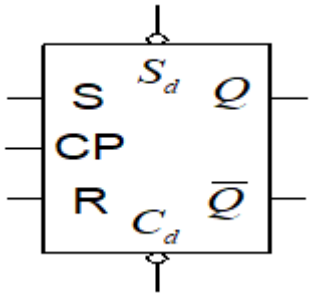
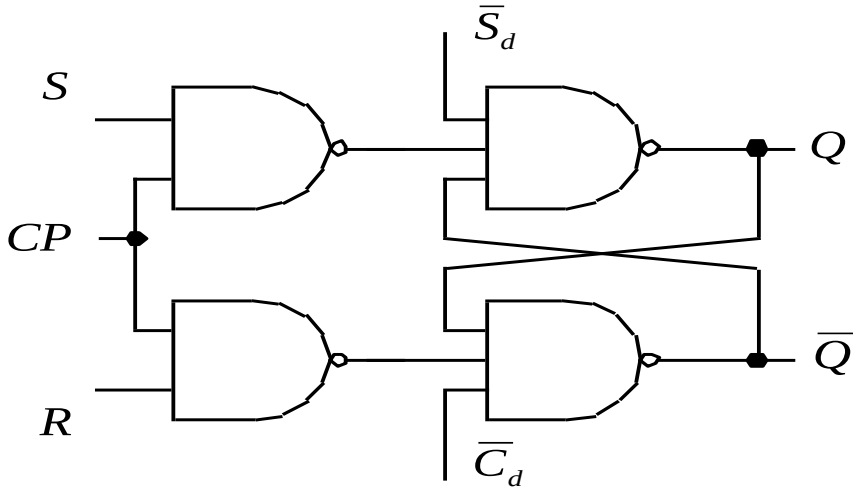
OSNOVE DIGITALNE ELEKTRONIKE

Registri

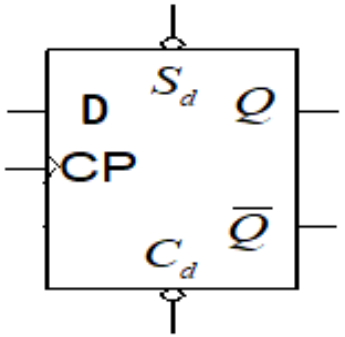
Asinkroni rad bistabila-

Preko asinkronih ulaza postavljamo bistabile u određeno stanje bez obzira na stanja sinkronih ulaza (SR; JK; D; T) i Cp impulsa
Sa Sd (PR) Q=1
Sa Cd (CLR; MR;B) Q=0
Sd i Cd aktivni u nuli(ako u simbolu postoji kružić ili crta iznad)

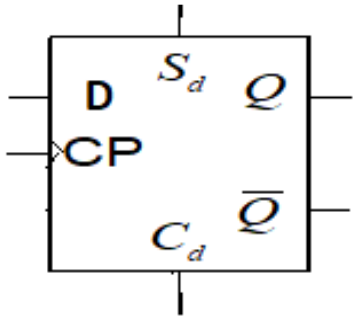




Asinkroni-sinkroni rad D bistabila



CP	Sd	Cd	D	Q	
x	0	1	x	1	asinkroni rad
x	1	0	x	0	
x	0	0	x	x	
⇧	1	1	0	0	sinkroni rad
⇧	1	1	1	1	



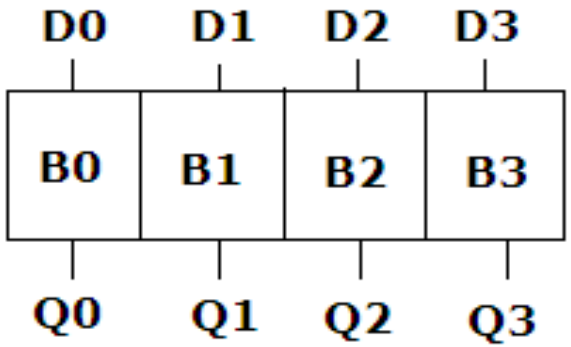
CP	Sd	Cd	D	Q	
x	1	0	x	1	asinkroni rad
x	0	1	x	0	
x	1	1	x	x	
⇧	0	0	0	0	sinkroni rad
⇧	0	0	1	1	

Registri - pojam

- Sklopovi za pamćenje višebitnih podataka:
  → "registriranje" podataka
- Sastavljen od niza bistabila
- Podjela prema načinu čitanja i upisivanja podataka:
- -paralelni: paralelni upis i ispis podataka
- -posmačni: serijski upis i ispis podataka

Paralelni registar

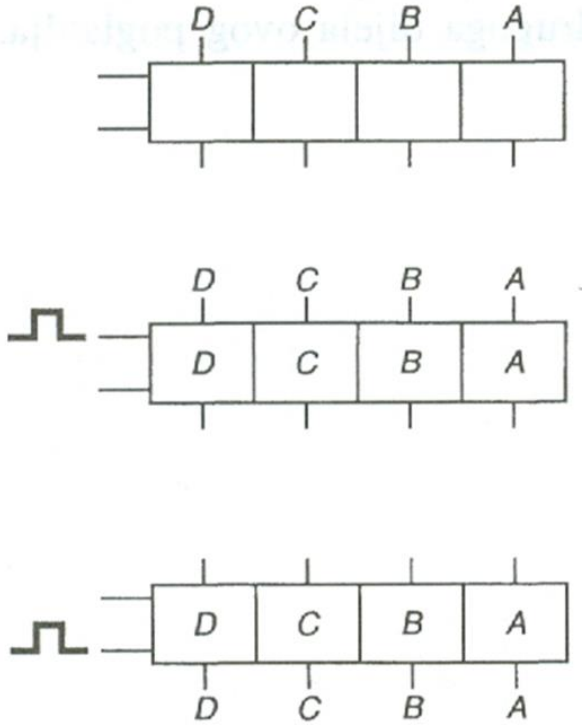
Osnovna struktura: *uređeni* skup *nepovezanih* bistabila

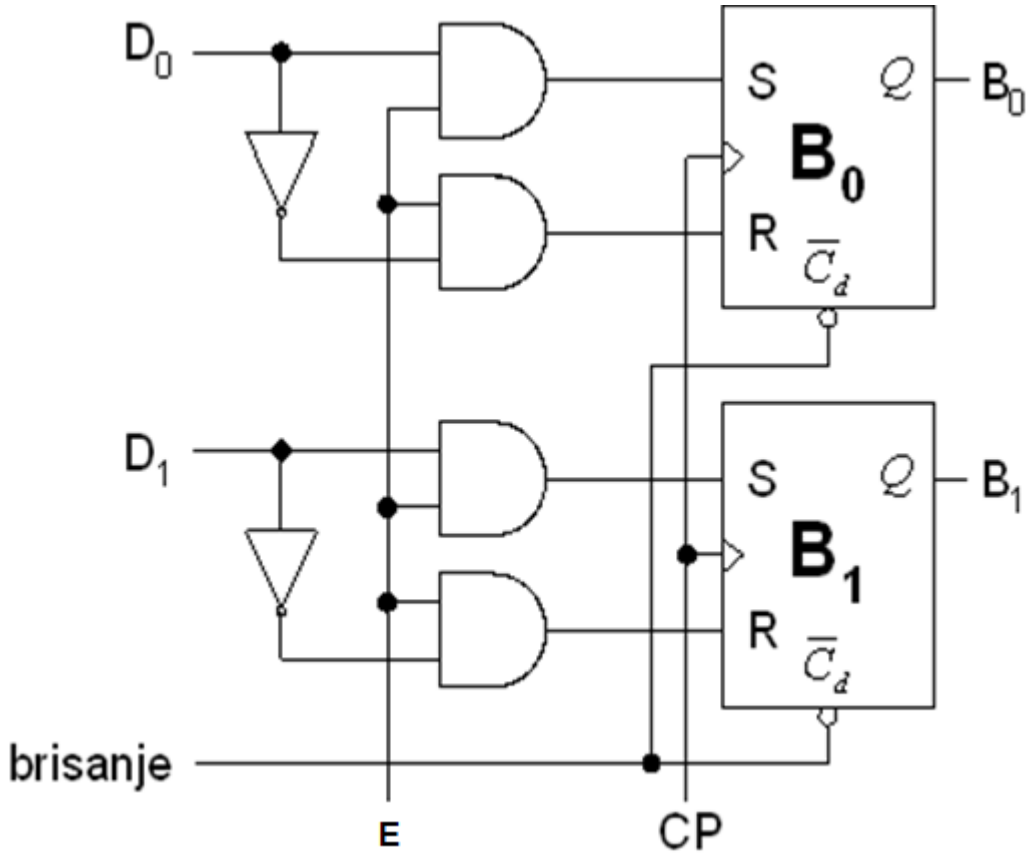


4-bitni registar - sastavljen od 4 bistabila (D; SR; JK)—za upis 4-bitnog podatka svaki bit podatka se dovodi na svoj ulaz (D0;D1;..) i na jedan Cp impuls se svaki bit podatka upiše u svoj bistabil; tj. nađe se na izlazu Q0;Q1;….

Paralelni registar

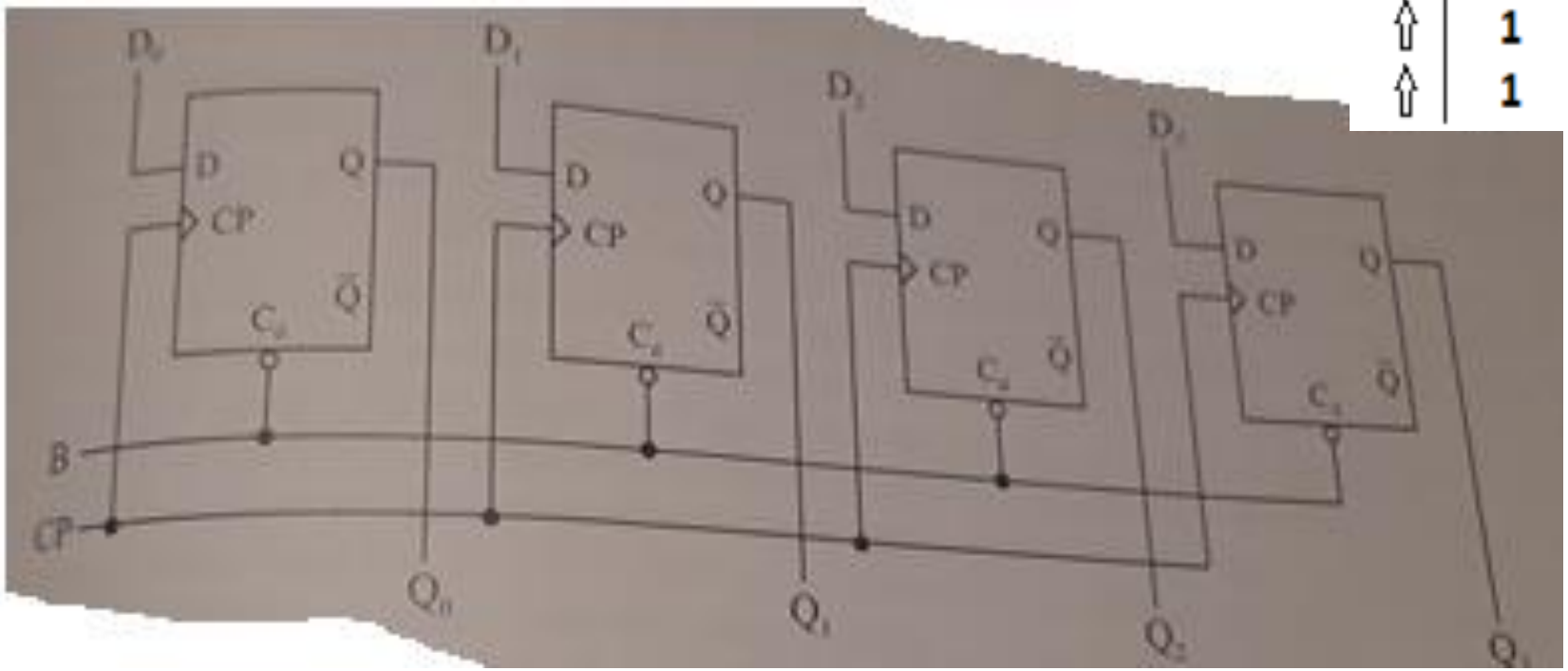
- Paralelni upis i čitanje podataka
- Način upisa: sinkroni i asinkroni



