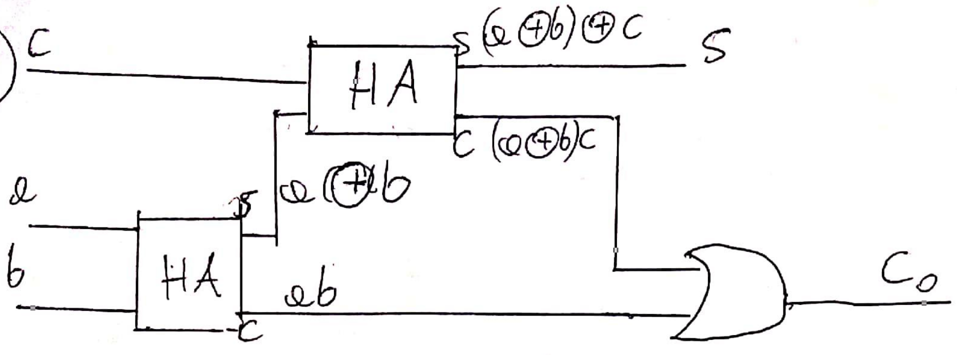
(1)



$S = a \oplus b \oplus c$

$C_0 = (a \oplus b)c + ab$

Mapa Karnough:

a \ bc	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$s = a\bar{b}\bar{c} + \bar{a}\bar{b}c + abc + \bar{a}b\bar{c}$

$\equiv \bar{c}(a\bar{b} + \bar{a}b) + c(ab + \bar{a}\bar{b})$

$$\boxed{\overset{XOR}{a \oplus b = a\bar{b} + \bar{a}b}, \quad \overset{XNOR}{\neg(a \oplus b) = ab + \bar{a}\bar{b}}}$$

$s = \bar{c}(a \oplus b) + c[\neg(a \oplus b)] \equiv a \oplus b \oplus c$

a \ bc	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$C_0 = ac + bc + ab$

$= c(a+b) + ab$

różni się od $c(a \oplus b) + ab$ tylko $a \oplus b$ i $a+b$ ale te wyrażenia są różne tylko dla $a = b = 1$, a wtedy $ab = 1$ więc mimo wszystko $C_0 = 1$.

Zatem układy są równoważne bo wyrażenia algebry Boolé je opisujące są logicznie równoważne.

(2)

a_k	b_k	c_k	s_k	a_k b_k $+c_k$ s_k	$a_k \oplus b_k$	$(a_k \oplus b_k) \oplus s_k$
0	0	0	0		0	0
0	1	0	1		1	0
1	0	0	1		1	0
1	1	0	0		0	0
0	0	1	1		0	1
0	1	1	0		1	1
1	0	1	0		1	1
1	1	1	1		0	1

formuły c_k i $(a_k \oplus b_k \oplus c_k)$ przyjmują te same wartości dla wszystkich wartościowań są więc równoważne

③ fan-in = 4 8-bit

$$c_{k+1} = g_k + p_k c_k$$

$$c_n = \sum_{i=0}^{n-1} g_i \prod_{j=i+1}^{n-1} p_j + c_0 \prod_{j=0}^{n-1} p_j$$

$c_1 = g_0 + p_0 c_0$ ② branch (AND ; OR)

$c_2 = g_1 + p_1 c_1 = g_1 + p_1(g_0 + p_0 c_0) = g_1 + p_1 g_0 + p_0 c_0$ (2 AND, 1 OR) ③ branch

$c_3 = g_2 + p_2 c_2 = g_2 + \overbrace{p_2 p_1 g_0}^{\text{ze nom } + p_2 g_1 +} + p_2 p_1 p_0 c_0$ (3 AND, 1 OR) ④ branch

$$c_4 = g_3 + \overbrace{p_3 g_2}^{1} + \overbrace{p_3 p_2 g_1}^{1} + \overbrace{p_3 p_2 p_1 g_0}^{1} + p_3 p_2 p_1 p_0 c_0$$

$$+ \underbrace{(p_3 p_2 p_1 p_0)(c_0)}_{2}$$

2 OR 5 AND ⑦ branch

$$c_5 = g_4 + \underline{p_4 g_3} + \underline{p_4 p_3 g_2} + \underline{p_4 p_3 p_2 g_1} + p_4 p_3 p_2 p_1 g_0 + p_4 p_3 p_2 p_1 p_0 c_0$$

$$-\|- + (-\|- + -\|- + -\|- + \underline{p_4 p_3 p_2 p_1}(g_0 + \underline{p_0 c_0})$$

