# MC14060B

## 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.

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 $V_{SS} \leq (V_{in}$ 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.

### Features

- 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
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free and are RoHS Compliant

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

| 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 | ±10 | mA |
| $P_D$ | Power Dissipation, per Package (Note 1) | 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 |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
1. Temperature Derating: "D/DW" Packages: −7.0 mW/°C from 65°C To 125°C.
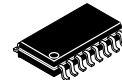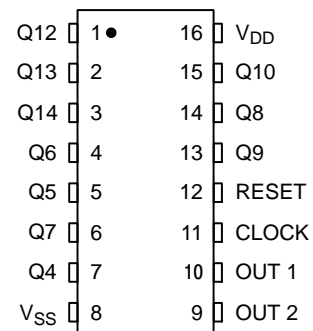
## ON Semiconductor®

http://onsemi.com
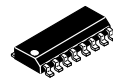
**SOIC−16**
D SUFFIX
CASE 751B

**SOEIAJ−16**
F SUFFIX
CASE 966

**TSSOP−16**
DT SUFFIX
CASE 948F

### PIN ASSIGNMENT

| | | | |
|---|---|---|---|
| Q12 | 1● | 16 | $V_{DD}$ |
| 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 |
| $V_{SS}$ | 8 | 9 | OUT 2 |

### MARKING DIAGRAMS

16
14060BG
AWLYWW
1

**SOIC−16**

16
MC14060B
ALYWG
1

**SOEIAJ−16**

16
14
060B
ALYW ▪
1
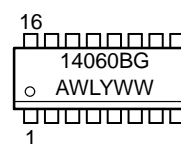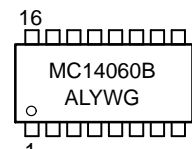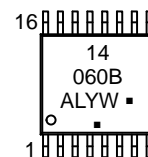
**TSSOP−16**

| A | = Assembly Location |
|---|---|
| WL, L | = Wafer Lot |
| YY, Y | = Year |
| WW, W | = Work Week |
| G or ▪ | = Pb−Free Package |

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

August, 2014 – Rev. 10

Publication Order Number:
**MC14060B/D**

# MC14060B

## 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 1. Logic Diagram**

Q6 = PIN 4    Q8 = PIN 14    Q10 = PIN 15    $V_{DD}$ = PIN 16
Q7 = PIN 6    Q9 = PIN 13                     $V_{SS}$ = PIN 8
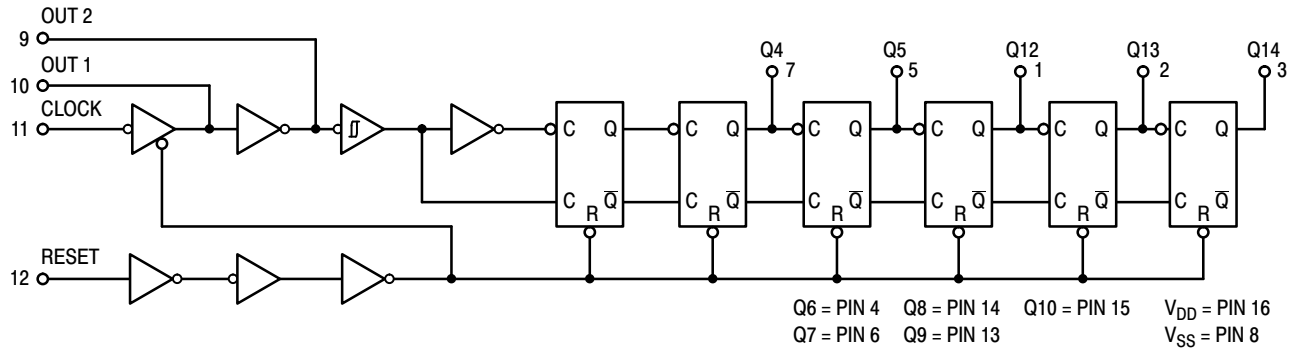
## ORDERING INFORMATION

| Device | Package | Shipping[†] |
|--------|---------|-------------|
| MC14060BDG | SOIC−16 (Pb−Free) | 48 Units / Rail |
| NLV14060BDG* | SOIC−16 (Pb−Free) | 48 Units / Rail |
| MC14060BDR2G | SOIC−16 (Pb−Free) | 2500 / Tape & Reel |
| NLV14060BDR2G* | SOIC−16 (Pb−Free) | 2500 / Tape & Reel |
| MC14060BDTR2G | TSSOP−16 (Pb−Free) | 2500 / Tape & Reel |
| NLV14060BDTR2G* | TSSOP−16 (Pb−Free) | 2500 / Tape & Reel |
| MC14060BFELG | SOEIAJ−16 (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.
*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

