

## FEATURES

- Member of the Texas Instruments Widebus™ Family
- UBT™ Transceiver Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, Clocked, or Clock-Enable Mode
- Operates From 1.65-V to 3.6-V  $V_{CC}$
- Max  $t_{pd}$  of 4 ns at 3.3-V  $V_{CC}$
- $\pm 24$ -mA Output Drive at 3.3-V  $V_{CC}$
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Performance Tested Per JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

## DESCRIPTION/ORDERING INFORMATION

This 18-bit universal bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

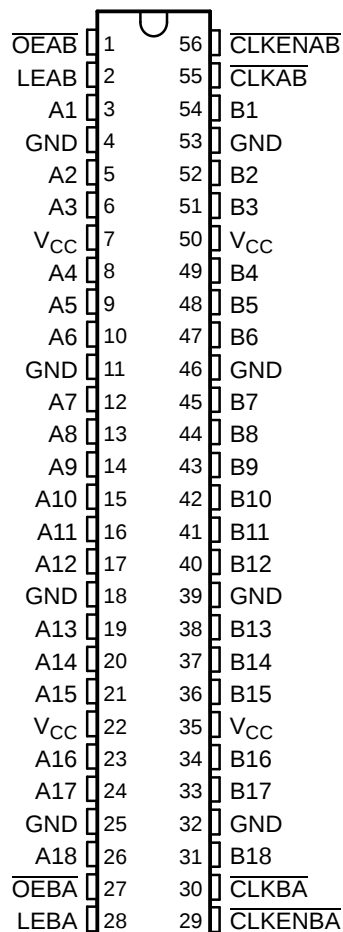
The SN74ALVCH16600 combines D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes.

Data flow in each direction is controlled by output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ), latch-enable (LEAB and LEBA), and clock ( $\overline{CLKAB}$  and  $\overline{CLKBA}$ ) inputs. The clock can be controlled by the clock-enable ( $\overline{CLKENAB}$  and  $\overline{CLKENBA}$ ) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if  $\overline{CLKAB}$  is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the high-to-low transition of  $\overline{CLKAB}$ . When  $\overline{OEAB}$  is low, the outputs are active. When  $\overline{OEAB}$  is high, the outputs are in the high-impedance state. Data flow for B to A is similar to that of A to B, but uses  $\overline{OEBA}$ , LEBA,  $\overline{CLKBA}$ , and  $\overline{CLKENBA}$ .

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 holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

DGG OR DL PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

| $T_A$       | PACKAGE <sup>(1)</sup> |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|-------------|------------------------|---------------|-----------------------|------------------|
| -40 to 85°C | SSOP - DL              | Tube          | SN74ALVCH16600DL      | ALVCH16600       |
|             |                        | Tape and reel | SN74ALVCH16600DLR     |                  |
|             | TSSOP - DGG            | Tape and reel | SN74ALVCH16600DGGR    | ALVCH16600       |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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# SN74ALVCH16600

