

## MM54HC85/MM74HC85

### 4-Bit Magnitude Comparator

#### General Description

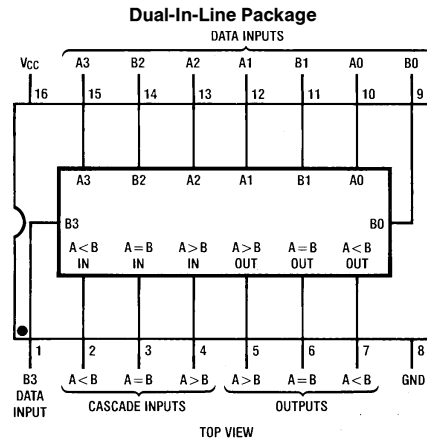
The MM54HC85/MM74HC85 is a 4-bit magnitude comparator that utilizes advanced silicon-gate CMOS technology. It is designed for high speed comparison of two four bit words. This circuit has eight comparison inputs, 4 for each word; three cascade inputs ( $A < B$ ,  $A > B$ ,  $A = B$ ); and three decision outputs ( $A < B$ ,  $A > B$ ,  $A = B$ ). The result of a comparison is indicated by a high level on one of the decision outputs. Thus it may be determined whether one word is "greater than," "less than," or "equal to" the other word. By connecting the outputs of the least significant stage to the cascade inputs of the next stage, words of greater than four bits can be compared. In addition the least significant stage must have a high level applied to the  $A = B$  input, and a low level to the  $A < B$ , and  $A > B$  inputs.

The comparator's outputs can drive 10 low power Schottky TTL (LS-TTL) equivalent loads, and is functionally, and pin equivalent to the 54LS85/74LS85. All inputs are protected from damage due to static discharge by diodes to  $V_{CC}$  and ground.

#### Features

- Typical propagation delay: 27 ns
- Wide operating voltage range: 2–6V
- Low input current: 1  $\mu$ A maximum
- Low quiescent current: 80  $\mu$ A maximum (74HC Series)
- Output drive capability: 10 LS-TTL loads

#### Connection Diagram



TL/F/5205-1

Order Number MM54HC85 or MM74HC85

#### Truth Table

| Comparing Inputs |         |         |         | Cascading Inputs |       |       | Outputs |       |       |
|------------------|---------|---------|---------|------------------|-------|-------|---------|-------|-------|
| A3, B3           | A2, B2  | A1, B1  | A0, B0  | A > B            | A < B | A = B | A > B   | A < B | A = B |
| A3 > B3          | X       | X       | X       | X                | X     | X     | H       | L     | L     |
| A3 < B3          | X       | X       | X       | X                | X     | X     | L       | H     | L     |
| A3 = B3          | A2 > B2 | X       | X       | X                | X     | X     | H       | L     | L     |
| A3 = B3          | A2 < B2 | X       | X       | X                | X     | X     | L       | H     | L     |
| A3 = B3          | A2 = B2 | A1 > B1 | X       | X                | X     | X     | H       | L     | L     |
| A3 = B3          | A2 = B2 | A1 < B1 | X       | X                | X     | X     | L       | H     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 > B0 | X                | X     | X     | H       | L     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 < B0 | X                | X     | X     | L       | H     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 = B0 | H                | L     | L     | H       | L     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 = B0 | L                | H     | L     | L       | H     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 = B0 | X                | X     | H     | L       | L     | H     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 = B0 | H                | X     | L     | L       | L     | L     |
| A3 = B3          | A2 = B2 | A1 = B1 | A0 = B0 | L                | L     | L     | H       | H     | L     |

