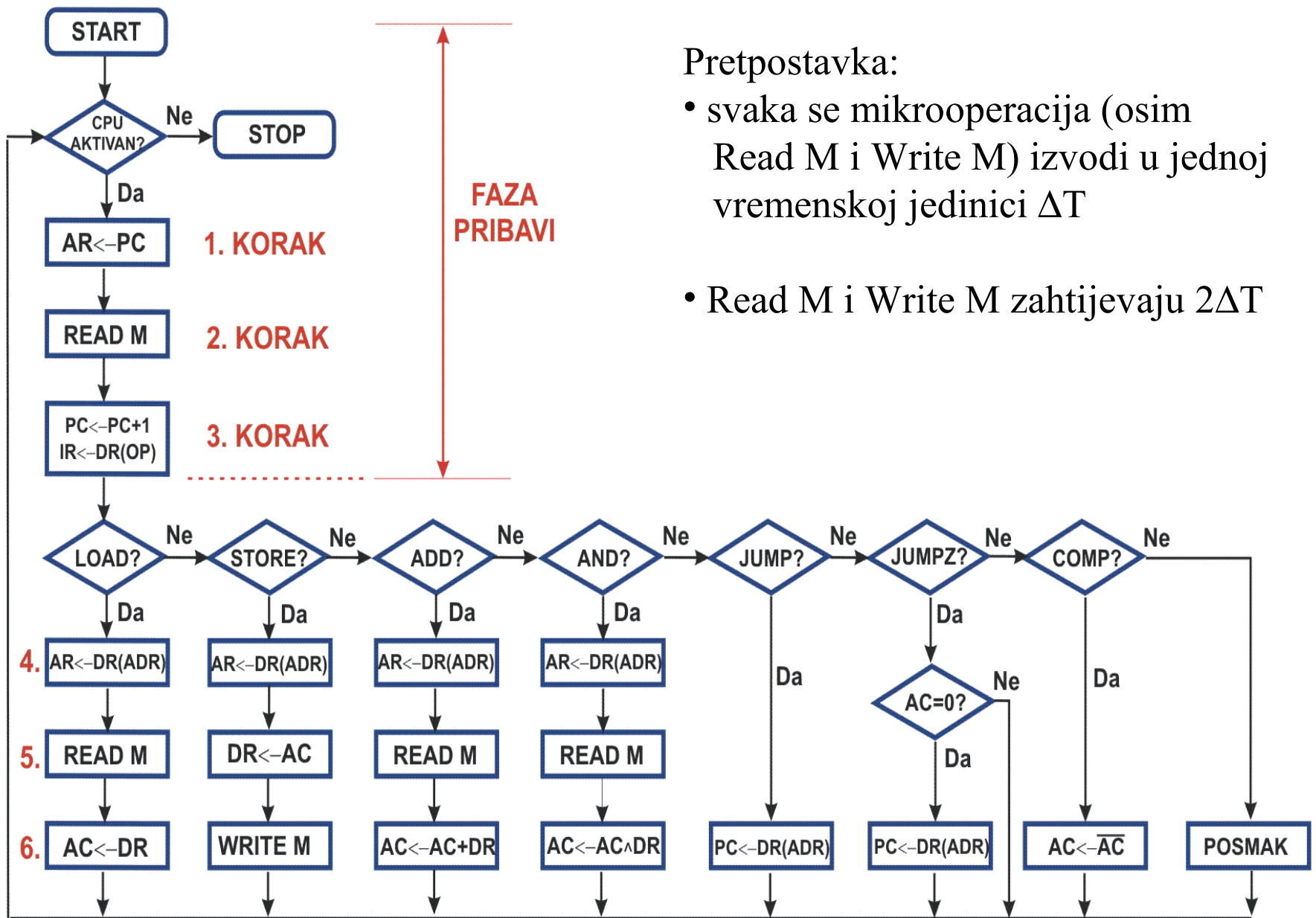


7. IZVEDBA UPRAVLJAČKE JEDINICE ZA RAČUNALO SA SKUPOM OD OSAM INSTRUKCIJA

- Skup instrukcija
- Organizacija računala
- Struktura upravljačke jedinice
- Komponente upravljačke jedinice: brojilo sekvenci, dekodер, PLA
generator taktnog signala

Skup instrukcija:

Mnemonik	Opis
ld X ; load X	$AC \leftarrow M(X)$
st X ; store X	$M(X) \leftarrow AC$
add X	$AC \leftarrow AC + M(X)$
and X	$AC \leftarrow AC \wedge M(X)$
jmp X ; jump X	$PC \leftarrow X$
jmpz X ; jump if zero	if $AC = 0$ then $PC \leftarrow X$
com ; 1's compl. AC	$AC \leftarrow \overline{AC}$
rsh ; shift right	posmak sadržaja AC udesno

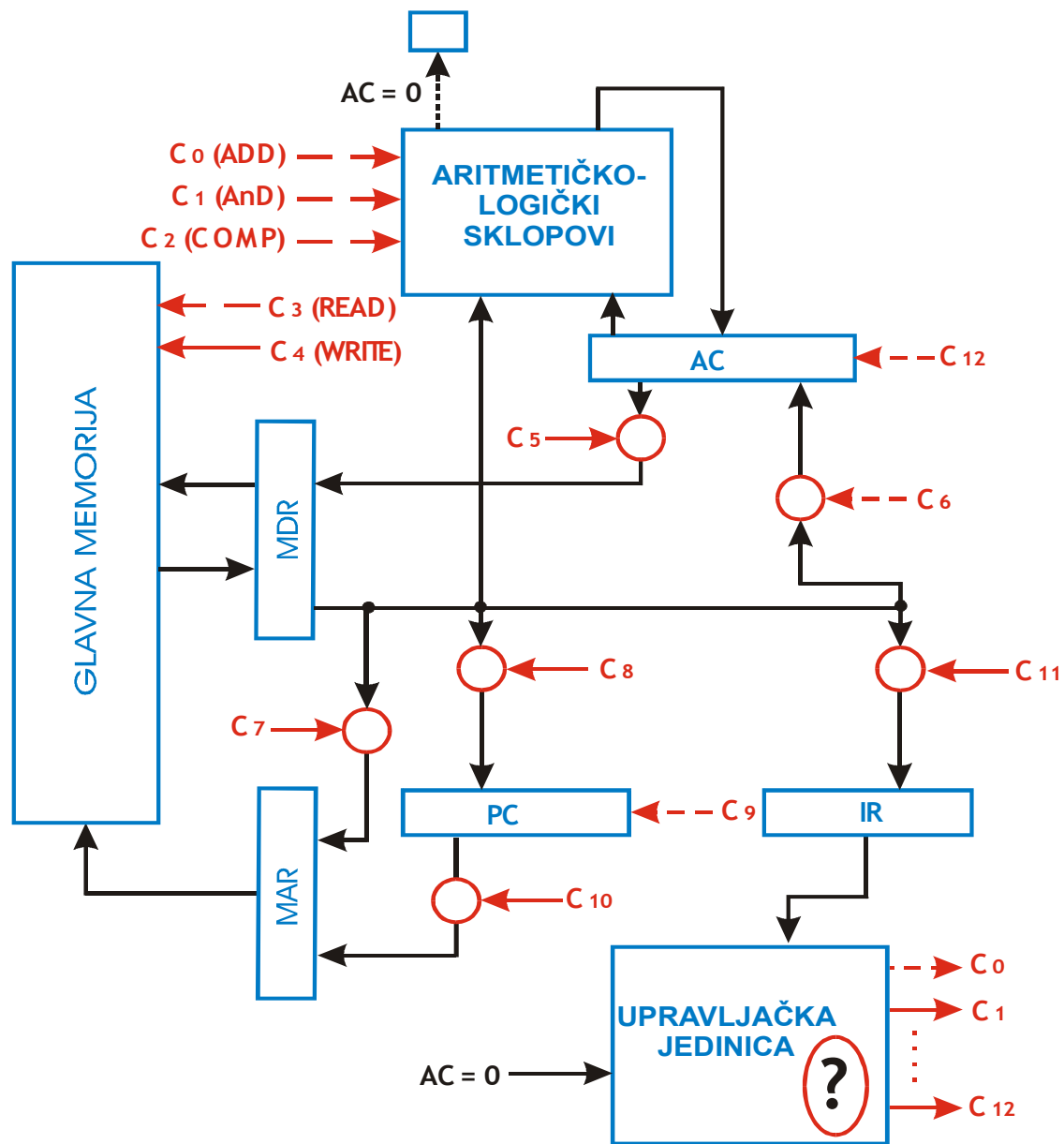


Pretpostavka:

