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California State University, Northridge
Department of Electrical & Computer Engineering

Experiment 13
Combinational Logic using DeMultiplexers

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ECE 320L
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Introduction:

The objective of this experiment is to better understand the logic and usage of a demultiplexer in combinational logic. The experiment uses demultiplexers to output different states to multiple functions displayed as two red, two green, and two yellow lights at an intersection. The experiment also covers the usage of counters and data flip flops.

Equipment used:

Type	Model	Serial No.	Calibration Date
Oscilloscope	Tektronix 2213A	N/A	N/A
Function Generator	Agilent 33220A	N/A	N/A
Proto Board	Tektronix	N/A	N/A

Parts Used:

QTY	Component	Value	Tolerance	Type
1	Quad 2-input AND Gate	N/A	N/A	N/A
1	7474 dual D flip-flop	N/A	N/A	N/A
1	74LS139A demultiplexer	N/A	N/A	N/A
1	7400 quad NAND Gate	N/A	N/A	N/A
6	Resistor	330 Ω	+/-5%	Carbon
2	Red LEDs	N/A	N/A	N/A
2	Green LEDs	N/A	N/A	N/A
2	Yellow LEDs	N/A	N/A	N/A

Software Used:

1. Google Docs
2. Krita
3. Snipping Tool

Theory:

A demultiplexer can be used as a decoder.

A demultiplexer has one input, n amount of selectors and 2^n amount of outputs.

For an active-high demultiplexer, a function with multiple outputs are ORed together

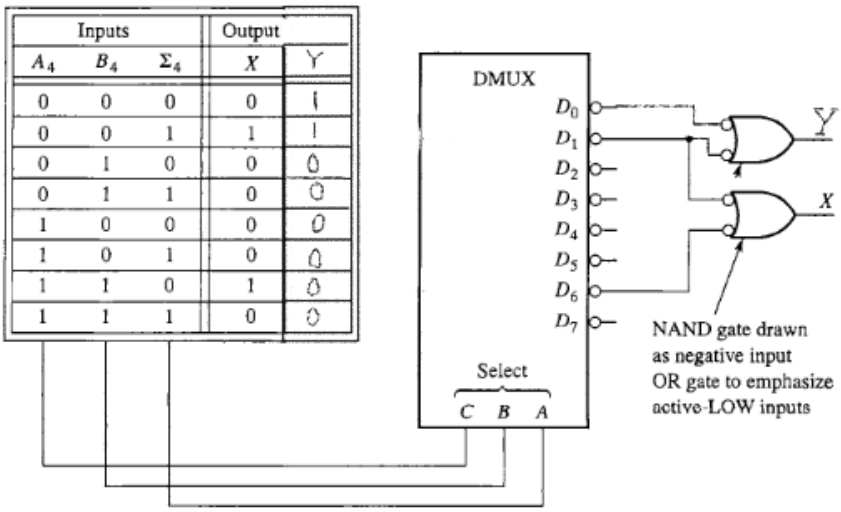
For an active-low DMux, function with multiple outputs are NANDed together.

A demultiplexer is more efficient than a decoder when selections can be used for different outputs.

FIGURE 13–2 (modified)

Truth table for overflow error

Inputs			Output	
A_4	B_4	Σ_4	X	Y
0	0	0	0	1
0	0	1	1	1
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	1	0
1	1	1	0	0



(a) Truth table (b) Implementation

Procedure & Results:

1. The truth table for the state decoder was reviewed and the partially completed schematic in figure 13-6 was drawn.

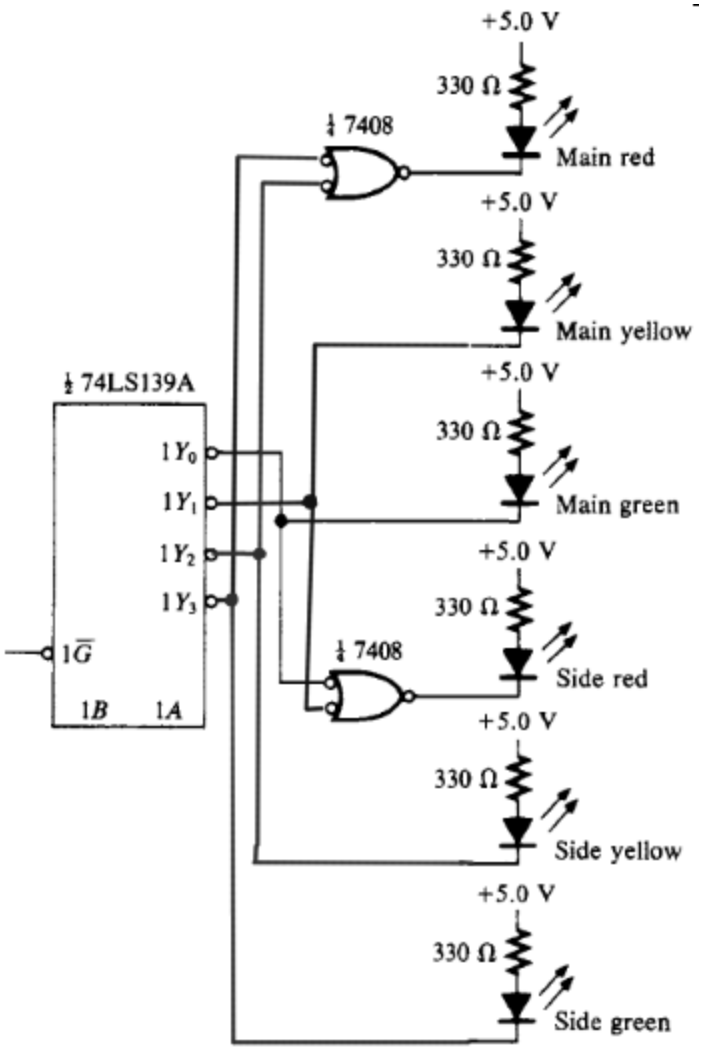


FIGURE 13–6
Traffic light output logic.

(Figure 13-6)

2. Figure 13-6 was constructed and every possible combination was tested. The correct outputs were observed and agreed with the expected outputs in Table 13-1

State Code		State Outputs				Light Outputs					
G_1	G_0	$\overline{S_1}$	$\overline{S_2}$	$\overline{S_3}$	$\overline{S_4}$	$\overline{MR}$	$\overline{MY}$	$\overline{MG}$	$\overline{SR}$	$\overline{SY}$	$\overline{SG}$
0	0	0	1	1	1	1	1	0	0	1	1
0	1	1	0	1	1	1	0	1	0	1	1
1	1	1	1	0	1	0	1	1	1	1	0
1	0	1	1	1	0	0	1	1	1	0	1

(Table 13-1)

3. The 2 bit gray code counter in figure 13-7 was constructed and connected to the data selectors of the input

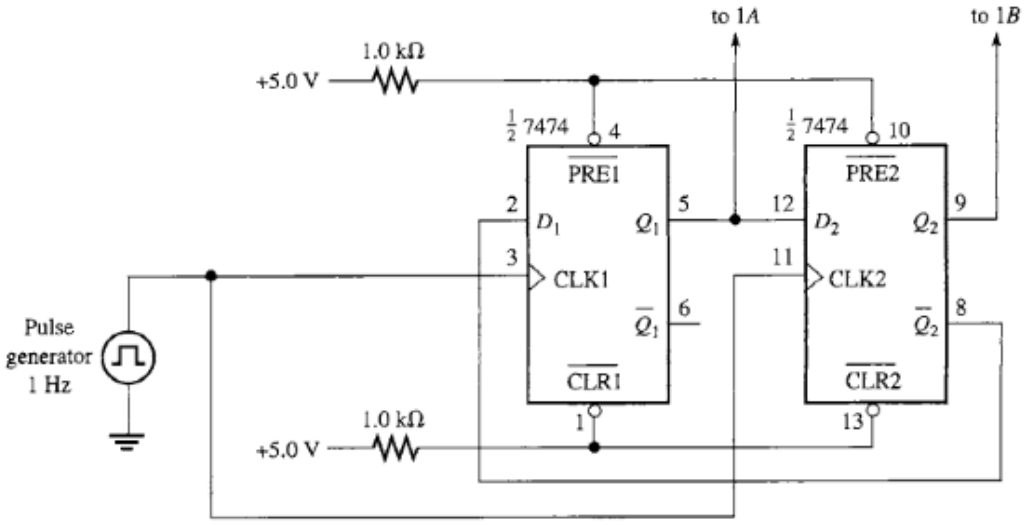
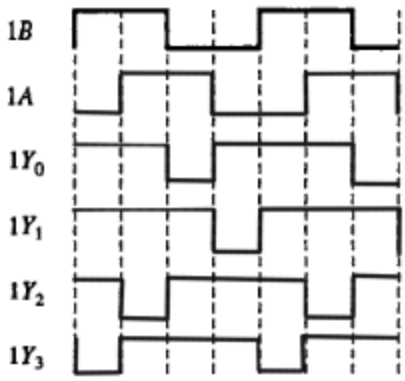


