Introduction to Digital Logic

Lecture 10:
Implementing Logic Functions w/ Memories
Decoders

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Building Larger Functions/Circuits

- Scalability issues
  - K-Maps: Up to 6 inputs
  - Decoders: 6-8 inputs
    - But larger decoders can be built from smaller ones
  - Multiplexers: Can be decomposed to multiple levels
    - Use Shannon's Theorem
  - Memories: 12-13 inputs (4K – 8K rows)
- Building Block Methodology
  - Decompose circuits into smaller units
  - Design the smaller units using any of the above methods
  - Use those smaller circuits as building blocks to construct arbitrarily large functions/circuits

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Combinational Building Blocks

- Fundamental blocks that other combinational structures can be built from
  - Decoders
  - Encoders
  - Multiplexers
  - Demultiplexers
  - Adders (Multipliers)
  - Comparators
  - Shifters

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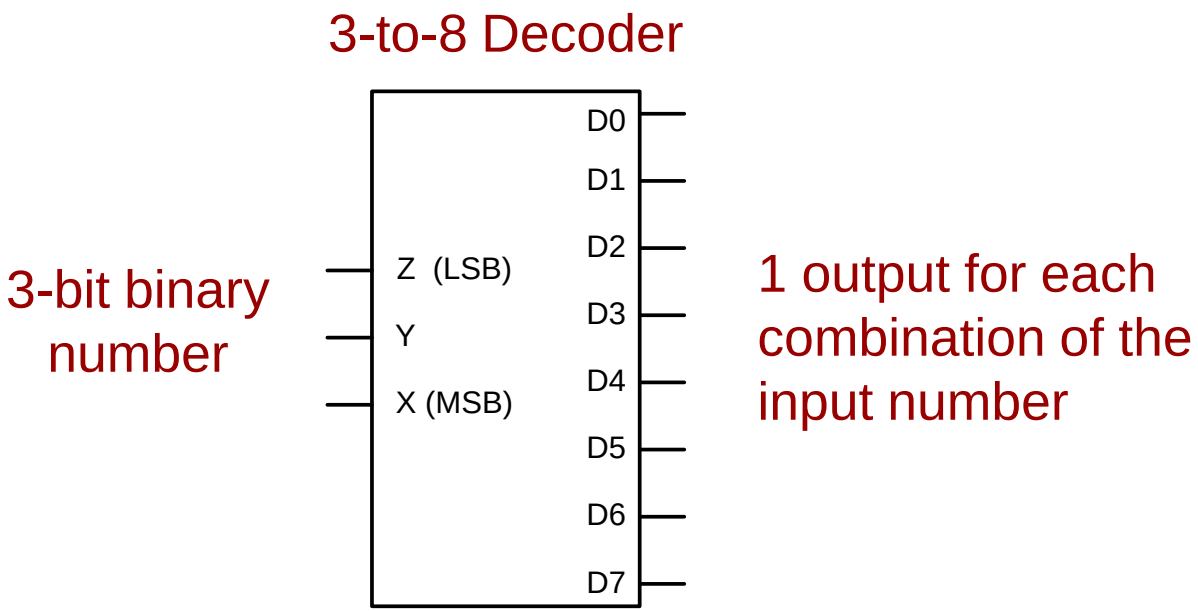
Decoders

- A decoder is a building block that:
  - Takes in an n-bit binary number as input
  - Decodes that binary number and activates the corresponding output
  - Individual outputs for EVERY input combination (i.e. 2^n outputs)



