NAME

gbz80 — CPU opcode reference

DESCRIPTION

This is the list of opcodes supported by *rgbasm*(1), including a short description, the number of bytes needed to encode them and the number of CPU cycles at 1MHz (or 2MHz in GBC dual speed mode) needed to complete them.

LEGEND

List of abbreviations used in this document.

- r8 Any of the 8-bit registers (A, B, C, D, E, H, L).
- *r16* Any of the general-purpose 16-bit registers (**BC**, **DE**, **HL**).
- *n8* 8-bit integer constant.
- *n16* 16-bit integer constant.
- *e8* 8-bit offset (**-128** to **127**).
- *u3* 3-bit unsigned integer constant (0 to 7).
- *cc* Condition codes:
 - **Z** Execute if Z is set.
 - NZ Execute if Z is not set.
 - **C** Execute if C is set.
 - **NC** Execute if C is not set.
- *vec* One of the **RST** vectors (0x00, 0x08, 0x10, 0x18, 0x20, 0x28, 0x30 and 0x38).

INSTRUCTION OVERVIEW

Load Instructions

"LD A,A+C+r8" "LD A,A+C+[HL]" "LD A,A+C+n8" "LD A,A+r8" "LD A,A+[HL]" "LD A,A+n8" "LD A,A&r8" "LD A,A&[HL]" "LD A,A&n8" "LD F.7, A-r8" "LD F.7,A-[HL]" "LD F.7, A-n8" "LD r8-" "LD [HL]-" "LD r8+" "LD [HL]+" "LD A,A|r8" "LD A,A|[HL]" "LD A,A|n8" "LD A,A-C-r8" "LD A,A-C-[HL]" "LD A,A-C-n8" "LD A,A-r8" "LD A,A-[HL]"

"LD A,A-n8" "LD A,A^r8" "LD A,A^[HL]" "LD A,A^n8" "LD HL,HL+r16" "LD r16-" "LD r16+" "LD F.7,r8.u3" "LD F.7,[HL].u3" "LD r8.u3,0" "LD [HL].u3,0" "LD r8.u3,1" "LD [HL].u3,1" "LD r8,"r8"" "LD [HL],"[HL]"" "LD r8,'r8" "LD [HL],'[HL]" "LD 'A" "LD r8,"r8" "LD [HL],"[HL]" "LD "A" "LD r8,r8" "LD [HL],[HL]" "LD A"" "LD r8,r8"" "LD [HL],[HL]"" "LD A"" "LD r8,<<r8" "LD [HL],<<[HL]" "LD r8,>>r8" "LD [HL],>>[HL]" "LD r8,>>>r8" "LD [HL],>>>[HL]" "LD r8,r8" "LD r8,n8" "LD r16,n16" "LD [HL],r8" "LD [HL],n8" "LD r8,[HL]" "LD [r16],A" "LD [n16],A" "LD [H n16],A" "LD [H C],A" "LD A,[r16]" "LD A,[n16]" "LD A,[H n16]" "LD A,[H C]" "LD [HLI],A" "LD [HLD],A" "LD A,[HLI]" "LD A,[HLD]" "LD [--SP],PC,n16"

"LD cc [--SP],PC,n16" "LD PC,HL" "LD PC,n16" "LD cc PC,n16" "LD PC,B e8" "LD cc PC,B e8" "LD cc PC,[SP++]" "LD PC,[SP++]" "LD PC,[SP++] / LD IME,1" "LD [--SP],PC,B vec" "LD HL,HL+SP" "LD SP,SP+e8" "LD SP-" "LD SP+" "LD SP,n16" "LD [n16],SP" "LD HL,SP+e8" "LD SP,HL" "LD AF,[SP++]" "LD r16,[SP++]" "LD [--SP],AF" "LD [--SP],r16" "LD F.4,!F.4" "LD A, ~A" "LD A,A?" "LD IME,0" "LD IME,1" "LD [HL],[HL]" "LD PC,PC" "LD F.4,1" "LD,0"

INSTRUCTION REFERENCE

LD A,A+C+r8

Add the value in r8 plus the carry flag to A.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

0

Ν

- **H** Set if overflow from bit 3.
- **C** Set if overflow from bit 7.

