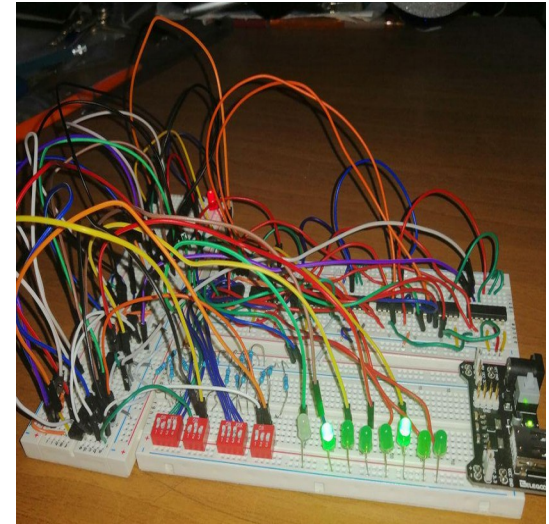
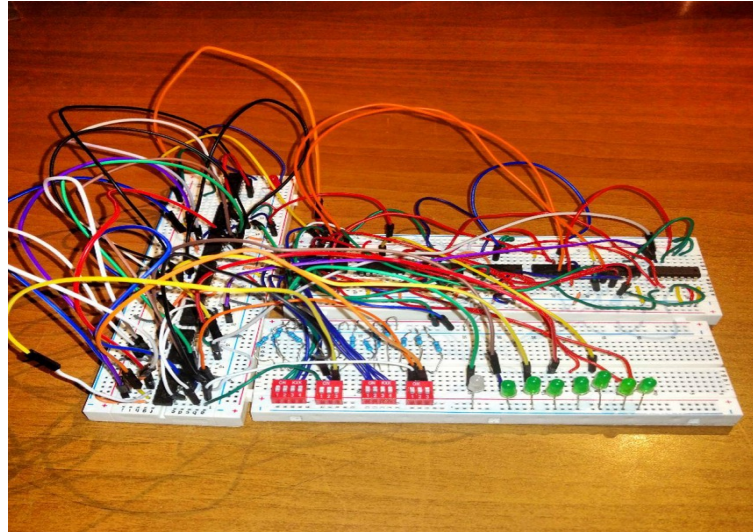
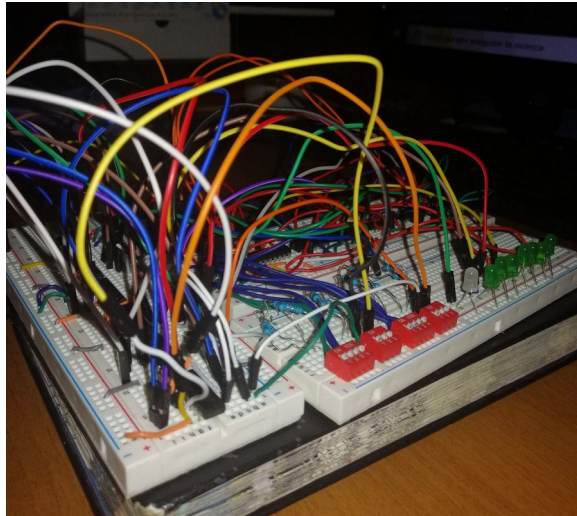


# Note di Installazione del progetto “circuito full-adder a 7 bit su breadboard” ( versione 1.0)

Guida tecnica per la realizzazione del full adder con propagazione del riporto a 7 bit.  
By Salvatore Maugeri



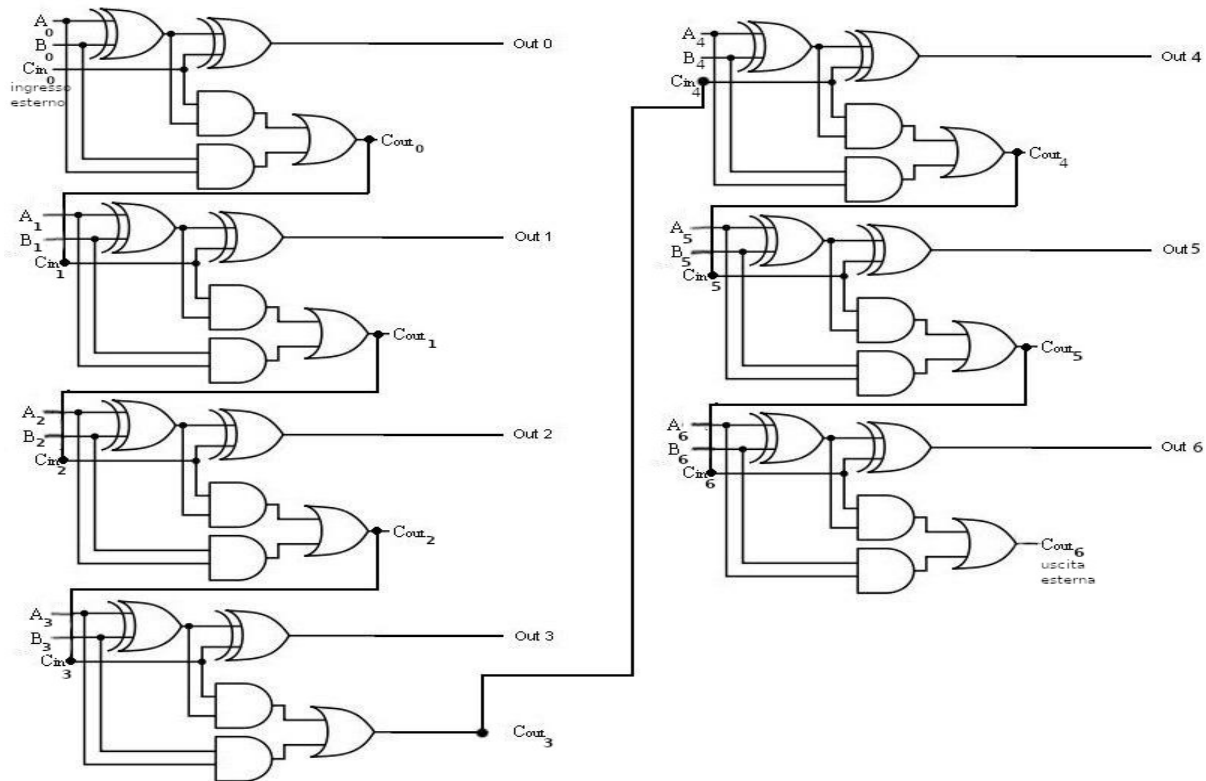
# Componenti Del Circuito

- Per realizzare il circuito full-adder a 7 bit si ha bisogno di vari componenti elettronici:

Nome	Descrizione	Quantità
BreadBoard	è uno strumento utilizzato per creare prototipi di circuiti elettrici	3 pcs - 4pcs
LED	Utilizzati per la visualizzazione dell'output	8 pcs
Cavi/Jumper	Per collegare le varie entrate e uscite	Min 65-80 pcs
Alimentatore Breadboard	Compatto alimentatore studiato appositamente per essere impiegato con le breadboard. Dispone di interruttore on/off, uscita USB 5V, LED di alimentazione e jumper di selezione tensione	1 pcs
Circuiti Integrati (porte logiche)	Le porte logiche non sono commercializzate come singoli componenti, ma sotto forma di circuiti integrati. Un circuito integrato in generale è un circuito elettronico complesso (contenente a volte molte migliaia di componenti singoli, quali transistor, diodi, resistenze etc.) interamente realizzato su un'unica piastrina (chip) di materiale semiconduttore (di solito silicio).	<ul style="list-style-type: none"><li>• 4 pcs QUAD XOR GATE</li><li>• 4 pcs DUAL 4-INPUT OR GATE</li><li>• 5 pcs TRIPLE-3-INPUT AND GATE</li></ul>
Dip Switch a Doppia Fila	interruttori per l'inserimento dell' input	2 pcs - variabile

# Prima di iniziare

- Per creare il circuito è fondamentale creare lo schema logico di esso:



Dove  $A$  è il bit del primo numero  
 $B$  è il bit del secondo numero.  
 $C_{out}$  indica il riporto  
E  $Out_n$  è il risultato dell' $n$  stadio.

Il circuito è formato da 7 stadi.

# Approfondimento dei circuiti integrati:

*n.b* essendo che disponevo solo dei circuiti integrati **AND a tre ingressi** e **OR a 4 ingressi** (e non a 2 ingressi come vale per il circuito integrato XOR) e poiché utilizzerò solo due ingressi per ogni porta, non usufruirò delle porte restanti (quindi resteranno inutilizzate).

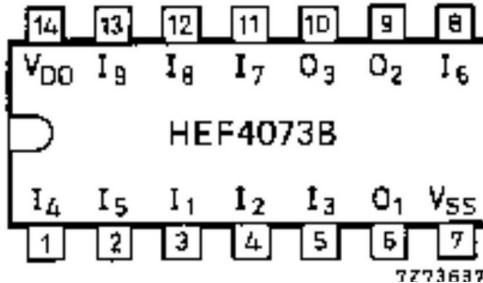
QUAD XOR GATE M74HC86



datasheet:

<https://www.st.com/resource/en/datasheet/cd00000351.pdf>

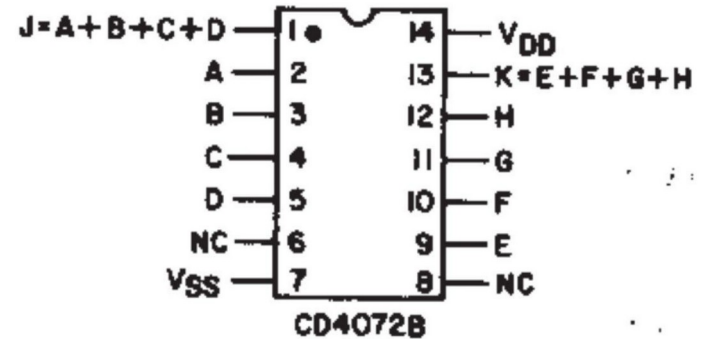
TRIPLE-3-INPUT AND GATE HEF4073B



datasheet:

<https://assets.nexperia.com/documents/datasheet/HEF4073B.pdf>

DUAL 4-INPUT OR GATE CD4072B



NC = NO CONNECTION

datasheet:

<http://www.ti.com/lit/ds/smlink/cd4071b.pdf>



# Prerequisiti

- Prima di cominciare la realizzazione del circuito è fondamentale avere basi di elettrotecnica (anche di base) e saper utilizzare un minimo la breadboard.
- Ecco dei brevi tutorial per apprendere l'utilizzo della breadboard:  
<https://www.youtube.com/watch?v=y12vySQPPIU>  
<https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard/all>

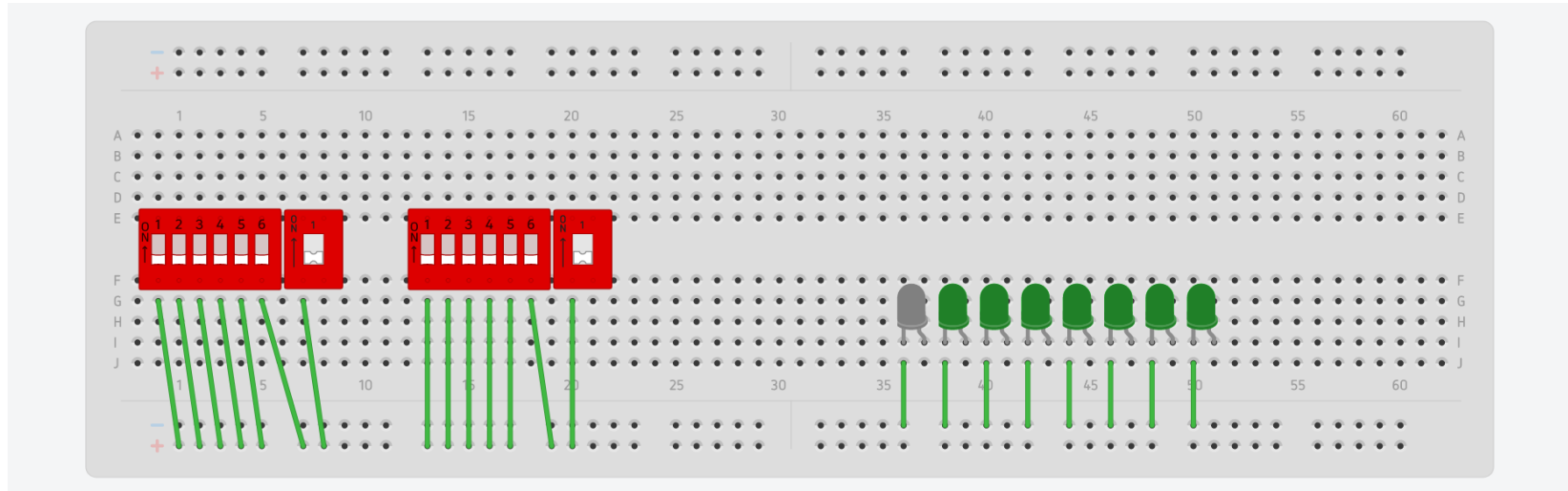
# Realizzazione del circuito

# Passo #1

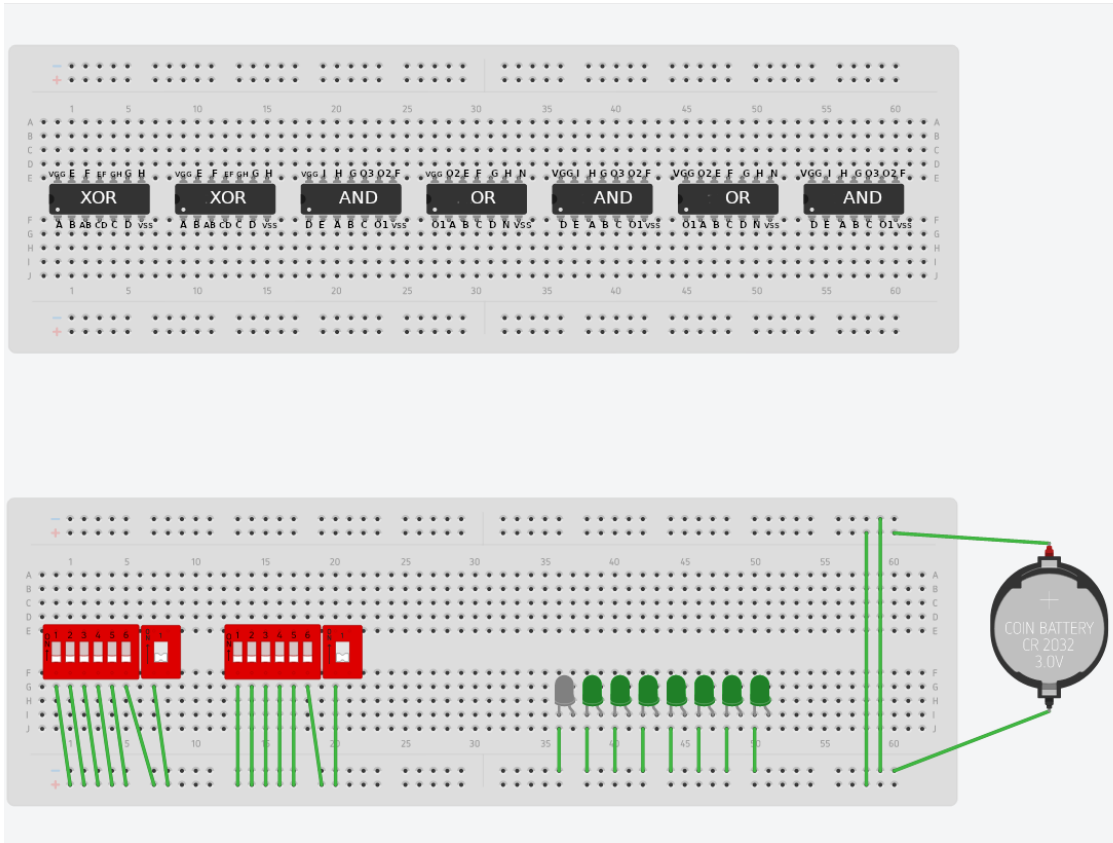
- Metteremo gli switch sulla breadboard: Gli switch: utili per l'inserimento dei bit.

Collegheremo i primi pin degli switch alla carica positiva.

- Metteremo anche i led utili per visualizzare il risultato in binario, ai LED presenti sulla breadboard collegheremo in futuro il catodo con la carica che rappresenterà il bit del risultato, mentre colleghiamo l'anodo alla carica negativa.

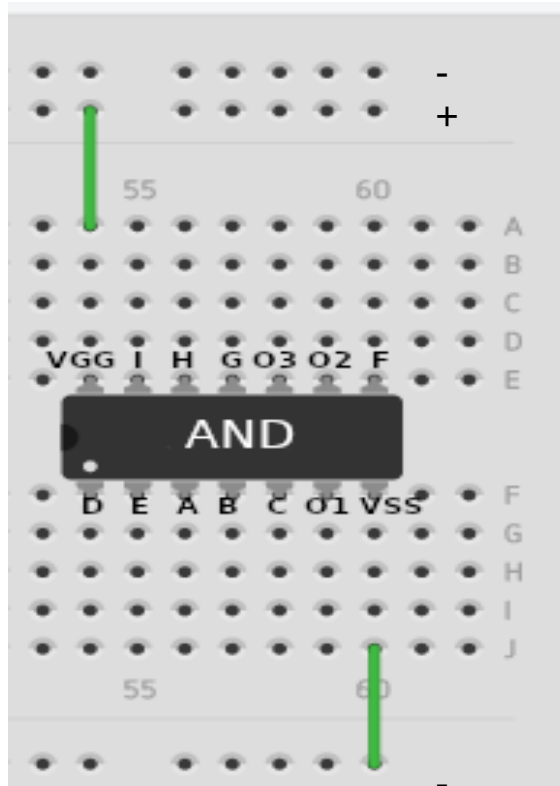


# Passo #2



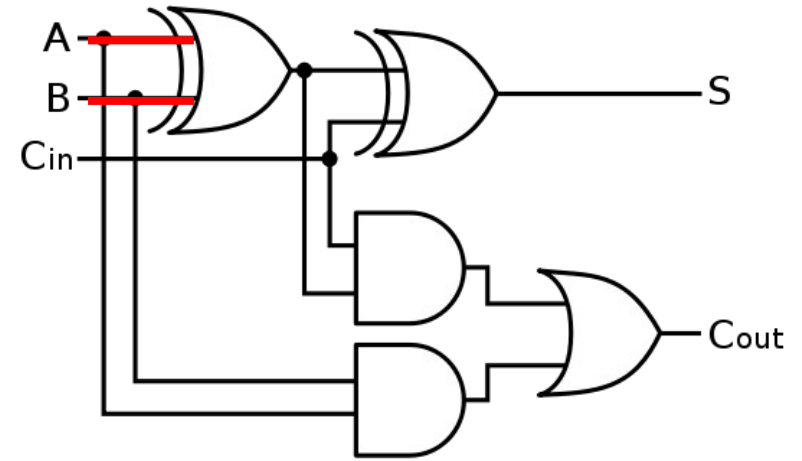
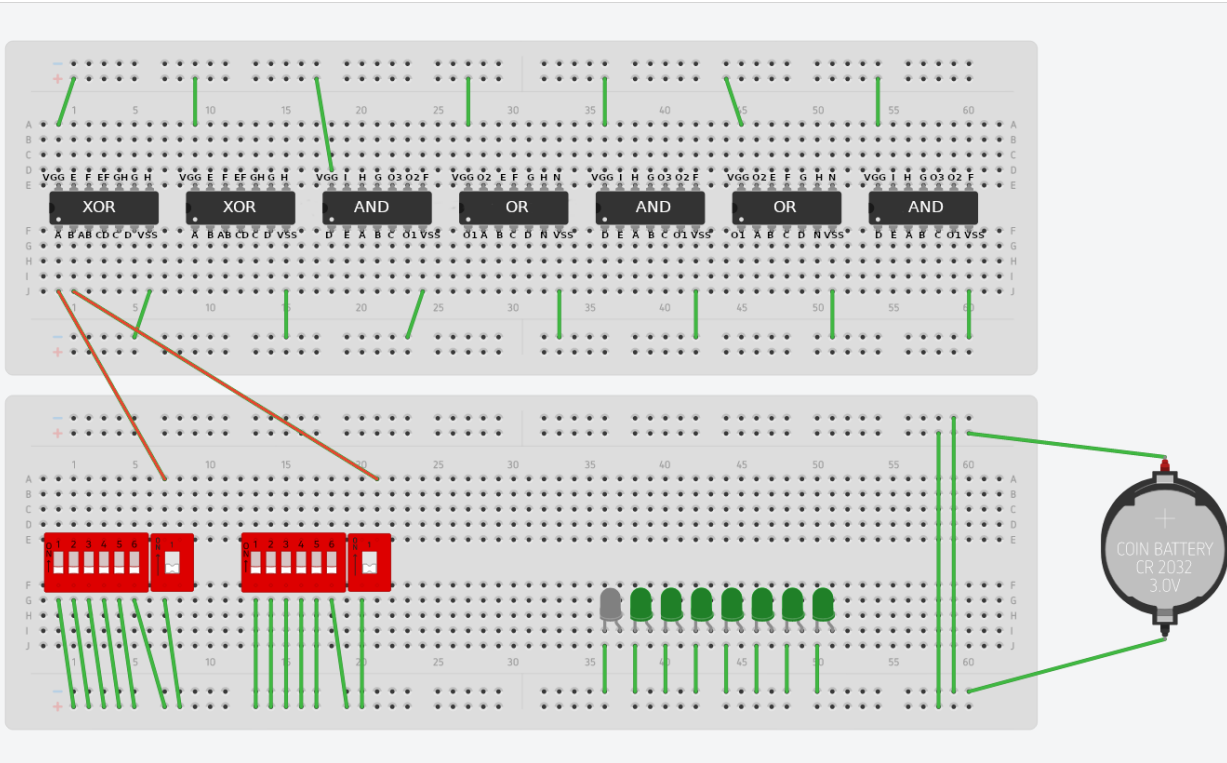
- Utilizziamo un'altra breadboard per inserire i circuiti integrati

# Passo #3



- **Per ogni circuito integrato** colleghiamo il pin Vgg alla carica positiva e il pin Vss alla carica negativa come in figura.

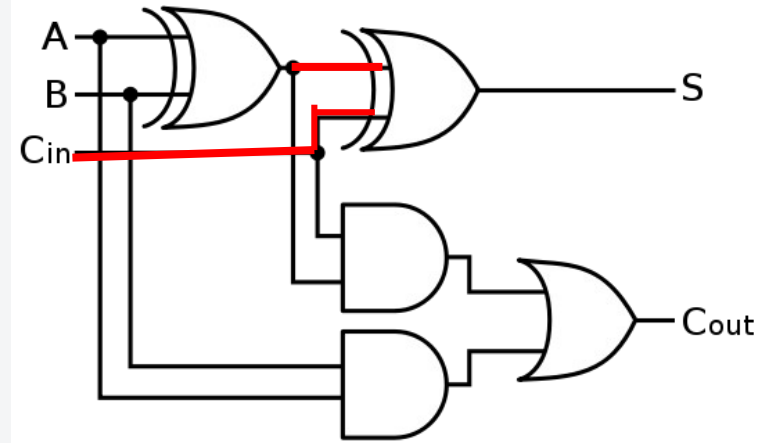
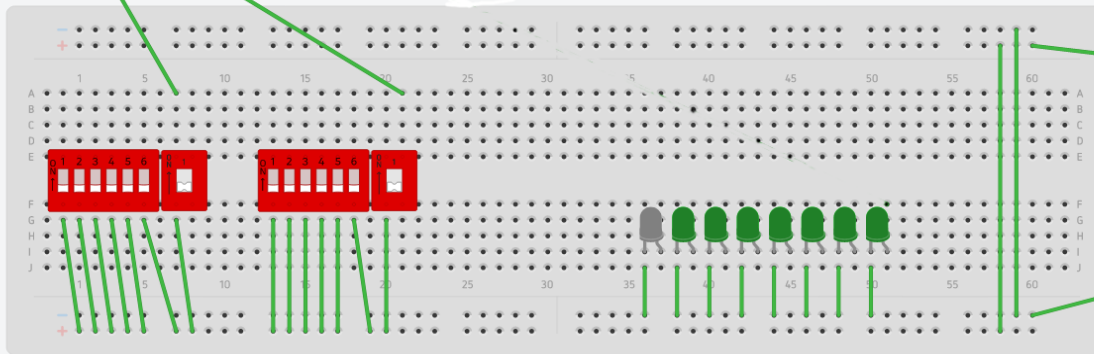
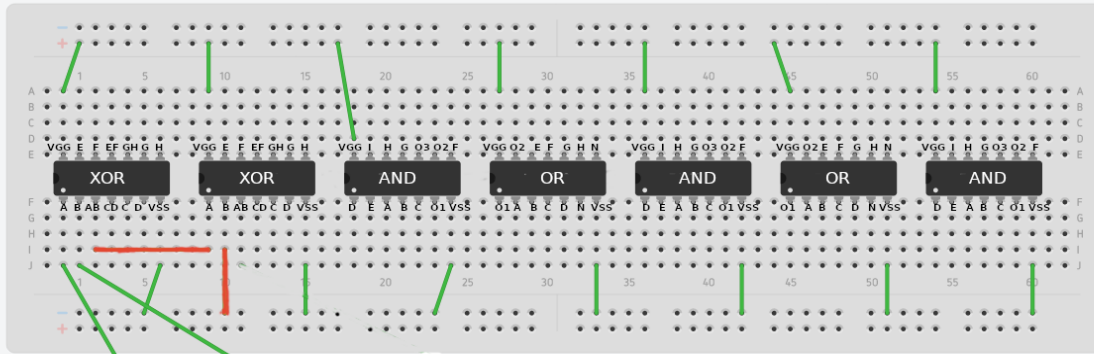
# Passo #4 Stadio 0



- Colleghiamo i primi bit all'entrate A e B del primo circuito integrato XOR.

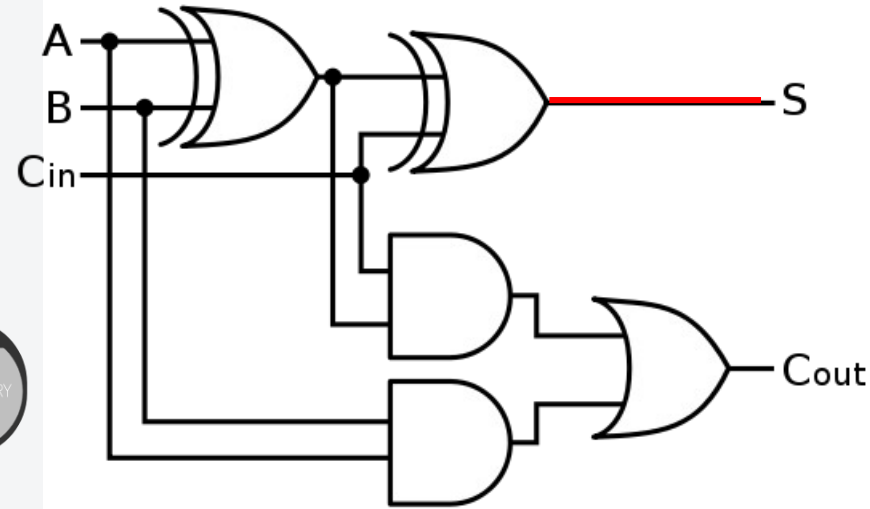
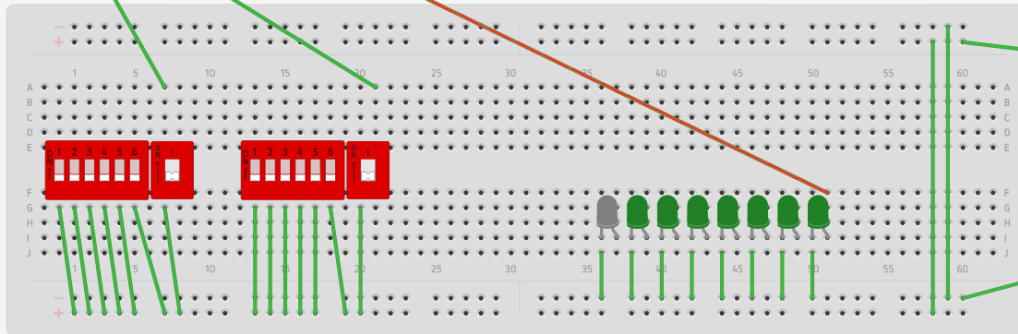
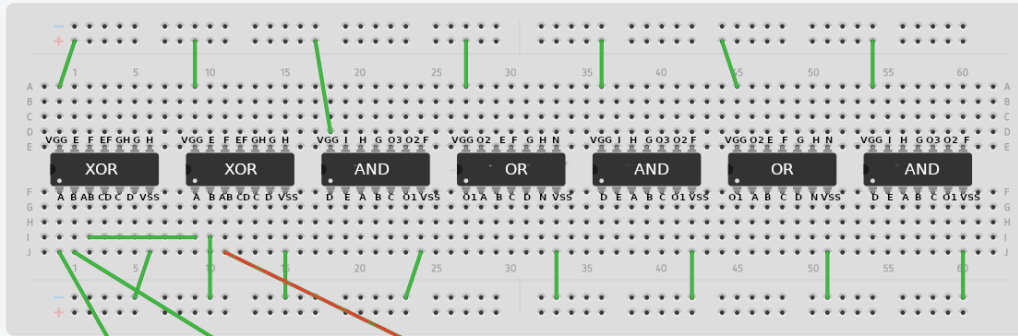


# Passo #5 Stadio 0



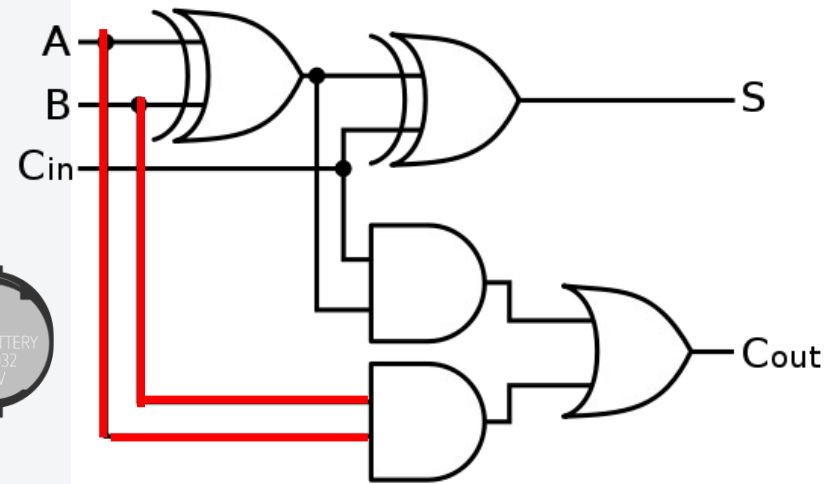
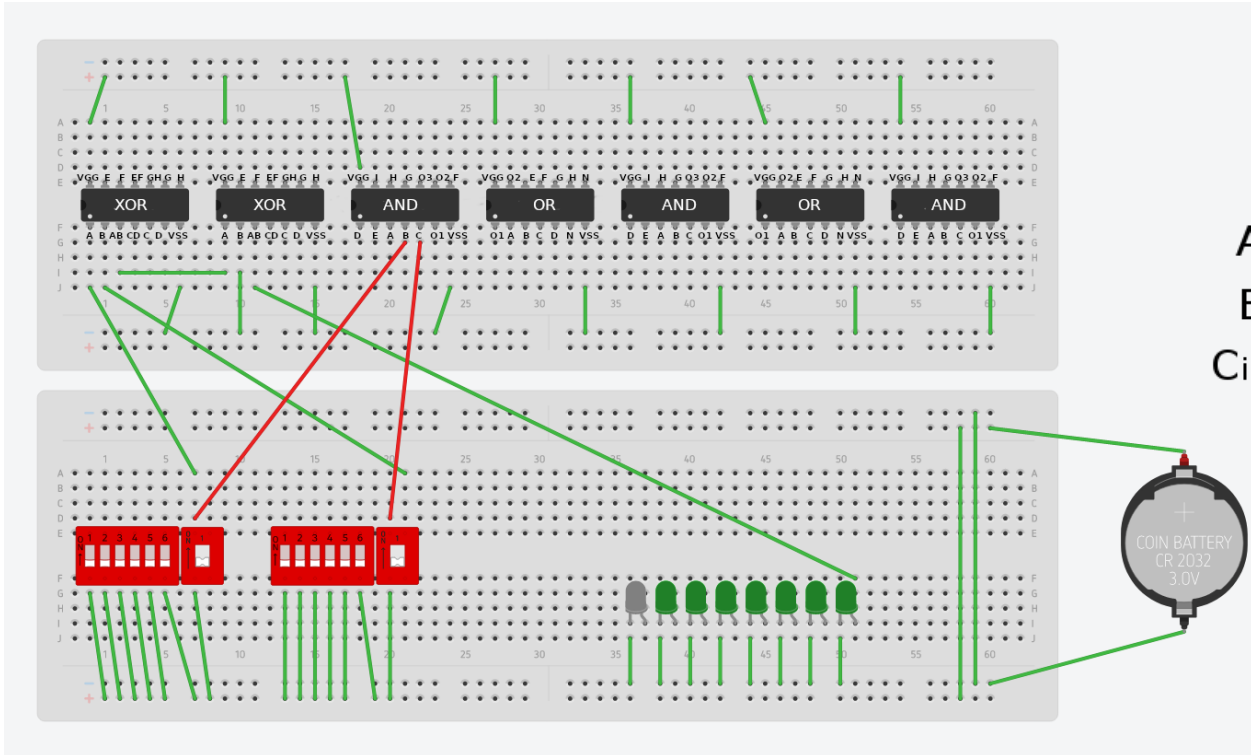
- L'uscita AB del primo circuito integrato XOR lo colleghiamo all'ingresso A del secondo circuito integrato XOR e il Carry (essendo che siamo ancora nello stadio 0) sarà 0 quindi collegheremo la carica negativa all'ingresso B del secondo circuito integrato XOR.

# Passo #6 Stadio 0



- l'uscita AB del secondo circuito integrato XOR va collegato al catodo del primo LED.

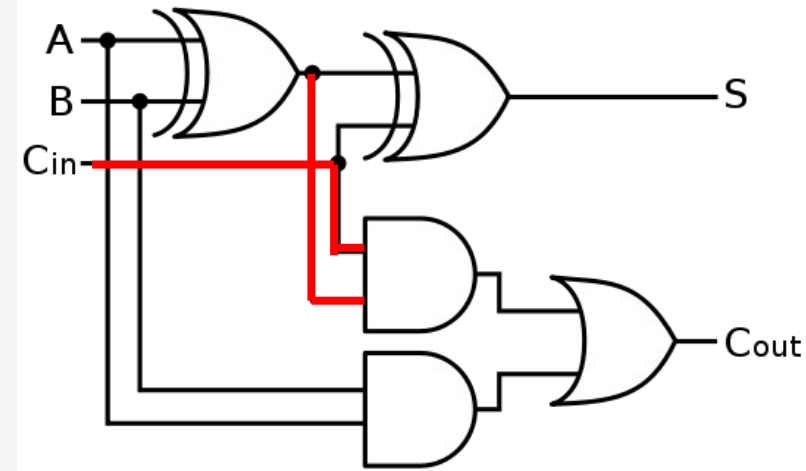
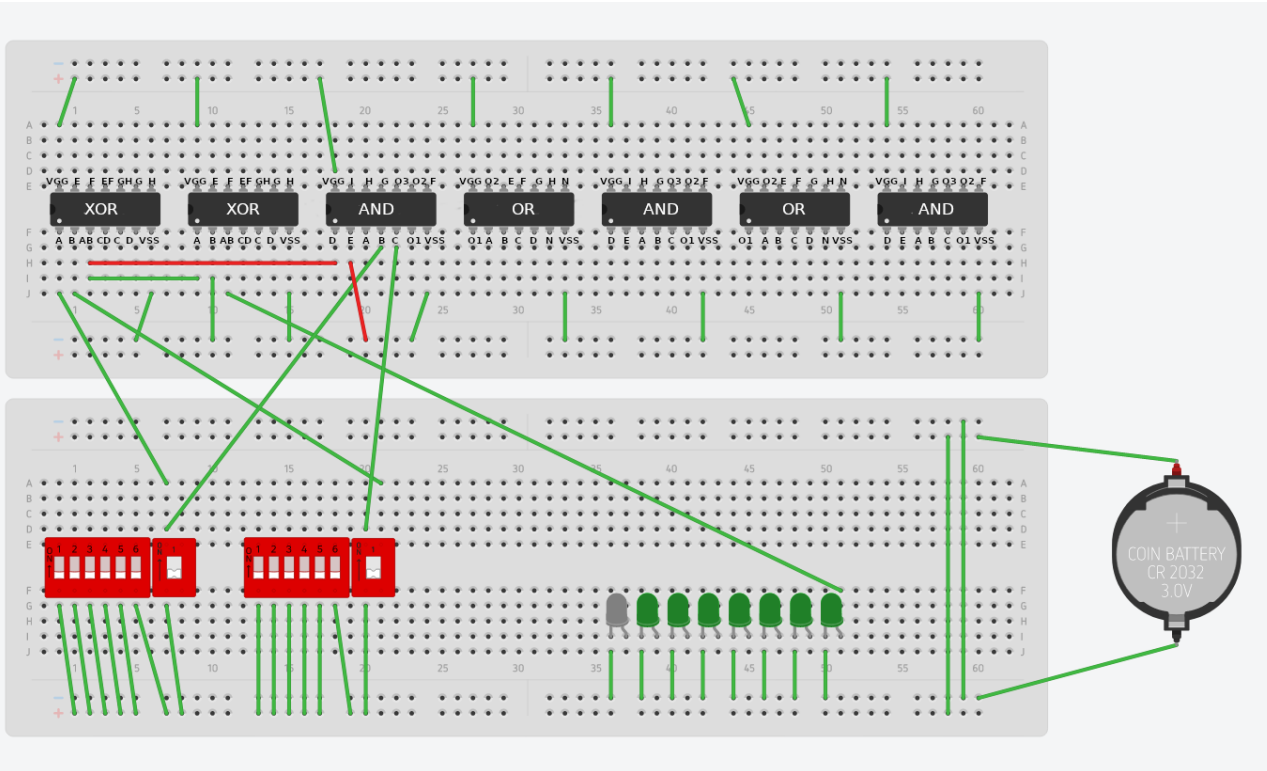
# Passo #7 Stadio 0



- Si effettua l'AND tra i bit dei numeri binari.

