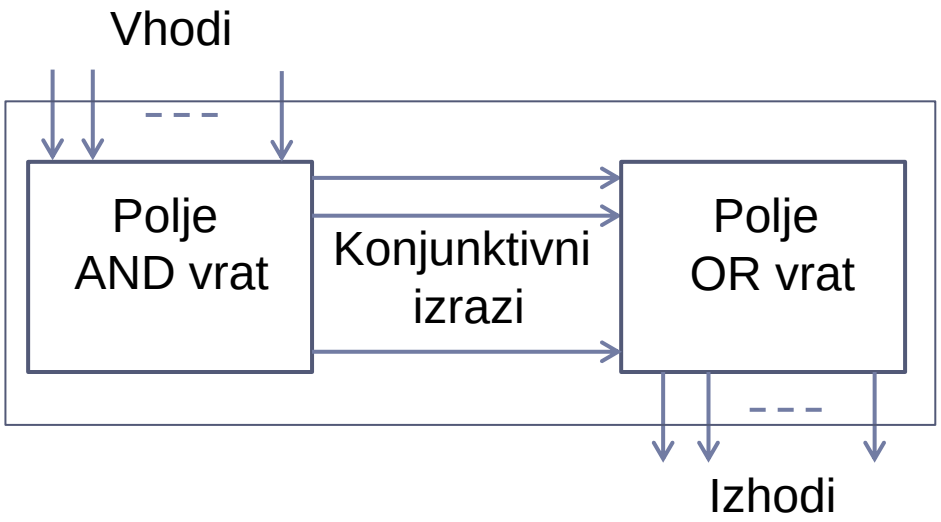
Digitalna vezja
UL, FRI

P9 Programabilni gradniki

Programabilni gradniki

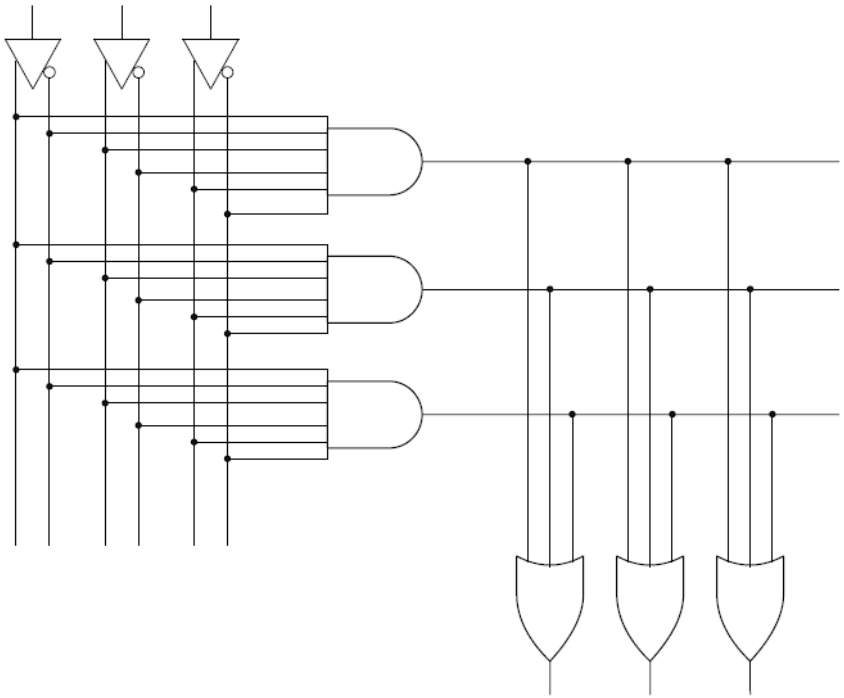
- Arhitektura:
  - AND polje
  - OR polje