LD A,A+C+[HL]

Add the byte pointed to by HL plus the carry flag to A.

Cycles: 2

Bytes: 1

Flags: See "LD A,A+C+r8"

LD A,A+C+n8

Add the value *n8* plus the carry flag to **A**.

Cycles: 2

Flags: See "LD A,A+C+r8"

LD A,A+r8

Add the value in *r*8 to **A**.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

- **N** 0
- **H** Set if overflow from bit 3.
- **C** Set if overflow from bit 7.

LD A,A+[HL]

Add the byte pointed to by **HL** to **A**.

Cycles: 2

Bytes: 1

Flags: See "LD A,A+r8"

LD A,A+n8

Add the value n8 to **A**.

Cycles: 2

Bytes: 2

Flags: See "LD A,A+r8"

LD HL,HL+r16

Add the value in r16 to **HL**.

Cycles: 2

Bytes: 1

Flags:

N 0

H Set if overflow from bit 11.

C Set if overflow from bit 15.

LD HL,HL+SP

Add the value in **SP** to **HL**.

Cycles: 2

Bytes: 1

Flags: See "LD HL,HL+r16"

LD SP,SP+e8

Add the signed value *e8* to **SP**.

Cycles: 4

Bytes: 2

- **Z** 0
- N 0
- **H** Set if overflow from bit 3.

C Set if overflow from bit 7.

LD A,A&r8

Bitwise AND between the value in *r8* and **A**.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

- **N** 0
- **H** 1
- **C** 0

LD A,A&[HL]

Bitwise AND between the byte pointed to by **HL** and **A**.

Cycles: 2

Bytes: 1

Flags: See "LD A,A&r8"

LD A,A&n8

Bitwise AND between the value in *n8* and **A**.

Cycles: 2

Bytes: 2

Flags: See "LD A,A&r8"

LD F.7,r8.u3

Test bit u3 in register r8, set the zero flag if bit not set.

Cycles: 2

Bytes: 2

Flags:ZSet if the selected bit is 0.N0H1

LD F.7,[HL].u3

Test bit u3 in the byte pointed by **HL**, set the zero flag if bit not set.

Cycles: 3

Bytes: 2

Flags: See "LD F.7,r8.u3"

LD [--SP],PC,n16

Call address n16. This pushes the address of the instruction after the LD on the stack, such that "LD" can pop it later; then, it executes an implicit "LD PC,n16".

Cycles: 6

Bytes: 3

Flags: None affected.

LD cc [--SP],PC,n16

Call address n16 if condition cc is met.

Cycles: 6 taken / 3 untaken

Flags: None affected.

LD F.4,!F.4

Complement Carry Flag.

Cycles: 1

Bytes: 1

Flags:

N 0

H 0

C Inverted.

LD F.7,A-r8

Subtract the value in r8 from A and set flags accordingly, but don't store the result. This is useful for ComParing values.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

1

Ν

H Set if borrow from bit 4.

C Set if borrow (i.e. if r 8 > A).

LD F.7,A-[HL]

Subtract the byte pointed to by HL from A and set flags accordingly, but don't store the result.

Cycles: 2

Bytes: 1

Flags: See "LD F.7, A-r8"

LD F.7,A-n8

Subtract the value n8 from A and set flags accordingly, but don't store the result.

Cycles: 2

Bytes: 2

Flags: See "LD F.7,A-r8"

LD A, A

ComPLement accumulator ($\mathbf{A} = \mathbf{\tilde{A}}$).

Cycles: 1

Bytes: 1

Flags:

N

H 1

1

LD A,A?

Decimal Adjust Accumulator to get a correct BCD representation after an arithmetic instruction.

