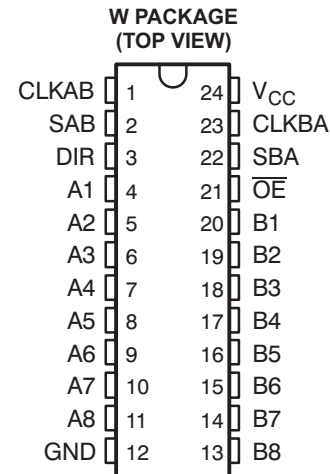


## RAD-TOLERANT CLASS V OCTAL BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

### FEATURES

- Operates From 1.65 V to 3.6 V
- Inputs Accept Voltages to 5.5 V
- Max  $t_{pd}$  of 7.4 ns at 3.3 V
- Typical  $V_{OLP}$  (Output Ground Bounce)  
<0.8 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,  $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V  $V_{CC}$ )
- $I_{off}$  Supports Partial Power-Down-Mode Operation
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)
- Rad Tolerant: 50kRad (Si) TID <sup>(1)</sup>
  - TID Dose Rate 0.10 rad/s
- QML-V Qualified, SMD 5962-97626

(1) Radiation tolerance is a typical value based upon initial device qualification. Radiation Lot Acceptance Testing is available – contact factory for details.



### DESCRIPTION/ORDERING INFORMATION

The SN54LVC646A octal bus transceiver and register is designed for 2.7-V to 3.6-V  $V_{CC}$  operation.

This device consists of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus is clocked into the registers on the low-to-high transition of the appropriate clock (CLKAB or CLKBA) input. [Figure 1](#) shows the four fundamental bus-management functions that are performed with the SN54LVC646A device.

### ORDERING INFORMATION

| $T_A$          | PACKAGE <sup>(1)(2)</sup> |            | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|---------------------------|------------|-----------------------|------------------|
| –55°C to 125°C | CFP – W                   | Tube of 85 | 5962-9762601VKA       | 5962-9762601VKA  |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).
- (2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).



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## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

Output-enable ( $\overline{\text{OE}}$ ) and direction-control (DIR) inputs control the transceiver functions. In the transceiver mode, data present at the high-impedance port is stored in either register or in both.

The select-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. DIR determines which bus receives data when  $\overline{\text{OE}}$  is low. In the isolation mode ( $\overline{\text{OE}}$  high), A data is stored in one register and B data can be stored in the other register.

When an output function is disabled, the input function still is enabled and can be used to store and transmit data. Only one of the two buses, A or B, can be driven at a time.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of this device as a translator in a mixed 3.3-V/5-V system environment.

