

FEATURES

- Member of the Texas Instruments Widebus™ Family
- EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process
- Typical V_{OLP} (Output Ground Bounce) < 0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Typical V_{OHV} (Output V_{OH} Undershoot) > 2 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Latch-Up Performance Exceeds 250 mA Per JEDEC Standard JESD-17
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

DESCRIPTION

This 16-bit edge-triggered D-type flip-flop is designed for 2.7-V to 3.6-V V_{CC} operation.

The SN74LVC16374 is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CLK) input, the Q outputs of the flip-flop take on the logic levels set up at the data (D) inputs.

A buffered output-enable (\overline{OE}) input can be used to place the eight outputs in either a normal logic state (high or low logic levels) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and the increased drive provide the capability to drive bus lines without need for interface or pullup components.

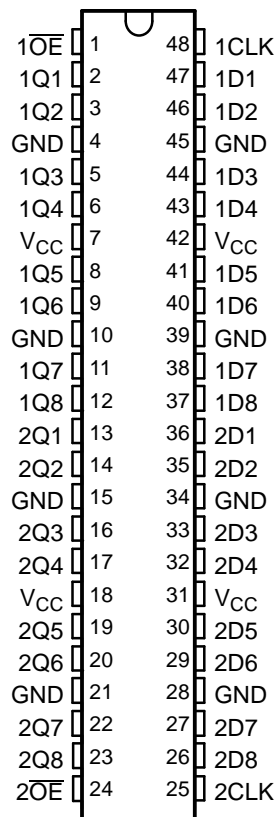
\overline{OE} does not affect internal operations of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN74LVC16374 is characterized for operation from -40°C to 85°C .

DGG OR DL PACKAGE
(TOP VIEW)



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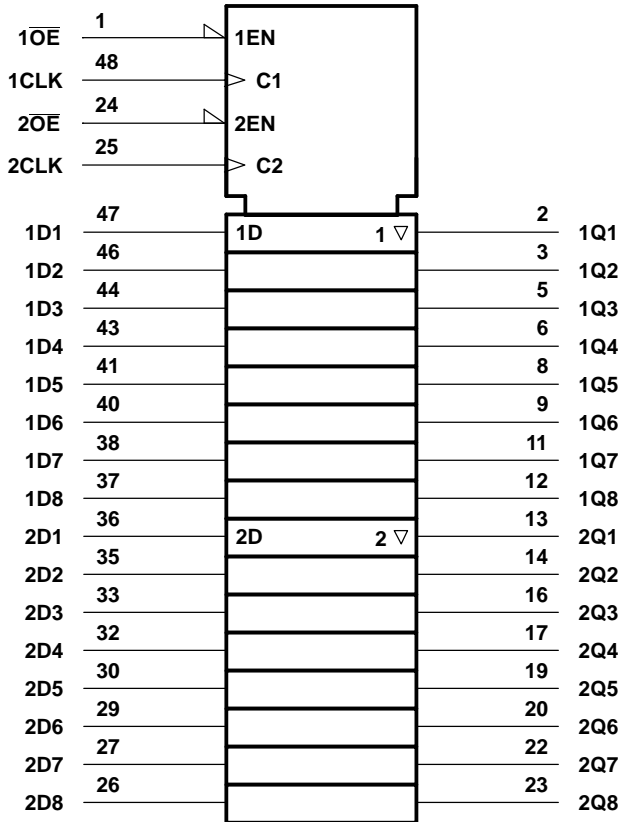
SN74LVC16374
16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP
WITH 3-STATE OUTPUTS

