

## NC7SP74

### TinyLogic® ULP D-Type Flip-Flop with Preset and Clear

#### General Description

The NC7SP74 is a single D-type CMOS Flip-Flop with preset and clear from Fairchild's Ultra Low Power (ULP) Series of TinyLogic®. Ideal for applications where battery life is critical, this product is designed for ultra low power consumption within the  $V_{CC}$  operating range of 0.9V to 3.6V.

The internal circuit is composed of a minimum of inverter stages including the output buffer, to enable ultra low static and dynamic power.

The NC7SP74, for lower drive requirements, is uniquely designed for optimized power and speed, and is fabricated with an advanced CMOS technology to achieve best in class speed operation while maintaining extremely low CMOS power dissipation.

The signal level applied to the D input is transferred to the Q output during the positive going transition of the CLK pulse.

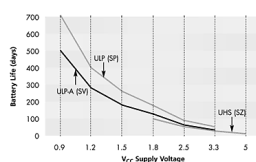
#### Features

- Space saving US8 surface mount package
- MicroPak™ leadless package
- 0.9V to 3.6V  $V_{CC}$  supply operation
- 3.6V overvoltage tolerant I/Os at  $V_{CC}$  from 0.9V to 3.6V
- $t_{PD}$ 
  - 3.0 ns typ for 3.0V to 3.6V  $V_{CC}$
  - 4.0 ns typ for 2.3V to 2.7V  $V_{CC}$
  - 5.0 ns typ for 1.65V to 1.95V  $V_{CC}$
  - 6.0 ns typ for 1.40V to 1.60V  $V_{CC}$
  - 9.0 ns typ for 1.10V to 1.30V  $V_{CC}$
  - 24.0 ns typ for 0.90V  $V_{CC}$
- Power-Off high impedance inputs and outputs
- Static Drive ( $I_{OH}/I_{OL}$ )
  - ±2.6 mA @ 3.00V  $V_{CC}$
  - ±2.1 mA @ 2.30V  $V_{CC}$
  - ±1.5 mA @ 1.65V  $V_{CC}$
  - ±1.0 mA @ 1.40V  $V_{CC}$
  - ±0.5 mA @ 1.10V  $V_{CC}$
  - ±20  $\mu$ A @ 0.9V  $V_{CC}$
- Uses patented Quiet Series™ noise/EMI reduction circuitry
- Ultra low dynamic power

#### Ordering Code:

| Order Number | Package Number | Product Code Top Mark | Package Description                               | Supplied As               |
|--------------|----------------|-----------------------|---------------------------------------------------|---------------------------|
| NC7SP74K8X   | MAB08A         | P74                   | 8-Lead US8, JEDEC MO-187, Variation CA 3.1mm Wide | 3k Units on Tape and Reel |
| NC7SP74L8X   | MAC08A         | X9                    | 8-Lead MicroPak, 1.6 mm Wide                      | 5k Units on Tape and Reel |

#### Battery Life vs. $V_{CC}$ Supply Voltage



TinyLogic ULP and ULP-A with up to 50% less power consumption can extend your battery life significantly.

$$\text{Battery Life} = (V_{\text{battery}} \cdot I_{\text{battery}} \cdot 9) / (P_{\text{device}}) / 24 \text{hrs/day}$$

$$\text{Where, } P_{\text{device}} = (I_{CC} \cdot V_{CC}) + (C_{PD} + C_L) \cdot V_{CC}^2 \cdot f$$

Assumes ideal 3.6V Lithium Ion battery with current rating of 900mAh and derated 90% and device frequency at 10MHz, with  $C_L = 15$  pF load

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MicroPak™ and Quiet Series™ are trademarks of Fairchild Semiconductor Corporation.

## Pin Descriptions

| Pin Names                | Description         |
|--------------------------|---------------------|
| D                        | Data Input          |
| CK                       | Clock Pulse Input   |
| $\overline{\text{CLR}}$  | Direct Clear Input  |
| Q, $\overline{\text{Q}}$ | Flip-Flop Output    |
| $\overline{\text{PR}}$   | Direct Preset Input |

## Truth Table

| Inputs                  |                        |   |              | Outputs |                       | Function  |
|-------------------------|------------------------|---|--------------|---------|-----------------------|-----------|
| $\overline{\text{CLR}}$ | $\overline{\text{PR}}$ | D | CK           | Q       | $\overline{\text{Q}}$ |           |
| L                       | H                      | X | X            | L       | H                     | Clear     |
| H                       | L                      | X | X            | H       | L                     | Preset    |
| L                       | L                      | X | X            | H       | H                     | —         |
| H                       | H                      | L | $\uparrow$   | L       | H                     | —         |
| H                       | H                      | H | $\uparrow$   | H       | L                     | —         |
| H                       | H                      | X | $\downarrow$ | $Q_n$   | $\overline{Q}_n$      | No Change |

