

Cascading Counters

When cascading divide by N counters, it is necessary to modify the control of the \overline{Clear} to prevent unwanted clears (e.g., 48,49,50,01,02 in a divide by 60 counter.) Suppose a divide by N counter is built using a binary counter (cascaded toggle cells) described as follows:

<i>Count</i>			<i>Out</i>	
<i>Enable</i>	\overline{Clear}	<i>cycle</i>		
X	0	↑↓	0	<i>clear</i>
0	1	↑↓	Q_o	<i>hold</i>
1	1	↑↓	$\overline{Q_o}$	<i>count</i>

This problem addresses the design of logic that accepts as inputs:

- Count Enable* allows divide by N counter to count
- External Clear* clears divide by N counter (active high)
- Max. Count* indicating the maximum count ($N - 1$) is currently output

The single output, \overline{Clear} , drives the binary counter clear signal.

Part A Complete the truth table below to describe the logic which prevents the unwanted clears mentioned above.

<i>External Clear</i>	<i>Count Enable</i>	<i>Max. Count</i>	\overline{Clear}
0	0	X	
0	1	0	
0	1	1	
1	X	X	

Part B Now determine a simplified expression for \overline{Clear} by completing the Karnaugh Map, circling the prime implicants, and writing a simplified expression.

	$\overline{\text{Count Enable}}$ 			
$\overline{\text{Ext. Clear}}$ $\overline{\text{Ext. Clear}}$		$\overline{\text{Max. Count}}$	$\overline{\text{Max. Count}}$	$\overline{\text{Max. Count}}$

	prime implicant	
		yes <input type="checkbox"/> no <input type="checkbox"/>
		yes <input type="checkbox"/> no <input type="checkbox"/>
		yes <input type="checkbox"/> no <input type="checkbox"/>

$\overline{Clear} =$ _____

Part C Implement this simplified expression using a mixed logic design methodology. Be sure and label the inputs *External Clear*, *Count Enable*, and *Max. Count*, and the output, \overline{Clear} .