

Minimization of Boolean Functions using K-maps

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September 19, 2022

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Abstract

This manual explains how to minimize the boolean functions using K-maps.

1 COMPONENTS

| component | value | quantity |
|----------------------|--------------|----------|
| Breadboard | | 1 |
| Resistor | 220ohm | 1 |
| Arduino | Uno | 1 |
| Sevensegment display | Common anode | 1 |
| Jumper wires | | 20 |

2 K-Maps

The Karnaugh map or K-map is used for minimization or simplification of Boolean function either in Sum of Product(SOP) form or in Product of Sum(POS) form. A Karnaugh map is similar to a truth table because it presents all of the possible values of input variables and the resulting output for each value. Instead of being organized into columns and rows like a truth table, the Karnaugh map is an array of cells in which each cell represents a binary value of the input variables. The cells are arranged in a way so that simplification of a given

expression is simply a matter of properly grouping the cells. Karnaugh maps can be used for expressions with two, three, four and five variables. Another method, called the Quine-McClusky method can be used for higher numbers of variables. The number of cells in a Karnaugh map is equal to the total number of possible input variable combinations as is the number of rows in a truth table. For three variables, the number of cells is $2^3 = 8$. For four variables, the number of cells is $2^4 = 16$.

3 Minimization

The boolean function given in (1) is minimized using 3-variable K-maps. Equation for F is

$$F = A'B'C' + A'BC' + A'BC + ABC' \quad (1)$$

the implicants 2,3 form a pair and results in the equation

$$A'B \quad (2)$$

the implicants 2,6 form a pair and results in the equation

$$B'C \quad (3)$$

the implicants 0,2 form a pair and results in the equation

$$A'C' \quad (4)$$

| | | | | | |
|-------|---|----------|----|----|----|
| | | X_1X_0 | | | |
| | | 00 | 01 | 11 | 10 |
| X_2 | 0 | 1 | 0 | 1 | 1 |
| | 1 | 0 | 0 | 0 | 1 |

Finally the minimized boolean function is represented by F' in (5)

4 Hardware



| | | | | | | | | | |
|----------------|---|---|---|---|---|---|---|-----|-----|
| Arduino | 2 | 3 | 4 | 5 | 6 | 7 | 8 | com | dot |
| Display | a | b | c | d | e | f | g | 5V | GRD |

Make the connections as per Table and execute the following program.

<https://github.com/SyedTabassumNazeer/FWC/blob/main/main.cpp>