

# Complete Z80 OP-Code Reference

Devin Gardner, 29<sup>th</sup> April 2000

email: cepaughfe@aol.com

LaTeX formatting by David Sinclair

Check the end of the document for explanations of abbreviations used below.

| Mnemonic     | Clock | Size | SZJPNC | Op-Code         | Description           | Notes   |
|--------------|-------|------|--------|-----------------|-----------------------|---|
| ADC A,r      | 4     | 1    | ***VO* | 88+rb           | Add with Carry        | $A \leftarrow A+s+CY$                             |
| ADC A,N      | 7     | 2    |        | CE XX           |                       |   |
| ADC A,(HL)   | 7     | 1    |        | 8E              |                       |   |
| ADC A,(IX+N) | 19    | 3    |        | DD 8E XX        |                       |   |
| ADC A,(IY+N) | 19    | 3    |        | FD 8E XX        |                       |   |
| ADC HL,BC    | 15    | 2    | **?VO* | ED 4A           | Add with Carry        | $HL \leftarrow HL+ss+CY$                          |
| ADC HL,DE    | 15    | 2    |        | ED 5A           |                       |   |
| ADC HL,HL    | 15    | 2    |        | ED 6A           |                       |   |
| ADC HL,SP    | 15    | 2    |        | ED 7A           |                       |   |
| ADD A,r      | 4     | 1    | ***VO* | 80+rb           | Add (8-bit)           | $A \leftarrow A+s$                                |
| ADD A,N      | 7     | 2    |        | C6 XX           |                       |   |
| ADD A,(HL)   | 7     | 1    |        | 86              |                       |   |
| ADD A,(IX+N) | 19    | 3    |        | DD 86 XX        |                       |   |
| ADD A,(IY+N) | 19    | 3    |        | FD 86 XX        |                       |   |
| ADD HL,BC    | 11    | 1    | --?-0* | 09              | Add (16-bit)          | $HL \leftarrow HL+ss$                             |
| ADD HL,DE    | 11    | 1    |        | 19              |                       |   |
| ADD HL,HL    | 11    | 1    |        | 29              |                       |   |
| ADD HL,SP    | 11    | 1    |        | 39              |                       |   |
| ADD IX,BC    | 15    | 2    | --?-0* | DD 09           | Add (IX register)     | $IX \leftarrow IX+pp$                             |
| ADD IX,DE    | 15    | 2    |        | DD 19           |                       |   |
| ADD IX,IX    | 15    | 2    |        | DD 29           |                       |   |
| ADD IX,SP    | 15    | 2    |        | DD 39           |                       |   |
| ADD IY,BC    | 15    | 2    | --?-0* | FD 09           | Add (IY register)     | $IY \leftarrow IY+rr$                             |
| ADD IY,DE    | 15    | 2    |        | FD 19           |                       |   |
| ADD IY,IY    | 15    | 2    |        | FD 29           |                       |   |
| ADD IY,SP    | 15    | 2    |        | FD 39           |                       |   |
| AND r        | 4     | 1    | ***PO0 | A0+rb           | Logical AND           | $A \leftarrow A \wedge s$                         |
| AND N        | 7     | 2    |        | E6 XX           |                       |   |
| AND (HL)     | 7     | 1    |        | A6              |                       |   |
| AND (IX+N)   | 19    | 3    |        | DD A6 XX        |                       |   |
| AND (IY+N)   | 19    | 3    |        | FD A6 XX        |                       |   |
| BIT b,r      | 8     | 2    | ?*1?0- | CB 40+8*b+rb    | Test Bit              | $m \wedge 2^b$                                    |
| BIT b,(HL)   | 12    | 2    |        | CB 46+8*b       |                       |   |
| BIT b,(IX+N) | 20    | 4    |        | DD CB XX 46+8*b |                       |   |
| BIT b,(IY+N) | 20    | 4    |        | FD CB XX 46+8*b |                       |   |
| CALL NN      | 17    | 3    | -----  | CD XX XX        | Unconditional Call    | $\overline{(SP)} \leftarrow PC, PC \leftarrow nn$ |
| CALL C,NN    | 17/1  | 3    | -----  | DC XX XX        | Conditional Call      | If Carry = 1                                      |
| CALL NC,NN   | 17/1  | 3    |        | D4 XX XX        |                       | If Carry = 0                                      |
| CALL M,NN    | 17/1  | 3    |        | FC XX XX        |                       | If Sign = 1 (negative)                            |
| CALL P,NN    | 17/1  | 3    |        | F4 XX XX        |                       | If Sign = 0 (positive)                            |
| CALL Z,NN    | 17/1  | 3    |        | CC XX XX        |                       | If Zero = 1 (ans.=0)                              |
| CALL NZ,NN   | 17/1  | 3    |        | C4 XX XX        |                       | If Zero = 0 (non-zero)                            |
| CALL PE,NN   | 17/1  | 3    |        | EC XX XX        |                       | If Parity = 1 (even)                              |
| CALL PO,NN   | 17/1  | 3    |        | E4 XX XX        |                       | If Parity = 0 (odd)                               |
| CCF          | 4     | 1    | --?-0* | 3F              | Complement Carry Flag | $CY \leftarrow \overline{CY}$                     |