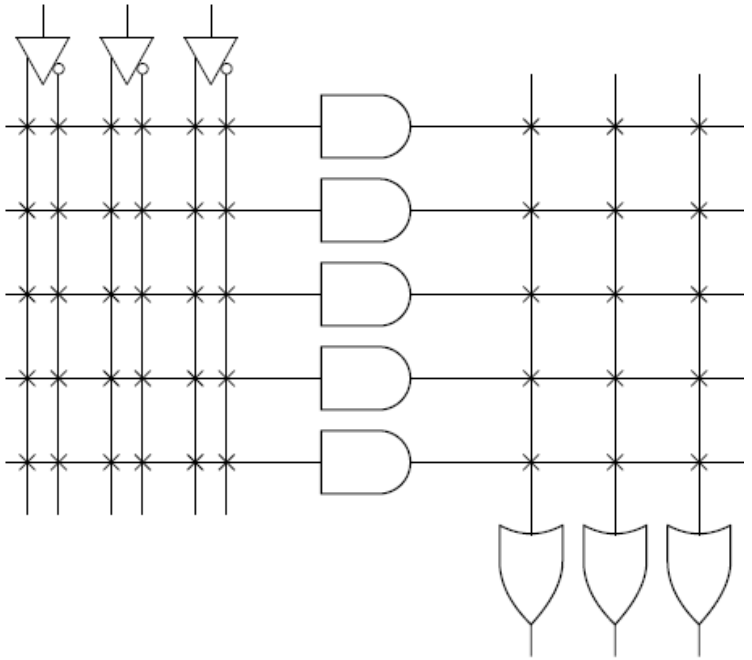


- Tipi:
  - PLA (Programmable Logic Array)
  - PAL (Programmable Array Logic)
  - ROM (Read Only Memory)

PLA

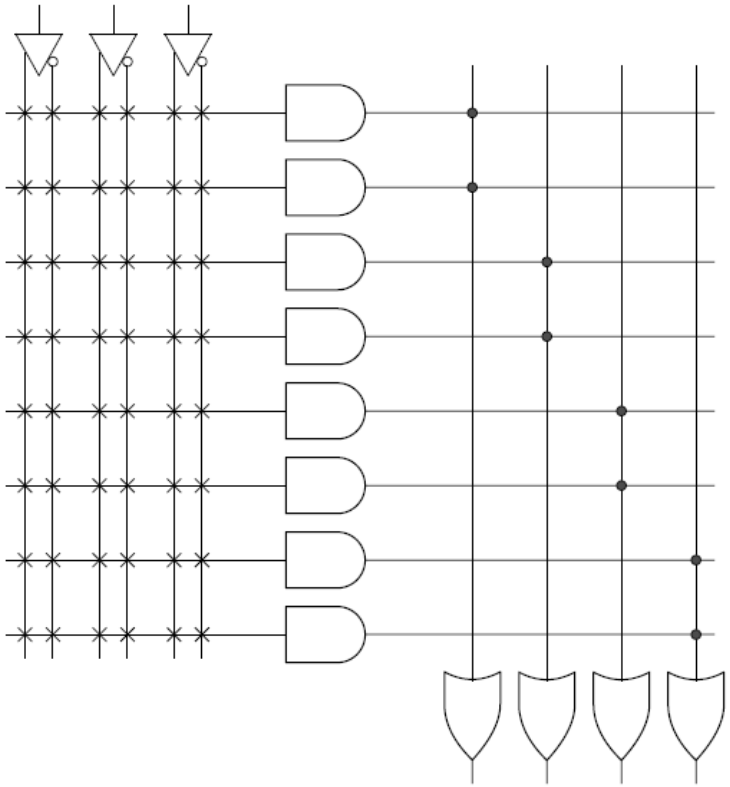
- PLA ima programabilni obe polji, tako AND in OR
- Primer PLA pred programiranjem: 3 vhodi, 3 izhodi
- Oznaka x označuje povezavo na konjunktivna, disjunktivna vrata

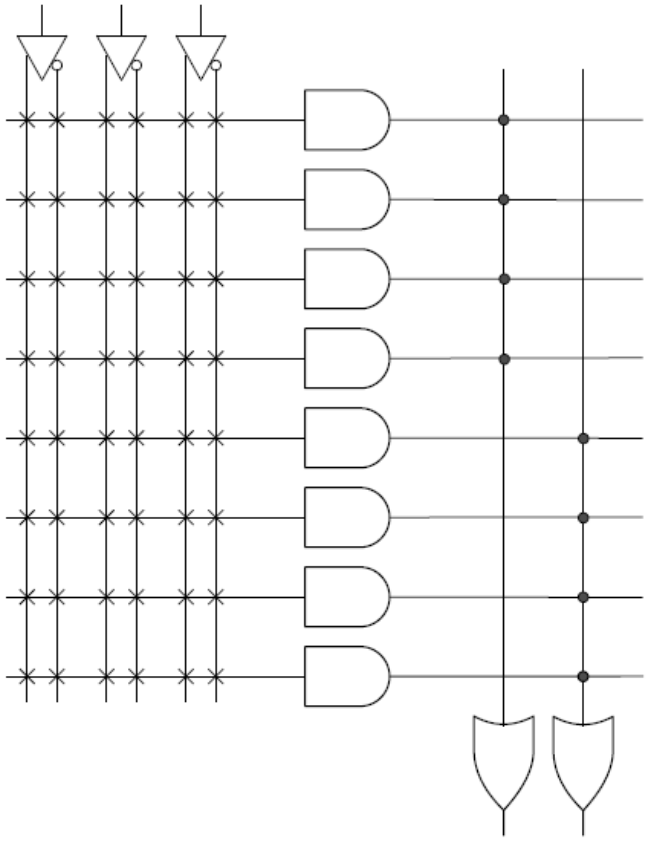




PAL

- PAL ima programabilno polje AND in fiksno polje OR.
- Oznaka x označuje povezavo na konjunktivna vrata.
- Oznaka • fiksne povezave (2, 4, 8, ...)





