

MC14543B

BCD-to-Seven Segment Latch/Decoder/Driver for Liquid Crystals

The MC14543B BCD-to-seven segment latch/decoder/driver is designed for use with liquid crystal readouts, and is constructed with complementary MOS (CMOS) enhancement mode devices. The circuit provides the functions of a 4-bit storage latch and an 8421 BCD-to-seven segment decoder and driver. The device has the capability to invert the logic levels of the output combination. The phase (Ph), blanking (BI), and latch disable (LD) inputs are used to reverse the truth table phase, blank the display, and store a BCD code, respectively. For liquid crystal (LC) readouts, a square wave is applied to the Ph input of the circuit and the electrically common backplane of the display. The outputs of the circuit are connected directly to the segments of the LC readout. For other types of readouts, such as light-emitting diode (LED), incandescent, gas discharge, and fluorescent readouts, connection diagrams are given on this data sheet.

Applications include instrument (e.g., counter, DVM etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

- Latch Storage of Code
- Blanking Input
- Readout Blanking on All Illegal Input Combinations
- Direct LED (Common Anode or Cathode) Driving Capability
- Supply Voltage Range = 3.0 V to 18 V
- Capable of Driving 2 Low-power TTL Loads, 1 Low-power Schottky TTL Load or 2 HTL Loads Over the Rated Temperature Range
- Pin-for-Pin Replacement for CD4056A (with Pin 7 Tied to V_{SS}).
- Chip Complexity: 207 FETs or 52 Equivalent Gates

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

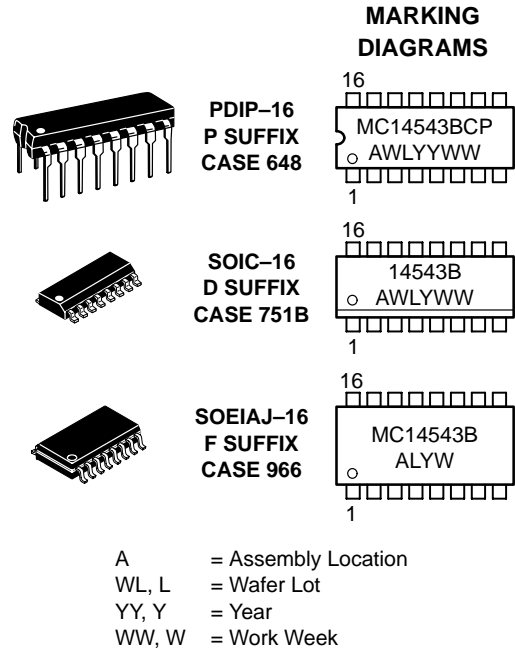
| Symbol | Parameter | Value | Unit |
|----------------------------|--|------------------------|-------------|
| V_{DD} | DC Supply Voltage Range | -0.5 to +18.0 | V |
| V_{in} | Input Voltage Range, All Inputs | -0.5 to $V_{DD} + 0.5$ | V |
| I_{in} | DC Input Current per Pin | ± 10 | mA |
| P_D | Power Dissipation, per Package (Note 3.) | 500 | mW |
| T_A | Operating Temperature Range | -55 to +125 | $^{\circ}C$ |
| T_{stg} | Storage Temperature Range | -65 to +150 | $^{\circ}C$ |
| I_{OHmax} I_{OLmax} | Maximum Continuous Output Drive Current (Source or Sink) | 10 (per Output) | mA |
| P_{OHmax} P_{OLmax} | Maximum Continuous Output Power (Source or Sink) (4.) | 70 (per Output) | mW |

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 $^{\circ}C$
4. $P_{OHmax} = I_{OH} (V_{OH} - V_{DD})$ and $P_{OLmax} = I_{OL} (V_{OL} - V_{SS})$



ON Semiconductor

<http://onsemi.com>



ORDERING INFORMATION

| Device | Package | Shipping |
|-------------|-----------|------------------|
| MC14543BCP | PDIP-16 | 2000/Box |
| MC14543BD | SOIC-16 | 48/Rail |
| MC14543BDR2 | SOIC-16 | 2500/Tape & Reel |
| MC14543BF | SOEIAJ-16 | See Note 1. |
| MC14543BFEL | SOEIAJ-16 | See Note 1. |

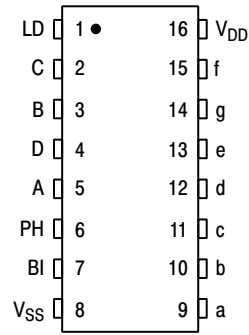
1. For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

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.

