



Digitalna vezja UL, FRI



Kombinacijska vezja - Primeri

Zapisi in pretvorbe logičnih funkcij

- Podani sta logični funkciji f_A in f_B .
- Zapišite jih v DNO in v Veitchev diagram

- Funkcije: $x \uparrow y = \overline{x \cdot y} = \bar{x} \vee \bar{y}$
 $x \downarrow y = \overline{x \vee y} = \bar{x} \cdot \bar{y}$
 $x \oplus y = \bar{x} \cdot y \vee x \cdot \bar{y}$
 $\overline{x \oplus y} = \bar{x} \cdot \bar{y} \vee x \cdot y$

$$\begin{aligned} f_A(x, y, z) &= (x \uparrow y) \uparrow (\bar{x} \vee \bar{z}) = \\ &= \overline{\overline{x \cdot y} \cdot (x \cdot z)} = x \cdot y \vee x \cdot z \end{aligned}$$

$$\begin{aligned} f_B(A, B, C, D) &= (A \oplus B) \uparrow ((C \vee \bar{D}) \downarrow \bar{A}) = \\ &= \overline{(A \oplus B) \cdot ((C \vee \bar{D}) \cdot \bar{A})} = \\ &= \overline{(A \oplus B)} \vee \overline{((C \vee \bar{D}) \cdot \bar{A})} = \\ &= (\bar{A} \cdot \bar{B} \vee A \cdot B) \vee (C \vee \bar{D} \vee \bar{A}) = \quad PKNO \\ &= \bar{A} \cdot \bar{B} \vee A \cdot B \vee C \vee \bar{D} \vee \bar{A} \end{aligned}$$

$$f_B(A, B, C, D) = \bar{A} \vee B \vee C \vee \bar{D}$$

		x				
y		1	1			
			1			
		z				
		A				
B		1	1	1	1	
		1	1	1	1	
			1	1	1	
		1	1	1	1	
		C				
		D				

Inkrementer

Vhodi: $B=(b_2,b_1,b_0)$, Izhodi $C=(c_2,c_1,c_0)$

Funkcija: 3-bitno število B se poveča za 2 ($C=B+2$)

Naloga: Zapis in realizacija izhodov C z XOR vrati

Rešitev: Minimalna oblika, Linearna funkcija

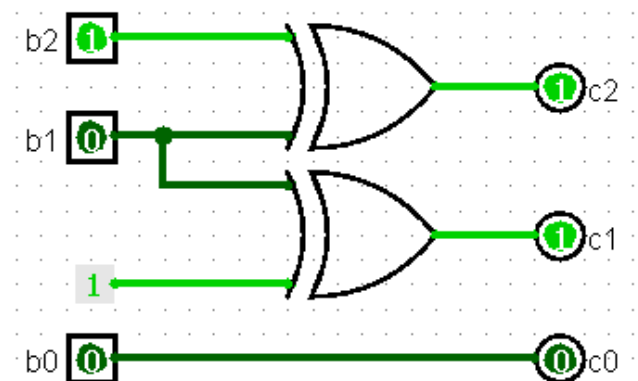
b_2	b_1	b_0	c_2	c_1	c_0
0	0	0	0	1	0
0	0	1	0	1	1
0	1	0	1	0	0
0	1	1	1	0	1
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	0	0	1

$$c_0 = b_0$$

$$c_1 = \bar{b}_1$$

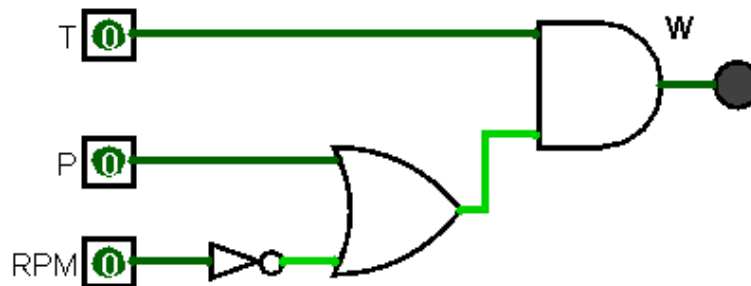
c_2	\bar{b}_0	b_0
$\bar{b}_2 \bar{b}_1$		
$\bar{b}_2 b_1$	I	I
$b_2 b_1$		
$b_2 \bar{b}_1$	I	I