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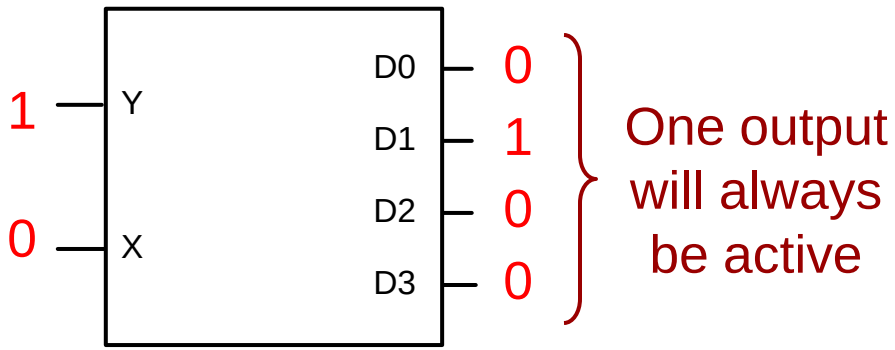
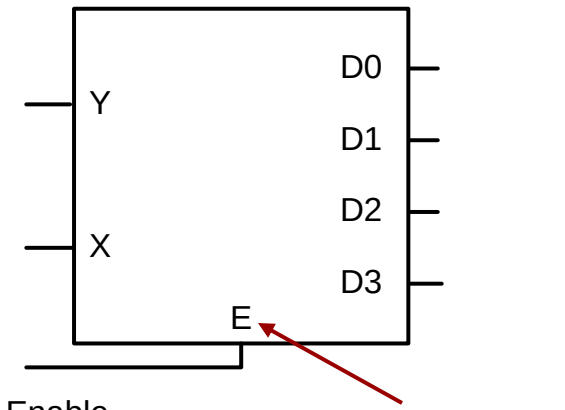
Enables

- Exactly one output is active at all times
- It may be undesirable to always have an active output
- Add an extra input (called an enable) that can independently force all the outputs to their inactive values



2-to-4 Decoder



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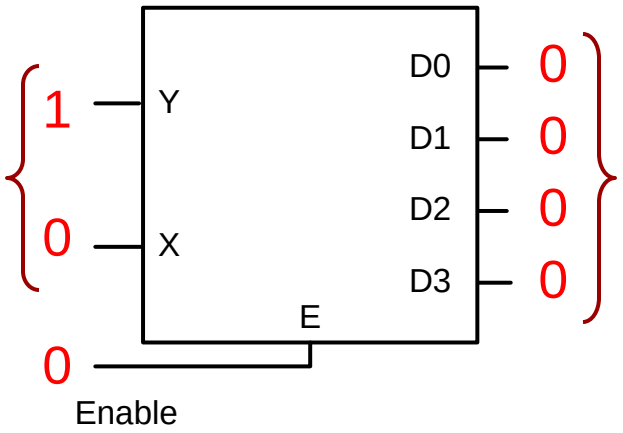
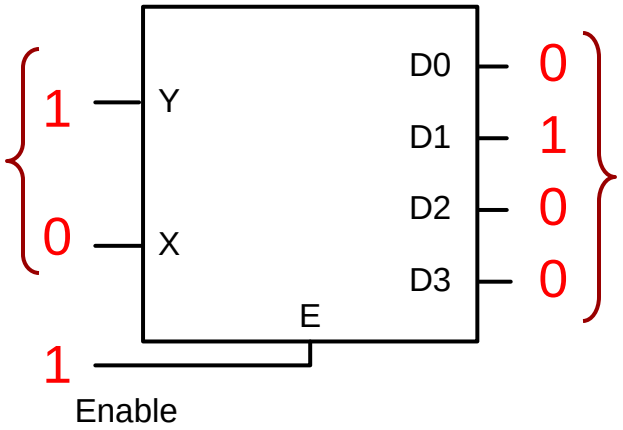
Enables

