Crappy CPU machine code equivalence

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1 Registers

Available registers :

— `A` : multi-purpose register. Is not overwriten quietly.
— `B` : work register. Used in many operations as a buffer
— `U#` : user registers. Will **never** be overwritten unless *explicitely* mentionned (see the instructions for more detail). There are only 4 of those currently.
— `ret` : not directly accessible. Used with `CALL` and `RET`
— `cmp` : not directly accessible. Used with `CMP` and `JMPxxx`
— `disp` : used to display something in decimal. Write-only.
— `C` : single bit register

2 High level instructions

2.1 ABRT

Set error bit and halt

— `ABRT` (size : 1, duration : 3)

2.2 ADD

Add a value from a register/memory address/const to a register or a memory address and save it in register A

— `ADD A, U#` (size : 1, duration : 6)
— `ADD R, B` (size : 1, duration : 5)
— `ADD R, A` (size : 1, duration : 6)
— `ADD R, @0xHH` (size : 2, duration : 9)
— `ADD R, #0xHH` (size : 2, duration : 7)
— `ADD @0xHH, @0xHH` (size : 3, duration : 13)
— `ADD @0xHH, R` (size : 2, duration : 9)
— `ADD #0xHH, #0xHH` (size : 3, duration : 9)
— `ADD @0xHH, #0xHH` (size : 3, duration : 10)

2.3 AND

AND two registers, save the result to the first operand

— `AND R, B` (size : 1, duration : 5)

2.4 CALL

Jump to specified address and save current PC in Ret register. Useful for subroutines.

— `CALL #0xHH` (size : 2, duration : 8)

2.5 CLR

Clear a register address.

— `CLR A` (size : 1, duration : 6)
— `CLR U#` (size : 1, duration : 6)
— `CLR @0xHH` (size : 3, duration : 7)

2.6 CMP

Compare two values (substracts them) and store the result in CMP register. Overwrites B.

— `CMP R, @0xHH` (size : 2, duration : 12)
— `CMP A, B` (size : 1, duration : 8)
— `CMP A, U#` (size : 1, duration : 8)
— `CMP R, #0xHH` (size : 2, duration : 10)
— `CMP U#, A` (size : 1, duration : 8)
— `CMP R` (size : 1, duration : 4)
— `CMP @0xHH` (size : 2, duration : 7)

2.7 DISP

Display a value contained in specified register/memory address as an unsigned integer.

— `DISP R` (size : 1, duration : 4)
— `DISP @0xHH` (size : 2, duration : 7)

2.8 HALT

Halt the CPU
— `HALT` (size : 1, duration : 3)

2.9 INC

Increment register or value at memory address
— `INC R` (size : 1, duration : 5)
— `INC @0xHH` (size : 2, duration : 8)

2.10 JBIT

Go to specified address if selected bit of comparison register is 1.
— `JBIT %b, #0xHH` (size : 2, duration : 6)

2.11 JG

Go to specified address if comparison register is strictly positive.
— `JG #0xHH` (size : 2, duration : 6)

2.12 JGE

Go to specified address if comparison register is positive (or zero).
— `JGE #0xHH` (size : 2, duration : 6)

2.13 JL

Go to specified address if comparison register is strictly negative.
— `JL #0xHH` (size : 2, duration : 6)

2.14 JLE

Go to specified address if comparison register is negative or zero.
— `JLE #0xHH` (size : 2, duration : 6)

2.15 JMP

Go to specified address
— `JMP @0xHH` (size : 2, duration : 7)
— `JMP #0xHH` (size : 2, duration : 5)

2.16 JMPPTR

Go to address value at memory address.
— `JMPPTR @0xHH` (size : 2, duration : 7)

2.17 JNBIT

Go to specified address if selected bit of comparison register is 0.
— `JNBIT %b, #0xHH` (size : 2, duration : 6)

2.18 JNZ

Go to specified address if comparison register is NOT zero.
— `JNZ #0xHH` (size : 2, duration : 6)

2.19 JZ

Go to specified address if comparison register is zero.
— `JZ #0xHH` (size : 2, duration : 6)

2.20 LEDTGL

Toggle led. Useful for debugging.
— `LEDTGL` (size : 1, duration : 4)

2.21 MOV

Move a value from a register/memory address/const to a register or a memory address
— `MOV A, R` (size : 1, duration : 4)
— `MOV B, R` (size : 1, duration : 4)
— `MOV U#, A` (size : 1, duration : 4)
— `MOV U#, B` (size : 1, duration : 4)
— `MOV R, @0xHH` (size : 2, duration : 7)
— `MOV R, #0xHH` (size : 2, duration : 5)
— `MOV @0xHH, R` (size : 2, duration : 6)
— `MOV @0xHH, @0xHH` (size : 3, duration : 10)
— `MOV @0xHH, #0xHH` (size : 3, duration : 7)

