpreted to mean 30 - 1 = 29.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** DA

-contents of Accumulator are BCD IF [[(A3-0) > 9] [(AC) = 1]] THEN (A3-0)  (A3-0) + 6



AND



IF [[(A7-4) > 9] [(C) = 1]] THEN (A7-4)  (A7-4) + 6

**21**



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**DEC byte**

**Function:** Decrement

**Description:** DEC byte decrements the variable indicated by 1. An original value of 00H underflows to 0FFH. No flags are affected. Four operand addressing modes are allowed: accumulator, register, direct, or register-indirect.

Note: When this instruction is used to modify an output port, the value used as the original port data will be read from the output data latch, *not* the input pins.

**Example:** Register 0 contains 7FH (01111111B). Internal RAM locations 7EH and 7FH contain 00H and 40H, respectively.

The following instruction sequence, DEC @R0

DEC R0

DEC @R0

leaves register 0 set to 7EH and internal RAM locations 7EH and 7FH set to 0FFH and 3FH.

#### DEC A

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** DEC

(A)  (A) - 1

#### DEC Rn

###### Bytes: 1

**Cycles:** 1

**Encoding: Operation:**

**DEC direct**

**Bytes: Cycles: Encoding: Operation:**

**DEC @Ri**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 1 | r | r | r |

DEC

(Rn)  (Rn) - 1

2

1

### 

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

direct address

DEC

(direct)  (direct) - 1

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** DEC

((Ri))  ((Ri)) - 1

**22**

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# DIV AB

**Function:** Divide

**Description:** DIV AB divides the unsigned eight-bit integer in the Accumulator by the unsigned eight-bit integer in register B. The Accumulator receives the integer part of the quotient; register B receives the integer remainder. The carry and OV flags are cleared.

*Exception*: if B had originally contained 00H, the values returned in the Accumulator and B-register are undefined and the overflow flag are set. The carry flag is cleared in any case.

**Example:** The Accumulator contains 251 (0FBH or 11111011B) and B contains 18 (12H or 00010010B). The following instruction,

DIV AB

leaves 13 in the Accumulator (0DH or 00001101B) and the value 17 (11H or 00010001B) in B, since 251 = (13 x 18) + 17. Carry and OV are both cleared.

###### Bytes: 1

**Cycles:** 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** DIV

(A)15-8  (A)/(B) (B)7-0

**23**



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**DJNZ <byte>,<rel-addr>**

**Function:** Decrement and Jump if Not Zero

**Description:** DJNZ decrements the location indicated by 1, and branches to the address indicated by the second operand if the resulting value is not zero. An original value of 00H underflows to 0FFH. No flags are affected. The branch destination is computed by adding the signed relative-displacement value in the last instruction byte to the PC, after incrementing the PC to the first byte of the following instruction.

The location decremented may be a register or directly addressed byte.

Note: When this instruction is used to modify an output port, the value used as the original port data will be read from the output data latch, *not* the input pins.

**Example:** Internal RAM locations 40H, 50H, and 60H contain the values 01H, 70H, and 15H, respectively. The following instruction sequence,

DJNZ 40H,LABEL\_1

DJNZ 50H,LABEL\_2

DJNZ 60H,LABEL\_3

causes a jump to the instruction at label LABEL\_2 with the values 00H, 6FH, and 15H in the three RAM locations. The first jump was *not* taken because the result was zero.

This instruction provides a simple way to execute a program loop a given number of times or for adding a moderate time delay (from 2 to 512 machine cycles) with a single instruction. The following instruction sequence,

MOV R2, # 8 TOGGLE: CPL P1.7

DJNZ R2,TOGGLE

toggles P1.7 eight times, causing four output pulses to appear at bit 7 of output Port 1. Each pulse lasts three machine cycles; two for DJNZ and one to alter the pin.

#### DJNZ Rn,rel

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** DJNZ

(PC)  (PC) + 2

(Rn)  (Rn) - 1

IF (Rn) > 0 or (Rn) < 0 THEN

(PC)  (PC) + rel

#### DJNZ direct,rel

###### Bytes: 3

**Cycles:** 2

rel. address

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** DJNZ

(PC)  (PC) + 2

(direct)  (direct) - 1

IF (direct) > 0 or (direct) < 0 THEN

(PC)  (PC) + rel

#### 24

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# INC <byte>

**Function:** Increment

**Description:** INC increments the indicated variable by 1. An original value of 0FFH overflows to 00H. No flags are affected.

Three addressing modes are allowed: register, direct, or register-indirect.

Note: When this instruction is used to modify an output port, the value used as the original port data will be read from the output data latch, *not* the input pins.

**Example:** Register 0 contains 7EH (011111110B). Internal RAM locations 7EH and 7FH contain 0FFH and 40H, respectively. The following instruction sequence,

INC @R0

INC R0

INC @R0

leaves register 0 set to 7FH and internal RAM locations 7EH and 7FH holding 00H and 41H, respectively.

