Факультет программной инженерии и компьютерной техники

Дискретная математика

Курсовая работа «Синтез комбинционных схем»

Часть №1 - Вариант 15

Часть №2 – Вариант 32

Преподаватель: Поляков Владимир Иванович

Выполнил: Кульбако Артемий Юрьевич

Р3112

Санкт-Петербург

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# Составление таблицу истинности:

Cоставим таблицу истинности для функции , которая принимает значение 1 при условии 2≤||≤5 и неопределённое значение на наборах, для которых ||=0.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| № |  |  |  |  |  | |-| |  |
| 1 | 0 0 0 0 0 | 000 | 0 | 00 | 0 | 0 | d |
| 2 | 0 0 0 0 1 | 010 | 2 | 00 | 0 | 2 | 1 |
| 3 | 0 0 0 1 0 | 100 | 4 | 00 | 0 | 4 | 1 |
| 4 | 0 0 0 1 1 | 110 | 6 | 00 | 0 | 6 | 0 |
| 5 | 0 0 1 0 0 | 000 | 0 | 01 | 1 | 1 | 0 |
| 6 | 0 0 1 0 1 | 010 | 2 | 01 | 1 | 1 | 0 |
| 7 | 0 0 1 1 0 | 100 | 4 | 01 | 1 | 3 | 1 |
| 8 | 0 0 1 1 1 | 110 | 6 | 01 | 1 | 5 | 1 |
| 9 | 0 1 0 0 0 | 000 | 0 | 10 | 2 | 2 | 1 |
| 10 | 0 1 0 0 1 | 010 | 2 | 10 | 2 | 0 | d |
| 11 | 0 1 0 1 0 | 100 | 4 | 10 | 2 | 2 | 1 |
| 12 | 0 1 0 1 1 | 110 | 6 | 10 | 2 | 4 | 1 |
| 13 | 0 1 1 0 0 | 000 | 0 | 11 | 3 | 3 | 1 |
| 14 | 0 1 1 0 1 | 010 | 2 | 11 | 3 | 1 | 0 |
| 15 | 0 1 1 1 0 | 100 | 4 | 11 | 3 | 1 | 0 |
| 16 | 0 1 1 1 1 | 110 | 6 | 11 | 3 | 3 | 1 |
| 17 | 1 0 0 0 0 | 001 | 1 | 00 | 0 | 1 | 0 |
| 18 | 1 0 0 0 1 | 011 | 3 | 00 | 0 | 3 | 1 |
| 19 | 1 0 0 1 0 | 101 | 5 | 00 | 0 | 5 | 1 |
| 20 | 1 0 0 1 1 | 111 | 7 | 00 | 0 | 7 | 0 |
| 21 | 1 0 1 0 0 | 001 | 1 | 01 | 1 | 0 | d |
| 22 | 1 0 1 0 1 | 011 | 3 | 01 | 1 | 2 | 1 |
| 23 | 1 0 1 1 0 | 101 | 5 | 01 | 1 | 4 | 1 |
| 24 | 1 0 1 1 1 | 111 | 7 | 01 | 1 | 6 | 0 |
| 25 | 1 1 0 0 0 | 001 | 1 | 10 | 2 | 1 | 0 |
| 26 | 1 1 0 0 1 | 011 | 3 | 10 | 2 | 1 | 0 |
| 27 | 1 1 0 1 0 | 101 | 5 | 10 | 2 | 3 | 1 |
| 28 | 1 1 0 1 1 | 111 | 7 | 10 | 2 | 5 | 1 |
| 29 | 1 1 1 0 0 | 001 | 1 | 11 | 3 | 2 | 1 |
| 30 | 1 1 1 0 1 | 011 | 3 | 11 | 3 | 0 | d |
| 31 | 1 1 1 1 0 | 101 | 5 | 11 | 3 | 2 | 1 |
| 32 | 1 1 1 1 1 | 111 | 7 | 11 | 3 | 4 | 1 |

# Представление функции в аналитическом виде:

КДНФ: *ƒ* =1234x5 v 123x45 v 12x3x45 v 12x3x4x5 v 1x2345 v 1x23x45 v 1x23x4x5 v 1x2x345 v 1x2x3x4x5 v x1234x5 v x123x45 v x12x34x5 v x12x3x45 v x1x23x45 v x1x23x4x5 v x1x2x345 v x1x2x3x45 v x1x2x3x4x5