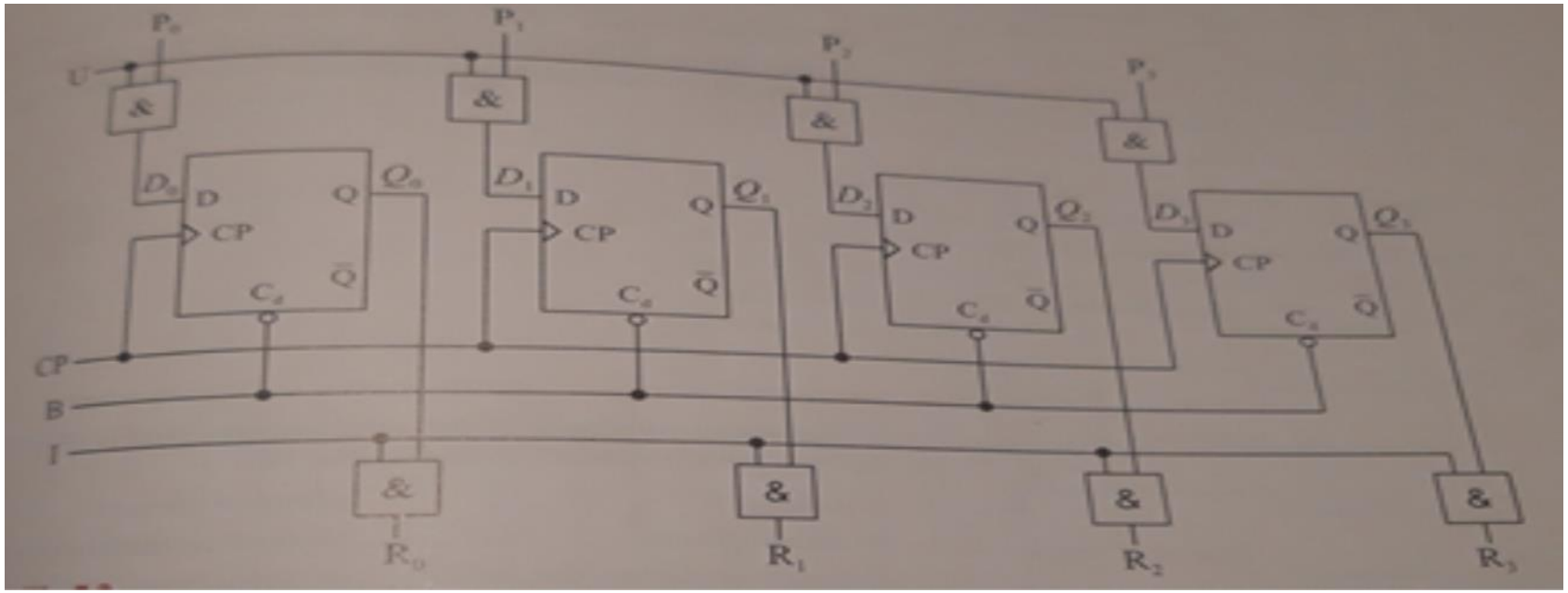


Zadatak: U četverobitni registar s paralelnim upisom i ispisom podataka upisati podatak $B_3B_2B_1B_0$=1101; 0110 (paziti na težinska mjesta bistabila)

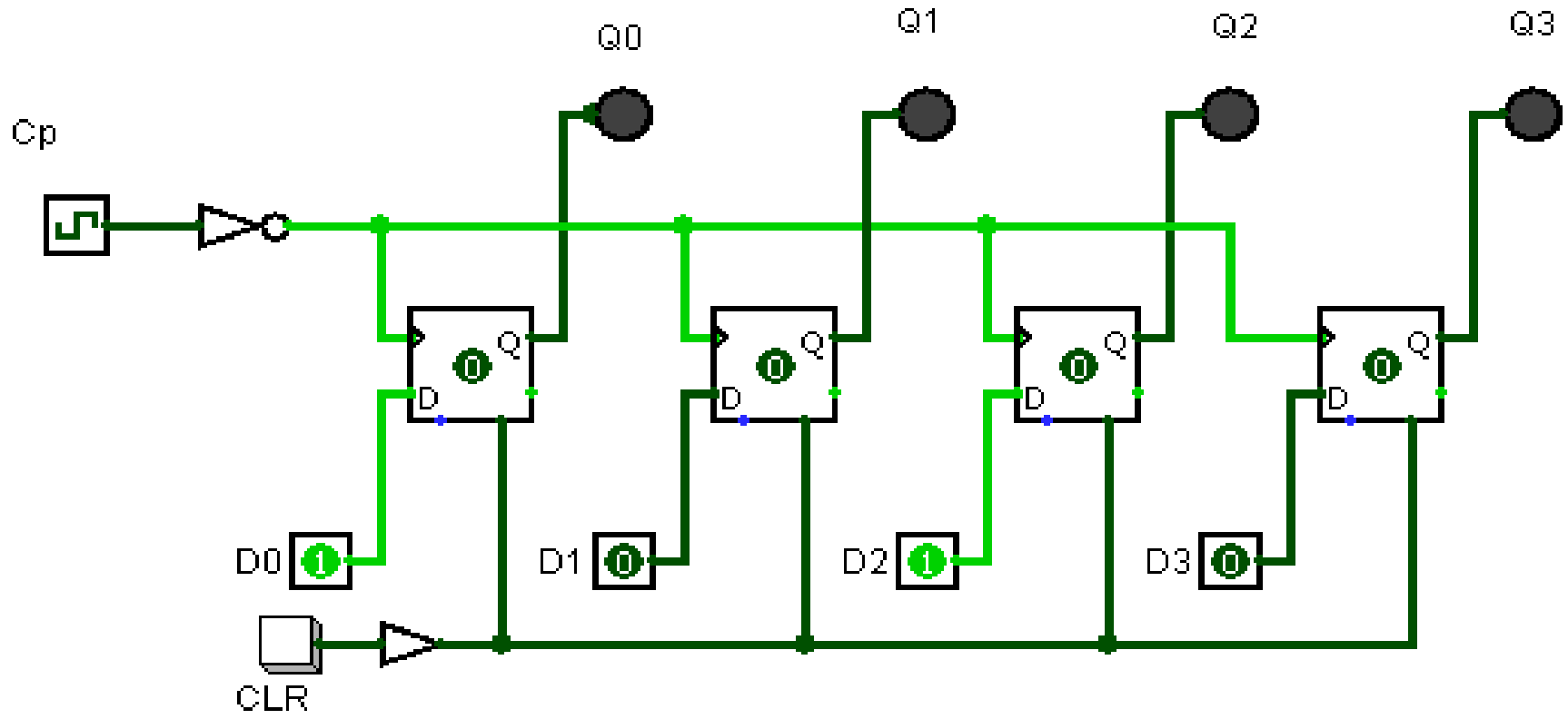
CP	B(CLR)	D0	D1	D2	D3	B0	B1	B2	B3
0	0	x	x	x	x	0	0	0	0
0	1	1	0	1	1	0	0	0	0
⇧	1	1	0	1	1	1	0	1	1
⇧	1	0	1	1	0	0	1	1	0