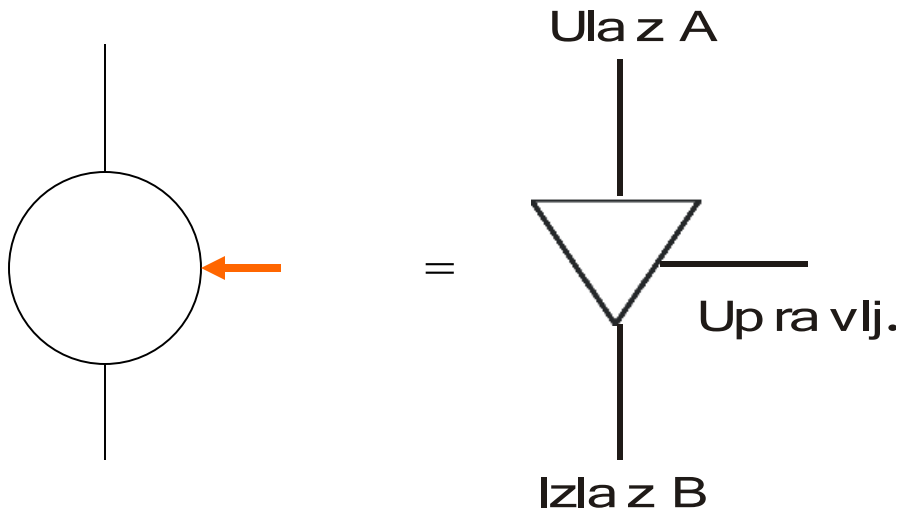
- svaka se mikrooperacija (osim Read M i Write M) izvodi u jednoj vremenskoj jedinici ΔT
- Read M i Write M zahtijevaju $2\Delta T$

“Spore” instrukcije (npr. add, st, ld) trebaju 8 vremenskih jedinica ($8 \Delta T$)

“Brze” instrukcije (npr. jmp) zahtijevaju samo 5 vremenskih jedinica ($5 \Delta T$)

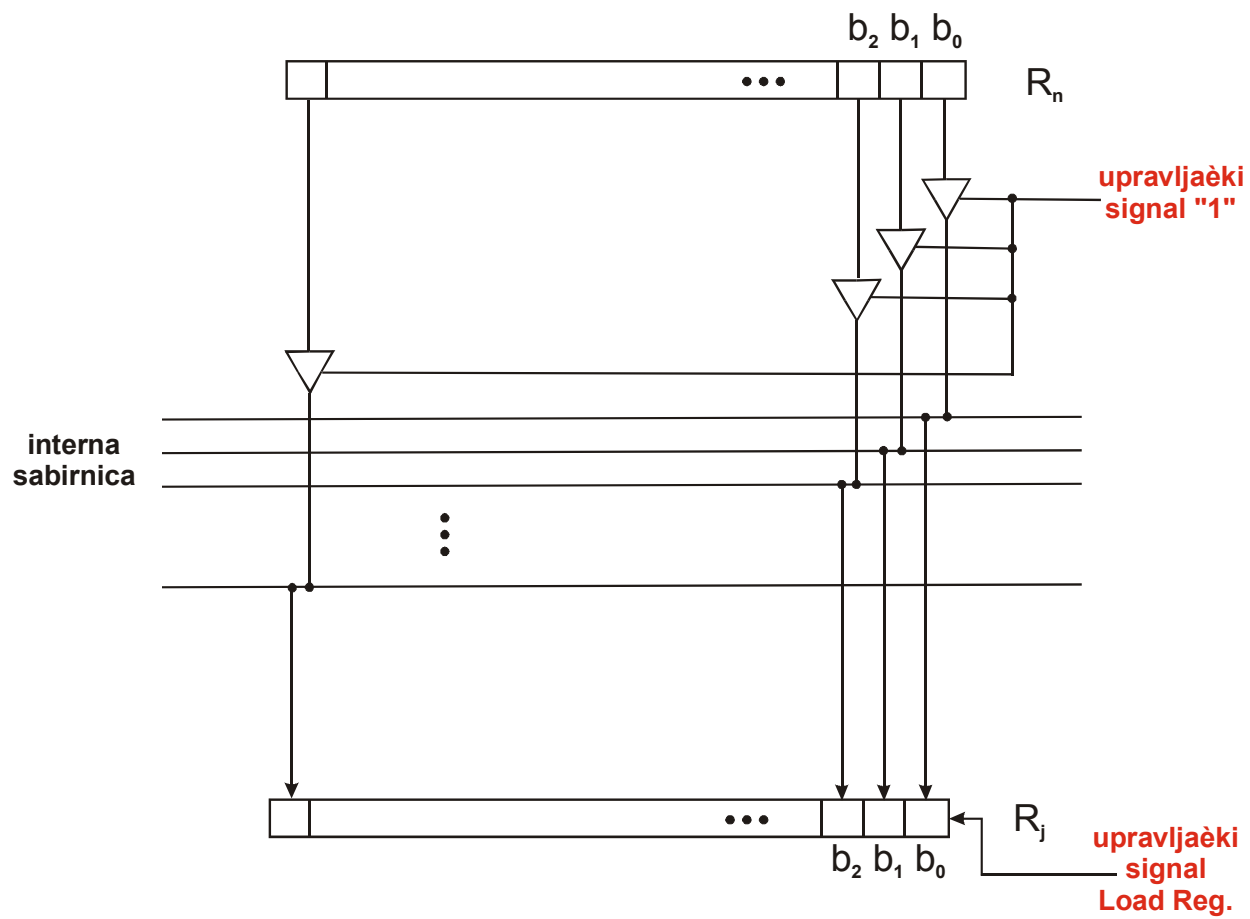


Izvedba nezavisne upravljačke točke:



Sklop s tri stanja:

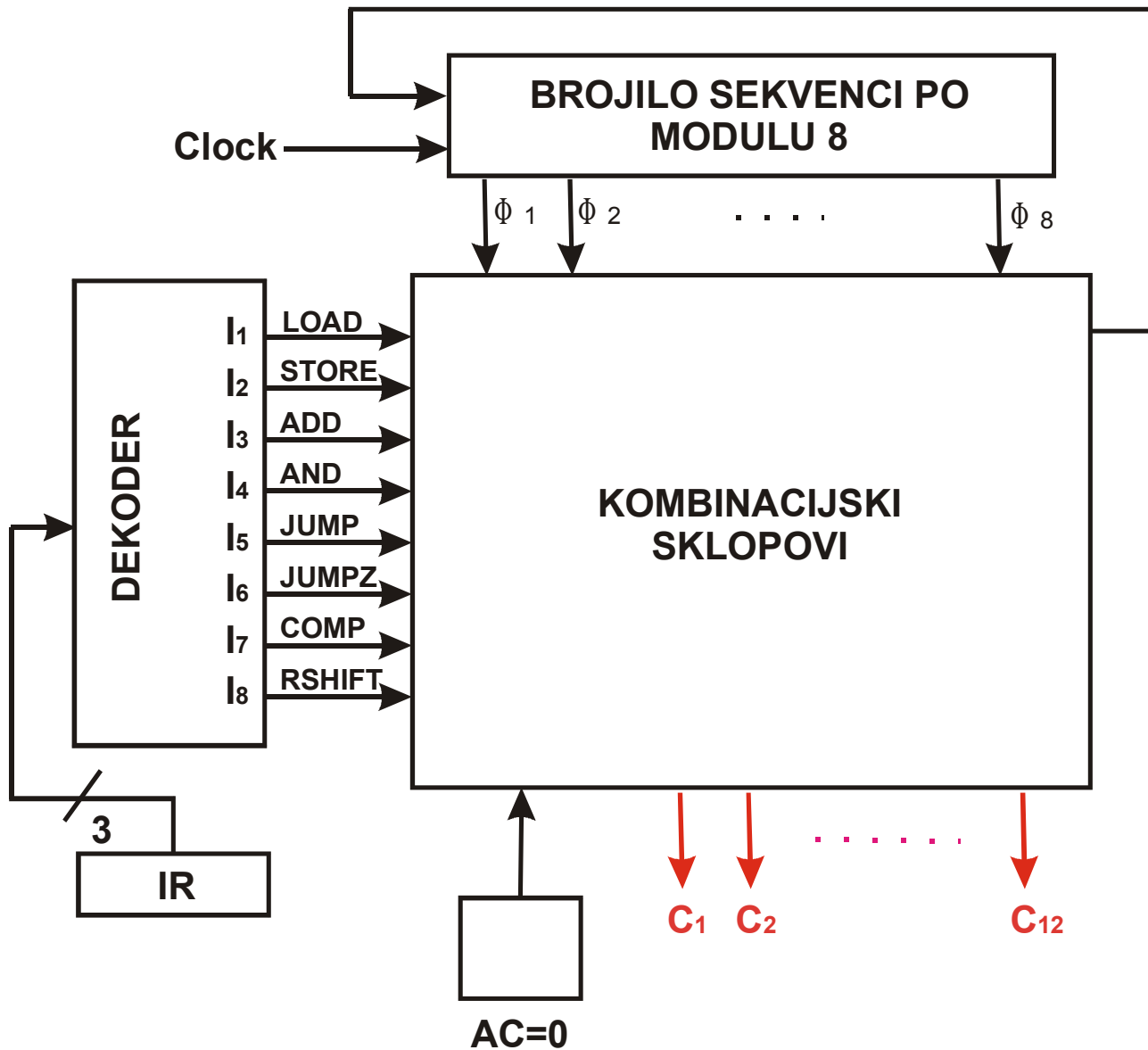
Upravljlj. signal	Ulaz	Izlaz
1	A	A
1	\overline{A}	\overline{A}
0	X	Z



