



Digitalna vezja UL, FRI



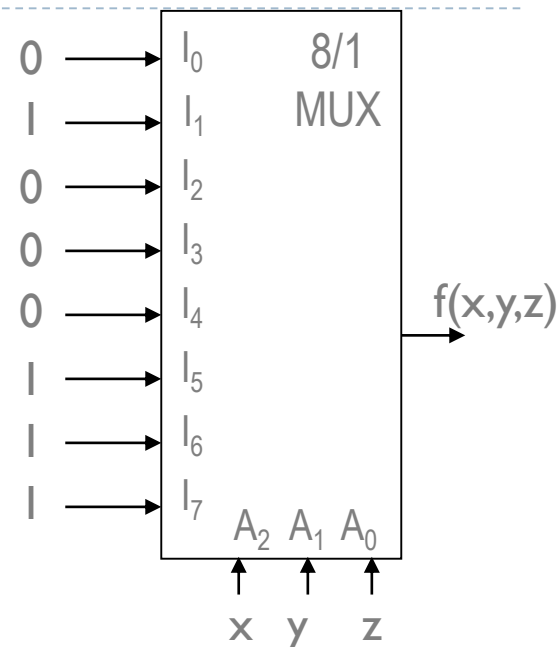
Vaja 6 Stukturalni gradniki

Realizacija logične funkcije z MUXi - tabela

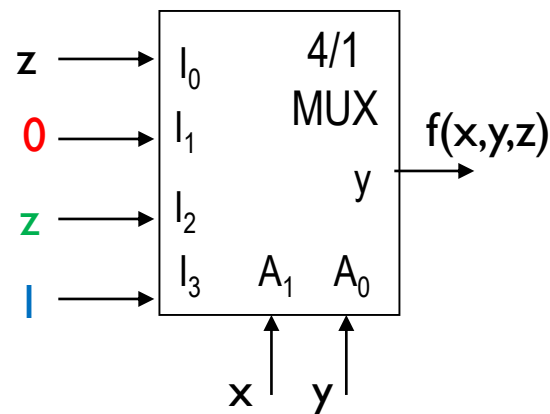
A_2	A_1	A_0		y
x	y	z	I_i	$f(x,y,z)$
0	0	0	0	0 = I_0
0	0	1	1	1 = I_1
0	1	0	2	0 = I_2
0	1	1	3	0 = I_3
1	0	0	4	0 = I_4
1	0	1	5	1 = I_5
1	1	0	6	1 = I_6
1	1	1	7	1 = I_7

A_2	A_1	A_0		y
x	y	z	I_i	$f(x,y,z)$
0	0	0	0	0 = I_0
0	0	1	1	1 = I_1
0	1	0	2	0 = I_2
0	1	1	3	0 = I_3
1	0	0	4	0 = I_4
1	0	1	5	1 = I_5
1	1	0	6	1 = I_6
1	1	1	7	1 = I_7

- Trivialna rešitev
 $f(x,y,z) \rightarrow n=3$
 3-naslovni MUX
 (8/1 MUX)



- Optimalna rešitev
 $f(x,y,z) \rightarrow n=3$
 2-naslovni MUX
 (4/1 MUX)



A_2	A_1	A_0		y
x	y	z	I_i	$f(x,y,z)$
0	0	0	0	0
0	0	1	1	1
0	1	0	2	0
0	1	1	3	0
1	0	0	4	0
1	0	1	5	1
1	1	0	6	1
1	1	1	7	1

I-nalovni MUX je podan:

$$y = \overline{A_0} \cdot I_0 \vee A_0 \cdot I_1$$

$$A_0 = y$$

$$I_0 = z$$

$$I_1 = x$$

□ Minimalna rešitev

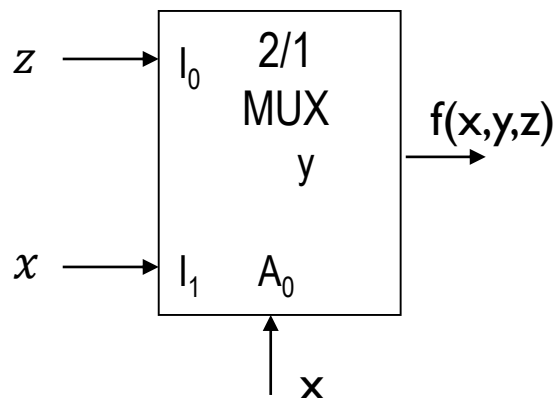
$$f(x,y,z) \rightarrow n=3$$

I-naslovni MUX
(2/1 MUX)

