Lecture 7: Flip-Flops and 555 Timer Circuit

Topics:
1) Comparator Review
2) Flip Flops
3) 555 as oscillator
4) 555 as “one-shot”

Comparator Review:

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- Feedback loop is not used.
- Decides if one voltage is greater than the other.
- Takes analog voltages and convert them into a series of bits.
- Binary representation of 4 digits give you 16 values (4-bit converter).
- Circuit above is a 1-bit converter:
  - “0” or “1” output depending which voltage is greater than the other.

Flip Flops:

- R-S Flip Flop
  - R ≡ Reset
  - S ≡ Set
  - Two Values
    - TRUE “1” Hi Voltage
    - FALSE “0” Lo Voltage
For some circuits: We use:

\[ \text{Hi} \equiv 5V \quad \text{Hi} \equiv +V \]
\[ \text{Lo} \equiv 0V \quad \text{Lo} \equiv -V \]

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R )</td>
<td>( S )</td>
</tr>
<tr>
<td>Lo</td>
<td>Lo</td>
</tr>
<tr>
<td>Lo</td>
<td>Hi</td>
</tr>
<tr>
<td>Hi</td>
<td>Lo</td>
</tr>
<tr>
<td>Hi</td>
<td>Hi</td>
</tr>
</tbody>
</table>

Once can force the output \( Q \) to be “HI” by setting \( S \) to “HI”. Similarly, one can force the \( Q \) output to “LO” by resetting \( R \) to “LO”. If one drives both \( R \) and \( S \) to “HI”, there is no guarantee about the output’s state.

**555 as Oscillator:**

![555 Circuit Diagram]
<table>
<thead>
<tr>
<th>Voltage @ Pin 2 &amp; 6 ($V_{2-6}$)</th>
<th>Output of $C_R$</th>
<th>Output of $C_S$</th>
<th>Output $Q$</th>
<th>Output $\overline{Q}$</th>
<th>Transistor @ Pin 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt; \frac{1}{3} V_0$</td>
<td>Lo</td>
<td>Hi</td>
<td>Hi</td>
<td>Lo</td>
<td>OFF</td>
</tr>
<tr>
<td>$\frac{1}{3} V_0 &lt; V_{2-6} &lt; \frac{2}{3} V_0$</td>
<td>Lo</td>
<td>Lo</td>
<td>Stay</td>
<td>Stay</td>
<td>Stay</td>
</tr>
<tr>
<td>$&gt; \frac{2}{3} V_0$</td>
<td>Hi</td>
<td>Lo</td>
<td>Lo</td>
<td>Hi</td>
<td>ON</td>
</tr>
</tbody>
</table>

**555 as Oscillator:**

![555 Oscillator Circuit Diagram]

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Assume there is no charge in the capacitor at start. Because $V_{\text{CAP}}$ is at 0V and it connects to pins 2 and 6, the input is at 0V at time $t = 0$. When the circuit is powered up, the capacitor starts charging. When the $V_{\text{CAP}}$ reaches $2/3 \, V_0$, the transistor turns on and grounds pin 7. Therefore, the capacitor starts to discharge through $R_B$ until $V_{\text{CAP}}$ reaches $1/3 \, V_0$, at which point the transistor turns off and the capacitor starts to charge up again.