6 AND 3 OR ⑨ branch

$$c_6 = \underbrace{g_5 + \underline{p_5 g_4} + \underline{p_5 p_4 g_3} + \underline{p_{5-3} g_2}}_{OR} + p_{5-3} p_2 g_1 + p_{5-2} p_1 g_0 + p_{5-2} p_1 p_0 c_0$$

$$+ \underset{OR}{\underline{p_{5-2}}}\underbrace{(\underline{g_1} + \underline{p_1 g_0} + \underline{p_1 p_0 c_0})}_{OR}$$

7 AND 3 OR ⑩ branch

$$c_7 = \underbrace{g_6 + p_6 g_5 + p_6 p_5 g_4 + p_6 p_5 p_4 g_3}_{-\|-} + p_{6-3} g_2 + p_{6-3} g_1 + p_{6-3} p_2 p_1 g_0 + p_{6-3} p_2 p_1 p_0 c_0$$

$$+ p_{6-3}(g_2 + p_2 g_1 + p_2 p_1 g_0 + p_2 p_1 p_0 c_0)$$

8 AND 3 OR ⑫ branch

$$C_8 = [g_7 + p_7 g_6 + p_7 p_6 g_5 + p_7 p_6 p_5 g_4] + [p_{7-4} g_3 + p_{7-4} p_3 g_2 + p_{7-4} p_3 p_2 g_1 + p_{7-4} p_3 p_2 p_1 g_0 + p_{7-4} p_{3-0} c_0]$$

