MOTOROLA

# MC54/74F85

# 4-BIT MAGNITUDE COMPARATOR

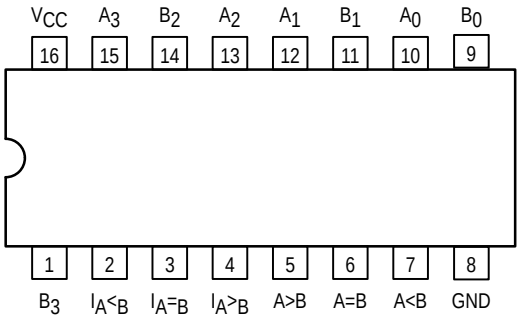
**4-BIT MAGNITUDE COMPARATOR**

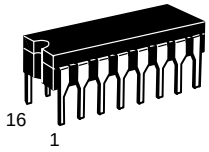
**FAST™ SCHOTTKY TTL**

The MC54/74F85 is a 4-Bit Magnitude Comparator which compares two 4-Bit words ($A_0$-$A_3$, $B_0$-$B_3$), $A_3$, $B_3$ being the most significant inputs. Operation is not restricted to binary codes; the device will work with any monotonic code. Three Outputs are provided: "A greater than B" ($0_{A > B}$), "A less than B" ($0_{A < B}$), "A equal to B" ($0_{A = B}$). Three Expander Inputs, $I_{A > B}$, $I_{A < B}$, $I_{A = B}$, allow cascading without external gates. For proper compare operation, the Expander Inputs to the least significant position must be connected as follows: $I_{A < B} = I_{A > B} = L$, $I_{A = B} = H$. For serial (ripple) expansion the $0_{A > B}$, $0_{A < B}$ Outputs are connected respectively to the $I_{A > B}$ and $I_{A = B}$ inputs of the next most significant comparator, as shown in Figure 1. Refer to applications section of data sheet for high speed method of comparing large words.

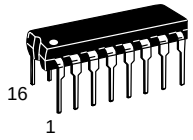
- High Impedance NPN Base Inputs for Reduced Loading (20 μA in HIGH and LOW States)
- Magnitude Comparison of any Binary Words
- Serial or Parallel Expansion Without Extra Gating
- ESD > 4000 Volts

**CONNECTION DIAGRAM**

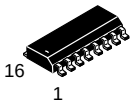



**J SUFFIX**
CERAMIC
CASE 620-09




**N SUFFIX**
PLASTIC
CASE 648-08




**D SUFFIX**
SOIC
CASE 751B-03

**ORDERING INFORMATION**

| | |
|---|---|
| MC74FXXJ | Ceramic |
| MC74FXXN | Plastic |
| MC74FXXD | SOIC |

**GUARANTEED OPERATING RANGES**

| Symbol | Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 54, 74 | 4.5 | 5.0 | 5.5 | V |
| $T_A$ | Operating Ambient Temperature Range | 54 | –55 | 25 | 125 | °C |
| | | 74 | 0 | 25 | 70 | |
| $I_{OH}$ | Output Current — High | 54, 74 | | | –1.0 | mA |
| $I_{OL}$ | Output Current — Low | 54, 74 | | | 20 | mA |