# MC14060B

**ELECTRICAL CHARACTERISTICS** (Voltages Referenced to $V_{SS}$)

| Symbol | Characteristic | $V_{DD}$ Vdc | −55°C Min | −55°C Max | 25°C Min | 25°C Typ (Note 2) | 25°C Max | 125°C Min | 125°C Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{OL}$ | Output Voltage "0" Level $V_{in} = V_{DD}$ or 0 | 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 | |
| $V_{OH}$ | $V_{in} = 0$ or $V_{DD}$ "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 | – | |
| $V_{IL}$ | Input Voltage "0" Level ($V_O$ = 4.5 or 0.5 V) ($V_O$ = 9.0 or 1.0 V) ($V_O$ = 13.5 or 1.5 V) | 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 | |
| $V_{IH}$ | ($V_O$ = 0.5 or 4.5 V) "1" Level ($V_O$ = 1.0 or 9.0 V) ($V_O$ = 1.5 or 13.5 V) | 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 | – | |
| $V_{IL}$ | Input Voltage "0" Level ($V_O$ = 4.5 Vdc) (For Input 11 ($V_O$ = 9.0 Vdc) and Output 10) ($V_O$ = 13.5 Vdc) | 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 | |
| $V_{IH}$ | ($V_O$ = 0.5 Vdc) "1" Level ($V_O$ = 1.0 Vdc) ($V_O$ = 1.5 Vdc) | 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 | – | |
| $I_{OH}$ | Output Drive Current ($V_{OH}$ = 2.5 V) (Except Source ($V_{OH}$ = 4.6 V) Pins 9 and 10) ($V_{OH}$ = 9.5 V) ($V_{OH}$ = 13.5 V) | 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 | – | |
| $I_{OL}$ | ($V_{OL}$ = 0.4 V) Sink ($V_{OL}$ = 0.5 V) ($V_{OL}$ = 1.5 V) | 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 | – | |
| $I_{in}$ | Input Current | 15 | – | ±0.1 | – | ±0.00001 | ±0.1 | – | ±1.0 | µA |
| $C_{in}$ | Input Capacitance ($V_{in} = 0$) | – | – | – | – | 5.0 | 7.5 | – | – | pF |
| $I_{DD}$ | Quiescent Current (Per Package) | 5.0 | – | 5.0 | – | 0.005 | 5.0 | – | 150 | µA |
| | | 10 | – | 10 | – | 0.010 | 10 | – | 300 | |
| | | 15 | – | 20 | – | 0.015 | 20 | – | 600 | |
| $I_T$ | Total Supply Current (Notes 3, 4) (Dynamic plus Quiescent, Per Package) ($C_L$ = 50 pF on all outputs, all buffers switching) | 5.0 10 15 | $I_T = (0.25\ \mu A/kHz)\ f + I_{DD}$ $I_T = (0.54\ \mu A/kHz)\ f + I_{DD}$ $I_T = (0.85\ \mu A/kHz)\ f + I_{DD}$ | | | | | | | µA |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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: $I_T(C_L) = I_T(50\ pF) + (C_L − 50)\ Vfk$
   where: $I_T$ is in µA (per package), $C_L$ in pF, $V = (V_{DD} − V_{SS})$ in volts, f in kHz is input frequency, and k = 0.002.

