MCTE 2332

SECTION 1

PROJECT

SIMPLE COMBINATION LOCK

SUBMITTED BY: ZHAO YAQI 1739844

LECTURER: Dr. HAZLINA BT. MD. YUSOF

SEM 1 20/21

DEPARTMENT OF MECHATRONICS ENGINEERING

INTERNATIONAL ISLAMIC UNIVERSITY OF MALAYSIA

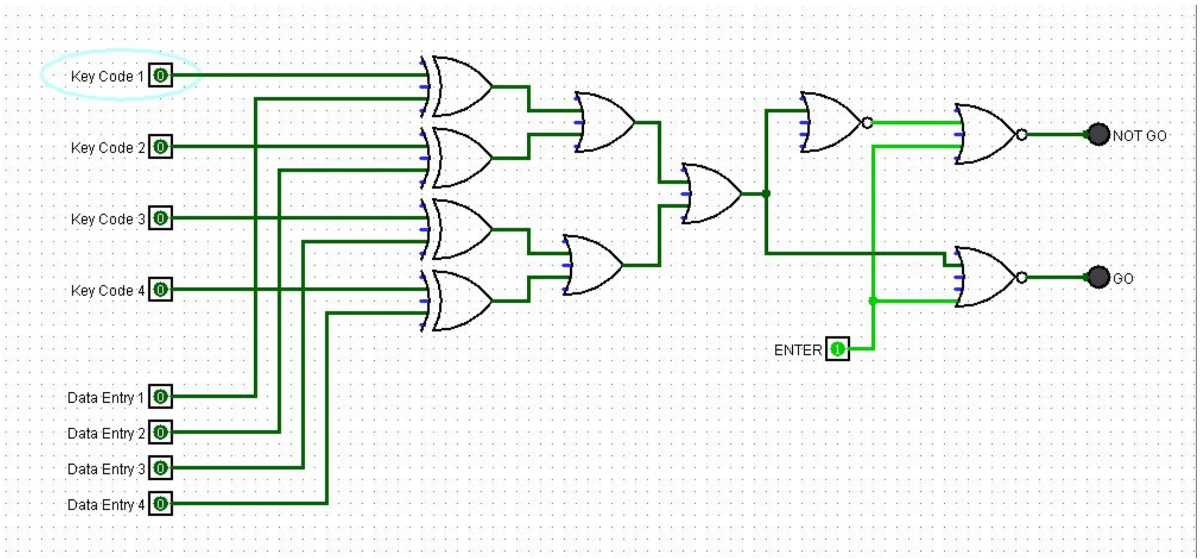
SIMPLE COMBINATION LOCK

Objectives

1. To use XOR gates as bit comparators
2. To use OR gates as logical disjunction
3. To use NOR gates as controlled inverters

Design process

Logisim circuit



Instruction

This project uses XOR (Exclusive-OR) gates as bit comparators. Firstly, the four-bit key code is entered into the circuit using a set of SPST (Single Pole Single Throw) switch. Then, the four-bit data entry is entered through another set of SPST switches. Four of the XOR gates compare the two 4-bit binary numbers respectively. If the two numbers match, bit for bit, the green "Go" LED will light up when the "Enter" switch (normally high) is closed. If the two numbers do not exactly match, the red "Not go" LED will light up when the "Enter" switch is closed.

Design Logic

XOR gate will output a "high" (1) signal if the input signals are not the same logic state. The four XOR gates' output terminals are connected through a set of OR gates: if any of the four XOR gates outputs a "high" signal (indicating that the entered code and the key code are not identical) then a “high” signal will be passed on to the NOR gate logic. If the two 4-bit codes are identical, then none of the XOR gate outputs will be “high,” and the OR gate will provide a “low” signal state to the NOR logic.

The NOR gate logic prevents either of the LEDs from turning on if the “Enter” switch is not closed. Only when this switch is closed then either of the LEDs can energize. If the Enter switch is closed and the XOR outputs are all “low,” the “Go” LED will light up, indicating that the correct code has been entered. If the Enter switch is pressed and any of the XOR outputs are “high,” the “No go” LED will light up, indicating that an incorrect code has been entered.

