

# SN74ALVC16821

## 3.3-V 20-BIT BUS-INTERFACE FLIP-FLOP WITH 3-STATE OUTPUTS

SCAS269A – MARCH 1993 – REVISED AUGUST 1995

- Member of the Texas Instruments *Widebus*™ Family
- EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 250 mA Per JEDEC Standard JESD-17
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

### description

This 20-bit bus-interface flip-flop is designed for low-voltage (3.3-V)  $V_{CC}$  operation; it is tested at 2.5-V, 2.7-V, and 3.3-V  $V_{CC}$ .

The SN74ALVC16821 can be used as two 10-bit flip-flops or one 20-bit flip-flop. The 20 flip-flops are edge-triggered D-type flip-flops. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs.

A buffered output-enable ( $\overline{OE}$ ) input can be used to place the ten outputs in either a normal logic state (high or low level) 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 increased drive provide the capability to drive bus lines without interface or pullup components.

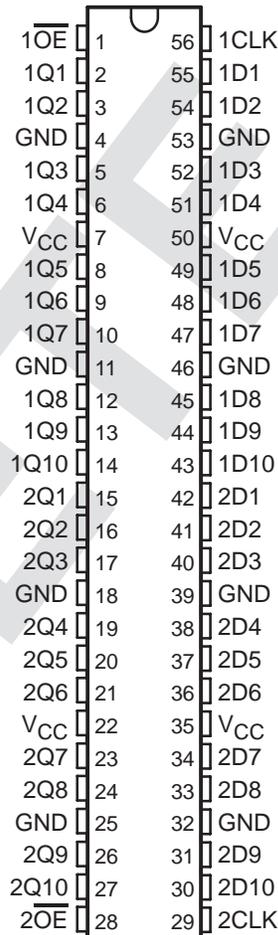
The output-enable ( $\overline{OE}$ ) input does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

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

The SN74ALVC16821 is available in TI's shrink small-outline (DL) and thin shrink small-outline (DGG) packages, which provide twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The SN74ALVC16821 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

DGG OR DL PACKAGE  
(TOP VIEW)



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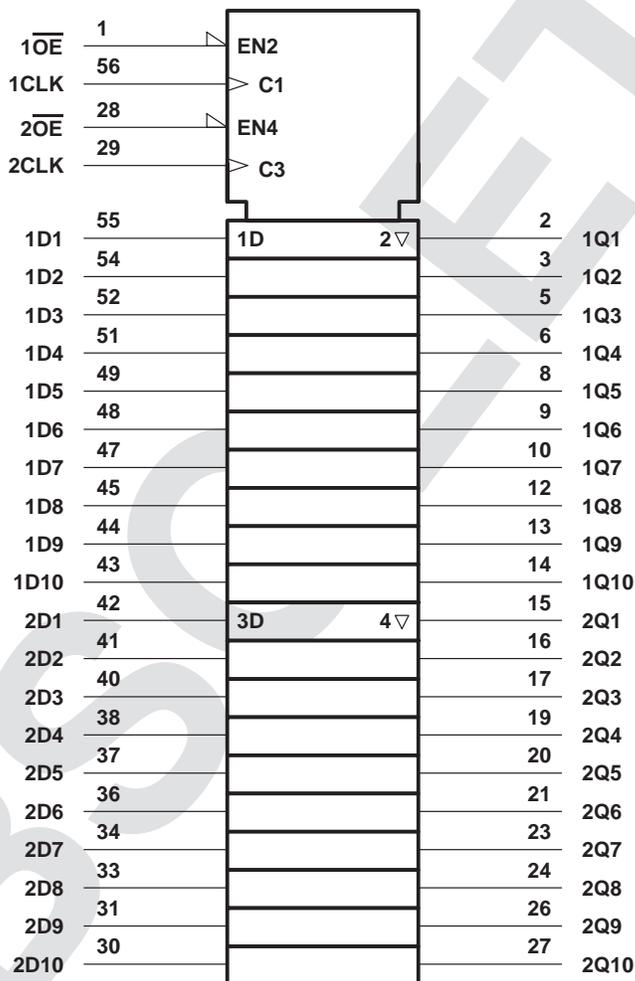
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FUNCTION TABLE  
(each 10-bit flip-flop)

