

# MC14040B

## 12-Bit Binary Counter

The MC14040B 12-stage binary counter is constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. This part is designed with an input wave shaping circuit and 12 stages of ripple-carry binary counter. The device advances the count on the negative-going edge of the clock pulse. Applications include time delay circuits, counter controls, and frequency-driving circuits.

- Fully Static Operation
- 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
- Common Reset Line
- Pin-for-Pin Replacement for CD4040B

### 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            | °C   |
| $T_{stg}$         | Storage Temperature Range                         | -65 to +150            | °C   |
| $T_L$             | Lead Temperature (8-Second Soldering)             | 260                    | °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/°C From 65°C To 125°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  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

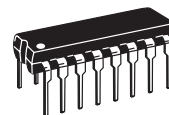
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ). Unused outputs must be left open.



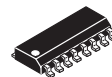
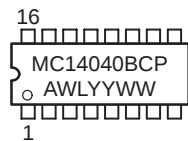
ON Semiconductor

<http://onsemi.com>

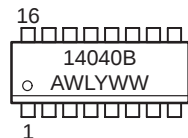
### MARKING DIAGRAMS



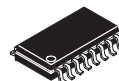
PDIP-16  
P SUFFIX  
CASE 648



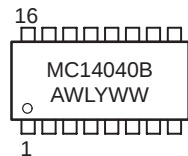
SOIC-16  
D SUFFIX  
CASE 751B



TSSOP-16  
DT SUFFIX  
CASE 948F



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         |
|-------------|-----------|------------------|
| MC14040BCP  | PDIP-16   | 2000/Box         |
| MC14040BD   | SOIC-16   | 2400/Box         |
| MC14040BDR2 | SOIC-16   | 2500/Tape & Reel |
| MC14040BDT  | TSSOP-16  | 96/Rail          |
| MC14040BF   | SOEIAJ-16 | See Note 1.      |
| MC14040BFEL | SOEIAJ-16 | See Note 1.      |

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

# MC14040B

## PIN ASSIGNMENT

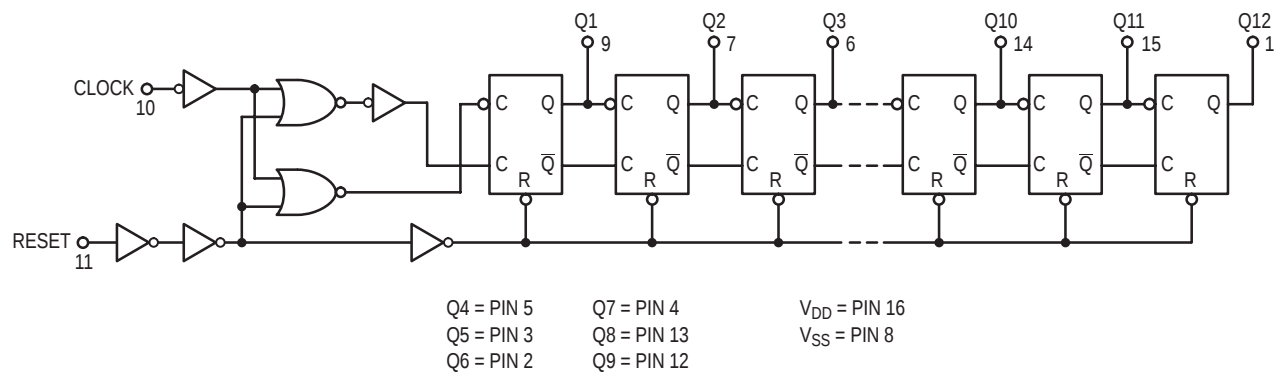
|                 |   |    |                 |
|-----------------|---|----|-----------------|
| Q12             | 1 | 16 | V <sub>DD</sub> |
| Q6              | 2 | 15 | Q11             |
| Q5              | 3 | 14 | Q10             |
| Q7              | 4 | 13 | Q8              |
| Q4              | 5 | 12 | Q9              |
| Q3              | 6 | 11 | R               |
| Q2              | 7 | 10 | C               |
| V <sub>SS</sub> | 8 | 9  | Q1              |

## TRUTH TABLE

| Clock                                                                             | Reset | Output State          |
|-----------------------------------------------------------------------------------|-------|-----------------------|
|  | 0     | No Change             |
|  | 0     | Advance to next state |
| X                                                                                 | 1     | All Outputs are low   |

X = Don't Care

## LOGIC DIAGRAM



# MC14040B

## 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> = (0.42 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.85 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.43 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.

