Министерство науки и высшего образования Российской Федерации
Федеральное государственное бюджетное образовательное учреждение
высшего образования
«Московский государственный технический университет
имени Н. Э. Баумана
(национальный исследовательский университет)»
(МГТУ им. Н. Э. Баумана)

ФАКУЛЬТЕТ «Радиоэлектроника и лазерная техника (РЛ)»

КАФЕДРА «Технология приборостроения (РЛ6)»

ОТЧЕТ

по домашней работе №1

по курсу «Цифровые устройства и микропроцессоры»

на тему: «ПЛИС Altera ССИ, минимизация алгебраических функций»

Вариант № 20Л274

Студент РЛ6-61 (Группа) _____ (Подпись, дата) Филимонов С. В. (И. О. Фамилия)

Преподаватель _____ (Подпись, дата) Семеренко Д. А. (И. О. Фамилия)

2023 г.

Оглавление

1 Реализация шифратора для вывода знака на ССИ. 3

1.1 Алгебраические уравнения в СКНФ и СДНФ 3

1.2 Минимизация с помощью различных алгоритмов 4

1.2.1 Законы алгебры логики 4

1.2.2 Карты Карно 6

1.2.3 Метод Квайна 8

1.3 Перевод полученных выражений к базису 2И-НЕ/2ИЛИ-НЕ . . 11

1.3.1 2И-НЕ 11

1.3.2 2ИЛИ-НЕ 12

1.4 Цифровая схема 13

2 xxx 14

1 Реализация шифратора для вывода знака на ССИ.

На рисунке 1.1 пример семисегментного индикатора.

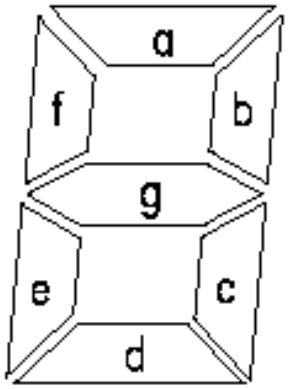

Рисунок 1.1 – Семисегментный индикатор

Кодировка

Символ	x_0	x_1	x_2	x_3	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
Л	1	0	1	0	1	1	1	0	1	1	0

1.1 Алгебраические уравнения в СКНФ и СДНФ

Определим СКНФ и СДНФ:

$y_a^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3)$

$y_a^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}x_2\bar{x_3}$

$y_b^{\text{СКНФ}} = (x_0 \vee \bar{x_1} \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee x_3)$

$y_b^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}\bar{x_1}\bar{x_2}x_3 \vee \bar{x_0}\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}x_2\bar{x_3}$

$y_c^{\text{СКНФ}} = (x_0 \vee x_1 \vee \bar{x_2} \vee x_3)$
$y_c^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}\bar{x_1}\bar{x_2}x_3 \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}x_2\bar{x_3}$

$y_d^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$
$y_d^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3$

$y_e^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee x_1 \vee \bar{x_2} \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee x_2 \vee \bar{x_3})$
$y_e^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}x_2\bar{x_3}$

$y_f^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee x_1 \vee \bar{x_2} \vee x_3) \cdot (x_0 \vee x_1 \vee \bar{x_2} \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3})$
$y_f^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}x_2\bar{x_3}$

$y_g^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee x_3) \cdot (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$
$y_g^{\text{СДНФ}} = \bar{x_0}\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}x_3$

1.2 Минимизация с помощью различных алгоритмов

1.2.1 Законы алгебры логики

Для начала сократим выражение с помощью законов алгебры логики:

$$y_a^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3) =$$
$$((x_0 \vee x_2) \vee (x_1 \vee \bar{x_3})) \cdot ((x_0 \vee x_2) \vee (\bar{x_1} \vee x_3)) =$$
$$(x_0 \vee x_2) \vee ((x_1 \vee \bar{x_3}) \cdot (\bar{x_1} \vee x_3))$$
$$y_a^{\text{СДНФ}} = \bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \underline{\bar{x_0}\bar{x_1}x_2\bar{x_3}} \vee \underline{\underline{\bar{x_0}\bar{x_1}x_2x_3}} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee \underline{\underline{\bar{x_0}x_1x_2x_3}} \vee \underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}}} \vee \underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}x_3}}}} \vee \underline{x_0\bar{x_1}x_2\bar{x_3}} =$$
$$\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3} \vee \bar{x_0}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2} \vee \bar{x_1}x_2\bar{x_3}$$

Используем закон дистрибутивности

$$\boxed{x \vee (y \cdot z) = (x \vee y) \cdot (x \vee z)}$$

$$y_b^{\text{СКНФ}} = (x_0 \vee \bar{x_1} \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee x_3) =$$
$$\bar{x_1} \vee x_0 \vee (x_2 \vee \bar{x_3} \cdot (\bar{x_2} \vee x_3))$$
$$y_b^{\text{СДНФ}} = \underline{\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}} \vee \underline{\bar{x_0}\bar{x_1}\bar{x_2}x_3} \vee \underline{\underline{\bar{x_0}\bar{x_1}x_2\bar{x_3}}} \vee \underline{\underline{\bar{x_0}\bar{x_1}x_2x_3}} \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee$$
$$\underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}}}} \vee x_0\bar{x_1}\bar{x_2}x_3 \vee \underline{\underline{\underline{\underline{x_0\bar{x_1}x_2\bar{x_3}}}}} =$$
$$\underline{\bar{x_0}\bar{x_1}\bar{x_2}} \vee \underline{\bar{x_0}\bar{x_1}x_2} \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}\bar{x_3} =$$
$$\bar{x_0}\bar{x_1} \vee \bar{x_0}x_1\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1x_2x_3 \vee x_0\bar{x_1}\bar{x_2}x_3 \vee x_0\bar{x_1}\bar{x_3}$$

Для $y_c^{\text{СКНФ}}$ сокращать нечего $y_c^{\text{СКНФ}} = (x_0 \vee x_1 \vee \bar{x_2} \vee x_3)$.

