

Assignment 2 — FPGA Lab

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1 Question

Reduce the following Boolean expression to its simplest form using K-Map

$$F(X, Y, Z, W) = \sum(0, 1, 6, 8, 9, 10, 11, 12, 15) \quad (1)$$

Verify the above Boolean expression using using Arduino.

2 Solution

- Step1 : Enter ones in the cells of the K-Map denoting the product terms of the give sum of products (SOP) form. Enter zeros in the remaining cells of the K-Map

		ZW			
		00	01	11	10
XY	00	1	1	0	0
	01	0	0	0	1
	11	1	0	1	0
	10	1	1	1	1

- Step2 : From the groups in the K-Map.

		ZW			
		00	01	11	10
XY	00	1	1	0	0
	01	0	0	0	1
	11	1	0	1	0
	10	1	1	1	1

- Step3 : Write down the Boolean expression for each of the group in the K-Map

$$F(X, Y, Z, W) = \bar{Y}.\bar{Z} + X.\bar{Y} + X.\bar{Z}.\bar{W} + X.Z.W + \bar{X}.Y.Z.\bar{W} \quad (2)$$

3 Implementation using NAND gate

$$F(X, Y, Z, W) = \overline{\bar{Y}.\bar{Z} + X.\bar{Y} + X.\bar{Z}.\bar{W} + X.Z.W + \bar{X}.Y.Z.\bar{W}} \quad (3)$$

$$F(X, Y, Z, W) = \overline{(\bar{Y}.\bar{Z}) \cdot (X.\bar{Y}) \cdot (X.\bar{Z}.\bar{W}) \cdot (X.Z.W) \cdot (\bar{X}.Y.Z.\bar{W})} \quad (4)$$

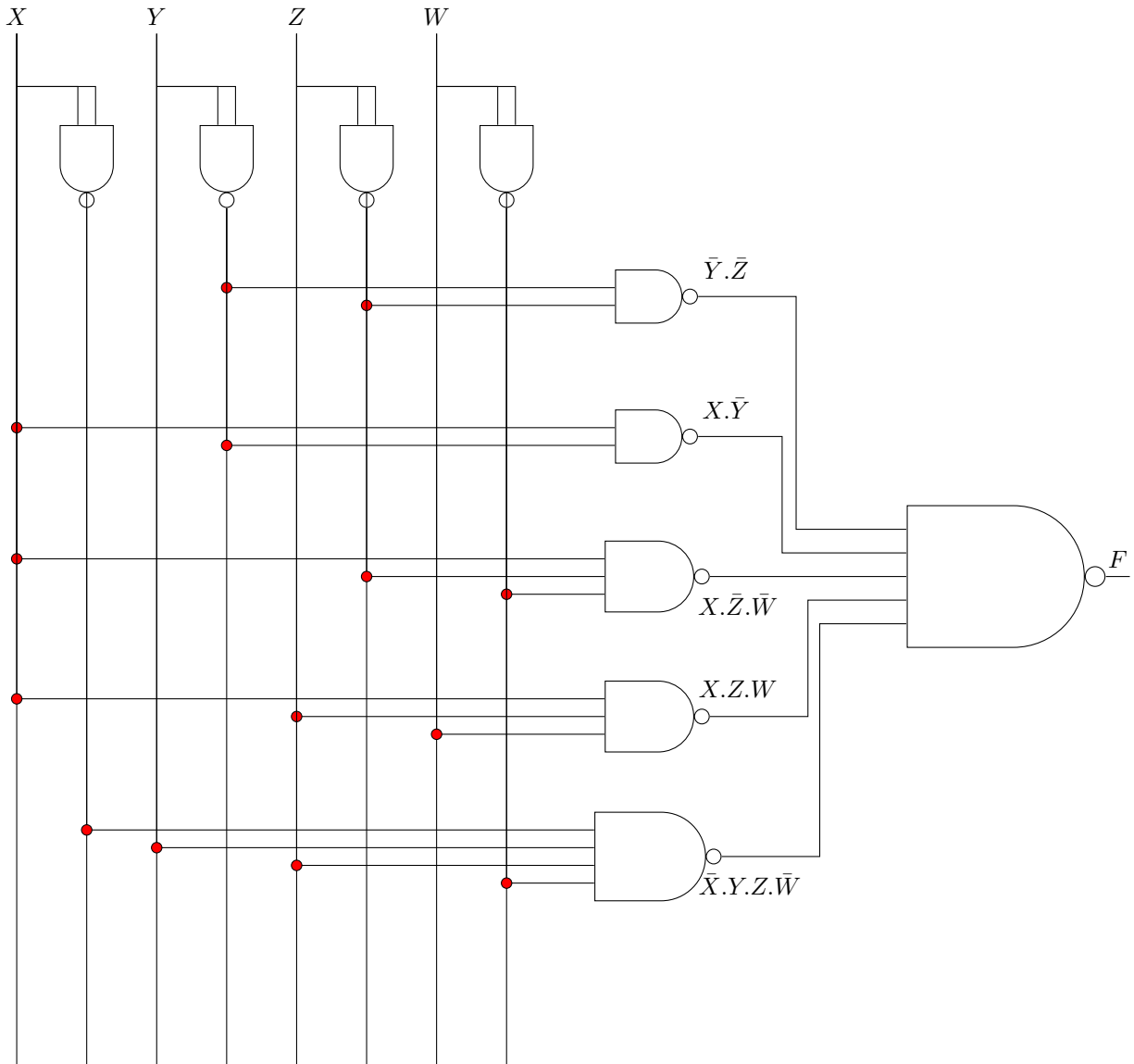


Figure 1: Circuit Diagram for the simplified Boolean expression using NAND gate

4 Verification of the Boolean expression through Arduino

4.1 Code to generate the .bin file.

```
#include <Arduino.h>
# define X 2
# define Y 3
# define Z 4
# define W 5
int x,y,z,w,term1,term2,term3,term4,term5,out;
void setup() {
  pinMode(LED_BUILTIN,OUTPUT);
  pinMode(X,INPUT);
  pinMode(Y,INPUT);
  pinMode(Z,INPUT);
  pinMode(W,INPUT);
}
int nand2(int x, int y) // Two input NAND gate
{ return !(x && y); }
int nand3(int x, int y, int z) // Three input NAND gate
{ return !((x && y) && z); }
int nand4(int x, int y, int z, int w) // 4 input NAND gate
{ return !((x && y) && (z && w)); }
int nand5(int x, int y, int z, int w, int a) // 5 input NAND gate
{ return !((x && y) && (z && w) && a ); }
void loop() {
  x=digitalRead(X);
  y=digitalRead(Y);
  z=digitalRead(Z);
  w=digitalRead(W);
  term1 = nand2(nand2(y,y),nand2(z,z));
  term2 = nand2(x,nand2(y,y));
  term3 = nand3(x,nand2(z,z),nand2(w,w));
  term4 = nand3(x,z,w);
  term5 = nand4(nand2(x,x),y,z,nand2(w,w));
  out = nand5(term1,term2,term3,term4,term5);
  if(out==1)
    digitalWrite(LED_BUILTIN,HIGH);
  else
    digitalWrite(LED_BUILTIN,LOW);
}
```