## 18-BIT UNIVERSAL BUS TRANSCEIVER

### WITH 3-STATE OUTPUTS

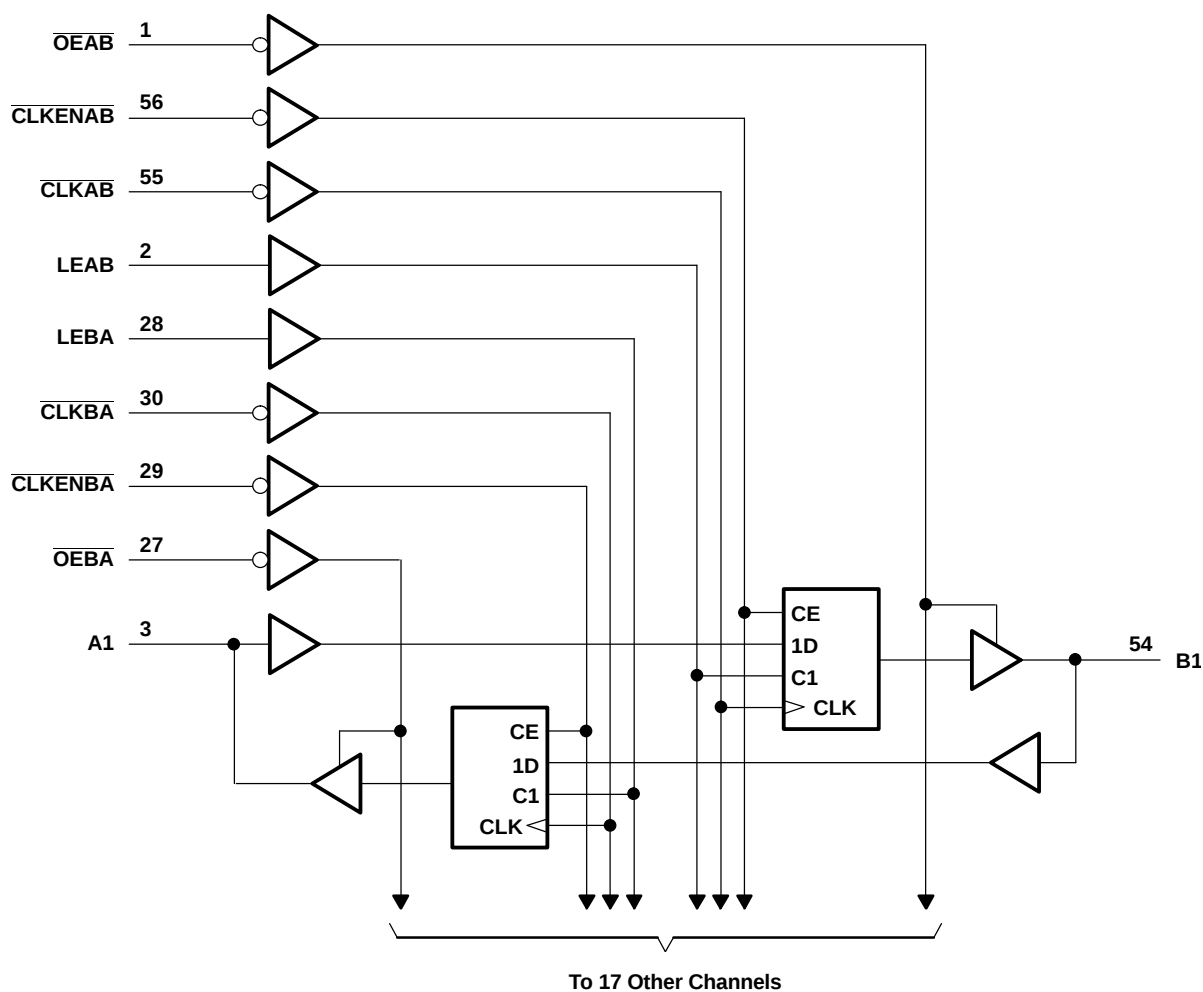
SCES030G—JULY 1995—REVISED JULY 2004

**FUNCTION TABLE<sup>(1)</sup>**

| INPUTS                      |                          |      |                           |   | OUTPUT<br>B                   |
|-----------------------------|--------------------------|------|---------------------------|---|-------------------------------|
| $\overline{\text{CLKENAB}}$ | $\overline{\text{OEAB}}$ | LEAB | $\overline{\text{CLKAB}}$ | A |                               |
| X                           | H                        | X    | X                         | X | Z                             |
| X                           | L                        | H    | X                         | L | L                             |
| X                           | L                        | H    | X                         | H | H                             |
| H                           | L                        | L    | X                         | X | B <sub>0</sub> <sup>(2)</sup> |
| H                           | L                        | L    | X                         | X | B <sub>0</sub> <sup>(2)</sup> |
| L                           | L                        | L    | ↓                         | L | L                             |
| L                           | L                        | L    | ↓                         | H | H                             |
| L                           | L                        | L    | H                         | X | B <sub>0</sub> <sup>(2)</sup> |
| L                           | L                        | L    | L                         | X | B <sub>0</sub> <sup>(3)</sup> |

- (1) A-to-B data flow is shown; B-to-A flow is similar, but uses  $\overline{\text{OEBA}}$ , LEBA, and  $\overline{\text{CLKBA}}$ .  
 (2) Output level before the indicated steady-state input conditions were established, provided that  $\overline{\text{CLKAB}}$  was high before LEAB went low  
 (3) Output level before the indicated steady-state input conditions were established