$$y_c^{\text{СДНФ}} = \underline{\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}} \vee \underline{\bar{x_0}\bar{x_1}\bar{x_2}x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \underline{\underline{\bar{x_0}x_1\bar{x_2}\bar{x_3}}} \vee \underline{\underline{\bar{x_0}x_1\bar{x_2}x_3}} \vee \underline{\underline{\underline{\underline{\bar{x_0}x_1x_2\bar{x_3}}}}} \vee$$
$$\underline{\underline{\underline{\underline{\bar{x_0}x_1x_2x_3}}}} \vee \underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}}}} \vee \underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}x_3}}}} \vee x_0\bar{x_1}x_2\bar{x_3} =$$
$$\underline{\bar{x_0}\bar{x_1}\bar{x_2}} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \underline{\underline{\bar{x_0}x_1\bar{x_2}}} \vee \underline{\underline{\bar{x_0}x_1x_2}} \vee \underline{x_0\bar{x_1}\bar{x_2}} \vee x_0\bar{x_1}x_2\bar{x_3} =$$
$$\bar{x_1}\bar{x_2} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1 \vee x_0\bar{x_1}x_2\bar{x_3}$$

$$y_d^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3) =$$
$$(x_0 \vee (x_1 \vee x_2 \vee \bar{x_3}) \cdot (\bar{x_1} \vee x_2 \vee x_3) \cdot (\bar{x_1} \vee \bar{x_2} \vee \bar{x_3})) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$$
$$y_d^{\text{СДНФ}} = \underline{\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}} \vee \underline{\bar{x_0}\bar{x_1}x_2\bar{x_3}} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee$$
$$\underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}}}} \vee \underline{\underline{\underline{\underline{x_0\bar{x_1}\bar{x_2}x_3}}}} =$$
$$\bar{x_0}\bar{x_1}\bar{x_3} \vee \bar{x_0}\bar{x_1}x_2x_3 \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2}$$

$$y_e^{\text{СКНФ}} = \underline{(x_0 \vee x_1 \vee x_2 \vee \bar{x_3})} \cdot \underline{(x_0 \vee x_1 \vee \bar{x_2} \vee \bar{x_3})} \cdot \underline{\underline{(x_0 \vee \bar{x_1} \vee x_2 \vee x_3)}} \cdot$$
$$\underline{\underline{(x_0 \vee \bar{x_1} \vee x_2 \vee \bar{x_3})}} \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee x_2 \vee \bar{x_3}) =$$
$$(x_0 \vee x_1 \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee x_2) \cdot ((x_0 \vee \bar{x_1} \vee \bar{x_2}) \cdot (\bar{x_0} \vee x_1 \vee x_2)) \vee \bar{x_3}$$
$$y_e^{\text{СДНФ}} = \underline{\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}} \vee \underline{\bar{x_0}\bar{x_1}x_2\bar{x_3}} \vee \bar{x_0}x_1x_2\bar{x_3} \vee \underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}} \vee \underline{\underline{x_0\bar{x_1}x_2\bar{x_3}}} =$$
$$\underline{\bar{x_0}\bar{x_1}\bar{x_3}} \vee \bar{x_0}x_1x_2\bar{x_3} \vee \underline{x_0\bar{x_1}\bar{x_3}} =$$
$$\bar{x_1}\bar{x_3} \vee \bar{x_0}x_1x_2\bar{x_3}$$

$$y_f^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x_3}) \cdot (x_0 \vee x_1 \vee \bar{x_2} \vee x_3) \cdot (x_0 \vee x_1 \vee \bar{x_2} \vee \bar{x_3}) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) =$$
$$(x_0 \vee x_1 \vee (x_2 \vee \bar{x_3}) \cdot (\bar{x_2} \vee x_3)) \cdot (x_0 \vee \bar{x_2}\bar{x_3})$$
$$y_f^{\text{СДНФ}} = \underline{\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}} \vee \underline{\bar{x_0}x_1\bar{x_2}\bar{x_3}} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee \underline{\underline{x_0\bar{x_1}\bar{x_2}\bar{x_3}}} \vee$$
$$\underline{\underline{x_0\bar{x_1}\bar{x_2}x_3}} \vee x_0\bar{x_1}x_2\bar{x_3} =$$
$$\bar{x_0}\bar{x_2}\bar{x_3} \vee \bar{x_0}x_1\bar{x_2}x_3 \vee \bar{x_0}x_1x_2\bar{x_3} \vee x_0\bar{x_1}\bar{x_2} \vee x_0\bar{x_1}x_2\bar{x_3}$$

$$y_g^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee x_3) \cdot (x_0 \vee x_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3) \cdot (\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3) =$$
$$(x_0 \vee x_1 \vee x_2) \cdot ((x_0 \vee \bar{x}_1 \vee \bar{x}_3) \cdot (\bar{x}_0 \vee x_1 \vee x_3) \vee \bar{x}_2)$$
$$y_g^{\text{СДНФ}} = \underline{\bar{x}_0\bar{x}_1x_2\bar{x}_3} \vee \underline{\bar{x}_0\bar{x}_1x_2x_3} \vee \underline{\underline{\bar{x}_0x_1\bar{x}_2\bar{x}_3}} \vee \underline{\underline{\bar{x}_0x_1\bar{x}_2x_3}} \vee \bar{x}_0x_1x_2\bar{x}_3 \vee \underline{\underline{\underline{x_0\bar{x}_1\bar{x}_2\bar{x}_3}}} \vee$$
$$\underline{\underline{\underline{x_0\bar{x}_1\bar{x}_2x_3}}} =$$
$$\bar{x}_0\bar{x}_1x_2 \vee \bar{x}_0x_1\bar{x}_2 \vee \bar{x}_0x_1x_2\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_2$$

1.2.2 Карты Карно

$a^{\text{СДНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	0	0	1	1
01	0	1	1	1
11	0	1	1	0
10	0	1	0	1

$a^{\text{СКНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	1	0	1	1
01	1	1	1	1
11	1	1	1	1
10	0	1	1	1

$$y_a^{\text{СДНФ}} = x_2\bar{x}_0 \vee \bar{x}_1\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0x_1x_3$$
$$y_a^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)$$

$b^{\text{СДНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	0	0	1	1
01	0	1	1	0
11	0	1	1	1
10	0	1	1	0

$b^{\text{СКНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	1	1	1	1
01	1	0	1	1
11	1	1	1	1
10	1	0	1	1

$$y_b^{\text{СДНФ}} = \bar{x}_1x_2\bar{x}_3 \vee \bar{x}_0x_2x_3 \vee \bar{x}_0\bar{x}_1x_3 \vee \bar{x}_0\bar{x}_2\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_3$$
$$y_b^{\text{СКНФ}} = (x_0 \vee \bar{x}_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee x_3)$$

