#### **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
```

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).
- r16 Any of the general-purpose 16-bit registers (**BC**, **DE**, **HL**).
- 8-bit integer constant (signed or unsigned, -128 to 255).
- 16-bit integer constant (signed or unsigned, -32768 to 65535).
- e8 8-bit signed offset (-128 to 127).
- 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 [HLI],A"

```
"LD [HLD],A"
```

"LD A,[HLI]"

"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.

 $\mathbf{N} = 0$ 

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

Set if overflow from bit 7.

# C 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.

 $\mathbf{N} = 0$ 

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
     Η
              Set if overflow from bit 11.
     \mathbf{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
     H
              Set if overflow from bit 3.
     \mathbf{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:
     \mathbf{Z}
              Set if result is 0.
     N
              0
     Η
              1
              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.

 $\mathbf{N} = 0$ 

**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

 $\mathbf{H} = 0$ 

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 > 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  $(A = \tilde{A})$ ; 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 **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.

 $\mathbf{H} = 0$ 

C Set or unaffected 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.

 $\mathbf{N}$  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.

#### ΕI

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.

 $\mathbf{N} = 0$ 

**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 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  $\mathbf{JR}$  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  $\bf A$  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 [HLI],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:

 $\mathbf{Z}$  0

 $\mathbf{N} = 0$ 

**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

 $\mathbf{C}$  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
```

Cycles: 4 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
```

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.

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

 $\mathbf{H} = 0$ 

C Set according to result.

# RLC r8

Rotate register r8 left.

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.

Cycles: 4 Bytes: 2

Flags: See "RLC r8"

# **RLCA**

Rotate register A left.

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.

 $\mathbf{Z}$ 

N

Set if result is 0.

0

```
Cycles: 2
   Bytes: 2
   Flags:
   \mathbf{Z}
        Set if result is 0.
   Ν
        0
   Η
        0
   \mathbf{C}
        Set according to result.
RR [HL]
   Rotate the byte pointed to by HL right, through the carry flag.
     âââââââ [HL] ââââââ ââ Flags ââ
   ââââ b7 â ... â b0 âââââ
                          С
   Cycles: 4
   Bytes: 2
   Flags: See "RR r8"
RRA
   Rotate register A right, through the carry flag.
     ââââââââ A âââââââââ ââ Flags ââ
   ââââ b7 â ... â b0 âââââ C
   Cycles: 1
   Bytes: 1
   Flags:
   \mathbf{Z}
        0
   N
        0
   Η
        0
   \mathbf{C}
        Set according to result.
RRC r8
   Rotate register r8 right.
     ââââââââ r8 âââââââ
                         ââ Flags ââ
   ââââ b7 â ... â b0 ââââ¬âââ
                             C
   Cycles: 2
   Bytes: 2
   Flags:
```

```
\mathbf{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 0N 0H 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:

**Z** Set if result is 0.

**N** 1

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

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**.

 $\mathbf{C}$ 

Set according to result.

```
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
            0
    Η
    \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
    Flags: None affected.
SLA r8
    Shift Left Arithmetically register r8.
    ââ Flags ââ ââââââââ r8 âââââââ
                âââââ b7 â ... â b0 âââ 0
    Cycles: 2
    Bytes: 2
    Flags:
            Set if result is 0.
    \mathbf{Z}
    N
            0
    Η
            0
```

#### SLA [HL]

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

Cycles: 4 Bytes: 2

Flags: See "SLA r8"

#### SRA r8

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

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).

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 0H 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 GBC double speed and normal speed CPU modes.

The exact behavior of this instruction is fragile and may interpret its second byte as a separate instruction (see *the Pan Docs*: https://gbdev.io/pandocs/Reducing\_Power\_Consumption.html#using-the-stop-instruction), which is why *rgbasm*(1) allows explicitly specifying the second byte (**STOP** *n8*) to override the default of \$00 (a **NOP** instruction).

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 (i.e. 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 r8 and the lower 4 ones.

Cycles: 2

Bytes: 2

```
Flags:
```

**Z** Set if result is 0.

 $\mathbf{N} = 0$ 

 $\mathbf{H} = 0$ 

 $\mathbf{C}$  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.

 $\mathbf{N} = 0$ 

 $\mathbf{H} = 0$ 

 $\mathbf{C}$  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), rgbgfx(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.