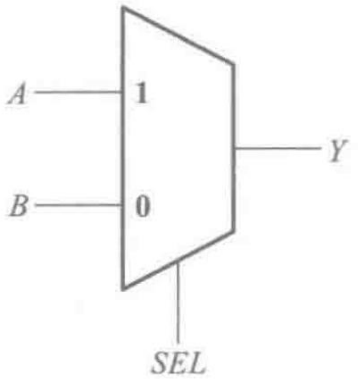
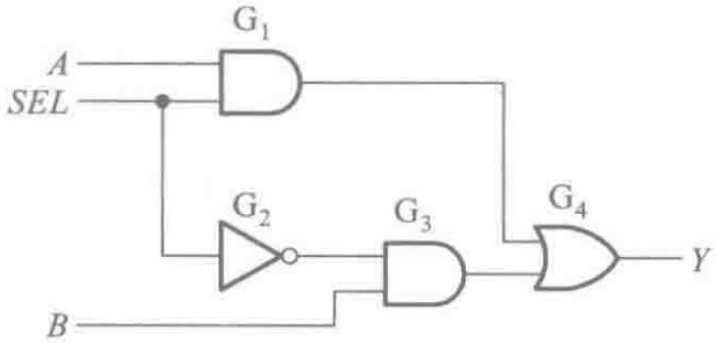
Multiplexers (Data Selectors)

- A multiplexer (MUX) permit digital data on any one of the inputs to be switched to the output line.