| Mnemonic   | Clck | Siz | SZJPNC | Op-Code  | Description           | Notes                    |
|------------|------|-----|--------|----------|-----------------------|--------------------------|
| CP r       | 4    | 1   | ***V1* | B8+rb    | Compare               | Compare A-s              |
| CP N       | 7    | 2   |        | FE XX    |                       |                          |
| CP (HL)    | 7    | 1   |        | BE       |                       |                          |
| CP (IX+N)  | 19   | 3   |        | DD BE XX |                       |                          |
| CP (IY+N)  | 19   | 3   |        | FD BE XX |                       |                          |
| CPD        | 16   | 2   | ****1- | ED A9    | Compare and Decrement | A-(HL),HL←HL-1,BC←BC-1   |
| CPDR       | 21/1 | 2   | ****1- | ED B9    | Compare, Dec., Repeat | CPD until A=(HL) or BC=0 |
| CPI        | 16   | 2   | ****1- | ED A1    | Compare and Increment | A-(HL),HL←HL+1,BC←BC-1   |
| CPIR       | 21/1 | 2   | ****1- | ED B1    | Compare, Inc., Repeat | CPI until A=(HL) or BC=0 |
| CPL        | 4    | 1   | --1-1- | 2F       | Complement            | A← $\bar{A}$             |
| DAA        | 4    | 1   | ***P-* | 27       | Decimal Adjust Acc.   | A←BCD format (dec.)      |
| DEC A      | 4    | 1   | ***V1- | 3D       | Decrement (8-bit)     | s←s-1                    |
| DEC B      | 4    | 1   |        | 05       |                       |                          |
| DEC C      | 4    | 1   |        | 0D       |                       |                          |
| DEC D      | 4    | 1   |        | 15       |                       |                          |
| DEC E      | 4    | 1   |        | 1D       |                       |                          |
| DEC H      | 4    | 1   |        | 25       |                       |                          |
| DEC L      | 4    | 2   |        | 2D       |                       |                          |
| DEC (HL)   | 11   | 1   |        | 35       |                       |                          |
| DEC (IX+N) | 23   | 3   |        | DD 35 XX |                       |                          |
| DEC (IY+N) | 23   | 3   |        | FD 35 XX |                       |                          |
| DEC BC     | 6    | 1   | -----  | 0B       | Decrement (16-bit)    | ss←ss-1                  |
| DEC DE     | 6    | 1   |        | 1B       |                       |                          |
| DEC HL     | 6    | 1   |        | 2B       |                       |                          |
| DEC SP     | 6    | 1   |        | 3B       |                       |                          |
| DEC IX     | 10   | 2   | -----  | DD 2B    | Decrement             | xx←xx-1                  |
| DEC IY     | 10   | 2   |        | FD 2B    |                       |                          |
| DI         | 4    | 1   | -----  | F3       | Disable Interrupts    |                          |
| DJNZ \$N+2 | 13/8 | 1   | -----  | 10 XX    | Dec., Jump Non-Zero   | B←B-1 til B=0, PC←PC+e   |
| EI         | 4    | 1   | -----  | FB       | Enable Interrupts     |                          |
| EX (SP),HL | 19   | 1   | -----  | E3       | Exchange              | (SP)↔HL                  |
| EX (SP),IX | 23   | 2   | -----  | DD E3    |                       | (SP)↔xx                  |
| EX (SP),IY | 23   | 2   |        | FD E3    |                       |                          |
| EX AF,AF'  | 4    | 1   | *****  | 08       |                       | AF↔AF'                   |
| EX DE,HL   | 4    | 1   | -----  | EB       |                       | DE↔HL                    |
| EXX        | 4    | 1   | -----  | D9       | Exchange              | qq↔qq' (except AF)       |
| HALT       | 4    | 1   | -----  | 76       | Halt                  |                          |
| IM 0       | 8    | 2   | -----  | ED 46    | Interrupt Mode        | (n=0,1,2)                |
| IM 1       | 8    | 2   |        | ED 56    |                       |                          |
| IM 2       | 8    | 2   |        | ED 5E    |                       |                          |
| IN A,(N)   | 11   | 2   | -----  | DB XX    | Input                 | A←(n)                    |
| IN (C)     | 12   | 2   | ***P0- | ED 70    | Input†                | (Unsupported)            |
| IN A,(C)   | 12   | 2   | ***P0- | ED 78    | Input                 | r←(C)                    |
| IN B,(C)   | 12   | 2   |        | ED 40    |                       |                          |
| IN C,(C)   | 12   | 2   |        | ED 48    |                       |                          |
| IN D,(C)   | 12   | 2   |        | ED 50    |                       |                          |
| IN E,(C)   | 12   | 2   |        | ED 58    |                       |                          |
| IN H,(C)   | 12   | 2   |        | ED 60    |                       |                          |
| IN L,(C)   | 12   | 2   |        | ED 68    |                       |                          |

