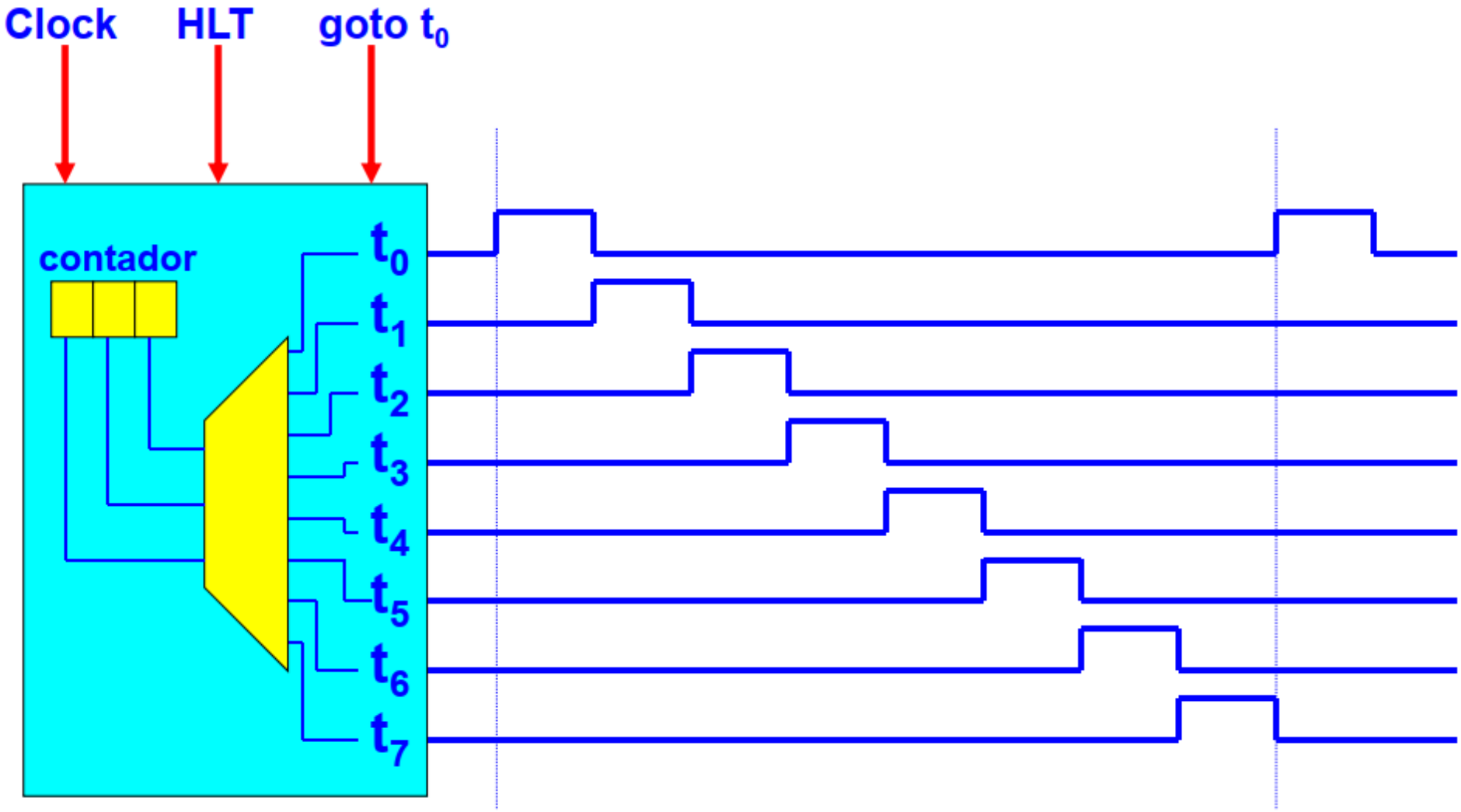
Organização e Arquitetura de Computadores

Arquitetura Neander

Funções Passo a Passo

Lúcio Renê Prade
Rodrigo Marques de Figueiredo

Neander: Temporização dos Sinais de Controle



Neander: Expressões Booleana dos Sinais de Controle

carga REM = t0 + t3.(STA+LDA+ADD+OR+AND+JMP+JN.N+JZ.Z + t5.(STA+LDA+ADD+OR+AND)

incrementa PC = t1 + t4.(STA+LDA+ADD+OR+AND) + t3.(JN.N' + JZ.Z')

carga RI = t2

sel = t5.(STA+LDA+ADD+OR+AND)

carga RDM = t6.STA

Read = t1 + t4.(STA+LDA+ADD+OR+AND+JMP+JN.N+JZ.Z) + t6.(LDA+ADD+OR+AND)

Write = t7.STA

UAL(Y) = t7.LDA

UAL(ADD) = t7.ADD

UAL(OR) = t7.OR

UAL(AND) = t7.AND

UAL(NOT) = t3.NOT

carga AC = t7.(LDA+ADD+OR+AND) + t3.NOT

carga NZ = t7.(LDA+ADD+OR+AND) + t3.NOT = carga AC

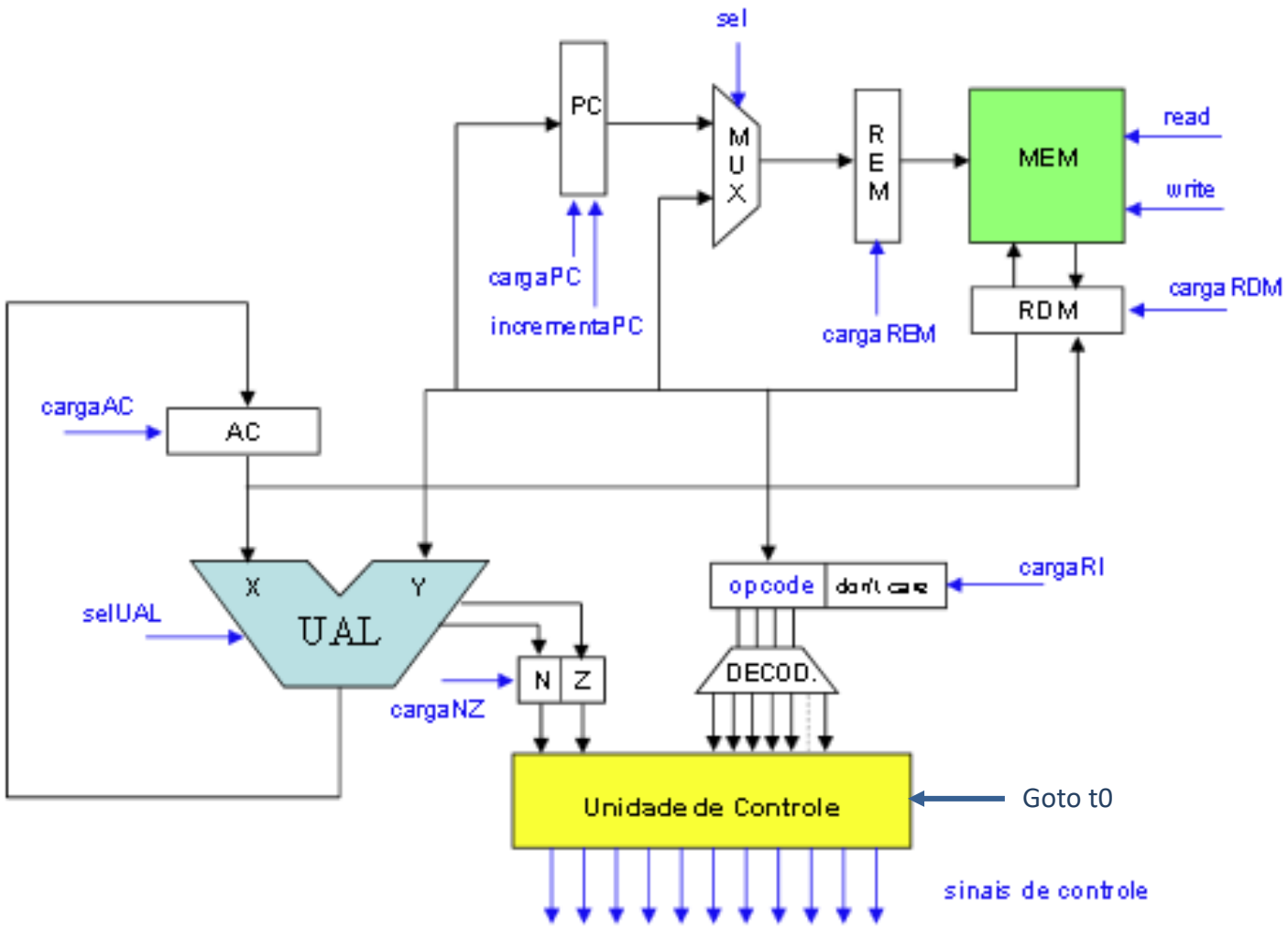
carga PC = t5.(JMP+JN.N+JZ.Z)

goto t0 = t7.(STA+LDA+ADD+OR+AND) + t3.(NOP+NOT+JN.N'+JZ.Z') + t5.(JMP+JN.N+JZ.Z)

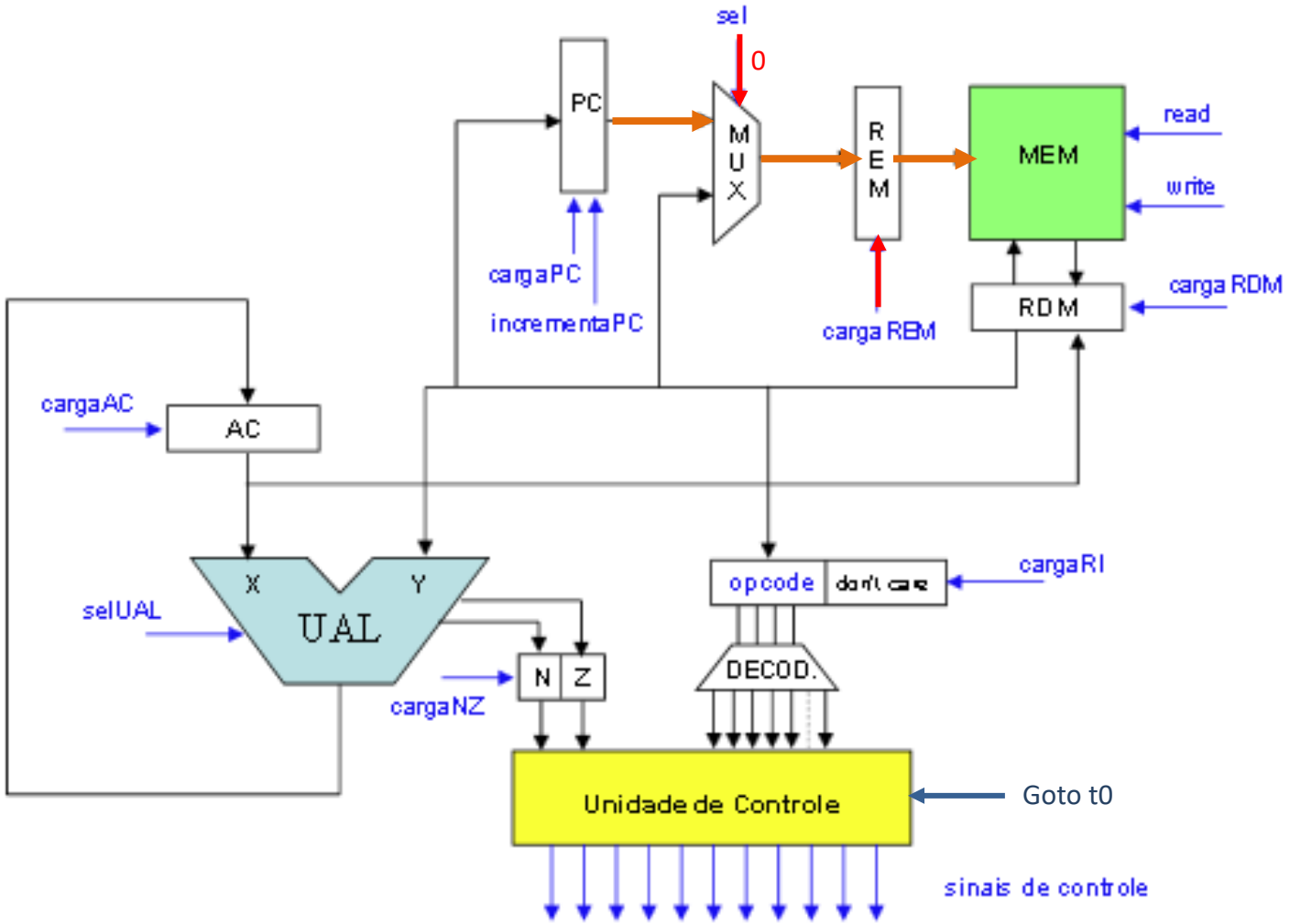
Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

Função STA



Função STA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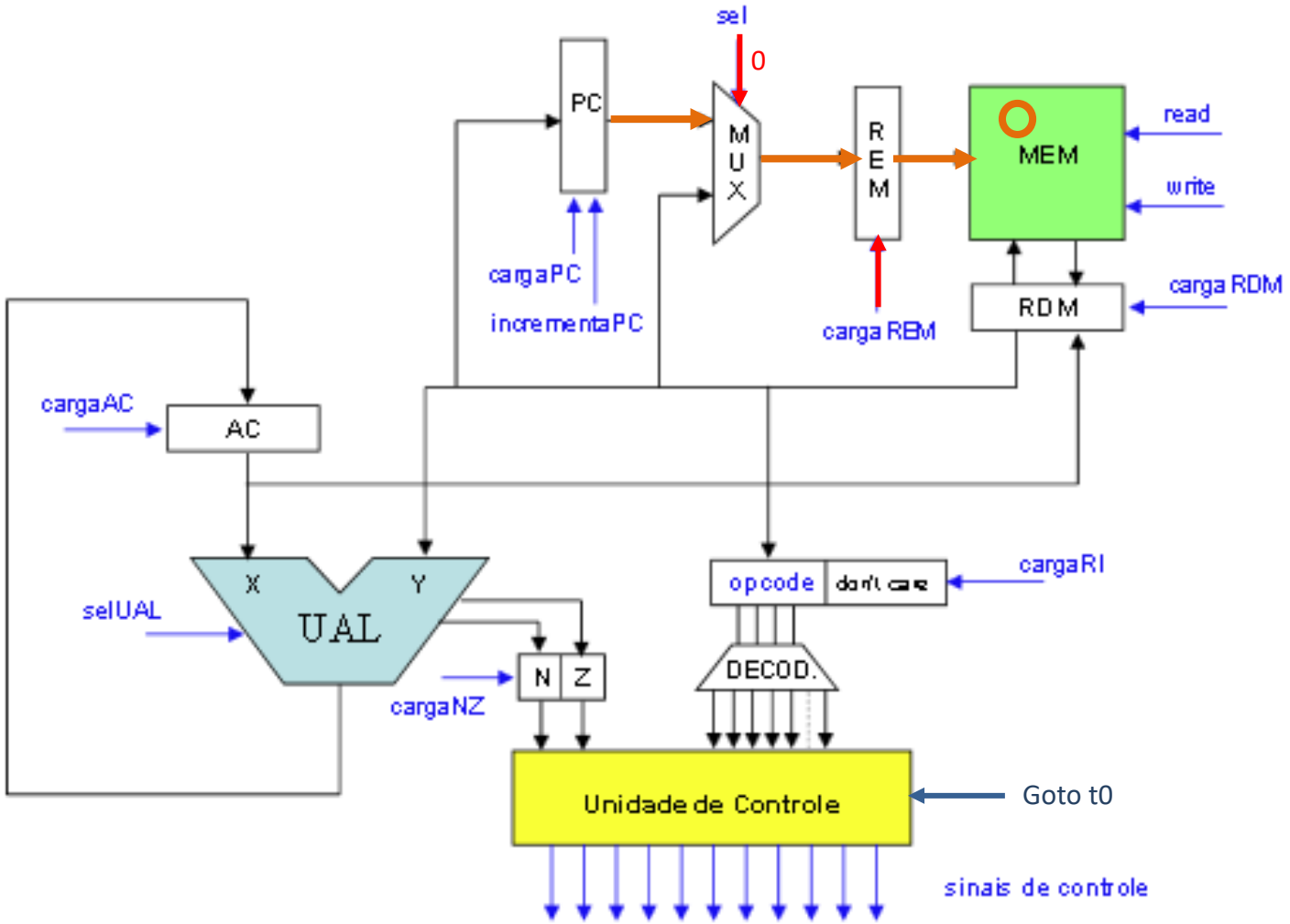
Unidade de Controle
Goto t0
sinais de controle

Função STA



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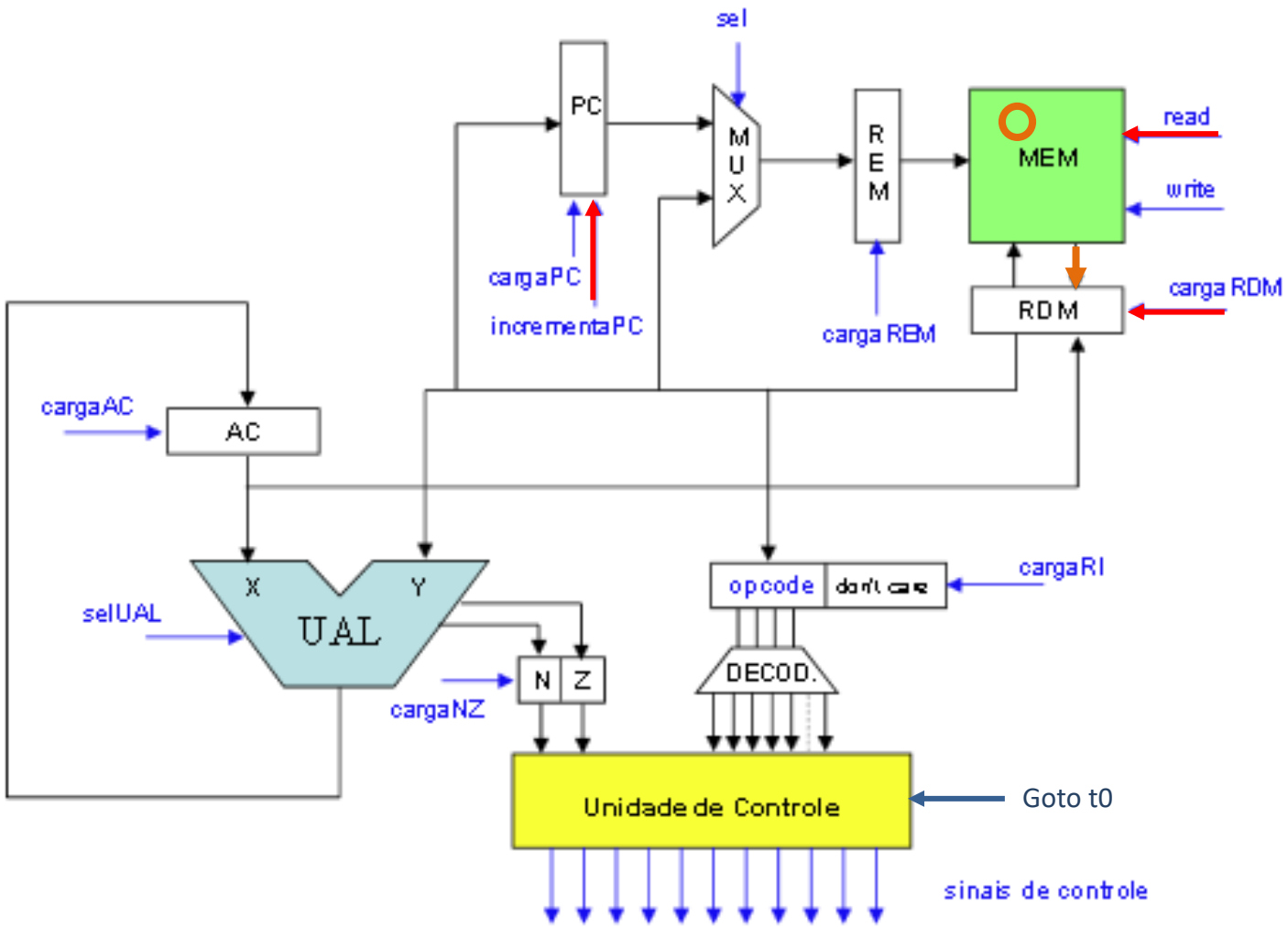

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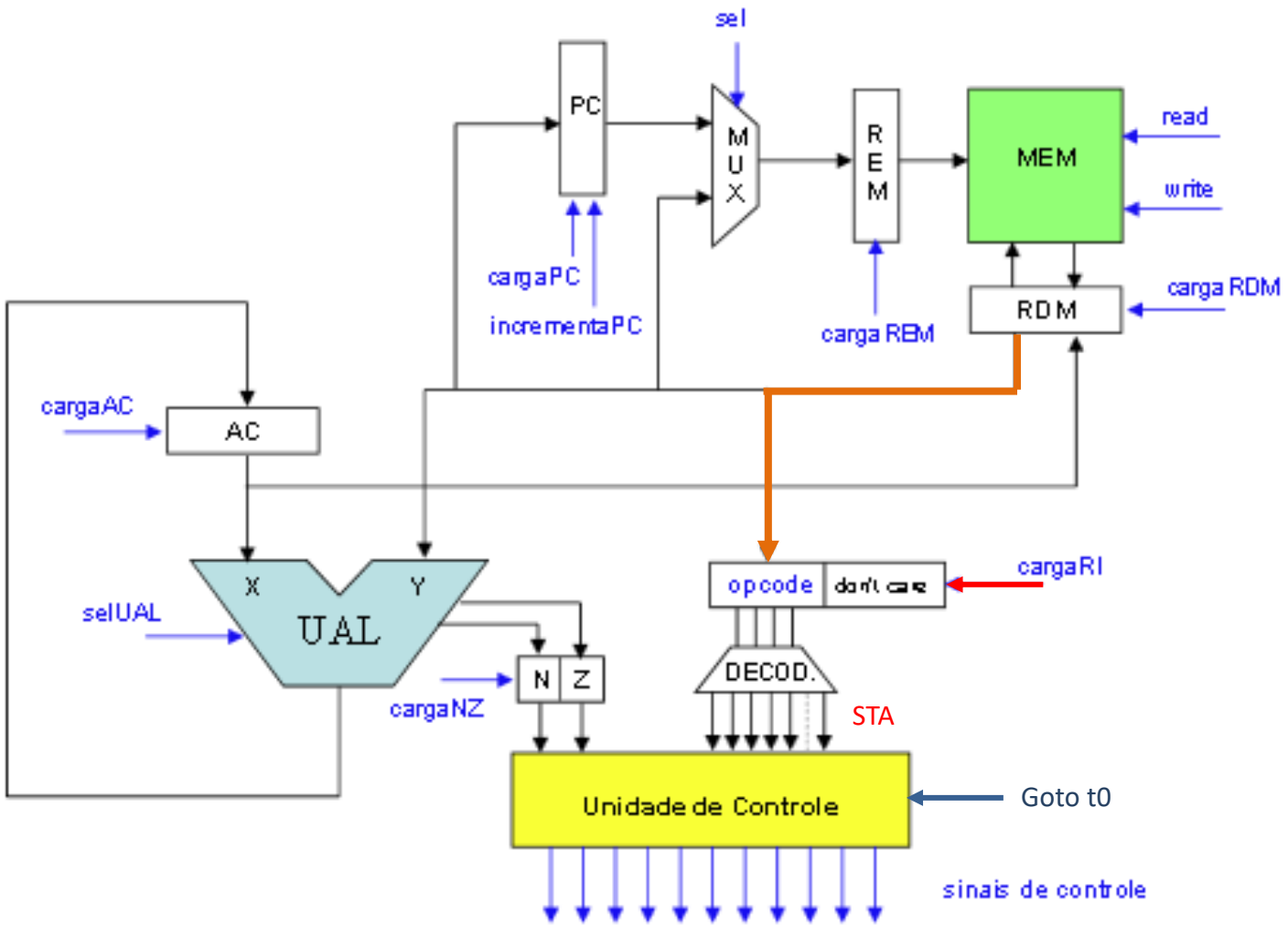

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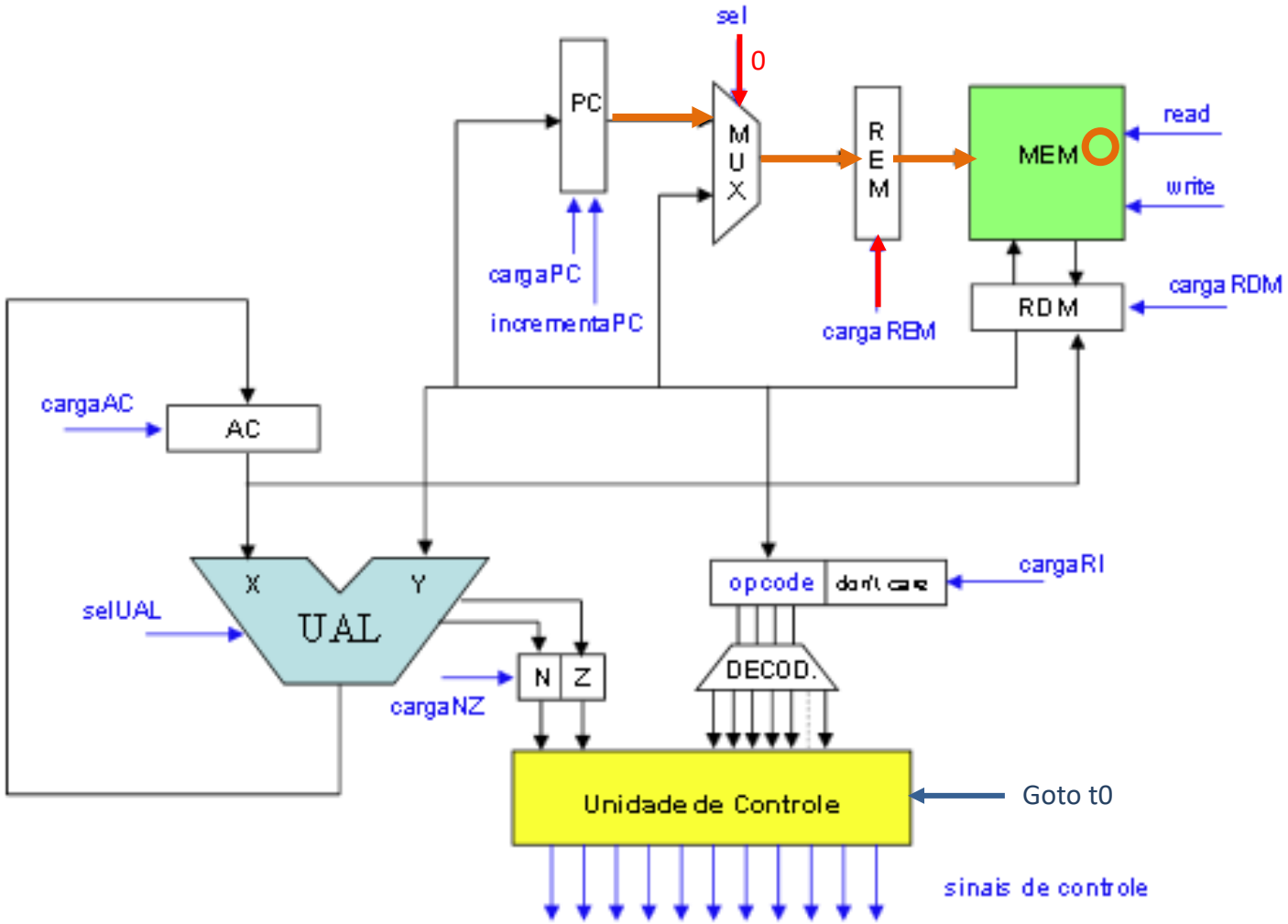
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Unidade de Controle
Goto t0
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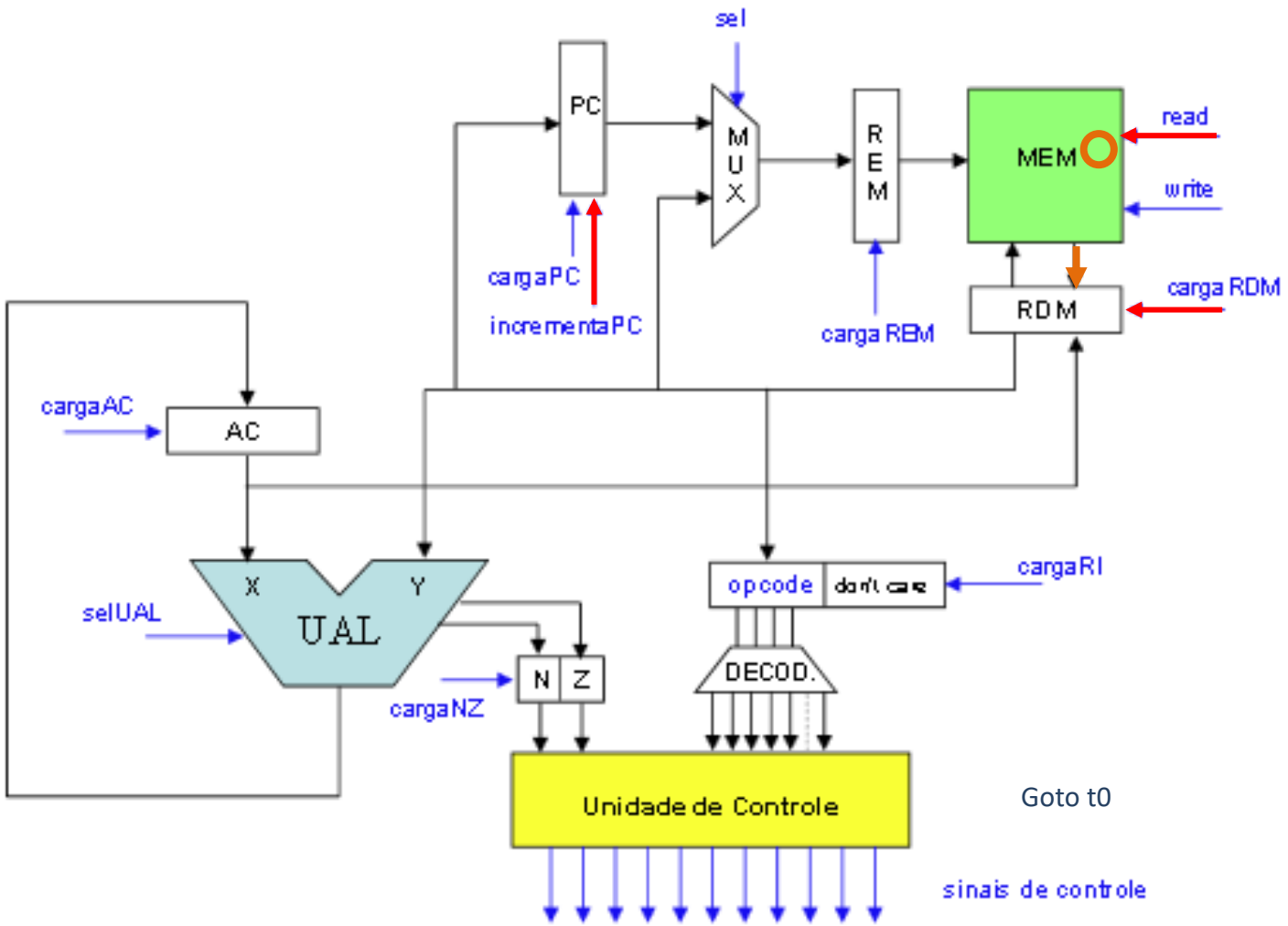
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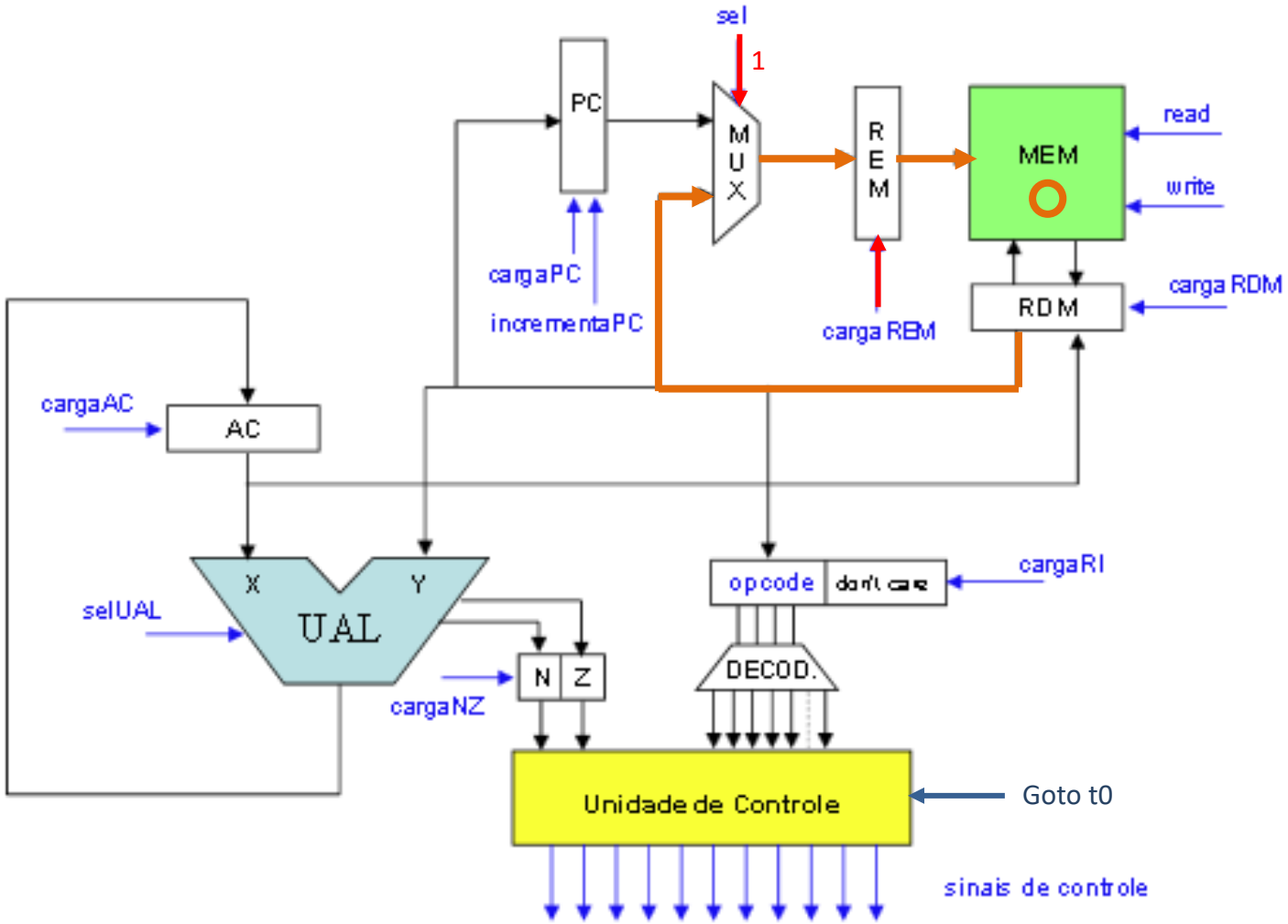
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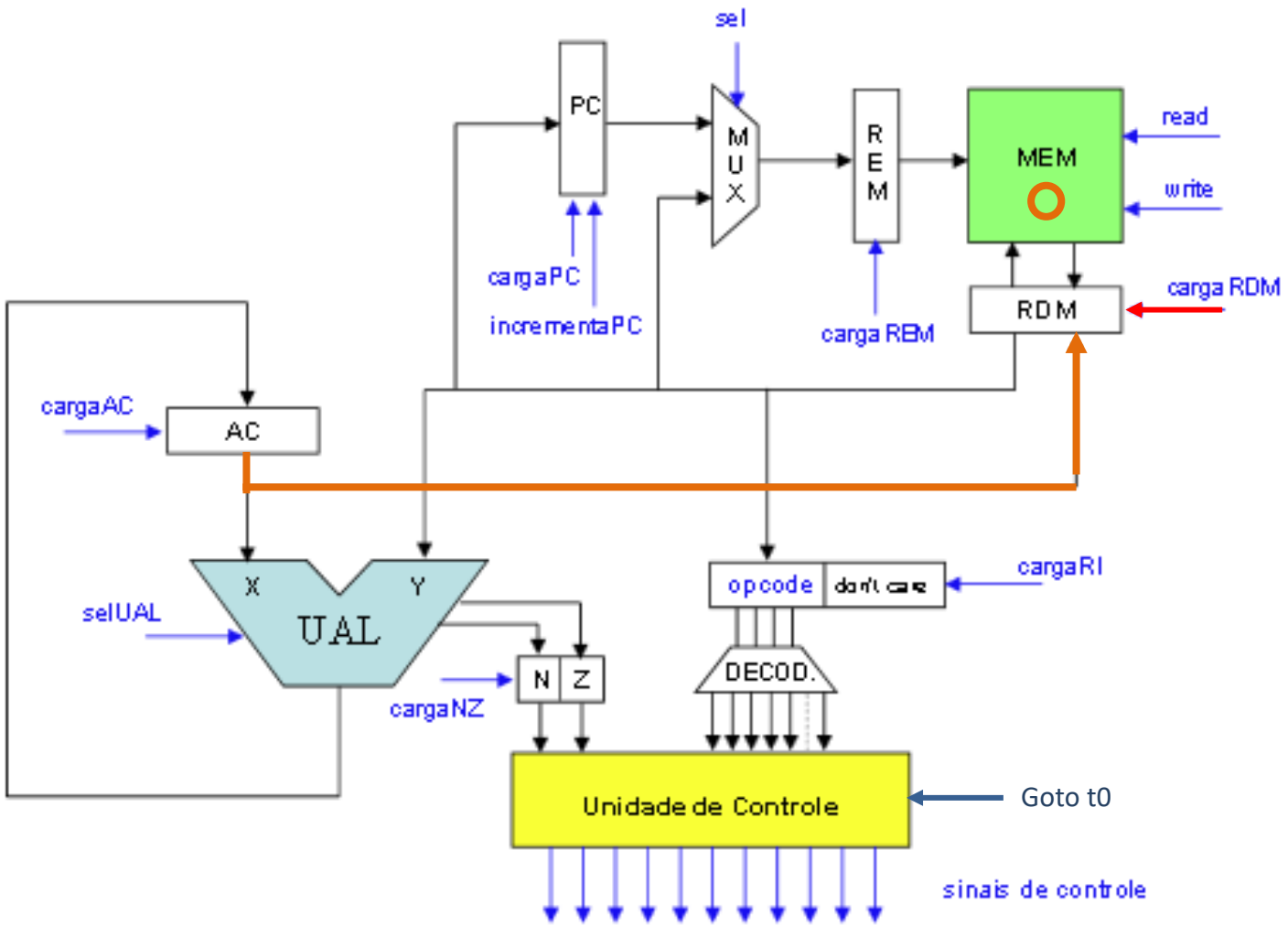
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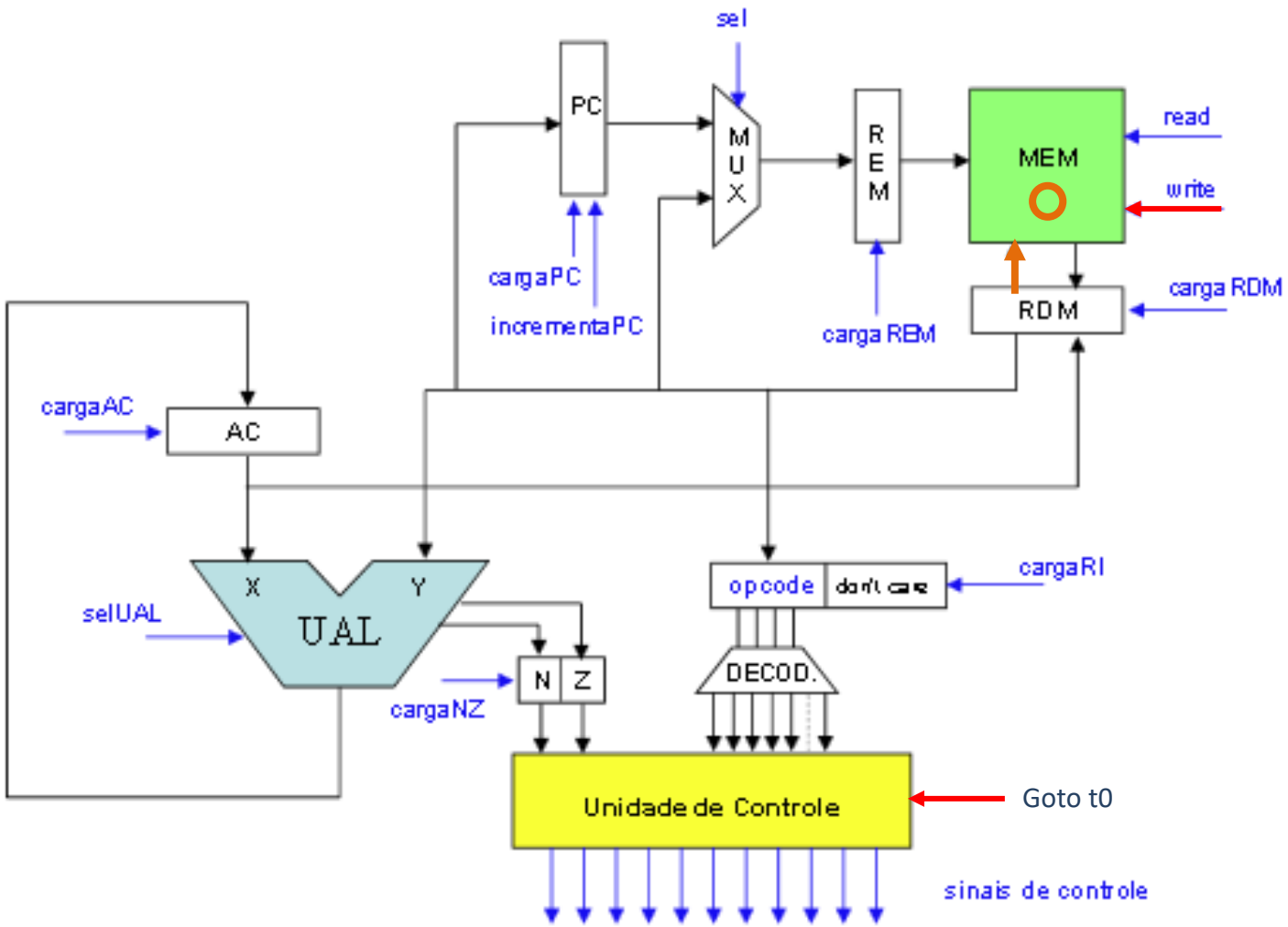
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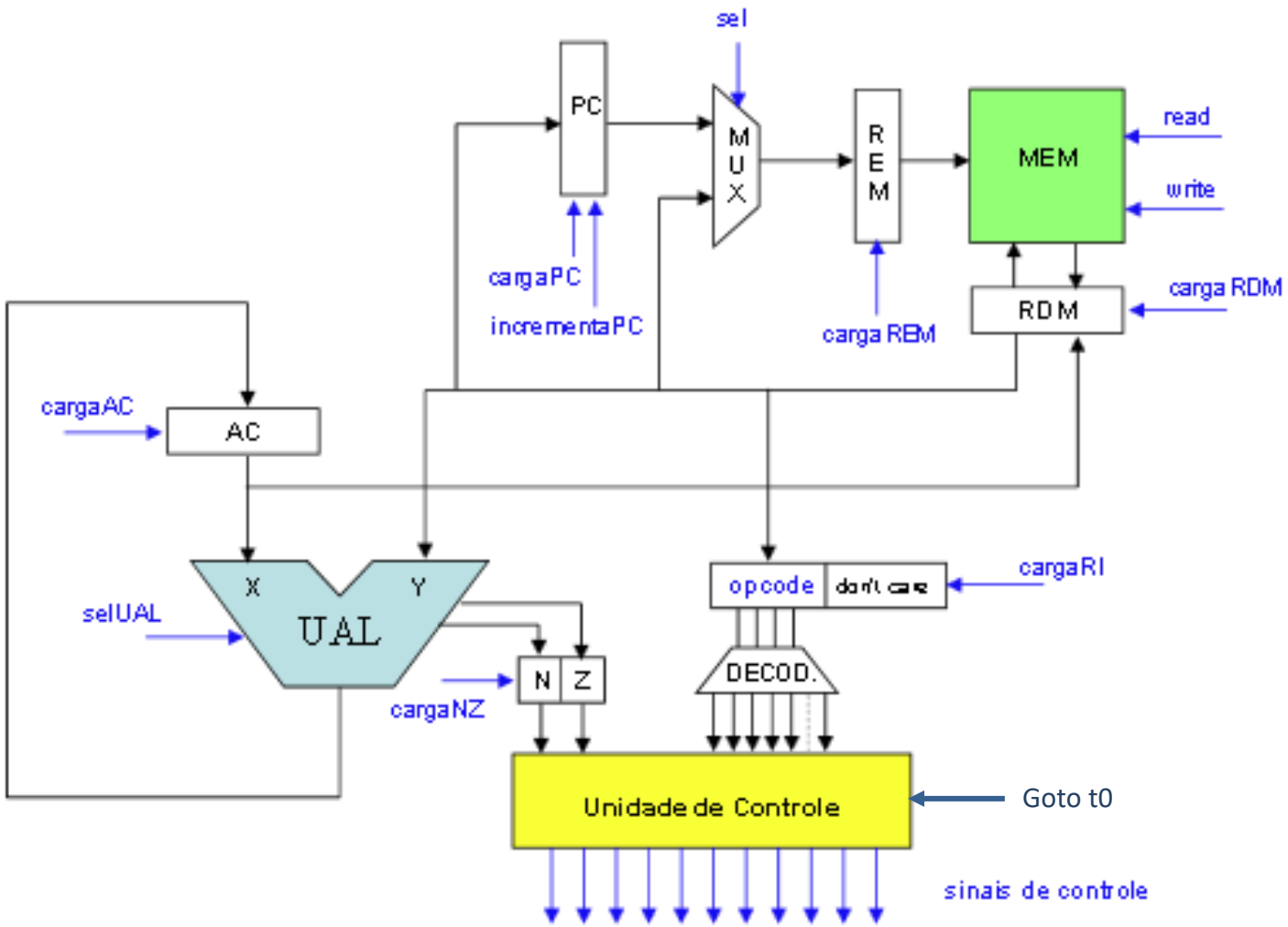
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