#### INC A

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** INC

(A)  (A) + 1

#### INC Rn

###### Bytes: 1

**Cycles:** 1

**Encoding: Operation:**

**INC direct Bytes: Cycles:**

###### Encoding: Operation:

**INC @Ri**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 1 | r | r | r |

INC

(Rn)  (Rn) + 1

2

1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

direct address

INC

(direct)  (direct) + 1

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** INC

((Ri))  ((Ri)) + 1

**25**



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### 



**INC DPTR**

**Function:** Increment Data Pointer

**Description:** INC DPTR increments the 16-bit data pointer by 1. A 16-bit increment (modulo 216) is performed, and an overflow of the low-order byte of the data pointer (DPL) from 0FFH to 00H increments the high-order byte (DPH). No flags are affected.

This is the only 16-bit register which can be incremented.

**Example:** Registers DPH and DPL contain 12H and 0FEH, respectively. The following instruction sequence, INC DPTR

INC DPTR

INC DPTR

changes DPH and DPL to 13H and 01H.

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** INC

(DPTR)  (DPTR) + 1

# JB blt,rel

**Function:** Jump if Bit set

**Description:** If the indicated bit is a one, JB jump to the address indicated; otherwise, it proceeds with the next instruction.

The branch destination is computed by adding the signed relative-displacement in the third instruction byte to the PC, after incrementing the PC to the first byte of the next instruction. The bit tested is not modified. No flags are affected.

**Example:** The data present at input port 1 is 11001010B. The Accumulator holds 56 (01010110B). The following instruction sequence,

JB P1.2,LABEL1

JB ACC. 2,LABEL2

causes program execution to branch to the instruction at label LABEL2.

###### Bytes: 3

**Cycles:** 2

rel. address

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JB

(PC)  (PC) + 3

IF (bit) = 1 THEN

(PC)  (PC) + rel

**26**

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# JBC bit,rel

**Function:** Jump if Bit is set and Clear bit

**Description:** If the indicated bit is one, JBC branches to the address indicated; otherwise, it proceeds with the next instruction.

*The bit will not be cleared if it is already a zero*. The branch destination is computed by adding the signed relative-displacement in the third instruction byte to the PC, after incrementing the PC to the first byte of the next instruction. No flags are affected.

Note: When this instruction is used to test an output pin, the value used as the original data will be read from the output data latch, *not* the input pin.

**Example:** The Accumulator holds 56H (01010110B). The following instruction sequence, JBC ACC.3,LABEL1

JBC ACC.2,LABEL2

causes program execution to continue at the instruction identified by the label LABEL2, with the Accumulator modified to 52H (01010010B).

###### Bytes: 3

**Cycles:** 2

rel. address

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JBC

(PC)  (PC) + 3

IF (bit) = 1 THEN

(bit)  0

(PC)  (PC) +rel

# JC rel

**Function:** Jump if Carry is set

**Description:** If the carry flag is set, JC branches to the address indicated; otherwise, it proceeds with the next instruction. The branch destination is computed by adding the signed relative-displacement in the second instruction byte to the PC, after incrementing the PC twice. No flags are affected.

**Example:** The carry flag is cleared. The following instruction sequence, JC LABEL1

CPL C

JC LABEL 2

sets the carry and causes program execution to continue at the instruction identified by the label LABEL2.

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JC

(PC)  (PC) + 2 IF (C) = 1

THEN

(PC)  (PC) + rel

**27**



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**JMP @A+DPTR**

**Function:** Jump indirect

**Description:** JMP @A+DPTR adds the eight-bit unsigned contents of the Accumulator with the 16-bit data pointer and loads the resulting sum to the program counter. This is the address for subsequent instruction fetches. Sixteen-bit addition is performed (modulo 216): a carry-out from the low-order eight bits propagates through the higher-order bits. Neither the Accumulator nor the Data Pointer is altered. No flags are affected.

**Example:** An even number from 0 to 6 is in the Accumulator. The following sequence of instructions branches to one of four AJMP instructions in a jump table starting at JMP\_TBL.

MOV DPTR, # JMP\_TBL

JMP @A + DPTR JMP\_TBL: AJMP LABEL0

AJMP LABEL1

AJMP LABEL2

AJMP LABEL3

If the Accumulator equals 04H when starting this sequence, execution jumps to label LABEL2. Because AJMP is a 2-byte instruction, the jump instructions start at every other address.

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** JMP

(PC)  (A) + (DPTR)

**28**

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# JNB bit,rel

**Function:** Jump if Bit Not set

**Description:** If the indicated bit is a 0, JNB branches to the indicated address; otherwise, it proceeds with the next instruction. The branch destination is computed by adding the signed relative-displacement in the third instruction byte to the PC, after incrementing the PC to the first byte of the next instruction. *The bit tested is not modified*. No flags are affected.

