

# 8-Bit Serial-In, Parallel-Out Shift Register

## 74VHC164

### General Description

The VHC164 is an advanced high-speed CMOS device fabricated with silicon gate CMOS technology. It achieves the high-speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. The VHC164 is a high-speed 8-Bit Serial-In/Parallel-Out Shift Register. Serial data is entered through a 2-input AND gate synchronous with the LOW-to-HIGH transition of the clock. The device features an asynchronous Master Reset which clears the register, setting all outputs LOW independent of the clock. An input protection circuit insures that 0 V to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

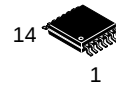
- High Speed:  $f_{MAX} = 175 \text{ MHz}$  at  $V_{CC} = 5 \text{ V}$
- Low Power Dissipation:  $I_{CC} = 4 \mu\text{A}$  (Max.) at  $T_A = 25^\circ\text{C}$
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Power Down Protection Provided on All Inputs
- Low Noise:  $V_{OLP} = 0.8 \text{ V}$  (Max.)
- Pin and Function Compatible with 74HC164
- This Device is Pb-Free, Halide Free and is RoHS Compliant

### Functional Description

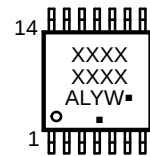
The VHC164 is an edge-triggered 8-bit shift register with serial data entry and an output from each of the eight stages. Data is entered serially through one of two inputs (A or B); either of these inputs can be used as an active High Enable for data entry through the other input. An unused input must be tied HIGH.

Each LOW-to-HIGH transition on the Clock (CP) input shifts data one place to the right and enters into  $Q_0$  the logical AND of the two data inputs ( $A \cdot B$ ) that existed before the rising clock edge. A LOW level on the Master Reset ( $\overline{MR}$ ) input overrides all other inputs and clears the register asynchronously, forcing all Q outputs LOW.

### MARKING DIAGRAM



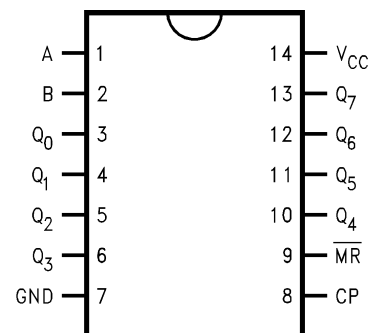
TSSOP-14  
DT SUFFIX  
CASE 948G



XXXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
■ = Pb-Free Package

(Note: Microdot may be in either location)

### CONNECTION DIAGRAM



### PIN ASSIGNMENT

| Pin Names       | Description                            |
|-----------------|----------------------------------------|
| A, B            | Data Inputs                            |
| CP              | Clock Pulse Input (Active Rising Edge) |
| $\overline{MR}$ | Master Reset Input (Active LOW)        |
| $Q_0$ - $Q_7$   | Outputs                                |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

# 74VHC164

## Logic Symbol

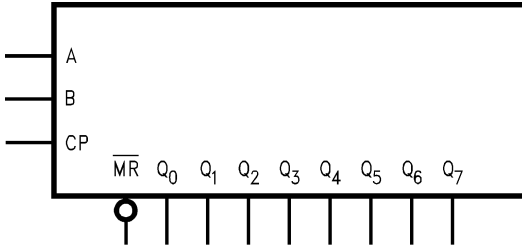


Figure 1. Logic Symbol

## FUNCTIONAL TABLE

| Operating Mode | Inputs |   |   | Outputs        |                                |
|----------------|--------|---|---|----------------|--------------------------------|
|                | MR     | A | B | Q <sub>0</sub> | Q <sub>1</sub> –Q <sub>7</sub> |
| Reset (Clear)  | L      | X | X | L              | L–L                            |
| Shift          | H      | L | L | L              | Q <sub>0</sub> –Q <sub>6</sub> |
|                | H      | L | H | L              | Q <sub>0</sub> –Q <sub>6</sub> |
|                | H      | H | L | L              | Q <sub>0</sub> –Q <sub>6</sub> |
|                | H      | H | H | H              | Q <sub>0</sub> –Q <sub>6</sub> |