C_0	$AC \leftarrow AC + DR$
C_1	$AC \leftarrow AC \wedge DR$
C_2	$AC \leftarrow \overline{AC}$
C_3	$DR \leftarrow M(AR)$
C_4	$M(AR) \leftarrow DR$
C_5	$DR \leftarrow AC$
C_6	$AC \leftarrow DR$
C_7	$AR \leftarrow DR(AR)$
C_8	$PC \leftarrow DR(AR)$
C_9	$PC = PC + 1$
C_{10}	$AR \leftarrow PC$
C_{11}	$IR \leftarrow DR(OP)$
C_{12}	Right shift AC

/READ M/

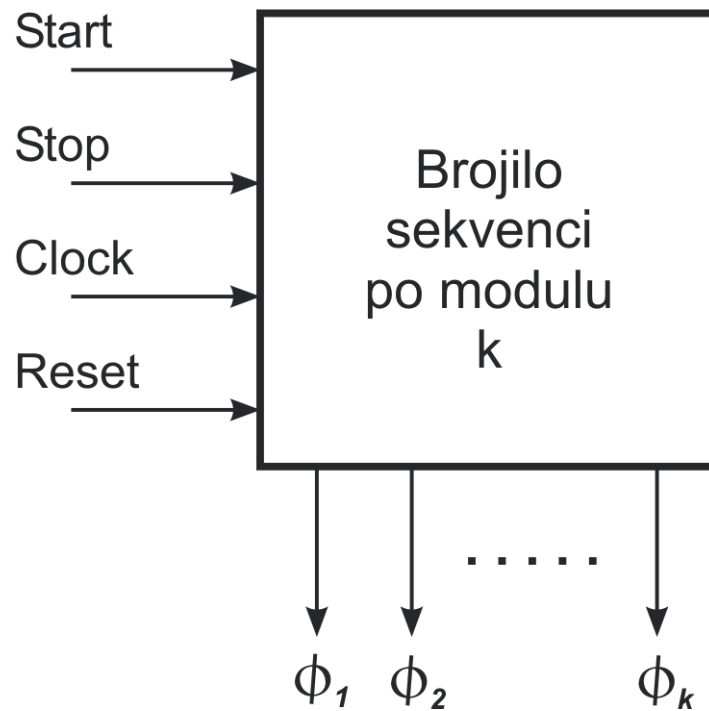
/ WRITE M/



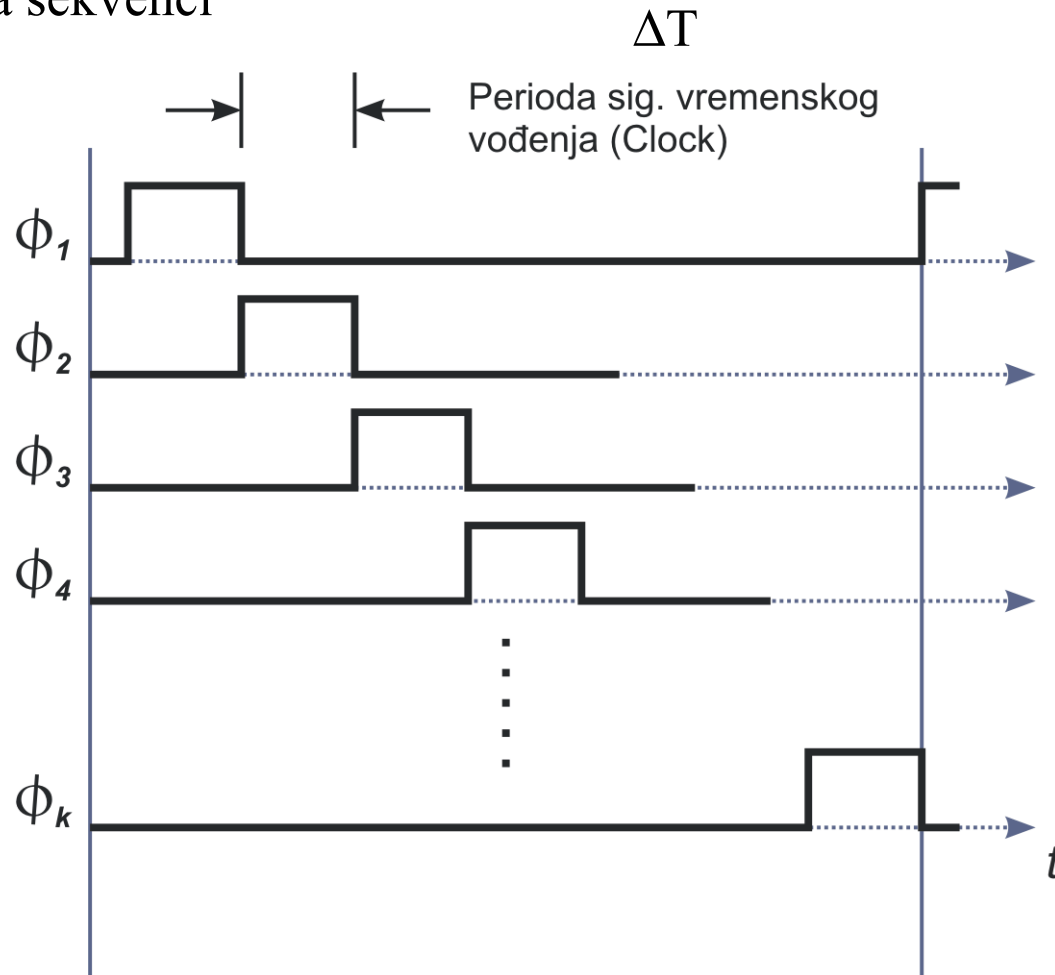
C_0	$AC \leftarrow AC + DR$
C_1	$AC \leftarrow AC \wedge DR$
C_2	$AC \leftarrow \overline{AC}$
C_3	$DR \leftarrow M(AR)$
C_4	$M(AR) \leftarrow DR$
C_5	$DR \leftarrow AC$
C_6	$AC \leftarrow DR$
C_7	$AR \leftarrow DR(AR)$
C_8	$PC \leftarrow DR(AR)$
C_9	$PC = PC + 1$
C_{10}	$AR \leftarrow PC$
C_{11}	$IR \leftarrow DR(OP)$
C_{12}	Right shift AC

/READ M/

/ WRITE M/



Izlaz iz brojila sekvenci



Upravljački signal C_i ($i = 0, 1, 2, \dots, 12$) može se opisati logičkom jednažbom:

$$C_i = \sum_j \left(\Phi_j \bullet \sum_m I_m \right)$$

$j = 1, 2, \dots, 8$

$m = 1, 2, \dots, 8$

I_m – izlaz iz dekodera instrukcija

Faza IZVRŠI:

Instrukcija ld:

$$C_7 = \Phi_5 \cdot I_1$$

$$C_3 = \Phi_6 \cdot I_1 + \Phi_7 \cdot I_1$$

$$C_6 = \Phi_8 \cdot I_1$$

st: $C_7 = \Phi_5 \cdot I_2$

$$C_5 = \Phi_6 \cdot I_2$$

$$C_4 = \Phi_7 \cdot I_2 + \Phi_8 \cdot I_2$$

add: $C_7 = \Phi_5 \cdot I_3$

$$C_3 = \Phi_6 \cdot I_3 + \Phi_7 \cdot I_3$$

$$C_0 = \Phi_8 \cdot I_3$$

and: $C_7 = \Phi_5 \cdot I_4$

$$C_3 = \Phi_6 \cdot I_4 + \Phi_7 \cdot I_4$$

$$C_1 = \Phi_8 \cdot I_4$$

S. Ribarić, AIOR

Faza **IZVRŠI**:

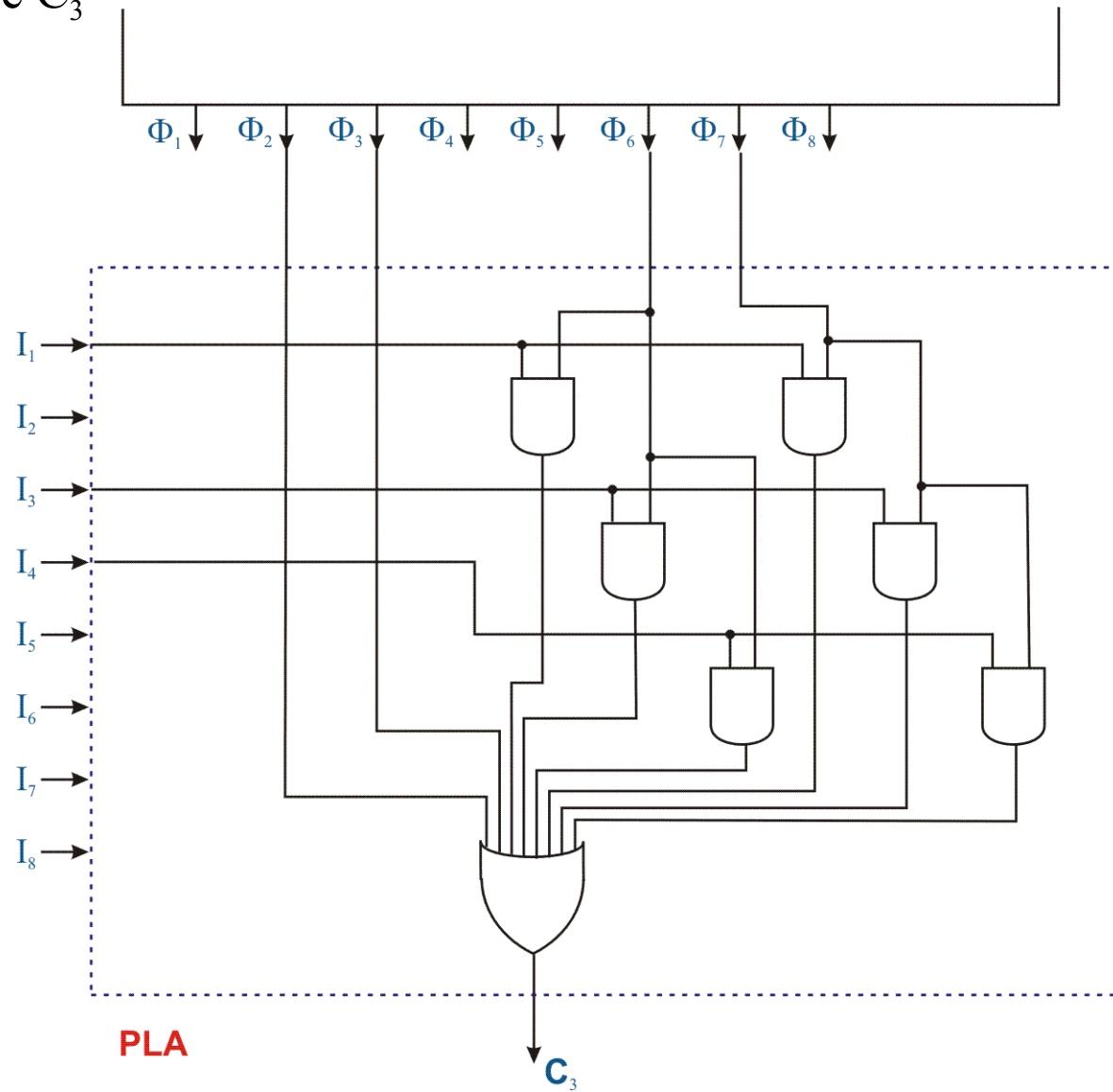
$$C_3 = \Phi_6 \cdot I_1 + \Phi_7 \cdot I_1 + \Phi_6 \cdot I_3 + \Phi_7 \cdot I_3 + \Phi_6 \cdot I_4 + \Phi_7 \cdot I_4$$

Faza **PRIBAVI** i **IZVRŠI**:

$$C_3 = \Phi_2 + \Phi_3 + \Phi_6 (I_1 + I_3 + I_4) + \Phi_7 (I_1 + I_3 + I_4)$$

$$C_i = \sum_j \left(\Phi_j \bullet \sum_m I_m \right)$$

Generiranje C_3

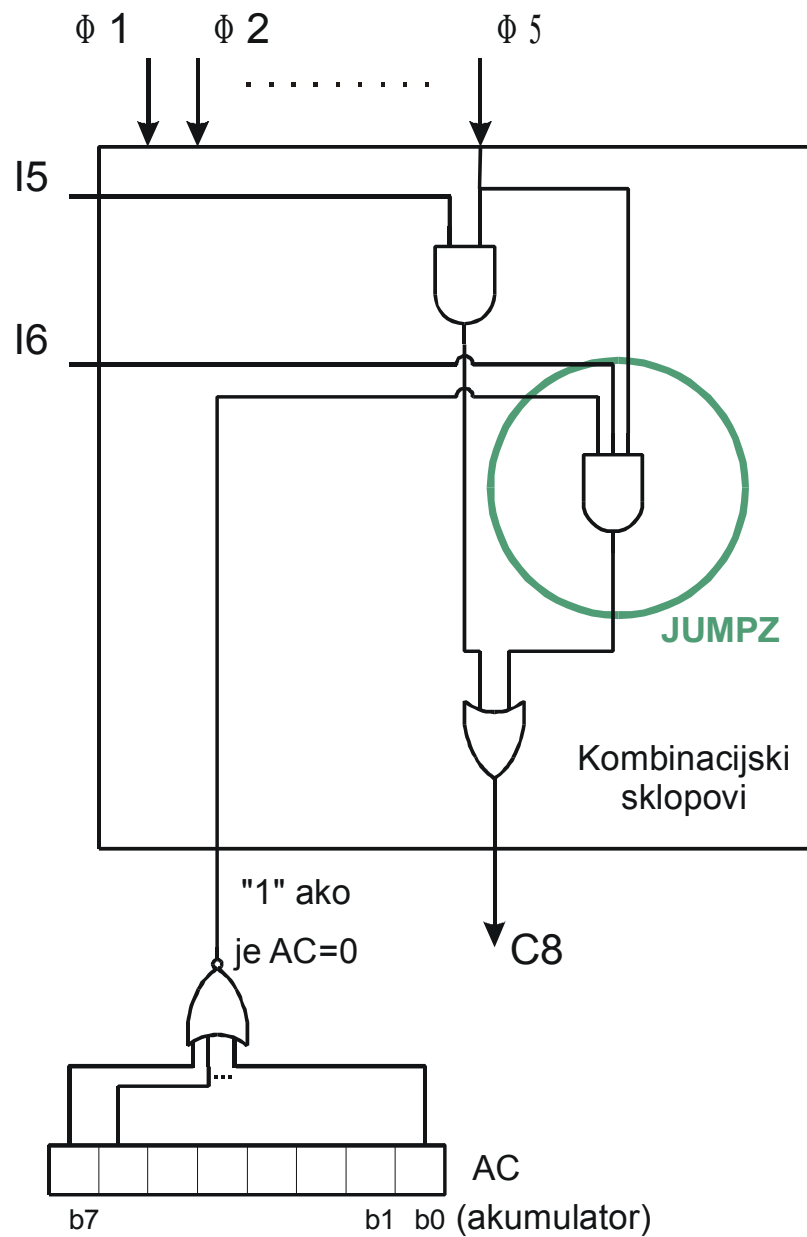


jmp: $C_8 = \Phi_5 \cdot I_5$

j = 5 i nakon toga resetira se brojilo
sekvenci!

jmpz: $C_8 = \Phi_5 \cdot I_6$ ako je $AC = 0$

Faza **IZVRŠI** za jmp (I_5) i
jmpz (I_6):