Realizacija funkcij

Vhodi: x_1, x_2, x_3

Logične funkcije: g_1, g_2, g_3, g_4

x_1	x_2	x_3		g_1	g_2	g_3	g_4
0	0	0	0	1	0	1	0
0	0	1	1	0	0	0	1
0	1	0	2	0	0	0	0
0	1	1	3	0	0	0	0
1	0	0	4	1	1	1	1
1	0	1	5	1	0	0	1
1	1	0	6	1	1	1	1
1	1	1	7	1	1	1	1

$$g_1 = x_1 \vee \bar{x}_2.\bar{x}_3$$

$$g_2 = x_1.\bar{x}_3 \vee x_1.x_2$$

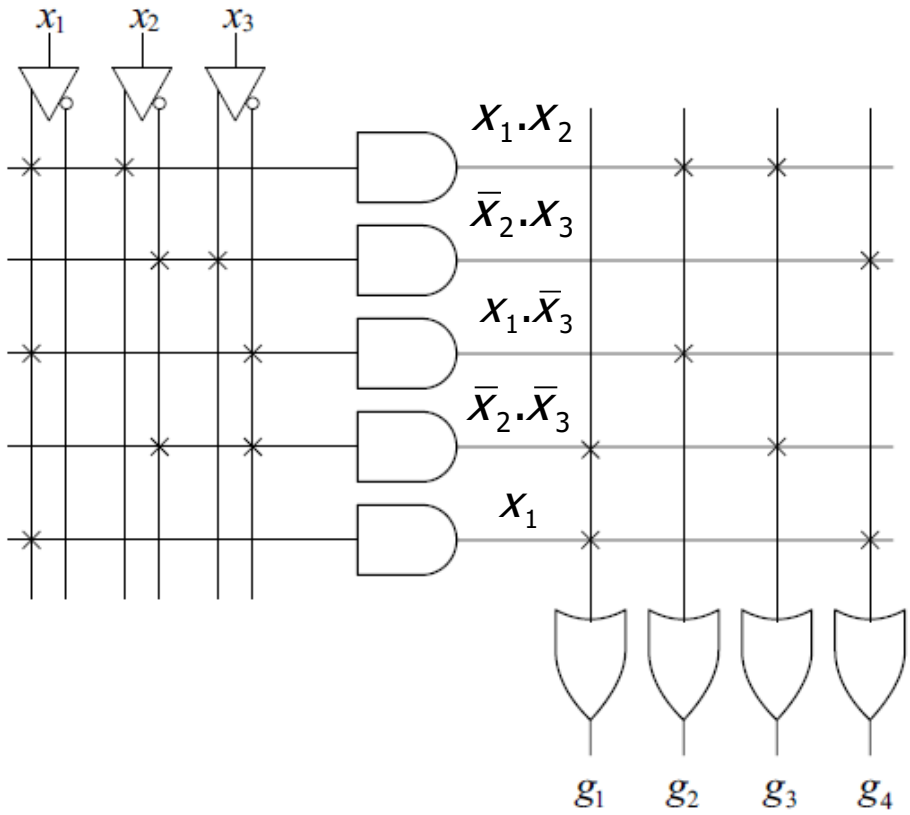
$$g_3 = \bar{x}_2.\bar{x}_3 \vee x_1.x_2$$

$$g_4 = \bar{x}_2.x_3 \vee x_1$$

(PLA)

- Za realizacijo uporabimo MDNO
- Programabilna matrika

Konjunkcija	$x_1x_2x_3$	$g_1g_2g_3g_4$
x_1x_2	1 1 -	0 1 1 0
$\bar{x}_2x_3$	- 0 1	0 0 0 1
$x_1\bar{x}_3$	1 - 0	0 1 0 0
$\bar{x}_2\bar{x}_3$	- 0 0	1 0 1 0
x_1	1 - -	1 0 0 1



(PAL)

