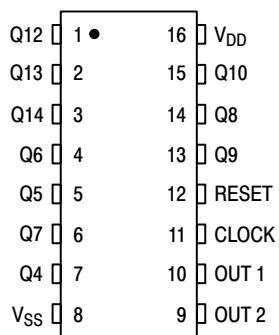


**MC14060B**

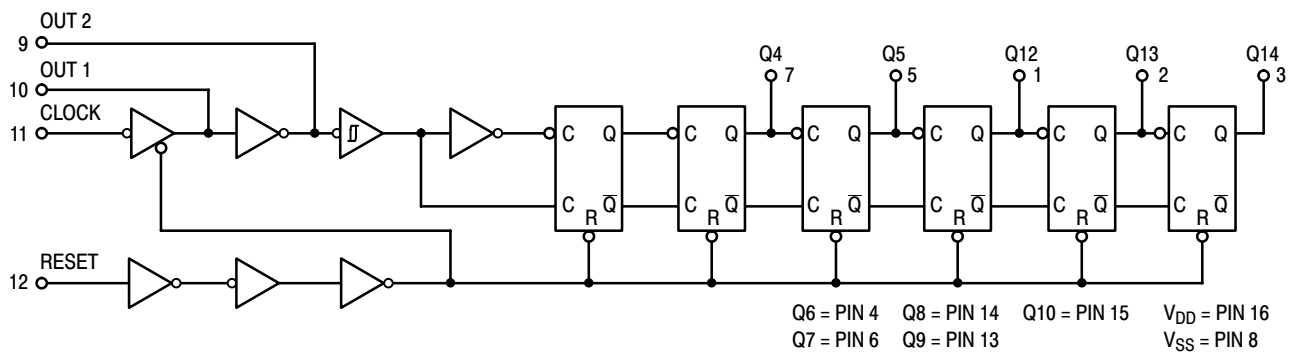


### Figure 1. Pin Assignment

### Table 1. Truth Table

| Clock                                                                             | Reset | Output State          |
|-----------------------------------------------------------------------------------|-------|-----------------------|
|  | L     | No Change             |
|  | L     | Advance to Next State |
| H                                                                                 | H     | All Outputs are Low   |

X = Don't Care



### Figure 2. Logic Diagram

## ORDERING INFORMATION

| Device       | Package                | Shipping <sup>†</sup> |
|--------------|------------------------|-----------------------|
| MC14060BCP   | PDIP–16                | 500 Units / Rail      |
| MC14060BCPG  | PDIP–16<br>(Pb–Free)   | 500 Units / Rail      |
| MC14060BD    | SOIC–16                | 48 Units / Rail       |
| MC14060BDG   | SOIC–16<br>(Pb–Free)   | 48 Units / Rail       |
| MC14060BDR2  | SOIC–16                | 2500 / Tape & Reel    |
| MC14060BDR2G | SOIC–16<br>(Pb–Free)   | 2500 / Tape & Reel    |
| MC14060BDTR2 | TSSOP–16*              | 2500 / Tape & Reel    |
| MC14060BFEL  | SOEIAJ–16<br>(Pb–Free) | 2000 / Tape & Reel    |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.

