

# Binary Up/Down Counter

## MC14516B

The MC14516B synchronous up/down binary counter is constructed with MOS P-channel and N-channel enhancement mode devices in a monolithic structure.

This counter can be preset by applying the desired value, in binary, to the Preset inputs (P0, P1, P2, P3) and then bringing the Preset Enable (PE) high. The direction of counting is controlled by applying a high (for up counting) or a low (for down counting) to the UP/DOWN input. The state of the counter changes on the positive transition of the clock input.

Cascading can be accomplished by connecting the Carry Out to the Carry In of the next stage while clocking each counter in parallel. The outputs (Q0, Q1, Q2, Q3) can be reset to a low state by applying a high to the reset (R) pin.

This CMOS counter finds primary use in up/down and difference counting. Other applications include: (1) Frequency synthesizer applications where low power dissipation and/or high noise immunity is desired, (2) Analog-to-Digital and Digital-to-Analog conversions, and (3) Magnitude and sign generation.

### Features

- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Internally Synchronous for High Speed
- Logic Edge-Clocked Design – Count Occurs on Positive Going Edge of Clock
- Single Pin Reset
- Asynchronous Preset Enable Operation
- Capable of Driving Two Low-Power TTL Loads or One Low-Power Schottky Load Over the Rated Temperature Range
- These Devices are Pb-Free and are RoHS Compliant
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

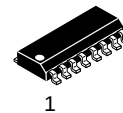
### MAXIMUM RATINGS (Voltages Referenced to V<sub>SS</sub>)

| Parameter                                         | Symbol                             | Value                         | Unit |
|---------------------------------------------------|------------------------------------|-------------------------------|------|
| DC Supply Voltage Range                           | V <sub>DD</sub>                    | -0.5 to +18.0                 | V    |
| Input or Output Voltage Range (DC or Transient)   | V <sub>in</sub> , V <sub>out</sub> | -0.5 to V <sub>DD</sub> + 0.5 | V    |
| Input or Output Current (DC or Transient) per Pin | I <sub>in</sub> , I <sub>out</sub> | ±10                           | mA   |
| Power Dissipation, per Package (Note 1)           | P <sub>D</sub>                     | 500                           | mW   |
| Ambient Temperature Range                         | T <sub>A</sub>                     | -55 to +125                   | °C   |
| Storage Temperature Range                         | T <sub>stg</sub>                   | -65 to +150                   | °C   |
| Lead Temperature (8-Second Soldering)             | T <sub>L</sub>                     | 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. Operating the device outside its recommended conditions, but still within its maximum rated limits may not cause immediate damage. However, doing so can lead to reduced performance, unpredictable behavior, and potentially shorten the device's lifespan or reliability.

1. Temperature Derating: Plastic "DW" Packages:  
- 7.0 mW/°C From 65 °C To 125 °C

### MARKING DIAGRAM



SOIC-16  
D SUFFIX  
CASE 751B



A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

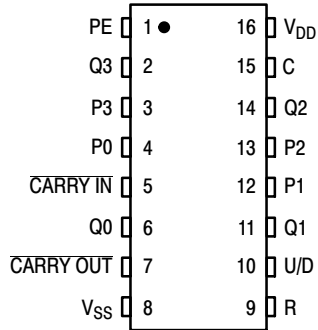
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V<sub>in</sub> and V<sub>out</sub> should be constrained to the range V<sub>SS</sub> ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>DD</sub>.

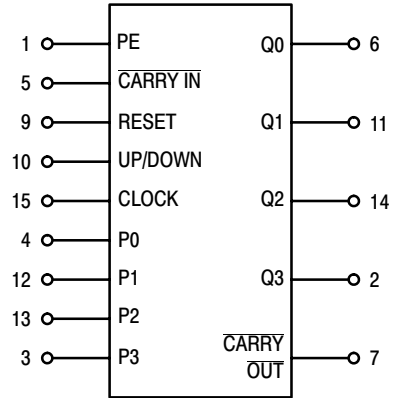
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>). Unused outputs must be left open.

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## PIN ASSIGNMENT



## BLOCK DIAGRAM



V<sub>DD</sub> = PIN 16  
V<sub>SS</sub> = PIN 8

## TRUTH TABLE

| Carry In | Up/Down | Preset Enable | Reset | Clock | Action     |
|----------|---------|---------------|-------|-------|------------|
| 1        | X       | 0             | 0     | X     | No Count   |
| 0        | 1       | 0             | 0     | ⌈     | Count Up   |
| 0        | 0       | 0             | 0     | ⌋     | Count Down |
| X        | X       | 1             | 0     | X     | Preset     |
| X        | X       | X             | 1     | X     | Reset      |

X = Don't Care

NOTE: When counting up, the  $\overline{\text{Carry Out}}$  signal is normally high and is low only when Q0 through Q3 are high and  $\overline{\text{Carry In}}$  is low. When counting down,  $\overline{\text{Carry Out}}$  is low only when Q0 through Q3 and  $\overline{\text{Carry In}}$  are low.

