

**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 double speed mode) needed to complete them.

Note: All arithmetic and logic instructions that use register **A** as a destination can omit the destination, since it is assumed to be register **A** by default. So the following two lines have the same effect:

```
OR A, B
OR B
```

Furthermore, the **CPL** instruction can take an optional **A** destination, since it can only be register **A**. So the following two lines have the same effect:

```
CPL
CPL A
```

**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 (signed or unsigned, **-128** to **255**).
- n16* 16-bit integer constant (signed or unsigned, **-32768** to **65535**).
- e8* 8-bit signed offset (**-128** to **127**).
- u3* 3-bit unsigned bit index (**0** to **7**, with **0** as the least significant bit).
- cc* A condition code:
  - 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* An **RST** vector (*0x00*, *0x08*, *0x10*, *0x18*, *0x20*, *0x28*, *0x30*, and *0x38*).

**INSTRUCTION OVERVIEW****Load instructions**

```
"LD r8,r8"
"LD r8,n8"
"LD r16,n16"
"LD [HL],r8"
"LD [HL],n8"
"LD r8,[HL]"
"LD [r16],A"
"LD [n16],A"
"LDH [n16],A"
"LDH [C],A"
"LD A,[r16]"
"LD A,[n16]"
"LDH A,[n16]"
"LDH A,[C]"
"LD [HL],A"
```

“LD [HLD],A”  
“LD A,[HL]”  
“LD A,[HLD]”

**8-bit arithmetic instructions**

“ADC A,r8”  
“ADC A,[HL]”  
“ADC A,n8”  
“ADD A,r8”  
“ADD A,[HL]”  
“ADD A,n8”  
“CP A,r8”  
“CP A,[HL]”  
“CP A,n8”  
“DEC r8”  
“DEC [HL]”  
“INC r8”  
“INC [HL]”  
“SBC A,r8”  
“SBC A,[HL]”  
“SBC A,n8”  
“SUB A,r8”  
“SUB A,[HL]”  
“SUB A,n8”

**16-bit arithmetic instructions**

“ADD HL,r16”  
“DEC r16”  
“INC r16”

**Bitwise logic instructions**

“AND A,r8”  
“AND A,[HL]”  
“AND A,n8”  
“CPL”  
“OR A,r8”  
“OR A,[HL]”  
“OR A,n8”  
“XOR A,r8”  
“XOR A,[HL]”  
“XOR A,n8”

**Bit flag instructions**

“BIT u3,r8”  
“BIT u3,[HL]”  
“RES u3,r8”  
“RES u3,[HL]”  
“SET u3,r8”  
“SET u3,[HL]”

**Bit shift instructions**

“RL r8”  
“RL [HL]”  
“RLA”  
“RLC r8”

“RLC [HL]”  
“RLCA”  
“RR r8”  
“RR [HL]”  
“RRA”  
“RRC r8”  
“RRC [HL]”  
“RRCA”  
“SLA r8”  
“SLA [HL]”  
“SRA r8”  
“SRA [HL]”  
“SRL r8”  
“SRL [HL]”  
“SWAP r8”  
“SWAP [HL]”

**Jumps and subroutine instructions**

“CALL n16”  
“CALL cc,n16”  
“JP HL”  
“JP n16”  
“JP cc,n16”  
“JR n16”  
“JR cc,n16”  
“RET cc”  
“RET”  
“RETI”  
“RST vec”

**Carry flag instructions**

“CCF”  
“SCF”

**Stack manipulation instructions**

“ADD HL,SP”  
“ADD SP,e8”  
“DEC SP”  
“INC SP”  
“LD SP,n16”  
“LD [n16],SP”  
“LD HL,SP+e8”  
“LD SP,HL”  
“POP AF”  
“POP r16”  
“PUSH AF”  
“PUSH r16”

**Interrupt-related instructions**

“DI”  
“EI”  
“HALT”

**Miscellaneous instructions**

“DAA”

“NOP”

“STOP”

## INSTRUCTION REFERENCE

### ADC A,r8

Add the value in *r8* plus the carry flag 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.