# MC14060B

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

| Symbol          | Characteristic                                                                                                                                                               | V <sub>DD</sub><br>Vdc | - 55°C                                                                                                                                                         |       | 25°C  |                 |       | 125°C |       | Unit |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-----------------|-------|-------|-------|------|
|                 |                                                                                                                                                                              |                        | Min                                                                                                                                                            | Max   | Min   | Typ<br>(Note 2) | Max   | Min   | Max   |      |
| V <sub>OL</sub> | Output Voltage<br>V <sub>in</sub> = V <sub>DD</sub> or 0      "0" Level                                                                                                      | 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> | V <sub>in</sub> = 0 or V <sub>DD</sub> "1" Level                                                                                                                             | 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 | –     |      |
| V <sub>IL</sub> | Input Voltage<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)      "0" Level                                       | 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> | (V <sub>O</sub> = 0.5 or 4.5 V)<br>(V <sub>O</sub> = 1.0 or 9.0 V)<br>(V <sub>O</sub> = 1.5 or 13.5 V)      "1" Level                                                        | 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  | –     |      |
| V <sub>IL</sub> | Input Voltage<br>(V <sub>O</sub> = 4.5 Vdc)<br>(V <sub>O</sub> = 9.0 Vdc)<br>(V <sub>O</sub> = 13.5 Vdc)      "0" Level<br>(For Input 11 and Output 10)                      | 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> | (V <sub>O</sub> = 0.5 Vdc)<br>(V <sub>O</sub> = 1.0 Vdc)<br>(V <sub>O</sub> = 1.5 Vdc)      "1" Level                                                                        | 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  | –     |      |
| I <sub>OH</sub> | Output Drive Current<br>(V <sub>OH</sub> = 2.5 V)<br>(V <sub>OH</sub> = 4.6 V)<br>(V <sub>OH</sub> = 9.5 V)<br>(V <sub>OH</sub> = 13.5 V)      (Except Source Pins 9 and 10) | 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> | (V <sub>OL</sub> = 0.4 V)<br>(V <sub>OL</sub> = 0.5 V)<br>(V <sub>OL</sub> = 1.5 V)      Sink                                                                                | 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   | –     |      |
| I <sub>in</sub> | Input Current                                                                                                                                                                | 15                     | –                                                                                                                                                              | ± 0.1 | –     | ± 0.00001       | ± 0.1 | –     | ± 1.0 | μA   |
| C <sub>in</sub> | Input Capacitance (V <sub>in</sub> = 0)                                                                                                                                      | –                      | –                                                                                                                                                              | –     | –     | 5.0             | 7.5   | –     | –     | pF   |
| I <sub>DD</sub> | Quiescent Current<br>(Per Package)                                                                                                                                           | 5.0                    | –                                                                                                                                                              | 5.0   | –     | 0.005           | 5.0   | –     | 150   | μA   |
|                 |                                                                                                                                                                              | 10                     | –                                                                                                                                                              | 10    | –     | 0.010           | 10    | –     | 300   |      |
|                 |                                                                                                                                                                              | 15                     | –                                                                                                                                                              | 20    | –     | 0.015           | 20    | –     | 600   |      |
| I <sub>T</sub>  | Total Supply Current (Notes 3, 4)<br>(Dynamic plus Quiescent,<br>Per Package)<br>(C <sub>L</sub> = 50 pF on all outputs,<br>all buffers switching)                           | 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   |

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

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

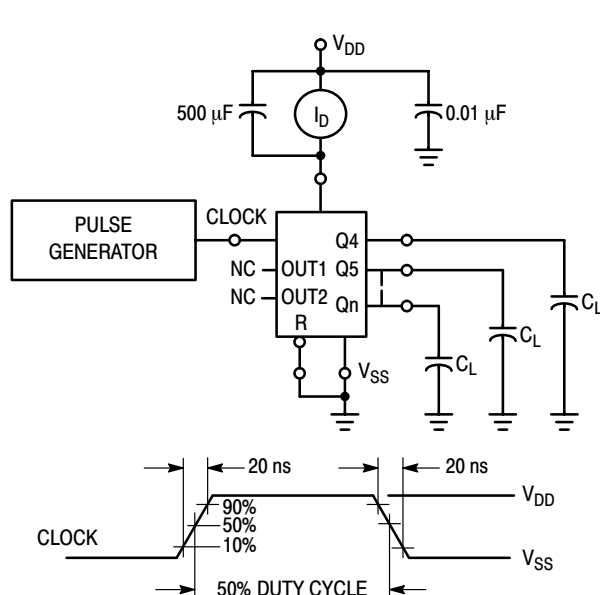
4. To calculate total supply current at loads other than 50 pF: I<sub>T</sub>(C<sub>L</sub>) = I<sub>T</sub>(50 pF) + (C<sub>L</sub> – 50) Vfk  
where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V = (V<sub>DD</sub> – V<sub>SS</sub>) in volts, f in kHz is input frequency, and k = 0.002.