Função LDA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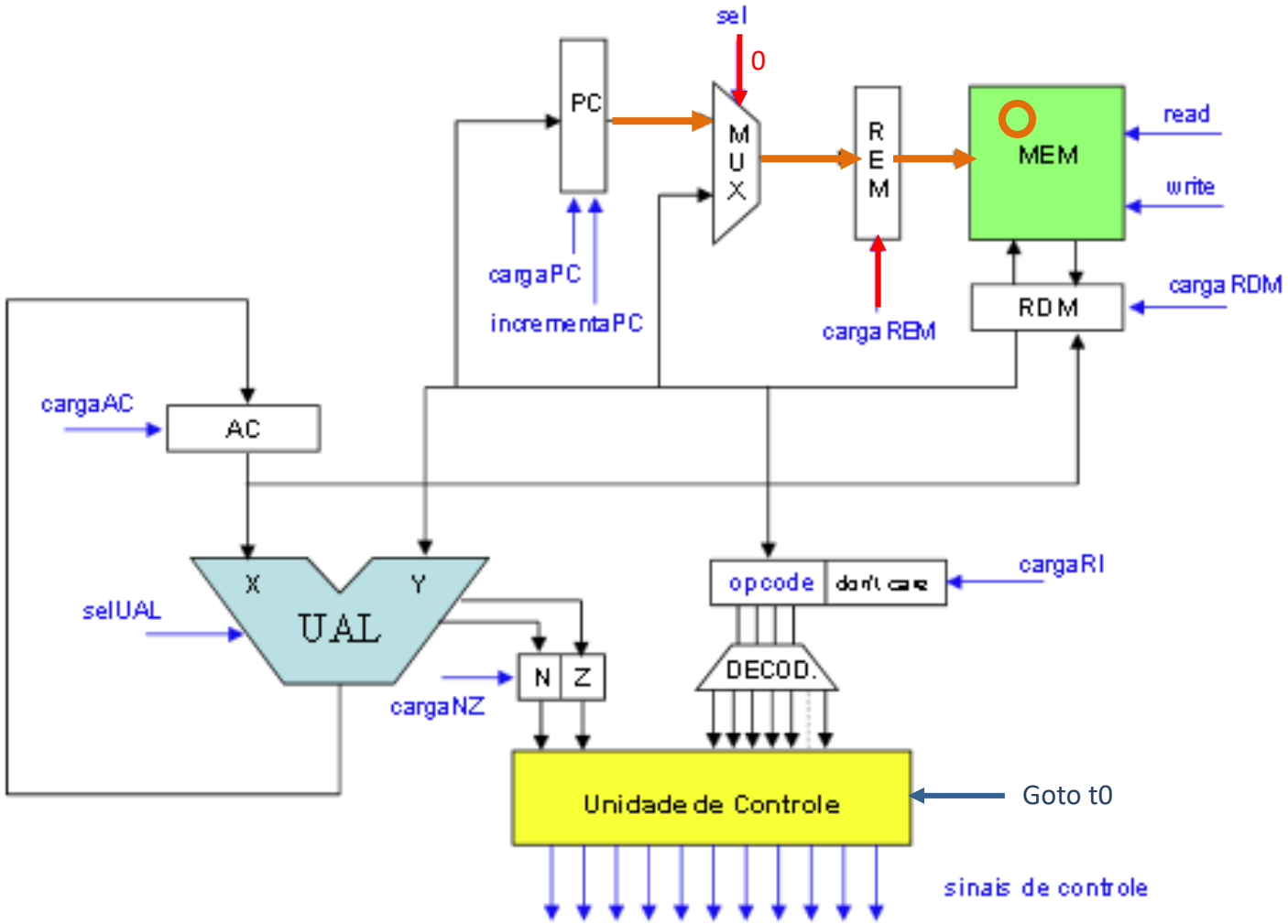
Função LDA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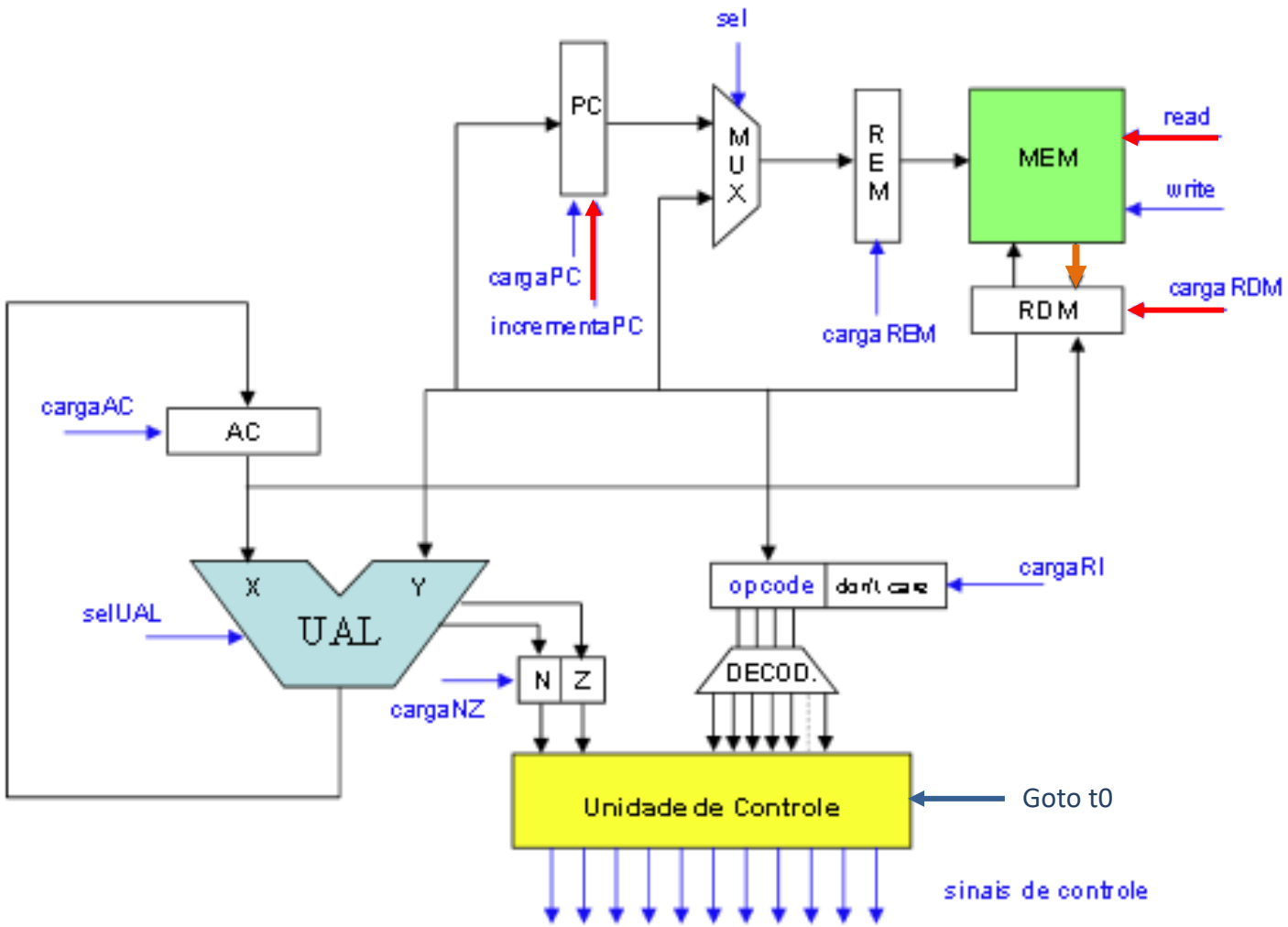
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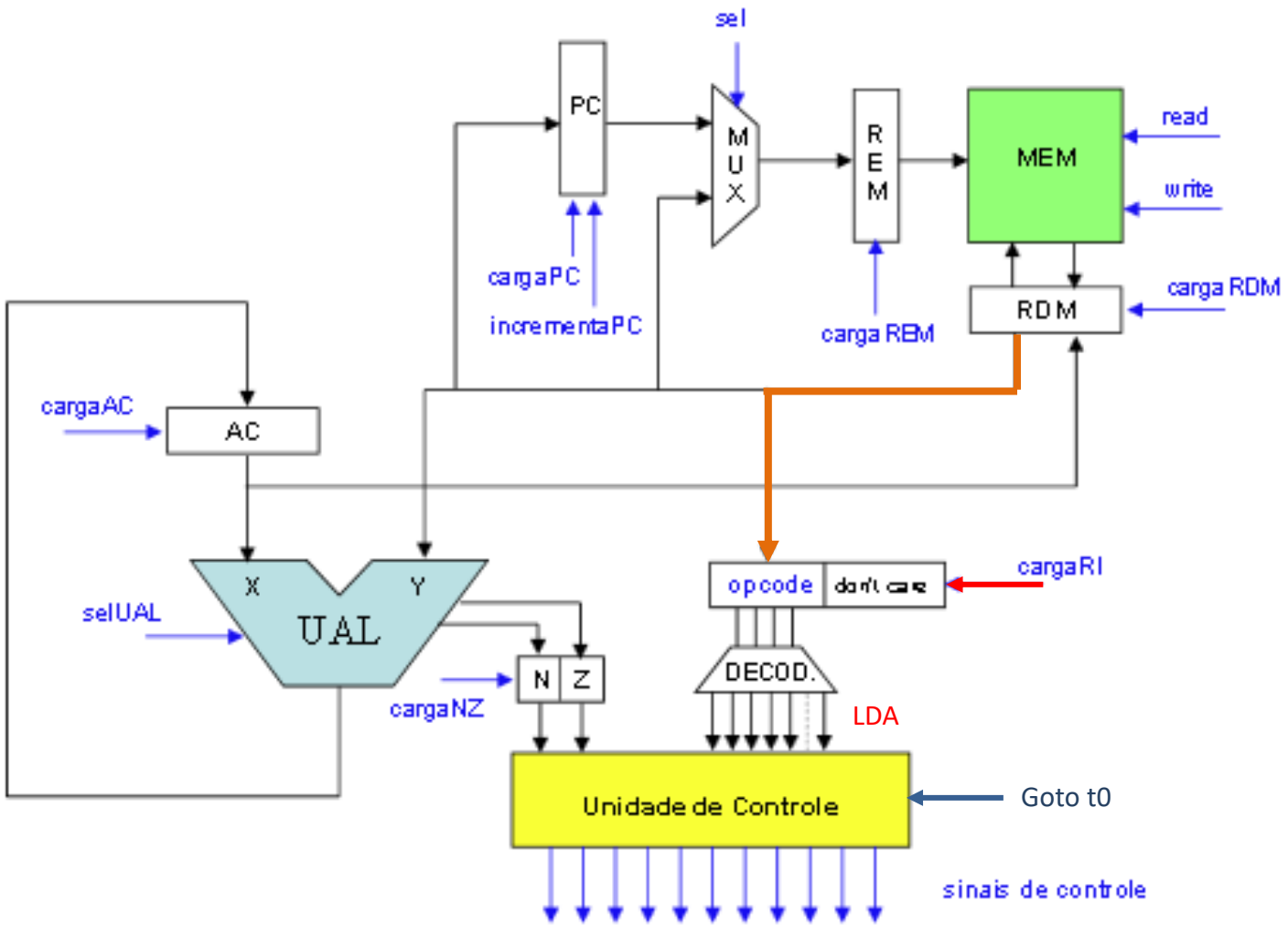
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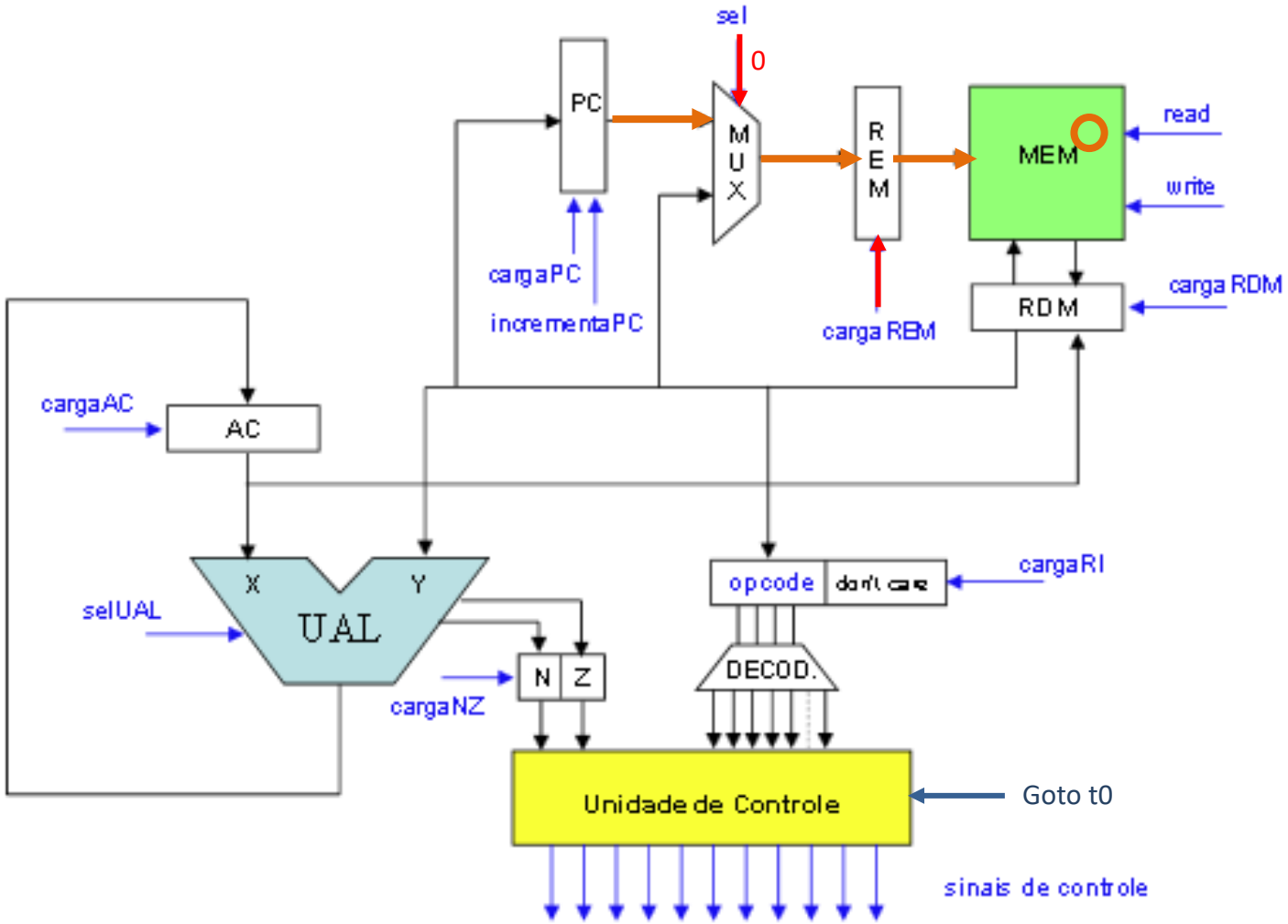
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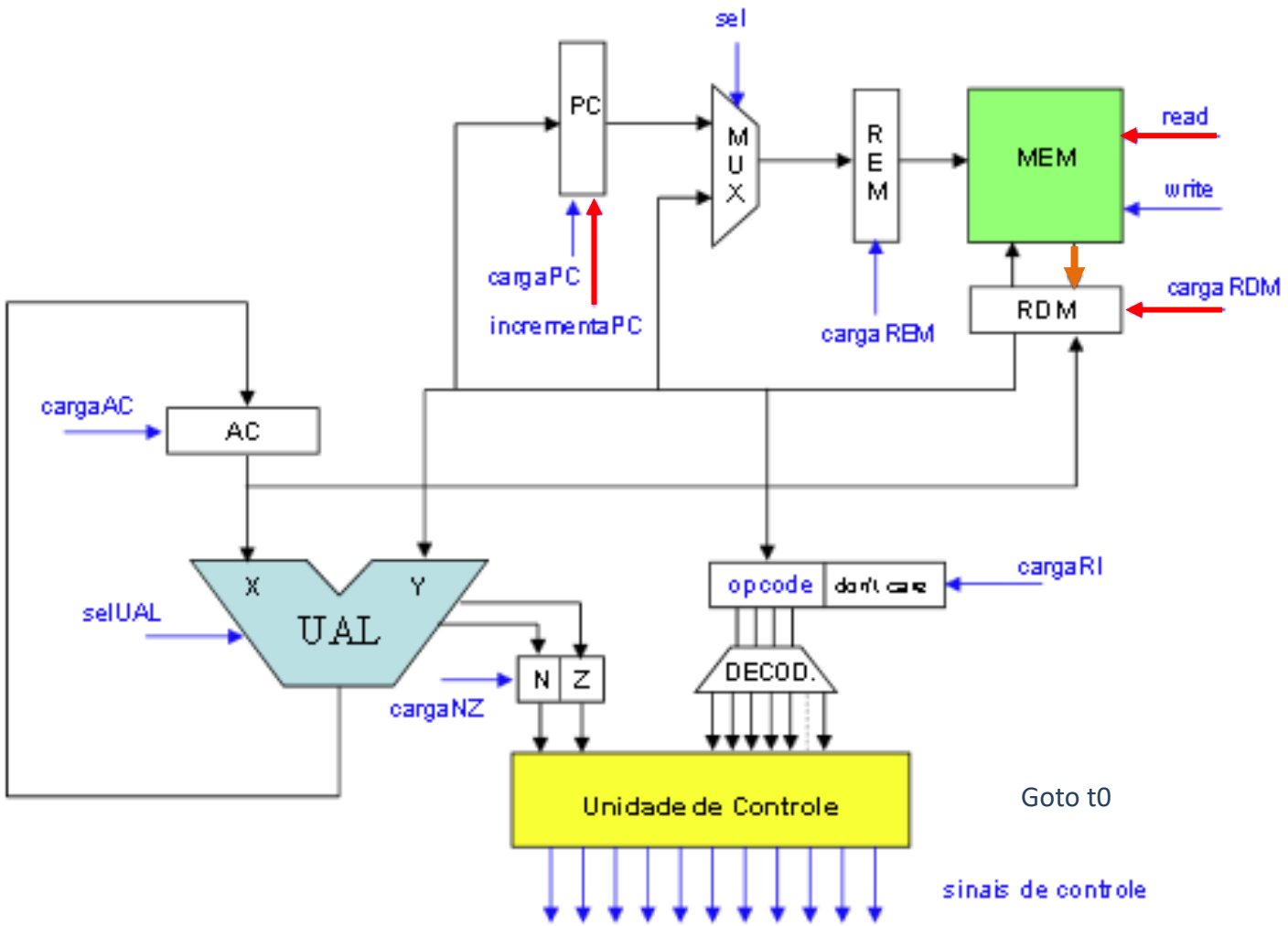
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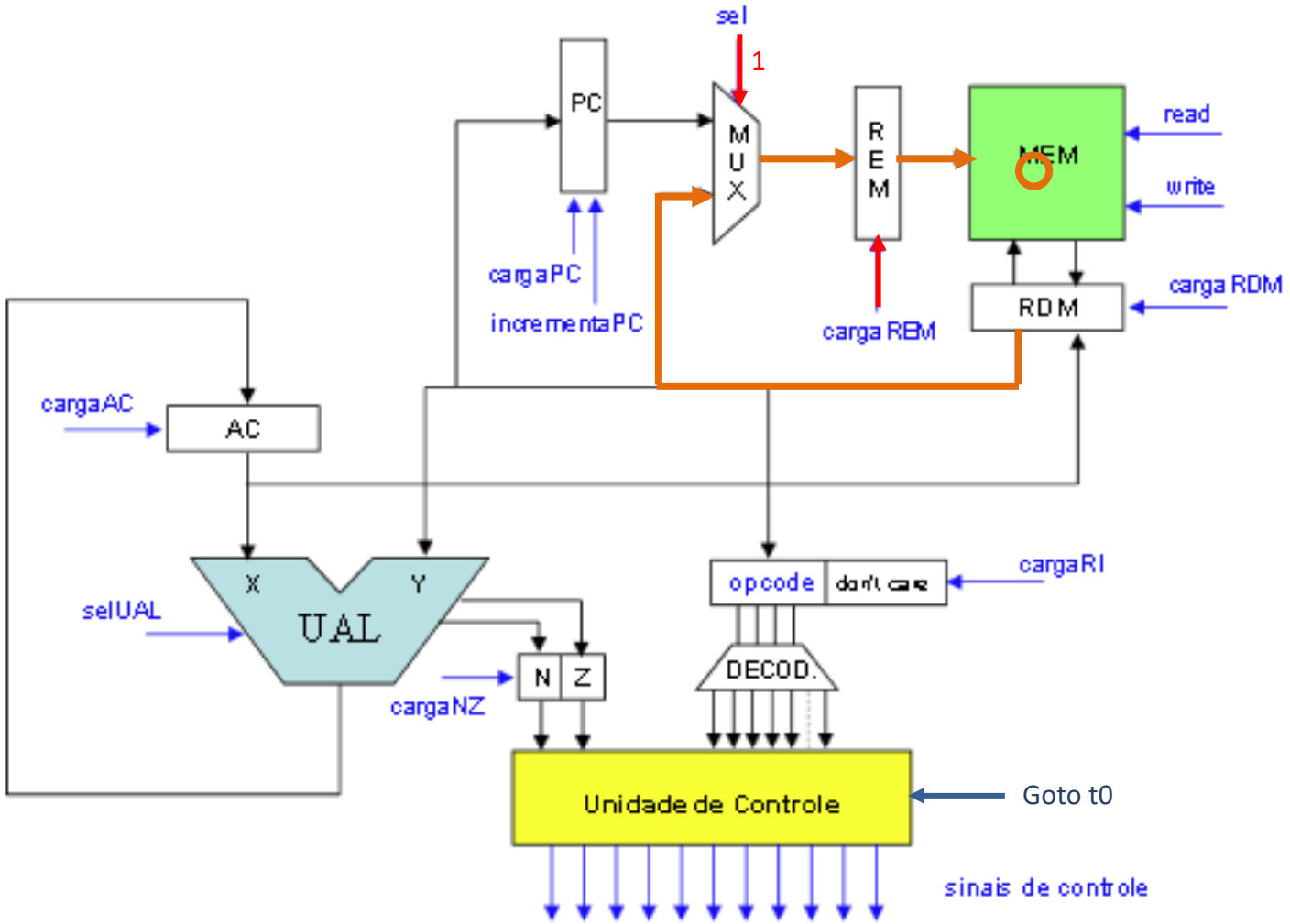
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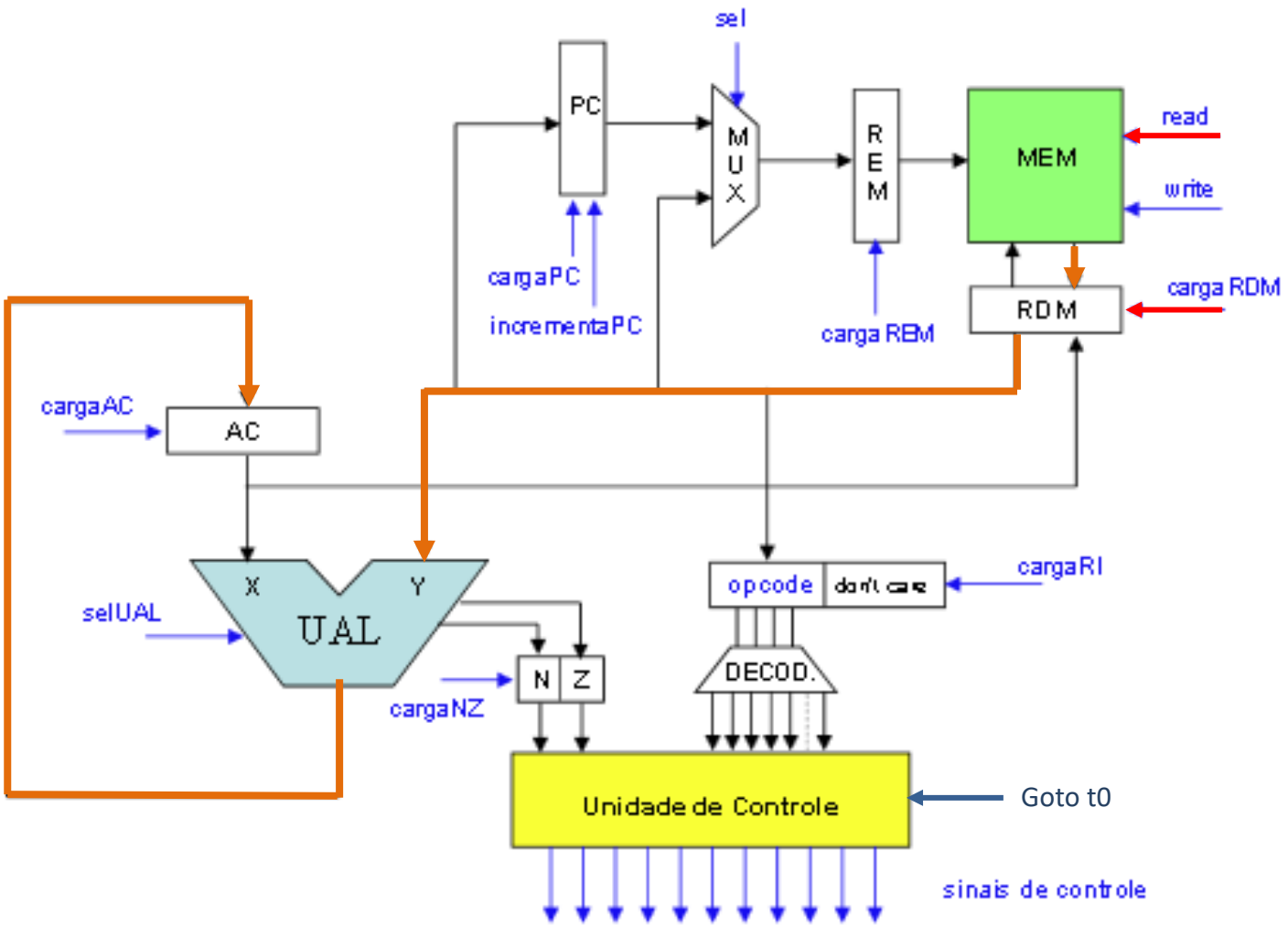
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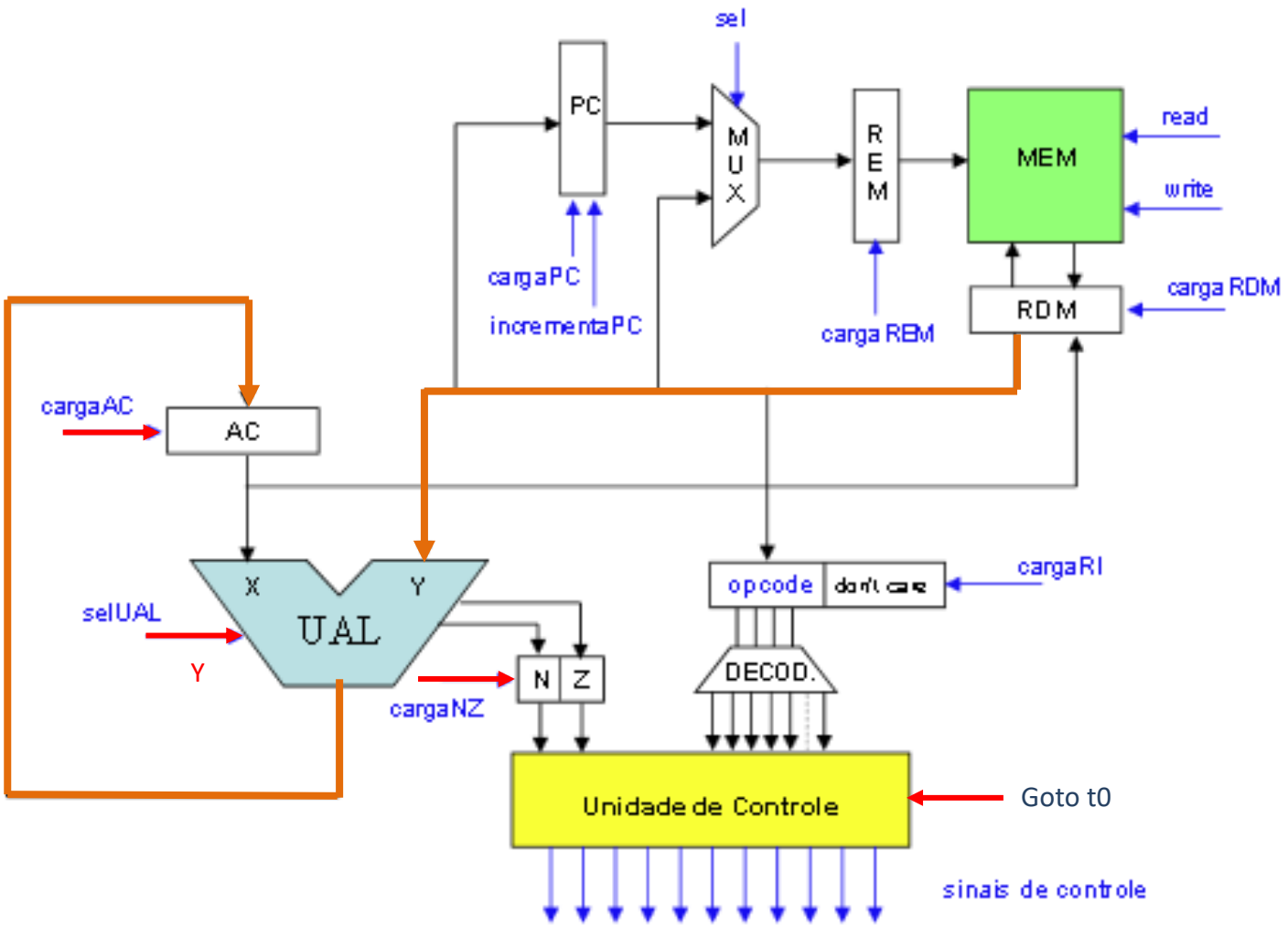
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Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