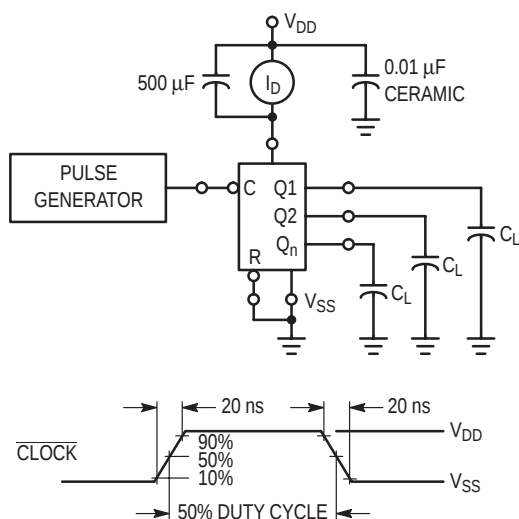
## MC14040B

**SWITCHING CHARACTERISTICS (7.)** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

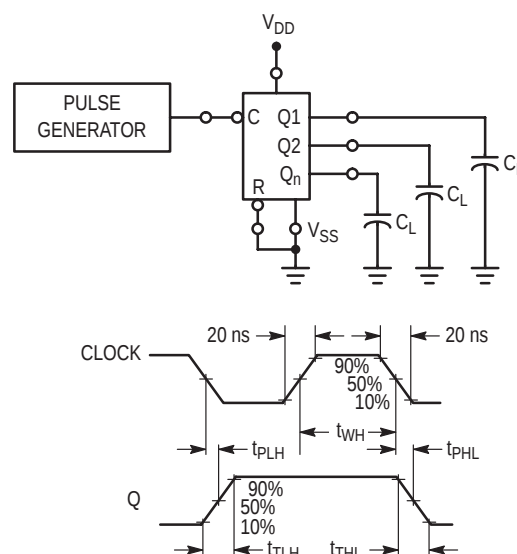
| Characteristic                                                                                                                                                                                                                                                               | Symbol                                 | V <sub>DD</sub><br>V <sub>dc</sub> | Min               | Typ <sup>(8.)</sup> | 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<br>10<br>15                    | —<br>—<br>—       | 100<br>50<br>40     | 200<br>100<br>80     | ns   |
| Propagation Delay Time<br>Clock to Q1<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (1.7 ns/pF) C <sub>L</sub> + 315 ns<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (0.66 ns/pF) C <sub>L</sub> + 137 ns<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (0.5 ns/pF) C <sub>L</sub> + 95 ns | t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | 5.0<br>10<br>15                    | —<br>—<br>—       | 260<br>115<br>80    | 520<br>230<br>160    | ns   |
| Clock to Q12<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (1.7 ns/pF) C <sub>L</sub> + 2415 ns<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (0.66 ns/pF) C <sub>L</sub> + 867 ns<br>t <sub>PHL</sub> , t <sub>PLH</sub> = (0.5 ns/pF) C <sub>L</sub> + 475 ns                        |                                        | 5.0<br>10<br>15                    | —<br>—<br>—       | 1625<br>720<br>500  | 3250<br>1440<br>1000 | ns   |
| Propagation Delay Time<br>Reset to Q <sub>n</sub><br>t <sub>PHL</sub> = (1.7 ns/pF) C <sub>L</sub> + 485 ns<br>t <sub>PHL</sub> = (0.86 ns/pF) C <sub>L</sub> + 182 ns<br>t <sub>PHL</sub> = (0.5 ns/pF) C <sub>L</sub> + 145 ns                                             | t <sub>PHL</sub>                       | 5.0<br>10<br>15                    | —<br>—<br>—       | 370<br>155<br>115   | 740<br>310<br>230    | ns   |
| Clock Pulse Width                                                                                                                                                                                                                                                            | t <sub>WH</sub>                        | 5.0<br>10<br>15                    | 385<br>150<br>115 | 140<br>55<br>38     | —<br>—<br>—          | ns   |
| Clock Pulse Frequency                                                                                                                                                                                                                                                        | f <sub>cl</sub>                        | 5.0<br>10<br>15                    | —<br>—<br>—       | 2.1<br>7.0<br>10.0  | 1.5<br>3.5<br>4.5    | MHz  |
| Clock Rise and Fall Time                                                                                                                                                                                                                                                     | t <sub>TLH</sub> , t <sub>THL</sub>    | 5.0<br>10<br>15                    | No Limit          |                     |                      | ns   |
| Reset Pulse Width                                                                                                                                                                                                                                                            | t <sub>WH</sub>                        | 5.0<br>10<br>15                    | 960<br>360<br>270 | 320<br>120<br>80    | —<br>—<br>—          | ns   |
| Reset Removal Time                                                                                                                                                                                                                                                           | t <sub>rem</sub>                       | 5.0<br>10<br>15                    | 130<br>50<br>30   | 65<br>25<br>15      | —<br>—<br>—          | ns   |

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.