When E=0, inputs is ignored



Since E=0, all outputs = 0

When E=1, inputs will cause the appropriate output to go active



Since E=1, outputs will function normally

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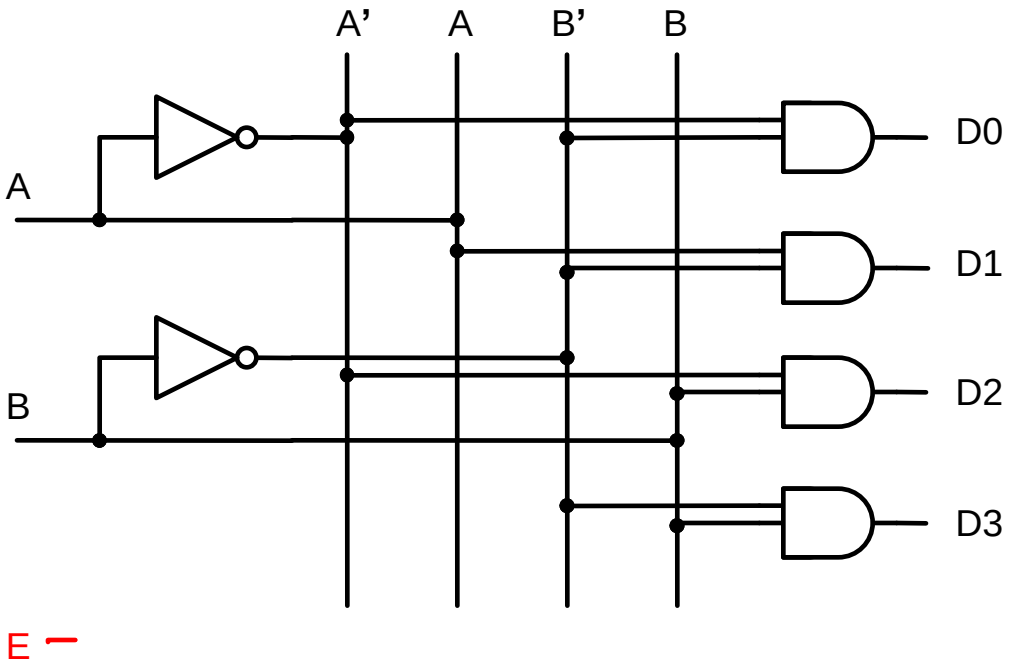
Implementing Enables

- Original 2-to-4 decoder



When E=0, force all outputs = 0

When E=1, outputs operate as they did originally

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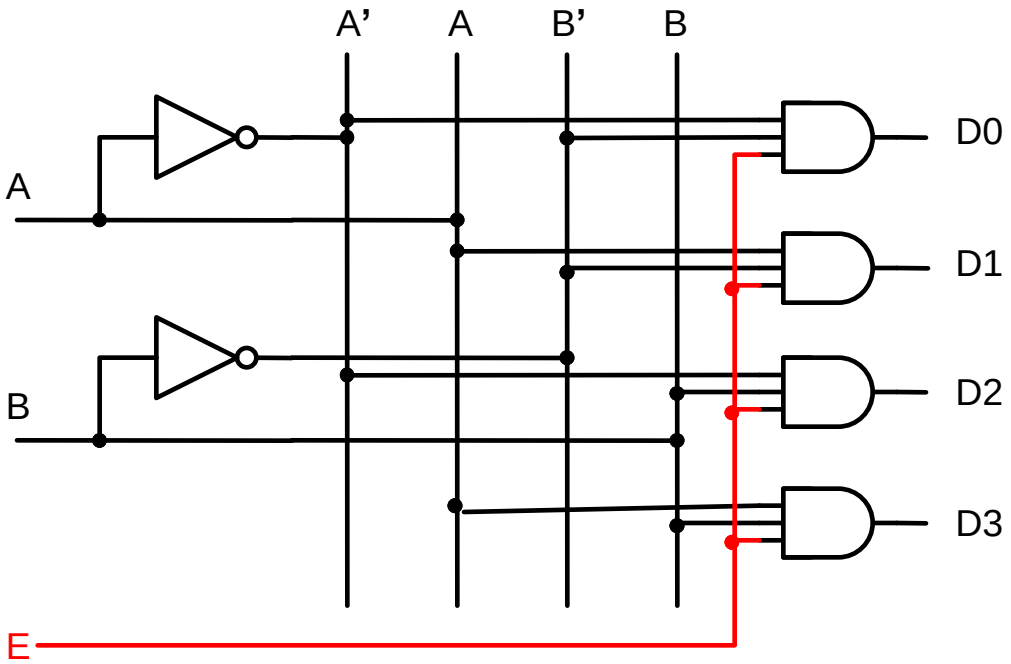
Enables

