

# MC14028B

## BCD-To-Decimal Decoder Binary-To-Octal Decoder

The MC14028B decoder is constructed so that an 8421 BCD code on the four inputs provides a decimal (one-of-ten) decoded output, while a 3-bit binary input provides a decoded octal (one-of-eight) code output with D forced to a logic "0". Expanded decoding such as binary-to-hexadecimal (one-of-16), etc., can be achieved by using other MC14028B devices. The part is useful for code conversion, address decoding, memory selection control, demultiplexing, or readout decoding.

- Diode Protection on All Inputs
- 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
- Positive Logic Design
- Low Outputs on All Illegal Input Combinations
- Similar to CD4028B.

### MAXIMUM RATINGS (Voltages Referenced to $V_{SS}$ ) (Note 2.)

| Symbol            | Parameter   | Value                  | Unit        |
|-------------------|---|------------------------|-------------|
| $V_{DD}$          | DC Supply Voltage Range                           | -0.5 to +18.0          | V           |
| $V_{in}, V_{out}$ | Input or Output Voltage Range (DC or Transient)   | -0.5 to $V_{DD} + 0.5$ | V           |
| $I_{in}, I_{out}$ | Input or Output Current (DC or Transient) per Pin | $\pm 10$               | mA          |
| $P_D$             | Power Dissipation, per Package (Note 3.)          | 500                    | mW          |
| $T_A$             | Ambient Temperature Range                         | -55 to +125            | $^{\circ}C$ |
| $T_{stg}$         | Storage Temperature Range                         | -65 to +150            | $^{\circ}C$ |
| $T_L$             | Lead Temperature (8-Second Soldering)             | 260                    | $^{\circ}C$ |

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

3. Temperature Derating:  
Plastic "P and D/DW" Packages: - 7.0 mW/ $^{\circ}C$  From 65 $^{\circ}C$  To 125 $^{\circ}C$

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  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

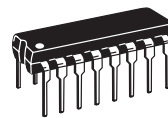
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ). Unused outputs must be left open.



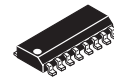
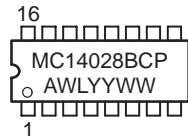
ON Semiconductor

<http://onsemi.com>

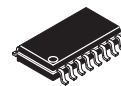
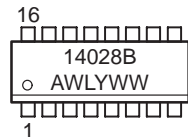
### MARKING DIAGRAMS



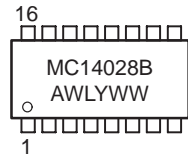
PDIP-16  
P SUFFIX  
CASE 648



SOIC-16  
D SUFFIX  
CASE 751B



SOEIAJ-16  
F SUFFIX  
CASE 966



A = Assembly Location  
WL or L = Wafer Lot  
YY or Y = Year  
WW or W = Work Week

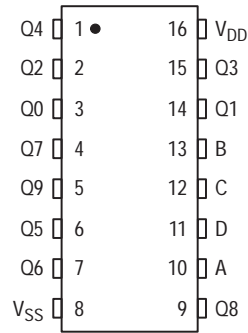
### ORDERING INFORMATION

| Device      | Package   | Shipping         |
|-------------|-----------|------------------|
| MC14028BCP  | PDIP-16   | 2000/Box         |
| MC14028BD   | SOIC-16   | 2400/Box         |
| MC14028BDR2 | SOIC-16   | 2500/Tape & Reel |
| MC14028BF   | SOEIAJ-16 | See Note 1.      |
| MC14028BFEL | SOEIAJ-16 | See Note 1.      |

