

## 14-Bit Binary Counter and Oscillator

The MC14060B is a 14-stage binary ripple counter with an on-chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on the chip is a reset function which places all outputs into the zero state and disables the oscillator. A negative transition on Clock will advance the counter to the next state. Schmitt trigger action on the input line permits very slow input rise and fall times. Applications include time delay circuits, counter controls, and frequency dividing circuits.

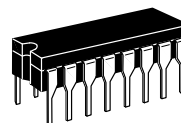
- Fully static operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 V to 18 V
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range
- Buffered Outputs Available from Stages 4 Through 10 and 12 Through 14
- Common Reset Line
- Pin-for-Pin Replacement for CD4060B

**TRUTH TABLE**

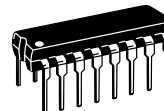
| Clock                                                                               | Reset | Output State          |
|-------------------------------------------------------------------------------------|-------|-----------------------|
|  | L     | No Change             |
|  | L     | Advance to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

X = Don't Care

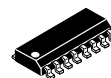
## MC14060B



**L SUFFIX**  
CERAMIC  
CASE 620



**P SUFFIX**  
PLASTIC  
CASE 648



**D SUFFIX**  
SOIC  
CASE 751B

### ORDERING INFORMATION

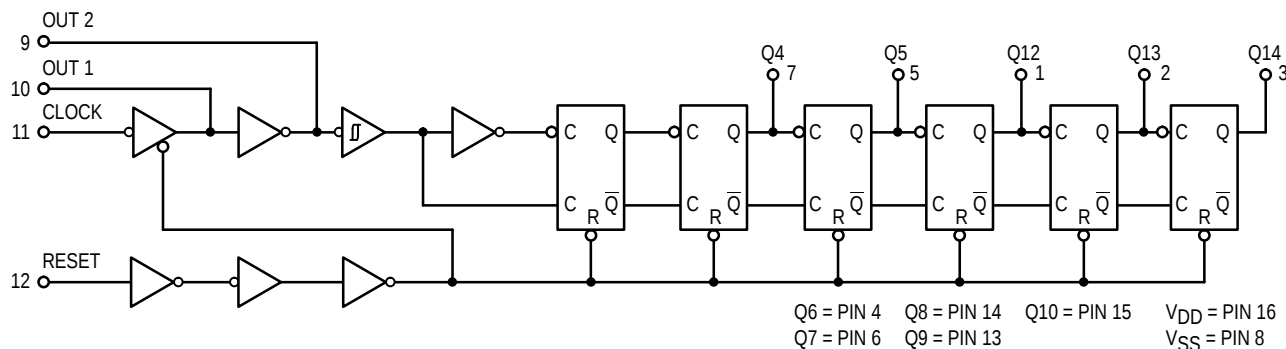
MC14XXXBCP Plastic  
MC14XXXBCL Ceramic  
MC14XXXBD SOIC

$T_A = -55^\circ$  to  $125^\circ\text{C}$  for all packages.

### PIN ASSIGNMENT

|                 |   |    |                 |
|-----------------|---|----|-----------------|
| Q12             | 1 | 16 | V <sub>DD</sub> |
| Q13             | 2 | 15 | Q10             |
| Q14             | 3 | 14 | Q8              |
| Q6              | 4 | 13 | Q9              |
| Q5              | 5 | 12 | RESET           |
| Q7              | 6 | 11 | CLOCK           |
| Q4              | 7 | 10 | OUT 1           |
| V <sub>SS</sub> | 8 | 9  | OUT 2           |

### LOGIC DIAGRAM



**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

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<sub>in</sub> and V<sub>out</sub> should be constrained to the range V<sub>SS</sub> ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>DD</sub>.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>). Unused outputs must be left open.