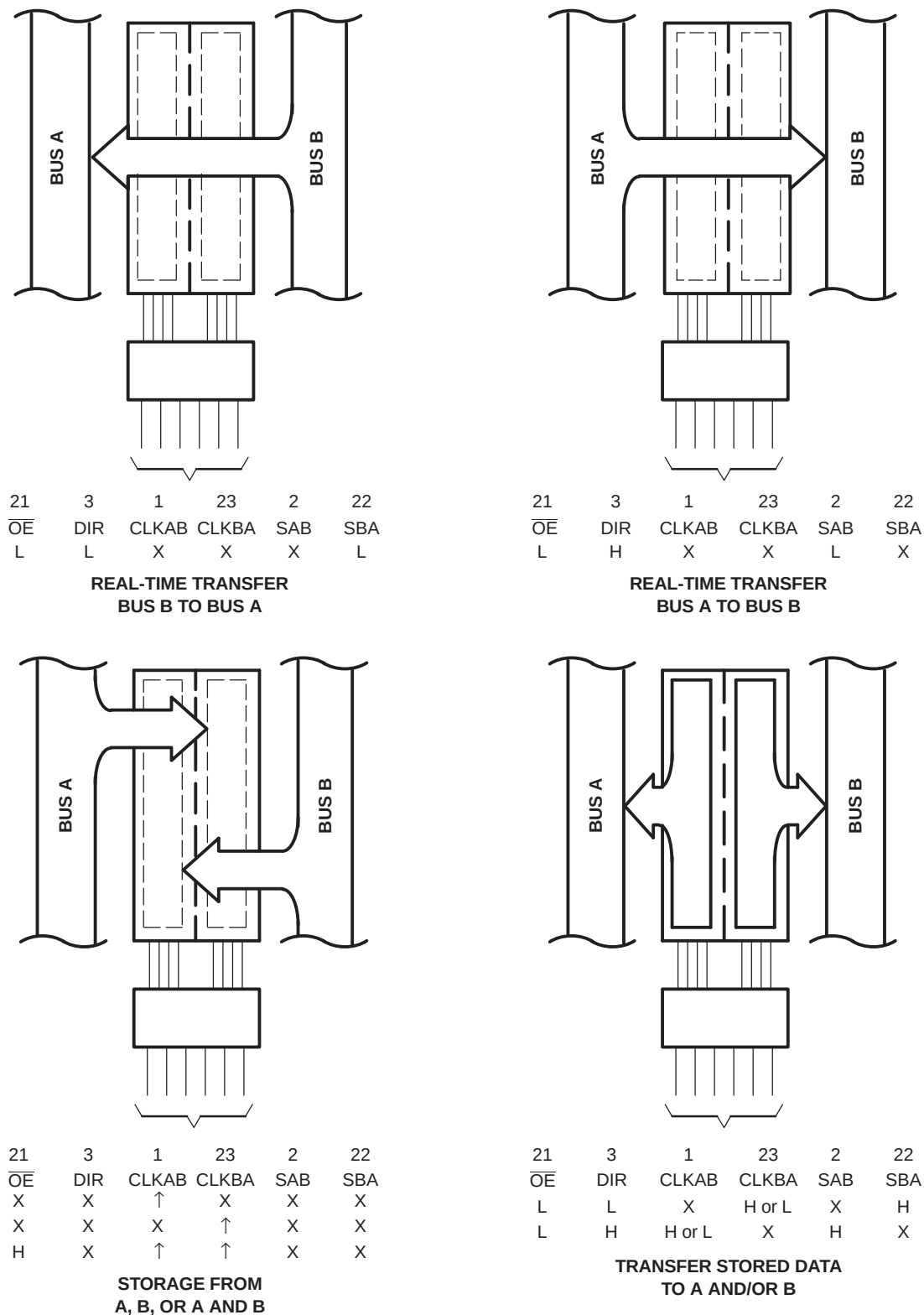
This device is fully specified for partial-power-down applications using  $I_{\text{off}}$ . The  $I_{\text{off}}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