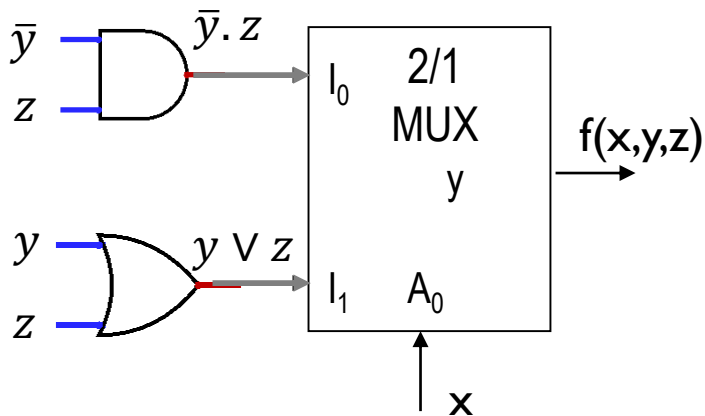
	\bar{z}	z
$\bar{x} \bar{y}$		1
$\bar{x} y$		
$x y$	1	1
$x \bar{y}$		1

Vsota produktov

$$f(x,y,z) = \bar{y} \cdot z \vee x \cdot y = \bar{y} \cdot z \vee y \cdot x$$



A_2	A_1	A_0		y
x	y	z	I_i	$f(x,y,z)$
0	0	0	0	0
0	0	1	1	1
0	1	0	2	0
0	1	1	3	0
				$I_0 = \bar{y} \cdot z$
1	0	0	4	0
1	0	1	5	1
1	1	0	6	1
1	1	1	7	1
				$I_0 = y \vee z$