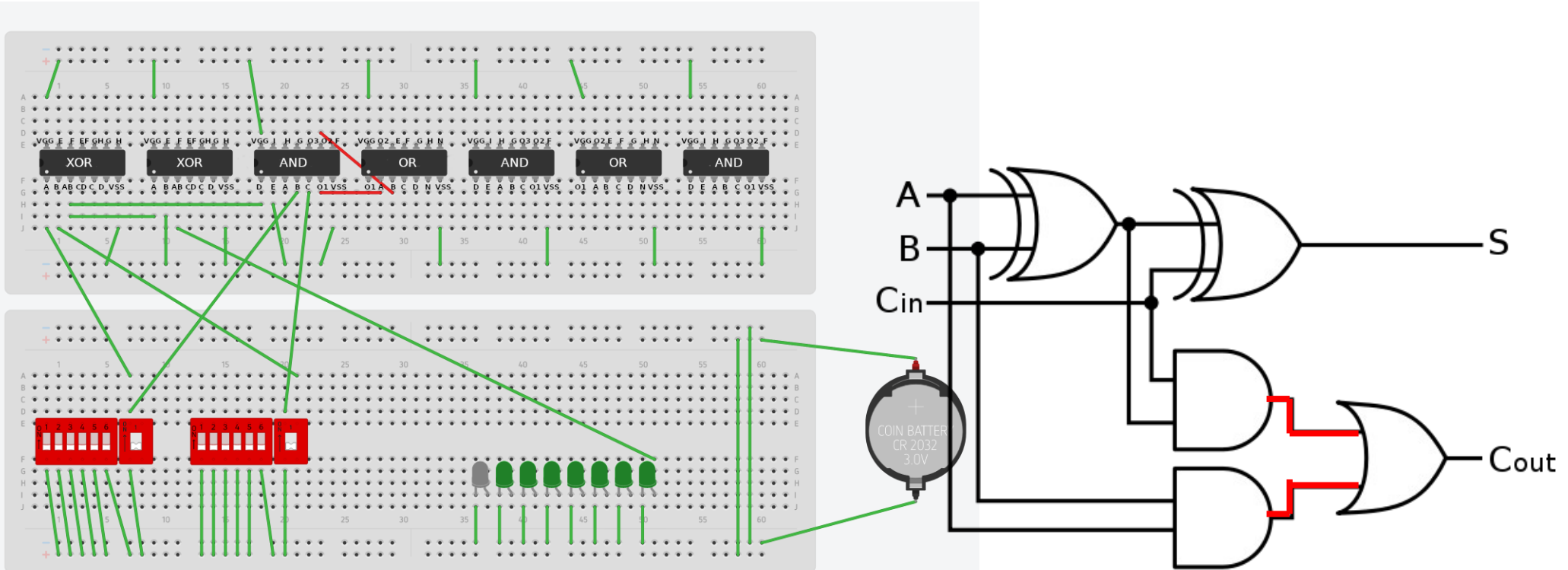
Quindi inseriamo all'entrata B e C del primo circuito integrato AND i due bit dei due numeri binari da sommare

# Passo #8 Stadio 0



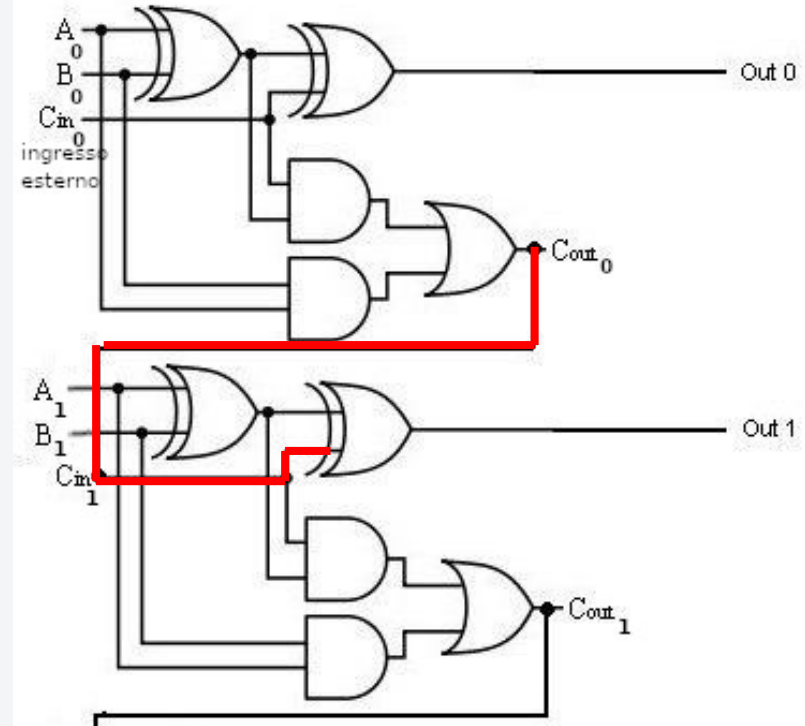
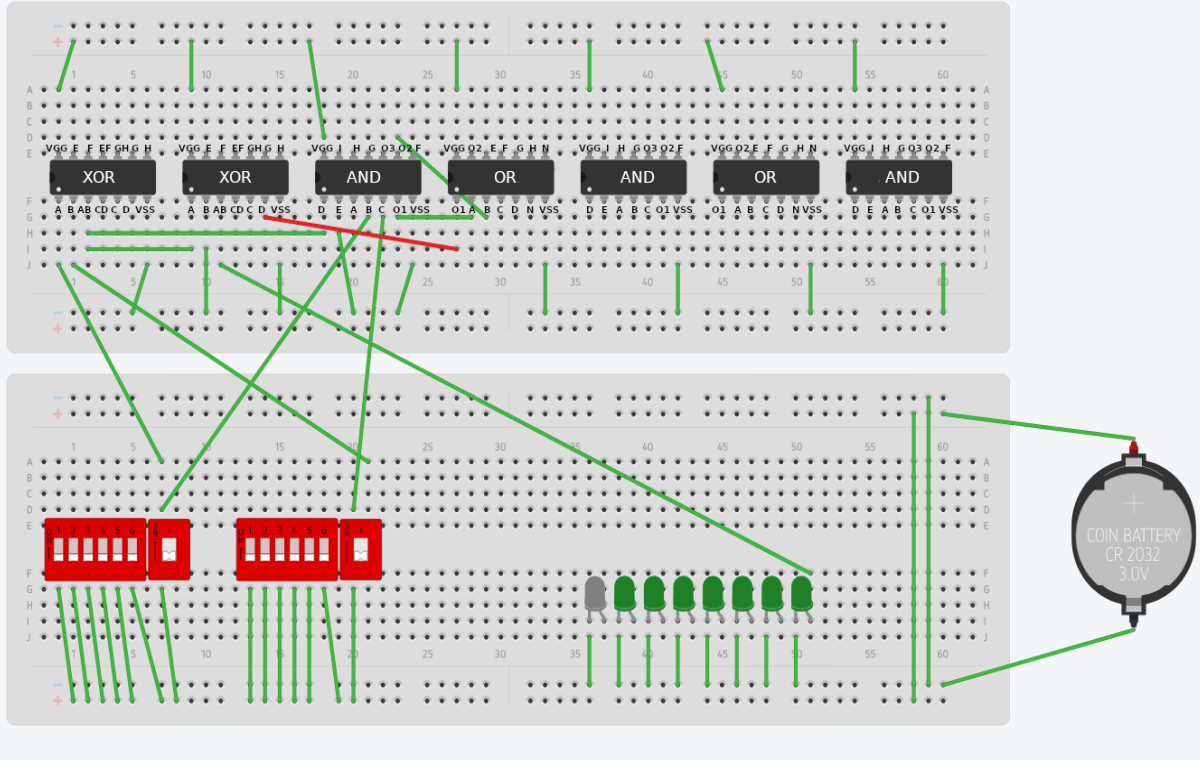
- Si effettua l'AND tra l'uscita AB del primo XOR e il carry che (come avevamo chiarito prima) avrà il valore 0, quindi colleghiamo l'entrata E del primo circuito integrato AND alla carica negativa e l'uscita XOR all'entrata D.

# Passo #9 Stadio 0



L'uscita O1 del primo circuito integrato AND va inserita nell'entrata A del primo circuito integrato OR e l'uscita O2 del primo circuito integrato AND va inserita nell'entrata B del primo circuito integrato OR.

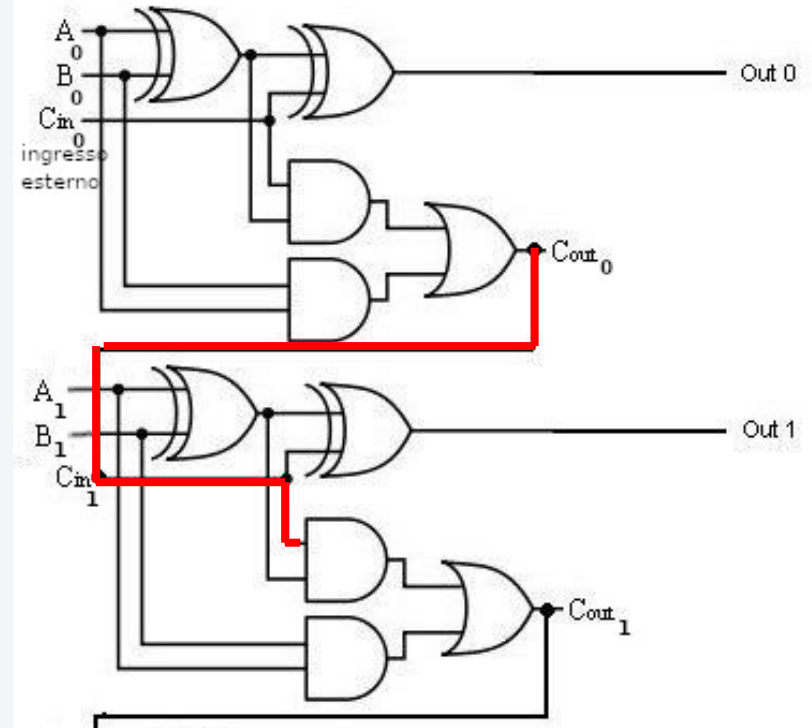
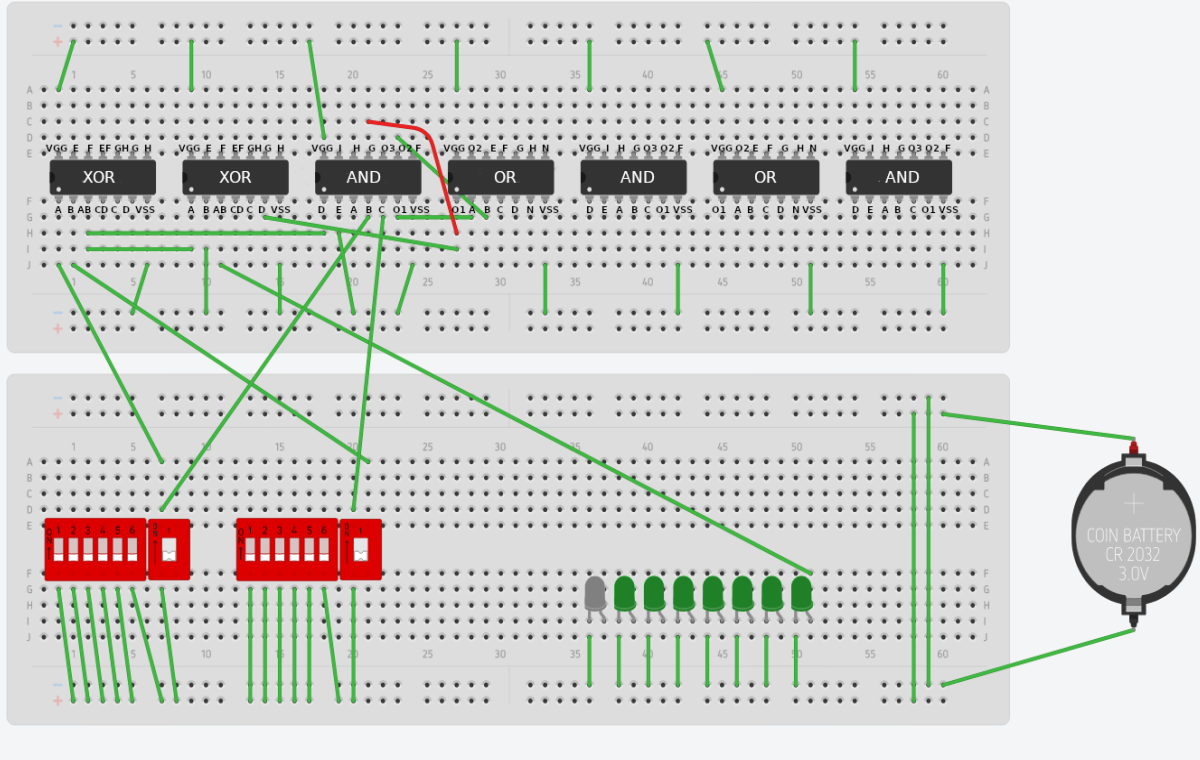
# Passo #10 Stadio 1



- Da qui si passa dallo stadio 0 allo stadio 1, abbiamo così riportato il carry allo stadio corrente. L'uscita  $O1$  del primo circuito integrato OR va inserito all'entrata  $D$  del secondo circuito integrato XOR.

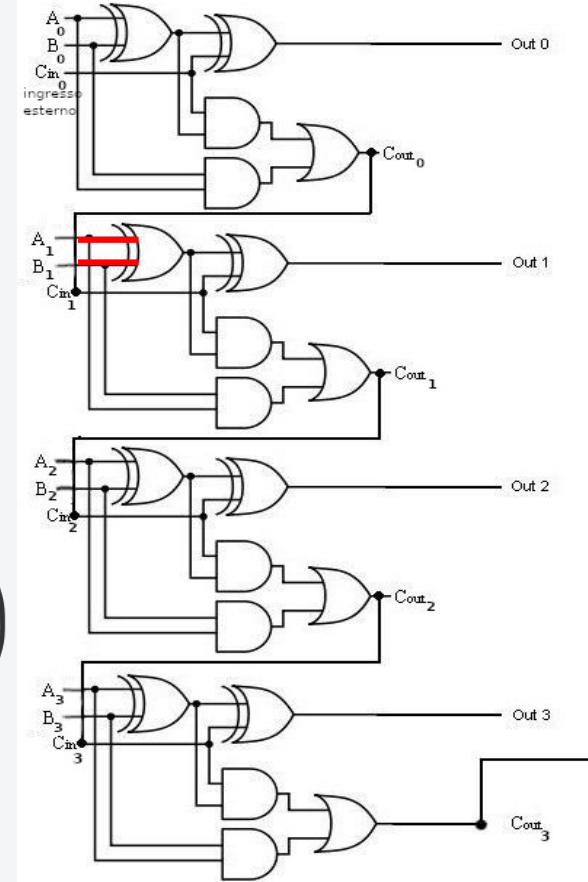
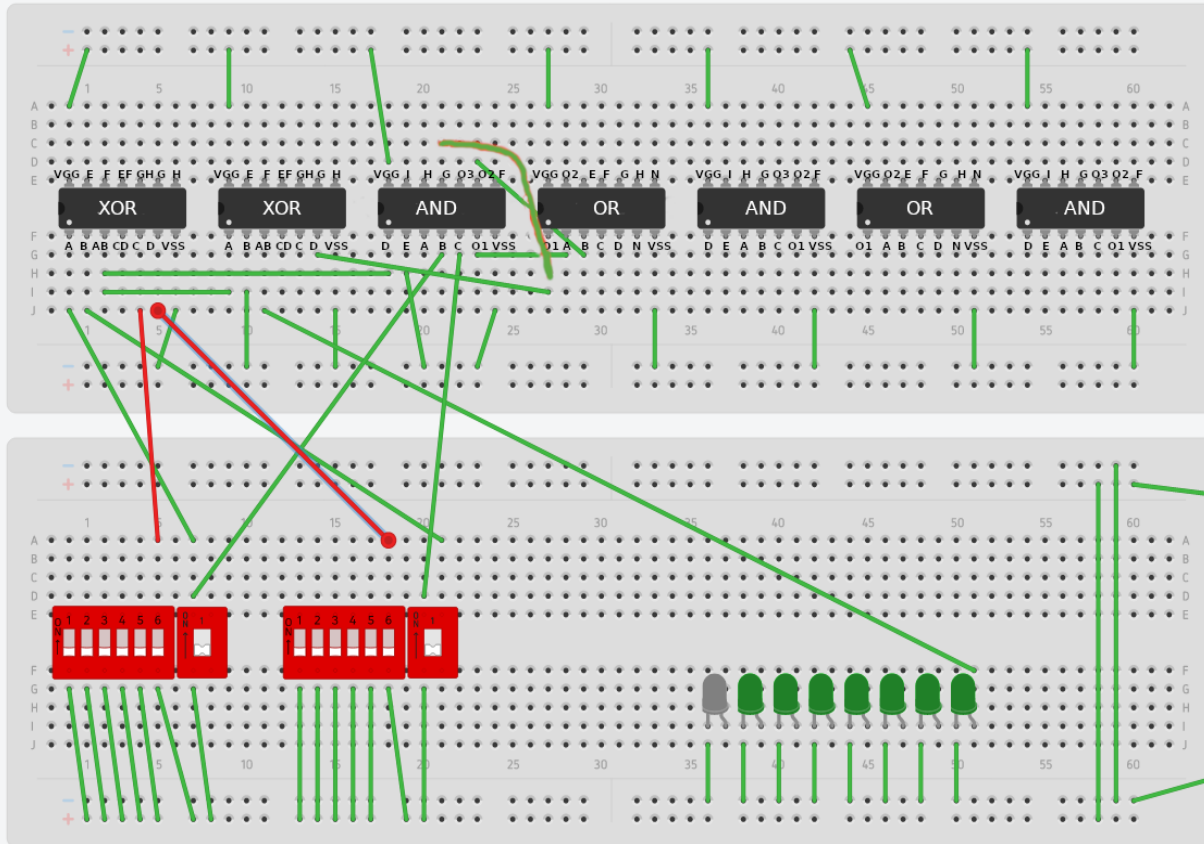


# Passo #11 Stadio 1

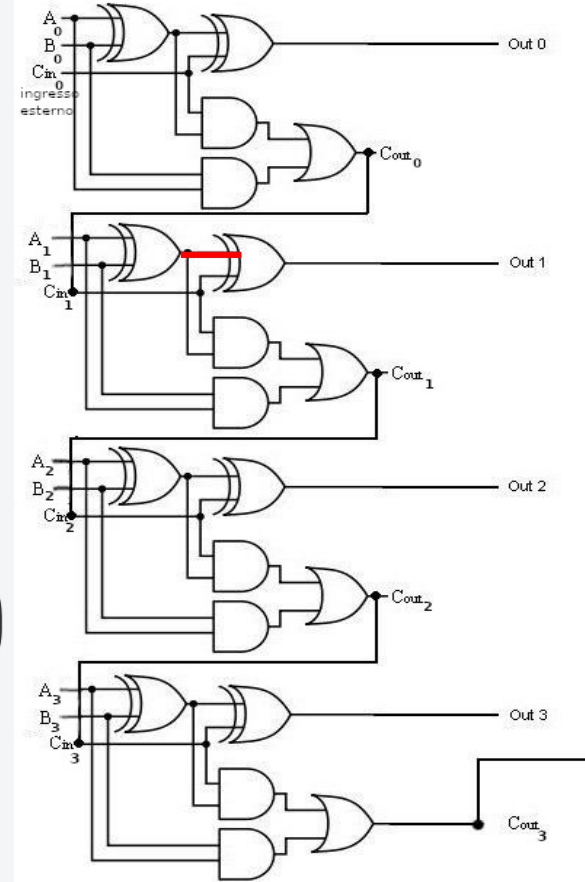
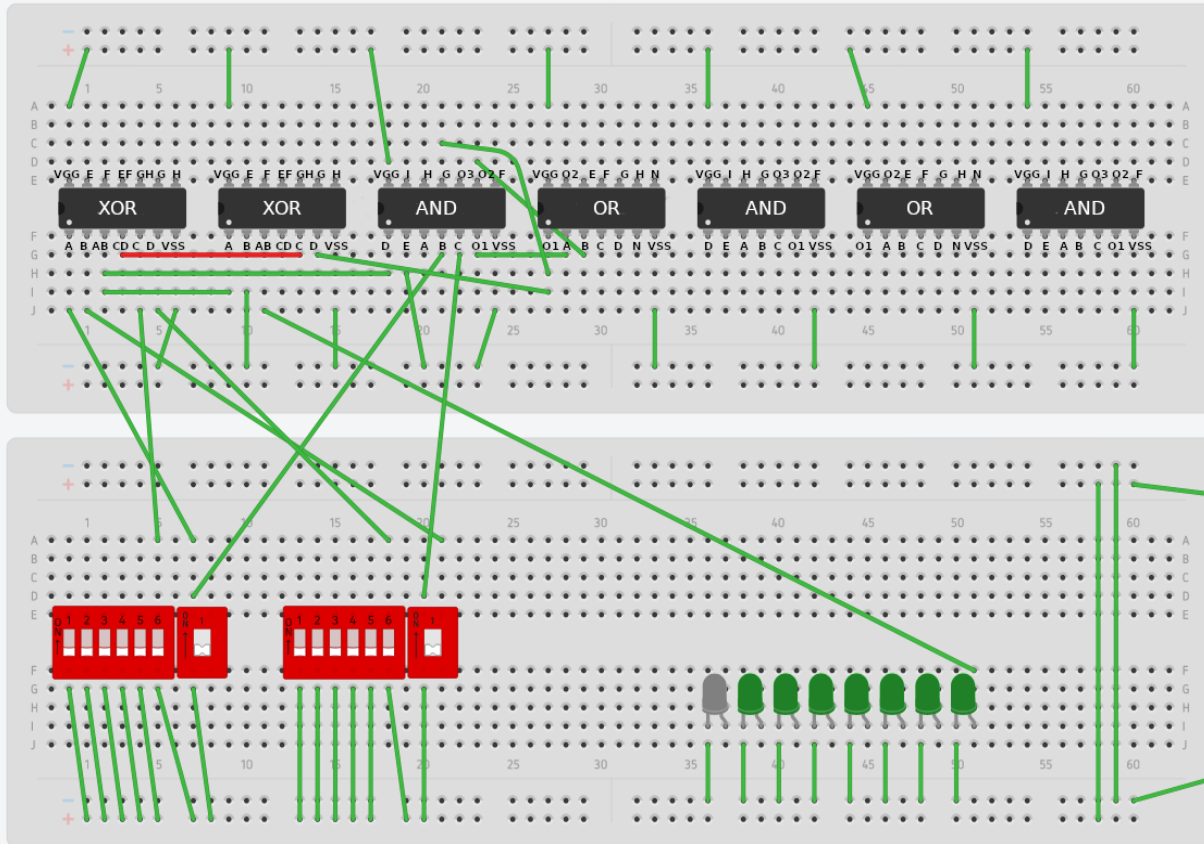


- L'uscita O1 del primo circuito integrato OR va inserito all'entrata G del secondo circuito integrato AND.  
D'ora in poi lo svolgimento per i successivi stadi sarà uguale allo stadio visto fino adesso, l'unica differenza sarà l'uso di porte diverse che saranno chiaramente visibili dalle immagini illustrative.

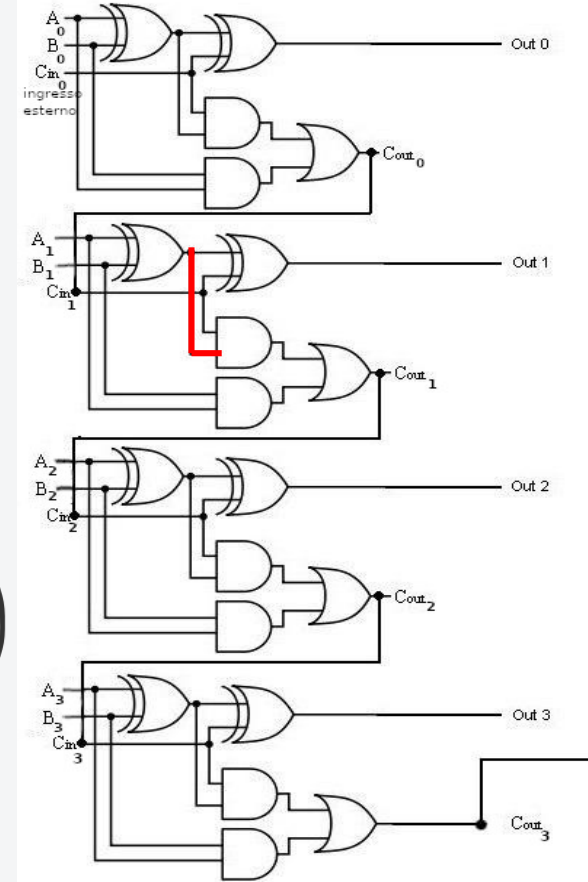
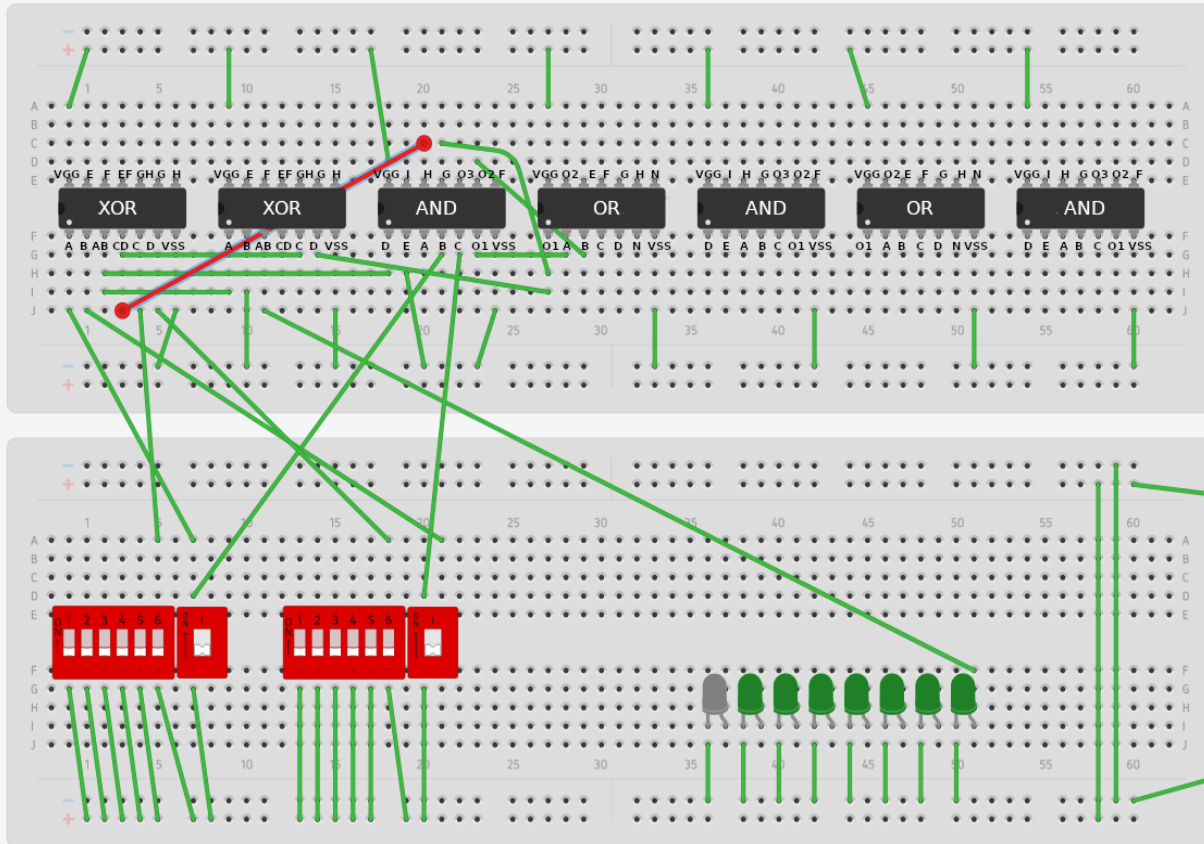
# Passo #12 Studio 1



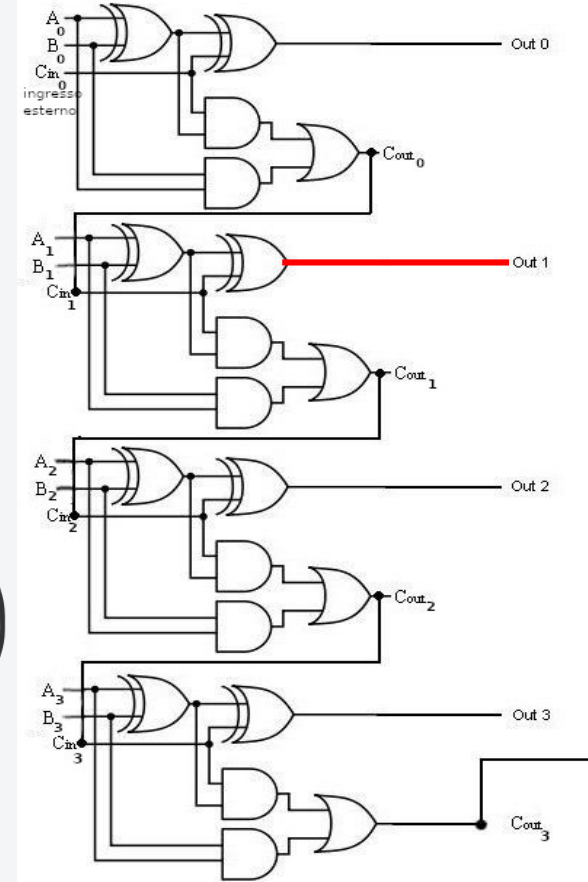
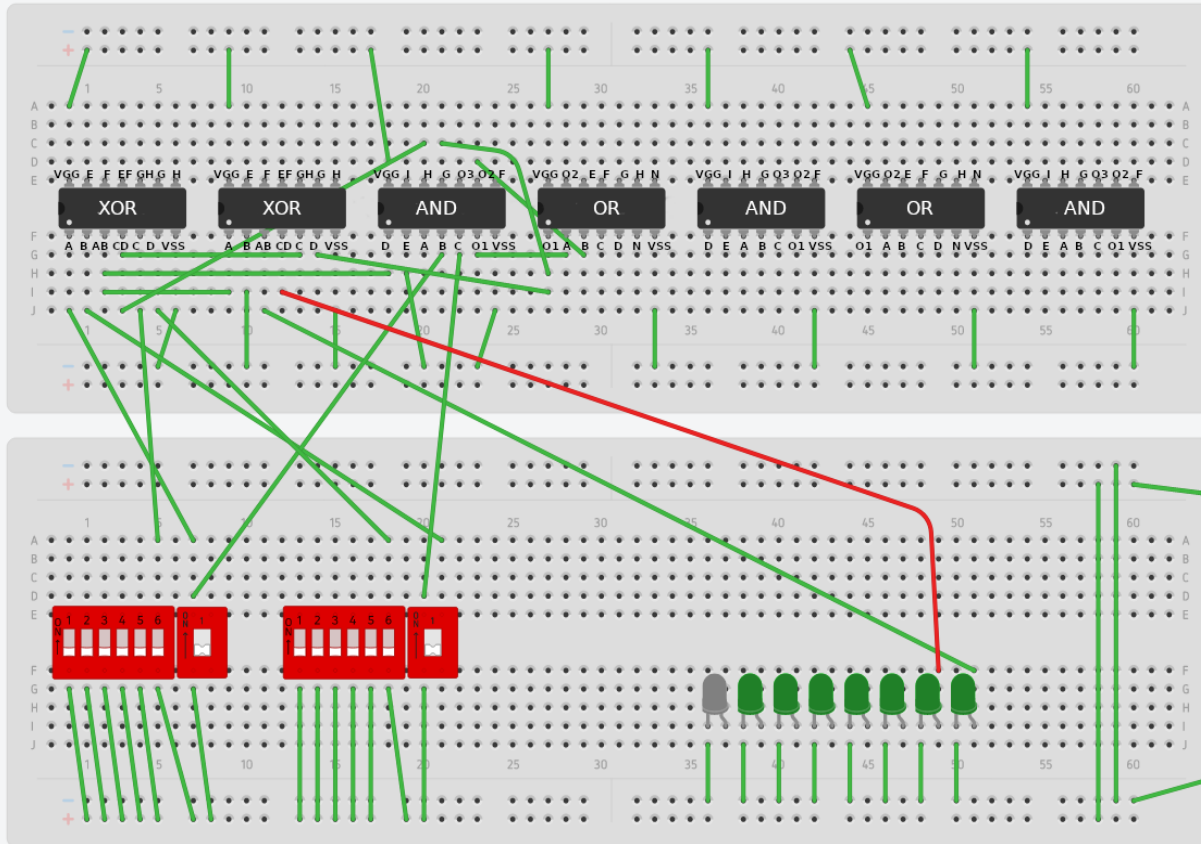
# Passo #13 Studio 1



# Passo #14 Studio 1

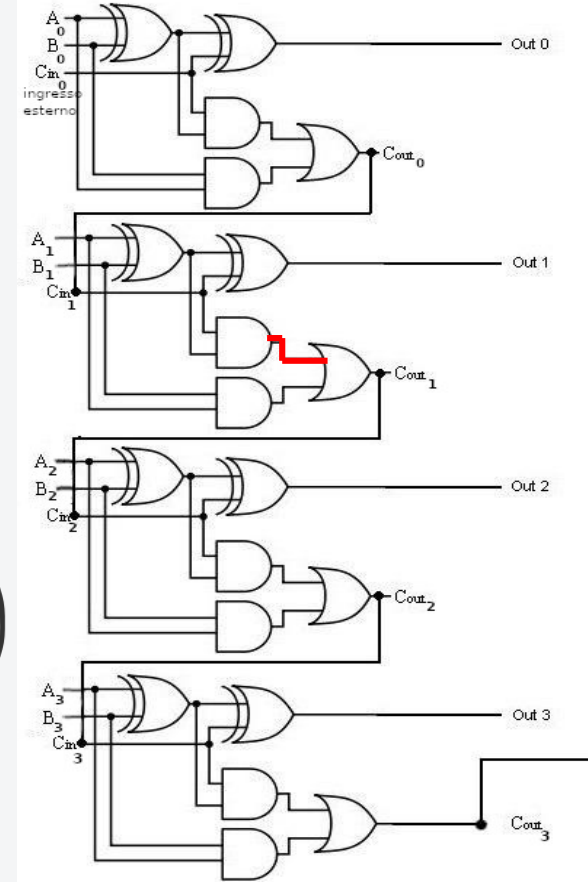
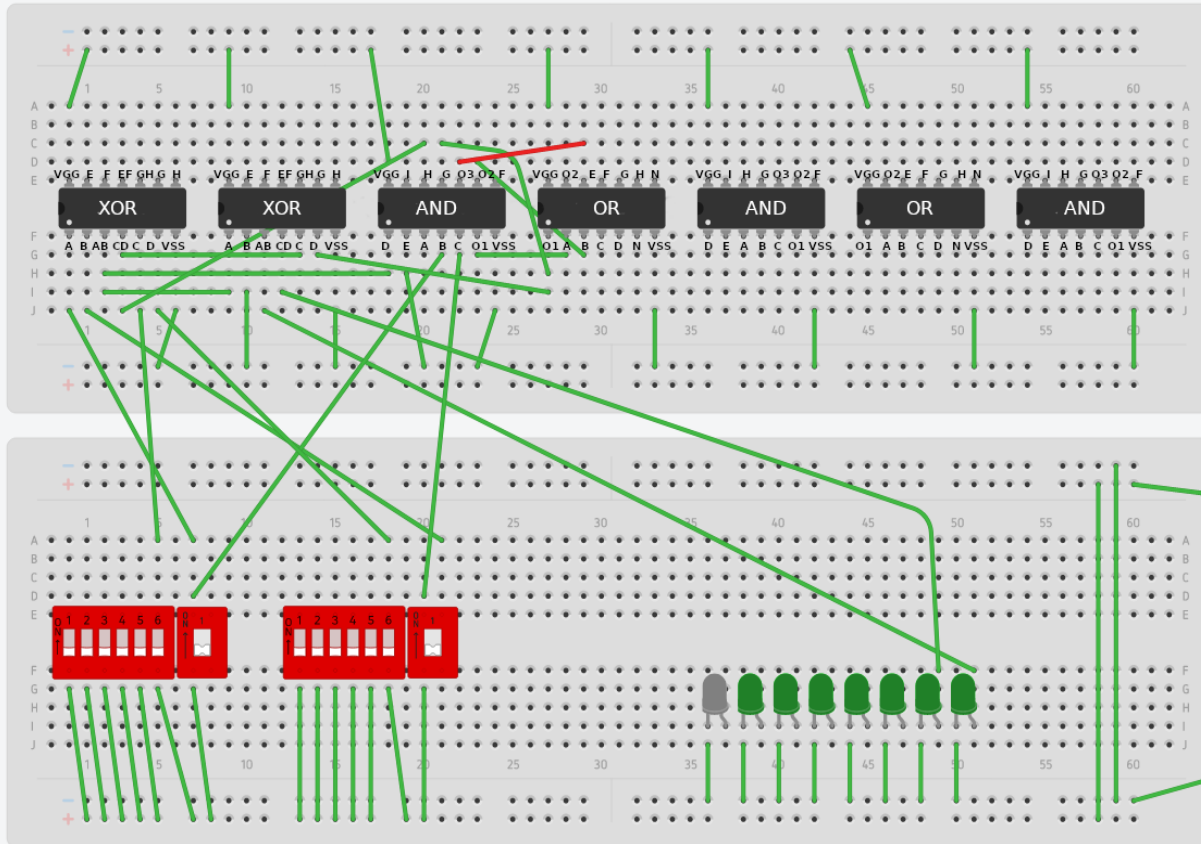


