

# 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
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	0
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

TABLE I  
TRUTH TABLE FOR GIVEN BOOLEAN EXPRESSION

#### B. K-map

K-map for the above truth table:

		PQ			
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

		PQ			
		00	01	11	10
RS	00	1	1	1	1
	01	0	1	1	1
	11	0	0	1	1
	10	0	0	0	1

TABLE III  
GROUPED K-MAP

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 the file in the below link which is a C++ program to implement the logic that is simplified using the K-map.

wget <https://raw.githubusercontent.com/parusamanideep/FWC/main/IDE/codes/src/main.cpp>

The same simplified boolean expression can be implemented using assembly code in the below link.

wget <https://raw.githubusercontent.com/parusamanideep/FWC/main/assembly/codes/kmap.asm>

It can also be implemented using C code in the below link.

wget <https://raw.githubusercontent.com/parusamanideep/FWC/main/gcc/codes/main.c>

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 verified for functionality.