**LOGIC DIAGRAM (POSITIVE LOGIC)**



## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

|                                                        |                                          |                                 | MIN  | MAX                   | UNIT |      |
|--------------------------------------------------------|------------------------------------------|---------------------------------|------|-----------------------|------|------|
| V <sub>CC</sub>                                        | Supply voltage range                     |                                 | -0.5 | 4.6                   | V    |      |
| V <sub>I</sub>                                         | Input voltage range                      | Except I/O ports <sup>(2)</sup> | -0.5 | 4.6                   | V    |      |
|                                                        |                                          | I/O ports <sup>(2)(3)</sup>     | -0.5 | V <sub>CC</sub> + 0.5 |      |      |
| V <sub>O</sub>                                         | Ouput voltage range <sup>(2)(3)</sup>    |                                 | -0.5 | V <sub>CC</sub> + 0.5 | V    |      |
| I <sub>IK</sub>                                        | Input clamp current                      | V <sub>I</sub> < 0              |      |                       | -50  | mA   |
| I <sub>OK</sub>                                        | Output clamp current                     | V <sub>O</sub> < 0              |      |                       | -50  | mA   |
| I <sub>O</sub>                                         | Continuous output current                |                                 |      |                       | ±50  | mA   |
| Continuous current through each V <sub>CC</sub> or GND |                                          |                                 |      |                       | ±100 | mA   |
| θ <sub>JA</sub>                                        | Package thermal impedance <sup>(4)</sup> | DGG package                     |      |                       | 64   | °C/W |
|                                                        |                                          | DL package                      |      |                       | 56   |      |
| T <sub>stg</sub>                                       | 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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) This value is limited to 4.6 V, maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

## RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>

|                 |                                    |                                    | MIN                    | MAX             | UNIT |
|-----------------|------------------------------------|------------------------------------|------------------------|-----------------|------|
| V <sub>CC</sub> | Supply voltage                     |                                    | 1.65                   | 3.6             | V    |
| V <sub>IH</sub> | High-level input voltage           | V <sub>CC</sub> = 1.65 V to 1.95 V | 0.65 × V <sub>CC</sub> |                 | V    |
|                 |                                    | V <sub>CC</sub> = 2.3 V to 2.7 V   | 1.7                    |                 |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V to 3.6 V   | 2                      |                 |      |
| V <sub>IL</sub> | Low-level input voltage            | V <sub>CC</sub> = 1.65 V to 1.95 V | 0.35 × V <sub>CC</sub> |                 | V    |
|                 |                                    | V <sub>CC</sub> = 2.3 V to 2.7 V   | 0.7                    |                 |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V to 3.6 V   | 0.8                    |                 |      |
| V <sub>I</sub>  | Input voltage                      |                                    | 0                      | V <sub>CC</sub> | V    |
| V <sub>O</sub>  | Output voltage                     |                                    | 0                      | V <sub>CC</sub> | V    |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 1.65 V           | -4                     |                 | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            | -12                    |                 |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            | -12                    |                 |      |
|                 |                                    | V <sub>CC</sub> = 3 V              | -24                    |                 |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 1.65 V           | 4                      |                 | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            | 12                     |                 |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            | 12                     |                 |      |
|                 |                                    | V <sub>CC</sub> = 3 V              | 24                     |                 |      |
| Δt/Δv           | Input transition rise or fall rate |                                    |                        | 10              | ns/V |
| T <sub>A</sub>  | Operating free-air temperature     |                                    | -40                    | 85              | °C   |