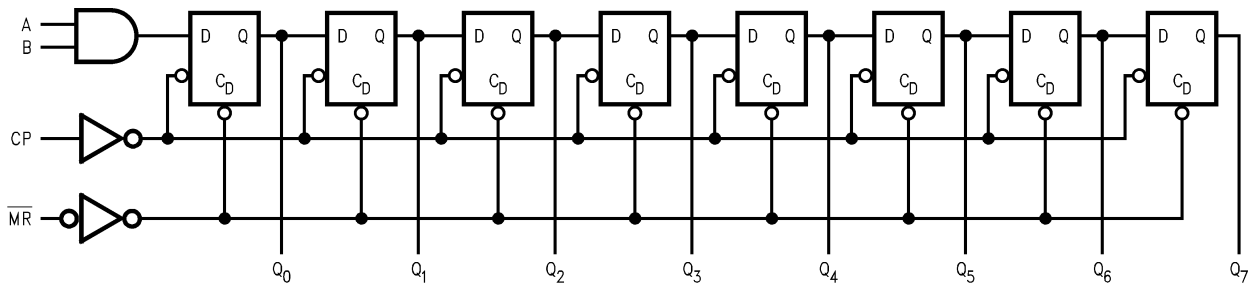
H = HIGH Voltage Levels

L = LOW Voltage Levels

X = Immaterial

Q = Lower case letters indicate the state of the referenced input or output one setup time prior to the LOW-to-HIGH clock transition.

## Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Figure 2. Logic Diagram

## MAXIMUM RATINGS

| Symbol           | Parameter                                       |                      | Value                         | Unit |
|------------------|-------------------------------------------------|----------------------|-------------------------------|------|
| V <sub>CC</sub>  | DC Supply Voltage                               |                      | –0.5 to +6.5                  | V    |
| V <sub>IN</sub>  | DC Input Voltage                                |                      | –0.5 to +6.5                  | V    |
| V <sub>OUT</sub> | DC Output Voltage                               |                      | –0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>IN</sub>  | DC Input Diode Current, per Pin                 |                      | ±20                           | mA   |
| I <sub>OUT</sub> | DC Output Diode Current, per Pin                |                      | ±25                           | mA   |
| I <sub>CC</sub>  | DC Supply Current, V <sub>CC</sub> and GND Pins |                      | ±75                           | mA   |
| I <sub>IK</sub>  | Input Clamp Current                             |                      | –20                           | mA   |
| I <sub>OK</sub>  | Output Clamp Current                            |                      | ±20                           | mA   |
| T <sub>STG</sub> | Storage Temperature Range                       |                      | –65 to +150                   | °C   |
| T <sub>L</sub>   | Lead Temperature, 1 mm from Case for 10 Seconds |                      | 260                           | °C   |
| T <sub>J</sub>   | Junction Temperature under Bias                 |                      | +150                          | °C   |
| θ <sub>JA</sub>  | Thermal Resistance (Note 1)                     |                      | 150                           | °C/W |
| P <sub>D</sub>   | Power Dissipation in Still Air at 25°C          |                      | 833                           | mW   |
| V <sub>ESD</sub> | ESD Withstand Voltage (Note 2)                  | Human Body Model     | 2000                          | V    |
|                  |                                                 | Charged Device Model | N/A                           |      |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Measured with minimum pad spacing on an FR4 board, using 76 mm-by-114 mm, 2-ounce copper trace no air flow per JESD51–7.
2. HBM tested to EIA / JESD22–A114–A. CDM tested to JESD22–C101–A. JEDEC recommends that ESD qualification to EIA/JESD22–A115A (Machine Model) be discontinued.

## RECOMMENDED OPERATING CONDITIONS

| Symbol     | Parameter                  |                                         | Min | Max      | Unit |
|------------|----------------------------|-----------------------------------------|-----|----------|------|
| $V_{CC}$   | DC Supply Voltage          |                                         | 2.0 | 5.5      | V    |
| $V_{IN}$   | DC Input Voltage (Note 3)  |                                         | 0   | 5.5      | V    |
| $V_{OUT}$  | DC Output Voltage (Note 3) |                                         | 0   | $V_{CC}$ | V    |
| $T_A$      | Operating Temperature      |                                         | -40 | +85      | °C   |
| $t_r, t_f$ | Input Rise or Fall Rate    | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ | 0   | 100      | ns/V |
|            |                            | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | 0   | 20       |      |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