$$c_2 = \bar{b}_2 \cdot b_1 \vee b_2 \cdot \bar{b}_1 = b_2 \oplus b_1$$



Senzorski sistem

- ▶ V letalu je sistem za pregled pritiska (P), temperature (T) in krožne hitrosti motorjev – RPM z uporabo senzorjev, ki imajo izhode določene kot:
 - ▶ $RPM = 0$, če je hitrost < 4800 rpm
 - ▶ $P = 0$, če je pritisk < 220 psi
 - ▶ $T = 0$, če je temperatura $< 200^{\circ}\text{F}$
- ▶ Logično vezje, ki skrbi za kontrolo opozorilne luči v pilotski kabini ima pri zgornjih pogojih na izhodu $W=1$. Prižge se opozorilna luč.
- ▶ Zapišite pogoje pri katerih se pilotu prižge opozorilna luč W .
- ▶ Spremenite vezje v zapis z
 - ▶ NAND vrati
 - ▶ NOR vrati.



Rešitev

- Logična funkcija: $W = T.(P \vee \overline{RPM}) = T.P \vee T.\overline{RPM}$
- Zapis s pogoji:
- $W=1$, če je $T=1$ and $P=1$ or $T=1$ and $RPM=0$)

P	T		
	1	1	
	1		

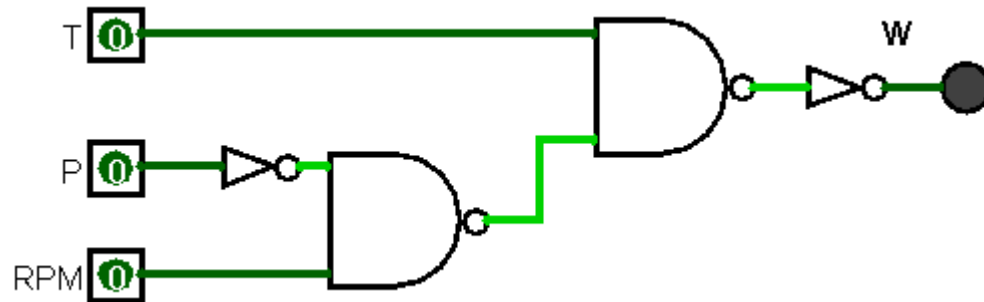
RPM

$$W = T.(P \vee \overline{RPM}) =$$

$$= \overline{\overline{T} . (P \vee \overline{RPM})} =$$

$$\overline{T \uparrow (\overline{P} . RPM)} =$$

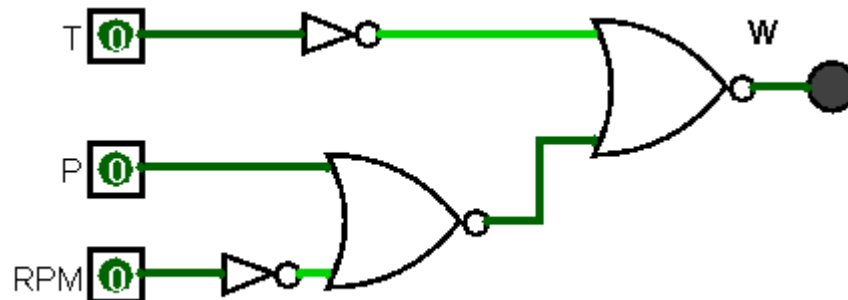
$$\overline{T \uparrow (\overline{P} \uparrow RPM)}$$