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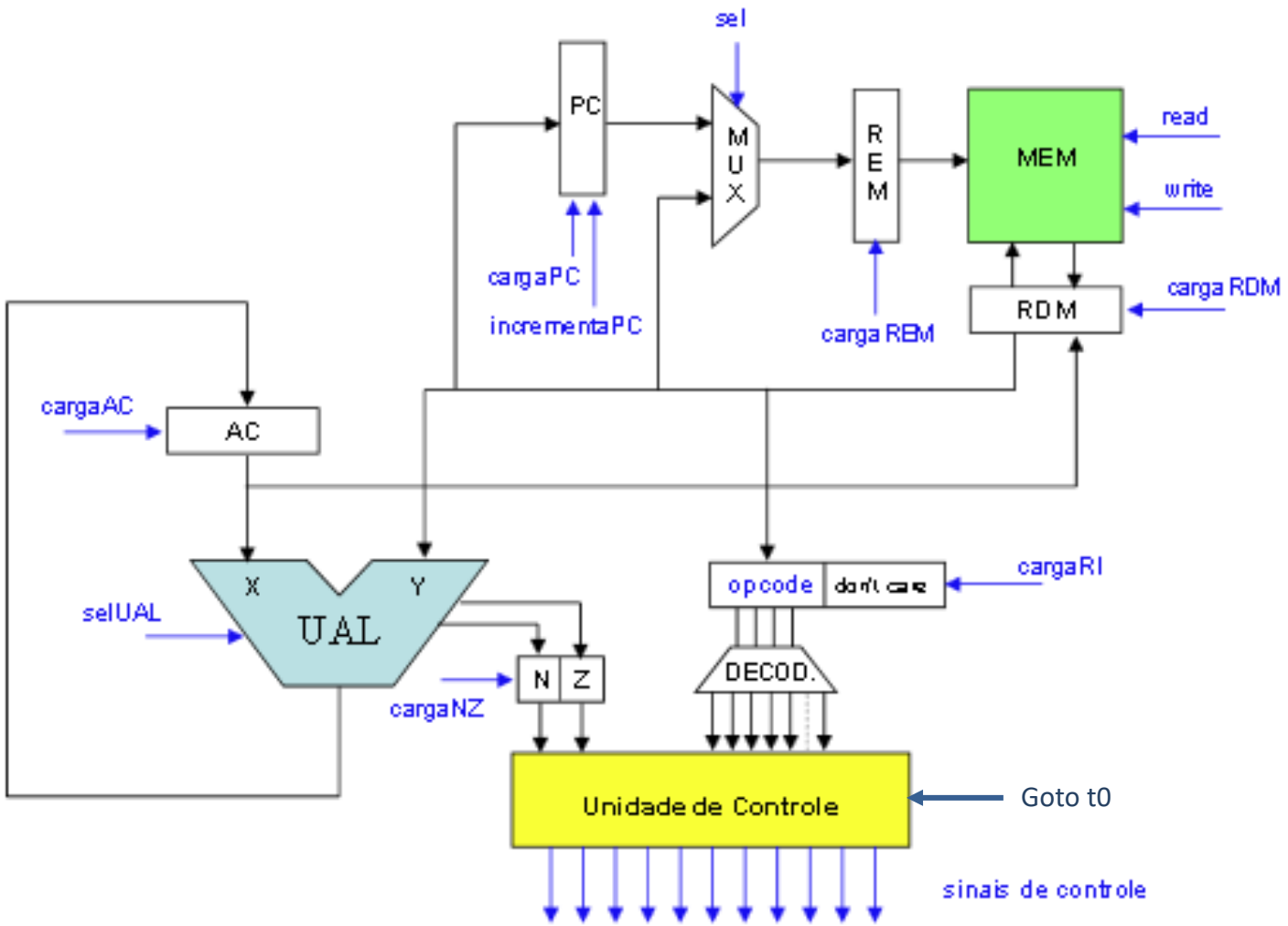
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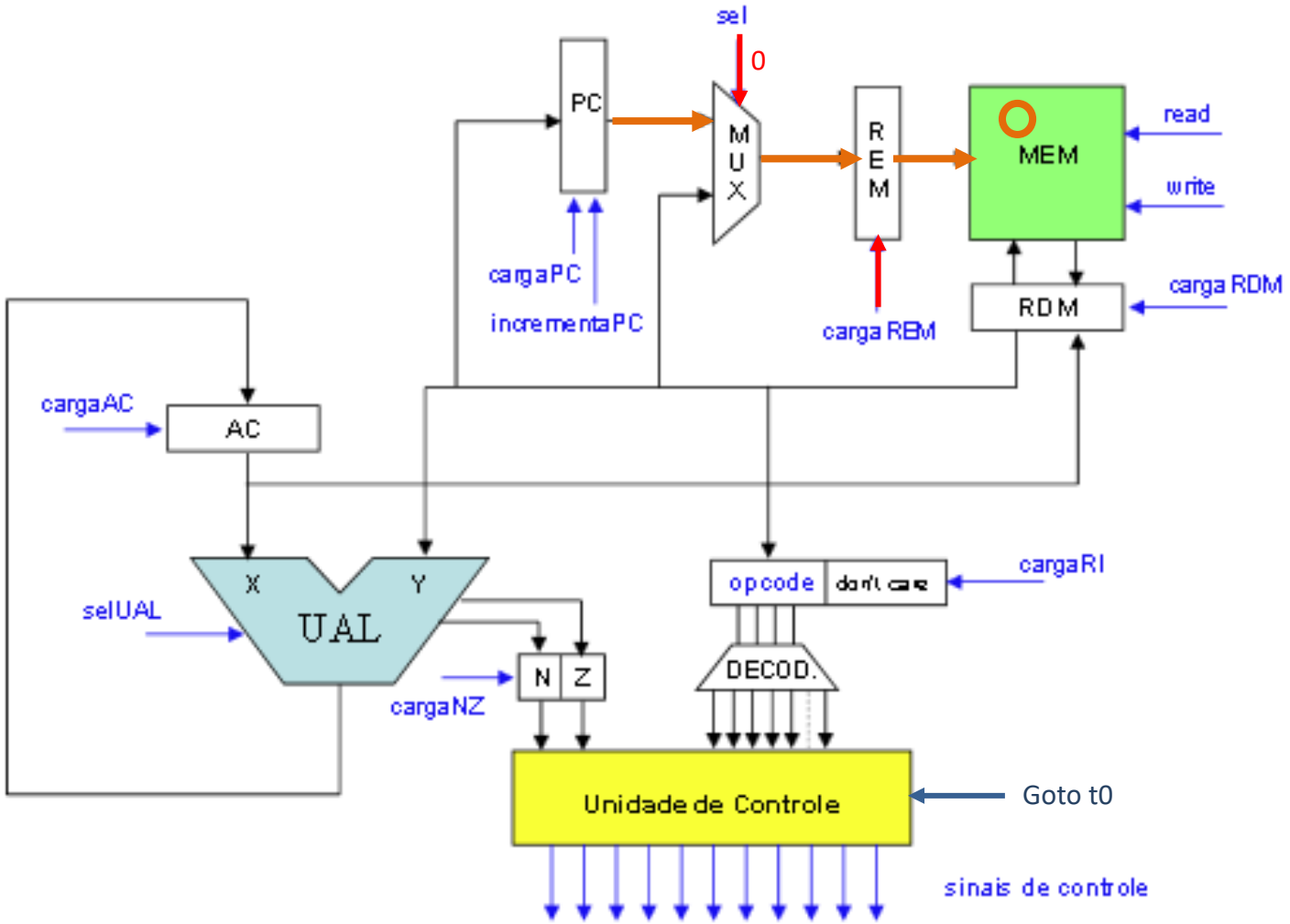
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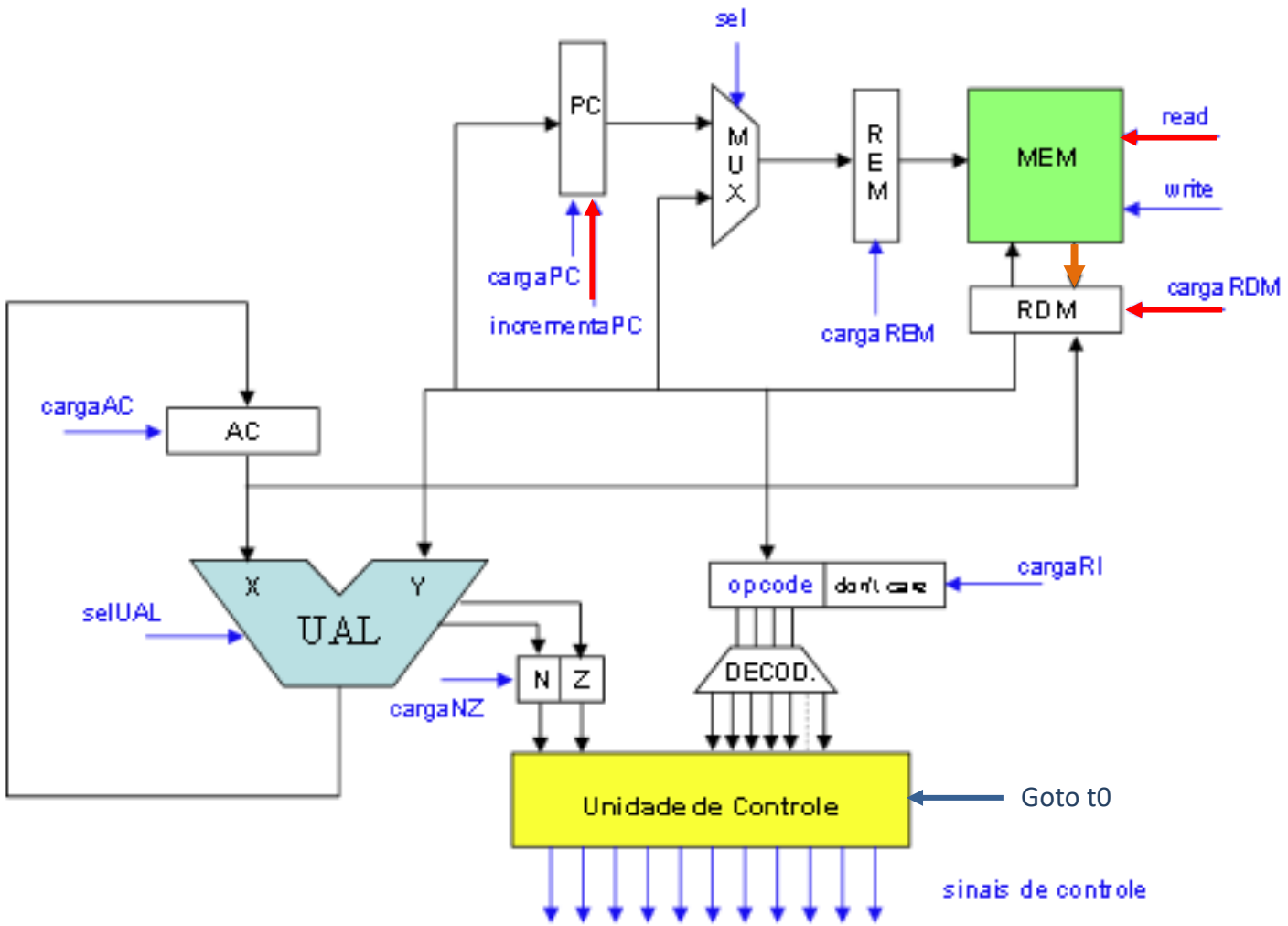
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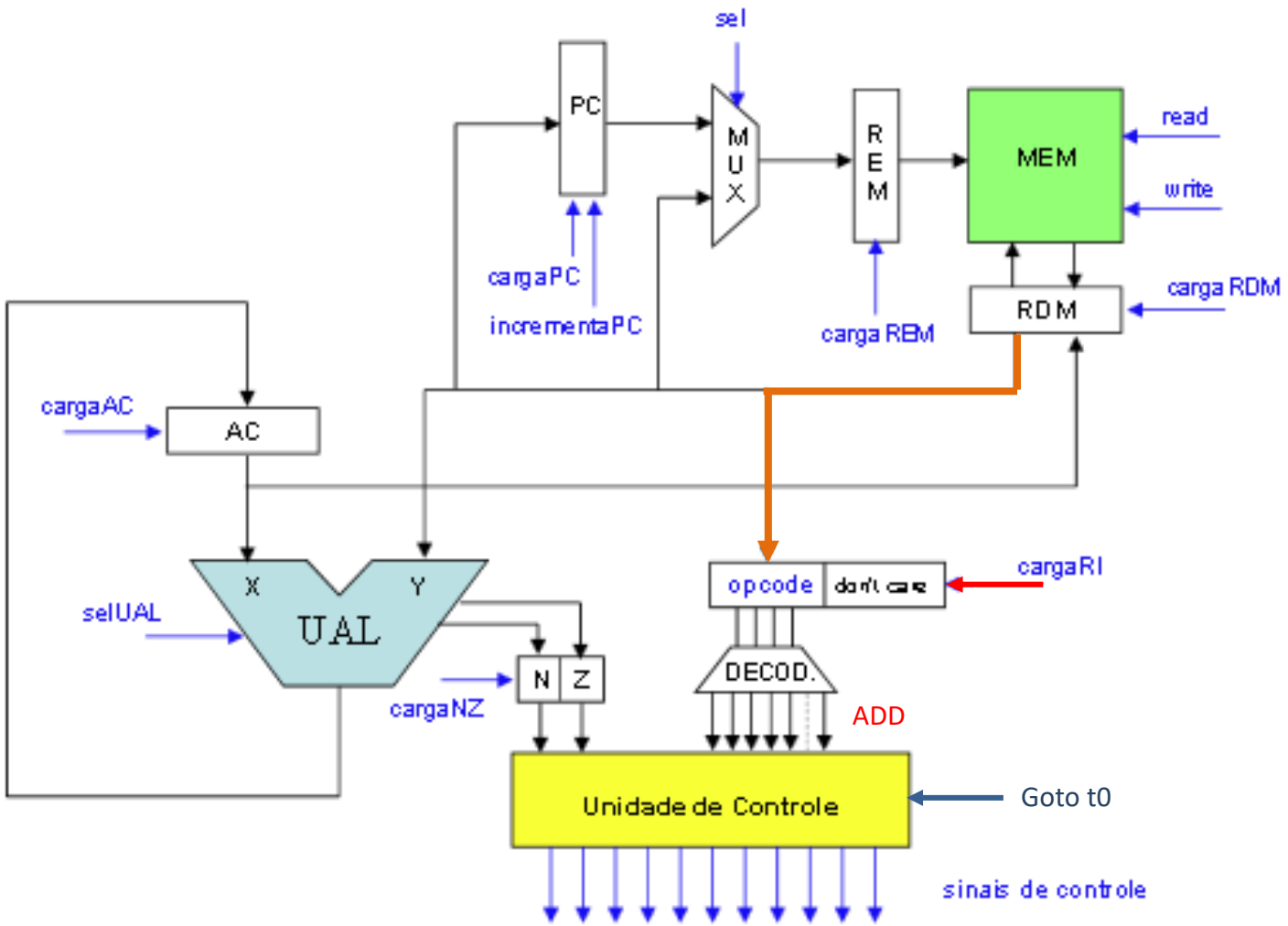
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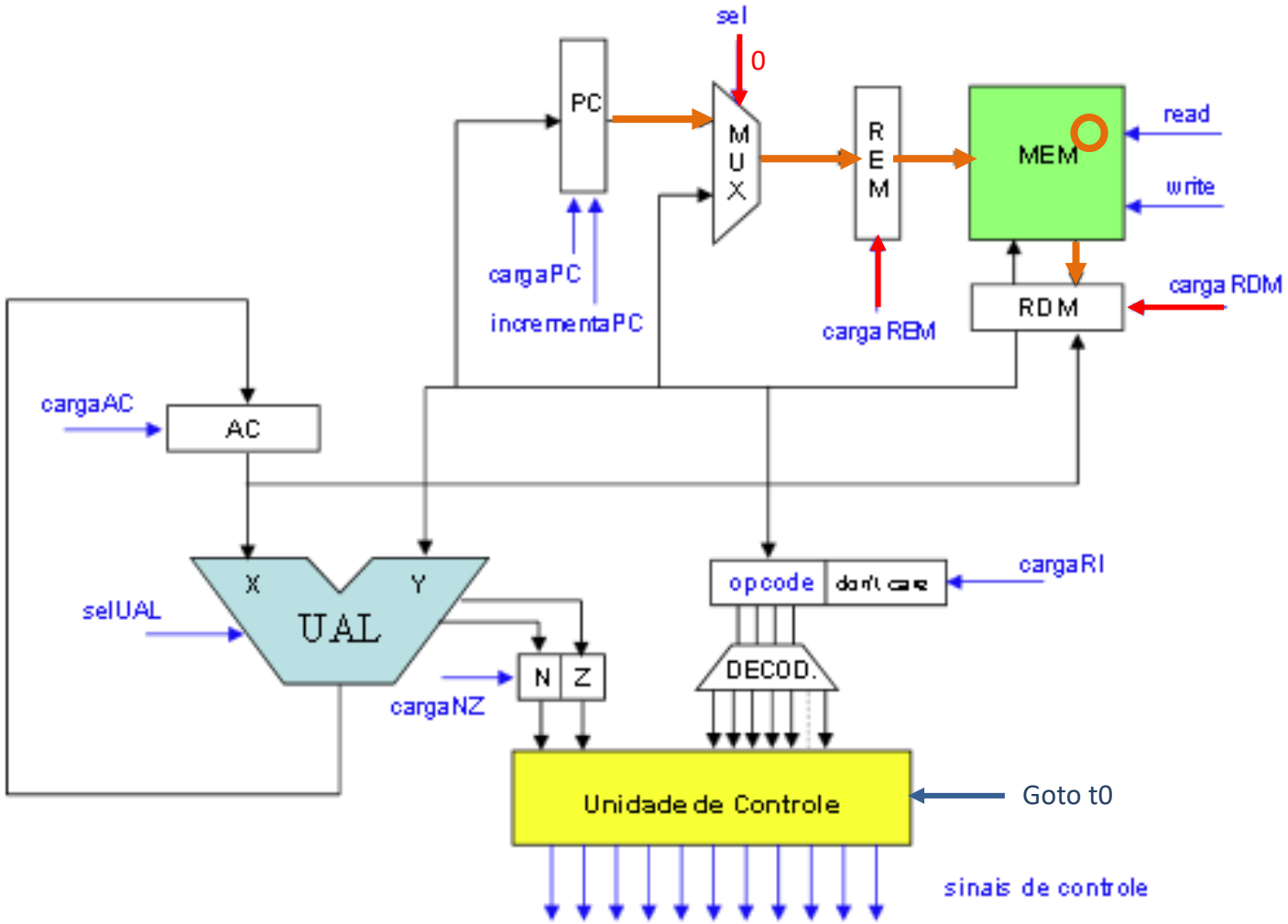
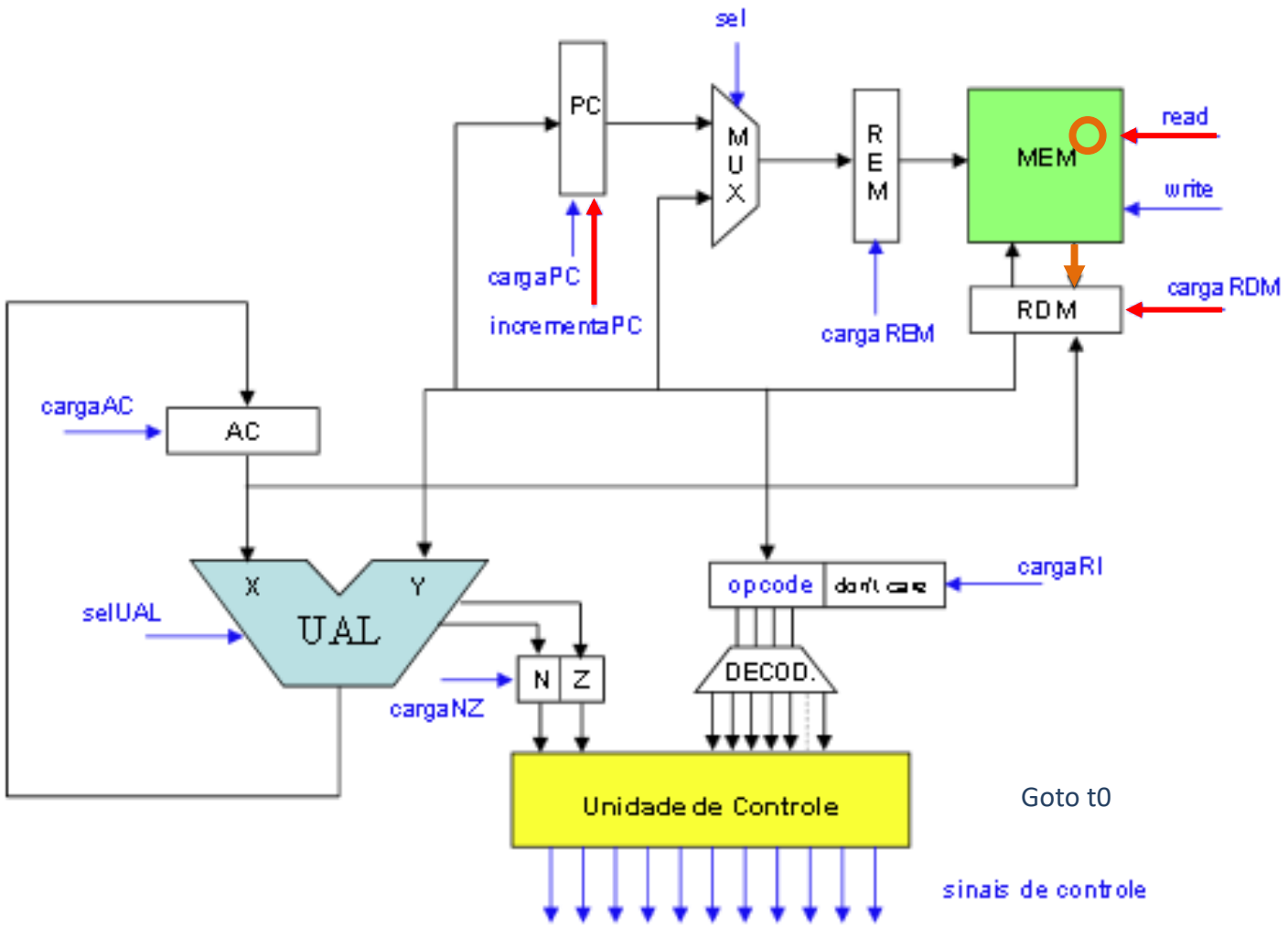
sinais de controle

Função ADD


sel
0
PC
M
U
X
R
E
M
MEM
read
write
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
Y
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função ADD


sel
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read
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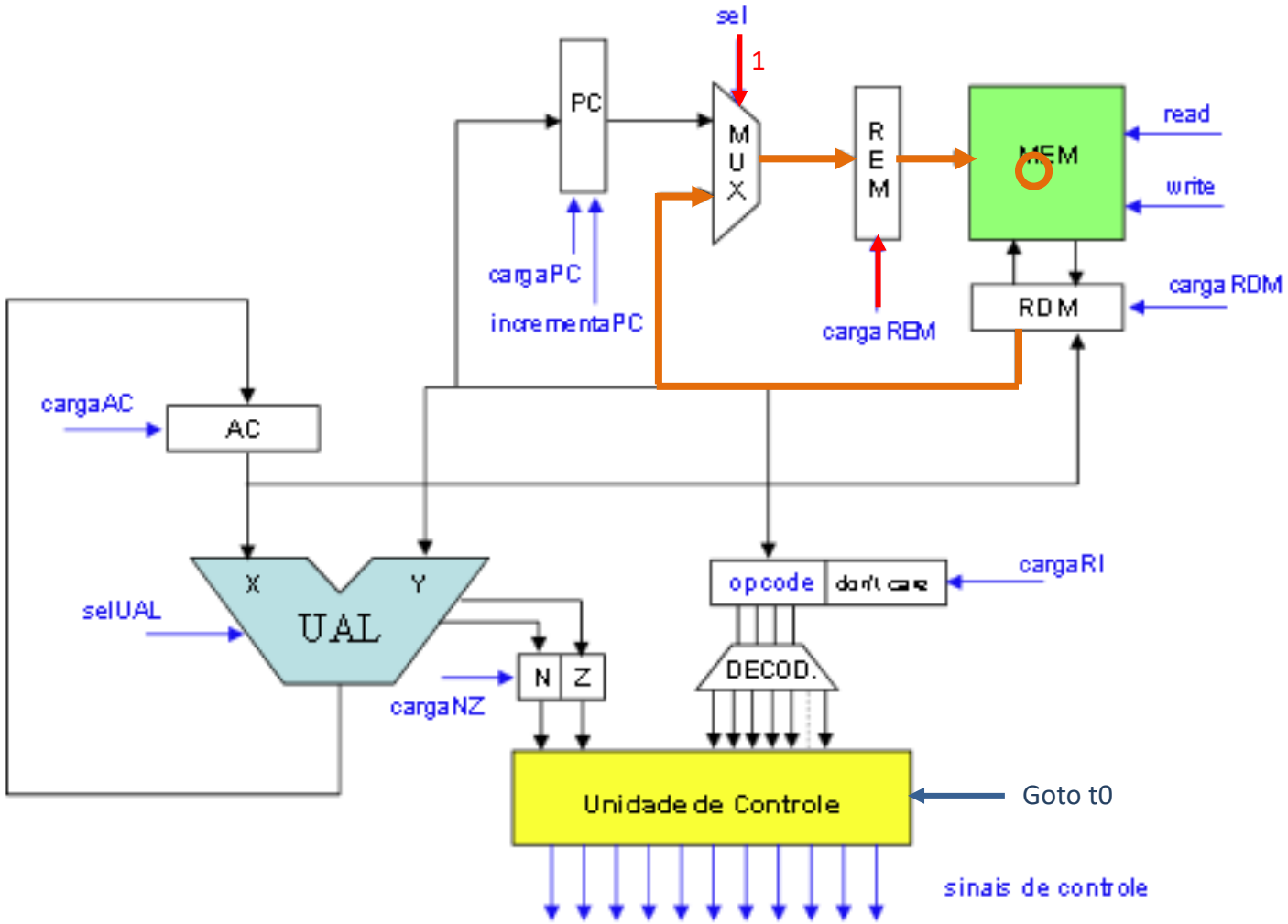
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
Y
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função ADD


sel
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read
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cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
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X
Y
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opcode
don't care
cargaRI
N
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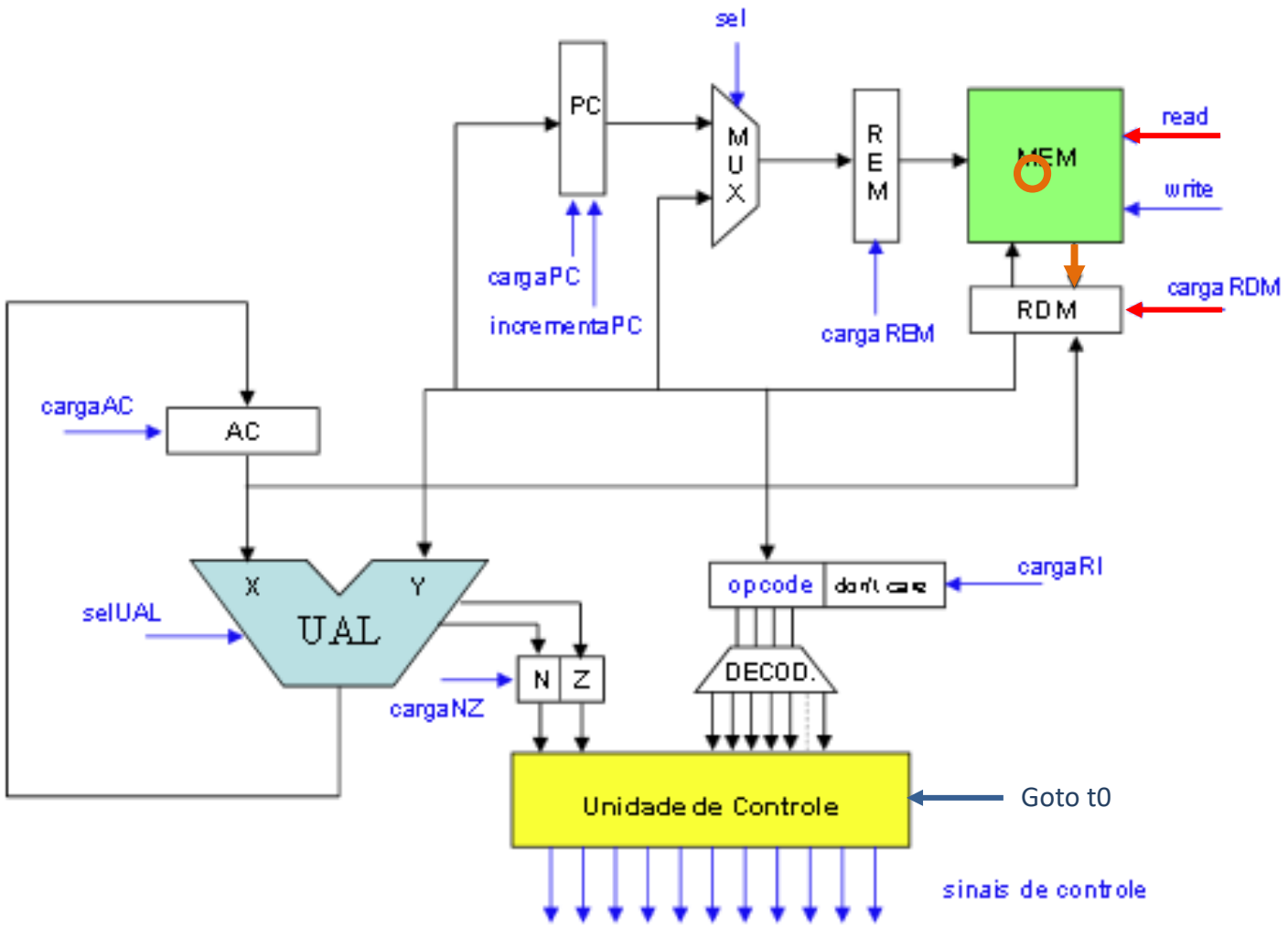
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função ADD


sel
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cargaPC
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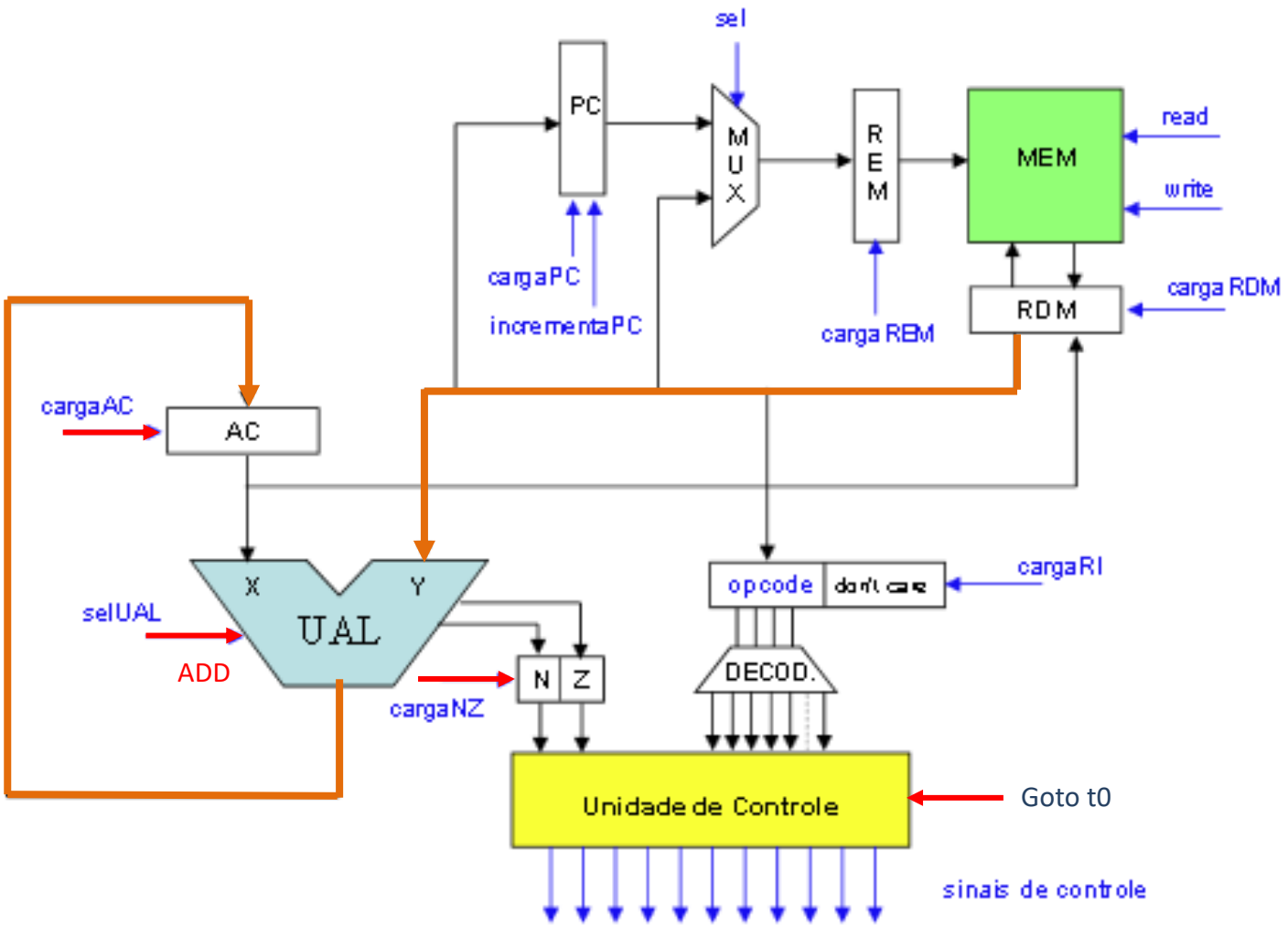
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função ADD


sel
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read
write
cargaPC
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X
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UAL
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ADD
N
Z
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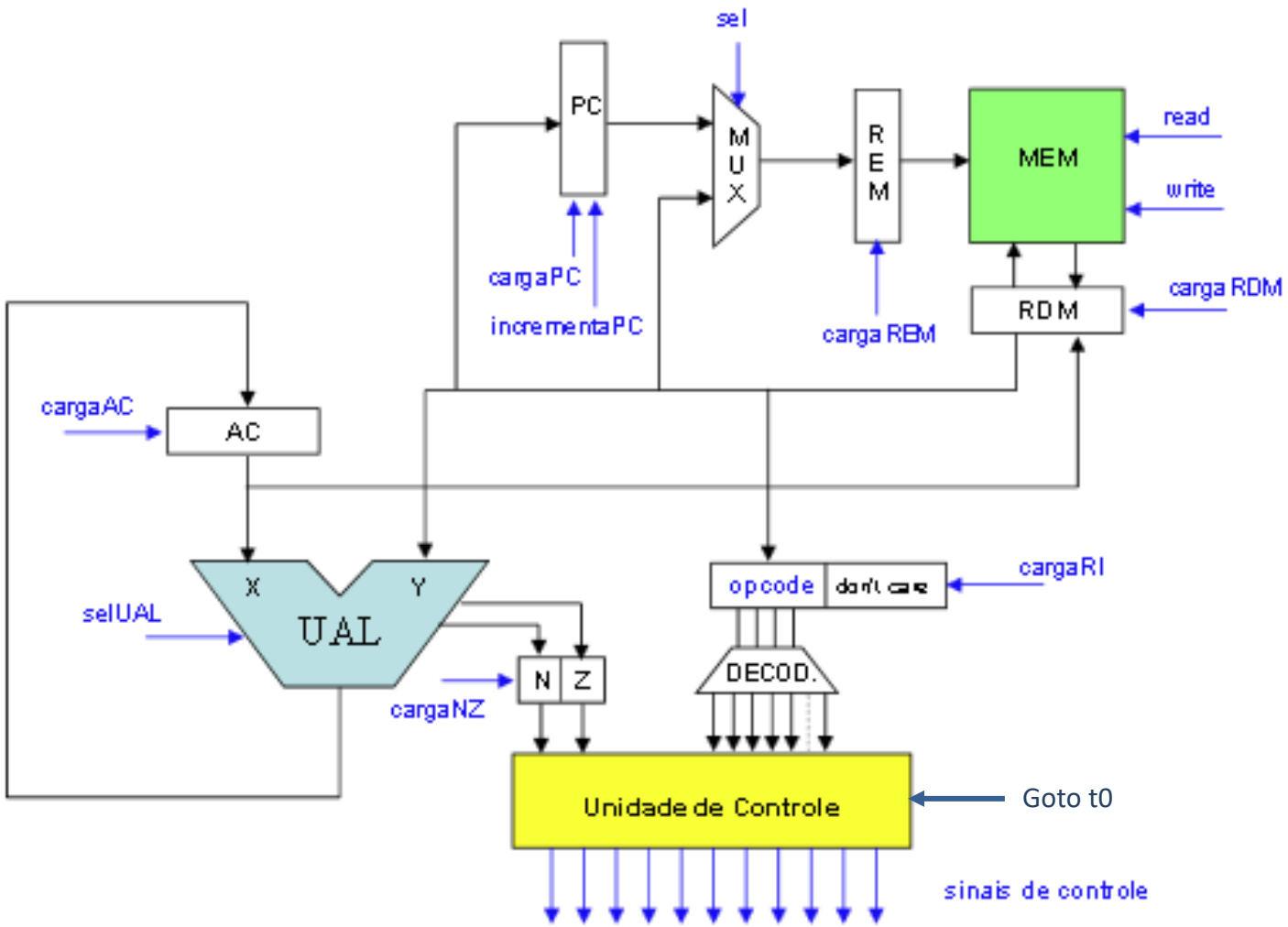
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