**FUNCTION TABLE**

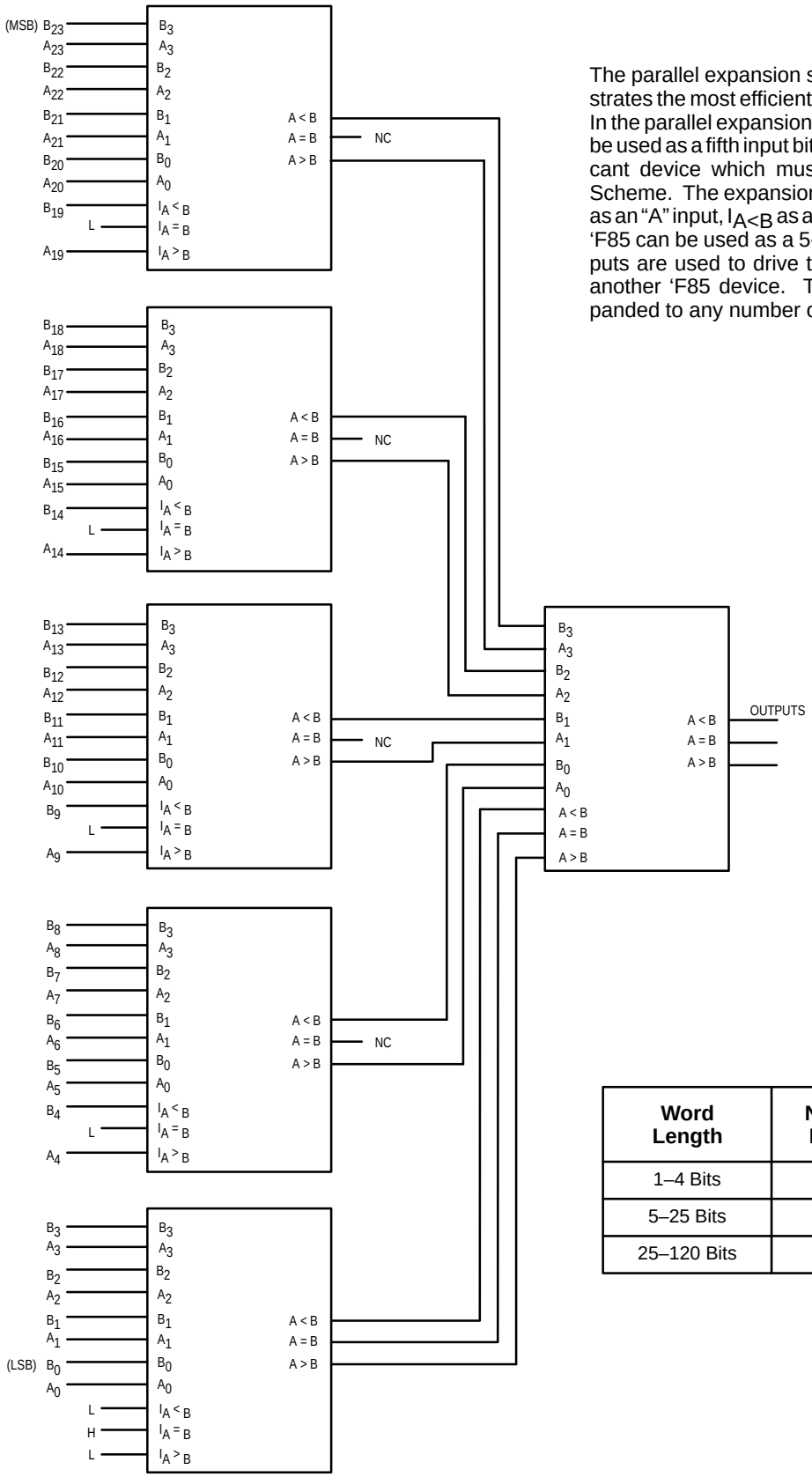
| Comparing Inputs | | | | Expansion Inputs | | | Outputs | | |
|---|---|---|---|---|---|---|---|---|---|
| $A_3, B_3$ | $A_2, B_2$ | $A_1, B_1$ | $A_0, B_0$ | $I_{A>B}$ | $I_{A<B}$ | $I_{A=B}$ | A > B | A < B | A = B |
| $A_3 > B_3$ | X | X | X | X | X | X | H | L | L |
| $A_3 < B_3$ | X | X | X | X | X | X | L | H | L |
| $A_3 = B_3$ | $A_2 > B_2$ | X | X | X | X | X | H | L | L |
| $A_3 = B_3$ | $A_2 < B_2$ | X | X | X | X | X | L | H | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 > B_1$ | X | X | X | X | H | L | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 < B_1$ | X | X | X | X | L | H | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 > B_0$ | X | X | X | H | L | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 < B_0$ | X | X | X | L | H | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | H | L | L | H | L | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | L | H | L | L | H | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | L | L | H | L | L | H |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | X | X | H | L | L | H |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | H | H | L | L | L | L |
| $A_3 = B_3$ | $A_2 = B_2$ | $A_1 = B_1$ | $A_0 = B_0$ | L | L | L | H | H | L |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care

**DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE** (unless otherwise specified)

| Symbol | Parameter | | Limits Min | Limits Typ | Limits Max | Unit | Test Conditions | |
|---|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage | | 2.0 | | | V | Guaranteed Input HIGH Voltage | |
| $V_{IL}$ | Input LOW Voltage | | | | 0.8 | V | Guaranteed Input LOW Voltage | |
| $V_{IK}$ | Input Clamp Diode Voltage | | | | –1.2 | V | $V_{CC}$ = MIN, $I_{IN}$ = –18 mA | |
| $V_{OH}$ | Output HIGH Voltage | 54, 74 | 2.5 | | | V | $I_{OH}$ = –1.0 mA | $V_{CC}$ = 4.50 V |
| | | 74 | 2.7 | | | | | $V_{CC}$ = 4.75 V |
| $V_{OL}$ | Output LOW Voltage | | | | 0.5 | V | $I_{OL}$ = 20 mA, $V_{CC}$ = MIN | |
| $I_{IH}$ | Input HIGH Current | | | | 20 | µA | $V_{CC}$ = MAX, $V_{IN}$ = 2.7 V | |
| | | | | | 0.1 | mA | $V_{CC}$ = 0 V, $V_{IN}$ = 7.0 V | |
| $I_{IL}$ | Input LOW Current | | | | –20 | µA | $V_{CC}$ = MAX, $V_{IN}$ = 0.5 V | |
| $I_{OS}$ | Output Short Circuit Current (Note 2) | | –60 | | –150 | mA | $V_{CC}$ = MAX, $V_{OUT}$ = 0 V | |
| $I_{CC}$ | Total Supply Current<br>HIGH $V_{IN}$ = HIGH | | | | 50 | mA | $V_{CC}$ = MAX | |
| | LOW $A_n = B_n = I_{A-B}$ = GND: $I_{A>B} = I_{A<B}$ = 4.5 V | | | | 54 | | | |

NOTES:
1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.
2. Not more than one output should be shorted at a time, nor for more than 1 second.




The parallel expansion scheme shown in Figure 1 demonstrates the most efficient general use of these comparators. In the parallel expansion scheme, the expansion inputs can be used as a fifth input bit position except on the least significant device which must be connected as in the Serial Scheme. The expansion inputs are used by labelling $I_{A>B}$ as an "A" input, $I_{A<B}$ as a "B" input and setting $I_{A=B}$ low. The 'F85 can be used as a 5-bit comparator only when the outputs are used to drive the ($A_0$-$A_3$) and ($B_0$-$B_3$) inputs of another 'F85 device. The parallel technique can be expanded to any number of bits as shown in Table 1.