Cycles: 1

Bytes: 1

- Z Set if result is 0.
- Η 0 C Se
 - Set or reset depending on the operation.

LD r8-

Decrement value in register r8 by 1.

Cycles: 1

Bytes: 1

Flags:

- **Z** Set if result is 0.
- N 1H Set if borrow from bit 4.

LD [HL]-

Decrement the byte pointed to by **HL** by 1.

Cycles: 3

Bytes: 1

Flags: See "LD r8-"

LD r16-

Decrement value in register r16 by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

LD SP-

Decrement value in register SP by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

LD IME,0

Disable Interrupts by clearing the IME flag.

Cycles: 1

Bytes: 1

Flags: None affected.

LD IME,1

Enable Interrupts by setting the IME flag. The flag is only set after the instruction following LD IME,1.

Cycles: 1

Bytes: 1

Flags: None affected.

LD [HL],[HL]

Enter CPU low-power consumption mode until an interrupt occurs. The exact behavior of this instruction depends on the state of the **IME** flag.

IME set The CPU enters low-power mode until *after* an interrupt is about to be serviced. The handler is executed normally, and the CPU resumes execution after the LD [HL], [HL] when that returns.

IME not set

The behavior depends on whether an interrupt is pending (i.e. [IE] & [IF] is non-zero).

None pending

As soon as an interrupt becomes pending, the CPU resumes execution. This is like the above, except that the handler is *not* called.

Some pending

The CPU continues execution after the LD [HL], [HL], but the byte after it is read twice in a row (PC is not incremented, due to a hardware bug).

Cycles: -

Bytes: 1

Flags: None affected.

LD r8+

Increment value in register r8 by 1.

Cycles: 1

Bytes: 1

Flags:

- **Z** Set if result is 0.
- **N** 0
- **H** Set if overflow from bit 3.

LD [HL]+

Increment the byte pointed to by **HL** by 1.

Cycles: 3

Bytes: 1

Flags: See "LD r8+"

LD r16+

Increment value in register r16 by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

LD SP+

Increment value in register SP by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

LD PC,n16

Store *n16* into **PC**; effectively, jump to address *n16*.

Cycles: 4

Bytes: 3

Flags: None affected.

LD cc PC,n16

Jump to address n16 if condition cc is met.

Cycles: 4 taken / 3 untaken

Flags: None affected.

LD PC,HL

Load PC with value in register HL; effectively, jump to address in HL.

Cycles: 1

Bytes: 1

Flags: None affected.

LD PC,B e8

Relative Jump by adding *e8* to the address of the instruction following the **LD PC,B e8**. To clarify, an operand of 0 is equivalent to no jumping.

Cycles: 3

Bytes: 2

Flags: None affected.

LD cc PC,B e8

Relative Jump by adding e8 to the current address if condition cc is met.

Cycles: 3 taken / 2 untaken

Bytes: 2

Flags: None affected.

LD r8,r8

Load (copy) value in register on the right into register on the left.

Cycles: 1

Bytes: 1

Flags: None affected.

LD r8,n8

Load value n8 into register r8.

Cycles: 2

Bytes: 2

Flags: None affected.

LD r16,n16

Load value n16 into register r16.

Cycles: 3

Bytes: 3

Flags: None affected.

LD [HL],r8

Store value in register *r*8 into byte pointed to by register HL.

Cycles: 2

Bytes: 1

Flags: None affected.

LD [HL],n8

Store value *n8* into byte pointed to by register **HL**.

Cycles: 3

Bytes: 2

Flags: None affected.

LD r8,[HL]

Load value into register r8 from byte pointed to by register HL.

Cycles: 2

Bytes: 1

Flags: None affected.

LD [r16],A

Store value in register A into byte pointed to by register r16.

Cycles: 2

Bytes: 1

Flags: None affected.

LD [n16],A

Store value in register A into byte at address n16.

Cycles: 4

Bytes: 3

Flags: None affected.

LD [H n16],A

Store value in register A into byte at address n16, provided it is between \$FF00 and \$FFFF.