SCAS316B—NOVEMBER 1993—REVISED MARCH 2005

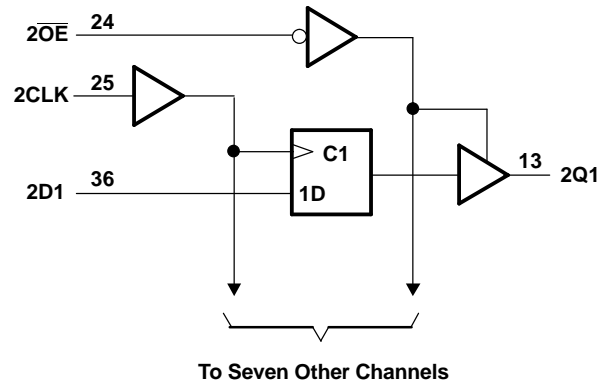
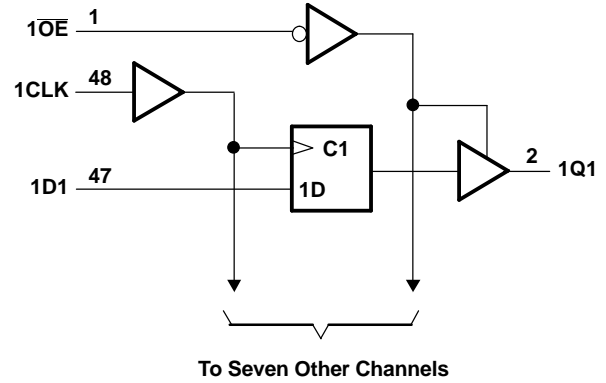
FUNCTION TABLE (EACH FLIP-FLOP)

| INPUTS | | | OUTPUT Q |
|-----------------|--------|---|-------------|
| \overline{OE} | CLK | D | |
| L | ↑ | H | H |
| L | ↑ | L | L |
| L | H or L | X | Q_0 |
| H | X | X | Z |

LOGIC SYMBOL⁽¹⁾



LOGIC DIAGRAM (POSITIVE LOGIC)



(1) This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

| | | MIN | MAX | UNIT | |
|-----------|---|-----------------------------|----------------|------|----|
| V_{CC} | Supply voltage range | -0.5 | 4.6 | V | |
| V_I | Input voltage range ⁽²⁾ | -0.5 | 4.6 | V | |
| V_O | Output voltage range ⁽²⁾⁽³⁾ | -0.5 | $V_{CC} + 0.5$ | V | |
| I_{IK} | Input clamp current | $V_I < 0$ | | -50 | mA |
| I_{OK} | Output clamp current | $V_O < 0$ or $V_O > V_{CC}$ | | ±50 | mA |
| I_O | Continuous output current | $V_O = 0$ to V_{CC} | | ±50 | mA |
| | Continuous current through V_{CC} or GND | | | ±100 | mA |
| | Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) ⁽⁴⁾ | DGG package | | 0.85 | W |
| | | DL package | | 1.2 | |
| T_{stg} | Storage temperature range | -65 | 150 | °C | |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (3) This value is limited to 4.6 V maximum.
- (4) The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils. For more information, refer to the *Package Thermal Considerations* application note in the 1994 *ABT Advanced BiCMOS Technology Data Book*, literature number SCBD002B.

Recommended Operating Conditions⁽¹⁾

| | | MIN | MAX | UNIT | |
|---------------------|------------------------------------|---|----------|------|----|
| V_{CC} | Supply voltage | 2.7 | 3.6 | V | |
| V_{IH} | High-level input voltage | $V_{CC} = 2.7\text{ V to }3.6\text{ V}$ | | 2 | V |
| V_{IL} | Low-level input voltage | $V_{CC} = 2.7\text{ V to }3.6\text{ V}$ | | 0.8 | V |
| V_I | Input voltage | 0 | V_{CC} | V | |
| V_O | Output voltage | 0 | V_{CC} | V | |
| I_{OH} | High-level output current | $V_{CC} = 2.7\text{ V}$ | | -12 | mA |
| | | $V_{CC} = 3\text{ V}$ | | -24 | |
| I_{OL} | Low-level output current | $V_{CC} = 2.7\text{ V}$ | | 12 | mA |
| | | $V_{CC} = 3\text{ V}$ | | 24 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0 | 10 | ns/V | |
| T_A | Operating free-air temperature | -40 | 85 | °C | |

- (1) Unused control inputs must be held high or low to prevent them from floating.