- Enables can be implemented by connecting it to each AND gate of the decoder



When E=0, 0 AND anything = 0

When E=1, 1 AND anything = that anything, which was the normal decoding logic

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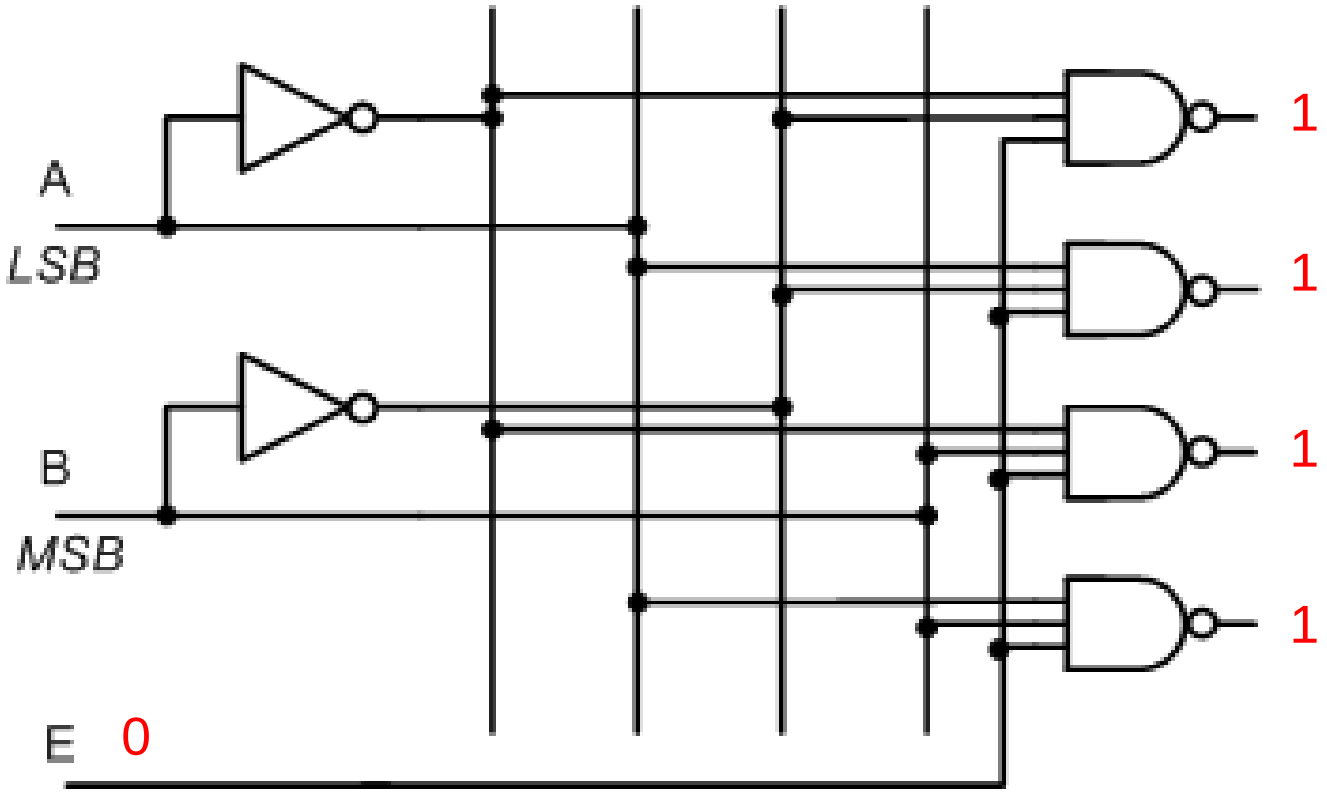
Active-Lo Outputs



When E=inactive (inactive means 0), Outputs turn off (off means 1)

When E=active (active means 1), Selected outputs turn on (on means 0)