2.22 NEG

Compute two's complement of register/memory (useful for substractions), and store result in itself.
— `NEG R` (size : 1, duration : 6)
— `NEG @0xHH` (size : 2, duration : 9)

2.23 NOP

Go to next address
— `NOP` (size : 1, duration : 3)

2.24 NOT

Invert bit by bit register, and store result in itself
— `NOT R` (size : 1, duration : 5)

2.25 OR

OR two registers, save the result to the first operand
— `OR A, B` (size : 1, duration : 5)
— `OR U#, B` (size : 1, duration : 5)

2.26 RET

Revert PC to value saved in Ret register. Use with `CALL`.
— `RET` (size : 1, duration : 6)

2.27 SHIFTL

Shift register to the left
— `SHIFTL R` (size : 1, duration : 5)

2.28 SHIFTR

Shift register to the right
— `SHIFTR R` (size : 1, duration : 5)

2.29 SLEEP

Pause clock for specified amount of ticks
— `SLEEP R` (size : 1, duration : 4)
— `SLEEP #0xHH` (size : 1, duration : 5)
— `SLEEP @0xHH` (size : 1, duration : 7)

2.30 SUB

Sub a value from a memory/register to register A and save it in register A. Overwrites B.
— `SUB R, @0xHH` (size : 2, duration : 12)
— `SUB A, R` (size : 1, duration : 9)

2.31 XOR

XOR two registers, save the result to the first operand
— `XOR A, B` (size : 1, duration : 5)
— `XOR A, A` (size : 1, duration : 6)
— `XOR U#, U#` (size : 1, duration : 6)

3 Instructions (low level)

3.1 default

3.1.1 default : `0x00`

Micro-instructions :

1. `outPC`, `loadRAM`
2. `outRAM`, `loadInstruction`, `incPC`

3.2 ADD

3.2.1 ADD__A__to__A : 0x01

Micro-instructions :

1. outA, loadB
2. enableAdd, loadALU, outA
3. outALU, loadA
4. clearMIcounter

3.2.2 ADD__A__to__U0 : 0x02

Micro-instructions :

1. outA, loadB
2. enableAdd, loadALU, outU0
3. outALU, loadU0
4. clearMIcounter

3.2.3 ADD__A__to__U1 : 0x03

Micro-instructions :

1. outA, loadB
2. enableAdd, loadALU, outU1
3. outALU, loadU1
4. clearMIcounter

3.2.4 ADD__A__to__U2 : 0x04

Micro-instructions :

1. outA, loadB
2. enableAdd, loadALU, outU2
3. outALU, loadU2
4. clearMIcounter

3.2.5 ADD__A__to__U3 : 0x05

Micro-instructions :

1. outA, loadB
2. enableAdd, loadALU, outU3
3. outALU, loadU3
4. clearMIcounter

3.2.6 ADD__A__to__mem : 0x06

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outA
6. outALU, storeRAM
7. clearMIcounter

3.2.7 ADD_B_to_A : 0x07

Micro-instructions :

1. enableAdd, loadALU, outA
2. outALU, loadA
3. clearMIcounter

3.2.8 ADD_B_to_U0 : 0x08

Micro-instructions :

1. enableAdd, loadALU, outU0
2. outALU, loadU0
3. clearMIcounter

3.2.9 ADD_B_to_U1 : 0x09

Micro-instructions :

1. enableAdd, loadALU, outU1
2. outALU, loadU1
3. clearMIcounter

3.2.10 ADD_B_to_U2 : 0x0a

Micro-instructions :

1. enableAdd, loadALU, outU2
2. outALU, loadU2
3. clearMIcounter

3.2.11 ADD_B_to_U3 : 0x0b

Micro-instructions :

1. enableAdd, loadALU, outU3
2. outALU, loadU3
3. clearMIcounter

3.2.12 ADD_U0_to_A : 0x0c

Micro-instructions :

1. outU0, loadB
2. enableAdd, loadALU, outA
3. outALU, loadA
4. clearMIcounter

3.2.13 ADD_U0_to_mem : 0x0d

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU0
6. outALU, storeRAM
7. clearMIcounter

3.2.14 ADD_U1_to_A : 0x0e

Micro-instructions :

1. outU1, loadB
2. enableAdd, loadALU, outA
3. outALU, loadA
4. clearMIcounter

3.2.15 ADD_U1_to_mem : 0x0f

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU1
6. outALU, storeRAM
7. clearMIcounter