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

logic symbol†

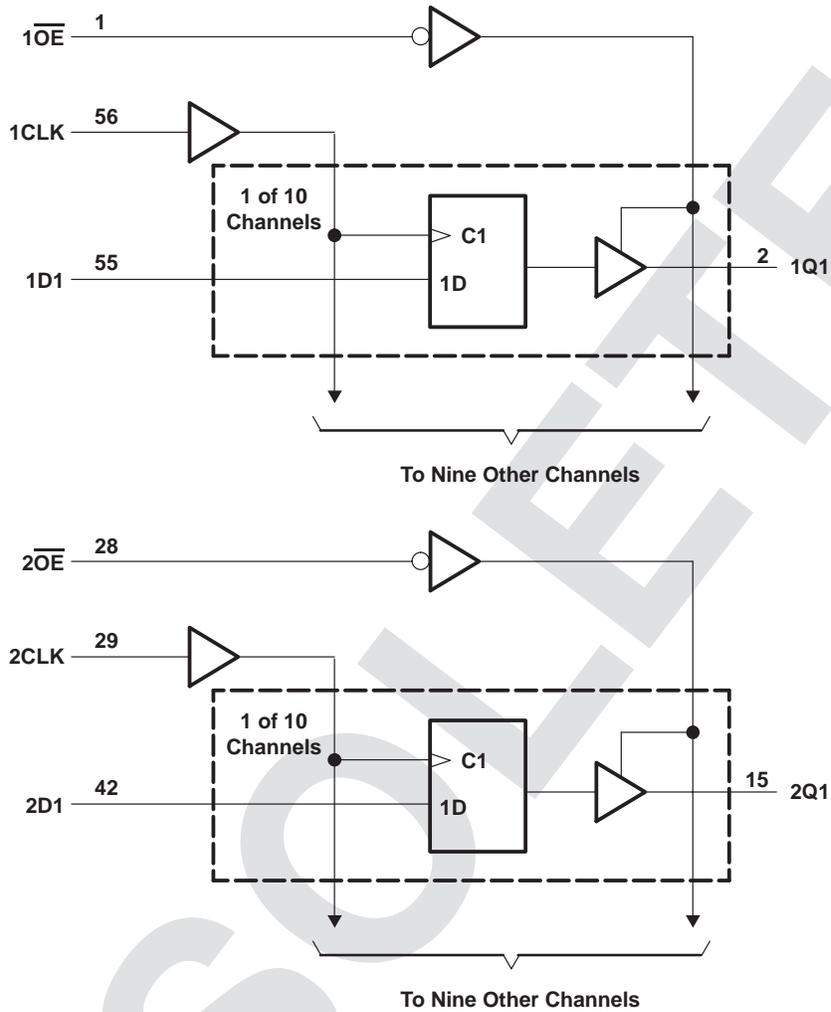


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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logic diagram (positive logic)



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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

|  |                            |
|--|----------------------------|
| Supply voltage range, $V_{CC}$   | -0.5 V to 4.6 V            |
| Input voltage range, $V_I$ (see Note 1)  | -0.5 V to $V_{CC} + 0.5$ V |
| Output voltage range, $V_O$ (see Notes 1 and 2)  | -0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ )  | -50 mA                     |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ )                                 | ±50 mA                     |
| Continuous output current, $I_O$ ( $V_O = 0$ 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) (see Note 3): DGG package | 1 W                        |
| DL package   | 1.4 W                      |
| Storage temperature range, $T_{stg}$   | -65°C to 150°C             |

† 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.