**Example:** The data present at input port 1 is 11001010B. The Accumulator holds 56H (01010110B). The following instruction sequence,

JNB P1.3,LABEL1

JNB ACC.3,LABEL2

causes program execution to continue at the instruction at label LABEL2.

###### Bytes: 3

**Cycles:** 2

bit address

**Encoding: Operation:**

**JNC rel**

**Function:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

JNB

(PC)  (PC) + 3

IF (bit) = 0

THEN (PC)  (PC) + rel

Jump if Carry not set

rel. address

**Description:** If the carry flag is a 0, JNC branches to the address indicated; otherwise, it proceeds with the next instruction. The branch destination is computed by adding the signal relative-displacement in the second instruction byte to the PC, after incrementing the PC twice to point to the next instruction. The carry flag is not modified.

**Example:** The carry flag is set. The following instruction sequence, JNC LABEL1

CPL C

JNC LABEL2

clears the carry and causes program execution to continue at the instruction identified by the label LABEL2.

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JNC

(PC)  (PC) + 2 IF (C) = 0

THEN (PC)  (PC) + rel

**29**



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**JNZ rel**

**Function:** Jump if Accumulator Not Zero

**Description:** If any bit of the Accumulator is a one, JNZ branches to the indicated address; otherwise, it proceeds with the next instruction. The branch destination is computed by adding the signed relative-displacement in the second instruction byte to the PC, after incrementing the PC twice. The Accumulator is not modified. No flags are affected.

**Example:** The Accumulator originally holds 00H. The following instruction sequence, JNZ LABEL1

INC A

JNZ LABEL2

sets the Accumulator to 01H and continues at label LABEL2.

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JNZ

(PC)  (PC) + 2 IF (A)  0

THEN (PC)  (PC) + rel

# JZ rel

**Function:** Jump if Accumulator Zero

**Description:** If all bits of the Accumulator are 0, JZ branches to the address indicated; otherwise, it proceeds with the next instruction. The branch destination is computed by adding the signed relative-displacement in the second instruction byte to the PC, after incrementing the PC twice. The Accumulator is not modified. No flags are affected.

**Example:** The Accumulator originally contains 01H. The following instruction sequence, JZ LABEL1

DEC A

JZ LABEL2

changes the Accumulator to 00H and causes program execution to continue at the instruction identified by the label LABEL2.

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** JZ

(PC)  (PC) + 2 IF (A) = 0

THEN (PC)  (PC) + rel

**30**

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# LCALL addr16

**Function:** Long call

**Description:** LCALL calls a subroutine located at the indicated address. The instruction adds three to the program counter to generate the address of the next instruction and then pushes the 16-bit result onto the stack (low byte first), incrementing the Stack Pointer by two. The high-order and low-order bytes of the PC are then loaded, respectively, with the second and third bytes of the LCALL instruction. Program execution continues with the instruction at this address. The subroutine may therefore begin anywhere in the full 64K byte program memory address space. No flags are affected.

**Example:** Initially the Stack Pointer equals 07H. The label SUBRTN is assigned to program memory location 1234H. After executing the instruction,

LCALL SUBRTN

at location 0123H, the Stack Pointer will contain 09H, internal RAM locations 08H and 09H will contain 26H and 01H, and the PC will contain 1234H.

###### Bytes: 3

**Cycles:** 2

addr7-addr0

addr15-addr8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** LCALL

(PC)  (PC) + 3

(SP)  (SP) + 1 ((SP))  (PC7-0) (SP)  (SP) + 1 ((SP))  (PC15-8)

(PC)  addr15-0

# LJMP addr16

**Function:** Long Jump

**Description:** LJMP causes an unconditional branch to the indicated address, by loading the high-order and low-order bytes of the PC (respectively) with the second and third instruction bytes. The destination may therefore be anywhere in the full 64K program memory address space. No flags are affected.

**Example:** The label JMPADR is assigned to the instruction at program memory location 1234H. The instruction, LJMP JMPADR

at location 0123H will load the program counter with 1234H.

###### Bytes: 3

**Cycles:** 2

addr15-addr8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

**Encoding: Operation:**

LJMP

(PC)  addr15-0

addr7-addr0

**31**



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**MOV <dest-byte>,<src-byte>**

**Function:** Move byte variable

**Description:** The byte variable indicated by the second operand is copied into the location specified by the first operand. The source byte is not affected. No other register or flag is affected.

This is by far the most flexible operation. Fifteen combinations of source and destination addressing modes are allowed.