Função OR


sel
PC
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MEM
read
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cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
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opcode
don't care
cargaRI
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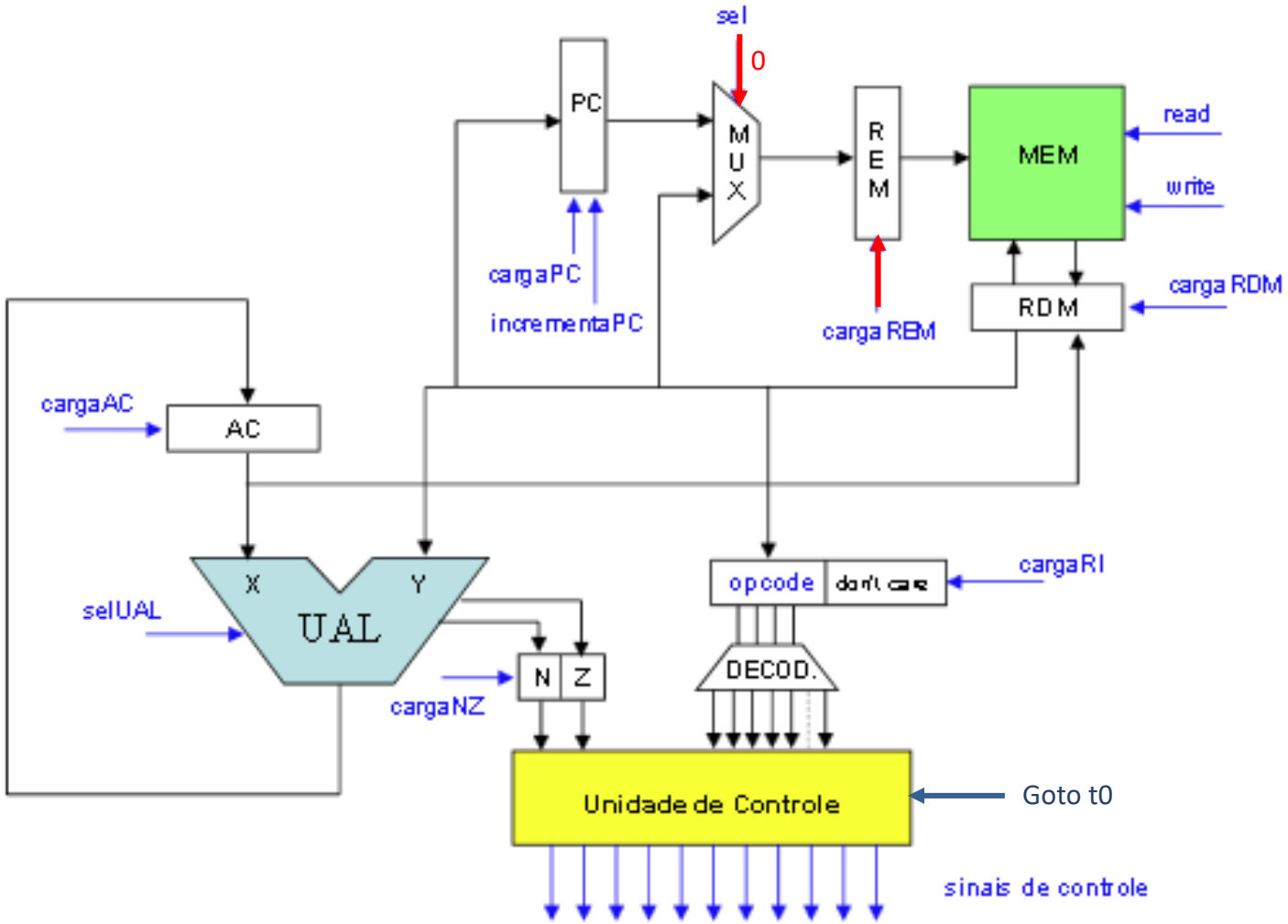
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaPC
incrementaPC
cargaREM
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cargaRDM
cargaAC
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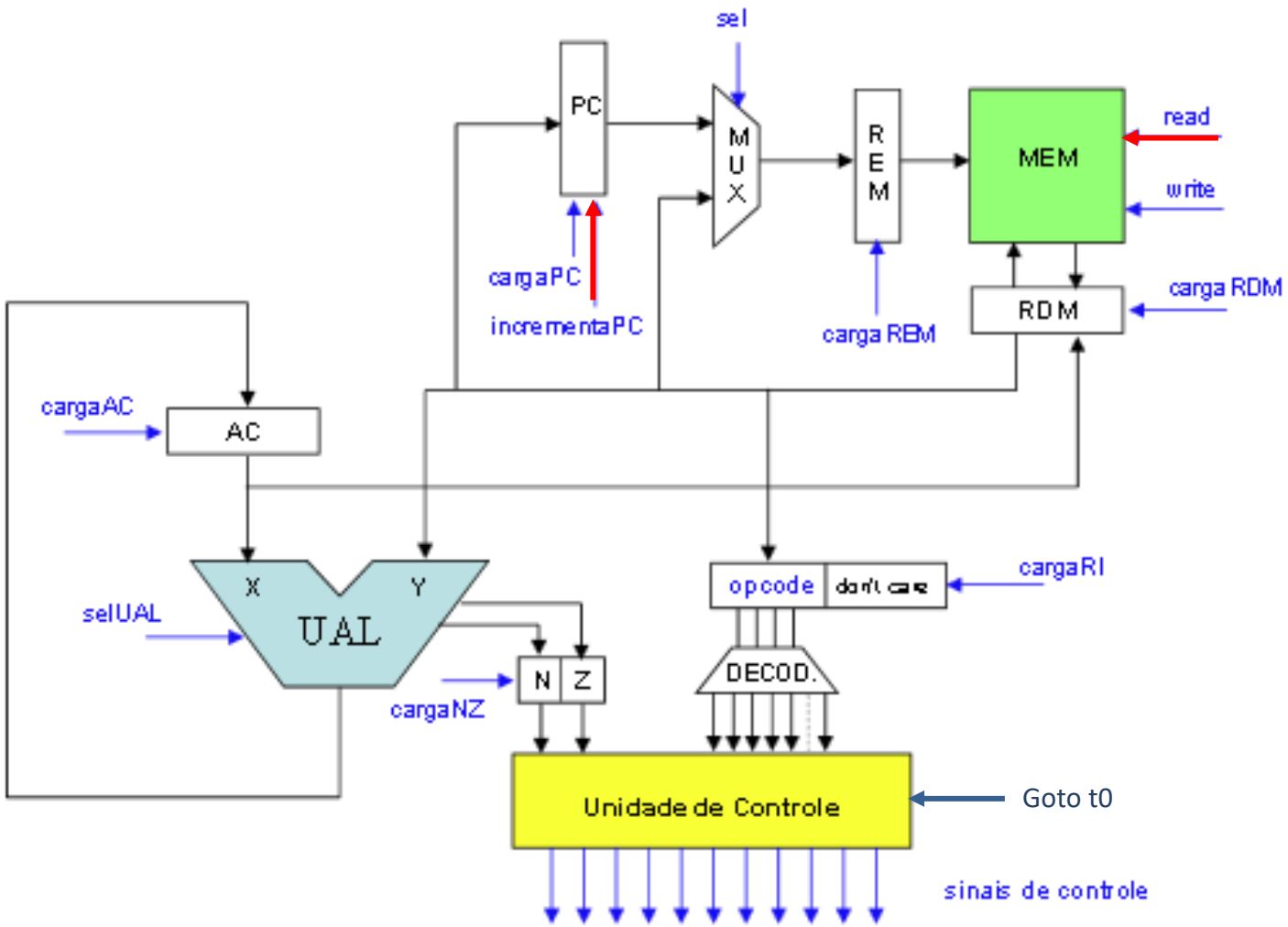
cargaNZ
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaAC
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opcode
don't care
cargaRI
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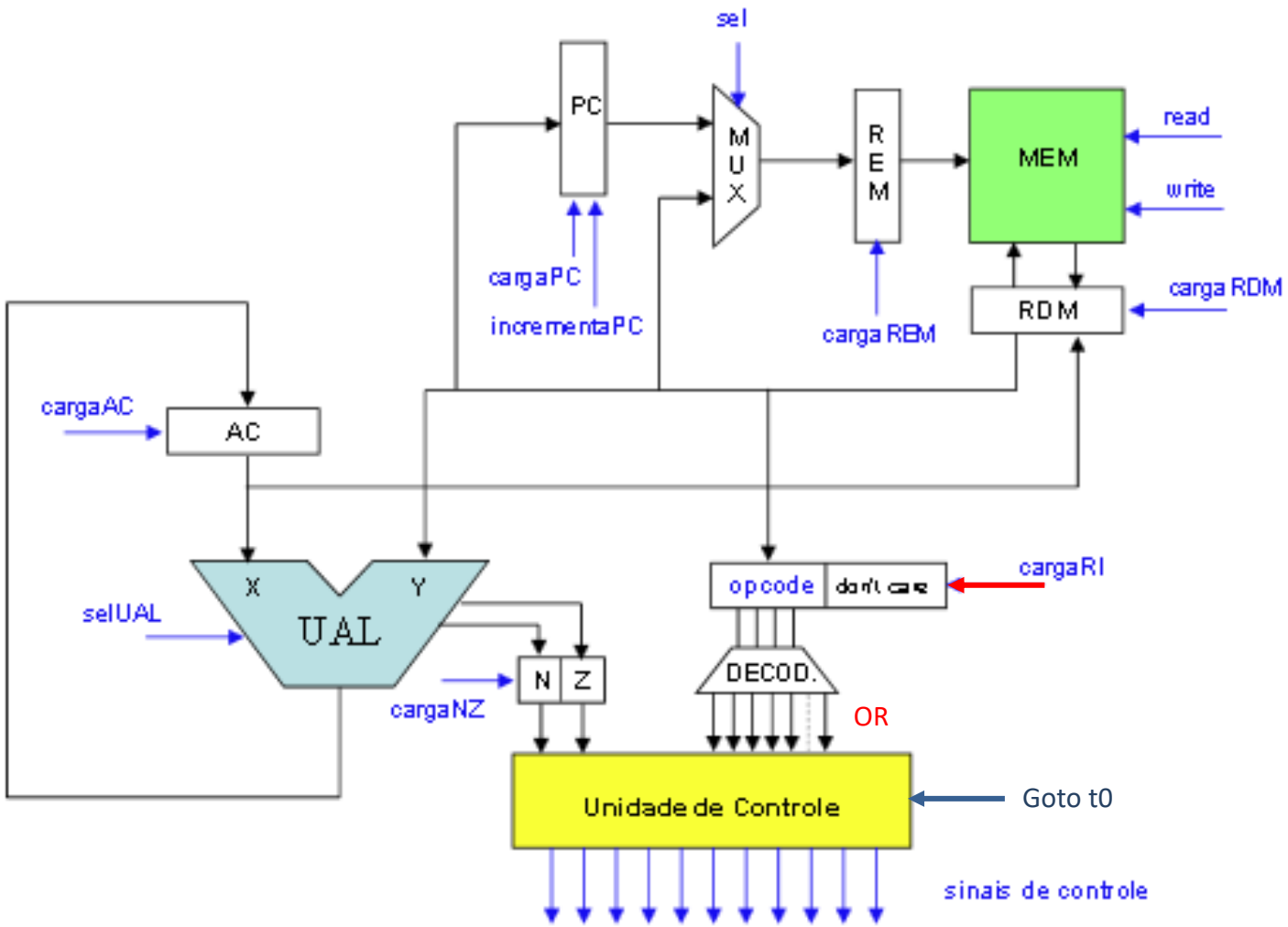
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
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opcode
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cargaRI
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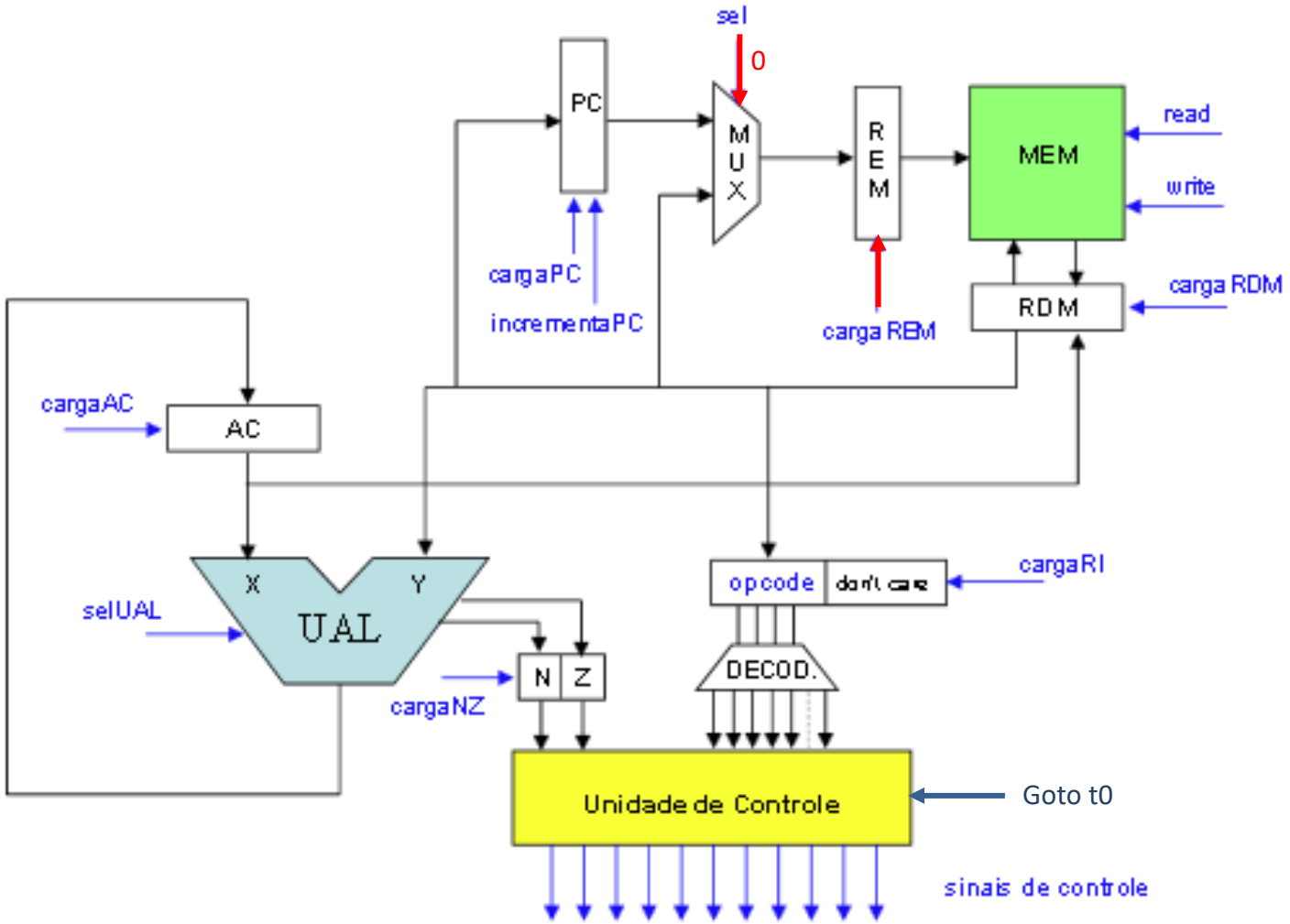
cargaNZ
DECOD.
OR
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaRDM
cargaAC
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don't care
cargaRI
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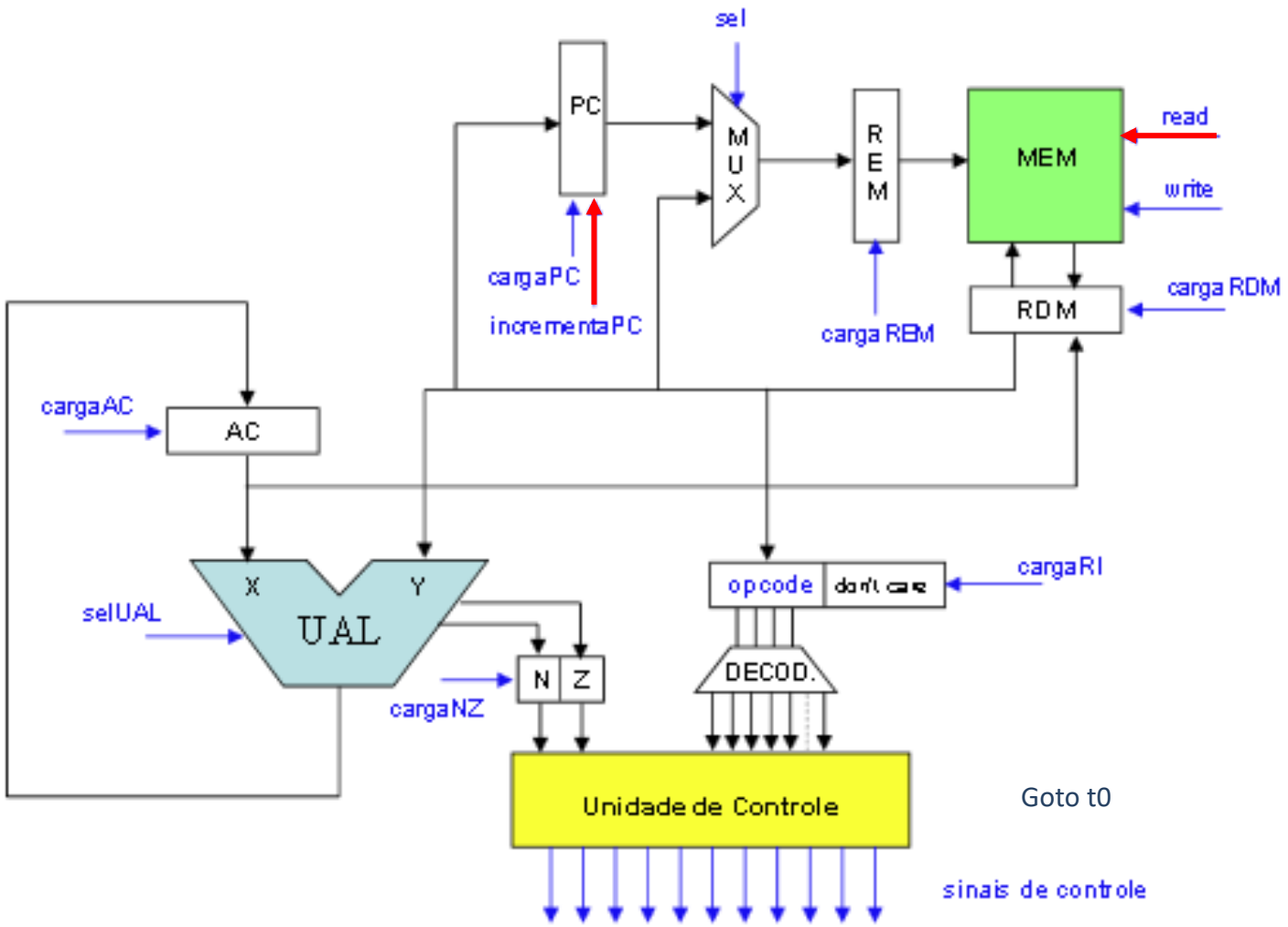
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaPC
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cargaREM
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cargaRI
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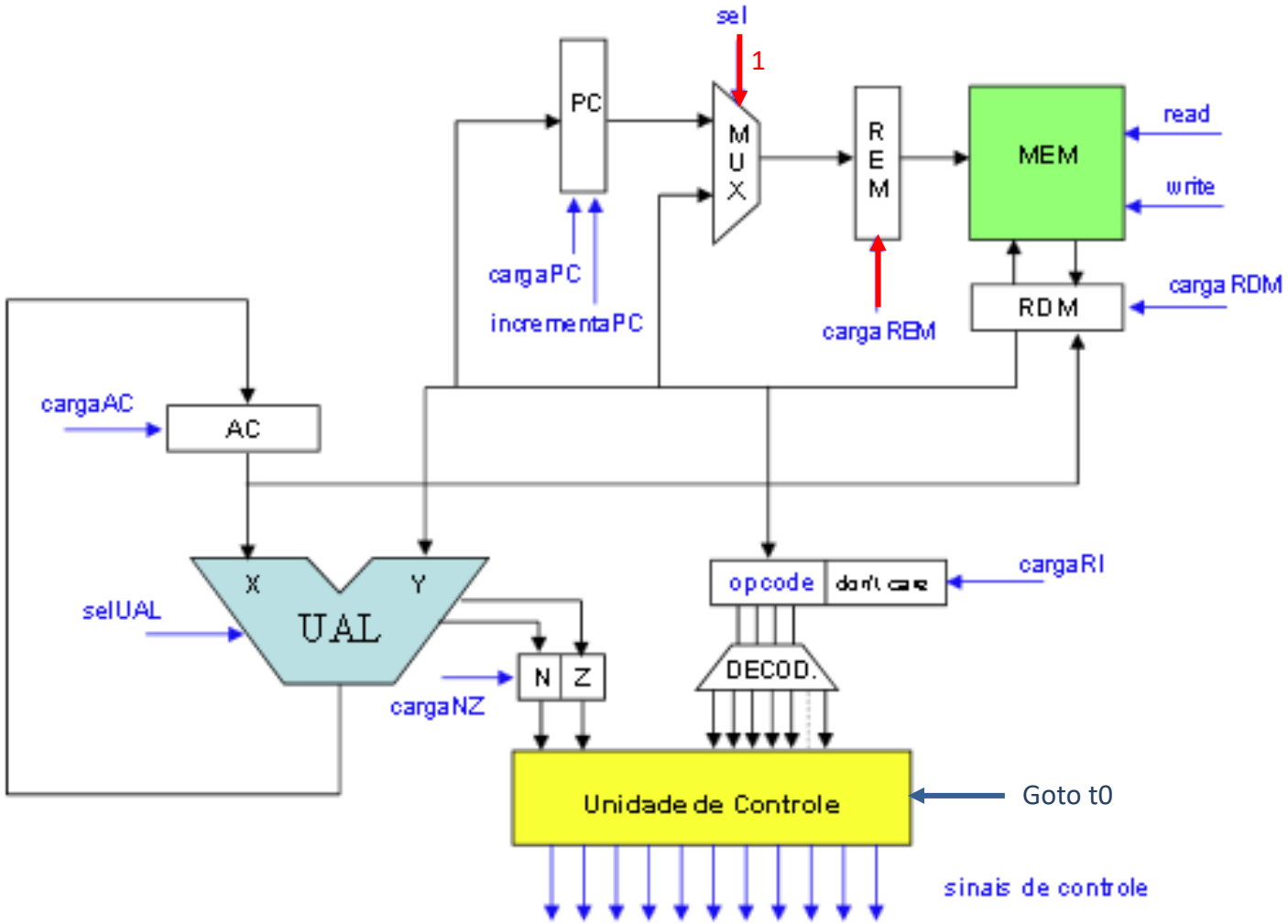
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaPC
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cargaREM
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cargaRDM
cargaAC
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opcode
don't care
cargaRI
N
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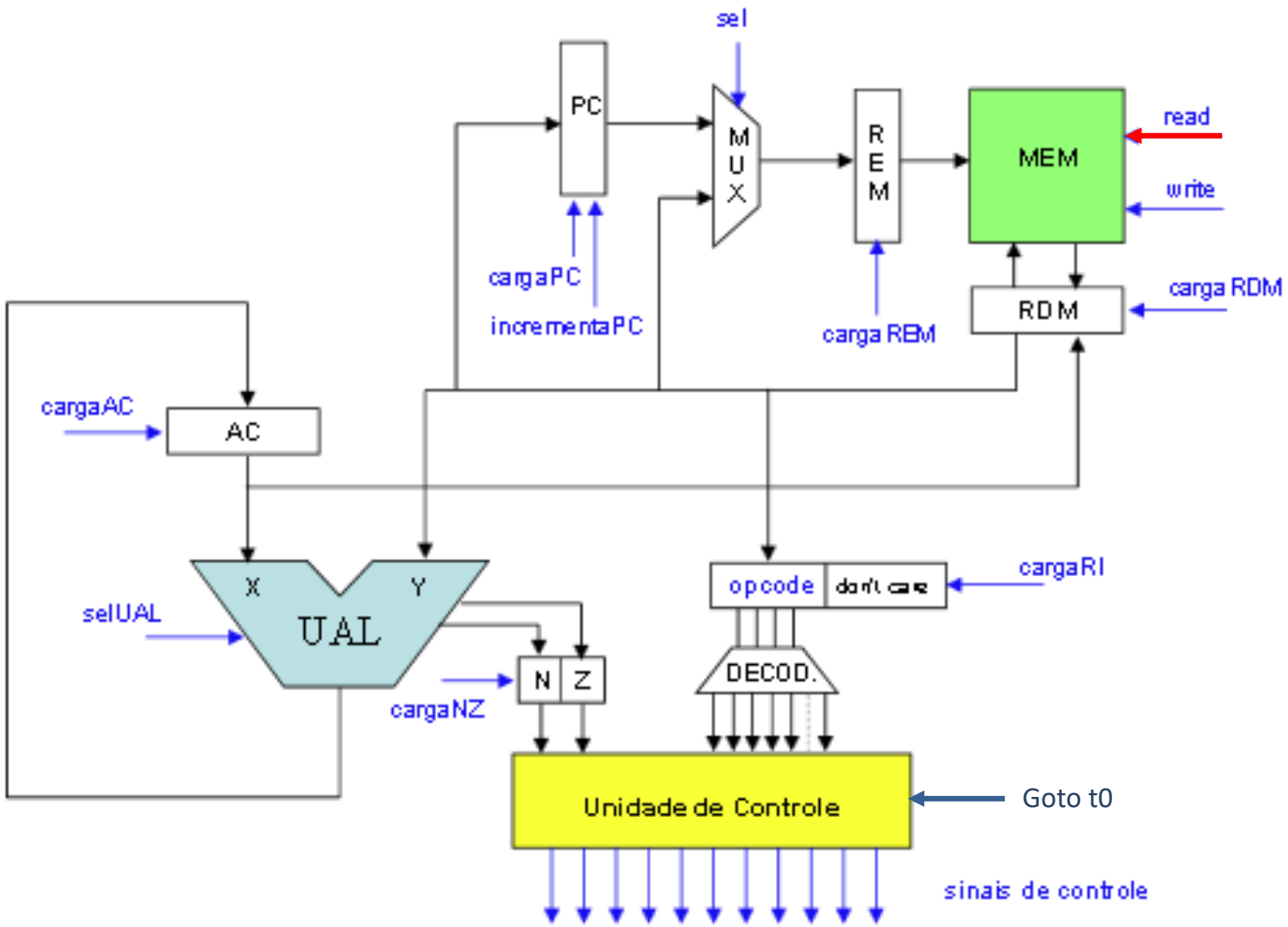
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaREM
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cargaRDM
cargaAC
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opcode
don't care
cargaRI
N
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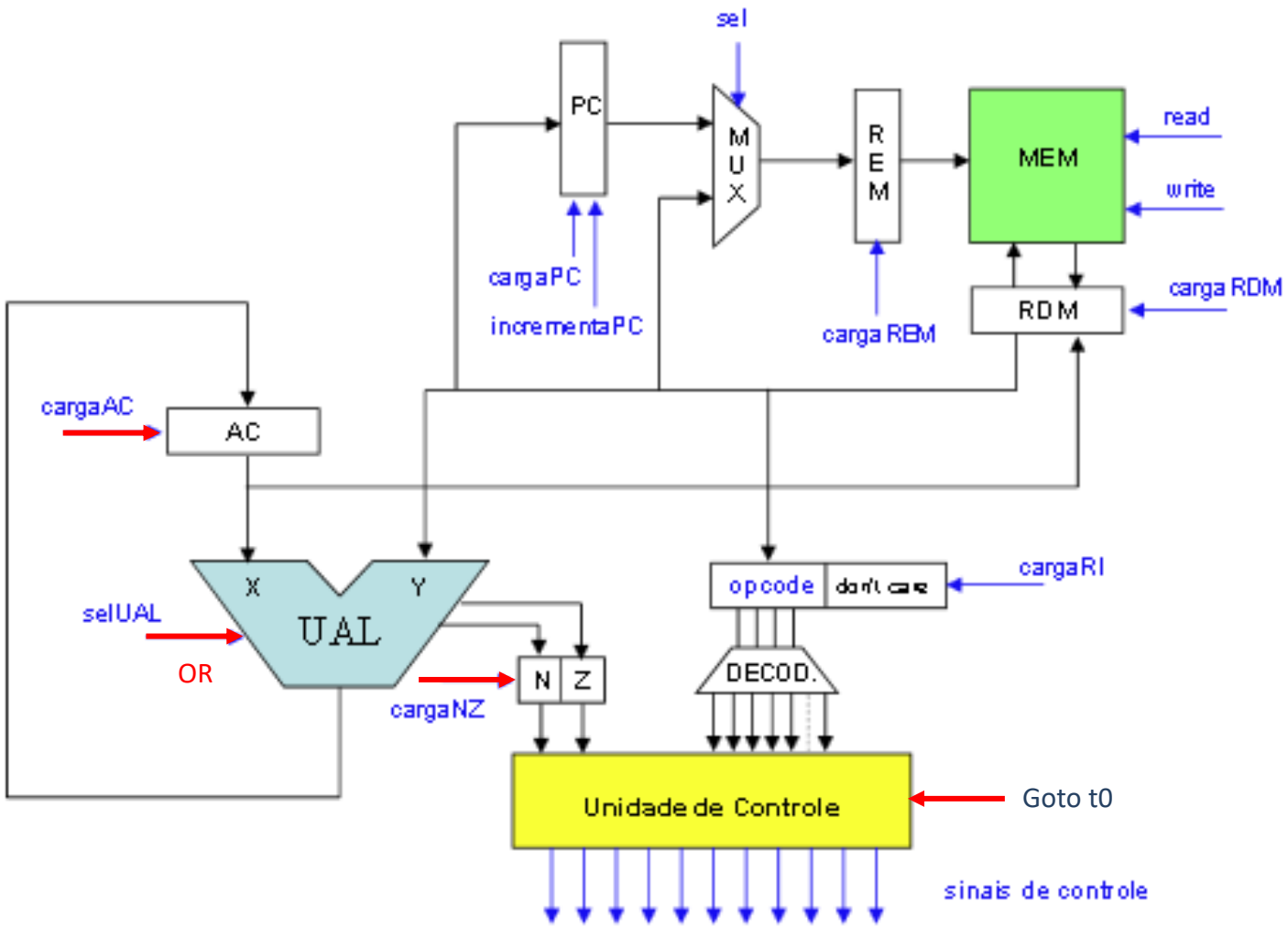
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função OR


sel
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cargaREM
RDM
cargaRDM
cargaAC
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OR
cargaNZ
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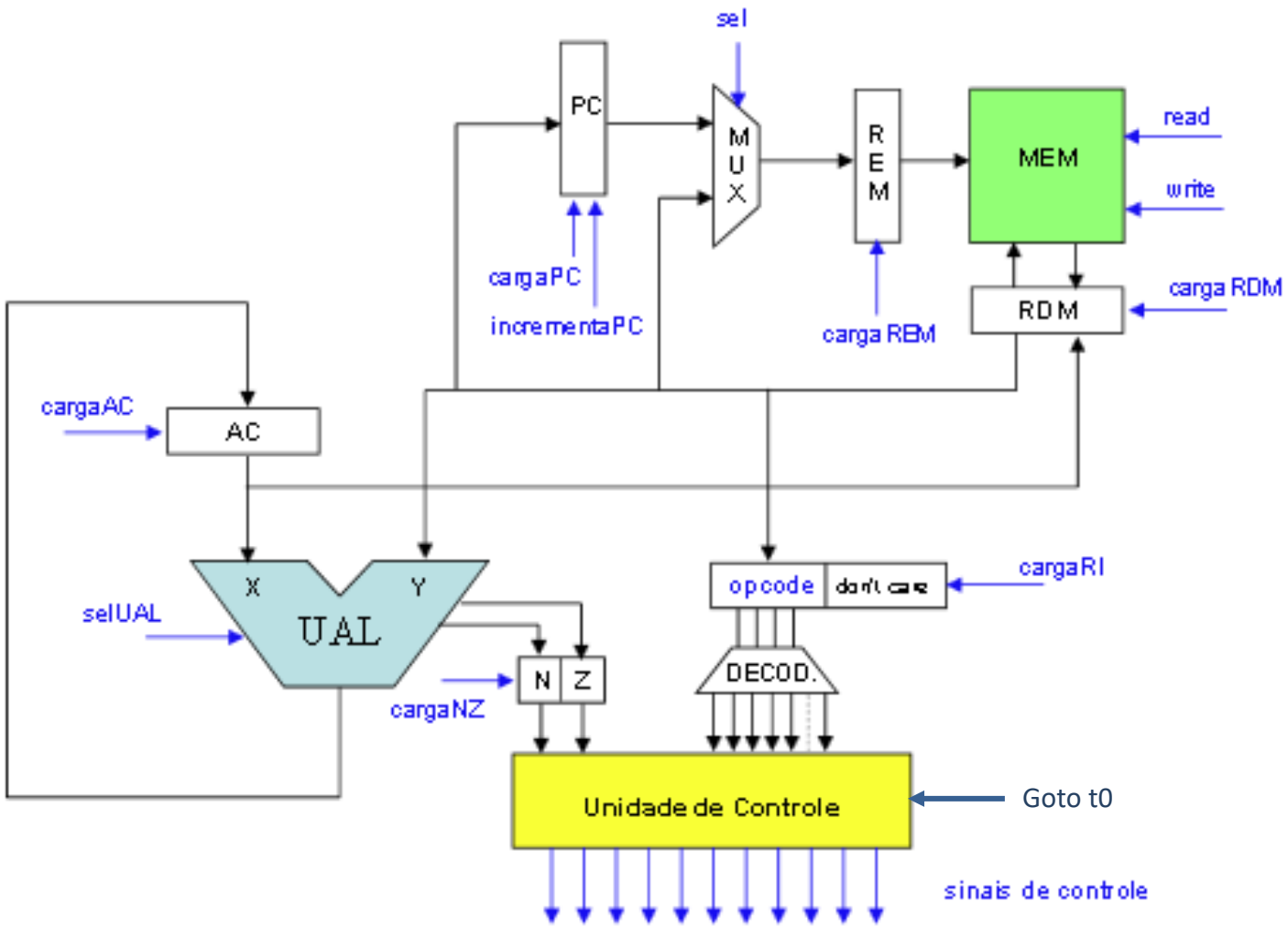
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