H = HIGH Logic Level

L = LOW Logic Level

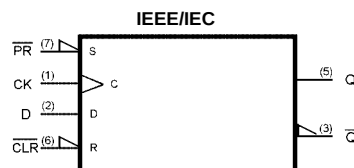
 $Q_n$  = No change in data

X = Immaterial

Z = High Impedance

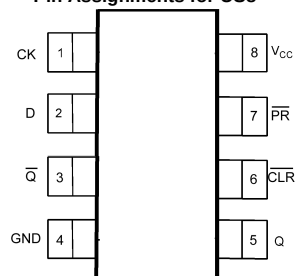
 $\uparrow$  = Rising Edge $\downarrow$  = Falling edge

## Logic Symbol



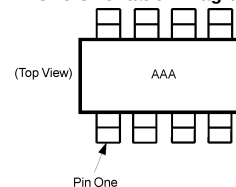
## Connection Diagrams

Pin Assignments for US8



(Top View)

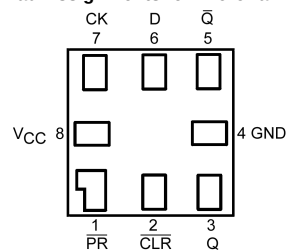
Pin One Orientation Diagram



AAA represents Product Code Top Mark - see ordering code

**Note:** Orientation of Top Mark determines Pin One location. Read the top product code mark left to right, Pin One is the lower left pin (see diagram).

Pad Assignments for MicroPak



(Top Thru View)

**Absolute Maximum Ratings**(Note 1)

|                                                   |                          |
|---------------------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )                       | -0.5V to +4.6V           |
| DC Input Voltage ( $V_{IN}$ )                     | -0.5V to +4.6V           |
| DC Output Voltage ( $V_{OUT}$ )                   | -0.5V to +7.0V           |
| HIGH or LOW State (Note 2)                        | -0.5V to $V_{CC} + 0.5V$ |
| $V_{CC} = 0V$                                     | -0.5V to 4.6V            |
| DC Input Diode Current ( $I_{IK}$ ) $V_{IN} < 0V$ | $\pm 50$ mA              |
| DC Output Diode Current ( $I_{OK}$ )              |                          |
| $V_{OUT} < 0V$                                    | -50 mA                   |
| $V_{OUT} > V_{CC}$                                | +50 mA                   |
| DC Output Source/Sink Current ( $I_{OH}/I_{OL}$ ) | $\pm 50$ mA              |
| DC $V_{CC}$ or Ground Current per                 |                          |
| Supply Pin ( $I_{CC}$ or Ground)                  | $\pm 50$ mA              |
| Storage Temperature Range ( $T_{STG}$ )           | -65°C to +150°C          |

**Recommended Operating Conditions** (Note 3)

|                                                 |                  |
|-------------------------------------------------|------------------|
| Power Supply                                    | 0.9V to 3.6V     |
| Input Voltage ( $V_{IN}$ )                      | 0V to 3.6V       |
| Output Voltage ( $V_{OUT}$ )                    |                  |
| HIGH or LOW State                               | 0V to $V_{CC}$   |
| $V_{CC} = 0V$                                   | 0V to 3.6V       |
| Output Current in ( $I_{OH}/I_{OL}$ )           |                  |
| $V_{CC} = 3.0V$ to 3.6V                         | $\pm 2.6$ mA     |
| $V_{CC} = 2.3V$ to 2.7V                         | $\pm 2.1$ mA     |
| $V_{CC} = 1.65V$ to 1.95V                       | $\pm 1.5$ mA     |
| $V_{CC} = 1.40V$ to 1.60V                       | $\pm 1.0$ mA     |
| $V_{CC} = 1.10V$ to 1.30V                       | $\pm 0.5$ mA     |
| $V_{CC} = 0.9V$                                 | $\pm 20$ $\mu$ A |
| Free Air Operating Temperature ( $T_A$ )        | -40°C to +85°C   |
| Minimum Input Edge Rate ( $\Delta t/\Delta V$ ) |                  |
| $V_{IN} = 0.8V$ to 2.0V, $V_{CC} = 3.0V$        | 10 ns/V          |

**Note 1:** Absolute Maximum Ratings: are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 2:**  $I_O$  Absolute Maximum rating must be observed.