- 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 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 (see Note 4)**

|                     |                                    | MIN                       | MAX      | UNIT |
|---------------------|------------------------------------|---------------------------|----------|------|
| $V_{CC}$            | Supply voltage                     | 2.3                       | 3.6      | V    |
| $V_{IH}$            | High-level input voltage           | $V_{CC} = 2.3$ V to 2.7 V | 1.7      | V    |
|                     |                                    | $V_{CC} = 2.7$ V to 3.6 V | 2        |      |
| $V_{IL}$            | Low-level input voltage            | $V_{CC} = 2.3$ V to 2.7 V | 0.7      | V    |
|                     |                                    | $V_{CC} = 2.7$ V to 3.6 V | 0.8      |      |
| $V_I$               | Input voltage                      | 0                         | $V_{CC}$ | V    |
| $V_O$               | Output voltage                     | 0                         | $V_{CC}$ | V    |
| $I_{OH}$            | High-level output current          | $V_{CC} = 2.3$ V          | -12      | mA   |
|                     |                                    | $V_{CC} = 2.7$ V          | -12      |      |
|                     |                                    | $V_{CC} = 3$ V            | -24      |      |
| $I_{OL}$            | Low-level output current           | $V_{CC} = 2.3$ V          | 12       | mA   |
|                     |                                    | $V_{CC} = 2.7$ V          | 12       |      |
|                     |                                    | $V_{CC} = 3$ 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   |

NOTE 4: Unused inputs must be held high or low to prevent them from floating.



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

| PARAMETER                | TEST CONDITIONS  |                         | V <sub>CC</sub> †                     | T <sub>A</sub> = -40°C to 85°C |      |     | UNIT |
|--------------------------|--|-------------------------|---------------------------------------|--------------------------------|------|-----|------|
|                          |  |                         |                                       | MIN                            | TYP‡ | MAX |      |
| V <sub>OH</sub>          | I <sub>OH</sub> = -100 µA  |                         | MIN to MAX                            | V <sub>CC</sub> -0.2           |      |     | V    |
|                          | I <sub>OH</sub> = -6 mA  | V <sub>IH</sub> = 1.7 V | 2.3 V                                 | 2.0                            |      |     |      |
|                          | I <sub>OH</sub> = -12 mA   | V <sub>IH</sub> = 1.7 V | 2.3 V                                 | 1.7                            |      |     |      |
|                          |  | V <sub>IH</sub> = 2 V   | 2.7 V                                 | 2.2                            |      |     |      |
|                          |  | V <sub>IH</sub> = 2 V   | 3 V                                   | 2.4                            |      |     |      |
| I <sub>OH</sub> = -24 mA | V <sub>IH</sub> = 2 V  | 3 V                     | 2                                     |                                |      |     |      |
| V <sub>OL</sub>          | I <sub>OL</sub> = 100 µA   |                         | MIN to MAX                            | 0.2                            |      |     | V    |
|                          | I <sub>OL</sub> = 6 mA   | V <sub>IL</sub> = 0.7 V | 2.3 V                                 | 0.4                            |      |     |      |
|                          | I <sub>OL</sub> = 12 mA  | V <sub>IL</sub> = 0.7 V | 2.3 V                                 | 0.7                            |      |     |      |
|                          |  | V <sub>IL</sub> = 0.8 V | 2.7 V                                 | 0.4                            |      |     |      |
|                          | I <sub>OL</sub> = 24 mA  | V <sub>IL</sub> = 0.8 V | 3 V                                   | 0.55                           |      |     |      |
| I <sub>I</sub>           | V <sub>I</sub> = V <sub>CC</sub> or GND                                |                         | 3.6 V                                 | ±5                             |      |     | µA   |
| I <sub>I</sub> (hold)    | V <sub>I</sub> = 0.7 V   |                         | 2.3 V                                 | 45                             |      |     | µA   |
|                          | V <sub>I</sub> = 1.7 V   |                         |                                       | -45                            |      |     |      |
|                          | V <sub>I</sub> = 0.8 V   |                         | 3 V                                   | 75                             |      |     |      |
|                          | V <sub>I</sub> = 2 V   |                         |                                       | -75                            |      |     |      |
|                          | V <sub>I</sub> = 0 to 3.6 V  |                         | 3.6 V                                 | ±500                           |      |     |      |
| I <sub>OZ</sub> §        | V <sub>O</sub> = V <sub>CC</sub> or GND                                |                         | 3.6 V                                 | ±10                            |      |     | µA   |
| I <sub>CC</sub>          | V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0            |                         | 3.6 V                                 | 40                             |      |     | µA   |
| ΔI <sub>CC</sub>         | V <sub>CC</sub> = 3 V to 3.6 V, Other inputs at V <sub>CC</sub> or GND |                         | One input at V <sub>CC</sub> - 0.6 V, |                                | 750  |     | µA   |
| C <sub>i</sub>           | V <sub>I</sub> = V <sub>CC</sub> or GND                                |                         | 3.3 V                                 | 3.5                            |      |     | pF   |
| C <sub>o</sub>           | V <sub>O</sub> = V <sub>CC</sub> or GND                                |                         | 3.3 V                                 | 7                              |      |     | pF   |

