

## 4-Bit Magnitude Comparator

The MC14585B 4-Bit Magnitude Comparator is constructed with complementary MOS (CMOS) enhancement mode devices. The circuit has eight comparing inputs (A3, B3, A2, B2, A1, B1, A0, B0), three cascading inputs (A < B, A = B, and A > B), and three outputs (A < B, A = B, and A > B). This device compares two 4-bit words (A and B) and determines whether they are "less than", "equal to", or "greater than" by a high level on the appropriate output. For words greater than 4-bits, units can be cascaded by connecting outputs (A > B), (A < B), and (A = B) to the corresponding inputs of the next significant comparator. Inputs (A < B), (A = B), and (A > B) on the least significant (first) comparator are connected to a low, a high, and a low, respectively.

Applications include logic in CPU's, correction and/or detection of instrumentation conditions, comparator in testers, converters, and controls.

- Diode Protection on All Inputs
- Expandable
- Applicable to Binary or 8421-BCD Code
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load over the Rated Temperature Range
- Can be Cascaded – See Fig. 3

### MAXIMUM RATINGS\* (Voltages Referenced to V<sub>SS</sub>)

| Symbol                             | Parameter                                          | Value                          | Unit |
|------------------------------------|----------------------------------------------------|--------------------------------|------|
| V <sub>DD</sub>                    | DC Supply Voltage                                  | – 0.5 to + 18.0                | V    |
| V <sub>in</sub> , V <sub>out</sub> | Input or Output Voltage (DC or Transient)          | – 0.5 to V <sub>DD</sub> + 0.5 | V    |
| I <sub>in</sub> , I <sub>out</sub> | Input or Output Current (DC or Transient), per Pin | ± 10                           | mA   |
| P <sub>D</sub>                     | Power Dissipation, per Package†                    | 500                            | mW   |
| T <sub>stg</sub>                   | Storage Temperature                                | – 65 to + 150                  | °C   |
| T <sub>L</sub>                     | Lead Temperature (8-Second Soldering)              | 260                            | °C   |

\* Maximum Ratings are those values beyond which damage to the device may occur.

† Temperature Derating:

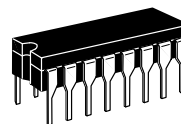
Plastic "P and D/DW" Packages: – 7.0 mW/°C From 65°C To 125°C

Ceramic "L" Packages: – 12 mW/°C From 100°C To 125°C

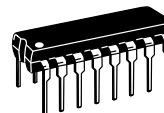
### TRUTH TABLE (x = Don't Care)

| Inputs    |         |         |         |           |       |       | Outputs |       |       |
|-----------|---------|---------|---------|-----------|-------|-------|---------|-------|-------|
| Comparing |         |         |         | Cascading |       |       |         |       |       |
| 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     | 0       | 0     | 1     |
| A3 = B3   | A2 > B2 | x       | x       | x         | x     | x     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 > B1 | x       | x         | x     | x     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 > B0 | x         | x     | x     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 0         | 0     | x     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 0         | 1     | x     | 0       | 1     | 0     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 1         | 0     | x     | 1       | 0     | 0     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 1         | 1     | x     | 1       | 1     | 0     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 < B0 | x         | x     | x     | 1       | 0     | 0     |
| A3 = B3   | A2 = B2 | A1 < B1 | x       | x         | x     | x     | 1       | 0     | 0     |
| A3 = B3   | A2 < B2 | x       | x       | x         | x     | x     | 1       | 0     | 0     |
| A3 < B3   | x       | x       | x       | x         | x     | x     | 1       | 0     | 0     |

