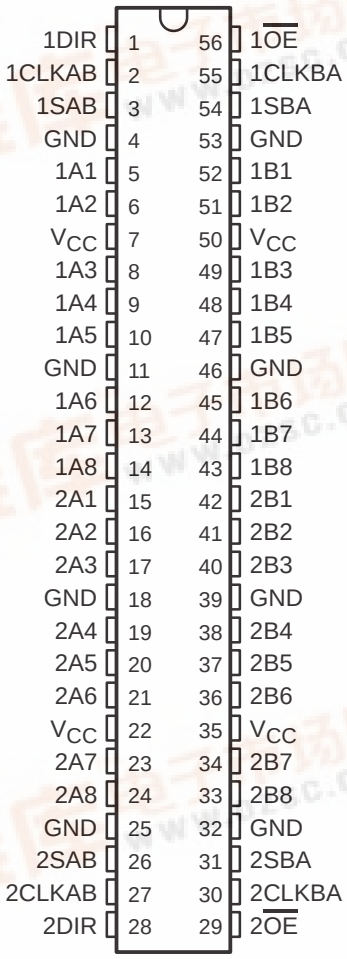
# 54ACT16646, 74ACT16646
# 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCAS127B – MARCH 1990 – REVISED APRIL 1996

- **Members of the Texas Instruments *Widebus*™ Family**
- **Inputs Are TTL-Voltage Compatible**
- **Independent Registers for A and B Buses**
- **Multiplexed Real-Time and Stored Data**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Distributed $V_{CC}$ and GND Pin Configuration Minimizes High-Speed Switching Noise**
- ***EPIC*™ (Enhanced-Performance Implanted CMOS) 1-μm Process**
- **500-mA Typical Latch-Up Immunity at 125°C**
- **Package Options Include Plastic 300-mil Shrink Small-Outline (DL) Packages Using 25-mil Center-to-Center Pin Spacings and 380-mil Fine-Pitch Ceramic Flat (WD) Packages Using 25-mil Center-to-Center Pin Spacings**

**54ACT16646 . . . WD PACKAGE**
**74ACT16646 . . . DL PACKAGE**
**(TOP VIEW)**




## description

The ’ACT16646 are 16-bit bus transceivers consisting of D-type flip-flops and control circuitry with 3-state outputs arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. The devices can be used as two 8-bit transceivers or one 16-bit transceiver. 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 illustrates the four fundamental bus-management functions that can be performed with the bus transceivers and registers.

Output-enable ($\overline{OE}$) and direction-control (DIR) inputs are provided to control the transceiver functions. In the transceiver mode, data present at the high-impedance port may be stored in either register or in both. The select controls (SAB and SBA) can multiplex stored and real-time (transparent mode) data. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. DIR determines which bus receives data when $\overline{OE}$ is low. In the isolation mode ($\overline{OE}$ high), A data may be stored in one register and/or B data may be stored in the other register.

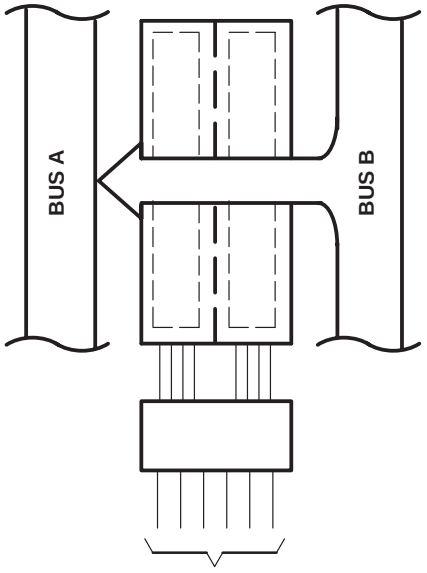
When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two buses, A or B, may be driven at a time.

The 74ACT16646 is packaged in TI’s shrink small-outline package, which provides twice the functionality of standard small-outline packages in the same printed-circuit-board area.