## SWITCHING CHARACTERISTICS ($C_L$ = 50 pF, $T_A$ = 25°C)

| Symbol | Characteristic | $V_{DD}$ Vdc | Min | Typ (Note 5) | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{TLH}$ | Output Rise Time (Counter Outputs) | 5.0<br>10<br>15 | –<br>–<br>– | 40<br>25<br>20 | 200<br>100<br>80 | ns |
| $t_{THL}$ | Output Fall Time (Counter Outputs) | 5.0<br>10<br>15 | –<br>–<br>– | 50<br>30<br>20 | 200<br>100<br>80 | ns |
| $t_{PLH}$<br>$t_{PHL}$ | 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 |
| $t_{wH}$ | Clock Pulse Width | 5.0<br>10<br>15 | 100<br>40<br>30 | 65<br>30<br>20 | –<br>–<br>– | ns |
| $f_\phi$ | Clock Pulse Frequency | 5.0<br>10<br>15 | –<br>–<br>– | 5<br>14<br>17 | 3.5<br>8<br>12 | MHz |
| $t_{TLH}$<br>$t_{THL}$ | Clock Rise and Fall Time | 5.0<br>10<br>15 | No Limit | | | ns |
| $t_w$ | Reset Pulse Width | 5.0<br>10<br>15 | 120<br>60<br>40 | 40<br>15<br>10 | –<br>–<br>– | ns |
| $t_{PHL}$ | 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.
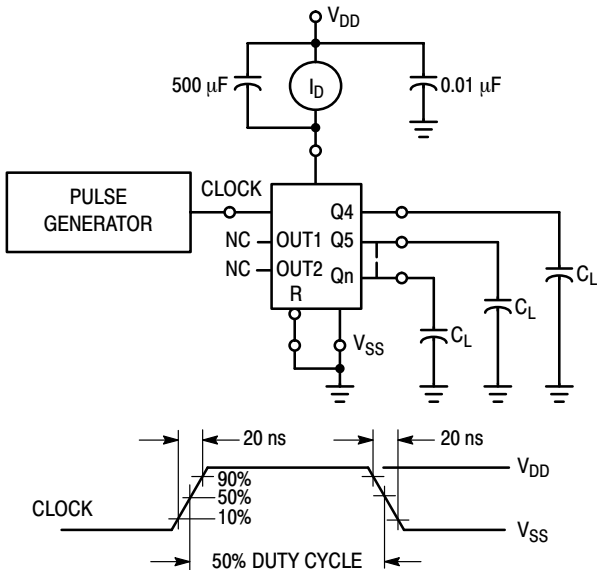


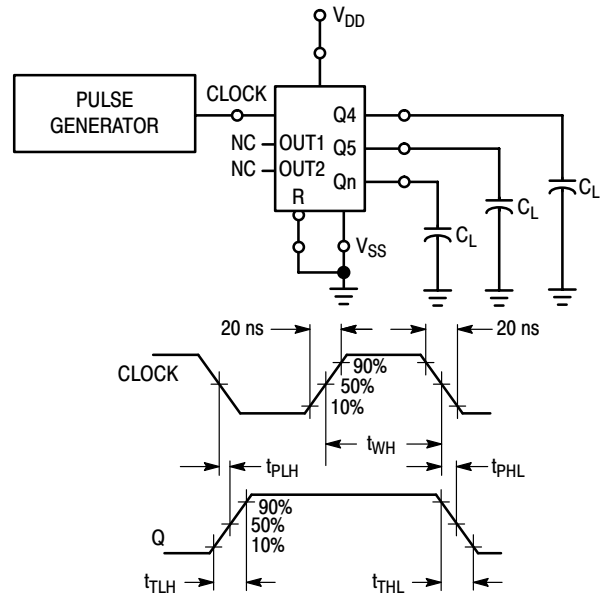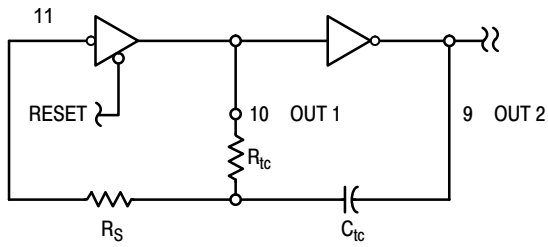**Figure 1. Power Dissipation Test Circuit and Waveform**