| Mnemonic    | Clock | Size | SZJPNC | Op-Code  | Description          | Notes  |                    |                 |
|-------------|-------|------|--------|----------|----------------------|--|--------------------|-----------------|
| INC A       | 4     | 1    | ***V0- | 3C       | Increment (8-bit)    | r←r+1  |                    |                 |
| INC B       | 4     | 1    |        | 04       |                      |  |                    |                 |
| INC C       | 4     | 1    |        | 0C       |                      |  |                    |                 |
| INC D       | 4     | 1    |        | 14       |                      |  |                    |                 |
| INC E       | 4     | 1    |        | 1C       |                      |  |                    |                 |
| INC H       | 4     | 1    |        | 24       |                      |  |                    |                 |
| INC L       | 4     | 1    |        | 2C       |                      |  |                    |                 |
| INC BC      | 6     | 1    | -----  | 03       |                      |  | Increment (16-bit) | ss←ss+1         |
| INC DE      | 6     | 1    |        | 13       |                      |  |                    |                 |
| INC HL      | 6     | 1    |        | 23       |                      |  |                    |                 |
| INC SP      | 6     | 1    |        | 33       | Increment            | xx←xx+1  |                    |                 |
| INC IX      | 10    | 2    | -----  | DD 23    |                      |  |                    |                 |
| INC IY      | 10    | 2    |        | FD 23    | Increment (indirect) | (HL)←(HL)+1  |                    |                 |
| INC (HL)    | 11    | 1    | ***V0- | 34       |                      |  |                    |                 |
| INC (IX+N)  | 23    | 3    | ***V0- | DD 34 XX |                      |  | Increment          | (xx+d)←(xx+d)+1 |
| INC (IY+N)  | 23    | 3    |        | FD 34 XX |                      |  |                    |                 |
| IND         | 16    | 2    | ?*??1- | ED AA    | Input and Decrement  | (HL)←(C),HL←HL-1,B←B-1   |                    |                 |
| INDR        | 21/1  | 2    | ?1??1- | ED BA    | Input, Dec., Repeat  | IND until B=0  |                    |                 |
| INI         | 16    | 2    | ?*??1- | ED A2    | Input and Increment  | (HL)←(C),HL←HL+1,B←B-1   |                    |                 |
| INIR        | 21/1  | 2    | ?1??1- | ED B2    | Input, Inc., Repeat  | INI until B=0  |                    |                 |
| JP \$NN     | 10    | 3    | -----  | C3 XX XX | Unconditional Jump   | PC←nn  |                    |                 |
| JP (HL)     | 4     | 1    | -----  | E9       | Unconditional Jump   | PC←(HL)  |                    |                 |
| JP (IX)     | 8     | 2    | -----  | DD E9    | Unconditional Jump   | PC←(xx)  |                    |                 |
| JP (IY)     | 8     | 2    |        | FD E9    | Conditional Jump     | If Carry = 1<br>If Carry = 0<br>If Sign = 1 (negative)<br>If Sign = 0 (positive)<br>If Zero = 1 (ans.= 0)<br>If Zero = 0 (non-zero)<br>If Parity = 1 (even)<br>If Parity = 0 (odd) |                    |                 |
| JP C,\$NN   | 10/1  | 3    | -----  | DA XX XX |                      |  |                    |                 |
| JP NC,\$NN  | 10/1  | 3    |        | D2 XX XX |                      |  |                    |                 |
| JP M,\$NN   | 10/1  | 3    |        | FA XX XX |                      |  |                    |                 |
| JP P,\$NN   | 10/1  | 3    |        | F2 XX XX |                      |  |                    |                 |
| JP Z,\$NN   | 10/1  | 3    |        | CA XX XX |                      |  |                    |                 |
| JP NZ,\$NN  | 10/1  | 3    |        | C2 XX XX |                      |  |                    |                 |
| JP PE,\$NN  | 10/1  | 3    |        | EA XX XX |                      |  |                    |                 |
| JP PO,\$NN  | 10/1  | 3    |        | E2 XX XX |                      |  |                    |                 |
| JR \$N+2    | 12    | 2    | -----  | 18 XX    |                      |  | Relative Jump      | PC←PC+e         |
| JR C,\$N+2  | 12/7  | 2    | -----  | 38 XX    | Cond. Relative Jump  | If cc JR(cc=C,NC,NZ,Z)   |                    |                 |
| JR NC,\$N+2 | 12/7  | 2    |        | 30 XX    |                      |  |                    |                 |
| JR Z,\$N+2  | 12/7  | 2    |        | 28 XX    |                      |  |                    |                 |
| JR NZ,\$N+2 | 12/7  | 2    |        | 20 XX    |                      |  |                    |                 |
| LD I,A      | 9     | 2    | -----  | ED 47    | Load†                | dst←src  |                    |                 |
| LD R,A      | 9     | 2    |        | ED 4F    | Load†                | dst←src  |                    |                 |
| LD A,I      | 9     | 2    | **0*0- | ED 57    |                      |  |                    |                 |
| LD A,R      | 9     | 2    |        | ED 5F    | Load (8-bit)         | dst←src  |                    |                 |
| LD A,r      | 4     | 1    | -----  | 78+rb    |                      |  |                    |                 |
| LD A,N      | 7     | 2    |        | 3E XX    |                      |  |                    |                 |
| LD A,(BC)   | 7     | 1    |        | 0A       |                      |  |                    |                 |
| LD A,(DE)   | 7     | 1    |        | 1A       |                      |  |                    |                 |
| LD A,(HL)   | 7     | 1    |        | 7E       |                      |  |                    |                 |
| LD A,(IX+N) | 19    | 3    |        | DD 7E XX |                      |  |                    |                 |
| LD A,(IY+N) | 19    | 3    |        | FD 7E XX |                      |  |                    |                 |
| LD A,(NN)   | 13    | 3    |        | 3A XX XX |                      |  |                    |                 |
| LD B,r      | 4     | 1    |        | 40+rb    |                      |  |                    |                 |
| LD B,N      | 7     | 2    |        | 06 XX    |                      |  |                    |                 |
| LD B,(HL)   | 7     | 1    |        | 46       |                      |  |                    |                 |
| LD B,(IX+N) | 19    | 3    |        | DD 46 XX |                      |  |                    |                 |
| LD B,(IY+N) | 19    | 3    |        | FD 46 XX |                      |  |                    |                 |