A: 3 AND 1 OR

B: $p_{7-4}(g_3 + p_3 g_2 + p_3 p_2 g_1 + p_3 p_2 p_1 g_0 + p_{3-0} c_0)$

~~$p_{7-4}(g_3 + p_3 g_2 + p_3 p_2 g_1 + p_3$~~ — ~~7~~ 2 AND 2 OR

1 OR (A ~~or~~ + B)

10 AND ~~4~~ OR 14 bramek

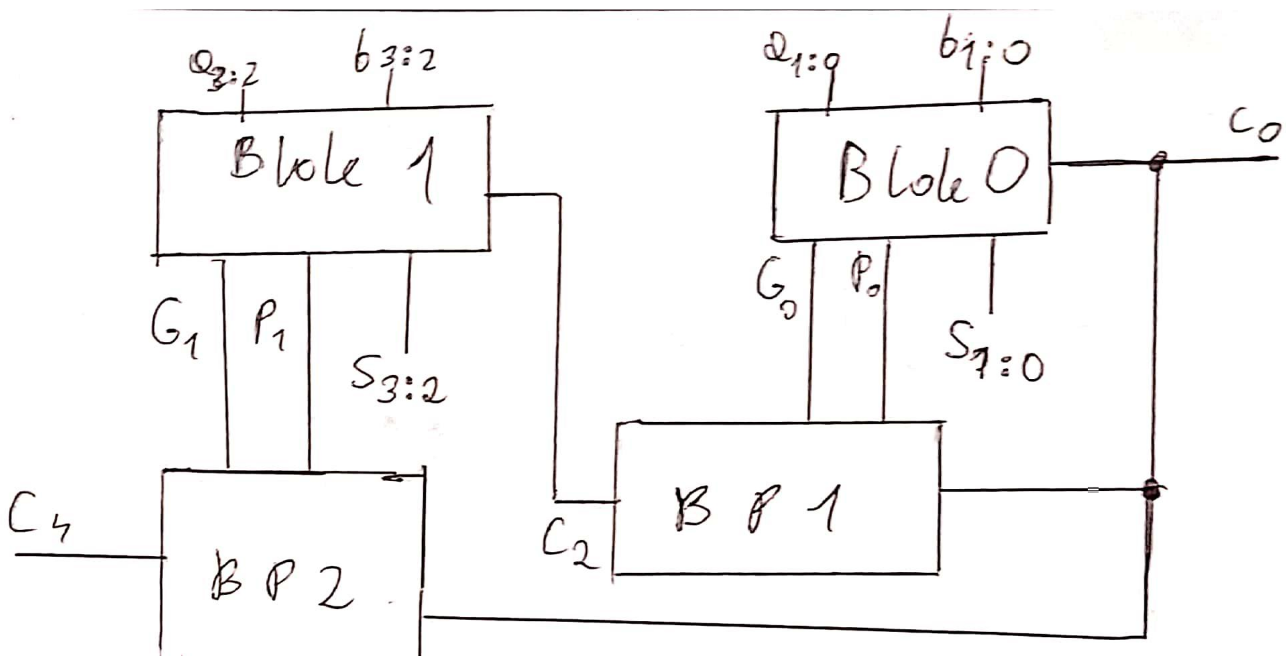
Suma jeden XOR na jeden bit 8 bramek

g_0, p_0 } 2 bramki na bit 16 bramek

SUMA: $2+3+4+7+9+10+12+14+8+16$

= 85 bramek

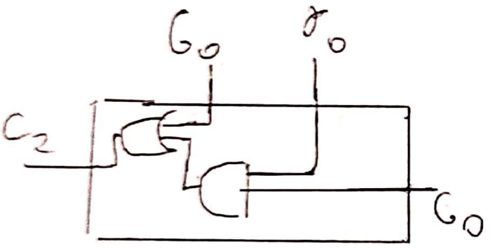
(5)



