Design of sequential circuits

Examples

Example 1: Stream 2's complement

110011100 2's complement
001100100 lead sequence
001110011 X lsb

Z 00010001100 time

\( S_1 \)

0/0 1/1

in lead sequence

\( S_2 \)

0/1

after lead sequence
<table>
<thead>
<tr>
<th>Present state</th>
<th>Next state</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>$S_1$</td>
<td>0</td>
</tr>
<tr>
<td>$S_1$</td>
<td>$S_2$</td>
<td>1</td>
</tr>
<tr>
<td>$S_2$</td>
<td>$S_2$</td>
<td>1</td>
</tr>
<tr>
<td>$S_2$</td>
<td>$S_2$</td>
<td>0</td>
</tr>
</tbody>
</table>

Encode states: $S_1 \rightarrow 0$, $S_2 \rightarrow 1$

One flipflop $A$

<table>
<thead>
<tr>
<th>Present state</th>
<th>Next state</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_0$</td>
<td>$m_0$</td>
<td>0</td>
</tr>
<tr>
<td>$m_1$</td>
<td>$m_0$</td>
<td>0</td>
</tr>
<tr>
<td>$m_2$</td>
<td>$m_0$</td>
<td>0</td>
</tr>
<tr>
<td>$m_3$</td>
<td>$m_0$</td>
<td>0</td>
</tr>
</tbody>
</table>

$D_A = A + X$

$Z = A \oplus X$

Diagram showing state transitions and logic gates.
Lesson 25: Serial adder

Example 2: Serial adder

\[ X \quad Y \quad \text{clock} \quad Z \]

\[ \text{without carry} \quad \text{carry} \quad \text{with carry} \]

\[ \begin{array}{cccc}
0 & 1 & 0 & 1 \\
0 & 0 & 1 & 0 \\
0 & 1 & 1 & 0 \\
1 & 0 & 1 & 1 \\
0 & 0 & 0 & 1 \\
1 & 1 & 0 & 1 \\
\end{array} \]

\[ \begin{array}{cccc}
1 & 1 & 1 & 1 \\
0 & 1 & 0 & 1 \\
0 & 0 & 1 & 1 \\
1 & 1 & 1 & 1 \\
1 & 0 & 0 & 1 \\
0 & 0 & 0 & 1 \\
\end{array} \]
Problem 2a: Complete the problem

State table, state encoding, flip-flop and output equations, simplify logical circuit.

Example 3: Serial subtractor

\[
\begin{array}{c}
\text{X} \\
\text{Y} \\
\text{clock} \\
\hline
\text{lsb} \\
\text{X} \\
\text{Y} \\
\end{array}
\]

\[
\text{Z}
\]
Problem 2 (b) complete the problem

state table, state encoding, flip flop and output equations
simplify logical circuit

Problem ends in state $S_2$ → answer negative not reliable

Do not supply borrow

Supply a borrow