3.2.16 ADD_U2_to_A : 0x10

Micro-instructions :

1. outU2, loadB
2. enableAdd, loadALU, outA
3. outALU, loadA
4. clearMIcounter

3.2.17 ADD_U2_to_mem : 0x11

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU2
6. outALU, storeRAM
7. clearMIcounter

3.2.18 ADD_U3_to_A : 0x12

Micro-instructions :

1. outU3, loadB
2. enableAdd, loadALU, outA
3. outALU, loadA
4. clearMIcounter

3.2.19 ADD_U3_to_mem : 0x13

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU3
6. outALU, storeRAM
7. clearMIcounter

3.2.20 ADD_const_to_A : 0x14

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. enableAdd, loadALU, outA
4. outALU, loadA
5. clearMIcounter

3.2.21 ADD_const_to_U0 : 0x15

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. enableAdd, loadALU, outU0
4. outALU, loadU0
5. clearMIcounter

3.2.22 ADD_const_to_U1 : 0x16

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. enableAdd, loadALU, outU1
4. outALU, loadU1
5. clearMIcounter

3.2.23 ADD_const_to_U2 : 0x17

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. enableAdd, loadALU, outU2
4. outALU, loadU2
5. clearMIcounter

3.2.24 ADD_const_to_U3 : 0x18

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. enableAdd, loadALU, outU3
4. outALU, loadU3
5. clearMIcounter

3.2.25 ADD_const_to_const_in_A : 0x19

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadA, incPC
3. outPC, loadRAM
4. outRAM, loadB, incPC
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.2.26 ADD_const_to_mem : 0x1a

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. outPC, loadRAM
6. enableAdd, loadALU, outRAM, incPC
7. outALU, storeRAM
8. clearMIcounter

3.2.27 ADD_mem_to_A : 0x1b

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.2.28 ADD_mem_to_U0 : 0x1c

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU0
6. outALU, loadU0
7. clearMIcounter

3.2.29 ADD_mem_to_U1 : 0x1d

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU1
6. outALU, loadU1
7. clearMIcounter

3.2.30 ADD_mem_to_U2 : 0x1e

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU2
6. outALU, loadU2
7. clearMIcounter

3.2.31 ADD_mem_to_U3 : 0x1f

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadB
5. enableAdd, loadALU, outU3
6. outALU, loadU3
7. clearMIcounter

3.2.32 ADD_mem_to_mem : 0x20

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr
3. outMemAddr, loadRAM
4. outRAM, loadA, incPC
5. outPC, loadRAM
6. outRAM, loadMemAddr
7. outMemAddr, loadRAM
8. outRAM, loadB, incPC
9. loadALU, enableAdd, outA
10. outALU, storeRAM
11. clearMIcounter

3.3 AND

3.3.1 AND_A_B_to_itself : 0x21

Micro-instructions :

1. enableAND, loadALU, outA
2. outALU, loadA
3. clearMIcounter

3.3.2 AND_U0_B_to_itself : 0x22

Micro-instructions :

1. enableAND, loadALU, outU0
2. outALU, loadU0
3. clearMIcounter

3.3.3 AND_U1_B_to_itself : 0x23

Micro-instructions :

1. enableAND, loadALU, outU1
2. outALU, loadU1
3. clearMIcounter

3.3.4 AND_U2_B_to_itself : 0x24

Micro-instructions :

1. enableAND, loadALU, outU2
2. outALU, loadU2
3. clearMIcounter

3.3.5 AND_U3_B_to_itself : 0x25

Micro-instructions :

1. enableAND, loadALU, outU3
2. outALU, loadU3
3. clearMIcounter

3.4 CALL

3.4.1 CALL_addr : 0x26

Micro-instructions :

1. outRetAddr, loadMemAddr
2. outPCp1, storeRAM, incRet
3. outPC, loadRAM
4. outRAM, loadMemAddr
5. loadPC, cond_always, outMemAddr
6. clearMIcounter

3.5 CMP

3.5.1 CMP_A_B : 0x27

Micro-instructions :

1. outB, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadCmp
6. clearMIcounter

3.5.2 CMP_A_U0 : 0x28

Micro-instructions :

1. outU0, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadCmp
6. clearMIcounter

3.5.3 CMP__A__U1 : 0x29

Micro-instructions :

1. outU1, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadCmp
6. clearMIcounter

3.5.4 CMP__A__U2 : 0x2a

Micro-instructions :

1. outU2, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadCmp
6. clearMIcounter

3.5.5 CMP__A__U3 : 0x2b

Micro-instructions :