Função AND


sel
PC
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read
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cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
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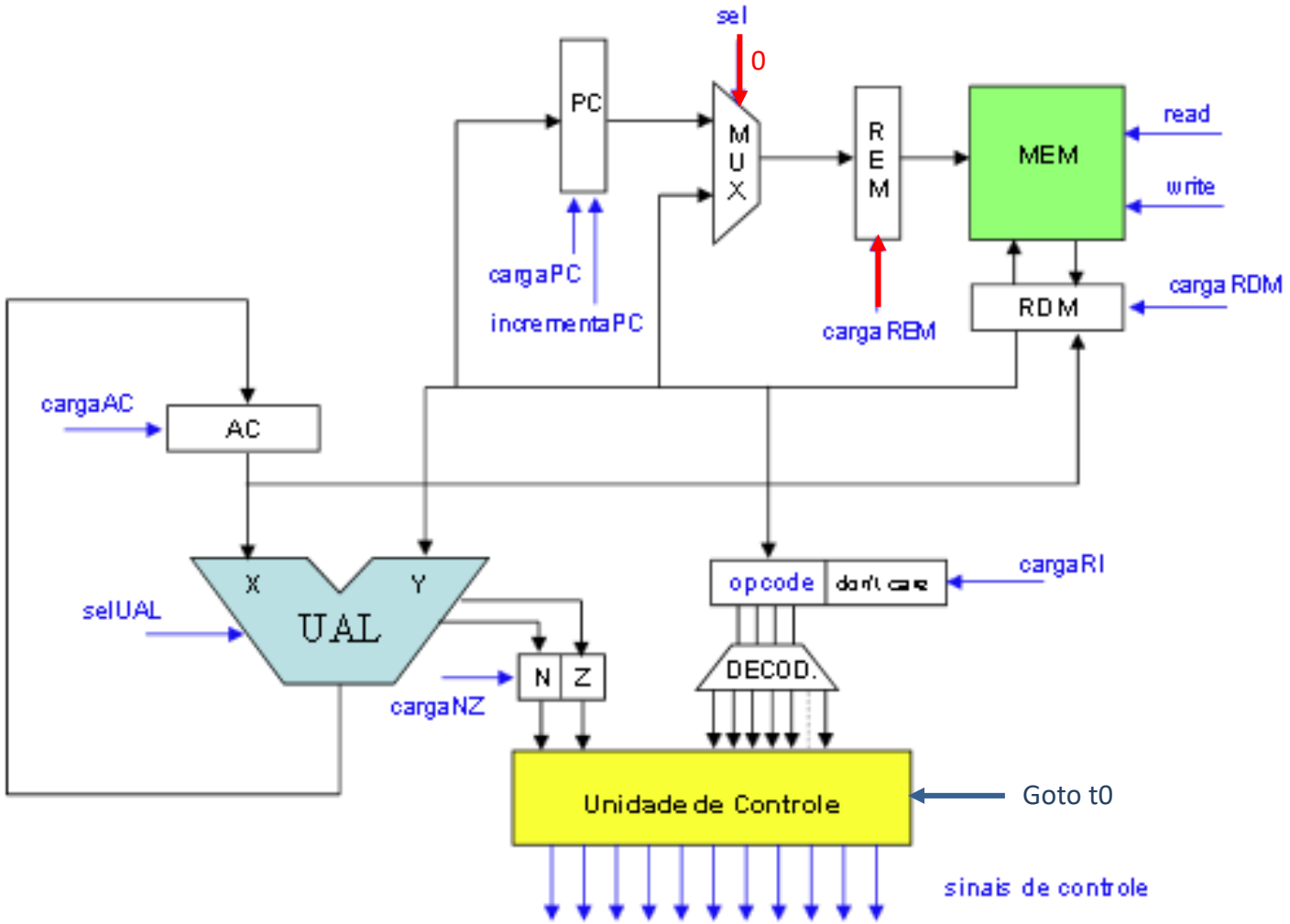
X
Y
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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cargaRI
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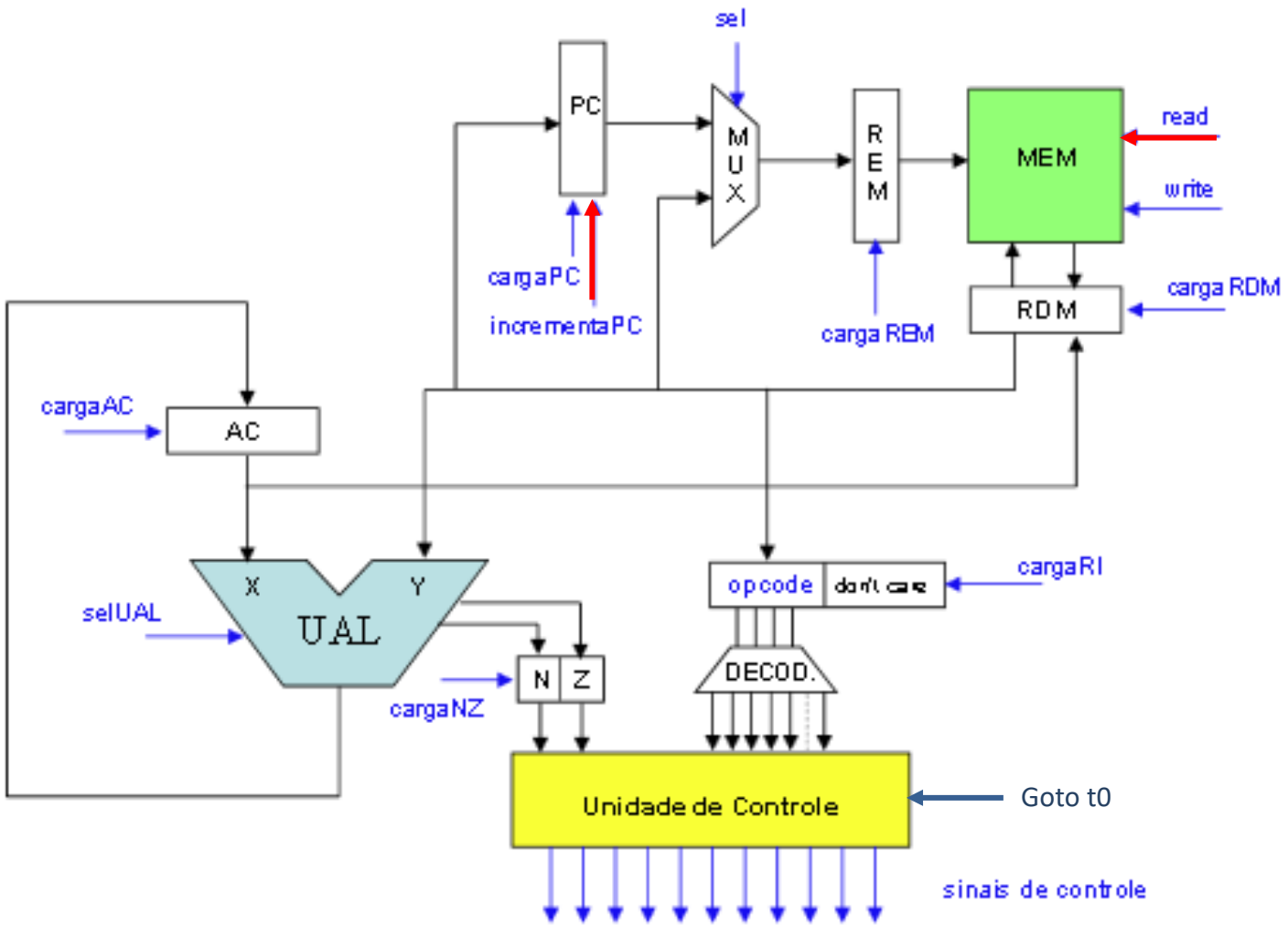
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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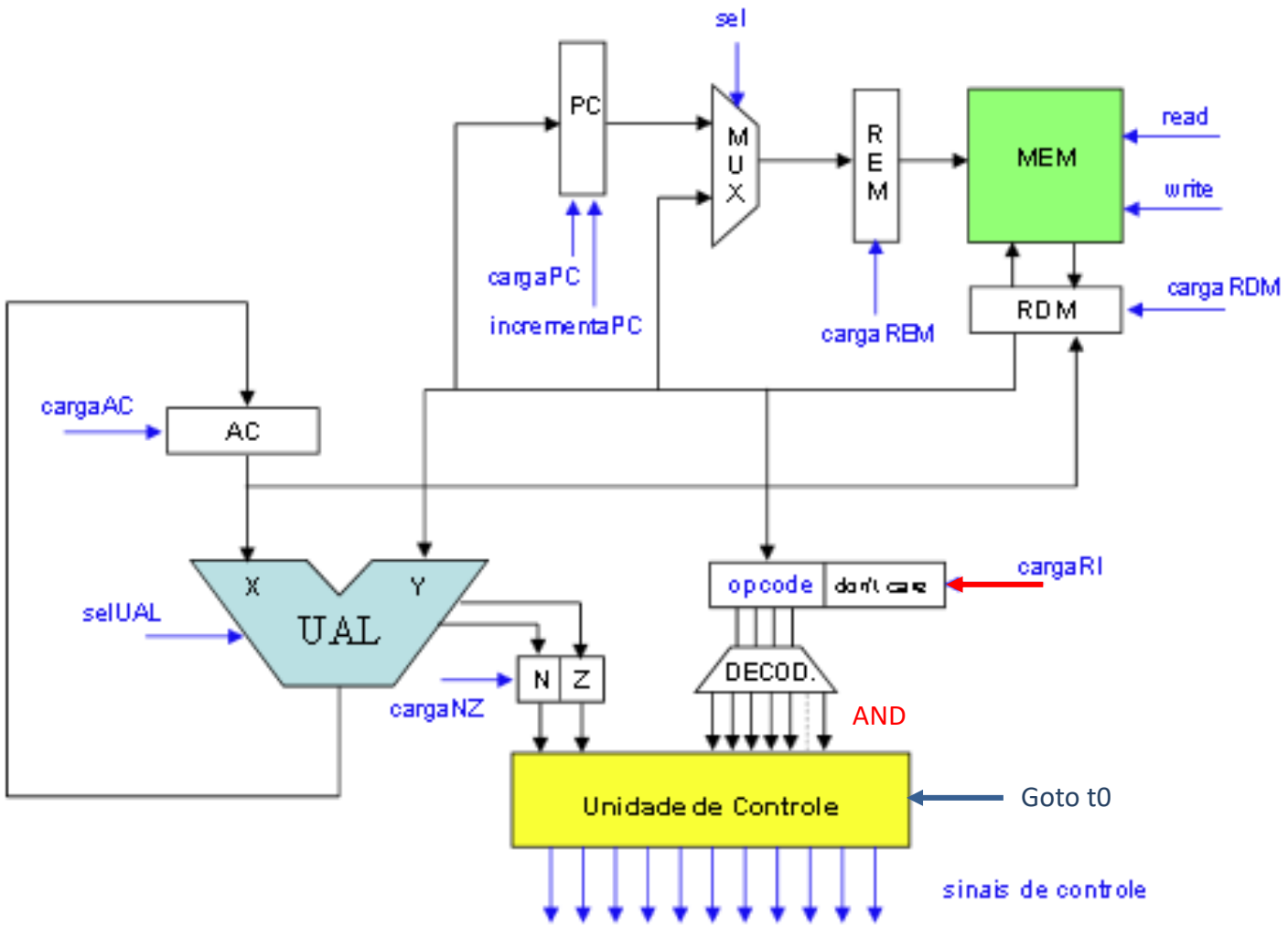
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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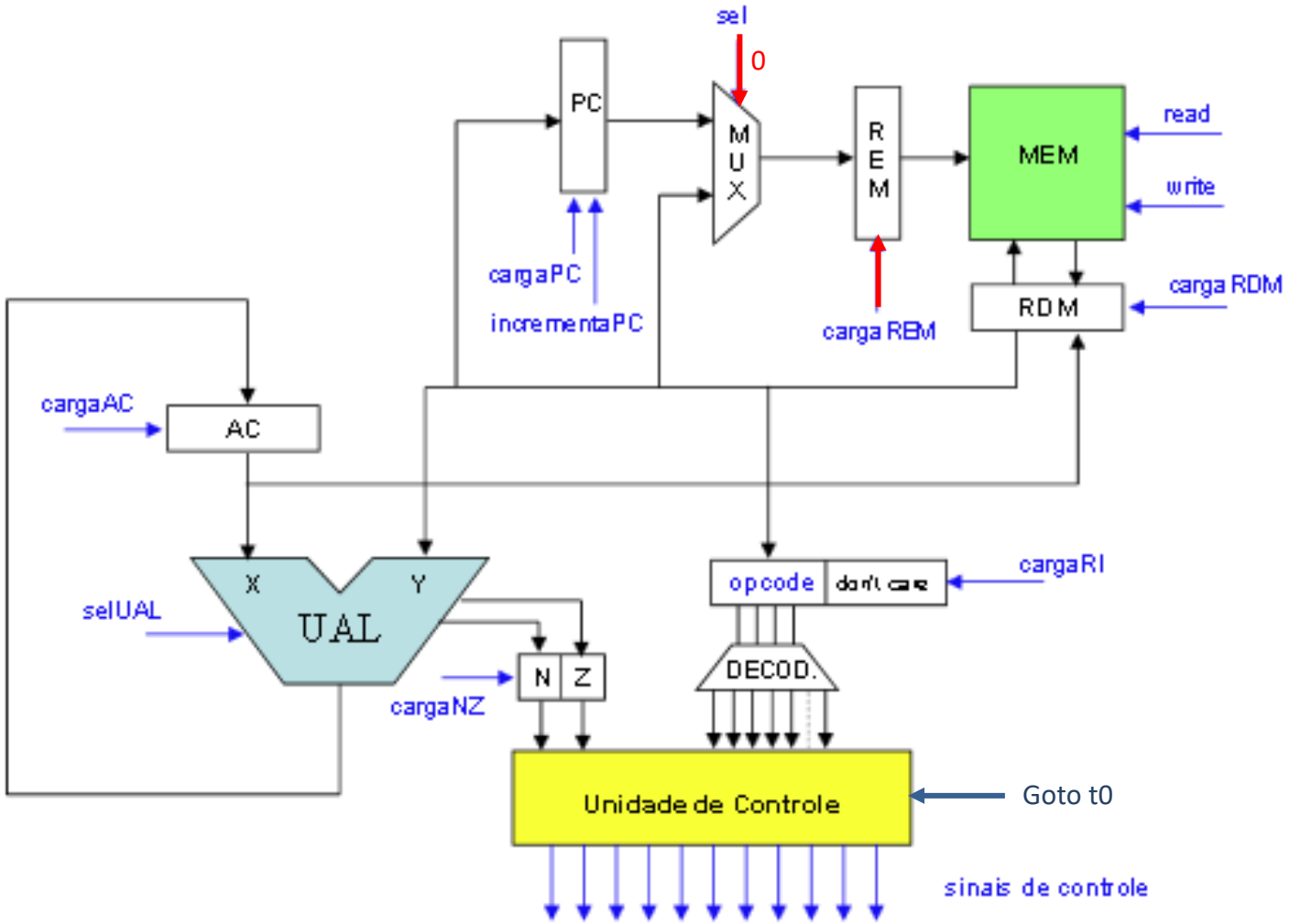
DECOD.
AND
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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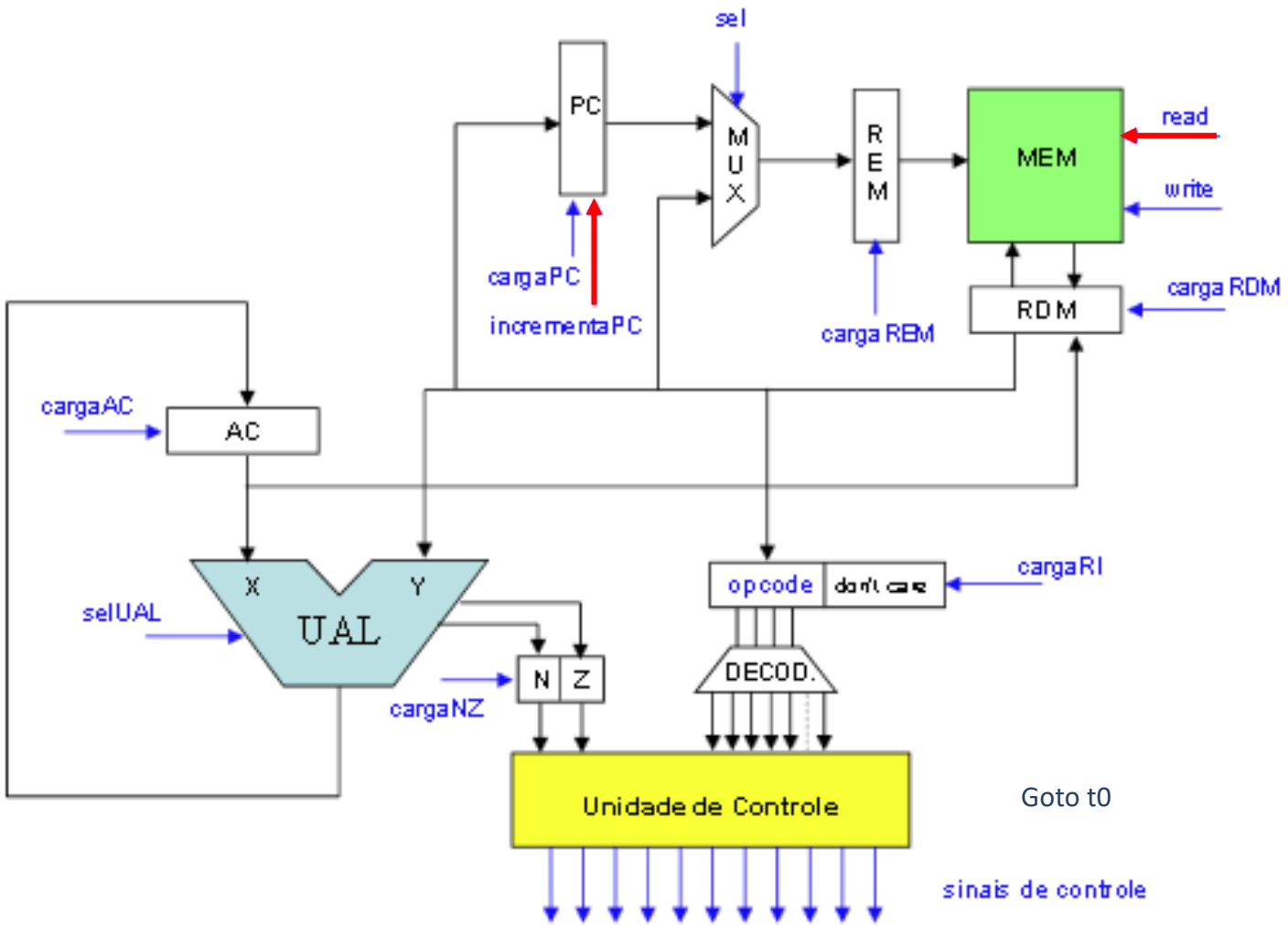
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND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cargaRI
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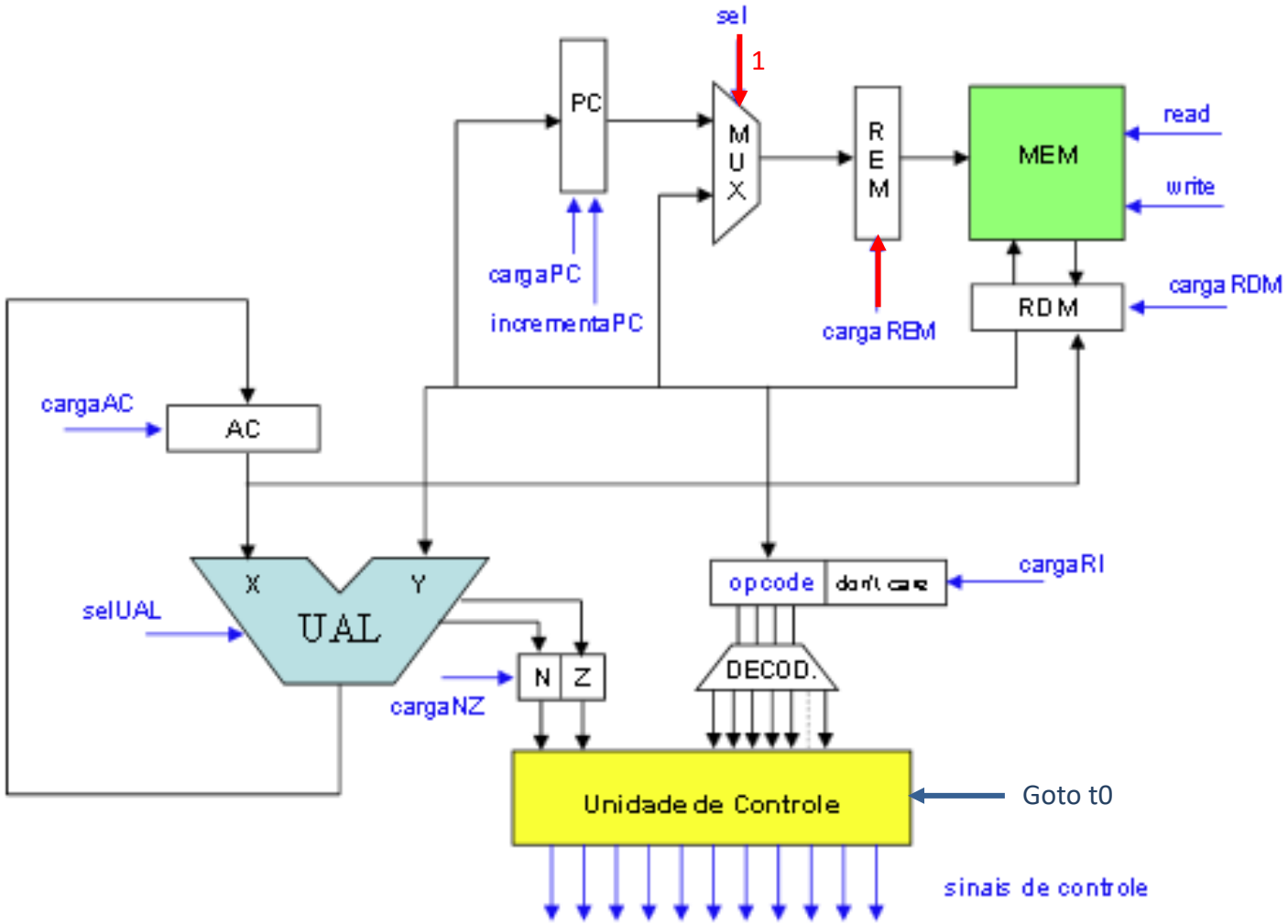
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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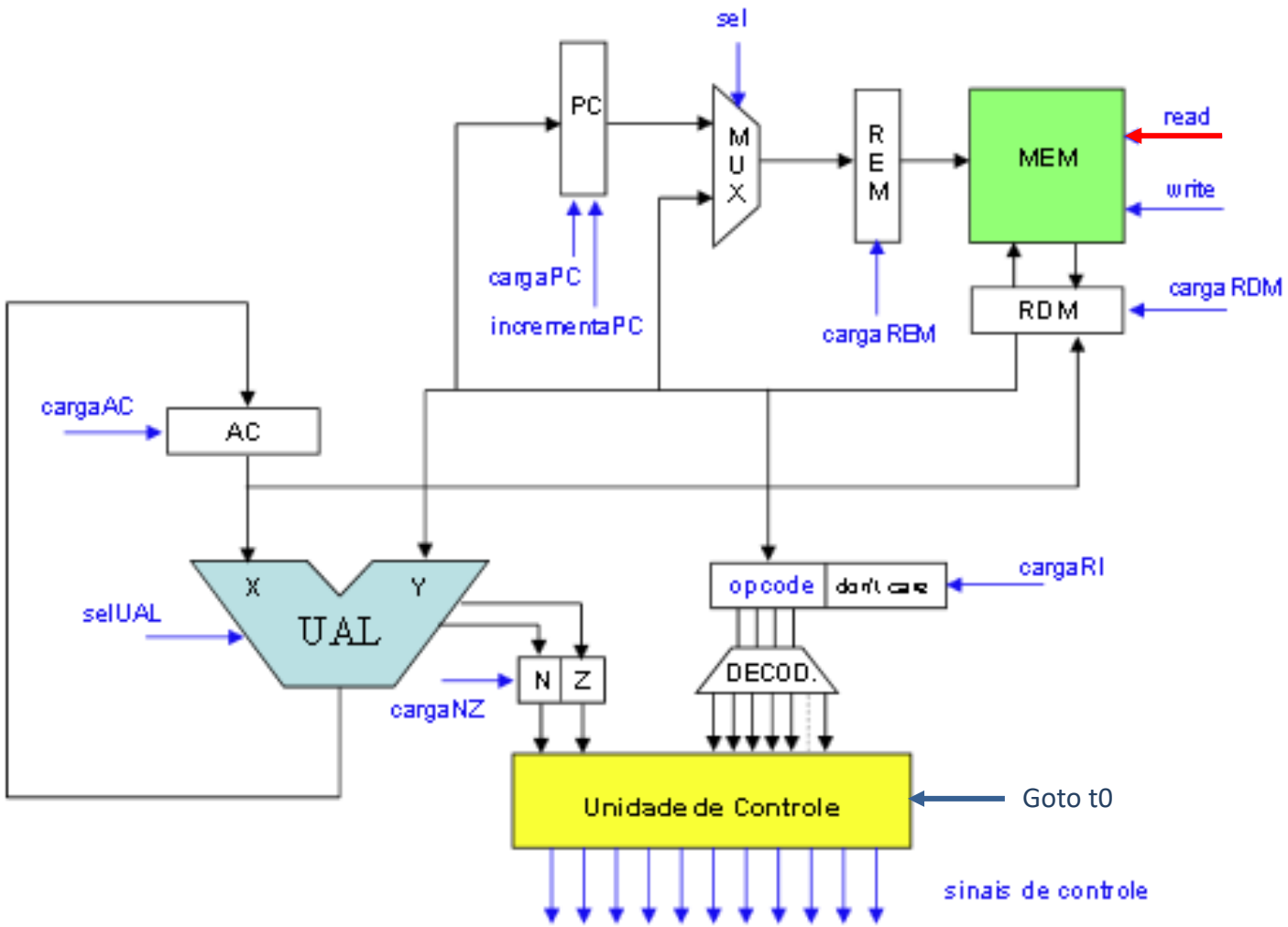
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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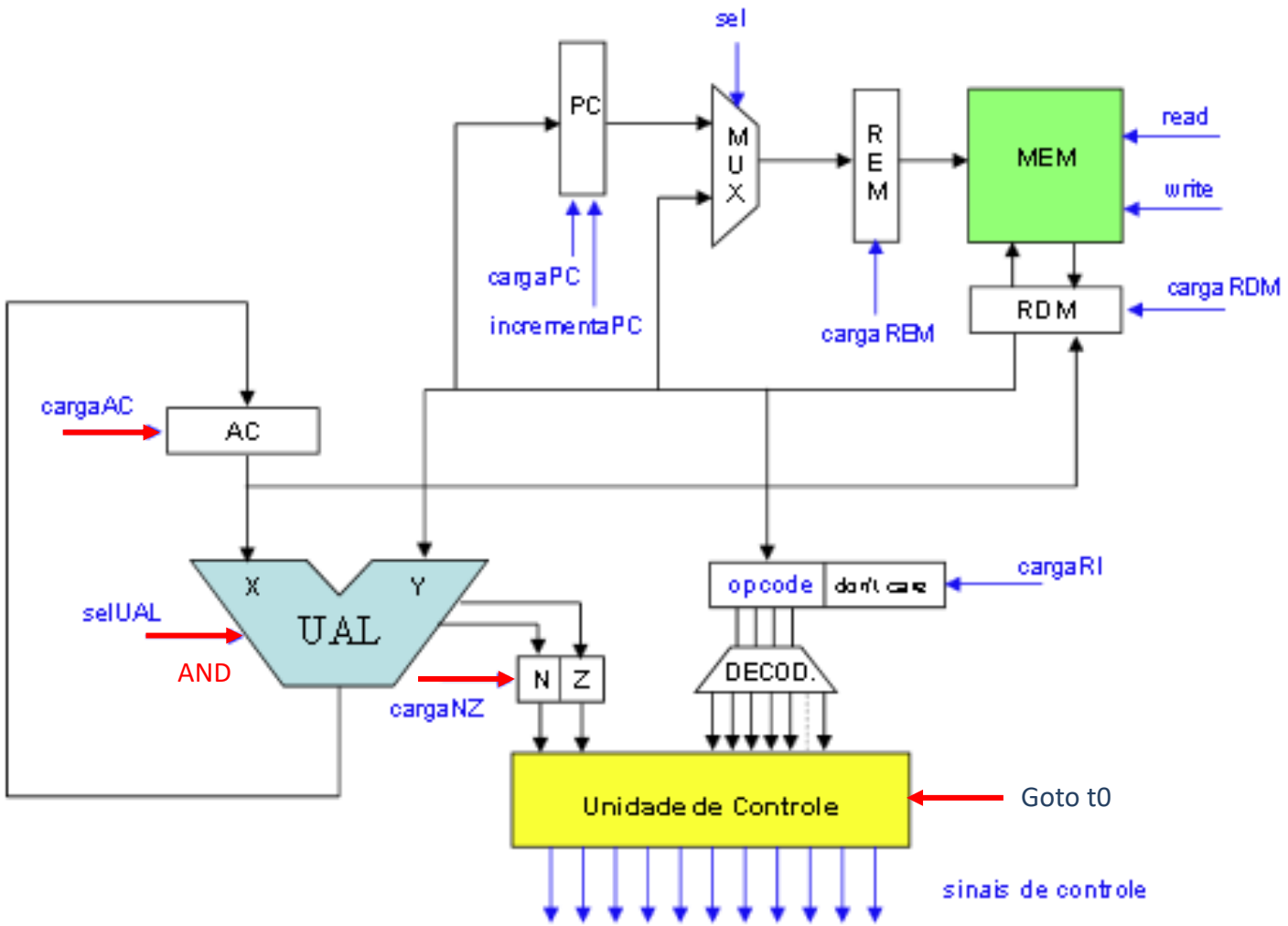
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função AND


sel
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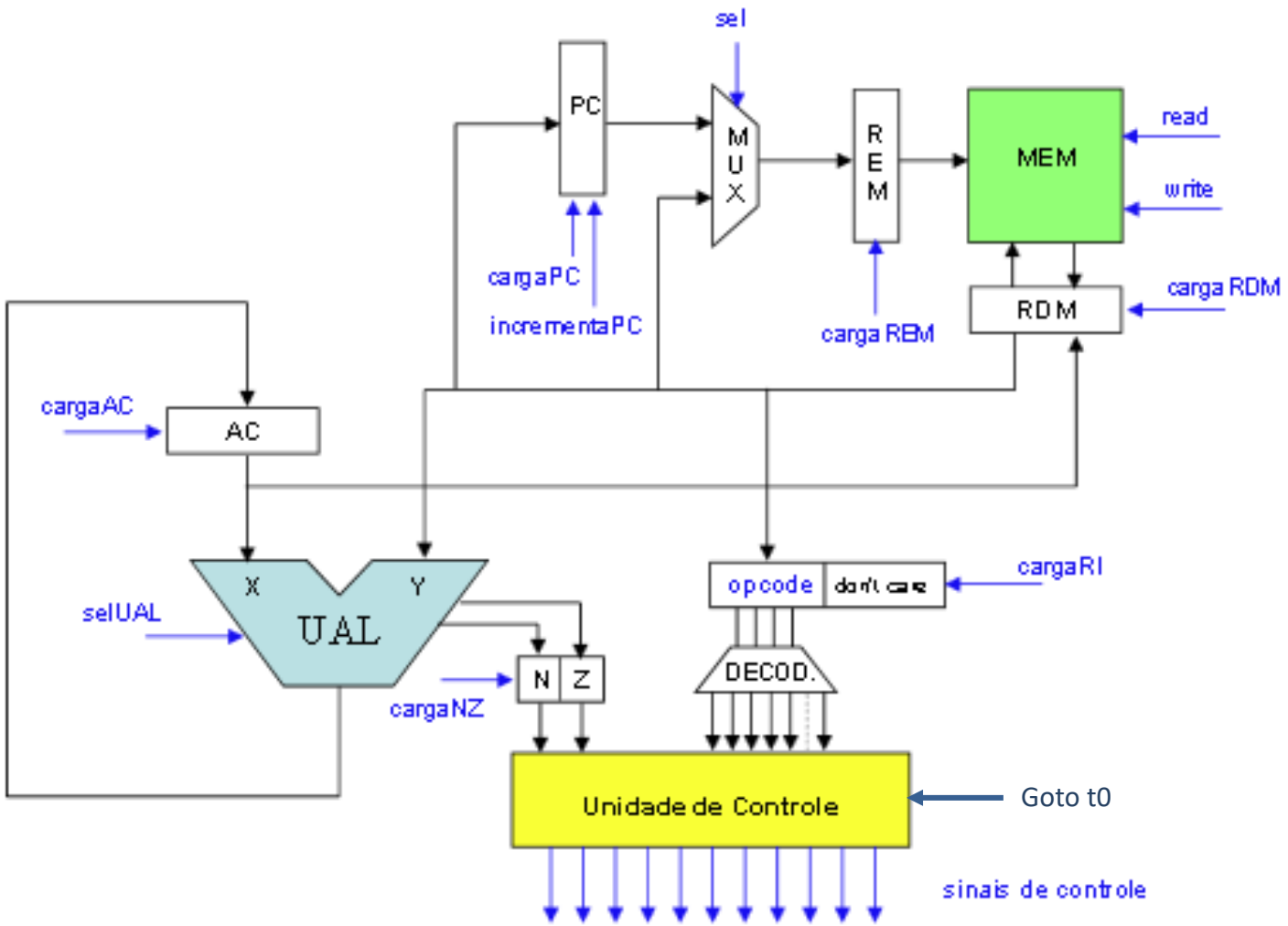
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

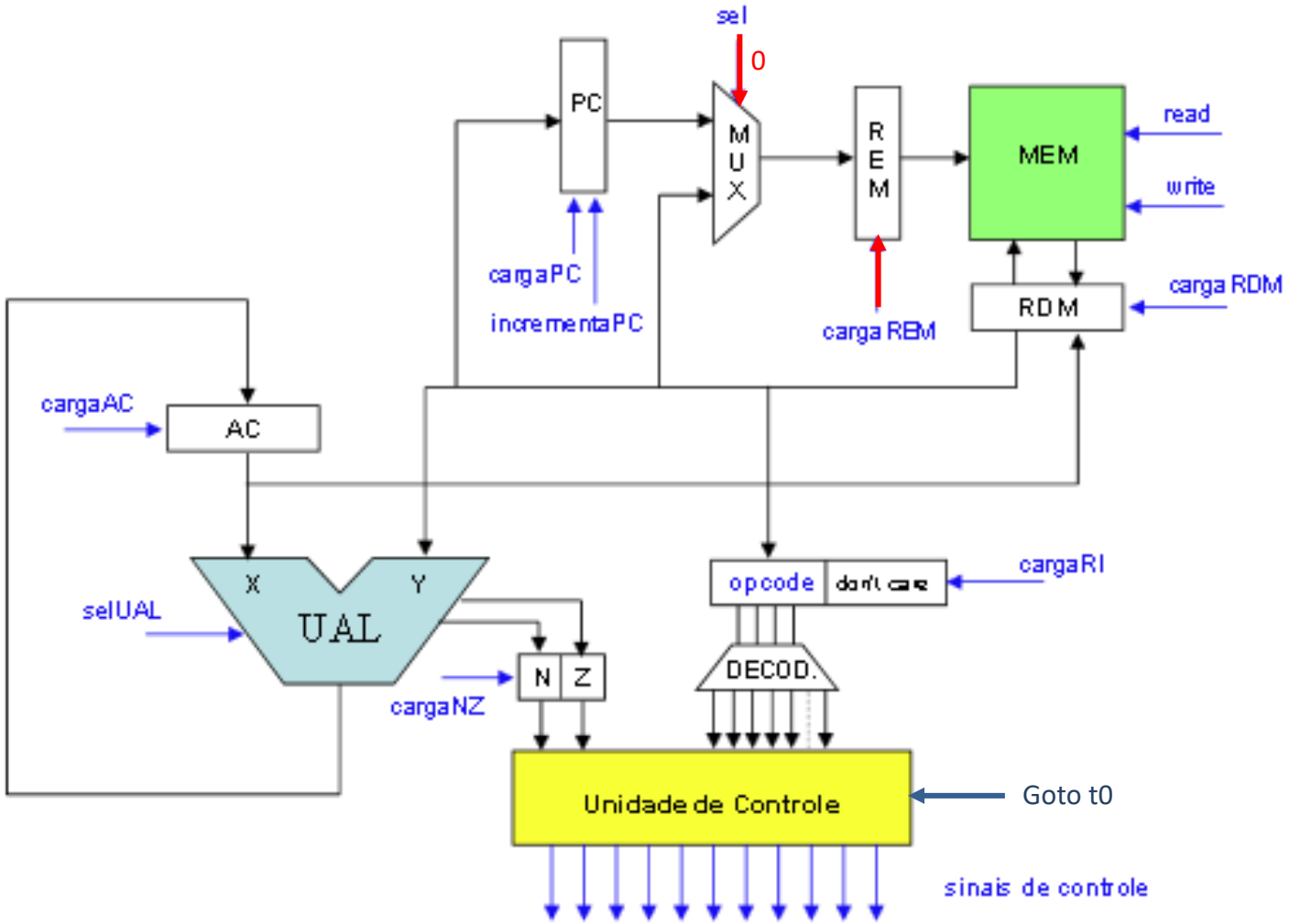
Neander: Temporização dos Sinais de Controle

tempo	STA	LDA	ADD	OR	AND	NOT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	UAL(NOT), carga AC, carga NZ, goto t0
t4	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	
t5	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	sel=1, carga REM	
t6	carga RDM	Read	Read	Read	Read	
t7	Write, goto t0	UAL(Y), carga AC, carga NZ, goto t0	UAL(ADD), carga AC, carga NZ, goto t0	UAL(OR), carga AC, carga NZ, goto t0	UAL(AND, carga AC, carga NZ, goto t0	

Função NOT


sel
PC
M
U
X
R
E
M
MEM
read
write
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
Y
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOT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incrementaPC
cargaREM
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cargaRDM
cargaAC
AC
X
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selUAL
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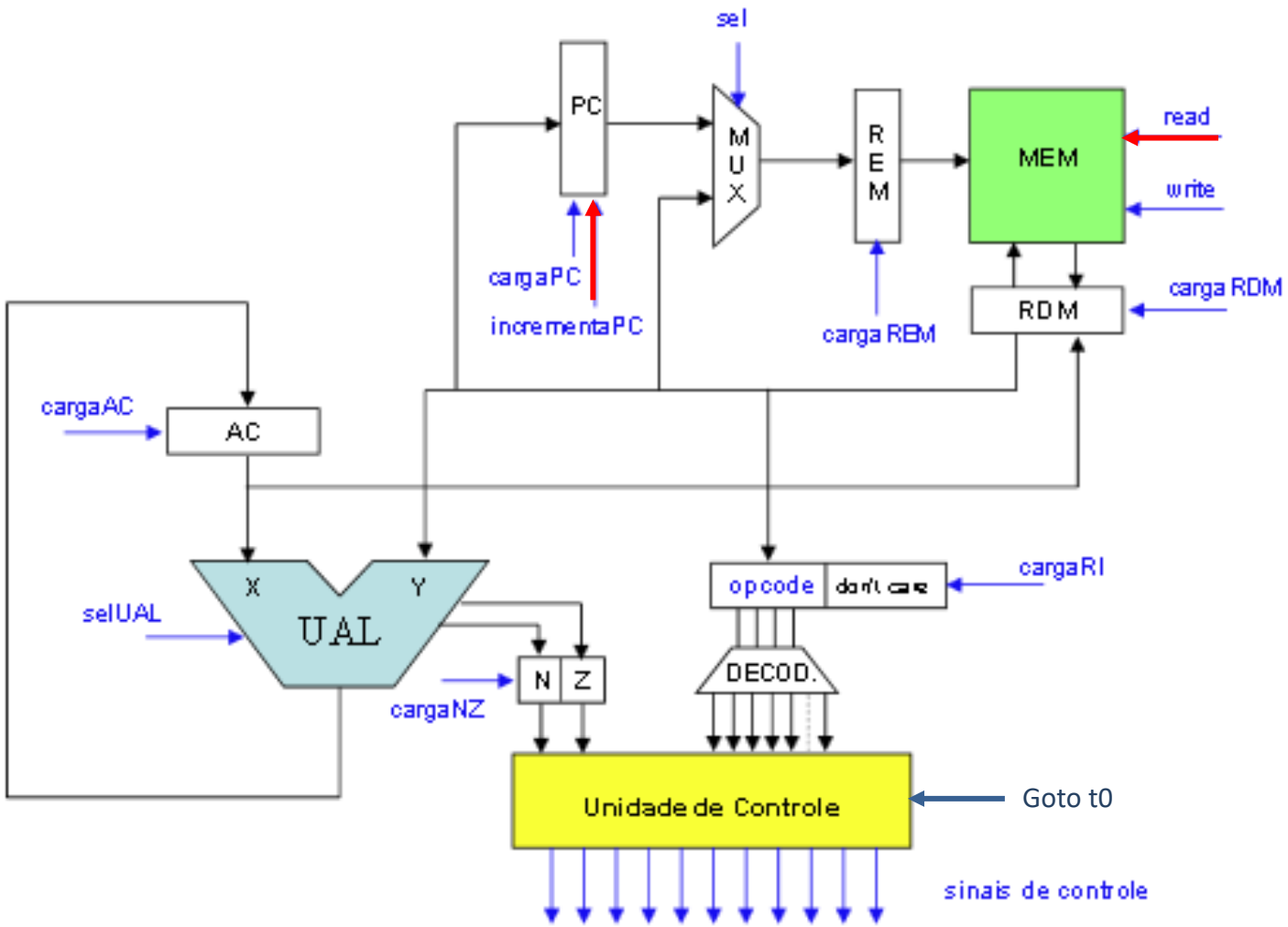
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOT


sel
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RDM
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opcode
don't care
cargaRI
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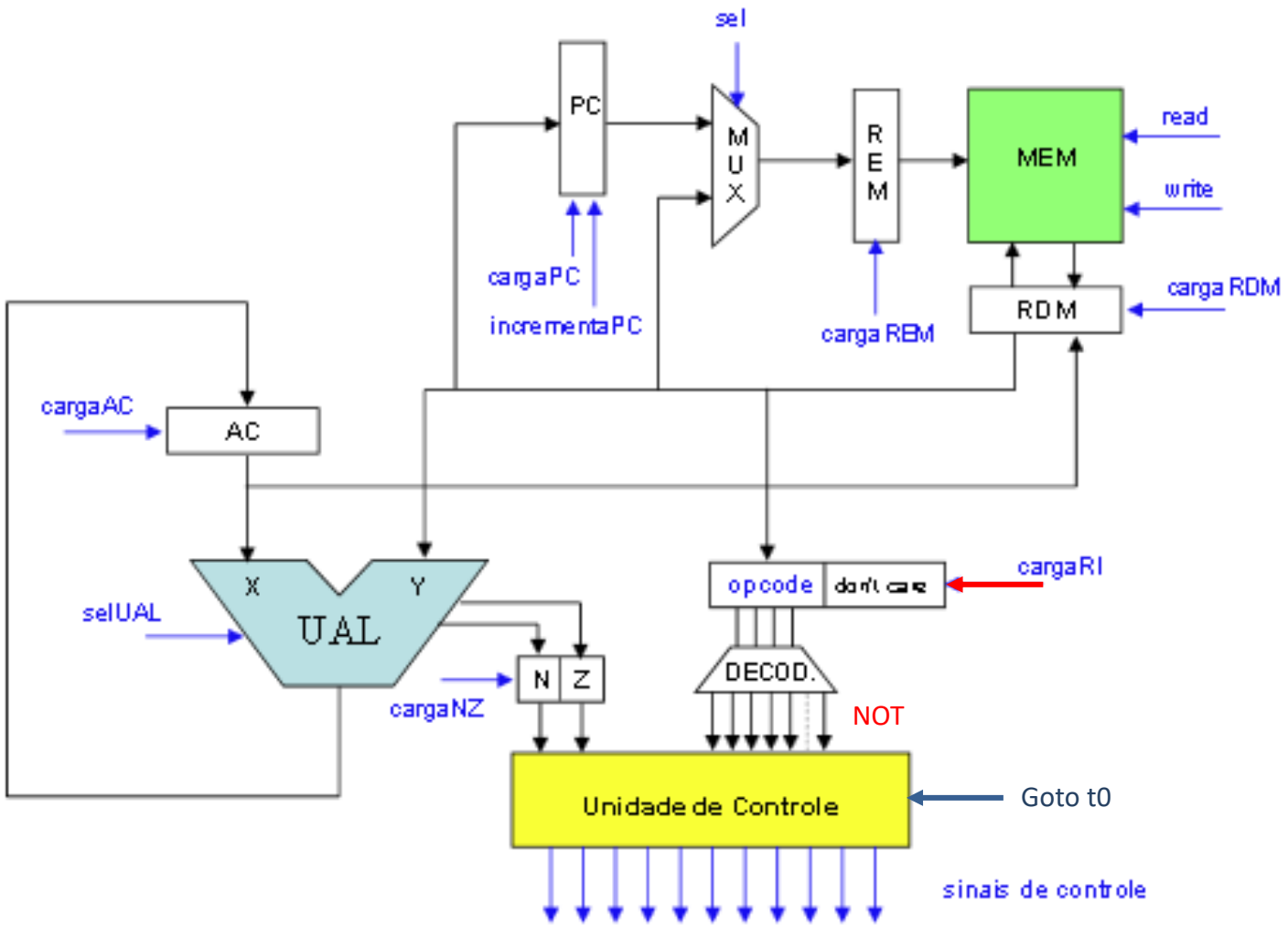
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOT


sel
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incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
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UAL
selUAL
N
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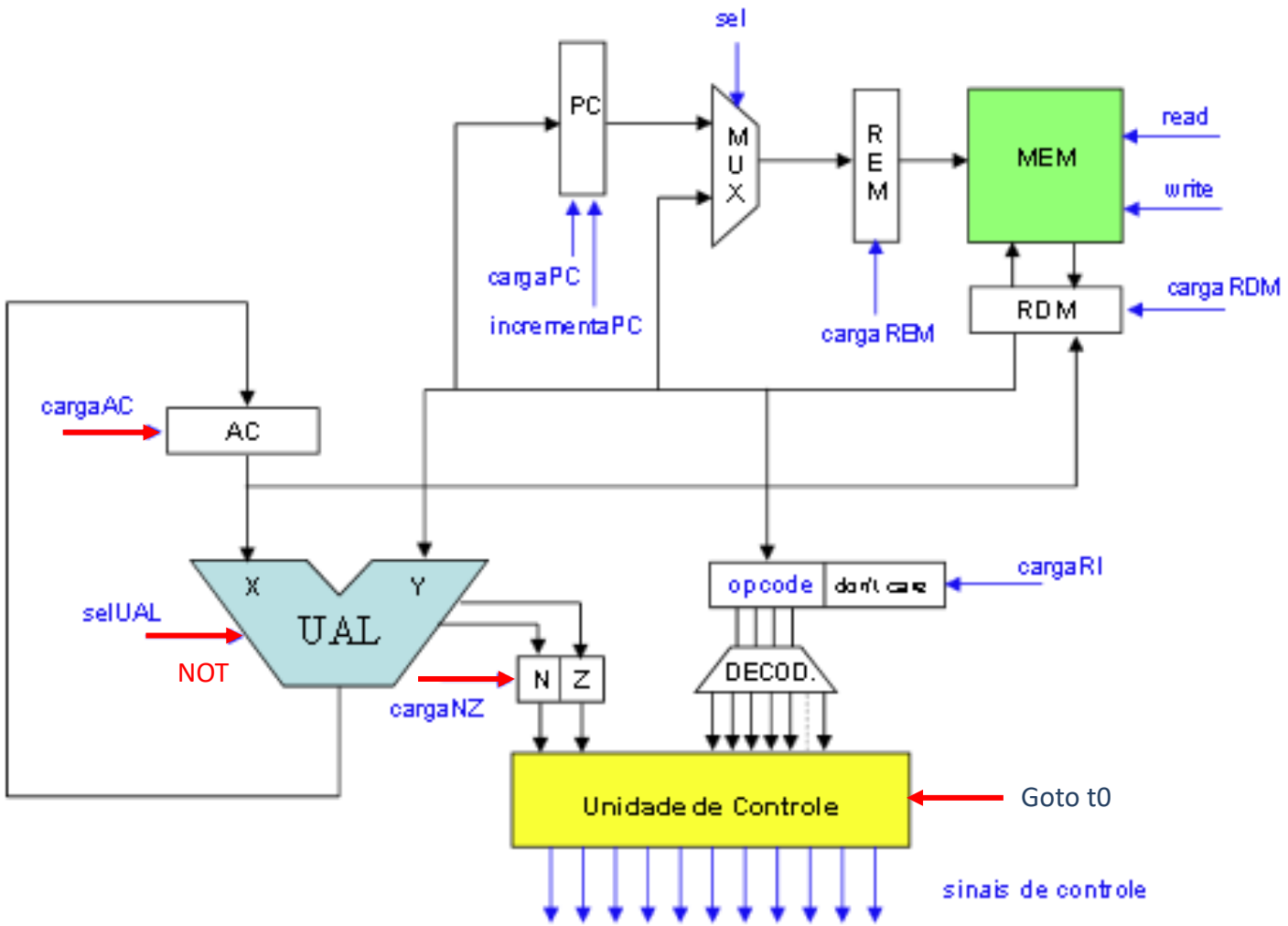
cargaNZ
opcode
don't care
cargaRI
DECOD.
NOT
Unidade de Controle
Goto t0
sinais de controle