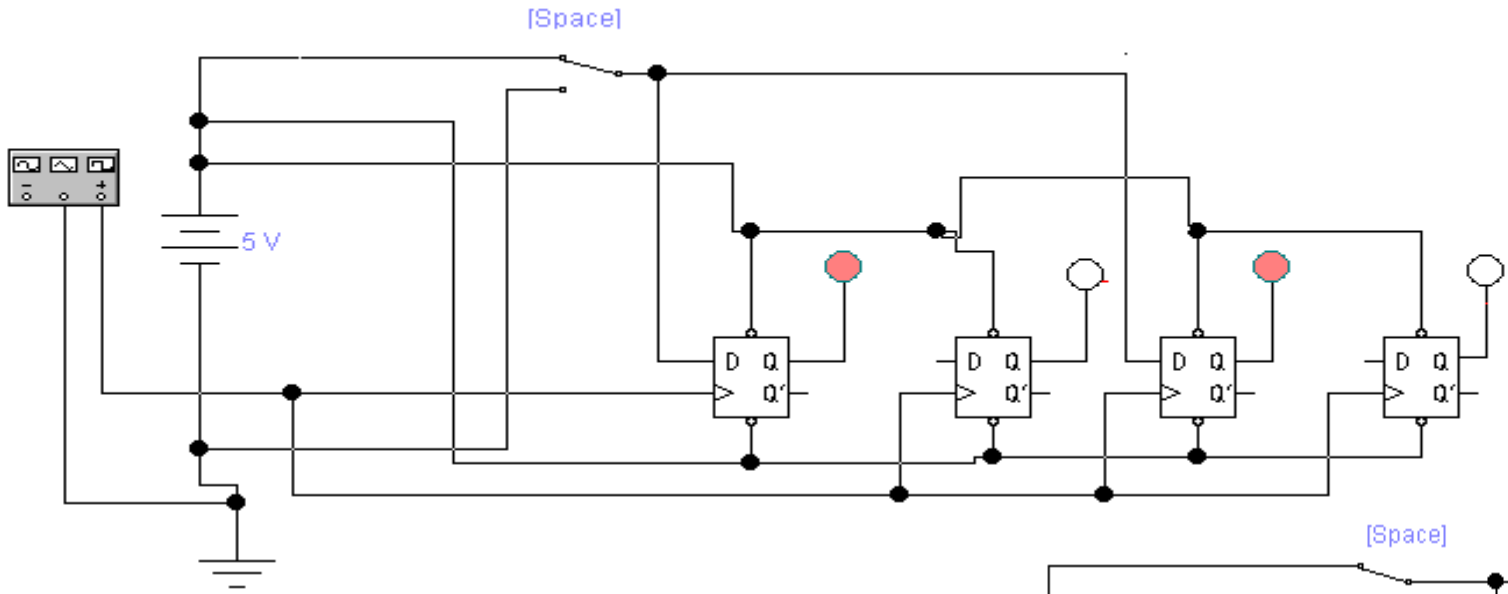


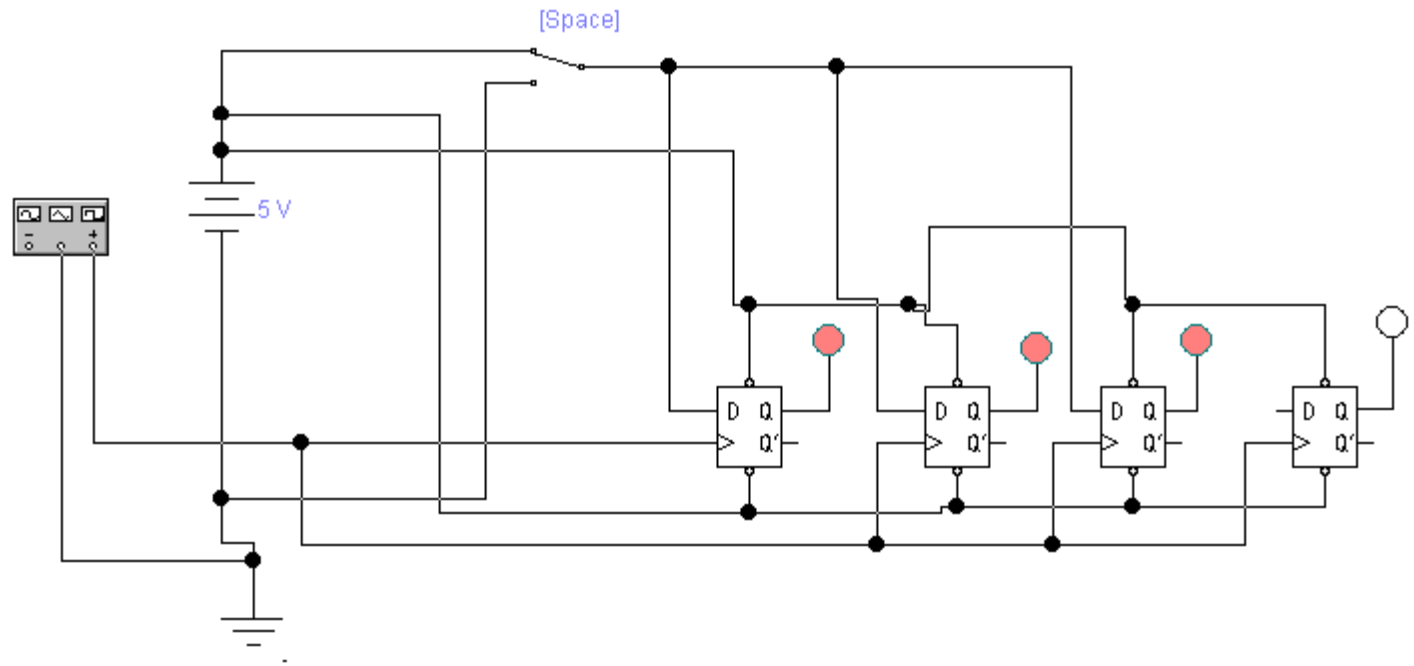
Četverobitni registar s posebnim ulazima za upravljanje paralelnim upisom i ispisom podataka



Paralelni registar - simulacija

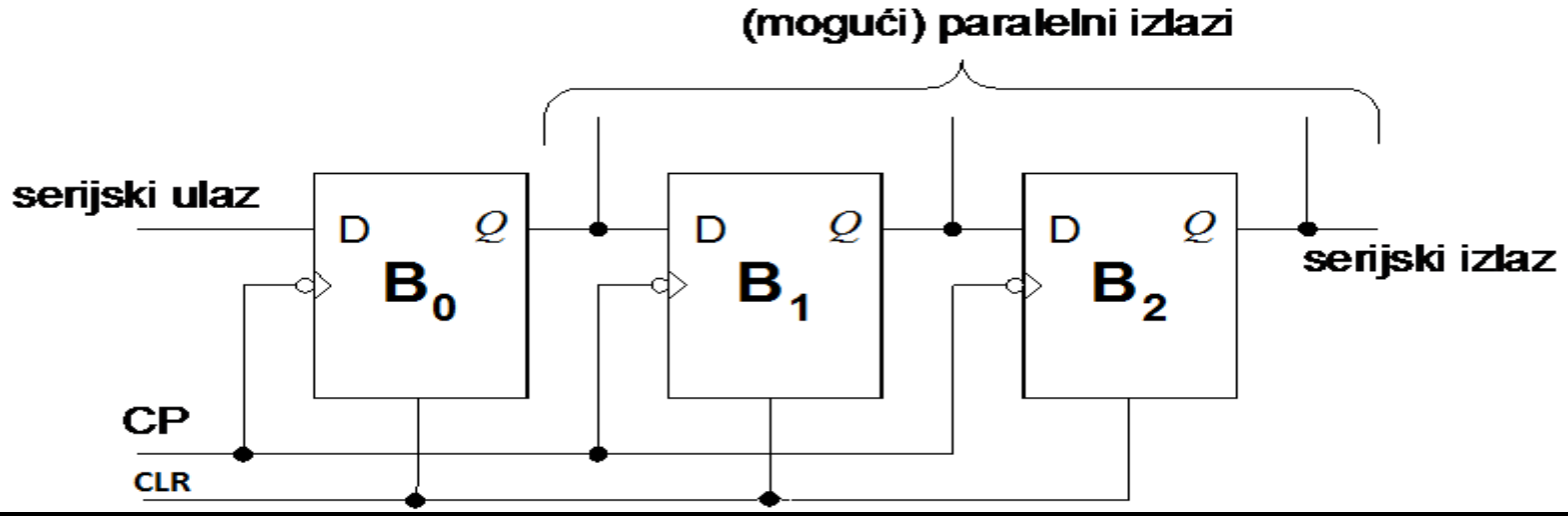



[Space]
5 V
D Q
Q'

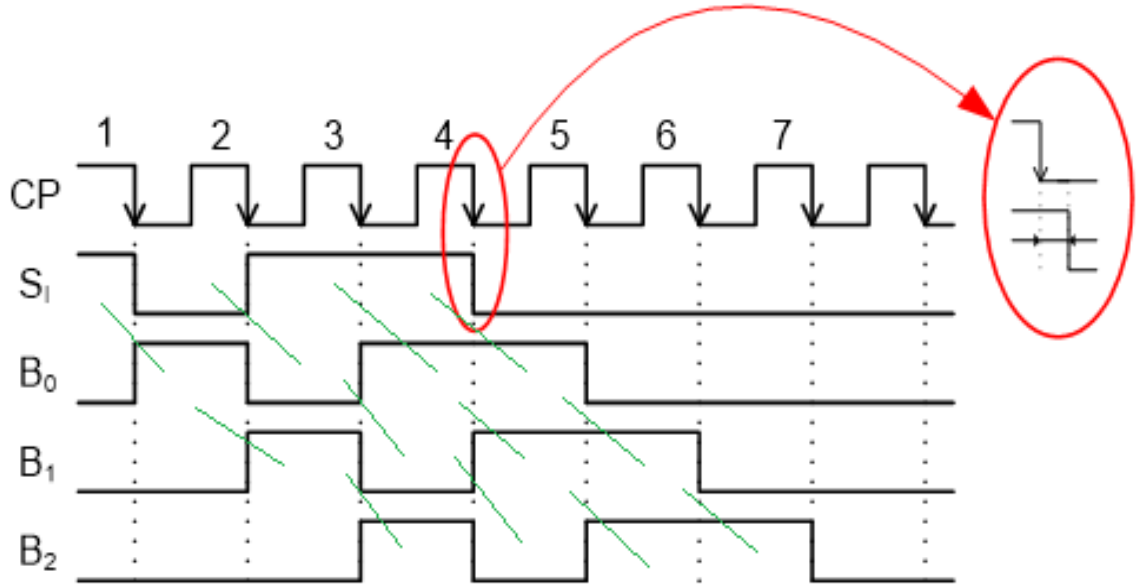

[Space]
5 V
D Q
Q'

Posmačni registar

- serijski upis i ispis
- Upisuje se bit po bit podatka
- mehanizam pomicanja (bitova) podatka: od ulaza prema izlazu - "posmak" [shift]
- Struktura- izlaz prethodnog bistabila spaja se na ulaz slijedećeg



Vremenski dijagram i tablica stanja –primjer serijskog upisa podatka

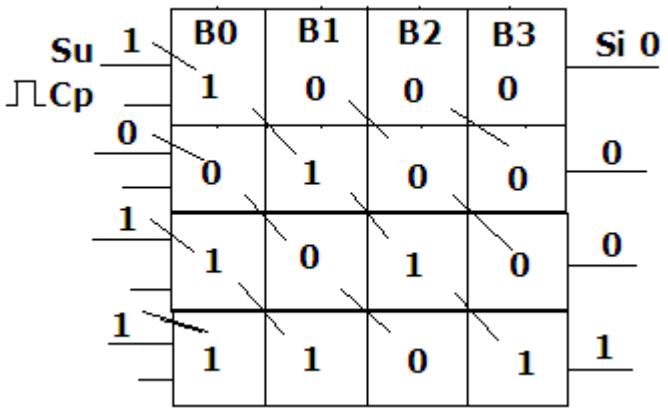


$S_0=B_2$

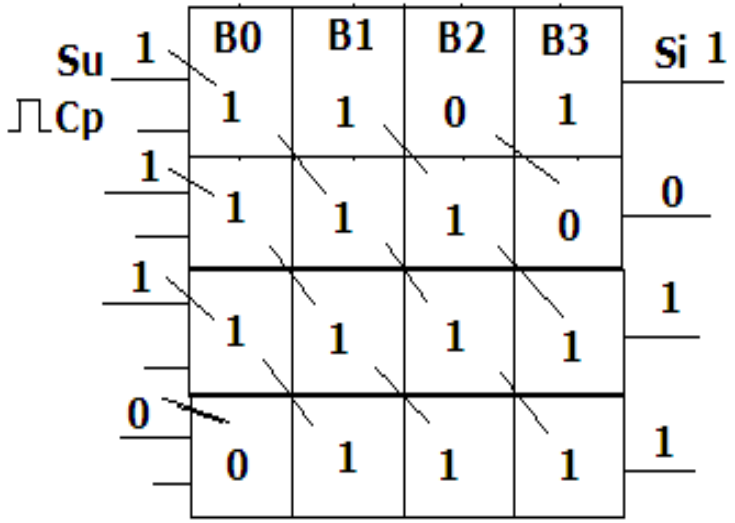
CP	S_I	B_0	B_1	B_2	S_0
	1	0	0	0	0
1	0	1	0	0	0
2	1	0	1	0	0
3	1	1	0	1	1
4	0	1	1	0	0
5	0	0	1	1	1
6	0	0	0	1	1
7	0	0	0	0	0