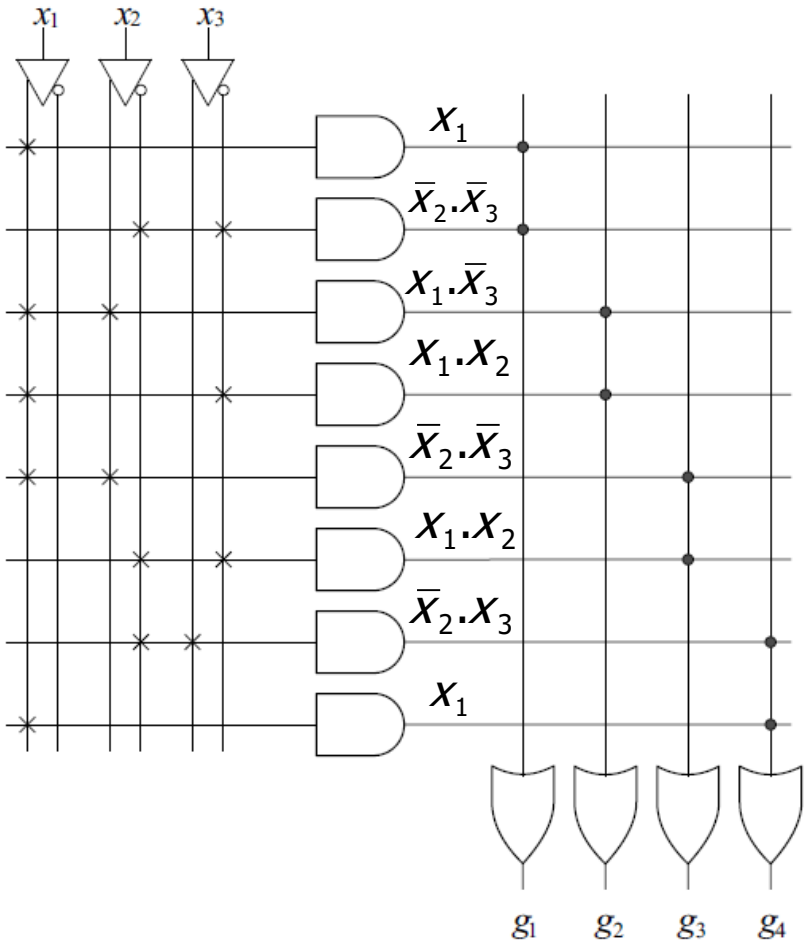
- Za realizacijo uporabimo MDNO
- PAL - Dve konjunkciji sta povezani v disjunkcijo

$$g_1 = x_1 \vee \bar{x}_2.\bar{x}_3$$

$$g_2 = x_1.\bar{x}_3 \vee x_1.x_2$$

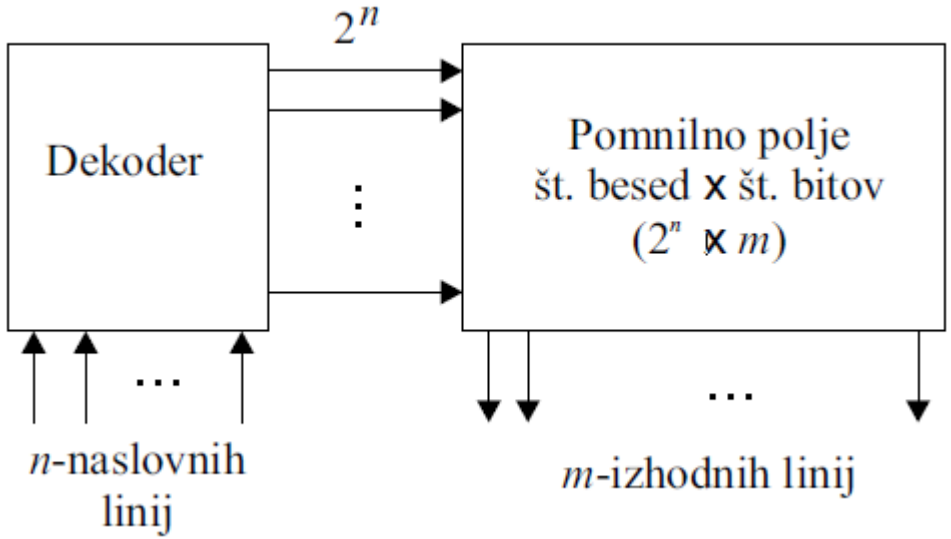
$$g_3 = \bar{x}_2.\bar{x}_3 \vee x_1.x_2$$