**Note 3:** Unused inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

| Symbol   | Parameter                    | $V_{CC}$<br>(V)              | $T_A = +25^\circ\text{C}$ |                      | $T_A = -40^\circ\text{C to } +85^\circ\text{C}$ |                      | Units | Conditions                 |
|----------|------------------------------|------------------------------|---------------------------|----------------------|-------------------------------------------------|----------------------|-------|----------------------------|
|          |                              |                              | Min                       | Max                  | Min                                             | Max                  |       |                            |
| $V_{IH}$ | HIGH Level<br>Input Voltage  | 0.90                         |                           | $0.65 \times V_{CC}$ |                                                 | $0.65 \times V_{CC}$ | V     |                            |
|          |                              | $1.10 \leq V_{CC} \leq 1.30$ |                           | $0.65 \times V_{CC}$ |                                                 | $0.65 \times V_{CC}$ |       |                            |
|          |                              | $1.40 \leq V_{CC} \leq 1.60$ |                           | $0.65 \times V_{CC}$ |                                                 | $0.65 \times V_{CC}$ |       |                            |
|          |                              | $1.65 \leq V_{CC} \leq 1.95$ |                           | $0.65 \times V_{CC}$ |                                                 | $0.65 \times V_{CC}$ |       |                            |
|          |                              | $2.30 \leq V_{CC} \leq 2.70$ |                           | 1.6                  |                                                 | 1.6                  |       |                            |
| $V_{IL}$ | LOW Level<br>Input Voltage   | $3.00 \leq V_{CC} \leq 3.60$ |                           | 2.1                  |                                                 | 2.1                  | V     |                            |
|          |                              | 0.90                         |                           | $0.35 \times V_{CC}$ |                                                 | $0.35 \times V_{CC}$ |       |                            |
|          |                              | $1.10 \leq V_{CC} \leq 1.30$ |                           | $0.35 \times V_{CC}$ |                                                 | $0.35 \times V_{CC}$ |       |                            |
|          |                              | $1.40 \leq V_{CC} \leq 1.60$ |                           | $0.35 \times V_{CC}$ |                                                 | $0.35 \times V_{CC}$ |       |                            |
|          |                              | $1.65 \leq V_{CC} \leq 1.95$ |                           | $0.35 \times V_{CC}$ |                                                 | $0.35 \times V_{CC}$ |       |                            |
| $V_{OH}$ | HIGH Level<br>Output Voltage | $2.30 \leq V_{CC} \leq 2.70$ |                           | 0.7                  |                                                 | 0.7                  | V     | $I_{OH} = -20 \mu\text{A}$ |
|          |                              | $3.00 \leq V_{CC} \leq 3.60$ |                           | 0.9                  |                                                 | 0.9                  |       |                            |
|          |                              | 0.90                         | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $1.10 \leq V_{CC} \leq 1.30$ | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $1.40 \leq V_{CC} \leq 1.60$ | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $1.65 \leq V_{CC} \leq 1.95$ | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $2.30 \leq V_{CC} \leq 2.70$ | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $3.00 \leq V_{CC} \leq 3.60$ | $V_{CC} - 0.1$            | $V_{CC} - 0.1$       | $V_{CC} - 0.1$                                  | $V_{CC} - 0.1$       |       |                            |
|          |                              | $1.10 \leq V_{CC} \leq 1.30$ | $0.75 \times V_{CC}$      | $0.70 \times V_{CC}$ | $0.70 \times V_{CC}$                            | $0.70 \times V_{CC}$ |       | $I_{OH} = -0.5 \text{ mA}$ |
|          |                              | $1.40 \leq V_{CC} \leq 1.60$ | 1.07                      | 0.99                 |                                                 |                      |       | $I_{OH} = -1.0 \text{ mA}$ |
|          |                              | $1.65 \leq V_{CC} \leq 1.95$ | 1.24                      | 1.22                 |                                                 |                      |       | $I_{OH} = -1.5 \text{ mA}$ |
|          |                              | $2.30 \leq V_{CC} \leq 2.70$ | 1.95                      | 1.87                 |                                                 |                      |       | $I_{OH} = -2.1 \text{ mA}$ |
|          |                              | $3.00 \leq V_{CC} \leq 3.60$ | 2.61                      | 2.55                 |                                                 |                      |       | $I_{OH} = -2.6 \text{ mA}$ |

# DC Electrical Characteristics (Continued)

| Symbol           | Parameter                   | V <sub>CC</sub><br>(V)        | T <sub>A</sub> = +25°C |     | T <sub>A</sub> = −40°C to +85°C |     | Units | Conditions                                    |
|------------------|-----------------------------|-------------------------------|------------------------|-----|---------------------------------|-----|-------|-----------------------------------------------|
|                  |                             |                               | Min                    | Max | Min                             | Max |       |                                               |
| V <sub>OL</sub>  | LOW Level<br>Output Voltage | 0.90                          |                        | 0.1 |                                 | 0.1 | V     | I <sub>OL</sub> = 20 μA                       |
|                  |                             | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 |                        | 0.1 |                                 | 0.1 |       |                                               |
|                  |                             | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 |                        | 0.1 |                                 | 0.1 |       |                                               |
|                  |                             | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 |                        | 0.1 |                                 | 0.1 |       |                                               |
|                  |                             | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 |                        | 0.1 |                                 | 0.1 |       |                                               |
|                  |                             | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 |                        | 0.1 |                                 | 0.1 |       |                                               |
|                  |                             | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 0.30 × V <sub>CC</sub> |     | 0.30 × V <sub>CC</sub>          |     |       | I <sub>OL</sub> = 0.5 mA                      |
|                  |                             | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 0.31                   |     | 0.37                            |     |       | I <sub>OL</sub> = 1.0 mA                      |
|                  |                             | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 0.31                   |     | 0.35                            |     |       | I <sub>OL</sub> = 1.5 mA                      |
|                  |                             | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 0.31                   |     | 0.33                            |     |       | I <sub>OL</sub> = 2.1 mA                      |
|                  |                             | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 0.31                   |     | 0.33                            |     |       | I <sub>OL</sub> = 2.6 mA                      |
| I <sub>IN</sub>  | Input Leakage Current       | 0.90 to 3.60                  | ±0.1                   |     | ±0.5                            |     | μA    | 0 ≤ V <sub>I</sub> ≤ 3.6V                     |
| I <sub>OFF</sub> | Power Off Leakage Current   | 0                             | 0.5                    |     | 0.5                             |     | μA    | 0 ≤ (V <sub>I</sub> , V <sub>O</sub> ) ≤ 3.6V |
| I <sub>CC</sub>  | Quiescent Supply Current    | 0.90 to 3.60                  | 0.9                    |     | 0.9                             |     | μA    | V <sub>I</sub> = V <sub>CC</sub> or GND       |

