# MC14024B

# 7-Stage Ripple Counter

The MC14024B is a 7−stage ripple counter with short propagation delays and high maximum clock rates. The Reset input has standard noise immunity, however the Clock input has increased noise immunity due to Hysteresis. The output of each counter stage is buffered.

### Features

- Diode Protection on All Inputs
- Output Transitions Occur on the Falling Edge of the Clock Pulse
- 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
- Pin−for−Pin Replacement for CD4024B
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- This Device is Pb−Free and is 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.

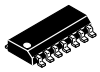
1. Temperature Derating: “D/DW” Packages: –7.0 mW/°C From 65°C To 125°C

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 $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$.

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

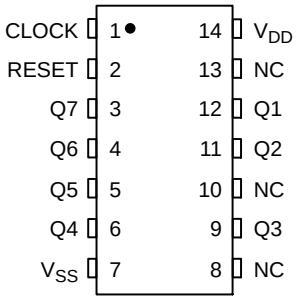
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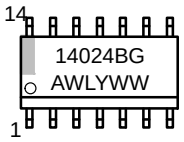
**SOIC−14**
**D SUFFIX**
**CASE 751A**

### PIN ASSIGNMENT




$V_{DD}$ = PIN 14
$V_{SS}$ = PIN 7
NC = NO CONNECTION

### MARKING DIAGRAM




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

### ORDERING INFORMATION

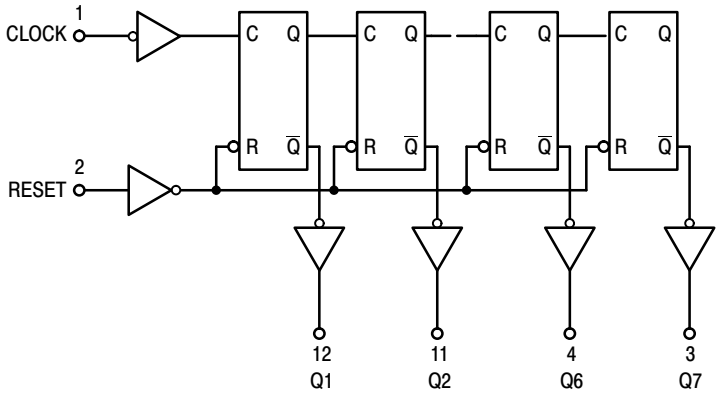
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

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### TRUTH TABLE

| Clock | Reset | State |
|---|---|---|
| 0 | 0 | No Change |
| 0 | 1 | All Outputs Low |
| 1 | 0 | No Change |
| 1 | 1 | All Outputs Low |
| ↗ | 0 | No Change |
| ↗ | 1 | All Outputs Low |
| ↘ | 0 | Advance One Count |
| ↘ | 1 | All Outputs Low |

### LOGIC DIAGRAM




Q3 = PIN 9
Q4 = PIN 6
Q5 = PIN 5

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| MC14024BDG | SOIC−14 (Pb−Free) | 55 Units / Rail |
| NLV14024BDG* | SOIC−14 (Pb−Free) | 55 Units / Rail |
| MC14024BDR2G | SOIC−14 (Pb−Free) | 2500 / Tape & Reel |
| NLV14024BDR2G* | SOIC−14 (Pb−Free) | 2500 / 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.