Serijski upisati podatak 1011, i pročitati ga upisom novog podatka 1110

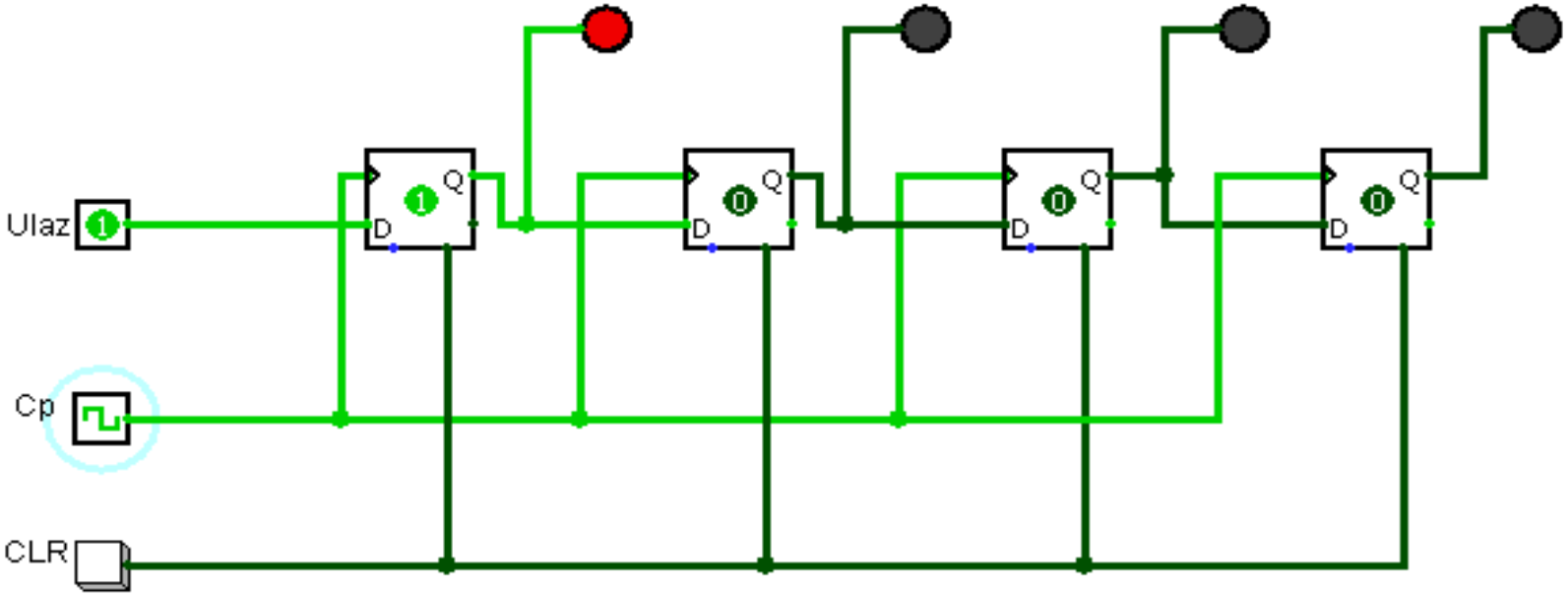
Serijski upis 1011



Čitanje podatka 1011 upisom 1110

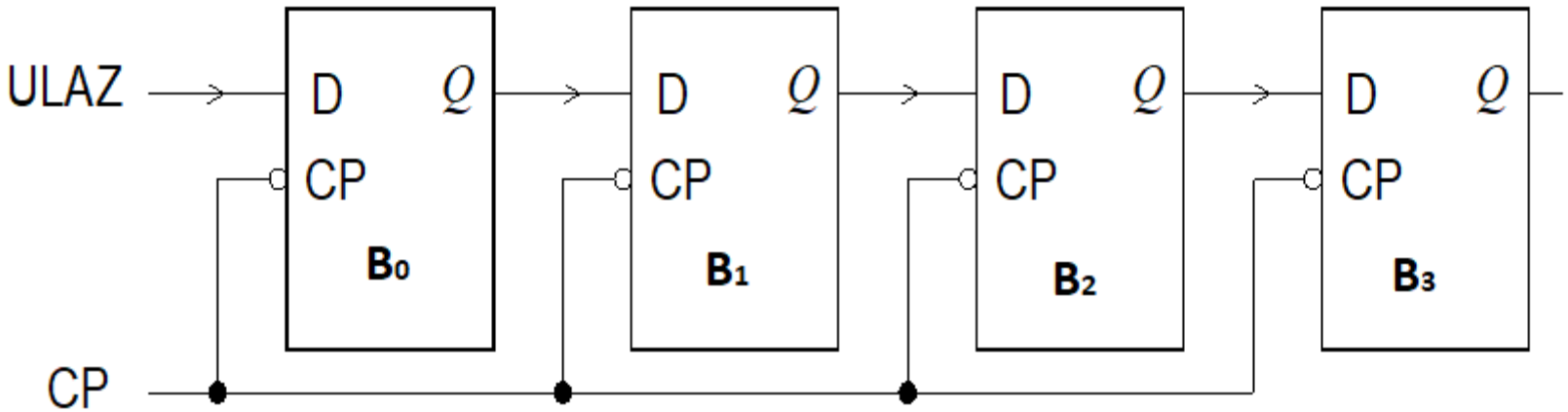


Posmačni registar - simulacija



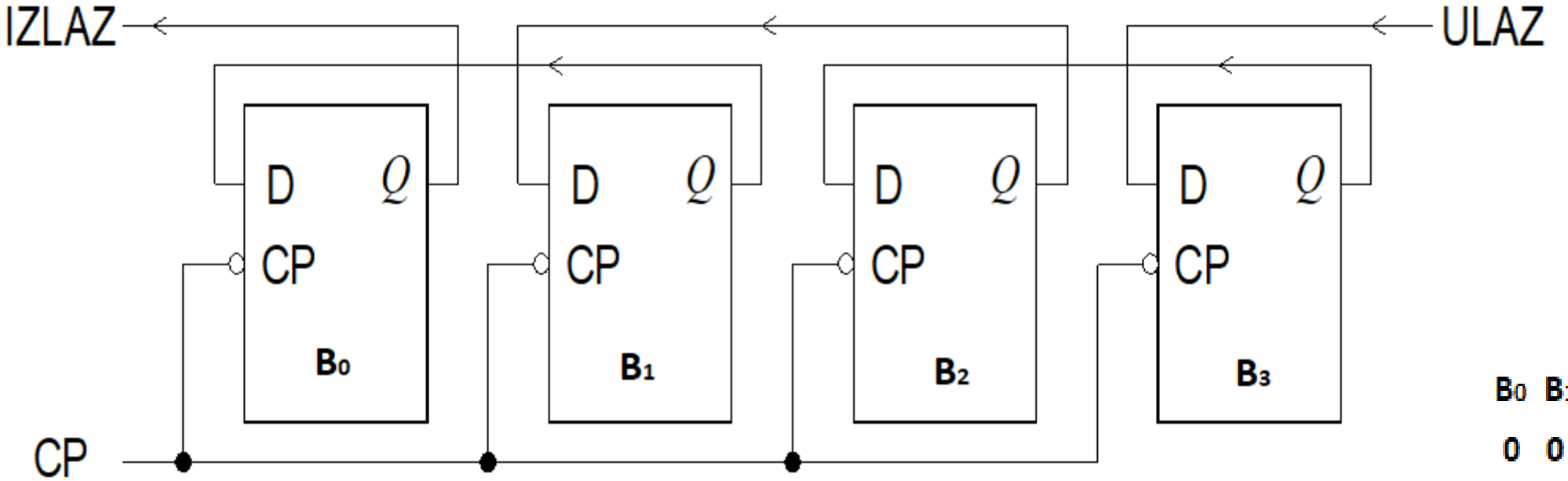
Smjer posmaka

- uobičajeno: prema naprijed - „u desno" (prema "normalnom" izlazu) –operacija množenja sa 2



B0	B1	B2	B3	dekadski
1	0	0	0	1
0	1	0	0	2
0	0	1	0	4
0	0	0	1	8

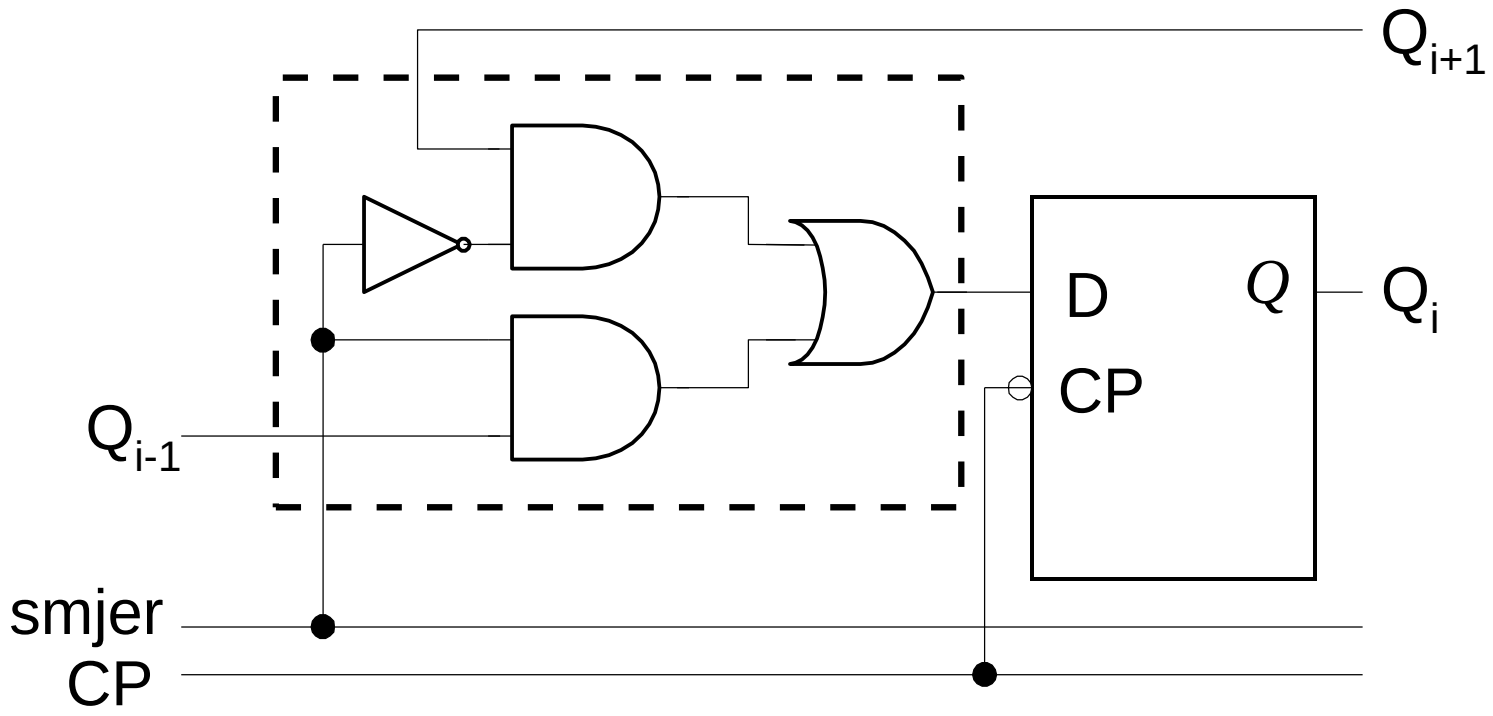
Posmak “u lijevo”-operacija dijeljenja sa 2



