

# LOW SKEW PCI/PCI-X BUFFER

# **ICS2304NZ-1**

## Description

The ICS2304NZ-1 is a high-performance, low skew, low jitter PCI/PCI-X clock driver. It is designed to distribute high-speed signals in PCI/PCI-X applications operating at speeds from 0 to 140 MHz.

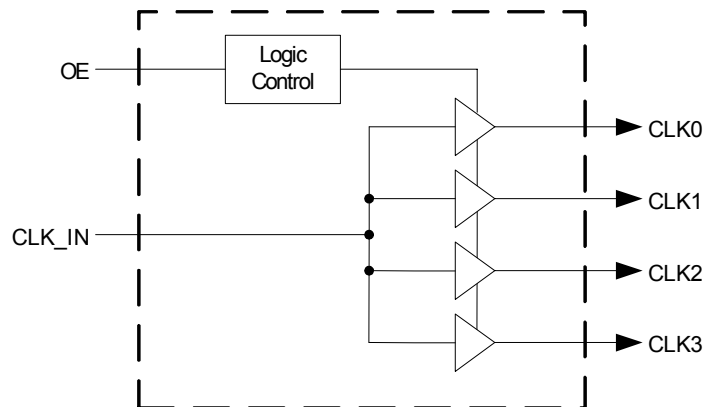
The ICS2304NZ-1 is characterized for operation from -40°C to +85°C for automotive and industrial applications.

## Features

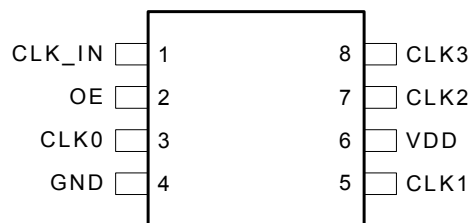
- Packaged in 8-pin TSSOP (4.4 mm body)
- Available in Pb (lead) free package
- Frequency range of 0 to 140 MHz
- Less than 100 ps skew between outputs
- Distribute one clock input to one bank of four outputs
- Operating voltage of 3.3 V  $\pm$ 10%
- Available in commercial and industrial temperature ranges

**NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01**

## Block Diagram



## Pin Assignment



## Functionality Table

| Inputs |    | Outputs  |
|--------|----|----------|
| CLK_IN | OE | CLK(3:0) |
| 0      | 0  | Tristate |
| 0      | 1  | 0        |
| 1      | 0  | Tristate |
| 1      | 1  | 1        |

## Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description                                             |
|------------|----------|----------|-------------------------------------------------------------|
| 1          | CLK_IN   | Input    | Input reference frequency.                                  |
| 2          | OE       | Input    | Output Enable. When OE is low, it tri-states clock outputs. |
| 3          | CLK0     | Output   | Buffered clock output.                                      |
| 4          | GND      | Power    | Connect to ground.                                          |
| 5          | CLK1     | Output   | Buffered clock output.                                      |
| 6          | VDD      | Power    | Power supply for 3.3 V.                                     |
| 7          | CLK2     | Output   | Buffered clock output.                                      |
| 8          | CLK3     | Output   | Buffered clock output.                                      |

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS2304NZ-1. These ratings, which are standard values for ICS commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| Item                                                              | Rating                     |
|-------------------------------------------------------------------|----------------------------|
| Supply Voltage Range, $V_{DD}$                                    | -0.5 V to 4.3 V            |
| Input Voltage Range, $V_I$ (see notes 1 and 2)                    | -0.5 V to $V_{DD} + 0.5$ V |
| Output Voltage Range, $V_O$ (see notes 1 and 2)                   | -0.5 V to $V_{DD} + 0.5$ V |
| Input Clamp Current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{DD}$ )     | $\pm 50$ mA                |
| Output Clamp Current, $I_{IK}$ ( $V_O < 0$ or $V_O$ )             | $\pm 50$ mA                |
| Continuous Total Output Current, $I_O$ ( $V_O = 0$ to $V_{DD}$ )  | $\pm 50$ mA                |
| Package Thermal Impedance, $\theta_{JA}$ (see note 3): PW Package | 230.5° C/W                 |
| Storage Temperature Range, $T_{stg}$                              | -65° C to 150° C           |

Notes:

1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This value is limited to 4.6 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.