$$W = T.(P \vee \overline{RPM}) =$$

$$= \overline{\overline{T} \vee (P \vee \overline{RPM})} =$$

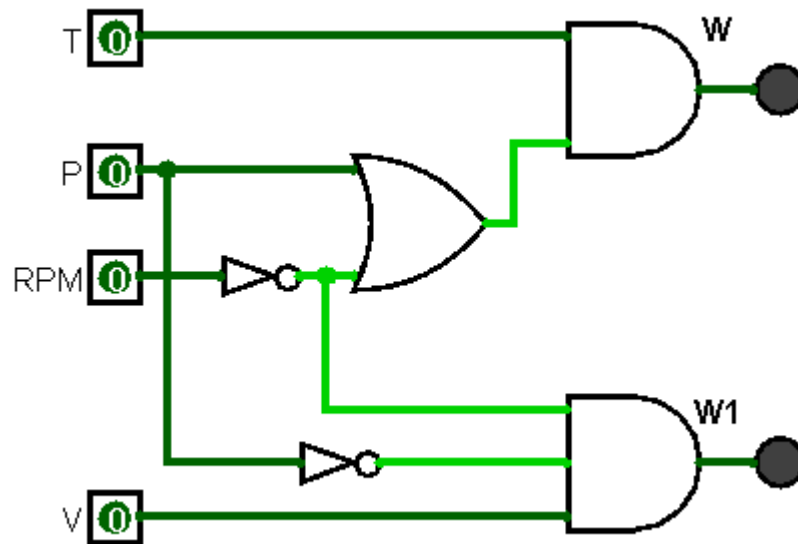
$$= \overline{T} \downarrow (P \downarrow \overline{RPM})$$



Senzorski sistem-nadgradnja

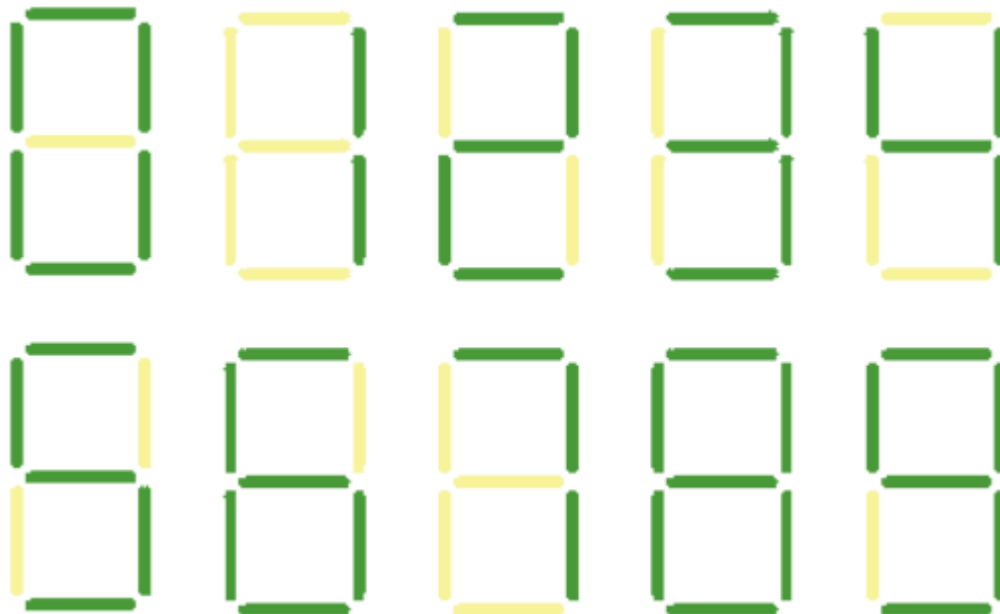
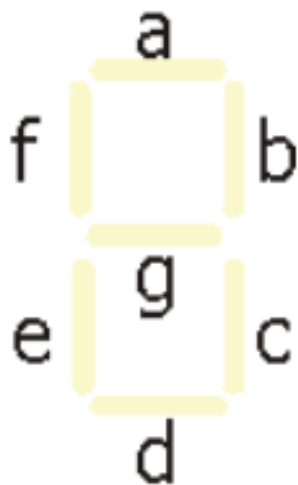
- ▶ Osnovni opozorilni sistem v letalu ima tudi senzor višine (V)
- ▶ $V=1$, če je višina $< 3000\text{m}$
- ▶ opozorilna lučka se prižge, če je $W1=1$ (senzorji so v tem primeru podani z $V=1$ and $P=0$ and $RPM=0$).

