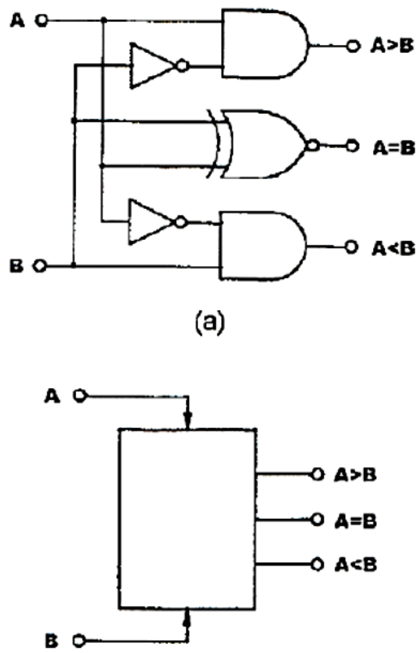
Comparator Circuit

OBJECTIVE

Understanding the construction and operational principles of digital comparators.

Summary

At least two numbers are required to perform any comparison. The most simple form of comparator has two inputs. If the two inputs are called A and B there are three possible outputs : A>B; A=B; A<B. Fig. 2-14 shows the schematic and symbol of a simple comparator.



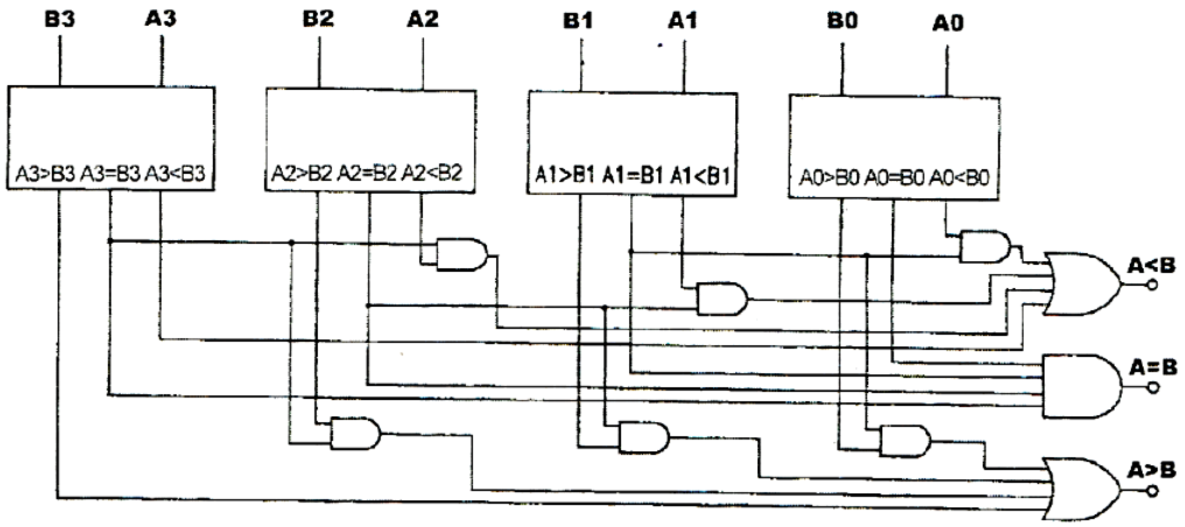
(a) (b)

Fig. 2-14 Comparators

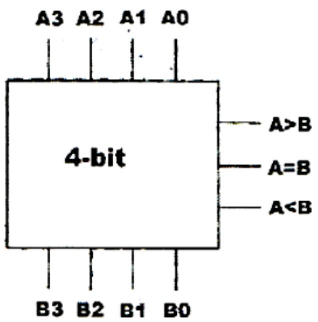
An 1-bit comparator is shown in Fig. 2-14. In actual applications 4-bit comparators are used most often. 4-bit comparator ICs that determine greater or less inputs include TTL 7485 and CMOS 4063. TTL 74689 is an IC that only compares whether the inputs are equal.

In a 4-bit comparators, each bit represents 2^0, 2^1, 2^2, 2^3. Comparisons will start from the highest bit (2^3), if input A is higher than input B at the 2^3 bit, the "A>B" output will be in high state.

If A and B are equal at the 2^3 bit, comparison will be carried out at the next highest bit (2^2). If there is still no result at this bit the process is repeated again at the next bit. At the lowest bit (2^0), if the inputs are still equal then the "A=B" output will be in high state.