- (1) All unused control inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

# SN74ALVCH16600

## 18-BIT UNIVERSAL BUS TRANSCEIVER

### WITH 3-STATE OUTPUTS

SCES030G–JULY 1995–REVISED JULY 2004

## ELECTRICAL CHARACTERISTICS

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

| PARAMETER                      |                          | TEST CONDITIONS                                                              | V <sub>CC</sub> | MIN                   | TYP <sup>(1)</sup> | MAX | UNIT |
|--------------------------------|--------------------------|------------------------------------------------------------------------------|-----------------|-----------------------|--------------------|-----|------|
| V <sub>OH</sub>                |                          | I <sub>OH</sub> = -100 μA                                                    | 1.65 V to 3.6 V | V <sub>CC</sub> - 0.2 |                    |     | V    |
|                                |                          | I <sub>OH</sub> = -4 mA                                                      | 1.65 V          | 1.2                   |                    |     |      |
|                                |                          | I <sub>OH</sub> = -6 mA                                                      | 2.3 V           | 2                     |                    |     |      |
|                                | I <sub>OH</sub> = -12 mA |                                                                              | 2.3 V           | 1.7                   |                    |     |      |
|                                |                          |                                                                              | 2.7 V           | 2.2                   |                    |     |      |
|                                |                          |                                                                              | 3 V             | 2.4                   |                    |     |      |
|                                |                          | I <sub>OH</sub> = -24 mA                                                     | 3 V             | 2                     |                    |     |      |
| V <sub>OL</sub>                |                          | I <sub>OL</sub> = 100 μA                                                     | 1.65 V to 3.6 V | 0.2                   |                    | V   |      |
|                                |                          | I <sub>OL</sub> = 4 mA                                                       | 1.65 V          | 0.45                  |                    |     |      |
|                                |                          | I <sub>OL</sub> = 6 mA                                                       | 2.3 V           | 0.4                   |                    |     |      |
|                                | I <sub>OL</sub> = 12 mA  |                                                                              | 2.3 V           | 0.7                   |                    |     |      |
|                                |                          |                                                                              | 2.7 V           | 0.4                   |                    |     |      |
|                                |                          | I <sub>OL</sub> = 24 mA                                                      | 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(hold)</sub>           |                          | V <sub>I</sub> = 0.58 V                                                      | 1.65 V          | 25                    |                    | μA  |      |
|                                |                          | V <sub>I</sub> = 1.07 V                                                      | 1.65 V          | -25                   |                    |     |      |
|                                |                          | V <sub>I</sub> = 0.7 V                                                       | 2.3 V           | 45                    |                    |     |      |
|                                |                          | V <sub>I</sub> = 1.7 V                                                       | 2.3 V           | -45                   |                    |     |      |
|                                |                          | V <sub>I</sub> = 0.8 V                                                       | 3 V             | 75                    |                    |     |      |
|                                |                          | V <sub>I</sub> = 2 V                                                         | 3 V             | -75                   |                    |     |      |
|                                |                          | V <sub>I</sub> = 0 to 3.6 V <sup>(2)</sup>                                   | 3.6 V           | ±500                  |                    |     |      |
| I <sub>OZ</sub> <sup>(3)</sup> |                          | 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>               |                          | One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND | 3 V to 3.6 V    | 750                   |                    | μA  |      |
| C <sub>i</sub>                 | Control inputs           | V <sub>I</sub> = V <sub>CC</sub> or GND                                      | 3.3 V           | 4                     |                    | pF  |      |
| C <sub>io</sub>                | A or B ports             | V <sub>O</sub> = V <sub>CC</sub> or GND                                      | 3.3 V           | 8                     |                    | pF  |      |