SN74LVC16374

16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

SCAS316B–NOVEMBER 1993–REVISED MARCH 2005

Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | $V_{CC}^{(1)}$ | MIN | TYP ⁽²⁾ | MAX | UNIT |
|----------------------|-------------|---|----------------|----------------|--------------------|----------|---------|
| V_{OH} | | $I_{OH} = -100 \mu A$ | MIN to MAX | $V_{CC} - 0.2$ | | | V |
| | | $I_{OH} = -12 \text{ mA}$ | 2.7 V | 2.2 | | | |
| | | $I_{OH} = -24 \text{ mA}$ | 3 V | 2.4 | | | |
| V_{OL} | | $I_{OL} = 100 \mu A$ | MIN to MAX | | | 0.2 | V |
| | | $I_{OL} = 12 \text{ mA}$ | 2.7 V | | | 0.4 | |
| | | $I_{OL} = 24 \text{ mA}$ | 3 V | | | 0.55 | |
| I_I | | $V_I = V_{CC}$ or GND | 3.6 V | | | ± 5 | μA |
| $I_{I(\text{hold})}$ | Data inputs | $V_I = 0.8 \text{ V}$ | 3 V | 75 | | | μA |
| | | $V_I = 2 \text{ V}$ | | -75 | | | |
| | | $V_I = 0$ to 3.6 V | 3.6 V | | ± 500 | | |
| I_{OZ} | | $V_O = V_{CC}$ or GND | 3.6 V | | | ± 10 | μA |
| I_{CC} | | $V_I = V_{CC}$ or GND, $I_O = 0$ | 3.6 V | | | 40 | μA |
| ΔI_{CC} | | One input at $V_{CC} - 0.6 \text{ V}$, Other inputs at V_{CC} or GND | 3 V to 3.6 V | | | 500 | μA |
| C_i | | $V_I = V_{CC}$ or GND | 3.3 V | | 3.5 | | pF |
| C_o | | $V_O = V_{CC}$ or GND | 3.3 V | | 7 | | pF |

(1) For conditions shown as MIN or MAX, use the appropriate values under recommended operating conditions.

(2) All typical values are at $V_{CC} = 3.3 \text{ V}$, $T_A = 25^\circ\text{C}$.

Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted)

| | | $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ | | $V_{CC} = 2.7 \text{ V}$ | | UNIT |
|--------------------|--|--|-----|--------------------------|-----|------|
| | | MIN | MAX | MIN | MAX | |
| f_{clock} | Clock frequency | 0 | 100 | 0 | 80 | MHz |
| t_w | Pulse duration, CLK high or low | 4 | | 4 | | ns |
| t_{su} | Setup time, data before CLK \uparrow | High or low | | 3 | | ns |
| t_h | Hold time, data after CLK \uparrow | High or low | | 1.5 | | ns |

Switching Characteristics

over recommended operating free-air temperature range, $C_L = 50 \text{ pF}$ (unless otherwise noted) (see Figure 1)

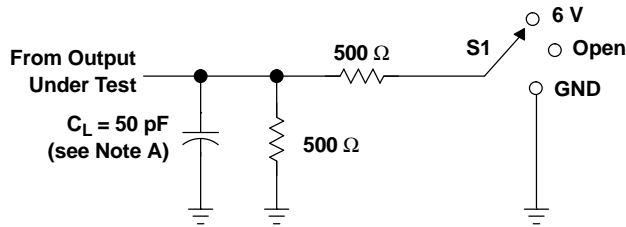
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$ | | $V_{CC} = 2.7 \text{ V}$ | | UNIT |
|------------------|-----------------|-------------|--|-----|--------------------------|-----|------|
| | | | MIN | MAX | MIN | MAX | |
| f_{max} | | | 100 | | 80 | | MHz |
| t_{pd} | CLK | Q | 1.5 | 7.5 | 1.5 | 8.5 | ns |
| t_{en} | \overline{OE} | Q | 1.5 | 7.5 | 1.5 | 8.5 | ns |
| t_{dis} | \overline{OE} | Q | 1.5 | 7 | 1.5 | 8 | ns |