## ORDERING INFORMATION

| Device         | Package           | Shipping <sup>†</sup> |
|----------------|-------------------|-----------------------|
| MC14516BDG     | SOIC-16 (Pb-Free) | 48 Units / Rail       |
| MC14516BDR2G   | SOIC-16 (Pb-Free) | 2500 / Tape & Reel    |
| NLV14516BDR2G* |                   |                       |

<sup>†</sup> 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.

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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<br>(Note 2) | 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>“0” Level<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>“1” Level<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 (V <sub>in</sub> = 0)                                                                                                                                                                                                                                     | C <sub>in</sub>           | –                      | –                                                                                                                                                              | –     | –      | 5.0             | 7.5   | –      | –     | pF   |
| Quiescent Current (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 (Note 3, 4)<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> = (0.58 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.20 μA/kHz) f + I <sub>DD</sub><br>I <sub>T</sub> = (1.70 μA/kHz) f + I <sub>DD</sub> |       |        |                 |       |        |       | μAdc |

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 = 0.001.

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## SWITCHING CHARACTERISTICS (Note 5) ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ )

| Characteristic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Symbol             | $V_{DD}$        | All Types            |                       |                    | Unit          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------|----------------------|-----------------------|--------------------|---------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                 | Min                  | Typ (Note 6)          | Max                |               |
| 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>$t_{TLH}, t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $t_{TLH}, t_{THL}$ | 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 Q<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$<br><br>Clock to $\overline{\text{Carry Out}}$<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$<br><br>$\overline{\text{Carry In}}$ to $\overline{\text{Carry Out}}$<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$<br><br>Preset or Reset to Q<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$<br><br>Preset or Reset to $\overline{\text{Carry Out}}$<br>$t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 465 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 192 \text{ ns}$<br>$t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 125 \text{ ns}$ | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | 315<br>130<br>100     | 630<br>260<br>200  | ns            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | 315<br>130<br>100     | 630<br>260<br>200  | ns            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | 180<br>80<br>60       | 360<br>160<br>120  | ns            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | 315<br>130<br>100     | 630<br>360<br>200  | ns            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $t_{PLH}, t_{PHL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | 550<br>225<br>150     | 1100<br>450<br>300 | ns            |
| Reset Pulse Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $t_w$              | 5.0<br>10<br>15 | 380<br>200<br>160    | 190<br>100<br>80      | –<br>–<br>–        | ns            |
| Clock Pulse Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $t_{WH}$           | 5.0<br>10<br>15 | 350<br>170<br>140    | 200<br>100<br>75      | –<br>–<br>–        | ns            |
| Clock Pulse Frequency                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $f_{cl}$           | 5.0<br>10<br>15 | –<br>–<br>–          | 3.0<br>6.0<br>8.0     | 1.5<br>3.0<br>4.0  | MHz           |
| Preset or Reset Removal Time<br>The Preset or Reset signal must be low prior to a positive-going transition of the clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $t_{rem}$          | 5.0<br>10<br>15 | 650<br>230<br>180    | 325<br>115<br>90      | –<br>–<br>–        | ns            |
| Clock Rise and Fall Time                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | $t_{TLH}, t_{THL}$ | 5.0<br>10<br>15 | –<br>–<br>–          | –<br>–<br>–           | 15<br>5<br>4       | $\mu\text{s}$ |
| Setup Time<br>Carry In to Clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $t_{su}$           | 5.0<br>10<br>15 | 260<br>120<br>100    | 130<br>60<br>50       | –<br>–<br>–        | ns            |
| Hold Time<br>Clock to $\overline{\text{Carry In}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $t_h$              | 5.0<br>10<br>15 | 0<br>20<br>20        | – 60<br>– 20<br>0     | –<br>–<br>–        | ns            |
| Setup Time<br>Up/Down to Clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $t_{su}$           | 5.0<br>10<br>15 | 500<br>200<br>150    | 250<br>100<br>75      | –<br>–<br>–        | ns            |
| Hold Time<br>Clock to Up/Down                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | $t_h$              | 5.0<br>10<br>15 | – 70<br>– 10<br>0    | – 160<br>– 60<br>– 40 | –<br>–<br>–        | ns            |
| Setup Time<br>Pn to PE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $t_{su}$           | 5.0<br>10<br>15 | – 40<br>– 30<br>– 25 | – 120<br>– 70<br>– 50 | –<br>–<br>–        | ns            |
| Hold Time<br>PE to Pn                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $t_h$              | 5.0<br>10<br>15 | 480<br>420<br>420    | 240<br>210<br>210     | –<br>–<br>–        | ns            |
| Preset Enable Pulse Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $t_{WH}$           | 5.0<br>10<br>15 | 200<br>100<br>80     | 100<br>50<br>40       | –<br>–<br>–        | ns            |