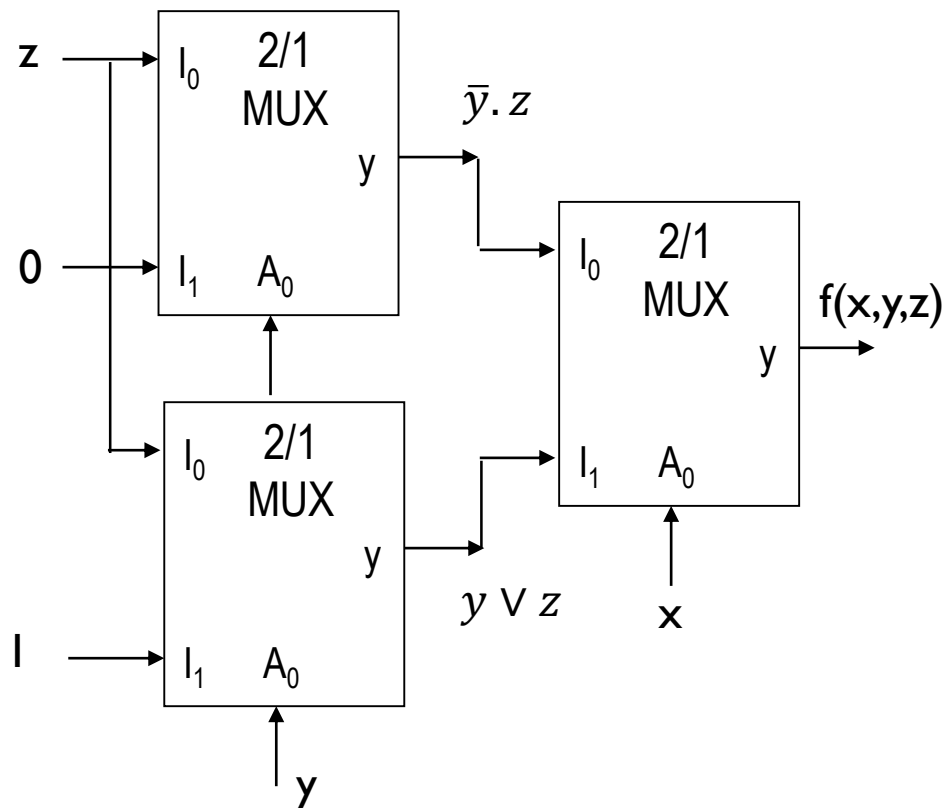


Funkciji realiziramo z I-naslovnim MUXom

□ Kaskadna rešitev

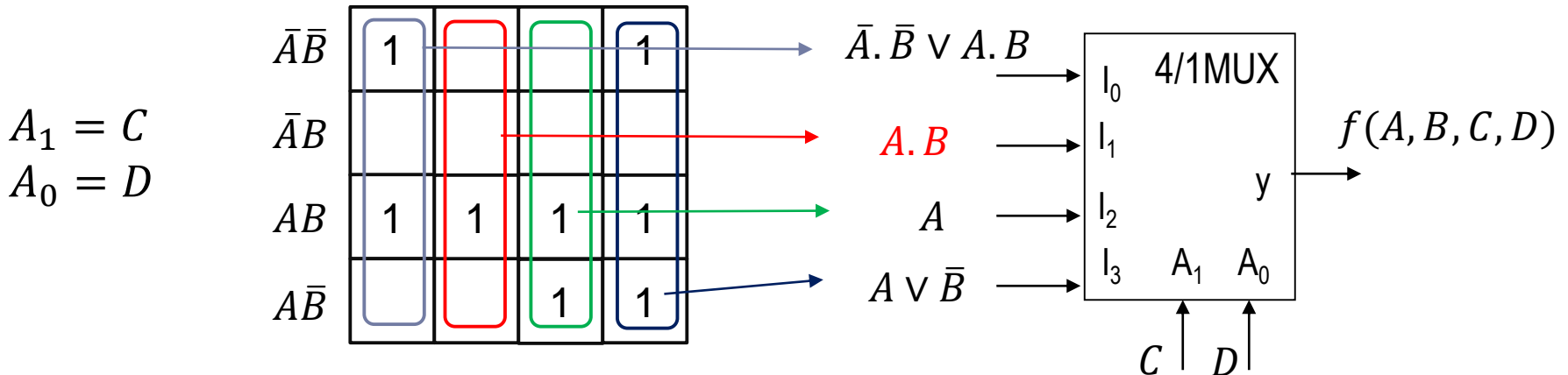
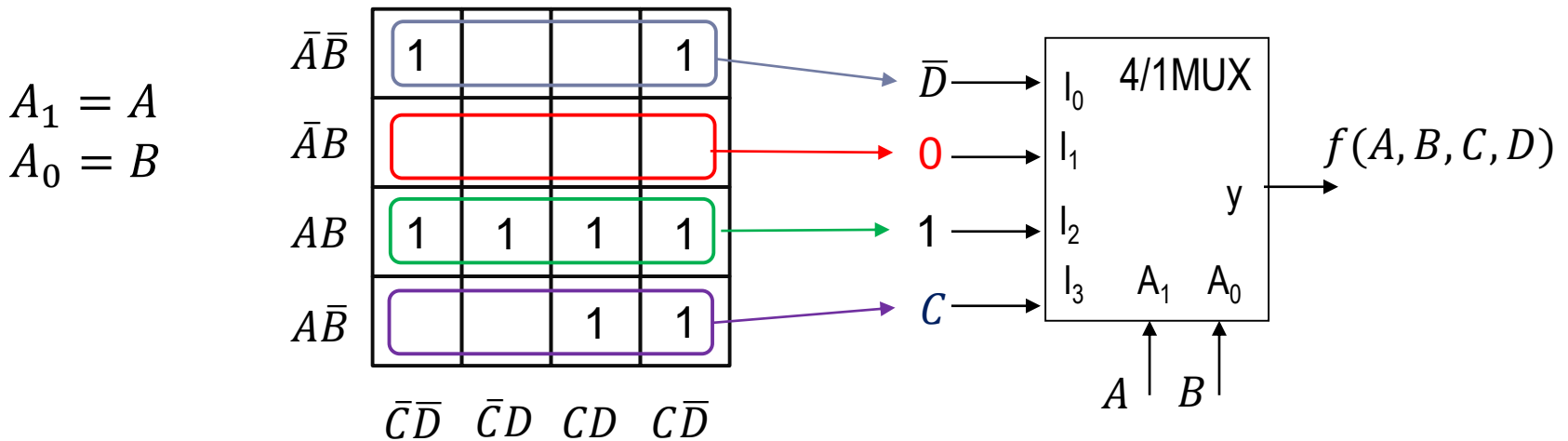
$f(x,y,z) \rightarrow n=3$