### Figure 1. Power Dissipation Test Circuit and Waveform



### Figure 2. Switching Time Test Circuit and Waveforms

## MC14040B

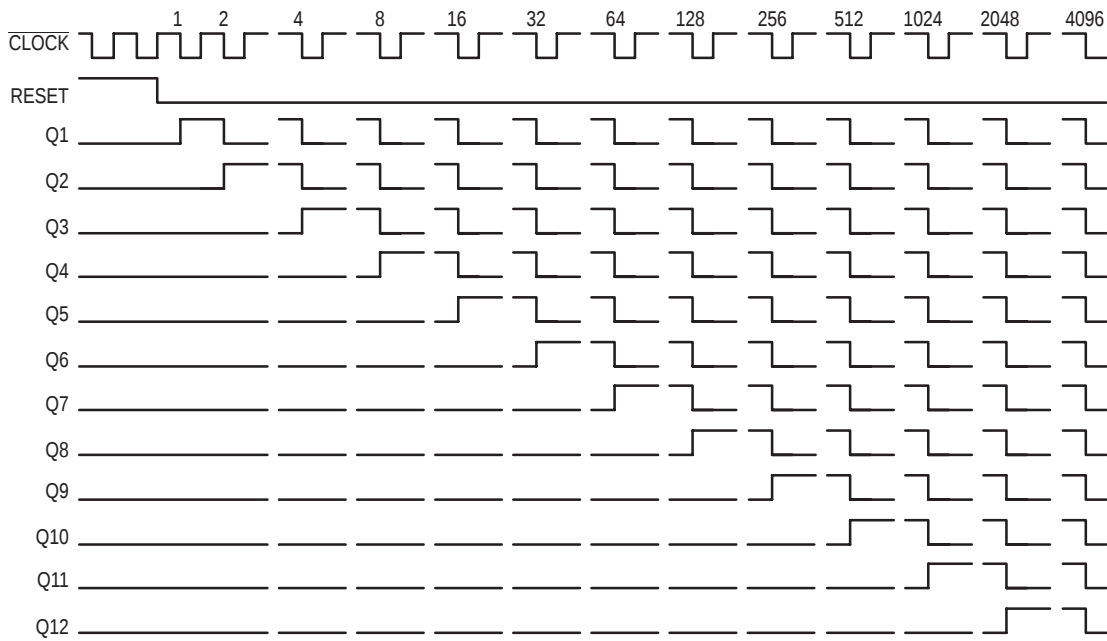


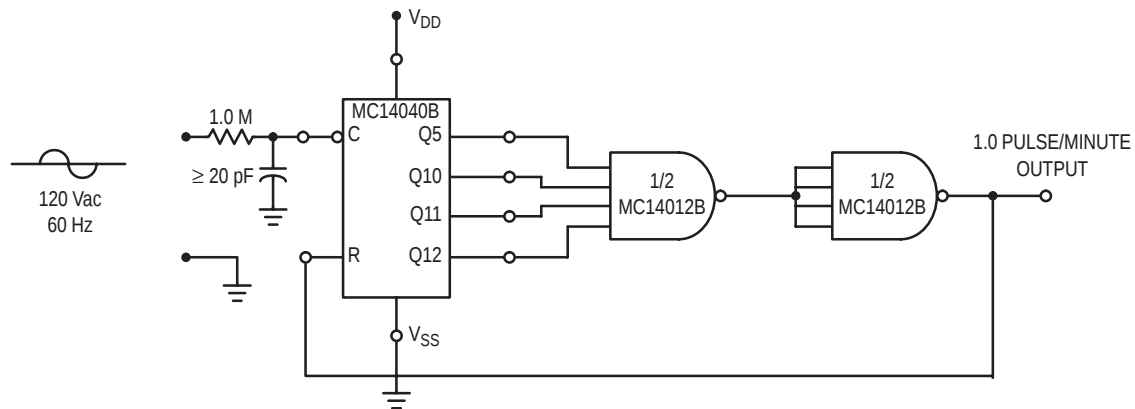
Figure 3. Timing Diagram

### APPLICATIONS INFORMATION

#### TIME-BASE GENERATOR

A 60 Hz sinewave obtained through a 1.0 Megohm resistor connected directly to a standard 120 Vac power line is applied to the clock input of the MC14040B. By selecting

outputs Q5, Q10, Q11, and Q12 division by 3600 is accomplished. The MC14012B decodes the counter outputs, produces a single output pulse, and resets the binary counter. The resulting output frequency is 1.0 pulse/minute.