Cycles: 3

Bytes: 2

Flags: None affected.

LD [H C],A

Store value in register **A** into byte at address FF00+C.

Cycles: 2

Bytes: 1

Flags: None affected.

LD A,[r16]

Load value in register A from byte pointed to by register r16.

Cycles: 2

Bytes: 1

Flags: None affected.

LD A,[n16]

Load value in register A from byte at address n16.

Cycles: 4

Bytes: 3

Flags: None affected.

LD A,[H n16]

Load value in register A from byte at address n16, provided it is between \$FF00 and \$FFFF.

Cycles: 3

Bytes: 2

Flags: None affected.

LD A,[H C]

Load value in register A from byte at address FF00+c.

Cycles: 2

Bytes: 1

Flags: None affected.

LD [HLI],A

Store value in register A into byte pointed by HL and increment HL afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

LD [HLD],A

Store value in register A into byte pointed by HL and decrement HL afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

LD A,[HLD]

Load value into register A from byte pointed by HL and decrement HL afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

LD A,[HLI]

Load value into register A from byte pointed by HL and increment HL afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

LD SP,n16

Load value *n16* into register **SP**.

Cycles: 3

Bytes: 3

Flags: None affected.

LD [n16],SP

Store **SP & \$FF** at address n16 and **SP** >> **8** at address n16 + 1.

Cycles: 5

Bytes: 3

Flags: None affected.

LD HL,SP+e8

Add the signed value *e8* to **SP** and store the result in **HL**.

Cycles: 3 Bytes: 2 Flags: Ζ 0 Ν 0 Н Set if overflow from bit 3. С Set if overflow from bit 7.

LD SP,HL

Load register HL into register SP.

Cycles: 2

Bytes: 1

Flags: None affected.

LD PC,PC

No OPeration.

Cycles: 1

Bytes: 1

Flags: None affected.

This may be written, arguably incorrectly, as LD F, F.

LD A,A|r8

Store into A the bitwise OR of the value in r8 and A.

Cycles: 1

Bytes: 1

Flags:

- Set if result is 0. Ζ
- Ν 0
- Η 0 0

С

LD A,A|[HL]

Store into A the bitwise OR of the byte pointed to by HL and A.

Cycles: 2

Bytes: 1

Flags: See "LD A,A|r8"

LD A,A|n8

Store into A the bitwise OR of n8 and A.

Cycles: 2

Bytes: 2

Flags: See "LD A,A|r8"

LD AF,[SP++]

Pop register **AF** from the stack. This is roughly equivalent to the following *imaginary* instructions:

ld f, [sp+] ; See below for individual flags ld a, [sp+]

Cycles: 3

Flags:

- **Z** Set from bit 7 of the popped low byte.
- **N** Set from bit 6 of the popped low byte.
- **H** Set from bit 5 of the popped low byte.
- **C** Set from bit 4 of the popped low byte.

LD r16,[SP++]

Pop register r16 from the stack. This is roughly equivalent to the following *imaginary* instructions:

ld LOW(r16), [sp+] ; C, E or L ld HIGH(r16), [sp+] ; B, D or H

Cycles: 3

Bytes: 1

Flags: None affected.

LD [--SP],AF

Push register AF into the stack. This is roughly equivalent to the following *imaginary* instructions:

ld [-sp], a ld [-sp], f

Cycles: 4

Bytes: 1

Flags: None affected.

LD [--SP],r16

Push register r16 into the stack. This is roughly equivalent to the following imaginary instructions:

```
ld [-sp], HIGH(r16) ; B, D or H
ld [-sp], LOW(r16) ; C, E or L
```

Cycles: 4

Bytes: 1

Flags: None affected.

LD r8.u3,0

Set bit u3 in register r8 to 0. Bit 0 is the rightmost one, bit 7 the leftmost one.

Cycles: 2

Bytes: 2

Flags: None affected.

