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 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
```

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 A
```

LEGEND

List of abbreviations used in this document.

```
Any of the 8-bit registers (A, B, C, D, E, H, L).
```

- Any of the general-purpose 16-bit registers (**BC**, **DE**, **HL**).
- *n8* 8-bit integer constant.
- *n*16 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 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]
```

8-bit arithmetic instructions

ADC A,r8
ADC A,RHL]
ADC A,n8
ADD A,r8
ADD A,RHL]
ADD A,n8
CP A,r8
CP A,[HL]
CP A,n8
DEC r8
DEC [HL]
INC r8
INC [HL]
SEC A r8

SBC A,r8 SBC A,[HL]

SBC A ng

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.

 $\mathbf{N} = 0$

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.

 \mathbf{N}

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:

 $\mathbf{N} = 0$

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:
    \mathbf{Z}
             0
    N
             0
    Н
             Set if overflow from bit 3.
    \mathbf{C}
             Set if overflow from bit 7.
AND A,r8
    Bitwise AND between the value in r8 and A.
    Cycles: 1
    Bytes: 1
    Flags:
    \mathbf{Z}
             Set if result is 0.
    Ν
    H
             1
    \mathbf{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.

 $\mathbf{N} = 0$

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 Com-Paring values.

Cycles: 1 Bytes: 1

Flags:

Z Set if result is 0.

N 1

H Set if borrow from bit 4.

N

1

```
\mathbf{C}
              Set if borrow (i.e. if r8 > A).
CP A,[HL]
    Subtract the byte pointed to by HL from A and set flags accordingly, but don't store the result.
    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 (A = \tilde{A}).
    Cycles: 1
    Bytes: 1
    Flags:
    N
              1
              1
    Η
DAA
    Decimal Adjust Accumulator to get a correct BCD representation after an arithmetic instruction.
    Cycles: 1
    Bytes: 1
    Flags:
    \mathbf{Z}
             Set if result is 0.
              0
    Η
    \mathbf{C}
              Set or reset depending on the operation.
DEC r8
    Decrement value in register r8 by 1.
    Cycles: 1
    Bytes: 1
    Flags:
    \mathbf{Z}
              Set if result is 0.
```

H Set if borrow from bit 4.

DEC [HL]

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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.

 \mathbf{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.

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 [HLI],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:
    \mathbf{Z}
             0
    Ν
             0
    Η
             Set if overflow from bit 3.
    \mathbf{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:
    \mathbf{Z}
             Set if result is 0.
    N
             0
    Н
             0
    \mathbf{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

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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 £16 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.</pre>
```

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.

```
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.

Cycles: 4 Bytes: 2

Flags: See RL r8

RLA

Rotate register A left, through the carry flag.

Cycles: 1
Bytes: 1
Flags:

Z 0**N** 0**H** 0

C Set according to result.

RLC r8

Rotate register r8 left.

Cycles: 2 Bytes: 2

```
Flags:
```

Z Set if result is 0.

 \mathbf{N} 0

 $\mathbf{H} = 0$

C Set according to result.

RLC [HL]

Rotate the byte pointed to by HL left.

Cycles: 4
Bytes: 2

Flags: See RLC r8

RLCA

Rotate register A left.

Cycles: 1

Bytes: 1

Flags:

 \mathbf{Z} 0

 $\mathbf{N} = 0$

 $\mathbf{H} = 0$

C Set according to result.

RR r8

Rotate register r8 right, through the carry flag.

Cycles: 2
Bytes: 2
Flags:

```
Z Set if result is 0.
```

 \mathbf{N}

 $\mathbf{H} = 0$

C Set according to result.

RR [HL]

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

Cycles: 4

Bytes: 2

Flags: See RR r8

RRA

Rotate register A right, through the carry flag.

Cycles: 1

Bytes: 1

Flags:

 \mathbf{Z} 0

 $\mathbf{N} = 0$

 $\mathbf{H} = 0$

C Set according to result.

RRC r8

Rotate register r8 right.

Cycles: 2

Bytes: 2

Flags:

Z Set if result is 0.

```
N 0 H 0
```

C Set according to result.

RRC [HL]

Rotate the byte pointed to by HL right.

Cycles: 4 Bytes: 2

Flags: See RRC r8

RRCA

Rotate register A right.

Cycles: 1 Bytes: 1

Flags:

Z 0**N** 0**H** 0

C Set according to result.

RST vec

Call address vec. This is a shorter and faster equivalent to CALL for suitable values of vec.

Cycles: 4 Bytes: 1

Flags: None affected.

SBC A,r8

Subtract the value in r8 and the carry flag from **A**.

Cycles: 1
Bytes: 1
Flags:

```
\mathbf{Z}
             Set if result is 0.
    N
    H
             Set if borrow from bit 4.
    \mathbf{C}
             Set if borrow (i.e. if (r8 + carry) > 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:
             0
    N
    Η
             0
    \mathbf{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
```

SLA r8

Shift Left Arithmetically register *r8*.

Flags: None affected.

```
ââ Flags ââ ââââââââ r8 âââââââ
   â C âââââ b7 â ... â b0 âââ 0
   Cycles: 2
   Bytes: 2
   Flags:
   \mathbf{Z}
         Set if result is 0.
   Ν
         0
   Η
   \mathbf{C}
         Set according to result.
SLA [HL]
   Shift Left Arithmetically the byte pointed to by HL.
   ââ Flags ââ âââââââ [HL] ââââââ
           âââââ b7 â ... â b0 âââ 0
   Cycles: 4
   Bytes: 2
   Flags: See SLA r8
SRA r8
   Shift Right Arithmetically register r8 (bit 7 of r8 is unchanged).
   âââââââ r8 ââââââââ ââ Flags ââ
   â b7 â ... â b0 âââââ
                           С
   Cycles: 2
   Bytes: 2
   Flags:
   \mathbf{Z}
         Set if result is 0.
   N
         0
   Η
   \mathbf{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).
   ââââââ [HL] ââââââ ââ Flags ââ
   â b7 â ... â b0 âââââ
   Cycles: 4
```

```
Bytes: 2
Flags: See SRA r8
```

SRL r8

Shift Right Logically register r8.

Cycles: 2 Bytes: 2 Flags:

Z Set if result is 0.

N 0 **H** 0

C Set according to result.

SRL [HL]

Shift Right Logically the byte pointed to by HL.

Cycles: 4 Bytes: 2

Flags: See SRL r8

STOP

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

Cycles: -Bytes: 2

Flags: None affected.

SUB A,r8

Subtract the value in r8 from A.

Cycles: 1
Bytes: 1
Flags:

Z Set if result is 0.

N 1

```
H Set if borrow from bit 4.C Set if borrow (set if r8 > A).
```

SUB A,[HL]

Subtract the byte pointed to by **HL** from **A**.

Cycles: 2 Bytes: 1

Flags: See SUB A,r8

SUB A,n8

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

Cycles: 2 Bytes: 2

Flags: See SUB A,r8

SWAP r8

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

Cycles: 2
Bytes: 2
Flags:

Z Set if result is 0.

N 0H 0C 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.

 $\mathbf{N} = 0$

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), rgblink(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.