## Recommended Operation Conditions

| Parameter                             | Min.                | Typ. | Max.                | Units |
|---------------------------------------|---------------------|------|---------------------|-------|
| Supply Voltage, $V_{DD}$              | 3                   | 3.3  | 3.6                 | V     |
| High-level Input Voltage, $V_{IH}$    | $0.7 \times V_{DD}$ |      |                     | V     |
| Low-level Input Voltage, $V_{IL}$     |                     |      | $0.3 \times V_{DD}$ | V     |
| Input Voltage, $V_I$                  | 0                   |      | $V_{DD}$            | V     |
| High-level Output Current, $I_{OH}$   |                     |      | -24                 | mA    |
| Low-level Output Current, $I_{OL}$    |                     |      | 24                  | mA    |
| Operating Free-air Temperature, $T_A$ | -40                 | —    | +85                 | °C    |

## Timing Requirements Over Recommended Ranges of Supply Voltage and Operating Free-air Temperature

|                            | Min. | Typ. | Max. | Units |
|----------------------------|------|------|------|-------|
| Clock Frequency, $f_{CLK}$ | 0    |      | 140  | MHz   |

**Electrical Characteristics at 3.3 V over Recommended Free-air Temperature Range**VDD = 3.3 V  $\pm$ 10%, T<sub>A</sub> = -40°C to +85°C (unless stated otherwise)

| Parameter                      | Symbol          | Conditions                                               | Min.                 | Typ.  | Max. | Units |
|--------------------------------|-----------------|----------------------------------------------------------|----------------------|-------|------|-------|
| Input Voltage                  | V <sub>IK</sub> | V <sub>DD</sub> at 3.3 V, I <sub>I</sub> = -18 mA        |                      |       | -1.2 | V     |
| High-level Output Voltage      | V <sub>OH</sub> | V <sub>DD</sub> = min to max,<br>I <sub>OH</sub> = -1 mA | V <sub>DD</sub> -0.2 | 3.3   |      | V     |
|                                |                 | V <sub>DD</sub> = 3 V, I <sub>OH</sub> = -24 mA          | 2                    | 2.3   |      |       |
|                                |                 | V <sub>DD</sub> = 3 V, I <sub>OH</sub> = -12 mA          | 2.4                  | 2.7   |      |       |
| Low-level Output Voltage       | V <sub>OL</sub> | V <sub>DD</sub> = min to max,<br>I <sub>OH</sub> = 1 mA  |                      | 0.222 | 0.2  | V     |
|                                |                 | V <sub>DD</sub> = 3 V, I <sub>OL</sub> = 24 mA           |                      | 0.61  | 0.8  |       |
|                                |                 | V <sub>DD</sub> = 3 V, I <sub>OL</sub> = 12 mA           |                      | 0.31  | 0.55 |       |
| High-level Input Current       | I <sub>OH</sub> | V <sub>DD</sub> = 3 V, V <sub>O</sub> = 1 V              |                      | -53   | -40  | mA    |
|                                |                 | V <sub>DD</sub> = 3.3 V, V <sub>O</sub> = 1.65 V         |                      | -54   |      |       |
| Low-level Input Current        | I <sub>OL</sub> | V <sub>DD</sub> = 3 V, V <sub>O</sub> = 2 V              | 40                   | 53    |      | mA    |
|                                |                 | V <sub>DD</sub> = 3.3 V, V <sub>O</sub> = 1.65 V         |                      | 57    |      |       |
| Input Current                  | I <sub>I</sub>  | V = V <sub>DD</sub> or V <sub>O</sub>                    | 0.1                  |       | 50   | μA    |
| Dynamic Supply Current         | I <sub>DD</sub> | Unloaded outputs at<br>66.67 MHz                         |                      | 13    | 37   | mA    |
| Input Capacitance<br>(Note 1)  | C <sub>I</sub>  | V <sub>DD</sub> = 3.3 V,<br>V <sub>I</sub> = 0V or 3.3 V |                      | 3     | 5    | pF    |
| Output Capacitance<br>(Note 1) | C <sub>O</sub>  | V <sub>DD</sub> = 3.3 V,<br>V <sub>I</sub> = 0V or 3.3 V |                      | 3.2   |      | pF    |

Note 1: Guaranteed by design, not 100% tested in production.