$c^{\text{СДНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	0	0	1	1
01	0	1	0	1
11	0	1	1	1
10	0	1	1	1

$c^{\text{СКНФ}}$

$x_2, x_3 \backslash x_0, x_1$	00	01	11	10
00	1	1	1	1
01	0	1	1	1
11	1	1	1	1
10	1	1	1	1

$$y_c^{\text{СДНФ}} = \bar{x}_0\bar{x}_2 \vee x_0\bar{x}_1\bar{x}_2 \vee x_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_2x_3 \vee \bar{x}_0x_1x_2$$
$$y_c^{\text{СКНФ}} = (x_0 \vee x_1 \vee \bar{x}_2 \vee x_3)$$

$d^{\text{СДНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	0	0	1	0
01	0	0	1	1
11	0	1	1	0
10	0	1	0	1

$d^{\text{СКНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	1	0	1	1
01	1	1	1	0
11	1	0	1	1
10	0	1	1	1

$$y_d^{\text{СДНФ}} = x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0\bar{x}_1x_2 \vee \bar{x}_0x_2\bar{x}_3 \vee \bar{x}_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_1\bar{x}_2x_3$$

$$y_d^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2 \vee \bar{x}_3)\cdot(x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)\cdot(x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)\cdot(\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)$$

$e^{\text{СДНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	0	0	0	0
01	0	1	1	1
11	0	1	1	0
10	0	0	0	0

$e^{\text{СКНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	1	0	1	1
01	1	1	1	1
11	0	0	1	1
10	0	0	1	0

$$y_e^{\text{СДНФ}} = \bar{x}_1\bar{x}_3 \vee \bar{x}_0x_2\bar{x}_3$$

$$y_e^{\text{СКНФ}} = (x_0 \vee \bar{x}_3)\cdot(x_0 \vee \bar{x}_1 \vee x_2)\cdot(x_1 \vee x_2 \vee \bar{x}_3)$$

$f^{\text{СДНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	0	0	0	0
01	0	1	0	1
11	0	1	1	1
10	0	1	0	1

$f^{\text{СКНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	1	1	1	1
01	0	1	1	1
11	0	0	1	1
10	0	1	1	1

$$y_f^{\text{СДНФ}} = x_0\bar{x}_1\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0\bar{x}_2\bar{x}_3 \vee \bar{x}_0x_1x_3 \vee \bar{x}_0x_1\bar{x}_2$$

$$y_f^{\text{СКНФ}} = (x_0 \vee x_1 \vee \bar{x}_2)\cdot(x_0 \vee \bar{x}_2 \vee \bar{x}_3)\cdot(x_0 \vee x_1 \vee \bar{x}_3)$$

$g^{\text{СДНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	0	0	1	0
01	0	1	1	1
11	0	1	0	1
10	0	0	0	1

$g^{\text{СКНФ}}$

$x_2,\ x_3 \backslash x_0,\ x_1$	00	01	11	10
00	0	1	1	1
01	1	1	1	0
11	1	0	1	1
10	0	1	1	1

$$y_g^{\text{СДНФ}} = x_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0\bar{x}_1x_2 \vee \bar{x}_0x_1\bar{x}_3 \vee \bar{x}_0x_1\bar{x}_2$$

$$y_g^{\text{СКНФ}} = (x_0 \vee x_1 \vee x_2) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$$

1.2.3 Метод Квайна

СДНФ

$\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}$ 0	0 + 1 = $\bar{x_0}\bar{x_1}\bar{x_3}$ 0'	0' + 9' = $\bar{x_1}\bar{x_3}$ 0"	$\bar{x_0}x_1x_3$
$\bar{x_0}\bar{x_1}x_2\bar{x_3}$ 1	0 + 6 = $\bar{x_1}\bar{x_2}\bar{x_3}$ 1'	1' + 4' = $\bar{x_1}\bar{x_3}$ 1"	$\bar{x_0}x_2$
$\bar{x_0}\bar{x_1}x_2x_3$ 2	1 + 2 = $\bar{x_0}\bar{x_1}x_2$ 2'	2' + 7' = $\bar{x_0}x_2$ 2"	$\bar{x_1}\bar{x_3}$
$\bar{x_0}x_1\bar{x_2}x_3$ 3	1 + 4 = $\bar{x_0}x_2\bar{x_3}$ 3'	3' + 5' = $\bar{x_0}x_2$ 3"	$x_0\bar{x_1}\bar{x_2}$
$\bar{x_0}x_1x_2\bar{x_3}$ 4	1 + 8 = $\bar{x_1}x_2\bar{x_3}$ 4'		
$\bar{x_0}x_1x_2x_3$ 5	2 + 5 = $\bar{x_0}x_2x_3$ 5'		
$x_0\bar{x_1}\bar{x_2}\bar{x_3}$ 6	3 + 5 = $\bar{x_0}x_1x_3$ 6'		
$x_0\bar{x_1}\bar{x_2}x_3$ 7	4 + 5 = $\bar{x_0}x_1x_2$ 7'		
$x_0\bar{x_1}x_2\bar{x_3}$ 8	6 + 7 = $x_0\bar{x_1}\bar{x_2}$ 8'		
	6 + 8 = $x_0\bar{x_1}\bar{x_3}$ 9'		

$$y_a = \bar{x_0}x_1x_3 + \bar{x_0}x_2 + \bar{x_1}\bar{x_3} + x_0\bar{x_1}\bar{x_2}$$

