

# 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.

- 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

### MAXIMUM RATINGS (Voltages Referenced to $V_{SS}$ ) (Note NO TAG)

| Symbol               | Parameter                                         | Value                  | Unit |
|----------------------|---------------------------------------------------|------------------------|------|
| $V_{DD}$             | DC Supply Voltage Range                           | -0.5 to +18.0          | V    |
| $V_{in}$ , $V_{out}$ | Input or Output Voltage Range (DC or Transient)   | -0.5 to $V_{DD} + 0.5$ | V    |
| $I_{in}$ , $I_{out}$ | Input or Output Current (DC or Transient) per Pin | $\pm 10$               | mA   |
| $P_D$                | Power Dissipation, per Package (Note NO TAG)      | 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   |

- 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

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

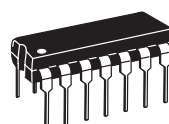
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ). Unused outputs must be left open.



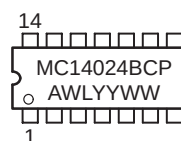
ON Semiconductor

<http://onsemi.com>

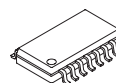
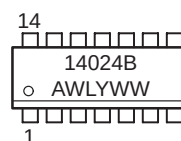
### MARKING DIAGRAMS



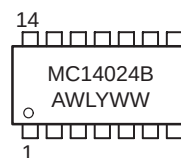
PDIP-14  
P SUFFIX  
CASE 646



SOIC-14  
D SUFFIX  
CASE 751A



SOEIAJ-14  
F SUFFIX  
CASE 965



A = Assembly Location  
WL or L = Wafer Lot  
YY or Y = Year  
WW or W = Work Week

### ORDERING INFORMATION

| Device      | Package   | Shipping         |
|-------------|-----------|------------------|
| MC14024BCP  | PDIP-14   | 2000/Box         |
| MC14024BD   | SOIC-14   | 2750/Box         |
| MC14024BDR2 | SOIC-14   | 2500/Tape & Reel |
| MC14024BF   | SOEIAJ-14 | See Note 1.      |
| MC14024BFEL | SOEIAJ-14 | See Note 1.      |

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

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## TRUTH TABLE

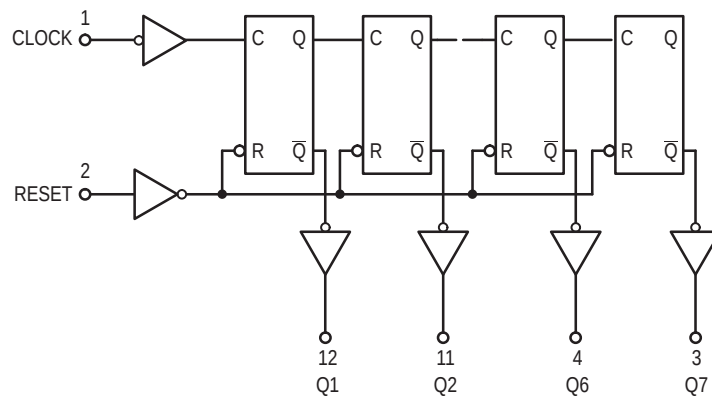
| Clock                                                                             | Reset | State             |
|-----------------------------------------------------------------------------------|-------|-------------------|
| 0                                                                                 | 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   |

## PIN ASSIGNMENT

|          |   |    |          |
|----------|---|----|----------|
| CLOCK    | 1 | 14 | $V_{DD}$ |
| RESET    | 2 | 13 | NC       |
| Q7       | 3 | 12 | Q1       |
| Q6       | 4 | 11 | Q2       |
| Q5       | 5 | 10 | NC       |
| Q4       | 6 | 9  | Q3       |
| $V_{SS}$ | 7 | 8  | NC       |