## Switching Characteristics at 3.3 V over Recommended Ranges of Supply Voltage and Operating Free-air Temperature

VDD = 3.3 V  $\pm$ 10%, T<sub>A</sub> = -40°C to 85°C (unless stated otherwise)

| Parameter                                                     | Symbol               | Conditions                                        | Min. | Typ. | Max. | Units |
|---------------------------------------------------------------|----------------------|---------------------------------------------------|------|------|------|-------|
| High-to-Low Propagation Delay (Note 1)                        | t <sub>PLH</sub>     | V <sub>O</sub> = V <sub>DD</sub> /2               | 1.8  | 3.1  | 3.8  | ns    |
| Low-to-High Propagation Delay (Note 1)                        | t <sub>PHL</sub>     | V <sub>O</sub> = V <sub>DD</sub> /2               | 1.8  | 2.9  | 3.8  | ns    |
| Output Skew Window (Note 1)                                   | T <sub>SK(o)</sub>   | V <sub>O</sub> = V <sub>DD</sub> /2               |      | 50   | 100  | ps    |
| Pulse Skew =   t <sub>PLH</sub> - t <sub>PHL</sub>   (Note 1) | T <sub>SK(p)</sub>   | V <sub>O</sub> = V <sub>DD</sub> /2               |      |      | 300  | ps    |
| Process Skew (Note 1)                                         | T <sub>SK(pr)</sub>  | V <sub>O</sub> = V <sub>DD</sub> /2               |      |      | 500  | ps    |
| CLKIN High Time (Note1)                                       | T <sub>high</sub>    | 66 MHz                                            | 6    |      |      | ns    |
|                                                               |                      | 140 MHz                                           | 3    |      |      | ns    |
| CLKIN Low Time (Note1)                                        | T <sub>low</sub>     | 66 MHz                                            | 6    |      |      | ns    |
|                                                               |                      | 140 MHz                                           | 3    |      |      | ns    |
| Rise Time (Note 1)                                            | T <sub>r</sub>       | V <sub>OL</sub> =0.8 V,<br>V <sub>OH</sub> =2.0 V |      | 1.2  | 2.0  | ns    |
| Fall Time (Note 1)                                            | T <sub>f</sub>       | V <sub>OH</sub> =2.0 V,<br>V <sub>OL</sub> =0.8 V |      | 1.2  | 2.0  | ns    |
| Cycle-to-Cycle Jitter                                         | T <sub>cyc-cyc</sub> | Loaded outputs                                    |      |      | 200  | ps    |
| Jitter, 1-Sigma                                               | T <sub>j1s</sub>     | 10,000 cycles                                     |      | 14   | 40   | ps    |

Note 1: Guaranteed by design, not 100% tested in production.

