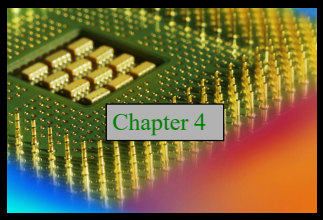
Digital Fundamentals

Tenth Edition

Floyd



Chapter 4

1

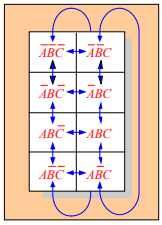
Summary

Karnaugh maps

The Karnaugh map (K-map) is a tool for simplifying combinational logic with 3 or 4 variables. For 3 variables, 8 cells are required (2^3).

The map shown is for three variables labeled *A, B,* and *C*. Each cell represents one possible product term.

Each cell differs from an adjacent cell by only one variable.

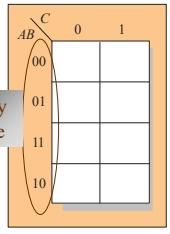


2

Summary

Karnaugh maps

Cells are usually labeled using 0's and 1's to represent the variable and its complement.



Gray code

The numbers are entered in gray code, to force adjacent cells to be different by only one variable.

Ones are read as the true variable and zeros are read as the complemented variable.

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Summary

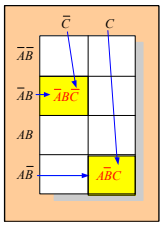
Karnaugh maps

Alternatively, cells can be labeled with the variable letters. This makes it simple to read, but it takes more time preparing the map.

Example Read the terms for the yellow cells.

Solution

The cells are $\bar{A}B\bar{C}$ and $A\bar{B}C$.



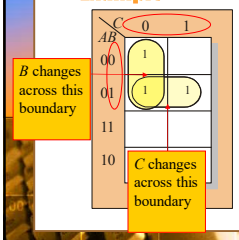
4

Summary

Karnaugh maps

K-maps can simplify combinational logic by grouping cells and eliminating variables that change.

Example Group the 1's on the map and read the minimum logic.



Solution

1. Group the 1's into two overlapping groups as indicated.
2. Read each group by eliminating any variable that changes across a boundary.
3. The vertical group is read $\bar{A}\bar{C}$.
4. The horizontal group is read $\bar{A}B$.

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

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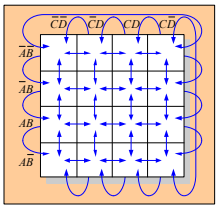
Summary

Karnaugh maps

A 4-variable map has an adjacent cell on each of its four boundaries as shown.



Each cell is different only by one variable from an adjacent cell.

Grouping follows the rules given in the text.

The following slide shows an example of reading a four variable map using binary numbers for the variables…

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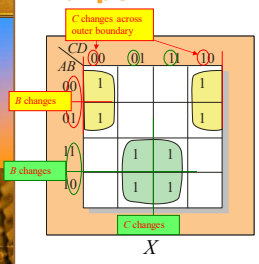
Summary

Karnaugh maps

Example Group the 1's on the map and read the minimum logic.



Solution

1. Group the 1's into two separate groups as indicated.
2. Read each group by eliminating any variable that changes across a boundary.
3. The upper (yellow) group is read as $\overline{AD}$.
4. The lower (green) group is read as AD.

$$X = \overline{AD} + AD$$

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K-Maps > 4var

Material beyond this point will NOT be tested…information only

(added by D. Kohn)

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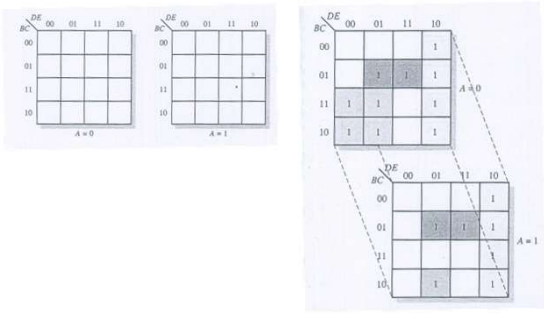
5 Variable K-MAP (ver 1)



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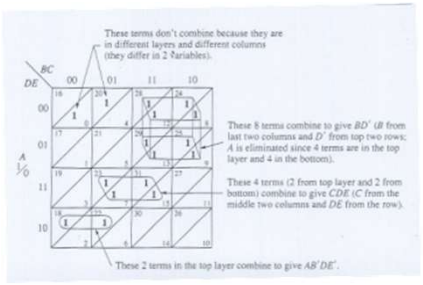
5 Variable K-MAP (ver 2)



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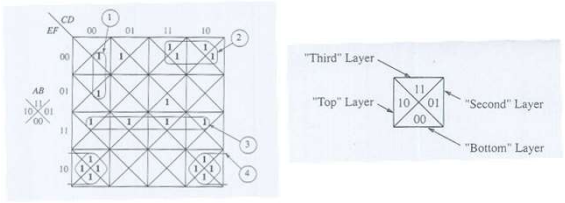
6 Variable K-MAPS

(ver 2.0)



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6 Variable or Greater

- There are a number of algorithms that allow minimization of digital logic circuits with any number of variables. Two of the most common are:
  - Quine-McCluskey
  - Espresso

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