$$W1 = V \cdot \overline{P} \cdot \overline{RPM}$$

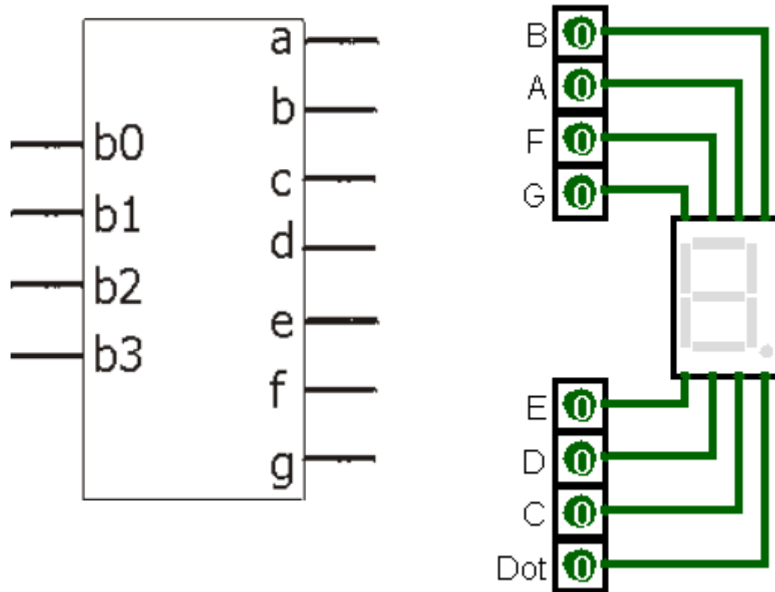


7-segmentni prikazovalnik

► Prikaz BCD števil



- ▶ Vezje za prikaz BCD števil
- ▶ Krmilni vhodi v logisimu
- ▶ Pravilnostna tabela
- ▶ Realizacija: 7-bitni dekodirnik



	b3 b2 b1 b0	a b c d e f g
0	0 0 0 0	1 1 1 1 1 1 0
1	0 0 0 1	0 1 1 0 0 0 0
2	0 0 1 0	1 1 0 1 1 0 1
3	0 0 1 1	1 1 1 1 0 0 1
4	0 1 0 0	0 1 1 0 0 1 1
5	0 1 0 1	1 0 1 1 0 1 1
6	0 1 1 0	1 0 1 1 1 1 1
7	0 1 1 1	1 1 1 0 0 0 0
8	1 0 0 0	1 1 1 1 1 1 1
9	1 0 0 1	1 1 1 1 0 1 1

- ▶ Realizacija izhodnih funkcij dekodirnika a, b, c, d, e, f, g:
- ▶ Logična vrata (AND, OR, NOT, NAND, XOR), MUXi