| Mnemonic    | Clock | Size | SZJPC  | Op-Code     | Description        | Notes               |
|-------------|-------|------|--------|-------------|--------------------|---------------------|
| LD C,r      | 4     | 1    |        | 48+rb       |                    |                     |
| LD C,N      | 7     | 2    |        | 0E XX       |                    |                     |
| LD C,(HL)   | 7     | 1    |        | 4E          |                    |                     |
| LD C,(IX+N) | 19    | 3    |        | DD 4E XX    |                    |                     |
| LD C,(IY+N) | 19    | 3    |        | FD 4E XX    |                    |                     |
| LD D,r      | 4     | 1    |        | 50+rb       |                    |                     |
| LD D,N      | 7     | 2    |        | 16 XX       |                    |                     |
| LD D,(HL)   | 7     | 1    |        | 56          |                    |                     |
| LD D,(IX+N) | 19    | 3    |        | DD 56 XX    |                    |                     |
| LD D,(IY+N) | 19    | 3    |        | FD 56 XX    |                    |                     |
| LD E,r      | 4     | 1    |        | 58+rb       |                    |                     |
| LD E,N      | 7     | 2    |        | 1E XX       |                    |                     |
| LD E,(HL)   | 7     | 1    |        | 5E          |                    |                     |
| LD E,(IX+N) | 19    | 3    |        | DD 5E XX    |                    |                     |
| LD E,(IY+N) | 19    | 3    |        | FD 5E XX    |                    |                     |
| LD H,r      | 4     | 1    |        | 60+rb       |                    |                     |
| LD H,N      | 7     | 2    |        | 26 XX       |                    |                     |
| LD H,(HL)   | 7     | 1    |        | 66          |                    |                     |
| LD H,(IX+N) | 19    | 3    |        | DD 66 XX    |                    |                     |
| LD H,(IY+N) | 19    | 3    |        | FD 66 XX    |                    |                     |
| LD L,r      | 4     | 1    |        | 68+rb       |                    |                     |
| LD L,N      | 7     | 2    |        | 2E XX       |                    |                     |
| LD L,(HL)   | 7     | 1    |        | 6E          |                    |                     |
| LD L,(IX+N) | 19    | 3    |        | DD 6E XX    |                    |                     |
| LD L,(IY+N) | 19    | 3    |        | FD 6E XX    |                    |                     |
| LD BC,(NN)  | 20    | 4    | -----  | ED 4B XX XX | Load (16-bit)      | dst←src             |
| LD BC,NN    | 10    | 3    |        | 01 XX XX    |                    |                     |
| LD DE,(NN)  | 20    | 4    |        | ED 5B XX XX |                    |                     |
| LD DE,NN    | 10    | 3    |        | 11 XX XX    |                    |                     |
| LD HL,(NN)  | 20    | 3    |        | 2A XX XX    |                    |                     |
| LD HL,NN    | 10    | 3    |        | 21 XX XX    |                    |                     |
| LD SP,(NN)  | 20    | 4    |        | ED 7B XX XX |                    |                     |
| LD SP,HL    | 6     | 1    |        | F9          |                    |                     |
| LD SP,IX    | 10    | 2    |        | DD F9       |                    |                     |
| LD SP,IY    | 10    | 2    |        | FD F9       |                    |                     |
| LD SP,NN    | 10    | 3    |        | 31 XX XX    |                    |                     |
| LD IX,(NN)  | 20    | 4    |        | DD 2A XX XX |                    |                     |
| LD IX,NN    | 14    | 4    |        | DD 21 XX XX |                    |                     |
| LD IY,(NN)  | 20    | 4    |        | FD 2A XX XX |                    |                     |
| LD IY,NN    | 14    | 4    |        | FD 21 XX XX |                    |                     |
| LD (HL),r   | 7     | 1    | -----  | 70+rb       | Load (Indirect)    | dst←src             |
| LD (HL),N   | 10    | 2    |        | 36 XX       |                    |                     |
| LD (BC),A   | 7     | 1    |        | 02          |                    |                     |
| LD (DE),A   | 7     | 1    |        | 12          |                    |                     |
| LD (NN),A   | 13    | 3    |        | 32 XX XX    |                    |                     |
| LD (NN),BC  | 20    | 4    |        | ED 43 XX XX |                    |                     |
| LD (NN),DE  | 20    | 4    |        | ED 53 XX XX |                    |                     |
| LD (NN),HL  | 16    | 3    |        | 22 XX XX    |                    |                     |
| LD (NN),IX  | 20    | 4    |        | DD 22 XX XX |                    |                     |
| LD (NN),IY  | 20    | 4    |        | FD 22 XX XX |                    |                     |
| LD (NN),SP  | 20    | 4    |        | ED 73 XX XX |                    |                     |
| LD (IX+N),r | 19    | 3    |        | DD 70+rb XX |                    |                     |
| LD (IX+N),N | 19    | 4    |        | DD 36 XX XX |                    |                     |
| LD (IY+N),r | 19    | 3    |        | FD 70+rb XX |                    |                     |
| LD (IY+N),N | 19    | 4    |        | FD 36 XX XX |                    |                     |
| LDD         | 16    | 2    | --0*0- | ED A8       | Load and Decrement | (DE)←(HL),HL←HL-1,# |
| LDDR        | 21/1  | 2    | --000- | ED B8       | Load, Dec., Repeat | LDD until BC=0      |
| LDI         | 16    | 2    | --0*0- | ED A0       | Load and Increment | (DE)←(HL),HL←HL+1,# |
| LDIR        | 21/1  | 2    | --000- | ED B0       | Load, Inc., Repeat | LDI until BC=0      |