ККНФ: *ƒ* =(x1 v x2 v x3 v 4 v 5)(x1 v x2 v 3 v x4 v x5)(x1 v x2 v 3 v x4 v 5)(x1 v 2 v 3 v x4 v 5)(x1 v 2 v 3 v 4 v x5)(1 v x2 v x3 v x4 v x5)(1 v x2 v x3 v 4 v 5)(1 v x2 v 3 v 4 v 5)(1 v 2 v x3 v x4 v x5)(1 v 2 v x3 v x4 v 5)

# Минимизация функции методом Квайна-Мак-Класки (импликанты):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Ko(ƒ) N(ƒ)* | | *K1(ƒ)* | | *K2(ƒ)* | | *Z(f)* | |
| 1 | 00000 + | 1 | 0000x (1-2) + | 1 | 0x00x (1-9) (3-4) | 1 | x0001 |
| 2 | 00001 + | 2 | 000x0 (1-3) + | 2 | 0x0x0 (2-10) (3-7) | 2 | 0011x |
| 3 | 00010 + | 3 | 0x000 (1-4) + | 3 | x0x10 (6-19) (8-13) | 3 | 0x111 |
| 4 | 01000 + | 4 | 0x001 (2-6) + | 4 | xx010 (7-20) (8-16) | 4 | 01x00 |
| 5 | 00110 + | 5 | x0001 (2-9) | 5 | 010xx (9-15) (10-14) | 5 | x1100 |
| 6 | 01001 + | 6 | 00x10 (3-5) + | 6 | x101x (15-29) (16-26) | 6 | 10x01 |
| 7 | 01010 + | 7 | 0x010 (3-7) + | 7 | 1xx10 (19-30) (20-28) | 7 | 0x00x |
| 8 | 01100 + | 8 | x0010 (3-10) + | 8 | 1x10x (21-31) (23-27) | 8 | 0x0x0 |
| 9 | 10001 + | 9 | 0100x (4-6) + | 9 | 1x1x0 (22-32) (23-28) | 9 | x0x10 |
| 10 | 10010 + | 10 | 010x0(4-7) + | 10 | x1x11 (25-34) (26-33) | 10 | xx010 |
| 11 | 10100 + | 11 | 01x00(4-8) | 11 | 11x1x (29-36) (30-34) | 11 | 010xx |
| 12 | 00111 + | 12 | 0011x (5-12) | 12 | 111xx (31-36) (32-35) | 12 | x101x |
| 13 | 01011 + | 13 | x0110 (5-15) + |  |  | 13 | x1x11 |
| 14 | 10101 + | 14 | 010x1 (6-13) + |  |  | 14 | 1xx10 |
| 15 | 10110 + | 15 | 0101x (7-13) + |  |  | 15 | 1x10x |
| 16 | 11010 + | 16 | x1010 (7-16) + |  |  | 16 | 1x1x0 |
| 17 | 11100 + | 17 | x1100 (8-17) |  |  | 17 | 11x1x |
| 18 | 01111 + | 18 | 10x01 (9-14) |  |  | 18 | 111xx |
| 19 | 11011 + | 19 | 10x10 (10-15) + |  |  |  |  |
| 20 | 11101 + | 20 | 1x010 (10-16) + |  |  |  |  |
| 21 | 11110 + | 21 | 1010x (11-14) + |  |  |  |  |
| 22 | 11111 + | 22 | 101x0 (11-15) + |  |  |  |  |
|  |  | 23 | 1x100 (11-17) + |  |  |  |  |
|  |  | 24 | 0x111 (12-18) |  |  |  |  |
|  |  | 25 | 01x11 (13-18) + |  |  |  |  |
|  |  | 26 | x1011 (13-19) + |  |  |  |  |
|  |  | 27 | 1x101 (14-20) + |  |  |  |  |
|  |  | 28 | 1x110 (15-21) + |  |  |  |  |
|  |  | 29 | 1101x (16-19) + |  |  |  |  |
|  |  | 30 | 11x10 (16-21) + |  |  |  |  |
|  |  | 31 | 1110x (17-20) + |  |  |  |  |
|  |  | 32 | 111x0 (17-21) + |  |  |  |  |
|  |  | 33 | x1111 (18-22) + |  |  |  |  |
|  |  | 34 | 11x11 (19-22) + |  |  |  |  |
|  |  | 35 | 111x1 (20-22) + |  |  |  |  |
|  |  | 36 | 1111x (21-22) + |  |  |  |  |