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

| Characteristic | Symbol | $V_{DD}$ 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Output Voltage “0” Level | $V_{OL}$ | 5.0 | − | 0.05 | − | 0 | 0.05 | − | 0.05 | Vdc |
| $V_{in}$ = $V_{DD}$ or 0 | | 10 | − | 0.05 | − | 0 | 0.05 | − | 0.05 | |
| | | 15 | − | 0.05 | − | 0 | 0.05 | − | 0.05 | |
| $V_{in}$ = 0 or $V_{DD}$ “1” Level | $V_{OH}$ | 5.0 | 4.95 | − | 4.95 | 5.0 | − | 4.95 | − | Vdc |
| | | 10 | 9.95 | − | 9.95 | 10 | − | 9.95 | − | |
| | | 15 | 14.95 | − | 14.95 | 15 | − | 14.95 | − | |
| Input Voltage “0” Level | $V_{IL}$ | | | | | | | | | Vdc |
| ($V_O$ = 4.5 or 0.5 Vdc) | | 5.0 | − | 1.5 | − | 2.25 | 1.5 | − | 1.5 | |
| ($V_O$ = 9.0 or 1.0 Vdc) | | 10 | − | 3.0 | − | 4.50 | 3.0 | − | 3.0 | |
| ($V_O$ = 13.5 or 1.5 Vdc) | | 15 | − | 4.0 | − | 6.75 | 4.0 | − | 4.0 | |
| ($V_O$ = 0.5 or 4.5 Vdc) “1” Level | $V_{IH}$ | 5.0 | 3.5 | − | 3.5 | 2.75 | − | 3.5 | − | Vdc |
| ($V_O$ = 1.0 or 9.0 Vdc) | | 10 | 7.0 | − | 7.0 | 5.50 | − | 7.0 | − | |
| ($V_O$ = 1.5 or 13.5 Vdc) | | 15 | 11 | − | 11 | 8.25 | − | 11 | − | |
| Output Drive Current | $I_{OH}$ | | | | | | | | | mAdc |
| ($V_{OH}$ = 2.5 Vdc) Source | | 5.0 | –3.0 | − | –2.4 | –4.2 | − | –1.7 | − | |
| ($V_{OH}$ = 4.6 Vdc) | | 5.0 | –0.64 | − | –0.51 | –0.88 | − | −0.36 | − | |
| ($V_{OH}$ = 9.5 Vdc) | | 10 | –1.6 | − | −1.3 | –2.25 | − | –0.9 | − | |
| ($V_{OH}$ = 13.5 Vdc) | | 15 | –4.2 | − | −3.4 | −8.8 | − | −2.4 | − | |
| ($V_{OL}$ = 0.4 Vdc) Sink | $I_{OL}$ | 5.0 | 0.64 | − | 0.51 | 0.88 | − | 0.36 | − | mAdc |
| ($V_{OL}$ = 0.5 Vdc) | | 10 | 1.6 | − | 1.3 | 2.25 | − | 0.9 | − | |
| ($V_{OL}$ = 1.5 Vdc) | | 15 | 4.2 | − | 3.4 | 8.8 | − | 2.4 | − | |
| Input Current | $I_{in}$ | 15 | − | ±0.1 | − | ±0.00001 | ±0.1 | − | ±1.0 | μAdc |
| Input Capacitance ($V_{in}$ = 0) | $C_{in}$ | − | − | − | − | 5.0 | 7.5 | − | − | pF |
| Quiescent Current (Per Package) | $I_{DD}$ | 5.0 | − | 5.0 | − | 0.005 | 5.0 | − | 150 | μAdc |
| | | 10 | − | 10 | − | 0.010 | 10 | − | 300 | |
| | | 15 | − | 20 | − | 0.015 | 20 | − | 600 | |
| Total Supply Current (Notes 3 & 4) (Dynamic plus Quiescent, Per Package) ($C_L$ = 50 pF on all outputs, all buffers switching) | $I_T$ | 5.0 | $I_T$ = (0.31 μA/kHz) f + $I_{DD}$ | | | | | | | μAdc |
| | | 10 | $I_T$ = (0.60 μA/kHz) f + $I_{DD}$ | | | | | | | |
| | | 15 | $I_T$ = (1.89 μA/kHz) f + $I_{DD}$ | | | | | | | |

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 = 0.001.