I-naslovnni MUX v dveh nivojih



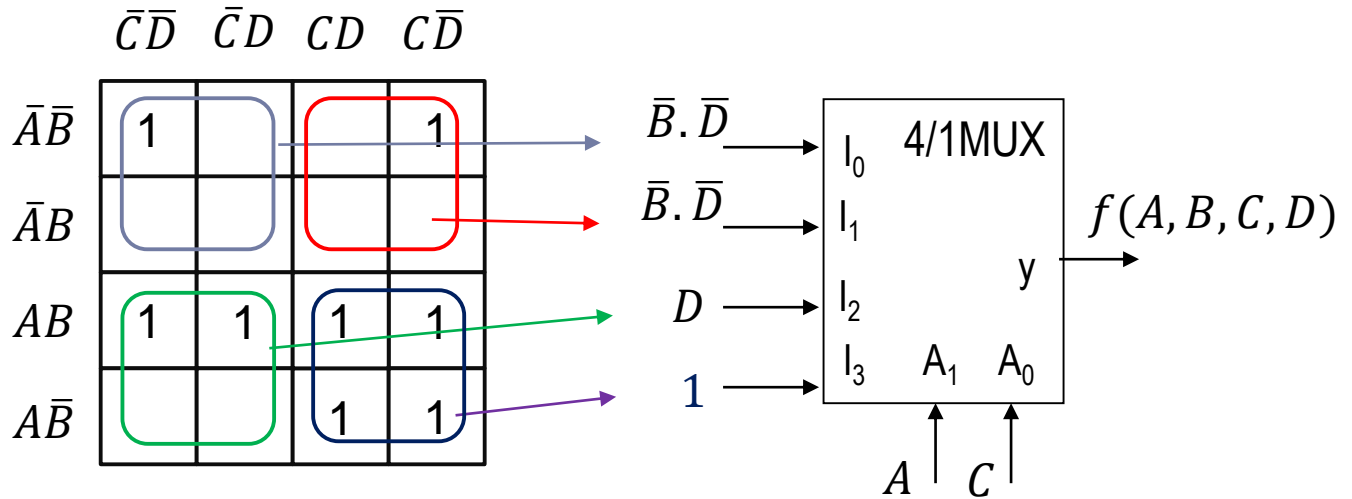
Realizacija logične funkcije – Karnaugh (4/1 MUX)