The 54ACT16646 is characterized for operation over the full military temperature range of –55°C to 125°C. The 74ACT16646 is characterized for operation from –40°C to 85°C.

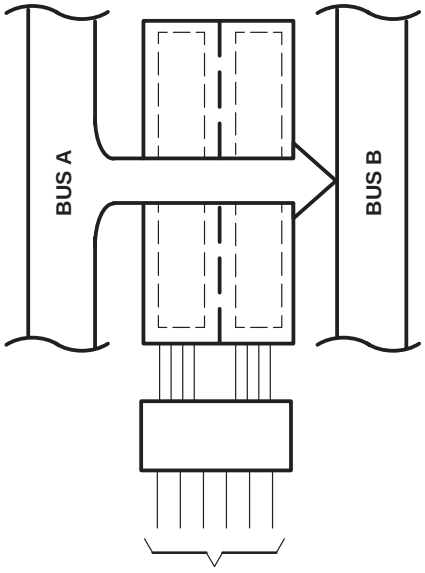


*EPIC* and Widebus are trademarks of Texas Instruments Incorporated.



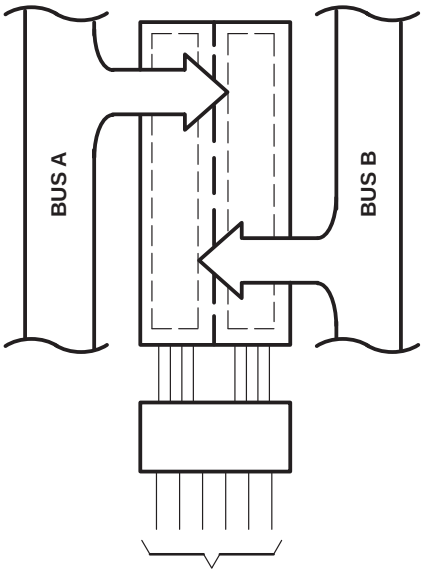

| $\overline{OE}$ | DIR | CLKAB | CLKBA | SAB | SBA |
|---|---|---|---|---|---|
| L | L | X | X | X | L |

**REAL-TIME TRANSFER**
**BUS B TO BUS A**



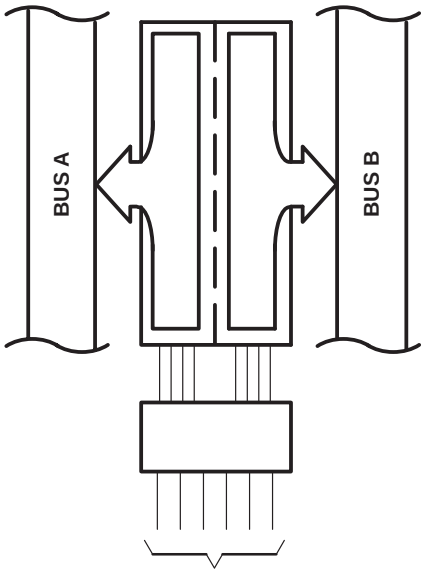

| $\overline{OE}$ | DIR | CLKAB | CLKBA | SAB | SBA |
|---|---|---|---|---|---|
| L | H | X | X | L | X |

**REAL-TIME TRANSFER**
**BUS A TO BUS B**




| $\overline{OE}$ | DIR | CLKAB | CLKBA | SAB | SBA |
|---|---|---|---|---|---|
| X | X | ↑ | X | X | X |
| X | X | X | ↑ | X | X |
| H | X | ↑ | ↑ | X | X |

**STORAGE FROM**
**A, B, OR A AND B**




| $\overline{OE}$ | DIR | CLKAB | CLKBA | SAB | SBA |
|---|---|---|---|---|---|
| L | L | X | H or L | X | H |
| L | H | H or L | X | H | X |