1. For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

# MC14028B

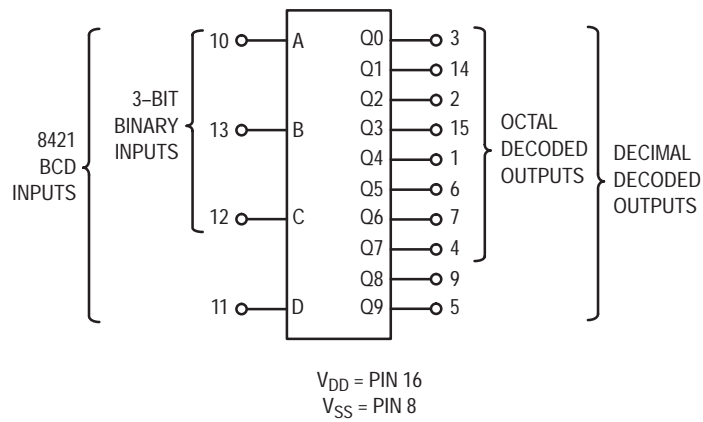
## PIN ASSIGNMENT



## TRUTH TABLE

| D | C | B | A | Q9 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q0 |
|---|---|---|---|----|----|----|----|----|----|----|----|----|----|
| 0 | 0 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| 0 | 0 | 0 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| 0 | 0 | 1 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| 0 | 0 | 1 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  |
| 0 | 1 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  |
| 0 | 1 | 0 | 1 | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
| 0 | 1 | 1 | 0 | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| 0 | 1 | 1 | 1 | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 0 | 0 | 0 | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 0 | 0 | 1 | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 0 | 1 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 0 | 1 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 1 | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 1 | 0 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 1 | 1 | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| 1 | 1 | 1 | 1 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |

## BLOCK DIAGRAM



# MC14028B

## 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 (4.) | Max  | Min   | Max  |      |
| Output Voltage<br>V <sub>in</sub> = V <sub>DD</sub> or 0<br><br>V <sub>in</sub> = 0 or V <sub>DD</sub>   | 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)<br><br>(V <sub>O</sub> = 0.5 or 4.5 Vdc)<br>(V <sub>O</sub> = 1.0 or 9.0 Vdc)<br>(V <sub>O</sub> = 1.5 or 13.5 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)<br><br>(V <sub>OL</sub> = 0.4 Vdc)<br>(V <sub>OL</sub> = 0.5 Vdc)<br>(V <sub>OL</sub> = 1.5 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 (5.) (6.)<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> = (0.3 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.6 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.9 μA/kHz) f + I <sub>DD</sub> |      |       |          |      |       |      | μAdc |

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

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

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

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

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.

## SWITCHING CHARACTERISTICS (7.) (C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C)

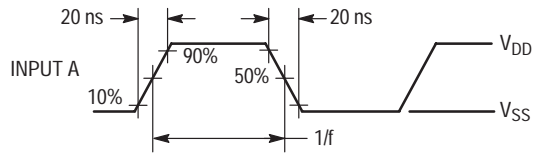
| Characteristic   | Symbol                                 | V <sub>DD</sub> | Min | Typ (8.) | Max | Unit |
|--|--|-----------------|-----|----------|-----|------|
| Output Rise and Fall Time<br>t <sub>TLH</sub> , t <sub>THL</sub> = (1.5 ns/pF) C <sub>L</sub> + 25 ns<br>t <sub>TLH</sub> , t <sub>THL</sub> = (0.75 ns/pF) C <sub>L</sub> + 12.5 ns<br>t <sub>TLH</sub> , t <sub>THL</sub> = (0.55 ns/pF) C <sub>L</sub> + 9.5 ns | t <sub>TLH</sub> ,<br>t <sub>THL</sub> | 5.0             | —   | 100      | 200 | ns   |
|  |  | 10              | —   | 50       | 100 |      |
|  |  | 15              | —   | 40       | 80  |      |
| Propagation Delay Time<br>t <sub>PLH</sub> , t <sub>PHL</sub> = (1.7 ns/pF) C <sub>L</sub> + 215 ns<br>t <sub>PLH</sub> , t <sub>PHL</sub> = (0.66 ns/pF) C <sub>L</sub> + 97 ns<br>t <sub>PLH</sub> , t <sub>PHL</sub> = (0.5 ns/pF) C <sub>L</sub> + 65 ns       | t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | 5.0             | —   | 300      | 600 | ns   |
|  |  | 10              | —   | 130      | 260 |      |
|  |  | 15              | —   | 90       | 180 |      |

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

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

# MC14028B

Inputs B, C, and D switching in respect to a BCD code.



All outputs connected to respective  $C_L$  loads.  $f$  in respect to a system clock.

Inputs A, B, and D low.

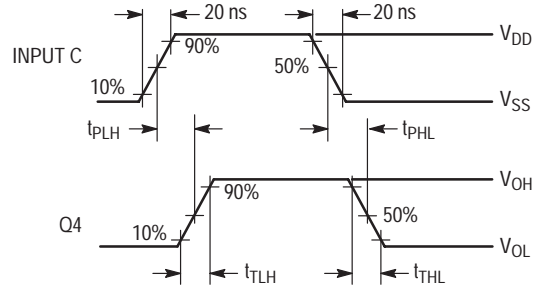
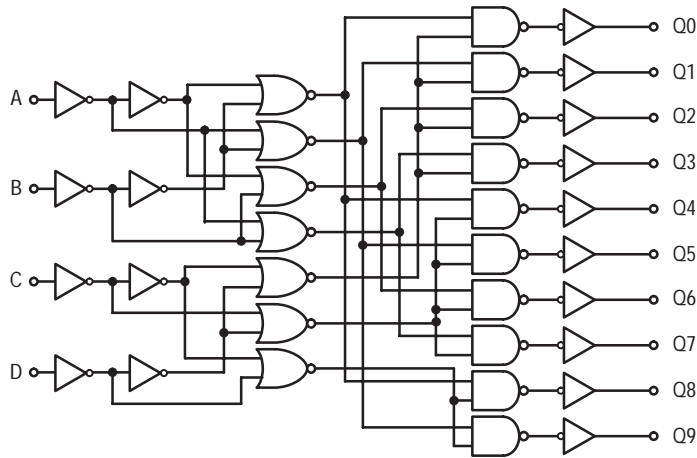