**Absolute Maximum Ratings** (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                                  |                         |
|--------------------------------------------------|-------------------------|
| Supply Voltage ( $V_{CC}$ )                      | −0.5 to +7.0V           |
| DC Input Voltage ( $V_{IN}$ )                    | −1.5 to $V_{CC} + 1.5V$ |
| DC Output Voltage ( $V_{OUT}$ )                  | −0.5 to $V_{CC} + 0.5V$ |
| Clamp Diode Current ( $I_{IK}, I_{OK}$ )         | ±20 mA                  |
| DC Output Current, per pin ( $I_{OUT}$ )         | ±25 mA                  |
| DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ ) | ±50 mA                  |
| Storage Temperature Range ( $T_{STG}$ )          | −65°C to +150°C         |
| Power Dissipation ( $P_D$ )                      |                         |
| (Note 3)                                         | 600 mW                  |
| S.O. Package only                                | 500 mW                  |
| Lead Temp. ( $T_L$ ) (Soldering 10 seconds)      | 260°C                   |

**Operating Conditions**

|                                                  | Min | Max      | Units |
|--------------------------------------------------|-----|----------|-------|
| Supply Voltage ( $V_{CC}$ )                      | 2   | 6        | V     |
| DC Input or Output Voltage ( $V_{IN}, V_{OUT}$ ) | 0   | $V_{CC}$ | V     |
| Operating Temp. Range ( $T_A$ )                  |     |          |       |
| MM74HC                                           | −40 | +85      | °C    |
| MM54HC                                           | −55 | +125     | °C    |
| Input Rise or Fall Times ( $t_r, t_f$ )          |     |          |       |
| $V_{CC} = 2.0V$                                  |     | 1000     | ns    |
| $V_{CC} = 4.5V$                                  |     | 500      | ns    |
| $V_{CC} = 6.0V$                                  |     | 400      | ns    |

**DC Electrical Characteristics** (Note 4)

| Symbol          | Parameter                         | Conditions                                                                                                           | V <sub>CC</sub> | T <sub>A</sub> = 25°C |                   | 74HC                         | 54HC                          | Units |
|-----------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------|-------------------|------------------------------|-------------------------------|-------|
|                 |                                   |                                                                                                                      |                 |                       |                   | T <sub>A</sub> = −40 to 85°C | T <sub>A</sub> = −55 to 125°C |       |
|                 |                                   |                                                                                                                      |                 | Typ                   | Guaranteed Limits |                              |                               |       |
| V <sub>IH</sub> | Minimum High Level Input Voltage  |                                                                                                                      | 2.0V            |                       | 1.5               | 1.5                          | 1.5                           | V     |
|                 |                                   |                                                                                                                      | 4.5V            |                       | 3.15              | 3.15                         | 3.15                          | V     |
|                 |                                   |                                                                                                                      | 6.0V            |                       | 4.2               | 4.2                          | 4.2                           | V     |
| V <sub>IL</sub> | Maximum Low Level Input Voltage** |                                                                                                                      | 2.0V            |                       | 0.5               | 0.5                          | 0.5                           | V     |
|                 |                                   |                                                                                                                      | 4.5V            |                       | 1.35              | 1.35                         | 1.35                          | V     |
|                 |                                   |                                                                                                                      | 6.0V            |                       | 1.8               | 1.8                          | 1.8                           | V     |
| V <sub>OH</sub> | Minimum High Level Output Voltage | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 20 μA                                  | 2.0V            | 2.0                   | 1.9               | 1.9                          | 1.9                           | V     |
|                 |                                   |                                                                                                                      | 4.5V            | 4.5                   | 4.4               | 4.4                          | 4.4                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 6.0                   | 5.9               | 5.9                          | 5.9                           | V     |
|                 |                                   | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 4.0 mA<br> I <sub>OUT</sub>   ≤ 5.2 mA | 4.5V            | 4.2                   | 3.98              | 3.84                         | 3.7                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 5.7                   | 5.48              | 5.34                         | 5.2                           | V     |
|                 |                                   |                                                                                                                      |                 |                       |                   |                              |                               |       |
| V <sub>OL</sub> | Maximum Low Level Output Voltage  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 20 μA                                  | 2.0V            | 0                     | 0.1               | 0.1                          | 0.1                           | V     |
|                 |                                   |                                                                                                                      | 4.5V            | 0                     | 0.1               | 0.1                          | 0.1                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 0                     | 0.1               | 0.1                          | 0.1                           | V     |
|                 |                                   | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 4.0 mA<br> I <sub>OUT</sub>   ≤ 5.2 mA | 4.5V            | 0.2                   | 0.26              | 0.33                         | 0.4                           | V     |
|                 |                                   |                                                                                                                      | 6.0V            | 0.2                   | 0.26              | 0.33                         | 0.4                           | V     |
|                 |                                   |                                                                                                                      |                 |                       |                   |                              |                               |       |
| I <sub>IN</sub> | Maximum Input Current             | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                                             | 6.0V            |                       | ±0.1              | ±1.0                         | ±1.0                          | μA    |
| I <sub>CC</sub> | Maximum Quiescent Supply Current  | V <sub>IN</sub> = V <sub>CC</sub> or GND<br>I <sub>OUT</sub> = 0 μA                                                  | 6.0V            |                       | 8.0               | 80                           | 160                           | μA    |