1. outU3, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadCmp
6. clearMIcounter

3.5.6 CMP__A__const : 0x2c

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. outB, enableNOT, loadALU
4. outALU, enableInc, loadALU
5. outALU, loadB
6. enableAdd, loadALU, outA
7. outALU, loadCmp
8. clearMIcounter

3.5.7 CMP__A__mem : 0x2d

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outA
9. outALU, loadCmp
10. clearMIcounter

3.5.8 CMP_U0_A : 0x2e

Micro-instructions :

1. outA, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outU0
5. outALU, loadCmp
6. clearMIcounter

3.5.9 CMP_U0_const : 0x2f

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. outB, enableNOT, loadALU
4. outALU, enableInc, loadALU
5. outALU, loadB
6. enableAdd, loadALU, outU0
7. outALU, loadCmp
8. clearMIcounter

3.5.10 CMP_U0_mem : 0x30

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outU0
9. outALU, loadCmp
10. clearMIcounter

3.5.11 CMP_U1_A : 0x31

Micro-instructions :

1. outA, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outU1
5. outALU, loadCmp
6. clearMIcounter

3.5.12 CMP_U1_const : 0x32

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. outB, enableNOT, loadALU
4. outALU, enableInc, loadALU
5. outALU, loadB
6. enableAdd, loadALU, outU1
7. outALU, loadCmp
8. clearMIcounter

3.5.13 CMP_U1_mem : 0x33

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outU1
9. outALU, loadCmp
10. clearMIcounter

3.5.14 CMP_U2_A : 0x34

Micro-instructions :

1. outA, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outU2
5. outALU, loadCmp
6. clearMIcounter

3.5.15 CMP_U2_const : 0x35

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. outB, enableNOT, loadALU
4. outALU, enableInc, loadALU
5. outALU, loadB
6. enableAdd, loadALU, outU2
7. outALU, loadCmp
8. clearMIcounter

3.5.16 CMP_U2_mem : 0x36

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outU2
9. outALU, loadCmp
10. clearMIcounter

3.5.17 CMP_U3_A : 0x37

Micro-instructions :

1. outA, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outU3
5. outALU, loadCmp
6. clearMIcounter

3.5.18 CMP_U3_const : 0x38

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. outB, enableNOT, loadALU
4. outALU, enableInc, loadALU
5. outALU, loadB
6. enableAdd, loadALU, outU3
7. outALU, loadCmp
8. clearMIcounter

3.5.19 CMP_U3_mem : 0x39

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outU3
9. outALU, loadCmp
10. clearMIcounter

3.6 COPY

3.6.1 COPY_A_to_A : 0x3a

Micro-instructions :

1. outA, loadA
2. clearMIcounter

3.6.2 COPY_A_to_B : 0x3b

Micro-instructions :

1. outA, loadB
2. clearMIcounter

3.6.3 COPY_A_to_U0 : 0x3c

Micro-instructions :

1. outA, loadU0
2. clearMIcounter

3.6.4 COPY_A_to_U1 : 0x3d

Micro-instructions :

1. outA, loadU1
2. clearMIcounter

3.6.5 COPY_A_to_U2 : 0x3e

Micro-instructions :

1. `outA`, `loadU2`
2. `clearMIcounter`

3.6.6 COPY_A_to_U3 : 0x3f

Micro-instructions :

1. `outA`, `loadU3`
2. `clearMIcounter`

3.6.7 COPY_A_to_cmp : 0x40

Micro-instructions :

1. `outA`, `loadCmp`
2. `clearMIcounter`

3.6.8 COPY_B_to_A : 0x41

Micro-instructions :

1. `outB`, `loadA`
2. `clearMIcounter`

3.6.9 COPY_B_to_B : 0x42

Micro-instructions :

1. `outB`, `loadB`
2. `clearMIcounter`

3.6.10 COPY_B_to_U0 : 0x43

Micro-instructions :

1. `outB`, `loadU0`
2. `clearMIcounter`

3.6.11 COPY_B_to_U1 : 0x44

Micro-instructions :

1. `outB`, `loadU1`
2. `clearMIcounter`

3.6.12 COPY_B_to_U2 : 0x45

Micro-instructions :

1. `outB`, `loadU2`
2. `clearMIcounter`

3.6.13 COPY_B_to_U3 : 0x46

Micro-instructions :

1. outB, loadU3
2. clearMIcounter

3.6.14 COPY_B_to_cmp : 0x47

Micro-instructions :

1. outB, loadCmp
2. clearMIcounter

3.6.15 COPY_U0_to_A : 0x48

Micro-instructions :