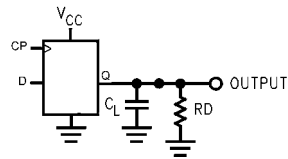
| AC Electrical Characteristics (10pF, 1MΩ) |                                                                  |                               |                        |      |     |                                 |     |       |                                                 |               |
|-------------------------------------------|------------------------------------------------------------------|-------------------------------|------------------------|------|-----|---------------------------------|-----|-------|-------------------------------------------------|---------------|
| Symbol                                    | Parameter                                                        | V <sub>CC</sub><br>(V)        | T <sub>A</sub> = +25°C |      |     | T <sub>A</sub> = −40°C to +85°C |     | Units | Conditions                                      | Figure Number |
|                                           |                                                                  |                               | Min                    | Typ  | Max | Min                             | Max |       |                                                 |               |
| f <sub>MAX</sub>                          | Maximum Clock Frequency                                          | 0.90                          | 40.0                   |      |     |                                 |     | MHz   | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 5  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 50                     |      |     | 50                              |     |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 75                     |      |     | 75                              |     |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 100                    |      |     | 100                             |     |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 125                    |      |     | 125                             |     |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 150                    |      |     | 150                             |     |       |                                                 |               |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>CK to Q, $\overline{Q}$                     | 0.90                          | 24.0                   |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 3  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 4.0                           | 15.0                   | 22.0 | 3.5 | 31.0                            |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 2.0                           | 9.0                    | 13.0 | 1.5 | 14.0                            |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 1.5                           | 7.0                    | 11.0 | 1.0 | 13.0                            |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 1.0                           | 5.0                    | 8.0  | 0.8 | 9.0                             |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 1.0                           | 4.0                    | 7.0  | 0.5 | 8.0                             |     |       |                                                 |               |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>CLR, $\overline{PR}$ , to Q, $\overline{Q}$ | 0.90                          | 6.5                    |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 3  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 4.0                           | 12.0                   | 23.0 | 4.0 | 34.0                            |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 2.0                           | 9.0                    | 12.0 | 2.0 | 14.0                            |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 1.5                           | 7.0                    | 11.0 | 1.5 | 13.0                            |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 1.0                           | 5.0                    | 9.0  | 1.0 | 9.0                             |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 1.0                           | 4.0                    | 7.0  | 1.0 | 8.0                             |     |       |                                                 |               |
| t <sub>S</sub>                            | Setup Time,<br>CK to D                                           | 0.90                          | 10.0                   |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 7.0                           |                        |      | 7.0 |                                 |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 3.0                           |                        |      | 3.0 |                                 |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 2.0                           |                        |      | 2.0 |                                 |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 1.5                           |                        |      | 1.5 |                                 |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 1.0                           |                        |      | 1.0 |                                 |     |       |                                                 |               |
| t <sub>H</sub>                            | Hold Time,<br>CK to D                                            | 0.90                          | 1.0                    |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 0.5                           |                        |      | 0.5 |                                 |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 0.5                           |                        |      | 0.5 |                                 |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 0.5                           |                        |      | 0.5 |                                 |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 0.5                           |                        |      | 0.5 |                                 |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 0.5                           |                        |      | 0.5 |                                 |     |       |                                                 |               |
| t <sub>W</sub>                            | Pulse Width,<br>CK, $\overline{PR}$ , CLR                        | 0.90                          | 5.0                    |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 5  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 5.0                           |                        |      | 5.0 |                                 |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 3.0                           |                        |      | 3.0 |                                 |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 2.5                           |                        |      | 2.5 |                                 |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 2.5                           |                        |      | 2.5 |                                 |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 2.0                           |                        |      | 2.0 |                                 |     |       |                                                 |               |
| t <sub>REC</sub>                          | Recover Time<br>$\overline{CLR}$ , $\overline{PR}$ to CK         | 0.90                          | 12.0                   |      |     |                                 |     | ns    | C <sub>L</sub> = 10 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           | 1.10 ≤ V <sub>CC</sub> ≤ 1.30                                    | 8.5                           |                        |      | 8.5 |                                 |     |       |                                                 |               |
|                                           | 1.40 ≤ V <sub>CC</sub> ≤ 1.60                                    | 3.5                           |                        |      | 3.5 |                                 |     |       |                                                 |               |
|                                           | 1.65 ≤ V <sub>CC</sub> ≤ 1.95                                    | 3.0                           |                        |      | 3.0 |                                 |     |       |                                                 |               |
|                                           | 2.30 ≤ V <sub>CC</sub> ≤ 2.70                                    | 2.5                           |                        |      | 2.5 |                                 |     |       |                                                 |               |
|                                           | 3.00 ≤ V <sub>CC</sub> ≤ 3.60                                    | 2.0                           |                        |      | 2.0 |                                 |     |       |                                                 |               |