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

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

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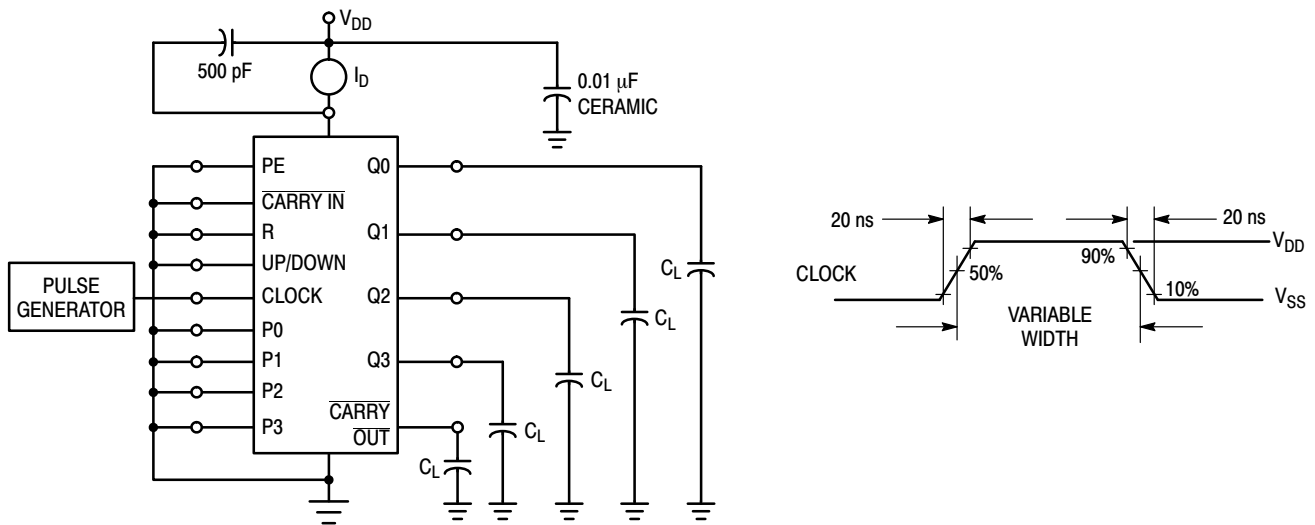
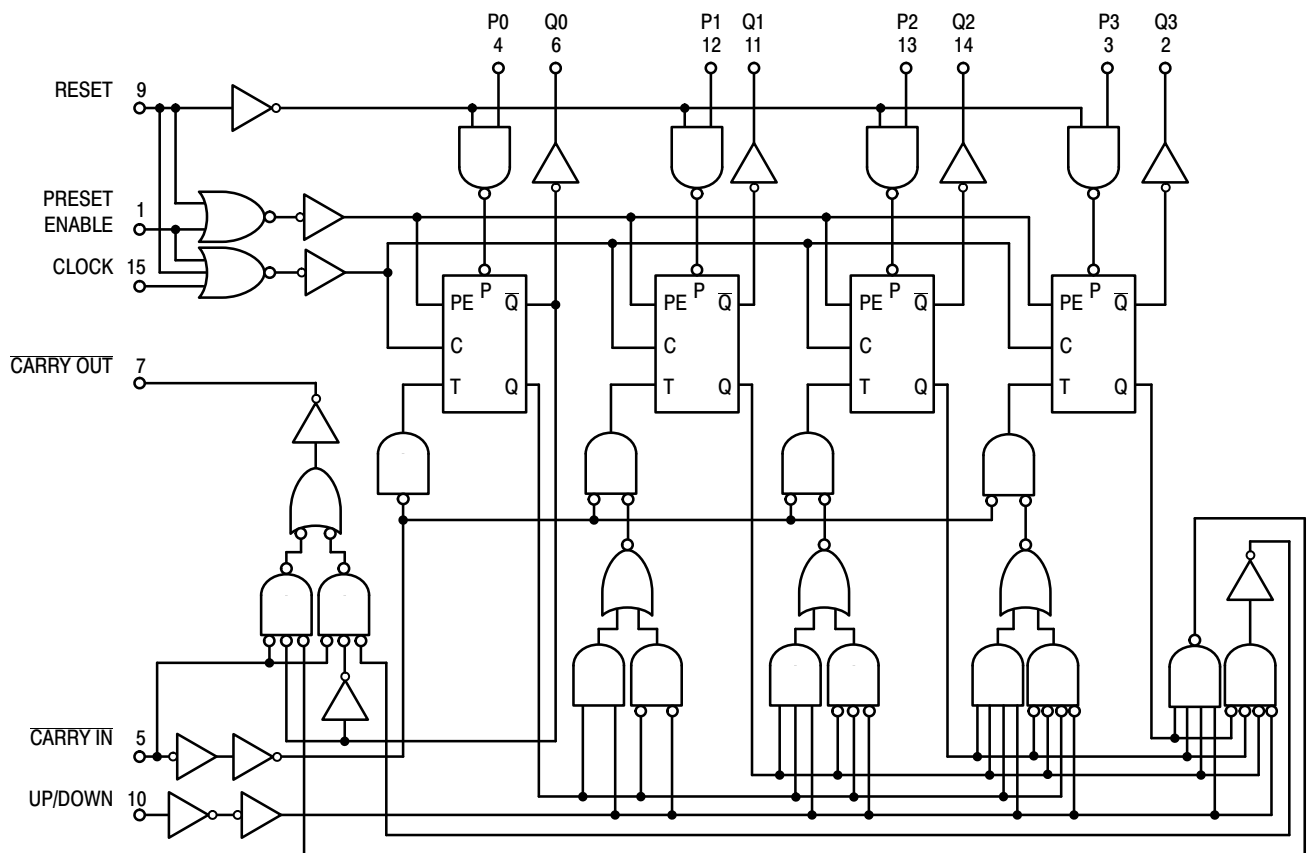