Função NOT


sel
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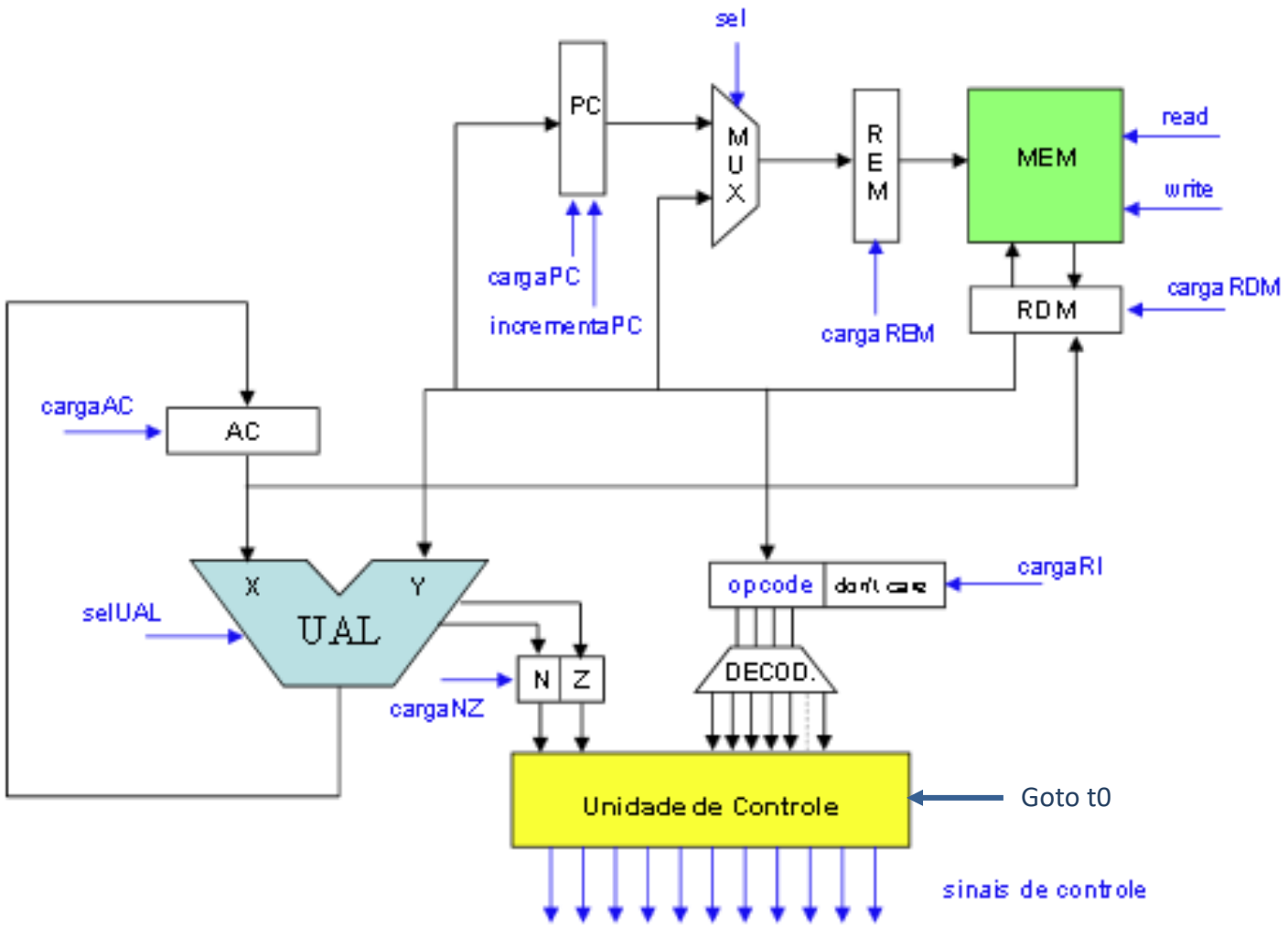
cargaNZ
opcode
don't care
cargaRI
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

tempo	JMP	JN, N=1	JN, N=0	JZ, Z=1	JZ, Z=0	NOP	HLT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	incrementa PC, goto t0	sel=0, carga REM	incrementa PC, goto t0	goto t0	Halt
t4	Read	Read		Read			
t5	carga PC, goto t0	carga PC, goto t0		carga PC, goto t0			
t6							
t7							

Função JMP


sel
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MEM
read
write
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
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opcode
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cargaRI
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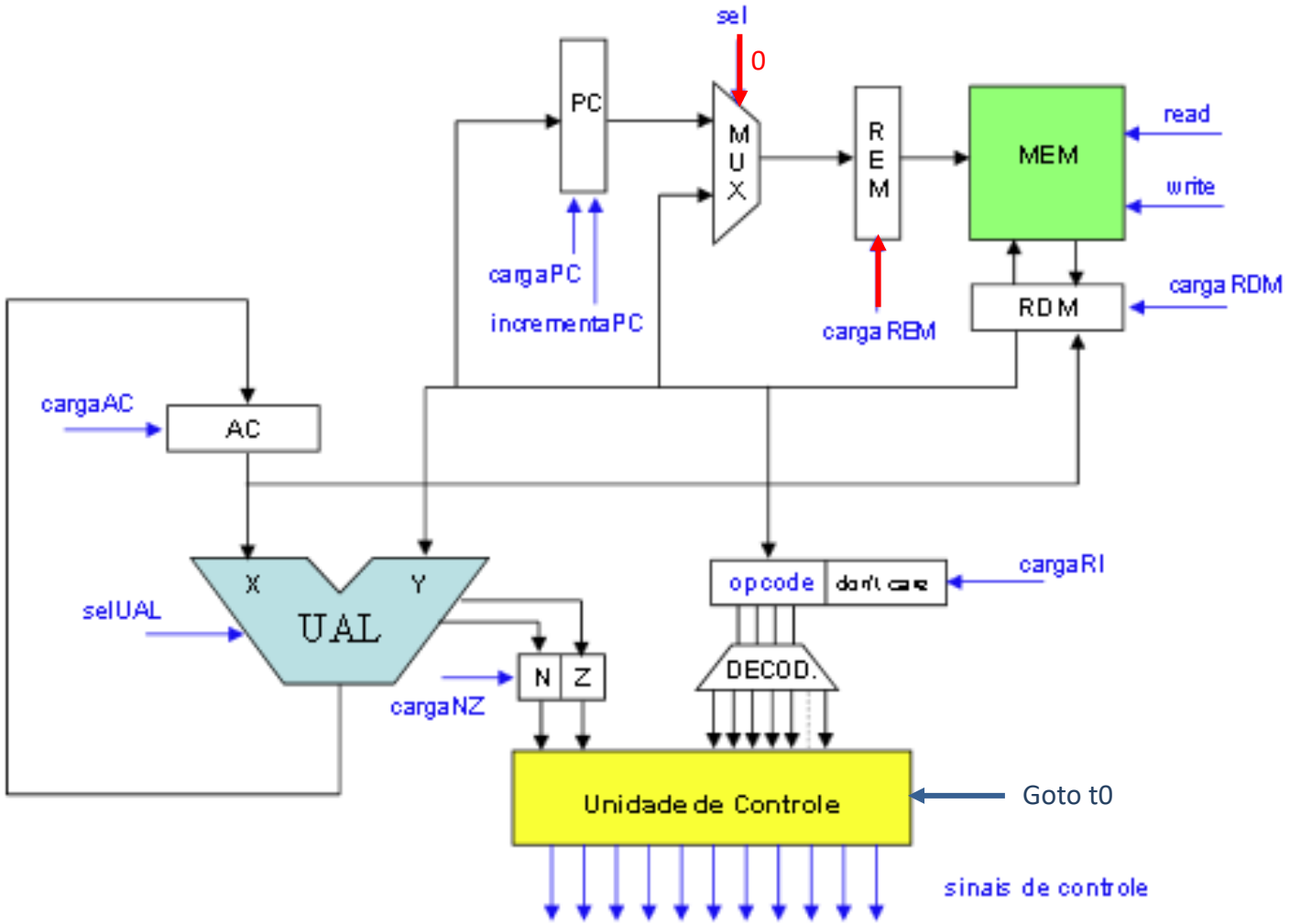
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função JMP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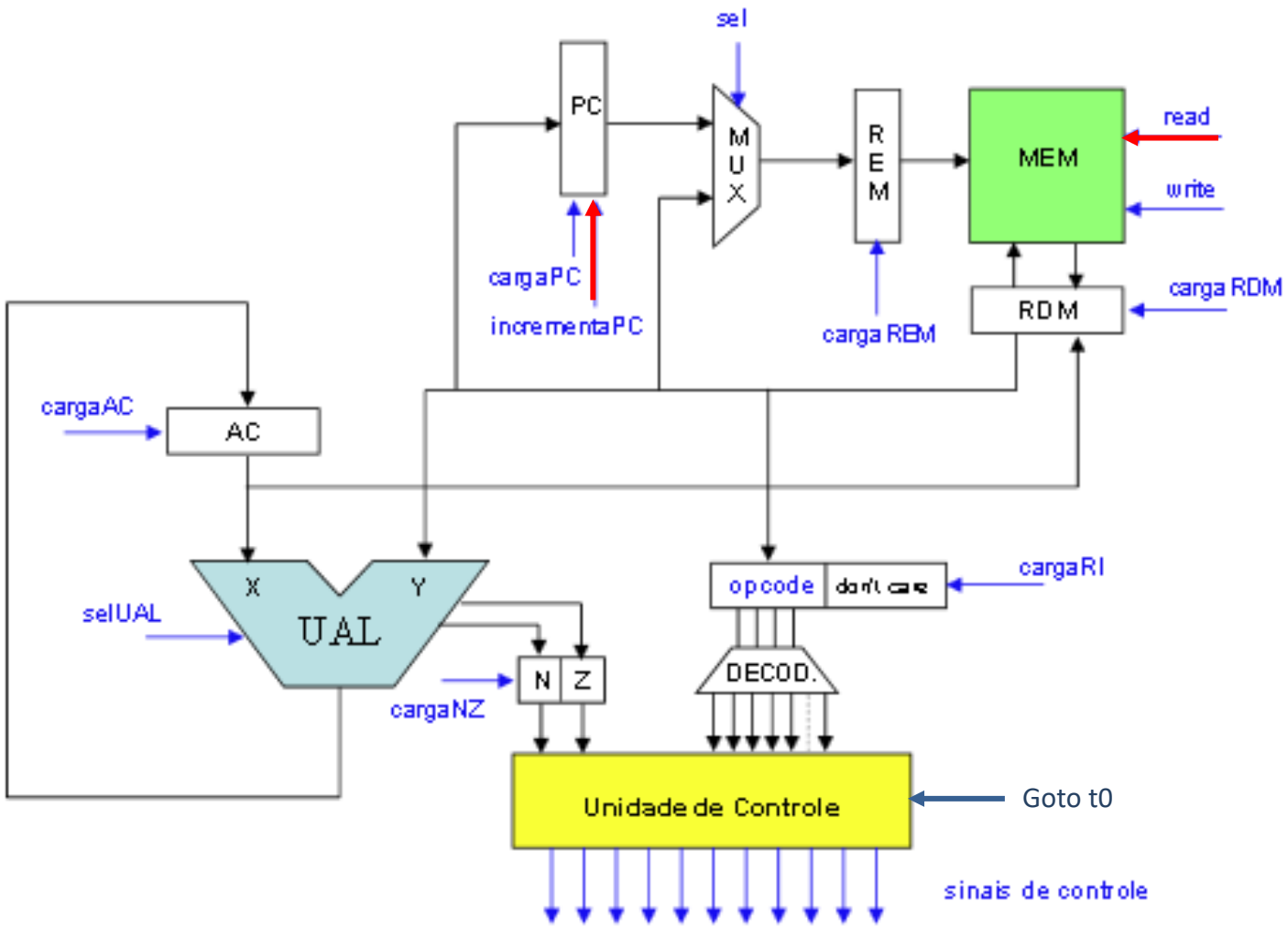
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função JMP


sel
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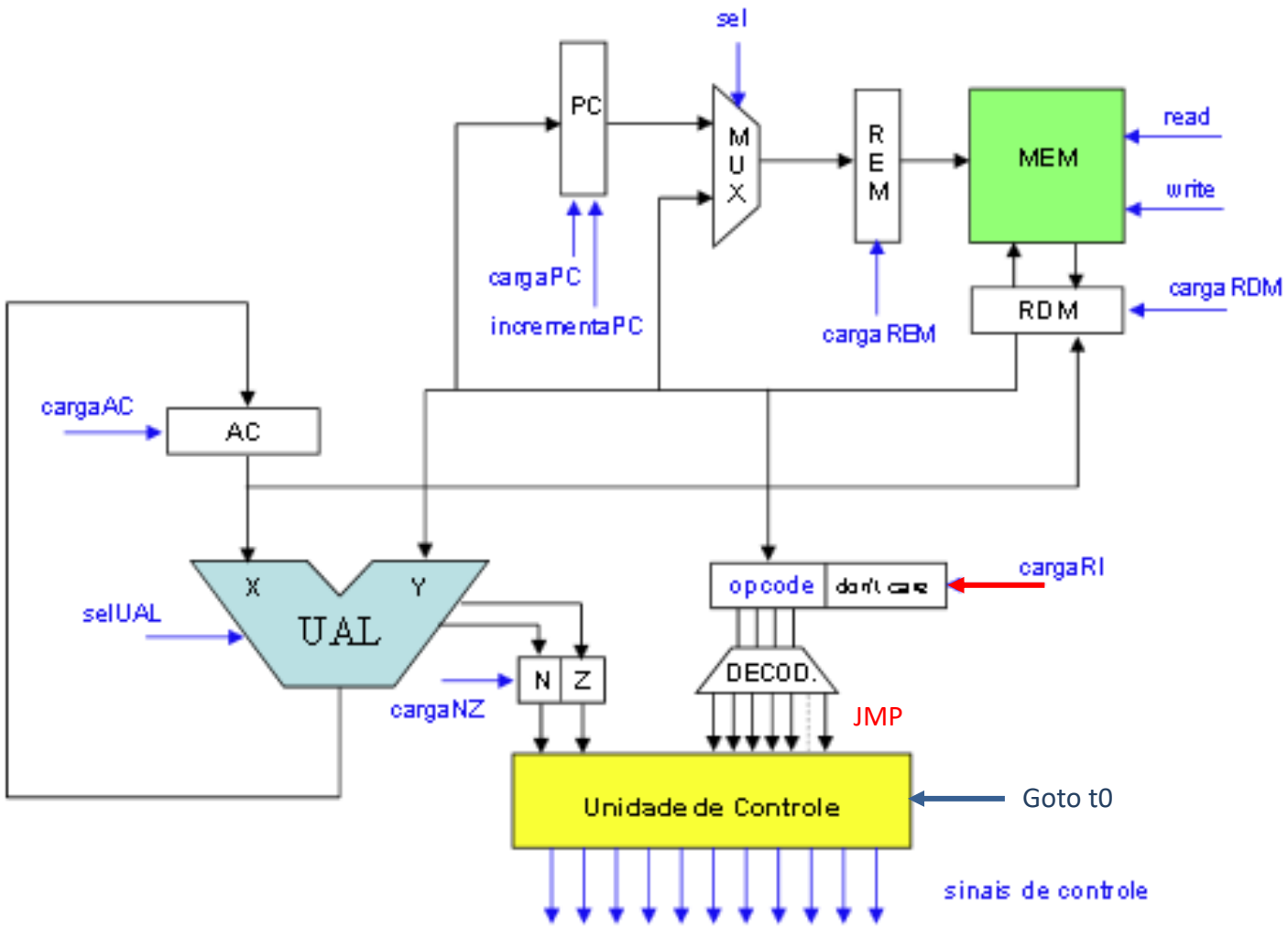
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função JMP


sel
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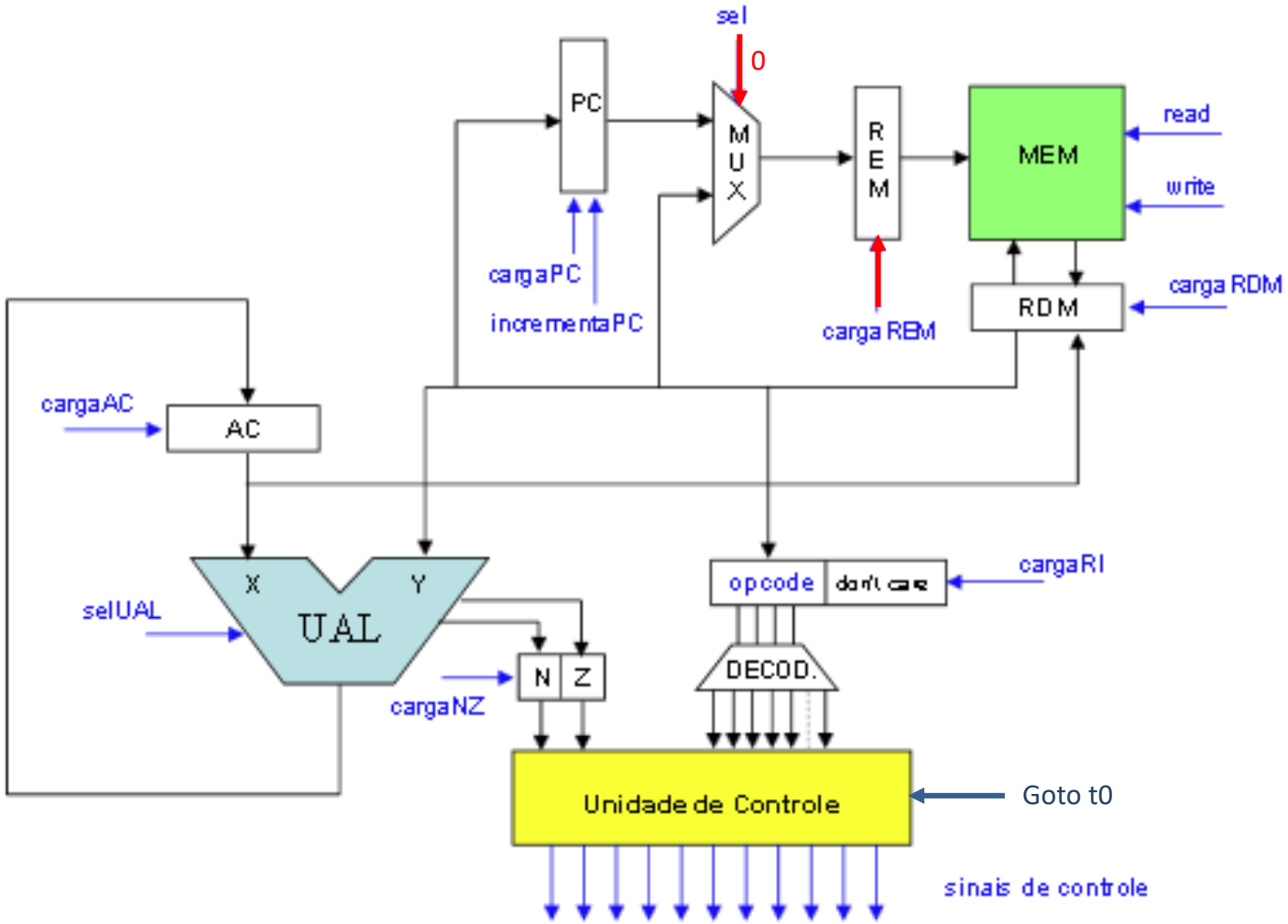
DECOD.
JMP
Unidade de Controle
Goto t0
sinais de controle

Função JMP


sel
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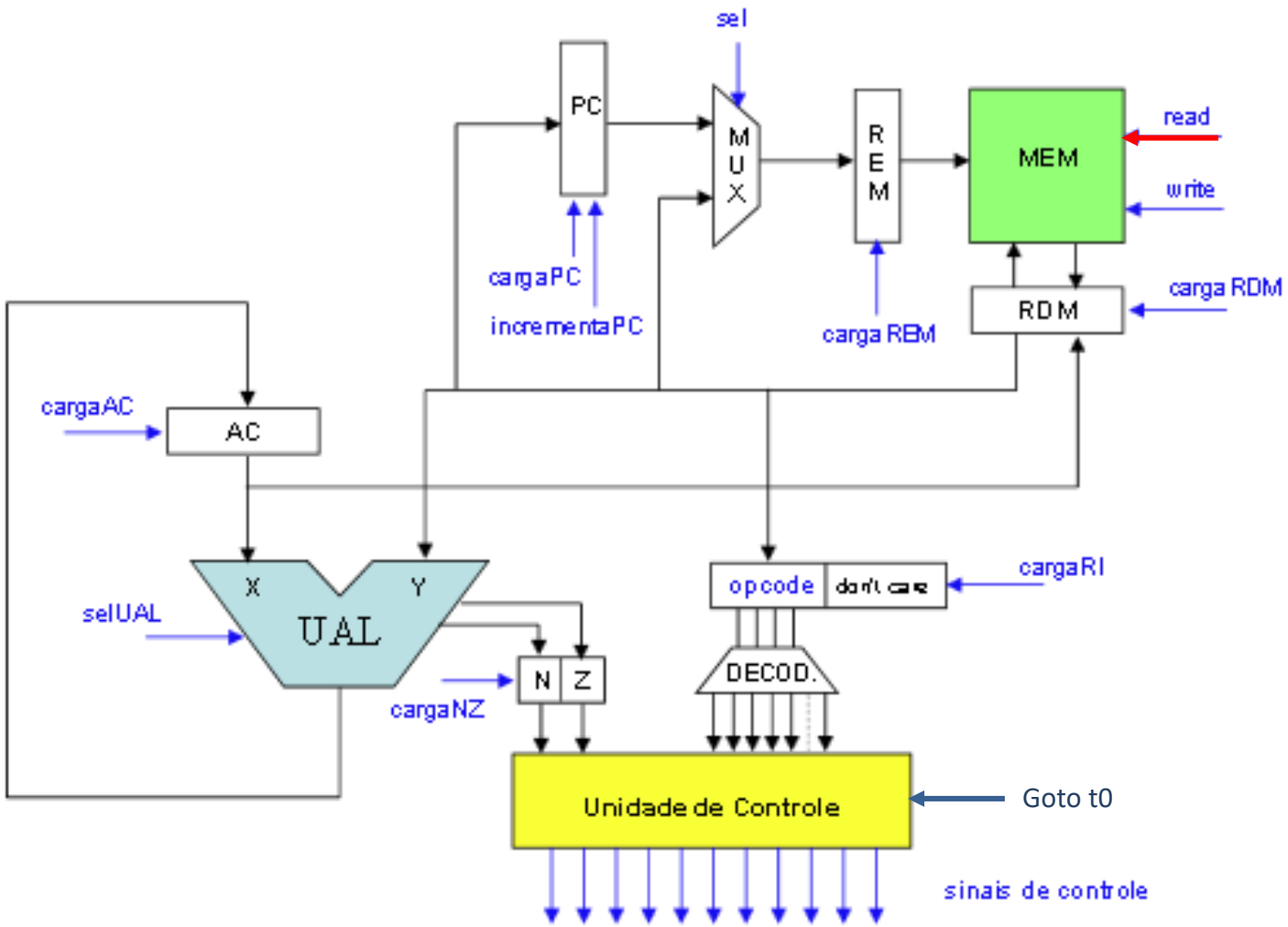
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função JMP


sel
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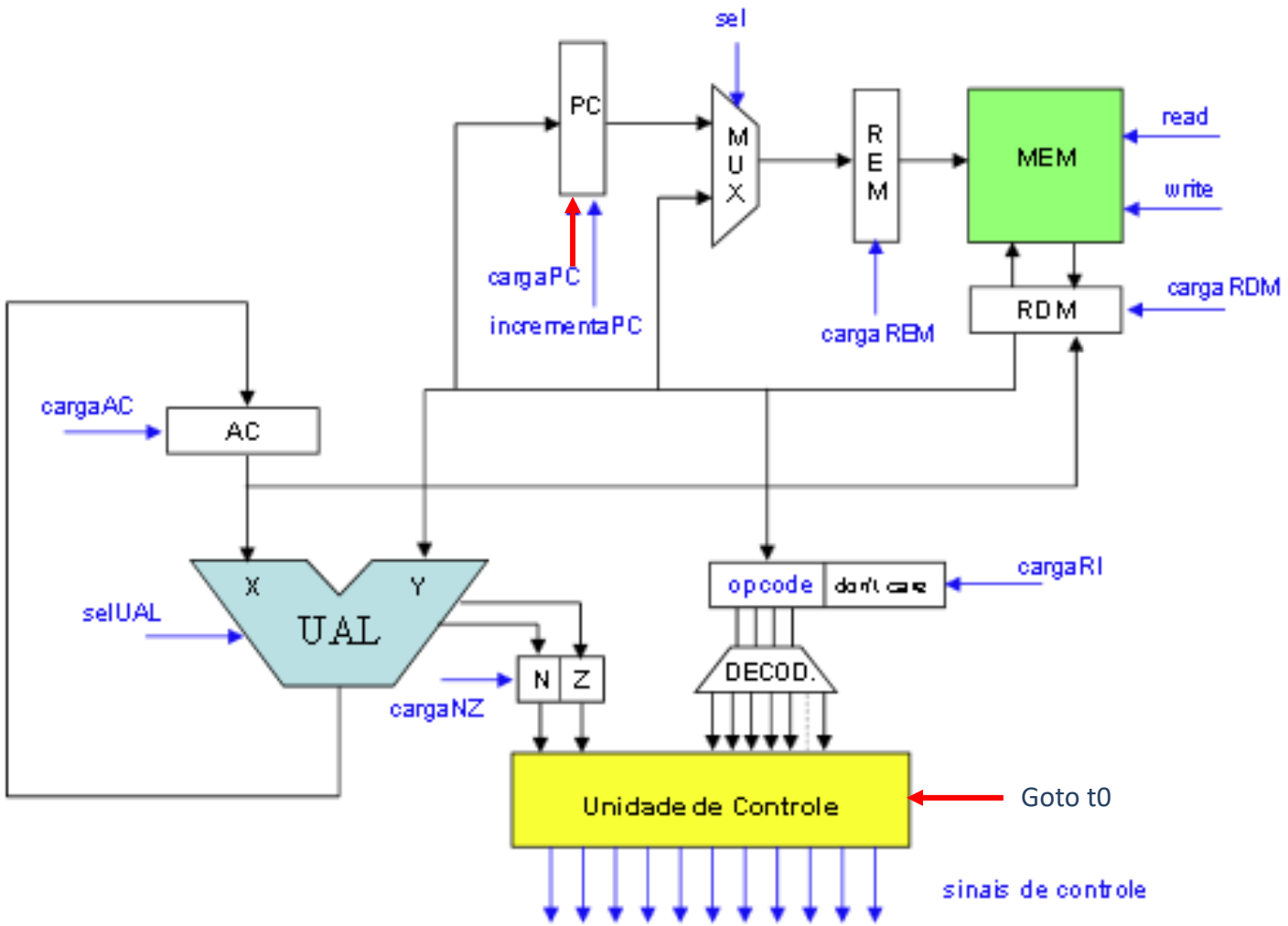
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função JMP


sel
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cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
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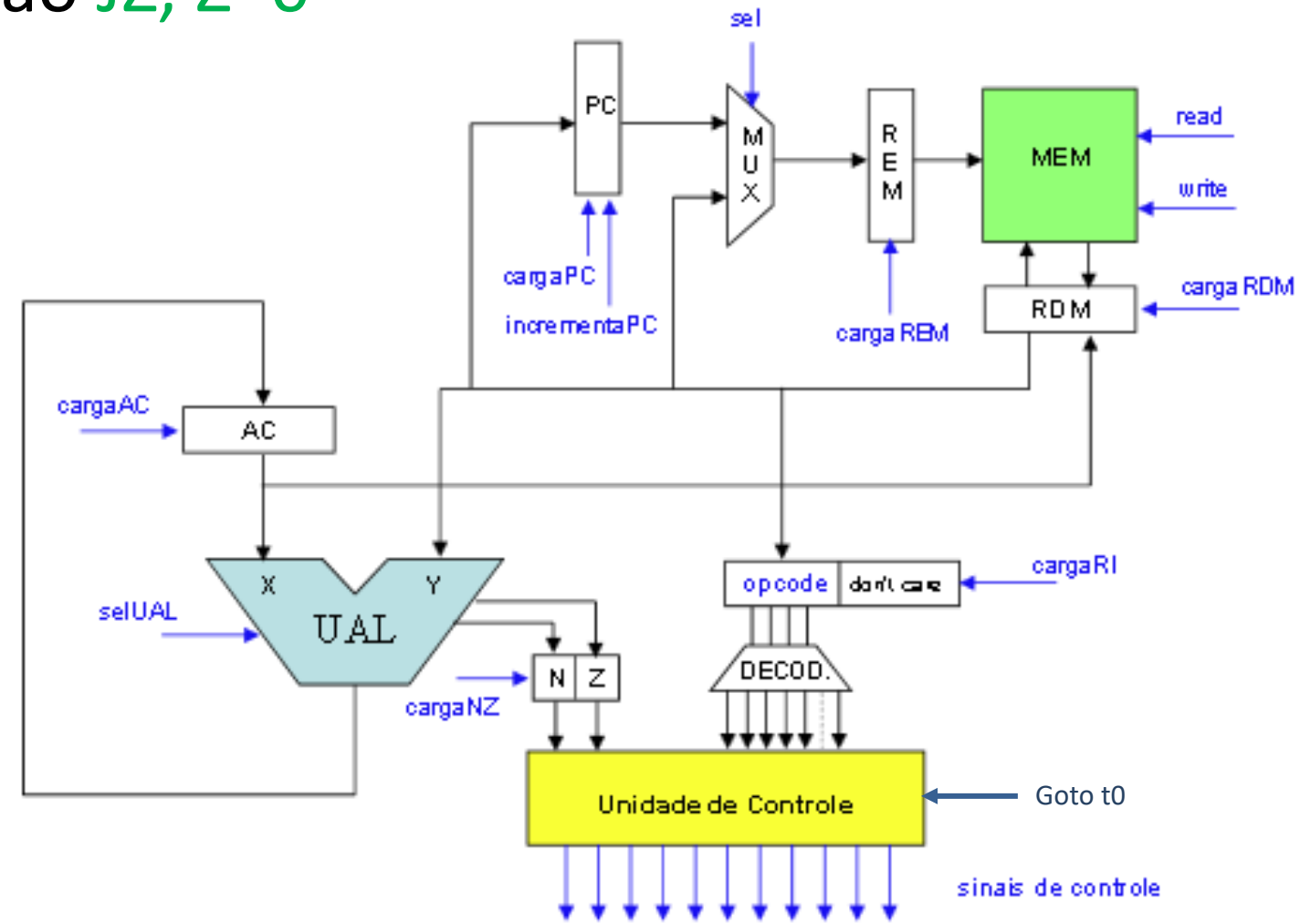
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

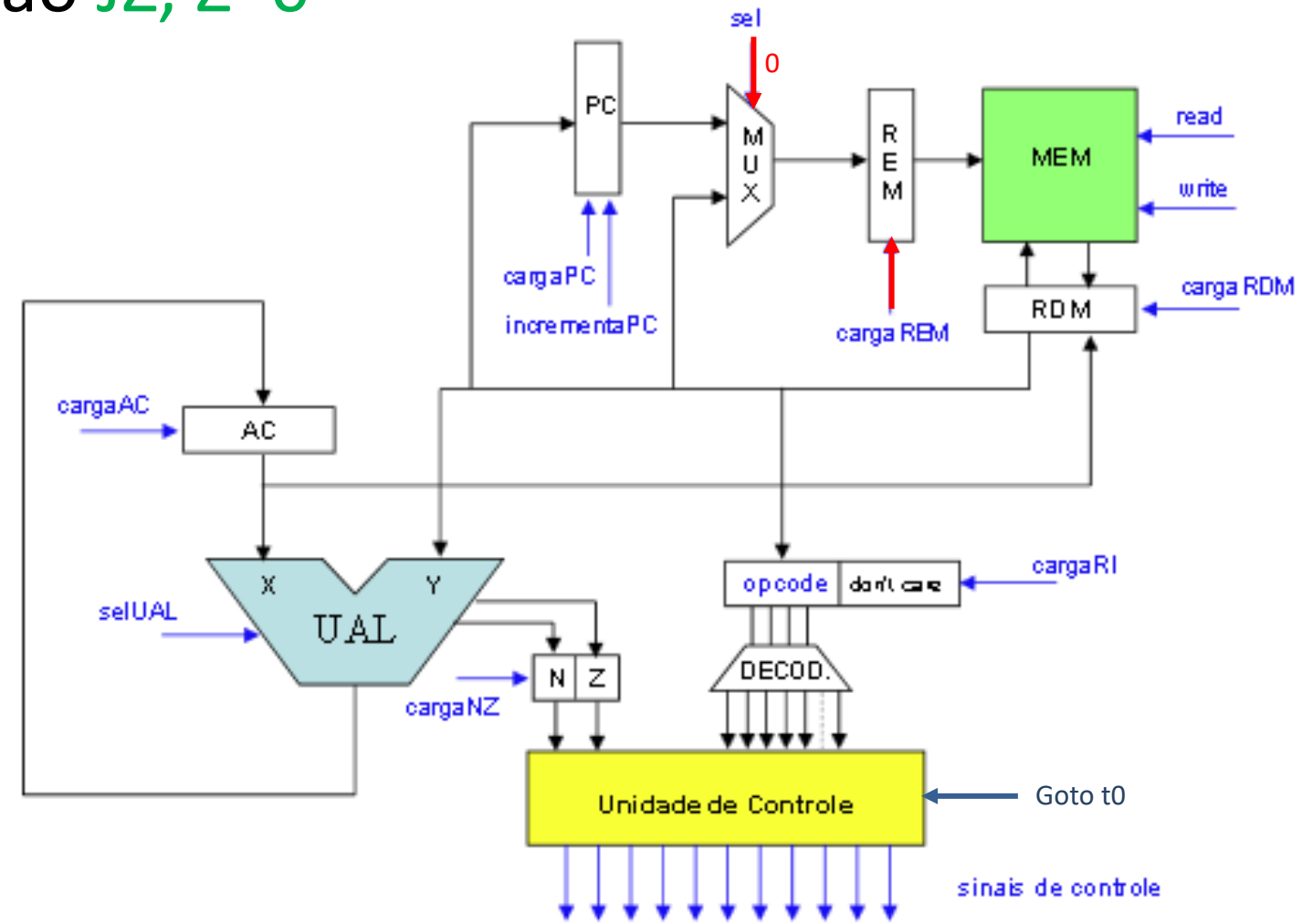
tempo	JMP	JN, N=1	JN, N=0	JZ, Z=1	JZ, Z=0	NOP	HLT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	incrementa PC, goto t0	sel=0, carga REM	incrementa PC, goto t0	goto t0	Halt
t4	Read	Read		Read			
t5	carga PC, goto t0	carga PC, goto t0		carga PC, goto t0			
t6							
t7							