| AC Electrical Characteristics (15pF, 1MΩ) |                                                                                |                                                                                                                                                                           |                                 |                                    |                                    |                                                                       |     |               |
|-------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------------------------------|------------------------------------|-----------------------------------------------------------------------|-----|---------------|
| Symbol                                    | Parameter                                                                      | V <sub>CC</sub><br>(V)                                                                                                                                                    | T <sub>A</sub> = +25°C          |                                    |                                    | T <sub>A</sub> = -40°C to +85°C                                       |     | Figure Number |
|                                           |                                                                                |                                                                                                                                                                           | Min                             | Typ                                | Max                                | Min                                                                   | Max |               |
| t <sub>MAX</sub>                          | Maximum Clock Frequency                                                        | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 50<br>75<br>100<br>125<br>150   | 40.0                               |                                    | 150<br>200<br>250<br>175<br>200                                       | MHz | Figures 1, 5  |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>CK to Q, $\overline{Q}$                                   | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 5.0<br>3.0<br>2.0<br>1.5<br>1.0 | 27.0<br>16.0<br>10.0<br>7.0<br>4.0 | 23.0<br>14.0<br>11.0<br>8.0<br>7.0 | 4.5<br>34.0<br>2.5<br>16.0<br>2.0<br>13.0<br>1.0<br>9.0<br>0.5<br>8.0 | ns  | Figures 1, 3  |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>$\overline{CLR}$ , $\overline{PR}$ , to Q, $\overline{Q}$ | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 5.0<br>3.0<br>2.0<br>1.5<br>1.0 | 27.0<br>15.0<br>10.0<br>7.0<br>4.0 | 24.0<br>13.0<br>11.0<br>9.0<br>7.0 | 5.0<br>37.0<br>3.0<br>16.0<br>2.0<br>13.0<br>1.5<br>9.0<br>1.0<br>8.0 | ns  | Figures 1, 3  |
| t <sub>S</sub>                            | Setup Time,<br>CK to D                                                         | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 7.0<br>3.0<br>2.0<br>1.5<br>1.0 | 10.0                               |                                    | 7.0<br>3.0<br>2.0<br>1.5<br>1.0                                       | ns  | Figures 1, 4  |
| t <sub>H</sub>                            | Hold Time,<br>CK to D                                                          | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 0.5<br>0.5<br>0.5<br>0.5<br>0.5 | 1.0                                |                                    | 0.5<br>0.5<br>0.5<br>0.5<br>0.5                                       | ns  | Figures 1, 4  |
| t <sub>W</sub>                            | Pulse Width,<br>CK, $\overline{PR}$ , $\overline{CLR}$                         | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 5.0<br>3.0<br>2.5<br>2.5<br>2.0 | 5.0                                |                                    | 5.0<br>3.0<br>2.5<br>2.5<br>2.0                                       | ns  | Figures 1, 5  |
| t <sub>REC</sub>                          | Recover Time<br>$\overline{CLR}$ , $\overline{PR}$ to CK                       | 0.90<br>1.10 ≤ V <sub>CC</sub> ≤ 1.30<br>1.40 ≤ V <sub>CC</sub> ≤ 1.60<br>1.65 ≤ V <sub>CC</sub> ≤ 1.95<br>2.30 ≤ V <sub>CC</sub> ≤ 2.70<br>3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 8.5<br>3.5<br>3.0<br>2.5<br>2.0 | 12.0                               |                                    | 8.5<br>3.5<br>3.0<br>2.5<br>2.0                                       | ns  | Figures 1, 4  |