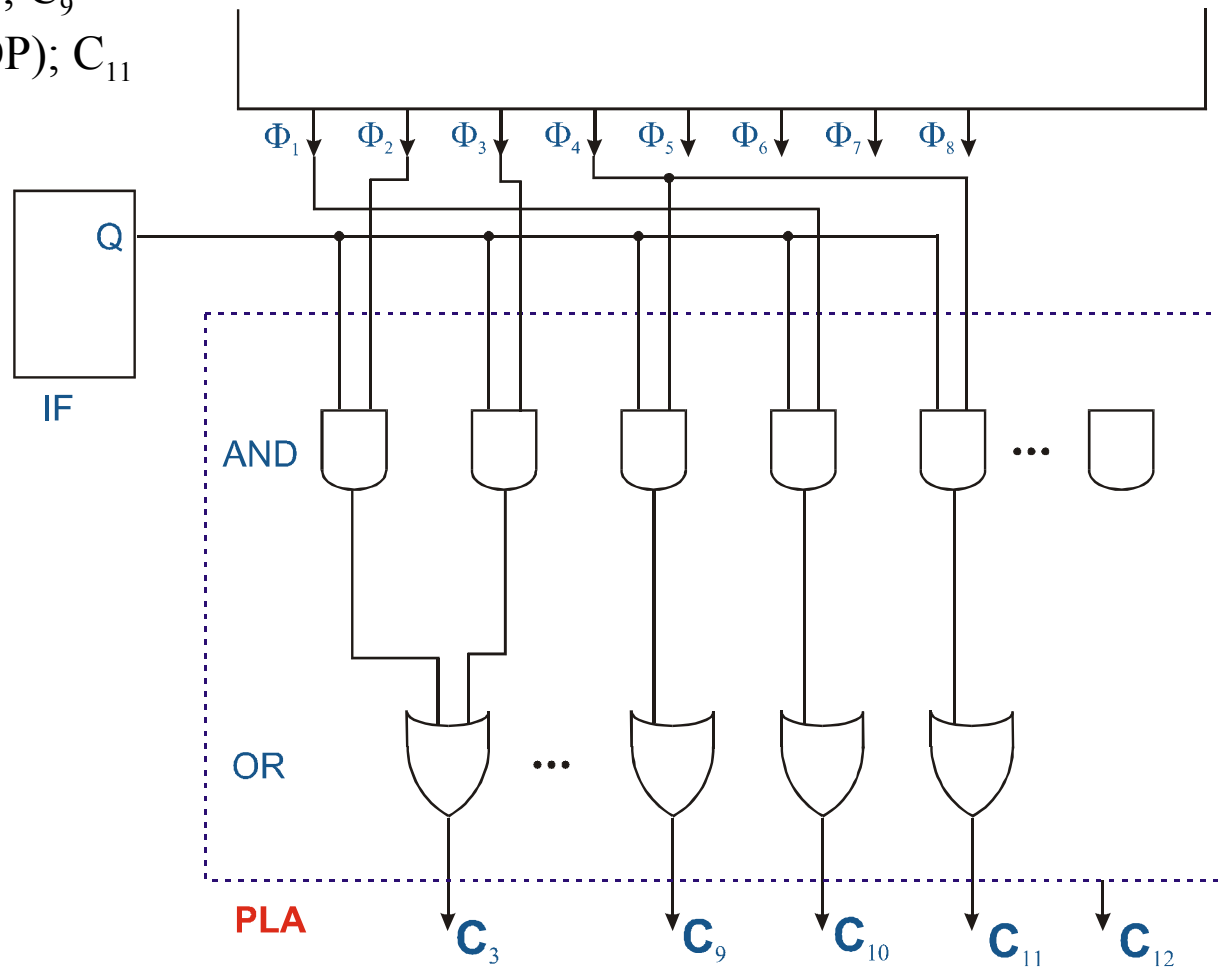
Faza **PRIBAVI**:

Φ_1 ; $AR \leftarrow PC$; C_{10}

Φ_2, Φ_3 ; Read M; C_3

Φ_4 ; $PC \leftarrow PC+1$; C_9

$IR \leftarrow DR(OP)$; C_{11}



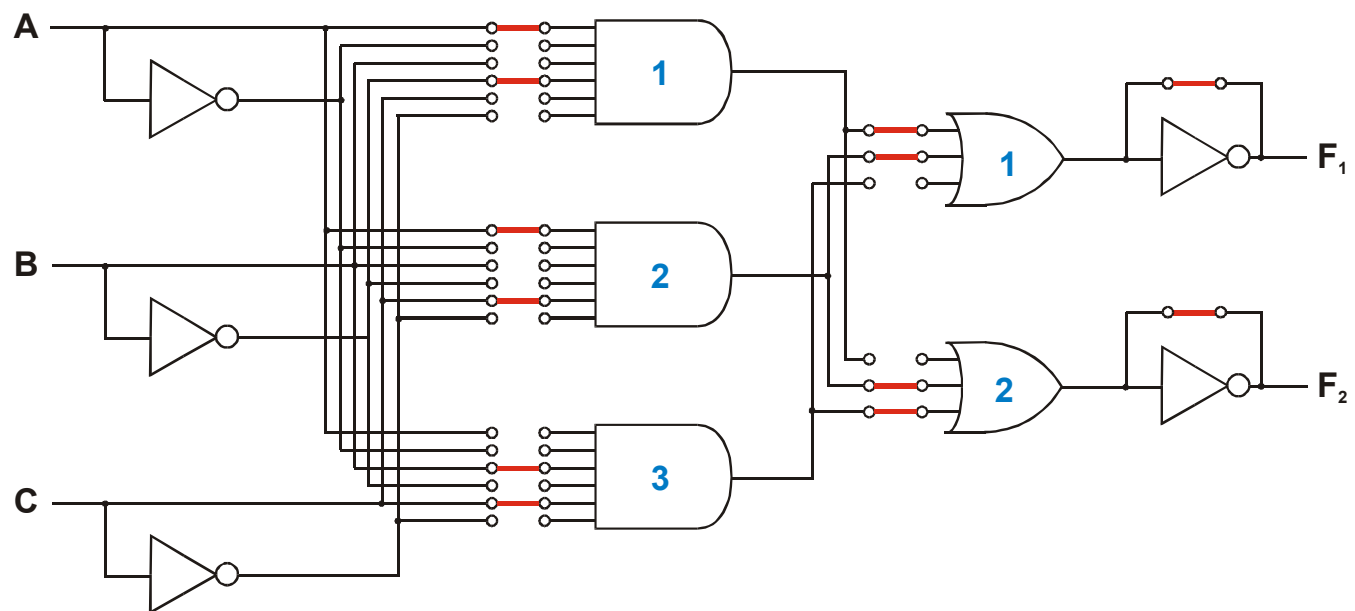
PLA – Programmable Logic Array

A	B	C	F ₁	F ₂
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	1	1
1	1	0	0	0
1	1	1	1	1

