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Assignment I

Simplifying Boolean expression using Kmap

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I. PROBLEM

Reduce the following Boolean expression in the simplest form using Kmap. The Expression with Sum of Products (SOP) is as follows:

$$F(P, Q, R, S) = \sum (0, 1, 2, 3, 5, 6, 7, 10, 14, 15)$$

II. SOLUTION

A. Truth Table

Truth table for the SOP given:

| | P | Q | R | S | F(P,Q,R,S) |
|------------------|---|---|---|---|------------|
| | | | | | |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| | 0 | 0 | 1 | 0 | 1 |
| 3 | 0 | 0 | 1 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 | 0 |
| 2 3 4 5 | 0 | 1 | 0 | 1 | 1 |
| 6 | 0 | 1 | 1 | 0 | 1 |
| 7 | 0 | 1 | 1 | 1 | 1 |
| | 1 | 0 | 0 | 0 | 0 |
| 8 9 | 1 | 0 | 0 | 1 | 0 |
| 10 | 1 | 0 | 1 | 0 | 1 |
| 11 | 1 | 0 | 1 | 1 | 0 |
| 12 | 1 | 1 | 0 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 | 0 |
| 14 | 1 | 1 | 1 | 0 | 1 |
| 15 | 1 | 1 | 1 | 1 | 1 |
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TABLE I
TRUTH TABLE FOR GIVEN BOOLEAN EXPRESSION

B. K-map

K-map for the above truth table:

| $\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ $ | | | | | | | | | |
|--|----|----|----|----|--|--|--|--|--|
| RS | 00 | 01 | 11 | 10 | | | | | |
| 00 | 1 | 1 | 1 | 1 | | | | | |
| 01 | 0 | 1 | 1 | 1 | | | | | |
| 11 | 0 | 0 | 1 | 1 | | | | | |
| 10 | 0 | 0 | 0 | 1 | | | | | |

TABLE II
K-Map from the Truth Table

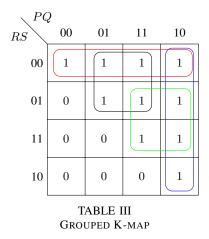
C. Rules to simplify K-maps

The Karnaugh map uses the following rules for the simplification of expressions by grouping together adjacent cells containing ones

- 1) Groups may not include any cell containing a zero
- 2) Groups may be horizontal or vertical, but not diagonal
- 3) Groups must contain 1, 2, 4, 8, or in general 2^n cells
- 4) Each group should be as large as possible.
- 5) Each cell containing a one must be in at least one group
- 6) Groups may overlap
- 7) Groups may wrap around the table. The leftmost cell in a row may be grouped with the rightmost cell and the top cell in a column may be grouped with the bottom cell

8) There should be as few groups as possible, as long as this does not contradict any of the previous rules

D. Simplification



Simplified Boolean expression using Kmap without don't care will be:

$$F(P,Q,R,S) = P'Q' + P'S + RS' + QR$$

III. VERIFICATION & CONCLUSION

The simplified Boolean expression can be implemented using

wget https://raw.githubusercontent.com/parusamanideep /FWC/main/assignment1/src/main.cpp

The file in the above link is a C program to implement the logic that is simplified using the K-map.

The below link has the assembly program to implement the simplified logic using K-map.

wget https://raw.githubusercontent.com/parusamanideep/FWC/main/assignment1/asm/Assignment1.asm

P, Q, R, S are given as inputs to 2, 3, 4, 5 pins respectively from the 5V and GND lines. The given Boolean expression is simplified and

The given Boolean expression is simplified and verified for functionality.