# Passo #15 Studio 1



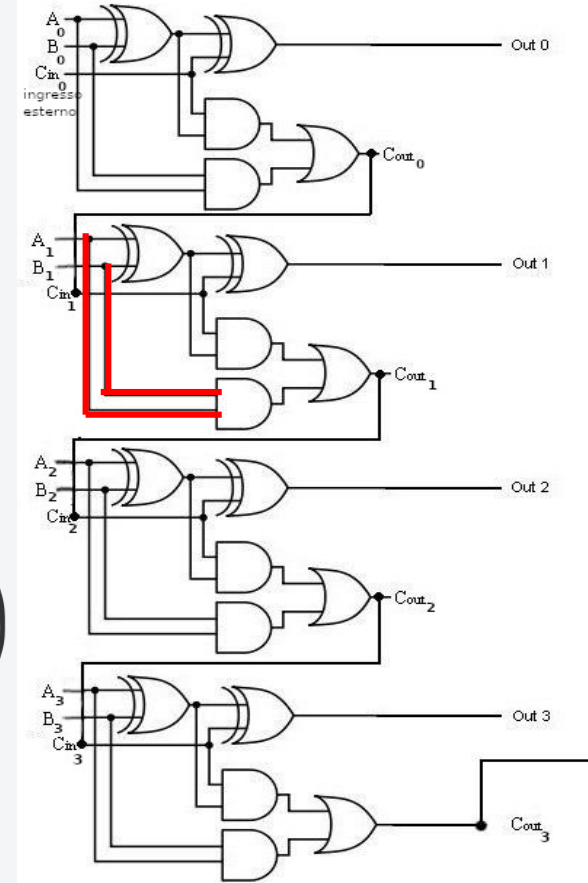
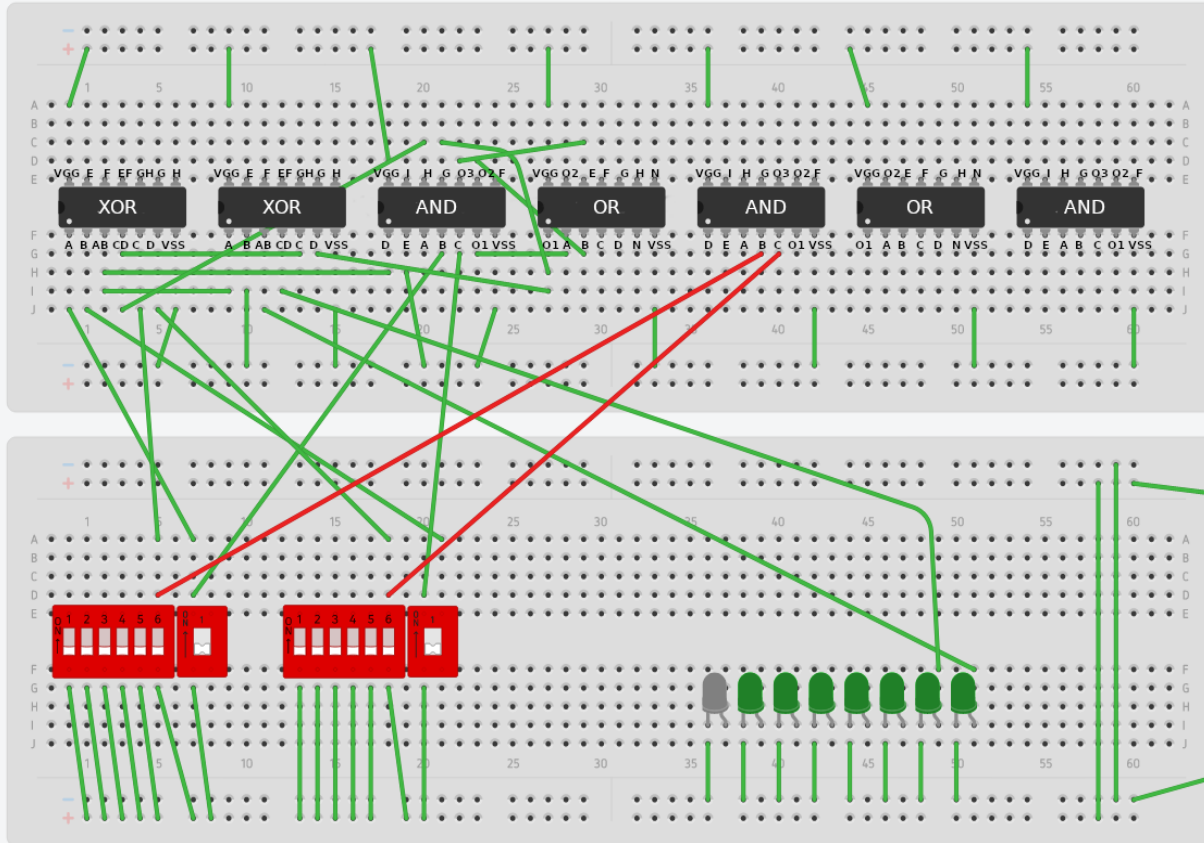


# Passo #16 Studio 1

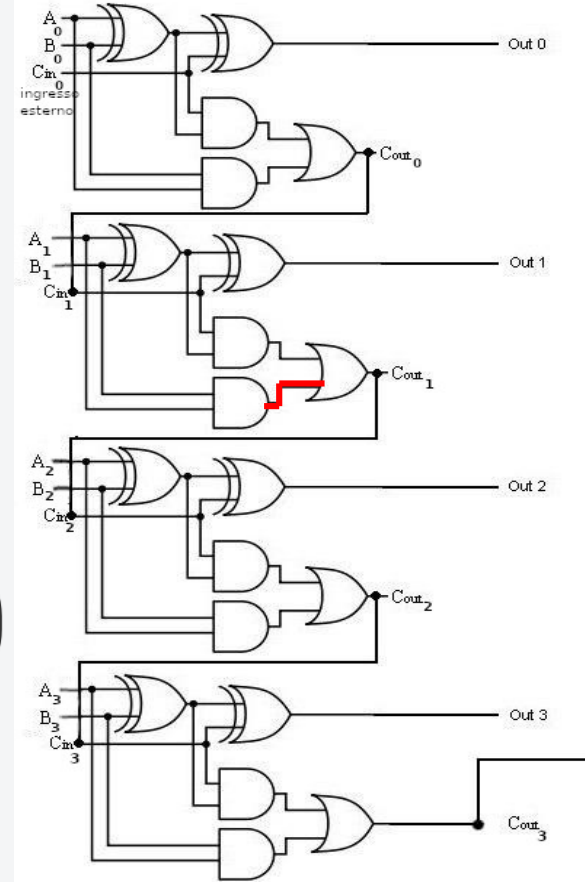
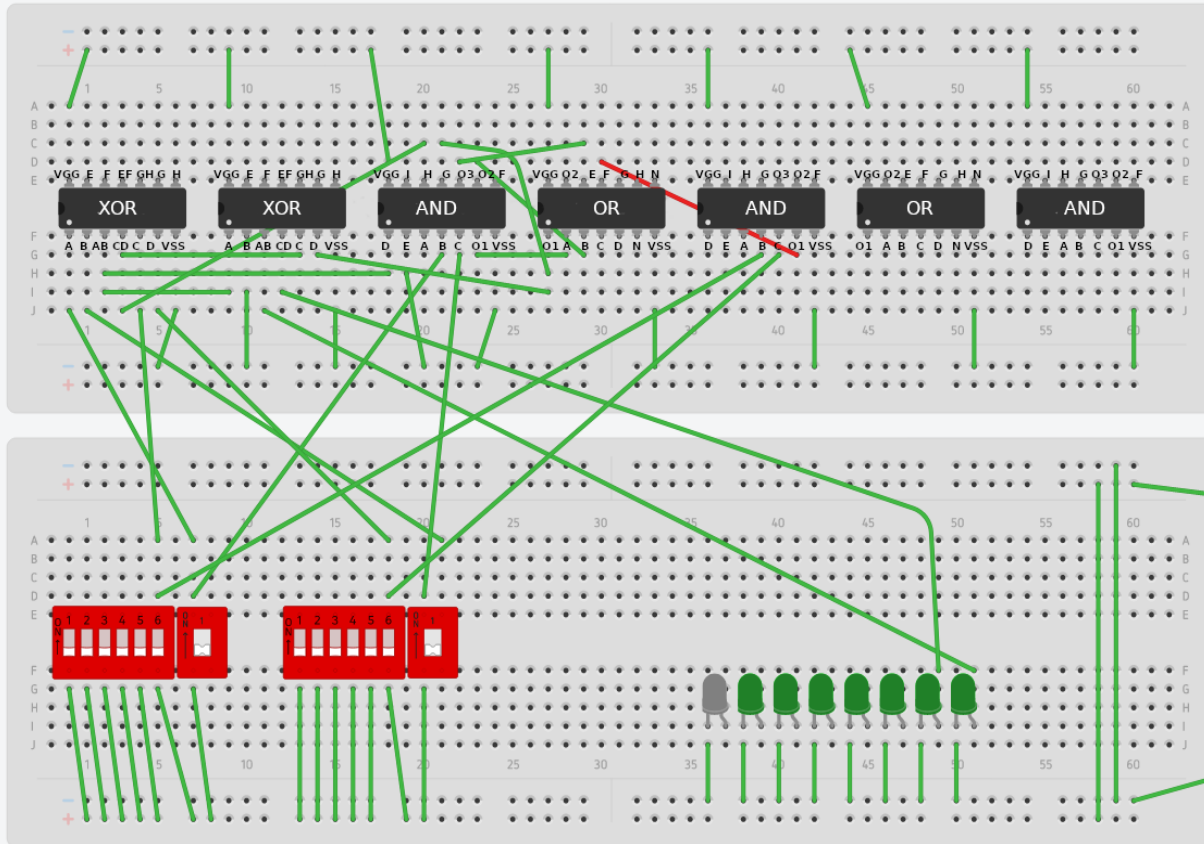




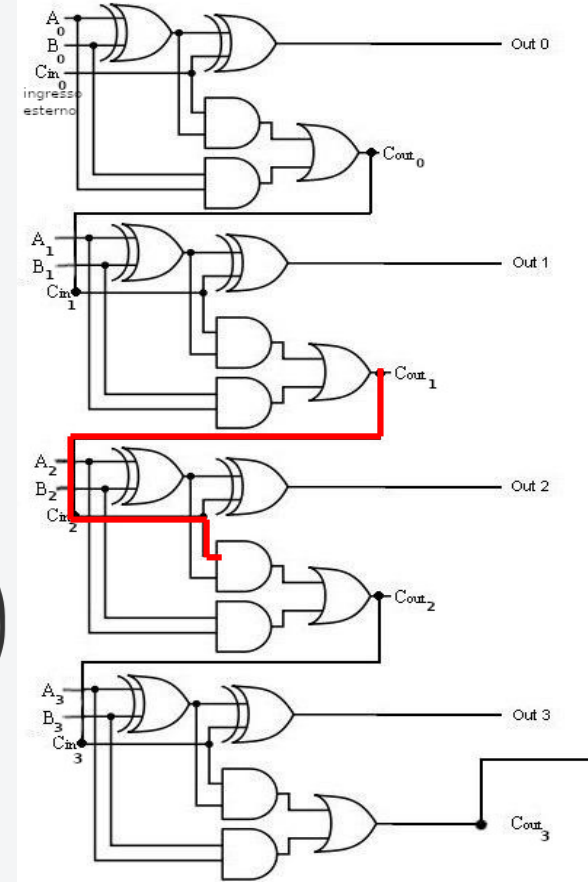
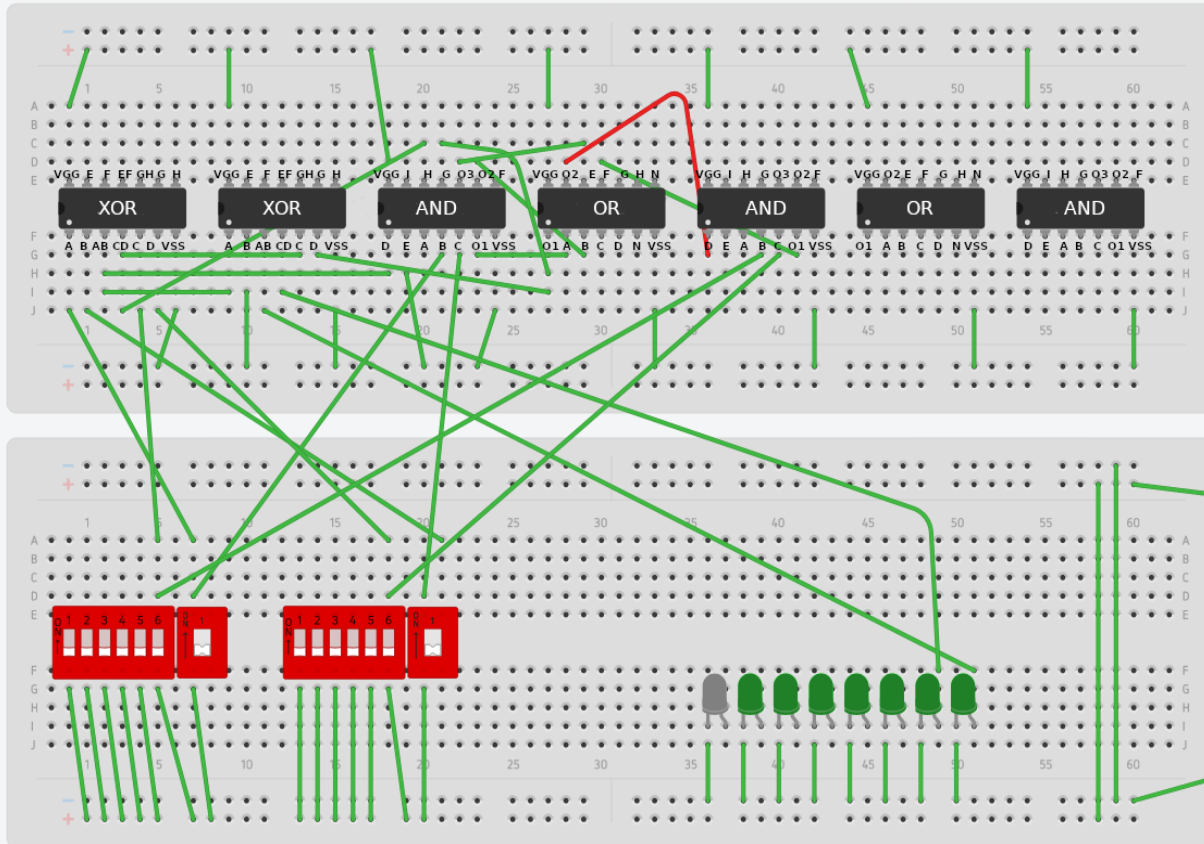
# Passo #17 Studio 1



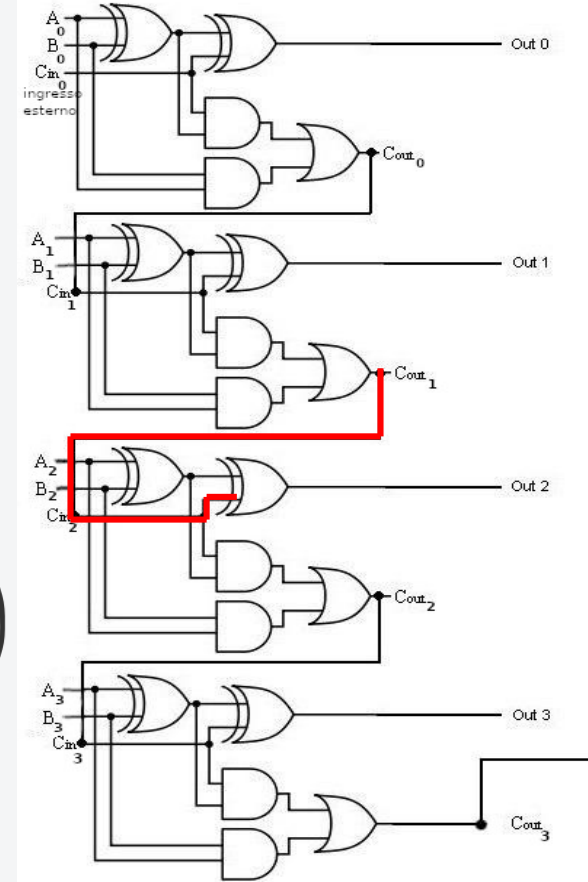
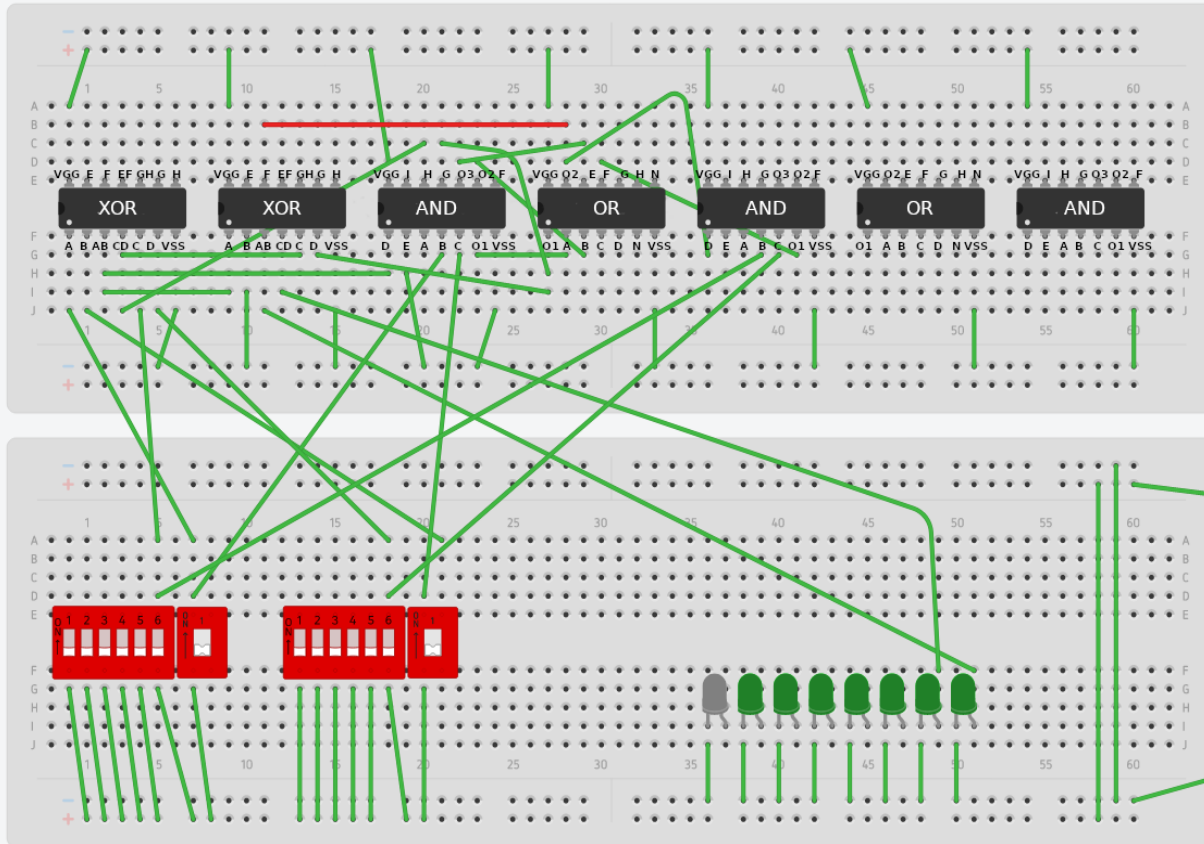
# Passo #18 Stadio 1



# Passo #19 Studio 2

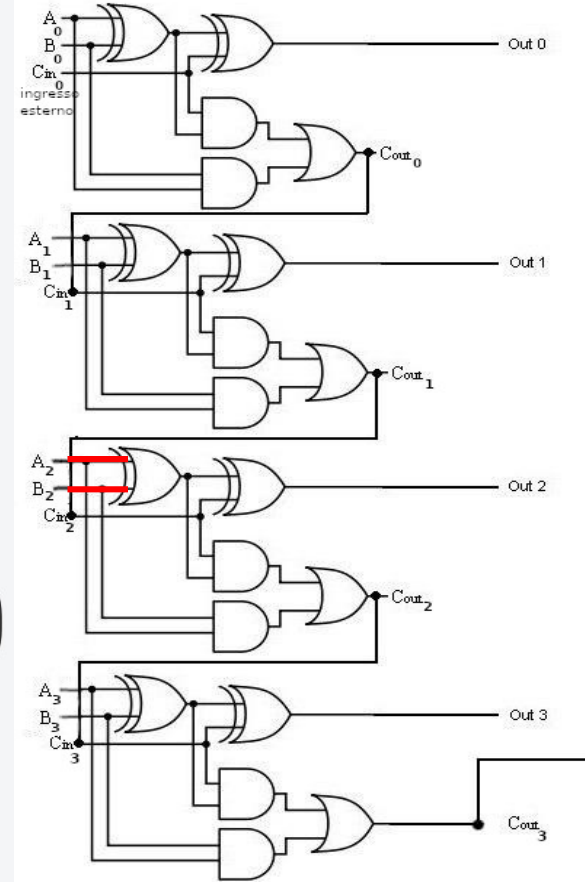
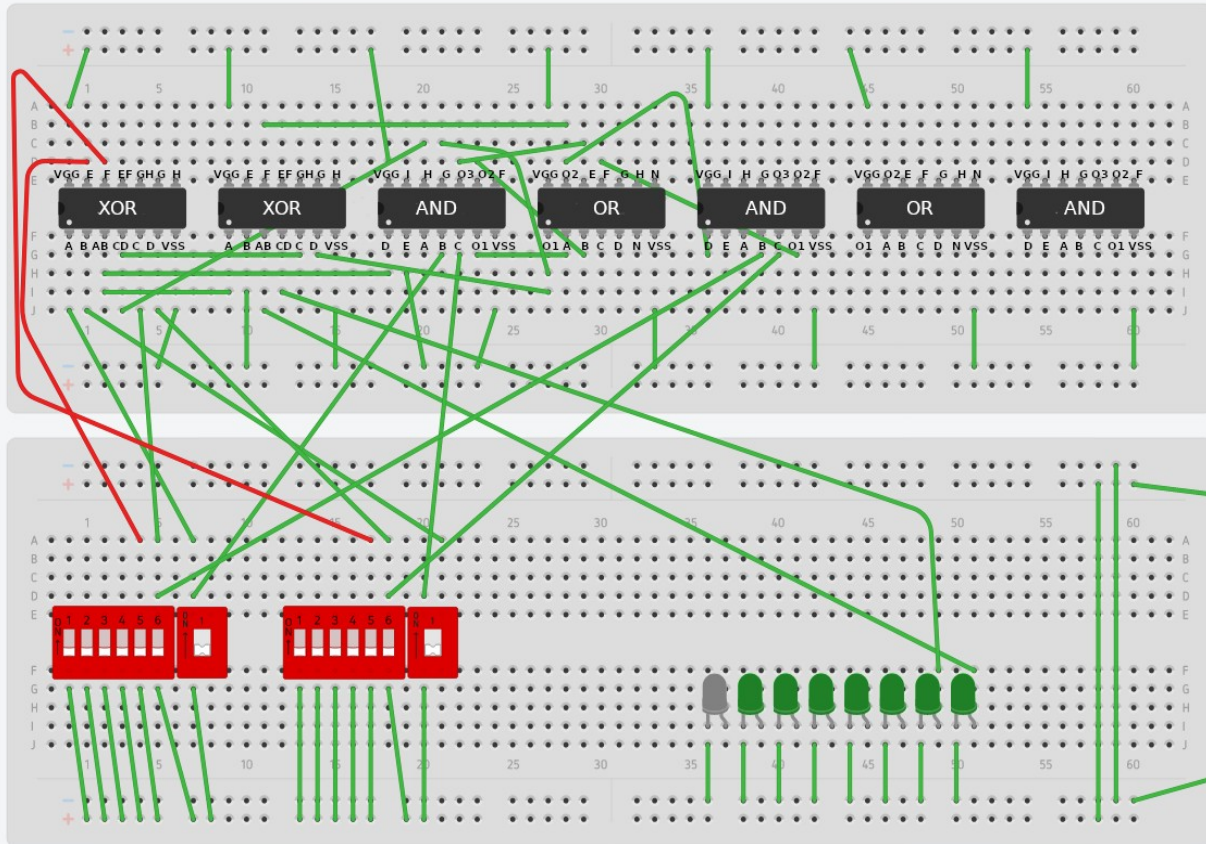


# Passo #20 Studio 2

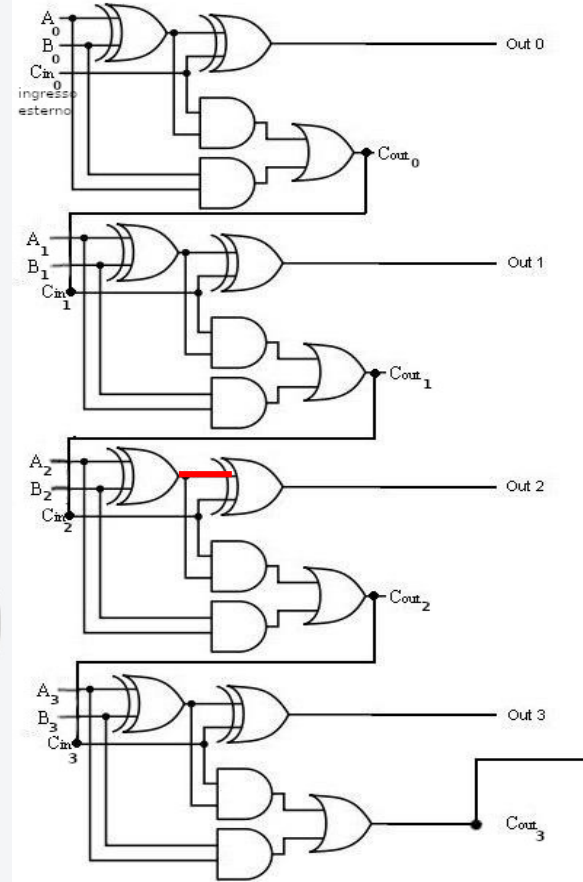
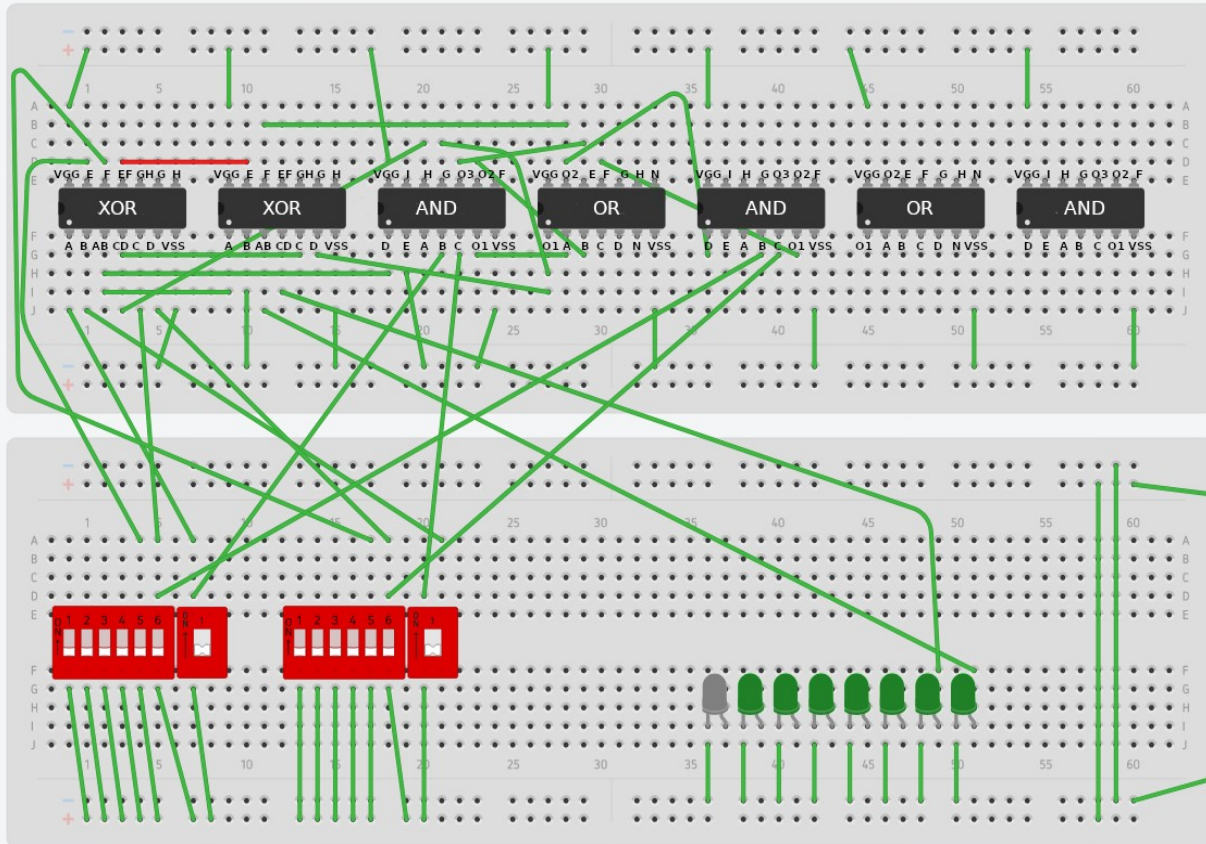




# Passo #21 Studio 2

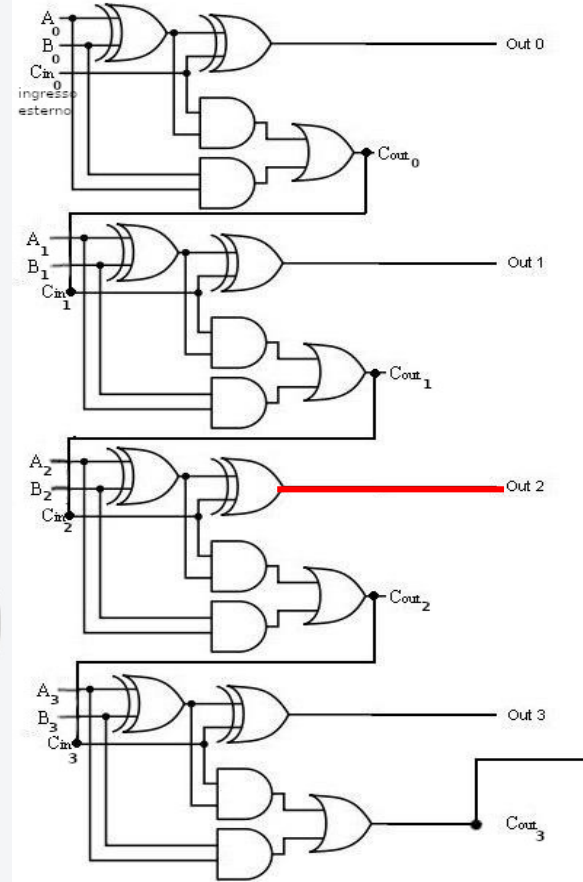
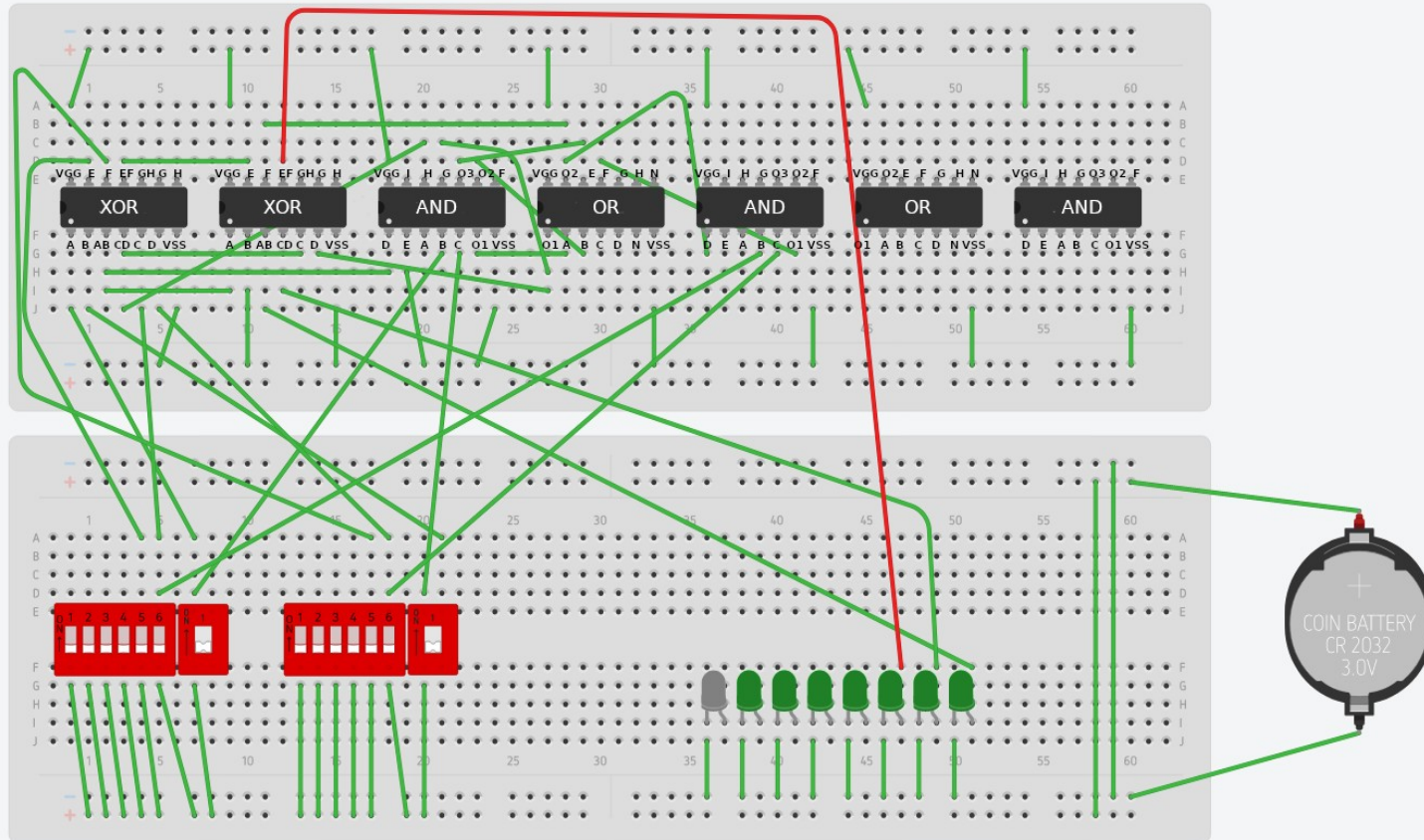


# Passo #22 Studio 2

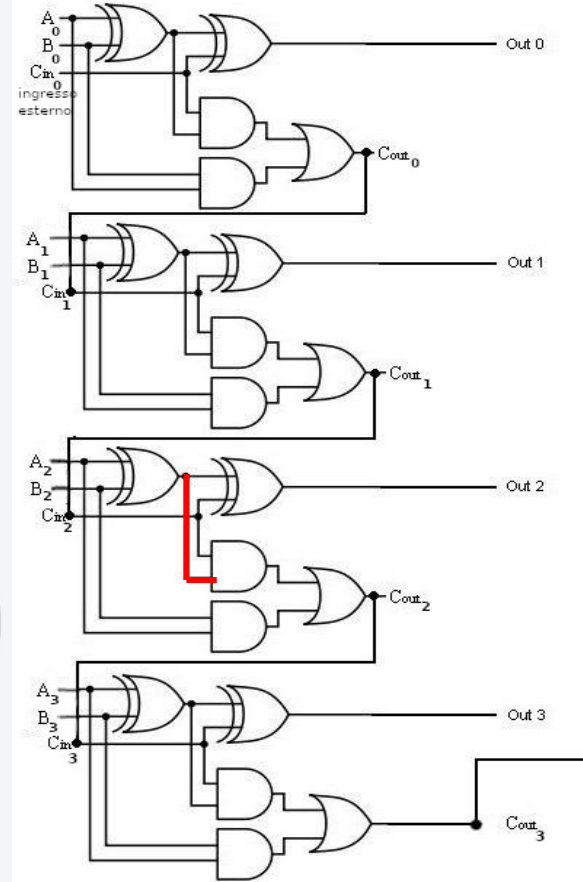
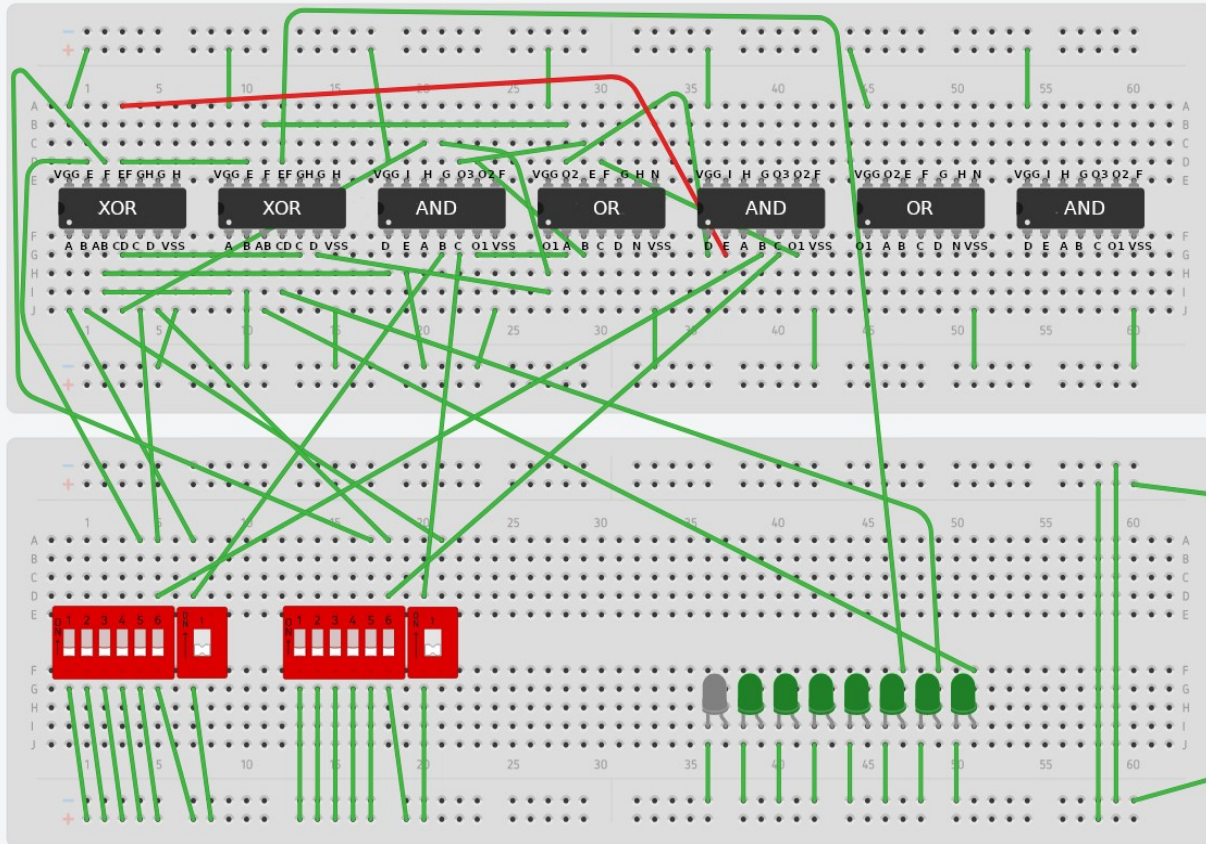