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

## LOGIC DIAGRAM



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

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

| Characteristic                                                                                                                                                                                                                                     | Symbol                    | V <sub>DD</sub><br>Vdc | - 55°C                                                                                                                                                         |       | 25°C   |           |       | 125°C  |       | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|-----------|-------|--------|-------|------|
|                                                                                                                                                                                                                                                    |                           |                        | Min                                                                                                                                                            | Max   | Min    | Typ (4.)  | Max   | Min    | Max   |      |
| Output Voltage<br>V <sub>in</sub> = V <sub>DD</sub> or 0<br><br>V <sub>in</sub> = 0 or V <sub>DD</sub>                                                                                                                                             | V <sub>OL</sub>           | 5.0                    | —                                                                                                                                                              | 0.05  | —      | 0         | 0.05  | —      | 0.05  | Vdc  |
|                                                                                                                                                                                                                                                    |                           | 10                     | —                                                                                                                                                              | 0.05  | —      | 0         | 0.05  | —      | 0.05  |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | —                                                                                                                                                              | 0.05  | —      | 0         | 0.05  | —      | 0.05  |      |
|                                                                                                                                                                                                                                                    | V <sub>OH</sub>           | 5.0                    | 4.95                                                                                                                                                           | —     | 4.95   | 5.0       | —     | 4.95   | —     | Vdc  |
|                                                                                                                                                                                                                                                    |                           | 10                     | 9.95                                                                                                                                                           | —     | 9.95   | 10        | —     | 9.95   | —     |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | 14.95                                                                                                                                                          | —     | 14.95  | 15        | —     | 14.95  | —     |      |
| Input Voltage<br>(V <sub>O</sub> = 4.5 or 0.5 Vdc)<br>(V <sub>O</sub> = 9.0 or 1.0 Vdc)<br>(V <sub>O</sub> = 13.5 or 1.5 Vdc)<br><br>(V <sub>O</sub> = 0.5 or 4.5 Vdc)<br>(V <sub>O</sub> = 1.0 or 9.0 Vdc)<br>(V <sub>O</sub> = 1.5 or 13.5 Vdc)  | V <sub>IL</sub>           | 5.0                    | —                                                                                                                                                              | 1.5   | —      | 2.25      | 1.5   | —      | 1.5   | Vdc  |
|                                                                                                                                                                                                                                                    |                           | 10                     | —                                                                                                                                                              | 3.0   | —      | 4.50      | 3.0   | —      | 3.0   |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | —                                                                                                                                                              | 4.0   | —      | 6.75      | 4.0   | —      | 4.0   |      |
|                                                                                                                                                                                                                                                    | V <sub>IH</sub>           | 5.0                    | 3.5                                                                                                                                                            | —     | 3.5    | 2.75      | —     | 3.5    | —     | Vdc  |
|                                                                                                                                                                                                                                                    |                           | 10                     | 7.0                                                                                                                                                            | —     | 7.0    | 5.50      | —     | 7.0    | —     |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | 11                                                                                                                                                             | —     | 11     | 8.25      | —     | 11     | —     |      |
| Output Drive Current<br>(V <sub>OH</sub> = 2.5 Vdc)<br>(V <sub>OH</sub> = 4.6 Vdc)<br>(V <sub>OH</sub> = 9.5 Vdc)<br>(V <sub>OH</sub> = 13.5 Vdc)<br><br>(V <sub>OL</sub> = 0.4 Vdc)<br>(V <sub>OL</sub> = 0.5 Vdc)<br>(V <sub>OL</sub> = 1.5 Vdc) | Source<br>I <sub>OH</sub> | 5.0                    | - 3.0                                                                                                                                                          | —     | - 2.4  | - 4.2     | —     | - 1.7  | —     | mAdc |
|                                                                                                                                                                                                                                                    |                           | 5.0                    | - 0.64                                                                                                                                                         | —     | - 0.51 | - 0.88    | —     | - 0.36 | —     |      |
|                                                                                                                                                                                                                                                    |                           | 10                     | - 1.6                                                                                                                                                          | —     | - 1.3  | - 2.25    | —     | - 0.9  | —     |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | - 4.2                                                                                                                                                          | —     | - 3.4  | - 8.8     | —     | - 2.4  | —     |      |
|                                                                                                                                                                                                                                                    | Sink<br>I <sub>OL</sub>   | 5.0                    | 0.64                                                                                                                                                           | —     | 0.51   | 0.88      | —     | 0.36   | —     | mAdc |
|                                                                                                                                                                                                                                                    |                           | 10                     | 1.6                                                                                                                                                            | —     | 1.3    | 2.25      | —     | 0.9    | —     |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | 4.2                                                                                                                                                            | —     | 3.4    | 8.8       | —     | 2.4    | —     |      |
| Input Current                                                                                                                                                                                                                                      | I <sub>in</sub>           | 15                     | —                                                                                                                                                              | ± 0.1 | —      | ± 0.00001 | ± 0.1 | —      | ± 1.0 | μAdc |
| Input Capacitance<br>(V <sub>in</sub> = 0)                                                                                                                                                                                                         | C <sub>in</sub>           | —                      | —                                                                                                                                                              | —     | —      | 5.0       | 7.5   | —      | —     | pF   |
| Quiescent Current<br>(Per Package)                                                                                                                                                                                                                 | I <sub>DD</sub>           | 5.0                    | —                                                                                                                                                              | 5.0   | —      | 0.005     | 5.0   | —      | 150   | μAdc |
|                                                                                                                                                                                                                                                    |                           | 10                     | —                                                                                                                                                              | 10    | —      | 0.010     | 10    | —      | 300   |      |
|                                                                                                                                                                                                                                                    |                           | 15                     | —                                                                                                                                                              | 20    | —      | 0.015     | 20    | —      | 600   |      |
| Total Supply Current (5.) (6.)<br>(Dynamic plus Quiescent,<br>Per Package)<br>(C <sub>L</sub> = 50 pF on all outputs, all<br>buffers switching)                                                                                                    | I <sub>T</sub>            | 5.0<br>10<br>15        | I <sub>T</sub> = (0.31 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (0.60 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.89 μA/kHz) f + I <sub>DD</sub> |       |        |           |       |        |       | μAdc |

