Multiplexers, Demultiplexers, Decoders, and Encoders

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February 13, 2023

- A demultiplexer has:
  - N control inputs
  - 1 data input
  - 2^N outputs
- A demultiplexer routes (or connects) the data input to the selected output
  - The value of the control inputs determines the output that is selected
- A demultiplexer performs the opposite function of a multiplexer
- Using an n-input multiplexer
  - Use an n-input multiplexer to realize a logic circuit for a function with n minterms
    - $n = 2^m$, where $m =$ # of variables in the function
  - Each minterm of the function can be mapped to an input of the multiplexer
  - For each row in the truth table, for the function, where the output is 1, set the corresponding input of the multiplexer to 1
    - That is, for each minterm in the minterm expansion of the function, set the corresponding input of the multiplexer to 1
  - Set the remaining inputs of the multiplexer to 0
- Using an $(\frac{n}{2})$-input multiplexer
  - $n = 2^m$, wehere $m =$ the number of variables in the function
- Group the rows of the truth table, for the function, into $\frac{n}{2}$ pairs of rows
  - Each pair of rows represents a product term of $(m-1)$ variables
  - Each pair of rows can be mapped to a multiplexer input
- Determine the logical function of each pair of rows in terms of the m^{th} variable
  - If the m^{th} variable, for example, is x, then the possible values are x, x', 0, and 1
- Decoders
  - A decoder has
    - N inputs
    - 2^N outputs
  - A decoder selects one of 2^N outputs by decoding the binary value on the N inputs

  - The decoder generates all of the minterms of the N input variables
    - Exactly one output will be active for each combination of the inputs

- Encoders
  - An encoder has:
    - 2^N inputs
    - N outputs
  - An encoder outputs the binary value of the selected (or active) input
  - An encoder performs the inverse operation of a decoder