Chapter 10

BINARY ARITHMETIC, DECODING AND MUX LOGIC UNITS
Lesson 4

Encoder
Outline

- Encoder
  - 2 of 1 and 4 of 1 line encoder
  - 8 of 1
  - 4 of 16 line encoder
  - Function specific encoders
Encoder

- An encoder is a circuit that converts the binary information from one form to another.
- Gives a unique combination of outputs according to the information at a unique input at one-line (or at multiple lines).
Encoder

• Action of a one active line input encoder is opposite of that of a one active line output decoder

• An encoder, which has multi-lines as the active inputs, is also called ‘priority encoder’. Encoder can be differentiated from decoder by greater number of inputs than outputs compared to the decoder.
Application of an encoder as keypad (or keyboard) encoder

- Keypad has limited number of keys as in telephone or mobile
- Keyboard has many more keys
- At an instant, when a key presses, the input (or a set of inputs from multiple times key pressing) after an appropriate de-bouncing circuit applies an input (s) to encoder. The encoder generates an 8-bit ASCII code for given active input
Example

- Let us encode output 000 when addition completes and activates an input A0, get an output 001 when subtraction completes and activates another input A1, and so on.
- Encoder can generate an outputs $Y_2Y_1Y_0 = 000$ or $001$ or $010$ or $011$ and so on depending on whether $A_0 = 1$ or $A_1 = 1$ or $A_2 = 1$ or $A_3 = 1$ and so on, respectively. Such an encoder circuit is called $2^n$ to $n$ line encoder.
Line Encoder

- Assume that we have $2^n$ combinations (one combination reflecting one state of the input(s) on the $n$ output lines. These lines reflect one of $2^n$ inputs that is active at an instance.

- $2^n$ of 1 encoder with n-bit output lets us select using n-lines only one of the input among $2^n$. For example, we want to encode when the fifth motor of a robot rotates, which activates 5th input at encoder and which gives an output 0101 to reflect that state at the input lines.
1 to $n$ Encoder

- A circuit, which takes the $2^n$ -bit input with only one bit = active and gives $n$-bit output
- Inactive input can be taken as tristate or 1 or 0
- Active input be taken as 1 or 0
Outline

- Encoder
- 2 of 1 and 4 of 1 line encoders
- 8 of 1 line encoder
- 4 of 16 line encoder
- Function specific encoders
2 of 1 Encoder with active 0 input

Inputs

\[
\begin{array}{cc}
\overline{A_0} & \overline{A_1} \\
0 & * \\
* & 0
\end{array}
\]

Output

\[
\begin{array}{c}
Y \\
0 \\
1
\end{array}
\]

* means tristate or 1

2 of 1 Encoder with active 1 input

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>Y</td>
</tr>
<tr>
<td>A1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>*</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>1</td>
</tr>
</tbody>
</table>

* means tristate or 0
4 of 1 Encoder with active 0 output

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Y0</td>
</tr>
<tr>
<td>A2</td>
<td>Y1</td>
</tr>
<tr>
<td>A1</td>
<td></td>
</tr>
<tr>
<td>A0</td>
<td></td>
</tr>
</tbody>
</table>

* means tristate or 1

0 0 0 0 0 0 0
0 0 1 0 1 0 0
0 1 1 1 1 1 1
Outline

• Encoder
• 2 of 1 and 4 of 1 line encoders
• 8 of 1 line encoder
• 4 of 16 line encoder
• Function specific encoders
8 of 1 Encoder with active 0 output

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7 ..... A0</td>
<td>Y2Y1Y0</td>
</tr>
<tr>
<td>*</td>
<td>0</td>
</tr>
<tr>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>0</td>
<td>**</td>
</tr>
<tr>
<td>0</td>
<td>**</td>
</tr>
</tbody>
</table>

* means tristate or 1
MSI 74148 — 8 of 1 (8 line to 3 line) Encoder with one input and one output control (enabling/disabling) pin.

\[ G = 0 \text{ means enable the input} \]

\[ \overline{G} \]

\[ \overline{OE} = 0 \text{ enable the output} \]
Outline

- Encoder
- 2 of 1 and 4 of 1 line encoders
- 8 of 1 line encoder
- 4 line of 16 line encoder
- Function specific encoders
16 of 1 (16 line to 4 line) Encoder with one input and one output control (enabling/disabling) pin

\[ \overline{G} = 0 \]

means enable the input

\[ \overline{OE} = 0 \]

means enable the input
Outline

• Encoder
• 2 of 1 and 4 of 1 line encoders
• 8 of 1 line encoder
• 4 of 16 line encoder
• Function specific encoders (Priority Encoder)
BCD 10 of 1 bit Priority encoder

A9A7A8A7A6A5A4A3A2A1A0

MSI IC 74147

Y0 Y1 Y2 Y3

Active means 0
Inactive means 1. Output 1111 when none 0

BCD
Octal of 1 bit Priority encoder

A7A6A5A4A3A2A1A0

Active means 1
Inactive means 0

BCD

Y0
Y1
Y2
Y3

MSI IC
Hexadecimal of 1 bit Priority encoder

- MSI
- IC

A15 .... A0

Hexadecimal
Active means 1
Inactive means 0
Multi-line Priority encoder

\[ Y_3Y_2Y_1Y_0 \]

Active means 0
Inactive means 1
Summary
Encoder

- Line Encoder has one active input pin among $2^n$ input pins and has $n$ outputs to enable circuit to select corresponding input.
- Specific function priority encoder gives set of $n$-output bits as per the active set of $m$ input pins among $2^n$ pins at input.
Encoder

- An encoder can have inactive inputs in tristate and active input as 0 or 1
- An encoder can have control gate pin(s) for input enable
- An encoder can have control gate pin(s) for output enable
End of Lesson 4 on

Encoder
THANK YOU