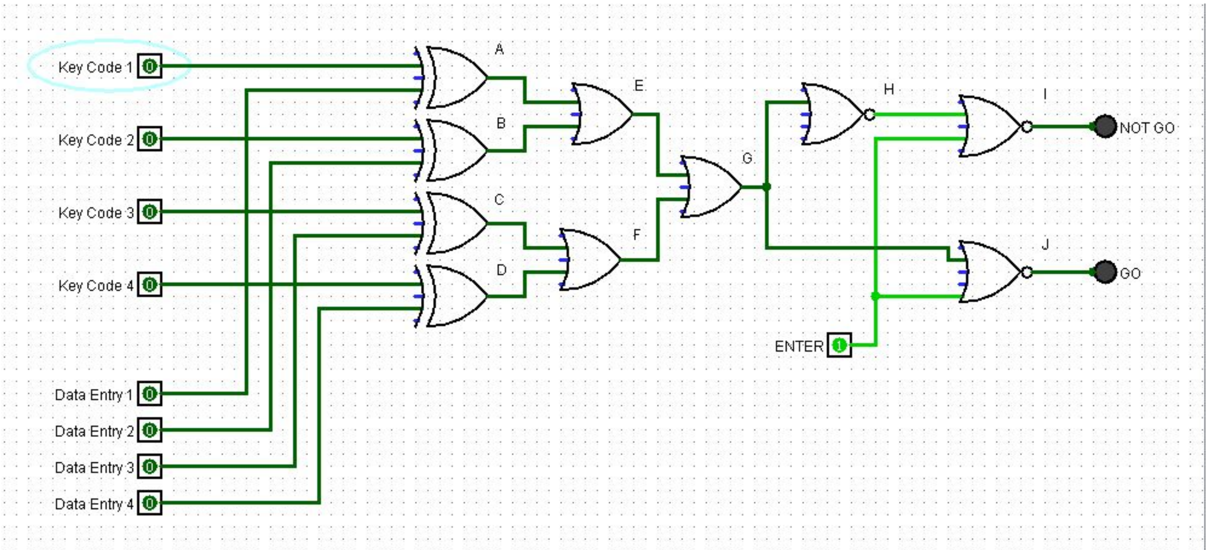
Application

This simple combination lock is suitable for applications that do not require a very high level of security, because the four-bit combination provides a mere sixteen possible combinations, this lock circuit is not very sophisticated. In fact, it would not take so long to try all combinations (0000 to 1111) until the correct one was found.

However, one of the improvements in the security is to connect the “No go” output to a counter, which will stimulate an alarming device or an emergency call at a set count. For example, when the wrong entry “No go” is counted to three, the alarm will be activated and lock the entry panel. This will prevent unauthorized people from attempting further entries.

The “key code” that used to set up the password should be hidden from view. If this simple combination lock is designed as a home security system, the data entry switch would be located outside the door and the key code switch would be behind the door.

Design detail



Logic equations & Tables

*K1-K4 = Key code

*D1-D4 = Data entry

$A = K1 \oplus D1$

$B = K2 \oplus D2$

$C = K3 \oplus D3$

$D = K4 \oplus D4$

K1	D1	K2	D2	K3	D3	K4	D4	A	B	C	D
0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	1	0	1	0	1	1	1	1	1
1	0	1	0	1	0	1	0	1	1	1	1
1	1	1	1	1	1	1	1	0	0	0	0