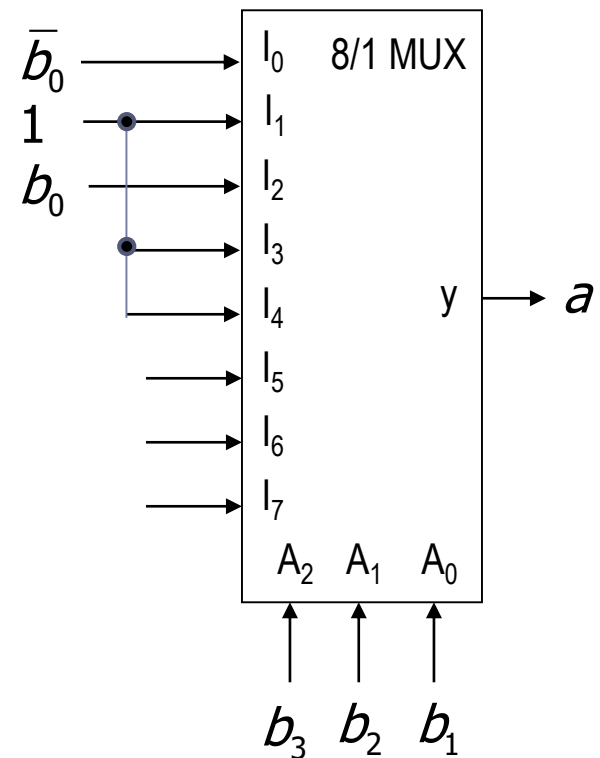
a

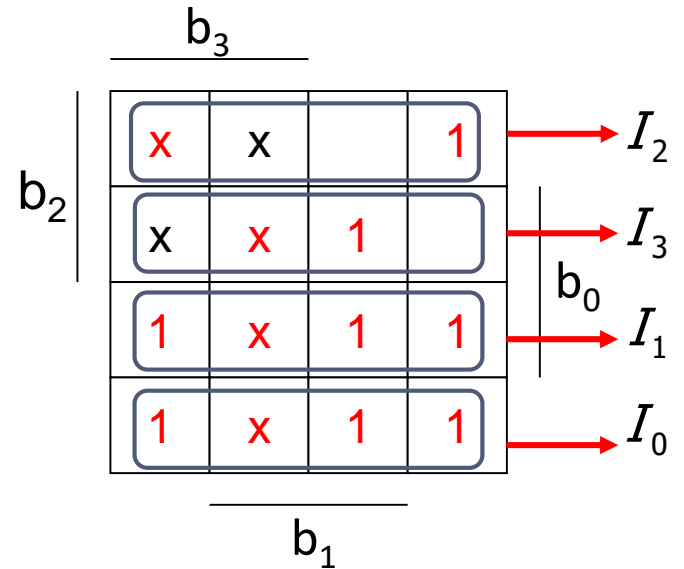
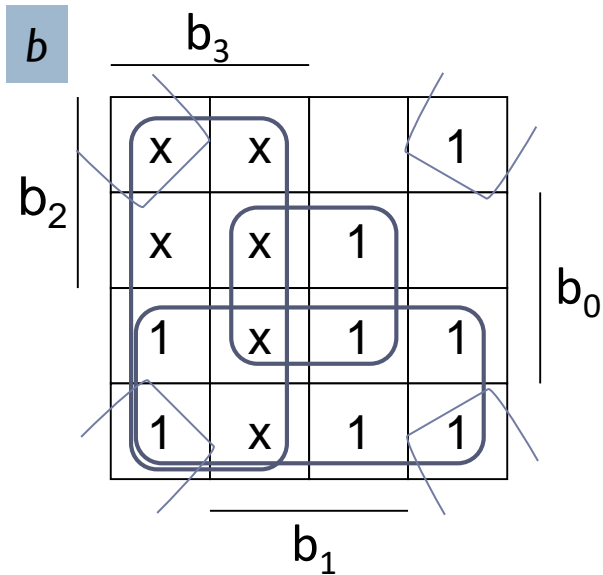
	b_3				
b_2	x	x	1		b_0
	x	x	1	1	
	1	x	1		
	1	x	1	1	
	b_1				

$$a = (b_3 \vee b_2 \vee b_1 \vee \bar{b}_0) \cdot (b_3 \vee \bar{b}_2 \vee b_1 \vee b_0)$$

$$a = b_3 \vee b_1 \vee b_2 \cdot b_0 \vee \bar{b}_2 \cdot \bar{b}_0 =$$

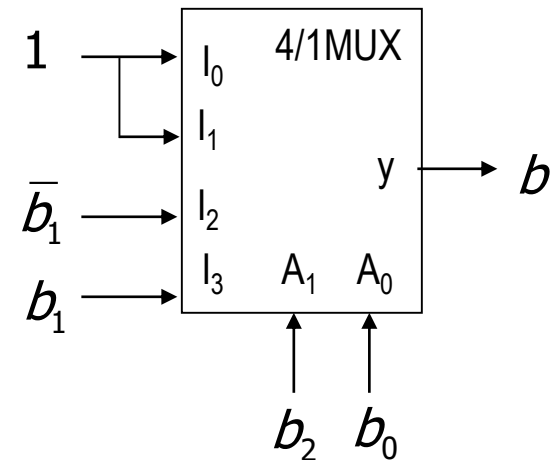
$$= b_3 \vee b_1 \vee b_2 \oplus b_0$$





$$b = (b_3 \vee \bar{b}_2 \vee b_1 \vee \bar{b}_0) \cdot (b_3 \vee \bar{b}_2 \vee \bar{b}_1 \vee b_0)$$