## Составляем импликантную таблицу:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0-кубы | | | | | | | | | | | | | | | | | |
| Импликанты | 00001 | 00010 | 00110 | 00111 | 01000 | 01010 | 01011 | 01100 | 01111 | 10001 | 10010 | 10101 | 10110 | 11010 | 11011 | 11100 | 11110 | 11111 |
| x0001 | + |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |
| 01x00 |  |  |  |  | + |  |  | + |  |  |  |  |  |  |  |  |  |  |
| 0011x |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| x1100 |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |  |  |
| 10x01 |  |  |  |  |  |  |  |  |  | + |  | + |  |  |  |  |  |  |
| 0x111 |  |  |  | + |  |  |  |  | + |  |  |  |  |  |  |  |  |  |
| 0x00x | + |  |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0x0x0 |  | + |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |
| x0x10 |  | + | + |  |  |  |  |  |  |  | + |  | + |  |  |  |  |  |
| xx010 |  | + |  |  |  | + |  |  |  |  | + |  |  | + |  |  |  |  |
| 010xx |  |  |  |  | + | + | + |  |  |  |  |  |  |  |  |  |  |  |
| x101x |  |  |  |  |  | + | + |  |  |  |  |  |  | + | + |  |  |  |
| 1xx10 |  |  |  |  |  |  |  |  |  |  | + |  | + | + |  |  | + |  |
| 1x10x |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  | + |  |  |
| 1x1x0 |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  | + | + |  |
| x1x11 |  |  |  |  |  |  | + |  | + |  |  |  |  |  |  |  |  | + |
| 11x1x |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + |  | + | + |
| 111xx |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + |

Т.к. строки не вычёркиваются, будет работать не с импликантами, а имплицентами.

# Минимизация функции методом Квайна-Мак-Класки (имплиценты):

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Ko(ƒ) N(ƒ)* | | *K1(ƒ)* | | *K2(ƒ)* | | *Z(f)* | |
| 1 | 00000 + | 1 | 00x00 (1-3) + | 1 | x0x00 (1-10) | 1 | 01110 |
| 2 | 00100 + | 2 | x0000 (1-8) + | 2 | X1x01 (7-14) | 2 | x0011 |
| 3 | 10000 + | 3 | 0010x (3-4) |  |  | 3 | 0010x |
| 4 | 00011 + | 4 | x0100 (3-10) + |  |  | 4 | 0x101 |
| 5 | 00101 + | 5 | 10x00 (8-10) + |  |  | 5 | 1x000 |
| 6 | 01001 + | 6 | 1x000 (8-12) |  |  | 6 | 10x11 |
| 7 | 10100 + | 7 | x0011 (2-9) |  |  | 7 | 1100x |
| 8 | 11000 + | 8 | 0x101 (4-6) |  |  | 8 | X0x00 |
| 9 | 01101 + | 9 | 01x01 (5-6) + |  |  | 9 | X1x01 |
| 10 | 01110 | 10 | x1001 (5-13) + |  |  |  |  |
| 11 | 10011 + | 11 | 1100x (12-13) |  |  |  |  |
| 12 | 11001 + | 12 | x1101 (6-14) + |  |  |  |  |
| 13 | 10111 + | 13 | 10x11 (9-11) |  |  |  |  |
| 14 | 11101 + | 14 | 11x01 (13-14) + |  |  |  |  |

## Составляем имплицентную таблицу:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1-кубы | | | | | | | | | |
| Имплиценты | 00011 | 00100 | 00101 | 01101 | 01110 | 10000 | 10011 | 10111 | 11000 | 11001 |
| 01110 |  |  |  |  | + |  |  |  |  |  |
| x0011 | + |  |  |  |  |  | + |  |  |  |
| 0010x |  | + | + |  |  |  |  |  |  |  |
| 0x101 |  |  | + | + |  |  |  |  |  |  |
| 1x000 |  |  |  |  |  | + |  |  | + |  |
| 10x11 |  |  |  |  |  |  | + | + |  |  |
| 1100x |  |  |  |  |  |  |  |  | + | + |
| x0x00 |  | + |  |  |  | + |  |  |  |  |
| x1x01 |  |  |  | + |  |  |  |  |  | + |