## Parameter Measurement Information

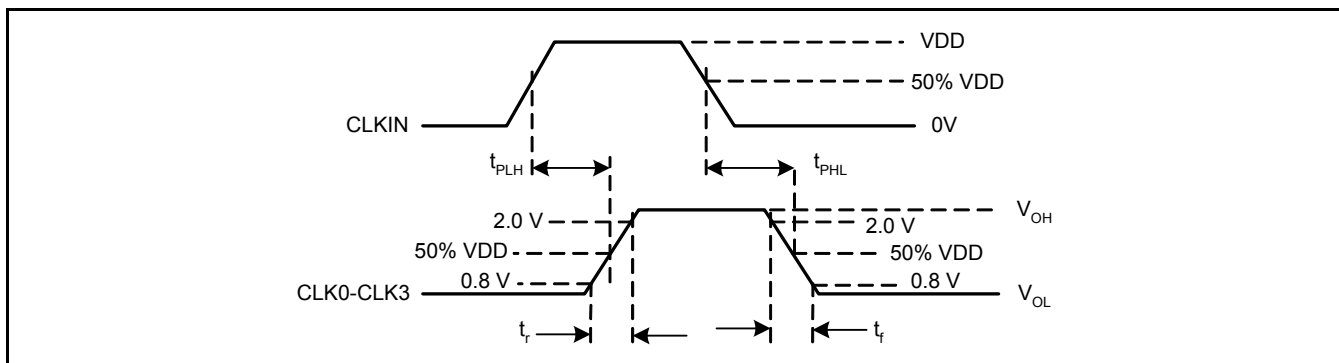


Figure 2. Voltage Thresholds for Propagation Delay ( $t_{pd}$ ) Measurements

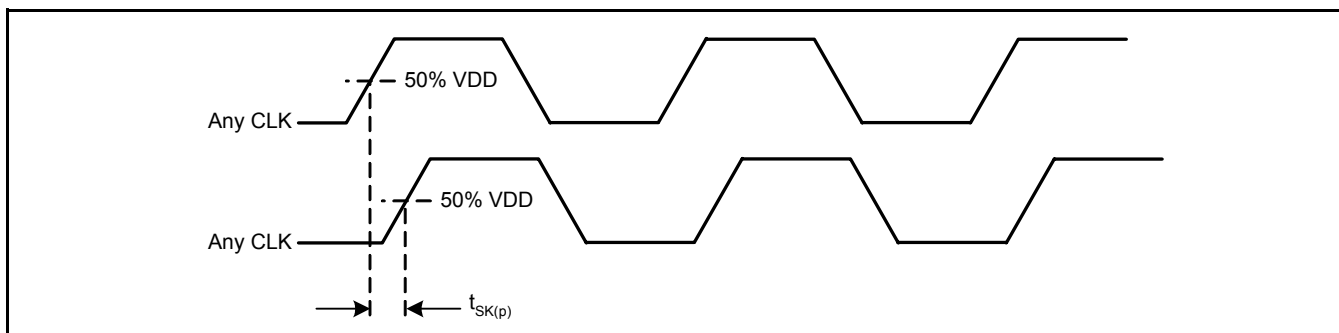


Figure 3. Output Skew

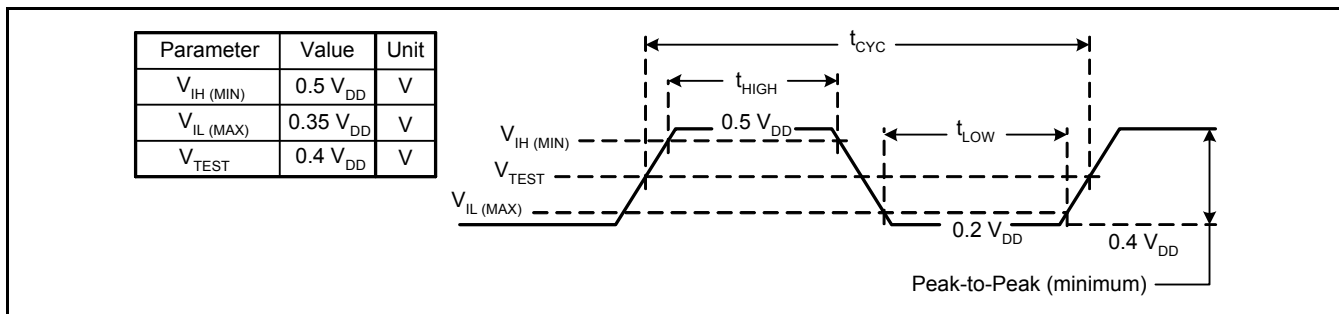


Figure 4. Clock Waveform