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

‡ All typical values are measured at V<sub>CC</sub> = 3.3 V.

§ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

**timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

|                    |                                 | V <sub>CC</sub> = 2.5 V ± 0.2 V |     | V <sub>CC</sub> = 2.7 V |     | V <sub>CC</sub> = 3.3 V ± 0.3 V |     | UNIT |
|--------------------|---------------------------------|---------------------------------|-----|-------------------------|-----|---------------------------------|-----|------|
|                    |                                 | MIN                             | MAX | MIN                     | MAX | MIN                             | MAX |      |
| f <sub>clock</sub> | Clock frequency                 | 0                               | 150 | 0                       | 150 | 0                               | 150 | MHz  |
| t <sub>w</sub>     | Pulse duration, CLK high or low | 3.3                             |     | 3.3                     |     | 3.3                             |     | ns   |
| t <sub>su</sub>    | Setup time, data before CLK↑    | 4.4                             |     | 3.9                     |     | 3.4                             |     | ns   |
| t <sub>h</sub>     | Hold time, data after CLK↑      | 0                               |     | 0                       |     | 0                               |     | ns   |



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switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 1 and 2)

| PARAMETER        | FROM (INPUT)    | TO (OUTPUT) | V <sub>CC</sub> = 2.5 V ± 0.2 V |     | V <sub>CC</sub> = 2.7 V |     | V <sub>CC</sub> = 3.3 V ± 0.3 V |     | UNIT |
|------------------|-----------------|-------------|---------------------------------|-----|-------------------------|-----|---------------------------------|-----|------|
|                  |                 |             | MIN                             | MAX | MIN                     | MAX | MIN                             | MAX |      |
| f <sub>max</sub> |                 |             | 150                             |     | 150                     |     | 150                             |     | ns   |
| t <sub>pd</sub>  | CLK             | Q           | 1                               | 6.4 |                         | 5.3 | 1                               | 4.5 | ns   |
| t <sub>en</sub>  | $\overline{OE}$ | Q           | 1                               | 7.1 |                         | 6.2 | 1                               | 5.1 | ns   |
| t <sub>dis</sub> | $\overline{OE}$ | Q           | 1.4                             | 5.9 |                         | 5   | 1                               | 4.6 | ns   |

operating characteristics, T<sub>A</sub> = 25°C

| PARAMETER       |                               | TEST CONDITIONS                    | V <sub>CC</sub> = 2.5 V | V <sub>CC</sub> = 3.3 V | UNIT |
|-----------------|-------------------------------|------------------------------------|-------------------------|-------------------------|------|
|                 |                               |                                    | TYP                     | TYP                     |      |
| C <sub>pd</sub> | Power dissipation capacitance | C <sub>L</sub> = 50 pF, f = 10 MHz | 36                      | 40                      | pF   |
|                 |                               |                                    | Outputs enabled         | 22                      |      |
|                 |                               |                                    |                         |                         |      |