**TRANSFER STORED DATA**
**TO A AND/OR B**

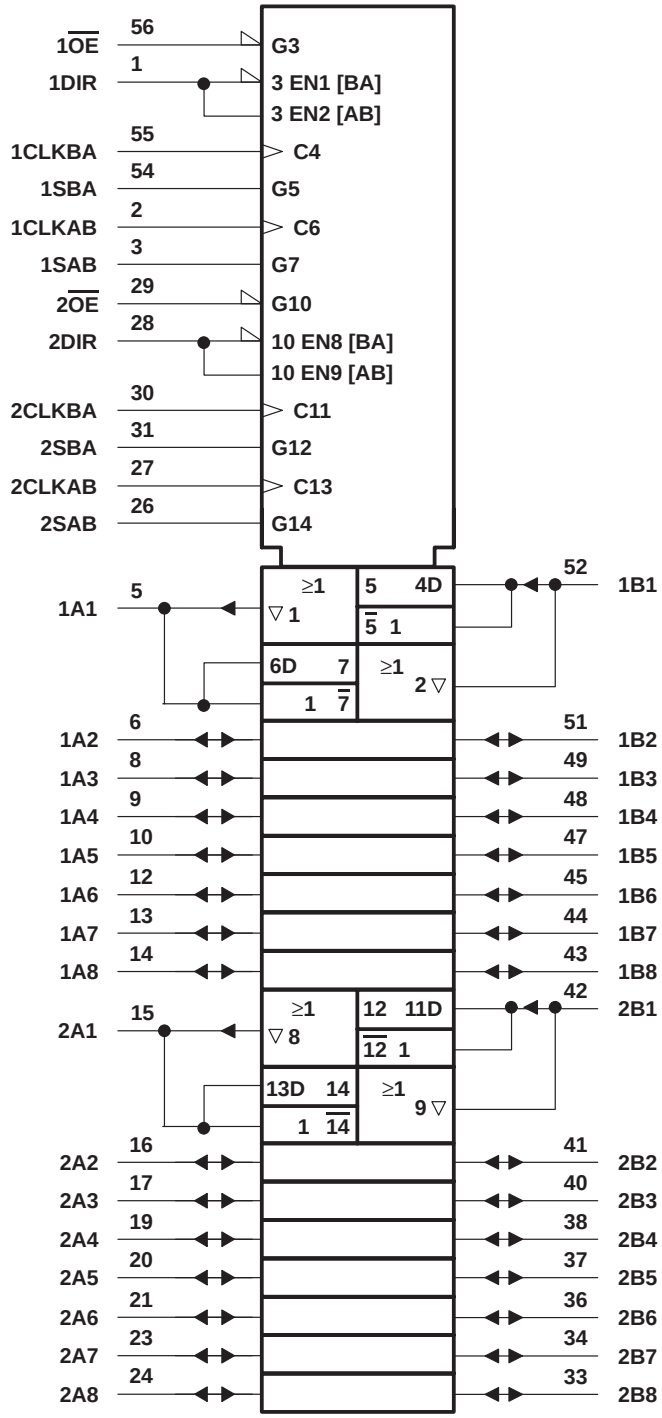
**Figure 1. Bus-Management Functions**

**FUNCTION TABLE**

| INPUTS | | | | | | DATA I/O† | | OPERATION OR FUNCTION |
|---|---|---|---|---|---|---|---|---|
| $\overline{OE}$ | DIR | CLKAB | CLKBA | SAB | SBA | A1–A8 | B1–B8 | |
| X | X | ↑ | X | X | X | Input | Unspecified | Store A, B unspecified† |
| X | X | X | ↑ | X | X | Unspecified | Input | Store B, A unspecified† |
| H | X | ↑ | ↑ | X | X | Input | Input | Store A and B data |
| H | X | H or L | H or L | X | X | Input | Input | 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 bus |