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

# MC14060B



$$f \approx \frac{1}{2.3\,R_{tc}C_{tc}}$$

if 1 kHz ≤ f ≤ 100 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**
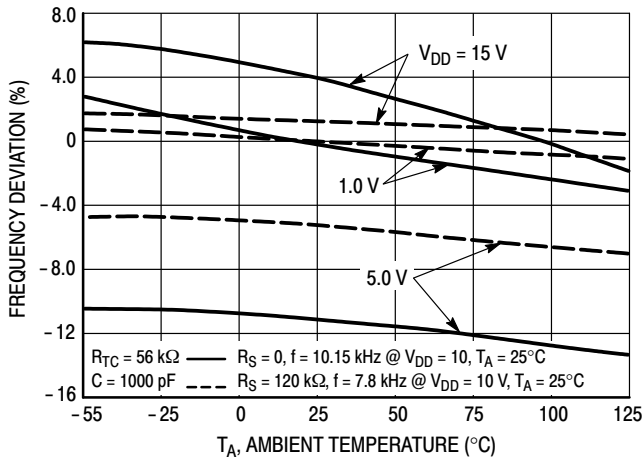
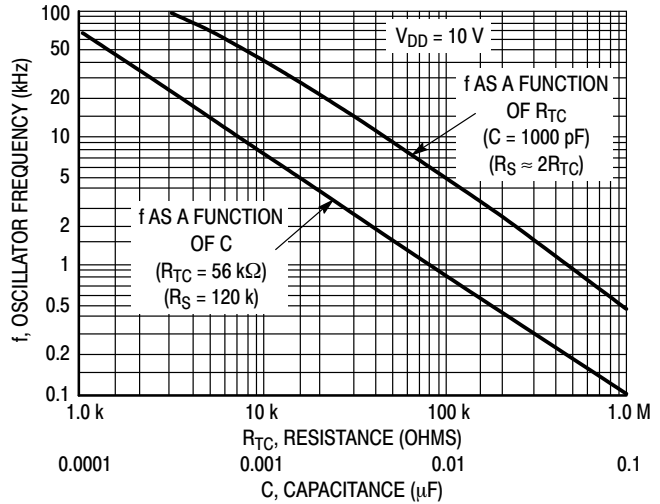## TYPICAL RC OSCILLATOR CHARACTERISTICS



**Figure 4. RC Oscillator Stability**



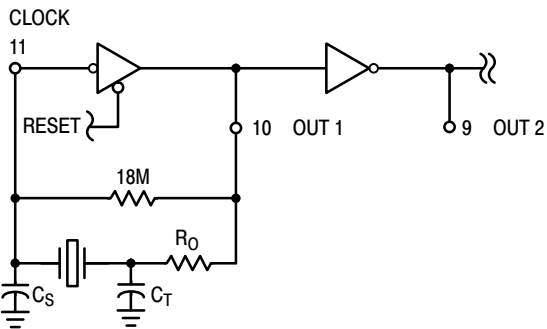**Figure 5. RC Oscillator Frequency as a Function of $R_{TC}$ and C**



**Figure 6. Typical Crystal Oscillator Circuit**

**Table 2. Typical Data for Crystal Oscillator Circuit**

| Characteristic | 500 kHz Circuit | 32 kHz Circuit | Unit |
|---|---|---|---|
| Crystal Characteristics<br>Resonant Frequency<br>Equivalent Resistance, $R_S$ | 500<br>1.0 | 32<br>6.2 | kHz<br>kΩ |
| External Resistor/Capacitor Values<br>$R_O$<br>$C_T$<br>$C_S$ | 47<br>82<br>20 | 750<br>82<br>20 | kΩ<br>pF<br>pF |
| Frequency Stability<br>  Frequency Changes as a<br>  Function of $V_{DD}$ ($T_A$ = 25°C)<br>    $V_{DD}$ Change from 5.0 V to 10 V<br>    $V_{DD}$ Change from 10 V to 15 V<br>    Frequency Change as a Function of<br>Temperature ($V_{DD}$ = 10 V)<br>$T_A$ Change from – 55°C to<br> +25°C Complete Oscillator (Note 6)<br>$T_A$ Change from + 25°C to<br> +125°C Complete Oscillator<br>(Note 6) | <br><br><br>+6.0<br>+2.0<br><br><br><br>+100<br><br>–160 | <br><br><br>+2.0<br>+2.0<br><br><br><br>+120<br><br>–560 | <br><br><br>ppm<br>ppm<br><br><br><br>ppm<br><br>ppm |