BP1

Blok ~~przeniesienia~~ 1
przewidywania przeniesienia

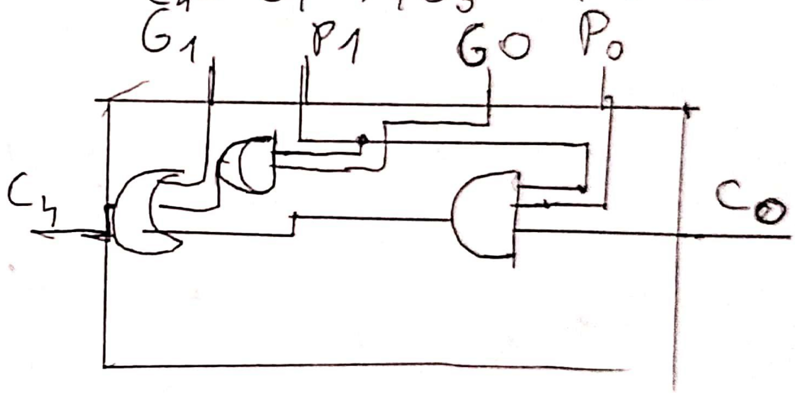
$$C_2 = G_0 + P_0 C_0$$



BP2

Blok ~~przeniesienia~~ 2
przewidywania przeniesienia

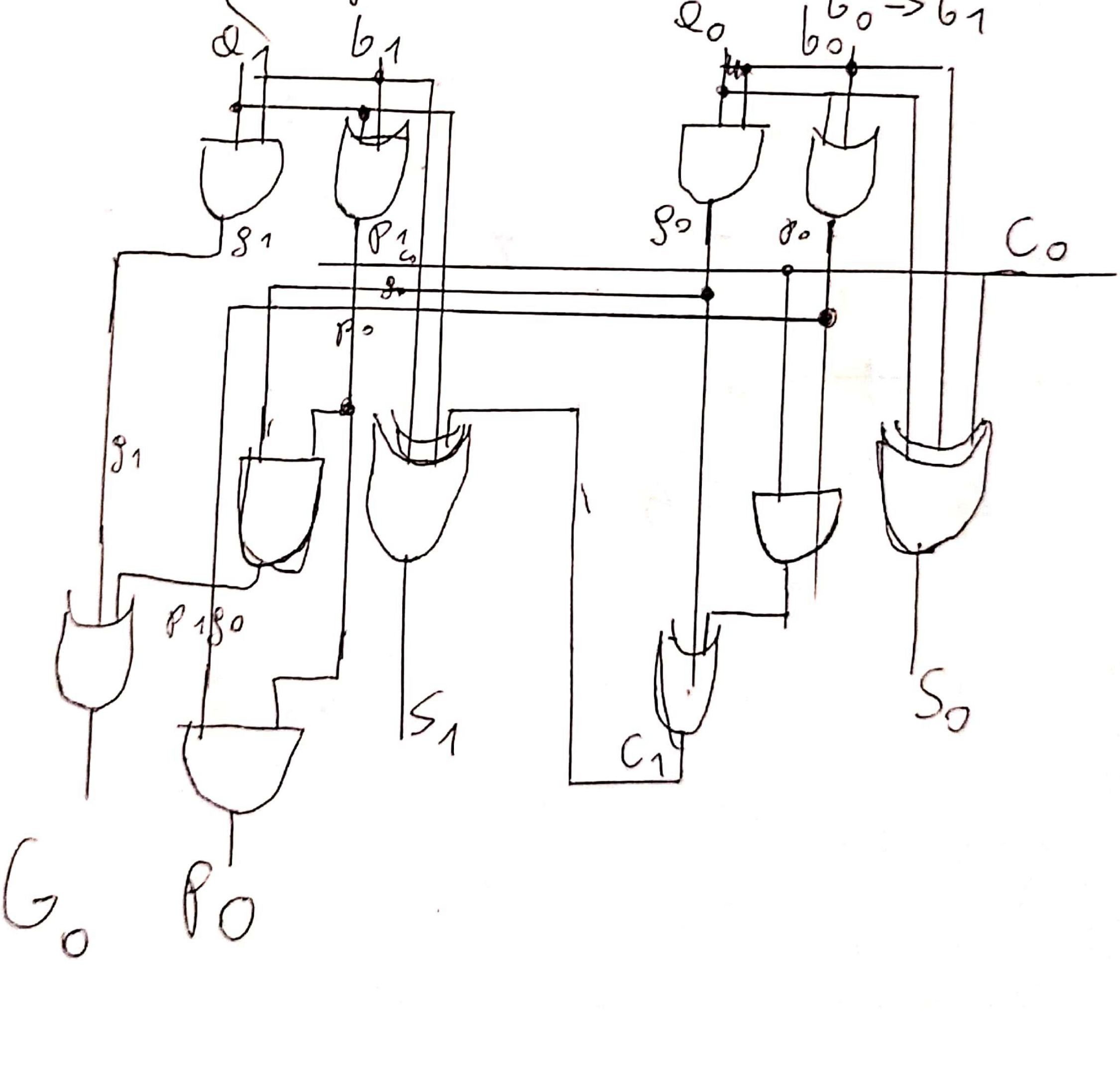
$$C_4 = G_1 + P_1 G_0 + P_1 P_0 C_0$$



4) kont $p_0 = a_0 + b_0$ $p_1 = a_1 + b_1$ $P_0 = p_1 p_0$

$g_0 = a_0 b_0$ $g_1 = a_1 b_1$ $G_0 = g_1 + p_1 g_0$

Blok 0 (1 podobnie tylko $p_0 \to p_2$, $p_1 \to p_3$ itp.
$G_0 \to G_1$)



5) Na każdym z sumatorów pełnych opóźnienie wynosi 2. Na najdłuższej ścieżce jest ich 6 oraz 1 bramkę AND, co razem daje $6 \cdot 2 + 1 = 13$ bramek opóźnienia na 31 bramkowej ścieżce

6) W układach w których ważny jest niski pobór mocy lub niskie wydzielane ciepło lub wtedy gdy niskie skomplikowanie układu jest ważniejsze od prędkości obliczeń.