$$b = b_3 \vee \bar{b}_2 \vee b_1 \cdot b_0 \vee \bar{b}_1 \cdot \bar{b}_0$$



c

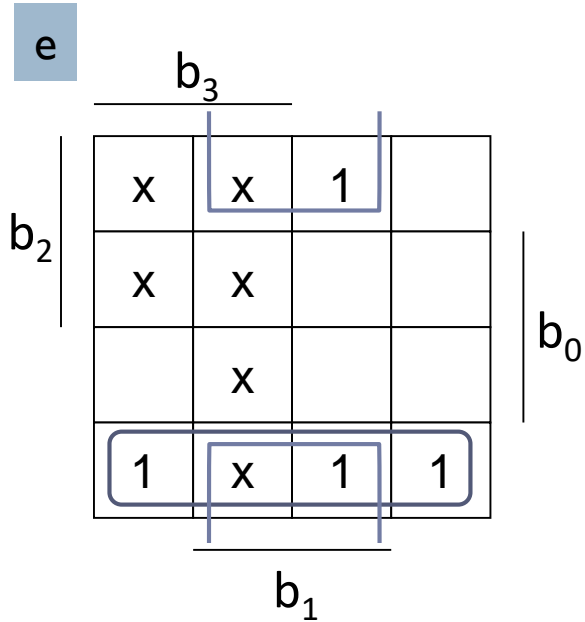
	b_3				
b_2					b_0
	x	x	1	1	
	x	x	1	1	
	1	x	1	1	
	1	x		1	
	b_1				

$$c = b_3 \vee b_2 \vee \bar{b}_1 \vee b_0$$

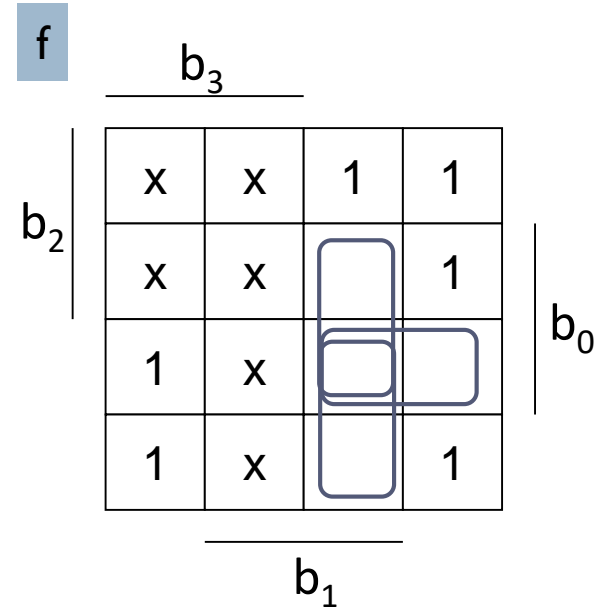
d

	b_3				
b_2					b_0
	x	x	1		
	x	x		1	
	1	x	1		
	1	x	1	1	
	b_1				

$$d = (b_3 \vee b_2 \vee b_1 \vee \bar{b}_0) \cdot (b_3 \vee \bar{b}_2 \vee b_1 \vee b_0) \cdot (b_3 \vee \bar{b}_2 \vee \bar{b}_1 \vee \bar{b}_0)$$



$$d = \bar{b}_2 \cdot \bar{b}_0 \vee b_1 \vee \bar{b}_0$$



$$d = (b_3 \vee \bar{b}_1 \vee \bar{b}_0) \cdot (b_3 \vee b_2 \vee \bar{b}_0) \cdot (b_3 \vee b_2 \vee \bar{b}_1)$$

g

	<u>b_3</u>			
b_2	x	x	1	1
	x	x		1
	1	x	1	
	1	x	1	
	<u>b_1</u>			b_0

$$d = (b_3 \vee b_2 \vee b_1) \cdot (b_3 \vee \bar{b}_2 \vee \bar{b}_1 \vee \bar{b}_0)$$