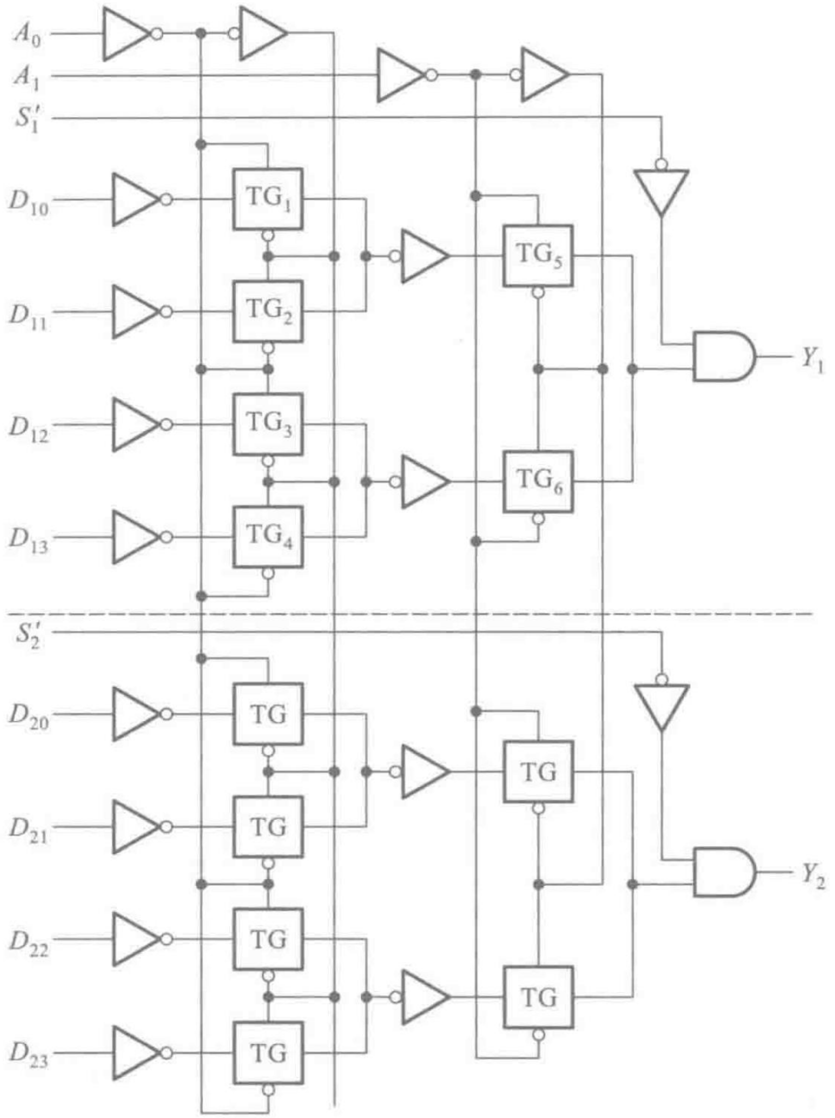


SEL	A	B	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

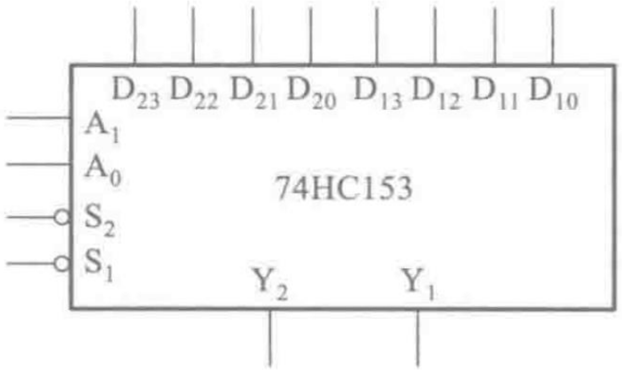
$Y = SEL \cdot A + SEL' \cdot B$



4-to-1 MUX



74HC153



- 74HC153 consists of two 4-to-1 MUX sharing the same address

$$Y_1 = [D_{10}(A_1'A_0') + D_{11}(A_1'A_0) + D_{12}(A_1A_0') + D_{13}(A_1A_0)] \cdot S_1$$

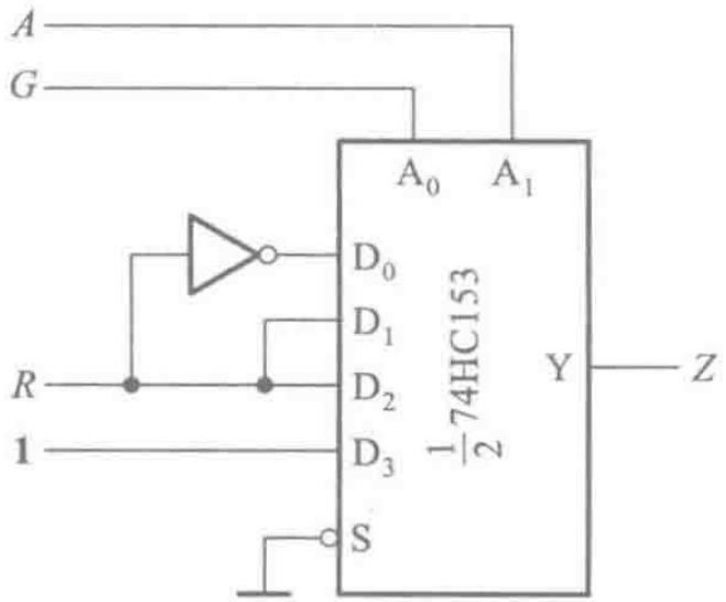
MUX application

- Use 74HC153 to realize the traffic light detection task

$$Z = R'A'G' + R'AG + RA'G + RAG' + RAG$$

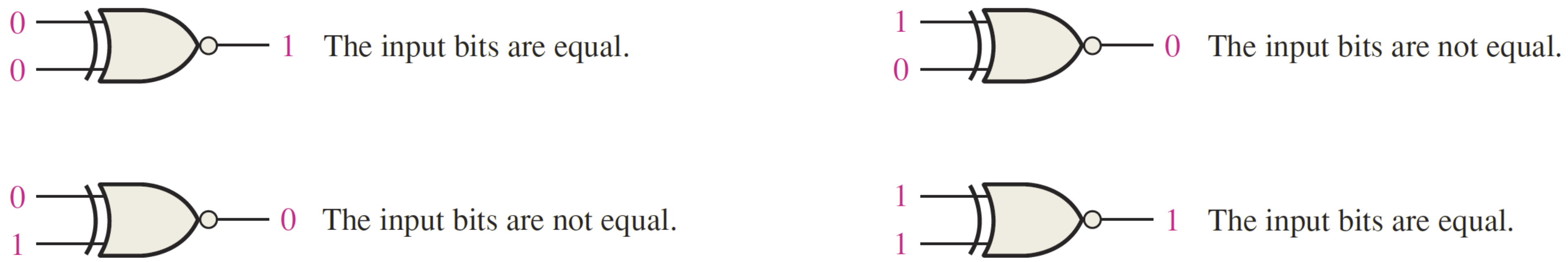
$$Z = R'(A'G') + R(A'G) + R(AG') + 1 \cdot (AG)$$

