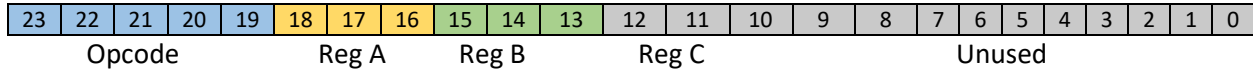


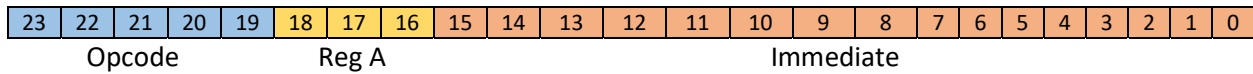
# Instruction set architecture (RISC)

## Instruction formats

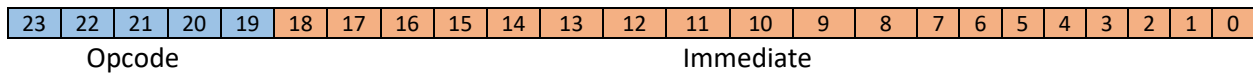
### 1. RRR type



### 2. RI type



### 3. I type



## Architecture

Data Memory (RAM) – 8M x 16 bits

Instruction Memory (ROM) – 4K x 24 bits

MAR – 24-bit Register

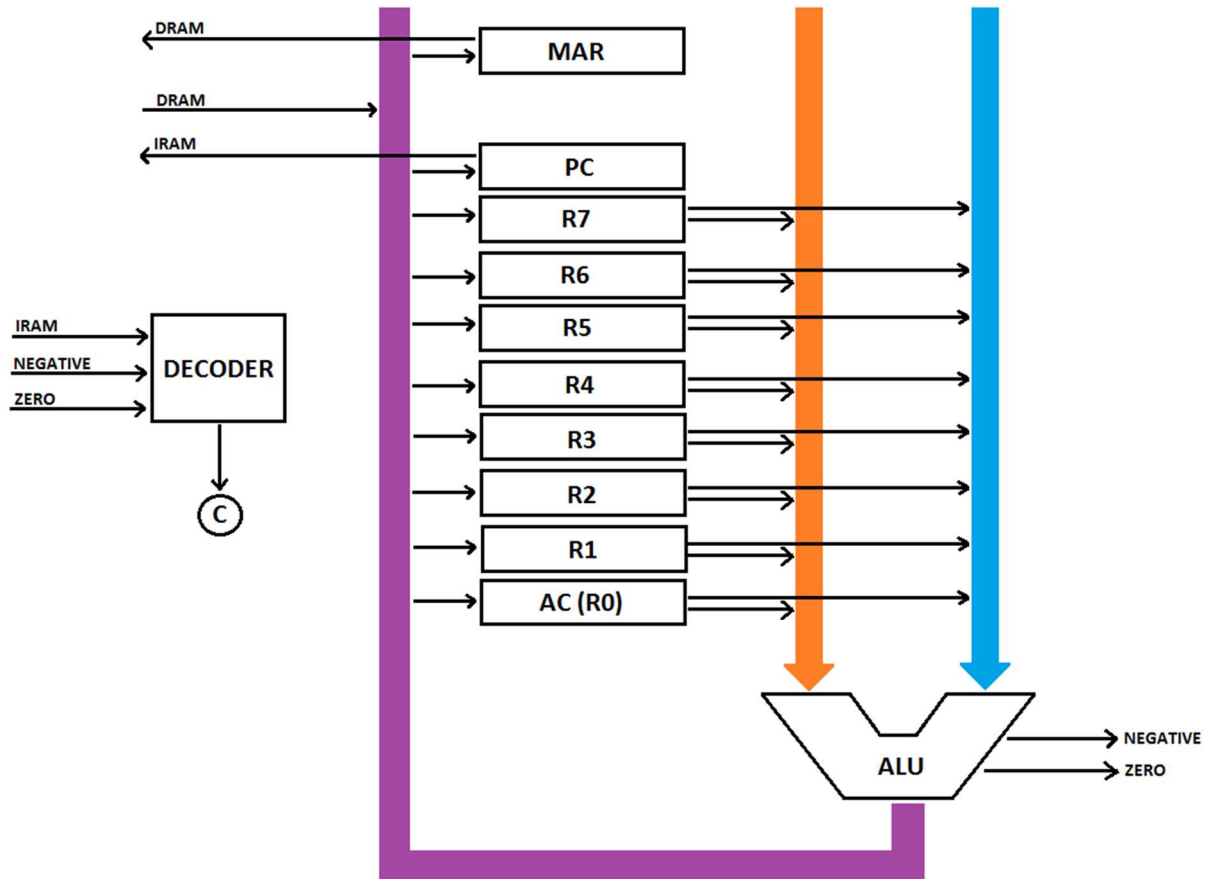
PC – 24-bit Register

Accumulator (AC, R0) – 24-bit Register

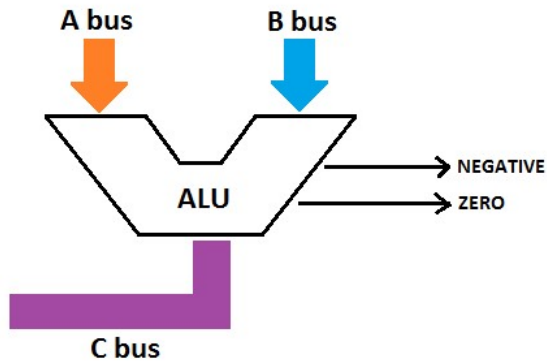
R1 – R7 General Purpose Registers – 24-bit

Instruction	Opcode	operation
NOP	00000	No operation
LOAD	00001	Reg A $\leftarrow$ RAM[MAR]
STORE	00010	RAM[MAR] $\leftarrow$ Reg B
MOVE	00011	Reg A $\leftarrow$ Reg B
LDPC	00100	PC $\leftarrow$ Reg A
LDMAR	00101	MAR $\leftarrow$ Reg A
LOADI	00110	Reg A $\leftarrow$ signed immediate (16-bit)
LDACI	00111	AC $\leftarrow$ signed immediate (19-bit)
ADD	01000	Reg A $\leftarrow$ Reg B + Reg C
SUB	01001	Reg A $\leftarrow$ Reg B - Reg C
MUL	01010	Reg A $\leftarrow$ Reg B $\ll$ Reg C
DIV	01011	Reg A $\leftarrow$ Reg B $\gg$ Reg C
INC	01100	Reg A $\leftarrow$ Reg A + 1
DEC	01101	Reg A $\leftarrow$ Reg A - 1
NEG	01110	Reg A $\leftarrow$ -Reg B
NOT	01111	Reg A $\leftarrow$ Reg B (NOT) Reg C
AND	10000	Reg A $\leftarrow$ Reg B (AND) Reg C
OR	10001	Reg A $\leftarrow$ Reg B (OR) Reg C
XOR	10010	Reg A $\leftarrow$ Reg B (XOR) Reg C