$$F_1 = \overline{A}B + AC$$

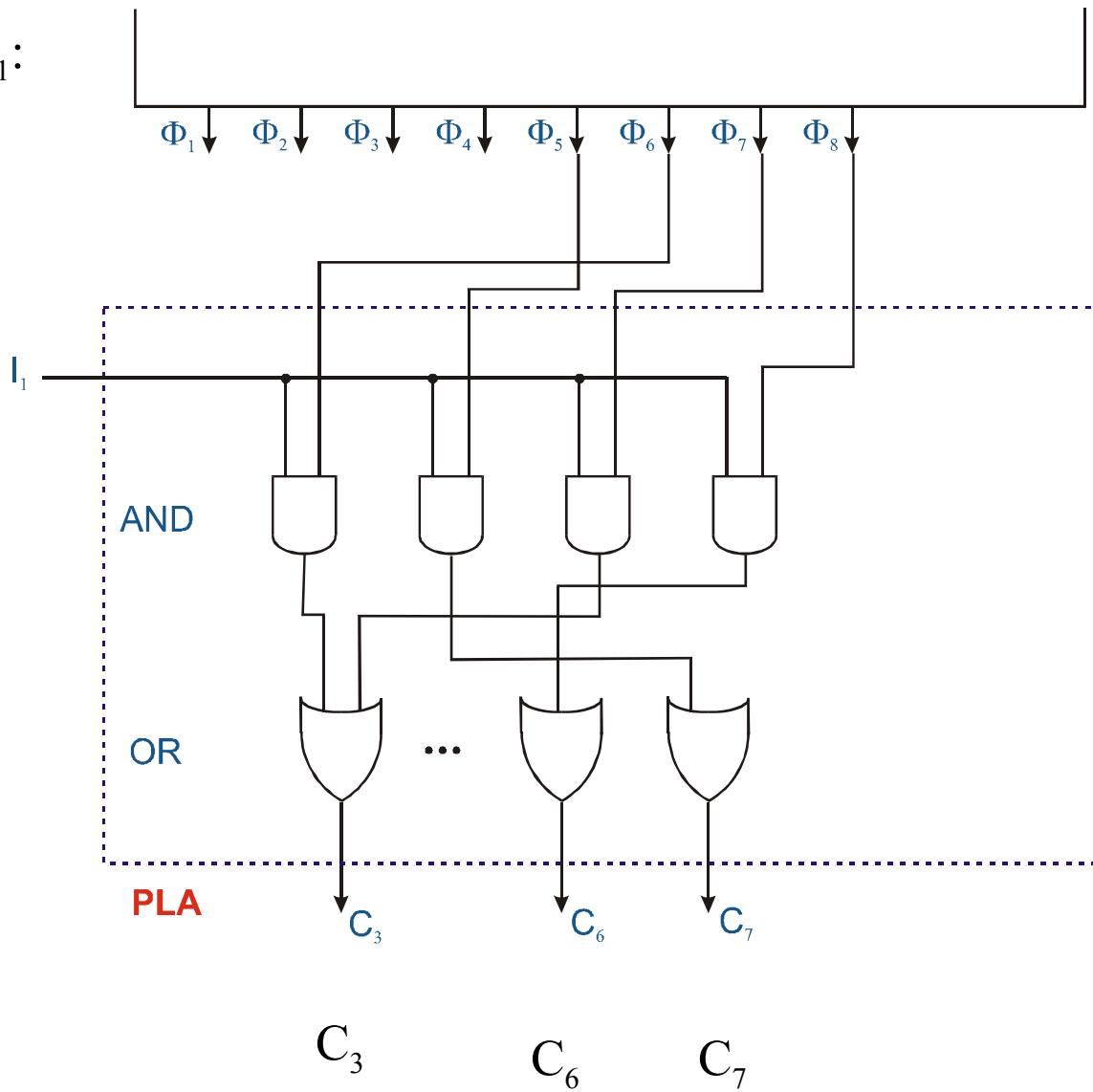
$$F_2 = AC + BC$$

PLA (3 ulaza, 3 AND, 2 OR, 2 izlaza)



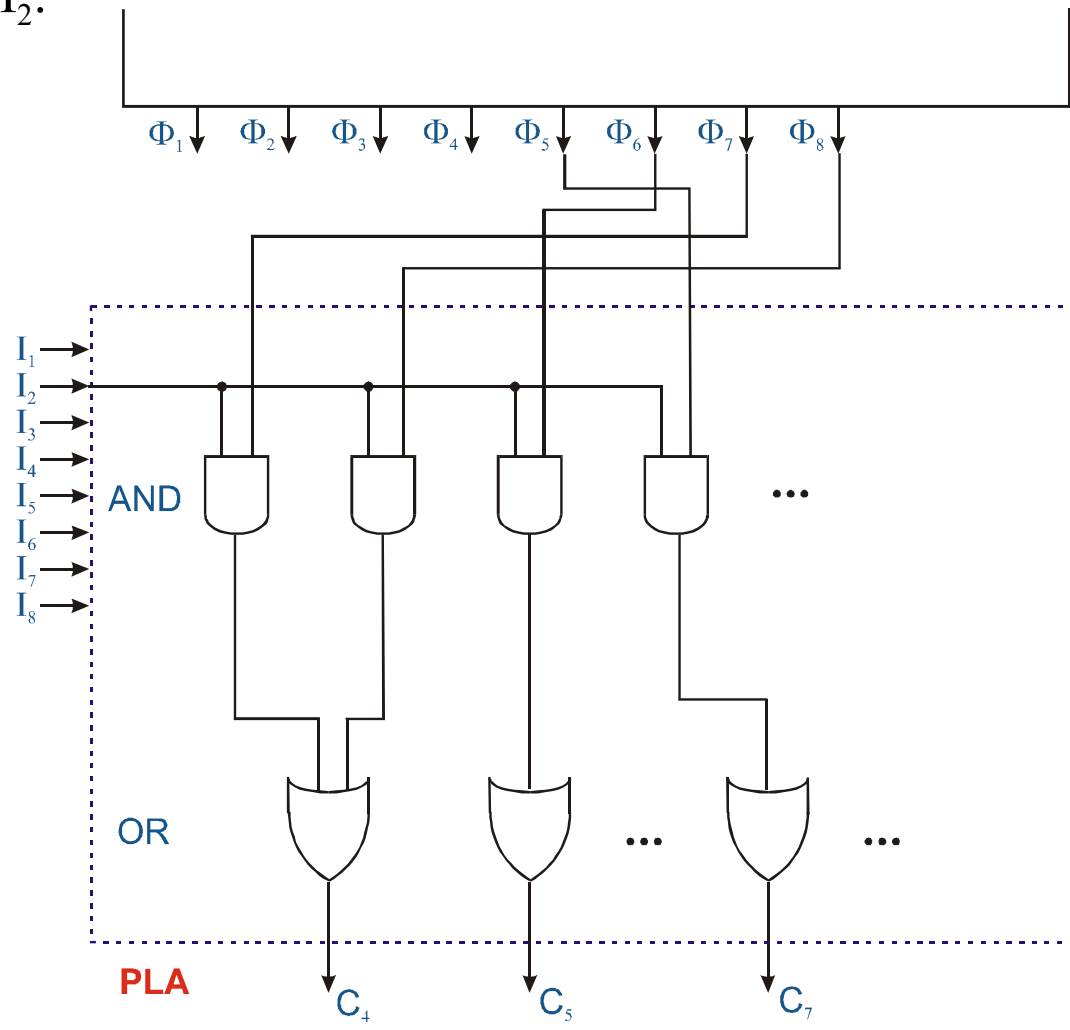
Instrukcija I_1 :

ld

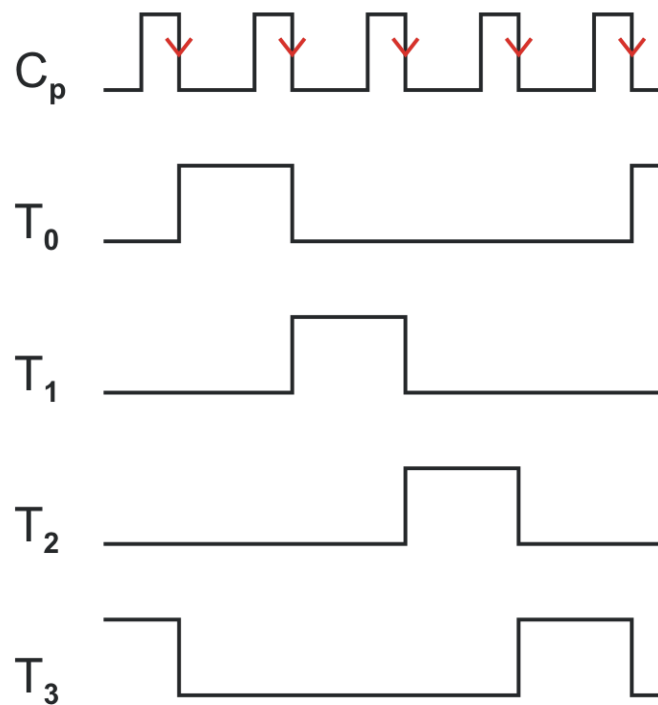
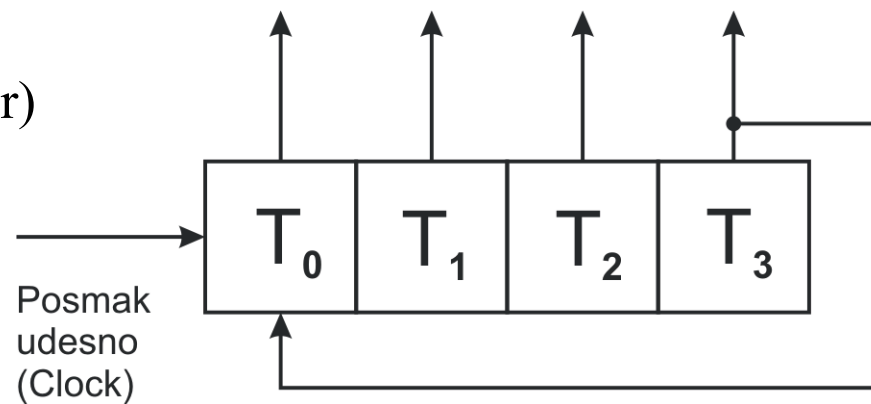


Instrukcija I_2 :