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

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

6. To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) \text{ Vfk}$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V = (V<sub>DD</sub> - V<sub>SS</sub>) in volts, f in kHz is input frequency, and k = 0.001.

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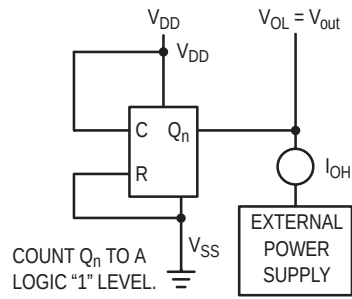
## SWITCHING CHARACTERISTICS <sup>(7.)</sup> ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ )

| Characteristic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Symbol                  | $V_{DD}$                                                      | Min                                               | Typ <sup>(8.)</sup>                                                  | Max                                                                  | Unit                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------|
| Output Rise and Fall Time<br>$t_{TLH}, t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$<br>$t_{TLH}, t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$<br>$t_{TLH}, t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$                                                                                                                                                                                                                                                                                                                                                                                                                                                    | $t_{TLH},$<br>$t_{THL}$ | 5.0<br>10<br>15                                               | —<br>—<br>—                                       | 100<br>50<br>40                                                      | 200<br>100<br>80                                                     | ns                       |
| Propagation Delay Time<br>Clock to Q1<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 295 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 117 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 85 \text{ ns}$<br>Clock to Q7<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 915 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 367 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 275 \text{ ns}$<br>Reset to $Q_n$<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 415 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 217 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 155 \text{ ns}$ | $t_{PLH},$<br>$t_{PHL}$ | 5.0<br>10<br>15<br><br>5.0<br>10<br>15<br><br>5.0<br>10<br>15 | —<br>—<br>—<br><br>—<br>—<br>—<br><br>—<br>—<br>— | 380<br>150<br>110<br><br>1000<br>400<br>300<br><br>500<br>250<br>180 | 600<br>230<br>175<br><br>2000<br>750<br>565<br><br>800<br>400<br>300 | ns                       |
| Clock Pulse Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $t_{WH}$                | 5.0<br>10<br>15                                               | 500<br>165<br>125                                 | 200<br>60<br>40                                                      | —<br>—<br>—                                                          | ns                       |
| Reset Pulse Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $t_{WH}$                | 5.0<br>10<br>15                                               | 600<br>350<br>260                                 | 375<br>200<br>150                                                    | —<br>—<br>—                                                          | ns                       |
| Reset Removal Time                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | $t_{rem}$               | 5.0<br>10<br>15                                               | 625<br>190<br>145                                 | 250<br>75<br>50                                                      | —<br>—<br>—                                                          | ns                       |
| Clock Input Rise and Fall Time                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | $t_{TLH}, t_{THL}$      | 5.0<br>10<br>15                                               | —<br>—<br>—                                       | —<br>—<br>—                                                          | 1.0<br>8.0<br>200                                                    | s<br>ms<br>$\mu\text{s}$ |
| Input Pulse Frequency                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | $f_{cl}$                | 5.0<br>10<br>15                                               | —<br>—<br>—                                       | 2.5<br>8.0<br>12                                                     | 1.0<br>3.0<br>4.0                                                    | MHz                      |