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

**FUNCTION TABLE**

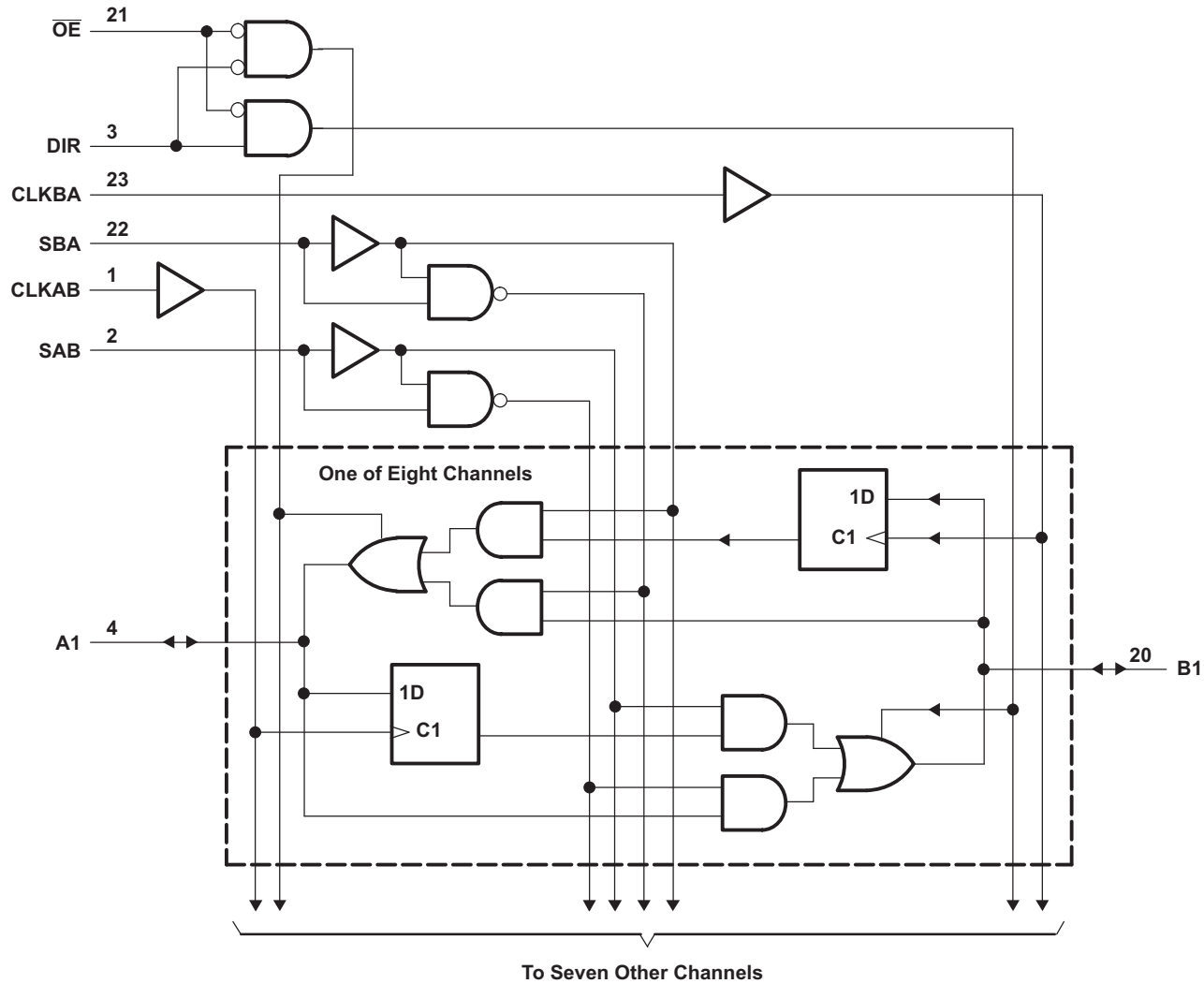
| INPUTS                 |     |        |        |     |     | DATA I/O                   |                            | OPERATION OR<br>FUNCTION              |
|------------------------|-----|--------|--------|-----|-----|----------------------------|----------------------------|---------------------------------------|
| $\overline{\text{OE}}$ | DIR | CLKAB  | CLKBA  | SAB | SBA | A1–A8                      | B1–B8                      |                                       |
| X                      | X   | ↑      | X      | X   | X   | Input                      | Unspecified <sup>(1)</sup> | Store A, B unspecified <sup>(1)</sup> |
| X                      | X   | X      | ↑      | X   | X   | Unspecified <sup>(1)</sup> | Input                      | Store B, A unspecified <sup>(1)</sup> |
| H                      | X   | ↑      | ↑      | X   | X   | Input                      | Input                      | Store and B data                      |
| H                      | X   | H or L | H or L | X   | X   | Input disabled             | Input disabled             | Isolation, hold storage               |
| L                      | L   | X      | X      | X   | L   | Output                     | Input                      | Real-time B data to A bus             |
| L                      | L   | X      | H or L | X   | H   | Output                     | Input                      | Stored B data to A bus                |
| L                      | H   | X      | X      | L   | X   | Input                      | Output                     | Real-time A data to B bus             |
| L                      | H   | H or L | X      | H   | X   | Input                      | Output                     | Stored A data to B bus                |

- (1) The data-output functions can be enabled or disabled by various signals at  $\overline{\text{OE}}$  and DIR. Data-input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.