FIGURE 13–7
Gray-code counter for sequencing the traffic signal decoder.

4. The counter was connected to a pulse generator at 1Hz and the sequence of lights were observed. The sequence of lights remained the same, but now the states changed automatically and sequentially every second.
5. The frequency of the pulse generator was increased to 10kHz and the timing diagrams were recorded and plotted using an oscilloscope for the inputs 1A, 1B and outputs 1Y0, 1Y1, 1Y2, and 1Y3 in Figure 13-8.

FIGURE 13–8
Timing diagram for Step 5.



(Figure 13-8).

6. For further investigation, the demultiplexer was used for time division. The outputs of the counter were used as ANDed inputs for the enable gate of the demultiplexer as shown in Figure 13-9 and the results were observed.

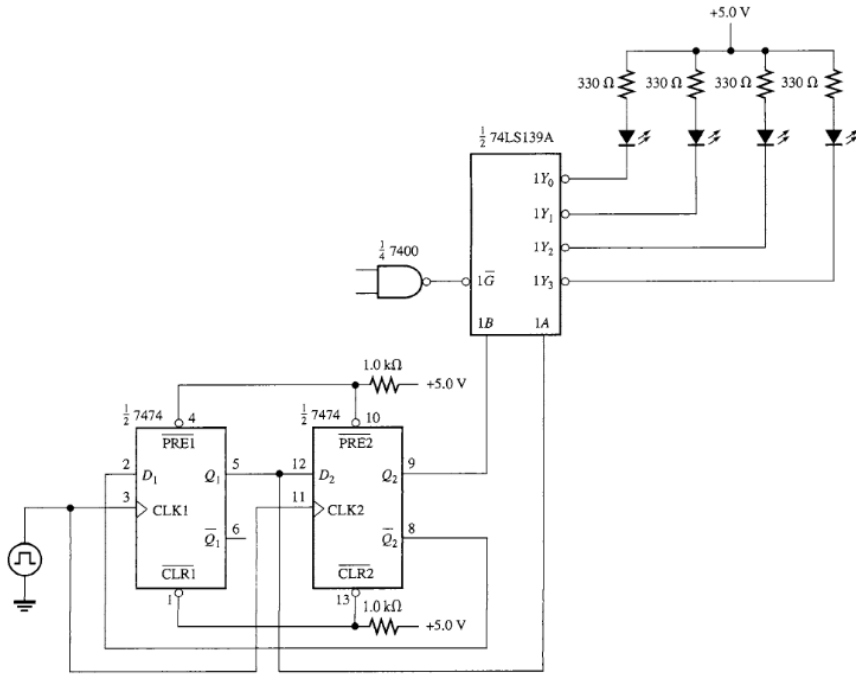


FIGURE 13–9

For Q_1 and Q_2, the lights for the output $1Y_3$ flickered.

For Q_1' and Q_2', the lights for output $1Y_0$ flickered.

These setups could be used to display a flickering light like we would at an intersection, when a light is about to change.

Conclusion:

The experiment was a success by demonstrating the usage and underlying logic behind a multiplexer in combinational logic. Through a single 4/1 demultiplexer, the 6 different lights that would be seen at a traffic intersection were correctly displayed which shows good understanding of how to design a circuit using a demultiplexer. The experiment was also a success in creating a counter using data flip flops. The correct timings of each of the input and outputs were observed.