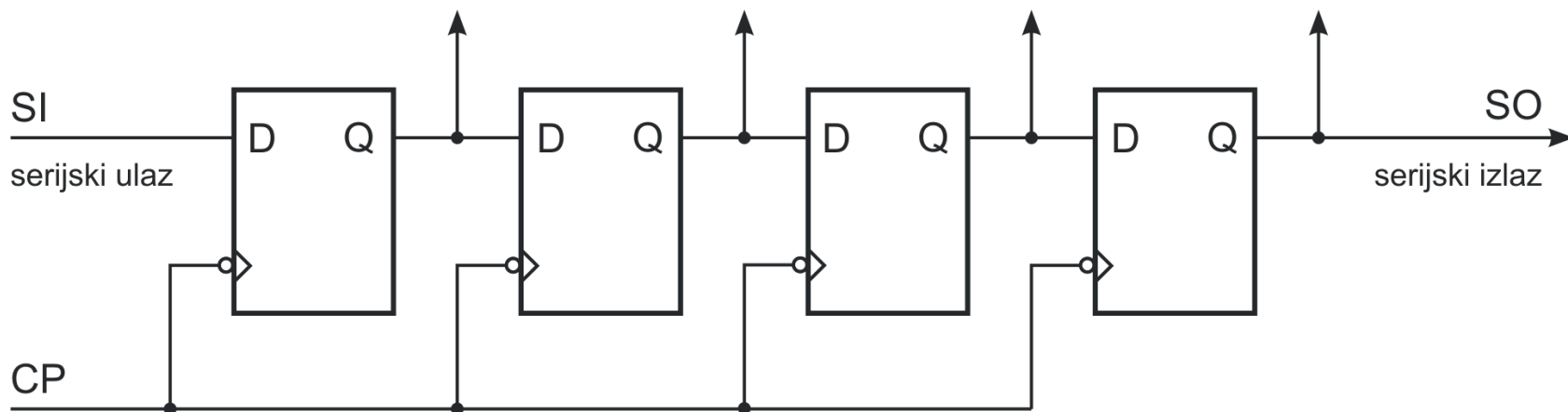
st

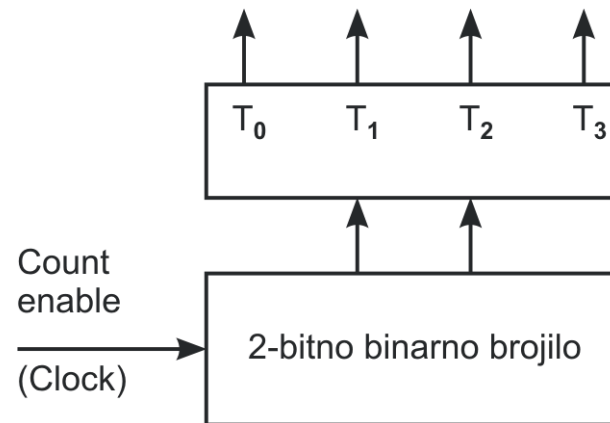


Prstenasto brojilo (engl. Ring-counter)



Posmačni registar

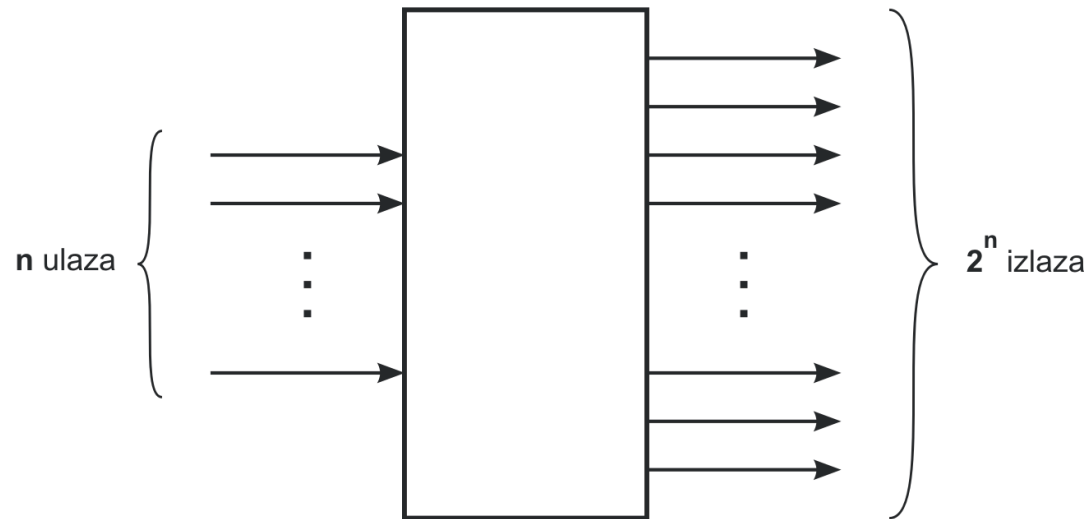




Dekoder

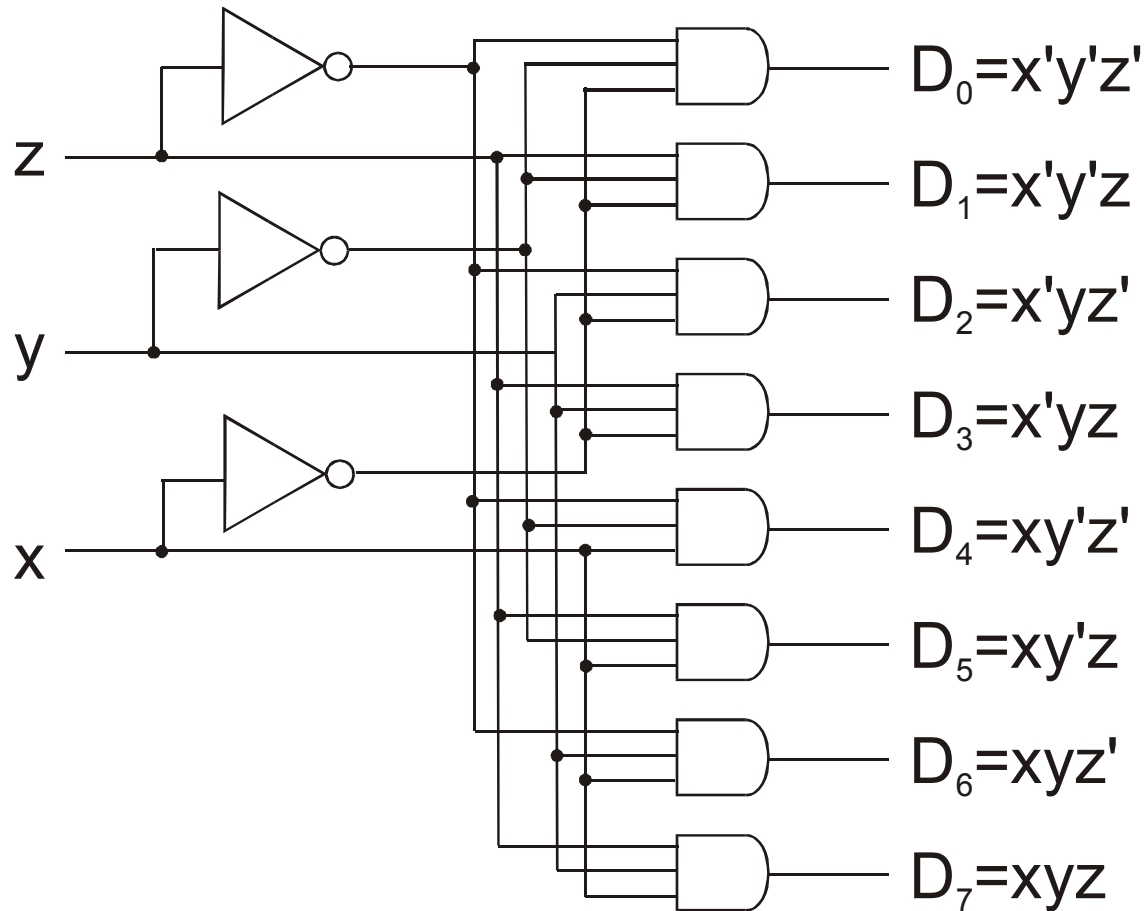
Brojilo

Dekoder

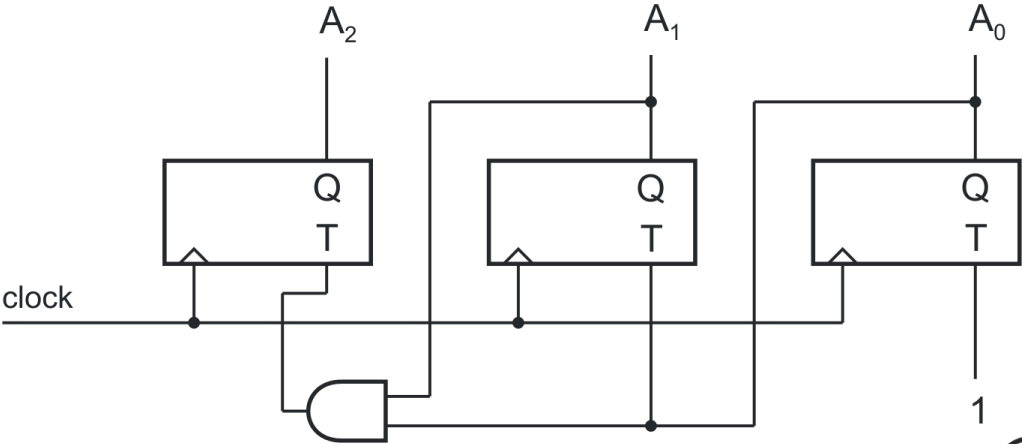


ULAZI			IZLAZI							
X	Y	Z	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Izvedba dekodera