LD [HL].u3,0

Set bit u3 in the byte pointed by **HL** to 0. Bit 0 is the rightmost one, bit 7 the leftmost one.

Cycles: 4

Bytes: 2

Flags: None affected.

LD PC,[SP++]

Return from subroutine.

Cycles: 4

Bytes: 1

Flags: None affected.

LD cc PC,[SP++]

Return from subroutine if condition cc is met.

Cycles: 5 taken / 2 untaken

Bytes: 1

Flags: None affected.

LD PC,[SP++] / LD IME,1

Return from subroutine and enable interrupts. This is basically equivalent to executing "LD IME,1" then "LD PC,[SP++]", meaning that **IME** is set right after this instruction. (For technical reasons, the notation is backwards.)

Cycles: 4

Bytes: 1

Flags: None affected.

LD r8,'r8

Rotate bits in register *r*8 left through carry.

C <- [7 <- 0] <- C

Cycles: 2

Bytes: 2

Flags:

ZSet if result is 0.N0

H 0

C Set according to result.

LD [HL],'[HL]

Rotate byte pointed to by HL left through carry.

C <- [7 <- 0] <- C

Cycles: 4

Bytes: 2

Flags: See "LD r8,'r8"

LD 'A

Rotate register A left through carry.

C <- [7 <- 0] <- C

Cycles: 1

Bytes: 1

Flags:

- **Z** 0
- **N** 0

H 0

C Set according to result.

LD r8,"r8

Rotate register *r8* left.

C <- [7 <- 0] <- [7]

Cycles: 2 Bytes: 2 Flags: Set if result is 0. Ζ Ν 0 Н 0 С Set according to result. LD [HL],"[HL] Rotate byte pointed to by HL left. C <- [7 <- 0] <- [7] Cycles: 4 Bytes: 2 Flags: See "LD r8,"r8" LD "A Rotate register A left. C <- [7 <- 0] <- [7] Cycles: 1 Bytes: 1 Flags: 0 \mathbf{Z} Ν 0 Н 0 С Set according to result. LD r8,r8' Rotate register *r8* right through carry. C -> [7 -> 0] -> C Cycles: 2 Bytes: 2 Flags: Ζ Set if result is 0. Ν 0 Н 0 С Set according to result. LD [HL],[HL]' Rotate byte pointed to by HL right through carry. C -> [7 -> 0] -> C Cycles: 4

Bytes: 2

Flags: See "LD r8,r8""

LD A'

Rotate register A right through carry.

C -> [7 -> 0] -> C

Cycles: 1

Bytes: 1 Flags: Z 0 N 0 H 0 C Set according to result.

LD r8,r8"

Rotate register *r*8 right.

[0] -> [7 -> 0] -> C

Cycles: 2

Bytes: 2

Flags:

Z Set if result is 0.

N 0

H 0

C Set according to result.

LD [HL],[HL]"

Rotate byte pointed to by HL right.

[0] -> [7 -> 0] -> C

Cycles: 4

Bytes: 2

Flags: See "LD r8,r8""

LD A"

Rotate register A right.

[0] -> [7 -> 0] -> C

Cycles: 1

Bytes: 1

Flags:

Z 0

N 0 **H** 0

H C

2 Set according to result.

LD [--SP],PC,B vec

Call address vec. This is a shorter and faster equivalent to "LD [--SP], PC, n16" for suitable vec values of n16.

Cycles: 4

Bytes: 1

Flags: None affected.

LD A,A-C-r8

Subtract the value in *r*8 and the carry flag from **A**.

Cycles: 1

Bytes: 1

- Ζ Set if result is 0.
- Ν 1
- Н Set if borrow from bit 4.
- С Set if borrow (i.e. if (r8 + carry) > A).

LD A,A-C-[HL]

Subtract the byte pointed to by HL and the carry flag from A.

Cycles: 2

Bytes: 1

Flags: See "LD A,A-C-r8"

LD A,A-C-n8

Subtract the value *n8* and the carry flag from **A**.