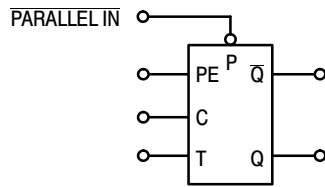
Figure 1. Power Dissipation Test Circuit and Waveform

## LOGIC DIAGRAM



# MC14516B

## TOGGLE FLIP-FLOP



## FLIP-FLOP FUNCTIONAL TRUTH TABLE

| Preset Enable | Clock | T | $Q_{n+1}$        |
|---------------|-------|---|------------------|
| 1             | X     | X | Parallel In      |
| 0             |       | 0 | $Q_n$            |
| 0             |       | 1 | $\overline{Q}_n$ |
| 0             |       | X | $Q_n$            |

X = Don't Care

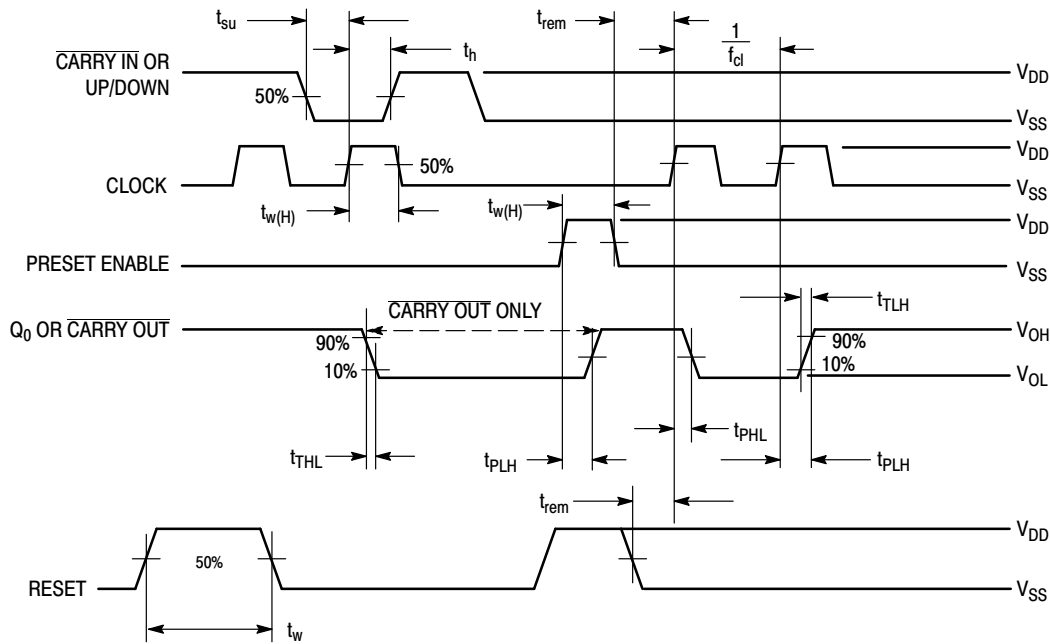


Figure 2. Switching Time Waveforms

## PIN DESCRIPTIONS

### INPUTS

**P0, P1, P2, P3, Preset Inputs (Pins 4, 12, 13, 3)** – Data on these inputs is loaded into the counter when PE is taken high.

