
# Lab#8
# Vending machine controller

Digital design principles.

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The vending machine sell bottles of water for 75¢. Customers can enter either a dollar bill or quarters. Once a sufficient amount of money is entered, the vending machine will dispense a bottle of water and, if the user entered a dollar, return one quarter in change. If a dollar is entered after or at the same time as a coin, the transaction is cancelled.

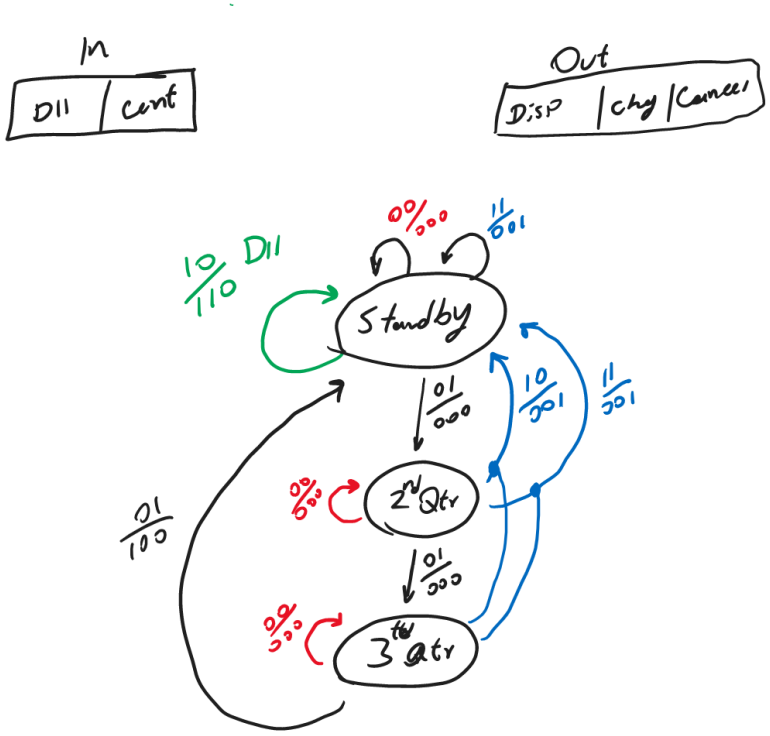


*Figure 1 State diagram*

Looking at the state diagram proposed, it has 2 inputs (dollar entered, cent entered) and 3 outputs (dispenser, change, cancel), and with 2 D-flipflops its possible to complete the sequence because it has 3 stages where the first is the standby (waiting for an entry), the second is the waiting for a second coin, and the third is the waiting for the third coin. Fallowing the diagram, the next state table is obtained.

| a | B | DLL | COIN | fa | fb | dispenser | change | cancel |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 | x | x | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | x | x | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | x | x | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | x | x | 0 | 0 | 0 |

*Figure 2 next state table*

from the next state table, the Boolean expressions were obtained assuming that each da1 and db1 are the flipflop outputs and the next state is equal to the design table of the DFlip-flop.

DLL

| | C | | | | |
|---|---|---|---|---|---|
| A | B | [00] | [01] | [11] | [10] |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | x | x | x | x |
| 1 | 0 | 1 | 0 | 0 | 0 |

DA=AD'C'+BD'C

a)

DLL

| | C | | | | |
|---|---|---|---|---|---|
| A | B | [00] | [01] | [11] | [10] |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | x | x | x | x |
| 1 | 0 | 0 | 0 | 0 | 0 |

DB=BD'C'+A'B'D'C'

b)

DLL

| | C | | | | |
|---|---|---|---|---|---|
| A | B | [00] | [01] | [11] | [10] |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 |

DISP=AB'D'C'+A'B'DC'

c)

*Figure 3 a) da expression b) db expression c) dispenser expression.*

DLL

| | C | | | | |
|---|---|---|---|---|---|
| A | B | [00] | [01] | [11] | [10] |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |

change=A'B'DC'

DLL

| | C | | | | |
|---|---|---|---|---|---|
| A | B | [00] | [01] | [11] | [10] |
| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 |

cancel=A'DC+A'BD+AB'D

The next step is drawing the circuit and test it. using the program Proteus.