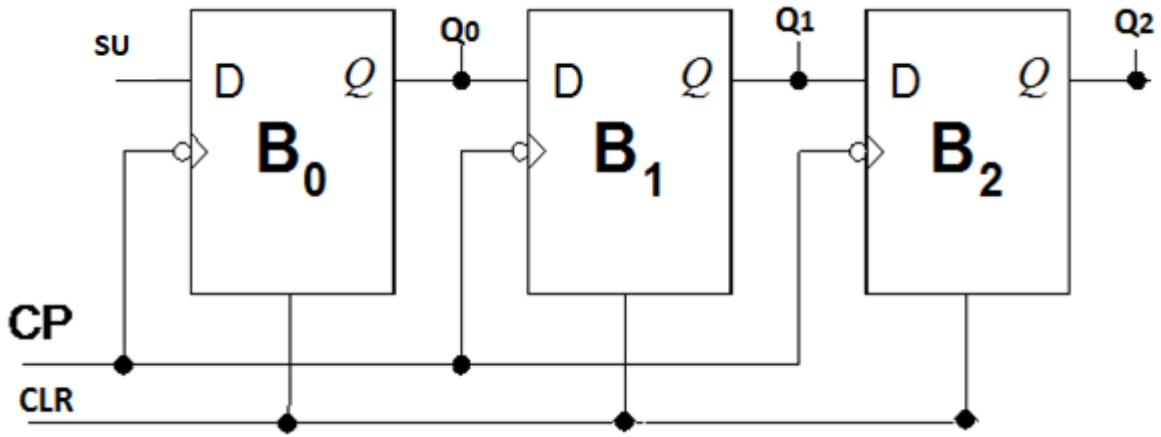
B_0	B_1	B_2	B_3	dekadski
0	0	0	1	8
0	0	1	0	4
0	1	0	0	2
1	0	0	0	1

Kombiniranje smjera posmaka

- ***dvosmjerni*** [bidirectional] posmačni registar-sa ulazom **smjer** biramo smjer pomaka-sa 1-u desno//sa 0 u lijevo

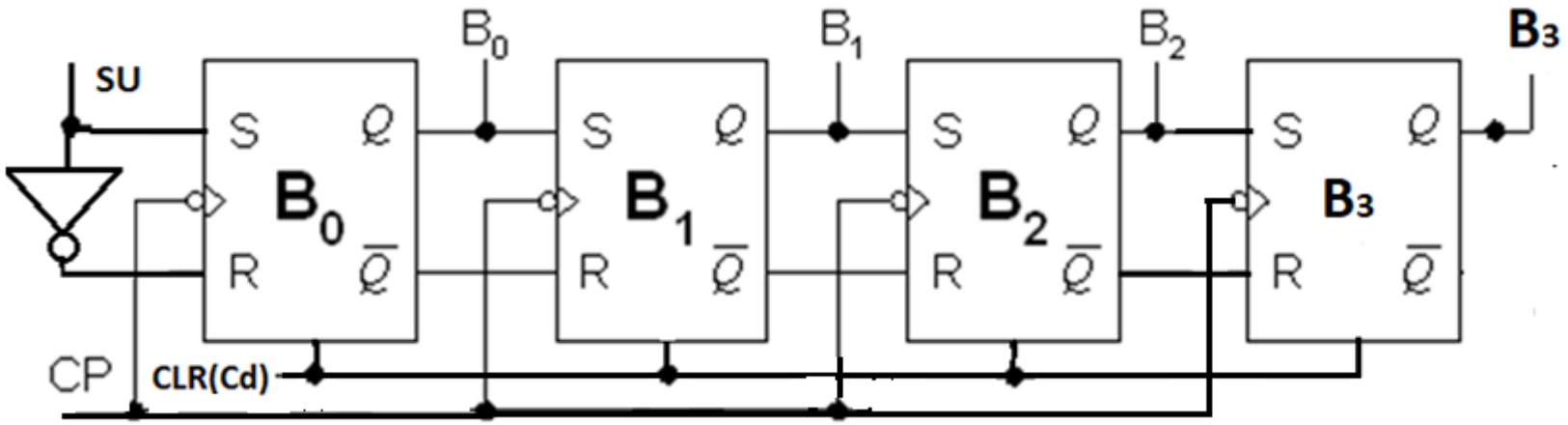


Zadatak: Nacrtati serijski posmačni registar izveden sa D bistabilima i upisati podatak 110 prikazom tablice stanja.



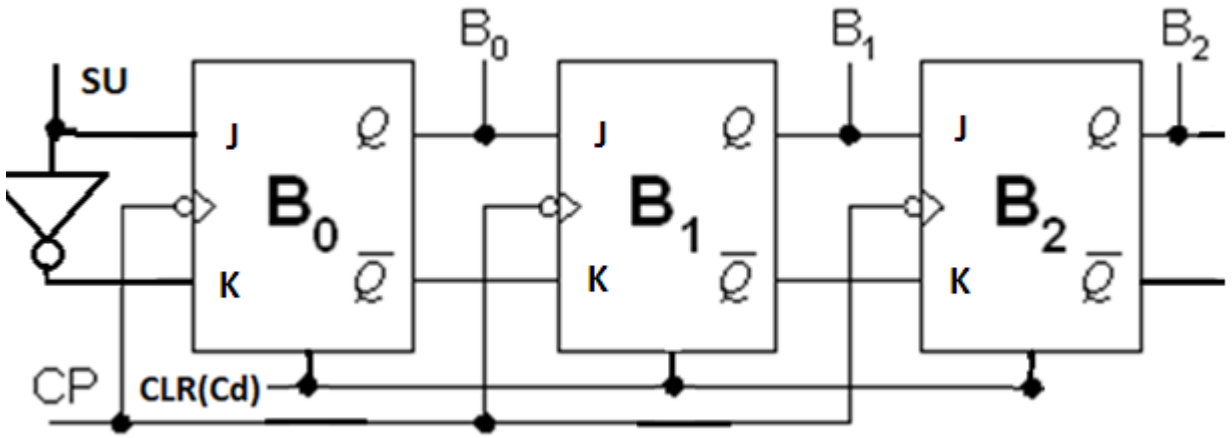
CP	CLR	SU	B0	B1	B2
x	1	x	0	0	0
⇩	0	1	1	0	0
⇩	0	1	1	1	0
⇩	0	0	0	1	1

Zadatak: Nacrtati serijski posmačni registar izveden sa SR bistabilima i upisati podatak 1011 prikazom tablice stanja.



CP	CLR	SU	B0	B1	B2	B3
x	1	x	0	0	0	0
⇩	0	1	1	0	0	0
⇩	0	0	0	1	0	0
⇩	0	1	1	0	1	0
⇩	0	1	1	1	0	1

Zadatak: Nacrtati serijski posmačni registar izveden sa JK bistabilima i upisati podatak 100 prikazom tablice stanja.



CP	CLR	SU	B0	B1	B2
x	1	x	0	0	0
⇩	0	1	1	0	0
⇩	0	0	0	1	0
⇩	0	0	0	0	1

Registri kao brojila

- sekvencijski sklopovi koji pod utjecajem CP prolaze kroz utvrđeni niz stanja te se potom vraćaju u početno stanje
- sklop "broji" ulazne impulse
- ***ciklus brojanja***: niz stanja kroz koja brojilo prolazi

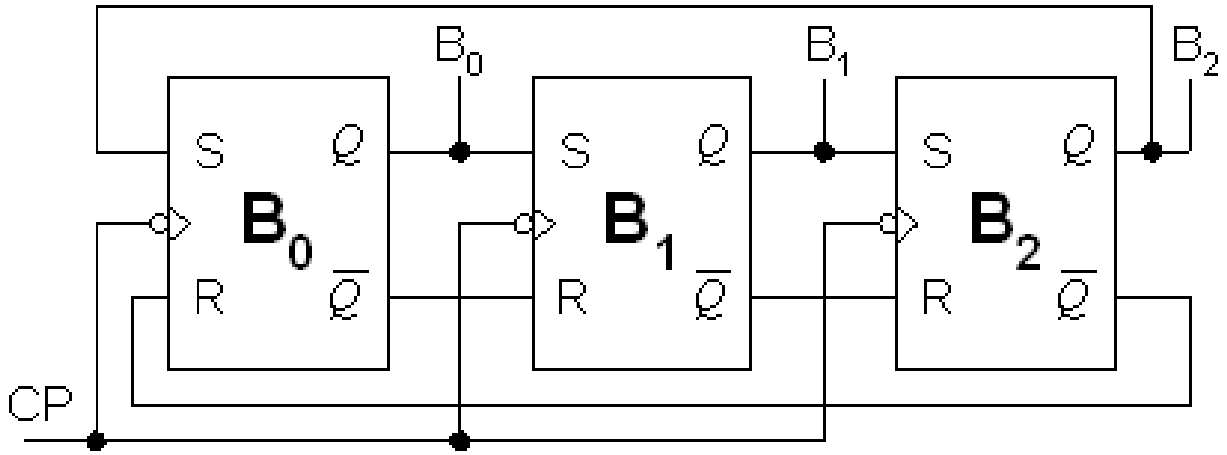
Brojila na osnovi posmačnog registra

- struktura: ostvariti povratnu vezu s izlaza posmačnog registra na njegov ulaz
- dvije mogućnosti:
  - **prstenasto brojilo**:
    -povratna veza $(D_0 = Q_{n-1})$
  -
    - početno stanje-bar jedna 1 u posmačnom registru
  - **Johnsonovo brojilo**:

$$D_o = \overline{Q_{n-1}}$$

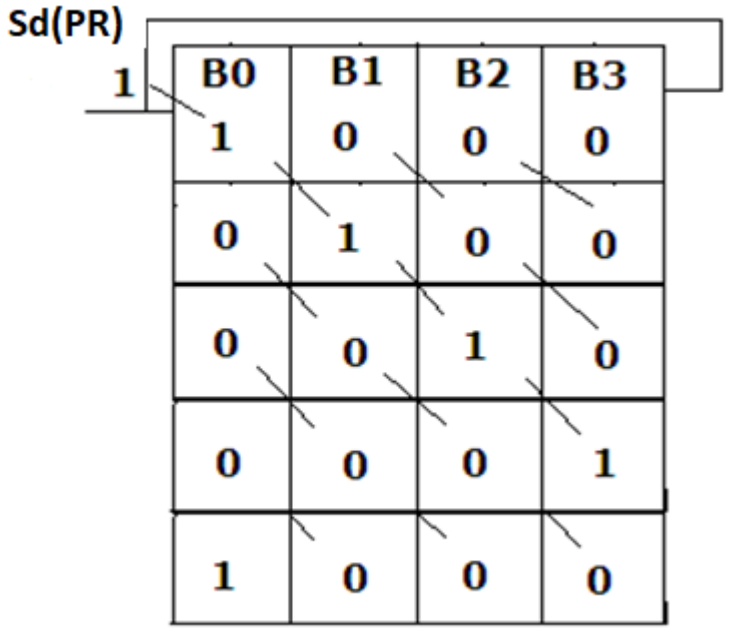
Prstenasto brojilo [ring counter]

- brojanje impulsa na "ulazu" CP
- Izlaz zadnjeg bistabila vezan na ulaz prvog
- „1” cirkulira u posmačnom registru