Operating Characteristics

$V_{CC} = 3.3 \text{ V}$, $T_A = 25^\circ\text{C}$

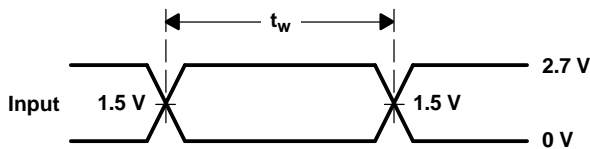
| PARAMETER | | TEST CONDITIONS | TYP | UNIT |
|-----------|---|------------------|-----|------|
| C_{pd} | Power dissipation capacitance per flip-flop | Outputs enabled | 22 | pF |
| | | Outputs disabled | 9 | |

PARAMETER MEASUREMENT INFORMATION

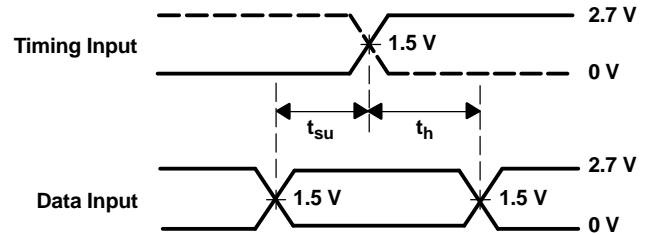


| TEST | S1 |
|-------------------|------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | 6 V |
| t_{PHZ}/t_{PZH} | GND |

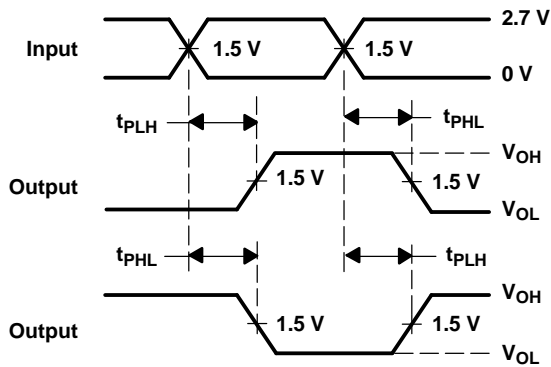
LOAD CIRCUIT FOR OUTPUTS



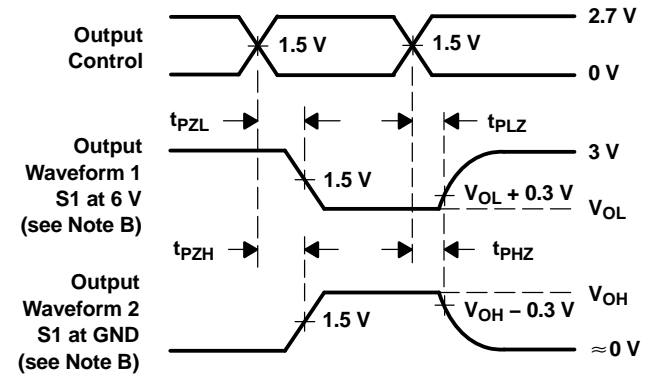
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- NOTES:
- A. C_L includes probe and jig capacitance.
 - B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 - C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10$ MHz, $Z_O = 50 \Omega$, $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns.
 - D. The outputs are measured one at a time, with one transition per measurement.
 - E. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 - F. t_{PZL} and t_{PZH} are the same as t_{en} .
 - G. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| SN74LVC16374DGGR | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | LVC16374 | Samples |
| SN74LVC16374DL | ACTIVE | SSOP | DL | 48 | 25 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | LVC16374 | Samples |
| SN74LVC16374DLR | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | LVC16374 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74LVC16374DGGR | TSSOP | DGG | 48 | 2000 | 330.0 | 24.4 | 8.6 | 13.0 | 1.8 | 12.0 | 24.0 | Q1 |
| SN74LVC16374DLR | SSOP | DL | 48 | 1000 | 330.0 | 32.4 | 11.35 | 16.2 | 3.1 | 16.0 | 32.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