**Carry In, (Pin 5)** – This active-low input is used when Cascading stages. Carry In is usually connected to Carry Out of the previous stage. While high, Clock is inhibited.

**Clock, (Pin 15)** – Binary data is incremented or decremented, depending on the direction of count, on the positive transition of this input.

### OUTPUTS

**Q0, Q1, Q2, Q3, Binary outputs (Pins 6, 11, 14, 2)** – Binary data is present on these outputs with Q0 corresponding to the least significant bit.

**Carry Out, (Pin 7)** – Used when cascading stages, Carry Out is usually connected to Carry In of the next stage. This synchronous output is active low and may also be used to indicate terminal count.

### CONTROLS

**PE, Preset Enable, (Pin 1)** – Asynchronously loads data on the Preset Inputs. This pin is active high and inhibits the clock when high.

**R, Reset, (Pin 9)** – Asynchronously resets the Q outputs to a low state. This pin is active high and inhibits the clock when high.

**Up/Down, (Pin 10)** – Controls the direction of count, high for up count, low for down count.

### SUPPLY PINS

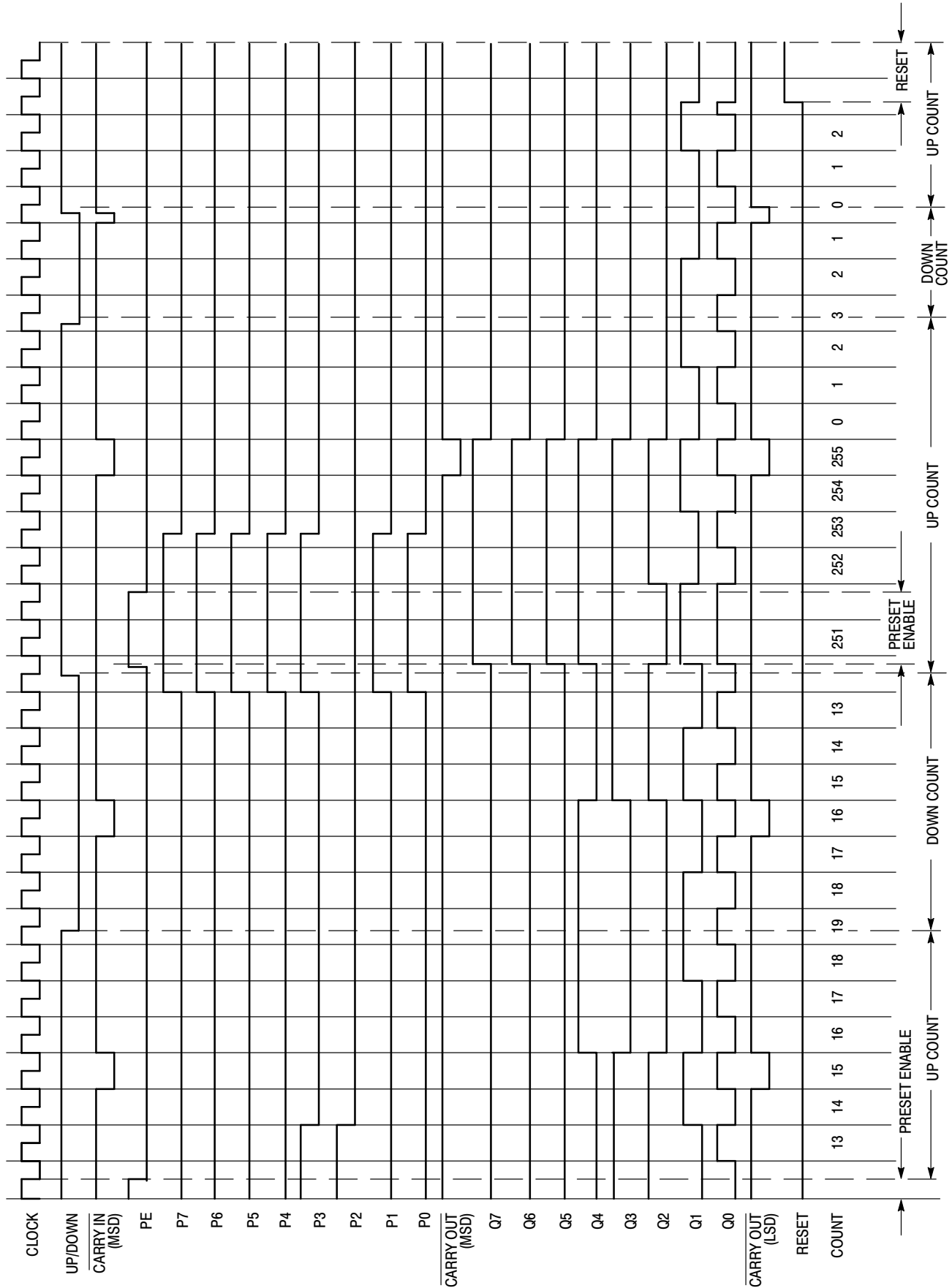
**VSS, Negative Supply Voltage, (Pin 8)** – This pin is usually connected to ground.