### ADC A,[HL]

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

Cycles: 2

Bytes: 1

Flags: See “ADC A,r8”

### ADC A,n8

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

Cycles: 2

Bytes: 2

Flags: See “ADC A,r8”

### ADD A,r8

Add the value in *r8* 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.

### ADD A,[HL]

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

Cycles: 2

Bytes: 1

Flags: See “ADD A,r8”

### ADD A,n8

Add the value *n8* to **A**.

Cycles: 2

Bytes: 2

Flags: See “ADD A,r8”

**ADD 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.

**ADD HL,SP**

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

Cycles: 2

Bytes: 1

Flags: See “ADD HL,r16”

**ADD SP,e8**

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

Cycles: 4

Bytes: 2

Flags:

**Z** 0

**N** 0

**H** Set if overflow from bit 3.

**C** Set if overflow from bit 7.

**AND A,r8**

Set **A** to the 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

**AND A,[HL]**

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

Cycles: 2

Bytes: 1

Flags: See “AND A,r8”

**AND A,n8**

Set **A** to the bitwise AND between the value *n8* and **A**.

Cycles: 2

Bytes: 2

Flags: See “AND A,r8”

**BIT u3,r8**

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

Cycles: 2

Bytes: 2

Flags:

**Z**     Set if the selected bit is 0.

**N**     0

**H**     1

**BIT u3,[HL]**

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

Cycles: 3

Bytes: 2

Flags: See “BIT u3,r8”

**CALL n16**

Call address *n16*.

This pushes the address of the instruction after the **CALL** on the stack, such that “RET” can pop it later; then, it executes an implicit “JP *n16*”.

Cycles: 6

Bytes: 3

Flags: None affected.

**CALL cc,n16**

Call address *n16* if condition *cc* is met.

Cycles: 6 taken / 3 untaken

Bytes: 3

Flags: None affected.

**CCF**

Complement Carry Flag.

Cycles: 1

Bytes: 1

Flags:

**N**     0

**H**     0

**C**     Inverted.

**CP A,r8**

ComPare the value in **A** with the value in *r8*.

This subtracts the value in  $r8$  from **A** and sets flags accordingly, but discards the result.

Cycles: 1

Bytes: 1

Flags:

**Z**     Set if result is 0.  
**N**     1  
**H**     Set if borrow from bit 4.  
**C**     Set if borrow (i.e. if  $r8 > \mathbf{A}$ ).

#### **CP A,[HL]**

ComPare the value in **A** with the byte pointed to by **HL**.

This subtracts the byte pointed to by **HL** from **A** and sets flags accordingly, but discards the result.

Cycles: 2

Bytes: 1

Flags: See “CP A,r8”

#### **CP A,n8**

ComPare the value in **A** with the value  $n8$ .

This subtracts the value  $n8$  from **A** and sets flags accordingly, but discards the result.

Cycles: 2

Bytes: 2

Flags: See “CP A,r8”

#### **CPL**

ComPlement accumulator ( $\mathbf{A} = \sim\mathbf{A}$ ); also called bitwise NOT.

Cycles: 1

Bytes: 1

Flags:

**N**     1  
**H**     1

#### **DAA**

Decimal Adjust Accumulator.

Designed to be used after performing an arithmetic instruction (**ADD**, **ADC**, **SUB**, **SBC**) whose inputs were in Binary-Coded Decimal (BCD), adjusting the result to likewise be in BCD.

The exact behavior of this instruction depends on the state of the subtract flag **N**:

If the subtract flag **N** is set:

1. Initialize the adjustment to 0.
2. If the half-carry flag **H** is set, then add \$6 to the adjustment.
3. If the carry flag is set, then add \$60 to the adjustment.
4. Subtract the adjustment from **A**.

If the subtract flag **N** is not set:

1. Initialize the adjustment to 0.
2. If the half-carry flag **H** is set or  $\mathbf{A} \& \$F > \$9$ , then add \$6 to the adjustment.

3. If the carry flag is set or  $A > \$99$ , then add  $\$60$  to the adjustment and set the carry flag.
4. Add the adjustment to **A**.