$$g_4 = \bar{x}_2.x_3 \vee x_1$$



Programabilno vezje - ROM

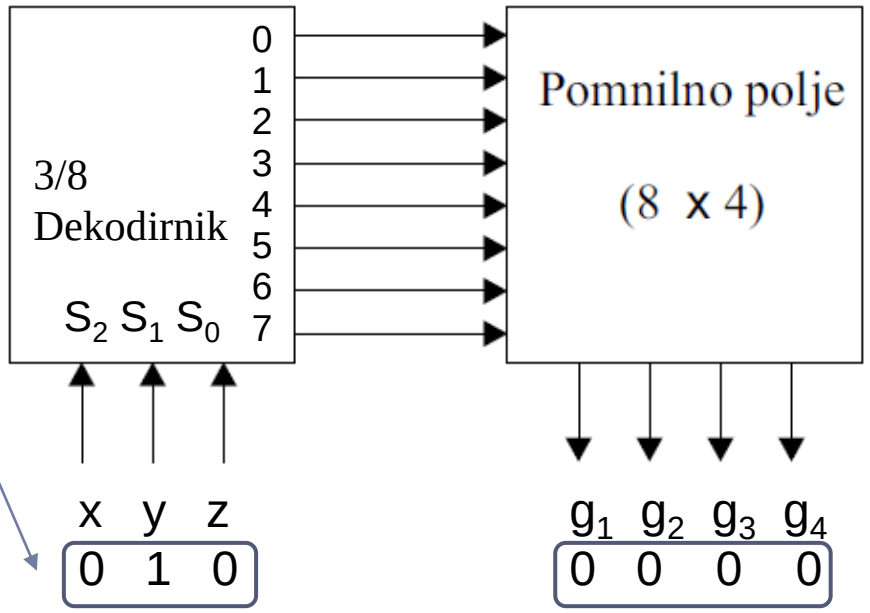
- ROM ima fiksno polje AND in programabilno polje OR.
- Fiksno polje AND je dekodirnik:
  - n naslovnih linij – spremenljivke
  - 2^n izhodov – vhodne kombinacije, ki določajo izbiro pomnilne besede
- Programabilno polje OR – pomnilna beseda v katero se vpišejo funkcijske



Realizacija funkcij (ROM)

- Za realizacijo uporabimo PDNO
- Pravilnostna tabela
  - x, y, z – krmilni vhodi dekodirnika
  - Izhod dekodirnika določa naslov za preslikavo funkcijskih vrednosti (zapisane so v pomnilnem polju) na izhode g_1 g_2 g_3 g_4

x	y	z		g_1	g_2	g_3	g_4
0	0	0	0	1	0	1	0
0	0	1	1	0	0	0	1
0	1	0	2	0	0	0	0
0	1	1	3	0	0	0	0
1	0	0	4	1	1	1	1
1	0	1	5	1	0	0	1
1	1	0	6	1	1	1	1
1	1	1	7	1	1	1	1



Naloga

- 2-bitni seštevalnik:

  Z=X + Y, prenos C
  - Vhodi: X=(x1,x0), Y=(y1,y0)
  - Izhodi: Z=(z1,z0), C
- Zapis funkcij:
  - MDNO → NAND
  - MKNO → NOR
  - NOT, AND, OR, XOR
  - Multiplekserji: 2/1, 4/1,8/1
  - Programabilni gradniki:

    PLA, PAL, ROM

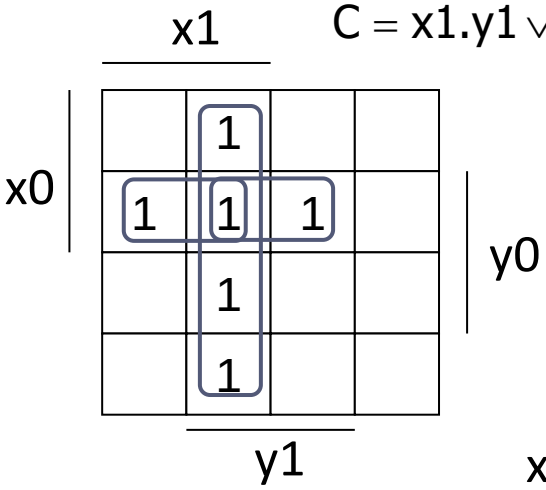
x1	x0	y1	y0	C	z1	z0
0	0	0	0			
0	0	0	1			
0	0	1	0			
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0			
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			

Pravilnostna tabela, MDNO

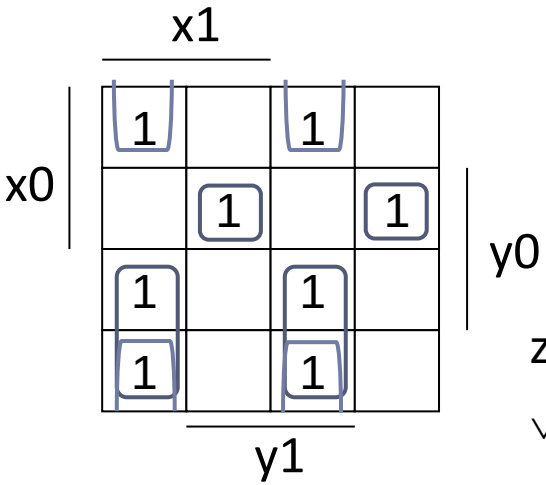
x1	x0	y1	y0	C	z1	z0
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