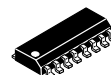
## MC14585B



**L SUFFIX**  
CERAMIC  
CASE 620



**P SUFFIX**  
PLASTIC  
CASE 648



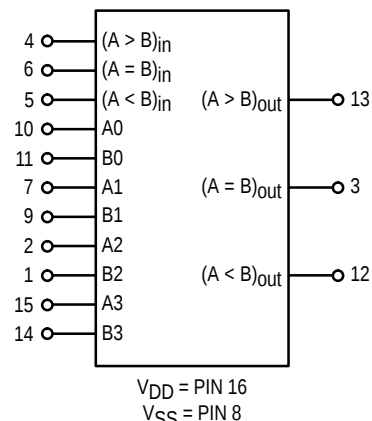
**D SUFFIX**  
SOIC  
CASE 751B

### ORDERING INFORMATION

|            |         |
|------------|---------|
| MC14XXXBCP | Plastic |
| MC14XXXBCL | Ceramic |
| MC14XXXBD  | SOIC    |

T<sub>A</sub> = – 55° to 125°C for all packages.

### BLOCK DIAGRAM



# **ELECTRICAL CHARACTERISTICS** (Voltages Referenced to V<sub>SS</sub>)

| Characteristic                                                                                                                                    | Symbol                    | V <sub>DD</sub><br>Vdc | - 55°C                                                                                                                                                      |      | 25°C   |          |      | 125°C  |      | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------|----------|------|--------|------|------|
|                                                                                                                                                   |                           |                        | Min                                                                                                                                                         | Max  | Min    | Typ #    | Max  | Min    | Max  |      |
| Output Voltage<br>V <sub>in</sub> = V <sub>DD</sub> or 0                                                                                          | V <sub>OL</sub>           | 5.0                    | —                                                                                                                                                           | 0.05 | —      | 0        | 0.05 | —      | 0.05 | Vdc  |
|                                                                                                                                                   |                           | 10                     | —                                                                                                                                                           | 0.05 | —      | 0        | 0.05 | —      | 0.05 |      |
|                                                                                                                                                   |                           | 15                     | —                                                                                                                                                           | 0.05 | —      | 0        | 0.05 | —      | 0.05 |      |
|                                                                                                                                                   | V <sub>OH</sub>           | 5.0                    | 4.95                                                                                                                                                        | —    | 4.95   | 5.0      | —    | 4.95   | —    | Vdc  |
|                                                                                                                                                   |                           | 10                     | 9.95                                                                                                                                                        | —    | 9.95   | 10       | —    | 9.95   | —    |      |
|                                                                                                                                                   |                           | 15                     | 14.95                                                                                                                                                       | —    | 14.95  | 15       | —    | 14.95  | —    |      |
| Input Voltage<br>(V <sub>O</sub> = 4.5 or 0.5 Vdc)<br>(V <sub>O</sub> = 9.0 or 1.0 Vdc)<br>(V <sub>O</sub> = 13.5 or 1.5 Vdc)                     | V <sub>IL</sub>           | 5.0                    | —                                                                                                                                                           | 1.5  | —      | 2.25     | 1.5  | —      | 1.5  | Vdc  |
|                                                                                                                                                   |                           | 10                     | —                                                                                                                                                           | 3.0  | —      | 4.50     | 3.0  | —      | 3.0  |      |
|                                                                                                                                                   |                           | 15                     | —                                                                                                                                                           | 4.0  | —      | 6.75     | 4.0  | —      | 4.0  |      |
|                                                                                                                                                   | V <sub>IH</sub>           | 5.0                    | 3.5                                                                                                                                                         | —    | 3.5    | 2.75     | —    | 3.5    | —    | Vdc  |
|                                                                                                                                                   |                           | 10                     | 7.0                                                                                                                                                         | —    | 7.0    | 5.50     | —    | 7.0    | —    |      |
|                                                                                                                                                   |                           | 15                     | 11                                                                                                                                                          | —    | 11     | 8.25     | —    | 11     | —    |      |
| Output Drive Current<br>(V <sub>OH</sub> = 2.5 Vdc)<br>(V <sub>OH</sub> = 4.6 Vdc)<br>(V <sub>OH</sub> = 9.5 Vdc)<br>(V <sub>OH</sub> = 13.5 Vdc) | Source<br>I <sub>OH</sub> | 5.0                    | - 3.0                                                                                                                                                       | —    | - 2.4  | - 4.2    | —    | - 1.7  | —    | mAdc |
|                                                                                                                                                   |                           | 5.0                    | - 0.64                                                                                                                                                      | —    | - 0.51 | - 0.88   | —    | - 0.36 | —    |      |
|                                                                                                                                                   |                           | 10                     | - 1.6                                                                                                                                                       | —    | - 1.3  | - 2.25   | —    | - 0.9  | —    |      |
|                                                                                                                                                   |                           | 15                     | - 4.2                                                                                                                                                       | —    | - 3.4  | - 8.8    | —    | - 2.4  | —    |      |
|                                                                                                                                                   | Sink<br>I <sub>OL</sub>   | 5.0                    | 0.64                                                                                                                                                        | —    | 0.51   | 0.88     | —    | 0.36   | —    | mAdc |
|                                                                                                                                                   |                           | 10                     | 1.6                                                                                                                                                         | —    | 1.3    | 2.25     | —    | 0.9    | —    |      |
|                                                                                                                                                   |                           | 15                     | 4.2                                                                                                                                                         | —    | 3.4    | 8.8      | —    | 2.4    | —    |      |
| Input Current                                                                                                                                     | I <sub>in</sub>           | 15                     | —                                                                                                                                                           | ±0.1 | —      | ±0.00001 | ±0.1 | —      | ±1.0 | μAdc |
| Input Capacitance<br>(V <sub>in</sub> = 0)                                                                                                        | C <sub>in</sub>           | —                      | —                                                                                                                                                           | —    | —      | 5.0      | 7.5  | —      | —    | pF   |
| Quiescent Current<br>(Per Package)                                                                                                                | I <sub>DD</sub>           | 5.0                    | —                                                                                                                                                           | 5.0  | —      | 0.005    | 5.0  | —      | 150  | μAdc |
|                                                                                                                                                   |                           | 10                     | —                                                                                                                                                           | 10   | —      | 0.010    | 10   | —      | 300  |      |
|                                                                                                                                                   |                           | 15                     | —                                                                                                                                                           | 20   | —      | 0.015    | 20   | —      | 600  |      |
| Total Supply Current**†<br>(Dynamic plus Quiescent,<br>Per Package)<br>(C <sub>L</sub> = 50 pF on all outputs, all<br>buffers switching)          | I <sub>T</sub>            | 5.0<br>10<br>15        | I <sub>T</sub> = (0.6 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.2 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.8 μA/kHz) f + I <sub>DD</sub> |      |        |          |      |        |      | μAdc |

