Note Title 4/3/2009

HW 5 delayed to Friday, April 10

New topic: Multiplexers, Decoders, and Programmable Logic Devices

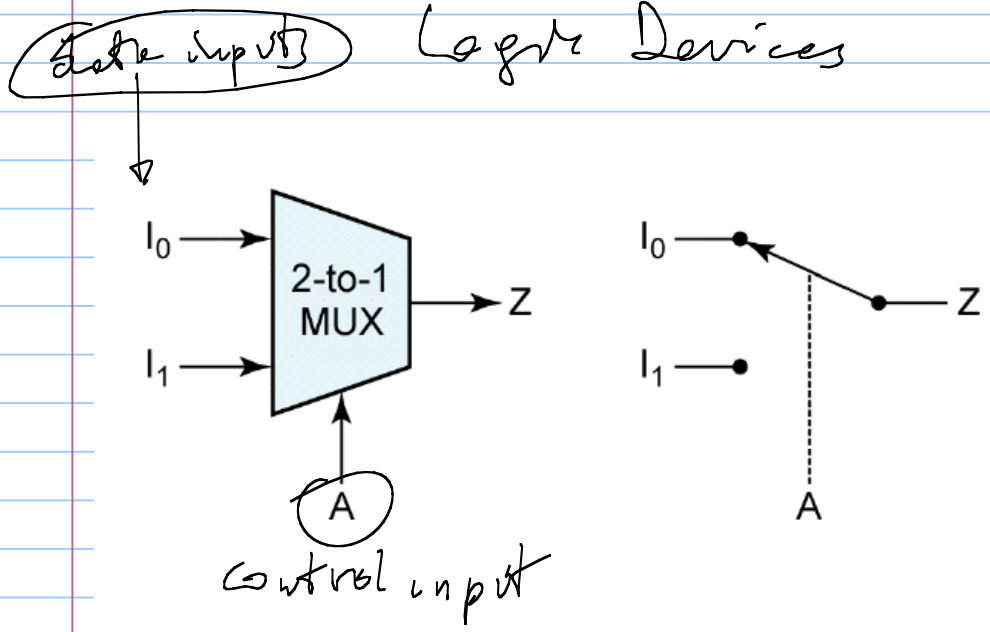


Figure 9-1: **2-to-1 Multiplexer and Switch Analog**

Multiplexers and Decoders are examples of medium-scale integrated circuits (MSI circuits), which contain 12–100 gates in one package (one "chip").

LSI (large-scale integrated) circuits: ~100 – several thousand,

VLSI: from several thousands up

A multiplexer (MUX) is also called a data selector.