**Example:** Internal RAM location 30H holds 40H. The value of RAM location 40H is 10H. The data present at input port 1 is 11001010B (0CAH).

|  |  |  |
| --- | --- | --- |
| MOV | R0,#30H | ;R0 < = 30H |
| MOV | A,@R0 | ;A < = 40H |
| MOV | R1,A | ;R1 < = 40H |
| MOV | B,@R1 | ;B < = 10H |
| MOV | @R1,P1 | ;RAM (40H) < = 0CAH |
| MOV | P2,P1 | ;P2 #0CAH |

#### MOV A,Rn

leaves the value 30H in register 0, 40H in both the Accumulator and register 1, 10H in register B, and 0CAH (11001010B) both in RAM location 40H and output on port 2.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 1 | r | r | r |

**Encoding:**

**Operation:** MOV

(A)  (Rn)

#### \*MOV A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** MOV

(A)  (direct)

#### \* MOV A,ACC is not a valid Instruction. MOV A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** MOV

(A)  ((Ri))

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#### MOV A,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** MOV

(A)  #data

#### MOV Rn,A

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** MOV

(Rn)  (A)

#### MOV Rn,direct

###### Bytes: 2

**Cycles:** 2

direct addr.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 1 | r | r | r |

**Encoding:**

**Operation:** MOV

(Rn)  (direct)

#### MOV Rn,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** MOV

(Rn)  #data

#### MOV direct,A

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** MOV

(direct)  (A)

#### MOV direct,Rn

###### Bytes: 2

**Cycles:** 2

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 1 | r | r | r |

**Encoding:**

**Operation:** MOV

(direct)  (Rn)

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### 

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | i |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | i |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | i |



|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **MOV** | **direct,direct**  **Bytes:** | 3 |  | | | | |
|  | **Cycles:** | 2 |
|  | **Encoding:** |  |  |  | dir. addr. (dest) |  | dir. addr. (scr) |
|  | **Operation:** | MOV  (direct)  (direct) |  |  |  |  |  |
| **MOV** | **direct,@Ri** |  |  |  |  |  |  |
|  | **Bytes:** | 2 |  |  |  |  |  |
|  | **Cycles:** | 2 |  |  |  |  |  |
|  | **Encoding:** |  |  |  | direct addr. |  |  |
|  | **Operation:** | MOV  (direct)  ((Ri)) |  |  |  |  |  |
| **MOV** | **direct,#data** |  |  |  |  |  |  |
|  | **Bytes:** | 3 |  |  |  |  |  |
|  | **Cycles:** | 2 |  |  |  |  |  |
|  | **Encoding:** |  |  |  | direct address |  | immediate data |
|  | **Operation:** | MOV  (direct)  #data |  |  |  |  |  |
| **MOV** | **@Ri,A** |  |  |  |  |  |  |
|  | **Bytes:** | 1 |  |  |  |  |  |
|  | **Cycles:** | 1 |  |  |  |  |  |
|  | **Encoding:** |  |  |  |  |  |  |
|  | **Operation:** | MOV  ((Ri))  (A) |  |  |  |  |  |
| **MOV** | **@Ri,direct** |  |  |  |  |  |  |
|  | **Bytes:** | 2 |  |  |  |  |  |
|  | **Cycles:** | 2 |  |  |  |  |  |
|  | **Encoding:** |  |  |  | direct addr. |  |  |
|  | **Operation:** | MOV  ((Ri))  (direct) |  |  |  |  |  |
| **MOV** | **@Ri,#data** |  |  |  |  |  |  |
|  | **Bytes:** | 2 |  |  |  |  |  |
|  | **Cycles:** | 1 |  |  |  |  |  |
|  | **Encoding:** |  |  |  | immediate data |  |  |
|  | **Operation:** | MOV  ((Ri))  #data |  |  |  |  |  |

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|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | i |

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# MOV <dest-bit>,<src-bit>

**Function:** Move bit data

**Description:** MOV <dest-bit>,<src-bit> copies the Boolean variable indicated by the second operand into the location specified by the first operand. One of the operands must be the carry flag; the other may be any directly addressable bit. No other register or flag is affected.

**Example:** The carry flag is originally set. The data present at input Port 3 is 11000101B. The data previously written to output Port 1 is 35H (00110101B).

MOV P1.3,C

MOV C,P3.3

MOV P1.2,C

leaves the carry cleared and changes Port 1 to 39H (00111001B).

#### MOV C,bit

###### Bytes: 2

**Cycles:** 1

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** MOV

(C)  (bit)

#### MOV bit,C

###### Bytes: 2

**Cycles:** 2

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** MOV

(bit)  (C)

# MOV DPTR,#data16

**Function:** Load Data Pointer with a 16-bit constant

**Description:** MOV DPTR,#data16 loads the Data Pointer with the 16-bit constant indicated. The 16-bit constant is loaded into the second and third bytes of the instruction. The second byte (DPH) is the high-order byte, while the third byte (DPL) holds the lower-order byte. No flags are affected.

This is the only instruction which moves 16 bits of data at once.

**Example:** The instruction,

MOV DPTR, # 1234H

loads the value 1234H into the Data Pointer: DPH holds 12H, and DPL holds 34H.

