Today's Mission: Multiple Outputs

The U.S. Atlas Rocket Network is a set of defensive intercontinental missiles that are launched whenever it is certain that enemy missiles have been launched at the United States. To ensure that defensive missiles are not mistakenly or prematurely launched, the presence of enemy missiles must be verified by four separate Missile Surveillance Systems (MSS):

(S) Space Satellite Surveillance
(L) Long Range Radar Surveillance
(R) Radar Surveillance by Ship
(V) Visual observation by USAF pilots

The DEFCON (Defensive Condition) level is based on the number of MSS that have detected incoming missiles. If none of the MSS have detected missiles, then the DEFCON is set to zero. If two MSS have detected missiles, then the DEFCON is set to two, and so forth.

The DEFCON status is indicated by a "barchart" of four LEDs.

DEFCON ZERO	All of the SLRV are inactive (no LEDs are lit).
DEFCON ONE	Only one of the SLRV is active (LED 1 is lit).
DEFCON TWO	Two of the SLRV are active (LED 1 and 2 are lit).
DEFCON THREE	Three of the SLRV are active (LED 1, 2, and 3 are lit).
DEFCON FOUR	Four of the SLRV are active (LED 1, 2, 3, and 4 are lit).

You must build a circuit that evaluates the overall status of the four early warning systems, and uses this information to indicate the appropriate DEFCON Level.

Input Summary: Three inputs (switches 0, 1, and 2)
Output Summary: Four DEFCON indicators (LEDs #0, 1, 2, and 3)

Instructions for Part A

- Complete the truth table for each of the Four LED's Q1, Q2, Q3, and Q4.
- Draw your final circuit *neatly* on the worksheet using only two 74151 Multiplexer chips, two 74153 Multiplexer chips, one inverter, and two OR gates. It might be worth your time to decide which Q to solve with each type of MUX before getting too deep into your solution.

  Next to each pin of each chip, name the appropriate connection (for example, **V**, or $\overline{S}$, or +5v, or Q2, or GROUND). You may also draw your two OR gates as necessary. Remember, you may only use **one** inverter, so you may not include both $\overline{S}$ and $\overline{R}$ in your circuits (for example).
- Build the circuit on a proto-board, and have Dr. Pogo verify that it works.

Part B

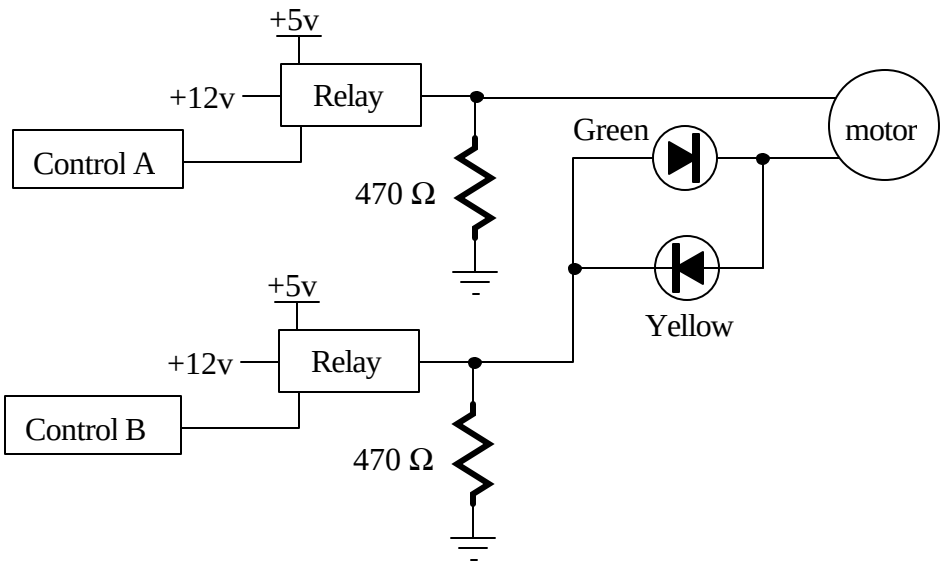
A soldier in the bunker must manually throw a switch (use momentary switch 0) to open or close the door to the missile silo (motor spins clockwise). The soldier is instructed to *open* the silo door (motor spins clockwise) by pushing the switch when the DEFCON rises from 2 to 3. Also, he is instructed to *close* the door (motor spins counter-clockwise) by pushing the switch again whenever the DEFCON falls from 2 to 1. Again, in case you missed it, the motor ONLY runs during DEFCON 3 or DEFCON 1.