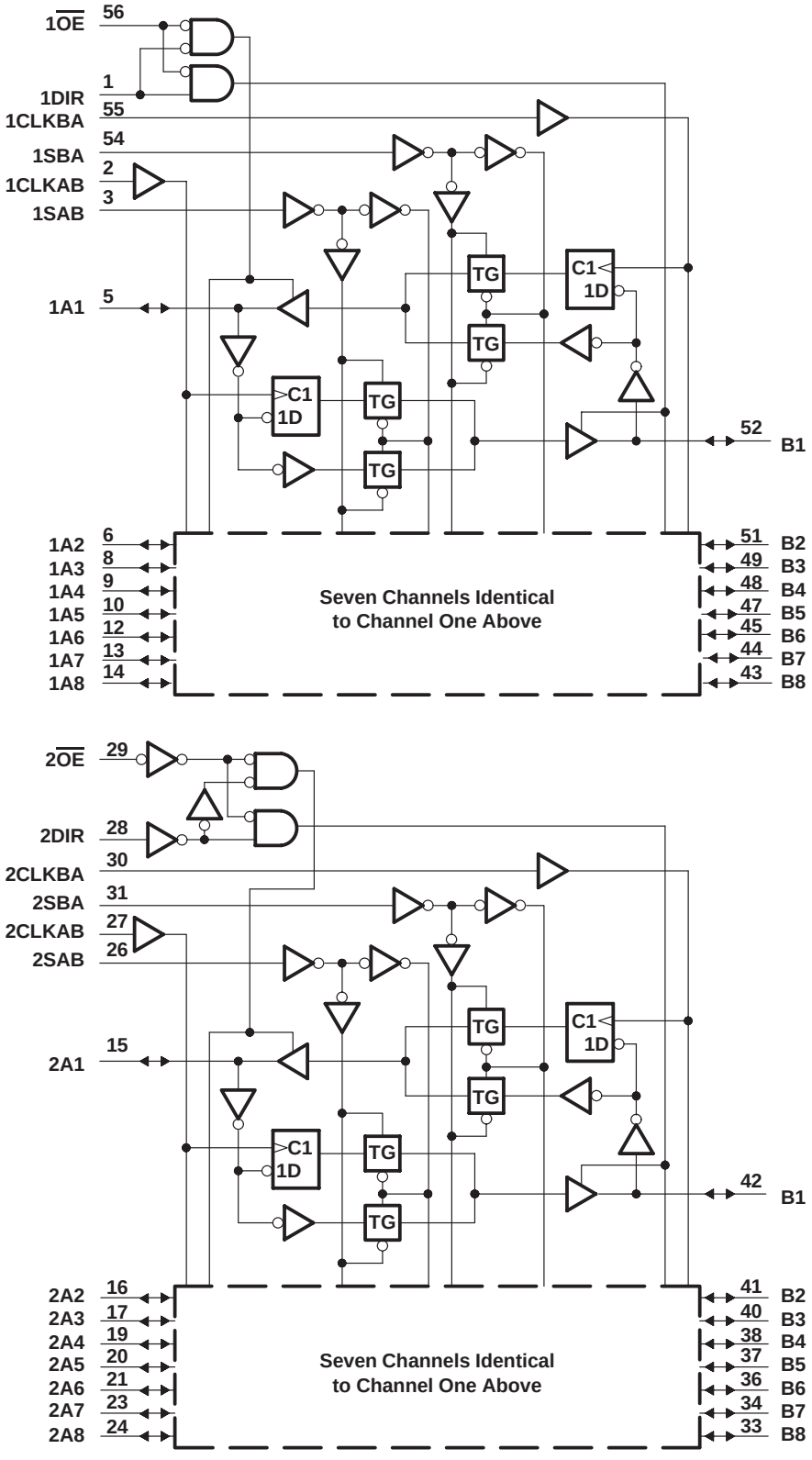
† The data-output functions may be enabled or disabled by various signals at $\overline{OE}$ or DIR. Data-input functions are always enabled, i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

## logic symbol†




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

## logic diagram (positive logic)



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

Supply voltage range, $V_{CC}$ . . . . . –0.5 V to 7 V
Input voltage range, $V_I$ (see Note 1) . . . . . –0.5 V to $V_{CC}$ + 0.5 V
Output voltage range, $V_O$ (see Note 1) . . . . . –0.5 V to $V_{CC}$ + 0.5 V
Input clamp current, $I_{IK}$ ($V_I$ < 0 or $V_I$ > $V_{CC}$) . . . . . ±20 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 . . . . . ±400 mA
Maximum package power dissipation at $T_A$ = 55°C (in still air) (see Note 2): 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 voltage ratings may be exceeded if the input and output current ratings are observed.
2. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils.