###### Bytes: 3

**Cycles:** 2

immed. data7-0

immed. data15-8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** MOV

(DPTR)  #data15-0

DPH  DPL  #data15-8  #data7-0

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**MOVC A,@A+ <base-reg>**

**Function:** Move Code byte

**Description:** The MOVC instructions load the Accumulator with a code byte or constant from program memory. The address of the byte fetched is the sum of the original unsigned 8-bit Accumulator contents and the contents of a 16-bit base register, which may be either the Data Pointer or the PC. In the latter case, the PC is incremented to the address of the following instruction before being added with the Accumulator; otherwise the base register is not altered. Sixteen-bit addition is performed so a carry-out from the low-order eight bits may propagate through higher-order bits. No flags are affected.

**Example:** A value between 0 and 3 is in the Accumulator. The following instructions will translate the value in the Accumulator to one of four values defined by the DB (define byte) directive.

|  |  |  |
| --- | --- | --- |
| REL\_PC: | INC | A |
|  | MOVC | A,@A+PC |
|  | RET |  |
|  | DB | 66H |
|  | DB | 77H |
|  | DB | 88H |
|  | DB | 99H |

If the subroutine is called with the Accumulator equal to 01H, it returns with 77H in the Accumulator. The INC A before the MOVC instruction is needed to “get around” the RET instruction above the table. If several bytes of code separate the MOVC from the table, the corresponding number is added to the Accumulator instead.

#### MOVC A,@A+DPTR

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** MOVC

(A)  ((A) + (DPTR))

#### MOVC A,@A+PC

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** MOVC

(PC)  (PC) + 1 (A)  ((A) + (PC))

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# MOVX <dest-byte>,<src-byte>

**Function:** Move External

**Description:** The MOVX instructions transfer data between the Accumulator and a byte of external data memory, which is why “X” is appended to MOV. There are two types of instructions, differing in whether they provide an 8-bit or 16-bit indirect address to the external data RAM.

In the first type, the contents of R0 or R1 in the current register bank provide an 8-bit address multiplexed with data on P0. Eight bits are sufficient for external I/O expansion decoding or for a relatively small RAM array. For somewhat larger arrays, any output port pins can be used to output higher-order address bits. These pins are controlled by an output instruction preceding the MOVX.

In the second type of MOVX instruction, the Data Pointer generates a 16-bit address. P2 outputs the high-order eight address bits (the contents of DPH), while P0 multiplexes the low-order eight bits (DPL) with data. The P2 Special Function Register retains its previous contents, while the P2 output buffers emit the contents of DPH. This form of MOVX is faster and more efficient when accessing very large data arrays (up to 64K bytes), since no additional instructions are needed to set up the output ports.

It is possible to use both MOVX types in some situations. A large RAM array with its high-order address lines driven by P2 can be addressed via the Data Pointer, or with code to output high-order address bits to P2, followed by a MOVX instruction using R0 or R1.

**Example:** An external 256 byte RAM using multiplexed address/data lines is connected to the 8051 Port 0. Port 3 provides control lines for the external RAM. Ports 1 and 2 are used for normal I/O. Registers 0 and 1 contain 12H and 34H. Location 34H of the external RAM holds the value 56H. The instruction sequence,

MOVX A,@R1

MOVX @R0,A

copies the value 56H into both the Accumulator and external RAM location 12H.

#### MOVX A,@Ri

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | i |

**Encoding:**

**Operation:** MOVX

(A)  ((Ri))

#### MOVX A,@DPTR

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** MOVX

(A)  ((DPTR))

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#### MOVX @Ri,A

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 0 | 0 | 1 | i |

**Encoding:**

**Operation:** MOVX

((Ri))  (A)

#### MOVX @DPTR,A

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** MOVX

(DPTR)  (A)

# MUL AB

**Function:** Multiply

**Description:** MUL AB multiplies the unsigned 8-bit integers in the Accumulator and register B. The low-order byte of the 16-bit product is left in the Accumulator, and the high-order byte in B. If the product is greater than 255 (0FFH), the overflow flag is set; otherwise it is cleared. The carry flag is always cleared.

**Example:** Originally the Accumulator holds the value 80 (50H). Register B holds the value 160 (0A0H). The instruction, MUL AB

will give the product 12,800 (3200H), so B is changed to 32H (00110010B) and the Accumulator is cleared. The overflow flag is set, carry is cleared.

###### Bytes: 1

**Cycles:** 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** MUL

(A)7-0  (A) X (B) (B)15-8

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# NOP

**Function:** No Operation

**Description:** Execution continues at the following instruction. Other than the PC, no registers or flags are affected.

**Example:** A low-going output pulse on bit 7 of Port 2 must last exactly 5 cycles. A simple SETB/CLR sequence generates a one-cycle pulse, so four additional cycles must be inserted. This may be done (assuming no interrupts are enabled) with the following instruction sequence,

CLR P2.7 NOP

NOP NOP NOP

SETB P2.7

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** NOP

(PC)  (PC) + 1

# ORL <dest-byte> <src-byte>

**Function:** Logical-OR for byte variables

**Description:** ORL performs the bitwise logical-OR operation between the indicated variables, storing the results in the destination byte. No flags are affected.