(7) 0 → 9, 1 → 8 itd. - ~~i[3] i[2] i[1] i[0]~~ / d3 d2 d1 d0

i[3] (x)	i[2] (y)	i[1] (z)	i[0] (w)	d3	d2	d1	d0	
0	0	0	0	1	0	0	1	9
0	0	0	1	1	0	0	0	8
0	0	1	0	0	1	1	1	7
0	0	1	1	0	1	1	0	6
0	1	0	0	0	1	0	1	5
0	1	0	1	0	1	0	0	4
0	1	1	0	0	0	1	1	3
0	1	1	1	0	0	1	0	2
1	0	0	0	0	0	0	1	1
1	0	0	1	0	0	0	0	0
⋮	⋮	⋮	⋮	X	X	X	X	

d3:

zw \ xy	00	01	11	10
00	1	0	X	0
01	1	0	X	0
11	0	0	X	X
10	0	0	X	X

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

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

d2:

zw \ xy	00	01	11	10
00	0	1	X	0
01	0	1	X	0
11	1	0	X	X
10	1	0	X	X

d1:

zw \ xy	00	01	11	10
00	0	0	X	0
01	0	0	X	0
11	1	1	X	X
10	1	1	X	X

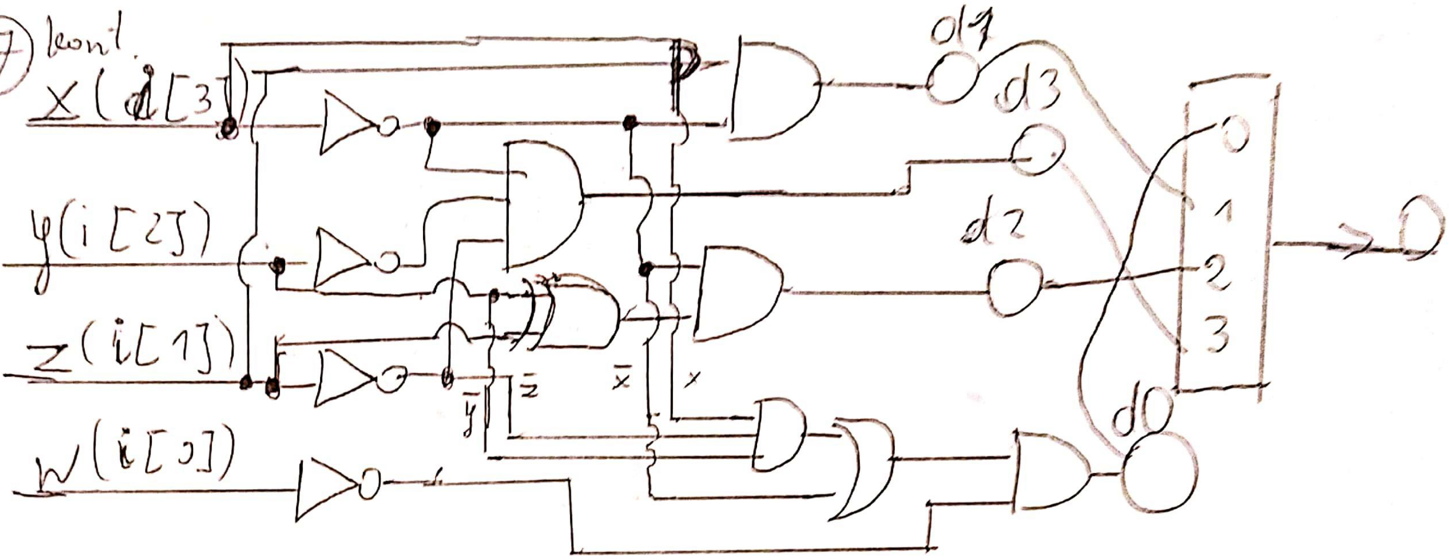
xz

$\bar{x}\bar{w}$
$+x\bar{y}\bar{z}\bar{w}$

d0:

zw \ xy	00	01	11	10
00	1	1	X	1
01	0	0	X	0
11	0	0	X	X
10	1	1	X	X

7 kont.