(1) All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

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

## TIMING REQUIREMENTS

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

|                    |                 |                   | V <sub>CC</sub> = 1.8 V |     | V <sub>CC</sub> = 2.5 V<br>± 0.2 V |     | V <sub>CC</sub> = 2.7 V |     | V <sub>CC</sub> = 3.3 V<br>± 0.3 V |     | UNIT |    |  |
|--------------------|-----------------|-------------------|-------------------------|-----|------------------------------------|-----|-------------------------|-----|------------------------------------|-----|------|----|--|
|                    |                 |                   | MIN                     | MAX | MIN                                | MAX | MIN                     | MAX | MIN                                | MAX |      |    |  |
| f <sub>clock</sub> | Clock frequency |                   | (1)                     |     | 150                                |     | 150                     |     | 150                                |     | MHz  |    |  |
| t <sub>w</sub>     | Pulse duration  | LE high           | (1)                     |     | 3.3                                |     | 3.3                     |     | 3.3                                |     | ns   |    |  |
|                    |                 | CLK high or low   |                         | (1) |                                    | 3.3 |                         | 3.3 |                                    |     |      |    |  |
| t <sub>su</sub>    | Setup time      | Data before CLK↑  |                         | (1) |                                    | 1.3 |                         | 1.3 |                                    | 1.2 |      | ns |  |
|                    |                 | Data before LE↓   | CLK high                |     | (1)                                |     | 1.2                     |     | 1.1                                |     | 1.1  |    |  |
|                    |                 |                   | CLK low                 |     | (1)                                |     | 1.8                     |     | 1.5                                |     | 1.5  |    |  |
|                    |                 | CLKEN before CLK↑ |                         | (1) |                                    | 0.7 |                         | 0.7 |                                    | 0.8 |      |    |  |
| t <sub>h</sub>     | Hold time       | Data after CLK↑   |                         | (1) |                                    | 1.5 |                         | 1.8 |                                    | 1.5 |      | ns |  |
|                    |                 | Data after LE↓    | CLK high                |     | (1)                                |     | 1.6                     |     | 1.9                                |     | 1.6  |    |  |
|                    |                 |                   | CLK low                 |     | (1)                                |     | 1.2                     |     | 1.6                                |     | 1.3  |    |  |
|                    |                 | CLKEN after CLK↑  |                         | (1) |                                    | 1.4 |                         | 1.7 |                                    | 1.4 |      |    |  |

(1) This information was not available at the time of publication.

## SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM<br>(INPUT)                                        | TO<br>(OUTPUT) | $V_{CC} = 1.8\text{ V}$ |     | $V_{CC} = 2.5\text{ V}$<br>$\pm 0.2\text{ V}$ |     | $V_{CC} = 2.7\text{ V}$ |     | $V_{CC} = 3.3\text{ V}$<br>$\pm 0.3\text{ V}$ |     | UNIT |
|------------------|--------------------------------------------------------|----------------|-------------------------|-----|-----------------------------------------------|-----|-------------------------|-----|-----------------------------------------------|-----|------|
|                  |                                                        |                | MIN                     | TYP | MIN                                           | MAX | MIN                     | MAX | MIN                                           | MAX |      |
| $f_{\text{max}}$ |                                                        |                | (1)                     |     | 150                                           |     | 150                     |     | 150                                           |     | MHz  |
| $t_{\text{pd}}$  | A or B                                                 | B or A         | (1)                     |     | 1                                             | 5.1 | 4.7                     |     | 1                                             | 4   | ns   |
|                  | LEAB or LEBA                                           | A or B         | (1)                     |     | 1                                             | 5.9 | 5.5                     |     | 1                                             | 4.8 |      |
|                  | $\overline{\text{CLKAB}}$ or $\overline{\text{CLKBA}}$ |                | (1)                     |     | 1                                             | 7.3 | 6.8                     |     | 1.3                                           | 5.7 |      |
| $t_{\text{en}}$  | $\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$   | A or B         | (1)                     |     | 1                                             | 6.5 | 6.3                     |     | 1.1                                           | 5.2 | ns   |
| $t_{\text{dis}}$ | $\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$   | A or B         | (1)                     |     | 1                                             | 5.1 | 4.7                     |     | 1.2                                           | 4.4 | ns   |

(1) This information was not available at the time of publication.

## OPERATING CHARACTERISTICS

$T_A = 25^\circ\text{C}$

| PARAMETER       |                               |                  | TEST CONDITIONS                            | $V_{CC} = 1.8\text{ V}$ | $V_{CC} = 2.5\text{ V}$ | $V_{CC} = 3.3\text{ V}$ | UNIT |
|-----------------|-------------------------------|------------------|--------------------------------------------|-------------------------|-------------------------|-------------------------|------|
|                 |                               |                  |                                            | TYP                     | TYP                     | TYP                     |      |
| $C_{\text{pd}}$ | Power dissipation capacitance | Outputs enabled  | $C_L = 50\text{ pF}$ , $f = 10\text{ MHz}$ | (1)                     | 43                      | 56                      | pF   |
|                 |                               | Outputs disabled |                                            | (1)                     | 6                       | 6                       |      |

(1) This information was not available at the time of publication.