| AC Electrical Characteristics (30pF, 1MΩ) |                                                                  |                               |                        |      |      |                                 |      |       |                                                 |               |
|-------------------------------------------|------------------------------------------------------------------|-------------------------------|------------------------|------|------|---------------------------------|------|-------|-------------------------------------------------|---------------|
| Symbol                                    | Parameter                                                        | V <sub>CC</sub><br>(V)        | T <sub>A</sub> = +25°C |      |      | T <sub>A</sub> = −40°C to +85°C |      | Units | Conditions                                      | Figure Number |
|                                           |                                                                  |                               | Min                    | Typ  | Max  | Min                             | Max  |       |                                                 |               |
| f <sub>MAX</sub>                          | Maximum Clock Frequency                                          | 0.90                          | 40.0                   |      |      |                                 |      | MHz   | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 5  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 50                     |      |      | 150                             |      |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 75                     |      |      | 200                             |      |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 100                    |      |      | 250                             |      |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 125                    |      |      | 175                             |      |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 150                    |      |      | 200                             |      |       |                                                 |               |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>CK to Q, $\overline{Q}$                     | 0.90                          | 34.0                   |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 3  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 6.0                    | 18.0 | 27.0 | 5.0                             | 43.0 |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 4.0                    | 11.0 | 17.0 | 3.0                             | 18.0 |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 2.0                    | 8.0  | 13.0 | 2.0                             | 15.0 |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 1.0                    | 6.0  | 10.0 | 1.0                             | 11.0 |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 0.8                    | 5.0  | 8.0  | 0.5                             | 10.0 |       |                                                 |               |
| t <sub>PLH</sub><br>t <sub>PHL</sub>      | Propagation Delay<br>CLR, $\overline{PR}$ , to Q, $\overline{Q}$ | 0.90                          | 34.0                   |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 3  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 6.0                    | 17.0 | 28.0 | 5.5                             | 46.0 |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 4.0                    | 11.0 | 16.0 | 3.5                             | 18.0 |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 2.0                    | 8.0  | 13.0 | 2.5                             | 15.0 |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 1.0                    | 6.0  | 9.0  | 1.5                             | 11.0 |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 0.8                    | 5.0  | 8.0  | 1.0                             | 10.0 |       |                                                 |               |
| t <sub>S</sub>                            | Setup Time,<br>CK to D                                           | 0.90                          | 10.0                   |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 7.0                    |      |      | 7.0                             |      |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 3.0                    |      |      | 3.0                             |      |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 2.0                    |      |      | 2.0                             |      |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 1.5                    |      |      | 1.5                             |      |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 1.0                    |      |      | 1.0                             |      |       |                                                 |               |
| t <sub>H</sub>                            | Hold Time,<br>CK to D                                            | 0.90                          | 1.0                    |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 0.5                    |      |      | 0.5                             |      |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 0.5                    |      |      | 0.5                             |      |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 0.5                    |      |      | 0.5                             |      |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 0.5                    |      |      | 0.5                             |      |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 0.5                    |      |      | 0.5                             |      |       |                                                 |               |
| t <sub>W</sub>                            | Pulse Width,<br>CK, $\overline{PR}$ , CLR                        | 0.90                          | 5.0                    |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 5  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 5.0                    |      |      | 4.0                             |      |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 3.0                    |      |      | 3.0                             |      |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 2.5                    |      |      | 2.0                             |      |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 2.5                    |      |      | 3.0                             |      |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 2.0                    |      |      | 2.0                             |      |       |                                                 |               |
| t <sub>REC</sub>                          | Recover Time<br>$\overline{CLR}$ , $\overline{PR}$ to CK         | 0.90                          | 12.0                   |      |      |                                 |      | ns    | C <sub>L</sub> = 30 pF<br>R <sub>D</sub> = 1 MΩ | Figures 1, 4  |
|                                           |                                                                  | 1.10 ≤ V <sub>CC</sub> ≤ 1.30 | 8.5                    |      |      | 8.5                             |      |       |                                                 |               |
|                                           |                                                                  | 1.40 ≤ V <sub>CC</sub> ≤ 1.60 | 3.5                    |      |      | 3.5                             |      |       |                                                 |               |
|                                           |                                                                  | 1.65 ≤ V <sub>CC</sub> ≤ 1.95 | 3.0                    |      |      | 3.0                             |      |       |                                                 |               |
|                                           |                                                                  | 2.30 ≤ V <sub>CC</sub> ≤ 2.70 | 2.5                    |      |      | 2.5                             |      |       |                                                 |               |
|                                           |                                                                  | 3.00 ≤ V <sub>CC</sub> ≤ 3.60 | 2.0                    |      |      | 2.0                             |      |       |                                                 |               |

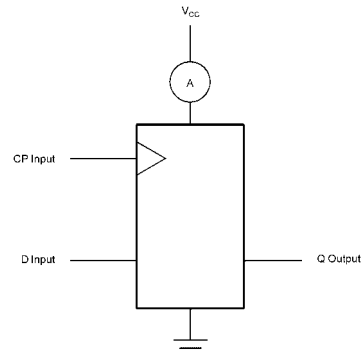
| Capacitance      |                               |     |     |       |                                                      |               |
|------------------|-------------------------------|-----|-----|-------|------------------------------------------------------|---------------|
| Symbol           | Parameter                     | Typ | Max | Units | Conditions                                           | Figure Number |
| C <sub>IN</sub>  | Input Capacitance             | 2.0 |     | pF    | V <sub>CC</sub> = 0V                                 |               |
| C <sub>OUT</sub> | Output Capacitance            | 4.0 |     | pF    | V <sub>CC</sub> = 0V                                 |               |
| C <sub>PD</sub>  | Power Dissipation Capacitance | 8.0 |     | pF    | V <sub>I</sub> = 0V or V <sub>CC</sub><br>f = 10 MHz | Figure 2      |

## AC Loading and Waveforms



$C_L$  includes load and stray capacitance  
Input PRR = 1.0 MHz;  $t_w = 500$  ns

FIGURE 1. AC Test Circuit



CP Input = AC Waveform;  $t_r = t_f = 2.5$  ns;  
CP Input PRR = 10 MHz; Duty Cycle = 50%  
D Input PRR = 5MHz; Duty Cycle = 50%