Figure 1. Dynamic Signal Waveforms

## LOGIC DIAGRAM



# MC14028B

## APPLICATIONS INFORMATION

Expanded decoding can be performed by using the MC14028B and other CMOS Integrated Circuits. The circuit in Figure 2 converts any 4-bit code to a decimal or hexadecimal code. The accompanying table shows the input binary combinations, the associated "output numbers" that go "high" when selected, and the "redefined output numbers" needed for the proper code. For example: For the combination DCBA = 0111 the output number 7 is redefined for the 4-bit binary, 4-bit gray, excess-3, or excess-3 gray codes as 7, 5, 4, or 2, respectively. Figure 3 shows a 6-bit binary 1-of-64 decoder using nine MC14028B circuits and two MC14069UB inverters.

The MC14028B can be used in decimal digit displays, such as, neon readouts or incandescent projection indicators as shown in Figure 4.

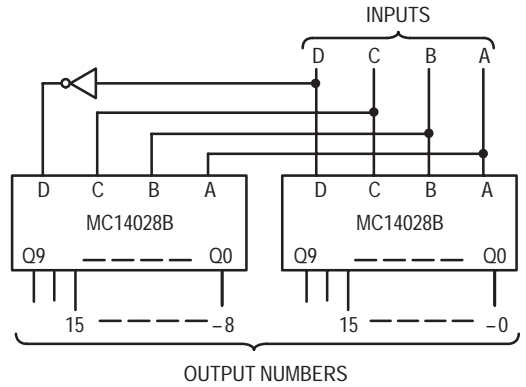


Figure 2. Code Conversion Circuit and Truth Table

| Inputs |   |   |   | Output Numbers |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   | Code and Redefined Output Numbers |            |          |               |       |      |   |   |
|--------|---|---|---|----------------|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|-----------------------------------|------------|----------|---------------|-------|------|---|---|
|        |   |   |   |                |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   | Hexadecimal                       |            |          | Decimal       |       |      |   |   |
|        |   |   |   |                |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   | 4-Bit Binary                      | 4-Bit Gray | Excess-3 | Excess-3 Gray | Aiken | 4221 |   |   |
| D      | C | B | A | 15             | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 4-Bit Binary                      | 4-Bit Gray | Excess-3 | Excess-3 Gray | Aiken | 4221 |   |   |
| 0      | 0 | 0 | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0                                 | 0          |          |               |       |      | 0 | 0 |
| 0      | 0 | 0 | 1 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1                                 | 1          |          |               |       |      | 1 | 1 |
| 0      | 0 | 1 | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2                                 | 3          |          | 0             |       |      | 2 | 2 |
| 0      | 0 | 1 | 1 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3                                 | 2          | 0        | 3             |       |      | 3 |   |
| 0      | 1 | 0 | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4                                 | 7          | 1        | 4             |       |      | 4 |   |
| 0      | 1 | 0 | 1 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5                                 | 6          | 2        |               |       |      |   | 3 |
| 0      | 1 | 1 | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 6                                 | 4          | 3        | 1             |       |      |   | 4 |
| 0      | 1 | 1 | 1 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7                                 | 5          | 4        | 2             |       |      |   |   |
| 1      | 0 | 0 | 0 | 0              | 0  | 0  | 0  | 0  | 0  | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8                                 | 15         | 5        |               |       |      |   |   |
| 1      | 0 | 0 | 1 | 0              | 0  | 0  | 0  | 0  | 0  | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9                                 | 14         | 6        |               |       |      |   | 5 |
| 1      | 0 | 1 | 0 | 0              | 0  | 0  | 0  | 0  | 1  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10                                | 12         | 7        | 9             |       |      |   | 6 |
| 1      | 0 | 1 | 1 | 0              | 0  | 0  | 0  | 1  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11                                | 13         | 8        |               | 5     |      |   | 6 |
| 1      | 1 | 0 | 0 | 0              | 0  | 0  | 1  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12                                | 8          | 9        | 5             | 6     |      |   | 7 |
| 1      | 1 | 0 | 1 | 0              | 0  | 1  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13                                | 9          |          | 6             | 7     |      |   | 7 |
| 1      | 1 | 1 | 0 | 0              | 1  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14                                | 11         |          | 8             | 8     |      |   | 8 |
| 1      | 1 | 1 | 1 | 1              | 0  | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15                                | 10         |          | 7             | 9     |      |   | 9 |