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PIN ASSIGNMENT



TRUTH TABLE

| Inputs | | | | | | | Outputs | | | | | | | |
|--------|----|-----|---|---|---|---|--------------------------------------|---|---|---|---|---|---|------------------|
| LD | BI | Ph* | D | C | B | A | a | b | c | d | e | f | g | Display |
| X | 1 | 0 | X | X | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 3 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 5 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 6 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 7 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 9 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Blank |
| 0 | 0 | 0 | X | X | X | X | ** | | | | | | | ** |
| † | † | † | † | | | | Inverse of Output Combinations Above | | | | | | | Display as above |

X = Don't care

† = Above Combinations

* = For liquid crystal readouts, apply a square wave to Ph

For common cathode LED readouts, select Ph = 0

For common anode LED readouts, select Ph = 1

** = Depends upon the BCD code previously applied when LD = 1

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ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

| Characteristic | Symbol | V_{DD} Vdc | -55°C | | 25°C | | | 125°C | | Unit | |
|---|--|-----------------|--|-------|-------|---------------------|------|-------|-------|------|------|
| | | | Min | Max | Min | Typ ^(5.) | Max | Min | Max | | |
| Output Voltage $V_{in} = V_{DD}$ or 0 | "0" Level V_{OL} | 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 | | |
| | "1" Level $V_{in} = 0$ or V_{DD} | V_{OH} | 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 $(V_O = 4.5$ or 0.5 Vdc) $(V_O = 9.0$ or 1.0 Vdc) $(V_O = 13.5$ or 1.5 Vdc) | "0" Level V_{IL} | 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 | | |
| | "1" Level $(V_O = 0.5$ or 4.5 Vdc) $(V_O = 1.0$ or 9.0 Vdc) $(V_O = 1.5$ or 13.5 Vdc) | V_{IH} | 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 $(V_{OH} = 2.5$ Vdc) $(V_{OH} = 4.6$ Vdc) $(V_{OH} = 0.5$ Vdc) $(V_{OH} = 9.5$ Vdc) $(V_{OH} = 13.5$ Vdc) | Source I_{OH} | 5.0 | -3.0 | — | -2.4 | -4.2 | — | -1.7 | — | mAdc | |
| | | 5.0 | -0.64 | — | -0.51 | -0.88 | — | -0.36 | — | | |
| | | 10 | — | — | — | -10.1 | — | — | — | | |
| | | 10 | -1.6 | — | -1.3 | -2.25 | — | -0.9 | — | | |
| | | 15 | -4.2 | — | -3.4 | -8.8 | — | -2.4 | — | | |
| | Sink $(V_{OL} = 0.4$ Vdc) $(V_{OL} = 0.5$ Vdc) $(V_{OL} = 9.5$ Vdc) $(V_{OL} = 1.5$ Vdc) | I_{OL} | 5.0 | 0.64 | — | 0.51 | 0.88 | — | 0.36 | — | mAdc |
| | | | 10 | 1.6 | — | 1.3 | 2.25 | — | 0.9 | — | |
| | | | 10 | — | — | — | 10.1 | — | — | — | |
| | | | 10 | — | — | — | 10.1 | — | — | — | |
| | | | 15 | 4.2 | — | 3.4 | 8.8 | — | 2.4 | — | |
| Input Current | I_{in} | 15 | — | ±0.1 | — | ±0.00001 | ±0.1 | — | ±1.0 | μAdc | |
| Input Capacitance | C_{in} | — | — | — | — | 5.0 | 7.5 | — | — | pF | |
| Quiescent Current (Per Package) $V_{in} = 0$ or V_{DD} , $I_{out} = 0$ μA | I_{DD} | 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 ^(6.) ^(7.) (Dynamic plus Quiescent, Per Package) ($C_L = 50$ pF on all outputs, all buffers switching) | I_T | 5.0 | $I_T = (1.6 \mu\text{A/kHz}) f + I_{DD}$ | | | | | | | μAdc | |
| | | 10 | $I_T = (3.1 \mu\text{A/kHz}) f + I_{DD}$ | | | | | | | | |
| | | 15 | $I_T = (4.7 \mu\text{A/kHz}) f + I_{DD}$ | | | | | | | | |

