FIVE VARIABLE KARNAUGH MAP

There are several different formats of a 5 variable K map of which we discuss two most popular ones in this book : *reflection map* and *overlay map*.

Reflection Map

The 5 variable reflection map that uses gray code (Refer to section 5.8 for details) numbering of Karnaugh Map is shown in Fig. x-1. The top of the map is numbered in full Gray code where adjacent addresses have only one bit change between themselves. The Gray code reflects about the middle of the code. Thus, 00000 position for ABCDE is reflection of 00100 about the central vertical line. Note that, members of these two positions can be grouped, if possible, as between them only one variable C is changing. Similarly, position 00001 is reflection of 00101 and they can be grouped together. Adjacency in the vertical direction is considered in the same way as is done in case of 4 variable Karnaugh Map.

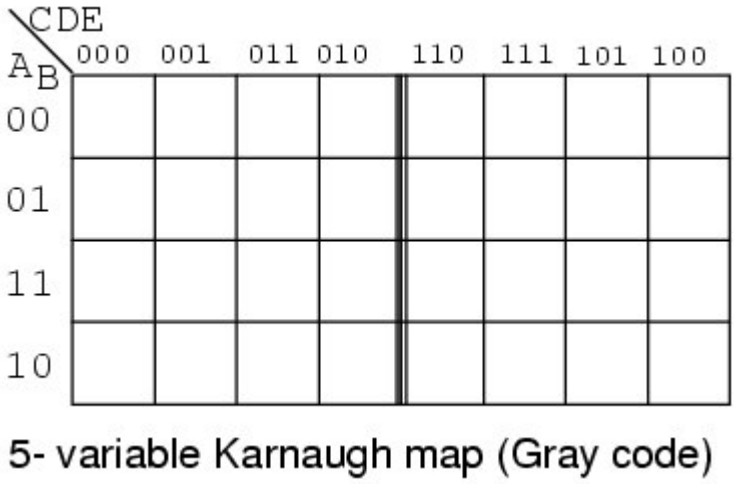

Fig. x-1 Five variable Reflection Map

The minterm assignment follows a format as shown in the Fig. x-2..

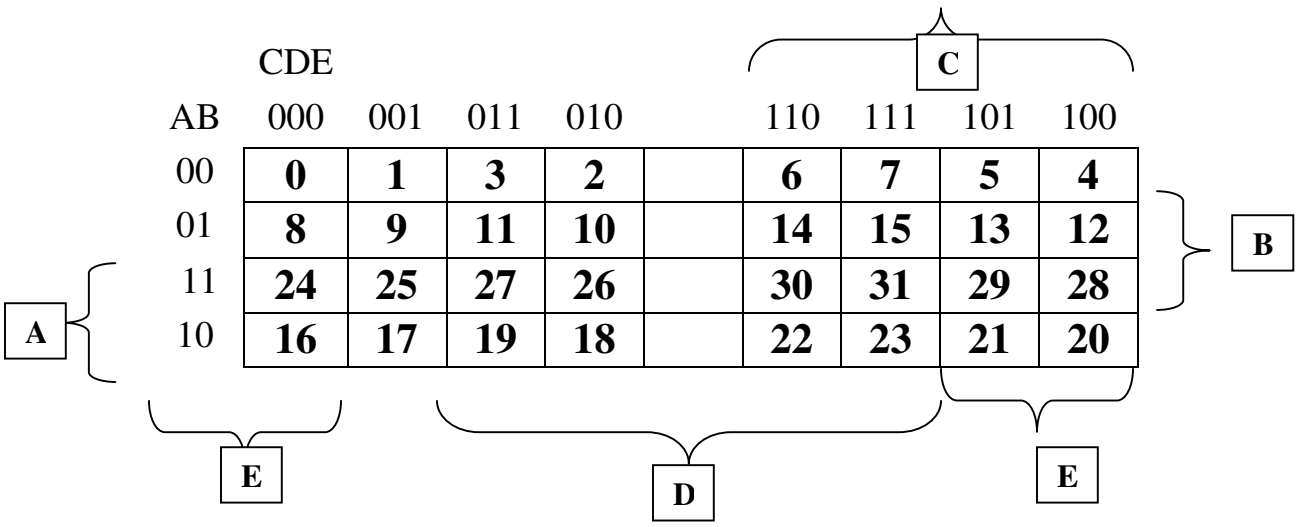

Fig. x-2 Minterm assignment in five variable Reflection Map

Example x1

Design a circuit which has a 5-bit binary input (A, B, C, D, E), with A being the MSB (Most Significant Bit). It must produce an output logic High for any prime number detected in the input data.