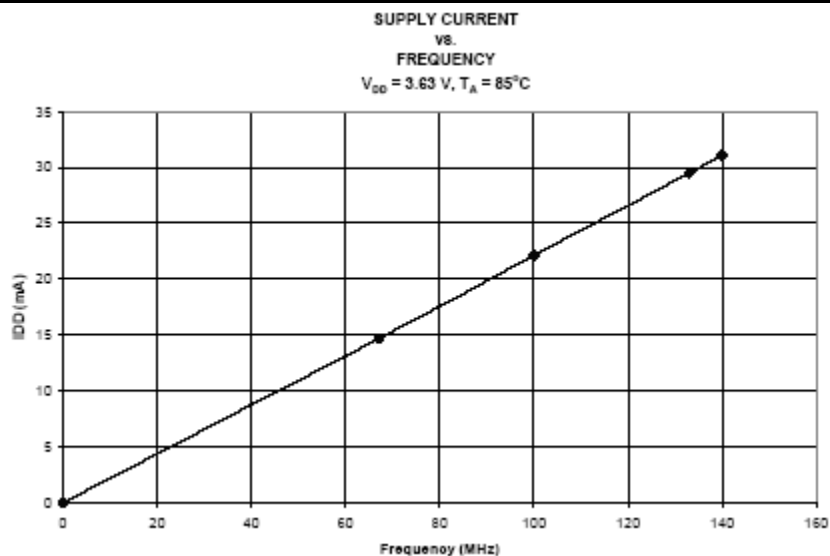


Figure 5. Supply Current vs. Frequency

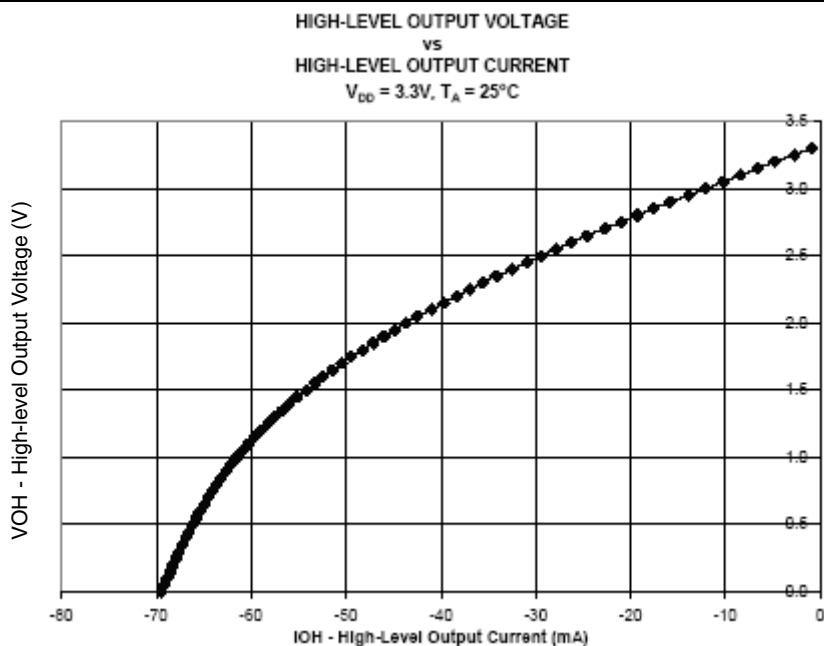


Figure 6. High-level Output Voltage vs. High-level Output Current

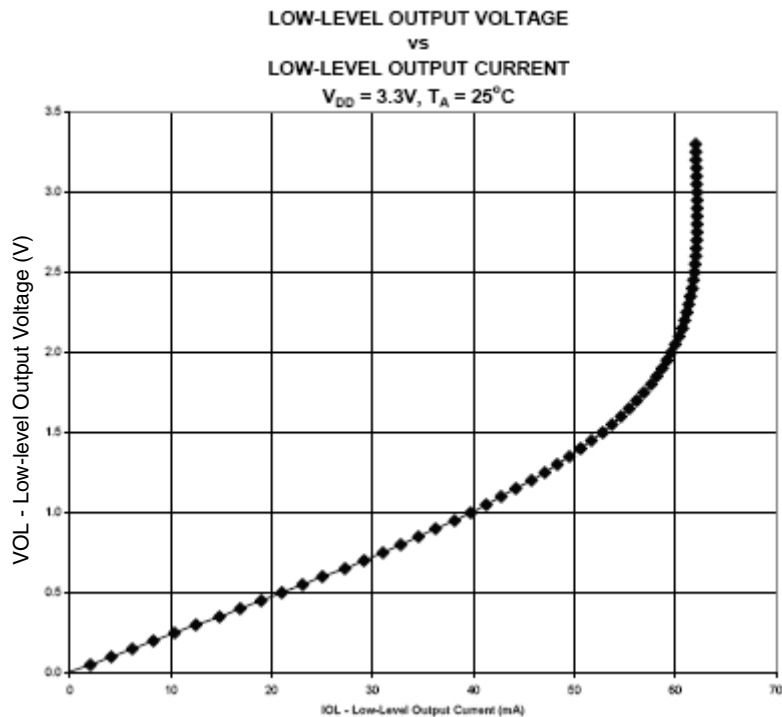
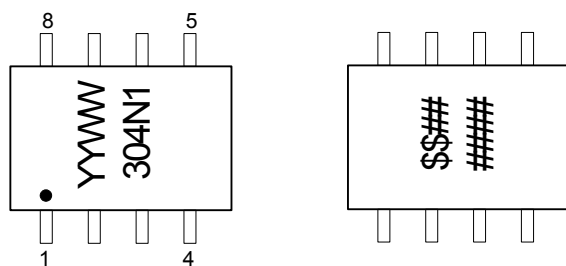