**Figure 1. Bus-Management Functions**

**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 | 6.5                   | V    |
| V <sub>I</sub>   | Input voltage range <sup>(2)</sup>                                                          | −0.5 | 6.5                   | V    |
| V <sub>O</sub>   | Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup> | −0.5 | 6.5                   | V    |
| V <sub>O</sub>   | Voltage range applied to any output in the high or low state <sup>(2)(3)</sup>              | −0.5 | V <sub>CC</sub> + 0.5 | V    |
| I <sub>IK</sub>  | Input clamp current                                                                         |      | −50                   | mA   |
| I <sub>OK</sub>  | Output clamp current                                                                        |      | −50                   | mA   |
| I <sub>O</sub>   | Continuous output current                                                                   |      | ±50                   | mA   |
|                  | Continuous current through V <sub>CC</sub> or GND                                           |      | ±100                  | mA   |
| 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) The value of V<sub>CC</sub> is provided in the recommended operating conditions table.

## Recommended Operating Conditions<sup>(1)</sup>

|                 |                                    |                                  | MIN | MAX             | UNIT |
|-----------------|------------------------------------|----------------------------------|-----|-----------------|------|
| V <sub>CC</sub> | Supply voltage                     | Operating                        | 2   | 3.6             | V    |
|                 |                                    | Data retention only              | 1.5 |                 |      |
| V <sub>IH</sub> | High-level input voltage           | V <sub>CC</sub> = 2.7 V to 3.6 V | 2   |                 | V    |
| V <sub>IL</sub> | Low-level input voltage            | V <sub>CC</sub> = 2.7 V to 3.6 V |     | 0.8             | V    |
| V <sub>I</sub>  | Input voltage                      |                                  | 0   | 5.5             | V    |
| V <sub>O</sub>  | Output voltage                     | High or low state                | 0   | V <sub>CC</sub> | V    |
|                 |                                    | 3-state                          | 0   | 5.5             |      |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 2.7 V          |     | –12             | mA   |
|                 |                                    | V <sub>CC</sub> = 3 V            |     | –24             |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 2.7 V          |     | 12              | mA   |
|                 |                                    | 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     |                                  | –55 | 125             | °C   |

(1) All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## 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    |
|                                |                         |                                                                              | 2.7 V to 3.6 V  | V <sub>CC</sub> – 0.2 |                    |      |      |
|                                | I <sub>OH</sub> = –4 mA | I <sub>OH</sub> = –8 mA                                                      | 1.65 V          |                       |                    |      |      |
|                                |                         |                                                                              | 2.3 V           |                       |                    |      |      |
|                                |                         |                                                                              | 2.7 V           | 2.2                   |                    |      |      |
|                                |                         |                                                                              | 3 V             | 2.4                   |                    |      |      |
| V <sub>OL</sub>                |                         | I <sub>OL</sub> = 100 μA                                                     | 1.65 V to 3.6 V |                       |                    |      | V    |
|                                |                         |                                                                              | 2.7 V to 3.6 V  |                       |                    | 0.2  |      |
|                                | I <sub>OL</sub> = 4 mA  | I <sub>OL</sub> = 8 mA                                                       | 1.65 V          |                       |                    |      |      |
|                                |                         |                                                                              | 2.3 V           |                       |                    |      |      |
|                                |                         |                                                                              | 2.7 V           |                       |                    | 0.4  |      |
|                                |                         |                                                                              | 3 V             |                       |                    | 0.55 |      |
| I <sub>I</sub>                 | Control inputs          | V <sub>I</sub> = 0 to 5.5 V                                                  | 3.6 V           |                       |                    | ±5   | μA   |
| I <sub>off</sub>               |                         | V <sub>I</sub> or V <sub>O</sub> = 5.5 V                                     | 0               |                       |                    |      | μA   |
| I <sub>OZ</sub> <sup>(2)</sup> |                         | V <sub>O</sub> = 0 to 5.5 V                                                  | 3.6 V           |                       |                    | ±15  | μA   |
| I <sub>CC</sub>                |                         | V <sub>I</sub> = V <sub>CC</sub> or GND                                      | 3.6 V           |                       |                    | 10   | μA   |
|                                |                         | 3.6 V ≤ V <sub>I</sub> ≤ 5.5 V <sup>(3)</sup>                                |                 |                       |                    | 10   |      |
| ΔI <sub>CC</sub>               |                         | One input at V <sub>CC</sub> – 0.6 V, Other inputs at V <sub>CC</sub> or GND | 2.7 V to 3.6 V  |                       |                    | 500  | μA   |
| C <sub>i</sub>                 | Control inputs          | V <sub>I</sub> = V <sub>CC</sub> or GND                                      | 3.3 V           |                       | 4.5                |      | pF   |
| C <sub>io</sub>                | A or B port             | V <sub>O</sub> = V <sub>CC</sub> or GND                                      | 3.3 V           |                       | 7.5                |      | pF   |

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

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

(3) This applies in the disabled state only.

## Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 2](#))

|                    |                                        | $V_{CC} = 2.7\text{ V}$ |     | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | UNIT |
|--------------------|----------------------------------------|-------------------------|-----|------------------------------------------|-----|------|
|                    |                                        | MIN                     | MAX | MIN                                      | MAX |      |
| $f_{\text{clock}}$ | Clock frequency                        |                         | 150 |                                          | 150 | MHz  |
| $t_w$              | Pulse duration                         | 3.3                     |     | 3.3                                      |     | ns   |
| $t_{\text{su}}$    | Setup time, data before CLK $\uparrow$ | 1.6                     |     | 1.5                                      |     | ns   |
| $t_h$              | Hold time, data after CLK $\uparrow$   | 1.7                     |     | 1.7                                      |     | ns   |

## Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 2](#))

| PARAMETER        | FROM<br>(INPUT)        | TO<br>(OUTPUT) | $V_{CC} = 2.7\text{ V}$ |     | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | UNIT |
|------------------|------------------------|----------------|-------------------------|-----|------------------------------------------|-----|------|
|                  |                        |                | MIN                     | MAX | MIN                                      | MAX |      |
| $f_{\text{max}}$ |                        |                | 150                     |     | 150                                      |     | MHz  |
| $t_{\text{pd}}$  | A or B                 | B or A         | 7.9                     |     | 1                                        | 7.4 | ns   |
|                  | CLK                    | A or B         | 8.8                     |     | 1                                        | 8.4 |      |
|                  | SBA or SAB             |                | 9.9                     |     | 1                                        | 8.6 |      |
| $t_{\text{en}}$  | $\overline{\text{OE}}$ | A              | 10.2                    |     | 1                                        | 8.2 | ns   |
| $t_{\text{dis}}$ | $\overline{\text{OE}}$ | A              | 8.9                     |     | 1                                        | 7.5 | ns   |
| $t_{\text{en}}$  | DIR                    | B              | 10.4                    |     | 1                                        | 8.3 | ns   |
| $t_{\text{dis}}$ | DIR                    | B              | 8.7                     |     | 1                                        | 7.9 | ns   |

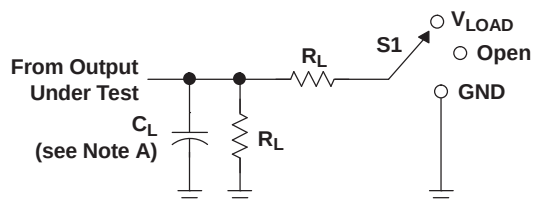
## Operating Characteristics

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

| 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                     |      |
| Cpd       | Power dissipation capacitance per transceiver | Outputs enabled  | f = 10 MHz      | (1)                     | (1)                     | 75                      | pF   |
|           |                                               | Outputs disabled |                 | (1)                     | (1)                     | 9                       |      |

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

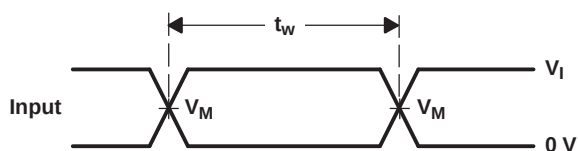
## PARAMETER MEASUREMENT INFORMATION



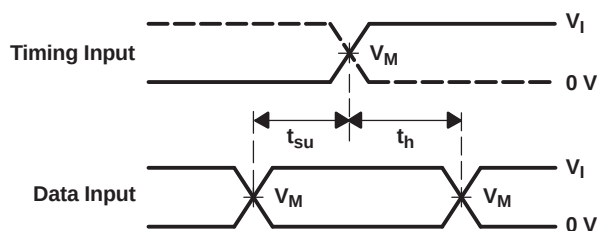
LOAD CIRCUIT

| TEST              | S1         |
|-------------------|------------|
| $t_{PLH}/t_{PHL}$ | Open       |
| $t_{PLZ}/t_{PZL}$ | $V_{LOAD}$ |
| $t_{PHZ}/t_{PZH}$ | GND        |