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

\*\*The formulas given are for the typical characteristics only at 25°C.

†To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) V_{fk}$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V = (V<sub>DD</sub> - V<sub>SS</sub>) in volts, f in kHz is input frequency, and k = 0.001.

## **PIN ASSIGNMENT**

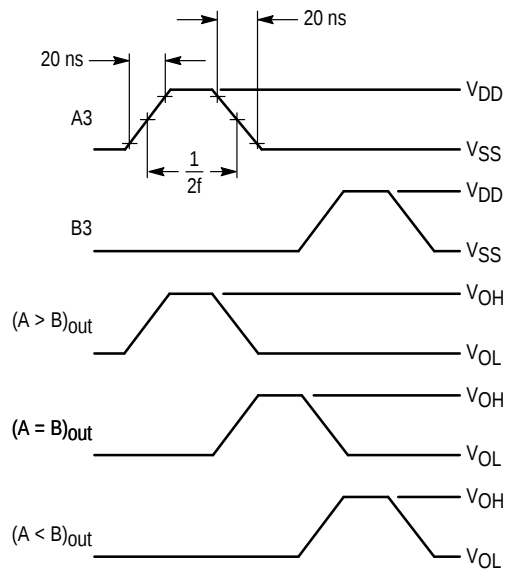
|                        |     |    |                        |
|------------------------|-----|----|------------------------|
| B2                     | 1 ● | 16 | V <sub>DD</sub>        |
| A2                     | 2   | 15 | A3                     |
| (A = B) <sub>out</sub> | 3   | 14 | B3                     |
| (A > B) <sub>in</sub>  | 4   | 13 | (A > B) <sub>out</sub> |
| (A < B) <sub>in</sub>  | 5   | 12 | (A < B) <sub>out</sub> |
| (A = B) <sub>in</sub>  | 6   | 11 | B0                     |
| A1                     | 7   | 10 | A0                     |
| V <sub>SS</sub>        | 8   | 9  | B1                     |