Figure 7. Low-level Output Voltage vs. Low-level Output Current

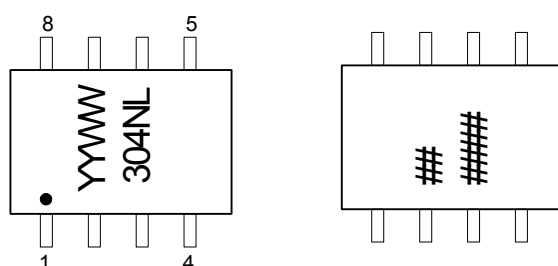
## Marking Diagram



TOP

BOTTOM

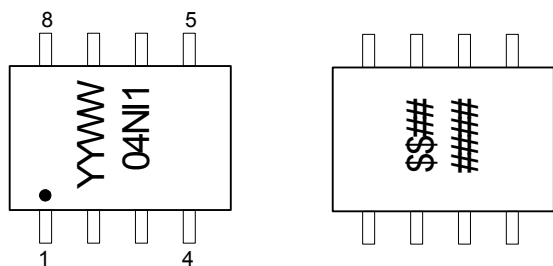
## Marking Diagram (Pb free)



TOP

BOTTOM

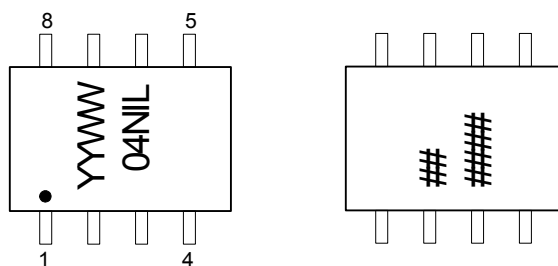
## Marking Diagram (industrial)