$\bar{x_0}\bar{x_1}\bar{x_2}\bar{x_3}$ 0	0 + 1 = $\bar{x_0}\bar{x_1}\bar{x_2}$ 0'	0' + 6' = $\bar{x_0}\bar{x_1}$ 0"	$\bar{x_0}\bar{x_1}$
$\bar{x_0}\bar{x_1}\bar{x_2}x_3$ 1	0 + 2 = $\bar{x_0}\bar{x_1}\bar{x_3}$ 1'	0' + 9' = $\bar{x_1}\bar{x_2}$ 1"	$\bar{x_0}\bar{x_2}\bar{x_3}$
$\bar{x_0}\bar{x_1}x_2\bar{x_3}$ 2	0 + 4 = $\bar{x_0}\bar{x_2}\bar{x_3}$ 2'	1' + 4' = $\bar{x_0}\bar{x_1}$ 2"	$\bar{x_0}x_2x_3$
$\bar{x_0}\bar{x_1}x_2x_3$ 3	0 + 6 = $\bar{x_1}\bar{x_2}\bar{x_3}$ 3'	1' + 10' = $\bar{x_1}\bar{x_3}$ 3"	$\bar{x_1}\bar{x_2}$
$\bar{x_0}x_1\bar{x_2}\bar{x_3}$ 4	1 + 3 = $\bar{x_0}\bar{x_1}x_3$ 4'	3' + 5' = $\bar{x_1}\bar{x_2}$ 4"	$\bar{x_1}\bar{x_3}$
$\bar{x_0}x_1x_2x_3$ 5	1 + 7 = $\bar{x_1}\bar{x_2}x_3$ 5'	3' + 7' = $\bar{x_1}\bar{x_3}$ 5"	
$x_0\bar{x_1}\bar{x_2}\bar{x_3}$ 6	2 + 3 = $\bar{x_0}\bar{x_1}x_2$ 6'		
$x_0\bar{x_1}\bar{x_2}x_3$ 7	2 + 8 = $\bar{x_1}x_2\bar{x_3}$ 7'		
$x_0\bar{x_1}x_2\bar{x_3}$ 8	3 + 5 = $\bar{x_0}x_2x_3$ 8'		
	6 + 7 = $x_0\bar{x_1}\bar{x_2}$ 9'		
	6 + 8 = $x_0\bar{x_1}\bar{x_3}$ 10'		

$$y_b = \bar{x_0}\bar{x_1} + \bar{x_0}\bar{x_2}\bar{x_3} + \bar{x_0}x_2x_3 + \bar{x_1}\bar{x_2} + \bar{x_1}\bar{x_3}$$

$\bar{x}_0\bar{x}_1\bar{x}_2\bar{x}_3$ 0	0 + 1 = $\bar{x}_0\bar{x}_1\bar{x}_2$ 0'	0' + 7' = $\bar{x}_0\bar{x}_2$ 0"	$\bar{x}_0\bar{x}_2$
$\bar{x}_0\bar{x}_1\bar{x}_2x_3$ 1	0 + 3 = $\bar{x}_0\bar{x}_2\bar{x}_3$ 1'	0' + 11' = $\bar{x}_1\bar{x}_2$ 1"	$\bar{x}_0x_1$
$\bar{x}_0\bar{x}_1x_2x_3$ 2	0 + 7 = $\bar{x}_1\bar{x}_2\bar{x}_3$ 2'	1' + 4' = $\bar{x}_0\bar{x}_2$ 2"	$\bar{x}_0x_3$
$\bar{x}_0x_1\bar{x}_2\bar{x}_3$ 3	1 + 2 = $\bar{x}_0\bar{x}_1x_3$ 3'	2' + 5' = $\bar{x}_1\bar{x}_2$ 3"	$\bar{x}_1\bar{x}_2$
$\bar{x}_0x_1\bar{x}_2x_3$ 4	1 + 4 = $\bar{x}_0\bar{x}_2x_3$ 4'	3' + 9' = $\bar{x}_0x_3$ 4"	$x_0\bar{x}_1\bar{x}_3$
$\bar{x}_0x_1x_2\bar{x}_3$ 5	1 + 8 = $\bar{x}_1\bar{x}_2x_3$ 5'	4' + 6' = $\bar{x}_0x_3$ 5"	
$\bar{x}_0x_1x_2x_3$ 6	2 + 6 = $\bar{x}_0x_2x_3$ 6'	7' + 10' = $\bar{x}_0x_1$ 6"	
$x_0\bar{x}_1\bar{x}_2\bar{x}_3$ 7	3 + 4 = $\bar{x}_0x_1\bar{x}_2$ 7'	8' + 9' = $\bar{x}_0x_1$ 7"	
$x_0\bar{x}_1\bar{x}_2x_3$ 8	3 + 5 = $\bar{x}_0x_1\bar{x}_3$ 8'		
$x_0\bar{x}_1x_2\bar{x}_3$ 9	4 + 6 = $\bar{x}_0x_1x_3$ 9'		
	5 + 6 = $\bar{x}_0x_1x_2$ 10'		
	7 + 8 = $x_0\bar{x}_1\bar{x}_2$ 11'		
	7 + 9 = $x_0\bar{x}_1\bar{x}_3$ 12'		

$$y_c = \bar{x}_0\bar{x}_2 + \bar{x}_0x_1 + \bar{x}_0x_3 + \bar{x}_1\bar{x}_2 + x_0\bar{x}_1\bar{x}_3$$

$\bar{x}_0\bar{x}_1\bar{x}_2\bar{x}_3$ 0	0 + 1 = $\bar{x}_0\bar{x}_1\bar{x}_3$ 0'	$\bar{x}_0\bar{x}_1\bar{x}_3$
$\bar{x}_0\bar{x}_1x_2\bar{x}_3$ 1	0 + 5 = $\bar{x}_1\bar{x}_2\bar{x}_3$ 1'	$\bar{x}_0\bar{x}_1x_2$
$\bar{x}_0\bar{x}_1x_2x_3$ 2	1 + 2 = $\bar{x}_0\bar{x}_1x_2$ 2'	$\bar{x}_0x_2\bar{x}_3$
$\bar{x}_0x_1\bar{x}_2x_3$ 3	1 + 4 = $\bar{x}_0x_2\bar{x}_3$ 3'	$\bar{x}_1\bar{x}_2\bar{x}_3$
$\bar{x}_0x_1x_2\bar{x}_3$ 4	5 + 6 = $x_0\bar{x}_1\bar{x}_2$ 4'	$x_0\bar{x}_1\bar{x}_2$
$x_0\bar{x}_1\bar{x}_2\bar{x}_3$ 5		
$x_0\bar{x}_1\bar{x}_2x_3$ 6		

$$y_d = \bar{x}_0\bar{x}_1\bar{x}_3 + \bar{x}_0\bar{x}_1x_2 + \bar{x}_0x_2\bar{x}_3 + \bar{x}_1\bar{x}_2\bar{x}_3 + x_0\bar{x}_1\bar{x}_2$$