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

| Characteristic                                                                                                                                                                                                                   | Symbol             | $V_{DD}$        | Min         | Typ #             | Max               | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------|-------------|-------------------|-------------------|------|
| Output Rise and Fall Time<br>$t_{TLH}, t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$<br>$t_{TLH}, t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$<br>$t_{TLH}, t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$   | $t_{TLH}, t_{THL}$ | 5.0<br>10<br>15 | —<br>—<br>— | 100<br>50<br>40   | 200<br>100<br>80  | ns   |
| Turn-On, Turn-Off Delay Time<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 345 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 147 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 105 \text{ ns}$ | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | —<br>—<br>— | 430<br>180<br>130 | 860<br>360<br>260 | ns   |

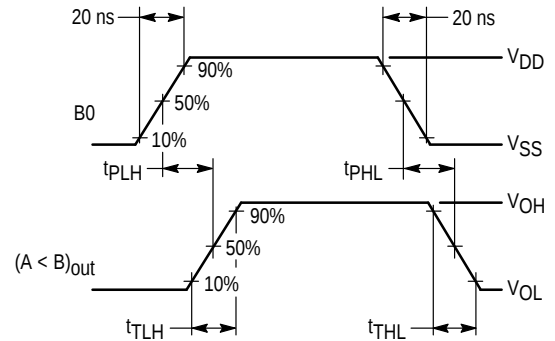
\* The formulas given are for the typical characteristics only at  $25^\circ\text{C}$ .

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.



Inputs (A>B) and (A=B) high, and inputs B2, A2, B1, A1, B0, A0 and (A<B) low.  
f in respect to a system clock.

**Figure 1. Dynamic Power Dissipation Signal Waveforms**



Inputs (A>B) and (A=B) high, and inputs B3, A3, B2, A2, B1, A1, A0, and (A<B) low.

**Figure 2. Dynamic Signal Waveforms**

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ). Unused outputs must be left open.