**SWITCHING CHARACTERISTICS** (Note 5) ($C_L$ = 50 pF, $T_A$ = 25°C)

| Characteristic | Symbol | $V_{DD}$ | Min | Typ (Note 6) | Max | Unit |
|---|---|---|---|---|---|---|
| Output Rise and Fall Time | $t_{TLH}$, | | | | | ns |
| $t_{TLH}$, $t_{THL}$ = (1.5 ns/pF) $C_L$ + 25 ns | $t_{THL}$ | 5.0 | – | 100 | 200 | |
| $t_{TLH}$, $t_{THL}$ = (0.75 ns/pF) $C_L$ + 12.5 ns | | 10 | – | 50 | 100 | |
| $t_{TLH}$, $t_{THL}$ = (0.55 ns/pF) $C_L$ + 9.5 ns | | 15 | – | 40 | 80 | |
| Propagation Delay Time | $t_{PLH}$, | | | | | ns |
| Clock to Q1 | $t_{PHL}$ | | | | | |
| $t_{PLH}$, $t_{PHL}$ = (1.7 ns/pF) $C_L$ + 295 ns | | 5.0 | – | 380 | 600 | |
| $t_{PLH}$, $t_{PHL}$ = (0.66 ns/pF) $C_L$ + 117 ns | | 10 | – | 150 | 230 | |
| $t_{PLH}$, $t_{PHL}$ = (0.5 ns/pF) $C_L$ + 85 ns | | 15 | – | 110 | 175 | |
| Clock to Q7 | | | | | | |
| $t_{PLH}$, $t_{PHL}$ = (1.7 ns/pF) $C_L$ + 915 ns | | 5.0 | – | 1000 | 2000 | |
| $t_{PLH}$, $t_{PHL}$ = (0.66 ns/pF) $C_L$ + 367 ns | | 10 | – | 400 | 750 | |
| $t_{PLH}$, $t_{PHL}$ = (0.5 ns/pF) $C_L$ + 275 ns | | 15 | – | 300 | 565 | |
| Reset to $Q_n$ | | | | | | |
| $t_{PLH}$, $t_{PHL}$ = (1.7 ns/pF) $C_L$ + 415 ns | | 5.0 | – | 500 | 800 | |
| $t_{PLH}$, $t_{PHL}$ = (0.66 ns/pF) $C_L$ + 217 ns | | 10 | – | 250 | 400 | |
| $t_{PLH}$, $t_{PHL}$ = (0.5 ns/pF) $C_L$ + 155 ns | | 15 | – | 180 | 300 | |
| Clock Pulse Width | $t_{WH}$ | 5.0 | 500 | 200 | – | ns |
| | | 10 | 165 | 60 | – | |
| | | 15 | 125 | 40 | – | |
| Reset Pulse Width | $t_{WH}$ | 5.0 | 600 | 375 | – | ns |
| | | 10 | 350 | 200 | – | |
| | | 15 | 260 | 150 | – | |
| Reset Removal Time | $t_{rem}$ | 5.0 | 625 | 250 | – | ns |
| | | 10 | 190 | 75 | – | |
| | | 15 | 145 | 50 | – | |
| Clock Input Rise and Fall Time | $t_{TLH}$, $t_{THL}$ | 5.0 | – | – | 1.0 | s |
| | | 10 | – | – | 8.0 | ms |
| | | 15 | – | – | 200 | μs |
| Input Pulse Frequency | $f_{cl}$ | 5.0 | – | 2.5 | 1.0 | MHz |
| | | 10 | – | 8.0 | 3.0 | |
| | | 15 | – | 12 | 4.0 | |

5. The formulas given are for the typical characteristics only at 25°C.
6. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