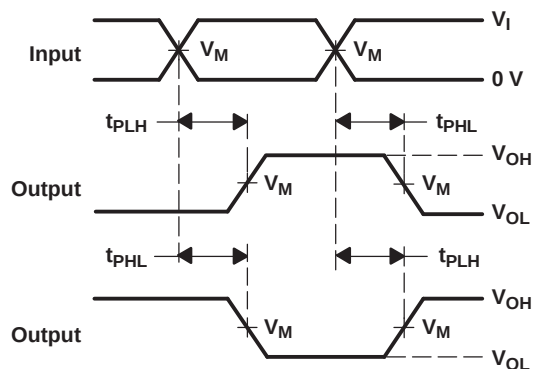
| $V_{CC}$                         | INPUTS   |                      | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|----------------------------------|----------|----------------------|------------|-------------------|-------|--------------|--------------|
|                                  | $V_I$    | $t_r/t_f$            |            |                   |       |              |              |
| $1.8\text{ V} \pm 0.15\text{ V}$ | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 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        |



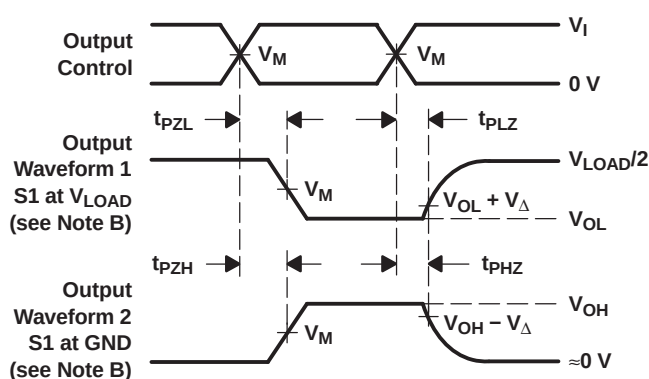
VOLTAGE WAVEFORMS  
PULSE DURATION



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:
- $C_L$  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 2. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable part number | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                  |
|-----------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|--------------------------------------|
| 5962-9762601VKA       | Active        | Production           | CFP (W)   24   | 25   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-9762601VK<br>A<br>SNV54LVC646AW |

- <sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).
- <sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.
- <sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.
- <sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.
- <sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.
- <sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

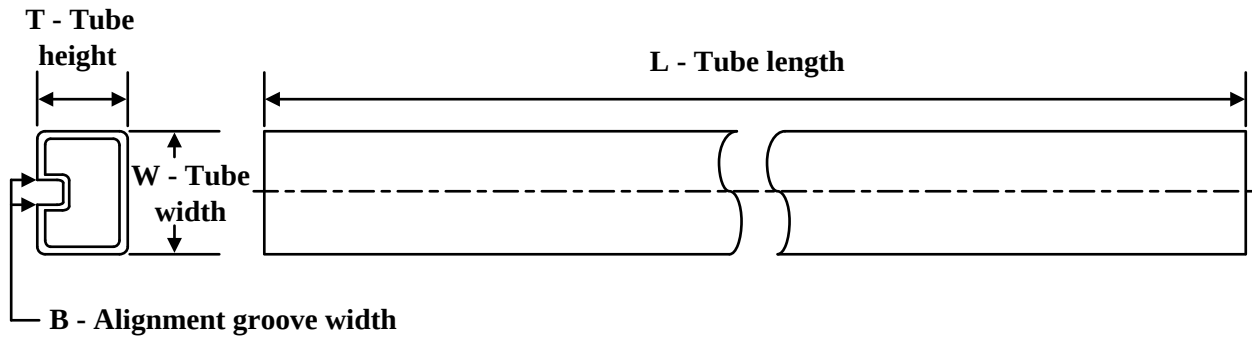
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TUBE