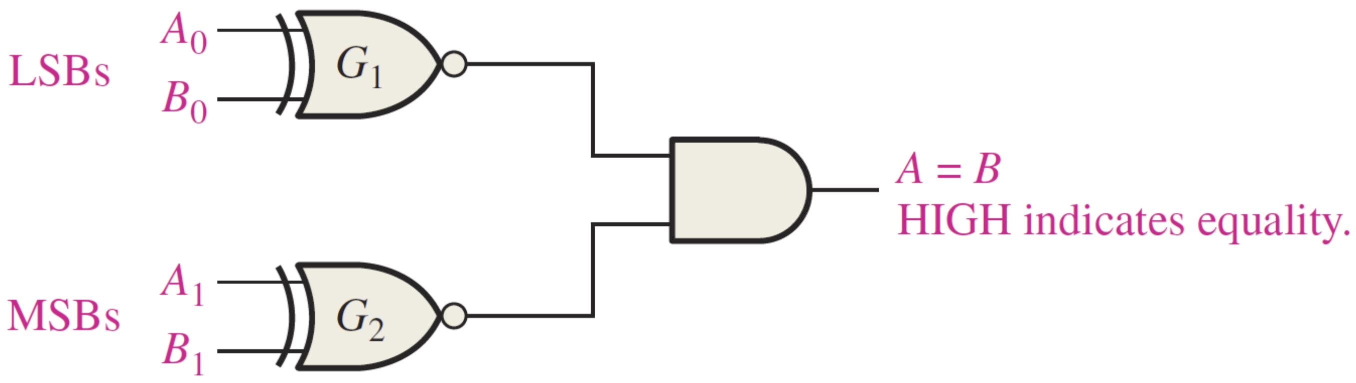
$$\begin{cases} A_1 = A \\ A_0 = G \end{cases} \quad \begin{cases} D_0 = R' \\ D_1 = D_2 = R \\ D_3 = 1 \end{cases}$$



Comparators

Equality

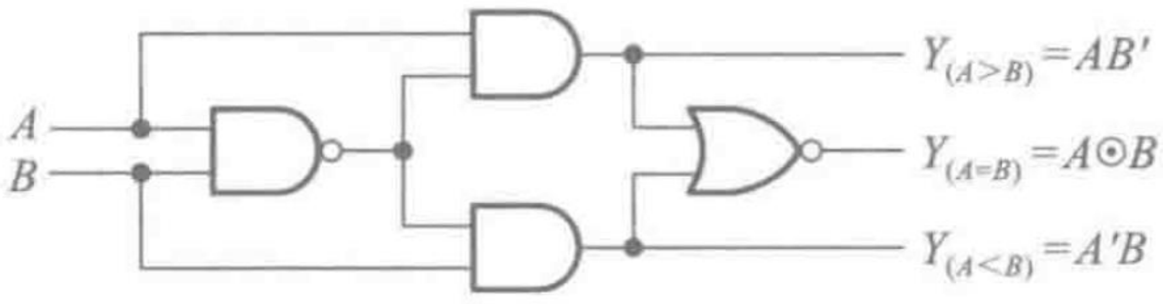




Comparators

For the two bits comparison,

- $A>B$ -> $A=1$, $B=0$ -> AB'
- $A<B$ -> $A=0$, $B=1$ -> $A'B$
- $A=B$ -> $A=1$, $B=1$ or $A=0$, $B=0$ -> $A \odot B$



4 bits comparators

For multi bits comparison,

$$
\begin{aligned}
Y_{(A>B)} = {} & A_3B_3' + (A_3 \odot B_3)A_2B_2' + (A_3 \odot B_3)(A_2 \odot B_2)A_1B_1' \\
& + (A_3 \odot B_3)(A_2 \odot B_2)(A_1 \odot B_1)A_0B_0' \\
& + (A_3 \odot B_3)(A_2 \odot B_2)(A_1 \odot B_1)(A_0 \odot B_0)I_{(A>B)}
\end{aligned}
$$