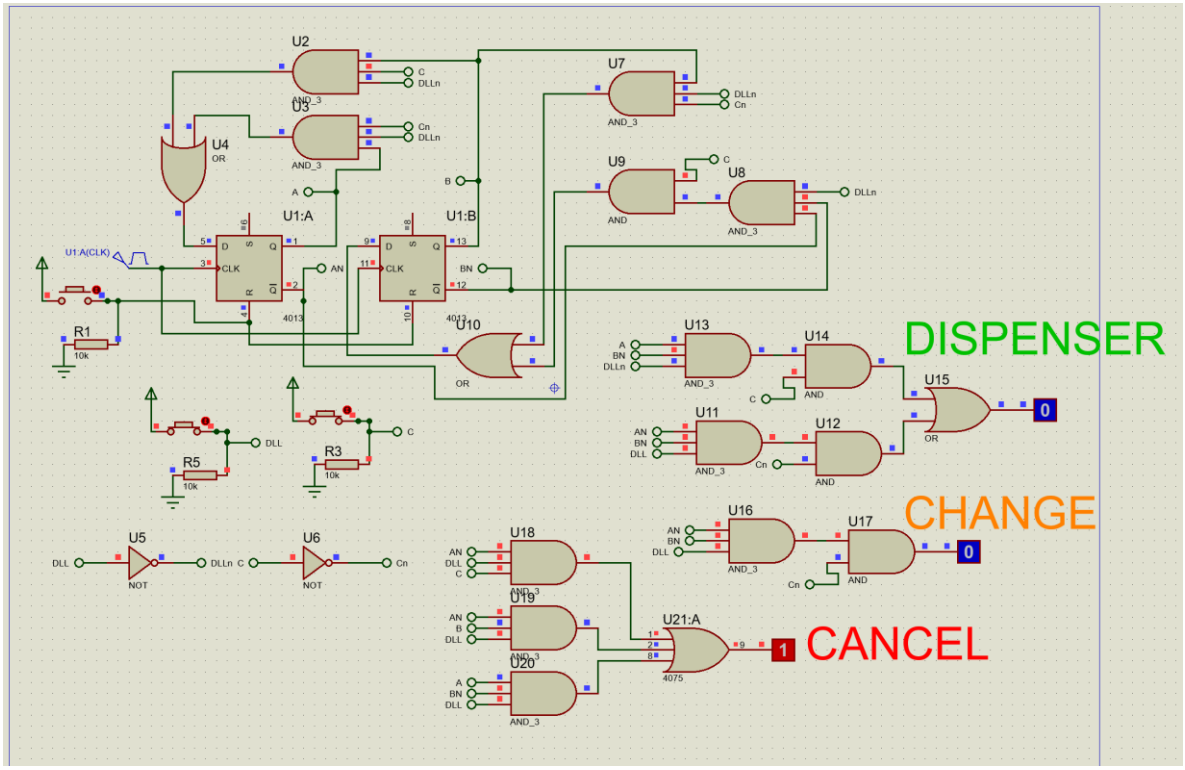


*Figure 4 Results when a dollar and a coin is inserted simultaneously.*

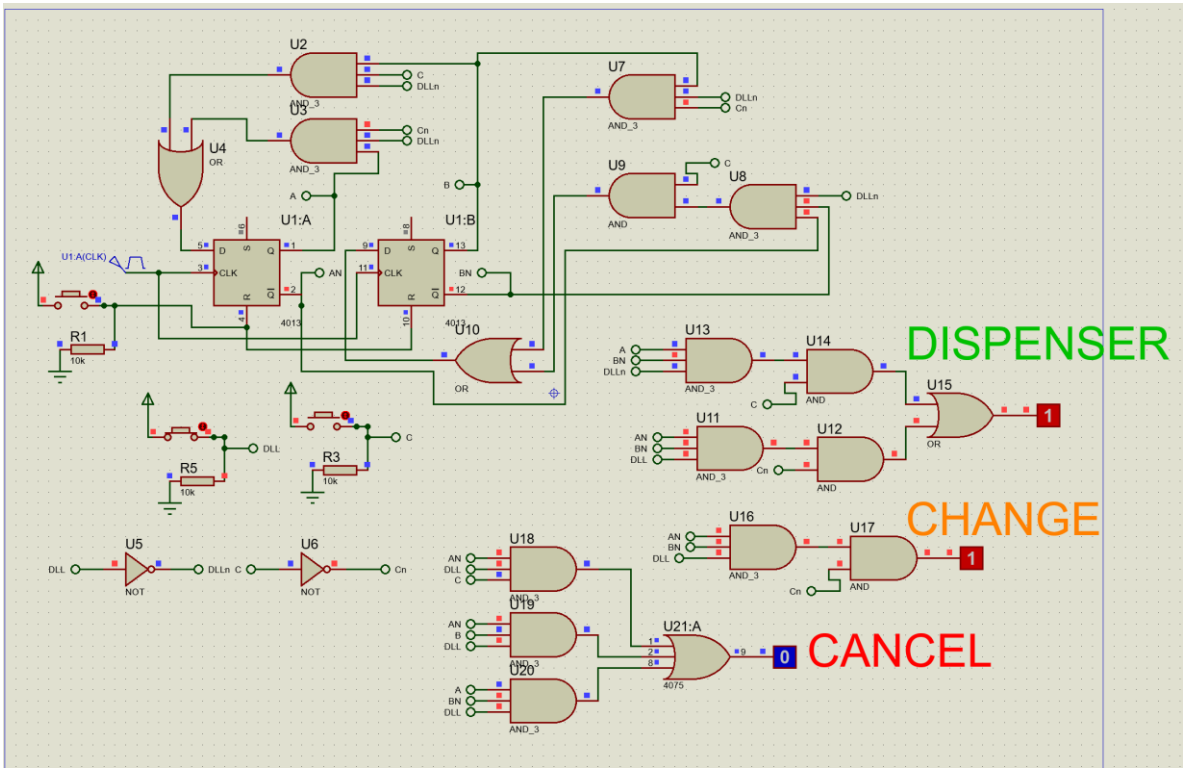