$\bar{x}_0\bar{x}_1\bar{x}_2\bar{x}_3$ 0	0 + 1 = $\bar{x}_0\bar{x}_1\bar{x}_3$ 0'	0' + 4' = $\bar{x}_1\bar{x}_3$ 0"	$\bar{x}_0x_2\bar{x}_3$
$\bar{x}_0\bar{x}_1x_2\bar{x}_3$ 1	0 + 3 = $\bar{x}_1\bar{x}_2\bar{x}_3$ 1'	1' + 3' = $\bar{x}_1\bar{x}_3$ 1"	$\bar{x}_1\bar{x}_3$
$\bar{x}_0x_1x_2\bar{x}_3$ 2	1 + 2 = $\bar{x}_0x_2\bar{x}_3$ 2'		
$x_0\bar{x}_1\bar{x}_2\bar{x}_3$ 3	1 + 4 = $\bar{x}_1x_2\bar{x}_3$ 3'		
$x_0\bar{x}_1x_2\bar{x}_3$ 4	3 + 4 = $x_0\bar{x}_1\bar{x}_3$ 4'		

$$y_e = \bar{x}_0x_2\bar{x}_3 + \bar{x}_1\bar{x}_3$$

$\bar{x}_0\bar{x}_1\bar{x}_2\bar{x}_3$ 0	$0 + 1 = \bar{x}_0\bar{x}_2\bar{x}_3$ 0'	$\bar{x}_0\bar{x}_2\bar{x}_3$
$\bar{x}_0x_1\bar{x}_2\bar{x}_3$ 1	$0 + 4 = \bar{x}_1\bar{x}_2\bar{x}_3$ 1'	$\bar{x}_0x_1\bar{x}_2$
$\bar{x}_0x_1\bar{x}_2x_3$ 2	$1 + 2 = \bar{x}_0x_1\bar{x}_2$ 2'	$\bar{x}_0x_1\bar{x}_3$
$\bar{x}_0x_1x_2\bar{x}_3$ 3	$1 + 3 = \bar{x}_0x_1\bar{x}_3$ 3'	$\bar{x}_1\bar{x}_2\bar{x}_3$
$x_0\bar{x}_1\bar{x}_2\bar{x}_3$ 4	$4 + 5 = x_0\bar{x}_1\bar{x}_2$ 4'	$x_0\bar{x}_1\bar{x}_2$
$x_0\bar{x}_1\bar{x}_2x_3$ 5	$4 + 6 = x_0\bar{x}_1\bar{x}_3$ 5'	$x_0\bar{x}_1\bar{x}_3$
$x_0\bar{x}_1x_2\bar{x}_3$ 6		

$$y_f = \bar{x}_0\bar{x}_2\bar{x}_3 + \bar{x}_0x_1\bar{x}_2 + \bar{x}_0x_1\bar{x}_3 + \bar{x}_1\bar{x}_2\bar{x}_3 + x_0\bar{x}_1\bar{x}_2 + x_0\bar{x}_1\bar{x}_3$$

$\bar{x}_0\bar{x}_1x_2\bar{x}_3$ 0	$0 + 1 = \bar{x}_0\bar{x}_1x_2$ 0'	$\bar{x}_0\bar{x}_1x_2$
$\bar{x}_0\bar{x}_1x_2x_3$ 1	$0 + 4 = \bar{x}_0x_2\bar{x}_3$ 1'	$\bar{x}_0x_1\bar{x}_2$
$\bar{x}_0x_1\bar{x}_2\bar{x}_3$ 2	$2 + 3 = \bar{x}_0x_1\bar{x}_2$ 2'	$\bar{x}_0x_1\bar{x}_3$
$\bar{x}_0x_1\bar{x}_2x_3$ 3	$2 + 4 = \bar{x}_0x_1\bar{x}_3$ 3'	$\bar{x}_0x_2\bar{x}_3$
$\bar{x}_0x_1x_2\bar{x}_3$ 4	$5 + 6 = x_0\bar{x}_1\bar{x}_2$ 4'	$x_0\bar{x}_1\bar{x}_2$
$x_0\bar{x}_1\bar{x}_2\bar{x}_3$ 5		
$x_0\bar{x}_1\bar{x}_2x_3$ 6		

$$y_g = \bar{x}_0\bar{x}_1x_2 + \bar{x}_0x_1\bar{x}_2 + \bar{x}_0x_1\bar{x}_3 + \bar{x}_0x_2\bar{x}_3 + x_0\bar{x}_1\bar{x}_2$$

СКНФ

Корректно сократить возможно только СКНФ для e, f и g.

$(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3)$ 0	0+1=$(x_0 \vee x_1 \vee \bar{x}_3)$ 0'	0'+5'=$(x_0 \vee \bar{x}_3)$ 0"	$(x_0 \vee \bar{x}_1 \vee x_2)$
$(x_0 \vee x_1 \vee \bar{x}_2 \vee \bar{x}_3)$ 1	0+3=$(x_0 \vee x_2 \vee \bar{x}_3)$ 1'	1'+3'=$(x_0 \vee \bar{x}_3)$ 1"	$(x_0 \vee \bar{x}_3)$
$(x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)$ 2	0+5=$(x_1 \vee x_2 \vee \bar{x}_3)$ 2'		$(x_1 \vee x_2 \vee \bar{x}_3)$
$(x_0 \vee \bar{x}_1 \vee x_2 \vee \bar{x}_3)$ 3	1+4=$(x_0 \vee \bar{x}_2 \vee \bar{x}_3)$ 3'		
$(x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)$ 4	2+3=$(x_0 \vee \bar{x}_1 \vee x_2)$ 4'		
$(\bar{x}_0 \vee x_1 \vee x_2 \vee \bar{x}_3)$ 5	3+4=$(x_0 \vee \bar{x}_1 \vee \bar{x}_3)$ 5'		

$$y_e = (x_0 \vee \bar{x}_1 \vee x_2) \cdot (x_0 \vee \bar{x}_3) \cdot (x_1 \vee x_2 \vee \bar{x}_3)$$