$Z = A' I_0 + A I_1$

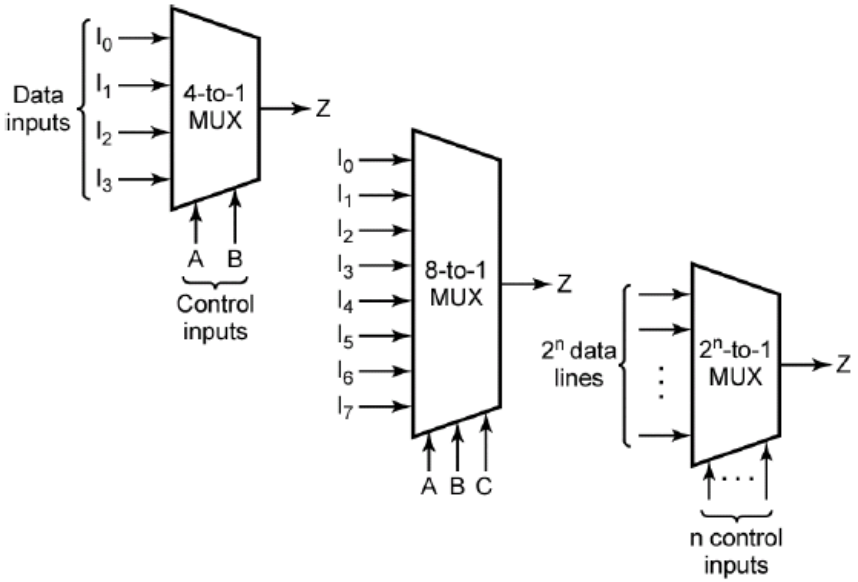


Figure 9-2: **Multiplexers**

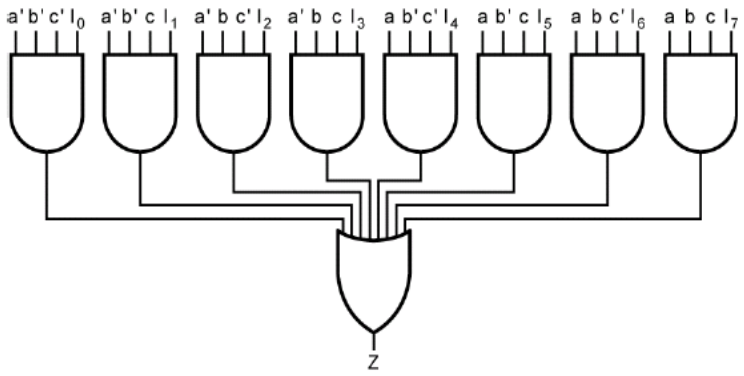


Figure 9-3: **Logic Diagram for 8-to-1 MUX**

4-to-1 MUX: (9-1)

$Z = A'B'I_0 + A'BI_1 + AB'I_2 + ABI_3$

8-to-1 MUX:

$Z = A'B'C'I_0 + A'B'CI_1 + A'BC'I_2 + \dots + ABCI_7$

2^n-to-1 MUX:

$$Z = \sum_{k=0}^{2^n-1} m_k I_k$$

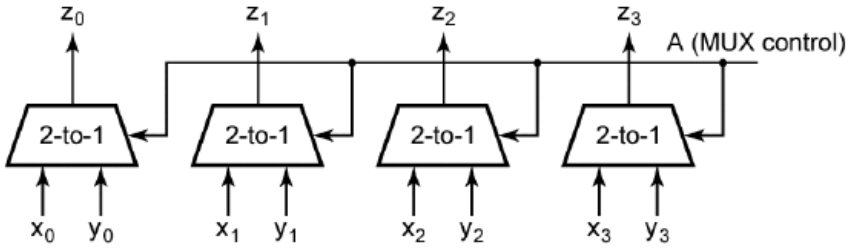


Figure 9-4: **Quad Multiplexer Used to Select Data**

shorthand

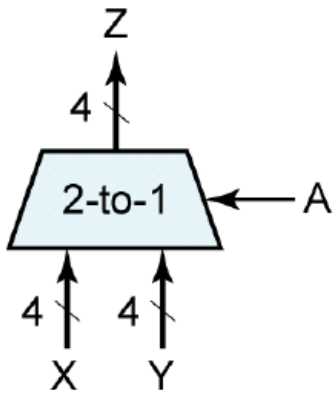


Figure 9-5: **Quad Multiplexer with Bus Inputs and Output**

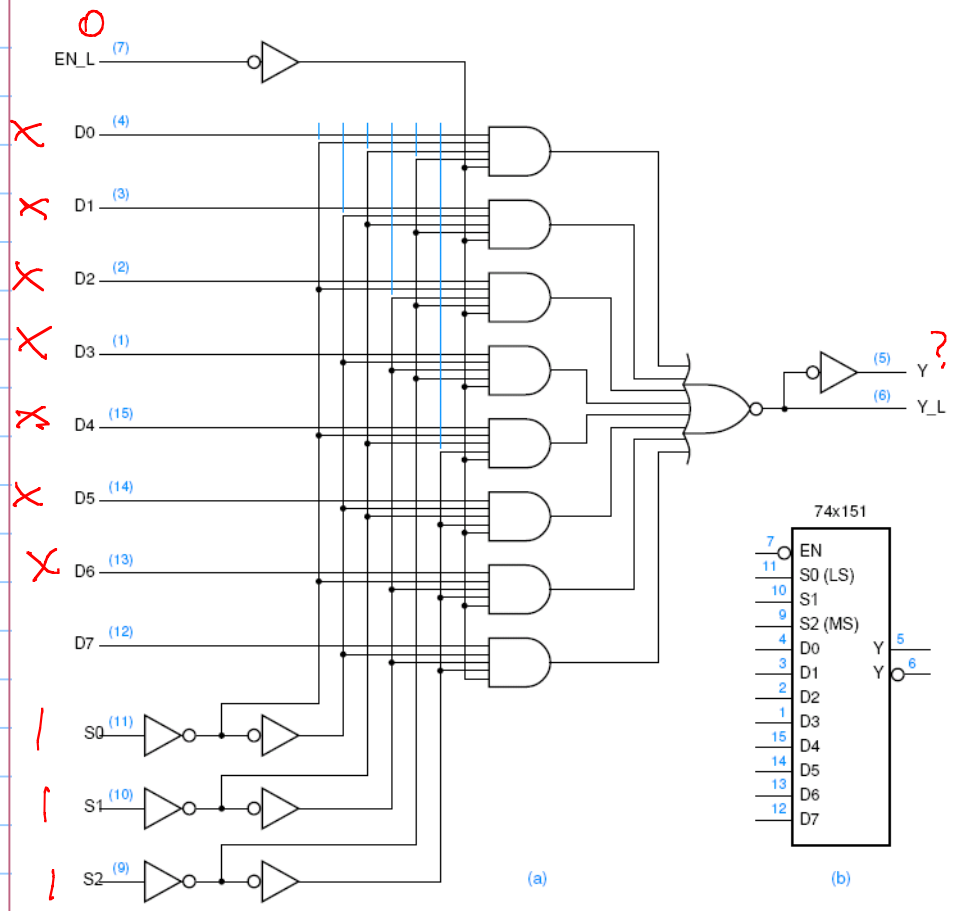
CSCE211, Homework Assignment No. 5

· Show all your steps—answers alone are not sufficient.
· Homework must be done neatly
· Use straight-edged paper (no notebook tear-outs with ragged edges)
· STAPLE papers to a signed cover sheet.

Please print the following for reference and for this assignment: MUX-Decoder instructions. Also, please print for reference and inclusion in your Homework paper MSI diagrams 74LS151 (8-to-1 MUX) and 74LS138 (3-to 8 Decoder/De-MUX)

1. Use a 74x151 (8-to-1 MUX) to implement f(W, X, Y, Z) = Sm(2, 4, 7, 8, 9, 13, 14). Use the "rowpairs" method shown in class. Show all enable and address connections. (20pts) (See instructions above.)
2. Use a 74x138 decoder and an external AND gate to implement f(X, Y, Z) = Sm(1, 2, 4, 5, 6). Show all enable and address connections. (HINT: AND the MAX terms) (20pts) (See instructions above)
3. Use a 74x138 decoder and an external NAND gate to implement f(p, q, r) = Sm(1, 3, 7). Show all enable and address connections. (20 pts) (See instructions above)
4. Design an 8-to-1 MUX from *three* 4-to-1 MUXs. Label the inputs on each 4-to1 MUX as I0 to I3. In the "first stage," place one MUX on "top" of another and connect their select lines S1 (most significant) and S0 together. Let I0 on the "top" MUX correspond to D0 of 8 inputs and let I0 on the "bottom" MUX be D4. Use the third MUX to select between the **two** "first-stage" MUX outputs. You can configure a 4-to-1 MUX to be a 2-to-1 MUX by setting its MS select line to logic "0." When you finish, label the three 8-to-1 select lines as S2 (most significant) to S0 (least significant). (20 pts)
5. Design an 8-input to 8-output MUX-DEMUX system using a 74x151 for the MUX part and a 74x138 for the DEMUX. Leave the outputs of the 74x138 as *active-low* signals (leave the output bubbles as-is). Configure ("hard wire") the select-lines values on the MUX and address-lines values on the DEMUX so that *input* **D4** is routed to *output* **Y6_L**. Wire so that there is only **one** active low ENABLE signal that controls **both** chips. You can do this because there are 3 enable lines (one active high, two active low) on the DECODER (20pts).

74x151



EN-L: enable low: enables when 0
disables when 1

S2 is the most significant (MS) control bit
S0 is the least significant (LS) control bit

D0-D7 are the data inputs

Y is the output
Y_L is the negated output

Check: what is Y when
- EN-L = 0
- S0 = S1 = S2 = 1 ?