*Figure 5 result of a dollar insertion*

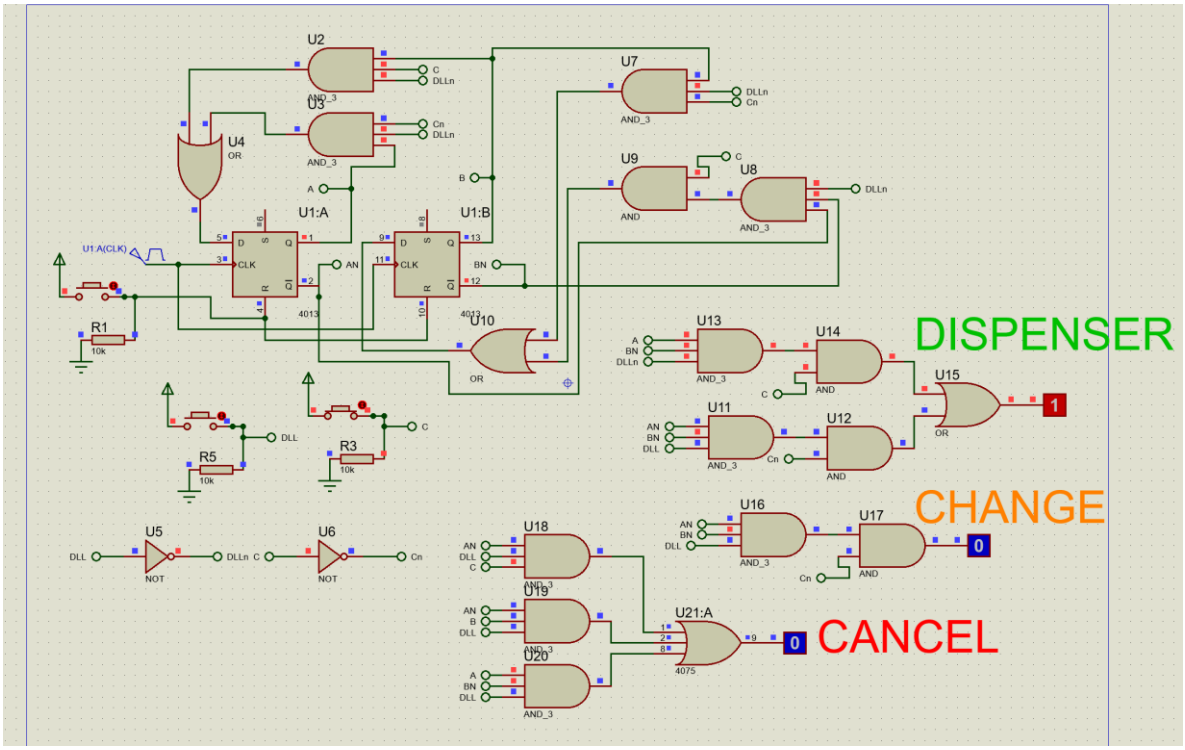


*Figure 6 result of insert 3 coins of 25 cents.*