| Mnemonic     | Clock | Size | SZJPNC | Op-Code           | Description           | Notes   |
|--------------|-------|------|--------|-------------------|-----------------------|---|
| NEG          | 8     | 2    | ***V1* | ED 44             | Negate                | $A \leftarrow -A$   |
| NOP          | 4     | 1    | -----  | 00                | No Operation          |   |
| OR r         | 4     | 1    | ***P00 | B0+rb             | Logical inclusive OR  | $A \leftarrow A \vee r$   |
| OR N         | 7     | 2    |        | F6 XX             |                       |   |
| OR (HL)      | 7     | 1    |        | B6                |                       |   |
| OR (IX+N)    | 19    | 3    |        | DD B6 XX          |                       |   |
| OR (IY+N)    | 19    | 3    |        | FD B6 XX          |                       |   |
| OUT (N),A    | 11    | 2    | -----  | D3 XX             | Output                | $(n) \leftarrow A$  |
| OUT (C),0    | 12    | 2    | -----  | ED 71             | Output†               | (Unsupported)   |
| OUT (C),A    | 12    | 2    | -----  | ED 79             | Output                | $(C) \leftarrow r$  |
| OUT (C),B    | 12    | 2    |        | ED 41             |                       |   |
| OUT (C),C    | 12    | 2    |        | ED 49             |                       |   |
| OUT (C),D    | 12    | 2    |        | ED 51             |                       |   |
| OUT (C),E    | 12    | 2    |        | ED 59             |                       |   |
| OUT (C),H    | 12    | 2    |        | ED 61             |                       |   |
| OUT (C),L    | 12    | 2    |        | ED 69             |                       |   |
| OUTD         | 16    | 2    | ?*??1- | ED AB             | Output and Decrement  | $(C) \leftarrow (HL), HL \leftarrow HL - 1, B \leftarrow B - 1$ |
| OTDR         | 21/1  | 2    | ?1??1- | ED BB             | Output, Dec., Repeat  | OUTD until B=0  |
| OUTI         | 16    | 2    | ?*??1- | ED A3             | Output and Increment  | $(C) \leftarrow (HL), HL \leftarrow HL + 1, B \leftarrow B + 1$ |
| OTIR         | 21/1  | 2    | ?1??1- | ED B3             | Output, Inc., Repeat  | OUTI until B=0  |
| POP AF       | 10    | 1    | *****  | F1                | Pop                   | $qq \leftarrow (SP)^+$  |
| POP BC       | 10    | 1    | -----  | C1                |                       |   |
| POP DE       | 10    | 1    |        | D1                |                       |   |
| POP HL       | 10    | 1    |        | E1                |                       |   |
| POP IX       | 14    | 2    | -----  | DD E1             | Pop                   | $xx \leftarrow (SP)^+$  |
| POP IY       | 14    | 2    |        | FD E1             |                       |   |
| PUSH AF      | 11    | 1    | -----  | F5                | Push                  | $\neg(SP) \leftarrow qq$  |
| PUSH BC      | 11    | 1    |        | C5                |                       |   |
| PUSH DE      | 11    | 1    |        | D5                |                       |   |
| PUSH HL      | 11    | 1    |        | E5                |                       |   |
| PUSH IX      | 15    | 2    | -----  | DD E5             | Push                  | $\neg(SP) \leftarrow xx$  |
| PUSH IY      | 15    | 2    |        | FD E5             |                       |   |
| RES b,r      | 8     | 2    | -----  | CB $80+8*b+rb$    | Reset bit             | $m = m \wedge \neg 2^b$   |
| RES b,(HL)   | 15    | 2    | -----  | CB $86+8*b$       |                       |   |
| RES b,(IX+N) | 23    | 4    | -----  | DD CB XX $86+8*b$ |                       |   |
| RES b,(IY+N) | 23    | 4    | -----  | FD CB XX $86+8*b$ |                       |   |
| RET          | 10    | 1    | -----  | C9                | Return                | $PC \leftarrow (SP)^+$  |
| RET C        | 11/5  | 1    | -----  | D8                | Conditional Return    | If Carry = 1  |
| RET NC       | 11/5  | 1    |        | D0                |                       | If Carry = 0  |
| RET M        | 11/5  | 1    |        | F8                |                       | If Sign = 1 (negative)  |
| RET P        | 11/5  | 1    |        | F0                |                       | If Sign = 0 (positive)  |
| RET Z        | 11/5  | 1    |        | C8                |                       | If Zero = 1 (ans.=0)  |
| RET NZ       | 11/5  | 1    |        | C0                |                       | If Zero = 0 (non-zero)  |
| RET PE       | 11/5  | 1    |        | E8                |                       | If Parity = 1 (even)  |
| RET PO       | 11/5  | 1    |        | E0                |                       | If Parity = 0 (odd)   |
| RETI         | 14    | 2    | -----  | ED 4D             | Return from Interrupt | $PC \leftarrow (SP)^+$  |
| RETN         | 14    | 2    | -----  | ED 45             | Return from NMI       | $PC \leftarrow (SP)^+$  |