The two operands allow six addressing mode combinations. When the destination is the Accumulator, the source can use register, direct, register-indirect, or immediate addressing; when the destination is a direct address, the source can be the Accumulator or immediate data.

Note: When this instruction is used to modify an output port, the value used as the original port data is read from the output data latch, *not* the input pins.

**Example:** If the Accumulator holds 0C3H (11000011B) and R0 holds 55H (01010101B) then the following instruction,

ORL A,R0

leaves the Accumulator holding the value 0D7H (1101011lB).When the destination is a directly addressed byte, the instruction can set combinations of bits in any RAM location or hardware register. The pattern of bits to be set is determined by a mask byte, which may be either a constant data value in the instruction or a variable computed in the Accumulator at run-time. The instruction,

ORL P1,#00110010B

sets bits 5, 4, and 1 of output Port 1.

#### ORL A,Rn

###### Bytes: 1

**Cycles:** 1

**Encoding: Operation:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 1 | r | r | r |

ORL



1.  (A) (Rn)

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#### ORL A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** ORL



* 1.  (A) (direct)

#### ORL A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** ORL



(A)  (A) ((Ri))

#### ORL A,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** ORL



(A)  (A) #data

#### ORL direct,A

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** ORL



(direct)  (direct) (A)

#### ORL direct,#data

###### Bytes: 3

**Cycles:** 2

immediate data

direct addr.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** ORL



(direct)  (direct) #data

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# ORL C,<src-bit>

**Function:** Logical-OR for bit variables

**Description:** Set the carry flag if the Boolean value is a logical 1; leave the carry in its current state otherwise. A slash ( / ) preceding the operand in the assembly language indicates that the logical complement of the addressed bit is used as the source value, but the source bit itself is not affected. No other flags are affected.

**Example:** Set the carry flag if and only if P1.0 = 1, ACC. 7 = 1, or OV = 0: MOV C,P1.0 ;LOAD CARRY WITH INPUT PIN P10 ORL C,ACC.7 ;OR CARRY WITH THE ACC. BIT 7

ORL C,/OV ;OR CARRY WITH THE INVERSE OF OV.

#### ORL C,bit

###### Bytes: 2

**Cycles:** 2

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** ORL



(C)  (C) (bit)

#### ORL C,/bit

###### Bytes: 2

**Cycles:** 2

bit address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** ORL



(C)  (C) (bit)

# POP direct

**Function:** Pop from stack.

**Description:** The contents of the internal RAM location addressed by the Stack Pointer is read, and the Stack Pointer is decremented by one. The value read is then transferred to the directly addressed byte indicated. No flags are affected.

**Example:** The Stack Pointer originally contains the value 32H, and internal RAM locations 30H through 32H contain the values 20H, 23H, and 01H, respectively. The following instruction sequence,

POP DPH

POP DPL

leaves the Stack Pointer equal to the value 30H and sets the Data Pointer to 0123H. At this point, the following instruction,

POP SP

leaves the Stack Pointer set to 20H. In this special case, the Stack Pointer was decremented to 2FH before being loaded with the value popped (20H).

###### Bytes: 2

**Cycles:** 2

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** POP

(direct)  ((SP))

(SP)  (SP) - 1

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**PUSH direct**

**Function:** Push onto stack

**Description:** The Stack Pointer is incremented by one. The contents of the indicated variable is then copied into the internal RAM location addressed by the Stack Pointer. Otherwise no flags are affected.

**Example:** On entering an interrupt routine, the Stack Pointer contains 09H. The Data Pointer holds the value 0123H. The following instruction sequence,

PUSH DPL

PUSH DPH

leaves the Stack Pointer set to 0BH and stores 23H and 01H in internal RAM locations 0AH and 0BH, respectively.

###### Bytes: 2

**Cycles:** 2

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** PUSH

(SP)  (SP) + 1

((SP))  (direct)

# RET

**Function:** Return from subroutine

**Description:** RET pops the high- and low-order bytes of the PC successively from the stack, decrementing the Stack Pointer by two. Program execution continues at the resulting address, generally the instruction immediately following an ACALL or LCALL. No flags are affected.

**Example:** The Stack Pointer originally contains the value 0BH. Internal RAM locations 0AH and 0BH contain the values 23H and 01H, respectively. The following instruction,

RET

leaves the Stack Pointer equal to the value 09H. Program execution continues at location 0123H.

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** RET

(PC15-8)  ((SP))

(SP)  (SP) - 1

(PC7-0)  ((SP))

(SP)  (SP) - 1

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# RETI

**Function:** Return from interrupt

**Description:** RETI pops the high- and low-order bytes of the PC successively from the stack and restores the interrupt logic to accept additional interrupts at the same priority level as the one just processed. The Stack Pointer is left decremented by two. No other registers are affected; the PSW is *not* automatically restored to its pre-interrupt status. Program execution continues at the resulting address, which is generally the instruction immediately after the point at which the interrupt request was detected. If a lower- or same-level interrupt was pending when the RETI instruction is executed, that one instruction is executed before the pending interrupt is processed.