5. Noise immunity specified for worst-case input combination.

Noise Margin for both "1" and "0" level = 1.0 V min @ $V_{DD} = 5.0$ V
 2.0 V min @ $V_{DD} = 10$ V
 2.5 V min @ $V_{DD} = 15$ V

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

$$I_T(C_L) = I_T(50 \text{ pF}) + 3.5 \times 10^{-3} (C_L - 50) V_{DD} f$$

where: I_T is in μA (per package), C_L in pF, V_{DD} in V, and f in kHz is input frequency.

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

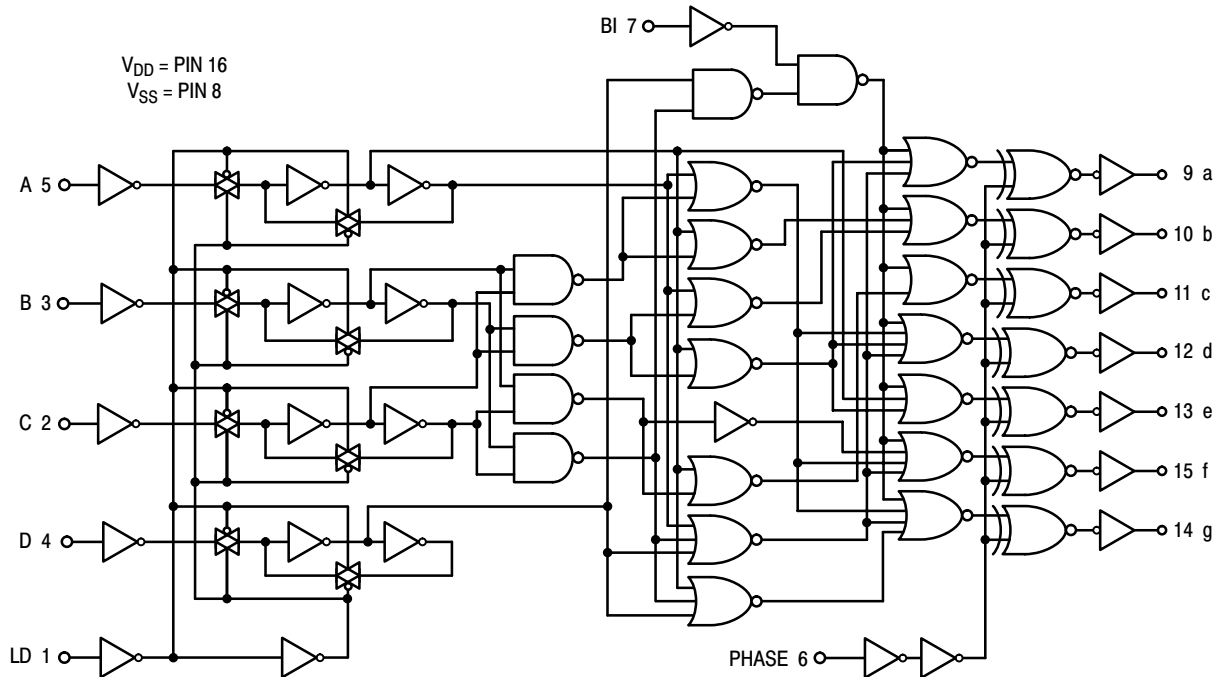
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SWITCHING CHARACTERISTICS (8.) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

