

Notes by:- Jpwebdevelopers.in

## K-MAP

- It is a graphical representation, that provides easy method for simplifying Boolean Expression.
- Just like the truth table, K-map contains all the possible values of input variables and the corresponding output values.
- The K-map method is used for expressions containing 2, 3, 4 and 5 variables.

Two variable K-map =  $(2^2 = 4 \text{ cells})$

A/B	0	1	A/B	$\bar{A}$	B
0	00	01	1	$\bar{A}B$	$AB$
1	10	11	0	$A\bar{B}$	$AB$

A/B	0	1
0	2	3

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\* Three Variable K-Map =  $2^3 = 8$

The number of cells in 3 variable K-map is eight, the number of variables is three.

A \ BC	00	01	11	10	A \ BC	00	01	11	10
0	0	1	3	2	0	000 $\bar{A}\bar{B}\bar{C}$	001 $\bar{A}\bar{B}C$	011 $\bar{A}B\bar{C}$	010 $\bar{A}BC$
1	4	5	7	6	1	100 $A\bar{B}\bar{C}$	101 $A\bar{B}C$	111 $AB\bar{C}$	110 $ABC$

(minterm)

A \ BC	00	01	11	10
0	$m_0$	$m_1$	$m_3$	$m_2$
1	$m_4$	$m_5$	$m_7$	$m_6$

A	B	C	(mi) minterm	(Mi)
0	0	0	$\bar{A}\bar{B}\bar{C} = m_0$	$A+B+C = M_0$
0	0	1	$\bar{A}\bar{B}C = m_1$	$A+B+\bar{C} = M_1$
0	1	0	$\bar{A}B\bar{C} = m_2$	$A+\bar{B}+C = M_2$
0	1	1	$\bar{A}BC = m_3$	$A+\bar{B}+\bar{C} = M_3$
1	0	0	$A\bar{B}\bar{C} = m_4$	$\bar{A}+B+C = M_4$
1	0	1	$A\bar{B}C = m_5$	$\bar{A}+B+\bar{C} = M_5$
1	1	0	$AB\bar{C} = m_6$	$\bar{A}+\bar{B}+C = M_6$
1	1	1	$ABC = m_7$	$\bar{A}+\bar{B}+\bar{C} = M_7$

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\* Four variable K-map =  $2^4 = 16$

The number of cells in 4 variable K-map is sixteen.

AB \ CD	00	01	11	10
00	0	1	3	2
01	4	5	7	6
11	12	13	15	14
10	8	9	11	10

\* Rules for Grouping / Filling of Cells:-

$$SOP = 1$$

$$POS = 0$$

(i) adjacent cells which have 1's can be grouped together.

A \ B	0	1
0	1	0
1	1	

(ii) Group can't contain 0.

(iii) Groups can't be diagonal

1	
1	1

(iv) Groups must contain  $2^n$  cells.

A \ B	0	1
0	1	1
1	1	1

(v) Each Group should be as large as possible

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# \* Simplification of Boolean Expression

## Using K-Maps :-

- (i) Use grouping Technique
- (ii) Grouping means combining the terms in adjacent cells.
- (iii) Grouping adjacent 1's  $\rightarrow$  SOP
- (iv) Grouping adjacent 0's  $\rightarrow$  POS

## (i) Example of Grouping (Pairs) :-

①  $X = \bar{A}BC + A\bar{B}\bar{C}$

A \ BC	$\bar{B}\bar{C}$	$\bar{B}C$	$BC$	$B\bar{C}$
$\bar{A}$	0	0	1	1
A	0	0	0	0

} In Groups look for variables whose value =  $\bar{A}B$  is not changing.

②  $X = \bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}D$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	$CD$	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	0	0
$\bar{A}B$	0	0	0	0
$A\bar{B}$	0	0	0	0
$AB$	0	1	0	0

=  $\bar{B}\bar{C}D$

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(iii)  $X = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}C$

	A	<sup>00</sup> $\bar{B}\bar{C}$	<sup>01</sup> $B\bar{C}$	<sup>11</sup> $\bar{B}C$	<sup>10</sup> $BC$
$\bar{A}$	0	1	0	1	1
A	1	0	1	0	0

$G_1 = \bar{A}B$

$G_2 = \bar{A}\bar{C}$

$G_3 = A\bar{B}C$

$\bar{A}B + \bar{A}\bar{C} + A\bar{B}C$  Ans

(iv)  $X = \sum m(0, 1, 2, 5, 13, 15)$

↳ minterm  $\rightarrow$  SOP

AB	CD	<sup>00</sup> $\bar{C}\bar{D}$	<sup>01</sup> $\bar{C}D$	<sup>11</sup> $CD$	<sup>10</sup> $C\bar{D}$
$\bar{A}\bar{B}$	00	0	1	3	2
$\bar{A}B$	01	4	5	7	6
$AB$	11	12	13	15	14
$A\bar{B}$	10	8	9	11	10

$\bar{A}\bar{B}\bar{D} + \bar{A}\bar{C}D + ABD$  Ans

(v)  $X = \sum m(1, 5, 7, 9, 11, 13, 15)$

AB	CD	<sup>00</sup> $\bar{C}\bar{D}$	<sup>01</sup> $\bar{C}D$	<sup>11</sup> $CD$	<sup>10</sup> $C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2	
$\bar{A}B$	4	5	7	6	
$AB$	12	13	15	14	
$A\bar{B}$	8	9	11	10	

$= \bar{C}D + AD + BD$

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