## Приведённая имплицентная таблица:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Имплиценты |  | 00100 | 00101 | 01101 | 10000 | 11000 | 11001 |
|  | ## | a | b | c | d | e | f |
| 0010x | A | + | + |  |  |  |  |
| 0x101 | B |  | + | + |  |  |  |
| 1x000 | C |  |  |  | + | + |  |
| 1100x | D |  |  |  |  | + | + |
| x0x00 | E | + |  |  | + |  |  |
| x1x01 | F |  |  | + |  |  | + |

## Определим минимальное покрытие методом Петрика:

Z=(AvE)(AvB)(BvF)(CvE)(CvD)(DvF)

Возможные варианты покрытия:

C1= C2= C3= C4= C5=

Cmin1(f)= S1a=11, S1b=14 Cmin2(f)= S2a=11, S1b=14

Будем использовать первый вариант.

МКНФ: *ƒ* =(2 v 3 v 4 v x5)(1 vx2 v x3 vx4 v 5)(1 v 2 vx4 v 5)(1 vx3 v 4 v 5)(x1 v x2 v 3 v 4)(2 v 4 v 5)

Преобразуем:

МДНФ: *ƒ* =(234x5)v(1x3x4x5)v(1x245)v(x2x45)v(x23x4)v(x1x34)v(x1x2x3)

# Минимизация функции на картах Карно:

## Нулевые покрытия:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | X4X5 | | | |  |  |  | X4X5 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| X2X3 | 00 | d |  | 0 |  |  | X2X3 | 00 | 0 |  | 0 |  |
| 01 | 0 | 0 |  |  |  | 01 | d |  | 0 |  |
| 11 |  | 0 |  | 0 |  | 11 |  | d |  |  |
| 10 |  | d |  |  |  | 10 | 0 | 0 |  |  |

**X1=0 X1=1**

Cmin(f)= S1a=11, S1b=14

МКНФ: *ƒ* =(2 v 3 v 4 v x5)(1 vx2 v x3 vx4 v 5)(1 v 2 vx4 v 5)(1 vx3 v 4 v 5)(x1 v x2 v 3 v 4)(2 v 4 v 5)

## Единичные покрытия:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | X4X5 | | | |  |  |  | X4X5 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| X2X3 | 00 | d | 1 |  | 1 |  | X2X3 | 00 | 1 | 1 |  | 1 |
| 01 |  |  | 1 | 1 |  | 01 | d | 1 |  | 1 |
| 11 | 1 |  | 1 |  |  | 11 | 1 | d | 1 | 1 |
| 10 | 1 | d | 1 | 1 |  | 10 |  |  | 1 | 1 |

**X1=0 X1=1**

Cmin(f)= S1a=24, S1b=31

МДНФ: *ƒ* =(234x5)v(1x3x4x5)v(1x245)v(x2x45)v(x23x4)v(x1x34)v(x1x2x3)

# Преобразование минимальных форм булевой функции:

## Факторизация МДНФ:

МДНФ: *ƒ* =(234x5)v(1x3x4x5)v(1x245)v(x2x45)v(x23x4)v(x1x34)v(x1x2x3)

Sq=31

Факторизация: *ƒ* =1(x3x4x5 v x245) v x2(x4(5 v 3)) v x1(x3(4 v x2)) v (234x5)

Sq=31 ΔSq=0 Факторизация не целесообразна. Можно ввести вспомогательную функцию ϕ=(5 v 3), и её отрицание =(x3x5), но это увеличит задержку.

## Факторизация МКНФ:

МКНФ: *ƒ* =(2 v 3 v 4 v x5)(1 vx2 v x3 vx4 v 5)(1 v 2 vx4 v 5)(1 vx3 v 4 v 5)(x1 v x2 v 3 v 4)(2 v 4 v 5)

Sq=30

Факторизация: *ƒ* =(4 v ((2 v 5)(x1 v x2 v 3)(1 v x3 v 5)))(x4 v ((2 v 5) v (3(1 v x2 v x3 v 5)1)))

Sq=30 ΔSq=0 Факторизация также не целесообразна.