| Characteristic | Symbol | V_{DD} | Min | Typ | Max | Unit |
|--|-----------|-----------------|-------------------|-------------------|--------------------|------|
| Output Rise Time $t_{TLH} = (3.0 \text{ ns/pF}) C_L + 30 \text{ ns}$ $t_{TLH} = (1.5 \text{ ns/pF}) C_L + 15 \text{ ns}$ $t_{TLH} = (1.1 \text{ ns/pF}) C_L + 10 \text{ ns}$ | t_{TLH} | 5.0 10 15 | — — — | 100 50 40 | 200 100 80 | ns |
| Output Fall Time $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{THL} = (0.55 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ | t_{THL} | 5.0 10 15 | — — — | 100 50 40 | 200 100 80 | ns |
| Turn-Off Delay Time $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 520 \text{ ns}$ $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 217 \text{ ns}$ $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 160 \text{ ns}$ | t_{PLH} | 5.0 10 15 | — — — | 605 250 185 | 1210 500 370 | ns |
| Turn-On Delay Time $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 420 \text{ ns}$ $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 172 \text{ ns}$ $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 130 \text{ ns}$ | t_{PHL} | 5.0 10 15 | — — — | 505 205 155 | 1650 660 495 | ns |
| Setup Time | t_{su} | 5.0 10 15 | 350 450 500 | | — — — | ns |
| Hold Time | t_h | 5.0 10 15 | 40 30 20 | | — — — | ns |
| Latch Disable Pulse Width (Strobing Data) | t_{WH} | 5.0 10 15 | 250 100 80 | 125 50 40 | — — — | ns |

8. The formulas given are for the typical characteristics only.

LOGIC DIAGRAM



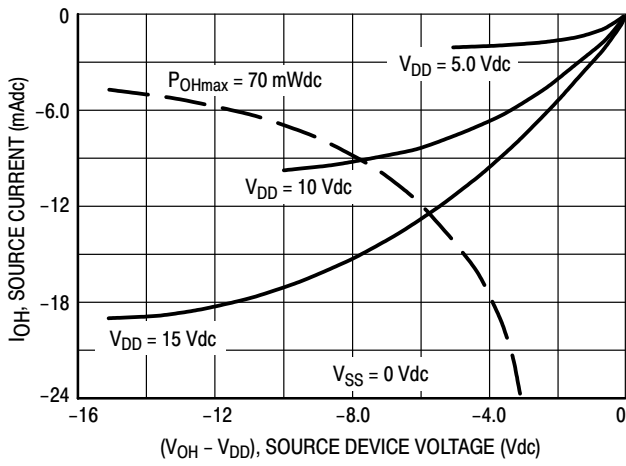


Figure 1. Typical Output Source Characteristics

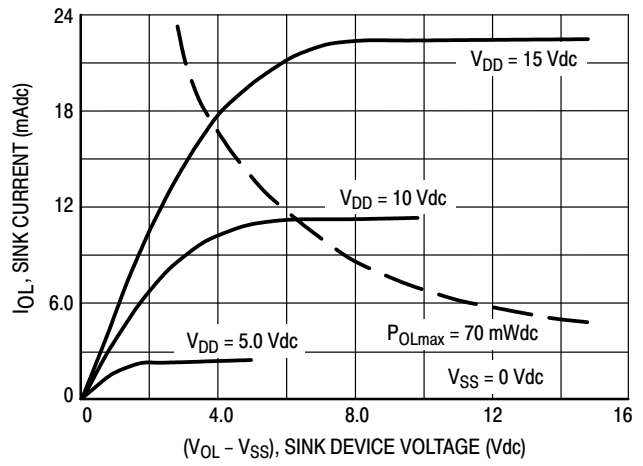


Figure 2. Typical Output Sink Characteristics

Inputs BI and Ph low, and Inputs D and LD high.
f in respect to a system clock.

All outputs connected to respective C_L loads.