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: −12 mW/°C from 100°C to 125°C.

**Note 4:** For a power supply of  $5V \pm 10\%$  the worst case output voltages ( $V_{OH}$ , and  $V_{OL}$ ) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case  $V_{IH}$  and  $V_{IL}$  occur at  $V_{CC} = 5.5V$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current ( $I_{IN}$ ,  $I_{CC}$ , and  $I_{OZ}$ ) occur for CMOS at the higher voltage and so the 6.0V values should be used.

\*\* $V_{IL}$  limits are currently tested at 20% of  $V_{CC}$ . The above  $V_{IL}$  specification (30% of  $V_{CC}$ ) will be implemented no later than Q1, CY'89.

## AC Electrical Characteristics $V_{CC} = 5V$ , $T_A = 25^\circ C$ , $C_L = 15\text{ pF}$ , $t_r = t_f = 6\text{ ns}$

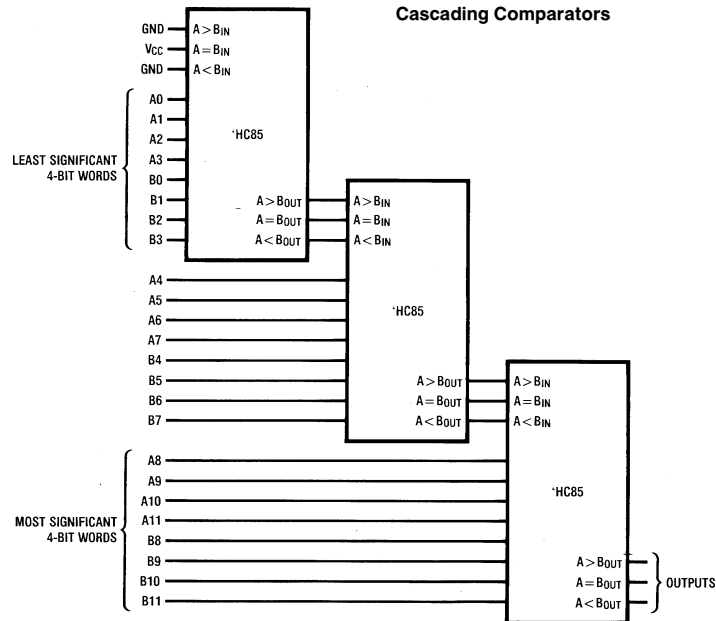
| Symbol                | Parameter                                                  | Conditions | Typ | Limit | Units |
|-----------------------|------------------------------------------------------------|------------|-----|-------|-------|
| $t_{PHL}$ , $t_{PLH}$ | Maximum Propagation Delay Data Input to $A < B$ or $A > B$ |            | 20  | 36    | ns    |
| $t_{PHL}$ , $t_{PLH}$ | Maximum Propagation Delay $A = B$ Input to $A = B$ Output  |            | 12  | 20    | ns    |
| $t_{PHL}$ , $t_{PLH}$ | Maximum Propagation Delay Cascade Input to Output          |            | 13  | 26    | ns    |
| $t_{PHL}$ , $t_{PLH}$ | Maximum Propagation Delay Data Input to $A = B$            |            | 20  | 30    | ns    |

