Implementation of a basic boolean function

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Using a given function, it will be simplified to its smallest expression. We will see the methods used in this process, the creation of the truth table as well as the diagramming of the function using logic gates given by Boolean algebra, to pass a physical implementation using integrated circuits.

1. Introduction.

The given function is $(x + y)(x' + z)(y + z)$ where it will be reduced through the [1]laws of Boolean algebra that describe the properties and relationships between logical operations, being Identity, Associative, Commutative, Inverse and Distributive the most well-known, these laws are used when simplifying Boolean expressions and optimizing logical circuits.

2. Function simplification and truth table.

Original function:$(x + y)(x' + z)(y + z)$
(1) Distributive property for two terms.
$(x + y)(x' + z)$
- $(x + y)(x' + z) = (x{\cdot}x') + (x{\cdot}z) + (y{\cdot}x') + (y{\cdot}z)$

where $(x{\cdot}x') = 0$ by cancellation.
- $(x + y)(x' + z) = (x{\cdot}z) + (y{\cdot}x') + (y{\cdot}z)$

(2) Multiplying the result by the missing term.
- $(y + z)[(x{\cdot}z) + (y{\cdot}x') + (y{\cdot}z)]$

through the distributive.
- $[(x{\cdot}z)(y + z)] + [(y{\cdot}x')(y + z)] + [(y{\cdot}z)(y + z)]$

(3) Simplification of terms.
- $(x{\cdot}z)(y + z) = (x{\cdot}z{\cdot}y) + (x{\cdot}z{\cdot}z) = (x{\cdot}z{\cdot}y) + (x{\cdot}z)$
- $(y{\cdot}x')(y + z) = (y{\cdot}x') + (y{\cdot}x'{\cdot}z)$
- $(y{\cdot}z)(y + z) = (y{\cdot}z) + (y{\cdot}z) = (y{\cdot}z)$

(4) grouping of terms
- $[(x{\cdot}z{\cdot}y) + (x{\cdot}z)] + [(y{\cdot}x') + (y{\cdot}x'{\cdot}z)] + [(y{\cdot}z)]$

simplify equation
- $[x{\cdot}z\cancel{(y+1)}]+[yx'\cancel{(1+z)}]+[(y{\cdot}z)]$
  $= (x{\cdot}z) + (y{\cdot}x') + (y{\cdot}z) = (x + y)(x' + z)$

The simplified result is a simpler function to evaluate, thanks to the laws of Boolean algebra, so it will always be good practice to simplify functions as much as possible. The truth table of the resulting function is shown in Figure 1.

Figure 1. Truth table

X	Y	Z	X+Y	-X	-X+Z	(X+Y)*(-X+Z)
0	0	0	0	1	1	0
0	0	1	0	1	1	0
0	1	0	1	1	1	1
0	1	1	1	1	1	1
1	0	0	1	0	0	0
1	0	1	1	0	1	1
1	1	0	1	0	0	0
1	1	1	1	0	1	1

3. Diagram of the resulting function.

For this purpose, [2] logic gates are used, which are based directly on the operations of Boolean algebra. Each gate represents an operation, the following being:
- NOT -> X'(Inverter)
- AND -> A·B(multiplication)
- OR -> Y+Z(addition)

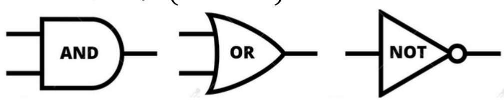

Figure 2. Gate diagrams

Therefore the diagram of the obtained function is shown in figure 3.

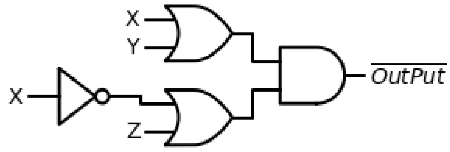

Figure 3. Diagram resulting from the function (x+y)(x'+z)

4. Physical implementation.

Using the integrated circuits 7408 (AND), 7432 (OR) both with 2 inputs and the 7404 (NOT)

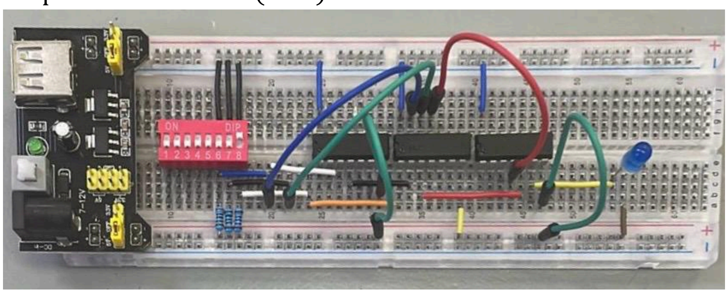
Figure 4. Physical circuit

The use of a switch helps us to represent the states of 1 and 0, along with a 12V to 5V converter to power the circuit, the response output is checked by using an LED which represents 1(on) and 0(off).

Conclusion.

We achieved the reduction of a function using the laws of Boolean algebra, how the function diagram is composed and its physical implementation in a circuit using chips was carried out, seeing how it works in a real environment.

References

1. (S/f-a). Escuala de Postgrado Retrieved January 28, 2025, from https://postgradoingenieria.com/algebra-boole/
2. (S/f-a). Material de aprendizaje Retrieved January 28, 2025, from https://materialesdeaprendizaje.org/circuitos_logicos/