FIGURE 2.  $I_{CCD}$  Test Circuit

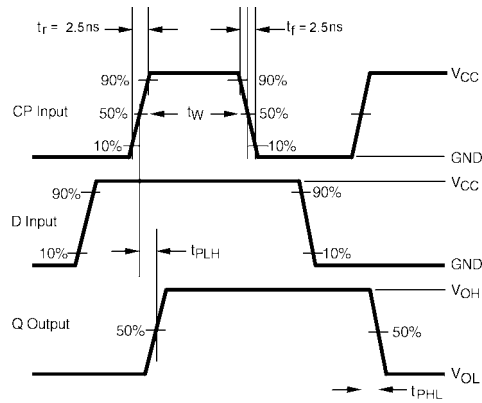


FIGURE 3. AC Waveforms

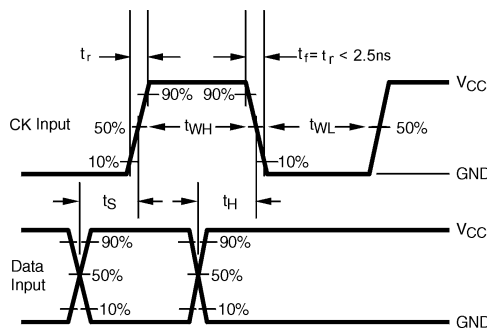


FIGURE 4. AC Waveforms

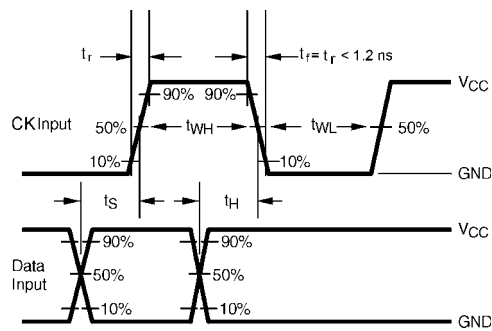
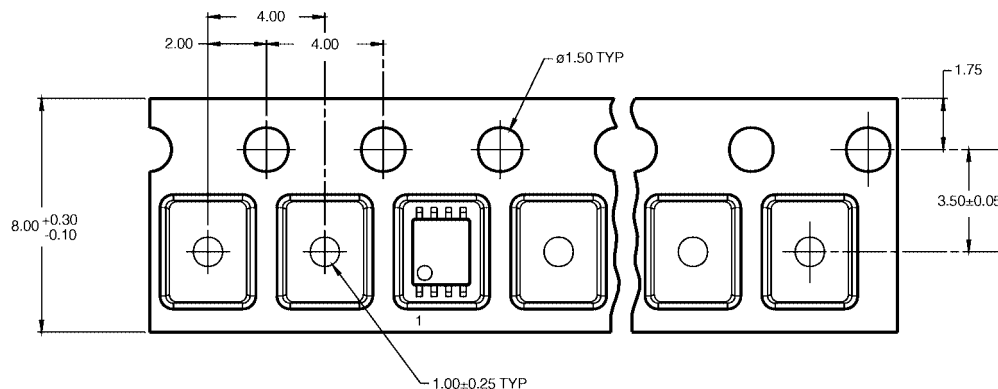
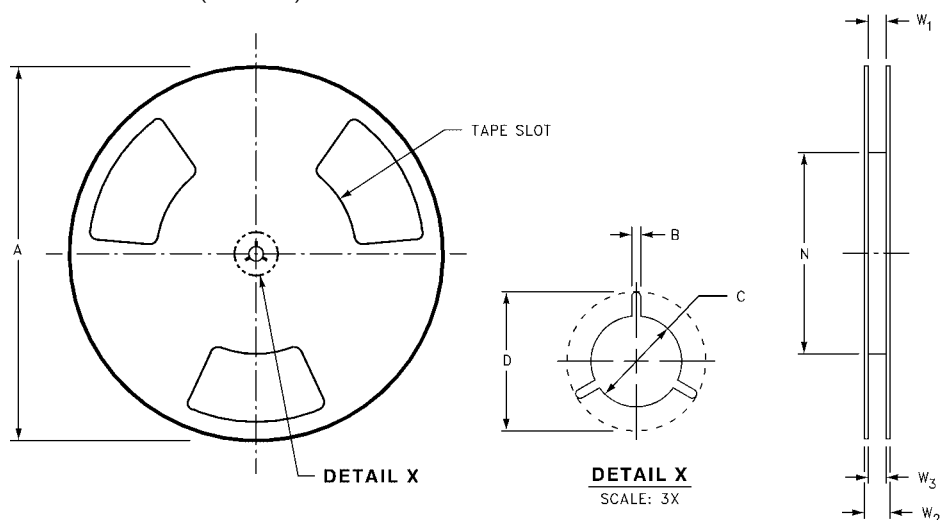