## MC14060B

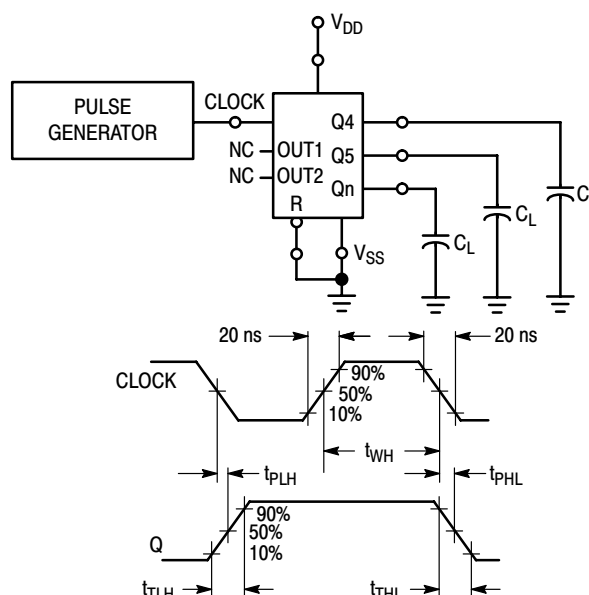
### SWITCHING CHARACTERISTICS (C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C)

| Symbol                               | Characteristic                        | V <sub>DD</sub><br>Vdc | Min             | Typ<br>(Note 5)   | Max               | Unit |
|--------------------------------------|---------------------------------------|------------------------|-----------------|-------------------|-------------------|------|
| t <sub>TLH</sub>                     | Output Rise Time (Counter Outputs)    | 5.0<br>10<br>15        | –<br>–<br>–     | 40<br>25<br>20    | 200<br>100<br>80  | ns   |
| t <sub>THL</sub>                     | Output Fall Time (Counter Outputs)    | 5.0<br>10<br>15        | –<br>–<br>–     | 50<br>30<br>20    | 200<br>100<br>80  | ns   |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay Time<br>Clock to Q4 | 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 | μs   |
| t <sub>WH</sub>                      | Clock Pulse Width                     | 5.0<br>10<br>15        | 100<br>40<br>30 | 65<br>30<br>20    | –<br>–<br>–       | ns   |
| f <sub>φ</sub>                       | Clock Pulse Frequency                 | 5.0<br>10<br>15        | –<br>–<br>–     | 5<br>14<br>17     | 3.5<br>8<br>12    | MHz  |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Clock Rise and Fall Time              | 5.0<br>10<br>15        | No Limit        |                   |                   | ns   |
| t <sub>w</sub>                       | Reset Pulse Width                     | 5.0<br>10<br>15        | 120<br>60<br>40 | 40<br>15<br>10    | –<br>–<br>–       | ns   |
| t <sub>PHL</sub>                     | Propagation Delay Time<br>Reset to On | 5.0<br>10<br>15        | –<br>–<br>–     | 170<br>80<br>60   | 350<br>160<br>100 | ns   |

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

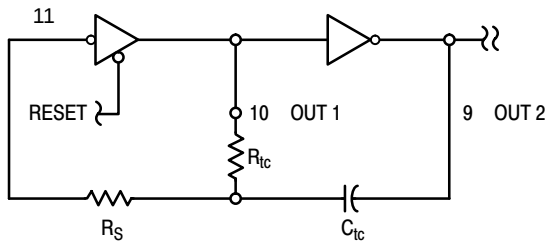


### Figure 1. Power Dissipation Test Circuit and Waveform



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

## MC14060B



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

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 MΩ.