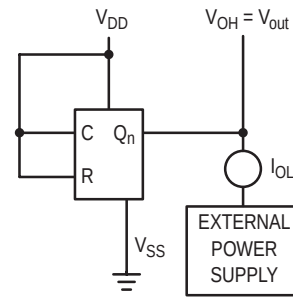
7. The formulas given are for the typical characteristics only at  $25^\circ\text{C}$ .

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

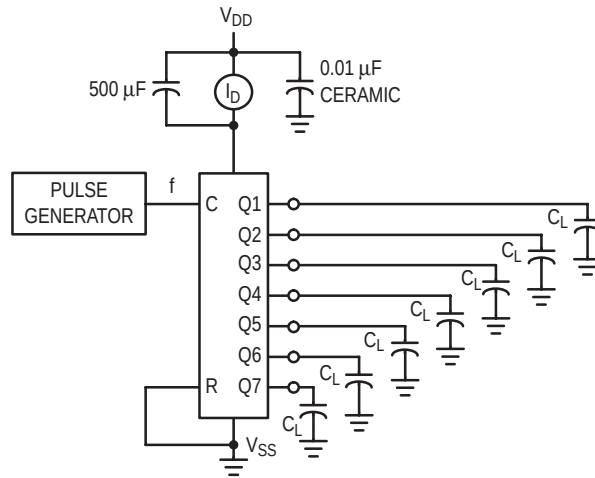
# MC14024B



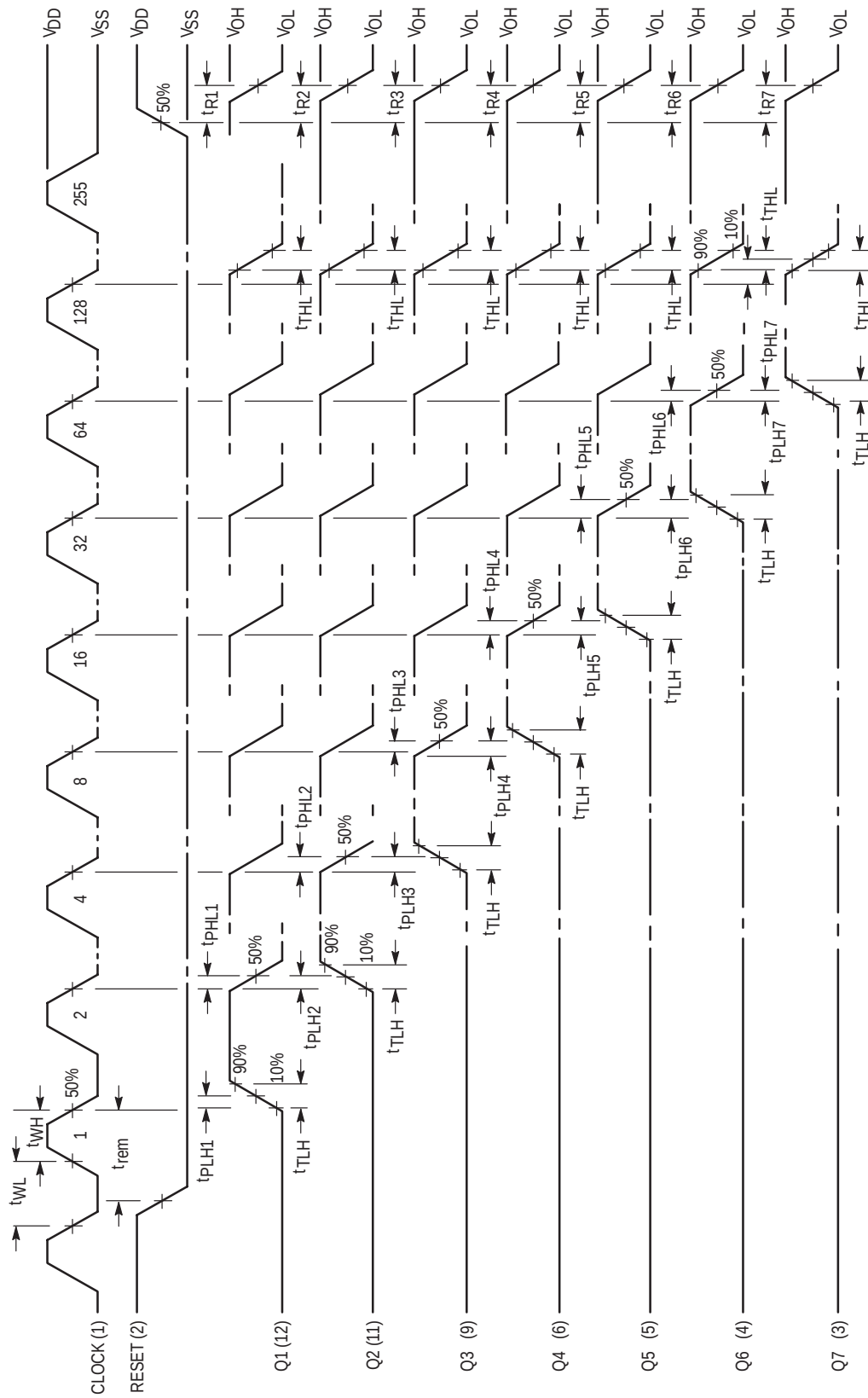