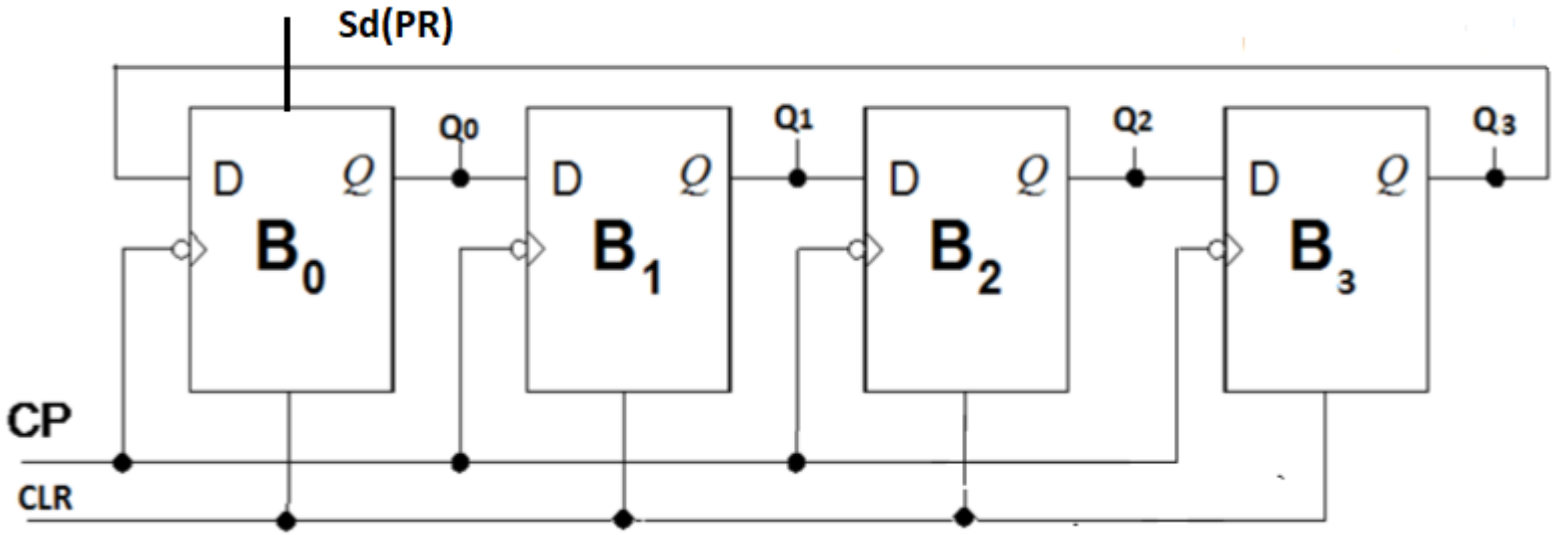


Analiza rada prstenastog brojila

- broji 4 (n)različita stanja ili 4(n) Cp impulsa i dijeli frekvenciju signala Cp sa 4(n) n= broj bistabila
- **Zadatak:** Prikazati rad prstenastog brojila uz početno stanje registra 0 0 0 1
- $B_3\ B_2\ B_1\ B_0$

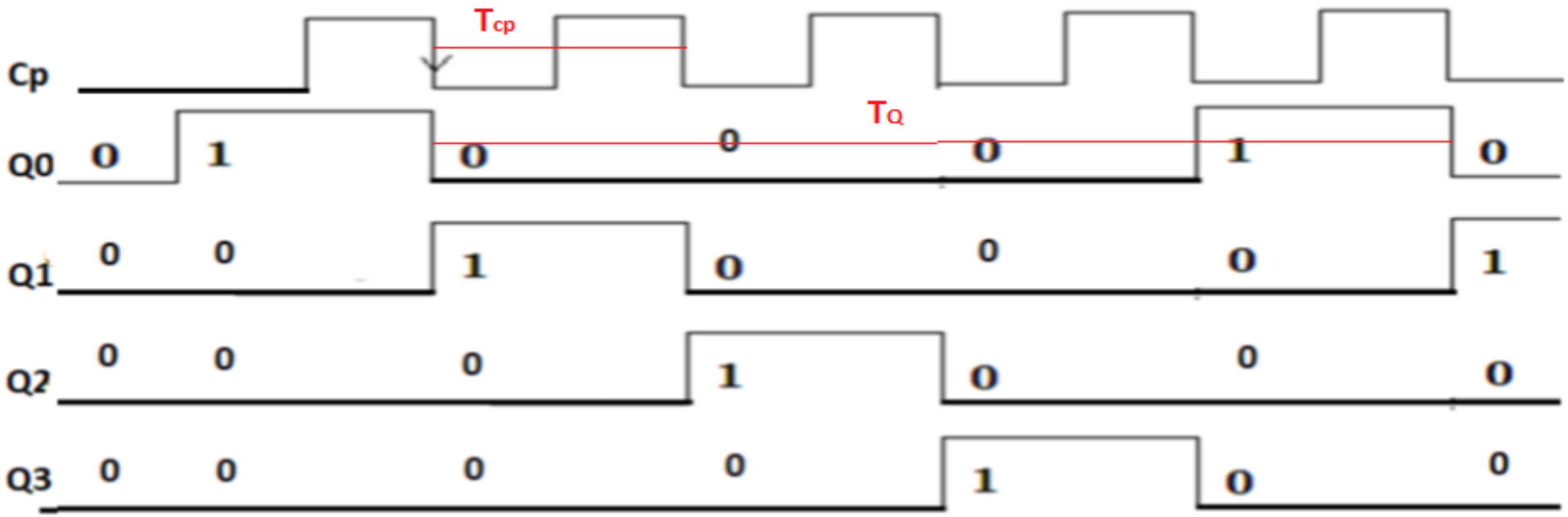


Prstenasto brojilo

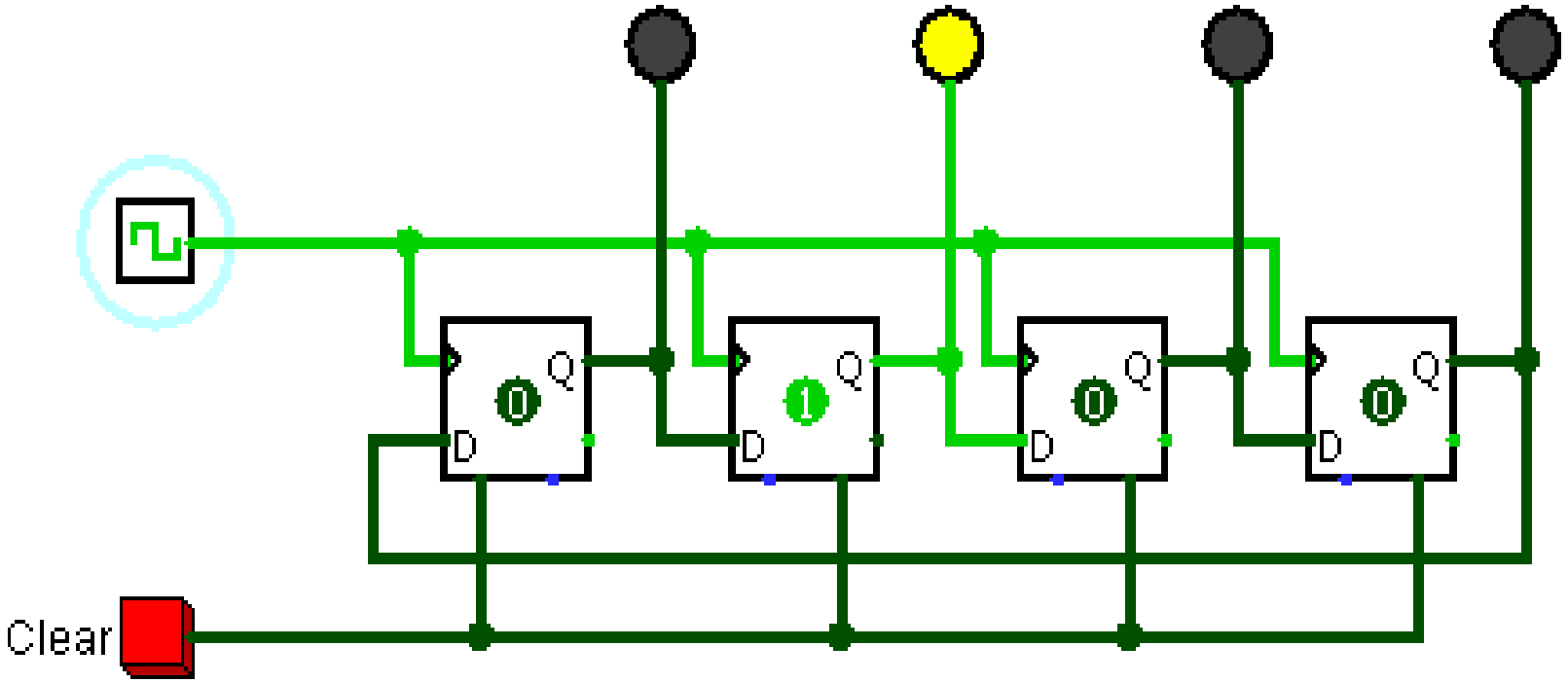


CLR	Sd PR	CP	B_0	B_1	B_2	B_3
0	1	X	1	0	0	0
0	0	1 ⇩	0	1	0	0
0	0	2 ⇩	0	0	1	0
0	0	3 ⇩	0	0	0	1
0	0	4 ⇩	1	0	0	0
0	0	5 ⇩	0	1	0	0

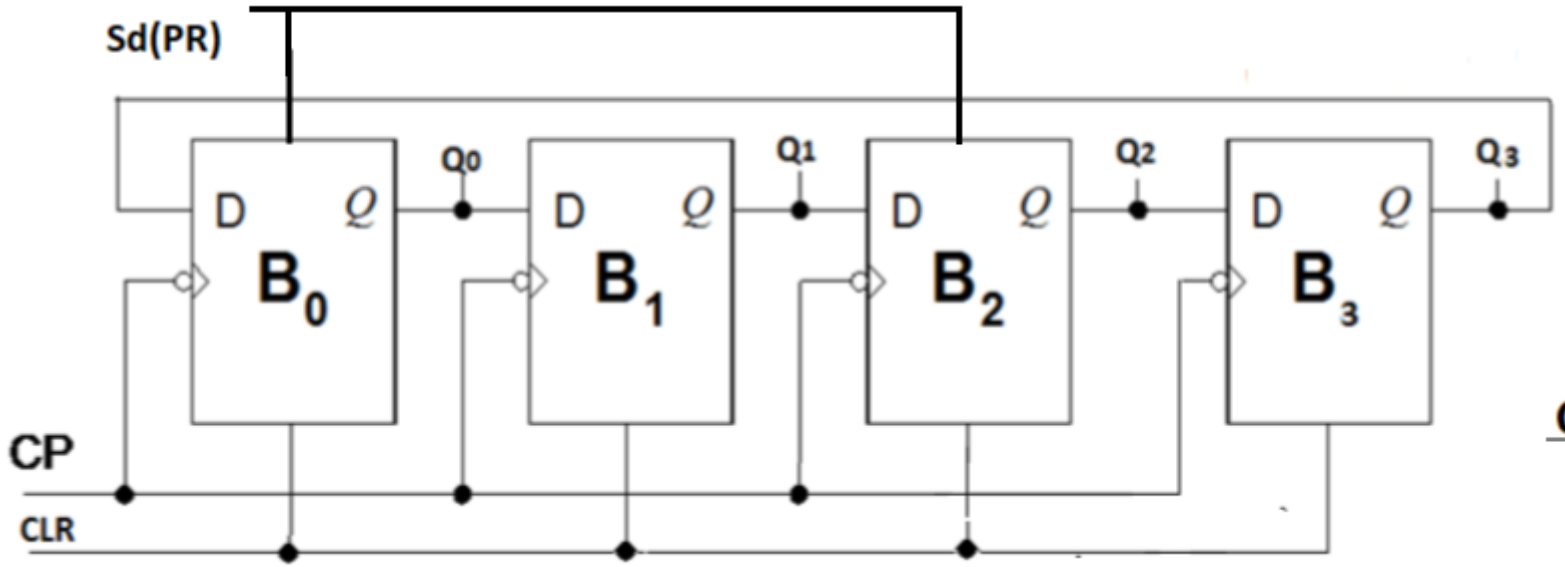
Vremenski dijagram $T_Q=4*T_{cp}$ $f_Q=f_{cp}/4$