OBSOLETE

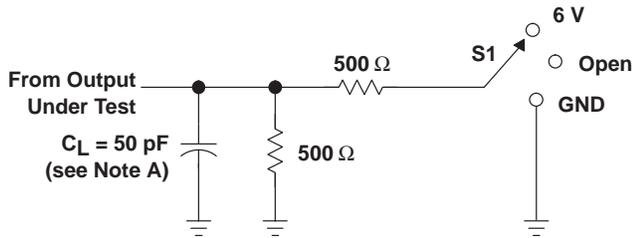




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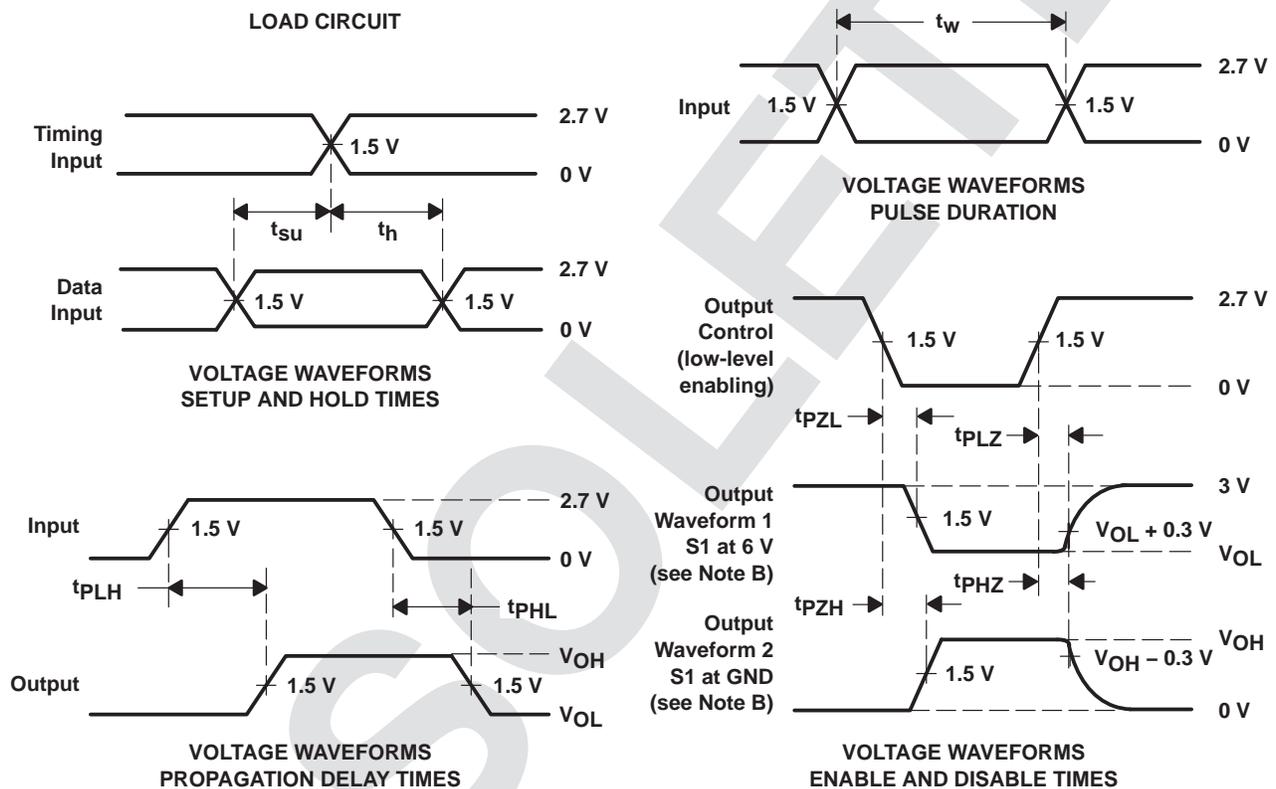
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**PARAMETER MEASUREMENT INFORMATION**  
 **$V_{CC} = 2.7\text{ V AND } 3.3\text{ V} \pm 0.3\text{ V}$**



**LOAD CIRCUIT**

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



- 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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2.5\text{ ns}$ ,  $t_f \leq 2.5\text{ ns}$ .
  - 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 2. Load Circuit and Voltage Waveforms**

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| SN74ALVC16821DL  | OBSOLETE              | SSOP         | DL              | 56   |             | TBD                     | Call TI          | Call TI                      |
| SN74ALVC16821DLR | OBSOLETE              | SSOP         | DL              | 56   |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