1. outU0, loadA
2. clearMIcounter

3.6.16 COPY_U0_to_B : 0x49

Micro-instructions :

1. outU0, loadB
2. clearMIcounter

3.6.17 COPY_U0_to_cmp : 0x4a

Micro-instructions :

1. outU0, loadCmp
2. clearMIcounter

3.6.18 COPY_U1_to_A : 0x4b

Micro-instructions :

1. outU1, loadA
2. clearMIcounter

3.6.19 COPY_U1_to_B : 0x4c

Micro-instructions :

1. outU1, loadB
2. clearMIcounter

3.6.20 COPY_U1_to_cmp : 0x4d

Micro-instructions :

1. outU1, loadCmp
2. clearMIcounter

3.6.21 COPY_U2_to_A : 0x4e

Micro-instructions :

1. outU2, loadA
2. clearMIcounter

3.6.22 COPY_U2_to_B : 0x4f

Micro-instructions :

1. outU2, loadB
2. clearMIcounter

3.6.23 COPY_U2_to_cmp : 0x50

Micro-instructions :

1. outU2, loadCmp
2. clearMIcounter

3.6.24 COPY_U3_to_A : 0x51

Micro-instructions :

1. outU3, loadA
2. clearMIcounter

3.6.25 COPY_U3_to_B : 0x52

Micro-instructions :

1. outU3, loadB
2. clearMIcounter

3.6.26 COPY_U3_to_cmp : 0x53

Micro-instructions :

1. outU3, loadCmp
2. clearMIcounter

3.6.27 COPY_mem : 0x54

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outPC, loadRAM
6. outRAM, loadMemAddr, incPC
7. storeRAM, outB
8. clearMIcounter

3.6.28 COPY_mem_to_cmp : 0x55

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadCmp
5. clearMIcounter

3.7 DISPLAY

3.7.1 DISPLAY_A : 0x56

Micro-instructions :

1. outA, loadDisplay
2. clearMIcounter

3.7.2 DISPLAY_B : 0x57

Micro-instructions :

1. outB, loadDisplay
2. clearMIcounter

3.7.3 DISPLAY_U0 : 0x58

Micro-instructions :

1. outU0, loadDisplay
2. clearMIcounter

3.7.4 DISPLAY_U1 : 0x59

Micro-instructions :

1. outU1, loadDisplay
2. clearMIcounter

3.7.5 DISPLAY_U2 : 0x5a

Micro-instructions :

1. outU2, loadDisplay
2. clearMIcounter

3.7.6 DISPLAY_U3 : 0x5b

Micro-instructions :

1. outU3, loadDisplay
2. clearMIcounter

3.7.7 DISPLAY_mem : 0x5c

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadDisplay
5. clearMIcounter

3.8 FAIL

3.8.1 FAIL : 0x5d

Micro-instructions :

1. error, halt

3.9 HALT

3.9.1 HALT : 0x5e

Micro-instructions :

1. halt

3.10 INC

3.10.1 INC_A : 0x5f

Micro-instructions :

1. outA, enableInc, loadALU
2. outALU, loadA
3. clearMIcounter

3.10.2 INC_B : 0x60

Micro-instructions :

1. outB, enableInc, loadALU
2. outALU, loadB
3. clearMIcounter

3.10.3 INC_U0 : 0x61

Micro-instructions :

1. outU0, enableInc, loadALU
2. outALU, loadU0
3. clearMIcounter

3.10.4 INC_U1 : 0x62

Micro-instructions :

1. outU1, enableInc, loadALU
2. outALU, loadU1
3. clearMIcounter

3.10.5 INC_U2 : 0x63

Micro-instructions :

1. outU2, enableInc, loadALU
2. outALU, loadU2
3. clearMIcounter

3.10.6 INC_U3 : 0x64

Micro-instructions :

1. outU3, enableInc, loadALU
2. outALU, loadU3
3. clearMIcounter

3.10.7 INC_mem : 0x65

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, enableInc, loadALU
5. outALU, storeRAM
6. clearMIcounter

3.11 JMP

3.11.1 JMP_const : 0x66

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadPC, cond_always
3. clearMIcounter

3.11.2 JMP_if_eq : 0x67

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_null
4. clearMIcounter

3.11.3 JMP_if_ge : 0x68

Micro-instructions :

1. outPC, loadRAM — cond_null
2. incPC
3. outRAM, loadPC, cond_pos — 4. clearMIcounter

3.11.4 JMP_if_gt : 0x69

Micro-instructions :

1. outPC, loadRAM — cond_not_null
2. incPC
3. outRAM, loadPC, cond_pos — 4. clearMIcounter