# Построение комбинационных схем:

МКНФ: *ƒ* =(2 v 3 v 4 v x5)(1 vx2 v x3 vx4 v 5)(1 v 2 vx4 v 5)(1 vx3 v 4 v 5)(x1 v x2 v 3 v 4)(2 v 4 v 5)

## Построение схемы в булевом базисе с парафазными входами:

1 2 x4 x5

1 x34 x5

1

1

1

1 x2 x3 x45

2 34 x5

1

&

1 x234

1

245

1

Задержка схемы с парафазными входами: T = 2τ.

Цена схемы с парафазными входами: Sq=30.

## Построение схемы в булевом базисе с однофазными входами:

&

1

12

1

1

5

3

1

45

1

1

234

2

1

3

1

4

1

5

1

45

1

1

1

Задержка схемы с однофазными входами: T = 3τ.

Цена схемы с однофазными входами: Sq=35.

# Синтез комбинационных схем в универсальных базисах:

Построение схемы в сокращённом базисе или-не:

Заменим операции булева базиса на операцию стрелка Пирса:

*ƒ* =(2  3  4  x5) (1 x2  x3 x4 5) (1 2 x4 5) (1 x3 4 5)(x1  x2 3 4)(2  4  5)

1 2 x4 x5

1 x34 x5

1

1

1

1 x2 x3 x45

2 34 x5

1

1

1 x234

1

245

1

Задержка схемы: T = 2τ.

Цена схемы: Sq=30.

Построение схемы в сокращённом базисе и-не:

Заменим операции булева базиса на операцию штрих Шеффера:

*ƒ* =

&

245

1234

1345

1245

&

12345

2345

&

&

&

&

&

&

Задержка схемы: T = 3τ.

Цена схемы: Sq=32.

# Синтез комбинационных схем в сокращенных булевых базисах:

Построение схемы в сокращённом базисе или, не:

*ƒ* =

Недостатком данной схемы является наличие выходного инвертора (который увеличивает цену и задержку), но даже с ним она более выгодна, чем синтезированная по МДНФ.

1

1

1

1

1

1

1

1

1

245

1 x234

1 x34 x5

1 2 x4 x5

1

1 x2 x3 x45

2 34 x5

1

1

1

1

Задержка схемы: T = 4τ.

Цена схемы: Sq=37.

Построение схемы в сокращённом базисе и, не:

*ƒ* =

&

1

1

1

1

1

1

245

1234

1345

1245

12345

2345

&

&

&

&

&

&

Задержка схемы: T = 3τ.

Цена схемы: Sq=36.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Номер варианта | Выполняемые операции | Число переменных | | Разрядность операндов | | З  Н  А  К  И | Использование дополнительного кода (для знаковых операций) | Фиксация переноса, заема, или переполнения | Для операции деления формирование | | Запрещенная нулевая комбинация | |
| Входных | Выходных | А | В | Частного | Остатка | А | В |
| 32 | C=A – 2 ( ± B) | 6 | 5 | 4(2) | -(2) | - | - | \* | - | - | - | - |

# Составляем таблицу истинности:

C = A – 2

|  |  |  |  |
| --- | --- | --- | --- |
| Y1 Y2 | A1 A2 A3 A4 | C1 C2 C3 C4 | V |
| 0 0 | 0 0 0 0 | 1 1 1 0 | 1 |
| 0 0 | 0 0 0 1 | 1 1 0 1 | 1 |
| 0 0 | 0 0 1 0 | 0 0 0 0 | 0 |
| 0 0 | 0 0 1 1 | 0 0 0 1 | 0 |
| 0 0 | 0 1 0 0 | 0 0 1 0 | 0 |
| 0 0 | 0 1 0 1 | 0 0 1 1 | 0 |
| 0 0 | 0 1 1 0 | 0 1 0 0 | 0 |
| 0 0 | 0 1 1 1 | 0 1 0 1 | 0 |
| 0 0 | 1 0 0 0 | 0 1 1 0 | 0 |
| 0 0 | 1 0 0 1 | 0 1 1 1 | 0 |
| 0 0 | 1 0 1 0 | 1 0 0 0 | 0 |
| 0 0 | 1 0 1 1 | 1 0 0 1 | 0 |
| 0 0 | 1 1 0 0 | 1 0 1 0 | 0 |
| 0 0 | 1 1 0 1 | 1 0 1 1 | 0 |
| 0 0 | 1 1 1 0 | 1 1 0 0 | 0 |
| 0 0 | 1 1 1 1 | 1 1 0 1 | 0 |