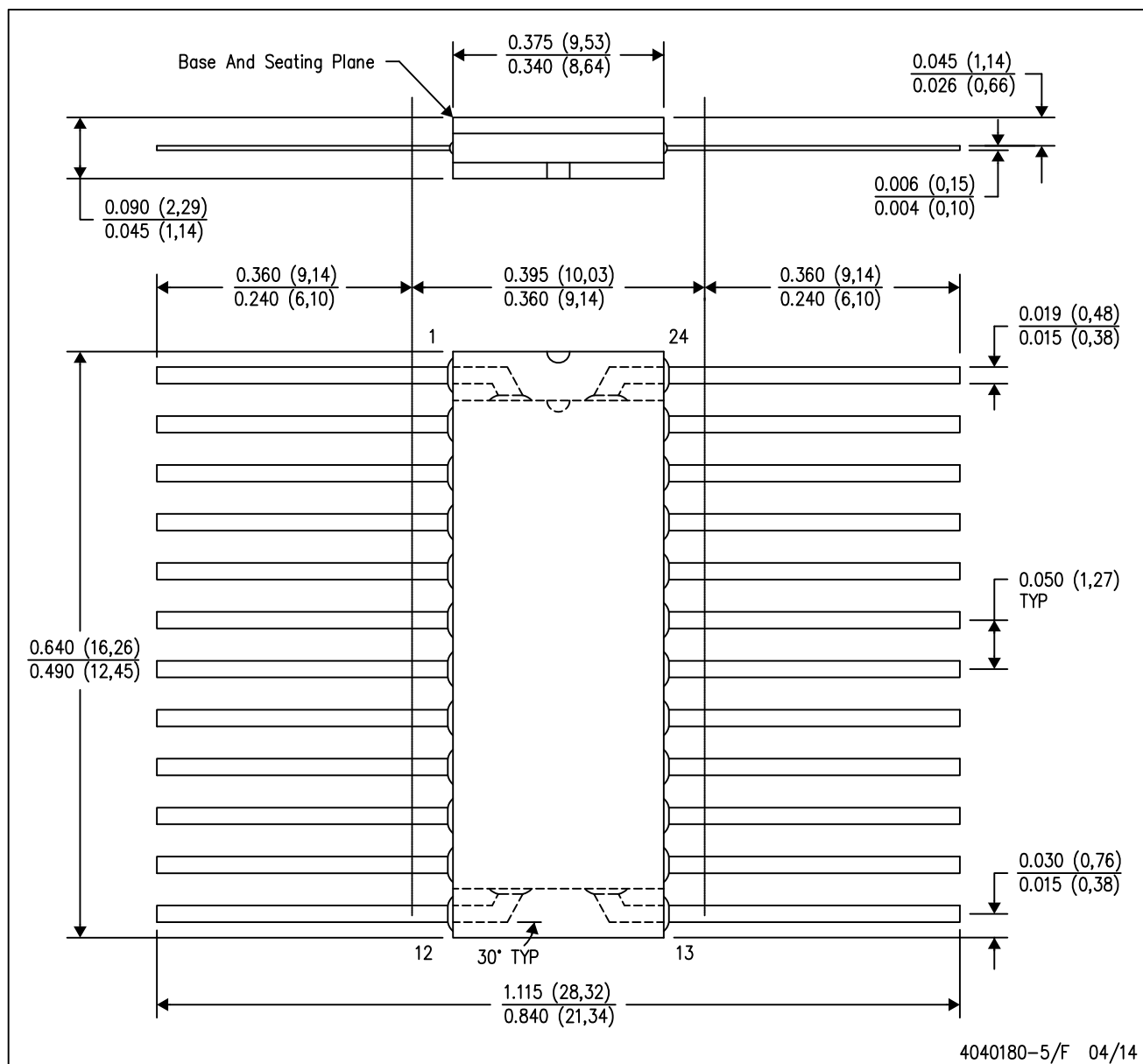
\*All dimensions are nominal

| Device          | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-9762601VKA | W            | CFP          | 24   | 25  | 506.98 | 26.16  | 6220   | NA     |

## MECHANICAL DATA

W (R-GDFP-F24)

CERAMIC DUAL FLATPACK



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only.
- E. Falls within Mil-Std 1835 GDP2-F20

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