3.11.5 JMP_if_le : 0x6a

Micro-instructions :

1. outPC, loadRAM — cond_null
2. incPC
3. outRAM, loadPC, cond_neg — 4. clearMIcounter

3.11.6 JMP_if_lt : 0x6b

Micro-instructions :

1. outPC, loadRAM — cond_not_null
2. incPC
3. outRAM, loadPC, cond_neg — 4. clearMIcounter

3.11.7 JMP_if_neq : 0x6c

Micro-instructions :

1. outPC, loadRAM — invert_cond
2. incPC
3. outRAM, loadPC, cond_null — 4. clearMIcounter

3.11.8 JMP_not_sel_bit_0 : 0x6d

Micro-instructions :

1. outPC, loadRAM — invert_cond
2. incPC
3. outRAM, loadPC, cond_selected_bit — 4. clearMIcounter

3.11.9 JMP_not_sel_bit_1 : 0x6e

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector0

3.11.10 JMP_not_sel_bit_2 : 0x6f

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector1

3.11.11 JMP_not_sel_bit_3 : 0x70

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector0, selector1

3.11.12 JMP_not_sel_bit_4 : 0x71

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector2

3.11.13 JMP_not_sel_bit_5 : 0x72

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector0, selector2

3.11.14 JMP_not_sel_bit_6 : 0x73

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit,
4. clearMIcounter

invert_cond, selector1, selector2

3.11.15 JMP_not_sel_bit_7 : 0x74

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit, invert_cond, selector0, selector1, selector2
4. clearMIcounter

3.11.16 JMP_ptr : 0x75

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr
3. outMemAddr, loadRAM
4. outRAM, loadPC, cond_always
5. clearMIcounter

3.11.17 JMP_sel_bit_0 : 0x76

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit
4. clearMIcounter

3.11.18 JMP_sel_bit_1 : 0x77

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit, selector0
4. clearMIcounter

3.11.19 JMP_sel_bit_2 : 0x78

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit, selector1
4. clearMIcounter

3.11.20 JMP_sel_bit_3 : 0x79

Micro-instructions :

1. outPC, loadRAM
2. incPC
3. outRAM, loadPC, cond_selected_bit, selector0, selector1
4. clearMIcounter

3.11.21 JMP_sel_bit_4 : 0x7a

Micro-instructions :

1. outPC, loadRAM — selector2
2. incPC
3. outRAM, loadPC, cond_selected_bit, — 4. clearMIcounter

3.11.22 JMP_sel_bit_5 : 0x7b

Micro-instructions :

1. outPC, loadRAM — selector0, selector2
2. incPC
3. outRAM, loadPC, cond_selected_bit, — 4. clearMIcounter

3.11.23 JMP_sel_bit_6 : 0x7c

Micro-instructions :

1. outPC, loadRAM — selector1, selector2
2. incPC
3. outRAM, loadPC, cond_selected_bit, — 4. clearMIcounter

3.11.24 JMP_sel_bit_7 : 0x7d

Micro-instructions :

1. outPC, loadRAM — selector0, selector1, selector2
2. incPC
3. outRAM, loadPC, cond_selected_bit, — 4. clearMIcounter

3.12 LED

3.12.1 LED_tgl : 0x7e

Micro-instructions :

1. flipLed — 2. clearMIcounter

3.13 LOAD

3.13.1 LOAD_const_to_A : 0x7f

Micro-instructions :

1. outPC, loadRAM — 3. clearMIcounter
2. outRAM, loadA, incPC

3.13.2 LOAD_const_to_B : 0x80

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadB, incPC
3. clearMIcounter

3.13.3 LOAD_const_to_U0 : 0x81

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadU0, incPC
3. clearMIcounter

3.13.4 LOAD_const_to_U1 : 0x82

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadU1, incPC
3. clearMIcounter

3.13.5 LOAD_const_to_U2 : 0x83

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadU2, incPC
3. clearMIcounter

3.13.6 LOAD_const_to_U3 : 0x84

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadU3, incPC
3. clearMIcounter

3.13.7 LOAD_ptr_to_A : 0x85

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadA
5. clearMIcounter

3.13.8 LOAD_ptr_to_B : 0x86

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. clearMIcounter

3.13.9 LOAD_ptr_to_U0 : 0x87

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadU0
5. clearMIcounter

3.13.10 LOAD_ptr_to_U1 : 0x88

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadU1
5. clearMIcounter

3.13.11 LOAD_ptr_to_U2 : 0x89

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadU2
5. clearMIcounter

3.13.12 LOAD_ptr_to_U3 : 0x8a

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadU3
5. clearMIcounter

3.14 NEG

3.14.1 NEG_A : 0x8b

Micro-instructions :