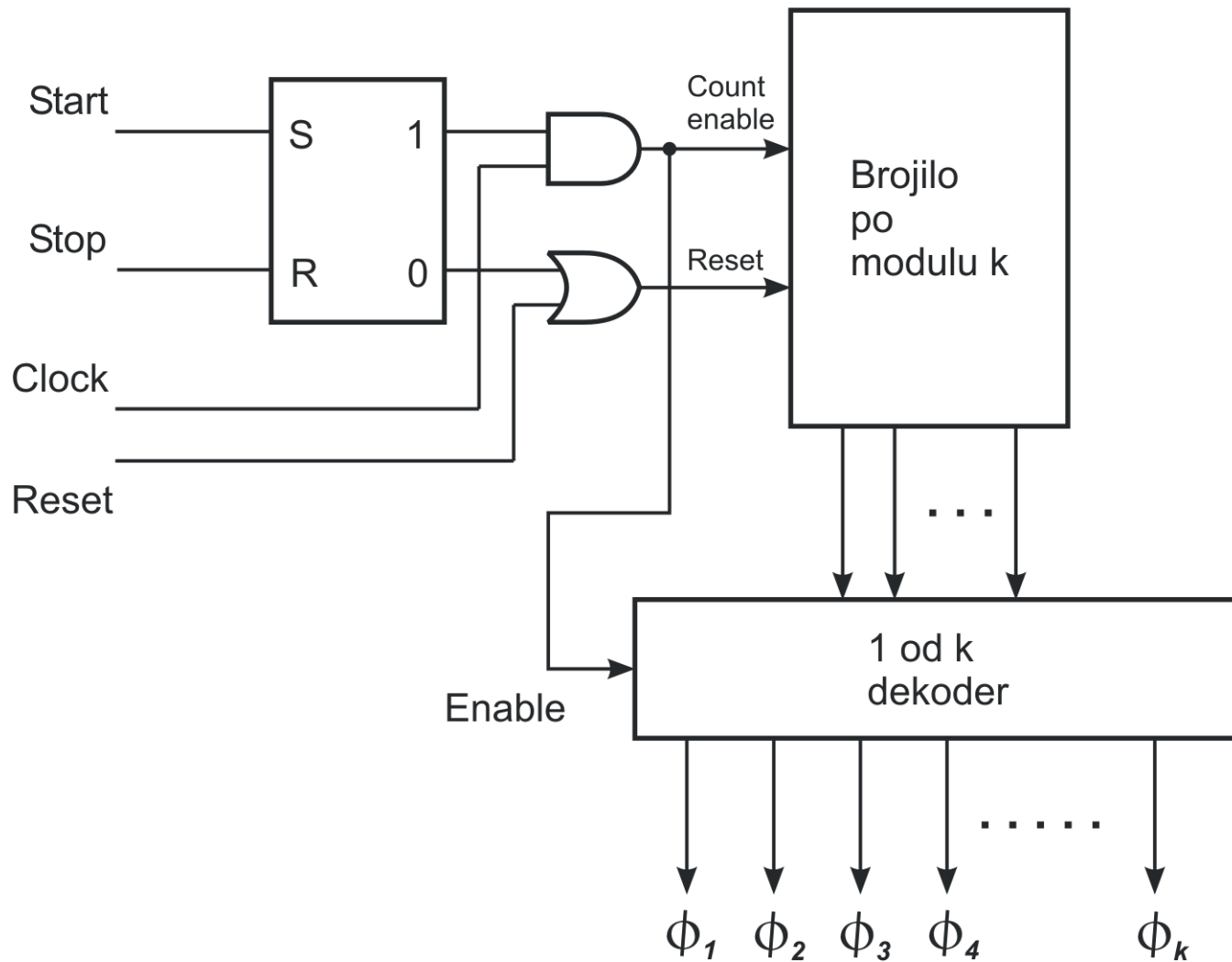


Izvedba brojila

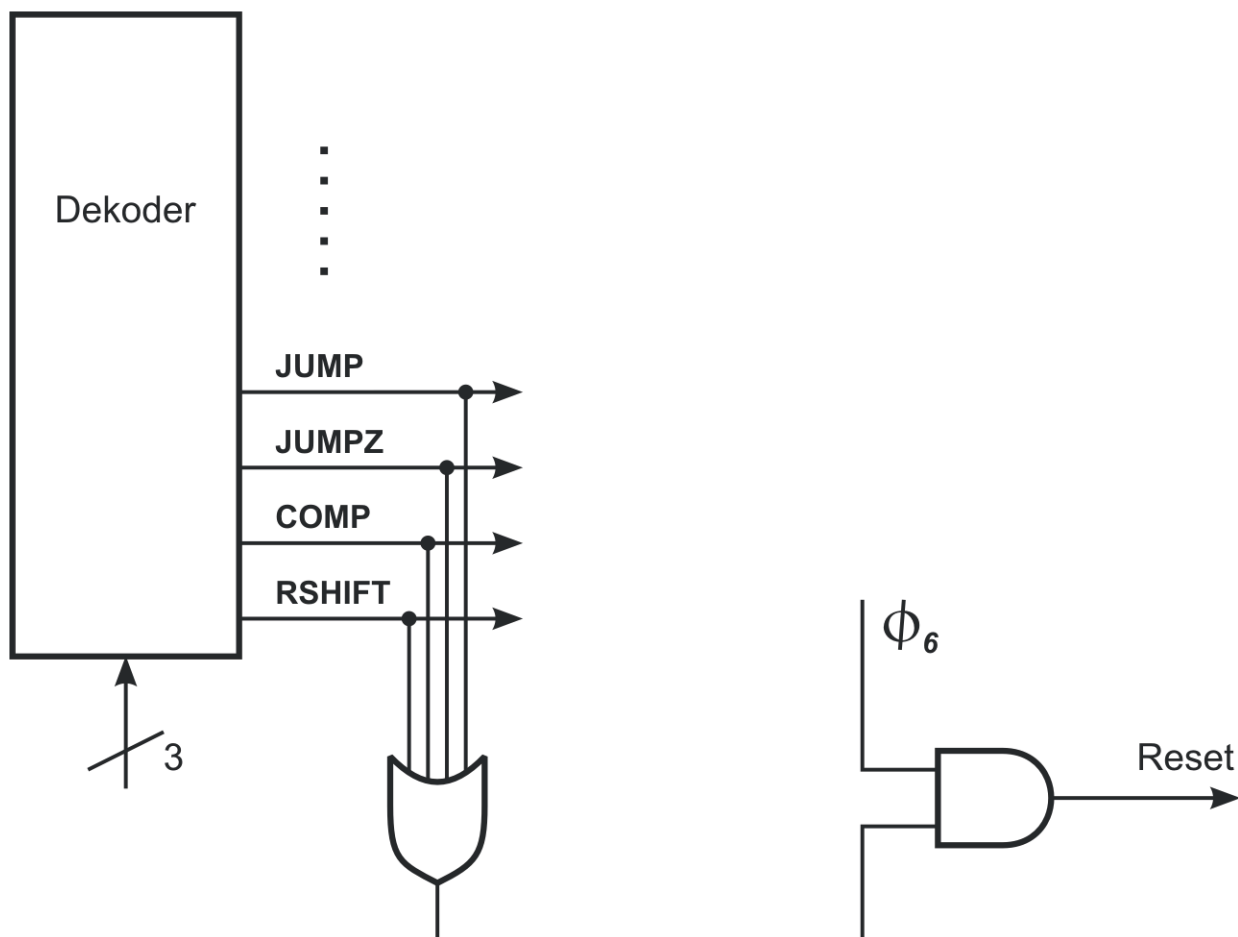


		ulaz T	
		0	1
stanje Q	0	0	1
	1	1	0

Sekvenca brojanja			Ulazi bistabila		
A ₂	A ₁	A ₀	TA ₂	TA ₁	TA ₀
0	0	0	0	0	1
0	0	1	0	1	1
0	1	0	0	0	1
0	1	1	1	1	1
1	0	0	0	0	1
1	0	1	0	1	1
1	1	0	0	0	1
1	1	1	1	1	1



Skraćivanje instrukcijskog ciklusa za “brze” instrukcije



Generator taktnog signala