C = A – B C = A + B

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Y1 Y2 | A1 A2 | B1 B2 | C1 C2 C3 | V | C4 |  | Y1 Y2 | A1 A2 | B1 B2 | C1 C2 C3 | d | C4 |
| 0 1 | 0 0 | 0 0 | 0 0 0 | 0 | d |  | 1 0 | 0 0 | 0 0 | 0 0 0 | 0 | d |
| 0 1 | 0 0 | 0 1 | 1 1 1 | 1 | d |  | 1 0 | 0 0 | 0 1 | 0 0 1 | 0 | d |
| 0 1 | 0 0 | 1 0 | 1 1 0 | 1 | d |  | 1 0 | 0 0 | 1 0 | 0 1 0 | 0 | d |
| 0 1 | 0 0 | 1 1 | 0 0 1 | 1 | d |  | 1 0 | 0 0 | 1 1 | 0 1 1 | 0 | d |
| 0 1 | 0 1 | 0 0 | 0 0 1 | 0 | d |  | 1 0 | 0 1 | 0 0 | 0 0 1 | 0 | d |
| 0 1 | 0 1 | 0 1 | 0 0 0 | 0 | d |  | 1 0 | 0 1 | 0 1 | 0 1 0 | 0 | d |
| 0 1 | 0 1 | 1 0 | 1 1 1 | 1 | d |  | 1 0 | 0 1 | 1 0 | 0 1 1 | 1 | d |
| 0 1 | 0 1 | 1 1 | 1 1 0 | 1 | d |  | 1 0 | 0 1 | 1 1 | 0 0 0 | 0 | d |
| 0 1 | 1 0 | 0 0 | 0 1 0 | 0 | d |  | 1 0 | 1 0 | 0 0 | 0 1 0 | 0 | d |
| 0 1 | 1 0 | 0 1 | 0 0 1 | 0 | d |  | 1 0 | 1 0 | 0 1 | 0 1 1 | 1 | d |
| 0 1 | 1 0 | 1 0 | 0 0 0 | 0 | d |  | 1 0 | 1 0 | 1 0 | 0 0 0 | 1 | d |
| 0 1 | 1 0 | 1 1 | 1 1 1 | 1 | d |  | 1 0 | 1 0 | 1 1 | 0 0 1 | 1 | d |
| 0 1 | 1 1 | 0 0 | 0 1 1 | 0 | d |  | 1 0 | 1 1 | 0 0 | 0 1 1 | 0 | d |
| 0 1 | 1 1 | 0 1 | 0 1 0 | 0 | d |  | 1 0 | 1 1 | 0 1 | 1 0 0 | 1 | d |
| 0 1 | 1 1 | 1 0 | 0 0 1 | 0 | d |  | 1 0 | 1 1 | 1 0 | 1 0 1 | 1 | d |
| 0 1 | 1 1 | 1 1 | 0 0 0 | 0 | d |  | 1 0 | 1 1 | 1 1 | 1 1 0 | 1 | d |

# Минимизация функции на картах Карно:

## Единичные покрытия:

\*В дальнейшем для удобства вместо символов B1, B2 будем использовать A3, A4.

### C1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 | 1 | 1 |  |  |  | A1A2 | 00 |  | 1 |  | 1 |
| 01 |  |  |  |  |  | 01 |  |  | 1 | 1 |
| 11 | 1 | 1 | 1 | 1 |  | 11 |  |  |  |  |
| 10 |  |  | 1 | 1 |  | 10 |  |  | 1 |  |

**Y1,2=00 Y1,2=01**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 |  |  |  |  |  | A1A2 | 00 | d | d | d | d |
| 01 |  |  |  |  |  | 01 | d | d | d | d |
| 11 |  | 1 | 1 | 1 |  | 11 | d | d | d | d |
| 10 |  |  |  |  |  | 10 | d | d | d | d |

**Y1,2=10 Y1,2=11**

C1min(f)= S1a=16, S1b=20

C1=(12a1a2)v(2a1a2a4)v(12a1a3)v(2a1a2a3)

### C2

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 | 1 | 1 |  |  |  | A1A2 | 00 |  | 1 |  | 1 |
| 01 |  |  | 1 | 1 |  | 01 |  |  | 1 | 1 |
| 11 |  |  | 1 | 1 |  | 11 | 1 | 1 |  |  |
| 10 | 1 |  |  |  |  | 10 | 1 |  | 1 |  |