Prstenasto brojilo – simulacija D

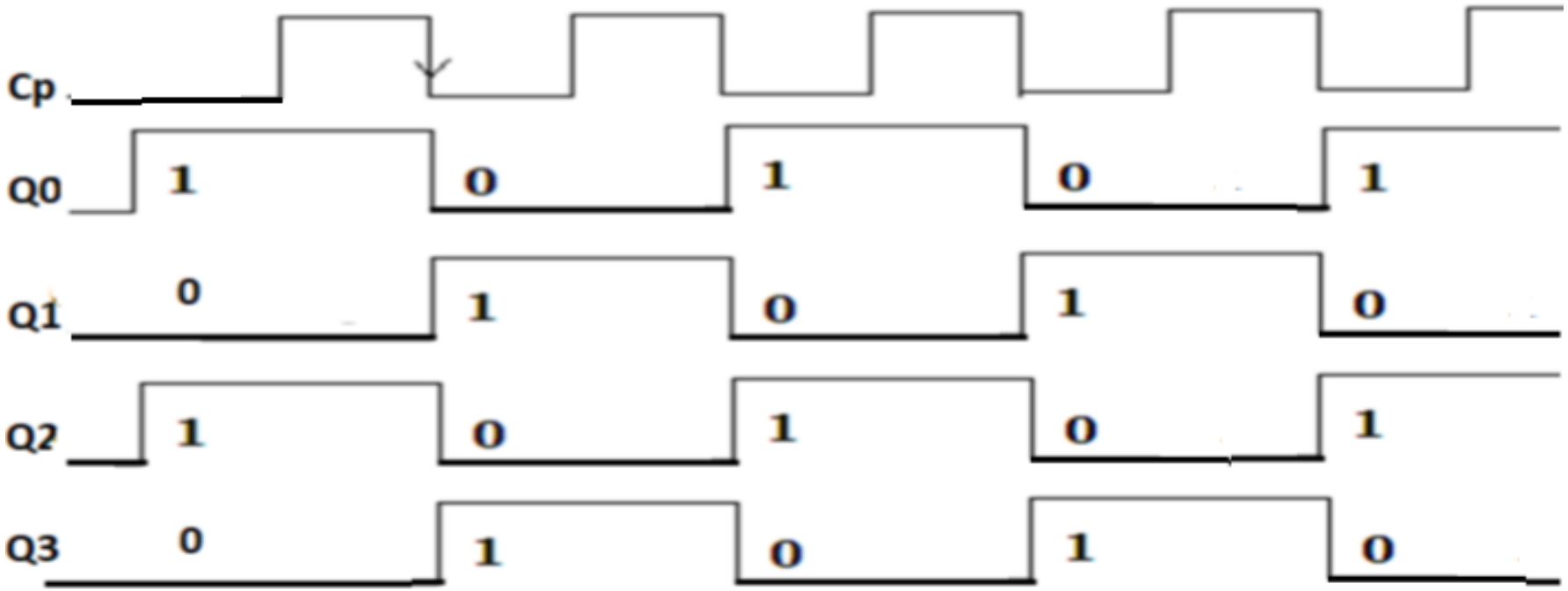


Zadatak: Realizirati i analizirati prstenasto brojilo sa početnim stanjem 0101

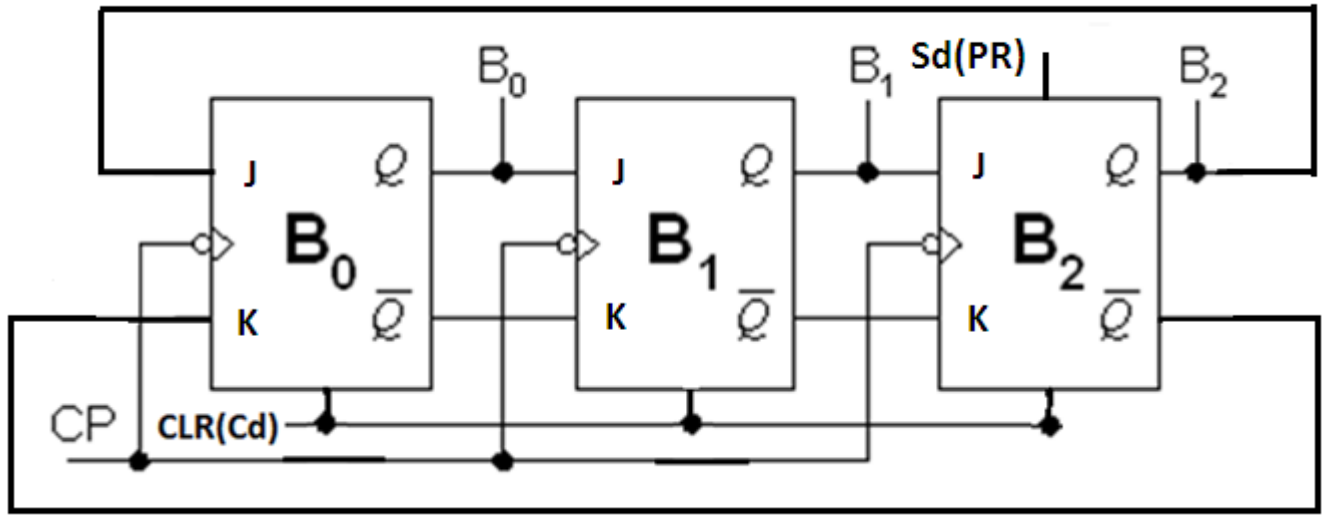


Sd						
CLR	PR02	CP	B_0	B_1	B_2	B_3
0	1	X	1	0	1	0
0	0	1 ⇩	0	1	0	1
0	0	2 ⇩	1	0	1	0
0	0	3 ⇩	0	1	0	1
0	0	4 ⇩	1	0	1	0
0	0	5 ⇩	0	1	0	1

Vremenski dijagram

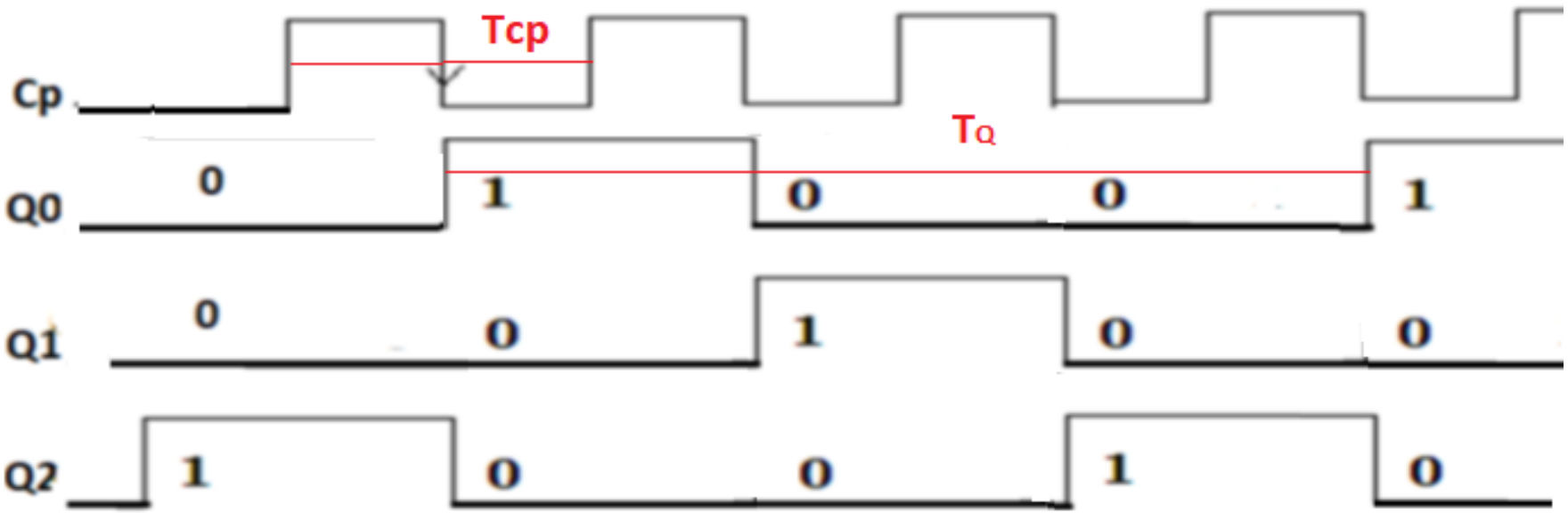


Zadatak: Nacrtati prstenato brojilo izvedeno sa JK bistabilima i početnim stanjem 100 , te prikazati tablicu stanja.