$(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3)$ 0	0+2=$(x_0 \vee x_1 \vee \bar{x}_3)$ 0'	$(x_0 \vee \bar{x}_2 \vee \bar{x}_3)$
$(x_0 \vee x_1 \vee \bar{x}_2 \vee x_3)$ 1	1+2=$(x_0 \vee x_1 \vee \bar{x}_2)$ 1'	$(x_0 \vee x_1 \vee \bar{x}_2)$
$(x_0 \vee x_1 \vee \bar{x}_2 \vee \bar{x}_3)$ 2	2+3=$(x_0 \vee \bar{x}_2 \vee \bar{x}_3)$ 2'	$(x_0 \vee x_1 \vee \bar{x}_3)$
$(x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)$ 3		

$$y_f = (x_0 \vee \bar{x_2} \vee \bar{x_3}) \cdot (x_0 \vee x_1 \vee \bar{x_2}) \cdot (x_0 \vee x_1 \vee \bar{x_3})$$

$(x_0 \vee x_1 \vee x_2 \vee x_3)$ 0	0+1=$(x_0 \vee x_1 \vee x_2)$ 0'	$(x_0 \vee x_1 \vee x_2)$
$(x_0 \vee x_1 \vee x_2 \vee \bar{x_3})$ 1		$(x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3})$
$(x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3})$ 2		$(\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$
$(\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$ 3		

$$y_g = (x_0 \vee x_1 \vee x_2) \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee \bar{x_3}) \cdot (\bar{x_0} \vee x_1 \vee \bar{x_2} \vee x_3)$$

1.3 Перевод полученных выражений к базису 2И-НЕ/2ИЛИ-НЕ

При переводе в базис к изначальному алгебраическому уравнению применяется двойное отрицание, после чего используются законы де Морагана:

$$\overline{a \cdot b} = \bar{a} \vee \bar{b}$$
$$\overline{a \vee b} = \bar{a} \cdot \bar{b}$$

Чтобы не загромождать запись двойными отрицаниями, они будут опускаться после того, как будет показано их применение, то есть:

$$\overline{\overline{A \vee B \vee C \vee D}} = |\text{убрали из записи}| = \overline{\bar{A} \cdot \bar{B} \cdot \bar{C} \cdot \bar{D}}$$

1.3.1 2И-НЕ

$$y_a^{\text{ДНФ}} = \overline{\overline{\bar{x_0}x_2 \vee \bar{x_1}\bar{x_3} \vee x_0\bar{x_1}\bar{x_2} \vee \bar{x_0}x_1x_2}} =$$
$$= \overline{\overline{\bar{x_0}x_2} \cdot \overline{\bar{x_0}\bar{x_3}} \cdot \overline{x_0\bar{x_1}\bar{x_2}} \cdot \overline{\bar{x_0}x_1x_2}}$$
$$y_a^{\text{КНФ}} = \overline{\overline{\overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x_3})} \cdot (x_0 \vee \bar{x_1} \vee x_2 \vee x_3)}}} =$$
$$= \overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x_3})} \cdot \overline{(x_0 \vee \bar{x_1} \vee x_2 \vee x_3)}} =$$
$$= \overline{\bar{x_0}\bar{x_1}\bar{x_2}x_3} \cdot \overline{\bar{x_0}x_1\bar{x_2}\bar{x_3}}$$
$$y_b^{\text{ДНФ}} = \overline{\overline{\bar{x_1}x_2\bar{x_3} \vee \bar{x_0}x_2x_3 \vee \bar{x_0}\bar{x_1}x_3 \vee \bar{x_0}\bar{x_2}\bar{x_3} \vee x_0\bar{x_1}\bar{x_3}}} =$$
$$= \overline{\overline{\bar{x_1}x_2\bar{x_3}} \cdot \overline{\bar{x_0}x_2x_3} \cdot \overline{\bar{x_0}\bar{x_1}x_3} \cdot \overline{\bar{x_0}\bar{x_2}\bar{x_3}} \cdot \overline{x_0\bar{x_1}\bar{x_3}}}$$
$$y_b^{\text{КНФ}} = \overline{\overline{\overline{\overline{(x_0 \vee \bar{x_1} \vee x_2\bar{x_3})} \cdot (x_0 \vee \bar{x_1} \vee \bar{x_2} \vee x_3)}}} =$$
$$= \overline{\overline{(x_0 \vee \bar{x_1} \vee x_2\bar{x_3})} \cdot \overline{(x_0 \vee \bar{x_1} \vee \bar{x_2} \vee x_3)}} =$$
$$= \overline{\bar{x_0}x_1\bar{x_2}x_3} \cdot \overline{\bar{x_0}x_1x_2\bar{x_3}}$$
$$y_c^{\text{ДНФ}} = \overline{\overline{\bar{x_0}\bar{x_2} \vee x_0\bar{x_1}\bar{x_2} \vee x_0\bar{x_1}\bar{x_3} \vee \bar{x_0}x_2x_3 \vee \bar{x_0}x_1x_2}} =$$

$$= \overline{\overline{\bar{x}_0\bar{x}_2} \cdot \overline{x_0\bar{x}_1\bar{x}_2} \cdot \overline{x_0\bar{x}_1\bar{x}_3} \cdot \overline{\bar{x}_0x_2x_3} \cdot \overline{\bar{x}_0x_1x_2}}$$

$$y_c^{\text{КНФ}} = \overline{\overline{(x_0 \vee x_1 \vee \bar{x}_2 \vee x_3)}} = \overline{\bar{x}_0\bar{x}_1x_2\bar{x}_3}$$

$$y_d^{\text{ДНФ}} = \overline{\overline{x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0\bar{x}_1x_2 \vee \bar{x}_0x_2\bar{x}_3 \vee \bar{x}_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_1\bar{x}_2x_3}} =$$

$$\overline{\overline{x_0\bar{x}_1\bar{x}_2} \vee \overline{\bar{x}_0\bar{x}_1x_2} \vee \overline{\bar{x}_0x_2\bar{x}_3} \vee \overline{\bar{x}_0\bar{x}_1\bar{x}_3} \vee \overline{\bar{x}_0x_1\bar{x}_2x_3}}$$

$$y_d^{\text{КНФ}} =$$

$$\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3)} \cdot (x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)} \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)} \cdot (\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)} =}}}}}}}}$$

$$\overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3)} \cdot \overline{(x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)} \cdot \overline{(x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)} \cdot \overline{(\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)} =$$

$$= \overline{\bar{x}_0\bar{x}_1\bar{x}_2x_3} \cdot \overline{\bar{x}_0x_1\bar{x}_2\bar{x}_3} \cdot \overline{\bar{x}_0x_1x_2x_3} \cdot \overline{x_0\bar{x}_1x_2\bar{x}_3}$$