Cycles: 1

Bytes: 1

Flags:

**Z** Set if result is 0.

**H** 0

**C** Set or reset depending on the operation.

#### **DEC r8**

Decrement the value in register *r8* by 1.

Cycles: 1

Bytes: 1

Flags:

**Z** Set if result is 0.

**N** 1

**H** Set if borrow from bit 4.

#### **DEC [HL]**

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

Cycles: 3

Bytes: 1

Flags: See “DEC r8”

#### **DEC r16**

Decrement the value in register *r16* by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

#### **DEC SP**

Decrement the value in register **SP** by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

#### **DI**

Disable Interrupts by clearing the **IME** flag.

Cycles: 1

Bytes: 1

Flags: None affected.

#### **EI**

Enable Interrupts by setting the **IME** flag.

The flag is only set *after* the instruction following **EI**.

Cycles: 1

Bytes: 1

Flags: None affected.

### **HALT**

Enter CPU low-power consumption mode until an interrupt occurs.

The exact behavior of this instruction depends on the state of the **IME** flag, and whether interrupts are pending (i.e. whether [ **IE** ] & [ **IF** ] is non-zero):

If the **IME** flag is 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 **HALT** when that returns.

If the **IME** flag is not set, and no interrupts are pending:

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

If the **IME** flag is not set, and some interrupt is pending:

The CPU continues execution after the **HALT**, 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.

### **INC r8**

Increment the 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.

### **INC [HL]**

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

Cycles: 3

Bytes: 1

Flags: See "INC r8"

### **INC r16**

Increment the value in register *r16* by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

### **INC SP**

Increment the value in register **SP** by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

### **JP n16**

Jump to address *n16*; effectively, copy *n16* into **PC**.

Cycles: 4

Bytes: 3

Flags: None affected.

### **JP cc,n16**

Jump to address *n16* if condition *cc* is met.

Cycles: 4 taken / 3 untaken

Bytes: 3

Flags: None affected.

### **JP HL**

Jump to address in **HL**; effectively, copy the value in register **HL** into **PC**.

Cycles: 1

Bytes: 1

Flags: None affected.

### **JR n16**

Relative Jump to address *n16*.

The address is encoded as a signed 8-bit offset from the address immediately following the **JR** instruction, so the target address *n16* must be between **-128** and **127** bytes away. For example:

```

    JR Label    ; no-op; encoded offset of 0
Label:
    JR Label    ; infinite loop; encoded offset of -2

```

Cycles: 3

Bytes: 2

Flags: None affected.

### **JR cc,n16**

Relative Jump to address *n16* if condition *cc* is met.

Cycles: 3 taken / 2 untaken

Bytes: 2

Flags: None affected.

### **LD r8,r8**

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

Storing a register into itself is a no-op; however, some Game Boy emulators interpret **LD B,B** as a breakpoint, or **LD D,D** as a debug message (such as *BGB*: <https://bgb.bircd.org/manual.html#expressions>).

Cycles: 1

Bytes: 1

Flags: None affected.

### **LD r8,n8**

Copy the value *n8* into register *r8*.

Cycles: 2

Bytes: 2

Flags: None affected.

**LD r16,n16**

Copy the value *n16* into register *r16*.

Cycles: 3

Bytes: 3

Flags: None affected.

**LD [HL],r8**

Copy the value in register *r8* into the byte pointed to by **HL**.

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [HL],n8**

Copy the value *n8* into the byte pointed to by **HL**.

Cycles: 3

Bytes: 2

Flags: None affected.

**LD r8,[HL]**

Copy the value pointed to by **HL** into register *r8*.

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [r16],A**

Copy the value in register **A** into the byte pointed to by *r16*.

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [n16],A**

Copy the value in register **A** into the byte at address *n16*.

Cycles: 4

Bytes: 3

Flags: None affected.

**LDH [n16],A**

Copy the value in register **A** into the byte at address *n16*, provided the address is between *\$FF00* and *\$FFFF*.

Cycles: 3

Bytes: 2

Flags: None affected.

**LDH [C],A**

Copy the value in register **A** into the byte at address  $\$FF00+C$ .

