

Questions

1. [15 points; 5 points for each for result] Does the timing of the 555 clock output match the predictions of the equations for frequency, t_{high} , and t_{low} that are given below the schematic? Show a calculation of the expected value for each of the three parameters.

$$f = 1 / (\ln(2) * C2 * (R1 + 2 * R2))$$

$$f = 1 / (\ln(2) * 0.001F * (470\Omega + 2 * 470\Omega)) = \mathbf{1.023}$$

$$t_{\text{high}} = \ln(2) * (R1 + R2) * C2$$

$$t_{\text{high}} = \ln(2) * (470\Omega + 470\Omega) * 0.001F = \mathbf{0.6516}$$

$$t_{\text{low}} = \ln(2) * R2 * C2$$

$$t_{\text{low}} = \ln(2) * 470\Omega * 0.001F = \mathbf{0.3258}$$

2. [10 points] The 74HC163 is a 4-bit counter, but this lab needs only a 3-bit counter. How can you obtain a 3-bit counter from the output of a 4-bit counter? Which three of the output signals would you select and why?

To get a 3-bit counter from a 4-bit counter, you take the 3 least significant bits as this set repeats itself for every 4-bit sequence, always giving a 3-bit counter, excluding the most significant bit of the 4-bit counter.

3. Derive the Boolean expressions for each color of the stoplight, and simplify in terms of 2-input NAND and NOR gates. Show your work to earn credit. Your Boolean expression must be in terms of QA, QB, QC, and QD, for the counter outputs, and/or D0 – D7 for the eight decoder/demux outputs. Draw the final schematic diagram using NAND and NOR gates for each color.

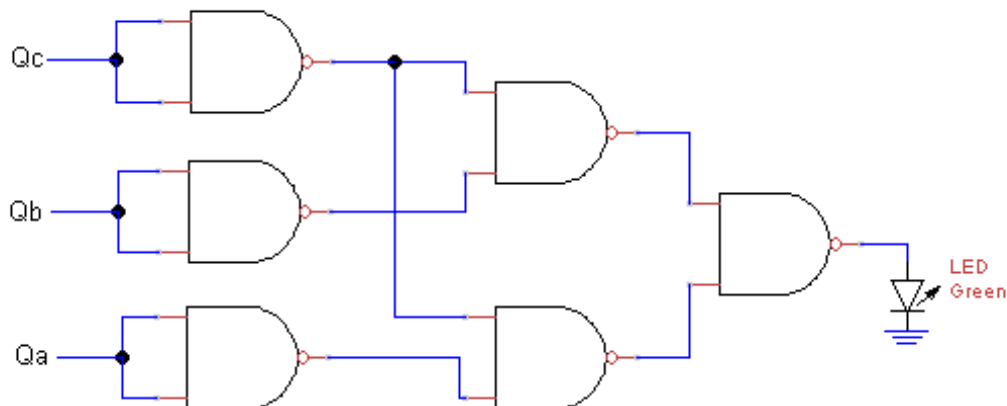
- a. [10 points] Green light Boolean expression and schematic.

Qc	Qb	Qa	Output
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Qa\QcQb	00	01	11	10
0	1	1	0	0
1	1	0	0	0

K-Map Expression: $Qc'Qb' + Qc'Qa'$

NAND Realization: $((Qc'Qb')' * (Qc'Qa'))'$



- b. [10 points] Yellow light Boolean expression and schematic.

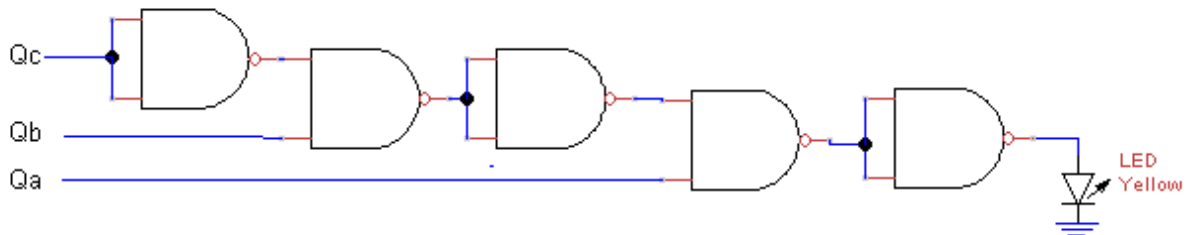
Qc	Qb	Qa	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Qa\QcQb	00	01	11	10
0	0	0	0	0
1	0	1	0	0

K-Map Expression: $Qc'QbQa$

Demux Realization: D3

This circuit shows the logic as NANDs, but the LED is lit using the D3 output pin of the Demux.



- c. [10 points] Red light Boolean expression and schematic drawing of gates.

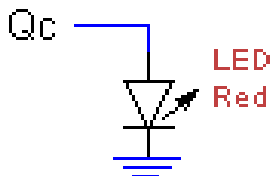
Qc	Qb	Qa	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Qa\QcQb	00	01	11	10
0	0	0	1	1
1	0	0	1	1

K-Map Expression: Qc

Counter Realization: Qc

The circuit is the literal output of the Qc output pin of the counter.



4. Demonstrate your circuit to your TA. Full credit when the order and timing of lights is correct.
- [15 points] Green light turns on for 3 seconds, then
 - [15 points] Yellow light turns on for 1 second, then
 - [15 points] Red light turns on for 4 seconds.