$$y_e^{\text{ДНФ}} = \overline{\overline{\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_2\bar{x}_3}} = \overline{\overline{\bar{x}_1\bar{x}_3} \cdot \overline{\bar{x}_0x_2\bar{x}_3}}$$

$$y_e^{\text{КНФ}} = \overline{\overline{\overline{(x_0 \vee \bar{x}_3) \vee (x_0 \vee \bar{x}_1 \vee x_2)} \cdot (x_1 \vee x_2 \vee \bar{x}_3)} =}$$

$$= \overline{\overline{(x_0 \vee \bar{x}_3)}} \cdot \overline{\overline{(x_0 \vee \bar{x}_1 \vee x_2)}} \cdot \overline{\overline{(x_1 \vee x_2 \vee \bar{x}_3)}} =$$

$$= \overline{\bar{x}_0x_3} \cdot \overline{\bar{x}_0x_1\bar{x}_2} \cdot \overline{\bar{x}_1\bar{x}_2x_3}$$

$$y_f^{\text{ДНФ}} = \overline{\overline{x_0\bar{x}_1\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0\bar{x}_2\bar{x}_3 \vee \bar{x}_0x_1x_2 \vee \bar{x}_0x_1\bar{x}_2}} =$$

$$= \overline{\overline{x_0\bar{x}_1\bar{x}_3} \vee \overline{x_0\bar{x}_1\bar{x}_2} \vee \overline{\bar{x}_0\bar{x}_2\bar{x}_3} \vee \overline{\bar{x}_0x_1x_3} \vee \overline{\bar{x}_0x_1\bar{x}_2}}$$

$$y_f^{\text{КНФ}} = \overline{\overline{\overline{(x_0 \vee x_1 \vee \bar{x}_2) \cdot (x_0 \vee \bar{x}_2 \vee \bar{x}_3)} \cdot (x_0 \vee x_1 \vee \bar{x}_3)} =}$$

$$= \overline{\overline{(x_0 \vee x_1 \vee \bar{x}_2)}} \cdot \overline{\overline{(x_0 \vee \bar{x}_2 \vee \bar{x}_3)}} \cdot \overline{\overline{(x_0 \vee x_1 \vee \bar{x}_3)}} = \overline{\bar{x}_0\bar{x}_1x_2} \cdot \overline{\bar{x}_0x_2x_3} \cdot \overline{\bar{x}_0\bar{x}_1\bar{x}_3}$$

$$y_g^{\text{ДНФ}} = \overline{\overline{x_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0\bar{x}_1x_2 \vee \bar{x}_0x_1\bar{x}_3 \vee \bar{x}_0x_1\bar{x}_2}} = \overline{\overline{x_0\bar{x}_1\bar{x}_3} \cdot \overline{\bar{x}_0\bar{x}_1x_2} \cdot \overline{\bar{x}_0x_1\bar{x}_3} \cdot \overline{\bar{x}_0x_1\bar{x}_2}}$$

$$y_g^{\text{КНФ}} = \overline{\overline{\overline{\overline{(x_0 \vee x_1 \vee x_2) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)} \cdot (\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)} =}}}$$

$$= \overline{\overline{(x_0 \vee x_1 \vee x_2)}} \cdot \overline{\overline{(x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)}} \cdot \overline{\overline{(\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)}} =$$

$$= \overline{\bar{x}_0\bar{x}_1\bar{x}_2} \cdot \overline{\bar{x}_0x_1x_2x_3} \cdot \overline{x_0\bar{x}_1x_2\bar{x}_3}$$

1.3.2 2ИЛИ-НЕ

$$y_a^{\text{ДНФ}} = \overline{\overline{\overline{\overline{\bar{x}_0x_2 \vee \bar{x}_1\bar{x}_3} \vee \overline{x_0\bar{x}_1\bar{x}_2 \vee \bar{x}_0x_1x_3}}}} = \overline{\overline{\bar{x}_0x_2} \vee \overline{\bar{x}_1\bar{x}_3} \vee \overline{x_0\bar{x}_1\bar{x}_2} \vee \overline{\bar{x}_0x_1x_3}} =$$

$$= \overline{x_0 \vee \bar{x}_2} \vee \overline{x_1 \vee x_3} \vee \overline{\bar{x}_0 \vee x_1 \vee x_2} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_3}$$

$$y_a^{\text{КНФ}} = \overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee x_2 \vee x_3)}} =$$

$$= \overline{\overline{x_0 \vee x_1 \vee x_2 \vee \bar{x}_3} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2 \vee x_3}}$$

$$y_b^{\text{ДНФ}} = \overline{\overline{\overline{\overline{x_1x_2\bar{x}_3 \vee \bar{x}_0x_2x_3}} \vee \overline{\overline{\overline{\overline{\bar{x}_0\bar{x}_1x_3 \vee \bar{x}_0\bar{x}_2\bar{x}_3}} \vee x_0\bar{x}_1\bar{x}_3}}}} =$$

$$= \overline{\overline{\bar{x}_1x_2x_3}} \vee \overline{\overline{\bar{x}_0x_2x_3}} \vee \overline{\overline{\bar{x}_0\bar{x}_1x_3}} \vee \overline{\overline{\bar{x}_0\bar{x}_2\bar{x}_3}} \vee \overline{\overline{x_0\bar{x}_1\bar{x}_3}} =$$

$$= \overline{x_1 \vee \bar{x}_2 \vee x_3} \vee \overline{x_0 \vee \bar{x}_2 \vee \bar{x}_3} \vee \overline{x_0 \vee x_1 \vee \bar{x}_3} \vee \overline{x_0 \vee x_2 \vee x_3} \vee \overline{\bar{x}_0 \vee x_1 \vee x_3}$$

$$y_b^{\text{КНФ}} = \overline{\overline{(x_0 \vee \bar{x}_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee x_3)}}$$

$$= \overline{\overline{x_0 \vee \bar{x}_1 \vee x_2 \vee \bar{x}_3} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee x_3}}$$

$$y_c^{\text{ДНФ}} = \overline{\overline{\overline{\overline{\bar{x}_0\bar{x}_2 \vee x_0\bar{x}_1\bar{x}_2}} \vee \overline{\overline{\overline{\overline{x_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_2x_3}} \vee \bar{x}_0x_1x_2}}}} =$$