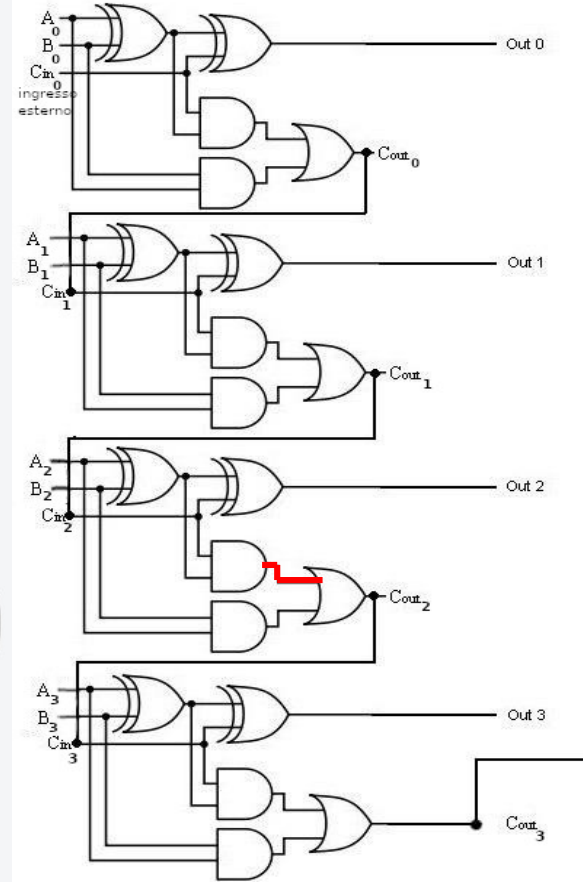
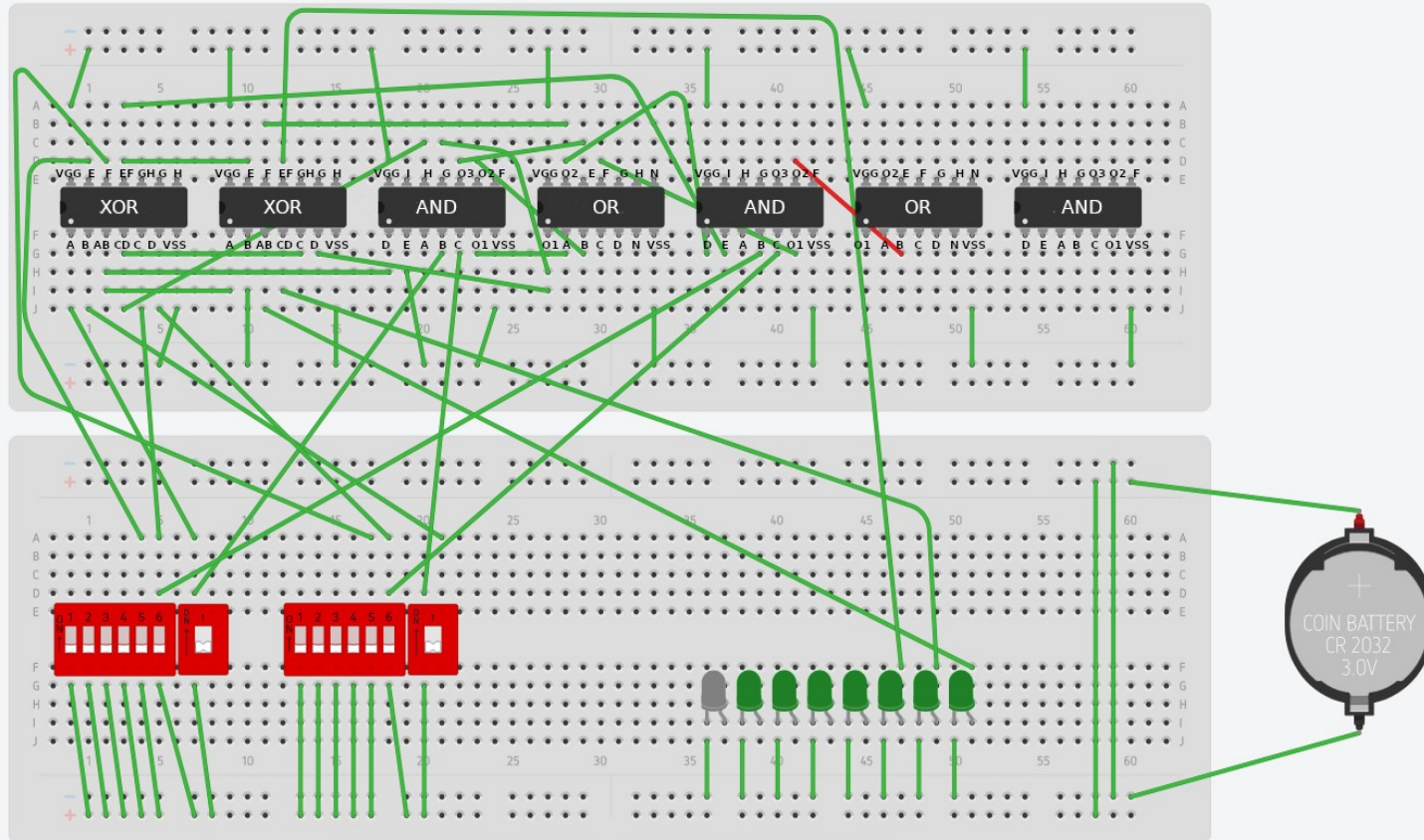
# Passo #23 Studio 2



# Passo #24 Studio 2

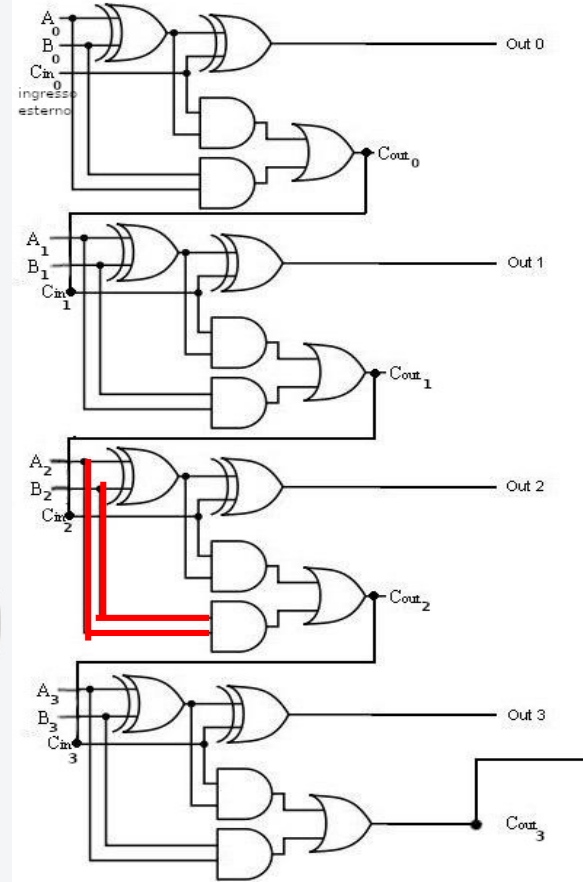
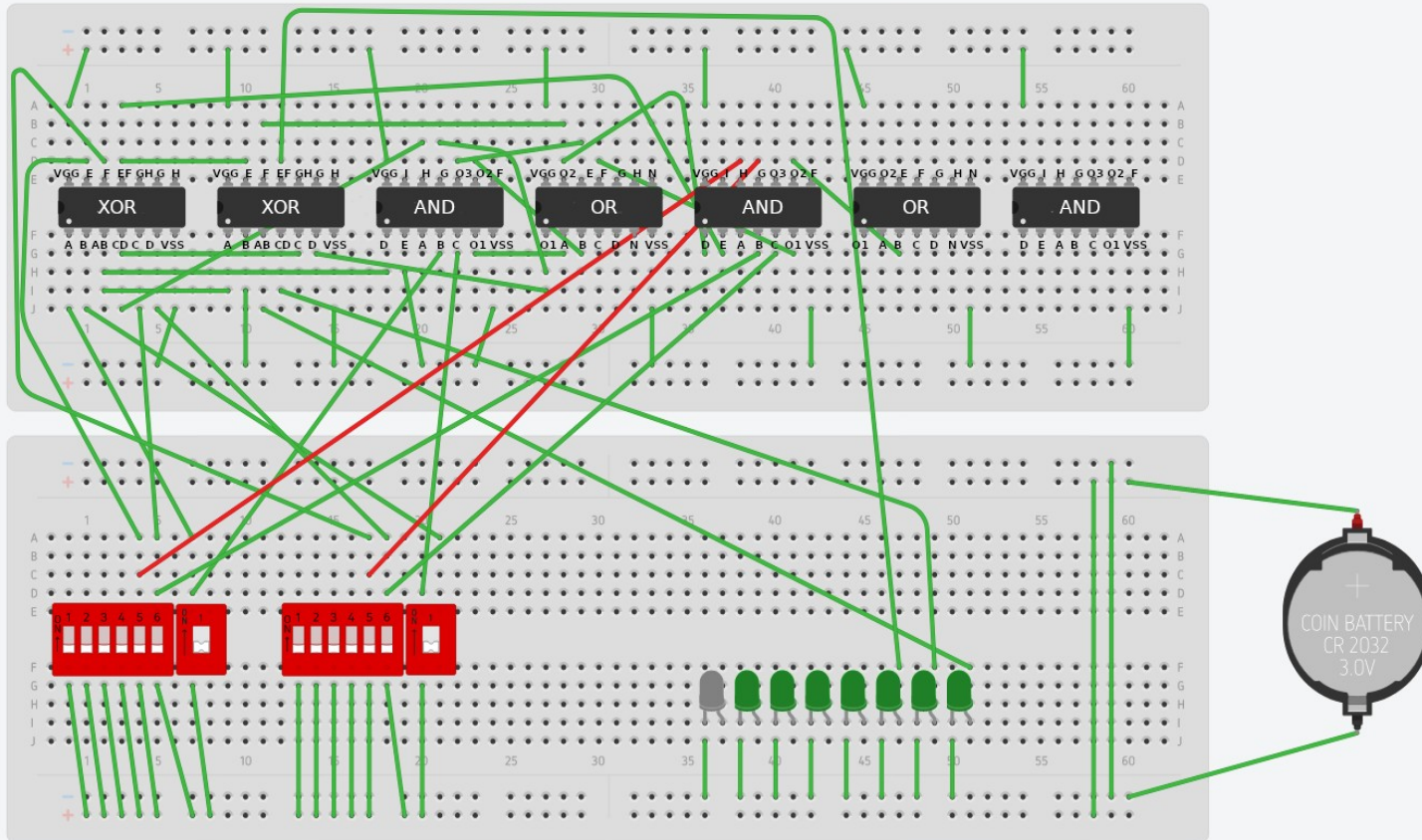


# Passo #25 Studio 2

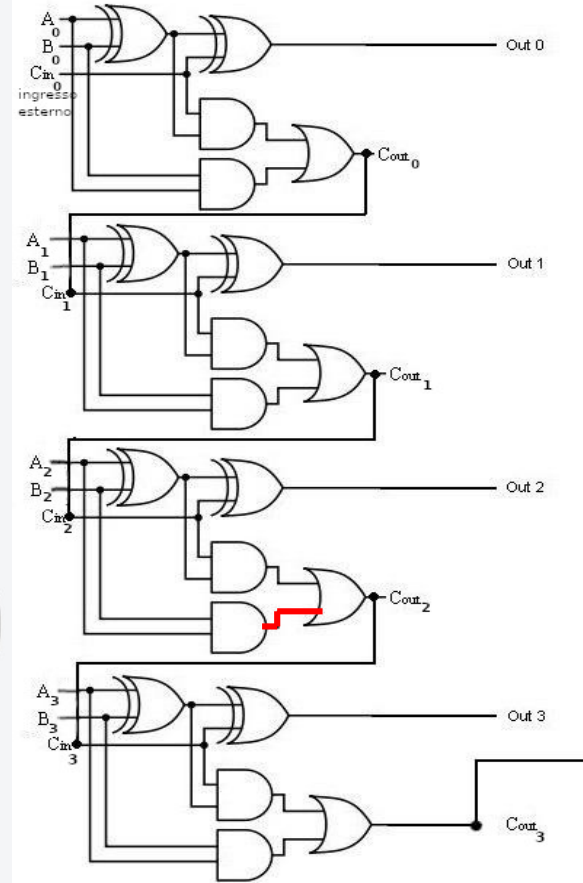
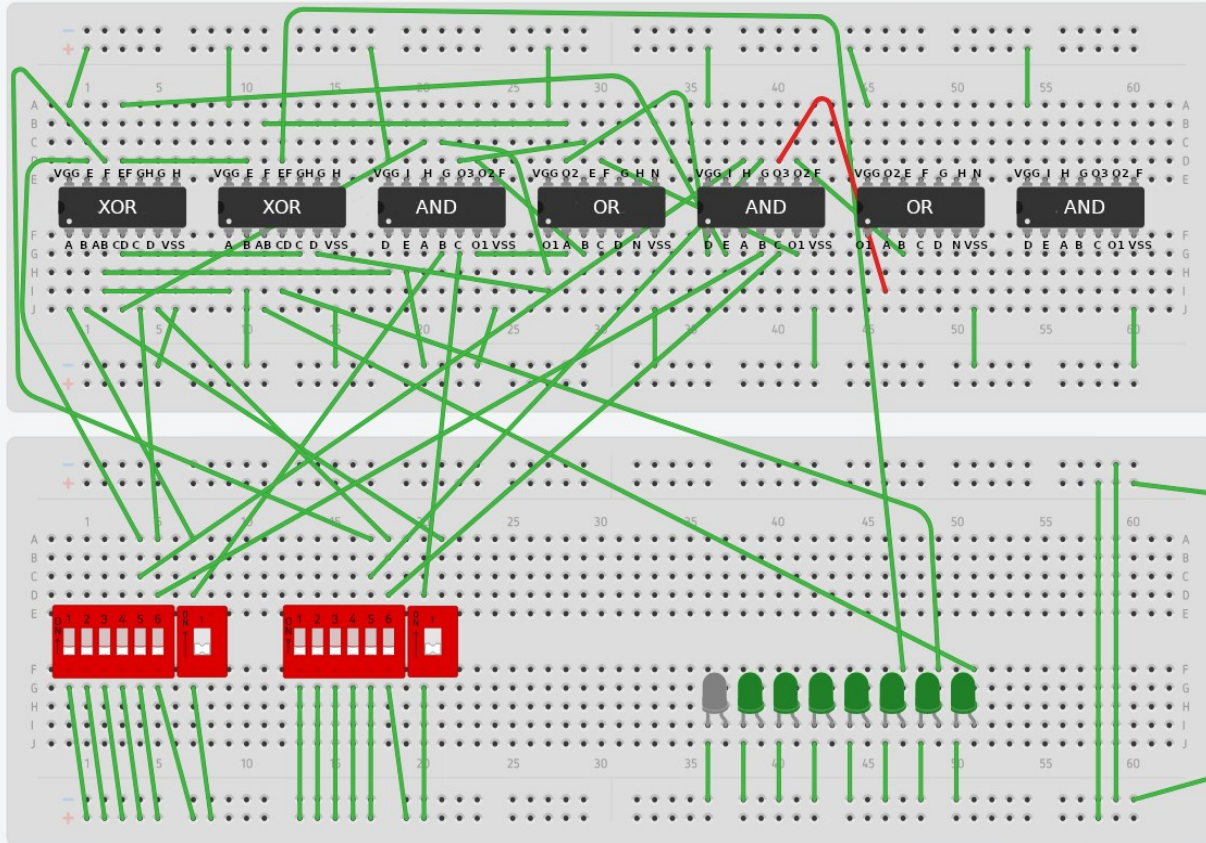




# Passo #26 Studio 2

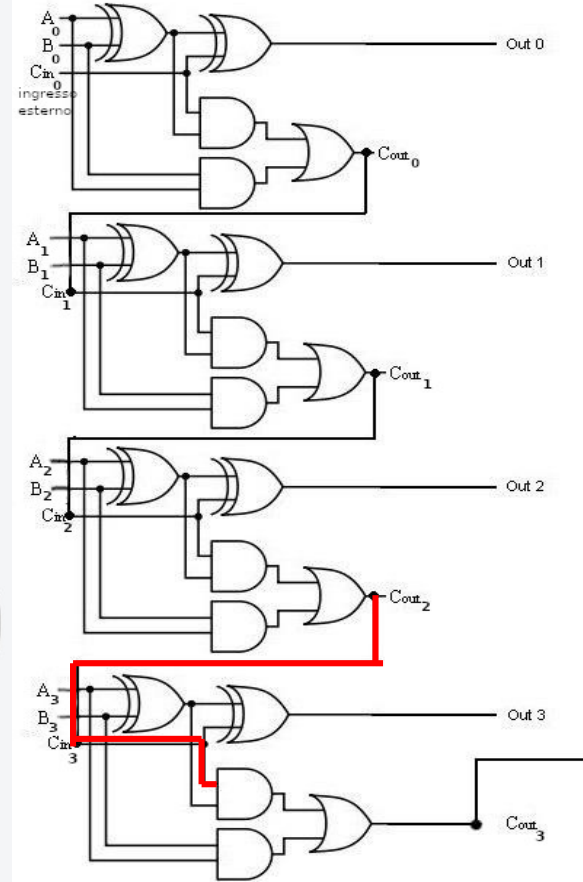
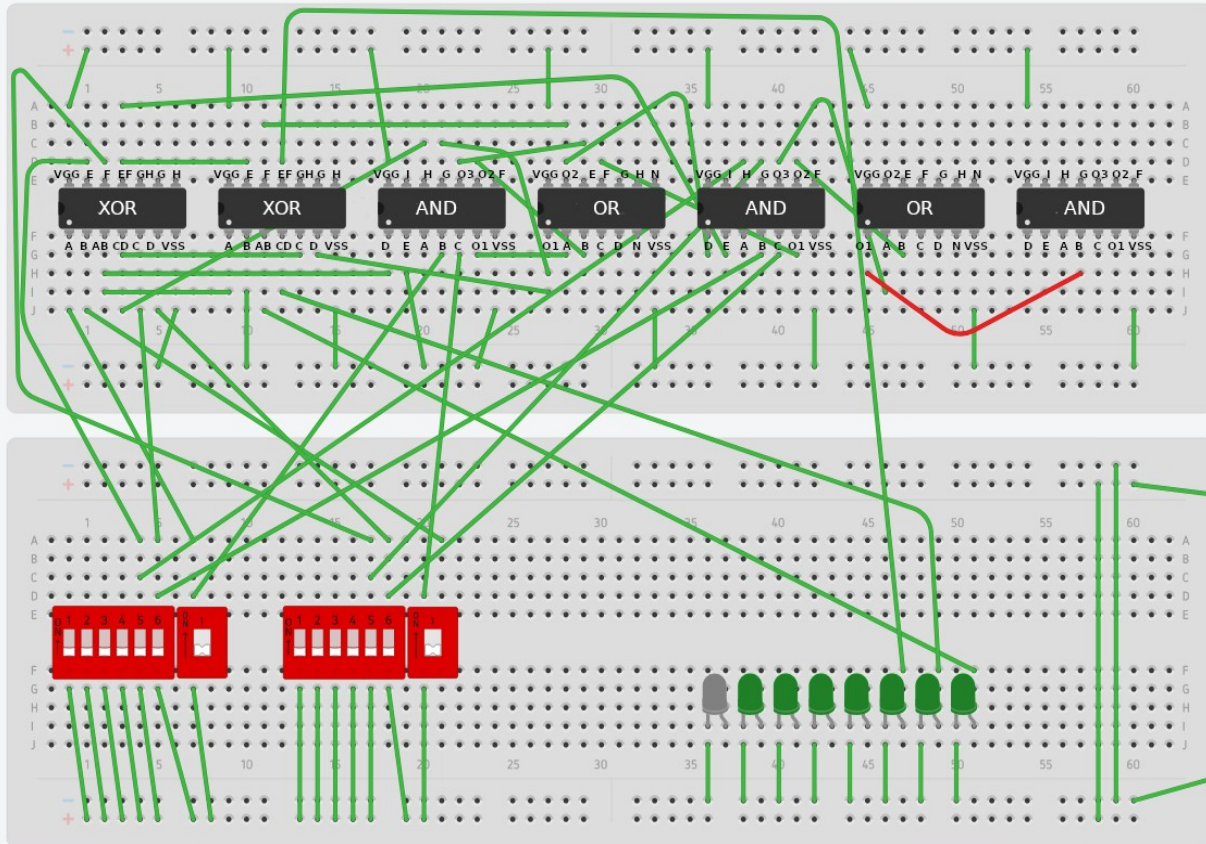


# Passo #27 Studio 2

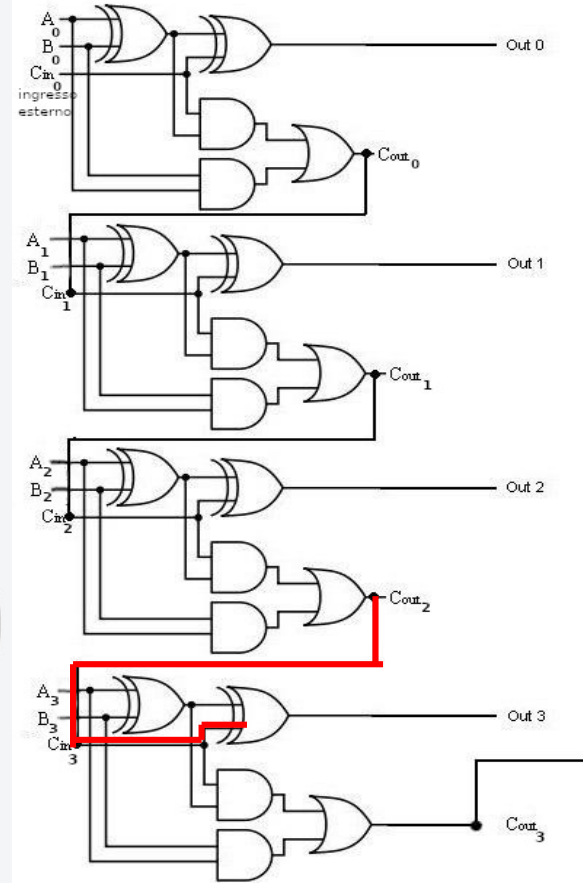
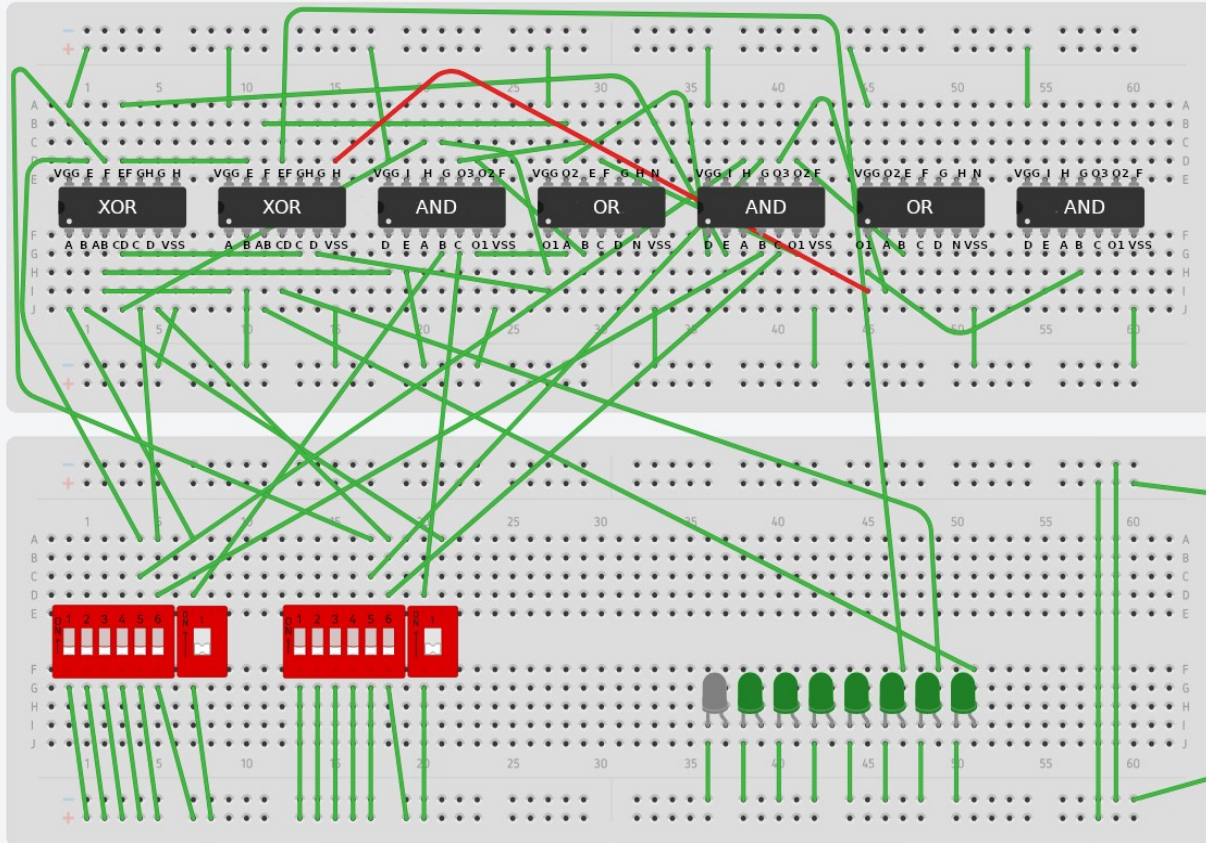




# Passo #28 Stadio 3

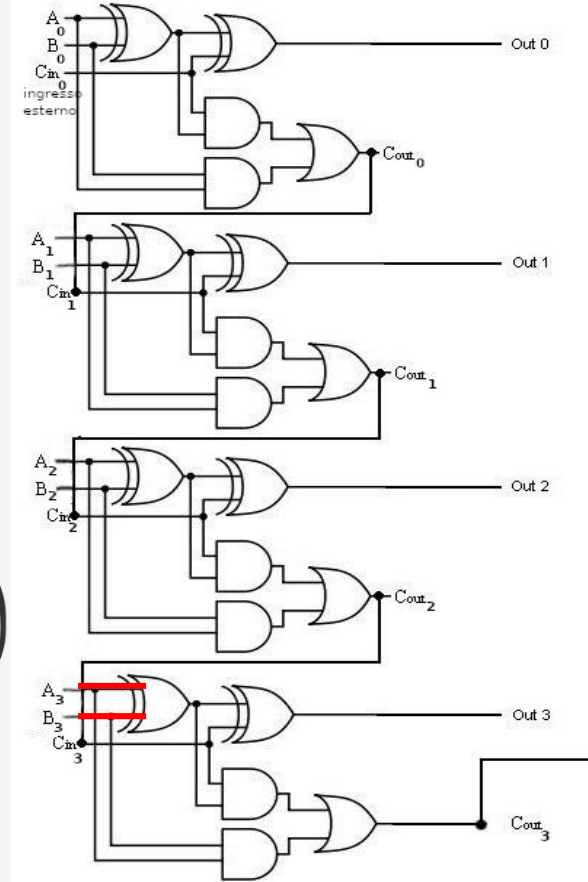
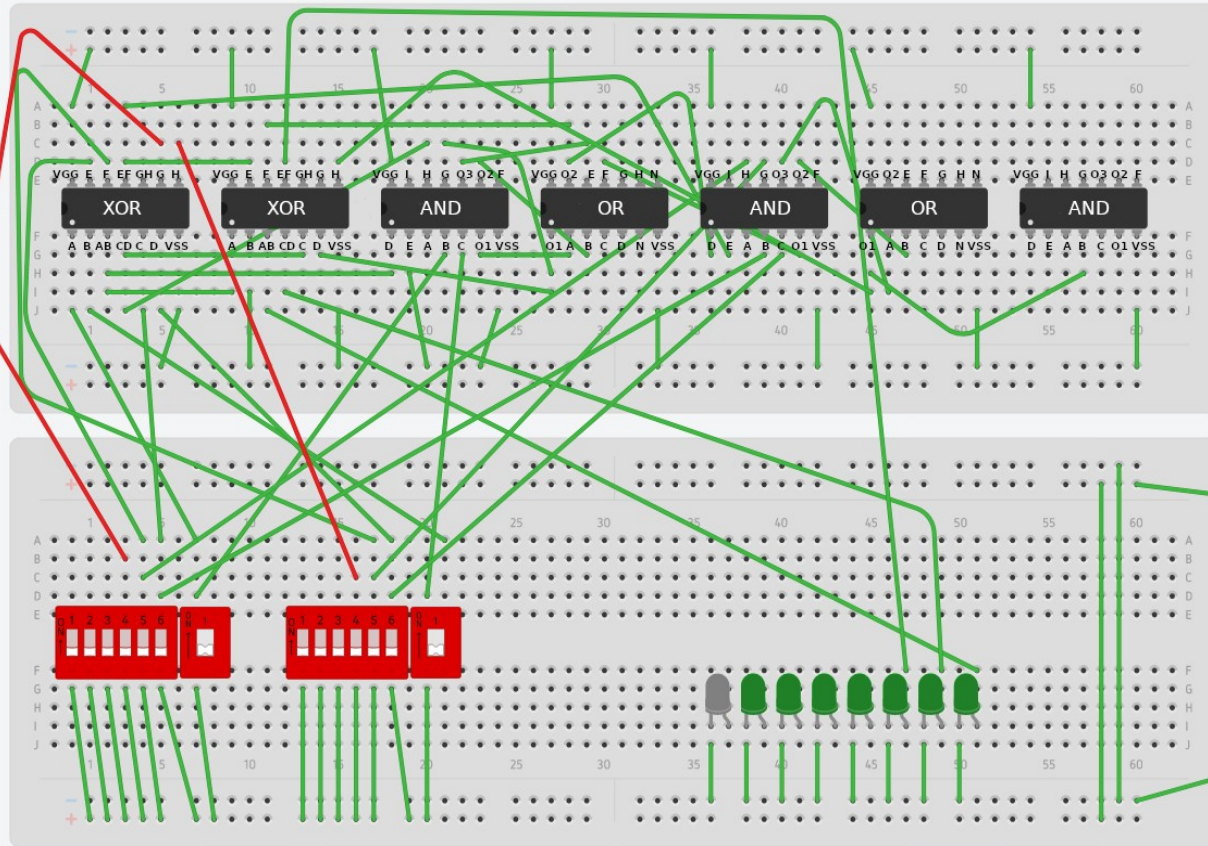


# Passo #29 Stadio 3

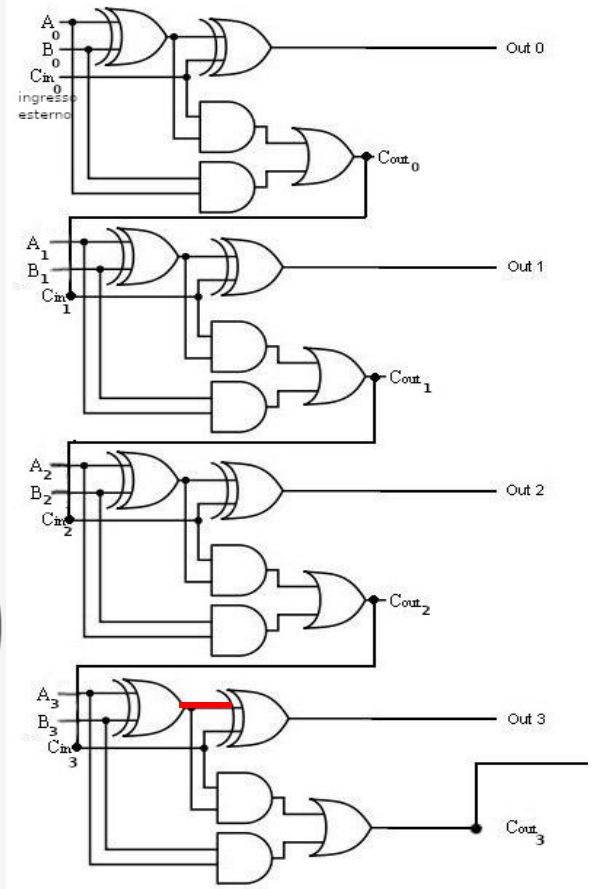
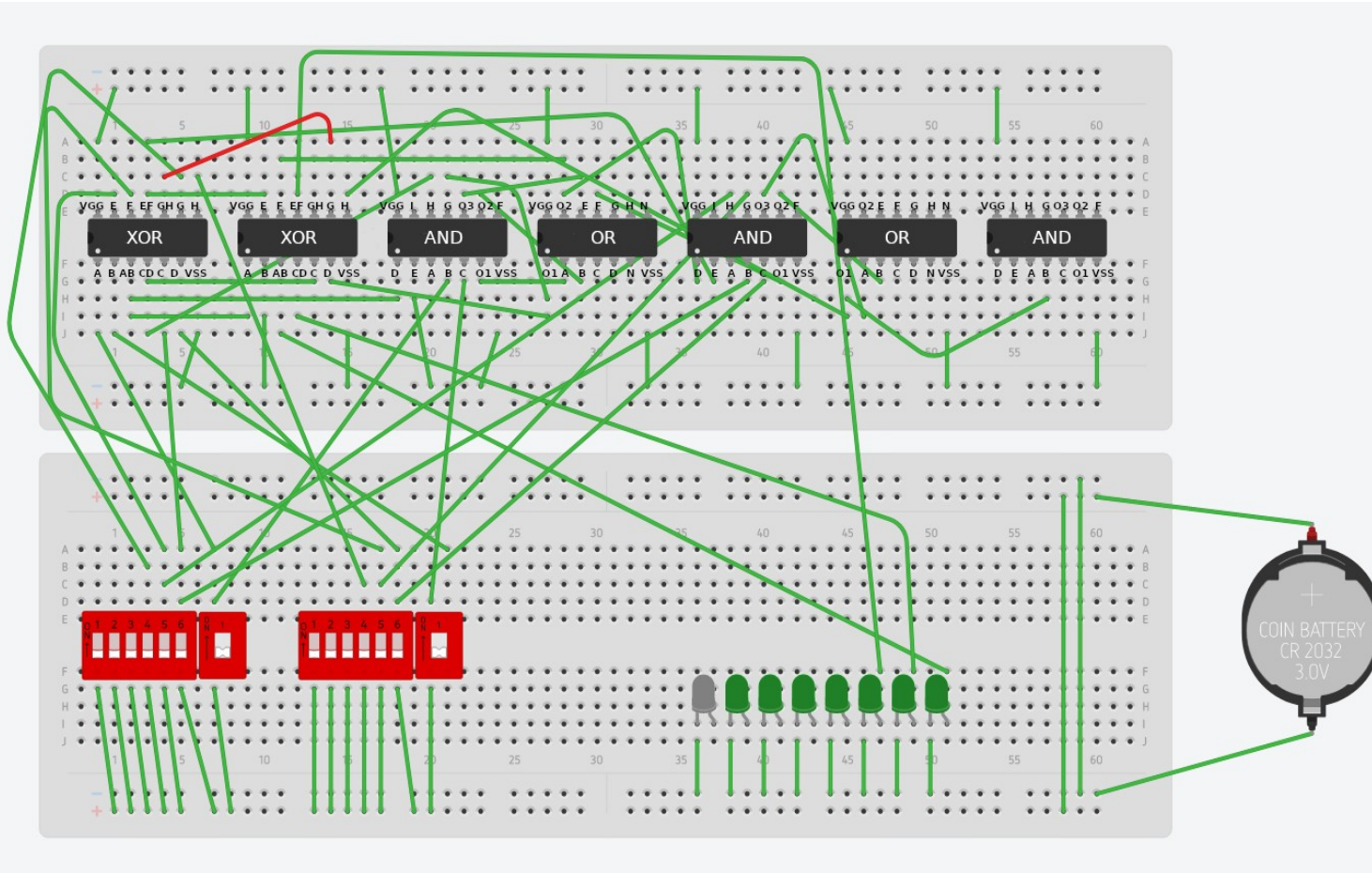