$d3 = \bar{x}\,\bar{y}\,\bar{z}$

$d2 = \bar{x}\bar{y}z + \bar{x}y\bar{z} = \bar{x}(\bar{y}z + y\bar{z}) = \bar{x}(XOR(y,z))$

$d1 = \bar{x}z$

$d0 = \bar{x}\bar{w} + x\bar{y}\bar{z}\bar{w} = \bar{w}(\bar{x} + x\bar{y}\bar{z})$

8

~~zmienne~~ wejście: ABCD to liczba w BCD

np.: 0001 to 1

0011 to 3 itp.

Które segmenty są zapalone dla odpowiednich liczb?

A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9
				x	x	x	x	x	x	x	

a ~~$\bar A\bar B\bar C D + \bar A B\bar C\bar D$~~

CD \ AB	00	01	11	10
00	1	0	X	1
01	0	1	X	1
11	1	1	X	X
10	1	1	X	X

$\bar a = \bar A\bar B\bar C D + B\bar C\bar D$

$a = (A+B+C+\bar D)(\bar B + C + D)$

b

CD \ AB	00	01	11	10
00	1	1	X	1
01	1	0	X	1
11	1	1	X	X
10	1	0	X	X

$\bar b = B\bar C D + B C\bar D$

$b = (\bar B + C + \bar D)(\bar B + \bar C + D)$

8 (kont) ~~b~~ (c) $\overline{\bar{A}\bar{B}C\bar{D}} = A+B+\bar{C}+D = C$

d

CD \ AB	00	01	11	10
00	1	0	X	1
01	0	1	X	1
11	1	0	X	X
10	1	1	X	X

$\bar{d} = AB\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + ABCD$

$d = (A+\bar{B}+C+D)(A+B+C+\bar{D})(A+\bar{B}+\bar{C}+\bar{D})$

e

CD \ AB	00	01	11	10
00	1	0	X	1
01	0	0	X	0
11	0	0	X	X
10	1	1	X	X

$e = \cancel{A\bar{C}\bar{D}} + \bar{B}\bar{C}\bar{D}$

$C\bar{D}$

f

CD \ AB	00	01	11	10
00	1	1	X	1
01	0	1	X	1
11	0	0	X	X
10	0	1	X	X

$\bar{f} = \bar{A}\bar{B}D + \bar{A}\bar{B}C + BCD$

$f = (A+B+\bar{D})(A+B+\bar{C})(\bar{B}+\bar{C}+\bar{D})$

g

CD \ AB	00	01	11	10
00	0	1	X	1
01	0	1	X	1
11	1	0	X	X
10	1	1	X	X

~~$\bar{g} = \bar{A}\bar{B}CD + \bar{A}\bar{B}C$~~

~~$g = (A+\bar{B}+\bar{C}+\bar{D})(A+B+\bar{C})$~~

$\bar{g} = \bar{A}\bar{B}\bar{C} + BCD$

$g = (A+B+C)(\bar{B}+\bar{C}+\bar{D})$

(9) 24 bity bez znaku

$\underbrace{\boxed{}}_{2^{11} \quad 2^0}^{12} . \underbrace{\boxed{}}_{2^{-1} \quad 2^{-12}}^{12}$

$(1,\dots,1).(1,\dots,1)$

maximum: $\sum_{i=-12}^{11} 2^i = 4095 + \frac{4095}{4096}$

$(0,\dots,0).(0,\dots,0)$

minimum: 0

---

24 bity ZM

$(0,1,\dots,1).(1,\dots,1)$

maximum: $\sum_{i=-12}^{10} 2^i = 2047 + \frac{4095}{4096}$

$(1,1,\dots,1).(1,\dots,1)$

minimum: $\left(\sum_{i=-12}^{10} 2^i\right)(-1) = -\left(2047 + \frac{4095}{4096}\right)$

---

24 bity U2

$(0,1,\dots,1).(1,\dots,1)$

maximum: $\sum_{i=-12}^{10} 2^i = 2047 + \frac{4095}{4096}$

$(1,0,\dots,0).(0,\dots,0)$

minimum: $-2^{11} = -2048$