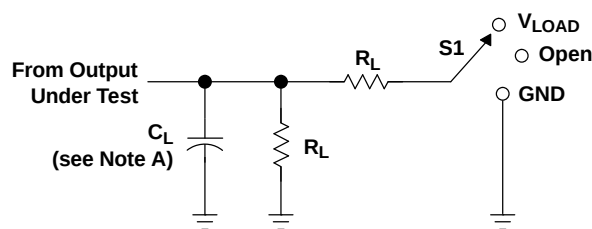
# SN74ALVCH16600

## 18-BIT UNIVERSAL BUS TRANSCEIVER

### WITH 3-STATE OUTPUTS

SCES030G–JULY 1995–REVISED JULY 2004

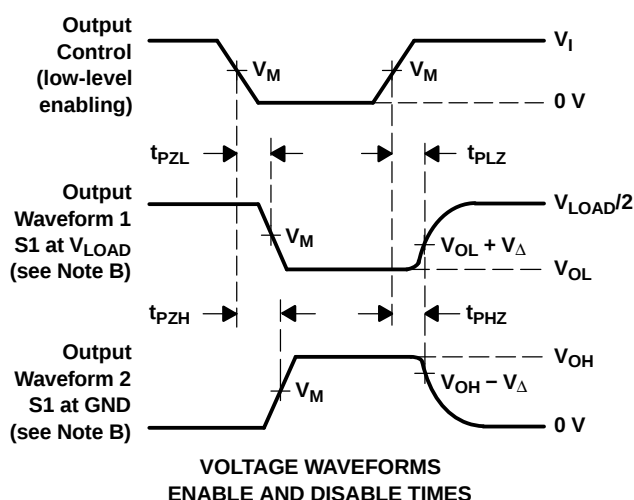
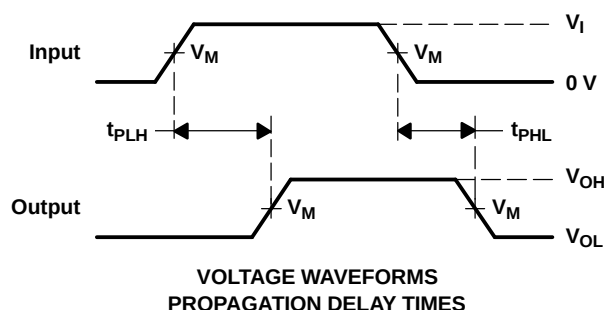
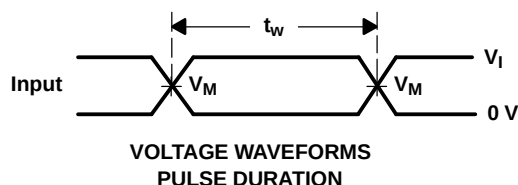
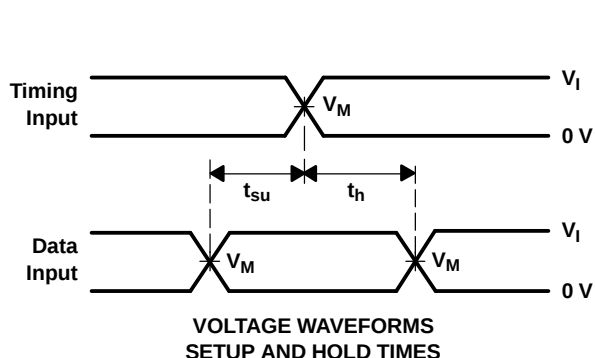
#### PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

| TEST                                               | S1                        |
|----------------------------------------------------|---------------------------|
| $t_{pd}$<br>$t_{PLZ}/t_{PZH}$<br>$t_{PHZ}/t_{PZL}$ | Open<br>$V_{LOAD}$<br>GND |

| $V_{CC}$                         | INPUT    |                      | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|----------------------------------|----------|----------------------|------------|-------------------|-------|--------------|--------------|
|                                  | $V_I$    | $t_r/t_f$            |            |                   |       |              |              |
| $1.8\text{ V} \pm 0.15\text{ V}$ | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30 pF | 1 k $\Omega$ | 0.15 V       |
| $2.5\text{ V} \pm 0.2\text{ V}$  | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30 pF | 500 $\Omega$ | 0.15 V       |
| 2.7 V                            | 2.7 V    | $\leq 2.5\text{ ns}$ | 1.5 V      | 6 V               | 50 pF | 500 $\Omega$ | 0.3 V        |
| $3.3\text{ V} \pm 0.3\text{ V}$  | 2.7 V    | $\leq 2.5\text{ ns}$ | 1.5 V      | 6 V               | 50 pF | 500 $\Omega$ | 0.3 V        |