**Table 1**

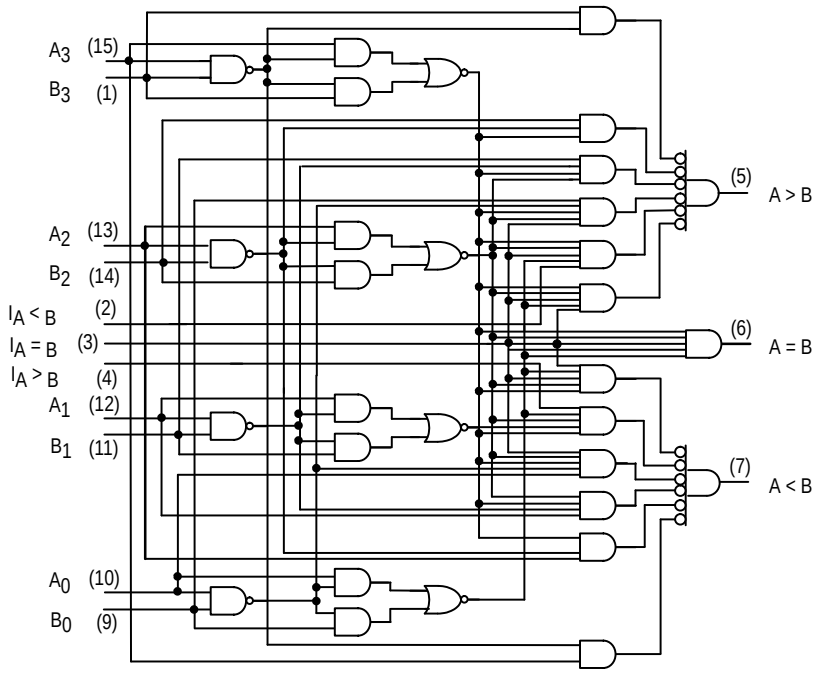
| Word Length | Number of Packages | Typical Speeds 74F |
|---|---|---|
| 1–4 Bits | 1 | 12 ns |
| 5–25 Bits | 2–6 | 22 ns |
| 25–120 Bits | 8–31 | 34 ns |

**Figure 1. Comparison of Two 24-Bit Words**

**AC ELECTRICAL CHARACTERISTICS**

| Symbol | Parameter | 54/74F $T_A$ = +25°C, $V_{CC}$ = +5.0 V, $C_L$ = 50 pF | | 54F $T_A$ = –55°C to +125°C, $V_{CC}$ = 5.0 V ± 10%, $C_L$ = 50 pF | | 74F $T_A$ = 0°C to + 70°C, $V_{CC}$ = 5.0 V ± 10%, $C_L$ = 50 pF | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | Min | Max | |
| $t_{PLH}$ | A or B Input to | 6.0 | 11 | 5.5 | 14 | 5.5 | 13 | ns |
| $t_{PHL}$ | A < B, A > B Output | 6.0 | 14 | 5.5 | 16.5 | 5.5 | 15.5 | |
| $t_{PLH}$ | A or B Input to | 5.5 | 11.5 | 5.0 | 15 | 5.0 | 14 | ns |
| $t_{PHL}$ | A = B Output | 7.0 | 14 | 6.5 | 15.5 | 6.5 | 14.5 | |
| $t_{PLH}$ | $I_{A<B}$ and $I_{A=B}$ Input | 3.0 | 7.5 | 2.5 | 10 | 2.5 | 9.0 | ns |
| $t_{PHL}$ | to A>B Output | 3.0 | 9.0 | 2.5 | 11 | 2.5 | 10 | |
| $t_{PLH}$ | $I_{A=B}$ Input to | 2.5 | 7.0 | 2.0 | 10 | 2.0 | 9.0 | ns |
| $t_{PHL}$ | A = B Output | 3.5 | 10 | 2.5 | 13 | 2.5 | 12 | |
| $t_{PLH}$ | $I_{A>B}$ and $I_{A=B}$ Input | 3.0 | 8.0 | 3.0 | 10.5 | 3.0 | 9.5 | ns |
| $t_{PHL}$ | to A<B Output | 3.0 | 9.0 | 2.0 | 10.5 | 2.0 | 9.5 | |

The expansion inputs $I_{A>B}$, $I_{A=B}$, and $I_{A<B}$ are the least significant bit positions. When used for series expansion, the A>B, A=B, and A<B outputs of the least significant word are connected to the corresponding $I_{A>B}$, $I_{A=B}$, and $I_{A<B}$ inputs of the next higher stage. Stages can be added in this manner to any length, but a propagation delay penalty of about 15 ns is added with each additional stage. For proper operation the expansion inputs of the least significant word should be tied as follows: $I_{A>B}$ = LOW, $I_{A=B}$ = HIGH, and $I_{A<B}$ = LOW.




NOTE:
This diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Figure 2. Logic Diagram**