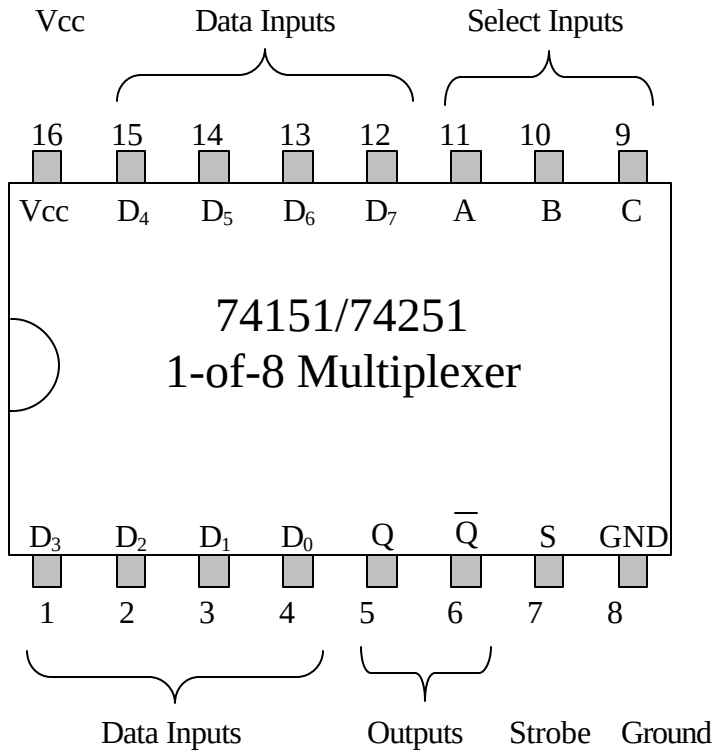
You must build the circuit to control the motor based on the status of the switch and on the DEFCON level. Besides the analog components described below, this project will require the use of a 7408 chip, and 2 more gates of the 7404 chip you are already using for part A (bringing your total number of inverters to three).

Input Summary: One "activate" switch (switch 7)
Output Summary: One motor, with two directional LED indicators:
Green LED (door is opening)
Yellow LED (door is closing)

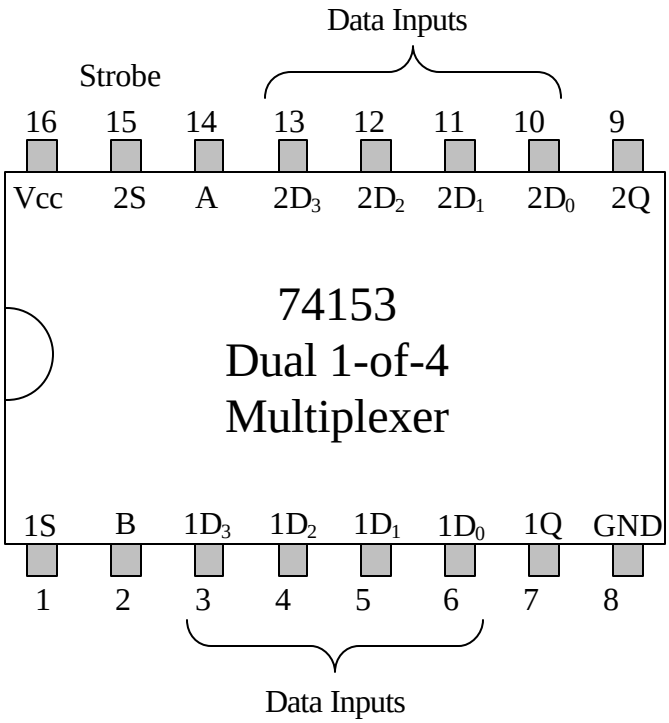
The circuit below shows the circuit needed to operate a DC motor in two directions. Control A is used to drive the motor in one direction (yellow), and control B in the other direction (green), as shown in this "truth table". You will need to design the logic to appropriately active "A" and "B" to achieve the desired outcomes. As a hint, I used only the switch and the four lights L1, L2, L3, and L4 to construct the two controls.

A	B	Motor Status
0	0	off
0	1	clockwise
1	0	Counter-clockwise
1	1	off





Inputs				Outputs	
Select			Strobe		
C	B	A	S	Q	$\overline{Q}$
any	any	any	1	0	1
0	0	0	0	D_0	$\overline{D_0}$
0	0	1	0	D_1	$\overline{D_1}$
0	1	0	0	D_2	$\overline{D_2}$
0	1	1	0	D_3	$\overline{D_3}$
1	0	0	0	D_4	$\overline{D_4}$
1	0	1	0	D_5	$\overline{D_5}$
1	1	0	0	D_6	$\overline{D_6}$
1	1	1	0	D_7	$\overline{D_7}$



Inputs			Output
Select		Strobe	
B	A	S	Q
any	any	1	0
0	0	0	D_0
0	1	0	D_1
1	0	0	D_2
1	1	0	D_3

Name: _____

You MAY NOT write on this sheet in pen!

Truth Table:

Boolean Expressions:

Q1 =

Q2 =

Q3 =

Q4 =

Your final diagrams:

S	L	R	V	Q1	Q2	Q3	Q4
0	0	0	0				
0	0	0	1				
0	0	1	0				
0	0	1	1				
0	1	0	0				
0	1	0	1				
0	1	1	0				
0	1	1	1				
1	0	0	0				
1	0	0	1				
1	0	1	0				
1	0	1	1				
1	1	0	0				
1	1	0	1				
1	1	1	0				
1	1	1	1