JGT	10011	If ALU out > 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JEQ	10100	If ALU out = 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JGE	10101	If ALU out $\geq$ 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JLT	10110	If ALU out < 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JNE	10111	If ALU out $\neq$ 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JLE	11000	If ALU out $\leq$ 0 then PC $\leftarrow$ Reg A else PC $\leftarrow$ PC + 1
JMP	11001	PC $\leftarrow$ Reg A (Unconditional Jump)

## Data path



## Arithmetic and Logic Unit (ALU)



Opcode	ALU control bits	Operation
-	0000	No Operation
01000	0001	ADD (A + B)
01001	0010	SUB (A - B)
01010	0011	MUL (A << B)
01011	0100	DIV (A >> B)
01100	0101	INC (A + 1)
01101	0110	DEC (A - 1)
01110	0111	NEG (-A)
01111	1000	NOT (!A)
10000	1001	AND (A & B)
10001	1010	OR (A   B)
10010	1011	XOR (A ^ B)

If ALU output = 0, then Z = 1 else Z = 0

If ALU output < 0, the N = 1 else N = 0

## Jump Logic

Opcode	Operation	Z flag	N flag	Jump
JGT	If ALU out > 0	0	0	PC ← Reg A
JEQ	If ALU out = 0	1	x	PC ← Reg A
JGE	If ALU out >= 0	x	0	PC ← Reg A
JLT	If ALU out < 0	0	1	PC ← Reg A
JNE	If ALU out != 0	0	x	PC ← Reg A
JLE	If ALU out <= 0	1/0	1	PC ← Reg A
JMP	Unconditional Jump	x	x	PC ← Reg A

## Control bits

Depending on the opcode and ALU flags the decoder will generate the control bits