### recommended operating conditions (see Note 3)

| | | 54ACT16646 | | 74ACT16646 | | UNIT |
|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | |
| $V_{CC}$ | Supply voltage (see Note 4) | 4.5 | 5.5 | 4.5 | 5.5 | V |
| $V_{IH}$ | High-level input voltage | 2 | | 2 | | V |
| $V_{IL}$ | Low-level input voltage | | 0.8 | | 0.8 | V |
| $V_I$ | Input voltage | 0 | $V_{CC}$ | 0 | $V_{CC}$ | V |
| $V_O$ | Output voltage | 0 | $V_{CC}$ | 0 | $V_{CC}$ | V |
| $I_{OH}$ | High-level output current | | –24 | | –24 | mA |
| $I_{OL}$ | Low-level output current | | 24 | | 24 | mA |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0 | 10 | 0 | 10 | ns/V |
| $T_A$ | Operating free-air temperature | –55 | 125 | –40 | 85 | °C |



NOTES: 3. Unused inputs must be held high or low to prevent them from floating.
4. All $V_{CC}$ and GND pins must be connected to the proper voltage power supply.

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

| PARAMETER | | TEST CONDITIONS | $V_{CC}$ | $T_A$ = 25°C | | | 54ACT16646 | | 74ACT16646 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $V_{OH}$ | | $I_{OH}$ = –50 μA | 4.5 V | 4.4 | | | 4.4 | | 4.4 | | V |
| | | | 5.5 V | 5.4 | | | 5.4 | | 5.4 | | |
| | | $I_{OH}$ = –24 mA | 4.5 V | 3.94 | | | 3.7 | | 3.8 | | |
| | | | 5.5 V | 4.94 | | | 4.7 | | 4.8 | | |
| | | $I_{OH}$ = –50 mA† | 5.5 V | | | | 3.85 | | | | |
| | | $I_{OH}$ = –75 mA† | 5.5 V | | | | | | 3.85 | | |
| $V_{OL}$ | | $I_{OL}$ = 50 μA | 4.5 V | | | 0.1 | | 0.1 | | 0.1 | V |
| | | | 5.5 V | | | 0.1 | | 0.1 | | 0.1 | |
| | | $I_{OL}$ = 24 mA | 4.5 V | | | 0.36 | | 0.5 | | 0.44 | |
| | | | 5.5 V | | | 0.36 | | 0.5 | | 0.44 | |
| | | $I_{OL}$ = 50 mA† | 5.5 V | | | | | 1.65 | | | |
| | | $I_{OL}$ = 75 mA† | 5.5 V | | | | | | | 1.65 | |
| $I_I$ | Control inputs | $V_I = V_{CC}$ or GND | 5.5 V | | | ±0.1 | | ±1 | | ±1 | μA |
| $I_{OZ}$ | A or B ports‡ | $V_O = V_{CC}$ or GND | 5.5 V | | | ±0.5 | | ±10 | | ±5 | μA |
| $I_{CC}$ | | $V_I = V_{CC}$ or GND, $I_O$ = 0 | 5.5 V | | | 8 | | 160 | | 80 | μA |
| $\Delta I_{CC}$§ | | One input at 3.4 V, Other inputs at GND or $V_{CC}$ | 5.5 V | | | 0.9 | | 1 | | 1 | mA |
| $C_i$ | Control inputs | $V_I = V_{CC}$ or GND | 5 V | | 4 | | | | | | pF |
| $C_{io}$ | A or B ports | $V_O = V_{CC}$ or GND | 5 V | | 12 | | | | | | pF |

† Not more than one output should be tested at a time, and the duration of the test should not exceed 10 ms.
‡ For I/O ports, the parameter $I_{OZ}$ includes the input leakage current.
§ This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or $V_{CC}$.