## AC Electrical Characteristics $C_L = 50\text{ pF}$ , $t_r = t_f = 6\text{ ns}$ (unless otherwise specified)

| Symbol                              | Parameter                                                        | Conditions | V <sub>CC</sub> | T <sub>A</sub> = 25°C |                   | 74HC | 54HC | Units |
|-------------------------------------|------------------------------------------------------------------|------------|-----------------|-----------------------|-------------------|------|------|-------|
|                                     |                                                                  |            |                 | Typ                   | Guaranteed Limits |      |      |       |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Propagation Delay Data Input to Output                   |            | 2.0V            | 100                   | 210               | 265  | 313  | ns    |
|                                     |                                                                  |            | 4.5V            | 21                    | 42                | 53   | 63   | ns    |
|                                     |                                                                  |            | 6.0V            | 18                    | 36                | 45   | 53   | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Propagation Delay Data Input to A = B Output             |            | 2.0V            | 88                    | 175               | 221  | 261  | ns    |
|                                     |                                                                  |            | 4.5V            | 18                    | 35                | 44   | 52   | ns    |
|                                     |                                                                  |            | 6.0V            | 15                    | 30                | 37   | 44   | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Propagation Delay A = B Input to A = B Output            |            | 2.0V            | 63                    | 125               | 158  | 186  | ns    |
|                                     |                                                                  |            | 4.5V            | 13                    | 25                | 32   | 37   | ns    |
|                                     |                                                                  |            | 6.0V            | 11                    | 21                | 27   | 32   | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Propagation Delay Cascade Input to Output (except A = B) |            | 2.0V            | 70                    | 155               | 195  | 231  | ns    |
|                                     |                                                                  |            | 4.5V            | 16                    | 31                | 39   | 46   | ns    |
|                                     |                                                                  |            | 6.0V            | 13                    | 26                | 33   | 39   | ns    |
| t <sub>TLH</sub> , t <sub>THL</sub> | Maximum Output Rise and Fall Time                                |            | 2.0V            | 25                    | 75                | 95   | 110  | ns    |
|                                     |                                                                  |            | 4.5V            | 7                     | 15                | 19   | 22   | ns    |
|                                     |                                                                  |            | 6.0V            | 6                     | 13                | 16   | 19   | ns    |
| C <sub>IN</sub>                     | Maximum Input Capacitance                                        |            |                 | 5                     | 10                | 10   | 10   | pF    |
| C <sub>PD</sub>                     | Power Dissipation Capacitance                                    | (Note 5)   |                 | 80                    |                   |      |      | pF    |