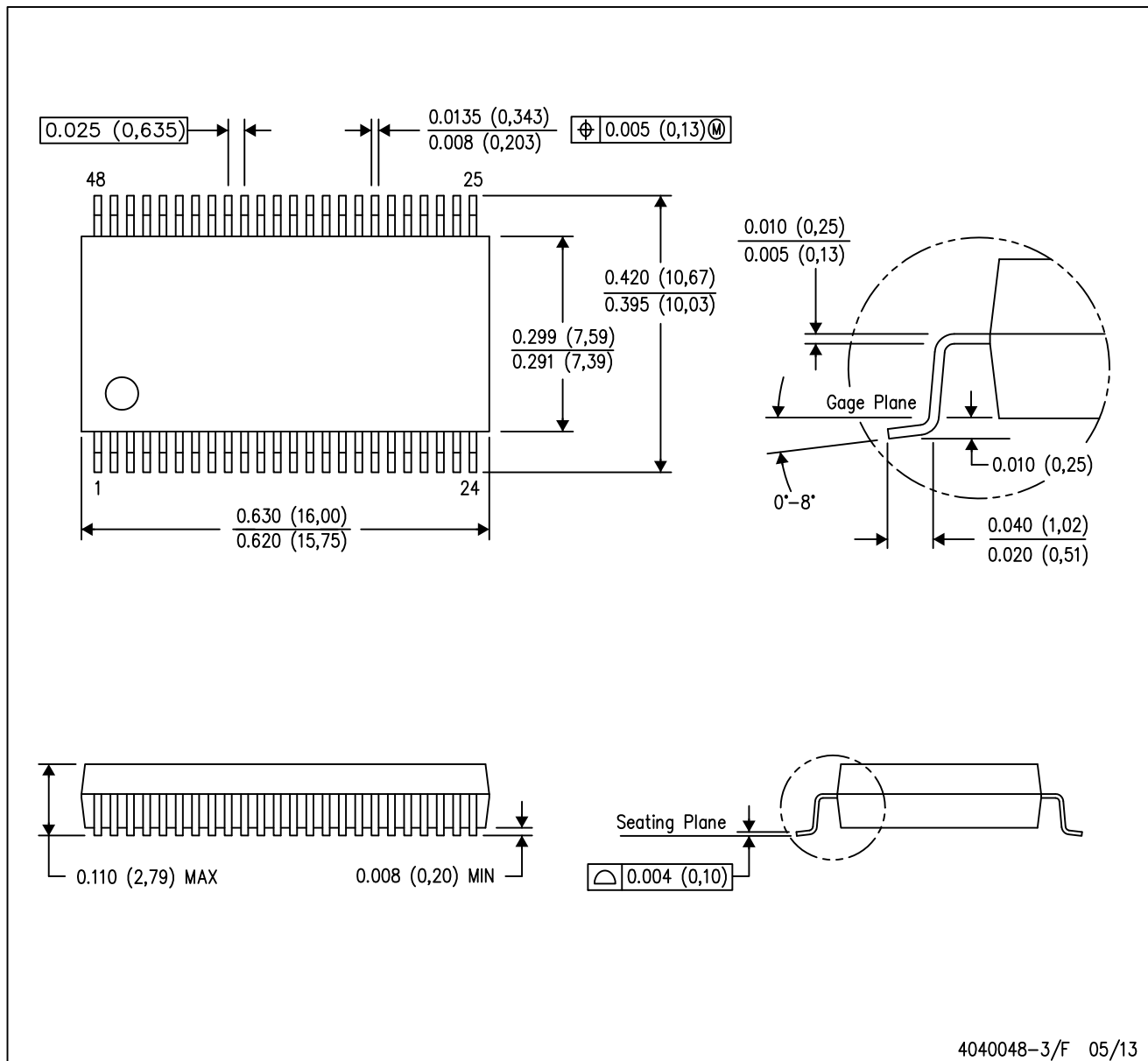

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74LVC16374DGGR | TSSOP | DGG | 48 | 2000 | 367.0 | 367.0 | 45.0 |
| SN74LVC16374DLR | SSOP | DL | 48 | 1000 | 367.0 | 367.0 | 55.0 |

