Sairam INSTITUTIONS

Sri SAI RAM ENGINEERING COLLEGE
INSTITUTE OF TECHNOLOGY
West Tambaram, Chennai - 44

YEAR	SEM
II	III

CS 8351

DIGITAL PRINCIPLES AND SYSTEM DESIGN
(Common to CSE & IT)

UNIT NO. 2

2.7 MAGNITUDE COMPARATOR

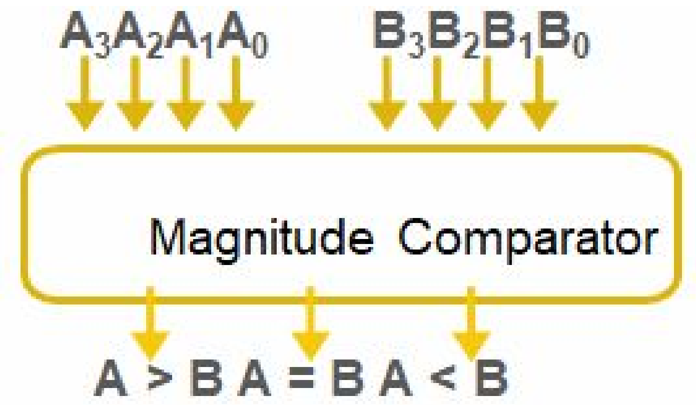
Version: 1.0

4 QUALITY EDUCATION

MAGNITUDE COMPARATOR

- It is a combinational circuit that compares two numbers (A and B).
- 3 outputs <, =, >(i.e.) A > B, A = B, A<B.
- Compares 4-bit number A to 4-bit number B.
- A magnitude digital Comparator is a combinational circuit that **compares two digital or binary numbers** in order to find out whether one binary number is equal, less than or greater than the other binary number. We logically design a circuit for which we will have two inputs one for A and other for B and have three output terminals, one for A > B condition, one for A = B condition and one for A < B condition.

BLOCK DIAGRAM:



SINGLE BIT MAGNITUDE COMPARATOR:

- A comparator used to compare two bits, i.e., two numbers each of a single bit is called a single bit comparator.
- It consists of two inputs for allowing two single bit numbers and three outputs to generate less than, equal and greater than comparison outputs.
- The figure below shows the block diagram of a single bit magnitude comparator.
- This comparator compares the two bits and produces one of the 3 outputs as L (A<B), E (A=B) and G (A>B).

TRUTHTABLE & LOGICAL EQUATIONs

- When A0 B0 = 00 & 11, both inputs are equal, therefore A=B output will be high.

- When A0 B0 = 01, B is more than A and hence AB is active.