# MC14028B

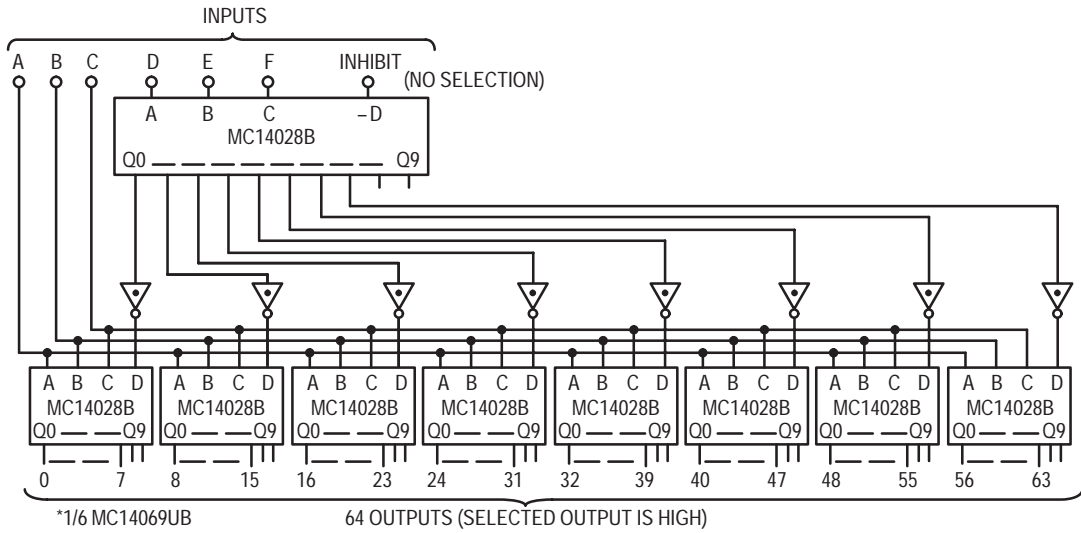


Figure 3. Six-Bit Binary 1-of-64 Decoder

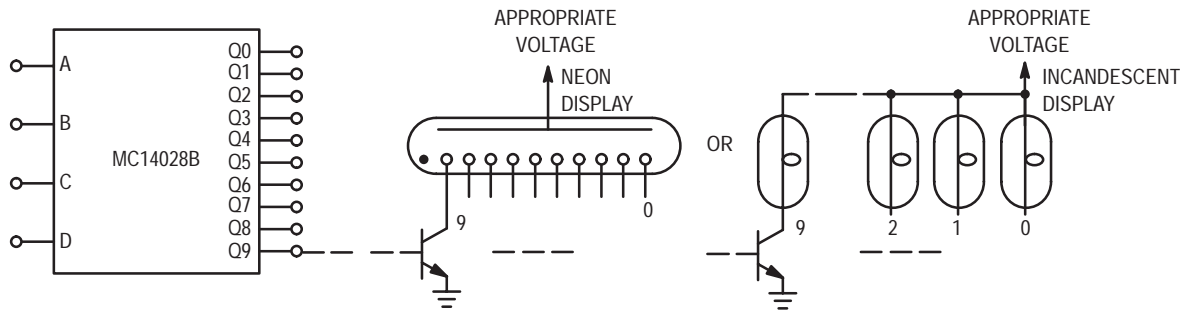
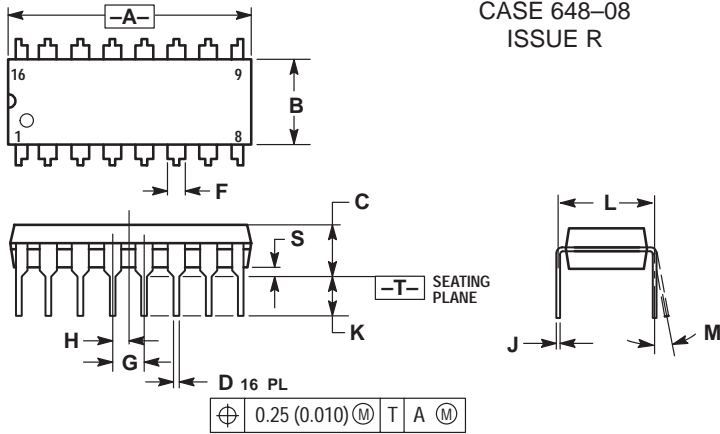