## timing requirements over recommended ranges of supply voltage and operating free-air temperature, (unless otherwise noted) (see Figure 2)

| | | | $T_A$ = 25°C | | 54ACT16646 | | 74ACT16646 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| $f_{clock}$ | Clock frequency | | 0 | 90 | 0 | 90 | 0 | 90 | MHz |
| $t_w$ | Pulse duration, CLKAB or CLKBA high or low | | 5.5 | | 5.5 | | 5.5 | | ns |
| $t_{su}$ | Setup time, A before CLKAB↑ or B before CLKBA↑ | Data high | 4 | | 4 | | 4 | | ns |
| | | Data low | 6 | | 6 | | 6 | | |
| $t_h$ | Hold time, A before CLKAB↑ or B before CLKBA↑ | | 1.5 | | 1.5 | | 1.5 | | ns |

## switching characteristics over recommended ranges of supply voltage and operating free-air temperature, (unless otherwise noted) (see Figure 2)

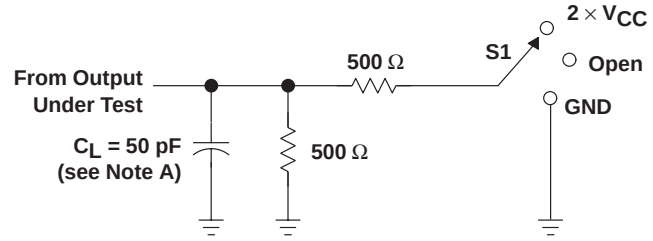
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $T_A$ = 25°C | | | 54ACT16646 | | 74ACT16646 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $f_{max}$ | | | 90 | | | 90 | | 90 | | MHz |
| $t_{PLH}$ | A or B | B or A | 3.9 | 7.5 | 9.4 | 3.9 | 11.5 | 3.9 | 10.6 | ns |
| $t_{PHL}$ | | | 3.4 | 7.6 | 10.6 | 3.4 | 12.2 | 3.4 | 11.4 | |
| $t_{PZH}$ | $\overline{OE}$ | A or B | 3.2 | 7.7 | 10.8 | 3.2 | 12.9 | 3.2 | 11.9 | ns |
| $t_{PZL}$ | | | 4.2 | 9 | 12.2 | 4.2 | 14.6 | 4.2 | 13.5 | |
| $t_{PHZ}$ | $\overline{OE}$ | A or B | 5.3 | 7.7 | 9.6 | 5.3 | 10.4 | 5.3 | 10.2 | ns |
| $t_{PLZL}$ | | | 4.9 | 7.3 | 9.2 | 4.9 | 10.3 | 4.9 | 9.9 | |
| $t_{PLH}$ | CLKBA or CLKAB | A or B | 4.9 | 8.9 | 11.1 | 4.9 | 13.1 | 4.9 | 12.2 | ns |
| $t_{PHL}$ | | | 5.1 | 9 | 11 | 5.1 | 13.1 | 5.1 | 12.3 | |
| $t_{PLH}$ | SAB or SBA† (with A or B high) | A or B | 5.2 | 10.3 | 13.8 | 5.2 | 17.2 | 5.2 | 15.6 | ns |
| $t_{PHL}$ | | | 4.9 | 8.2 | 10.6 | 4.9 | 12.5 | 4.9 | 11.7 | |
| $t_{PLH}$ | SBA or SAB† (with A or B high) | A or B | 4.3 | 7.8 | 9.9 | 4.3 | 12.1 | 4.3 | 11.1 | ns |
| $t_{PHL}$ | | | 5.9 | 11.2 | 14.9 | 5.9 | 18.2 | 5.9 | 16.7 | |
| $t_{PZH}$ | DIR | A or B | 4.5 | 9.5 | 13.6 | 4.5 | 16.2 | 4.5 | 15.2 | ns |
| $t_{PZL}$ | | | 4.3 | 9.2 | 11.8 | 4.3 | 14.2 | 4.3 | 13.1 | |
| $t_{PHZ}$ | DIR | A or B | 4.5 | 7.9 | 10.2 | 4.5 | 11.2 | 4.5 | 10.8 | ns |
| $t_{PLZ}$ | | | 4.4 | 7.5 | 9.8 | 4.4 | 10.8 | 4.4 | 10.4 | |