Pravilnostna tabela, MDNO

x1	x0	y1	y0	C	z1	z0
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

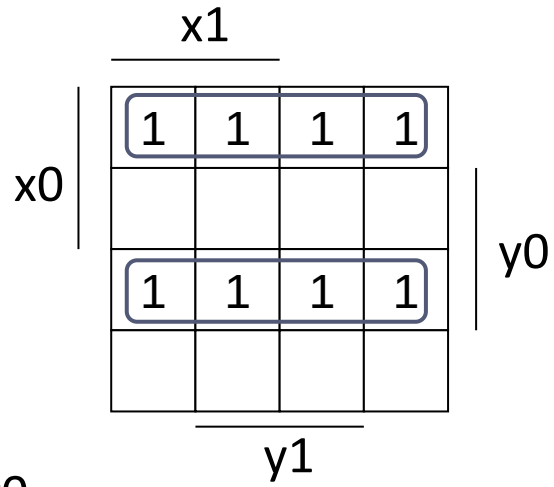


$C = x1.y1 \vee x1.x0.y1 \vee x0.y1.y0$



$z0 = x0.\overline{y0} \vee \overline{x0}.y0 =$

$= x0 \oplus y0$

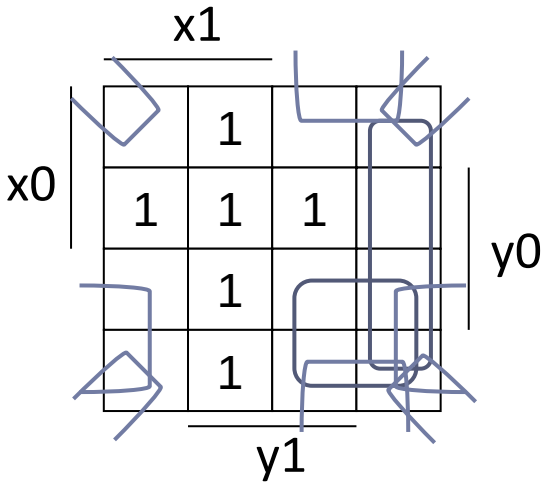


$z1 = x1.\overline{x0}.\overline{y1} \vee \overline{x1}.\overline{x0}.y1 \vee$

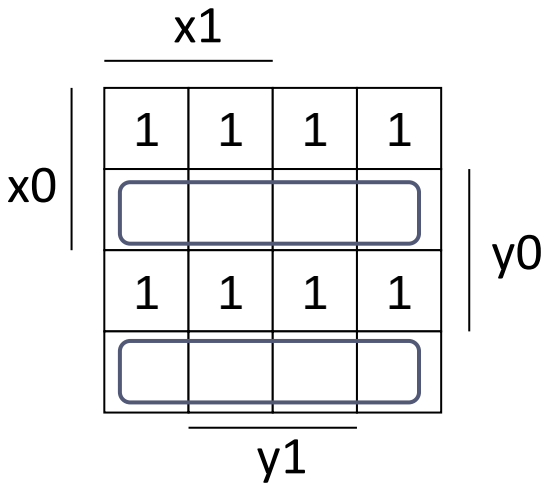
$\vee x1.\overline{x0}.\overline{y1} \vee \overline{x1}.y1.\overline{y0} \vee$

$\vee \overline{x1}.x0.\overline{y1}.y0 \vee x1.x0.y1.y0$

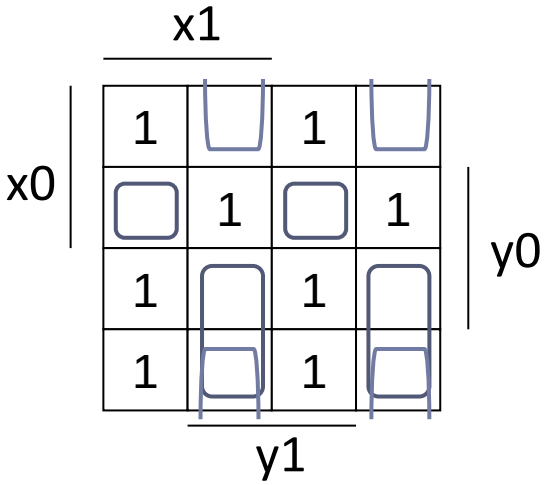
Pravilnostna tabela, MKNO



$$C = (x1 \vee x0).(x1 \vee y1).(y1 \vee y0).(x1 \vee y0).(x0 \vee y1)$$



$$z0 = (\overline{x0} \vee \overline{y0}).(x0 \vee y0) = \overline{x0 \oplus y0}$$



$$z1 = (x1 \vee y1 \vee y0).(x1 \vee x0 \vee y1).(\overline{x1} \vee \overline{y1} \vee y0).(\overline{x1} \vee x0 \vee \overline{y1}).(x1 \vee \overline{x0} \vee \overline{y1} \vee \overline{y0}).(\overline{x1} \vee \overline{x0} \vee \overline{y1} \vee \overline{y0})$$