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

## DC ELECTRICAL CHARACTERISTICS

| Symbol   | Parameter                 | Conditions                     | $V_{CC}$ (V)                      | $T_A = 25^\circ\text{C}$ |      |                     | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ |                     | Unit          |
|----------|---------------------------|--------------------------------|-----------------------------------|--------------------------|------|---------------------|------------------------------------------------|---------------------|---------------|
|          |                           |                                |                                   | Min                      | Typ  | Max                 | Min                                            | Max                 |               |
| $V_{IH}$ | HIGH Level Input Voltage  |                                | 2.0                               | 1.50                     | –    | –                   | 1.50                                           | –                   | V             |
|          |                           |                                | 3.0–5.5                           | $0.7 \times V_{CC}$      | –    | –                   | $0.7 \times V_{CC}$                            | –                   |               |
| $V_{IL}$ | LOW Level Input Voltage   |                                | 2.0                               | –                        | –    | 0.50                | –                                              | 0.50                | V             |
|          |                           |                                | 3.0–5.5                           | –                        | –    | $0.3 \times V_{CC}$ | –                                              | $0.3 \times V_{CC}$ |               |
| $V_{OH}$ | HIGH Level Output Voltage | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0                      | 1.9  | 2.0                 | –                                              | 1.9                 | V             |
|          |                           |                                |                                   | 3.0                      | 2.9  | 3.0                 | –                                              | 2.9                 |               |
|          |                           |                                |                                   | 4.5                      | 4.4  | 4.5                 | –                                              | 4.4                 |               |
|          |                           | $I_{OH} = -4\text{ mA}$        |                                   | 3.0                      | 2.58 | –                   | –                                              | 2.48                |               |
|          |                           |                                | $I_{OH} = -8\text{ mA}$           | 4.5                      | 3.94 | –                   | –                                              | 3.80                |               |
| $V_{OL}$ | LOW Level Output Voltage  | $V_{IN} = V_{IH}$ or $V_{IL}$  | $I_{OL} = 50\text{ }\mu\text{A}$  | 2.0                      | –    | 0.0                 | 0.1                                            | –                   | V             |
|          |                           |                                |                                   | 3.0                      | –    | 0.0                 | 0.1                                            | –                   |               |
|          |                           |                                |                                   | 4.5                      | –    | 0.0                 | 0.1                                            | –                   |               |
|          |                           | $I_{OL} = 4\text{ mA}$         |                                   | 3.0                      | –    | –                   | 0.36                                           | –                   |               |
|          |                           |                                | $I_{OL} = 8\text{ mA}$            | 4.5                      | –    | –                   | 0.36                                           | –                   |               |
| $I_{IN}$ | Input Leakage Current     | $V_{IN} = 5.5\text{ V or GND}$ | 0–5.5                             | –                        | –    | $\pm 0.1$           | –                                              | $\pm 1.0$           | $\mu\text{A}$ |
| $I_{CC}$ | Quiescent Supply Current  | $V_{IN} = V_{CC}$ or GND       | 5.5                               | –                        | –    | 4.0                 | –                                              | 40.0                | $\mu\text{A}$ |

## NOISE CHARACTERISTICS

| Symbol                | Parameter                                | Conditions           | $V_{CC}$ (V) | $T_A = 25^\circ\text{C}$ |        | Unit |
|-----------------------|------------------------------------------|----------------------|--------------|--------------------------|--------|------|
|                       |                                          |                      |              | Typ                      | Limits |      |
| $V_{OLP}$<br>(Note 4) | Quiet Output Maximum Dynamic $V_{OL}$    | $C_L = 50\text{ pF}$ | 5.0          | 0.5                      | 0.8    | V    |
| $V_{OLV}$<br>(Note 4) | Quiet Output Minimum Dynamic $V_{OL}$    | $C_L = 50\text{ pF}$ | 5.0          | –0.5                     | –0.8   | V    |
| $V_{IHD}$<br>(Note 4) | Minimum HIGH Level Dynamic Input Voltage | $C_L = 50\text{ pF}$ | 5.0          | –                        | 3.5    | V    |
| $V_{ILD}$<br>(Note 4) | Maximum LOW Level Dynamic Input Voltage  | $C_L = 50\text{ pF}$ | 5.0          | –                        | 1.5    | V    |