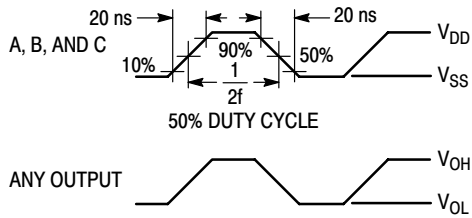
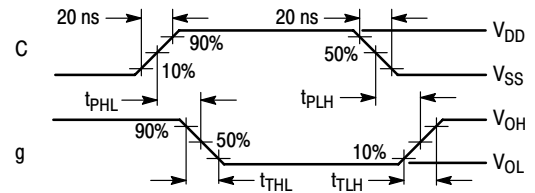
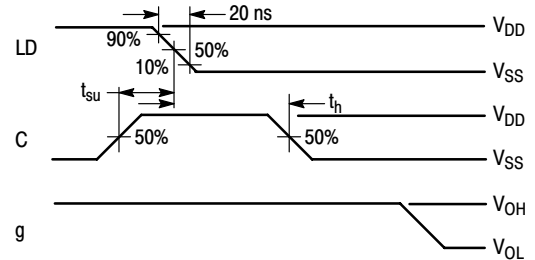


Figure 3. Dynamic Power Dissipation Signal Waveforms

(a) Inputs D, Ph, and BI low, and Inputs A, B, and LD high.



(b) Inputs D, Ph, and BI low, and Inputs A and B high.



(c) Data DCBA strobed into latches

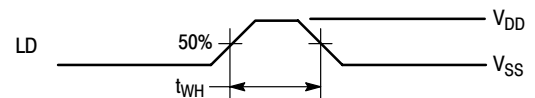
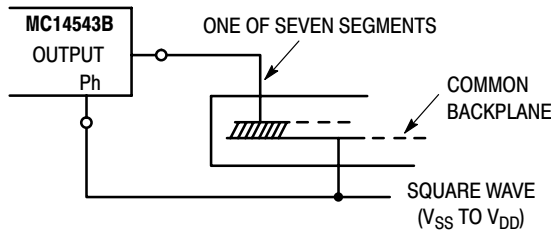


Figure 4. Dynamic Signal Waveforms

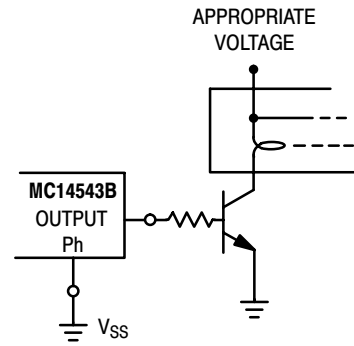
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CONNECTIONS TO VARIOUS DISPLAY READOUTS

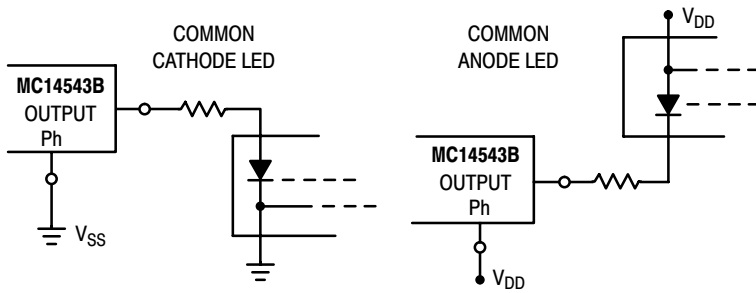
LIQUID CRYSTAL (LC) READOUT



INCANDESCENT READOUT

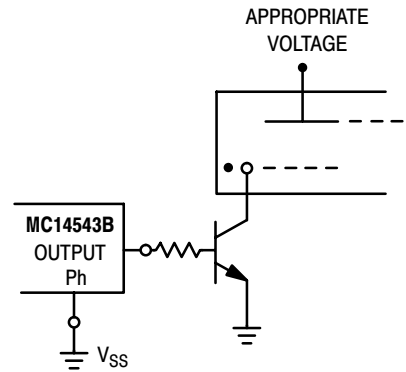


LIGHT EMITTING DIODE (LED) READOUT

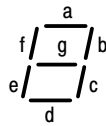


NOTE: Bipolar transistors may be added for gain (for $V_{DD} \leq 10$ V or $I_{out} \geq 10$ mA).