**Figure 1. Typical Output Source Characteristics Test Circuit**



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



**Figure 3. Power Dissipation Test Circuit**



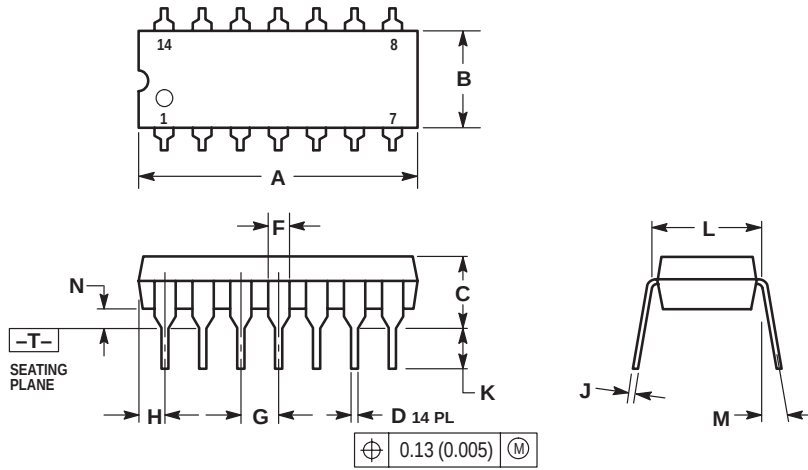
Input  $t_{TLH}$  and  $t_{THL} = 20$  ns