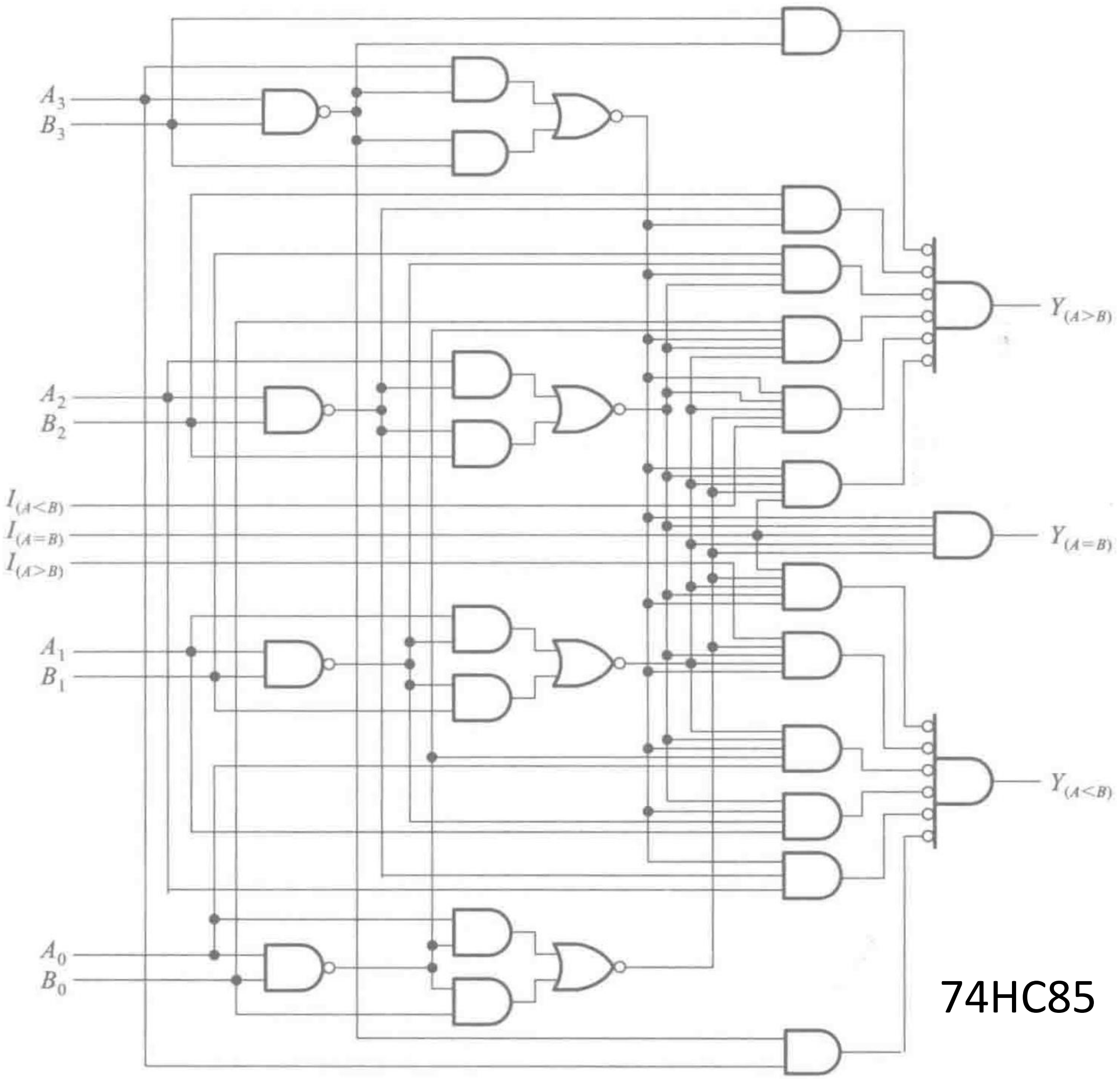
$$
\begin{aligned}
Y_{(A<B)} = {} & A_3'B_3 + (A_3 \odot B_3)A_2'B_2 + (A_3 \odot B_3)(A_2 \odot B_2)A_1'B_1 \\
& + (A_3 \odot B_3)(A_2 \odot B_2)(A_1 \odot B_1)A_0'B_0 \\
& + (A_3 \odot B_3)(A_2 \odot B_2)(A_1 \odot B_1)(A_0 \odot B_0)I_{(A<B)}
\end{aligned}
$$

$$
Y_{(A=B)} = (A_3 \odot B_3)(A_2 \odot B_2)(A_1 \odot B_1)(A_0 \odot B_0)I_{(A=B)}
$$