**Y1,2=00 Y1,2=01**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 |  |  | 1 | 1 |  | A1A2 | 00 | d | d | d | d |
| 01 |  | 1 |  | 1 |  | 01 | d | d | d | d |
| 11 | 1 |  | 1 |  |  | 11 | d | d | d | d |
| 10 | 1 | 1 |  |  |  | 10 | d | d | d | d |

**Y1,2=10 Y1,2=11**

C2min(f)= S1a=8, S1b=10

C2=(12a2a3)v(11a2a3)

### C3

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 | 1 |  |  |  |  | A1A2 | 00 |  | 1 | 1 |  |
| 01 | 1 | 1 |  |  |  | 01 | 1 |  |  | 1 |
| 11 | 1 | 1 |  |  |  | 11 | 1 |  |  | 1 |
| 10 | 1 | 1 |  |  |  | 10 |  | 1 | 1 |  |

**Y1,2=00 Y1,2=01**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 |  | 1 | 1 |  |  | A1A2 | 00 | d | d | d | d |
| 01 | 1 |  |  | 1 |  | 01 | d | d | d | d |
| 11 | 1 |  |  | 1 |  | 11 | d | d | d | d |
| 10 |  | 1 | 1 |  |  | 10 | d | d | d | d |

**Y1,2=10 Y1,2=11**

C3min(f)= S1a=36, S1b=45

C3=(1234)v(12a23)v(1a234)v(2a234)v(12a13)v(1y22a4)v(1y2a24)v(y122a4)v(y12a24)

### C4

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 |  | 1 | 1 |  |  | A1A2 | 00 | d | d | d | d |
| 01 |  | 1 | 1 |  |  | 01 | d | d | d | d |
| 11 |  | 1 | 1 |  |  | 11 | d | d | d | d |
| 10 |  | 1 | 1 |  |  | 10 | d | d | d | d |

**Y1,2=00 Y1,2=01**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 | d | d | d | d |  | A1A2 | 00 | d | d | d | d |
| 01 | d | d | d | d |  | 01 | d | d | d | d |
| 11 | d | d | d | d |  | 11 | d | d | d | d |
| 10 | d | d | d | d |  | 10 | d | d | d | d |

**Y1,2=10 Y1,2=11**

C4min(f)= S1a=3, S1b=4

C4=(12a4)

### V

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 | 1 | 1 |  |  |  | A1A2 | 00 |  | 1 | 1 | 1 |
| 01 |  |  |  |  |  | 01 |  |  | 1 | 1 |
| 11 |  |  |  |  |  | 11 |  |  |  |  |
| 10 |  |  |  |  |  | 10 |  |  | 1 |  |

**Y1,2=00 Y1,2=01**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A3A4 | | | |  |  |  | A3A4 | | | |
|  |  | 00 | 01 | 11 | 10 |  |  |  | 00 | 01 | 11 | 10 |
| A1A2 | 00 |  |  |  |  |  | A1A2 | 00 | d | d | d | d |
| 01 |  |  |  | 1 |  | 01 | d | d | d | d |
| 11 |  | 1 | 1 | 1 |  | 11 | d | d | d | d |
| 10 |  | 1 | 1 | 1 |  | 10 | d | d | d | d |

**Y1,2=10 Y1,2=11**

Vmin(f)= S1a=12, S1b=15

V=(1y21a3)v(y12a1a4)v(y12a1a3)

# Преобразование минимальных форм булевой функции:

C1=(12a1a2)v(2a1a2a4)v(12a1a3)v(2a1a2a3)

C2=(12a2a3)v(11a2a3)

C3=(1234)v(12a23)v(1a234)v(2a234)v(12a13)v(1y22a4)v(1y2a24)v(y122a4)v(y12a24)

C4=(12a4)

V=(1y21a3)v(y12a1a4)v(y12a1a3)

Введём вспомогательные функции:

Z1=12

Z2=a2a3

Z3=a23

C1=(Z1a1a2)v(2a1a2a4)v(Z1a1a3)v(2a1Z2)

C2=(Z1Z2)v(11Z2)

C3=(Z134)v(Z1Z3)v(1Z34)v(2Z34)v(Z1a13)v(1y22a4)v(1y2a24)v(y122a4)v(y12a24)

C4=(Z1a4)

V=(1y21a3)v(y12a1a4)v(y12a1a3)

# 