| Mnemonic      | Clock | Size | SZJPNC | Op-Code         | Description            | Notes  |
|---------------|-------|------|--------|-----------------|------------------------|--|
| RLA           | 4     | 1    | --0-0* | 17              | Rotate Left Acc.       | $A \leftarrow \{CY, A\} \leftarrow$                  |
| RL r          | 8     | 2    | **0P0* | CB 10+rb        | Rotate Left            | $m \leftarrow \{CY, m\} \leftarrow$                  |
| RL (HL)       | 15    | 2    |        | CB 16           |                        |  |
| RL (IX+N)     | 23    | 4    |        | DD CB XX 16     |                        |  |
| RL (IY+N)     | 23    | 4    |        | FD CB XX 16     |                        |  |
| RLCA          | 4     | 1    | --0-0* | 07              | Rotate Left Cir. Acc.  | $A \leftarrow A \leftarrow$                          |
| RLC r         | 8     | 2    | **0P0* | CB 00+rb        | Rotate Left Circular   | $m \leftarrow m \leftarrow$                          |
| RLC (HL)      | 15    | 2    |        | CB 06           |                        |  |
| RLC (IX+N)    | 23    | 4    |        | DD CB XX 06     |                        |  |
| RLC (IY+N)    | 23    | 4    |        | FD CB XX 06     |                        |  |
| RLD           | 18    | 2    | **0P0- | ED 6F           | Rotate Left 4 bits     | $\{A, (HL)\} \leftarrow \{A, (HL)\} \leftarrow \#\#$ |
| RRA           | 4     | 1    | --0-0* | 1F              | Rotate Right Acc.      | $A \leftarrow \{CY, A\}$                             |
| RR r          | 8     | 2    | **0P0* | CB 18+rb        | Rotate Right           | $m \leftarrow \{CY, sm\}$                            |
| RR (HL)       | 15    | 2    |        | CB 1E           |                        |  |
| RR (IX+N)     | 23    | 4    |        | DD CB XX 1E     |                        |  |
| RR (IY+N)     | 23    | 4    |        | FD CB XX 1E     |                        |  |
| RRCA          | 4     | 1    | --0-0* | 0F              | Rotate Right Cir. Acc. | $A \leftarrow A$                                     |
| RRC r         | 8     | 2    | **0P0* | CB 08+rb        | Rotate Right Circular  | $m \leftarrow m$                                     |
| RRC (HL)      | 15    | 2    |        | CB 0E           |                        |  |
| RRC (IX+N)    | 23    | 4    |        | DD CB XX 0E     |                        |  |
| RRC (IY+N)    | 23    | 4    |        | FD CB XX 0E     |                        |  |
| RRD           | 18    | 2    | **0P0- | ED 67           | Rotate Right 4 bits    | $\{A, (HL)\} \leftarrow \{A, (HL)\} \#\#$            |
| RST 0         | 11    | 1    | -----  | C7              | Restart                | $(p \leftarrow 0H, 8H, 10H, \dots, 38H)$             |
| RST 08H       | 11    | 1    |        | CF              |                        |  |
| RST 10H       | 11    | 1    |        | D7              |                        |  |
| RST 18H       | 11    | 1    |        | DF              |                        |  |
| RST 20H       | 11    | 1    |        | E7              |                        |  |
| RST 28H       | 11    | 1    |        | EF              |                        |  |
| RST 30H       | 11    | 1    |        | F7              |                        |  |
| RST 38H       | 11    | 1    |        | FF              |                        |  |
| SBC r         | 4     | 1    | ***V1* | 98+rb           | Subtract with Carry    | $A \leftarrow A - s - CY$                            |
| SBC A,N       | 7     | 2    |        | DE XX           |                        |  |
| SBC (HL)      | 7     | 1    |        | 9E              |                        |  |
| SBC A, (IX+N) | 19    | 3    |        | DD 9E XX        |                        |  |
| SBC A, (IY+N) | 19    | 3    |        | FD 9E XX        |                        |  |
| SBC HL,BC     | 15    | 2    | **?V1* | ED 42           | Subtract with Carry    | $HL \leftarrow HL - ss - CY$                         |
| SBC HL,DE     | 15    | 2    |        | ED 52           |                        |  |
| SBC HL,HL     | 15    | 2    |        | ED 62           |                        |  |
| SBC HL,SP     | 15    | 2    |        | ED 72           |                        |  |
| SCF           | 4     | 1    | --0-01 | 37              | Set Carry Flag         | $CY \leftarrow 1$                                    |
| SET b,r       | 8     | 2    | -----  | CB C0+8*b+rb    | Set bit                | $m \leftarrow m \vee 2^b$                            |
| SET b, (HL)   | 15    | 2    |        | CB C6+8*b       |                        |  |
| SET b, (IX+N) | 23    | 4    |        | DD CB XX C6+8*b |                        |  |
| SET b, (IY+N) | 23    | 4    |        | FD CB XX C6+8*b |                        |  |
| SLA r         | 8     | 2    | **0P0* | CB 20+rb        | Shift Left Arithmetic  | $m \leftarrow m * 2$                                 |
| SLA (HL)      | 15    | 2    |        | CB 26           |                        |  |
| SLA (IX+N)    | 23    | 4    |        | DD CB XX 26     |                        |  |
| SLA (IY+N)    | 23    | 4    |        | FD CB XX 26     |                        |  |
| SRA r         | 8     | 2    | **0P0* | CB 28+rb        | Shift Right Arith.     | $m \leftarrow m / 2$                                 |
| SRA (HL)      | 15    | 2    |        | CB 2E           |                        |  |
| SRA (IX+N)    | 23    | 4    |        | DD CB XX 2E     |                        |  |
| SRA (IY+N)    | 23    | 4    |        | FD CB XX 2E     |                        |  |