$$= \overline{\overline{\bar{x}_0\bar{x}_2}} \vee \overline{\overline{x_0\bar{x}_1\bar{x}_2}} \vee \overline{\overline{x_0\bar{x}_1\bar{x}_3}} \vee \overline{\overline{\bar{x}_0x_2x_3}} \vee \overline{\overline{\bar{x}_0x_1x_2}} =$$

$$= \overline{x_0 \vee x_2} \vee \overline{\bar{x}_0 \vee x_1 \vee x_2} \vee \overline{\bar{x}_0 \vee x_1 \vee x_3} \vee \overline{x_0 \vee \bar{x}_2 \vee \bar{x}_3} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_2}$$

$$y_c^{\text{КНФ}} = \overline{\overline{x_0 \vee x_1 \vee \bar{x}_2 \vee x_3}}$$

$$y_d^{\text{ДНФ}} = \overline{\overline{\overline{\overline{x_0\bar{x}_1\bar{x}_2} \vee \overline{\bar{x}_0\bar{x}_1x_2}} \vee \overline{\overline{\overline{\overline{\bar{x}_0x_2\bar{x}_3} \vee \overline{\bar{x}_0\bar{x}_1\bar{x}_3}} \vee \bar{x}_0x_1\bar{x}_2x_3}}}} =$$

$$= \overline{\overline{x_0\bar{x}_1\bar{x}_2}} \vee \overline{\overline{\bar{x}_0\bar{x}_1x_2}} \vee \overline{\overline{\bar{x}_0x_2\bar{x}_3}} \vee \overline{\overline{\bar{x}_0\bar{x}_1\bar{x}_3}} \vee \overline{\overline{\bar{x}_0x_1\bar{x}_2x_3}}$$

$$= \overline{\bar{x}_0 \vee x_1 \vee x_2} \vee \overline{x_0 \vee x_1 \vee \bar{x}_2} \vee \overline{x_0 \vee \bar{x}_2 \vee x_3} \vee \overline{x_0 \vee x_1 \vee x_3} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2 \vee \bar{x}_3}$$

$$y_d^{\text{КНФ}} =$$

$$\overline{\overline{(x_0 \vee x_1 \vee x_2 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee x_2 \vee x_3) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3) \cdot (\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)}} =$$

$$= \overline{\overline{x_0 \vee x_1 \vee x_2 \vee \bar{x}_3}} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2 \vee x_3} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3} \vee \overline{\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3}$$

$$y_e^{\text{ДНФ}} = \overline{\overline{\bar{x}_1\bar{x}_3 \vee \bar{x}_0x_2\bar{x}_3}} = \overline{\overline{\bar{x}_1\bar{x}_3}} \vee \overline{\overline{\bar{x}_0x_2\bar{x}_3}} = \overline{x_1 \vee x_3} \vee \overline{x_0 \vee \bar{x}_2 \vee x_3}$$

$$y_e^{\text{КНФ}} = \overline{\overline{(x_0 \vee \bar{x}_3) \cdot (x_0 \vee \bar{x}_1 \vee x_2) \cdot (x_1 \vee x_2 \vee \bar{x}_3)}}$$

$$= \overline{\overline{x_0 \vee \bar{x}_3}} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2} \vee \overline{x_1 \vee x_2 \vee \bar{x}_3}$$

$$y_f^{\text{ДНФ}} = \overline{\overline{\overline{\overline{x_0\bar{x}_1\bar{x}_3 \vee x_0\bar{x}_1\bar{x}_2}} \vee \overline{\overline{\overline{\overline{\bar{x}_0\bar{x}_2\bar{x}_3 \vee \bar{x}_0x_1x_3}} \vee \bar{x}_0x_1\bar{x}_2}}}} =$$

$$= \overline{\overline{x_0\bar{x}_1\bar{x}_3}} \vee \overline{\overline{x_0\bar{x}_1\bar{x}_2}} \vee \overline{\overline{\bar{x}_0\bar{x}_2\bar{x}_3}} \vee \overline{\overline{\bar{x}_0x_1x_3}} \vee \overline{\overline{\bar{x}_0x_1\bar{x}_2}}$$

$$= \overline{\bar{x}_0 \vee x_1 \vee x_3} \vee \overline{\bar{x}_0 \vee x_1 \vee x_2} \vee \overline{x_0 \vee x_2 \vee x_3} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_3} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2}$$

$$y_f^{\text{КНФ}} = \overline{\overline{(x_0 \vee x_1 \vee \bar{x}_2) \cdot (x_0 \vee \bar{x}_2 \vee \bar{x}_3) \cdot (x_0 \vee x_1 \vee \bar{x}_3)}}$$

$$= \overline{\overline{x_0 \vee x_1 \vee \bar{x}_2}} \vee \overline{x_0 \vee \bar{x}_2 \vee \bar{x}_3} \vee \overline{x_0 \vee x_1 \vee \bar{x}_3}$$

$$y_g^{\text{ДНФ}} = \overline{\overline{\overline{\overline{\bar{x}_0\bar{x}_1\bar{x}_3 \vee \bar{x}_0\bar{x}_1x_2}} \vee \overline{\overline{\bar{x}_0x_1\bar{x}_3 \vee \bar{x}_0x_1\bar{x}_2}}}} = \overline{\overline{\bar{x}_0\bar{x}_1\bar{x}_3}} \vee \overline{\overline{\bar{x}_0\bar{x}_1x_2}} \vee \overline{\overline{\bar{x}_0x_1\bar{x}_3}} \vee \overline{\overline{\bar{x}_0x_1\bar{x}_2}}$$

$$= \overline{x_0 \vee x_1 \vee x_3} \vee \overline{x_0 \vee x_1 \vee \bar{x}_2} \vee \overline{x_0 \vee \bar{x}_1 \vee x_3} \vee \overline{x_0 \vee \bar{x}_1 \vee x_2}$$

$$y_g^{\text{КНФ}} = \overline{\overline{(x_0 \vee x_1 \vee x_2) \cdot (x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3) \cdot (\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3)}}$$

$$= \overline{\overline{x_0 \vee x_1 \vee x_2}} \vee \overline{x_0 \vee \bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3} \vee \overline{\bar{x}_0 \vee x_1 \vee \bar{x}_2 \vee x_3}$$

1.4 Цифровая схема

2 xxx