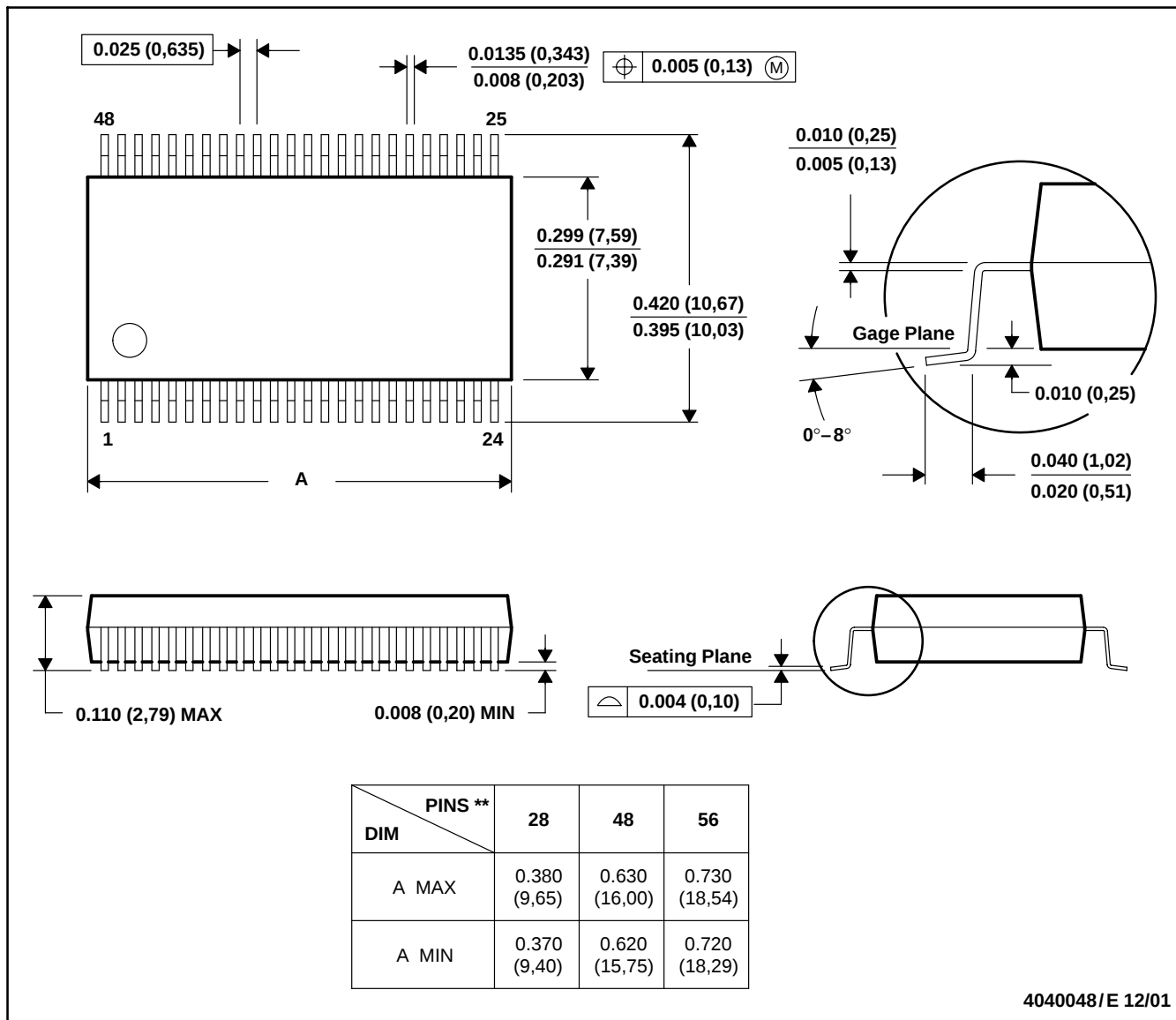
- NOTES:
- $C_L$  includes probe and jig capacitance.
  - Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
  - All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ .
  - The outputs are measured one at a time, with one transition per measurement.
  - $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
  - All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