Função JN, N=0

Função JZ, Z=0

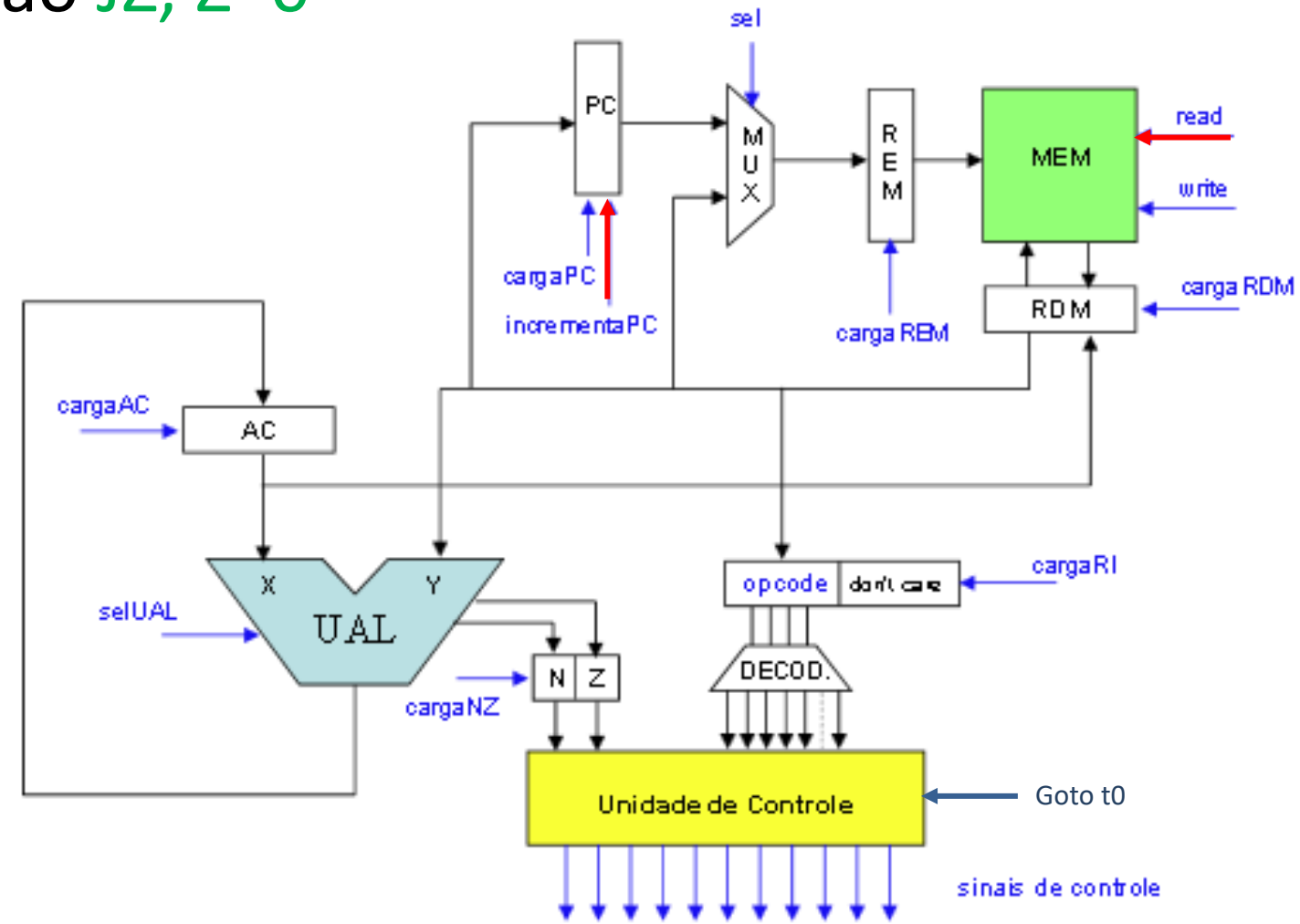


Função JN, N=0
Função JZ, Z=0

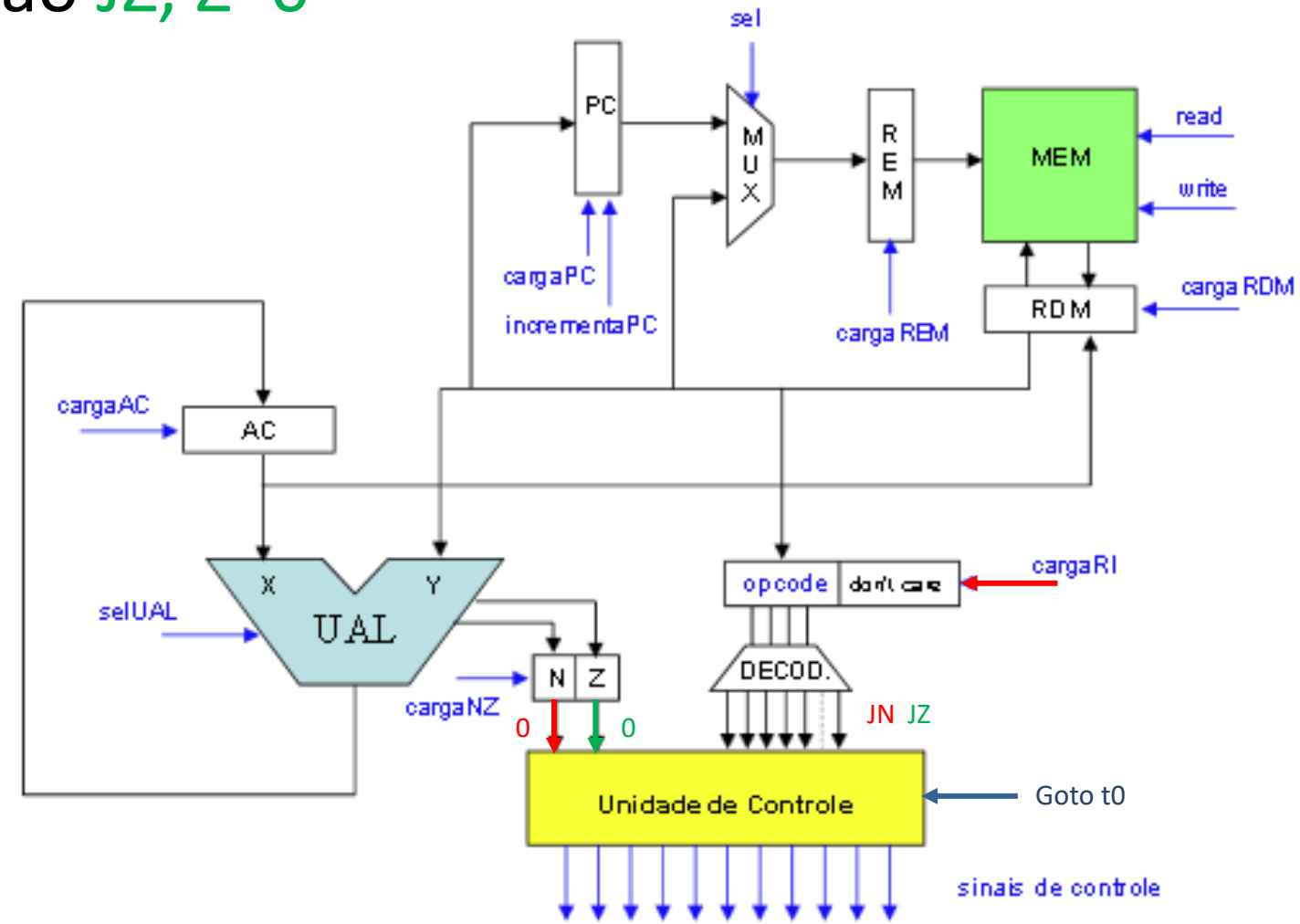


Função JN, N=0

Função JZ, Z=0

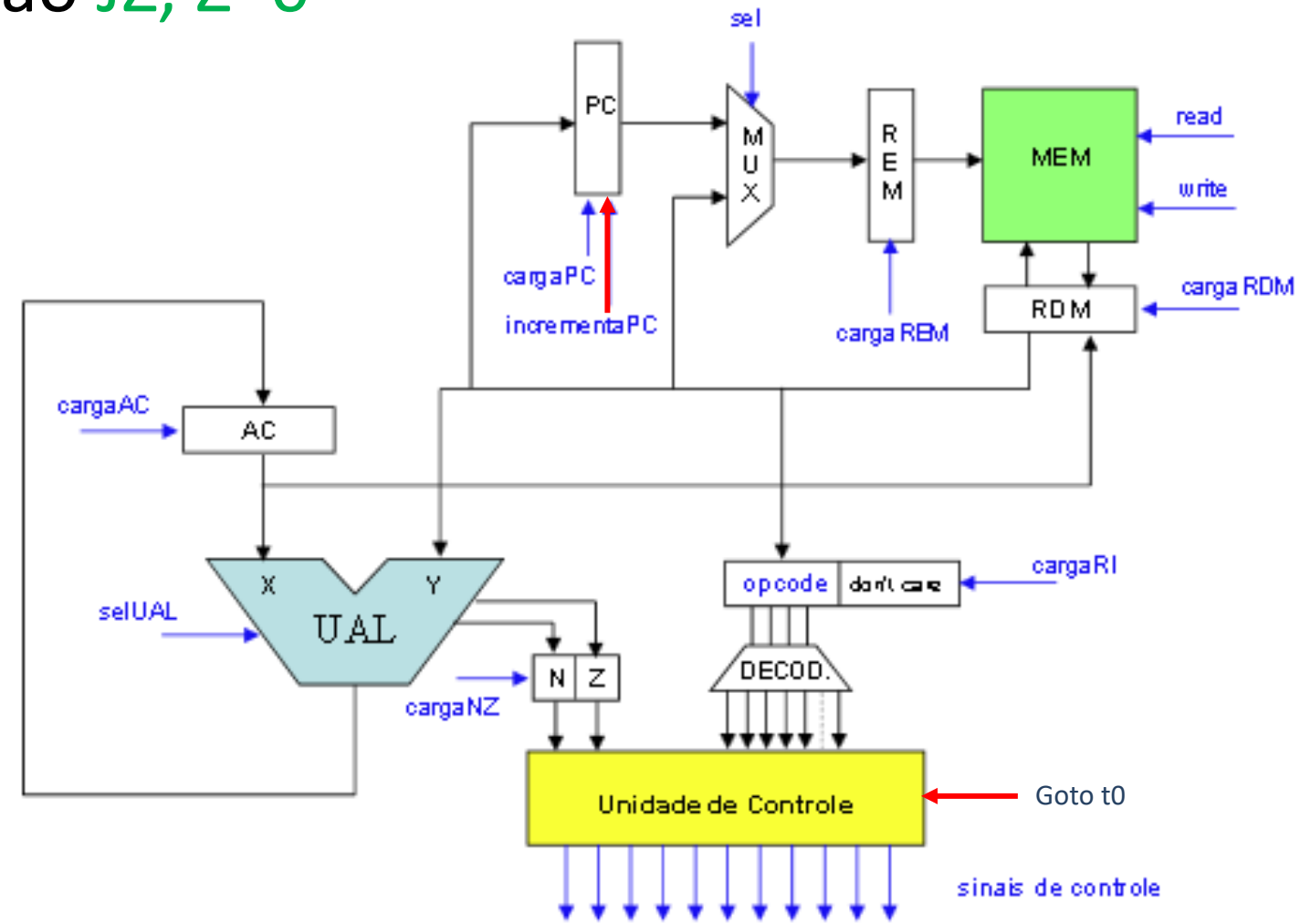


Função JN, N=0
Função JZ, Z=0



Função JN, N=0

Função JZ, Z=0

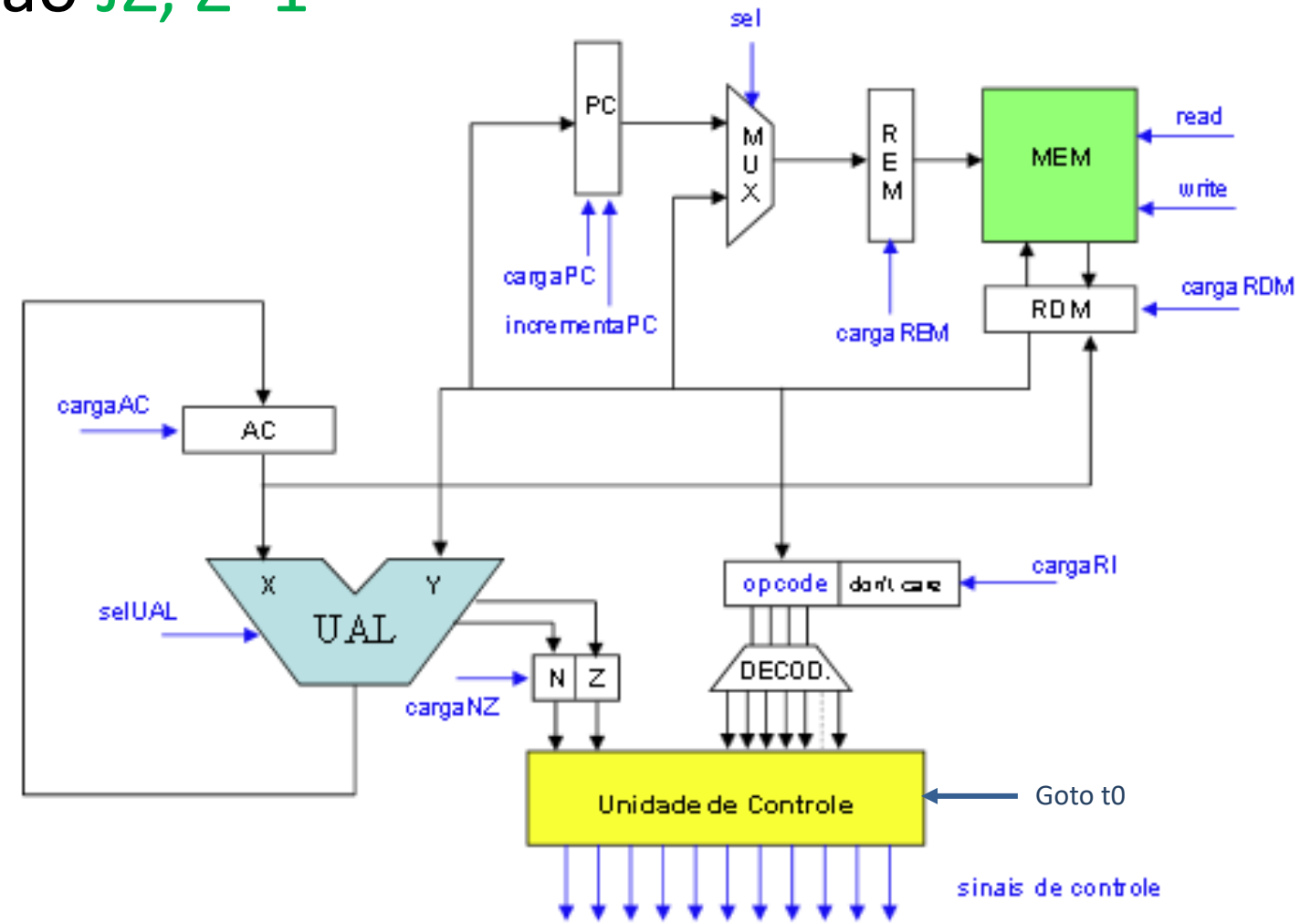


Neander: Temporização dos Sinais de Controle

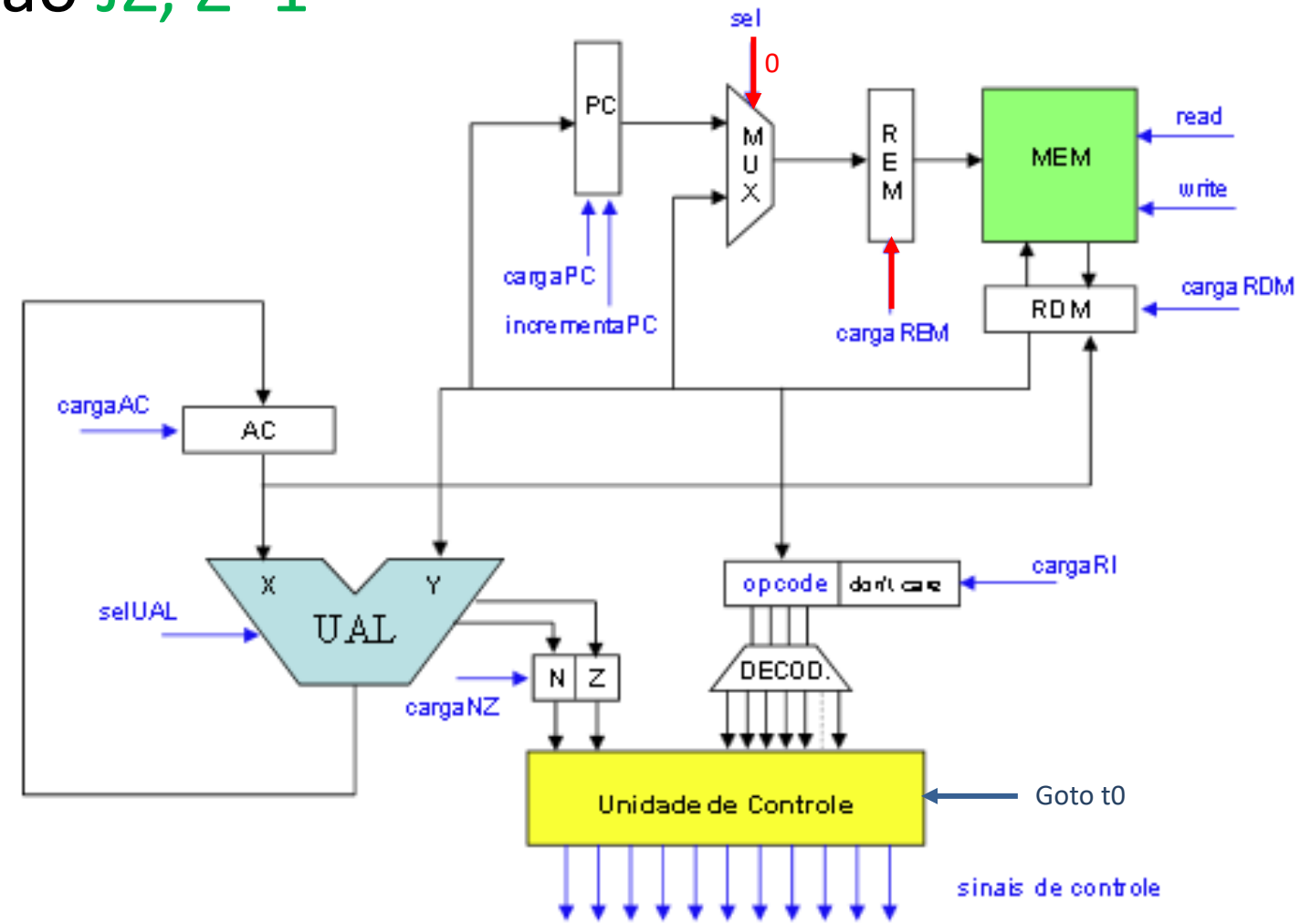
tempo	JMP	JN, N=1	JN, N=0	JZ, Z=1	JZ, Z=0	NOP	HLT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	incrementa PC, goto t0	sel=0, carga REM	incrementa PC, goto t0	goto t0	Halt
t4	Read	Read		Read			
t5	carga PC, goto t0	carga PC, goto t0		carga PC, goto t0			
t6							
t7							

Função JN, N=1

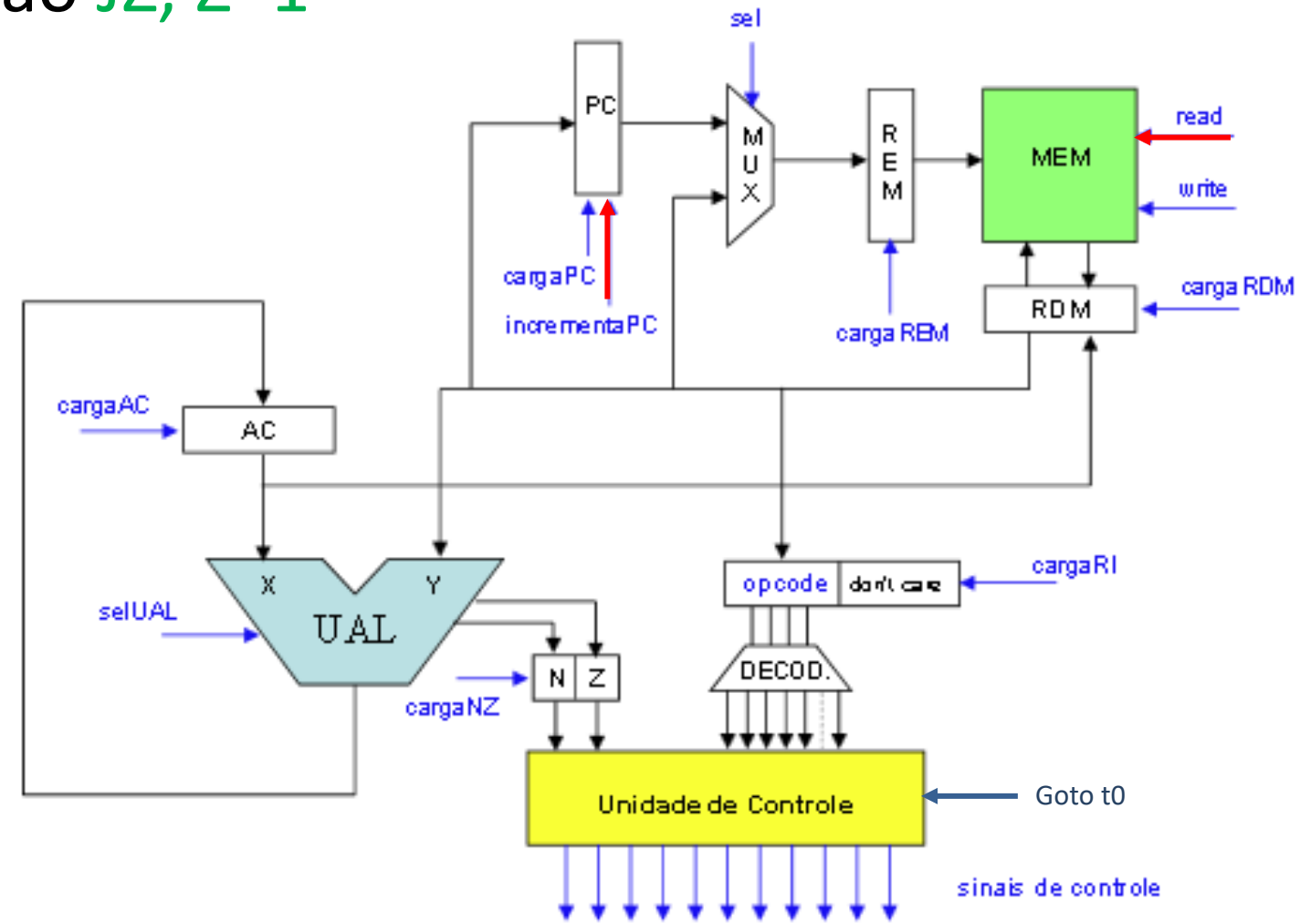
Função JZ, Z=1



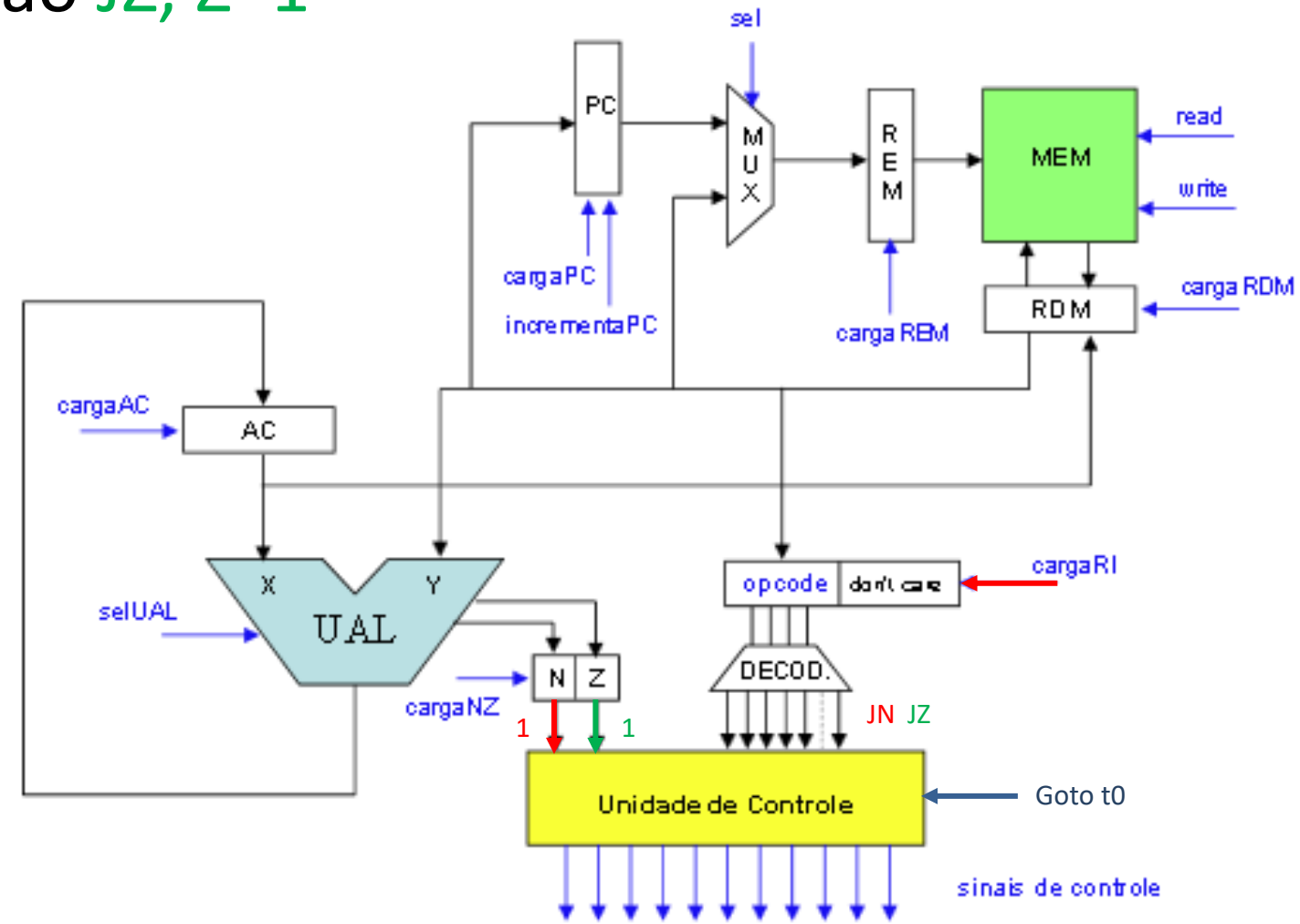
Função JN, N=1
Função JZ, Z=1



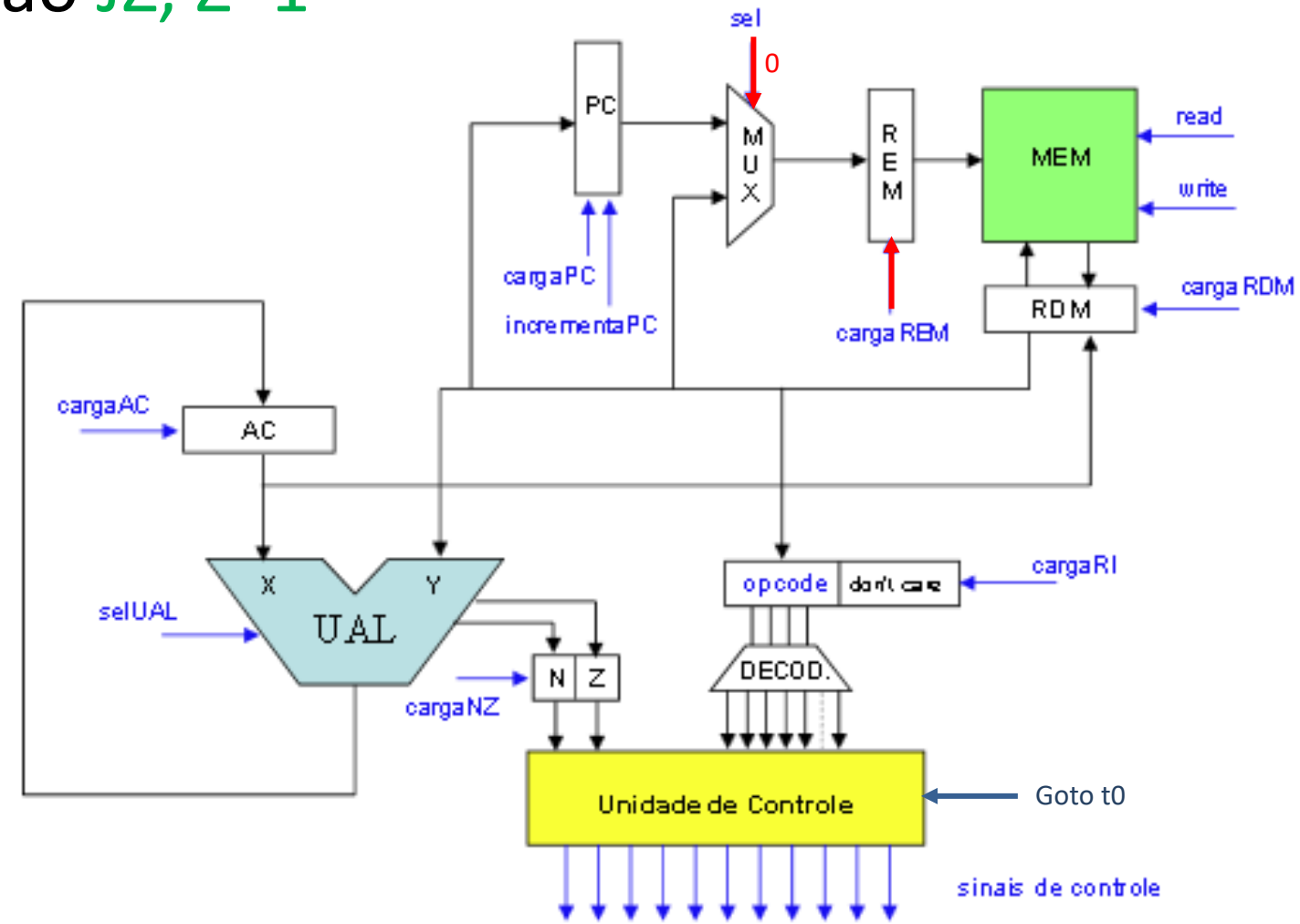
Função JN, N=1
Função JZ, Z=1



Função JN, N=1
Função JZ, Z=1

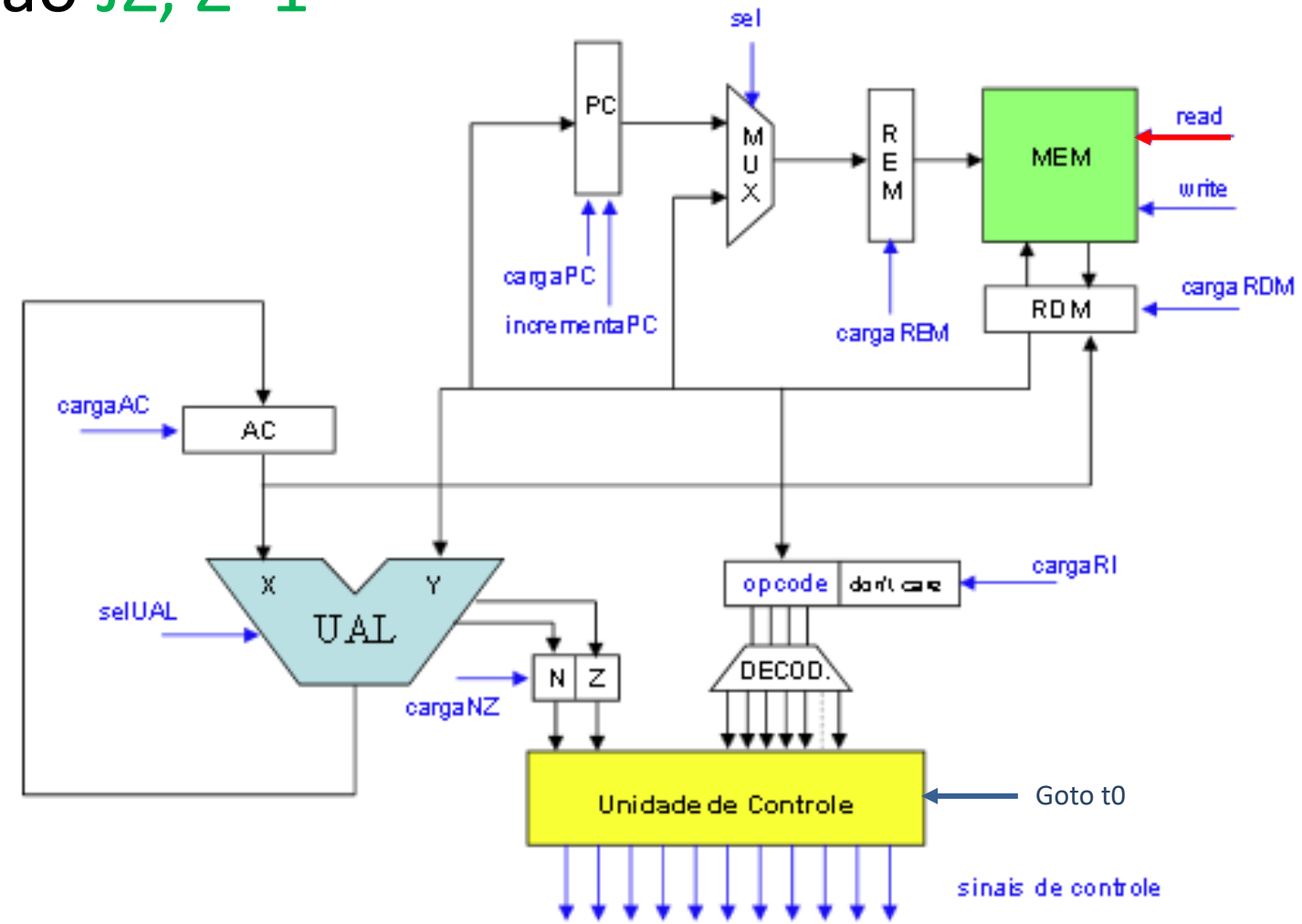


Função JN, N=1
Função JZ, Z=1

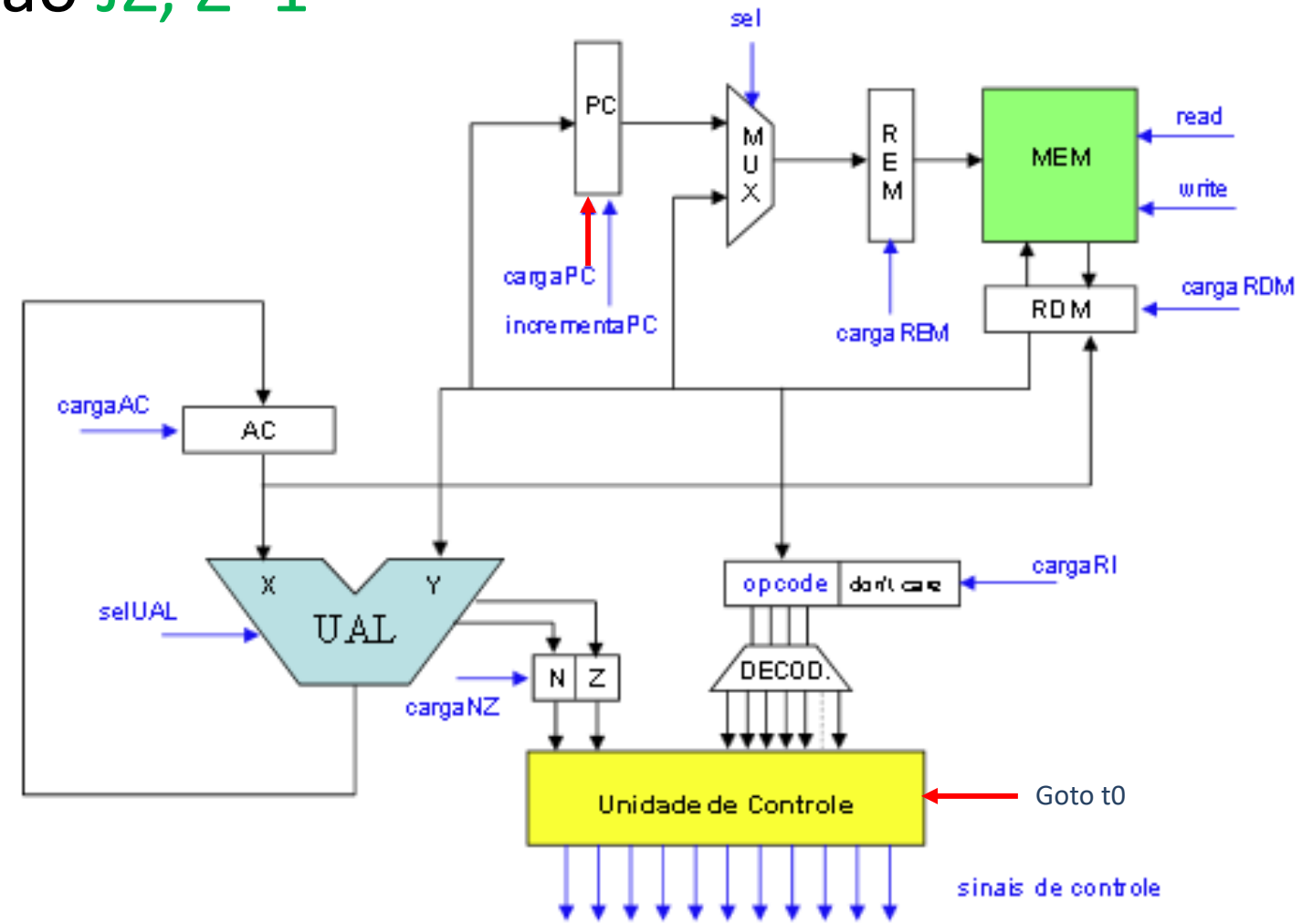


Função JN, N=1

Função JZ, Z=1



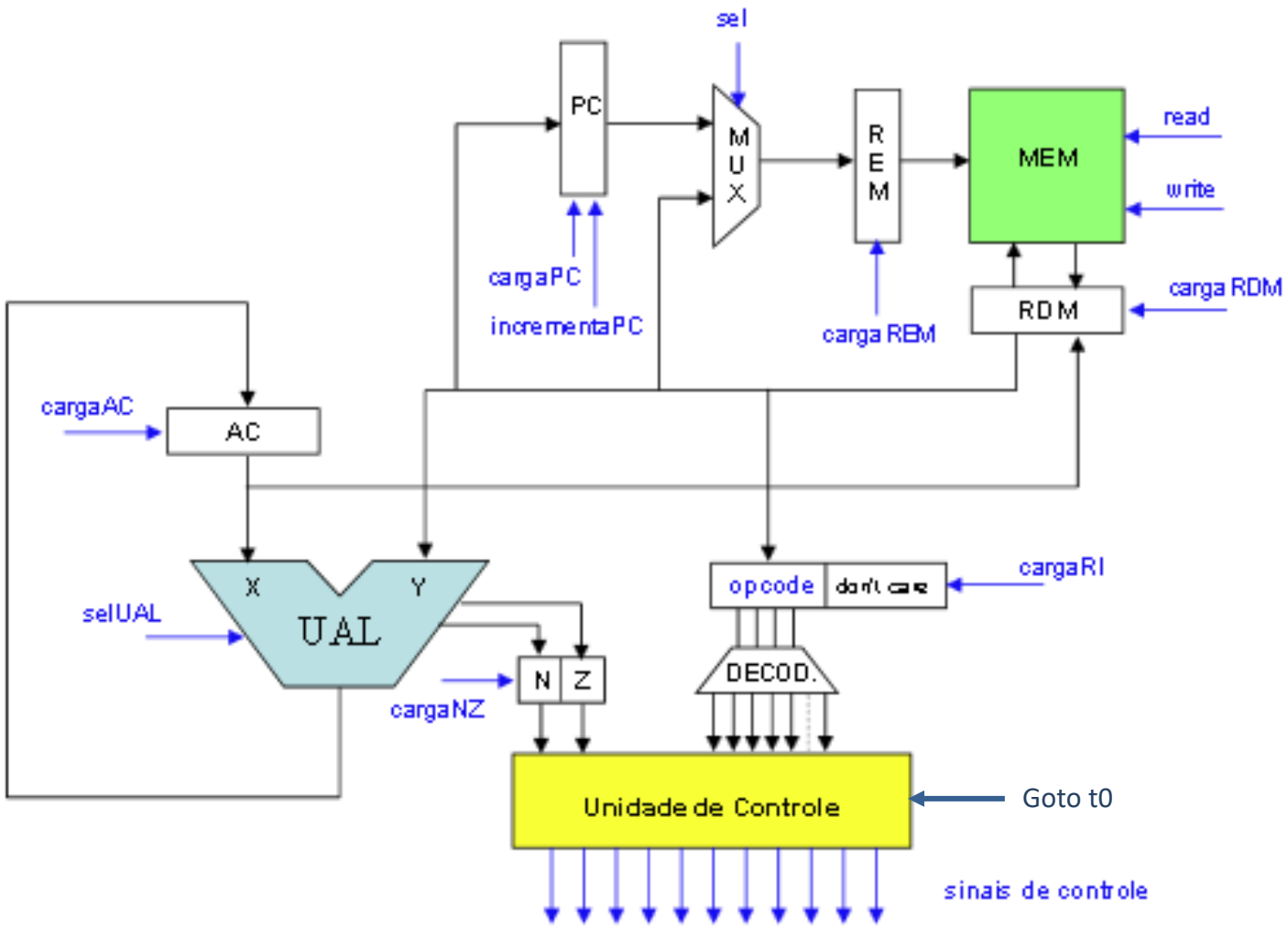
Função JN, N=1
Função JZ, Z=1



Neander: Temporização dos Sinais de Controle

tempo	JMP	JN, N=1	JN, N=0	JZ, Z=1	JZ, Z=0	NOP	HLT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	incrementa PC, goto t0	sel=0, carga REM	incrementa PC, goto t0	goto t0	Halt
t4	Read	Read		Read			
t5	carga PC, goto t0	carga PC, goto t0		carga PC, goto t0			
t6							
t7							