4. Parameter guaranteed by design.

## AC ELECTRICAL CHARACTERISTICS

| Symbol                              | Parameter                                   | Conditions                                    | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |      |      | T <sub>A</sub> = -40°C to +85°C |      | Unit |
|-------------------------------------|---------------------------------------------|-----------------------------------------------|---------------------|-----------------------|------|------|---------------------------------|------|------|
|                                     |                                             |                                               |                     | Min                   | Typ  | Max  | Min                             | Max  |      |
| f <sub>MAX</sub>                    | Maximum Clock Frequency                     | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 3.3 ±0.3            | 80                    | 125  | –    | 65                              | –    | MHz  |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | 50                    | 75   | –    | 45                              | –    |      |
|                                     |                                             | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 5.0 ±0.5            | 125                   | 175  | –    | 105                             | –    |      |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | 85                    | 115  | –    | 75                              | –    |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay Time (CP–Q <sub>n</sub> ) | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 3.3 ±0.3            | –                     | 8.4  | 12.8 | 1.0                             | 15.0 | ns   |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | –                     | 10.9 | 16.3 | 1.0                             | 18.5 |      |
|                                     |                                             | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 5.0 ±0.5            | –                     | 5.8  | 9.0  | 1.0                             | 10.5 |      |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | –                     | 7.3  | 11.0 | 1.0                             | 12.5 |      |
| t <sub>PHL</sub>                    | Propagation Delay Time (MR–Q <sub>n</sub> ) | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 3.3 ±0.3            | –                     | 8.3  | 12.8 | 1.0                             | 15.0 | ns   |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | –                     | 10.8 | 16.3 | 1.0                             | 18.5 |      |
|                                     |                                             | C <sub>L</sub> = 15 pF, R <sub>L</sub> = 1 kΩ | 5.0 ±0.5            | –                     | 5.2  | 8.6  | 1.0                             | 10.0 |      |
|                                     |                                             | C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ |                     | –                     | 6.7  | 10.6 | 1.0                             | 12.0 |      |
| C <sub>IN</sub>                     | Input Capacitance                           | V <sub>CC</sub> = Open                        |                     | –                     | 4    | 10   | –                               | 10   | pF   |
| C <sub>PD</sub>                     | Power Dissipation Capacitance               | (Note 5)                                      |                     | –                     | 76   | –    | –                               | –    | pF   |

5. C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained from the equation:

$$I_{CC}(\text{opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

## AC OPERATING REQUIREMENTS

| Symbol                                   | Parameter                 | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |                    | T <sub>A</sub> = -40°C to +85°C | Unit |
|------------------------------------------|---------------------------|---------------------|-----------------------|--------------------|---------------------------------|------|
|                                          |                           |                     | Typ                   | Guaranteed Minimum |                                 |      |
| t <sub>W(L)</sub> ,<br>t <sub>W(H)</sub> | Minimum Pulse Width (CP)  | 3.3                 | –                     | 5.0                | 5.0                             | ns   |
|                                          |                           | 5.0                 | –                     | 5.0                | 5.0                             |      |
| t <sub>W(L)</sub>                        | Minimum Pulse Width (MR)  | 3.3                 | –                     | 5.0                | 5.0                             | ns   |
|                                          |                           | 5.0                 | –                     | 5.0                | 5.0                             |      |
| t <sub>S</sub>                           | Minimum Setup Time        | 3.3                 | –                     | 5.0                | 6.0                             | ns   |
|                                          |                           | 5.0                 | –                     | 4.5                | 4.5                             |      |
| t <sub>H</sub>                           | Minimum Hold Time         | 3.3                 | –                     | 0.0                | 0.0                             | ns   |
|                                          |                           | 5.0                 | –                     | 1.0                | 1.0                             |      |
| t <sub>REC</sub>                         | Minimum Removal Time (MR) | 3.3                 | –                     | 2.5                | 2.5                             | ns   |
|                                          |                           | 5.0                 | –                     | 2.5                | 2.5                             |      |

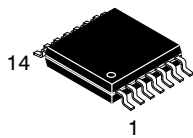
6. V<sub>CC</sub> is 3.3 ±0.3 V or 5.0 ±0.5 V

## ORDERING INFORMATION

| Device       | Marking    | Package                            | Shipping <sup>†</sup>    |
|--------------|------------|------------------------------------|--------------------------|
| 74VHC164MTCX | VHC<br>164 | TSSOP-14<br>(Pb-Free, Halide Free) | 2500 Units / Tape & Reel |

<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.