**VDD, Positive Supply Voltage, (Pin 16)** – This pin is connected to a positive supply voltage ranging from 3.0 V to 18 V.

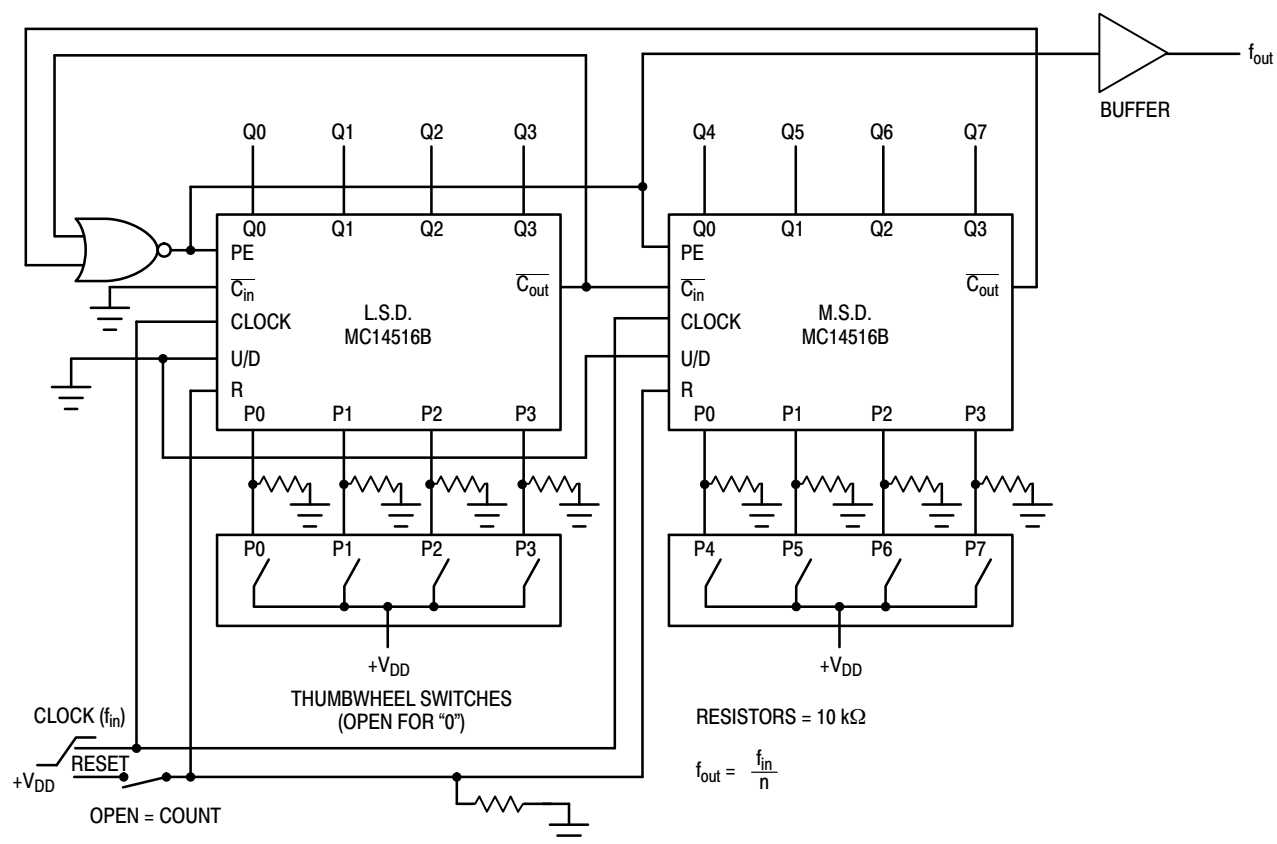
[www.onsemi.com](http://www.onsemi.com)

NOTE: The Least Significant Digit (L.S.D.) counts from a preset value once Preset Enable (PE) goes low. The Most Significant Digit (M.S.D.) is disabled while  $\overline{C_{in}}$  is high. When the count of the L.S.D. reaches 0 (count down mode) or reaches 15 (count up mode),  $\overline{C_{out}}$  goes low for one complete clock cycle, thus allowing the next counter to decrement/increment one count. (See Timing Diagram) The L.S.D. now counts through another cycle (15 clock pulses) and the above cycle is repeated.