GAS DISCHARGE READOUT

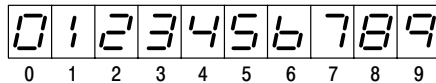


CONNECTIONS TO SEGMENTS



V_{DD} = PIN 16
 V_{SS} = PIN 8

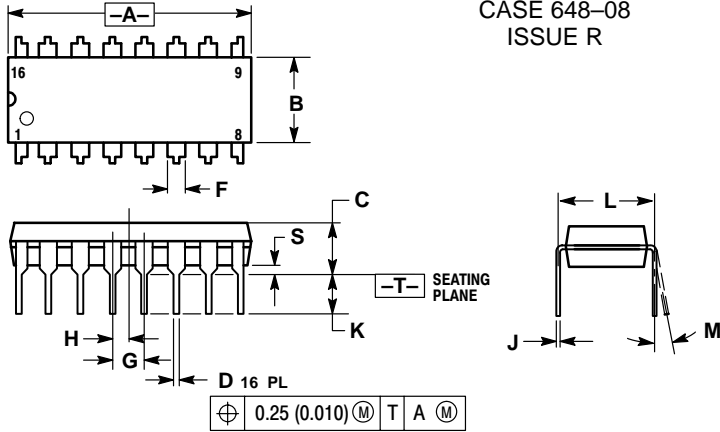
DISPLAY



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PACKAGE DIMENSIONS

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

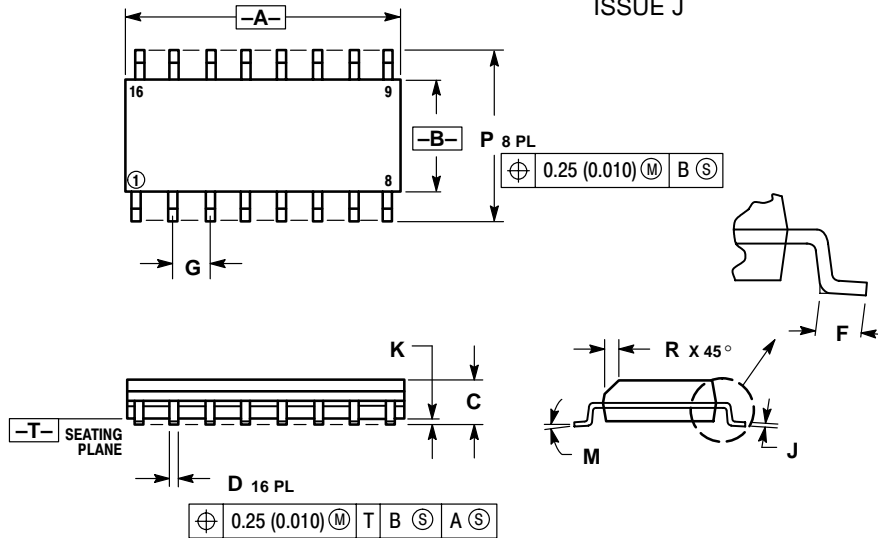


NOTES:

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:

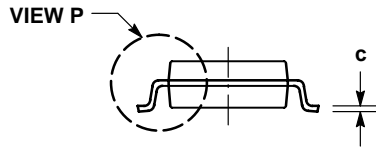
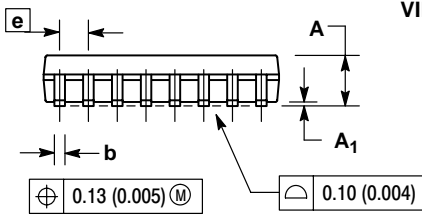
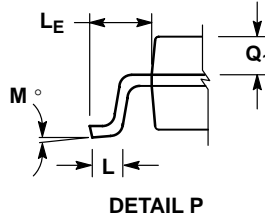
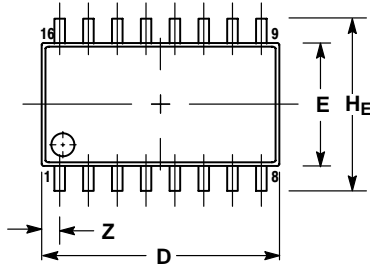
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL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

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PACKAGE DIMENSIONS

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




⊕ 0.13 (0.005) (M)

⊖ 0.10 (0.004)

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 ₁ | 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 | |
| HE | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| LE | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° 10° | | 0° 10° | |
| Q ₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

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