# Passo #30 Stadio 3

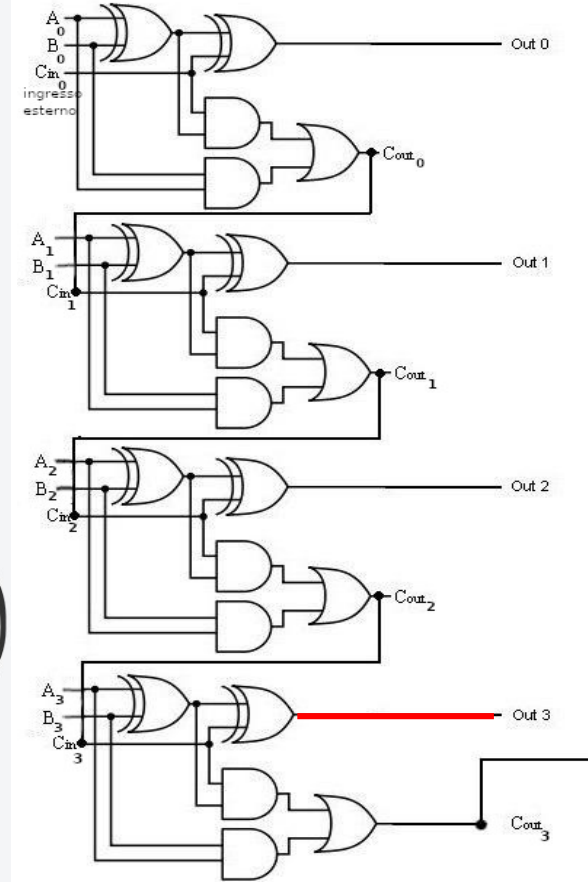
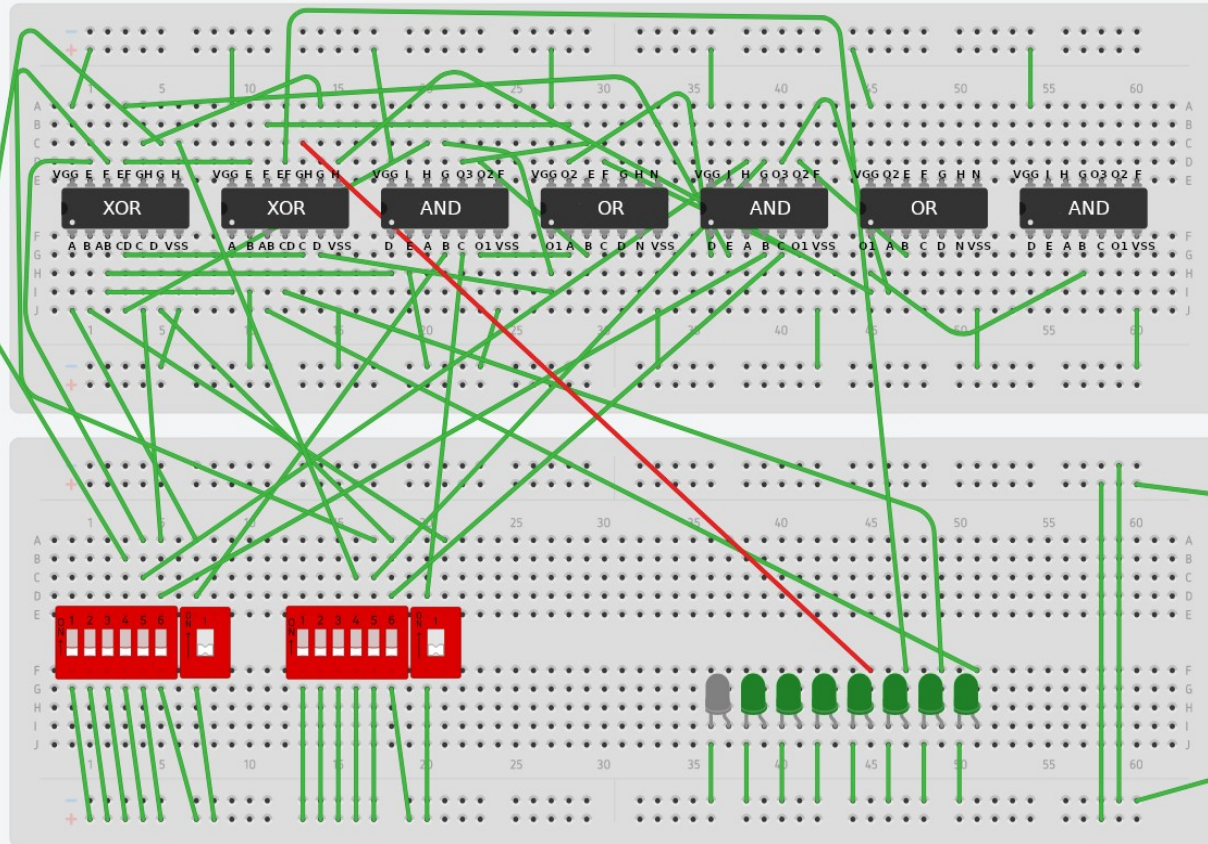


# Passo #31 Stadio 3

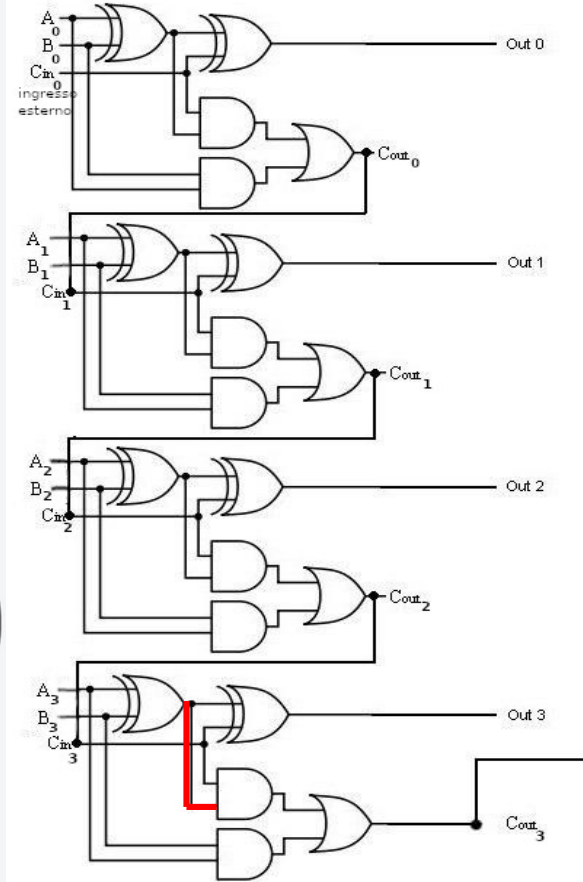
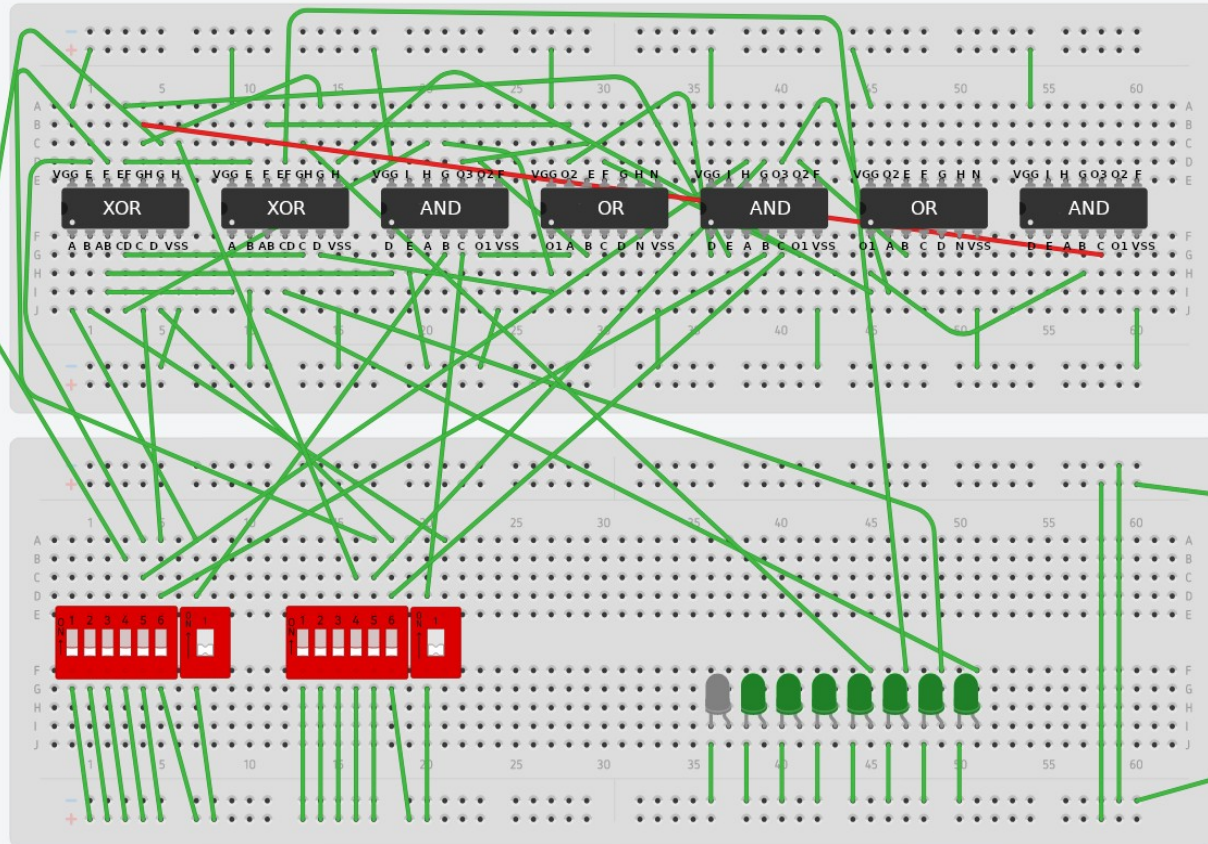




# Passo #32 Stadio 3

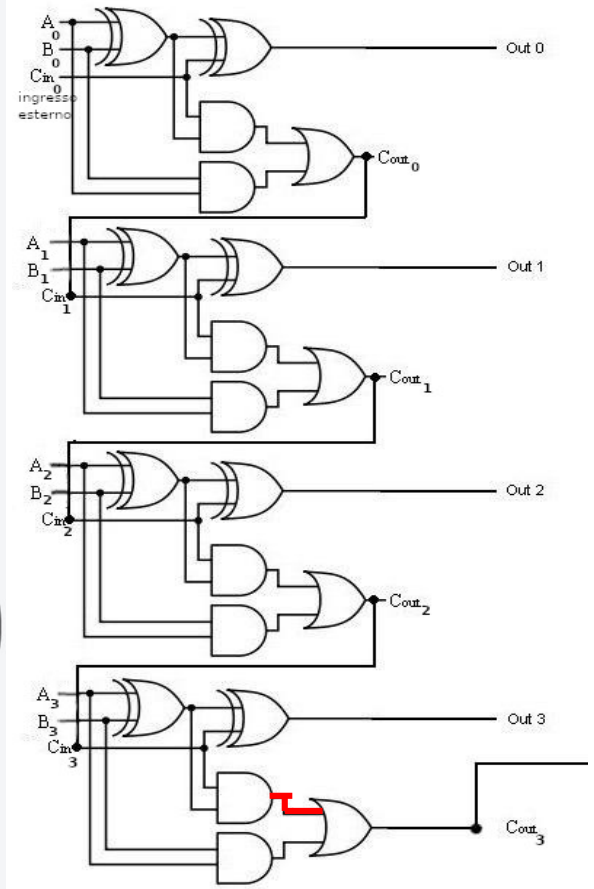
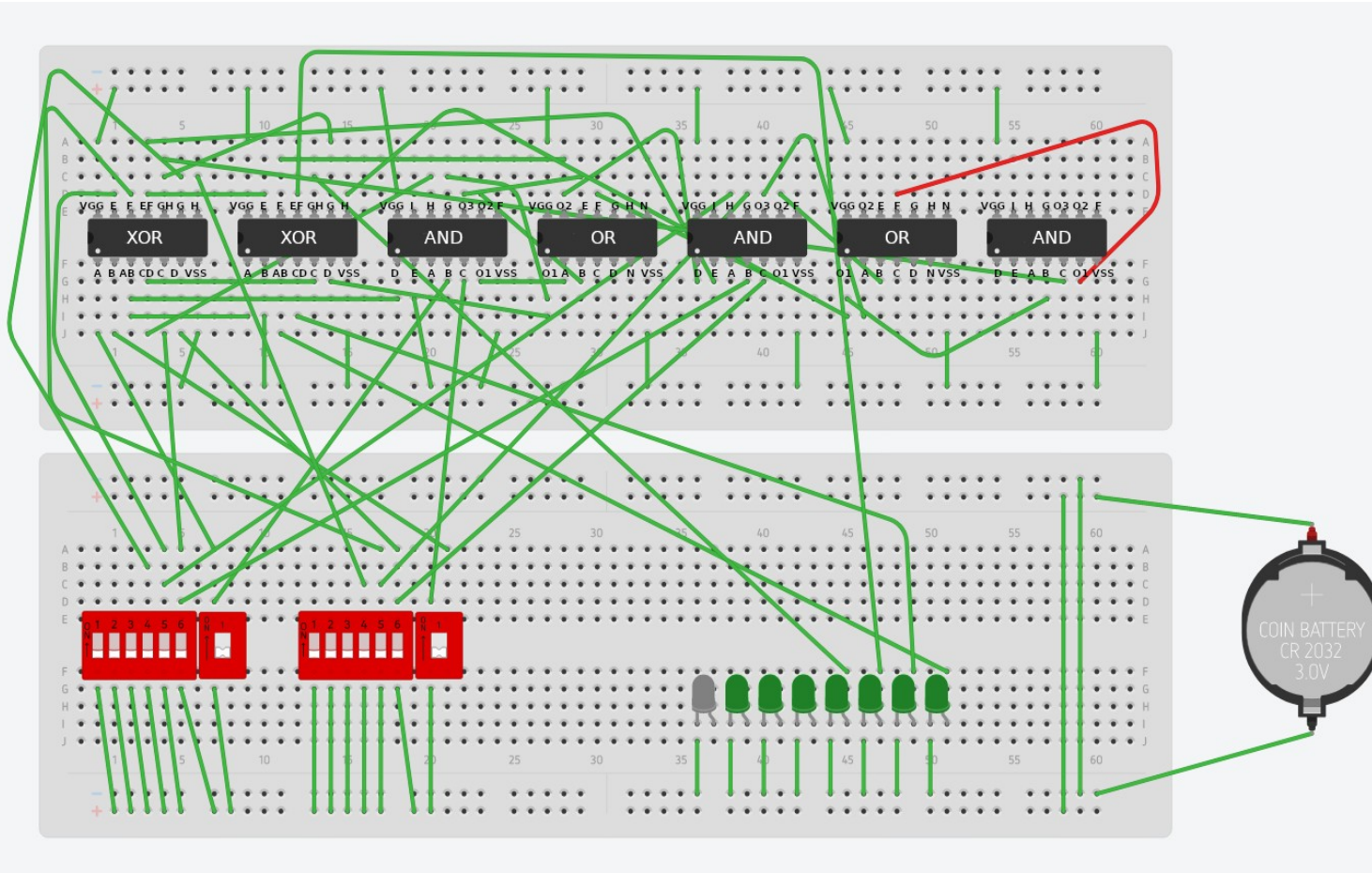


# Passo #33 Stadio 3

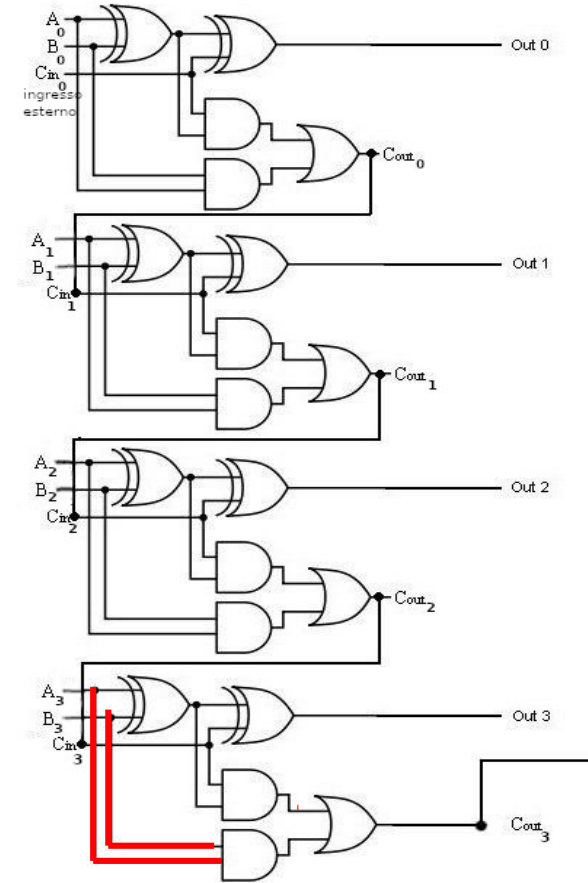
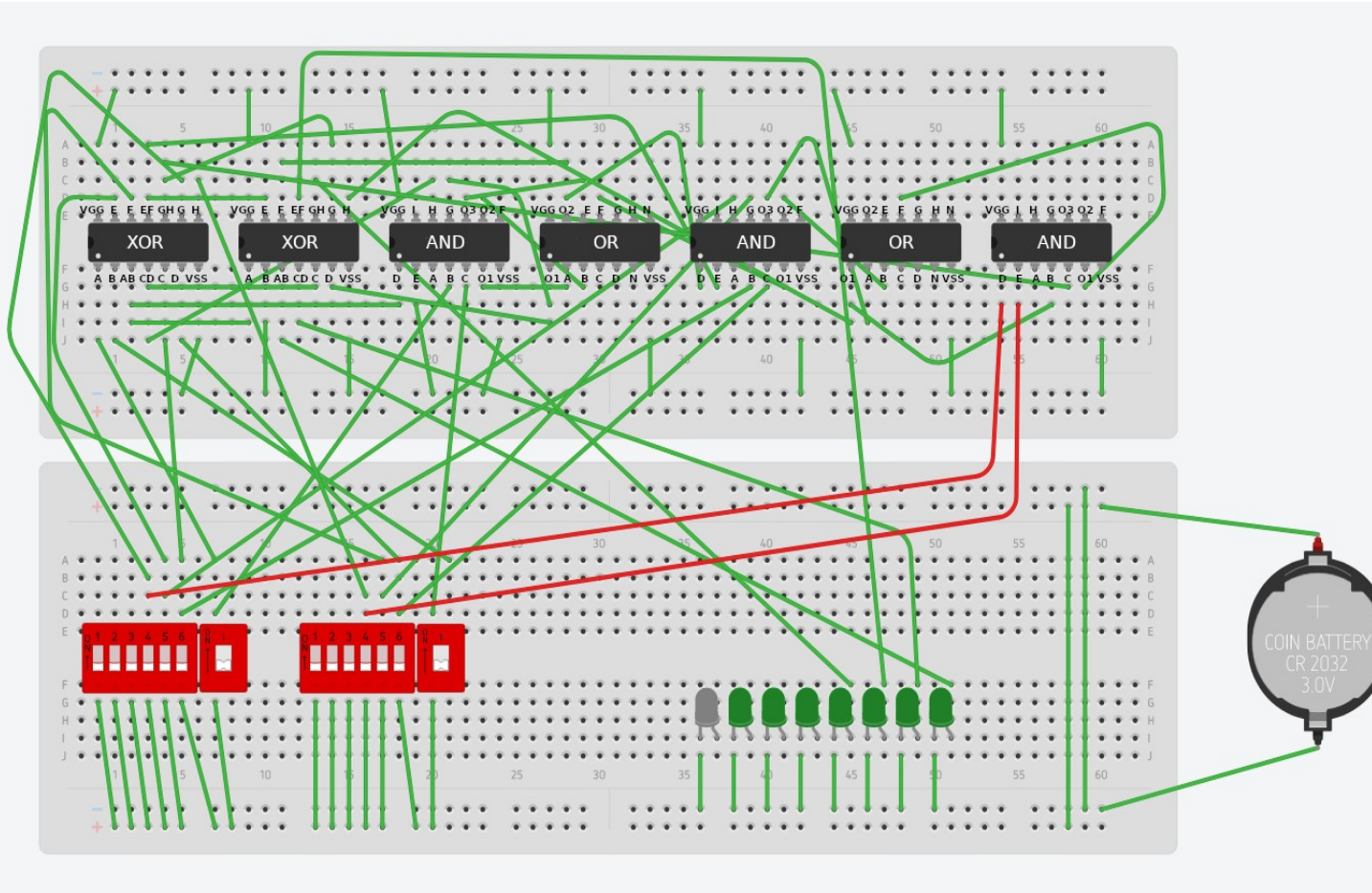




# Passo #34 Stadio 3

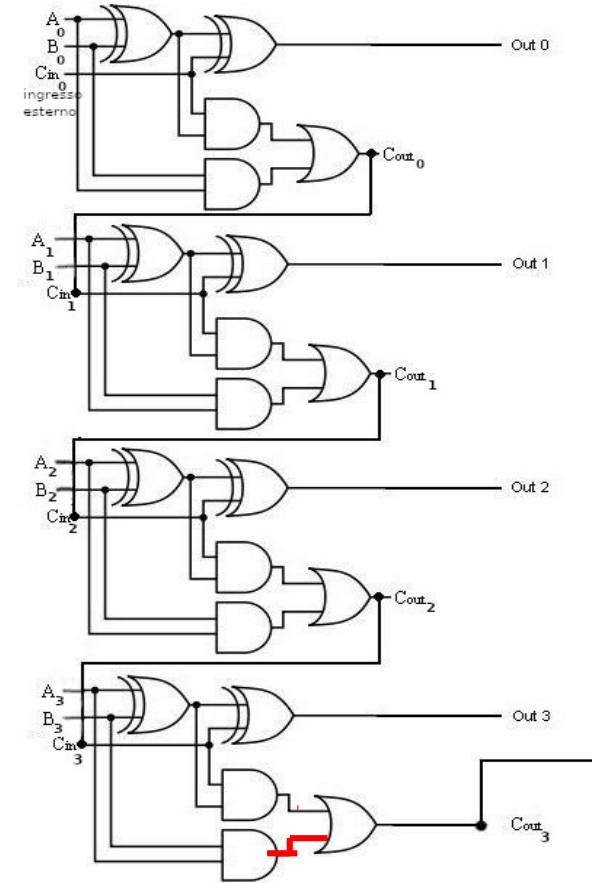
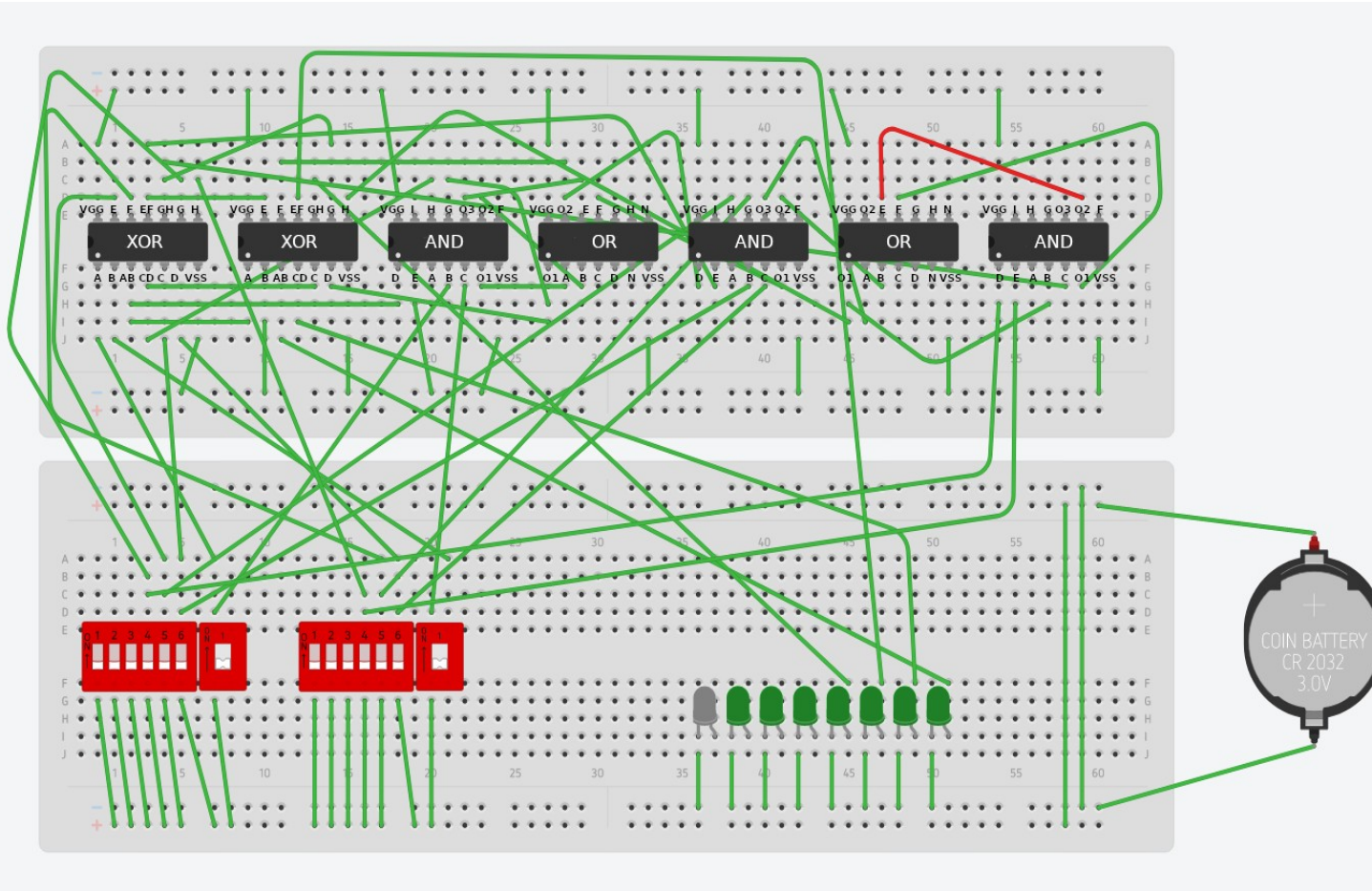


# Passo #35 Stadio 3





# Passo #36 Stadio 3

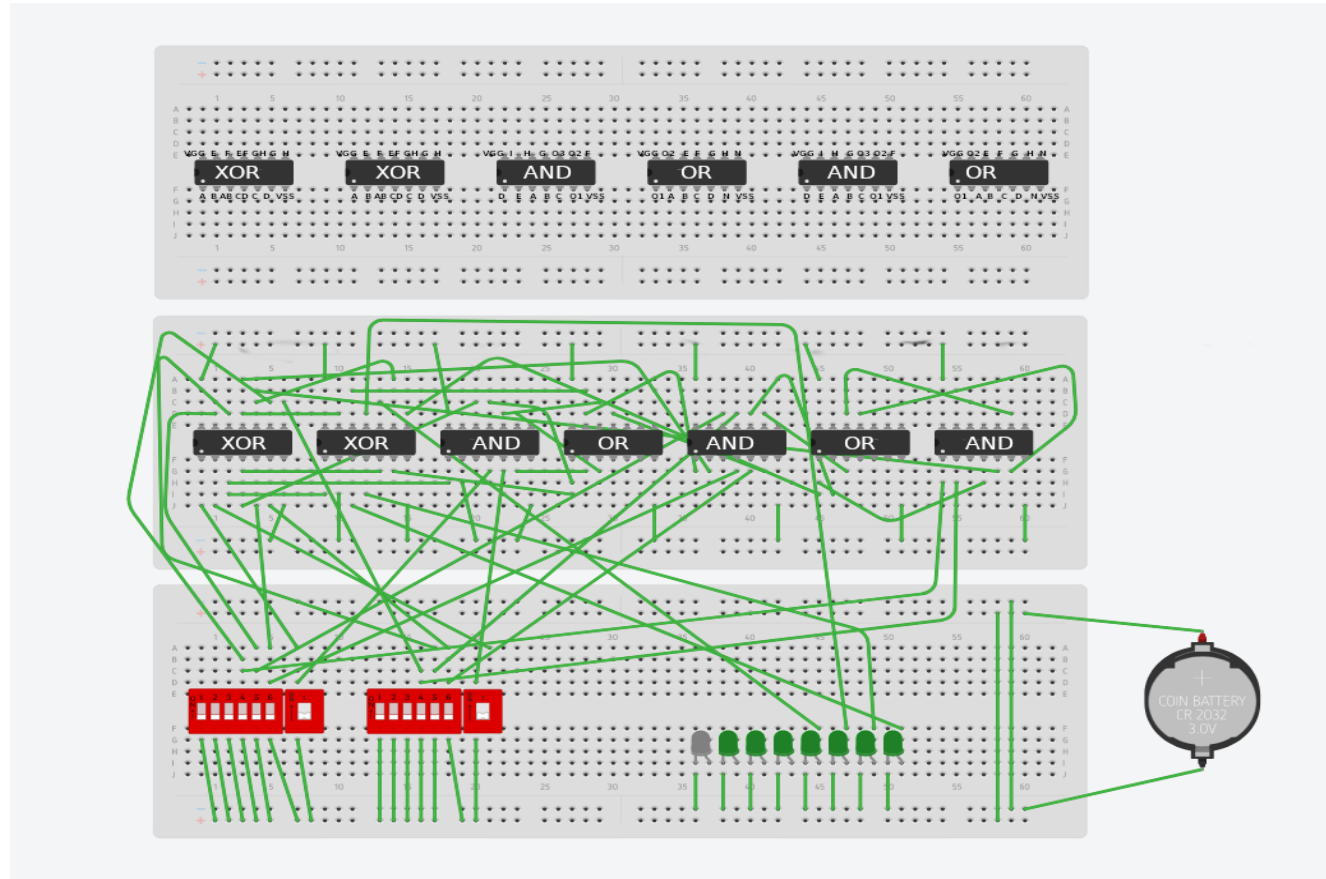




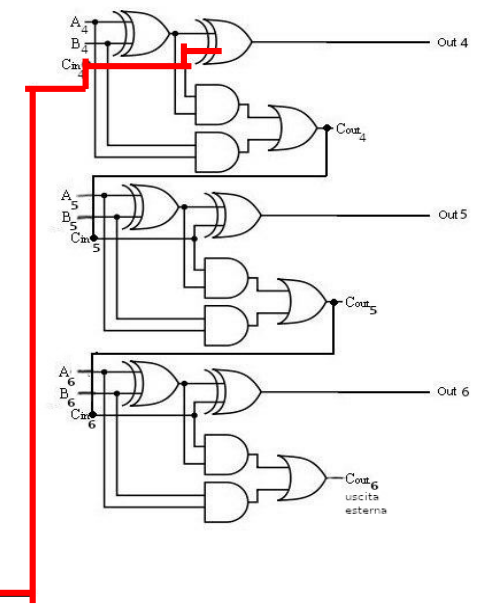
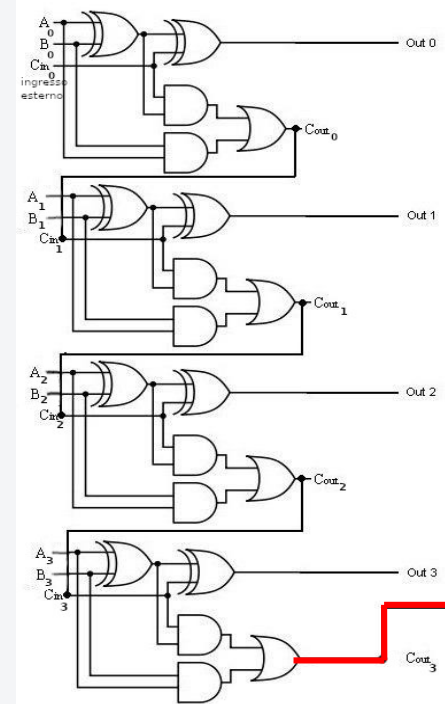
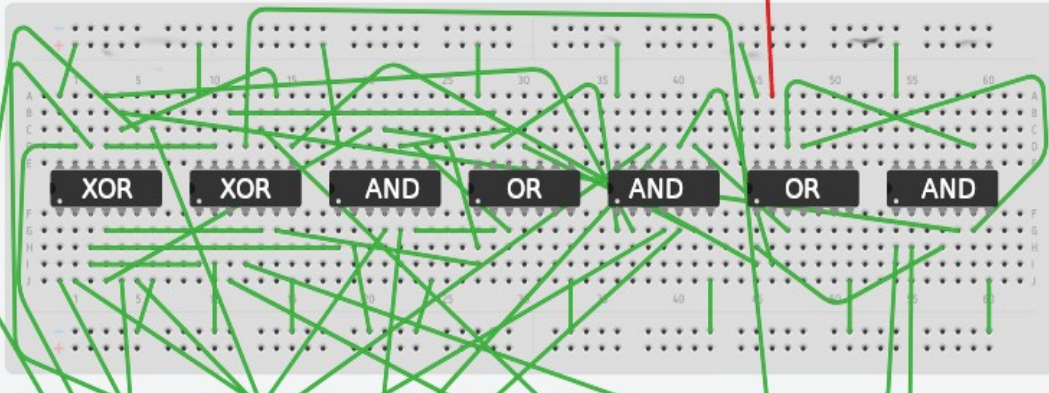
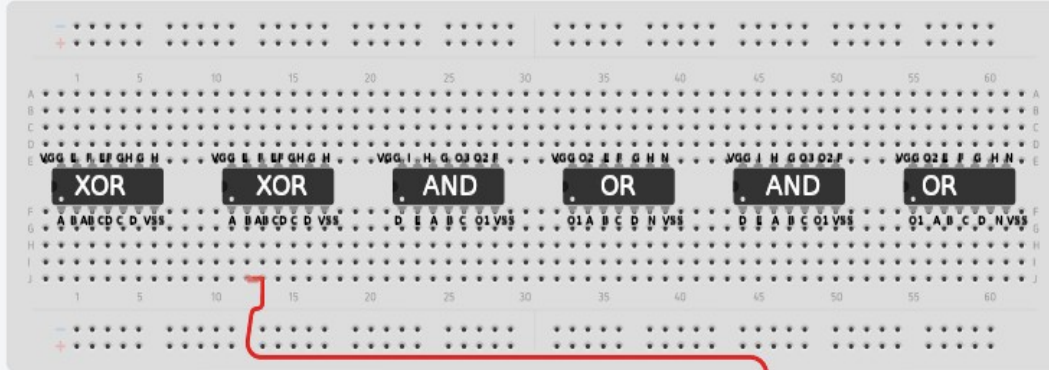
# Passo #37

## Si aggiunge la terza Breadboard

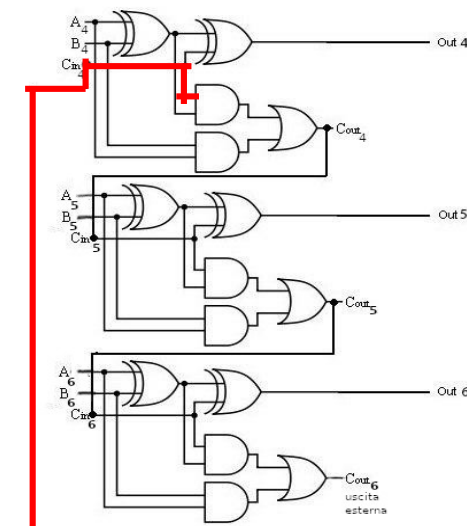
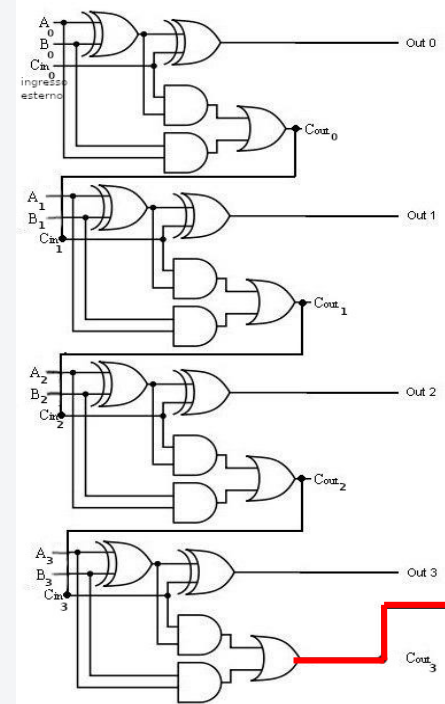
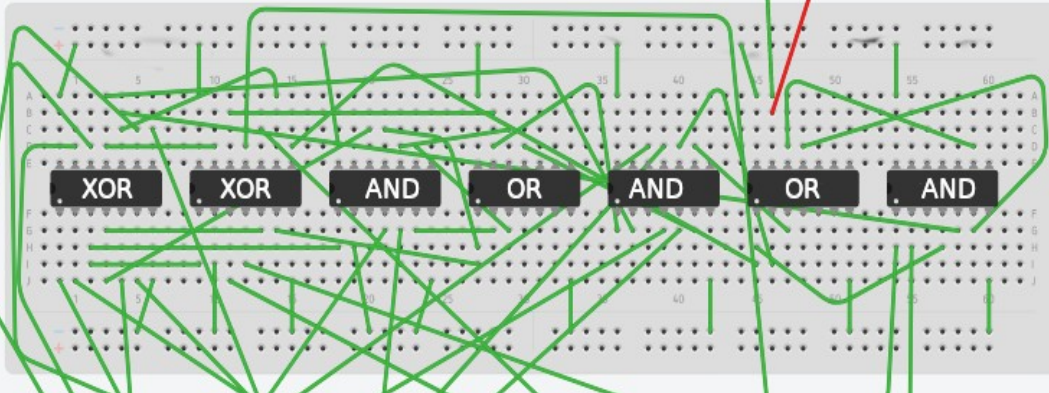
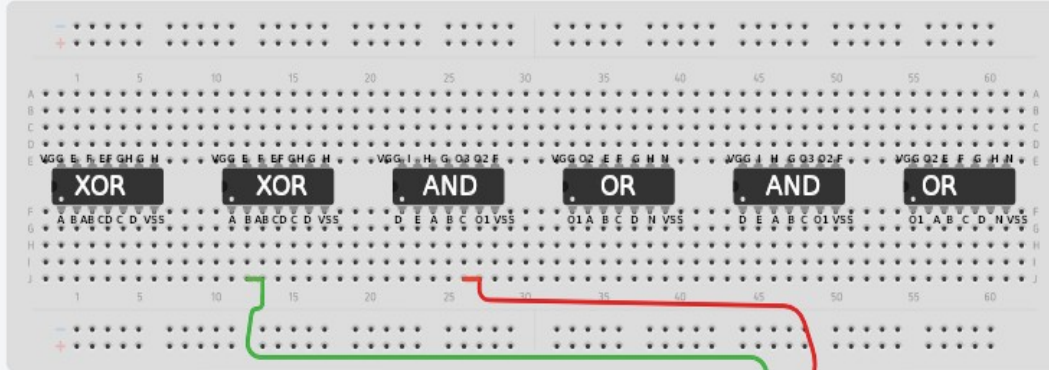
- Inseriamo un'altra breadboard per inserire i circuiti integrati mancanti