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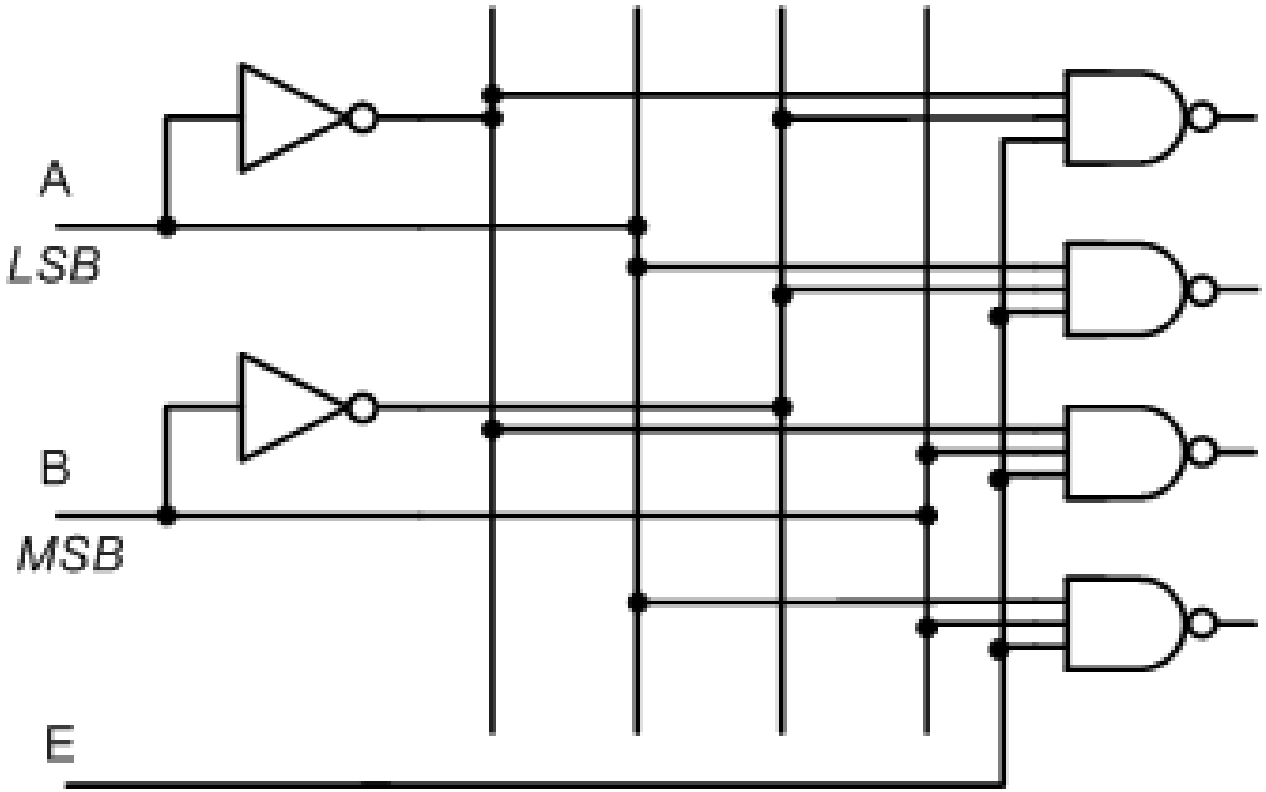
Active-Lo Outputs



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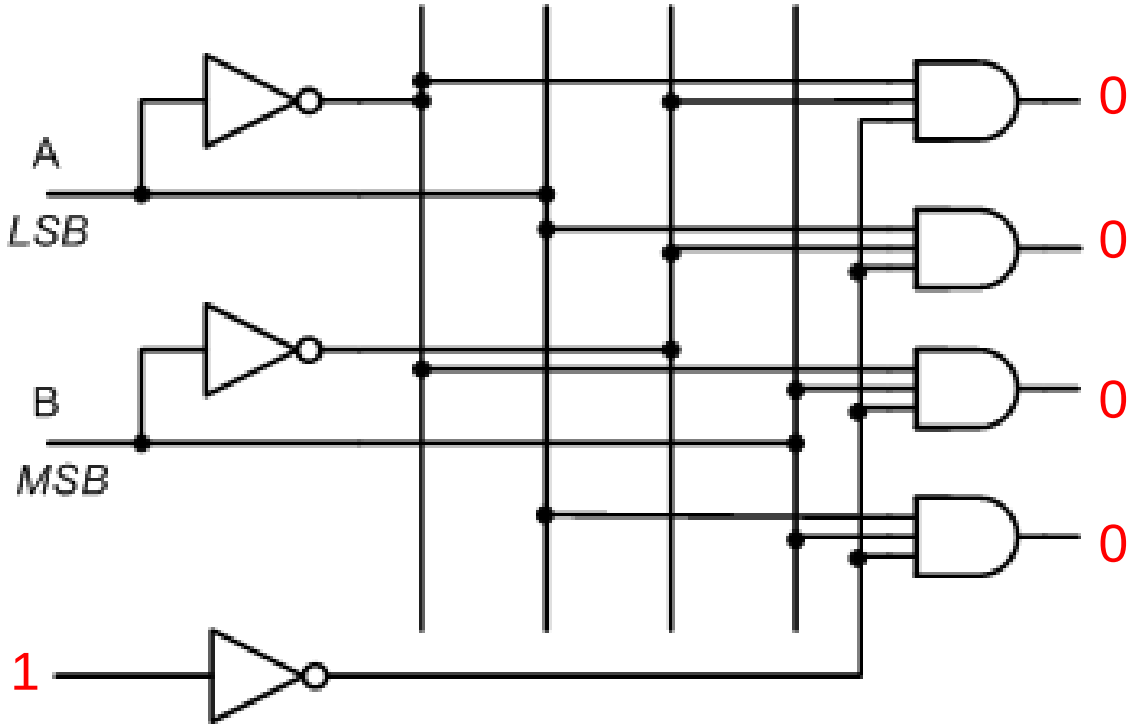
Active-Lo Enable



