Multiplexers and Decoders

Networks and Embedded Systems
First Grade Level
Wolfgang Neff
Signals (1)

- Analog Signals
  - Any value at any time
Signals (2)

- Digital Signals
  - Just 0 and 1 at certain times (clock ticks)
Multiplexers (1)

- Multiple-input, single-output switch
  - Selects one of several input line
  - Forwards the selected input to an output line

\[ \text{Signal A} \quad \text{Signal B} \]

\[ \text{Signal A or B} \]

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Multiplexers (2)

- **Multiplexer**
  One input line is selected

- **Demultiplexer**
  One output line is selected

![Diagram of MUX and DEMUX](image)
Multiplexers (3)

- **74153** – Dual 4-input multiplexer

![Block Diagram of 74153 Multiplexer](image)
Multiplexers (4)

- 74153 – Dual 4-input multiplexer (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Ē, 2Ē</td>
<td>1, 15</td>
<td>output enable inputs (active LOW)</td>
</tr>
<tr>
<td>S₀, S₁</td>
<td>14, 2</td>
<td>data select inputs</td>
</tr>
<tr>
<td>1</td>
<td>0, 1</td>
<td>1, 1</td>
</tr>
<tr>
<td>1Y</td>
<td>7</td>
<td>multiplexer output source 1</td>
</tr>
<tr>
<td>GND</td>
<td>8</td>
<td>ground (0 V)</td>
</tr>
<tr>
<td>2Y</td>
<td>9</td>
<td>multiplexer output source 2</td>
</tr>
<tr>
<td>2</td>
<td>0, 2</td>
<td>1, 2</td>
</tr>
<tr>
<td>V击杀</td>
<td>16</td>
<td>supply voltage</td>
</tr>
</tbody>
</table>
One-Hot Encoding (1)

- One Bit Per State
  - Exactly one bit must be set

<table>
<thead>
<tr>
<th>State</th>
<th>Binary Encoding</th>
<th>One-Hot Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>000</td>
<td>0000001</td>
</tr>
<tr>
<td>1</td>
<td>001</td>
<td>000010</td>
</tr>
<tr>
<td>2</td>
<td>010</td>
<td>000100</td>
</tr>
<tr>
<td>3</td>
<td>011</td>
<td>001000</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>010000</td>
</tr>
<tr>
<td>5</td>
<td>101</td>
<td>100000</td>
</tr>
</tbody>
</table>
One-Hot Encoding (2)

• Example
  – A dice has been thrown
  – We want to show the result
Decoders (1)

• Example (continued)
  – Realization with a decoder
Decoders (2)

• Encoder
  Tells which line is active

  Line 0
  Line 5
  Line 15

  Encoder

• Decoder
  Activates the selected line

  Line 0
  Line 5
  Line 15

  Decoder

Just one line may be active
Decoders (3)

- **7442** – BCD to decimal decoder

![Diagram of 7442 BCD to decimal decoder]

- **A0** to **A3**: Input lines
- **Y0** to **Y9**: Output lines
- **VCC**, **A0**, **A1**, **A2**, **A3**: Power and ground pins
- **GND**: Ground pin

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Multiplexers and Decoders
Decoders (4)

- 7442 – BCD to decimal decoder (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q₀, Q₁, Q₂, ..., Q₉</td>
<td>1, 2, 3, 4, 5, 6, 7, 9, 10, 11</td>
<td>multiplexer outputs</td>
</tr>
<tr>
<td>GND</td>
<td>8</td>
<td>ground</td>
</tr>
<tr>
<td>A₀, A₁, A₂, A₃</td>
<td>15, 14, 13, 12</td>
<td>data inputs</td>
</tr>
<tr>
<td>V_{SS}</td>
<td>16</td>
<td>supply voltage</td>
</tr>
</tbody>
</table>