$E = A + B$

$F = C + D$

$G = E + F = A + B + C + D$

$H = G'$

S = Enter Switch

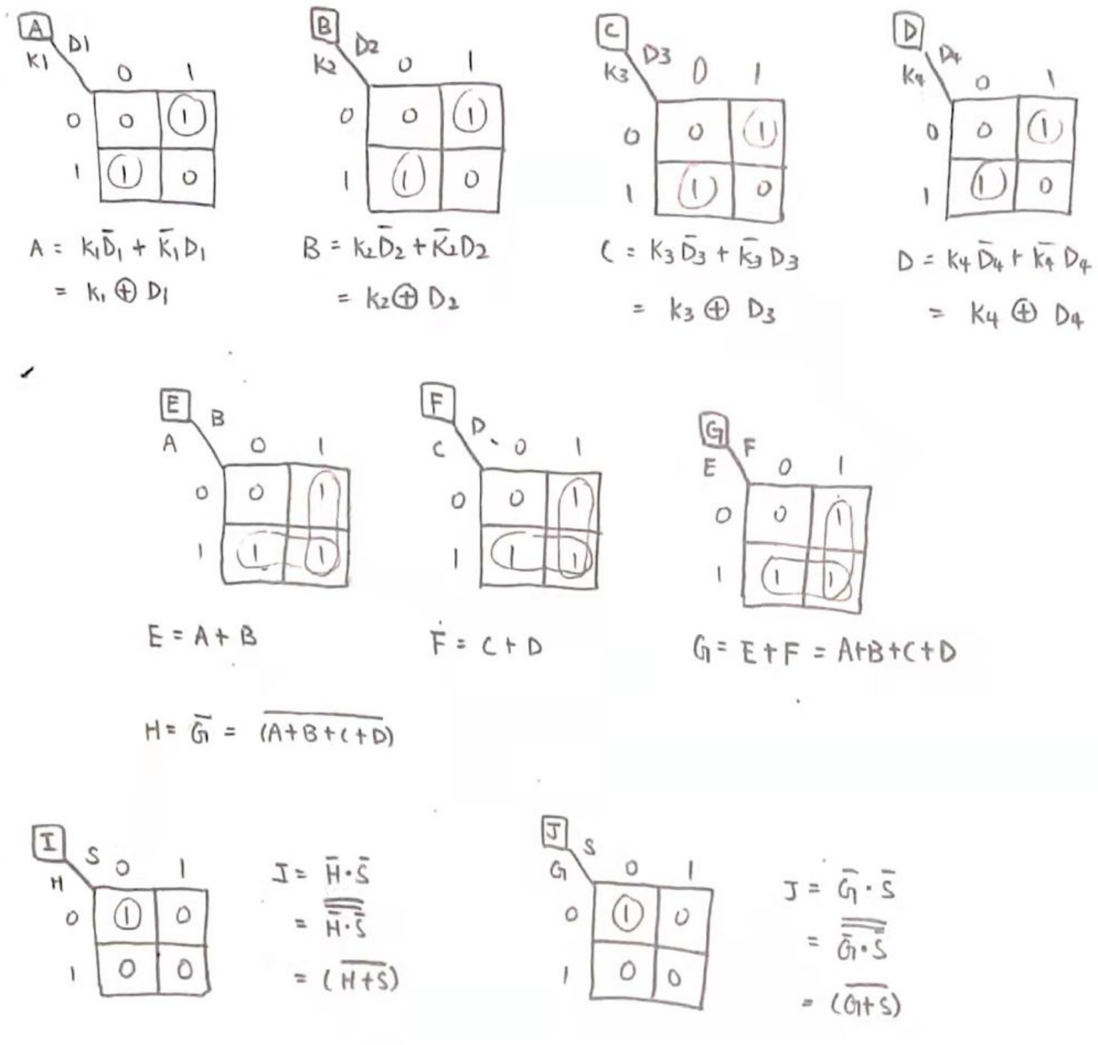
I = (H + S)’

J = (G + S)’

S	A	B	C	D	E	F	G	H	I	J
0	0	0	0	0	0	0	0	1	0	1
0	0	0	0	1	0	1	1	0	1	0
0	0	0	1	0	0	1	1	0	1	0
0	0	0	1	1	0	1	1	0	1	0
0	0	1	0	0	1	0	1	0	1	0
0	0	1	0	1	1	1	1	0	1	0
0	0	1	1	0	1	1	1	0	1	0
0	0	1	1	1	1	1	1	0	1	0
0	1	0	0	0	1	0	1	0	1	0
0	1	0	0	1	1	1	1	0	1	0
0	1	0	1	0	1	1	1	0	1	0
0	1	0	1	1	1	1	1	0	1	0
0	1	1	0	0	1	0	1	0	1	0
0	1	1	0	1	1	1	1	0	1	0
0	1	1	1	0	1	1	1	0	1	0
0	1	1	1	1	1	1	1	0	1	0
1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	1	0	1	1	0	0	0
1	0	0	1	0	0	1	1	0	0	0
1	0	0	1	1	0	1	1	0	0	0
1	0	1	0	0	1	0	1	0	0	0
1	0	1	0	1	1	1	1	0	0	0
1	0	1	1	0	1	1	1	0	0	0