- Funkcija $f(A, B, C, D) \rightarrow$ 2-naslovni MUX



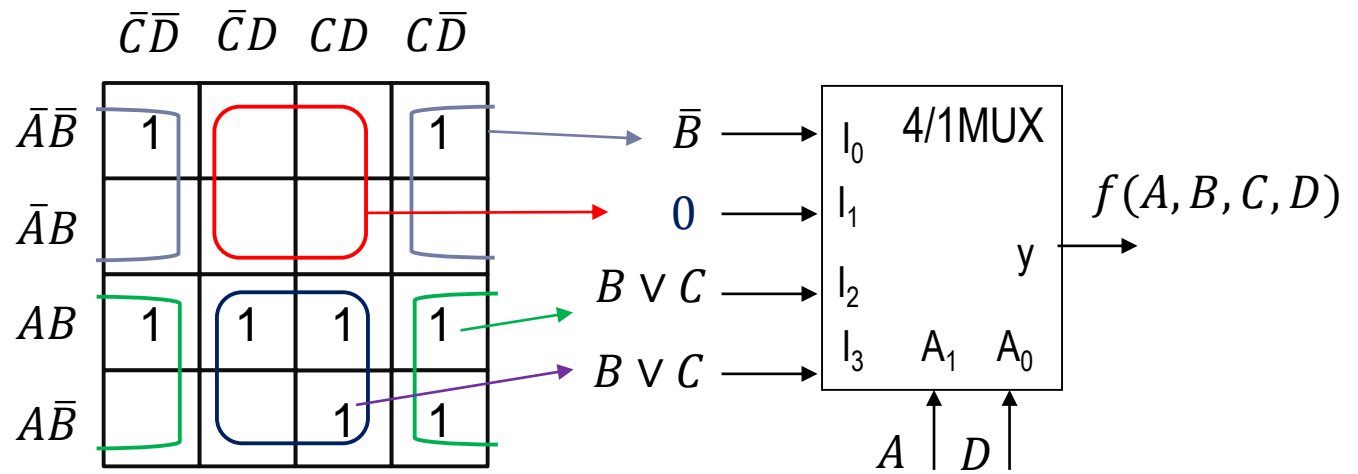
$$A_1 = A$$

$$A_0 = C$$



$$A_1 = A$$

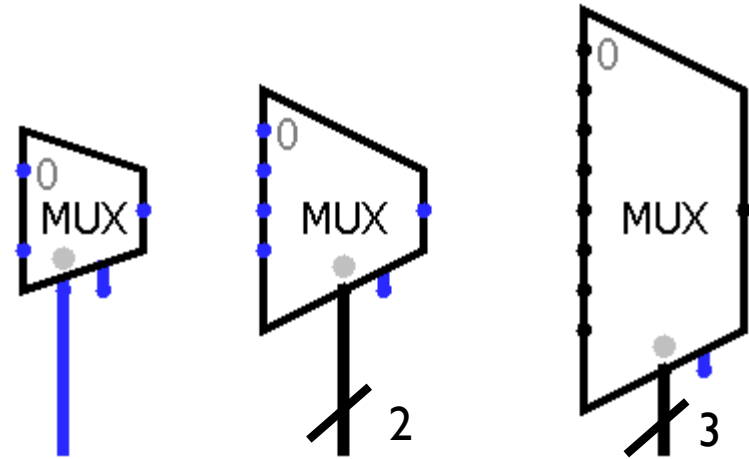
$$A_0 = D$$



Naloge: Strukturalni gradniki – MUX (logisim)

- ❑ Realizacija logičnih funkcij z MUXji, tako da uporabimo samo enega za vsako izhodno funkcijo:

- 8/1 MUX
- 4/1 MUX
- 2/1 MUX



- ❑ Naloge

- N1: Dvojiški komplement ($n=4$)
- N2: Množilnik
- N3: Vaja 3: Primerjalnik
- N4: Vaja 5: Inkrementer/Dekrementer

- Vežje v logisimu predstaviti na vajah

- ❑ Pri reševanju preverimo kateri MUX je najbolj primerno uporabiti.

Tabela z rešitvami za realizacijo z MUXi

$$A_2 = _, A_1 = _, A_0 = _ \quad A_1 = _, A_0 = _$$

														4/1 MUX				
0	0	0	0															
0	0	0	1					I_0										
0	0	1	0															
0	0	1	1					I_1						I_0				
0	1	0	0															
0	1	0	1					I_2										
0	1	1	0															
0	1	1	1					I_3						I_1				
1	0	0	0															
1	0	0	1					I_4										
1	0	1	0															
1	0	1	1					I_5						I_2				
1	1	0	0															
1	1	0	1					I_6										
1	1	1	0															
1	1	1	1					I_7						I_3				



Tabele z rešitvami za realizacijo z MUXi

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				

8/1 MUX

A_2	A_1	A_0	y				
0	0	0	I_0				
0	0	1	I_1				
0	1	0	I_2				
0	1	1	I_3				
1	0	0	I_4				
1	0	1	I_5				
1	1	0	I_6				
1	1	1	I_7				

4/1 MUX

A_1	A_0	y				
0	0	I_0				
0	1	I_1				
1	0	I_2				
1	1	I_3				

2/1 MUX

A_0	y				
0	I_0				
1	I_1				



N1: Dvojiški komplement (n=4)

- V tabeli zapišite pretvorbo 4-bitnih predznačenih števil (N) v dvojiški komplement (2^4K), kjer bit b_3 na vходу in bit k_3 na izhodu določata predznak:

Vhodi: b_3, b_2, b_1, b_0

Izhodi: k_3, k_2, k_1, k_0

- Primer izračuna pretvorbe:

$b_3, b_2, b_1, b_0 = 1011$

$1^4K + 1 : 0100 + 1 = 0101$

$k_3, k_2, k_1, k_0 = 1011$

b_3	b_2	b_1	b_0	k_3	k_2	k_1	k_0
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1
0	0	1	0	1	1	1	0
0	0	1	1	1	1	0	1
0	1	0	0	1	1	0	0
0	1	0	1	1	0	1	1
0	1	1	0	1	0	1	0
0	1	1	1	1	0	0	1
1	0	0	0	1	0	0	0
1	0	0	1	0	1	1	1
1	0	1	0	0	1	1	0
1	0	1	1	0	1	0	1
1	1	0	0	0	1	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	1



□ Rešitev s 3-naslovnimi MUXi (8/1 MUX)

b_3	b_2	b_1	b_0	k_3	k_2	k_1	k_0
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1
0	0	1	0	1	1	1	0
0	0	1	1	1	1	0	1
0	1	0	0	1	1	0	0
0	1	0	1	1	0	1	1
0	1	1	0	1	0	1	0
0	1	1	1	1	0	0	1
1	0	0	0	1	0	0	0
1	0	0	1	0	1	1	1
1	0	1	0	0	1	1	0
1	0	1	1	0	1	0	1
1	1	0	0	0	1	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	1

