PLTW Engineering

10-12/Basic Logic Circuits

4/16/2020

10-12/DE

Lesson: **4/16/2020**

Objective/Learning Target: Students will be able to determine the output of a circuit based on a truth table

Truth Tables and Logic Expressions

Truth tables are used to determine the output function of a circuit.

The number of inputs a circuit has, determines the number of combinations that can output a true condition or in other words a "1"

2 Inputs

$2^2 = 4$ Combinations

A	B	F_2
0	0	0
0	1	0
1	0	0
1	1	1

3 Inputs

$2^3 = 8$ Combinations

X	Y	Z	F_3
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

Truth Tables and Logic Expressions

Lets take a look at the examples of the truth tables shown on the previous slide to determine what the output would look like.

First, the 2 input truth table.

For this example, we have a “1” in the last output row.

A	B	F_2
0	0	0
0	1	0
1	0	0
1	1	1

This means our logic expression would be $F_2 = AB$ because for both A as well as B both of those inputs are “1”

Truth Tables and Logic Expressions

On the 3 input truth table we have more than one row with a "1" as the output. So we will OR (+) these groups together. Additionally, some of the inputs contain a zero (0) - we will call these inputs NOT, and designate them with a line over the top of the letter.

X	Y	Z	F_3
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

$\bar{X}YZ$

$\bar{X}YZ$

$X\bar{Y}Z$

Truth Tables and Logic Expressions

Now that we know each of the inputs that result in output F_3 resulting in a "1" / HIGH / ON condition, we can OR (+) them together.

X	Y	Z	F_3
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

$\bar{X}\bar{Y}Z$

$\bar{X}YZ$

$X\bar{Y}Z$

$F_3 = \bar{X}\bar{Y}Z + \bar{X}YZ + X\bar{Y}Z$

Truth Tables and Logic Expressions

The truth table on the left and the Sum of Product expressions on the right both say they same thing. In other words you should be able to produce the sum of products from any truth table you are given.

X	Y	Z	F_3
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

$\bar{X}\bar{Y}Z$

$\bar{X}YZ$

$X\bar{Y}Z$

$F_3 = \bar{X}\bar{Y}Z + \bar{X}YZ + X\bar{Y}Z$

Truth Tables and Logic Expressions

Here is an example for you to try on your own:

R	S	T	U	F_4
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

Step 1: Identify which F_4 functions have a "1"
Step 2: Write out the individual expressions
Step 3: OR the individual expressions together

Helpful Links

[All about circuits guide to truth tables]

[Intro to truth tables and Boolean expressions]