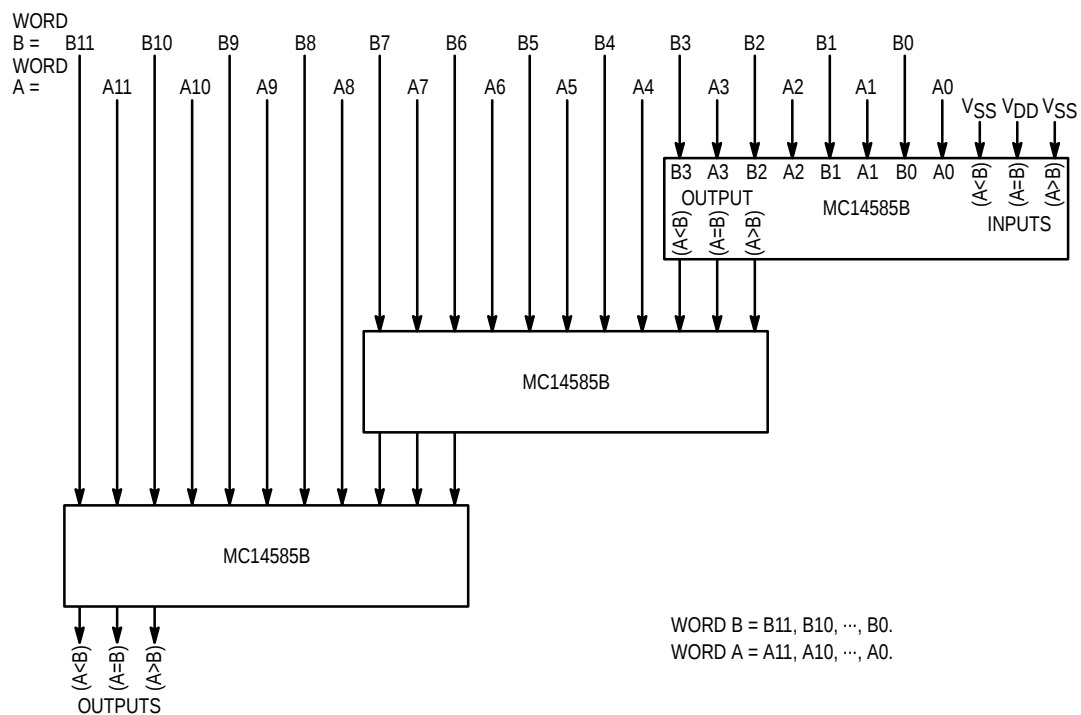
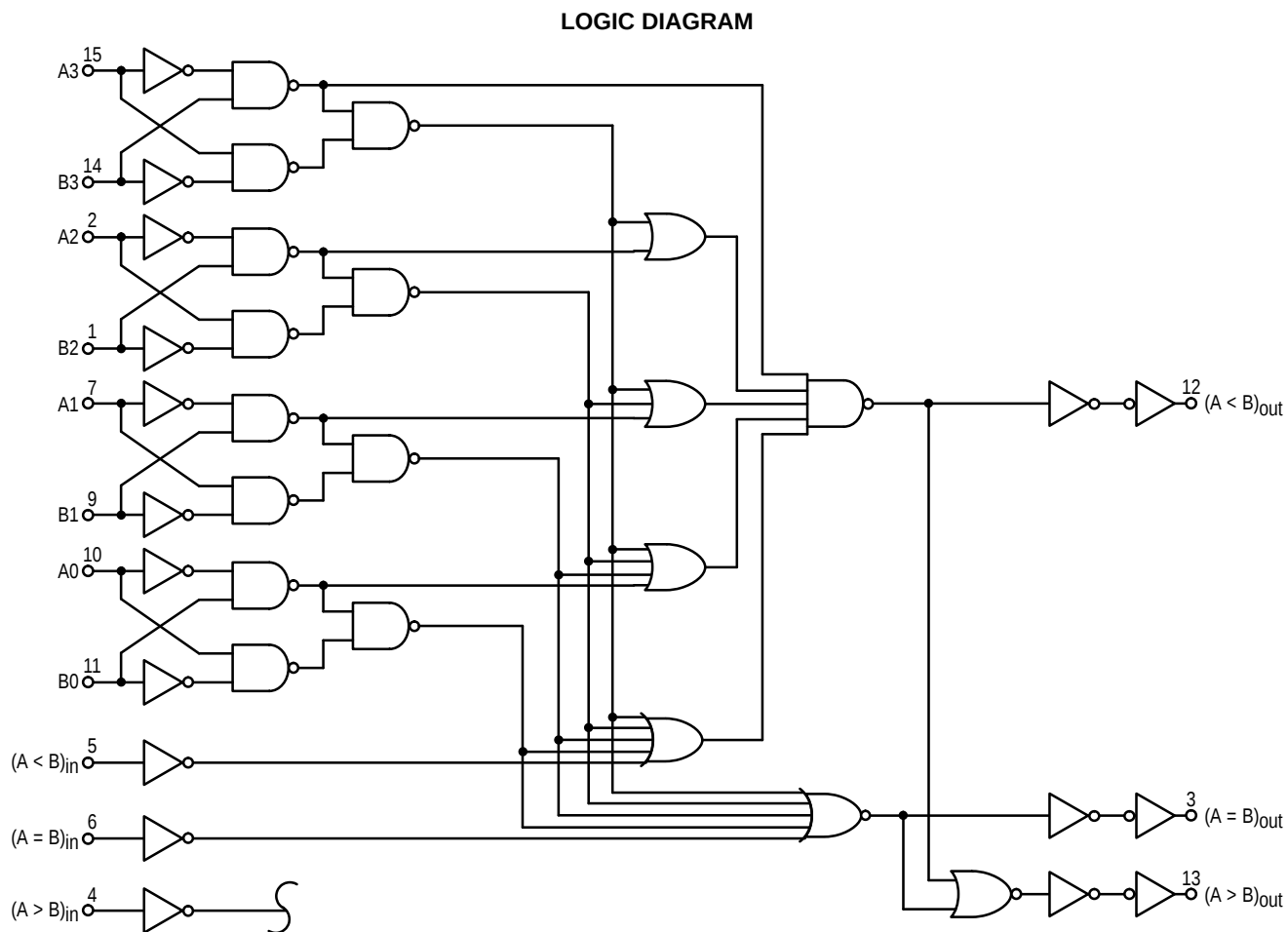
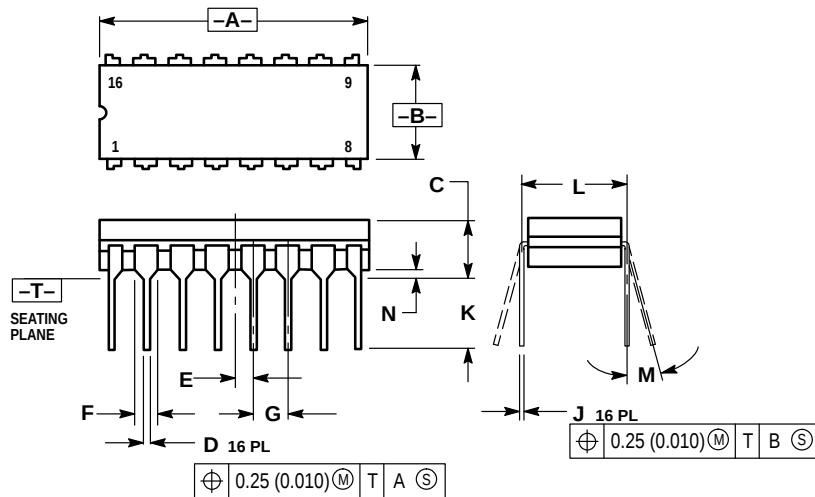