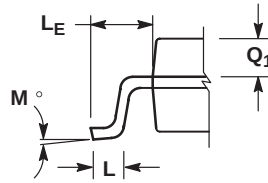
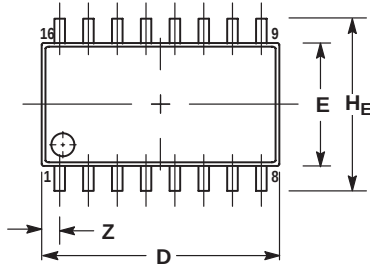




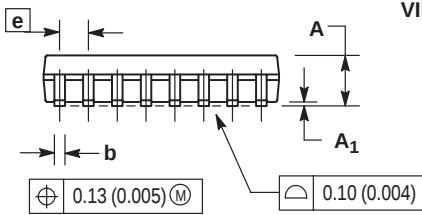
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## PACKAGE DIMENSIONS

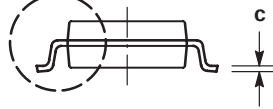
### SOEIAJ-16 F SUFFIX PLASTIC EIAJ SOIC PACKAGE CASE 966-01 ISSUE O



DETAIL P



VIEW P



#### 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).

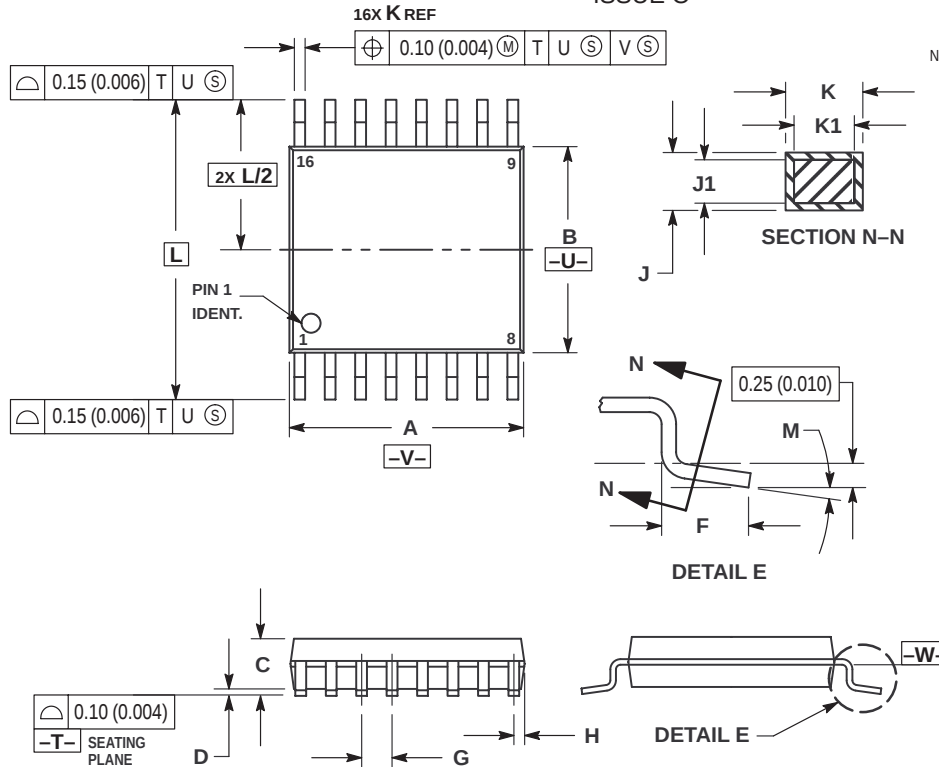
| DIM            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | MIN         | MAX   | MIN       | MAX   |
| A              | —           | 2.05  | —         | 0.081 |
| A <sub>1</sub> | 0.05        | 0.20  | 0.002     | 0.008 |
| 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 |

# MC14040B

## PACKAGE DIMENSIONS

### TSSOP-16 DT SUFFIX

#### PLASTIC TSSOP PACKAGE CASE 948F-01 ISSUE O



#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.90        | 5.10 | 0.193     | 0.200 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | —           | 1.20 | —         | 0.047 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.75 | 0.020     | 0.030 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| H   | 0.18        | 0.28 | 0.007     | 0.011 |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

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