(a) expansion of comparators



(b) symbol of 4- bit comparator

Fig. 2-15

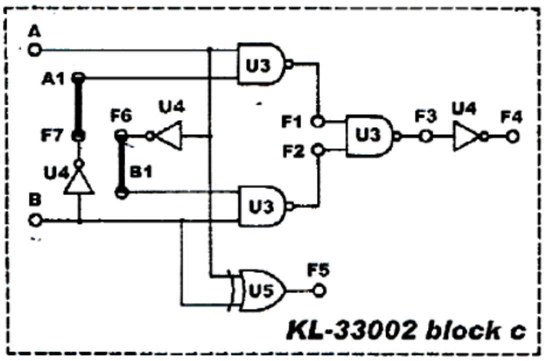
EQUIPMENTS REQUIRED

KL-31001 Digital Logic Lab; Module KL-33002

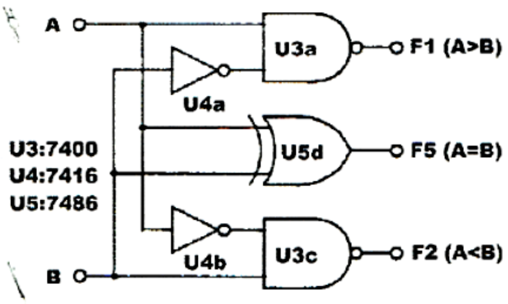
PROCEDURES

(a) Comparator Constructed with Basic Logic Gates

1. Insert connection clips according to Fig. 2-16 (a). U3a, U3b, U3c, U4a, U4b, U4c and U5 will be used to construct the 1-bit comparator shown in Fig. 2-16 (b).



(a)



(b)

Fig. 2-16 1bit comparator

2. The inputs are triggered by high state voltage. Connect inputs A and B to Data Switch SW1 and SW2. The outputs are triggered by low state voltage. Connect outputs F1, F2, F5 to Logic Indicators L1, L2, L3 respectively.

3. Follow the input sequences in Table 2-10.Measure and record the outputs.

INPUT			OUTPUT		
SW2(B)	SW1(A)		F1	F2	F5
0	0	A=B			
0	1	A>B			
1	0	A<B			
1	1	A=B			

Table 2-10

(b) Comparator Constructed with TTL IC

1. Block d of module KL-33002 will be used in this section. U6 is a 7485 4-bit Comparator IC. Its pin assignment and truth table are given below.

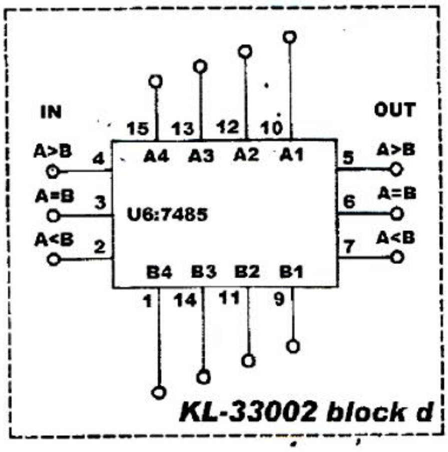


Fig.2-17

2. Connect input A>B to SW1 and F1; A=B to SW2 and F2; A<B to SW3 and F3. Connect inputs A1~A4 and B1~B4 of the 7458 to the output of Thumbwheel Switches on KL-31001.

3. Assuming inputs A1~A4=As and B1~B4=Bs and As=Bs, follow input sequences in Table 2-11 and record the outputs.

INPUT			OUTPUT		
SW3	SW2	SW1			
A>B	A=B	A<B	A<B	A=B	A>B
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	1			

Table 2-11

4. Set SW3 to "0"; SW2 to "1"; SW1 to "0". Observe and record the outputs under the following conditions：

   (1) As>Bs
   (2) As=Bs
   (3) As<Bs

5. Remove A1~A4 and B1~B4 from the Thumbwheel Switches and connect them to DIP Switches DIP1.0~DIP1.3 and DIP2.0~DIP 2.3 respectively. Repeat step 4. Are the results any different from step 4?

DISCUSSION:

1- A 7485 four-bit magnitude comparator has P=1011 and Q= 1001.
   a- Determine the outputs.
   b- Show how to connect the < , = and > inputs if this is to be the least significant state.

2- Draw the logic diagram for the comparison of two 4-bit binary numbers $P_3 P_2 P_1 P_0$ and $Q_3 Q_2 Q_1 Q_0$?

3- Draw circuit for equality comparison of two 4-bit numbers.

4- Design a digital comparator which compare two each with 2-bit using truth table method ?

5- Use 3-bit integrated comparators to compare the magnitude of two 6-bit binary numbers . Show the comparators with proper connections ?

6- Use 7485 comparators to compare the magnitudes of two 8-bit binary numbers. Show the comparators with proper interconnections.