Solution

The minterm associated for detection of prime numbers in the five variable inputs are m_1, m_2, m_3, m_5, m_7, m_{11}, m_{13}, m_{17}, m_{19}, m_{23}, m_{29} and m_{31}. The corresponding 5 variable Karnaugh Map using gray code is shown in Fig. x-3 along with the grouping e.g. minterms m_1, m_3, m_7, m_5 in positions 00001, 00011, 00111, 00101 can form a group and among them variables A, B and E remain constant with values 0,0,1 respectively. Hence, A′B′E represents that. Conducting this exercise for other groups we get final expression as

Y=A'B'E + B'C'E + A'B'C'D + AB'DE + A'CD'E + ABCE +A'C'DE

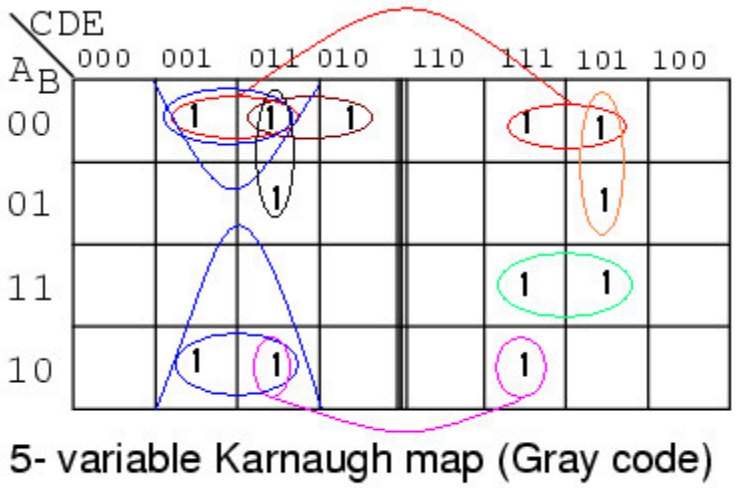

Fig. x-3 Solution for Example x1

Overlay Map

The overlay version of the Karnaugh map, shown in Fig. x-4, is simply two identical maps except for the most significant bit of the 3-bit address across the top. At the top, the numbering is different from Gray code map. Ignoring the most significant digit of the 3-digit numbers, the sequence **00, 01, 11, 10** is at the heading of both sub maps of the overlay map.

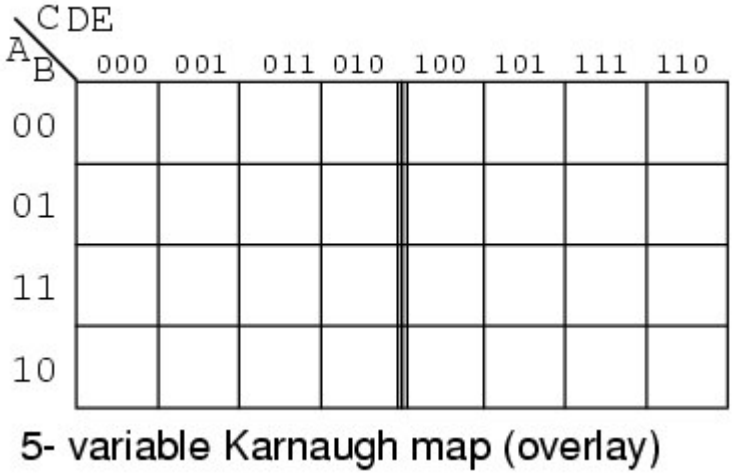

Fig. x-4 Five variable Overlay Map

The minterm assignment follows a format as shown in the Fig. x-5..