**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>“0” Level<br>V <sub>in</sub> = V <sub>DD</sub> or 0                                                                                                   | V <sub>OL</sub> | 5.0                    | —                                                                                                                                                              | 0.05  | —      | 0         | 0.05  | —      | 0.05  | V    |
|                                                                                                                                                                         |                 | 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   | —     | V    |
|                                                                                                                                                                         |                 | 10                     | 9.95                                                                                                                                                           | —     | 9.95   | 10        | —     | 9.95   | —     |      |
|                                                                                                                                                                         |                 | 15                     | 14.95                                                                                                                                                          | —     | 14.95  | 15        | —     | 14.95  | —     |      |
| Input Voltage<br>“0” Level<br>(V <sub>O</sub> = 4.5 or 0.5 V)<br>(V <sub>O</sub> = 9.0 or 1.0 V)<br>(V <sub>O</sub> = 13.5 or 1.5 V)                                    | V <sub>IL</sub> | 5.0                    | —                                                                                                                                                              | 1.5   | —      | 2.25      | 1.5   | —      | 1.5   | V    |
|                                                                                                                                                                         |                 | 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    | —     | V    |
|                                                                                                                                                                         |                 | 10                     | 7.0                                                                                                                                                            | —     | 7.0    | 5.50      | —     | 7.0    | —     |      |
|                                                                                                                                                                         |                 | 15                     | 11.0                                                                                                                                                           | —     | 11.0   | 8.25      | —     | 11.0   | —     |      |
| Input Voltage<br>“0” Level<br>(V <sub>O</sub> = 4.5 Vdc) (For Input 11<br>(V <sub>O</sub> = 9.0 Vdc) and Output 10)<br>(V <sub>O</sub> = 13.5 Vdc)                      | V <sub>IL</sub> | 5.0                    | —                                                                                                                                                              | 1.0   | —      | 2.25      | 1.0   | —      | 1.0   | Vdc  |
|                                                                                                                                                                         |                 | 10                     | —                                                                                                                                                              | 2.0   | —      | 4.50      | 2.0   | —      | 2.0   |      |
|                                                                                                                                                                         |                 | 15                     | —                                                                                                                                                              | 2.5   | —      | 6.75      | 2.5   | —      | 2.5   |      |
|                                                                                                                                                                         | V <sub>IH</sub> | 5.0                    | 4.0                                                                                                                                                            | —     | 4.0    | 2.75      | —     | 4.0    | —     | Vdc  |
|                                                                                                                                                                         |                 | 10                     | 8.0                                                                                                                                                            | —     | 8.0    | 5.50      | —     | 8.0    | —     |      |
|                                                                                                                                                                         |                 | 15                     | 12.5                                                                                                                                                           | —     | 12.5   | 8.25      | —     | 12.5   | —     |      |
| Output Drive Current<br>(V <sub>OH</sub> = 2.5 V) (Except Source<br>(V <sub>OH</sub> = 4.6 V) Pins 9 and 10)<br>(V <sub>OH</sub> = 9.5 V)<br>(V <sub>OH</sub> = 13.5 V) | I <sub>OH</sub> | 5.0                    | – 3.0                                                                                                                                                          | —     | – 2.4  | – 4.2     | —     | – 1.7  | —     | mA   |
|                                                                                                                                                                         |                 | 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  | —     |      |
|                                                                                                                                                                         | I <sub>OL</sub> | 5.0                    | 0.64                                                                                                                                                           | —     | 0.51   | 0.88      | —     | 0.36   | —     | mA   |
|                                                                                                                                                                         |                 | 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 | μA   |
| Input Capacitance (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   | μA   |
|                                                                                                                                                                         |                 | 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,<br>all buffers switching)                                | I <sub>T</sub>  | 5.0<br>10<br>15        | I <sub>T</sub> = (0.25 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.54 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.85 μA/kHz) f + I <sub>DD</sub> |       |        |           |       |        |       | μA   |

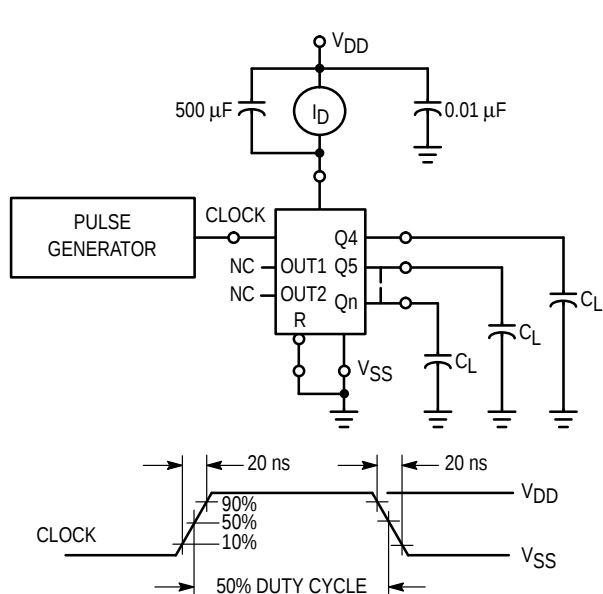
# Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