D7

See the Motorola datasheet, which is linked to the course web site.
Note that it provides a truth table and uses different names for the variables.

5. Design an 8-input to 8-output MUX-DEMUX system using a 74x151 for the MUX part and a 74x138 for the DEMUX. Leave the outputs of the 74x138 as *active-low* signals (leave the output bubbles as-is). Configure ("hard wire") the select-lines values on the MUX and address-lines values on the DEMUX so that *input* **D4** is routed to *output* **Y6_L**. Wire so that there is only **one** active low ENABLE signal that controls **both** chips. You can do this because there are 3 enable lines (one active high, two active low) on the DECODER (20pts).

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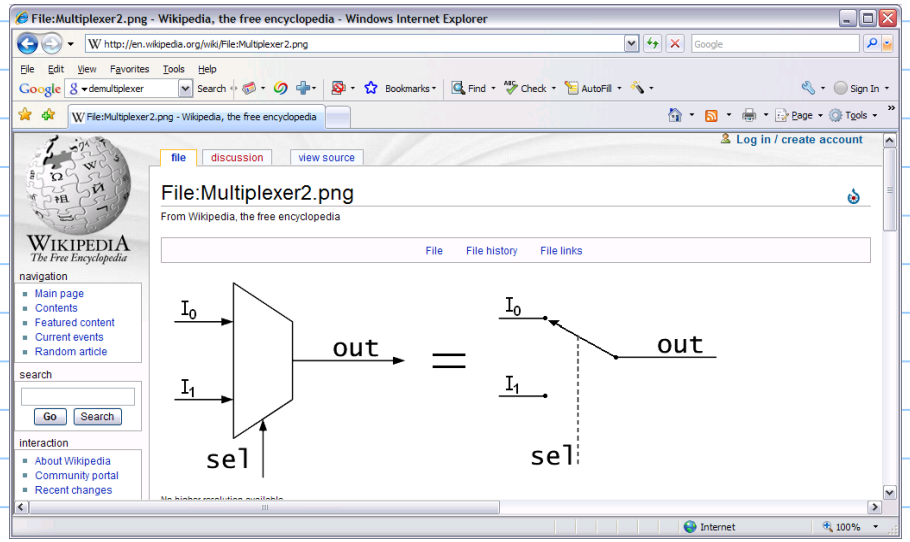

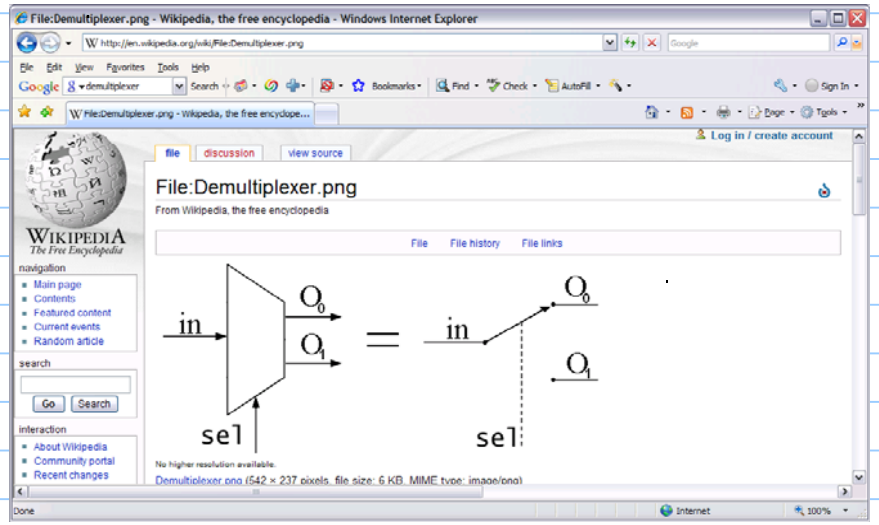

The 74x138 Decoder can be used as a demultipler (DEMUX), as explained on the Motorola data sheet (linked to course web site): use the high Enable line for in.