Zapis NAND, NOR

- NAND/NAND

$$C = (x1 \uparrow y1) \uparrow (x1 \uparrow x0 \uparrow y1) \uparrow (x0 \uparrow y1 \uparrow y0)$$

$$z1 = (x1 \uparrow \overline{x0} \uparrow \overline{y1}) \uparrow (\overline{x1} \uparrow \overline{x0} \uparrow y1) \uparrow (x1 \uparrow \overline{x0} \uparrow \overline{y1}) \uparrow$$
$$(\overline{x1} \uparrow y1 \uparrow \overline{y0}) \uparrow (\overline{x1} \uparrow x0 \uparrow \overline{y1} \uparrow y0) \uparrow (x1 \uparrow x0 \uparrow y1 \uparrow y0)$$

$$z0 = (x0 \uparrow \overline{y0}) \uparrow (\overline{x0} \uparrow y0)$$

- NOR/NOR

$$C = (x1 \downarrow x0) \downarrow (x1 \downarrow y1) \downarrow (y1 \downarrow y0) \downarrow (x1 \downarrow y0) \downarrow (x0 \downarrow y1)$$

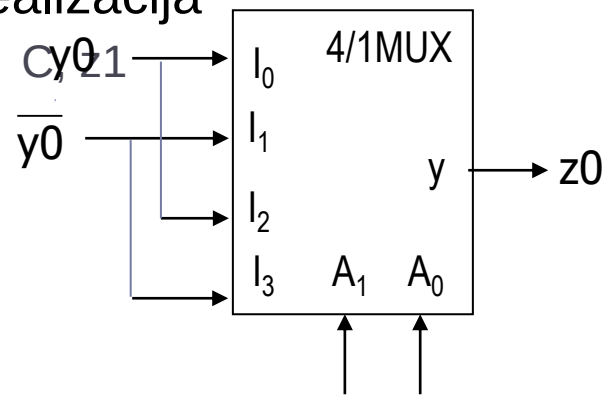
$$z1 = (x1 \downarrow y1 \downarrow y0) \downarrow (x1 \downarrow x0 \downarrow y1) \downarrow (\overline{x1} \downarrow \overline{y1} \downarrow y0) \downarrow$$
$$(\overline{x1} \downarrow x0 \downarrow \overline{y1}) \downarrow (x1 \downarrow \overline{x0} \downarrow \overline{y1} \downarrow \overline{y0}) \downarrow (\overline{x1} \downarrow \overline{x0} \downarrow \overline{y1} \downarrow \overline{y0})$$

$$z0 = (\overline{x0} \downarrow \overline{y0}) \downarrow (x0 \downarrow y0)$$

Pravilnostna tabela, MUX

x1	x0	y1	y0	C	z1	z0	C	z1	z0
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0	0	1
0	0	1	0	0	1	0	0	1	0
0	0	1	1	0	1	1	0	1	1
0	1	0	0	0	0	1	0	0	1
0	1	0	1	0	1	0	0	1	0
0	1	1	0	0	1	1	0	1	1
0	1	1	1	1	0	0	1	0	0
1	0	0	0	0	1	0	0	1	0
1	0	0	1	0	1	1	0	1	1
1	0	1	0	1	0	0	1	0	0
1	0	1	1	1	0	1	1	0	1
1	1	0	0	0	1	1	0	1	1
1	1	0	1	1	0	0	1	0	0
1	1	1	0	1	0	1	1	0	1
1	1	1	1	1	1	0	1	1	0

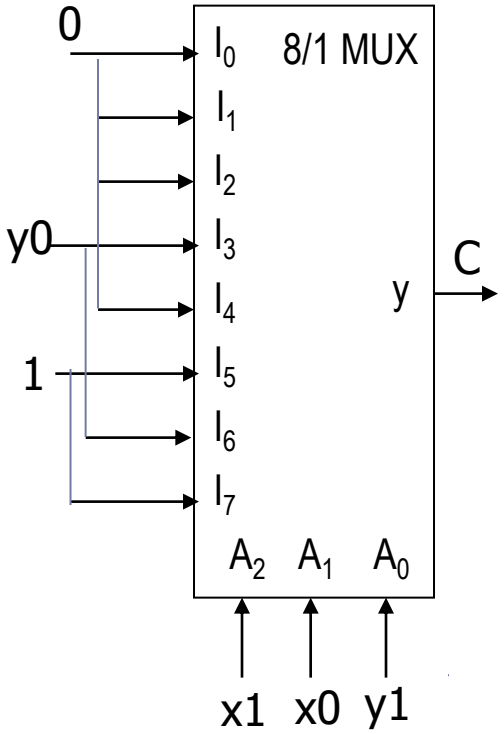
- 2/1 MUX – kaskadna realizacija
  - C, Z1, z0
- 4/1 MUX – kaskadna realizacija
  - C, Z1