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

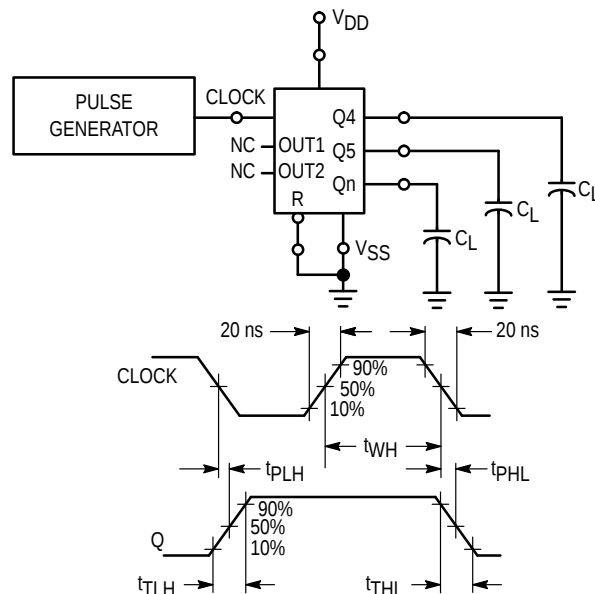
**SWITCHING CHARACTERISTICS** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

| Characteristic                        | Symbol                 | $V_{DD}$<br>Vdc | Min             | Typ #             | Max               | Unit          |
|---------------------------------------|------------------------|-----------------|-----------------|-------------------|-------------------|---------------|
| Output Rise Time (Counter Outputs)    | $t_{TLH}$              | 5.0<br>10<br>15 | —<br>—<br>—     | 40<br>25<br>20    | 200<br>100<br>80  | ns            |
| Output Fall Time (Counter Outputs)    | $t_{THL}$              | 5.0<br>10<br>15 | —<br>—<br>—     | 50<br>30<br>20    | 200<br>100<br>80  | ns            |
| Propagation Delay Time<br>Clock to Q4 | $t_{PLH}$<br>$t_{PHL}$ | 5.0<br>10<br>15 | —<br>—<br>—     | 415<br>175<br>125 | 740<br>300<br>200 | ns            |
| Clock to Q14                          |                        | 5.0<br>10<br>15 | —<br>—<br>—     | 1.5<br>0.7<br>0.4 | 2.7<br>1.3<br>1.0 | $\mu\text{s}$ |
| Clock Pulse Width                     | $t_{WH}$               | 5.0<br>10<br>15 | 100<br>40<br>30 | 65<br>30<br>20    | —<br>—<br>—       | ns            |
| Clock Pulse Frequency                 | $f_\phi$               | 5.0<br>10<br>15 | —<br>—<br>—     | 5<br>14<br>17     | 3.5<br>8<br>12    | MHz           |
| Clock Rise and Fall Time              | $t_{TLH}$<br>$t_{THL}$ | 5.0<br>10<br>15 | No Limit        |                   |                   | ns            |
| Reset Pulse Width                     | $t_W$                  | 5.0<br>10<br>15 | 120<br>60<br>40 | 40<br>15<br>10    | —<br>—<br>—       | ns            |
| Propagation Delay Time<br>Reset to On | $t_{PHL}$              | 5.0<br>10<br>15 | —<br>—<br>—     | 170<br>80<br>60   | 350<br>160<br>100 | ns            |

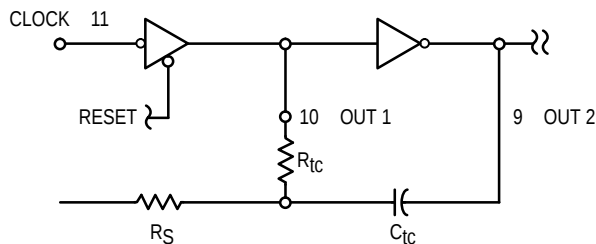
#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.



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



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



$$f \approx \frac{1}{2.3 R_{TC} C_{TC}}$$

if  $1 \text{ kHz} \leq f \leq 100 \text{ kHz}$   
and  $2R_{TC} < R_S < 10R_{TC}$   
( $f$  in Hz,  $R$  in ohms,  $C$  in farads)

The formula may vary for other frequencies. Recommended maximum value for the resistors in  $1 \text{ M}\Omega$ .