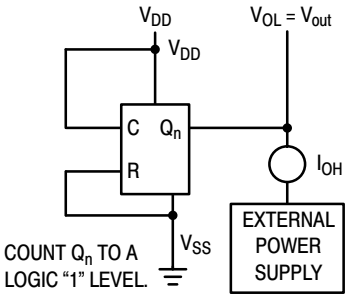



**Figure 1. Typical Output Source Characteristics Test Circuit**

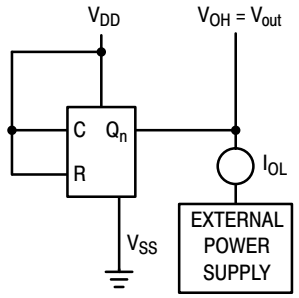



**Figure 2. Typical Output Sink Characteristics Test Circuit**

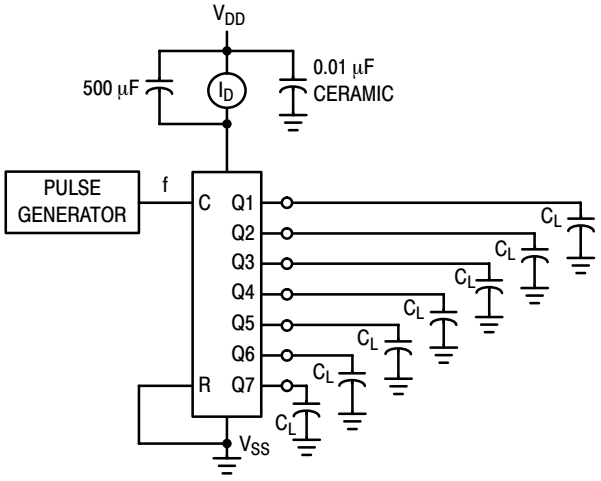



**Figure 3. Power Dissipation Test Circuit**

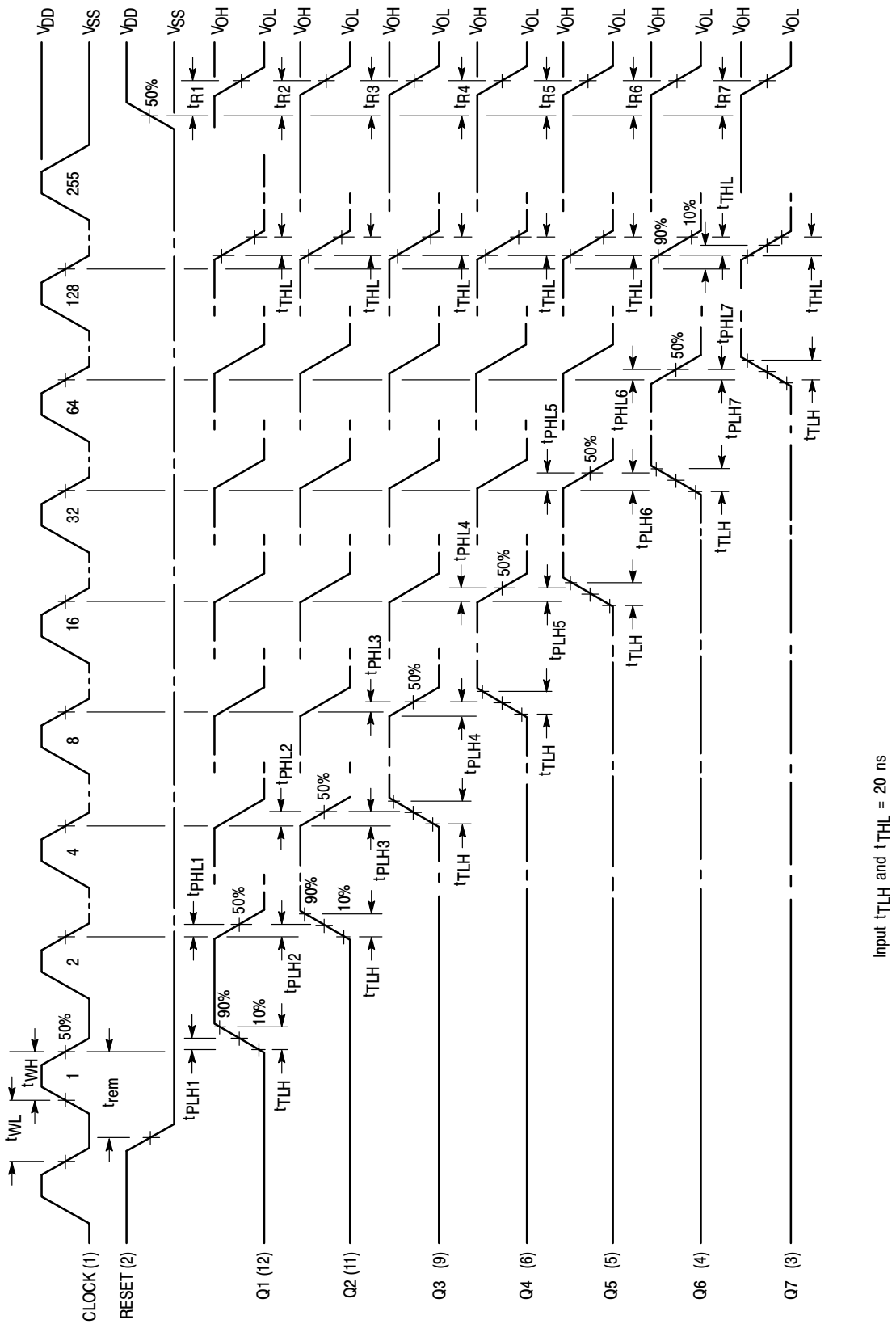
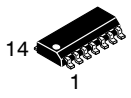



**Figure 4. Functional Waveforms**

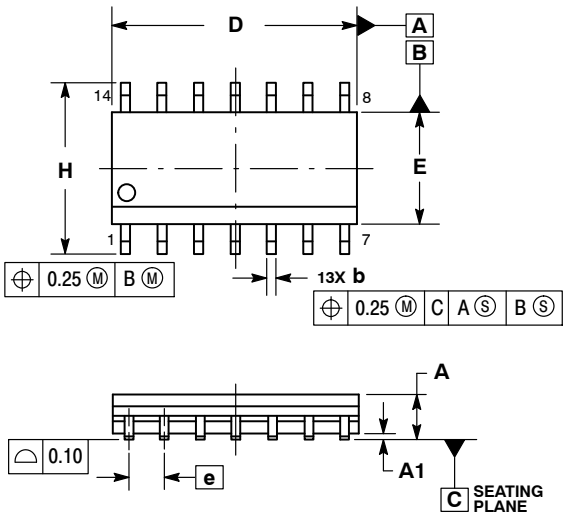
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