TOP

BOTTOM

## Marking Diagram (Pb free/industrial)



TOP

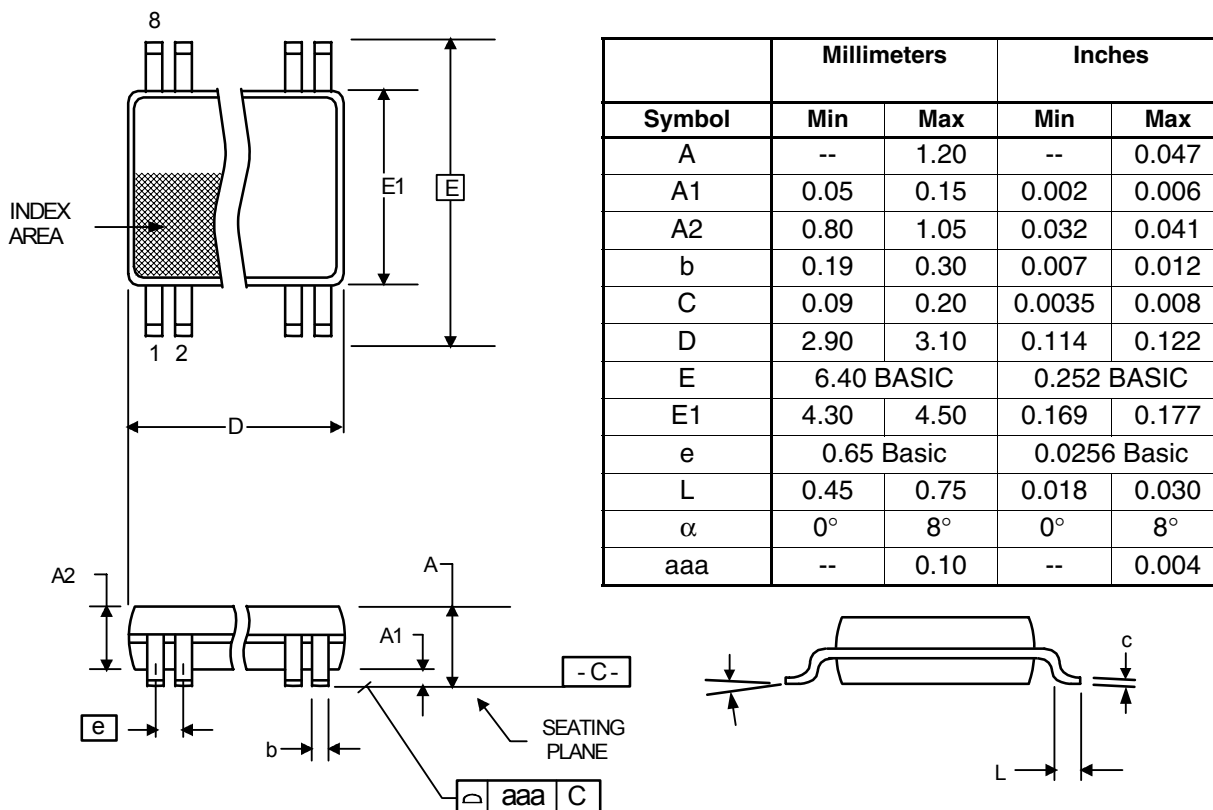
BOTTOM

### Notes:

1. ##### is the lot number.
2. YYWW is the last two digits of the year and week that the part was assembled.
3. "L" denotes Pb (lead) free package.

**Package Outline and Package Dimensions (8-pin TSSOP, 4.40 mm Body, 0.65 mm Pitch)**

Package dimensions are kept current with JEDEC Publication No. 95, MO-153

**Ordering Information**

| Part / Order Number | Marking    | Shipping Packaging | Package     | Temperature   |
|---------------------|------------|--------------------|-------------|---------------|
| 2304NZG-1*          | see page 8 | Tubes              | 8-pin TSSOP | 0 to +70° C   |
| 2304NZG-1T*         |            | Tape and Reel      | 8-pin TSSOP | 0 to +70° C   |
| 2304NZG-1LF         |            | Tubes              | 8-pin TSSOP | 0 to +70° C   |
| 2304NZG-1LFT        |            | Tape and Reel      | 8-pin TSSOP | 0 to +70° C   |
| 2304NZGI-1*         |            | Tubes              | 8-pin TSSOP | -40 to +85° C |
| 2304NZGI-1T*        |            | Tape and Reel      | 8-pin TSSOP | -40 to +85° C |
| 2304NZGI-1LF        |            | Tubes              | 8-pin TSSOP | -40 to +85° C |
| 2304NZGI-1LFT       |            | Tape and Reel      | 8-pin TSSOP | -40 to +85° C |

**\*NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01.****Parts that are ordered with a "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.**

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