Izhod:

$$k_0 = b_0$$

Izhodi k_3, k_2, k_1

Naslovnih vhodi :

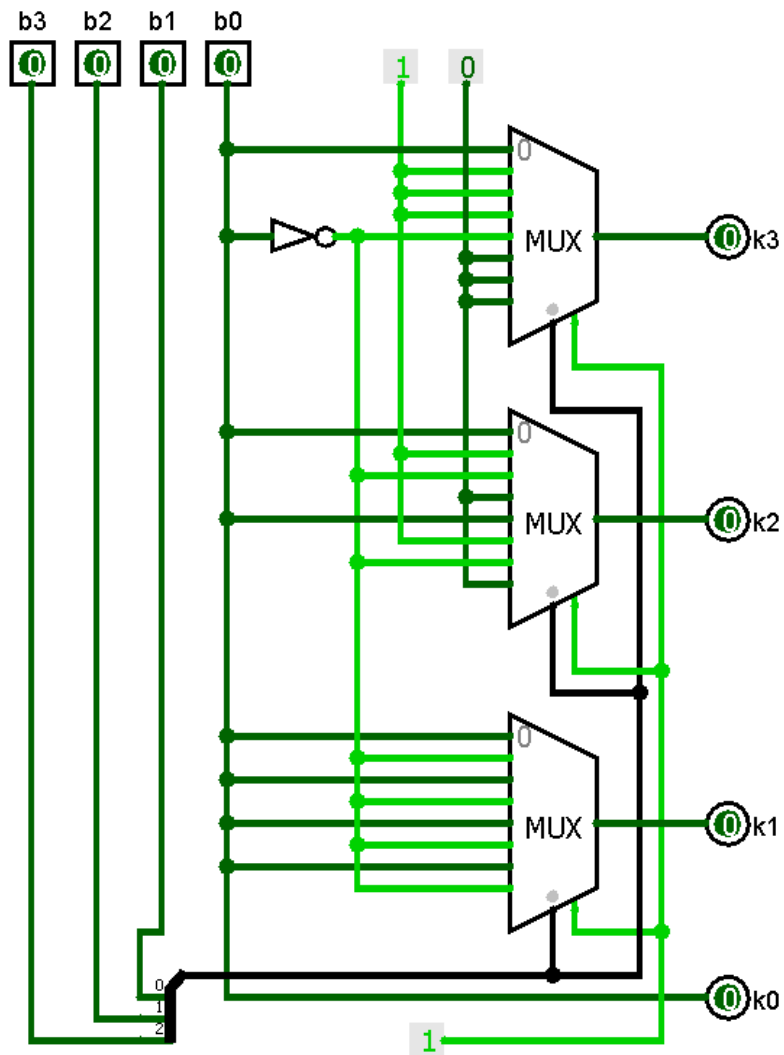
$$A_2 = b_3$$

$$A_1 = b_2$$

$$A_0 = b_1$$

	k_3	k_2	k_1
I_0	b_0	b_0	b_0
I_1	1	1	$\overline{b_0}$
I_2	1	$\overline{b_0}$	b_0
I_3	1	0	$\overline{b_0}$
I_4	$\overline{b_0}$	b_0	b_0
I_5	0	1	$\overline{b_0}$
I_6	0	$\overline{b_0}$	b_0
I_7	0	0	$\overline{b_0}$

Logično vezje



N2: Množilnik

- V tabeli zapišite množenje 2-bitnih podatkov $K=X*Y$, če imamo

- Vhoda:

$$X=(x_1, x_0) \text{ in}$$

$$Y=(y_1, y_0),$$

- Izhod:

$$K=(k_3, k_2, k_1, k_0)$$

- Primer izračuna pretvorbe:

$$b_3, b_2, b_1, b_0 = 1011$$

$$1 \cdot K + 1 : 0100 + 1 = 0101$$

$$k_3, k_2, k_1, k_0 = 1011$$

x_1	x_0	y_1	y_0	k_3	k_2	k_1	k_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	0	1	1
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0
1	0	1	0	0	1	0	0
1	0	1	1	0	1	1	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	1	1	0
1	1	1	1	1	0	0	1