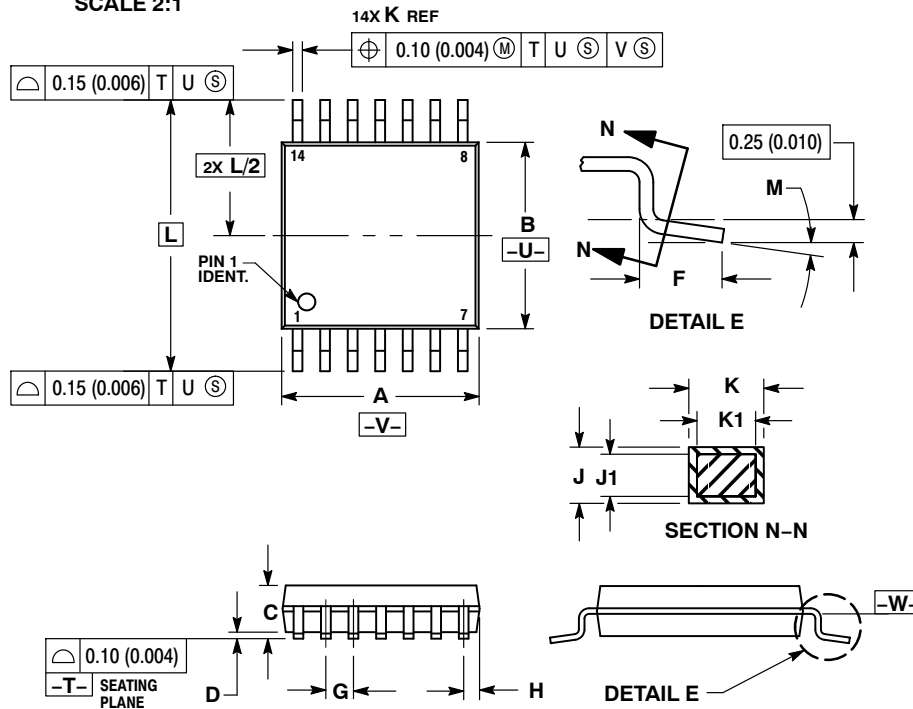
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**TSSOP-14 WB**  
CASE 948G  
ISSUE C

DATE 17 FEB 2016

SCALE 2:1

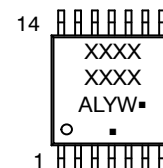


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.90        | 5.10 | 0.193     | 0.200 |
| B   | 4.30        | 4.50 | 0.169     | 0.177 |
| C   | ---         | 1.20 | ---       | 0.047 |
| D   | 0.05        | 0.15 | 0.002     | 0.006 |
| F   | 0.50        | 0.75 | 0.020     | 0.030 |
| G   | 0.65 BSC    |      | 0.026 BSC |       |
| H   | 0.50        | 0.60 | 0.020     | 0.024 |
| J   | 0.09        | 0.20 | 0.004     | 0.008 |
| J1  | 0.09        | 0.16 | 0.004     | 0.006 |
| K   | 0.19        | 0.30 | 0.007     | 0.012 |
| K1  | 0.19        | 0.25 | 0.007     | 0.010 |
| L   | 6.40 BSC    |      | 0.252 BSC |       |
| M   | 0°          | 8°   | 0°        | 8°    |

## GENERIC MARKING DIAGRAM\*

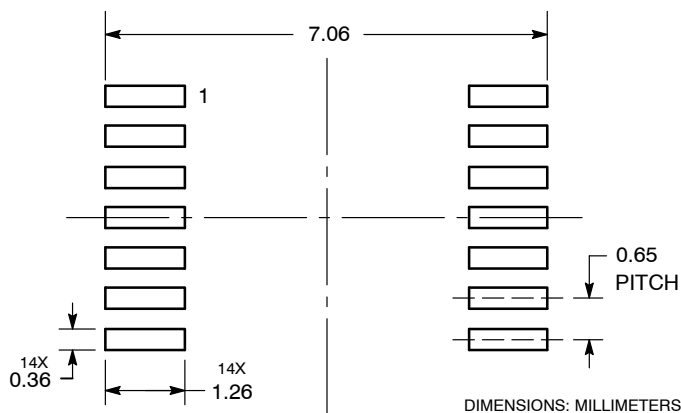


- A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*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.

## SOLDERING FOOTPRINT



DOCUMENT NUMBER: 98ASH70246A

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DESCRIPTION: TSSOP-14 WB

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