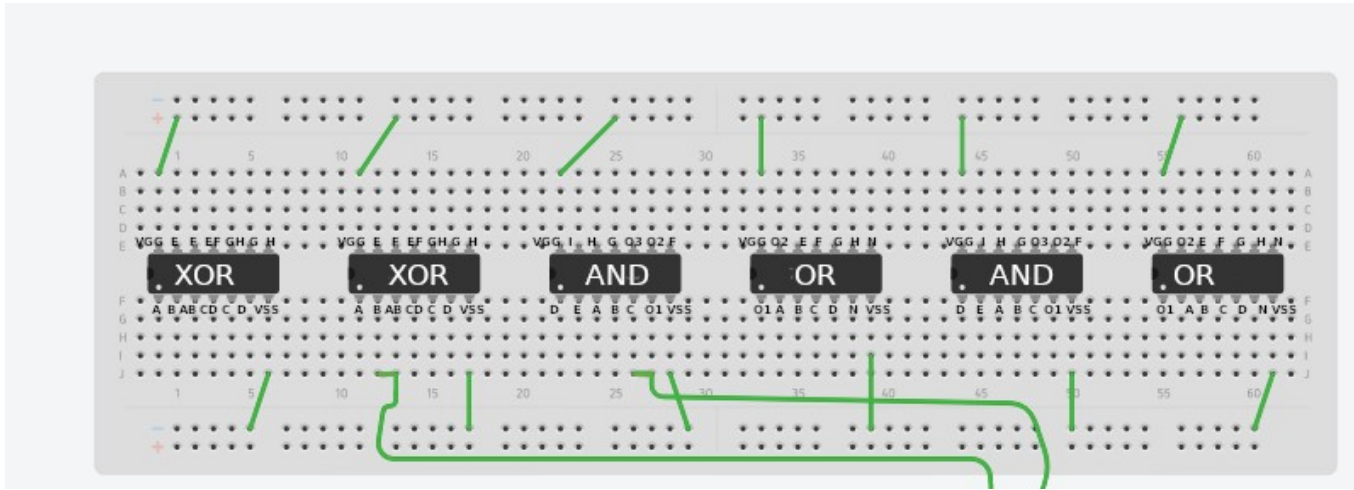
# Passo #38 Stadio 4



# Passo #39 Stadio 4



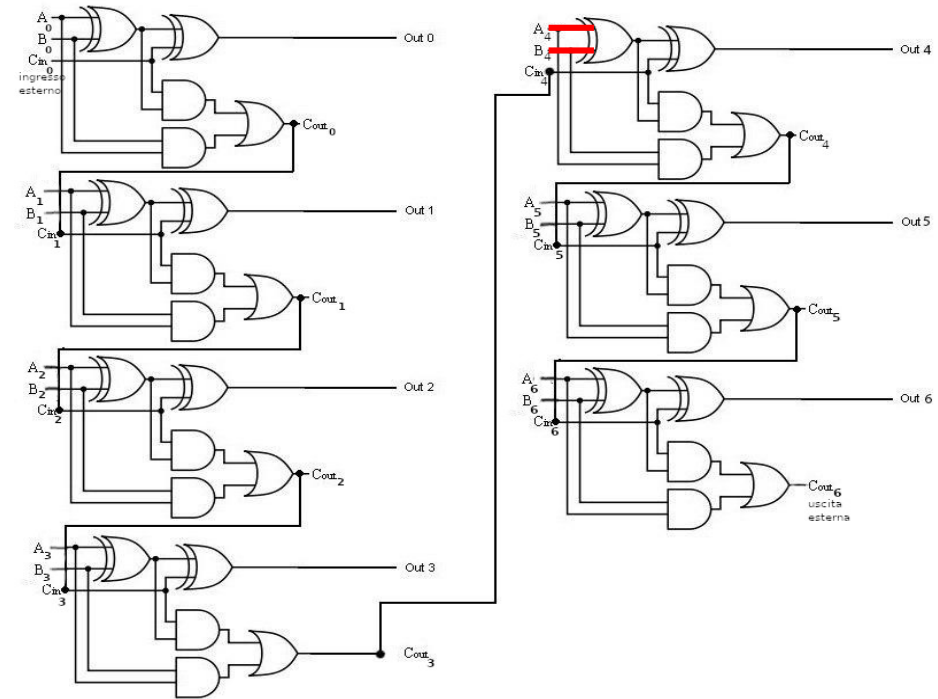
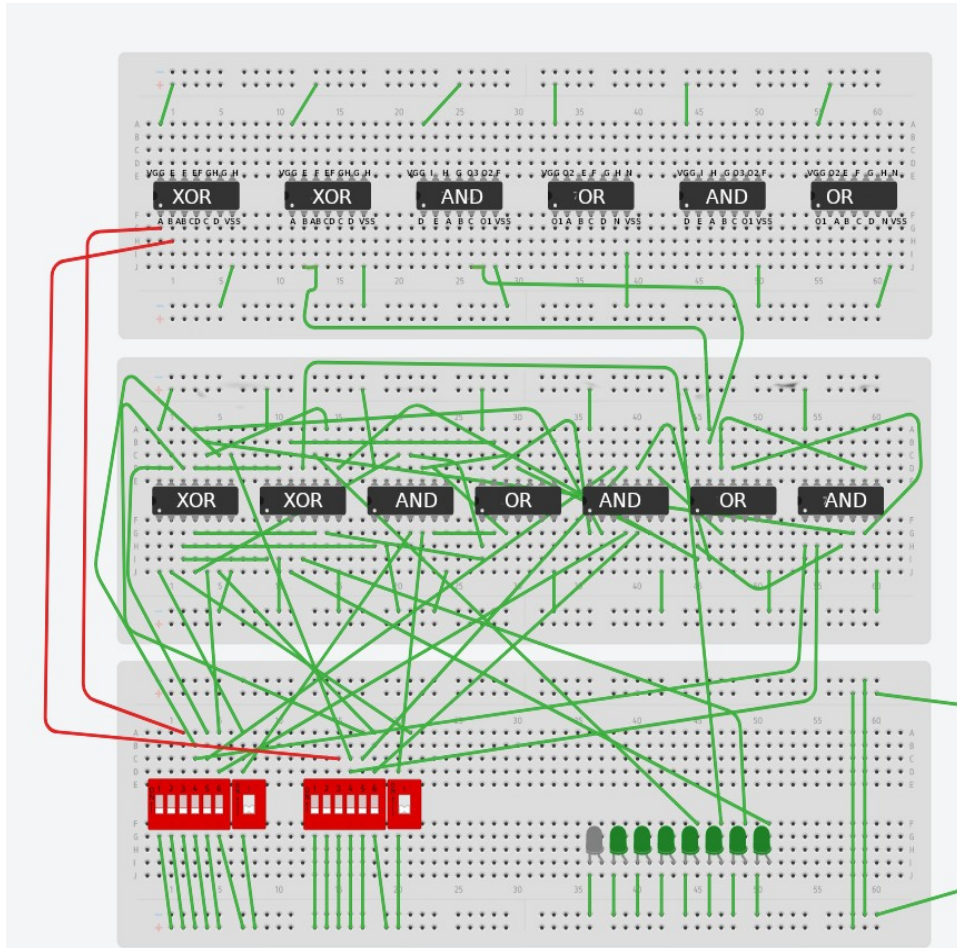
# Passo #40



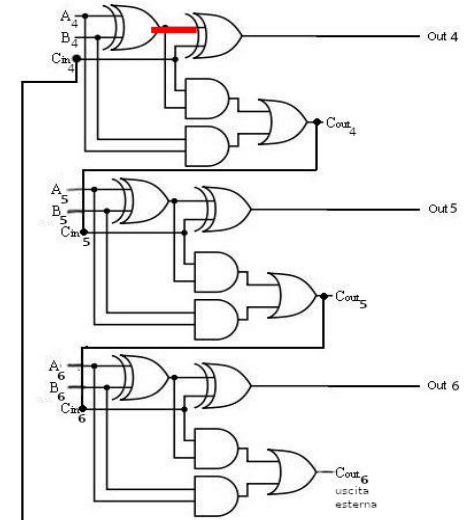
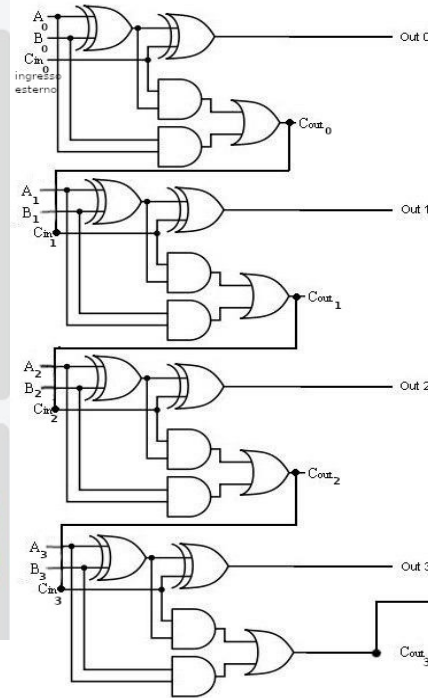
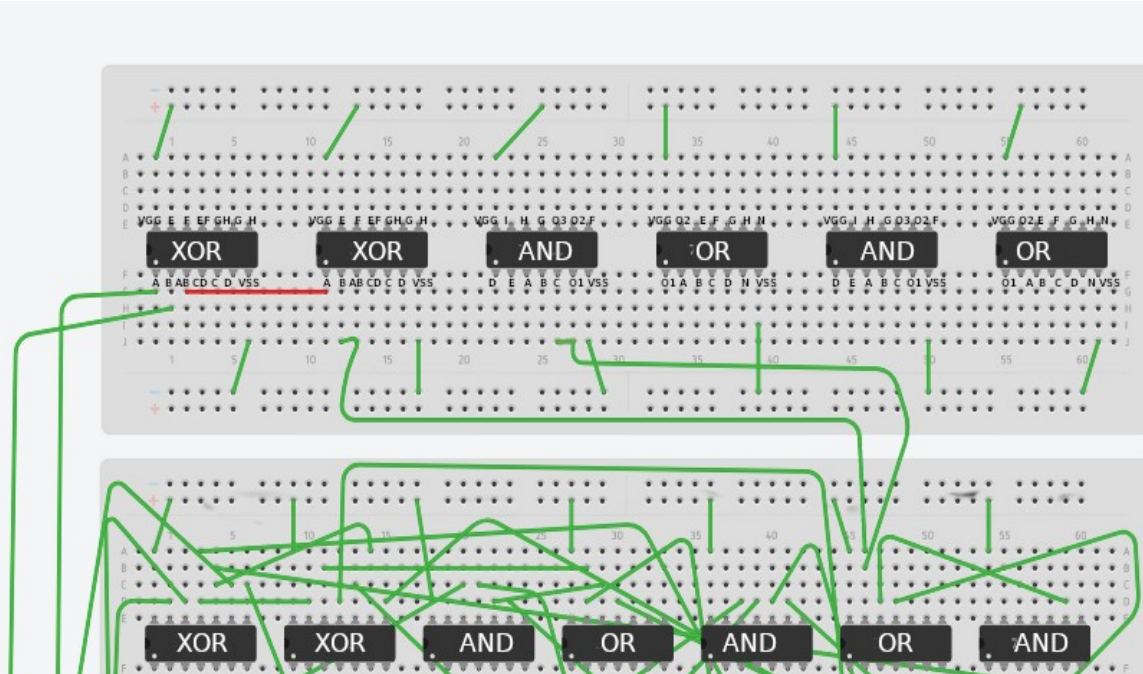
- Alimentiamo **tutti** i circuiti integrati della nuova breadboard mettendo in ingresso la carica positiva in Vcc e la carica negativa in Vss (come abbiamo già fatto per la precedente breadboard).



# Passo #41 Studio 4

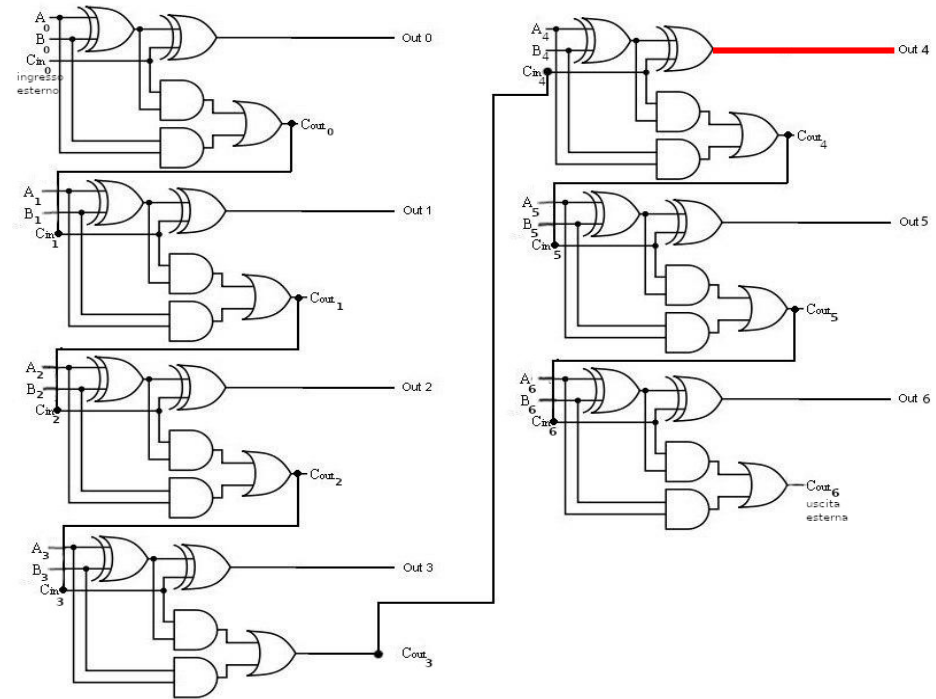
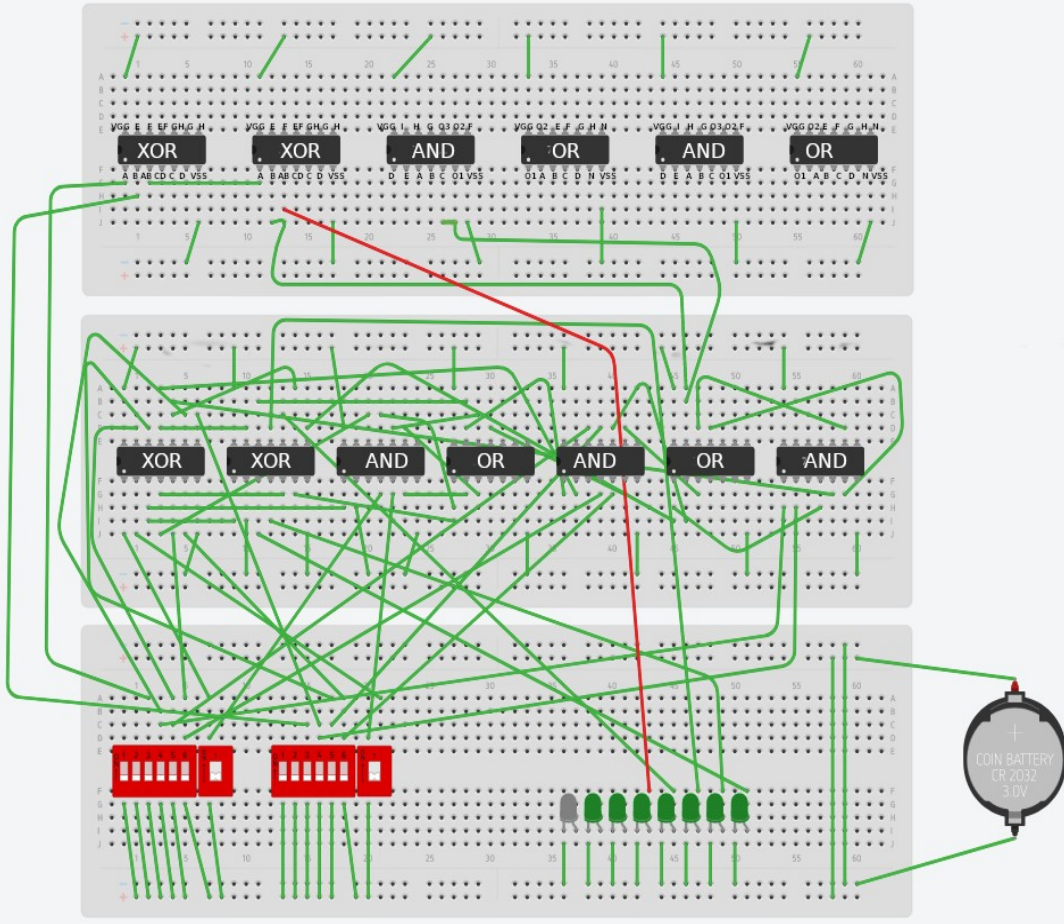


# Passo #42 Stadio 4

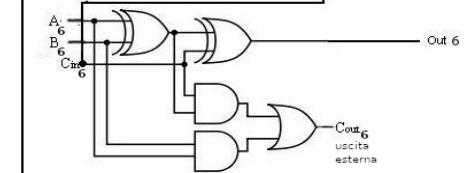
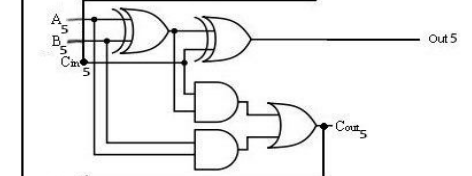
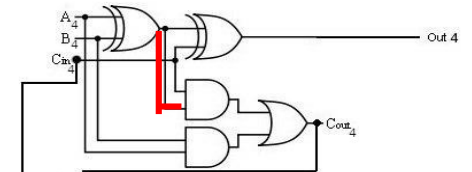
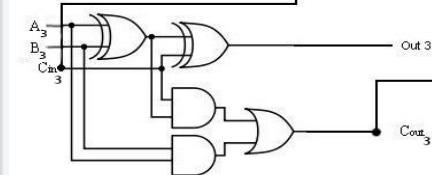
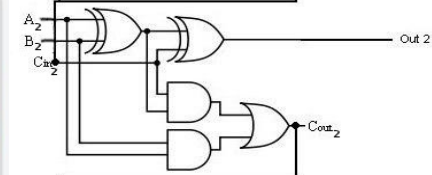
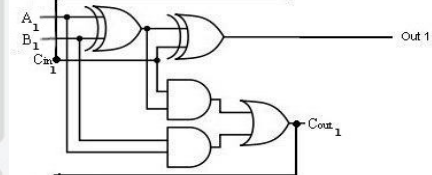
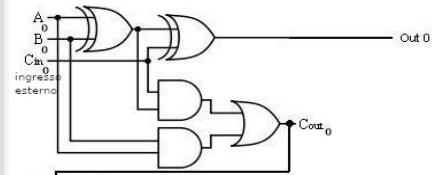
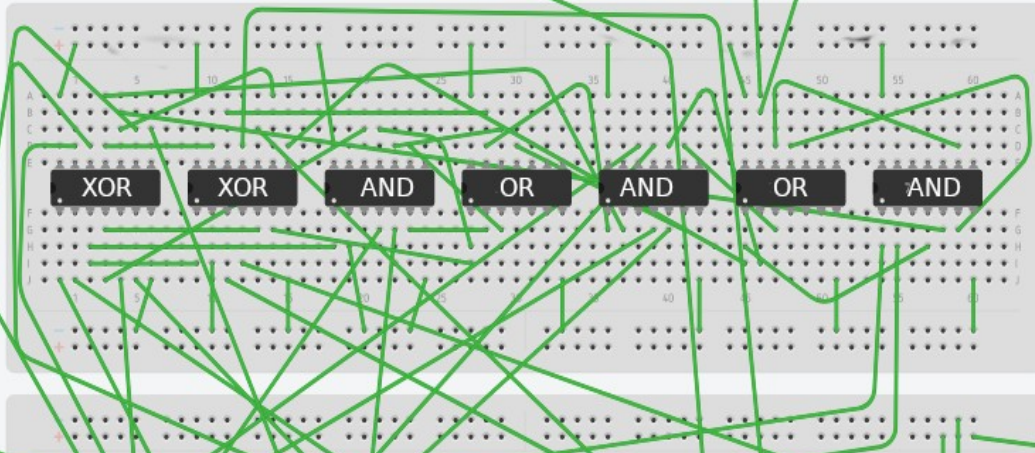
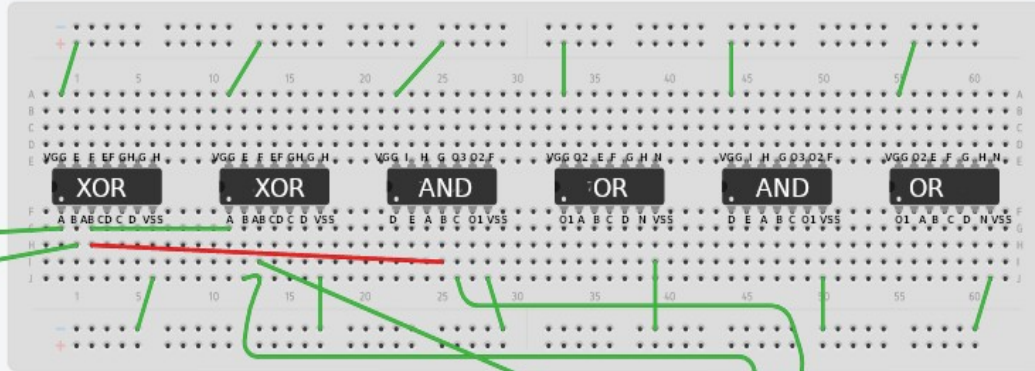




# Passo #43 Stadio 4

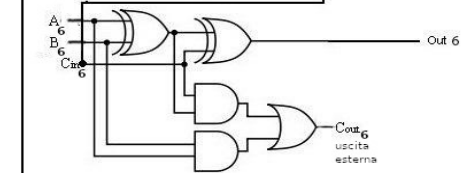
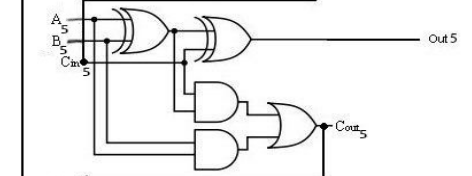
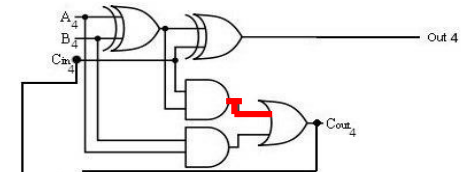
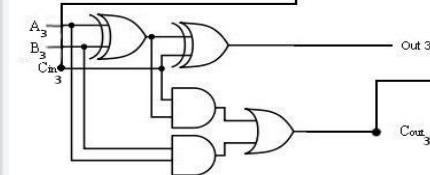
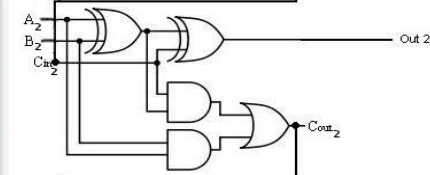
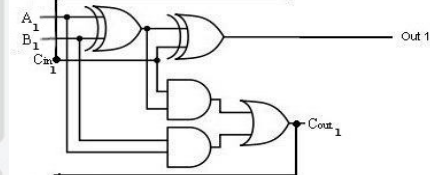
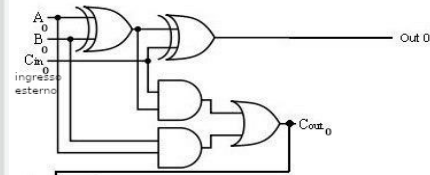
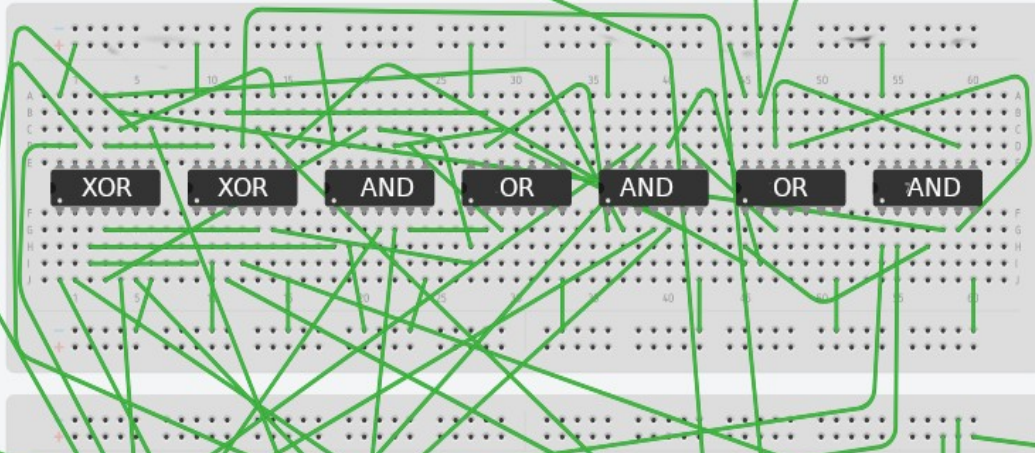
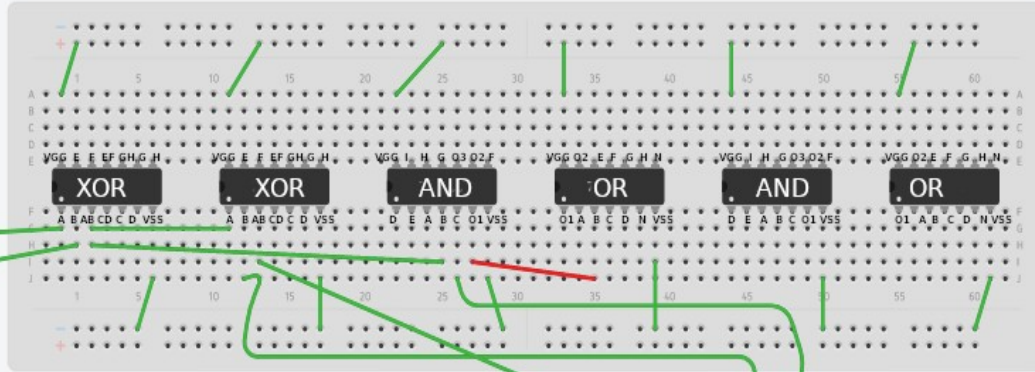


# Passo #44 Stadio 4

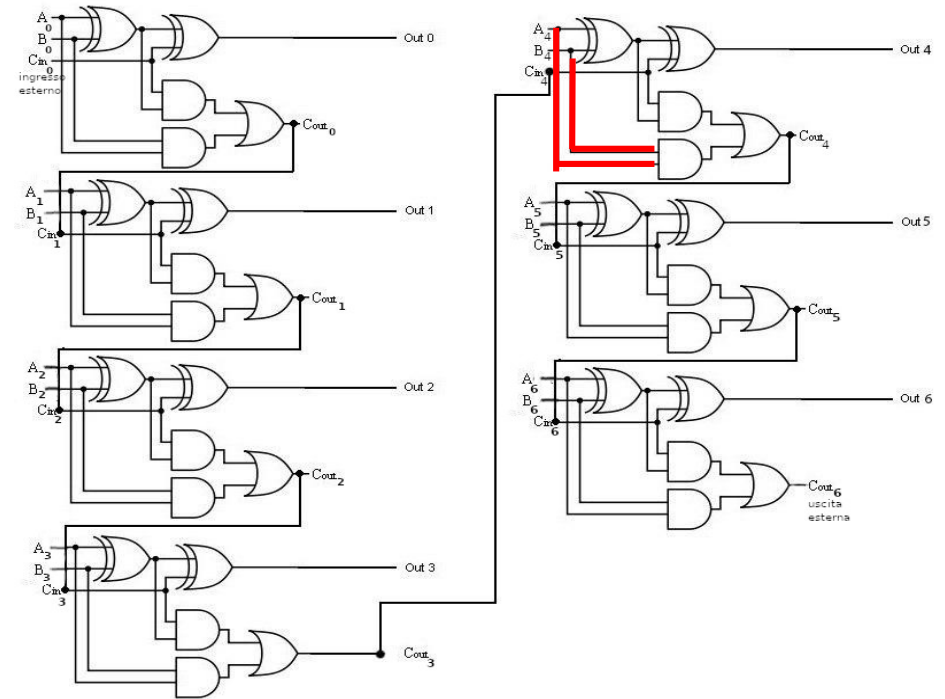
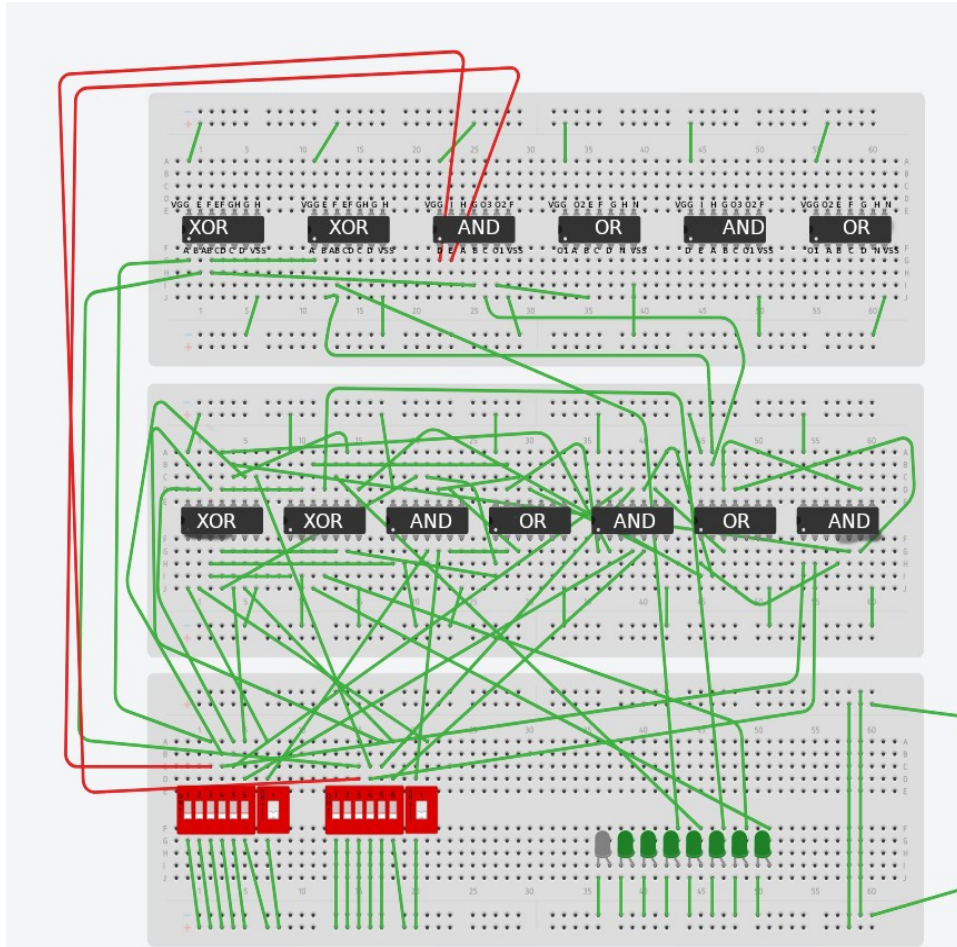




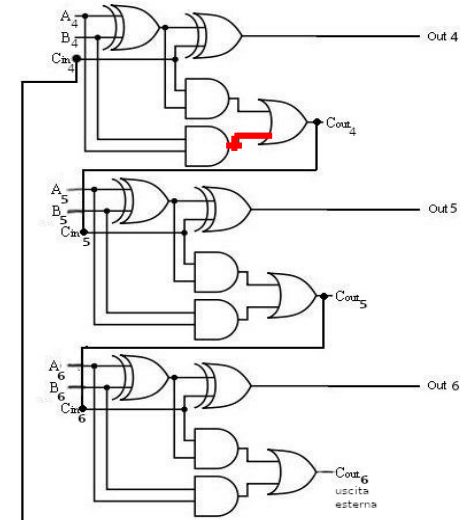
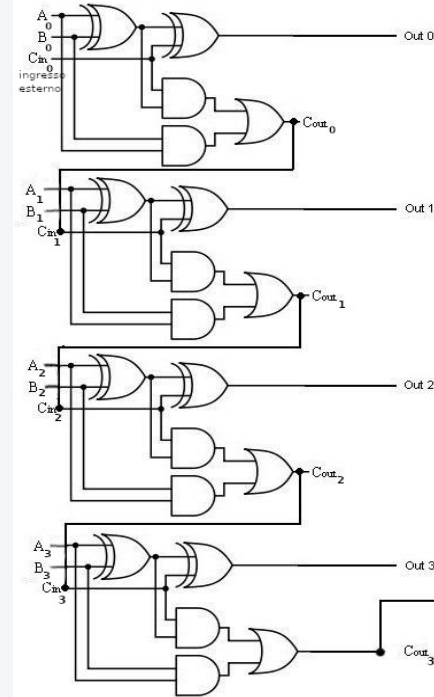
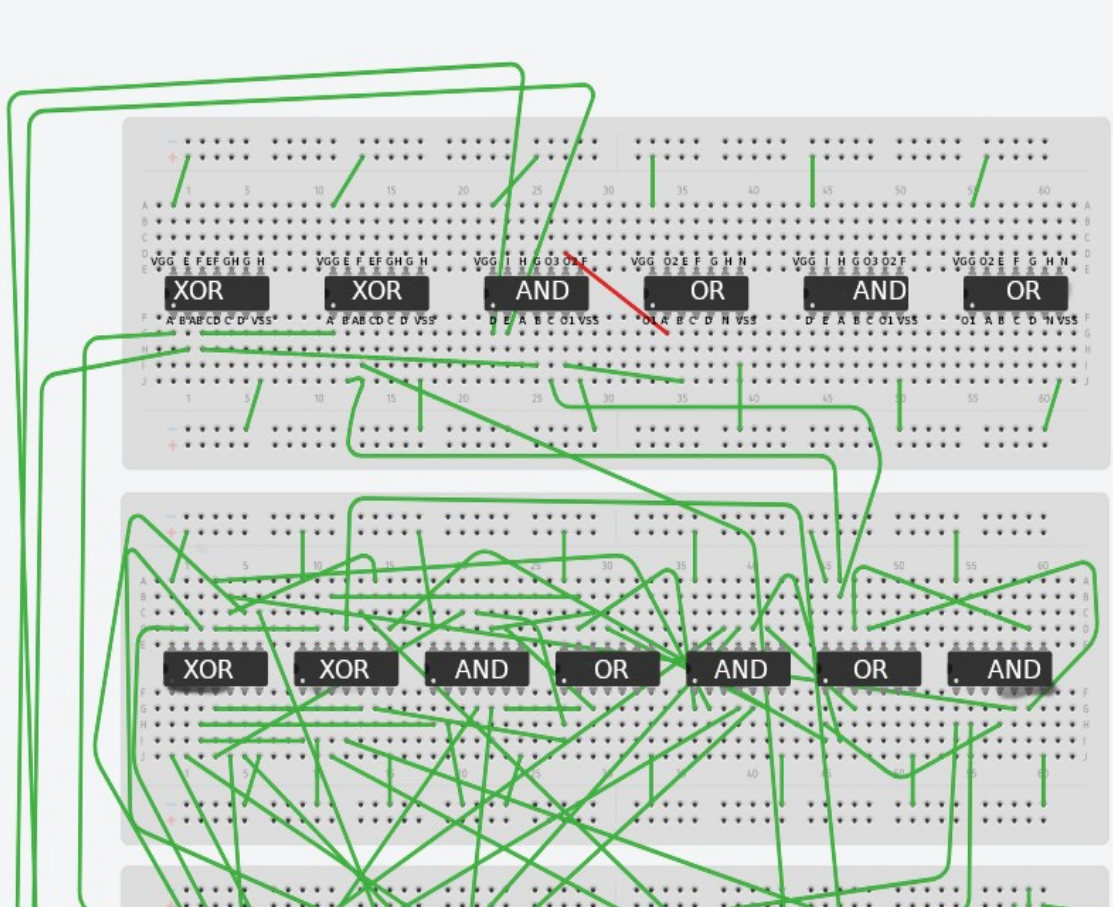
# Passo #45 Stadio 4



# Passo #46 Stadio 4

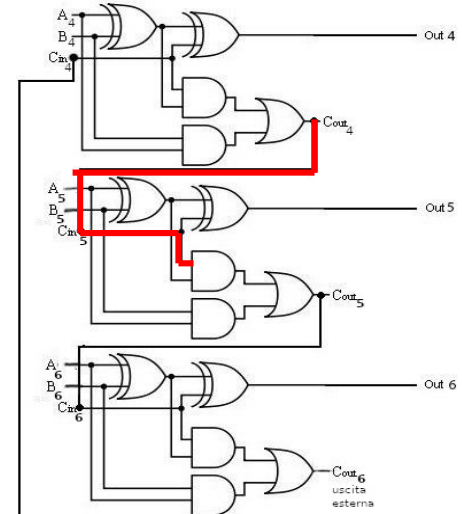
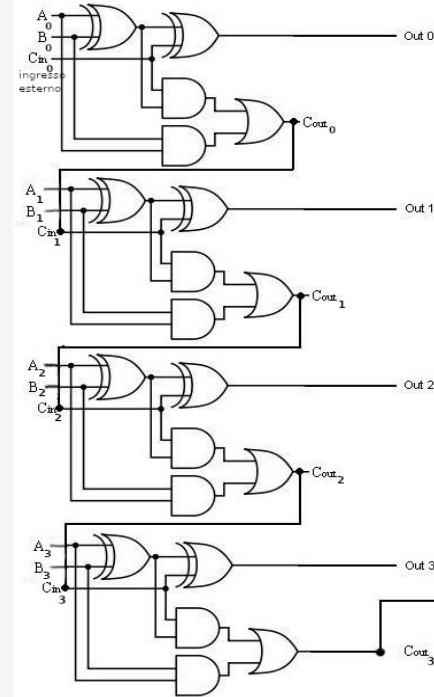
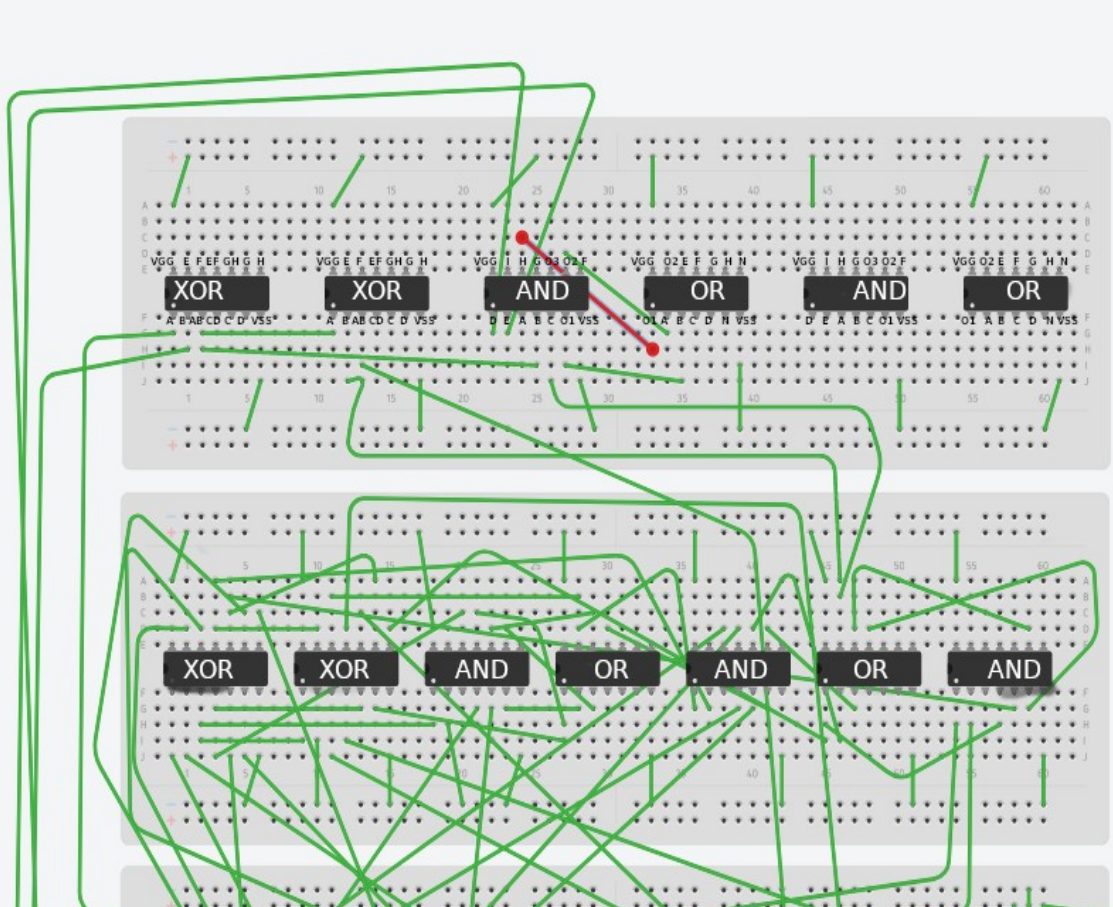