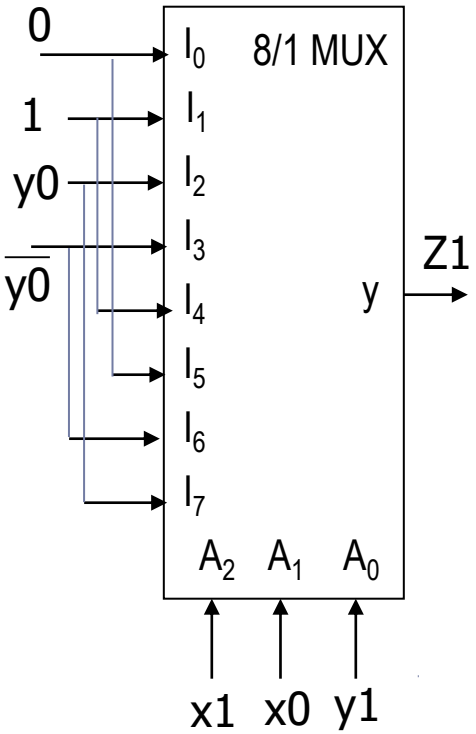


Pravilnostna tabela, MUX

x1	x0	y1	y0	C	z1	z0	
0	0	0	0	0	0	0	
0	0	0	1	0	0	1	
0	0	1	0	0	1	0	
0	0	1	1	0	1	1	
0	1	0	0	0	0	1	
0	1	0	1	0	1	0	
0	1	1	0	0	1	1	
0	1	1	1	1	0	0	
1	0	0	0	0	1	0	
1	0	0	1	0	1	1	
1	0	1	0	1	0	0	
1	0	1	1	1	0	1	
1	1	0	0	0	1	1	
1	1	0	1	1	0	0	
1	1	1	0	1	0	1	
1	1	1	1	1	1	0	

- 8/1 MUX – kaskadna realizacija
  - C, z1
  - z0 – realizacija z 2/1





Programabilni gradniki:

- PLA

  Konjunkcije: (11), vse so različne

  Disjunkcije: 3 izhodi (C, z1, z0)

  $x1.y1$

  $x1.x0.y1$

  $x0.y1.y0$

  $x1.\overline{x0}.\overline{y1}$

  $\overline{x1}.\overline{x0}.y1$

  $x1.\overline{x0}.\overline{y1}$

  $\overline{x1}.y1.\overline{y0}$

  $\overline{x1}.x0.\overline{y1}.y0$

  $x1.x0.y1.y0$

  $x0.\overline{y0}$

  $\overline{x0}.y0$

- PAL

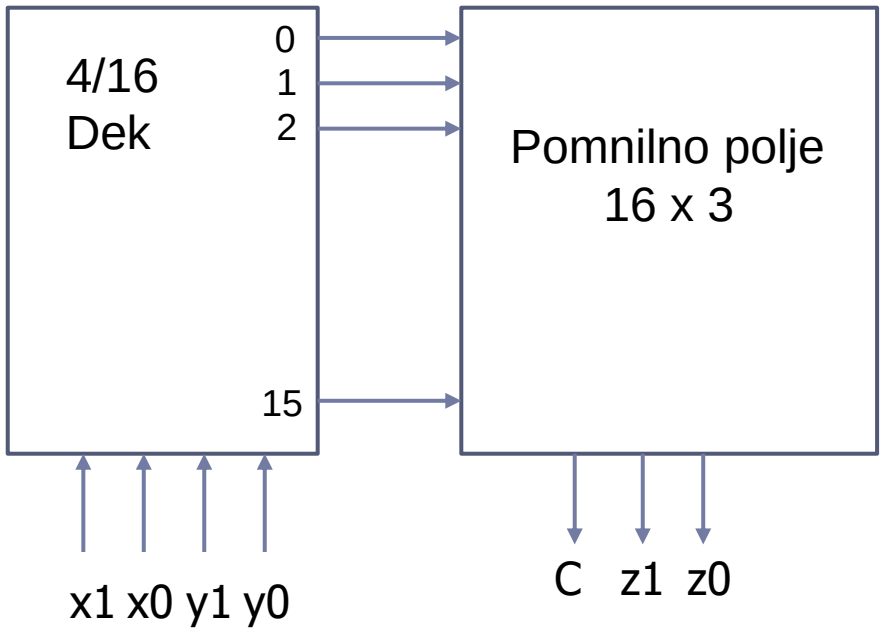
  Konjunkcije:

  - C: 3
  - z1: 6
  - z0: 2

  PAL – 8 konjunkcij povezanih v izhodno disjunkcijo

Pravilnostna tabela, ROM

x1	x0	y1	y0	C	z1	z0
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0



ROM: 16 x 3 ali 16 x 4