1. outA, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadA
4. clearMIcounter

3.14.2 NEG_B : 0x8c

Micro-instructions :

1. outB, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. clearMIcounter

3.14.3 NEG_U0 : 0x8d

Micro-instructions :

1. outU0, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadU0
4. clearMIcounter

3.14.4 NEG_U1 : 0x8e

Micro-instructions :

1. outU1, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadU1
4. clearMIcounter

3.14.5 NEG_U2 : 0x8f

Micro-instructions :

1. outU2, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadU2
4. clearMIcounter

3.14.6 NEG_U3 : 0x90

Micro-instructions :

1. outU3, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadU3
4. clearMIcounter

3.14.7 NEG_mem : 0x91

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr
3. outMemAddr, loadRAM, incPC
4. outRAM, enableNOT, loadALU
5. outALU, enableInc, loadALU
6. outALU, storeRAM
7. clearMIcounter

3.15 NOP

3.15.1 NOP : 0x92

Micro-instructions :

1. clearMIcounter

3.16 NOT

3.16.1 NOT_A : 0x93

Micro-instructions :

1. enableNOT, loadALU, outA
2. outALU, loadA
3. clearMIcounter

3.16.2 NOT_B : 0x94

Micro-instructions :

1. enableNOT, loadALU, outB
2. outALU, loadB
3. clearMIcounter

3.16.3 NOT_U0 : 0x95

Micro-instructions :

1. enableNOT, loadALU, outU0
2. outALU, loadU0
3. clearMIcounter

3.16.4 NOT_U1 : 0x96

Micro-instructions :

1. enableNOT, loadALU, outU1
2. outALU, loadU1
3. clearMIcounter

3.16.5 NOT_U2 : 0x97

Micro-instructions :

1. enableNOT, loadALU, outU2
2. outALU, loadU2
3. clearMIcounter

3.16.6 NOT_U3 : 0x98

Micro-instructions :

1. enableNOT, loadALU, outU3
2. outALU, loadU3
3. clearMIcounter

3.17 OR

3.17.1 OR_A_B_to_itself : 0x99

Micro-instructions :

1. enableOR, loadALU, outA
2. outALU, loadA
3. clearMIcounter

3.17.2 OR_U0_B_to_itself : 0x9a

Micro-instructions :

1. enableOR, loadALU, outU0
2. outALU, loadU0
3. clearMIcounter

3.17.3 OR_U1_B_to_itself : 0x9b

Micro-instructions :

1. enableOR, loadALU, outU1
2. outALU, loadU1
3. clearMIcounter

3.17.4 OR_U2_B_to_itself : 0x9c

Micro-instructions :

1. enableOR, loadALU, outU2
2. outALU, loadU2
3. clearMIcounter

3.17.5 OR_U3_B_to_itself : 0x9d

Micro-instructions :

1. enableOR, loadALU, outU3
2. outALU, loadU3
3. clearMIcounter

3.18 RET

3.18.1 RET : 0x9e

Micro-instructions :

1. decRet
2. outRetAddr, loadRAM
3. outRAM, loadPC, cond_always
4. clearMIcounter

3.19 SHIFTL

3.19.1 SHIFTL_A : 0x9f

Micro-instructions :

1. outA, enableSHIFTL, loadALU
2. outALU, loadA
3. clearMIcounter

3.19.2 SHIFTL_B : 0xa0

Micro-instructions :

1. outB, enableSHIFTL, loadALU
2. outALU, loadB
3. clearMIcounter

3.19.3 SHIFTL_U0 : 0xa1

Micro-instructions :

1. outU0, enableSHIFTL, loadALU
2. outALU, loadU0
3. clearMIcounter

3.19.4 SHIFTL_U1 : 0xa2

Micro-instructions :

1. outU1, enableSHIFTL, loadALU
2. outALU, loadU1
3. clearMIcounter

3.19.5 SHIFTL_U2 : 0xa3

Micro-instructions :

1. outU2, enableSHIFTL, loadALU
2. outALU, loadU2
3. clearMIcounter

3.19.6 SHIFTL_U3 : 0xa4

Micro-instructions :

1. outU3, enableSHIFTL, loadALU
2. outALU, loadU3
3. clearMIcounter

3.20 SHIFTR

3.20.1 SHIFTR_A : 0xa5

Micro-instructions :

1. outA, enableSHIFTR, loadALU
2. outALU, loadA
3. clearMIcounter

3.20.2 SHIFTR_B : 0xa6

Micro-instructions :