Figure 4. Decimal Digit Display Application

# MC14028B

## PACKAGE DIMENSIONS

### PDIP-16 P SUFFIX PLASTIC DIP PACKAGE CASE 648-08 ISSUE R

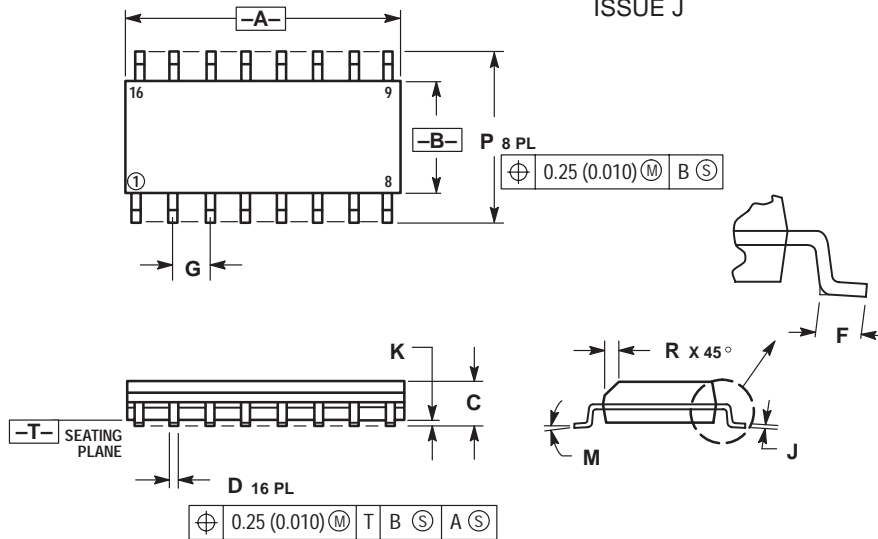


NOTES:

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  |

### SOIC-16 D SUFFIX PLASTIC SOIC PACKAGE CASE 751B-05 ISSUE J



NOTES:

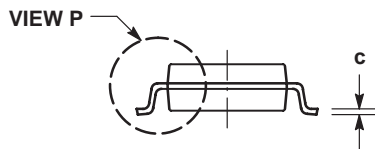
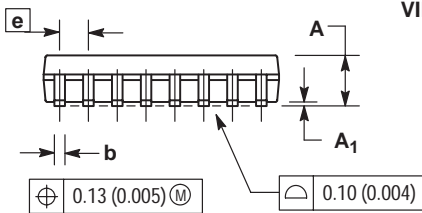
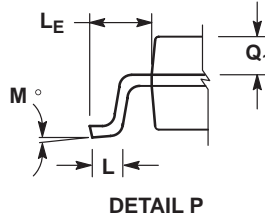
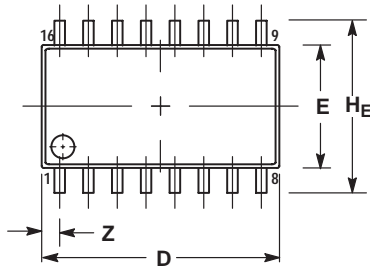
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL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

# MC14028B

## PACKAGE DIMENSIONS

### SOEIAJ-16 F SUFFIX PLASTIC EIAJ SOIC PACKAGE CASE 966-01 ISSUE O



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

| DIM            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | MIN         | MAX   | MIN       | MAX   |
| A              | ---         | 2.05  | ---       | 0.081 |
| A <sub>1</sub> | 0.05        | 0.20  | 0.002     | 0.008 |
| b              | 0.35        | 0.50  | 0.014     | 0.020 |
| c              | 0.18        | 0.27  | 0.007     | 0.011 |
| D              | 9.90        | 10.50 | 0.390     | 0.413 |
| E              | 5.10        | 5.45  | 0.201     | 0.215 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H <sub>E</sub> | 7.40        | 8.20  | 0.291     | 0.323 |
| L              | 0.50        | 0.85  | 0.020     | 0.033 |
| L <sub>E</sub> | 1.10        | 1.50  | 0.043     | 0.059 |
| M              | 0°          | 10°   | 0°        | 10°   |
| Q <sub>1</sub> | 0.70        | 0.90  | 0.028     | 0.035 |
| Z              | ---         | 0.78  | ---       | 0.031 |

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