Figure 4. Functional Waveforms

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## PACKAGE DIMENSIONS

### P SUFFIX PLASTIC DIP PACKAGE CASE 646-06 ISSUE M

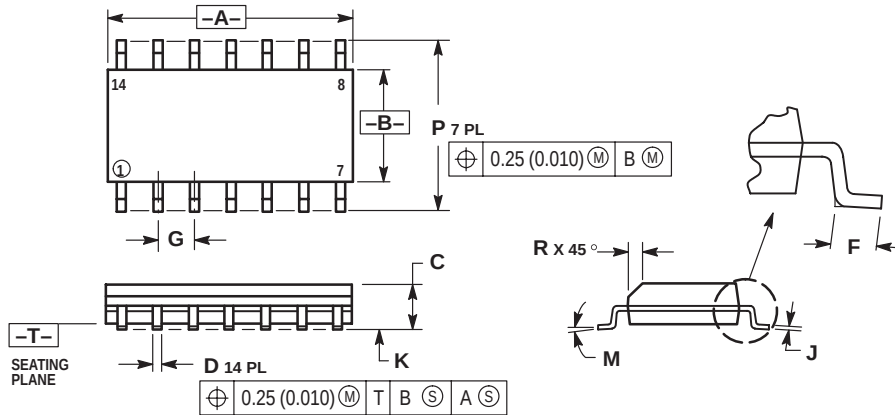


#### NOTES:

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   | 0.715     | 0.770 | 18.16       | 18.80 |
| B   | 0.240     | 0.260 | 6.10        | 6.60  |
| C   | 0.145     | 0.185 | 3.69        | 4.69  |
| D   | 0.015     | 0.021 | 0.38        | 0.53  |
| F   | 0.040     | 0.070 | 1.02        | 1.78  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.052     | 0.095 | 1.32        | 2.41  |
| J   | 0.008     | 0.015 | 0.20        | 0.38  |
| K   | 0.115     | 0.135 | 2.92        | 3.43  |
| L   | 0.290     | 0.310 | 7.37        | 7.87  |
| M   | —         | 10°   | —           | 10°   |
| N   | 0.015     | 0.039 | 0.38        | 1.01  |

### D SUFFIX PLASTIC SOIC PACKAGE CASE 751A-03 ISSUE F



#### NOTES:

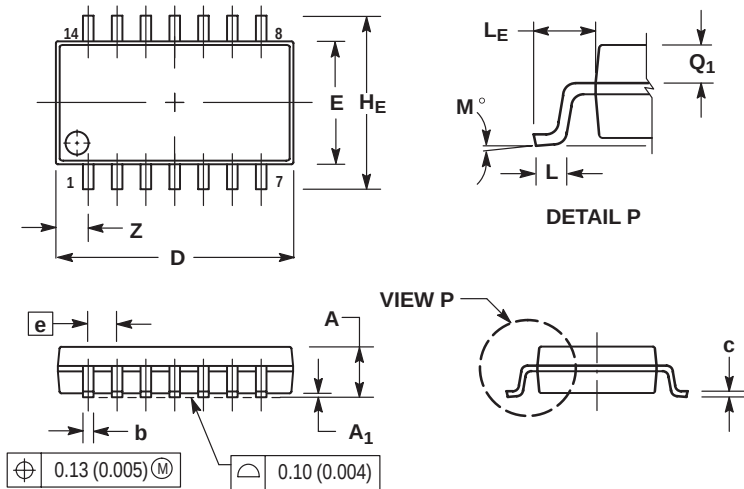
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 8.55        | 8.75 | 0.337     | 0.344 |
| 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   | 5.60        | 6.20 | 0.228     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

# MC14024B

## PACKAGE DIMENSIONS

### F SUFFIX PLASTIC EIAJ SOIC PACKAGE CASE 965-01 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 |
| 0.50           | 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              | —           | 1.42  | —         | 0.056 |

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