# Passo #47 Stadio 4



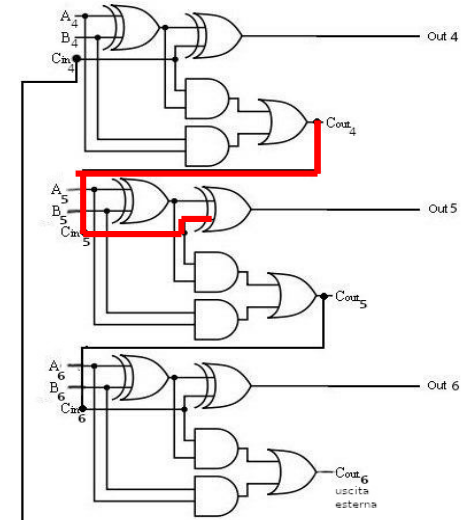
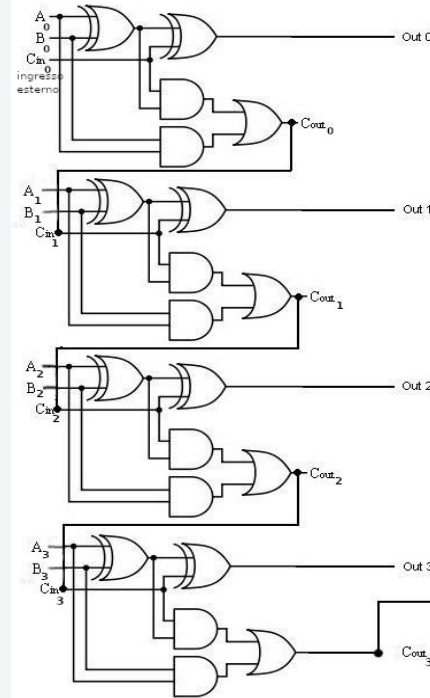
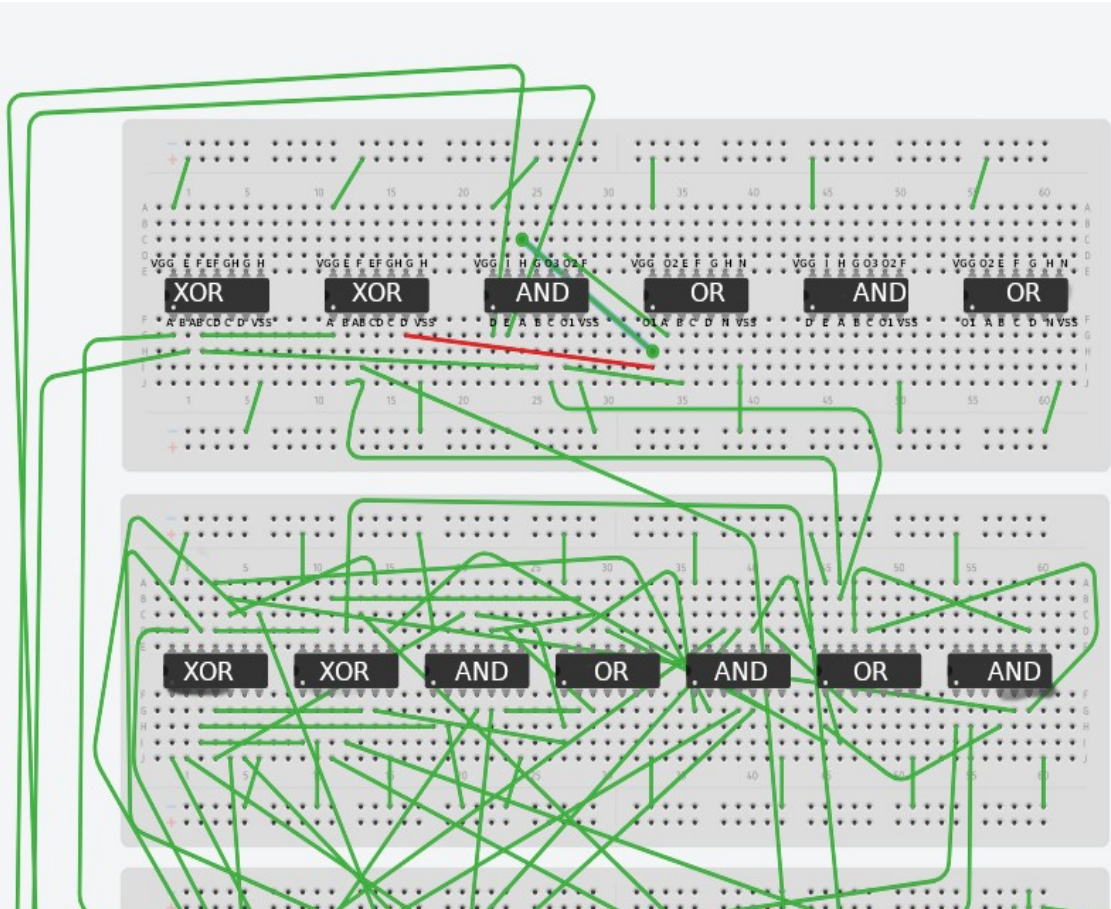


# Passo #48 Stadio 5

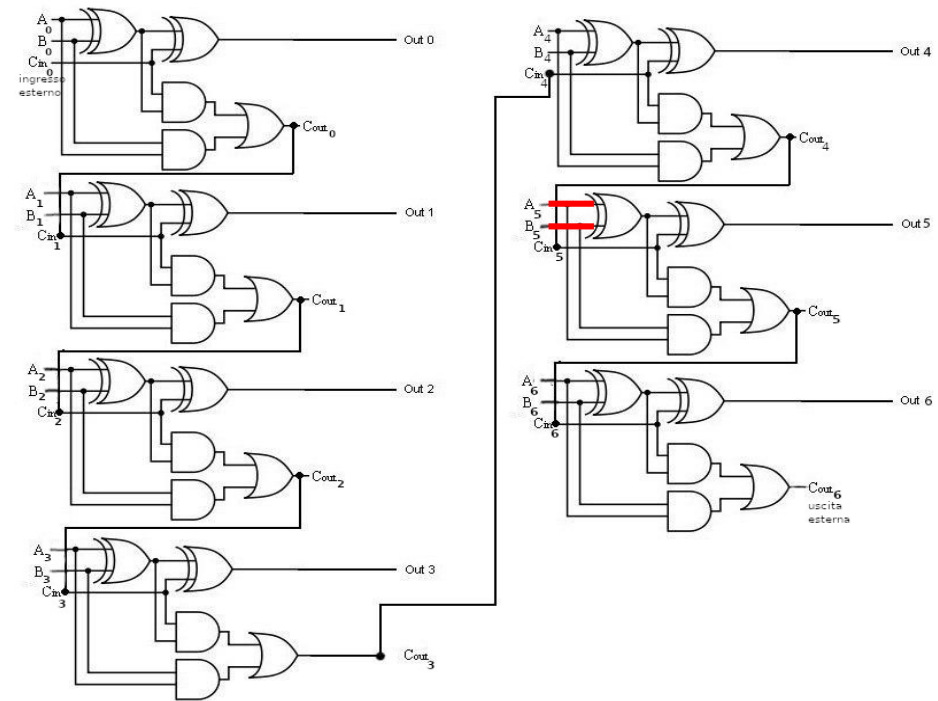
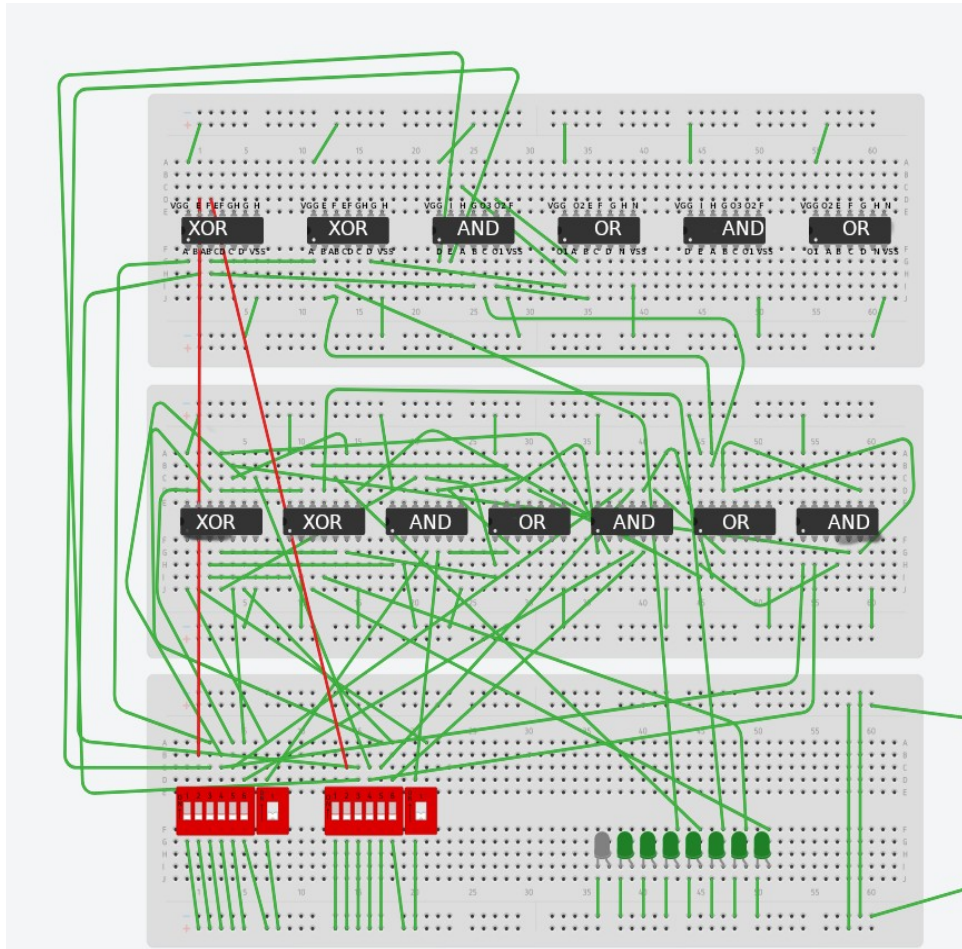




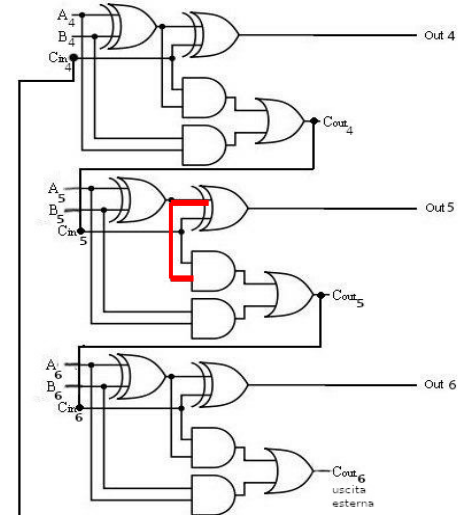
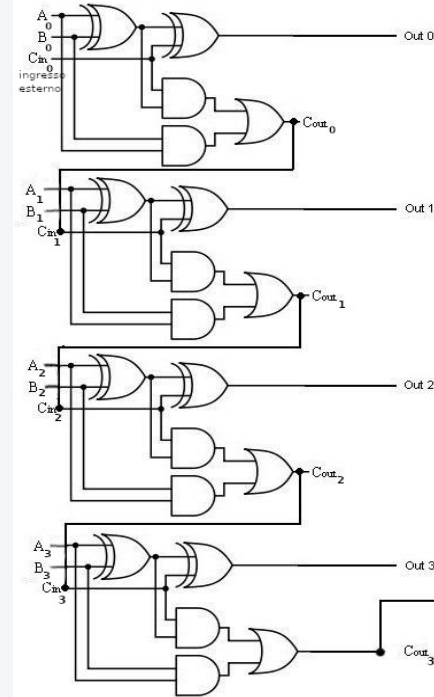
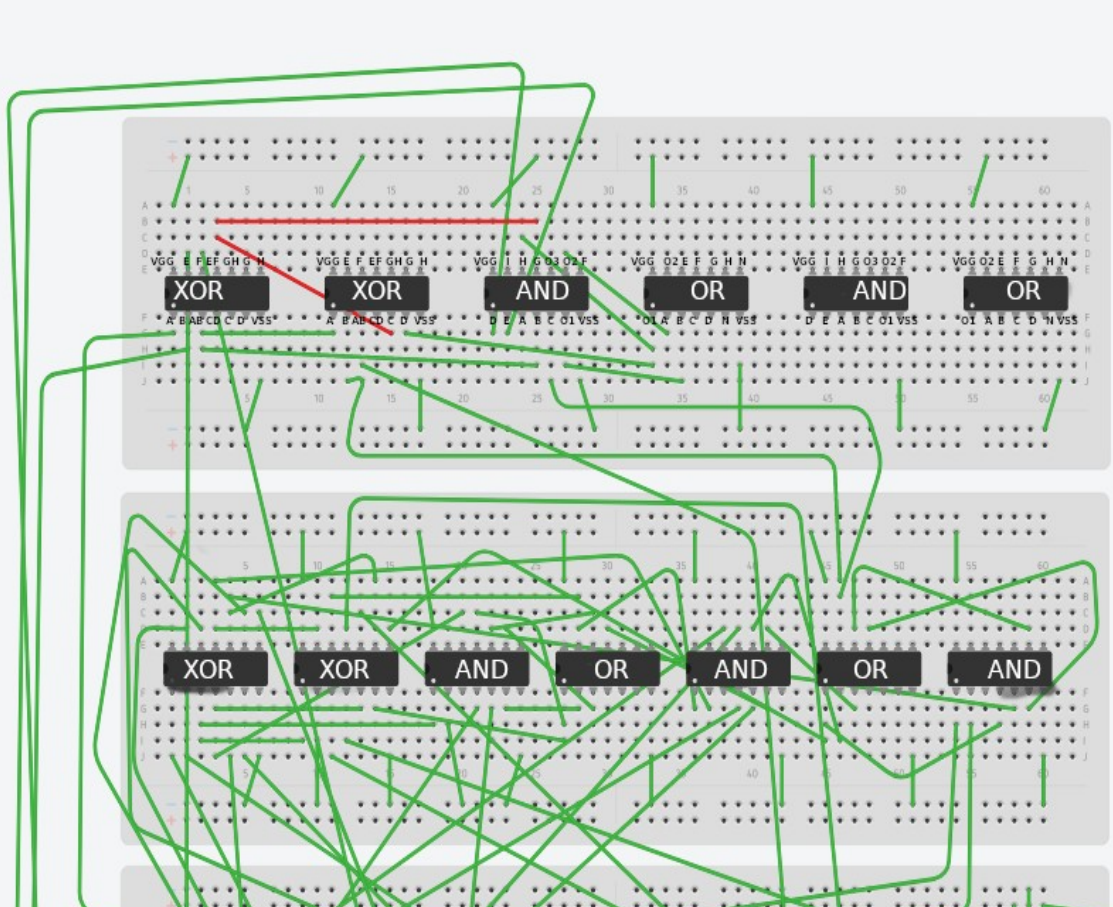
# Passo #49 Stadio 5



# Passo #50 Stadio 5

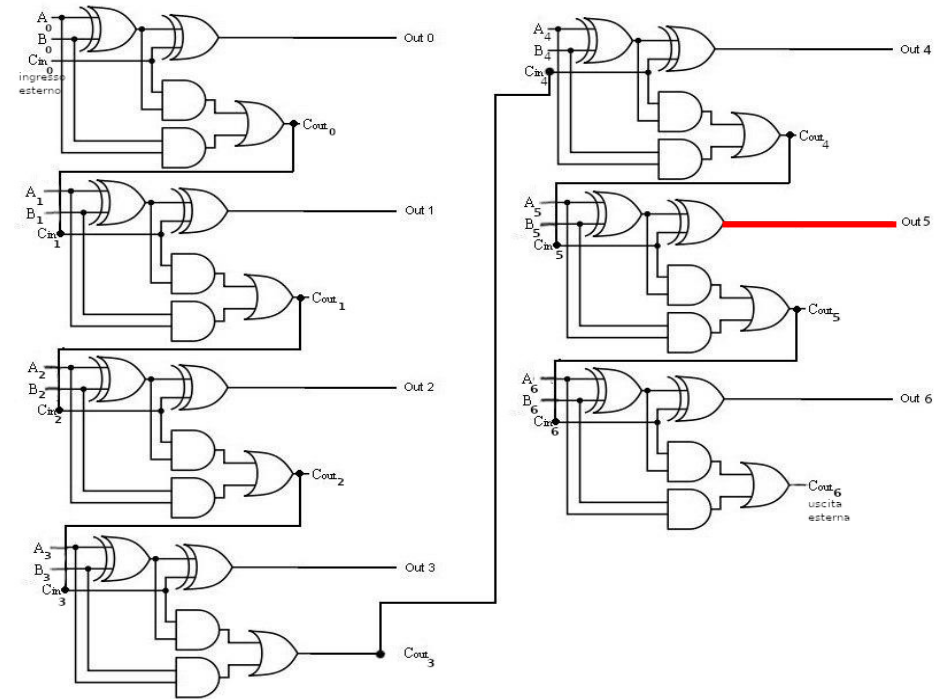
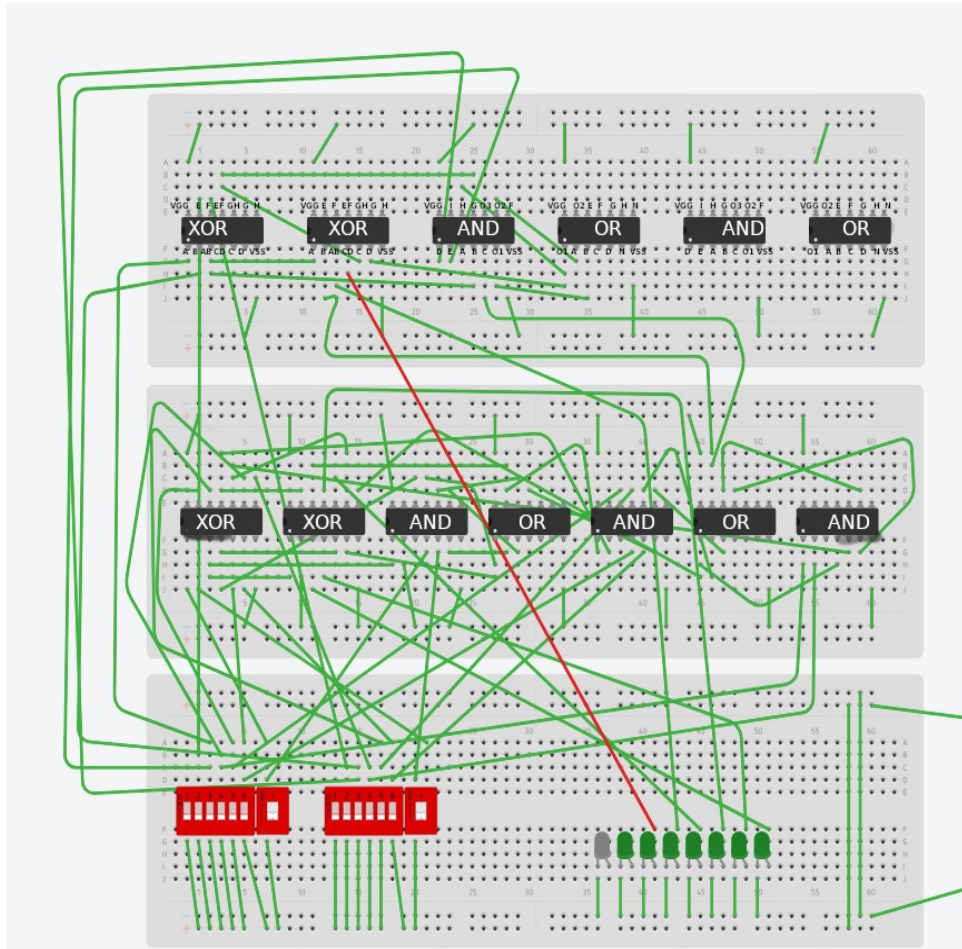


# Passo #51 Stadio 5



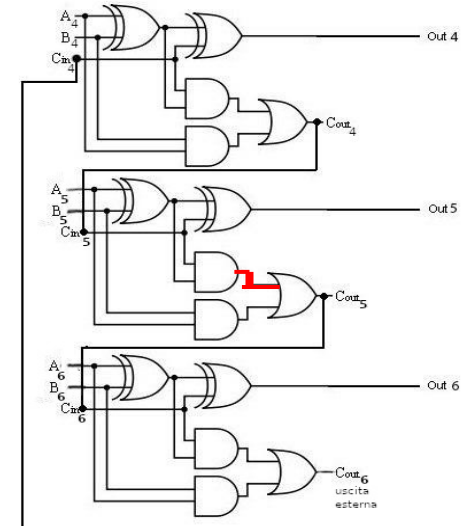
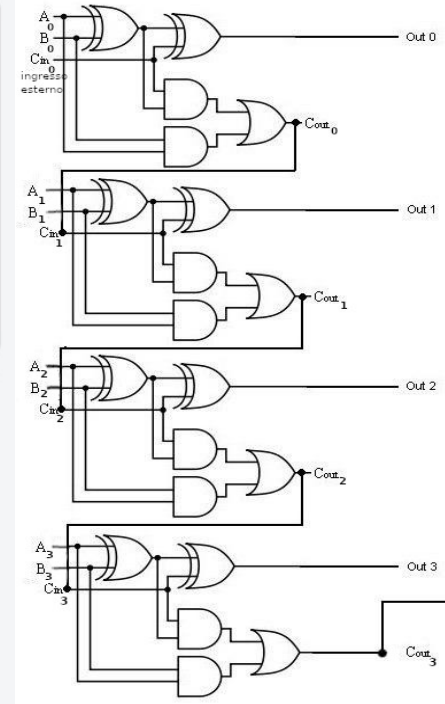
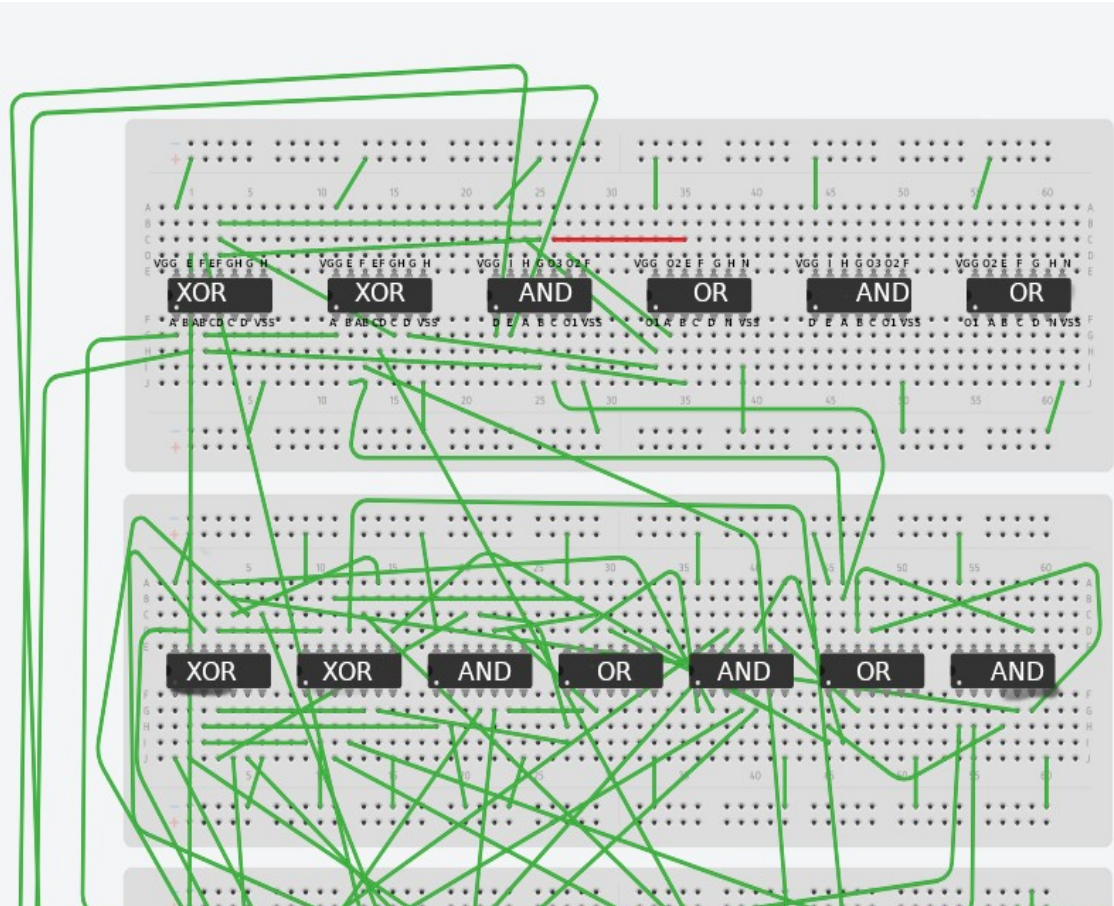


# Passo #52 Stadio 5

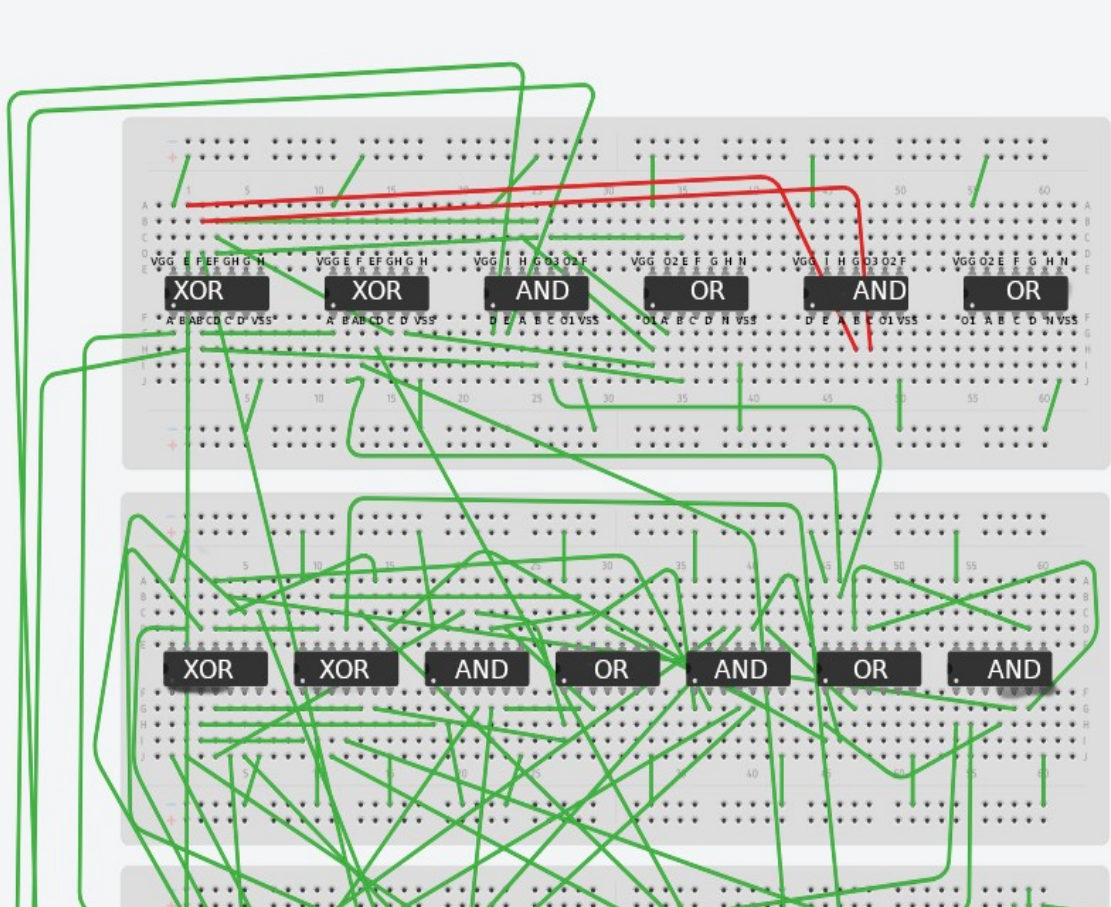




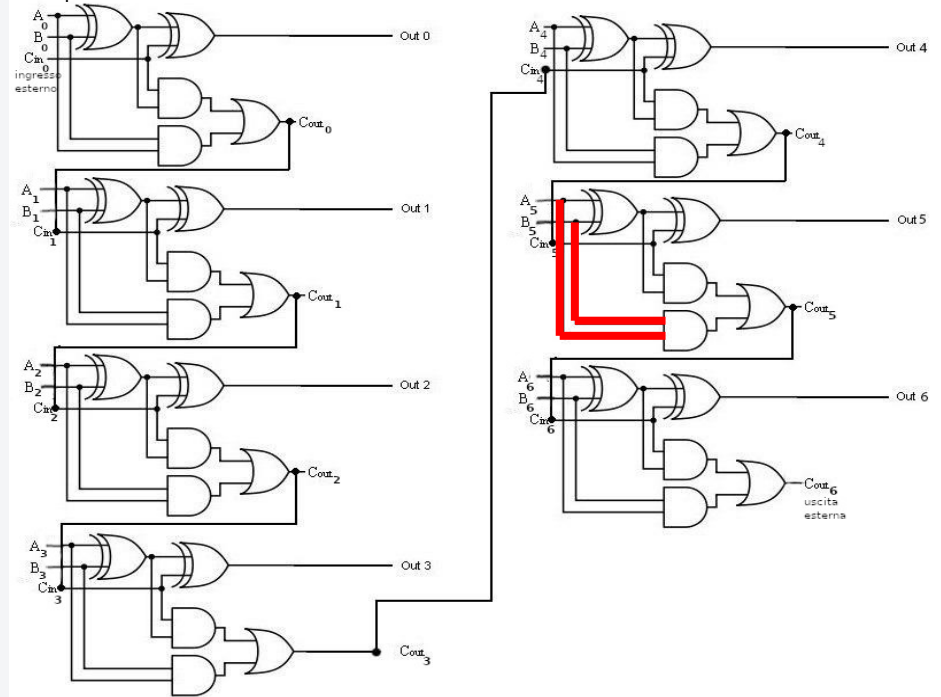
# Passo #53 Stadio 5



# Passo #54 Stadio 5

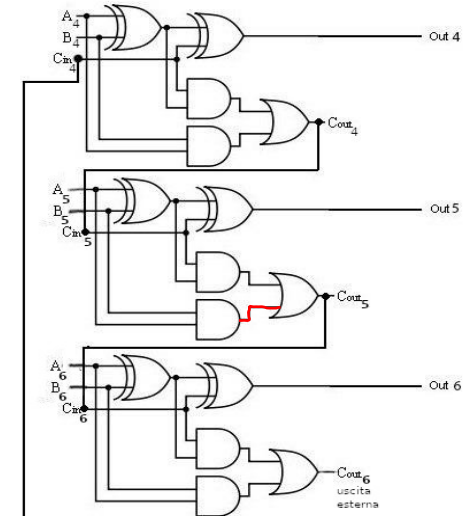
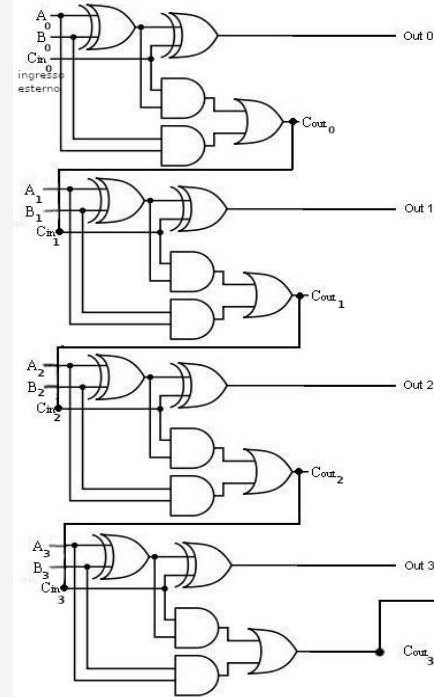
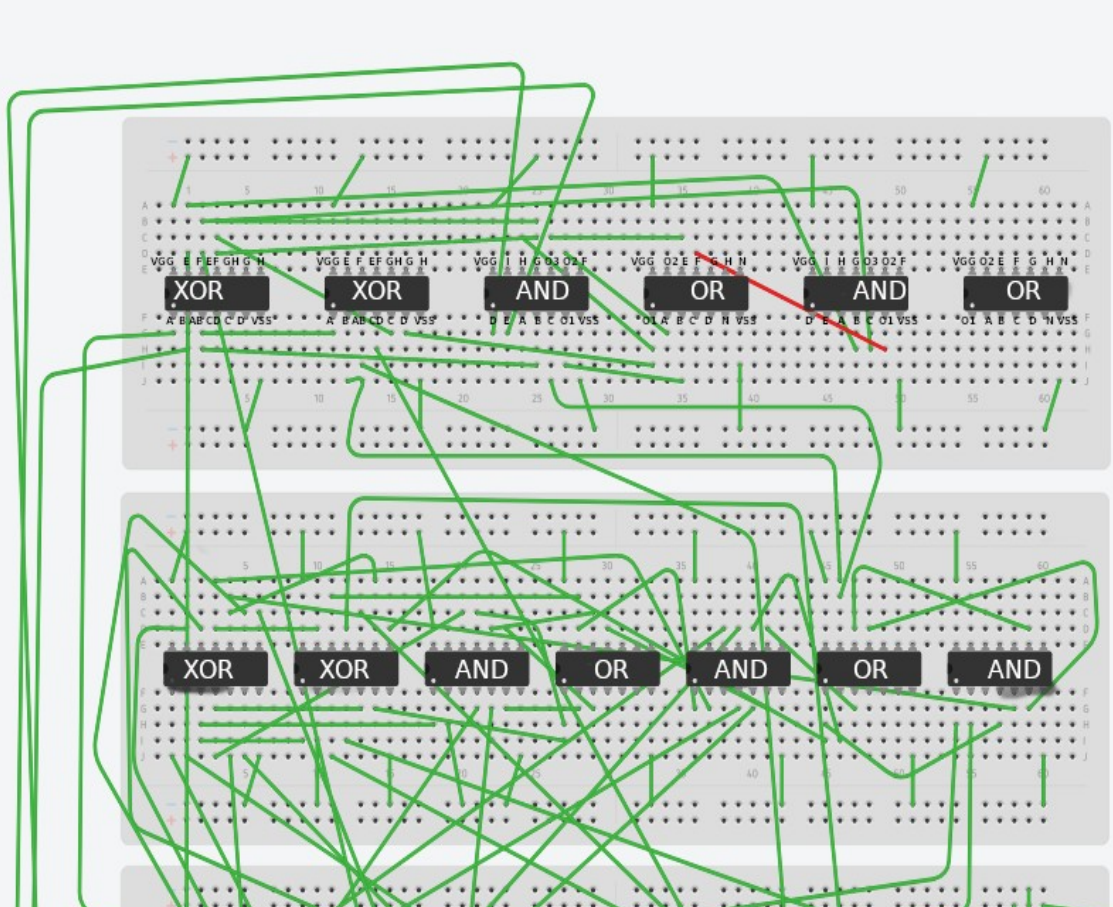


*n.b:* Per semplicità essendo che gli switch sono distanti dal quinto circuito integrato AND mostrato in figura, possiamo anche prendere i bit dei due numeri binari dall'entrate E e F del terzo circuito integrato XOR che corrispondono esattamente ai bit, ciò rende più facile il collegamento delle entrate. Sennò possiamo reperirli normalmente dagli switch come abbiamo svolto negli stadi precedenti (però ciò porta a utilizzare cavi più lunghi)