When E=inactive (inactive means 1), Outputs turn off (off means 0)

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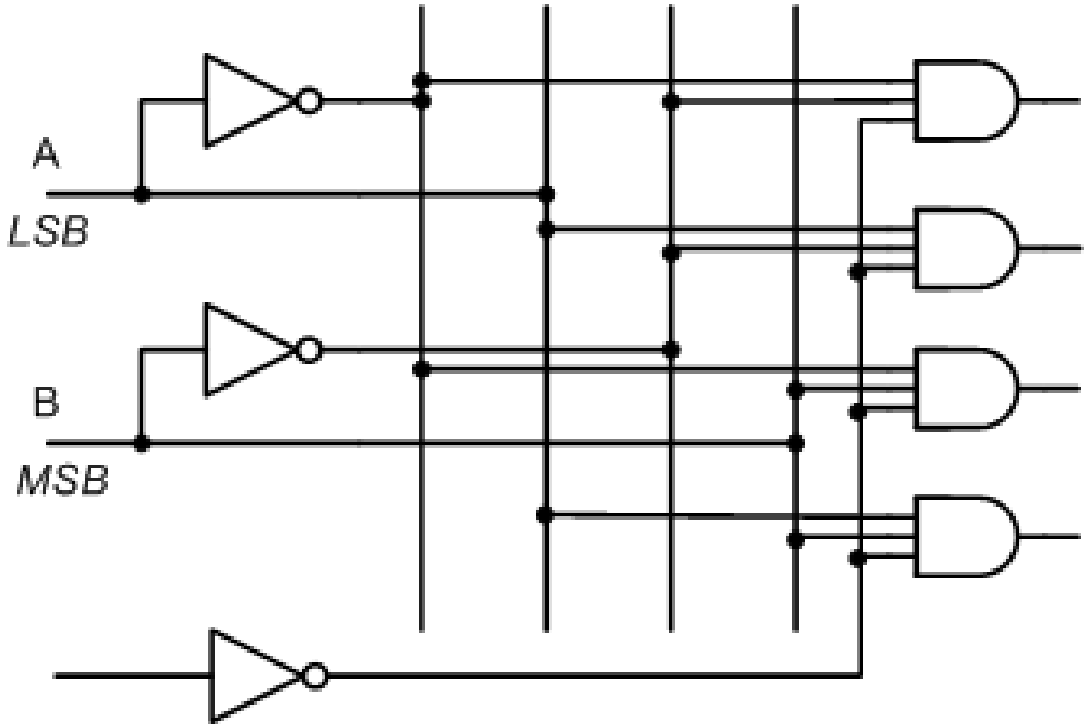
Active-Lo Enable



