

**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.

Note: All arithmetic/logic operations that use register **A** as destination can omit the destination as it is assumed to be register **A** by default. The following two lines have the same effect:

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

**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.
  - ! cc** Negates a condition code.
- vec* One of the **RST** vectors (*0x00, 0x08, 0x10, 0x18, 0x20, 0x28, 0x30, and 0x38*).

**INSTRUCTION OVERVIEW****8-bit Arithmetic and Logic Instructions**

```
ADC A,r8
ADC A,[HL]
ADC A,n8
ADD A,r8
ADD A,[HL]
ADD A,n8
AND A,r8
AND A,[HL]
AND A,n8
CP A,r8
CP A,[HL]
CP A,n8
DEC r8
DEC [HL]
```

INC r8  
INC [HL]  
OR A,r8  
OR A,[HL]  
OR A,n8  
SBC A,r8  
SBC A,[HL]  
SBC A,n8  
SUB A,r8  
SUB A,[HL]  
SUB A,n8  
XOR A,r8  
XOR A,[HL]  
XOR A,n8

#### 16-bit Arithmetic Instructions

ADD HL,r16  
DEC r16  
INC r16

#### Bit Operations Instructions

BIT u3,r8  
BIT u3,[HL]  
RES u3,r8  
RES u3,[HL]  
SET u3,r8  
SET u3,[HL]  
SWAP r8  
SWAP [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]

**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 [HLI],A  
LD [HLD],A  
LD A,[HLI]  
LD A,[HLD]

**Jumps and Subroutines**

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

**Stack Operations 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

**Miscellaneous Instructions**

CCF

**CPL**  
**DAA**  
**DI**  
**EI**  
**HALT**  
**NOP**  
**SCF**  
**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**

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]**

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

Cycles: 2

Bytes: 1

Flags: See **AND A,r8**

**AND A,n8**

Bitwise AND between the value in *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

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.

**N** 1

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

**C** Set if borrow (i.e. if  $r8 > \mathbf{A}$ ).

### CP 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 **CP A,r8**

### CP A,n8

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

Cycles: 2

Bytes: 2

Flags: See **CP A,r8**

### CPL

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

Cycles: 1

Bytes: 1

Flags:

**N** 1

**H** 1

**DAA**

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

Cycles: 1

Bytes: 1

Flags:

**Z** Set if result is 0.

**H** 0

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

**DEC r8**

Decrement 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 value in register *r16* by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

**DEC SP**

Decrement 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.

**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 **HALT** 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 **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 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 value in register *r16* by 1.

Cycles: 2

Bytes: 1

Flags: None affected.

### **INC SP**

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

Cycles: 2

Bytes: 1

Flags: None affected.

### **JP n16**

Jump to address *n16*; effectively, store *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, load **PC** with value in register **HL**.

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**

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 *r8* into the byte pointed to by register **HL**.

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [HL],n8**

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

Cycles: 3

Bytes: 2

Flags: None affected.

**LD r8,[HL]**

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

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [r16],A**

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

Cycles: 2

Bytes: 1

Flags: None affected.

**LD [n16],A**

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

Cycles: 4

Bytes: 3

Flags: None affected.

**LDH [n16],A**

Store 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.

This is sometimes written as LDIO [ *n16* ], *A*, or LD [ *\$FF00+n8* ], *A*.

**LDH [C],A**

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

Cycles: 2

Bytes: 1

Flags: None affected.

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

**LD A,[r16]**

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

Cycles: 2

Bytes: 1

Flags: None affected.

**LD A,[n16]**

Load value in register **A** from the byte at address *n16*.

Cycles: 4

Bytes: 3

Flags: None affected.

**LDH A,[n16]**

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

Cycles: 3

Bytes: 2

Flags: None affected.

This is sometimes written as `LDIO A, [n16]`, or `LD A, [$FF00+n8]`.

#### **LDH A,[C]**

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

Cycles: 2

Bytes: 1

Flags: None affected.

This is sometimes written as `LDIO A, [C]`, or `LD A, [$FF00+C]`.

#### **LD [HL],A**

Store 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**

Store 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]**

Load value into register **A** from the byte pointed by **HL** 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]**

Load value into register **A** from the byte pointed by **HL** 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**

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:

**Z** 0

**N** 0

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

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

#### **LD SP,HL**

Load 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**

Store into **A** the bitwise OR of 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]**

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

Cycles: 2

Bytes: 1

Flags: See **OR A,r8**

**OR A,n8**

Store into **A** the bitwise OR of *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], flag_Z << 7 | flag_N << 6 | flag_H << 5 | flag_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

Flags: None affected.

### **RETI**

Return from subroutine and enable interrupts. This is basically equivalent to executing **EI** then **RET**, meaning that **IME** is set right after this instruction.



Cycles: 4

Bytes: 1

Flags: None affected.

### RL r8

Rotate bits in register *r8* left, through the carry flag.

```

    Flags  C  b7  ...  b0
    r8
    C  b7  ...  b0
    C  b7  ...  b0
  
```

Cycles: 2

Bytes: 2

Flags:

**Z** Set if result is 0.

**N** 0

**H** 0

**C** Set according to result.

### RL [HL]

Rotate the byte pointed to by **HL** left, through the carry flag.

```

    Flags  C  b7  ...  b0
    [HL]
    C  b7  ...  b0
    C  b7  ...  b0
  
```

Cycles: 4

Bytes: 2

Flags: See **RL r8**

### RLA

Rotate register **A** left, through the carry flag.

```

    Flags  C  b7  ...  b0
    A
    C  b7  ...  b0
    C  b7  ...  b0
  
```

Cycles: 1

Bytes: 1

Flags:

**Z** 0

**N** 0

**H** 0

**C** Set according to result.







**C** Set if borrow (i.e. if  $(r8 + \text{carry}) > \mathbf{A}$ ).

### **SBC A,[HL]**

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

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] Flags  
 C b7 ... b0 0  
 Flags

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  
 Flags

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  
 Flags

Cycles: 4

Bytes: 2

Flags: See **SRA r8**

### SRL r8

Shift Right Logically register *r8*.

r8 Flags  
 b7 ... b0 C  
 Flags



Cycles: 2

Bytes: 2

Flags: See **SUB A,r8**

#### **SWAP r8**

Swap the upper 4 bits in register *r8* and the lower 4 ones.

Cycles: 2

Bytes: 2

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**

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]**

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

Cycles: 2

Bytes: 1

Flags: See **XOR A,r8**

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

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

Cycles: 2

Bytes: 2

Flags: See **XOR A,r8**



**SEE ALSO**

`rgbasm(1)`, `rgbblink(1)`, `rgbfix(1)`, `rgbgfx(1)`, `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>.