A_0	B_0	L	E	G
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0

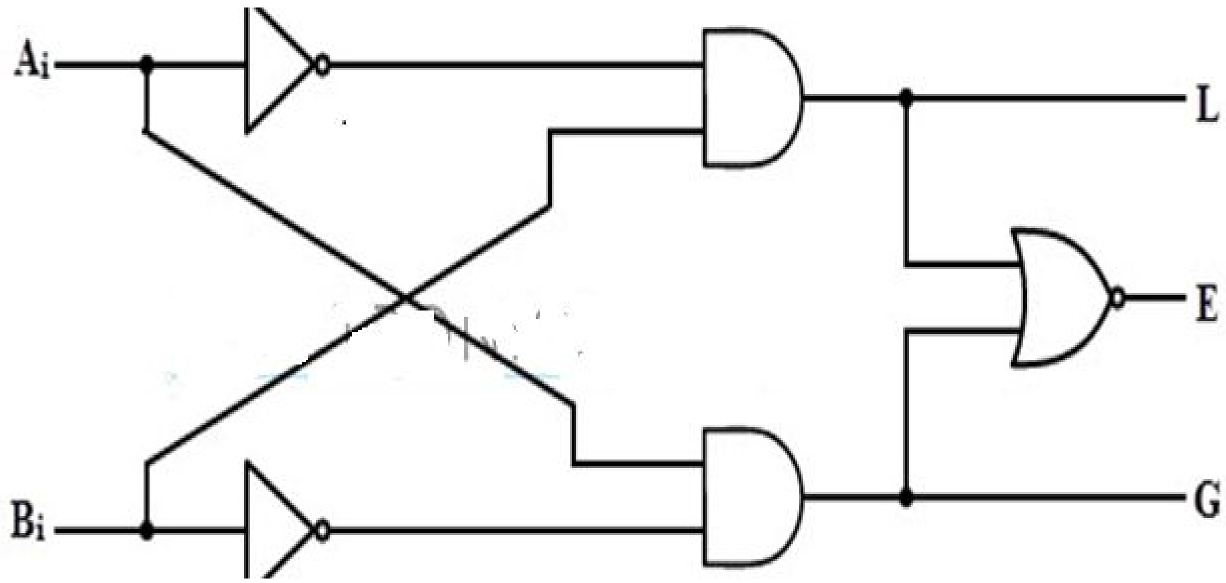
$A0 < B0: L = \overline{A0}\,B0$

$A0 = B0: E = \overline{A0}\,\overline{B0} + A0\,B0$

$A0 > B0: G = A0\,\overline{B0}$

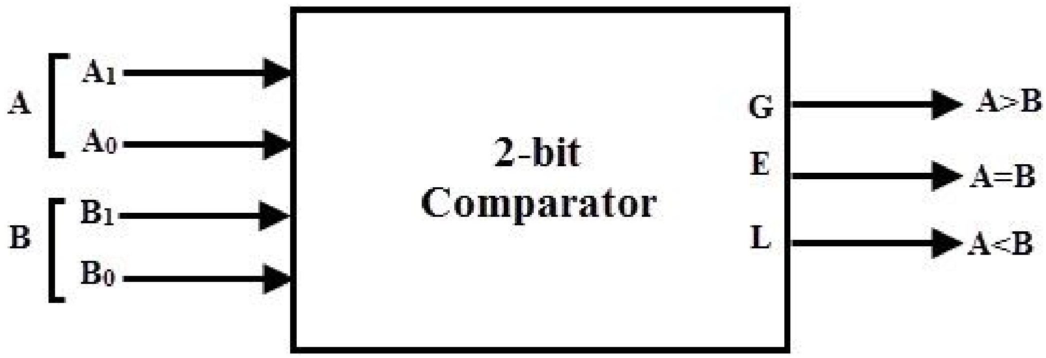
It is to be noted that E can be realized as $\overline{(L + G)}$.

LOGIC DIAGRAM



2-BIT COMPARATOR:

- A 2-bit comparator compares two binary numbers, each of two bits and produces their relation such as one number is equal or greater than or less than the other.
- The figure below shows the block diagram of a two-bit comparator which has four inputs and three outputs.
- The first number A is designated as A = A1A0 and the second number is designated as B = B1B0. This comparator produces three outputs as G (G = 1 if A>B), E (E = 1, if A = B) and L (L = 1 if A<B).



TRUTHTABLE

Inputs				Outputs		
A_1	A_0	B_1	B_0	A>B	A=B	A<B
0	0	0	0	0	1	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	0	0	1
0	1	0	0	1	0	0
0	1	0	1	0	1	0
0	1	1	0	0	0	1
0	1	1	1	0	0	1
1	0	0	0	1	0	0
1	0	0	1	1	0	0
1	0	1	0	0	1	0
1	0	1	1	0	0	1
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	0	1	0

TRUTH TABLE & LOGIC EQUATIONs

A>B

A_1A_0 \ B_1B_0	00	01	11	10
00	0	0	0	0
01	1	0	0	0
11	1	1	0	1
10	1	1	0	0

A=B

A_1A_0 \ B_1B_0	00	01	11	10
00	1	0	0	0
01	0	1	0	0
11	0	0	1	0
10	0	0	0	1

From the above k-map simplification, each output can be expressed as

$$A>B: G = A0\,\overline{B1}\;\overline{B0} + A1\,\overline{B1} + A1\;A0\;\overline{B0}$$

$$A = B: E = \overline{A1}\;\overline{A0}\;\overline{B1}\;\overline{B0} + \overline{A1}\;A0\;\overline{B1}\;B0 + A1\;A0\;B1\;B0 + A1\;\overline{A0}\;B1\;\overline{B0}$$

$$= \overline{A1}\;\overline{B1}\;(\overline{A0}\;\overline{B0} + A0\,B0) + A1\,B1\,(A0\,B0 + \overline{A0}\;\overline{B0})$$