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

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

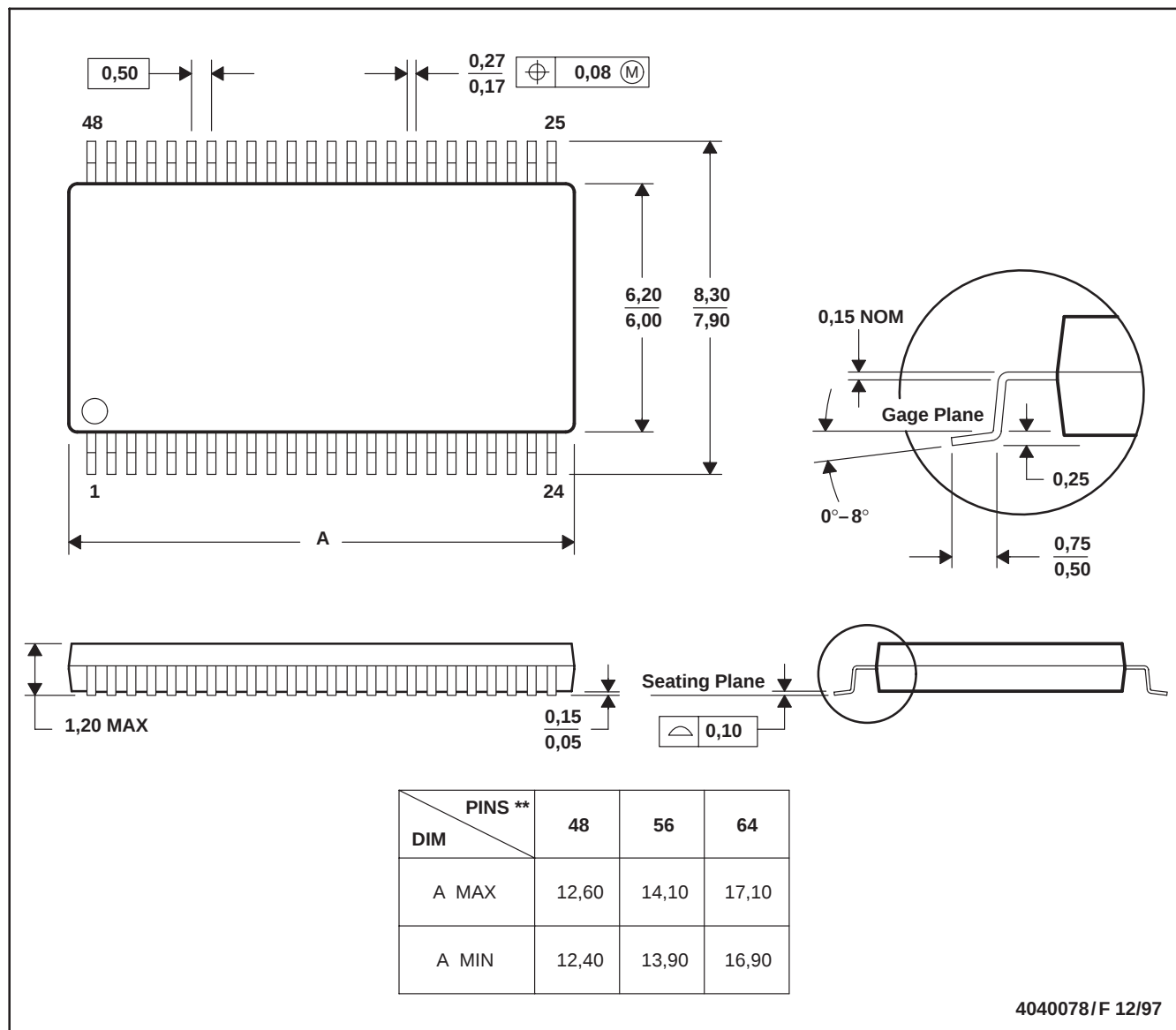


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

## 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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