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD [  $\$FF00+C$  ], A.

**LD A,[r16]**

Copy the byte pointed to by *r16* into register **A**.

Cycles: 2

Bytes: 1

Flags: None affected.

**LD A,[n16]**

Copy the byte at address *n16* into register **A**.

Cycles: 4

Bytes: 3

Flags: None affected.

**LDH A,[n16]**

Copy the byte at address *n16* into register **A**, provided the address is between  $\$FF00$  and  $\$FFFF$ .

Cycles: 3

Bytes: 2

Flags: None affected.

**LDH A,[C]**

Copy the byte at address  $\$FF00+C$  into register **A**.

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD A, [  $\$FF00+C$  ].

**LD [HL],A**

Copy the value in register **A** into the byte pointed by **HL** and increment **HL** afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD [HL+], A, or LDI [HL], A.

**LD [HLD],A**

Copy the value in register **A** into the byte pointed by **HL** and decrement **HL** afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD [HL-], A, or LDD [HL], A.

**LD A,[HLD]**

Copy the byte pointed to by **HL** into register **A**, and decrement **HL** afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD A, [HL-], or LDD A, [HL].

**LD A,[HLI]**

Copy the byte pointed to by **HL** into register **A**, and increment **HL** afterwards.

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as LD A, [HL+], or LDI A, [HL].

**LD SP,n16**

Copy the value *n16* into register **SP**.

Cycles: 3

Bytes: 3

Flags: None affected.

**LD [n16],SP**

Copy **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 copy the result in **HL**.

Cycles: 3

Bytes: 2

Flags:

**Z** 0

**N** 0

**H** Set if overflow from bit 3.

**C** Set if overflow from bit 7.

**LD SP,HL**

Copy register **HL** into register **SP**.

Cycles: 2

Bytes: 1

Flags: None affected.

**NOP**

No Operation.

Cycles: 1

Bytes: 1

Flags: None affected.

### OR A,r8

Set **A** to the bitwise OR between the value in *r8* and **A**.

Cycles: 1

Bytes: 1

Flags:

**Z** Set if result is 0.

**N** 0

**H** 0

**C** 0

### OR A,[HL]

Set **A** to the bitwise OR between the byte pointed to by **HL** and **A**.

Cycles: 2

Bytes: 1

Flags: See “OR A,r8”

### OR A,n8

Set **A** to the bitwise OR between the value *n8* and **A**.

Cycles: 2

Bytes: 2

Flags: See “OR A,r8”

### POP AF

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

```
LD F, [SP] ; See below for individual flags
INC SP
LD A, [SP]
INC SP
```

Cycles: 3

Bytes: 1

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.

### POP r16

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

```
LD LOW(r16), [SP] ; C, E or L
INC SP
LD HIGH(r16), [SP] ; B, D or H
INC SP
```

Cycles: 3

Bytes: 1

Flags: None affected.

### **PUSH AF**

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

```
DEC SP
LD [SP], A
DEC SP
LD [SP], F.Z << 7 | F.N << 6 | F.H << 5 | F.C << 4
```

Cycles: 4

Bytes: 1

Flags: None affected.

### **PUSH r16**

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

```
DEC SP
LD [SP], HIGH(r16) ; B, D or H
DEC SP
LD [SP], LOW(r16) ; C, E or L
```

Cycles: 4

Bytes: 1

Flags: None affected.

### **RES u3,r8**

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.

### **RES u3,[HL]**

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.

### **RET**

Return from subroutine. This is basically a **POP PC** (if such an instruction existed). See “POP r16” for an explanation of how **POP** works.

Cycles: 4

Bytes: 1

Flags: None affected.

### **RET cc**

Return from subroutine if condition *cc* is met.

Cycles: 5 taken / 2 untaken

Bytes: 1



**C** Set according to result.

**RLC r8**

Rotate register *r8* left.

Flags C b7 ... b0  
ââ Flags ââ âââââââ r8 âââââââ  
â C ââââ-âââ b7 â ... â b0 ââââ  
âââââââââââ â âââââââââââââââââââ â  
ââââââââââââââââââââââââââââââââ

Cycles: 2

Bytes: 2

Flags:

**Z** Set if result is 0.

**N** 0

**H** 0

**C** Set according to result.

**RLC [HL]**

Rotate the byte pointed to by **HL** left.