1. outB, enableSHIFTR, loadALU
2. outALU, loadB
3. clearMIcounter

3.20.3 SHIFTR_U0 : 0xa7

Micro-instructions :

1. outU0, enableSHIFTR, loadALU
2. outALU, loadU0
3. clearMIcounter

3.20.4 SHIFTR_U1 : 0xa8

Micro-instructions :

1. outU1, enableSHIFTR, loadALU
2. outALU, loadU1
3. clearMIcounter

3.20.5 SHIFTR_U2 : 0xa9

Micro-instructions :

1. outU2, enableSHIFTR, loadALU
2. outALU, loadU2
3. clearMIcounter

3.20.6 SHIFTR_U3 : 0xaa

Micro-instructions :

1. outU3, enableSHIFTR, loadALU
2. outALU, loadU3
3. clearMIcounter

3.21 SLEEP

3.21.1 SLEEP_A : 0xab

Micro-instructions :

1. outA, loadSleep, incPC
2. clearMIcounter

3.21.2 SLEEP_B : 0xac

Micro-instructions :

1. outB, loadSleep, incPC
2. clearMIcounter

3.21.3 SLEEP_U0 : 0xad

Micro-instructions :

1. outU0, loadSleep, incPC
2. clearMIcounter

3.21.4 SLEEP_U1 : 0xae

Micro-instructions :

1. outU1, loadSleep, incPC
2. clearMIcounter

3.21.5 SLEEP_U2 : 0xaf

Micro-instructions :

1. outU2, loadSleep, incPC
2. clearMIcounter

3.21.6 SLEEP_U3 : 0xb0

Micro-instructions :

1. outU3, loadSleep, incPC
2. clearMIcounter

3.21.7 SLEEP_const : 0xb1

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadSleep, incPC
3. clearMIcounter

3.21.8 SLEEP_mem : 0xb2

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. loadRAM, outMemAddr
4. outRAM, loadSleep
5. clearMIcounter

3.22 STORE

3.22.1 STORE_A_to_address : 0xb3

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outA
4. clearMIcounter

3.22.2 STORE_B_to_address : 0xb4

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outB
4. clearMIcounter

3.22.3 STORE_PCp1_to_address : 0xb5

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outPCp1
4. clearMIcounter

3.22.4 STORE_U0_to_address : 0xb6

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outU0
4. clearMIcounter

3.22.5 STORE_U1_to_address : 0xb7

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outU1
4. clearMIcounter

3.22.6 STORE_U2_to_address : 0xb8

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outU2
4. clearMIcounter

3.22.7 STORE_U3_to_address : 0xb9

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. storeRAM, outU3
4. clearMIcounter

3.22.8 STORE_const_to_address : 0xba

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outPC, loadRAM
4. storeRAM, outRAM, incPC
5. clearMIcounter

3.23 SUB

3.23.1 SUB_A_to_A : 0xbb

Micro-instructions :

1. outA, loadB
2. outB, enableNOT, loadALU
3. outALU, enableInc, loadALU
4. outALU, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.23.2 SUB_B_to_A : 0xbc

Micro-instructions :

1. outB, enableNOT, loadALU
2. outALU, enableInc, loadALU
3. outALU, loadB
4. enableAdd, loadALU, outA
5. outALU, loadA
6. clearMIcounter

3.23.3 SUB_U0_to_A : 0xbd

Micro-instructions :

1. outU0, loadB
2. outB, enableNOT, loadALU
3. outALU, enableInc, loadALU
4. outALU, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.23.4 SUB_U1_to_A : 0xbe

Micro-instructions :

1. outU1, loadB
2. outB, enableNOT, loadALU
3. outALU, enableInc, loadALU
4. outALU, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.23.5 SUB_U2_to_A : 0xbf

Micro-instructions :

1. outU2, loadB
2. outB, enableNOT, loadALU
3. outALU, enableInc, loadALU
4. outALU, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.23.6 SUB_U3_to_A : 0xc0

Micro-instructions :

1. outU3, loadB
2. outB, enableNOT, loadALU
3. outALU, enableInc, loadALU
4. outALU, loadB
5. enableAdd, loadALU, outA
6. outALU, loadA
7. clearMIcounter

3.23.7 SUB_mem_to_A : 0xc1

Micro-instructions :

1. outPC, loadRAM
2. outRAM, loadMemAddr, incPC
3. outMemAddr, loadRAM
4. outRAM, loadB
5. outB, enableNOT, loadALU
6. outALU, enableInc, loadALU
7. outALU, loadB
8. enableAdd, loadALU, outA
9. outALU, loadA
10. clearMIcounter