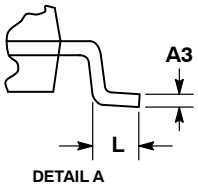


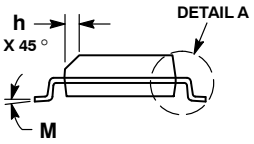

**SCALE 1:1**

**SOIC−14 NB**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016



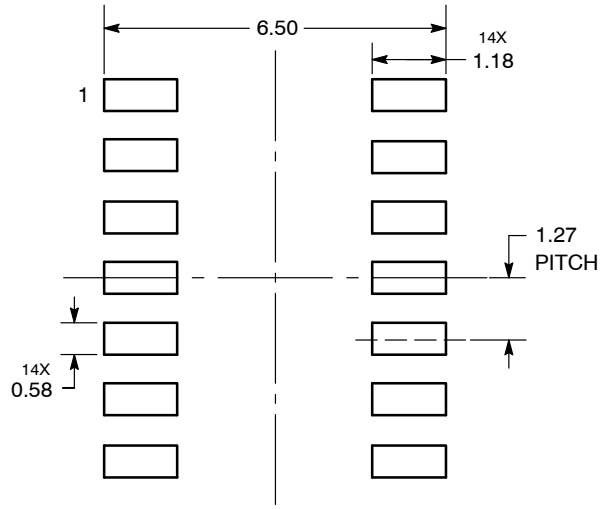




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.35 | 1.75 | 0.054 | 0.068 |
| A1 | 0.10 | 0.25 | 0.004 | 0.010 |
| A3 | 0.19 | 0.25 | 0.008 | 0.010 |
| b | 0.35 | 0.49 | 0.014 | 0.019 |
| D | 8.55 | 8.75 | 0.337 | 0.344 |
| E | 3.80 | 4.00 | 0.150 | 0.157 |
| e | 1.27 BSC | | 0.050 BSC | |
| H | 5.80 | 6.20 | 0.228 | 0.244 |
| h | 0.25 | 0.50 | 0.010 | 0.019 |
| L | 0.40 | 1.25 | 0.016 | 0.049 |
| M | 0 ° | 7 ° | 0 ° | 7 ° |

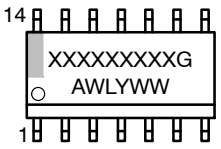
### SOLDERING FOOTPRINT*




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.

### GENERIC MARKING DIAGRAM*




XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

**STYLES ON PAGE 2**

| | | | |
|---|---|---|---|
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| **DESCRIPTION:** | **SOIC−14 NB** | | **PAGE 1 OF 2** |

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**SOIC−14**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016

STYLE 1:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. NO CONNECTION
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. NO CONNECTION
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 2:
CANCELLED

STYLE 3:
PIN 1. NO CONNECTION
2. ANODE
3. ANODE
4. NO CONNECTION
5. ANODE
6. NO CONNECTION
7. ANODE
8. ANODE
9. ANODE
10. NO CONNECTION
11. ANODE
12. ANODE
13. NO CONNECTION
14. COMMON CATHODE

STYLE 4:
PIN 1. NO CONNECTION
2. CATHODE
3. CATHODE
4. NO CONNECTION
5. CATHODE
6. NO CONNECTION
7. CATHODE
8. CATHODE
9. CATHODE
10. NO CONNECTION
11. CATHODE
12. CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 5:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. NO CONNECTION
7. COMMON ANODE
8. COMMON CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 6:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. ANODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE

STYLE 7:
PIN 1. ANODE/CATHODE
2. COMMON ANODE
3. COMMON CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. ANODE/CATHODE
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. COMMON CATHODE
12. COMMON ANODE
13. ANODE/CATHODE
14. ANODE/CATHODE

STYLE 8:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. ANODE/CATHODE
7. COMMON ANODE
8. COMMON ANODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. NO CONNECTION
12. ANODE/CATHODE
13. ANODE/CATHODE
14. COMMON CATHODE




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