FIGURE 5. AC Waveforms

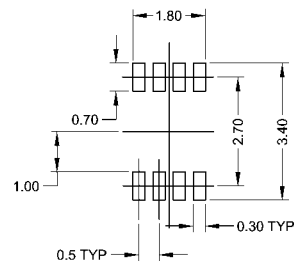
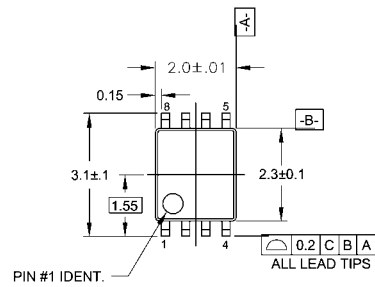
### TAPE FORMAT for US8

| Package Designator | Tape Section       | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| K8X                | Leader (Start End) | 125 (typ)       | Empty         | Sealed            |
|                    | Carrier            | 3000            | Filled        | Sealed            |
|                    | Trailer (Hub End)  | 75 (typ)        | Empty         | Sealed            |

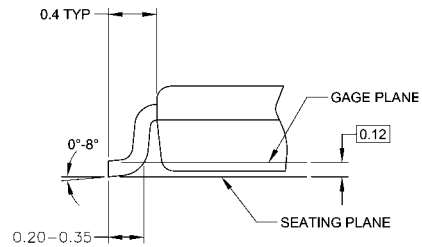
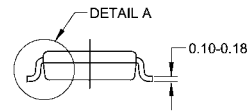
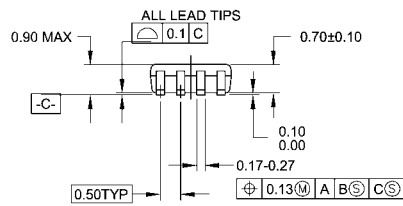
**TAPE DIMENSIONS** inches (millimeters)**REEL DIMENSIONS** inches (millimeters)

| Tap Size | A              | B               | C                | D                | N                | W1                                          | W2               | W3                                     |
|----------|----------------|-----------------|------------------|------------------|------------------|---------------------------------------------|------------------|----------------------------------------|
| 8 mm     | 7.0<br>(177.8) | 0.059<br>(1.50) | 0.512<br>(13.00) | 0.795<br>(20.20) | 2.165<br>(55.00) | 0.331 + 0.059/−0.000<br>(8.40 + 1.50/−0.00) | 0.567<br>(14.40) | W1 + 0.078/−0.039<br>(W1 + 2.00/−1.00) |

# Physical Dimensions inches (millimeters) unless otherwise noted



LAND PATTERN RECOMMENDATION



DETAIL A

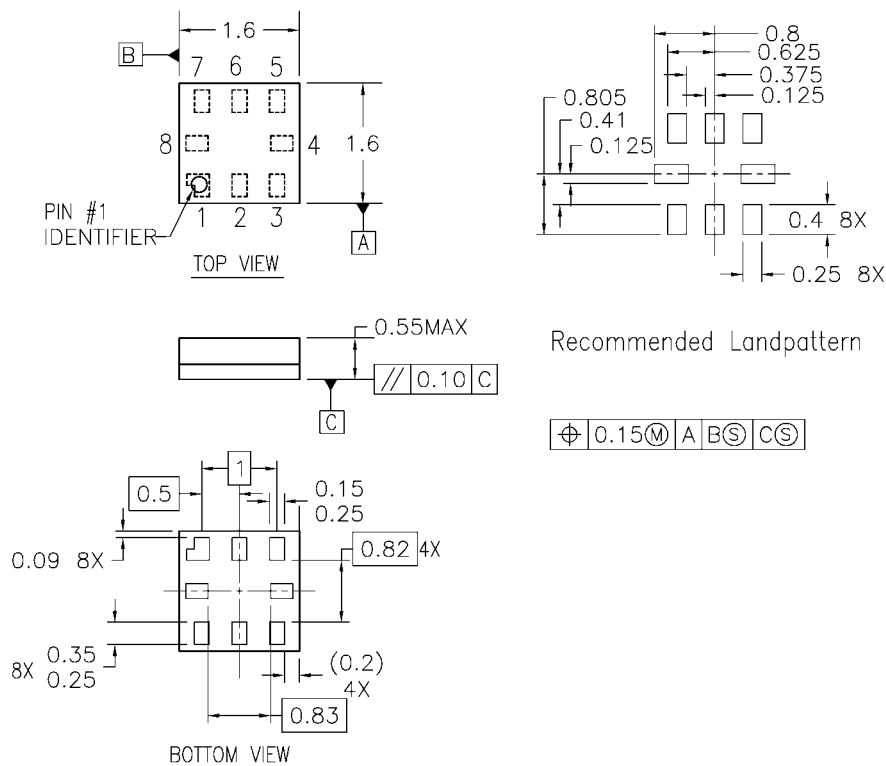
## NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-187
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MAB08AREVC

8-Lead US8, JEDEC MO-187, Variation CA 3.1mm Wide  
Package Number MAB08A

# Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



## Notes:

1. PACKAGE REGISTRATION WITH JEDEC IS ANTICIPATED
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y.14M-1994

MAC08AREVB

**8-Lead MicroPak, 1.6 mm Wide**  
**Package Number MAC08A**

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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