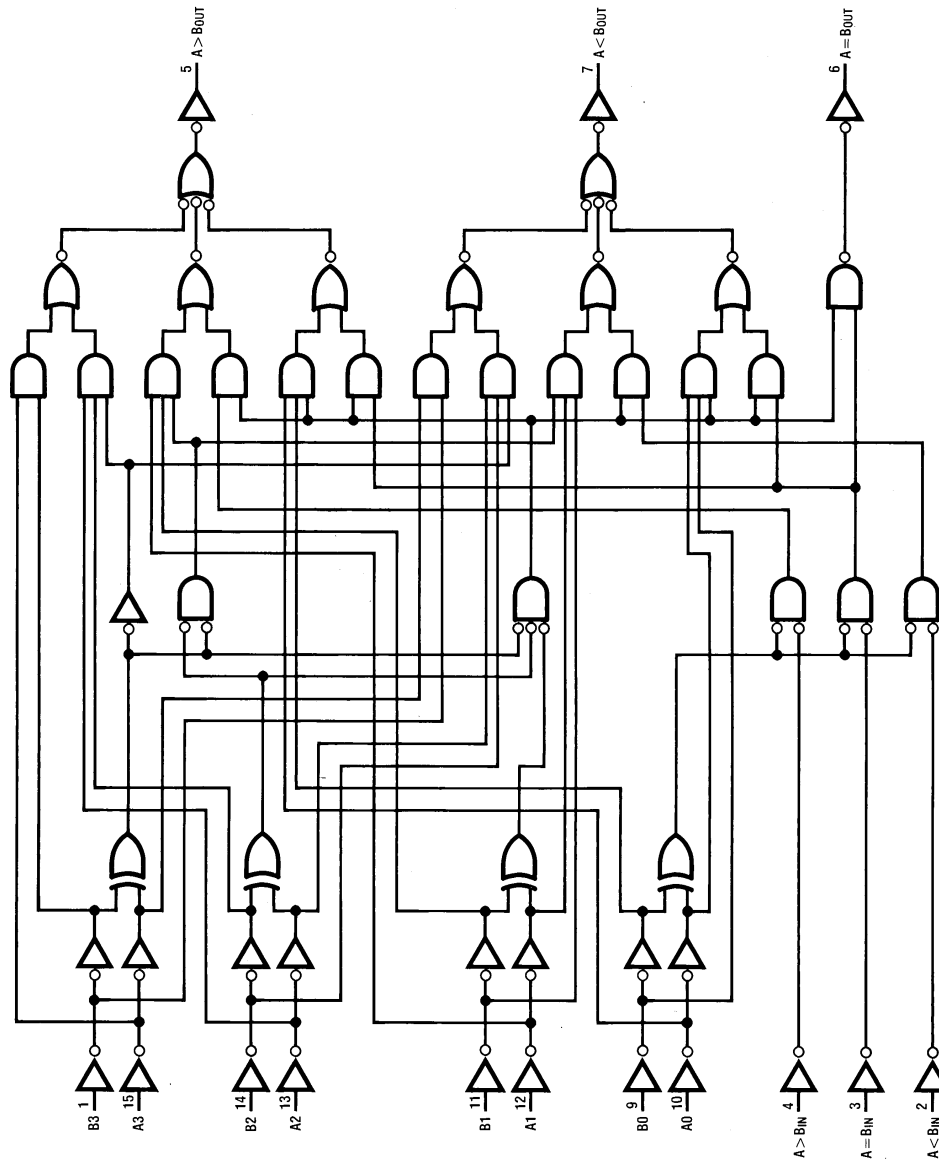
**Note 5:**  $C_{PD}$  determines the no load dynamic power consumption,  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ , and the no load dynamic current consumption,  $I_S = C_{PD} V_{CC} f + I_{CC}$ .

## Typical Application



TL/F/5205-4

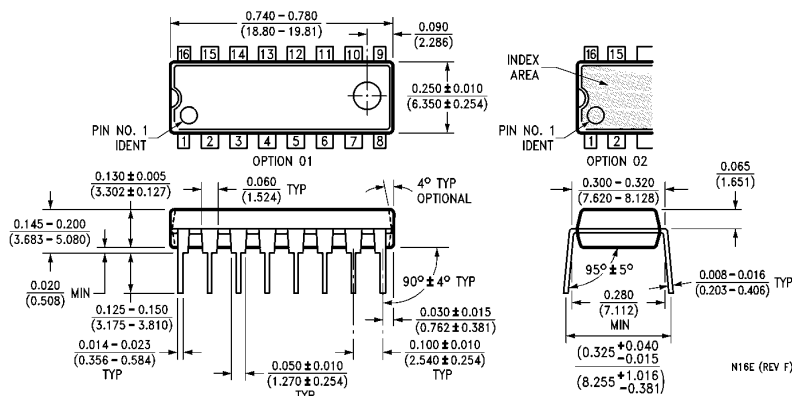
# Logic Diagram



TL/F/5205-3



**Order Number MM54HC85J or MM74HC85J**  
**NS Package J16A**



**Order Number MM74HC85N**  
**NS Package N16E**

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