**Example:** The Stack Pointer originally contains the value 0BH. An interrupt was detected during the instruction ending at location 0122H. Internal RAM locations 0AH and 0BH contain the values 23H and 01H, respectively. The following instruction,

RETI

leaves the Stack Pointer equal to 09H and returns program execution to location 0123H.

###### Bytes: 1

**Cycles:** 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |

**Encoding:**

**Operation:** RETI

(PC15-8)  ((SP))

(SP)  (SP) - 1

(PC7-0)  ((SP))

(SP)  (SP) - 1

# RL A

**Function:** Rotate Accumulator Left

**Description:** The eight bits in the Accumulator are rotated one bit to the left. Bit 7 is rotated into the bit 0 position. No flags are affected.

**Example:** The Accumulator holds the value 0C5H (11000101B). The following instruction, RL A

leaves the Accumulator holding the value 8BH (10001011B) with the carry unaffected.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** RL

(An + 1)  (An) n = 0 - 6

(A0)  (A7)

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**RLC A**

**Function:** Rotate Accumulator Left through the Carry flag

**Description:** The eight bits in the Accumulator and the carry flag are together rotated one bit to the left. Bit 7 moves into the carry flag; the original state of the carry flag moves into the bit 0 position. No other flags are affected.

**Example:** The Accumulator holds the value 0C5H(11000101B), and the carry is zero. The following instruction, RLC A

leaves the Accumulator holding the value 8BH (10001010B) with the carry set.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** RLC

(An + 1)  (An) n = 0 - 6

(A0)  (C)

(C)  (A7)

# RR A

**Function:** Rotate Accumulator Right

**Description:** The eight bits in the Accumulator are rotated one bit to the right. Bit 0 is rotated into the bit 7 position. No flags are affected.

**Example:** The Accumulator holds the value 0C5H (11000101B). The following instruction, RR A

leaves the Accumulator holding the value 0E2H (11100010B) with the carry unaffected.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** RR

(An)  (An + 1) n = 0 - 6

(A7)  (A0)

# RRC A

**Function:** Rotate Accumulator Right through Carry flag

**Description:** The eight bits in the Accumulator and the carry flag are together rotated one bit to the right. Bit 0 moves into the carry flag; the original value of the carry flag moves into the bit 7 position. No other flags are affected.

**Example:** The Accumulator holds the value 0C5H (11000101B), the carry is zero. The following instruction, RRC A

leaves the Accumulator holding the value 62 (01100010B) with the carry set.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** RRC

(An)  (An + 1) n = 0 - 6

(A7)  (C)

(C)  (A0)

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# SETB <bit>

**Function:** Set Bit

**Description:** SETB sets the indicated bit to one. SETB can operate on the carry flag or any directly addressable bit. No other flags are affected.

**Example:** The carry flag is cleared. Output Port 1 has been written with the value 34H (00110100B). The following instructions,

SETB C

SETB P1.0

sets the carry flag to 1 and changes the data output on Port 1 to 35H (00110101B).

#### SETB C

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |

**Encoding:**

**Operation:** SETB

(C)  1

#### SETB bit

###### Bytes: 2

**Cycles:** 1

**Encoding: Operation:**

**SJMP rel**

**Function:**

0

SETB

bit address

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 |

(bit)  1

Short Jump

**Description:** Program control branches unconditionally to the address indicated. The branch destination is computed by adding the signed displacement in the second instruction byte to the PC, after incrementing the PC twice. Therefore, the range of destinations allowed is from 128 bytes preceding this instruction 127 bytes following it.

**Example:** The label RELADR is assigned to an instruction at program memory location 0123H. The following instruction, SJMP RELADR

assembles into location 0100H. After the instruction is executed, the PC contains the value 0123H.

Note: Under the above conditions the instruction following SJMP is at 102H. Therefore, the displacement byte of the instruction is the relative offset (0123H-0102H) = 21H. Put another way, an SJMP with a displacement of 0FEH is a one-instruction infinite loop.

###### Bytes: 2

**Cycles:** 2

rel. address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Encoding:**

**Operation:** SJMP

(PC)  (PC) + 2

(PC)  (PC) + rel

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**SUBB A,<src-byte>**

**Function:** Subtract with borrow

**Description:** SUBB subtracts the indicated variable and the carry flag together from the Accumulator, leaving the result in the Accumulator. SUBB sets the carry (borrow) flag if a borrow is needed for bit 7 and clears C otherwise. (If C was set *before* executing a SUBB instruction, this indicates that a borrow was needed for the previous step in a multiple-precision subtraction, so the carry is subtracted from the Accumulator along with the source operand.) AC is set if a borrow is needed for bit 3 and cleared otherwise. OV is set if a borrow is needed into bit 6, but not into bit 7, or into bit 7, but not bit 6.