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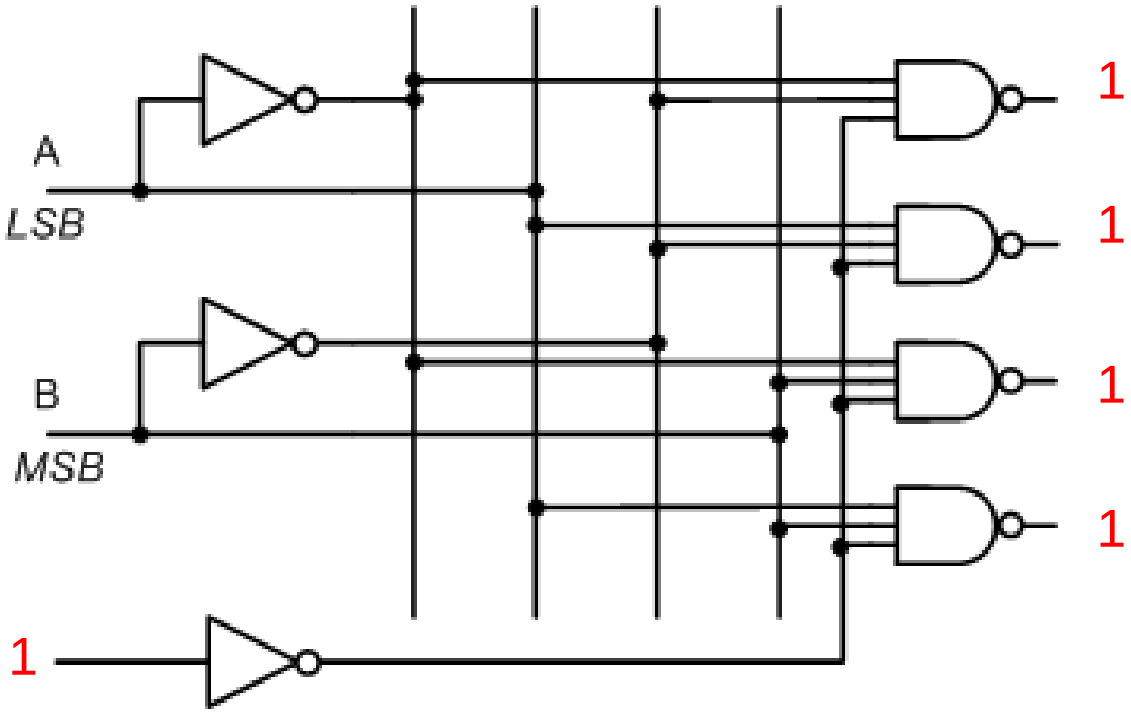
Active-Lo Enable



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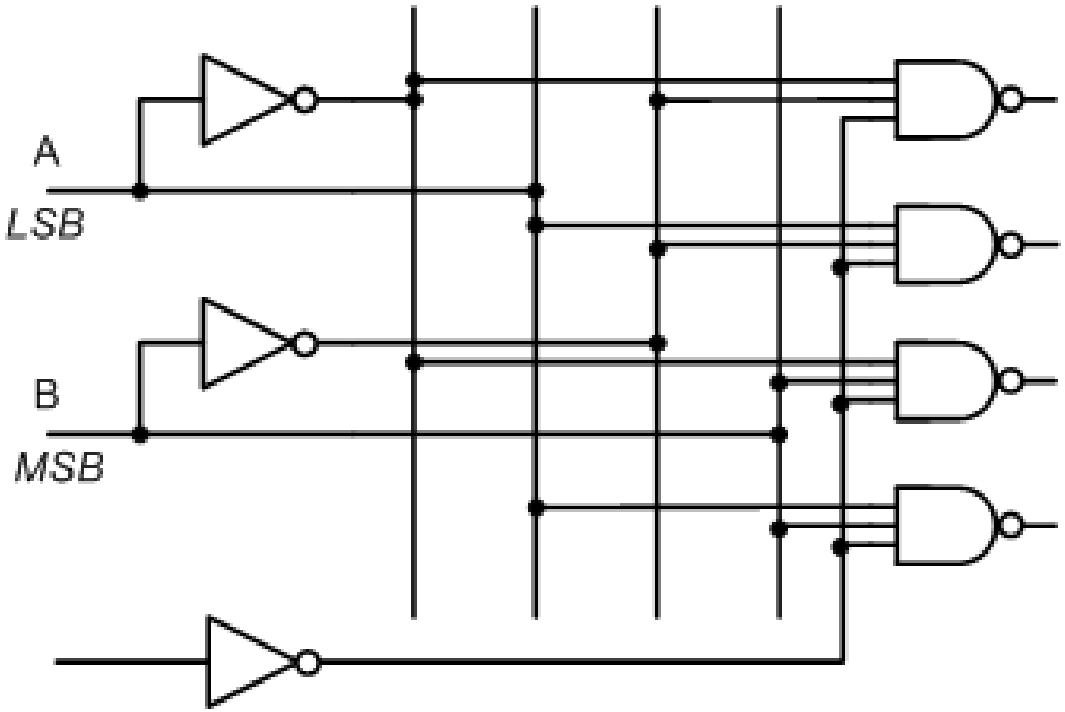
Active-Lo Enable



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