Figure 3. Cascading Comparators



## OUTLINE DIMENSIONS

### L SUFFIX CERAMIC DIP PACKAGE CASE 620-10 ISSUE V

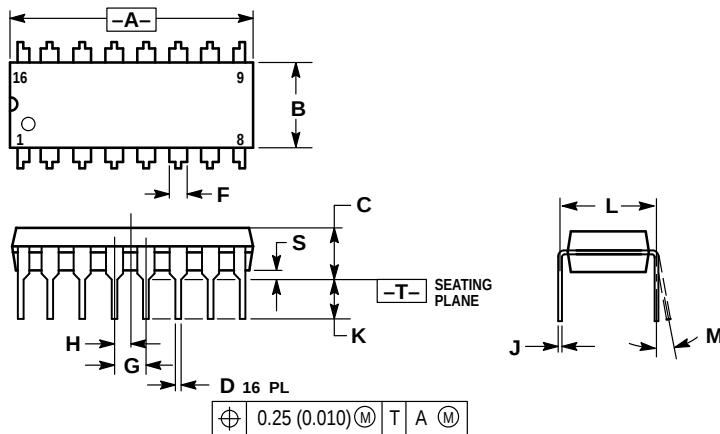


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.750  | 0.785 | 19.05       | 19.93 |
| B   | 0.240  | 0.295 | 6.10        | 7.49  |
| C   | —      | 0.200 | —           | 5.08  |
| D   | 0.015  | 0.020 | 0.39        | 0.50  |
| E   | 0.050  | BSC   | 1.27        | BSC   |
| F   | 0.055  | 0.065 | 1.40        | 1.65  |
| G   | 0.100  | BSC   | 2.54        | BSC   |
| H   | 0.008  | 0.015 | 0.21        | 0.38  |
| K   | 0.125  | 0.170 | 3.18        | 4.31  |
| L   | 0.300  | BSC   | 7.62        | BSC   |
| M   | 0°     | 15°   | 0°          | 15°   |
| N   | 0.020  | 0.040 | 0.51        | 1.01  |