Figure 3. Oscillator Circuit Using RC Configuration

### TYPICAL RC OSCILLATOR CHARACTERISTICS

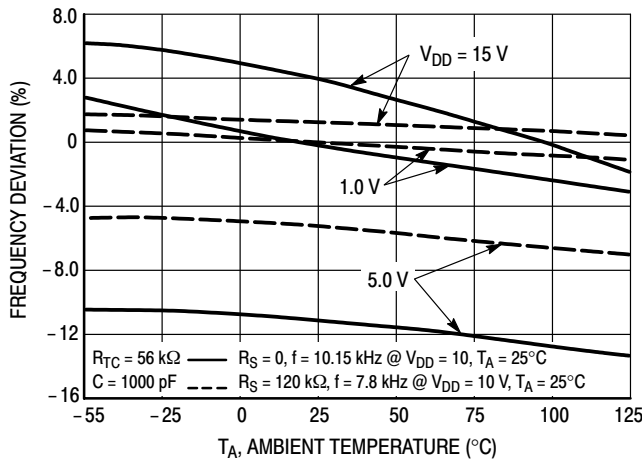


Figure 4. RC Oscillator Stability

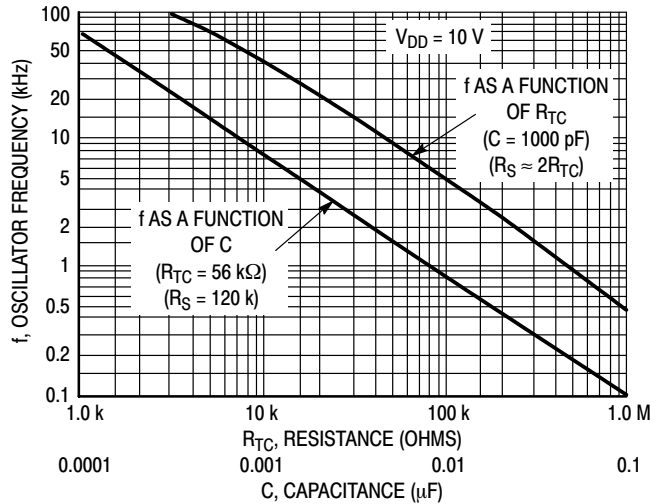


Figure 5. RC Oscillator Frequency as a Function of  $R_{TC}$  and C

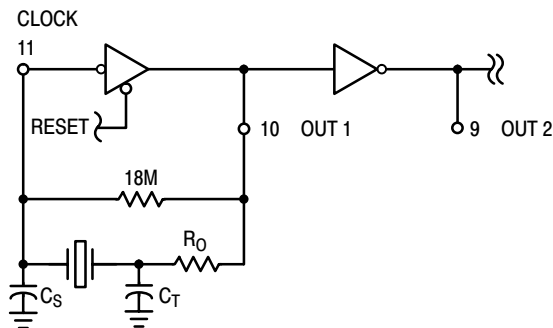


Figure 6. Typical Crystal Oscillator Circuit

Table 2. Typical Data for Crystal Oscillator Circuit

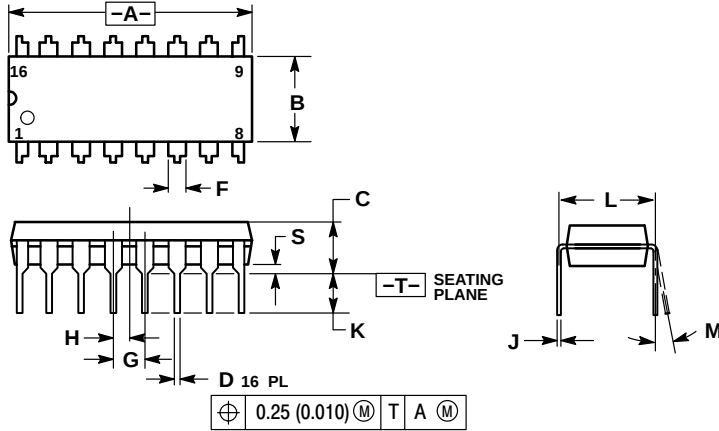
| Characteristic                                                                             | 500 kHz Circuit | 32 kHz Circuit | Unit |
|--------------------------------------------------------------------------------------------|-----------------|----------------|------|
| Crystal Characteristics                                                                    |                 |                |      |
| Resonant Frequency                                                                         | 500             | 32             | kHz  |
| Equivalent Resistance, $R_S$                                                               | 1.0             | 6.2            | kΩ   |
| External Resistor/Capacitor Values                                                         |                 |                |      |
| $R_0$                                                                                      | 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 (Note 6)  | +100            | +120           | ppm  |
| $T_A$ Change from $+25^\circ\text{C}$ to $+125^\circ\text{C}$ Complete Oscillator (Note 6) | -160            | -560           | ppm  |