Função NOP


sel
PC
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MEM
read
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incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
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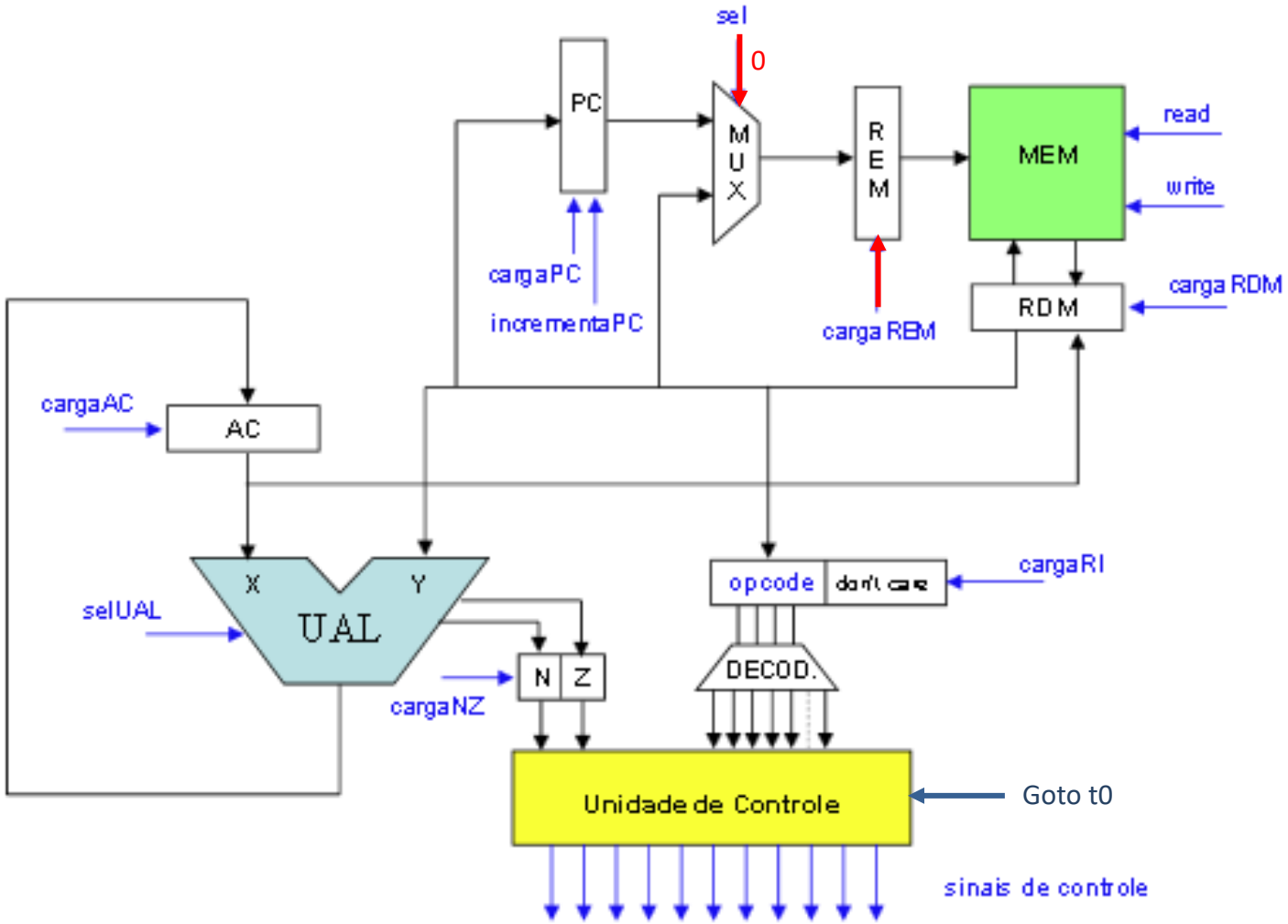
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOP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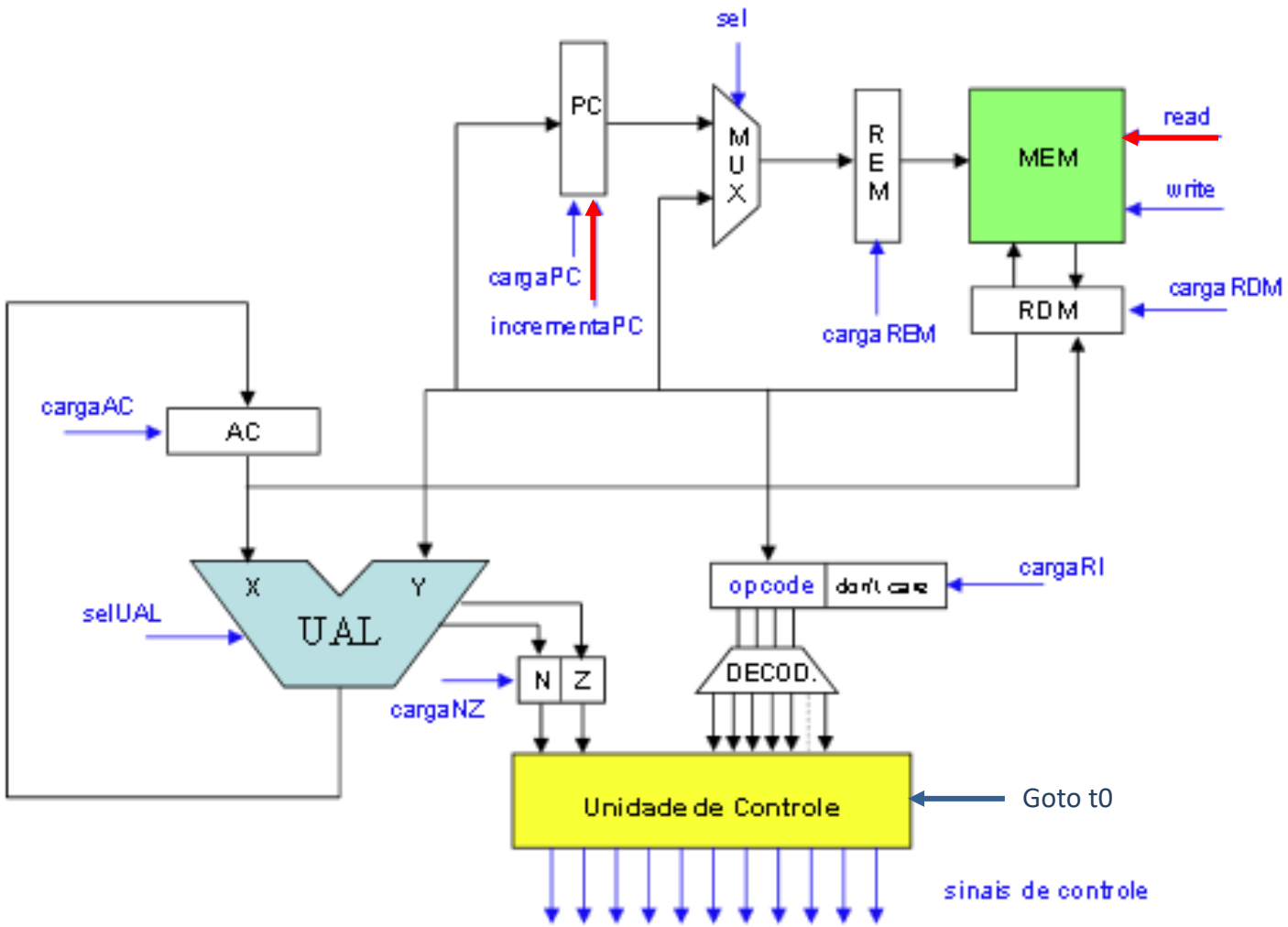
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOP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opcode
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cargaRI
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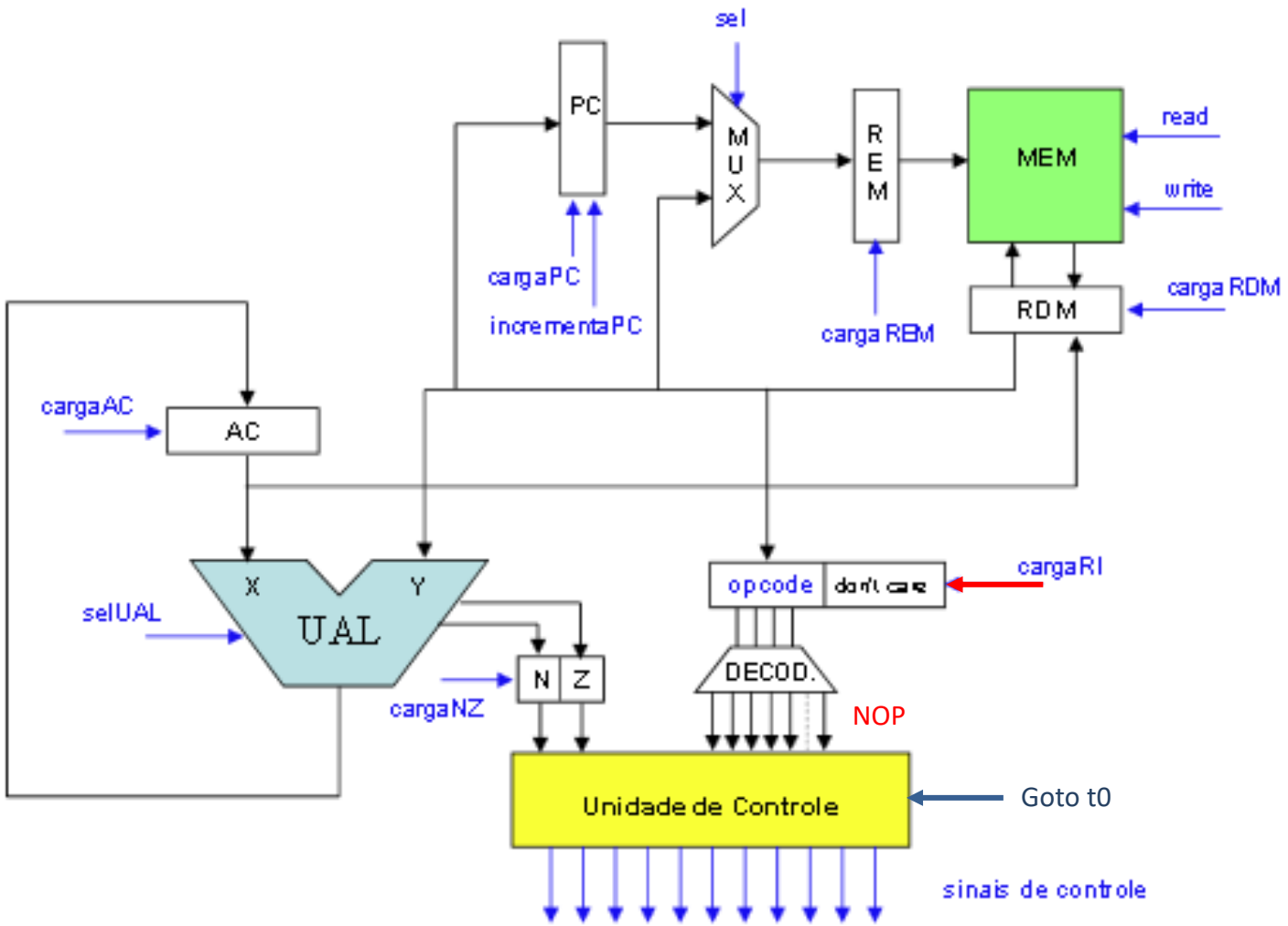
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Função NOP


sel
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incrementaPC
cargaREM
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cargaRDM
cargaAC
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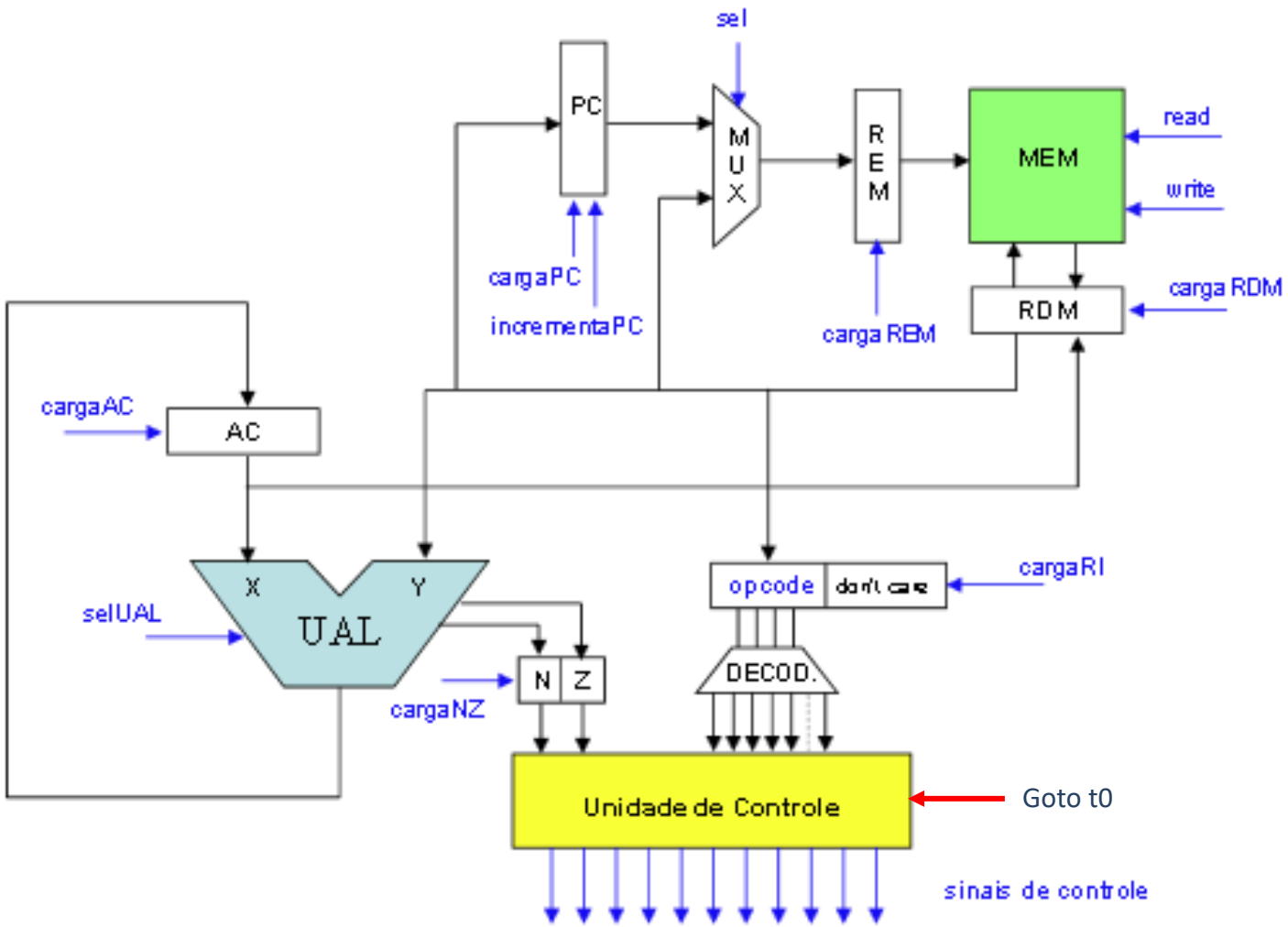
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
NOP
Unidade de Controle
Goto t0
sinais de controle

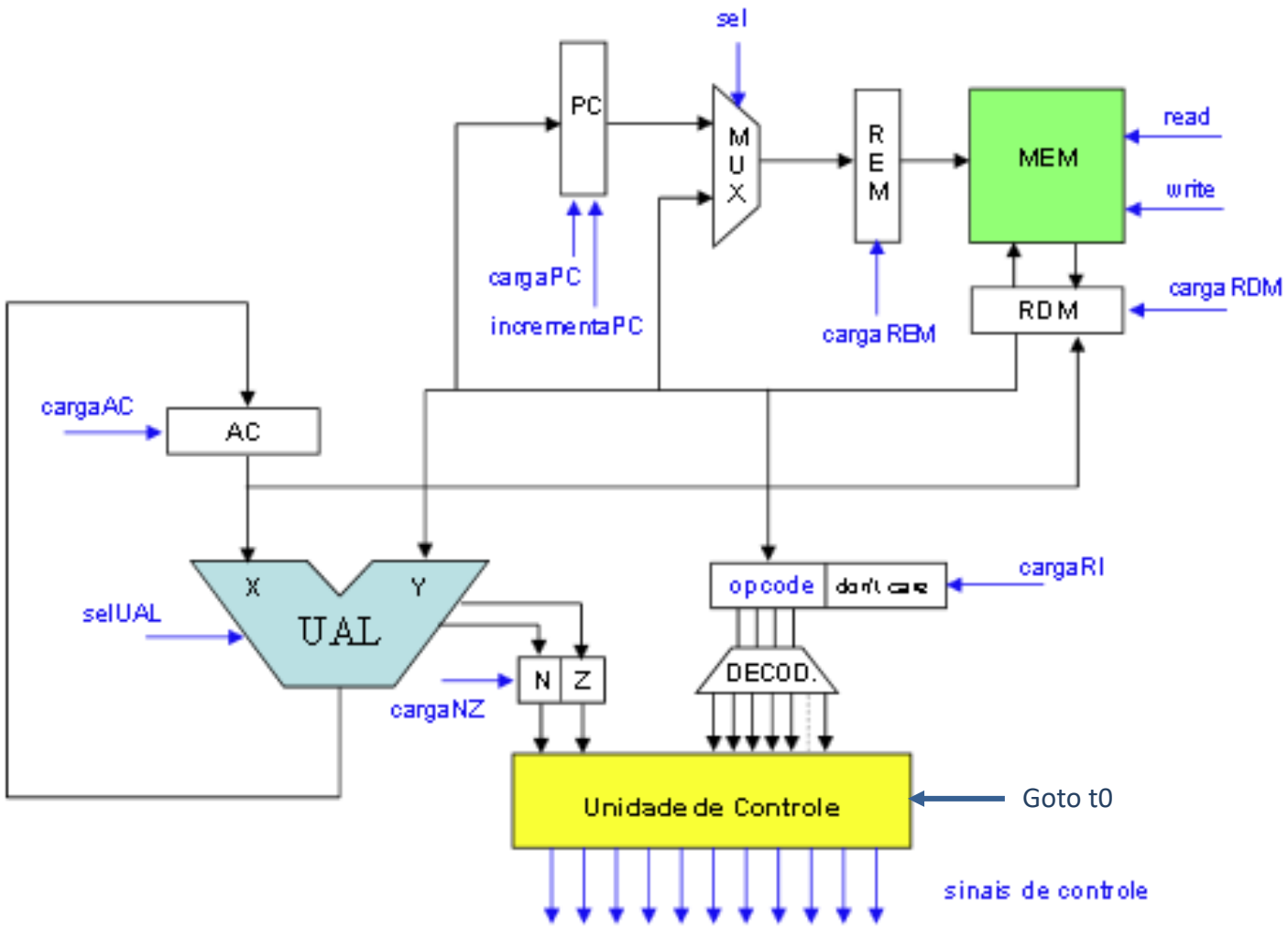
Função NOP


sel
PC
M
U
X
R
E
M
MEM
read
write
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
X
Y
UAL
selUAL
opcode
don't care
cargaRI
N
Z
cargaNZ
DECOD.
Unidade de Controle
Goto t0
sinais de controle

Neander: Temporização dos Sinais de Controle

tempo	JMP	JN, N=1	JN, N=0	JZ, Z=1	JZ, Z=0	NOP	HLT
t0	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM	sel=0, carga REM
t1	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC	Read, incrementa PC
t2	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI	carga RI
t3	sel=0, carga REM	sel=0, carga REM	incrementa PC, goto t0	sel=0, carga REM	incrementa PC, goto t0	goto t0	Halt
t4	Read	Read		Read			
t5	carga PC, goto t0	carga PC, goto t0		carga PC, goto t0			
t6							
t7							

Função HLT


sel
PC
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X
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M
MEM
read
write
cargaPC
incrementaPC
cargaREM
RDM
cargaRDM
cargaAC
AC
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opcode
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Z
cargaNZ
DECOD.
Unidade de Controle
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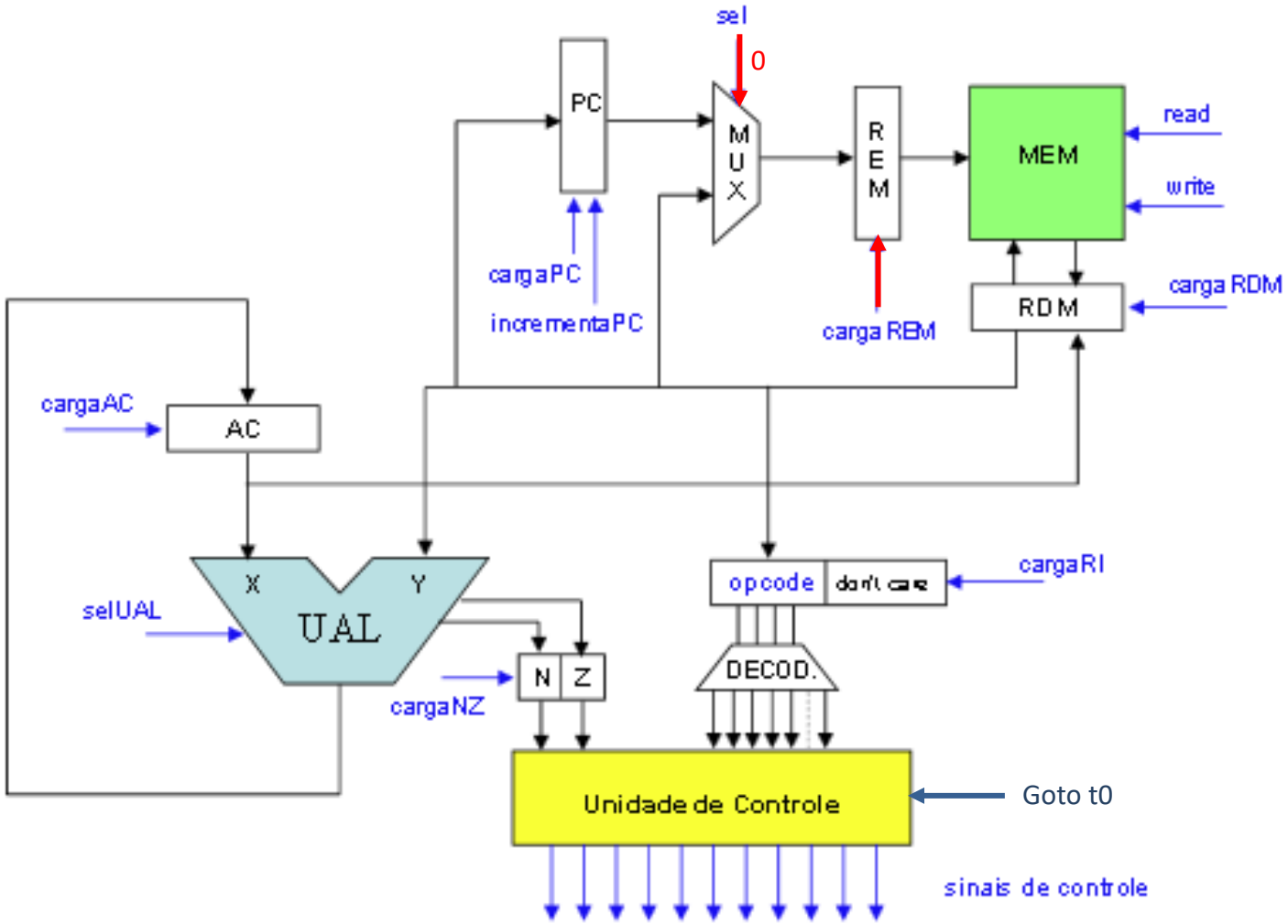
sinais de controle

Função HLT


sel
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PC
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U
X
R
E
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MEM
read
write
cargaPC
incrementaPC
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cargaRDM
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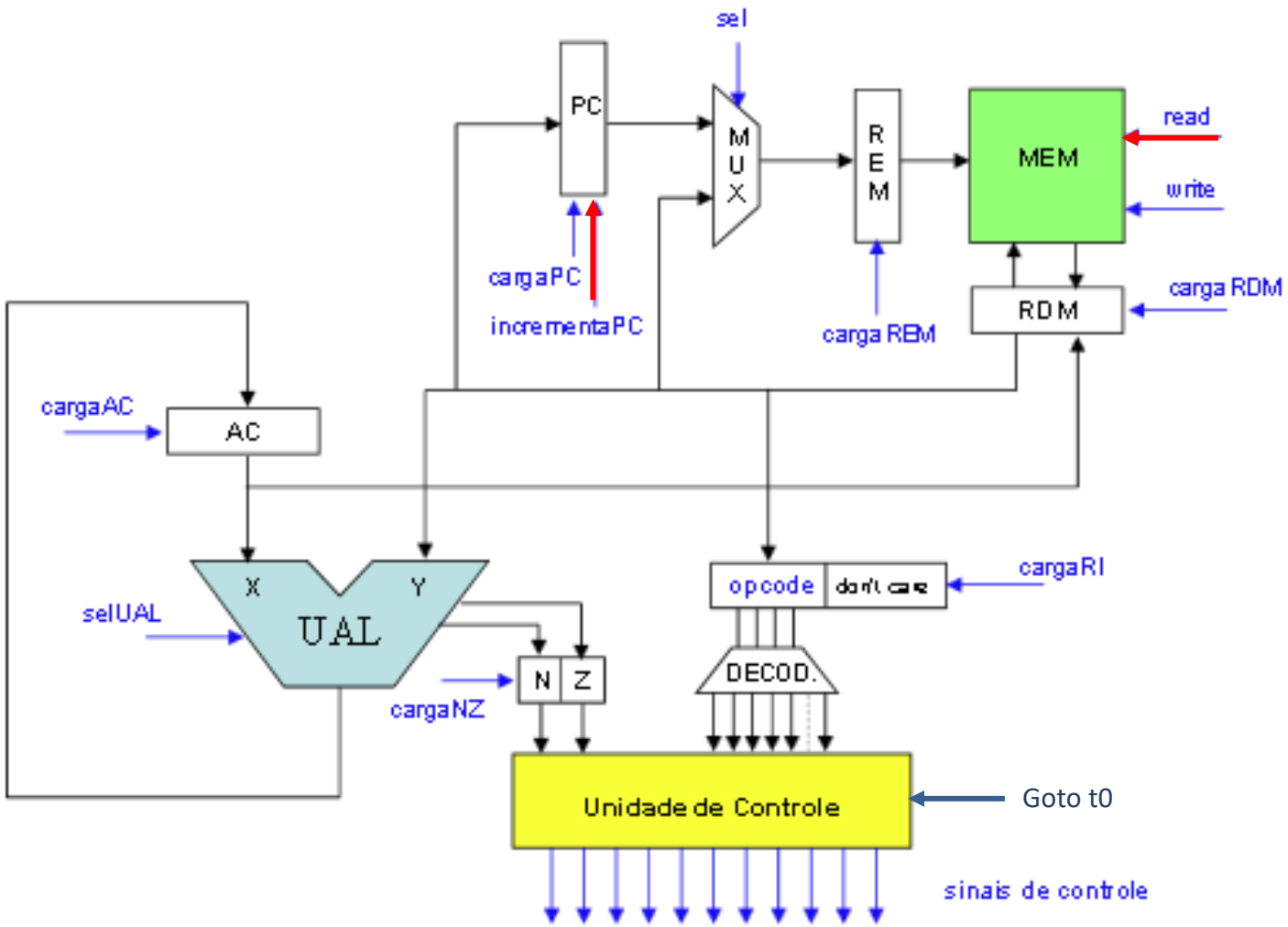
sinais de controle

Função HLT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read
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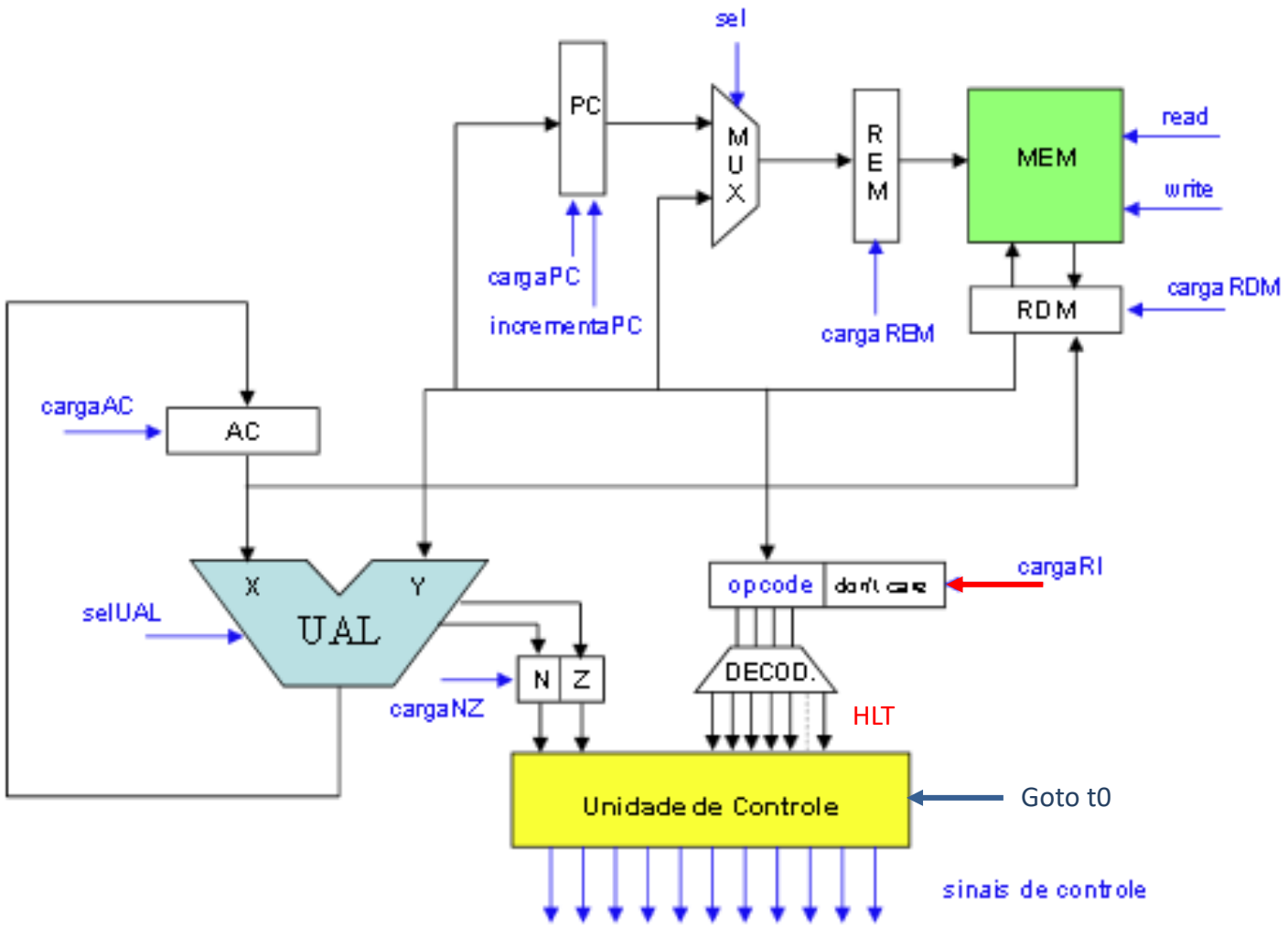
Função HLT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PC
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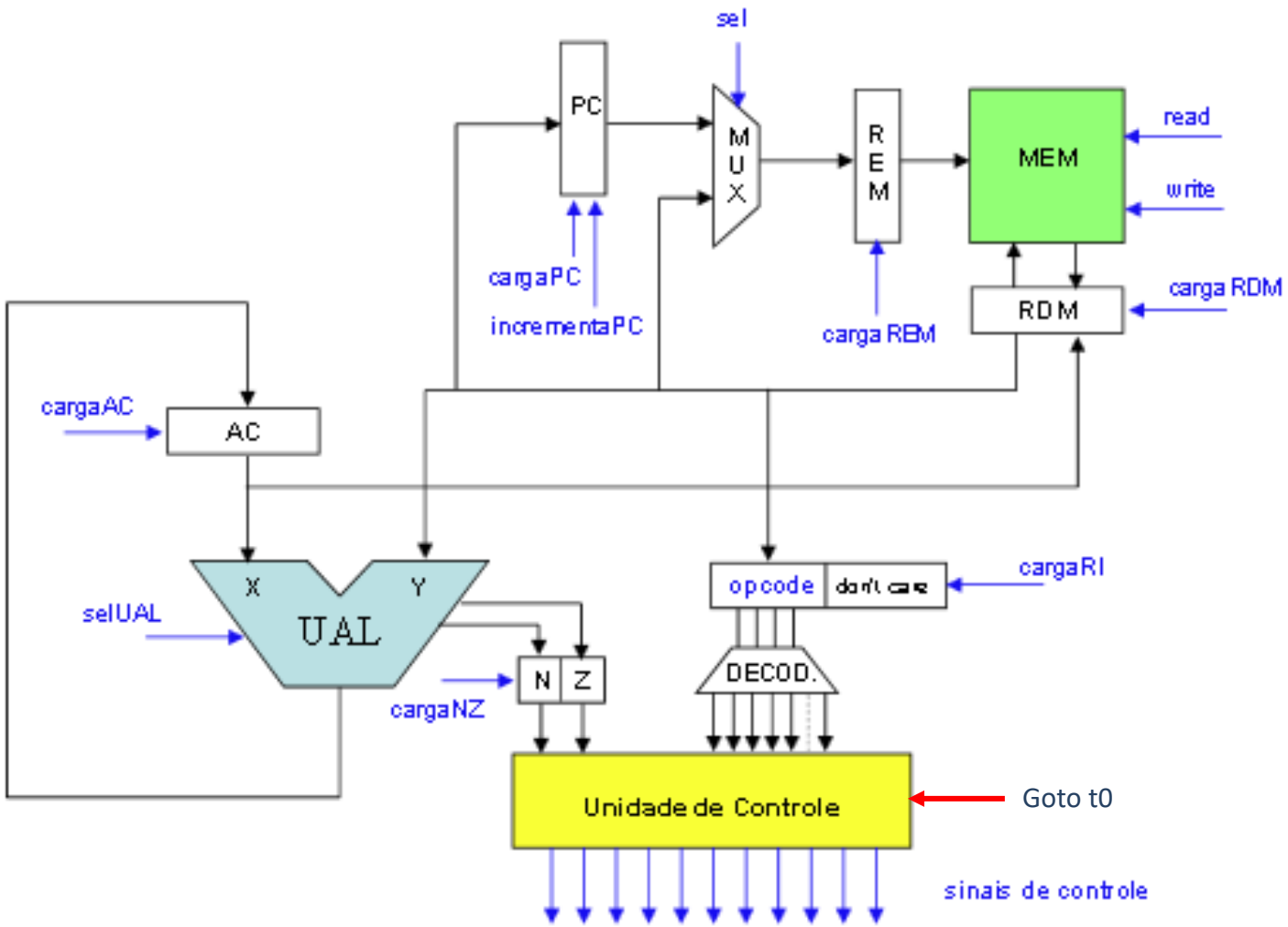
Função HLT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