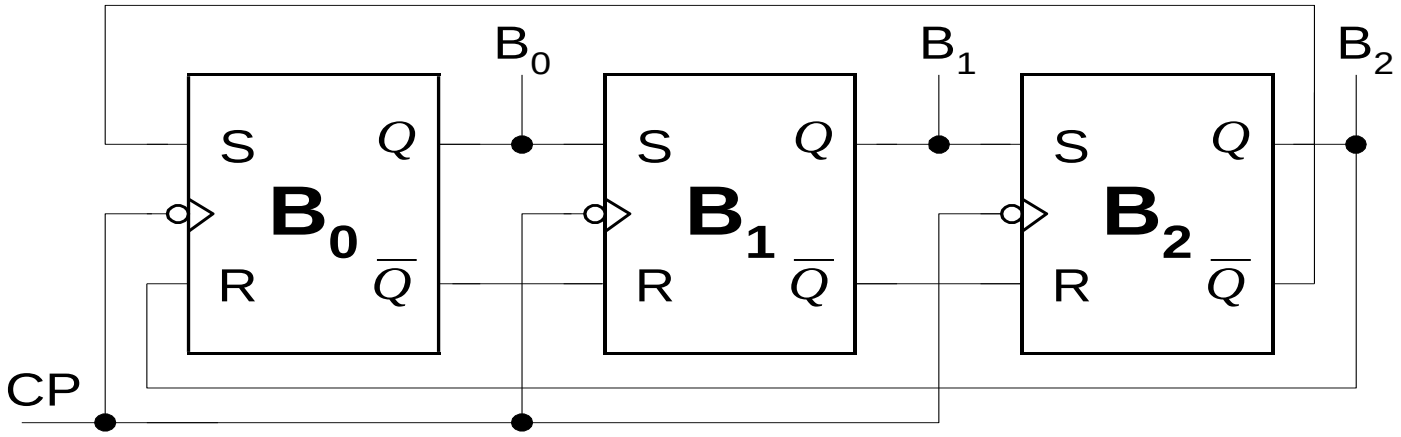
CLR	Sd PR	CP	B_0	B_1	B_2
0	1	X	0	0	1
0	0	1 ⇩	1	0	0
0	0	2 ⇩	0	1	0
0	0	3 ⇩	0	0	1
0	0	4 ⇩	1	0	0
0	0	5 ⇩	0	1	0

Vremenski dijagram $T_Q=3*T_{cp}$ $f_Q=f_{cp}/3$



Johnsonovo brojilo-ukršteno brojilo

- ukrštenim prstenom [twisted ring counter]:
- Broji ***2n*** *stanja –n=broj bistabila*
- ukrstiti povratnu vezu: bistabili SR i JK



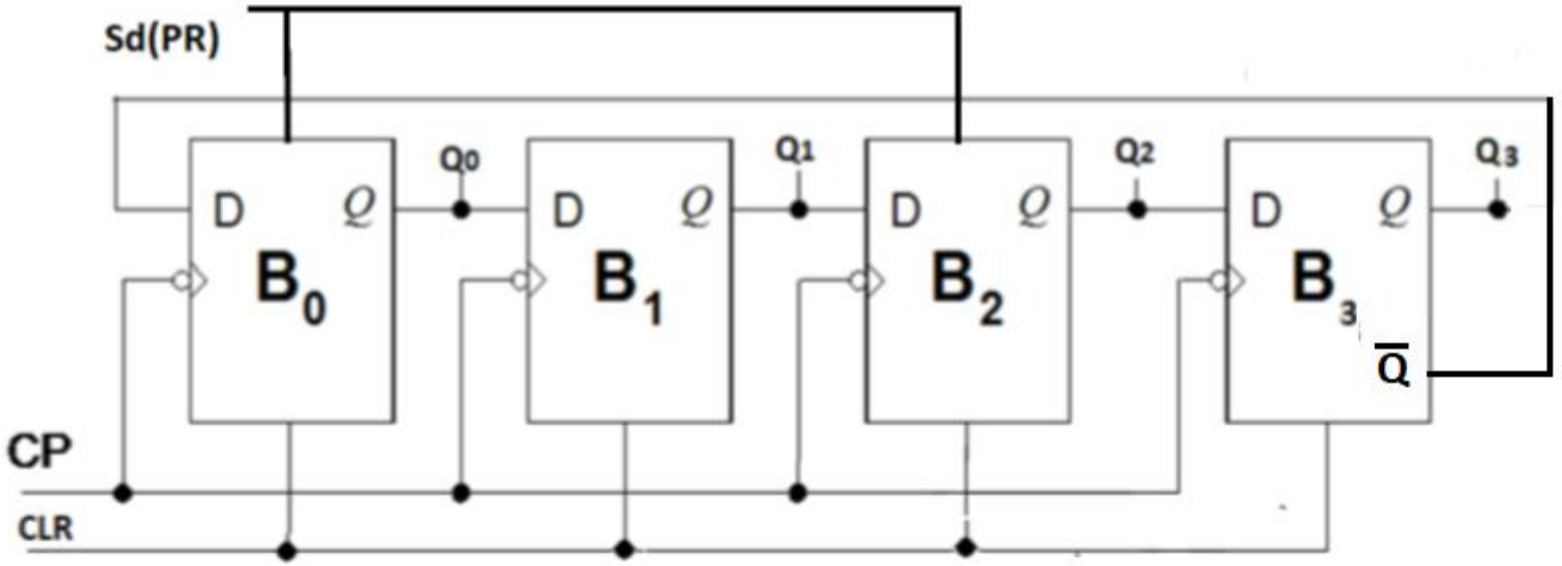
CP	B_0	B_1	B_2	$\overline{B_2}$
0	0	0	0	1
⇩ 1	1	0	0	1
⇩ 2	1	1	0	1
⇩ 3	1	1	1	0
⇩ 4	0	1	1	0
⇩ 5	0	0	1	0
6	0	0	0	1

Johnsonovo brojilo-ukršteno brojilo

- Početno stanje brojila ne mora uvijek biti stanje 0
- Primjer: postavljen jedan bistabil u stanje 1
- Brojilo i dalje broji 6 različitih stanja ili 6 impulsa (ako se radi o brojilu sa 3 bistabila

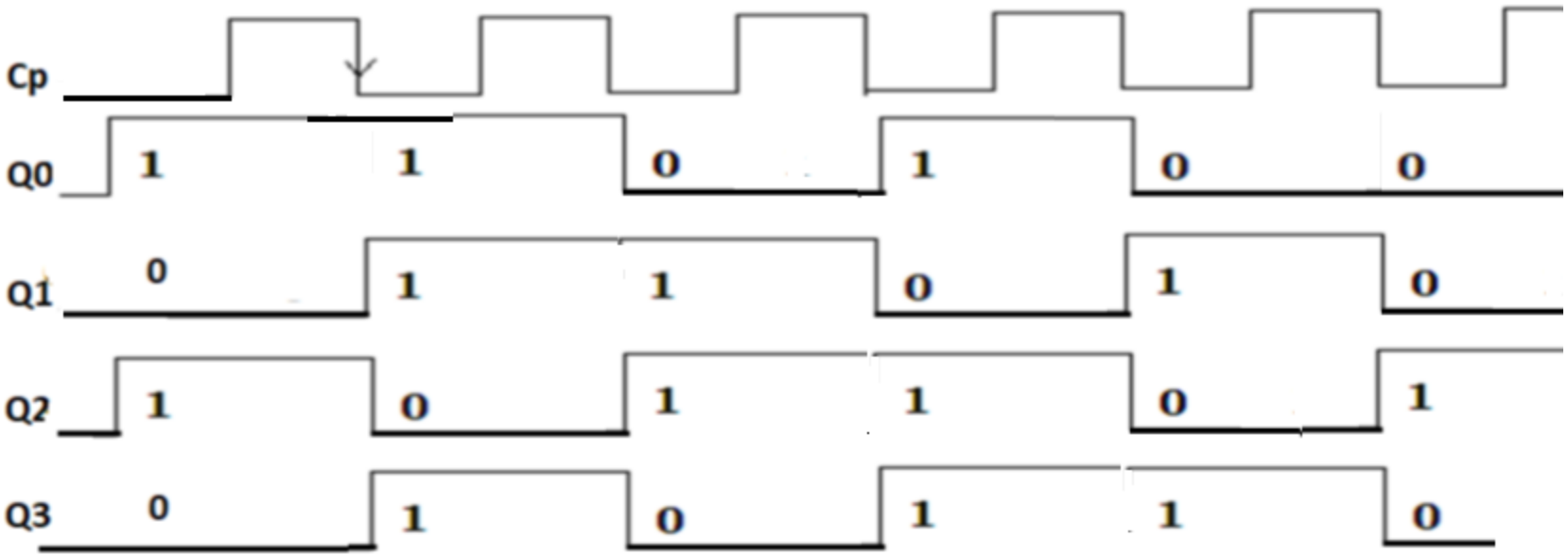
CP	B_0	B_1	B_2	$\overline{B_2}$
0	1	0	0	1
⇩ 1	1	1	0	1
⇩ 2	1	1	1	0
⇩ 3	0	1	1	0
⇩ 4	0	0	1	0
⇩ 5	0	0	0	1
6	1	0	0	1

Zadatak: Realizirati i analizirati Johnsonovo brojilo sa početnim stanjem 0101

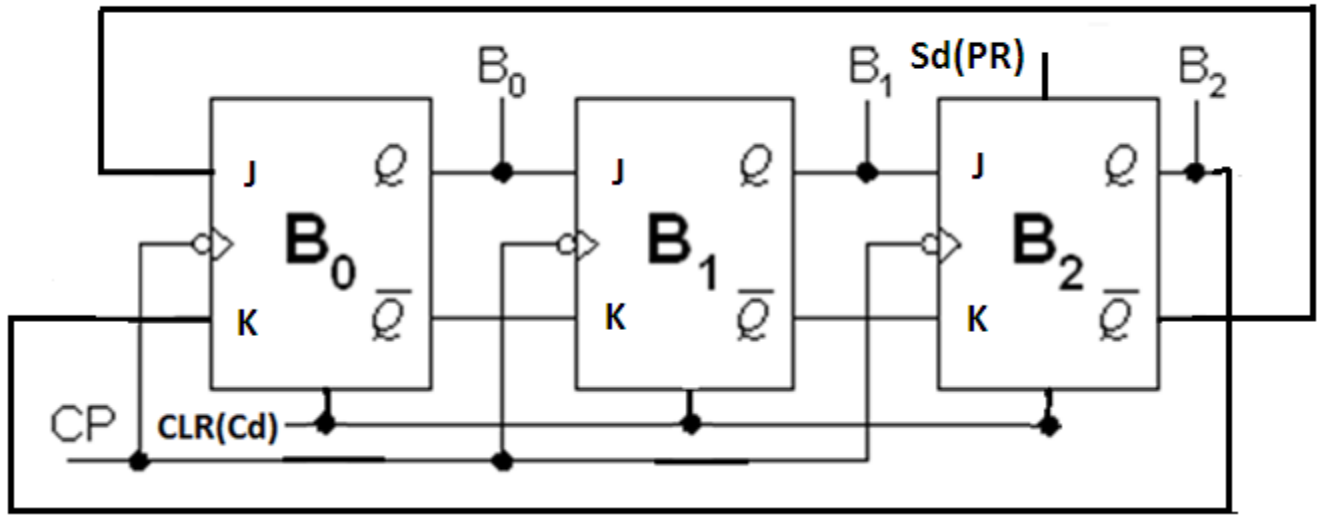


CLR	Sd PR02	CP	B_0	B_1	B_2	B_3	$\overline{B_3}$
0	1	X	1	0	1	0	1
0	0	1 ⇩	1	1	0	1	0
0	0	2 ⇩	0	1	1	0	1
0	0	3 ⇩	1	0	1	1	0
0	0	4 ⇩	0	1	0	1	0
0	0	5 ⇩	0	0	1	0	1
0	0	6 ⇩	1	0	0	1	0
0	0	7 ⇩	0	1	0	0	1
0	0	8 ⇩	1	0	1	0	1

Vremenski dijagram



Zadatak: Nacrtati Johnsonovo brojilo izvedeno sa JK bistabilima i početnim stanjem 100 , te prikazati tablicu stanja.



CLR	Sd PR	CP	B_0	B_1	B_2	$\overline{B_2}$
0	1	X	0	0	1	0
0	0	1 ⇩	0	0	0	1
0	0	2 ⇩	1	0	0	1
0	0	3 ⇩	1	1	0	1
0	0	4 ⇩	1	1	1	0
0	0	5 ⇩	0	1	1	0
0	0	6 ⇩	0	0	1	0
0	0	7 ⇩	0	0	0	1

Vremenski dijagram $T_Q=6*T_{cp}$ $f_Q=f_{cp}/6$