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

## PACKAGE DIMENSIONS

**SOIC−16**
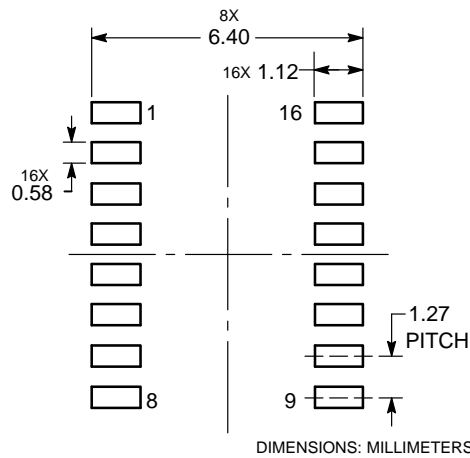**D SUFFIX**
CASE 751B−05
ISSUE K
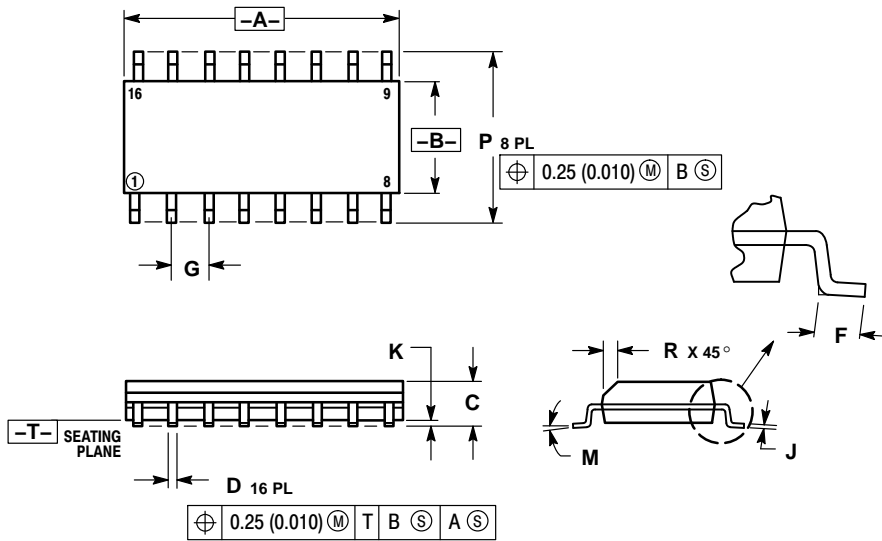
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) 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 |

## SOLDERING FOOTPRINT*
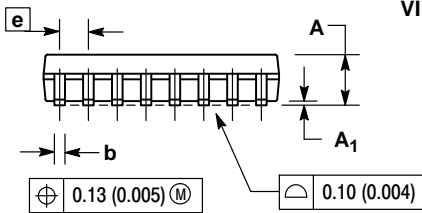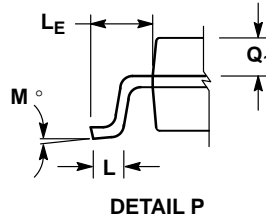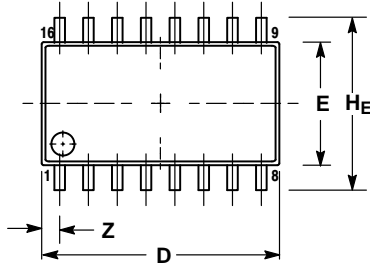
DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# MC14060B

## PACKAGE DIMENSIONS

**TSSOP−16**
**DT SUFFIX**
CASE 948F
ISSUE B

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 ° |

SECTION N–N

DETAIL E

## SOLDERING FOOTPRINT*

7.06

0.65 PITCH

16X 0.36

16X 1.26

DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## PACKAGE DIMENSIONS

**SOEIAJ–16**
**F SUFFIX**
CASE 966
ISSUE A
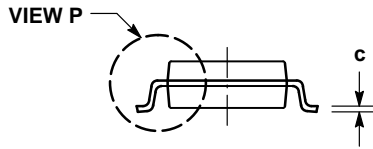


**DETAIL P**

**VIEW P**

⊕ | 0.13 (0.005) Ⓜ

△ | 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 |
| A₁ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.10 | 0.20 | 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_E | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| L_E | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0 ° | 10 ° | 0 ° | 10 ° |
| Q₁ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
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