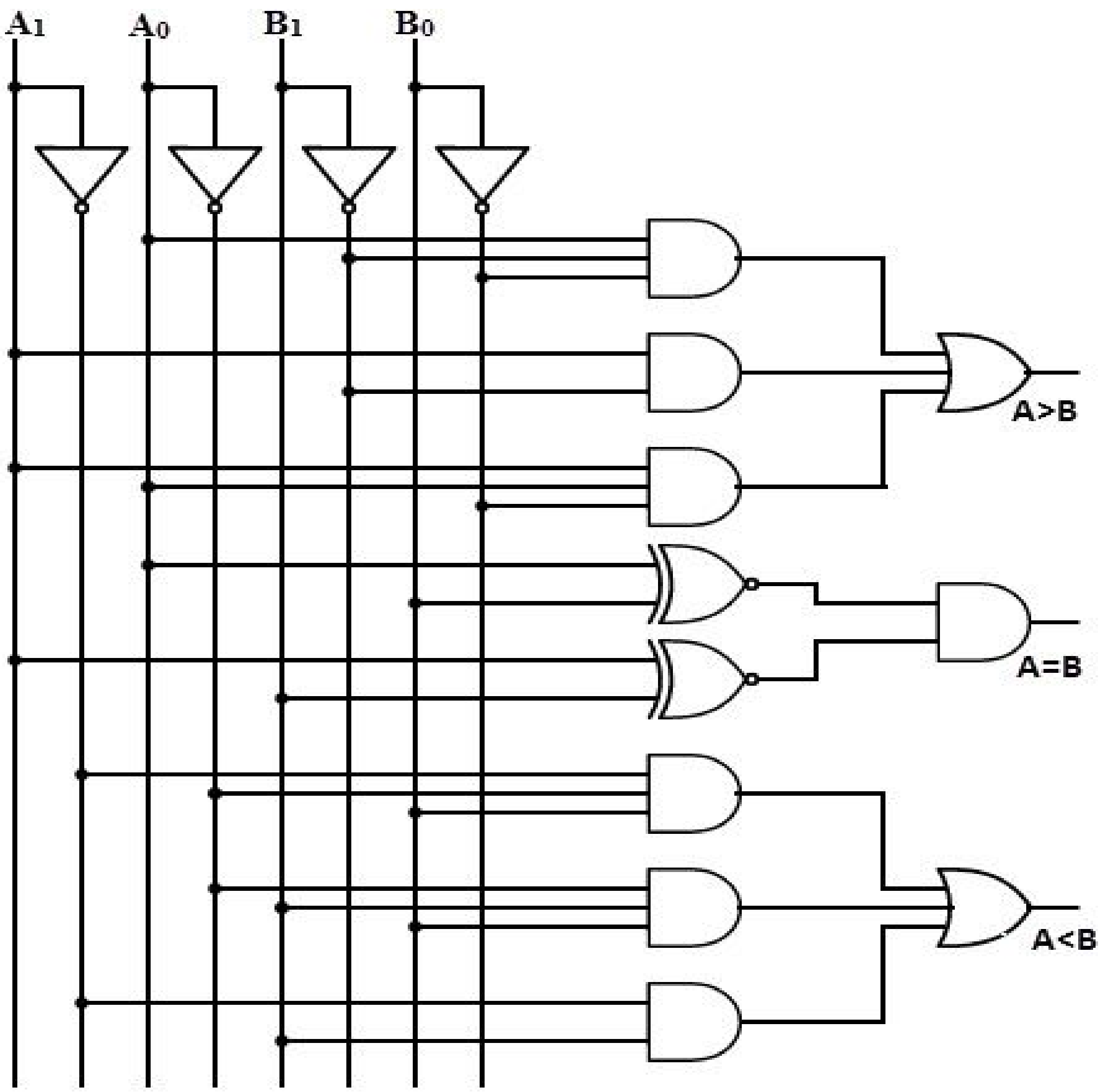
$$= (A0\,B0 + \overline{A0}\;\overline{B0})\;(A1\,B1 + \overline{A1}\;\overline{B1})$$

$$= (A0 \text{ Ex-NOR } B0)\;(A1 \text{ Ex-NOR } B1)$$

$$A < B: L = \overline{A1}\;B1 + \overline{A0}\;B1\;B0 + \overline{A1}\;\overline{A0}\;B0$$

- By using the Boolean equation for each output, the logic diagram can be implemented by using four NOT gates, seven AND gates, two OR gates and two Ex-NOR gates.
- The figure shows the logic diagram of a 2-bit comparator using basic logic gates.
- It is also possible to construct this comparator by cascading two 1-bit comparators.

LOGIC DIAGRAM



APPLICATIONS OF COMPARATORS

- These are used in the address decoding circuitry in computers and microprocessor based devices to select a specific input/output device for the storage of data.
- These are used in control applications in which the binary numbers representing physical variables such as temperature, position, etc. are compared with a reference value. Then the outputs from the comparator are used to drive the actuators so as to make the physical variables closest to the set or reference value.
- Process controllers
- Servo-motor control