When subtracting signed integers, OV indicates a negative number produced when a negative value is subtracted from a positive value, or a positive result when a positive number is subtracted from a negative number.

The source operand allows four addressing modes: register, direct, register-indirect, or immediate.

**Example:** The Accumulator holds 0C9H (11001001B), register 2 holds 54H (01010100B), and the carry flag is set. The instruction,

SUBB A,R2

will leave the value 74H (01110100B) in the accumulator, with the carry flag and AC cleared but OV set.

Notice that 0C9H minus 54H is 75H. The difference between this and the above result is due to the carry (borrow) flag being set before the operation. If the state of the carry is not known before starting a single or multiple-precision subtraction, it should be explicitly cleared by CLR C instruction.

#### SUBB A,Rn

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 1 | r | r | r |

**Encoding:**

**Operation:** SUBB

(A)  (A) - (C) - (Rn)

#### SUBB A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** SUBB

(A)  (A) - (C) - (direct)

#### SUBB A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** SUBB

(A)  (A) - (C) - ((Ri))

#### SUBB A,#data

###### Bytes: 2

**Cycles:** 1

immediate data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** SUBB

(A)  (A) - (C) - #data

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# SWAP A

**Function:** Swap nibbles within the Accumulator

**Description:** SWAP A interchanges the low- and high-order nibbles (four-bit fields) of the Accumulator (bits 3 through 0 and bits 7 through 4). The operation can also be thought of as a 4-bit rotate instruction. No flags are affected.

**Example:** The Accumulator holds the value 0C5H (11000101B). The instruction, SWAP A

leaves the Accumulator holding the value 5CH (01011100B).

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |

**Encoding:**

**Operation:** SWAP

(A3-0) D (A7-4)

# XCH A,<byte>

**Function:** Exchange Accumulator with byte variable

**Description:** XCH loads the Accumulator with the contents of the indicated variable, at the same time writing the original Accumulator contents to the indicated variable. The source/destination operand can use register, direct, or register-indirect addressing.

**Example:** R0 contains the address 20H. The Accumulator holds the value 3FH (0011111lB). Internal RAM location 20H holds the value 75H (01110101B). The following instruction,

XCH A,@R0

leaves RAM location 20H holding the values 3FH (00111111B) and 75H (01110101B) in the accumulator.

#### XCH A,Rn

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 1 | r | r | r |

**Encoding:**

**Operation:** XCH

(A) D ((Rn)

#### XCH A,direct

###### Bytes: 2

**Cycles:** 1

direct address

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |

**Encoding:**

**Operation:** XCH

(A) D (direct)

#### XCH A,@Ri

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** XCH

(A) D ((Ri))

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**XCHD A,@Ri**

**Function:** Exchange Digit

**Description:** XCHD exchanges the low-order nibble of the Accumulator (bits 3 through 0), generally representing a hexadecimal or BCD digit, with that of the internal RAM location indirectly addressed by the specified register. The high-order nibbles (bits 7-4) of each register are not affected. No flags are affected.

**Example:** R0 contains the address 20H. The Accumulator holds the value 36H (00110110B). Internal RAM location 20H holds the value 75H (01110101B). The following instruction,

XCHD A,@R0

leaves RAM location 20H holding the value 76H (01110110B) and 35H (00110101B) in the Accumulator.

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | i |

**Encoding:**

**Operation:** XCHD

(A3-0) D ((Ri3-0))

# XRL <dest-byte>,<src-byte>

**Function:** Logical Exclusive-OR for byte variables

**Description:** XRL performs the bitwise logical Exclusive-OR operation between the indicated variables, storing the results in the destination. No flags are affected.

The two operands allow six addressing mode combinations. When the destination is the Accumulator, the source can use register, direct, register-indirect, or immediate addressing; when the destination is a direct address, the source can be the Accumulator or immediate data.

Note: When this instruction is used to modify an output port, the value used as the original port data is read from the output data latch, *not* the input pins.

**Example:** If the Accumulator holds 0C3H (1100001lB) and register 0 holds 0AAH (10101010B) then the instruction,

XRL A,R0

leaves the Accumulator holding the value 69H (01101001B).

When the destination is a directly addressed byte, this instruction can complement combinations of bits in any RAM location or hardware register. The pattern of bits to be complemented is then determined by a mask byte, either a constant contained in the instruction or a variable computed in the Accumulator at run-time. The following instruction,

XRL P1,#00110001B

complements bits 5, 4, and 0 of output Port 1.

#### XRL A,Rn

###### Bytes: 1

**Cycles:** 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 1 | 0 | 1 | r | r | r |

**Encoding:**

**Operation:** XRL

(A)  (A) ~~V~~ (Rn)

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**Document Revision History**

# Changes from 0509B - 08/05 to 0509C - 07/06

##### 1. Correcto to MOV Direct, page 49.

**49**



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