### P SUFFIX PLASTIC DIP PACKAGE CASE 648-08 ISSUE R



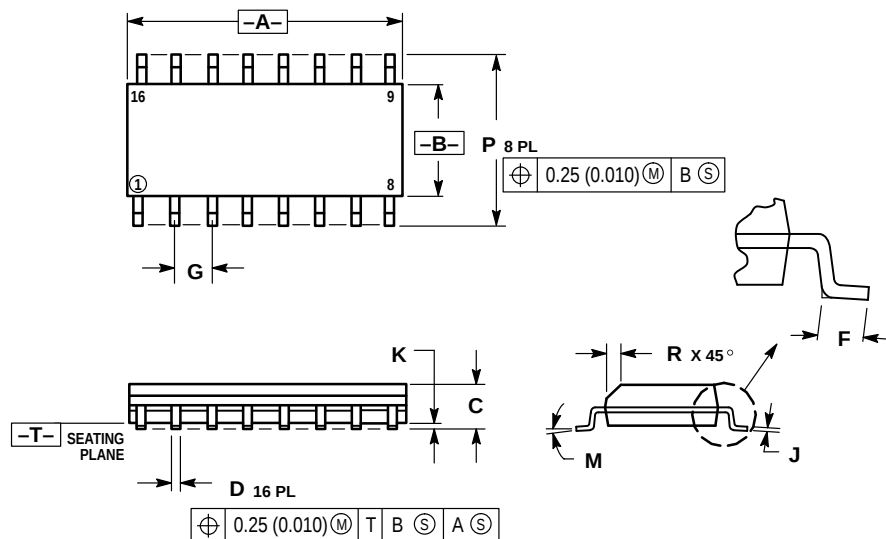
#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.740  | 0.770 | 18.80       | 19.55 |
| B   | 0.250  | 0.270 | 6.35        | 6.85  |
| C   | 0.145  | 0.175 | 3.69        | 4.44  |
| D   | 0.015  | 0.021 | 0.39        | 0.53  |
| F   | 0.040  | 0.70  | 1.02        | 1.77  |
| G   | 0.100  | BSC   | 2.54        | BSC   |
| H   | 0.050  | BSC   | 1.27        | BSC   |
| J   | 0.008  | 0.015 | 0.21        | 0.38  |
| K   | 0.110  | 0.130 | 2.80        | 3.30  |
| L   | 0.295  | 0.305 | 7.50        | 7.74  |
| M   | 0°     | 10°   | 0°          | 10°   |
| S   | 0.020  | 0.040 | 0.51        | 1.01  |

## OUTLINE DIMENSIONS

### D SUFFIX PLASTIC SOIC PACKAGE CASE 751B-05 ISSUE J



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 9.80        | 10.00 | 0.386  | 0.393 |
| B   | 3.80        | 4.00  | 0.150  | 0.157 |
| C   | 1.35        | 1.75  | 0.054  | 0.068 |
| D   | 0.35        | 0.49  | 0.014  | 0.019 |
| F   | 0.40        | 1.25  | 0.016  | 0.049 |
| G   | 1.27        | BSC   | 0.050  | BSC   |
| J   | 0.19        | 0.25  | 0.008  | 0.009 |
| K   | 0.10        | 0.25  | 0.004  | 0.009 |
| M   | 0°          | 7°    | 0°     | 7°    |
| P   | 5.80        | 6.20  | 0.229  | 0.244 |
| R   | 0.25        | 0.50  | 0.010  | 0.019 |

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MC14585B/D