Flags C b7 ... b0  
ââ Flags ââ âââââââ [HL] âââââââ  
â C ââââ-âââ b7 â ... â b0 ââââ  
âââââââââââ â âââââââââââââââââââ â  
ââââââââââââââââââââââââââââââââ

Cycles: 4

Bytes: 2

Flags: See "RLC r8"

**RLCA**

Rotate register **A** left.

Flags C b7 ... b0  
ââ Flags ââ âââââââ A âââââââââ  
â C ââââ-âââ b7 â ... â b0 ââââ  
âââââââââââ â âââââââââââââââââââ â  
ââââââââââââââââââââââââââââââââ

Cycles: 1

Bytes: 1

Flags:

**Z** 0

**N** 0

**H** 0

**C** Set according to result.

**RR r8**

Rotate register *r8* right, through the carry flag.

Flags C  
âââââââââ r8 âââââââââ Flags ââ  
ââââ b7 â ... â b0 âââââ C ââââ  
â ââââââââââââââââââââââââââââââââ  
ââââââââââââââââââââââââââââââââ





Cycles: 2

Bytes: 1

Flags: See “SBC A,r8”

### **SBC A,n8**

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

Cycles: 2

Bytes: 2

Flags: See “SBC A,r8”

### **SCF**

Set Carry Flag.

Cycles: 1

Bytes: 1

Flags:

**N** 0

**H** 0

**C** 1

### **SET u3,r8**

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.

### **SET u3,[HL]**

Set bit *u3* 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.

### **SLA r8**

Shift Left Arithmetically register *r8*.

Flags    *r8*

**C**    b7 ... b0    0

Cycles: 2

Bytes: 2

Flags:

**Z**    Set if result is 0.

**N**    0

**H**    0

**C**    Set according to result.

**SLA [HL]**

Shift Left Arithmetically the byte pointed to by **HL**.

Flags [HL] C b7 ... b0 0

Cycles: 4

Bytes: 2

Flags: See "SLA r8"

**SRA r8**

Shift Right Arithmetically register *r8* (bit 7 of *r8* is unchanged).

r8 Flags b7 ... b0 C

Cycles: 2

Bytes: 2

Flags:

**Z** Set if result is 0.

**N** 0

**H** 0

**C** Set according to result.

**SRA [HL]**

Shift Right Arithmetically the byte pointed to by **HL** (bit 7 of the byte pointed to by **HL** is unchanged).

[HL] Flags b7 ... b0 C

Cycles: 4

Bytes: 2

Flags: See "SRA r8"

**SRL r8**

Shift Right Logically register *r8*.

r8 Flags 0 b7 ... b0 C

Cycles: 2

Bytes: 2

Flags:

**Z** Set if result is 0.

**N** 0

**H** 0

**C** Set according to result.



Flags:

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

#### **SWAP [HL]**

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

Cycles: 4

Bytes: 2

Flags: See “SWAP r8”

#### **XOR A,r8**

Set **A** to the bitwise XOR between the value in *r8* and **A**.

Cycles: 1

Bytes: 1

Flags:

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

#### **XOR A,[HL]**

Set **A** to the bitwise XOR between the byte pointed to by **HL** and **A**.

Cycles: 2

Bytes: 1

Flags: See “XOR A,r8”

#### **XOR A,n8**

Set **A** to the bitwise XOR between the value *n8* and **A**.

Cycles: 2

Bytes: 2

Flags: See “XOR A,r8”

#### **SEE ALSO**

*rgbasm(1)*, *rgblink(1)*, *rgbfix(1)*, *rbgfx(1)*, *rgbasm-old(5)*, *rgbds(7)*

#### **HISTORY**

*rgbasm(1)* was originally written by Carsten Sørensen as part of the ASMotor package, and was later repackaged in RGBDS by Justin Lloyd. It is now maintained by a number of contributors at <https://github.com/gbdev/rgbds>.