| Mnemonic   | Clck | Siz | SZJPNC | Op-Code     | Description          | Notes   |
|------------|------|-----|--------|-------------|----------------------|---|
| SLL r      | 8    | 2   | **0P0* | CB 30+rb    | Shift Left Logical*  | m←{0,m,CY}←<br>(SLL instructions are Unsupported) |
| SLL (HL)   | 15   | 2   |        | CB 36       |                      |   |
| SLL (IX+N) | 23   | 4   |        | DD CB XX 36 |                      |   |
| SLL (IY+N) | 23   | 4   |        | FD CB XX 36 |                      |   |
| SRL r      | 8    | 2   | **0P0* | CB 38+rb    | Shift Right Logical  | m←⇒{0,m,CY}                                       |
| SRL (HL)   | 15   | 2   |        | CB 3E       |                      |   |
| SRL (IX+N) | 23   | 4   |        | DD CB XX 3E |                      |   |
| SRL (IY+N) | 23   | 4   |        | FD CB XX 3E |                      |   |
| SUB r      | 4    | 1   | ***V1* | 90+rb       | Subtract             | A←A-s   |
| SUB N      | 7    | 2   |        | D6 XX       |                      |   |
| SUB (HL)   | 7    | 1   |        | 96          |                      |   |
| SUB (IX+N) | 19   | 3   |        | DD 96 XX    |                      |   |
| SUB (IY+N) | 19   | 3   |        | FD 96 XX    |                      |   |
| XOR r      | 4    | 1   | ***P00 | A8+rb       | Logical Exclusive OR | A←A×s   |
| XOR N      | 7    | 2   |        | EE XX       |                      |   |
| XOR (HL)   | 7    | 1   |        | AE          |                      |   |
| XOR (IX+N) | 19   | 3   |        | DD AE XX    |                      |   |
| XOR (IY+N) | 19   | 3   |        | FD AE XX    |                      |   |