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

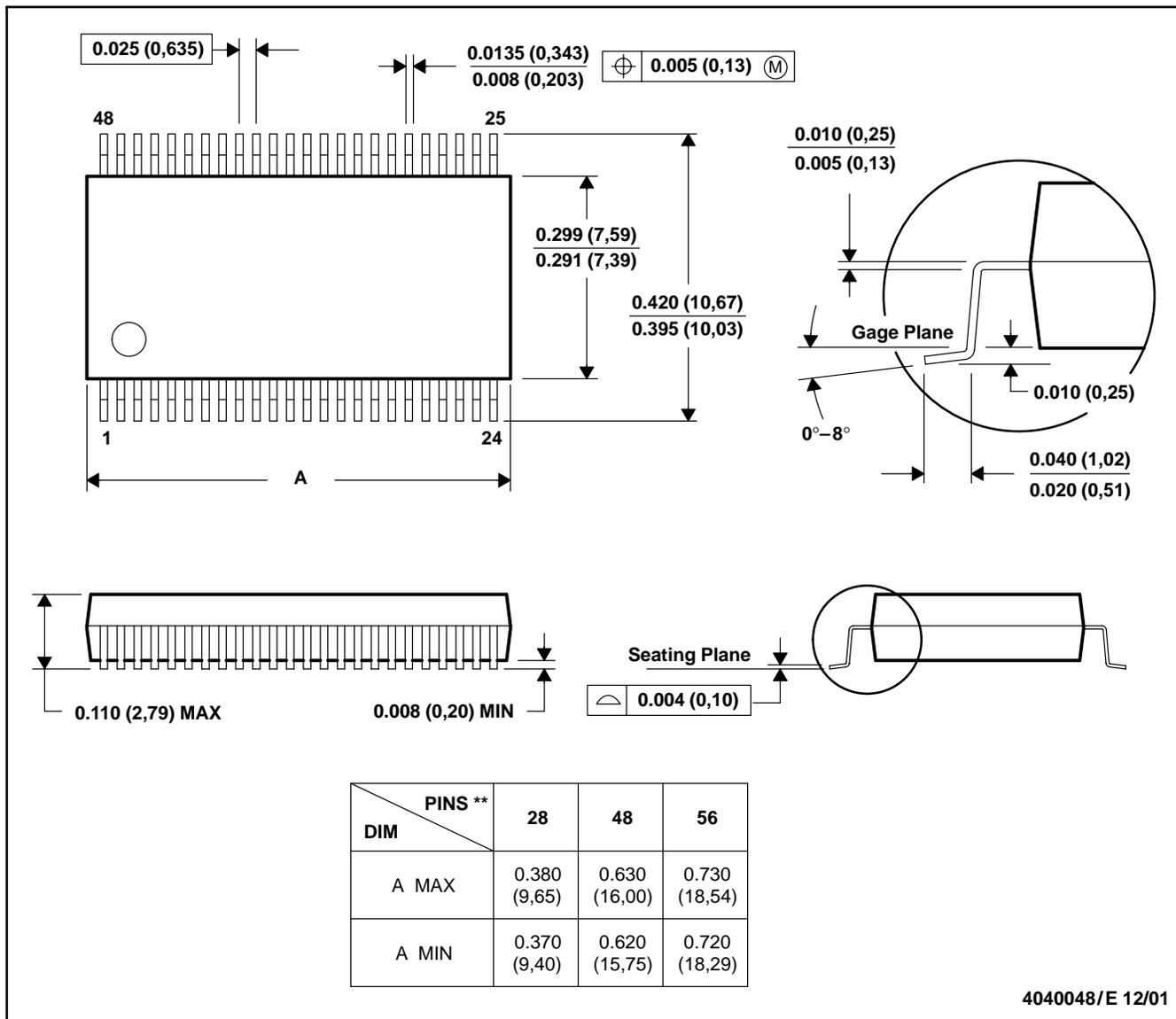
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DL (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



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

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| Data Converters             | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                    |  |
|--------------------|--|
| Audio              | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                   |
| Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
| Military           | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Optical Networking | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Security           | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
| Telephony          | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
| Video & Imaging    | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
| Wireless           | <a href="http://www.ti.com/wireless">www.ti.com/wireless</a>             |

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