AB \ CDE	000	001	011	010		100	101	111	110
00	**0**	**1**	**3**	**2**		**4**	**5**	**7**	**6**
01	**8**	**9**	**11**	**10**		**12**	**13**	**15**	**14**
11	**24**	**25**	**27**	**26**		**28**	**29**	**31**	**30**
10	**16**	**17**	**19**	**18**		**20**	**21**	**23**	**22**

Fig. x-5 Minterm assignment in five variable Overlay Map

Problem x2

Design a circuit of 5 input variables that generates output 1 if and only if the number of 1's in the input is prime (i.e., 2, 3 or 5).

Solution:-

The minterms can easily be found from Karnaugh Map where addresses of 2,3 or 5 numbers of 1. This is shown in Fig. x-6.

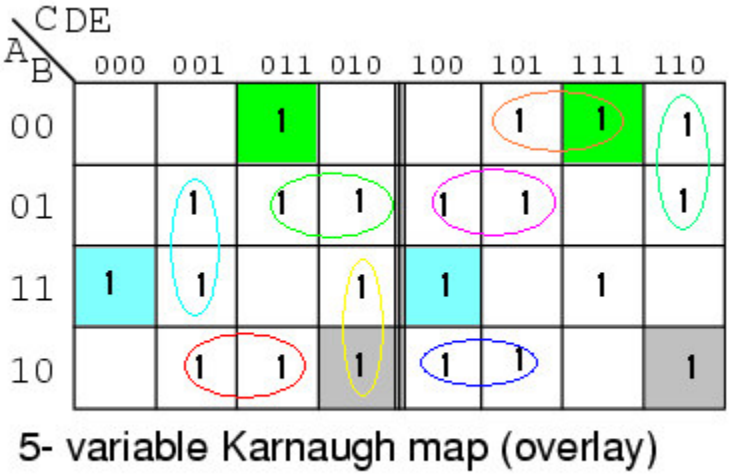

Fig. x-6 Truth Table of Example x2 in Overlay Map

In the overlay mode, the maps are laid one above the other just as shown in Fig. x-7 instead of folding it about the center and then the grouping is done.

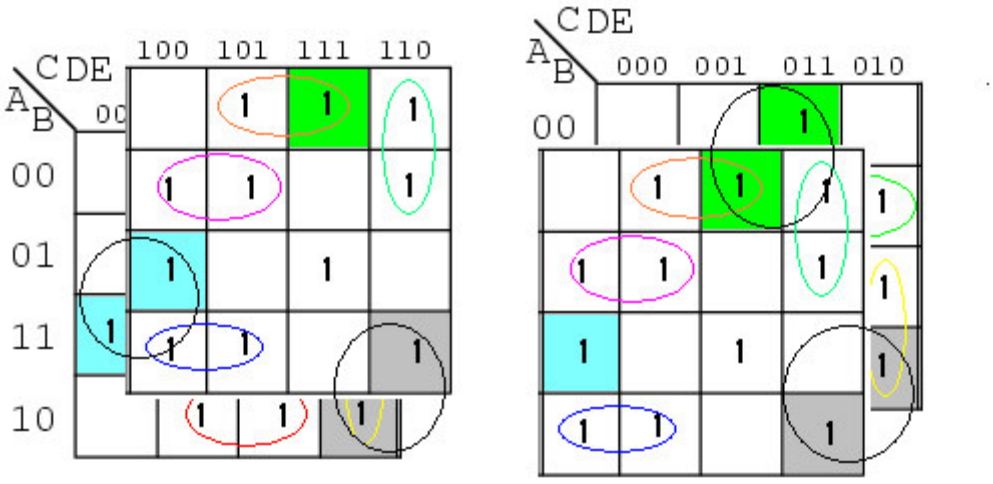

Fig. x-7 Solution for Example x2

Hence the simplified expression becomes

Y = BC'D'E + A'BC'D + AC'DE' + AB'C'D + A'B'CE + A'CDE' + A'BCD + AB'CD' + ABD'E' + AB'DE' + A'B'DE + ABCDE

SELF TEST

1. Which code is used in numbering of reflection map?
2. Which one is reflected location of 11011 in 5 variable reflection map?
3. How is overlay map formed?

ANSWER TO SELF TEST

1. Gray code.
2. 11111.
3. By forming two 4-variable maps in which one variable is held at 0 and 1.

PROBLEM

1. Find minimized expression for example-x1 using overlay method.
2. Find minimized expression for example-x2 using reflection map method.