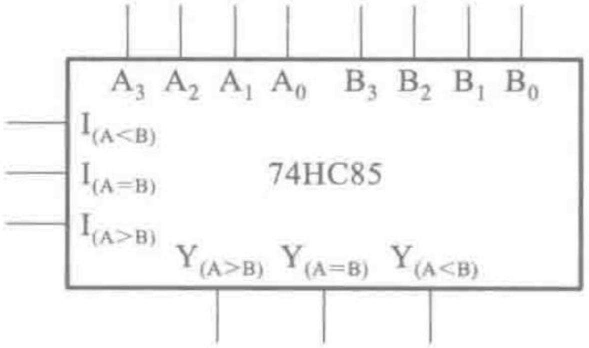
- $I(A>B)$, $I(A<B)$ and $I(A=B)$ are the inputs from the lower bits
- If there is no inputs from the lower bits, one should set $I(A>B)=0$, $I(A<B)=0$ and $I(A=B)=1$
- Since there are only three situations, i.e., $A>B$, $A<B$ and $A=B$,

$$
\begin{aligned}
Y_{(A>B)} &= (Y_{(A<B)} + Y_{(A=B)})' \\
Y_{(A<B)} &= (Y_{(A>B)} + Y_{(A=B)})'
\end{aligned}
$$

4 bits comparators

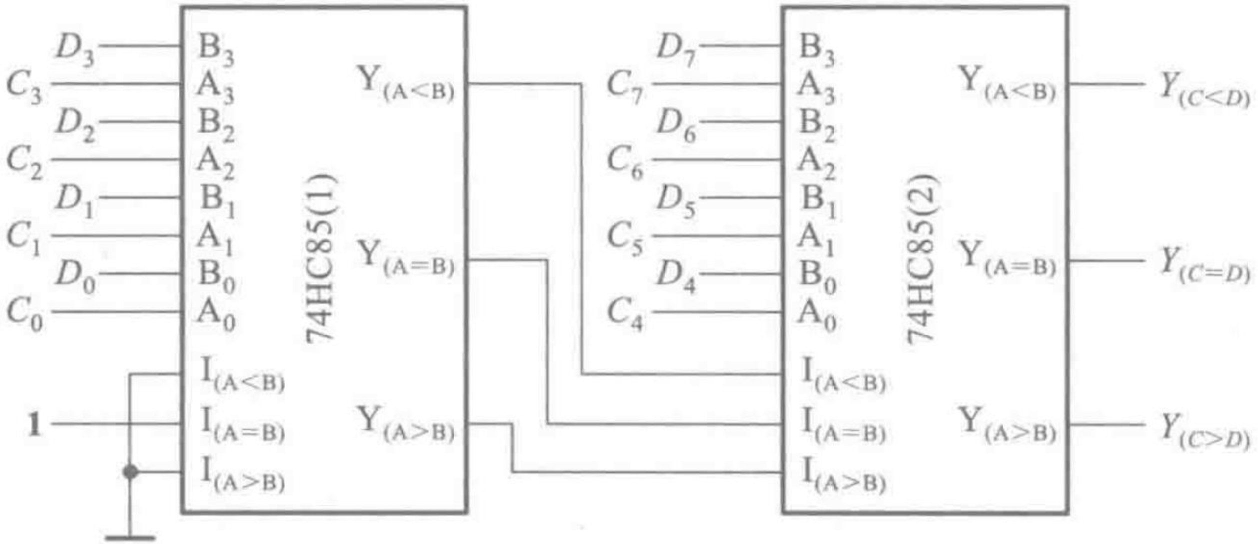


74HC85



8 bits comparators

Construct the 8 bits comparator using two 74HC85



Reading materials

- Chapter 6 of Floyd book
- Chapter 4 of 阎石 book