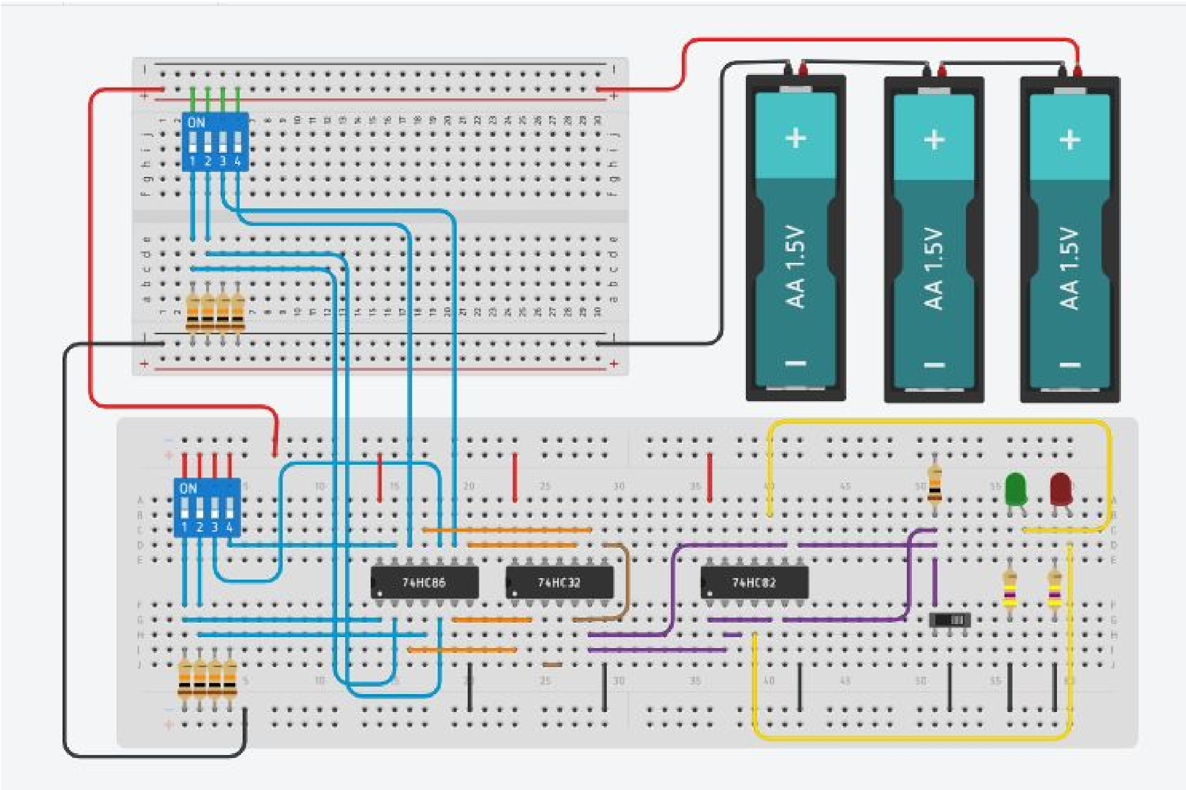
1	0	1	1	1	1	1	1	0	0	0
1	1	0	0	0	1	0	1	0	0	0
1	1	0	0	1	1	1	1	0	0	0
1	1	0	1	0	1	1	1	0	0	0
1	1	0	1	1	1	1	1	0	0	0
1	1	1	0	0	1	0	1	0	0	0
1	1	1	0	1	1	1	1	0	0	0
1	1	1	1	0	1	1	1	0	0	0
1	1	1	1	1	1	1	1	0	0	0

K-map



Design verification

Tinkercad simulation



https://www.tinkercad.com/things/dm0M0SJRmlR-mcte-2332-project-simple-combination-lock

Conclusion

This simple combination lock design is a type of locking device in which a four-bit binary number is used to open the lock. Two four-bit SPST switches are used as input of key code and data entry. The XOR gates functioned as comparators for each bit of the entry code to the pre-set key code. With a suitable combination of XOR gates with OR and NOR gates, the stimulation shows that the objective of the project has been fulfilled. The design can be used in different lock applications, with further adjustment and improvement, the limitation of the design is possible to be overcome.