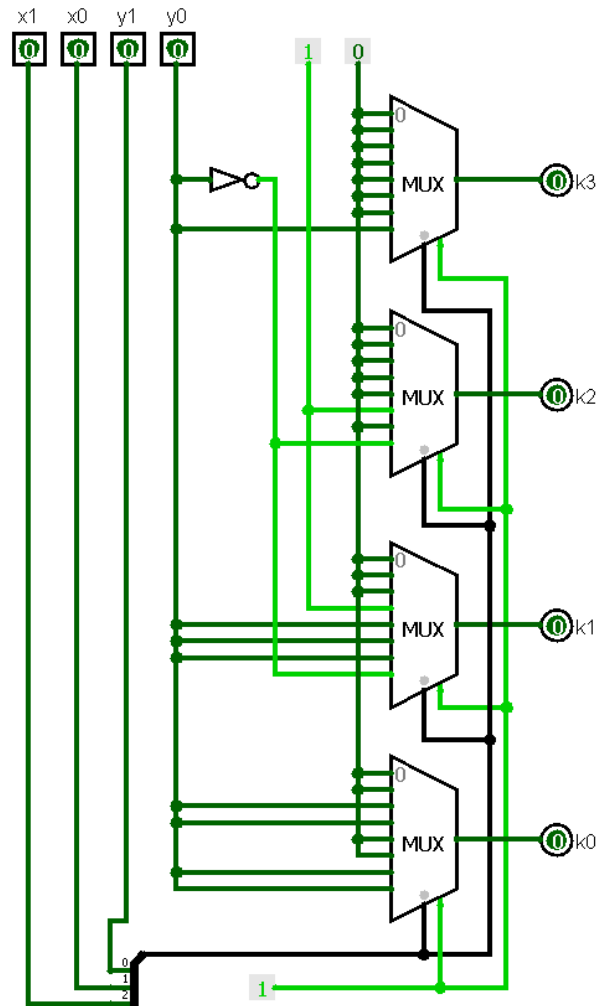
□ Rešitev s 3-naslovnimi MUXi (8/1 MUX)

x_1	x_0	y_1	y_0	k_3	k_2	k_1	k_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	1	0	1	0	0	0	1
0	1	1	0	0	0	1	0
0	1	1	1	0	0	1	1
1	0	0	0	0	0	0	0
1	0	0	1	0	0	1	0
1	0	1	0	0	1	0	0
1	0	1	1	0	1	1	0
1	1	0	0	0	0	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	1	1	0
1	1	1	1	1	0	0	1

A_2	A_1	A_0	y				
x_1	x_0	y_1		k_3	k_2	k_1	k_0
0	0	0	I_0	0	0	0	0
0	0	1	I_1	0	0	0	0
0	1	0	I_2	0	0	0	y_0
0	1	1	I_3	0	0	1	y_0
1	0	0	I_4	0	0	y_0	0
1	0	1	I_5	0	1	y_0	0
1	1	0	I_6	0	0	y_0	y_0
1	1	1	I_7	y_0	$\overline{y_0}$	$\overline{y_0}$	y_0



Logično vezje



N3: Primerjalnik

□ Vaja 3: Izvedba dvo-bitnega primerjalnika števil

- vhoda $X=(x_1, x_0)$, $Y=(y_1, y_0)$
- izhoda p_1 in p_0 :
 - $p_1 = 0, p_0 = 0$, če je $X=Y$,
 - $p_1 = 0, p_0 = 1$, če je $X < Y$, in
 - $p_1 = 1, p_0 = 0$, če je $X > Y$.

x_1	x_0	y_1	y_0	p_1	p_0
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	0	1
0	0	1	1	0	1
0	1	0	0	1	0
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	0	1
1	0	0	0	1	0
1	0	0	1	1	0
1	0	1	0	0	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	0	1	1	0
1	1	1	0	1	0
1	1	1	1	0	0