6. Complete oscillator includes crystal, capacitors, and resistors.

# MC14060B

## PACKAGE DIMENSIONS

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

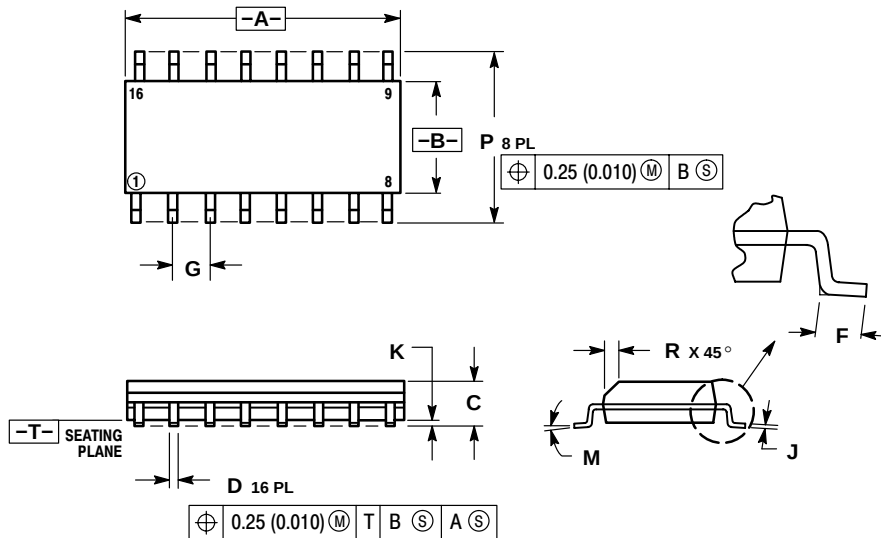


### NOTES:

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.

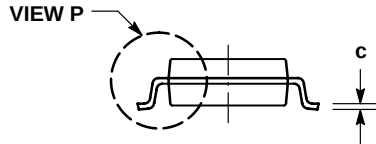
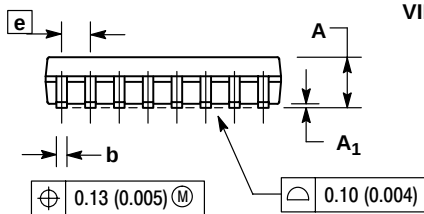
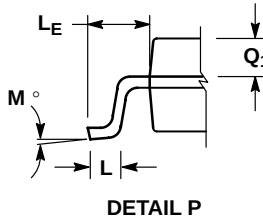
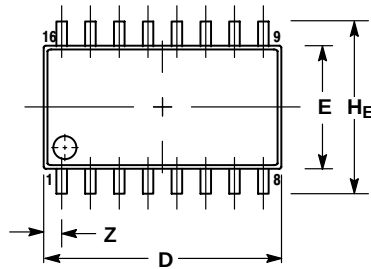
| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.80        | 10.00 | 0.386     | 0.393 |
| B   | 3.80        | 4.00  | 0.150     | 0.157 |
| C   | 1.35        | 1.75  | 0.054     | 0.068 |
| 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 |



# MC14060B

## 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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