Figure 3. Oscillator Circuit Using RC Configuration

#### TYPICAL RC OSCILLATOR CHARACTERISTICS

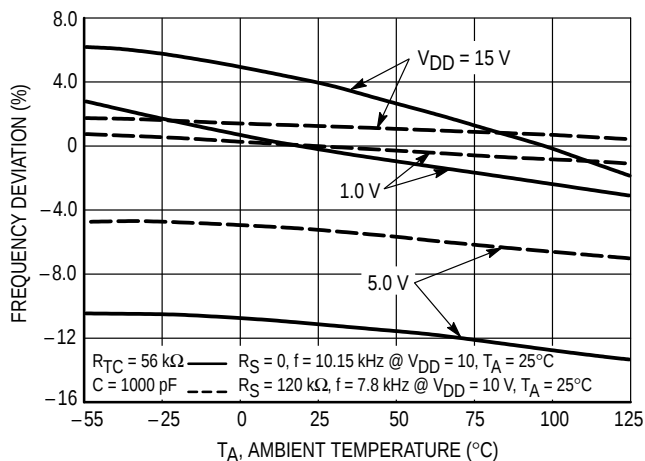


Figure 4. RC Oscillator Stability

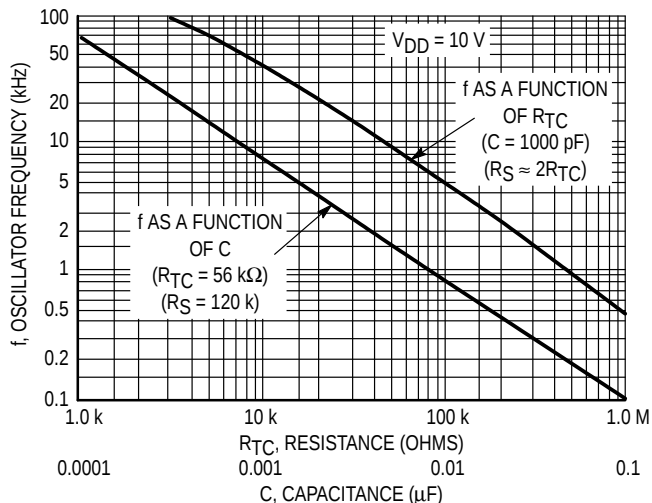


Figure 5. RC Oscillator Frequency as a Function of  $R_{TC}$  and  $C$

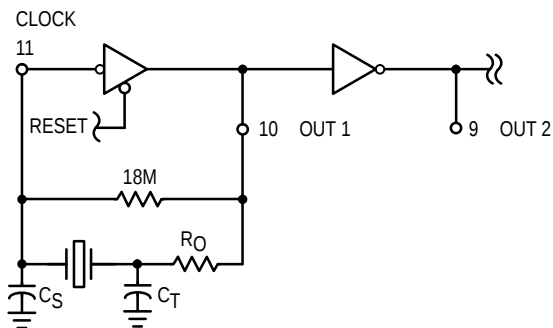


Figure 6. Typical Crystal Oscillator Circuit

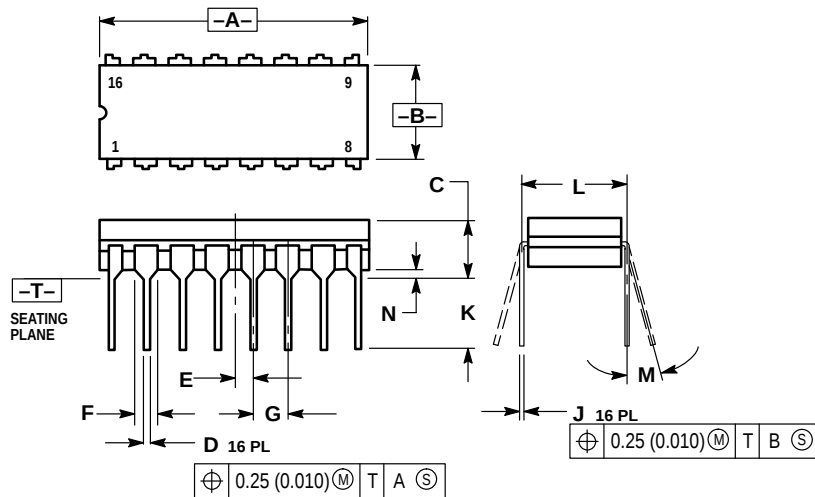
| Characteristic                                                                     | 500 kHz Circuit | 32 kHz Circuit | Unit |
|------------------------------------------------------------------------------------|-----------------|----------------|------|
| Crystal Characteristics                                                            |                 |                |      |
| Resonant Frequency                                                                 | 500             | 32             | kHz  |
| Equivalent Resistance, $R_S$                                                       | 1.0             | 6.2            | kΩ   |
| External Resistor/Capacitor Values                                                 |                 |                |      |
| $R_O$                                                                              | 47              | 750            | kΩ   |
| $C_T$                                                                              | 82              | 82             | pF   |
| $C_S$                                                                              | 20              | 20             | pF   |
| Frequency Stability                                                                |                 |                |      |
| Frequency Changes as a Function of $V_{DD}$ ( $T_A = 25^\circ\text{C}$ )           |                 |                |      |
| $V_{DD}$ Change from 5.0 V to 10 V                                                 | + 6.0           | + 2.0          | ppm  |
| $V_{DD}$ Change from 10 V to 15 V                                                  | + 2.0           | + 2.0          | ppm  |
| Frequency Change as a Function of Temperature ( $V_{DD} = 10 \text{ V}$ )          |                 |                |      |
| $T_A$ Change from $-55^\circ\text{C}$ to $+25^\circ\text{C}$ Complete Oscillator*  | + 100           | + 120          | ppm  |
| $T_A$ Change from $+25^\circ\text{C}$ to $+125^\circ\text{C}$ Complete Oscillator* | - 160           | - 560          | ppm  |