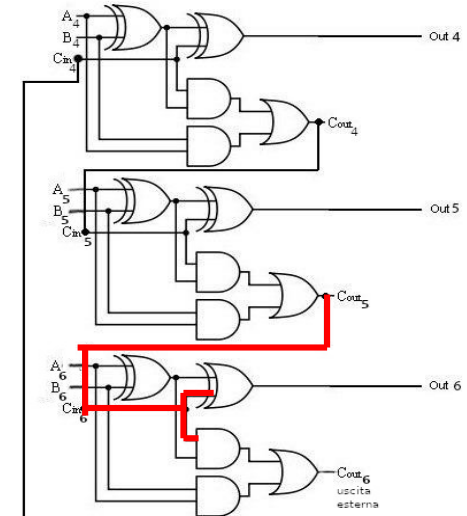
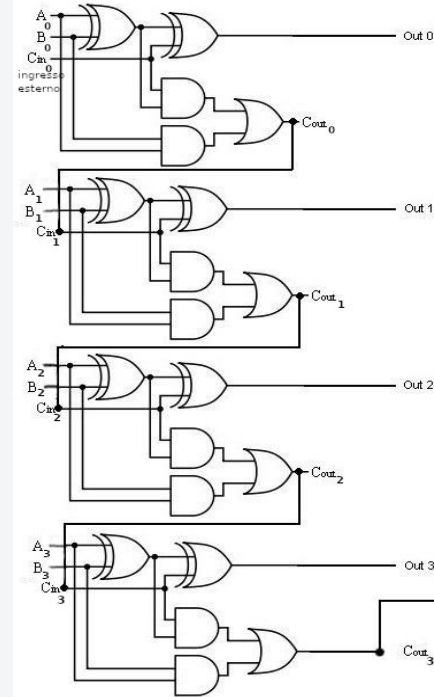
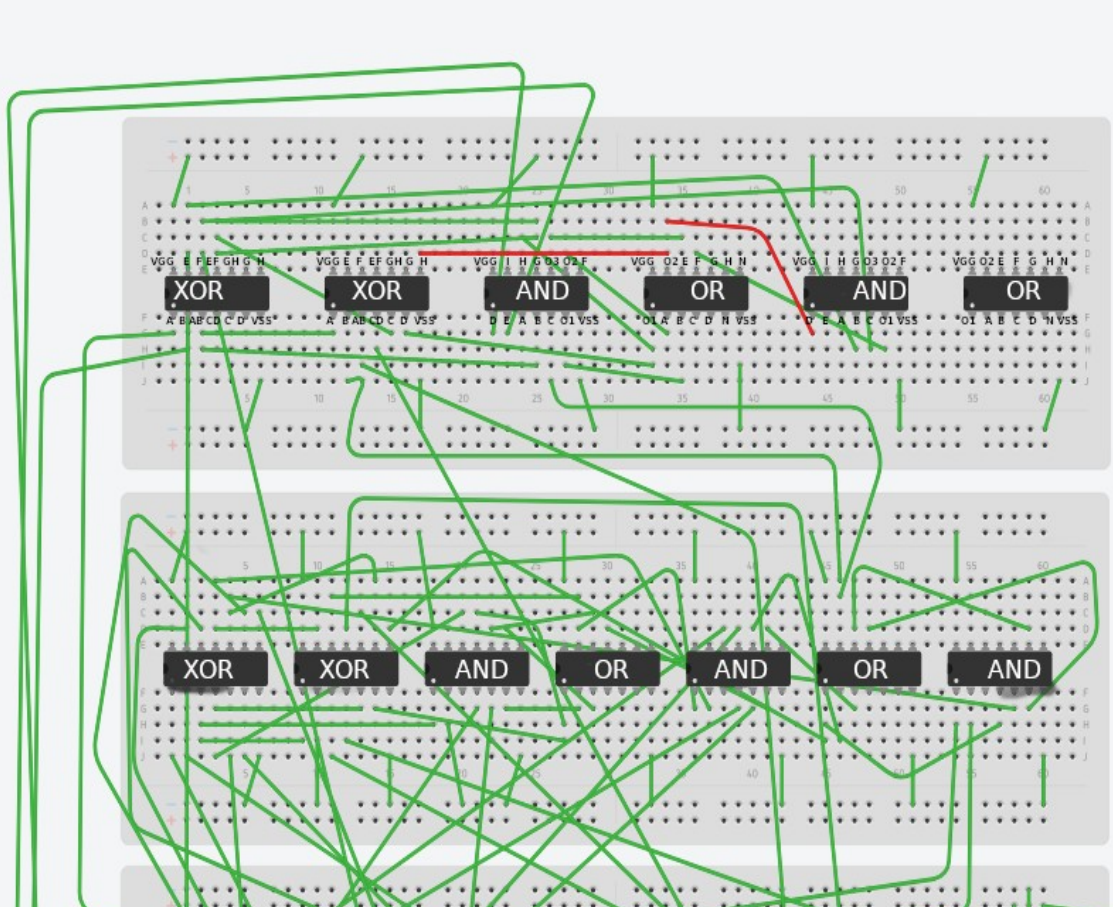




# Passo #55 Stadio 5

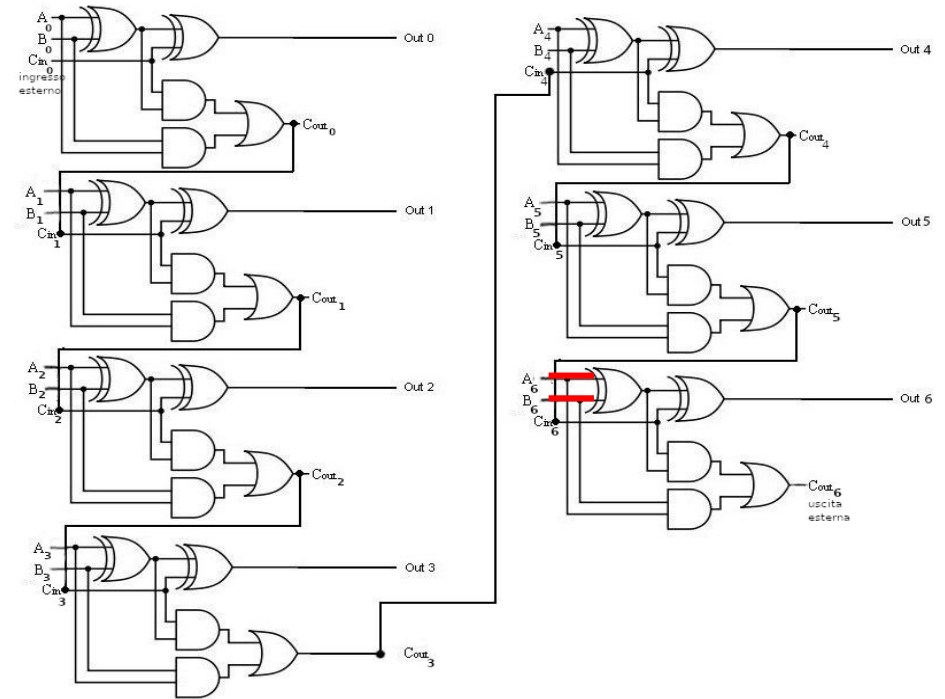
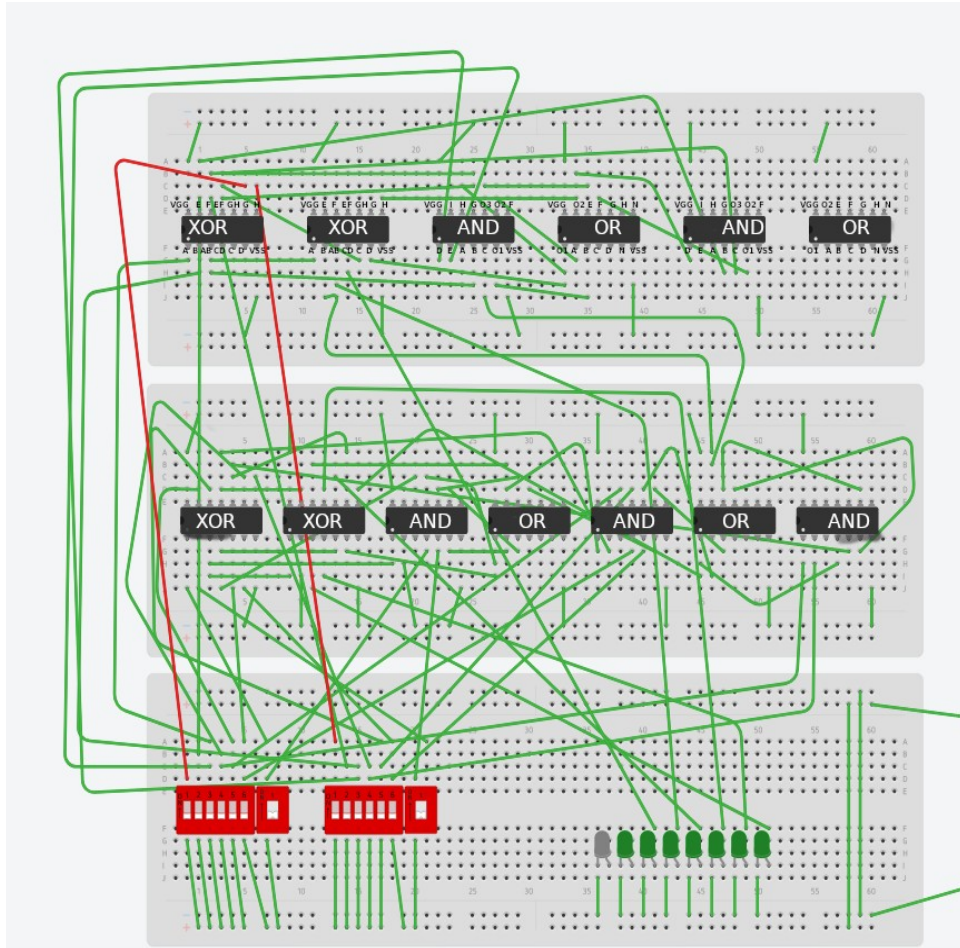


# Passo #56 Stadio 6

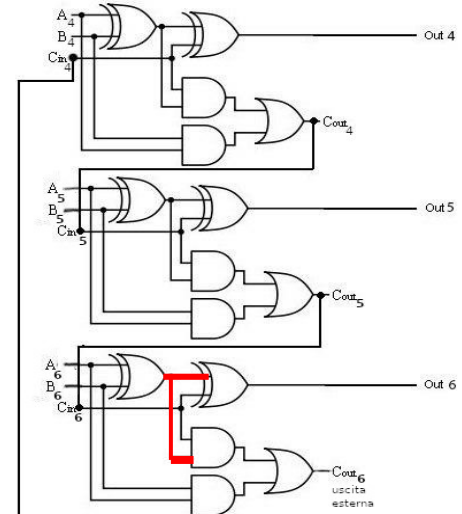
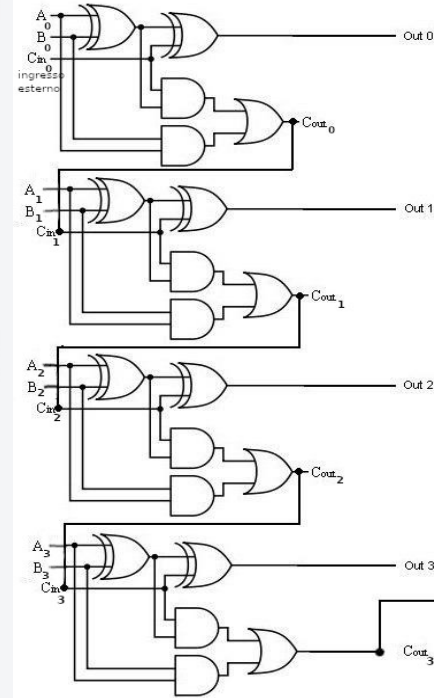
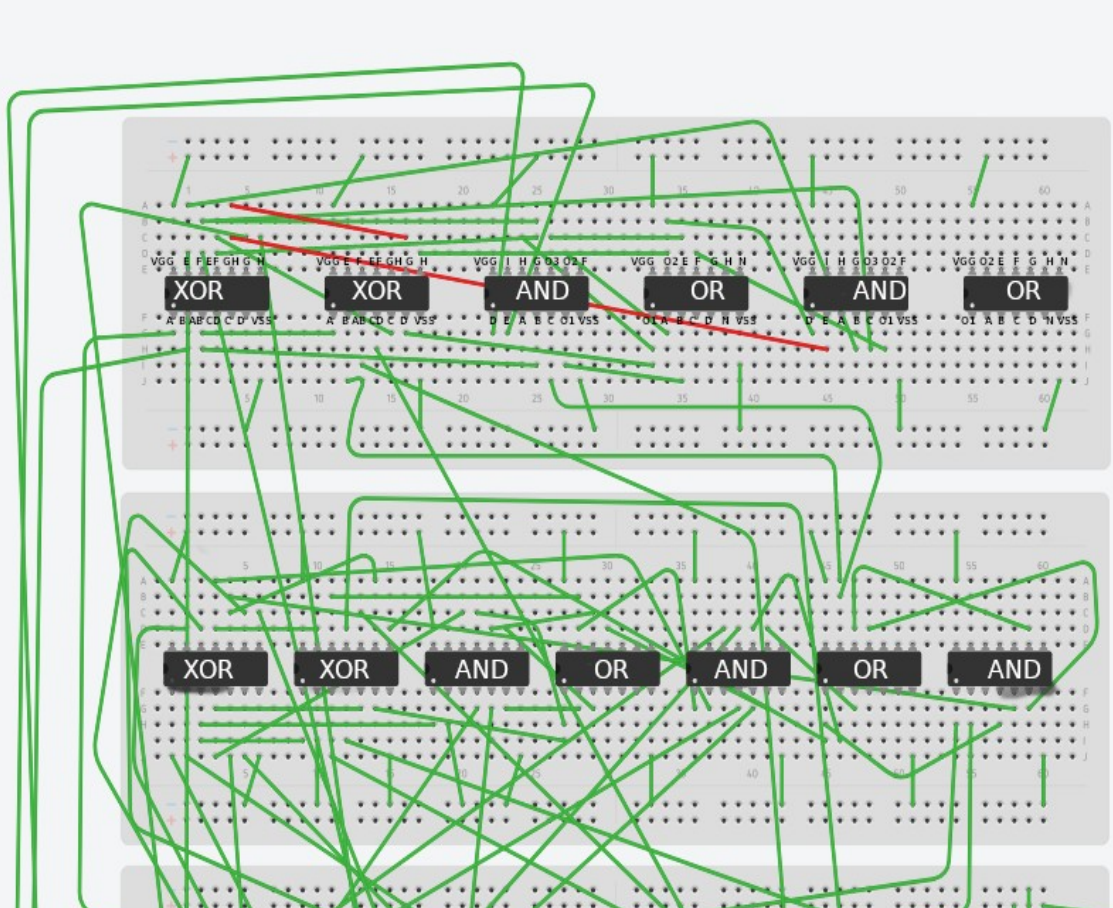




# Passo #57 Stadio 6



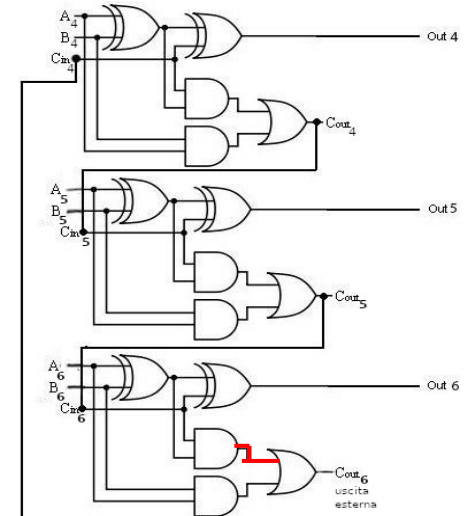
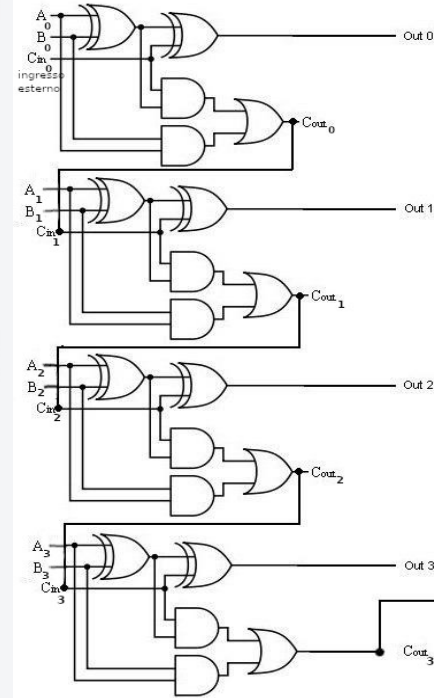
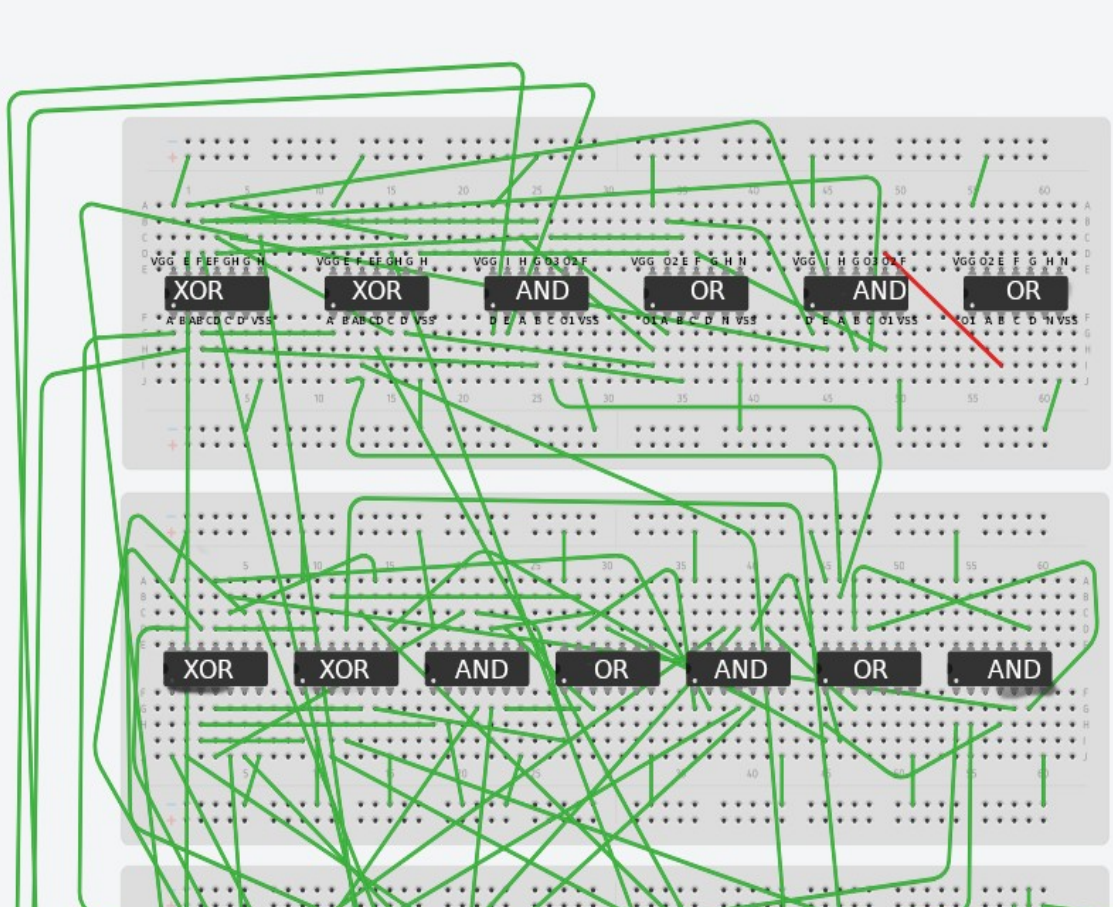
# Passo #58 Stadio 6





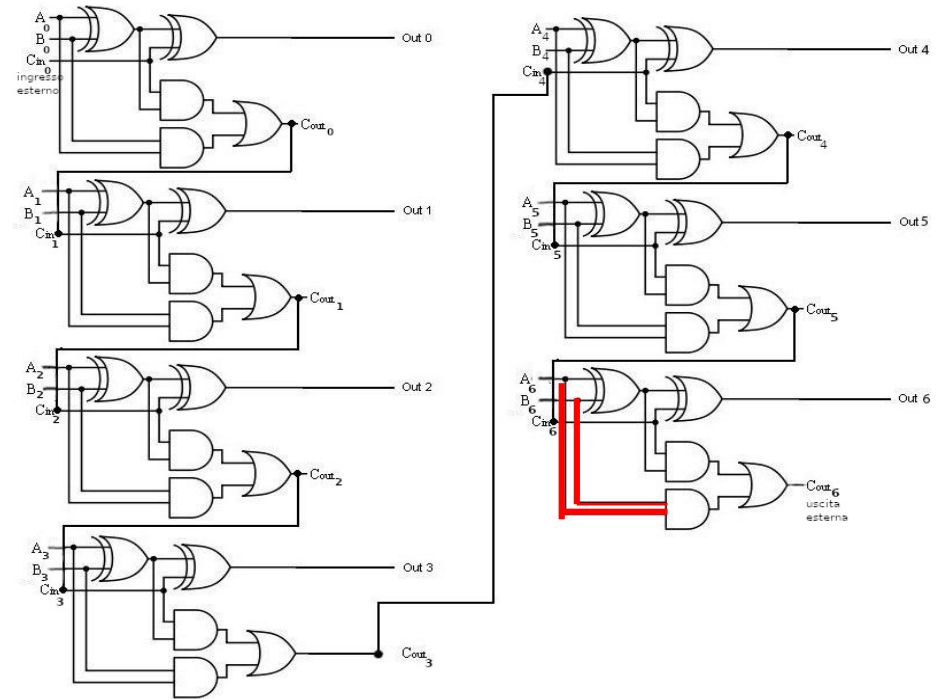
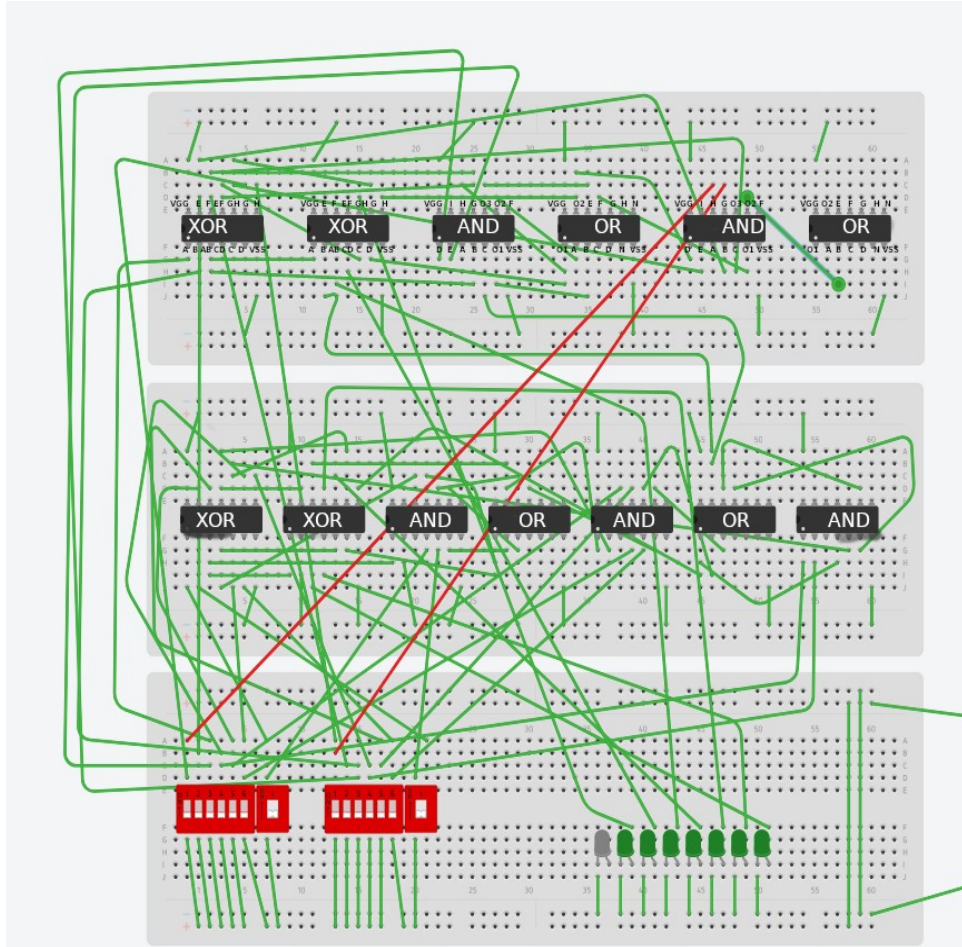


# Passo #60 Stadio 6

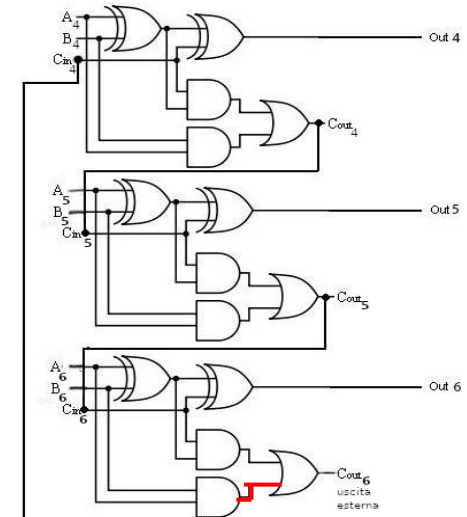
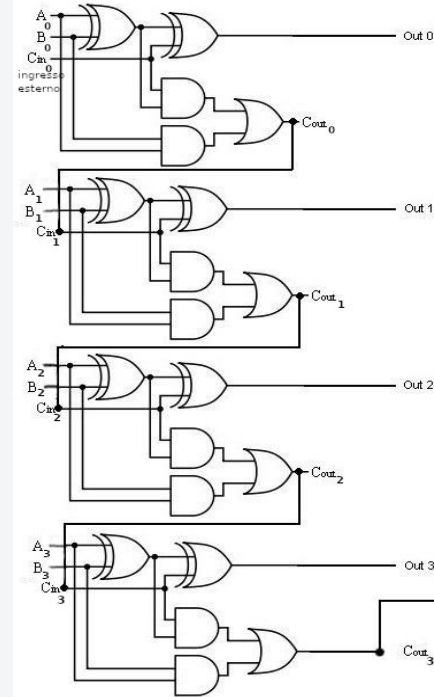
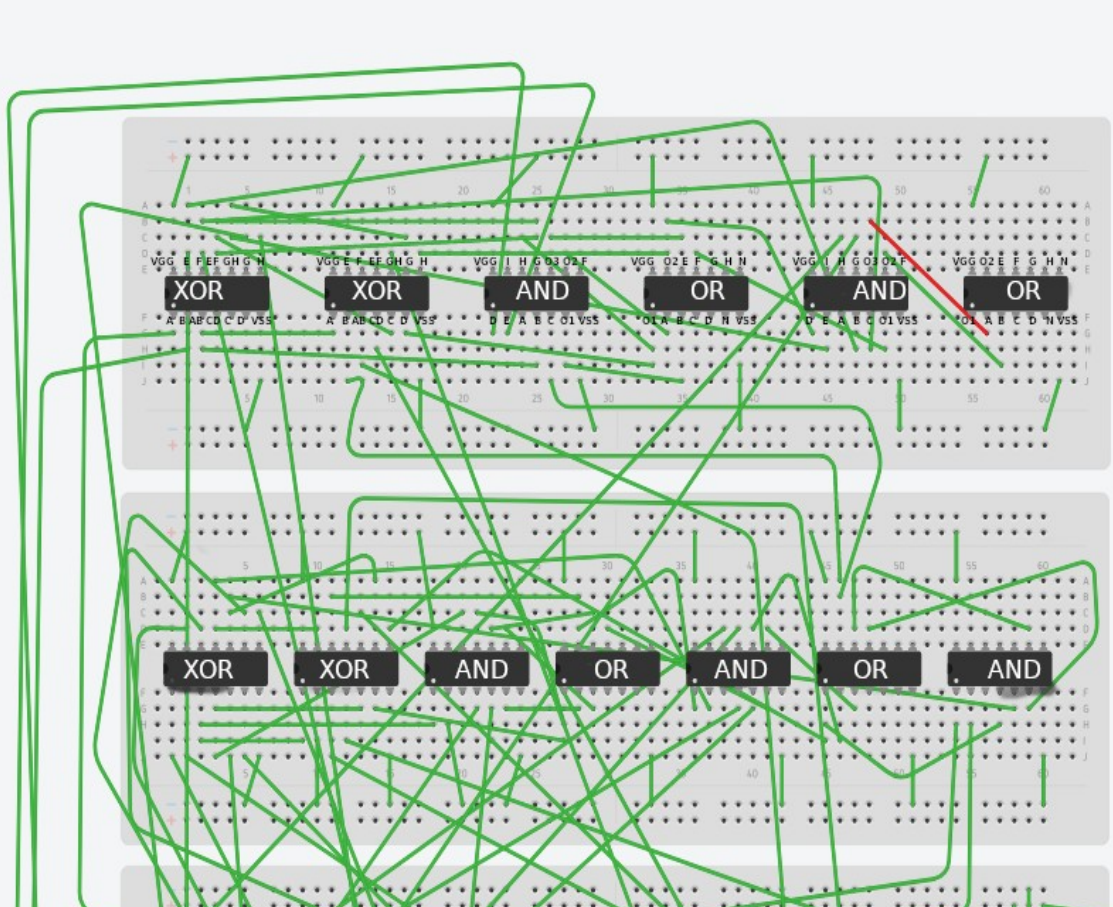




# Passo #61 Studio 6

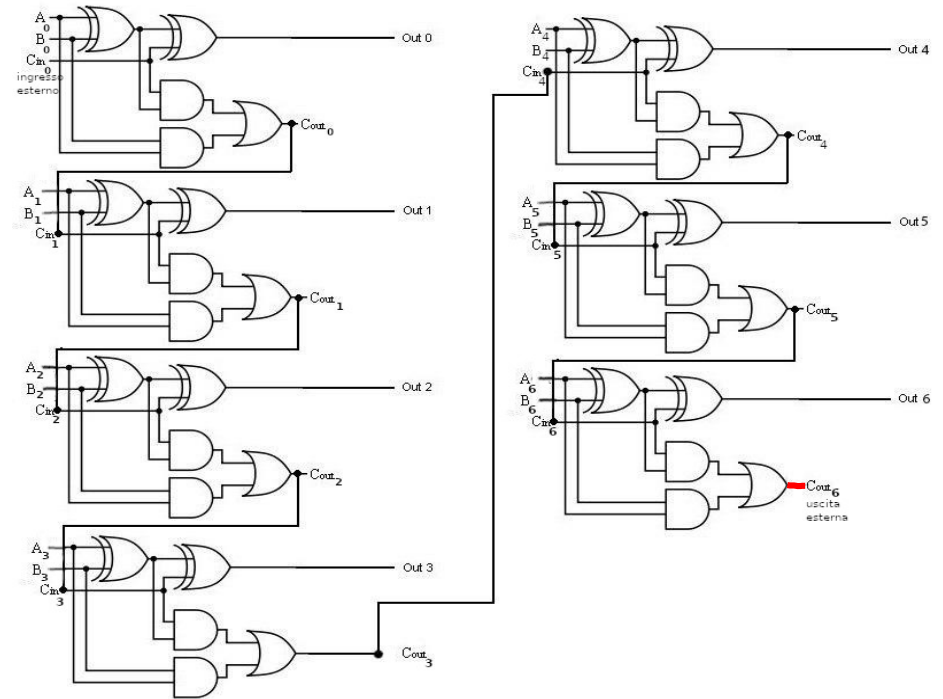
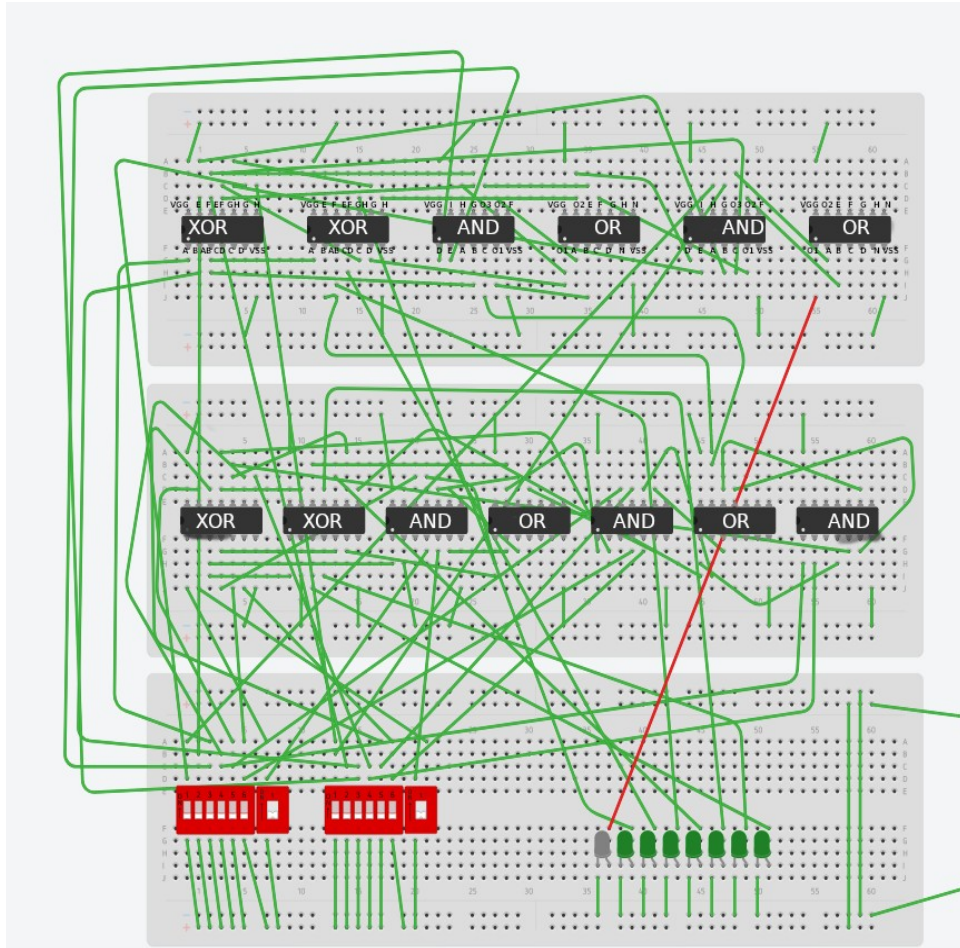


# Passo #62 Stadio 6



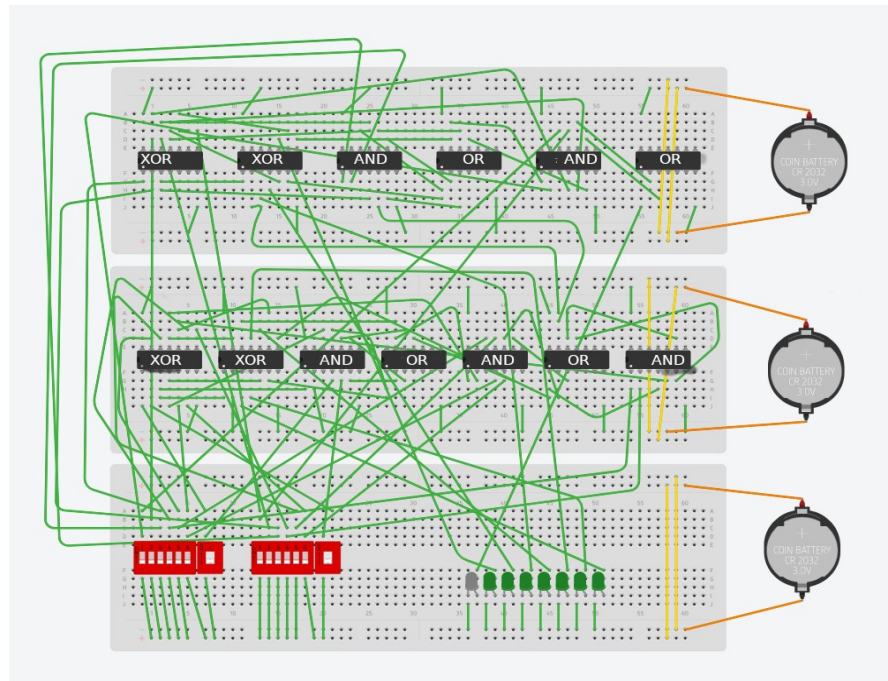


# Passo #63 Stadio 6



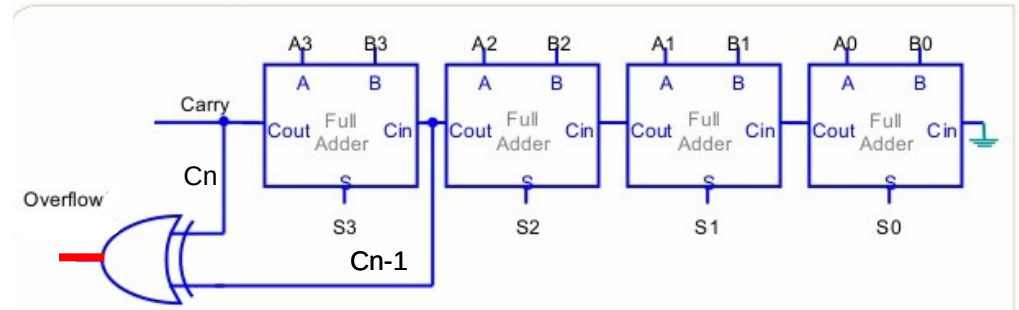
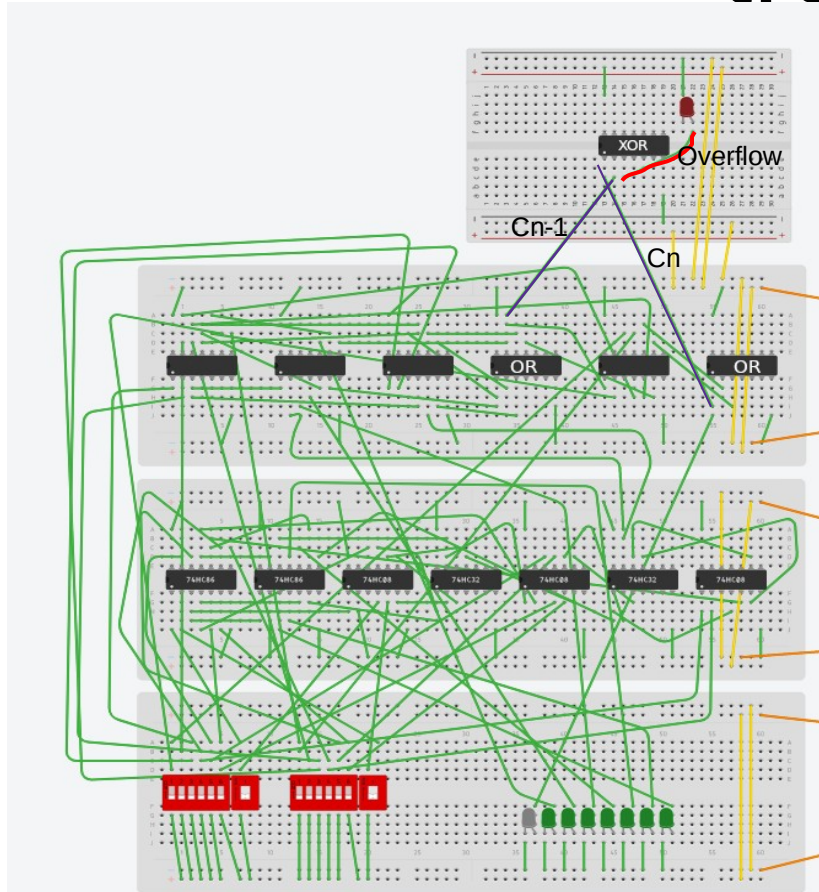
# Passo #64

- Per terminare basta collegare tutte le breadboard a un generatore di tensione.





# Implementazione del bit del trabocco



***la realizzazione fatta della rilevazione di trabocco ha senso solo per la rappresentazione in complemento a due degli interi con segno***

Per ricavare l'overflow si effettua lo XOR tra il carry n e il carry n-1.

# Crediti

- Editor online per la creazioni delle immagini illustrative del circuito visto:
- <https://www.tinkercad.com/circuits>
- Editor per le slide:
- <https://it.libreoffice.org/>