TIMING DIAGRAM FOR THE PRESETTABLE CASCADED 8-BIT UP/DOWN COUNTER



## MC14516B



NOTE: The programmable frequency divider can be set by applying the desired divide ratio, in binary, to the preset inputs. For example, the maximum divide ratio of 255 may be obtained by applying a 1111 1111 to the preset inputs P0 to P7. For this divide operation, both counters should be configured in the count down mode. The divide ratio of zero is an undefined state and should be avoided.

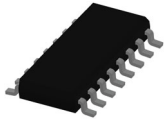
**Figure 4. Programmable Cascaded Frequency Divider**

## MC14516B

### REVISION HISTORY

| Revision | Description of Changes                            | Date      |
|----------|---------------------------------------------------|-----------|
| 11       | Rebranded the Data Sheet to <b>onsemi</b> format. | 10/3/2025 |

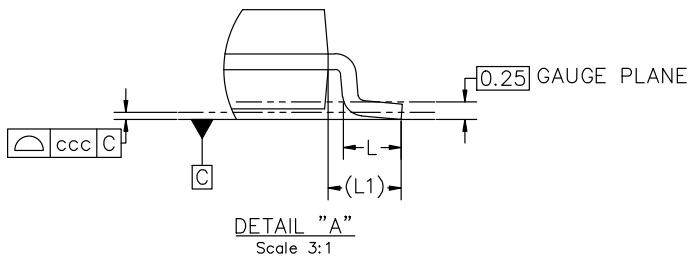
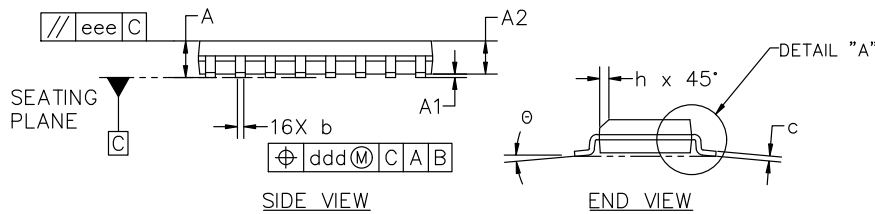
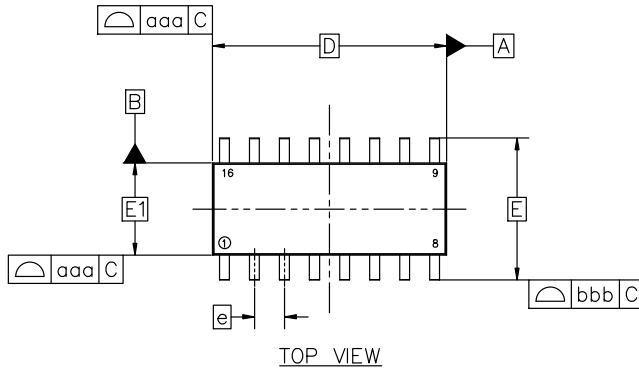
This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.


**SOIC-16 9.90x3.90x1.37 1.27P**  
**CASE 751B**  
**ISSUE M**

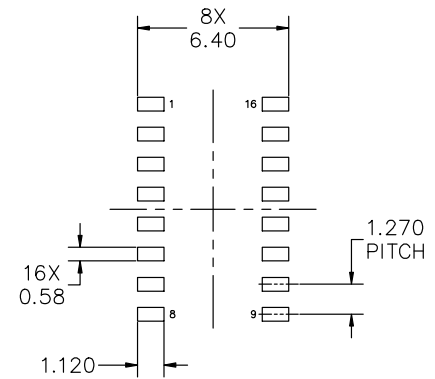
DATE 18 OCT 2024

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. DIMENSION IN MILLIMETERS. ANGLE IN DEGREES.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15mm PER SIDE.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127mm TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.



| MILLIMETERS                    |          |      |      |
|--------------------------------|----------|------|------|
| DIM                            | MIN      | NOM  | MAX  |
| A                              | 1.35     | 1.55 | 1.75 |
| A1                             | 0.10     | 0.18 | 0.25 |
| A2                             | 1.25     | 1.37 | 1.50 |
| b                              | 0.35     | 0.42 | 0.49 |
| c                              | 0.19     | 0.22 | 0.25 |
| D                              | 9.90 BSC |      |      |
| E                              | 6.00 BSC |      |      |
| E1                             | 3.90 BSC |      |      |
| e                              | 1.27 BSC |      |      |
| h                              | 0.25     | ---  | 0.50 |
| L                              | 0.40     | 0.83 | 1.25 |
| L1                             | 1.05 REF |      |      |
| θ                              | 0°       | ---  | 7°   |
| TOLERANCE OF FORM AND POSITION |          |      |      |
| aaa                            | 0.10     |      |      |
| bbb                            | 0.20     |      |      |
| ccc                            | 0.10     |      |      |
| ddd                            | 0.25     |      |      |
| eee                            | 0.10     |      |      |