\* Complete oscillator includes crystal, capacitors, and resistors.

Figure 7. Typical Data for Crystal Oscillator Circuit

## OUTLINE DIMENSIONS

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

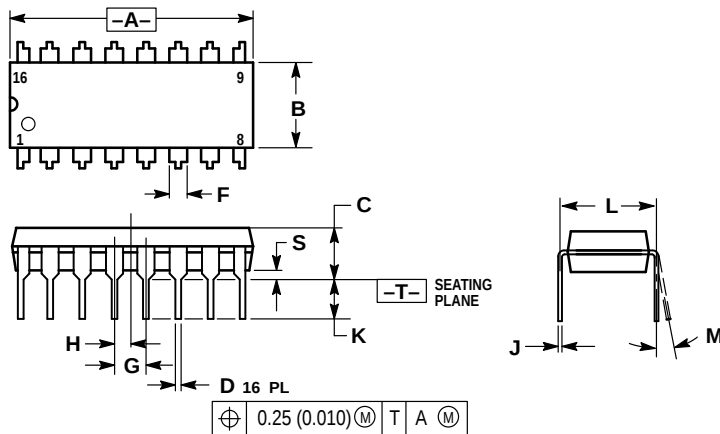


#### NOTES:

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



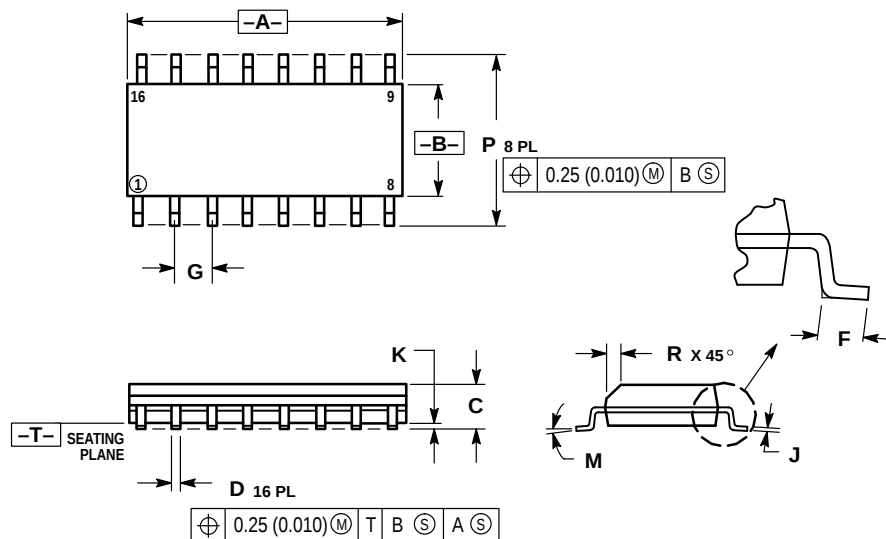
#### NOTES:

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 |

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

#### How to reach us:

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609  
**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



**MOTOROLA**



MC14060B/D