MECHANICAL DATA

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



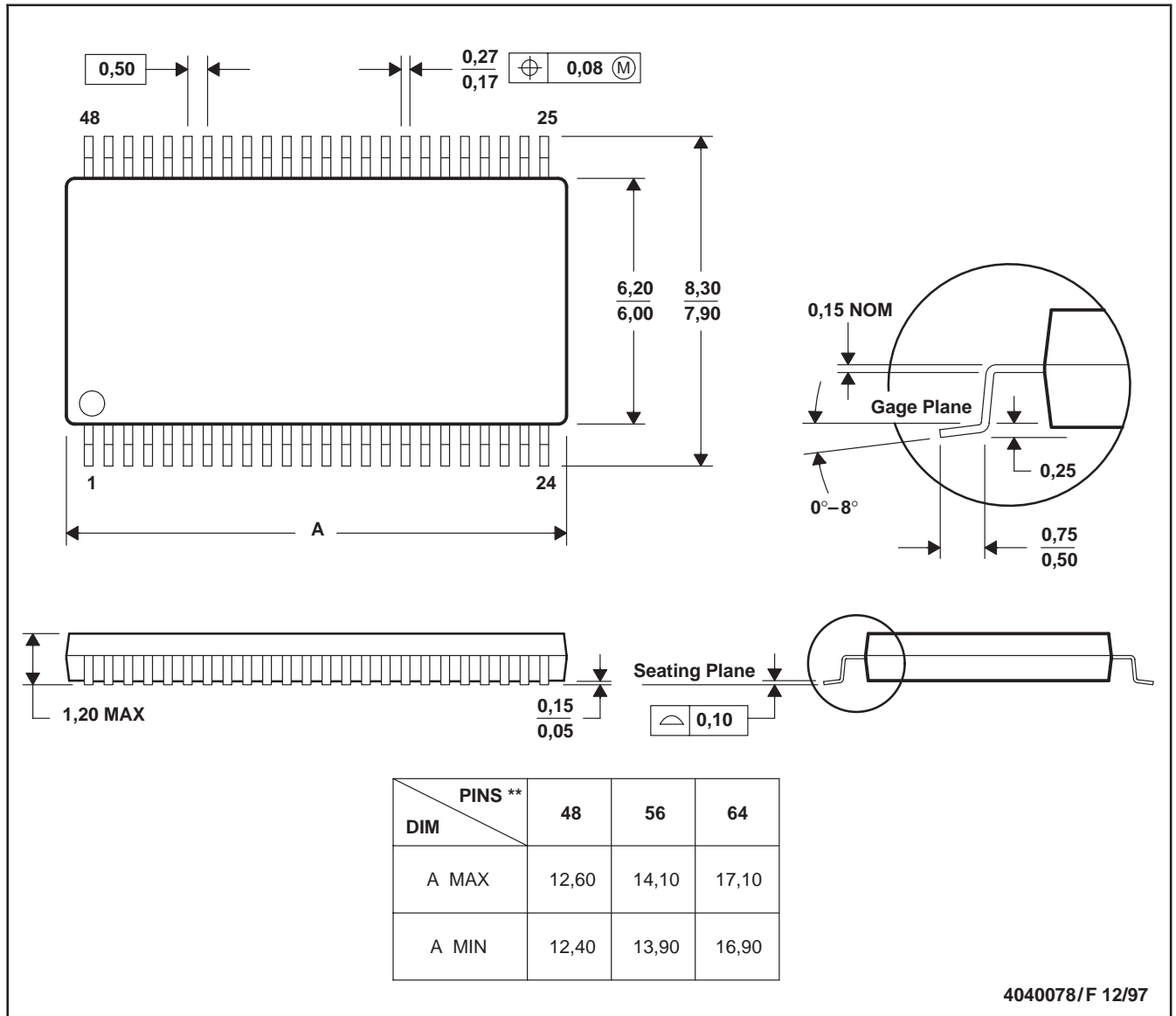
- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MO-118

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DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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