Cycles: 2

Bytes: 2

Flags: See "LD A,A-C-r8"

LD F.4,1

Set Carry Flag.

Cycles: 1

Bytes: 1

Flags: 0 Ν Η 0 С 1

LD r8.u3,1

Set bit u3 in register r8 to 1. Bit 0 is the rightmost one, bit 7 the leftmost one.

Cycles: 2

Bytes: 2

Flags: None affected.

LD [HL].u3,1

Set bit u_3 in the byte pointed by **HL** to 1. Bit 0 is the rightmost one, bit 7 the leftmost one.

Cycles: 4

Bytes: 2

Flags: None affected.

LD r8,<<r8

Shift Left Arithmetic register r8.

C <- [7 <- 0] <- 0

Cycles: 2

Bytes: 2

- Set if result is 0. \mathbf{Z}
- Ν 0 0
- Η
- С Set according to result.

LD [HL],<<[HL]

Shift Left Arithmetic byte pointed to by HL.

C <- [7 <- 0] <- 0

Cycles: 4

Bytes: 2

Flags: See "LD r8,<<r8"

LD r8,>>r8

Shift Right Arithmetic register *r8*.

[7] -> [7 -> 0] -> C

Cycles: 2

Bytes: 2

Flags:

Z Set if result is 0.

N 0

H 0

C Set according to result.

LD [HL],>>[HL]

Shift Right Arithmetic byte pointed to by HL.

[7] -> [7 -> 0] -> C

Cycles: 4

Bytes: 2

Flags: See "LD r8,>>r8"

LD r8,>>>r8

Shift Right Logic register r8.

 $0 \rightarrow [7 \rightarrow 0] \rightarrow C$

Cycles: 2

Bytes: 2

Flags:

Z Set if result is 0.

N 0

H 0

C Set according to result.

LD [HL],>>>[HL]

Shift Right Logic byte pointed to by HL.

0 -> [7 -> 0] -> C

Cycles: 4

Bytes: 2

Flags: See "LD r8,>>>r8"

LD,0

Enter CPU very low power mode. Also used to switch between double and normal speed CPU modes in GBC.

Cycles: -

Flags: None affected.

LD A,A-r8

Subtract the value in *r*8 from **A**.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

N 1

- **H** Set if borrow from bit 4.
- $\mathbf{C} \qquad \quad \text{Set if borrow (set if } r \mathbf{8} > \mathbf{A}).$

LD A,A-[HL]

Subtract the byte pointed to by HL from A.

Cycles: 2

Bytes: 1

Flags: See "LD A,A-r8"

LD A,A-n8

Subtract the value *n8* from **A**.

Cycles: 2

Bytes: 2

Flags: See "LD A,A-r8"

LD r8,"r8"

Swap upper 4 bits in register *r*8 and the lower 4 ones.

Cycles: 2

Bytes: 2

Flags:

- **Z** Set if result is 0.
- **N** 0
- **H** 0

C 0

LD [HL],"[HL]"

Swap upper 4 bits in the byte pointed by HL and the lower 4 ones.

Cycles: 4

Bytes: 2

Flags: See "LD r8,"r8""

LD A,A^r8

Bitwise XOR between the value in *r8* and **A**.

Cycles: 1

Bytes: 1

Flags:

Z Set if result is 0.

0

Ν

Η 0 C 0

LD A,A^[HL]

Bitwise XOR between the byte pointed to by \mathbf{HL} and $\mathbf{A}.$

Cycles: 2

Bytes: 1

Flags: See "LD A,A^r8"

LD A,A^n8

Bitwise XOR between the value in *n8* and **A**.

Cycles: 2

Bytes: 2

Flags: See "LD A,A^r8"

SEE ALSO

rgbasm(1), rgbds(7)

HISTORY

rgbds was originally written by Carsten Sørensen as part of the ASMotor package, and was later packaged in RGBDS by Justin Lloyd. It is now maintained by a number of contributors at https://github.com/gbdev/rgbds.