**Clck** The time it takes to execute the instruction in CPU cycles.

**Siz** How many bytes the instruction takes up in a program.

**SZHPNC** How the different bits of the Flag byte (the F in the AF register) are affected. Check the graph below this for more.

**Op-Code** The instruction's equivalent in hexadecimal.

**b** A bit. It can be 0-7. Increase the last byte of the OP-code with 8\*b. Used in SET, BIT and RES.

**r** A register. It can be A,B,C,D,E,H, or L.

**rb** Add this to last byte of OP-code:

| Reg  | = | Regbits |
|------|---|---------|
| A    | = | 7       |
| B    | = | 0       |
| C    | = | 1       |
| D    | = | 2       |
| E    | = | 3       |
| H    | = | 4       |
| L    | = | 5       |
| (HL) | = | 6       |

In "LD (IX+N),r" and "LD (IY+N),r" you add these to the byte before the last.

If there are two numbers given for Clock, then the highest is when the jump is taken, the lowest is when it skips the jump.

† For unsupported instructions, use the hexadecimal OP-Codes with the assembler instruction ".db"

EX: SLL (HL)

instead of this, use:

.db \$CB,\$36

|             |       |  |
|-------------|-------|--|
| F           | -*01? | Flag unaffected/affected/reset/set/unknown   |
| S           | S     | Sign flag (Bit 7)                            |
| Z           | Z     | Zero flag (Bit 6)                            |
| HC          | H     | Half carry flag (Bit 4)                      |
| P/V         | P     | Parity/Overflow flag (Bit 2,V=overflow)      |
| N           | N     | Add/Subtract flag (Bit 1)                    |
| CY          | C     | Carry flag (Bit 0)                           |
| n           |       | Immediate addressing                         |
| nn          |       | Immediate extended addressing                |
| e           |       | Relative addressing (PC=PC+2+offset)         |
| (nn)        |       | Extended addressing                          |
| (xx+d)      |       | Indexed addressing                           |
| r           |       | Register addressing                          |
| (rr)        |       | Register indirect addressing                 |
|             |       | Implied addressing                           |
| b           |       | Bit addressing                               |
| p           |       | Modified page zero addressing (see RST)      |
| A B C D E   |       | Registers (8-bit)                            |
| AF BC DE HL |       | Register pairs(16-bit)                       |
| F           |       | Flag register(8-bit)                         |
| I           |       | Interrupt page address register(8-bit)       |
| IX IY       |       | Index registers(16-bit)                      |
| PC          |       | Program Counter register(16-bit)             |
| R           |       | Memory Refresh register                      |
| SP          |       | Stack Pointer register(16-bit)               |
| b           |       | One bit (0 to 7)                             |
| cc          |       | Condition (C,M,NC,NZ,P,PE,P0,Z)              |
| d           |       | One-byte expression (-128 to +127)           |
| dst         |       | Destination s, ss, (BC), (DE), (HL), (nn)    |
| e           |       | One-byte expression (-126 to +129)           |
| m           |       | Any register r, (HL) or (xx+d)               |
| n           |       | One-byte expression (0 to 255)               |
| nn          |       | Two-byte expression (0 to 65535)             |
| pp          |       | Register pair BC, DE, IX or SP               |
| qq          |       | Register pair AF, BC, DE or HL               |
| qq'         |       | Alternative register pair AF, BC, DE or HL   |
| r           |       | Register A, B, C, D, E, H or L               |
| rr          |       | Register pair BC, DE, IY or SP               |
| s           |       | Any register r, value n, (HL) or (xx+d)      |
| src         |       | Source s, ss, (BC), (DE), (HL), nn, (nn)     |
| ss          |       | Register pair BC, DE, HL or SP               |
| xx          |       | Index register IX or IY                      |
| + - * /     |       | Add/subtract/multiply/divide                 |
| ^ ¬ ∨ ×     |       | Logical AND/NOT/inclusive OR/exclusive OR    |
| ← ⇒         |       | Rotate left/right                            |
| ( )         |       | Indirect addressing                          |
| ( )+ -( )   |       | Indirect addressing auto-increment/decrement |
| { }         |       | Combination of operands                      |
| #           |       | Also BC=BC-1,DE=DE-1                         |
| ##          |       | Only lower 4 bits of accumulator A used      |
| = ← ↔       |       | Equality/Assignment/Swap values              |