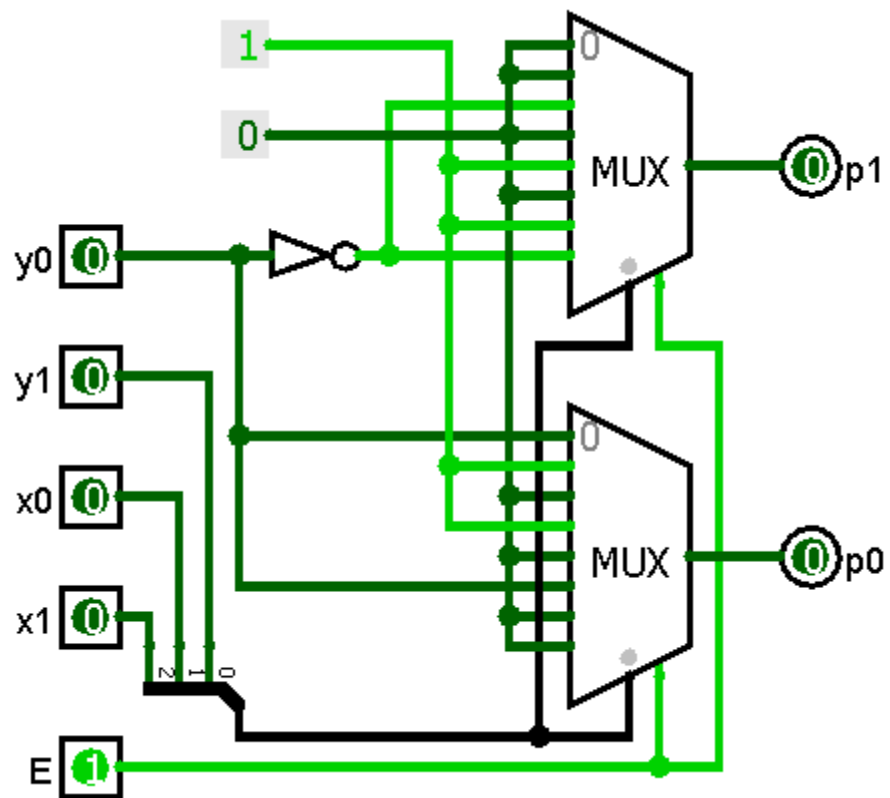
□ Rešitev s 3-naslovnimi MUXi (8/1 MUX)

x_1	x_0	y_1	y_0	P_1	P_0
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	0	1
0	0	1	1	0	1
0	1	0	0	1	0
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	0	1
1	0	0	0	1	0
1	0	0	1	1	0
1	0	1	0	0	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	0	1	1	0
1	1	1	0	1	0
1	1	1	1	0	0

A_2	A_1	A_0	y		
x_1	x_0	y_1		P_1	P_0
0	0	0	I_0	0	y_0
0	0	1	I_1	0	1
0	1	0	I_2	$\overline{y_0}$	0
0	1	1	I_3	0	1
1	0	0	I_4	1	0
1	0	1	I_5	0	y_0
1	1	0	I_6	1	0
1	1	1	I_7	$\overline{y_0}$	0



□ Logično vezje



N4: Inkrementer in dekrementer

□ Vaja 5: Digitalno vezje za povečevanje $C=B + 2$ (Inkrementer) in zmanjševanje $C=B - 2$ (Dekrementer) 3-bitnega dvojiškega števila B.

- Vhodi so $B=(b_2, b_1, b_0)$,
- izhodi so $C=(c_2, c_1, c_0)$
- Krmiljenje:
 - A=0 – inkrement (+2)
 - A=1 – dekrement (-2)

A	b_2	b_1	b_0	c_2	c_1	c_0
0	0	0	0	0	1	0
0	0	0	1	0	1	1
0	0	1	0	1	0	0
0	0	1	1	1	0	1
0	1	0	0	1	1	0
0	1	0	1	1	1	1
0	1	1	0	0	0	0
0	1	1	1	0	0	1
1	0	0	0	1	1	0
1	0	0	1	1	1	1
1	0	1	0	0	0	0
1	0	1	1	0	0	1
1	1	0	0	0	1	0
1	1	0	1	0	1	1
1	1	1	0	1	0	0
1	1	1	1	1	0	1

Rešitev z 2-naslovnimi MUXi (4/1 MUX)

A	b ₂	b ₁	b ₀	c ₂	c ₁	c ₀
0	0	0	0	0	1	0
0	0	0	1	0	1	1
0	0	1	0	1	0	0
0	0	1	1	1	0	1
0	1	0	0	1	1	0
0	1	0	1	1	1	1
0	1	1	0	0	0	0
0	1	1	1	0	0	1
1	0	0	0	1	1	0
1	0	0	1	1	1	1
1	0	1	0	0	0	0
1	0	1	1	0	0	1
1	1	0	0	0	1	0
1	1	0	1	0	1	1
1	1	1	0	1	0	0
1	1	1	1	1	0	1

$$c_1 = \overline{b_1}$$

$$c_0 = b_0$$

A ₁	A ₀		
A	b ₂	y	c ₂
0	0	I ₀	b ₁
0	1	I ₁	$\overline{b_1}$
1	0	I ₂	$\overline{b_1}$
1	1	I ₃	b ₁