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AND MOUNTING TECHNIQUES REFERENCE  
MANUAL, SOLDERM/D

|                         |                                     |                                                                                                                                                                                     |
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SOIC-16 9.90x3.90x1.37 1.27P  
CASE 751B  
ISSUE M

DATE 18 OCT 2024

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.

|                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>STYLE 1:</b><br>PIN 1. COLLECTOR<br>2. BASE<br>3. EMITTER<br>4. NO CONNECTION<br>5. EMITTER<br>6. BASE<br>7. COLLECTOR<br>8. COLLECTOR<br>9. BASE<br>10. EMITTER<br>11. NO CONNECTION<br>12. EMITTER<br>13. BASE<br>14. COLLECTOR<br>15. EMITTER<br>16. COLLECTOR                           | <b>STYLE 2:</b><br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION<br>4. CATHODE<br>5. CATHODE<br>6. NO CONNECTION<br>7. ANODE<br>8. CATHODE<br>9. CATHODE<br>10. ANODE<br>11. NO CONNECTION<br>12. CATHODE<br>13. CATHODE<br>14. NO CONNECTION<br>15. ANODE<br>16. CATHODE | <b>STYLE 3:</b><br>PIN 1. COLLECTOR, DYE #1<br>2. BASE, #1<br>3. EMITTER, #1<br>4. COLLECTOR, #1<br>5. COLLECTOR, #2<br>6. BASE, #2<br>7. EMITTER, #2<br>8. COLLECTOR, #2<br>9. COLLECTOR, #3<br>10. BASE, #3<br>11. EMITTER, #3<br>12. COLLECTOR, #3<br>13. COLLECTOR, #4<br>14. BASE, #4<br>15. EMITTER, #4<br>16. COLLECTOR, #4                                                                                         | <b>STYLE 4:</b><br>PIN 1. COLLECTOR, DYE #1<br>2. COLLECTOR, #1<br>3. COLLECTOR, #2<br>4. COLLECTOR, #2<br>5. COLLECTOR, #3<br>6. COLLECTOR, #3<br>7. COLLECTOR, #4<br>8. COLLECTOR, #4<br>9. BASE, #4<br>10. EMITTER, #4<br>11. BASE, #3<br>12. EMITTER, #3<br>13. BASE, #2<br>14. EMITTER, #2<br>15. BASE, #1<br>16. EMITTER, #1 |
| <b>STYLE 5:</b><br>PIN 1. DRAIN, DYE #1<br>2. DRAIN, #1<br>3. DRAIN, #2<br>4. DRAIN, #2<br>5. DRAIN, #3<br>6. DRAIN, #3<br>7. DRAIN, #4<br>8. DRAIN, #4<br>9. GATE, #4<br>10. SOURCE, #4<br>11. GATE, #3<br>12. SOURCE, #3<br>13. GATE, #2<br>14. SOURCE, #2<br>15. GATE, #1<br>16. SOURCE, #1 | <b>STYLE 6:</b><br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE<br>4. CATHODE<br>5. CATHODE<br>6. CATHODE<br>7. CATHODE<br>8. CATHODE<br>9. ANODE<br>10. ANODE<br>11. ANODE<br>12. ANODE<br>13. ANODE<br>14. ANODE<br>15. ANODE<br>16. ANODE                                 | <b>STYLE 7:</b><br>PIN 1. SOURCE N-CH<br>2. COMMON DRAIN (OUTPUT)<br>3. COMMON DRAIN (OUTPUT)<br>4. GATE P-CH<br>5. COMMON DRAIN (OUTPUT)<br>6. COMMON DRAIN (OUTPUT)<br>7. COMMON DRAIN (OUTPUT)<br>8. SOURCE P-CH<br>9. SOURCE P-CH<br>10. COMMON DRAIN (OUTPUT)<br>11. COMMON DRAIN (OUTPUT)<br>12. COMMON DRAIN (OUTPUT)<br>13. GATE N-CH<br>14. COMMON DRAIN (OUTPUT)<br>15. COMMON DRAIN (OUTPUT)<br>16. SOURCE N-CH |                                                                                                                                                                                                                                                                                                                                    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                     |                                                                                                                                                                                     |
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