† These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

## operating characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C

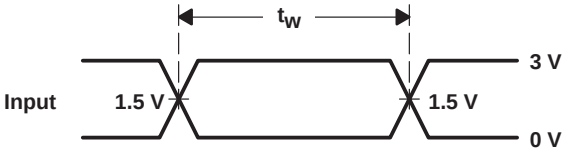
| PARAMETER | | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|---|
| $C_{pd}$ | Power dissipation capacitance per transceiver | Outputs enabled | $C_L$ = 50 pF, f = 1 MHz | 58 | pF |
| | | Outputs disabled | | 13 | |

## PARAMETER MEASUREMENT INFORMATION

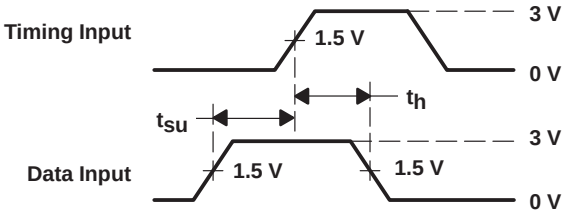



| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | 2 × $V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND |

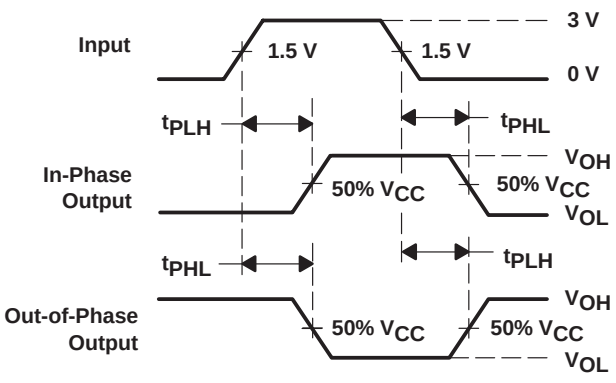
LOAD CIRCUIT



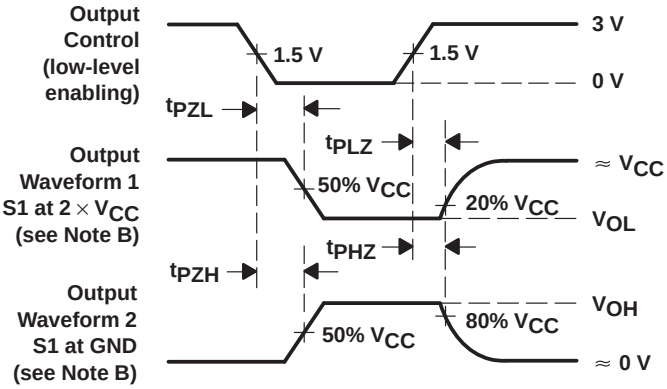

VOLTAGE WAVEFORMS




VOLTAGE WAVEFORMS




VOLTAGE WAVEFORMS




VOLTAGE WAVEFORMS

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 ≤ 1 MHz, $Z_O$ = 50 Ω, $t_r$ = 3 ns, $t_f$ = 3 ns.
D. The outputs are measured one at a time with one input transition per measurement.

**Figure 2. Load Circuit and Voltage Waveforms**

# PACKAGE OPTION ADDENDUM

8-Jun-2005

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| 74ACT16646DL | ACTIVE | SSOP | DL | 56 | 20 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| 74ACT16646DLR | ACTIVE | SSOP | DL | 56 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| 74ACT16646DLRG4 | ACTIVE | SSOP | DL | 56 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

(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.

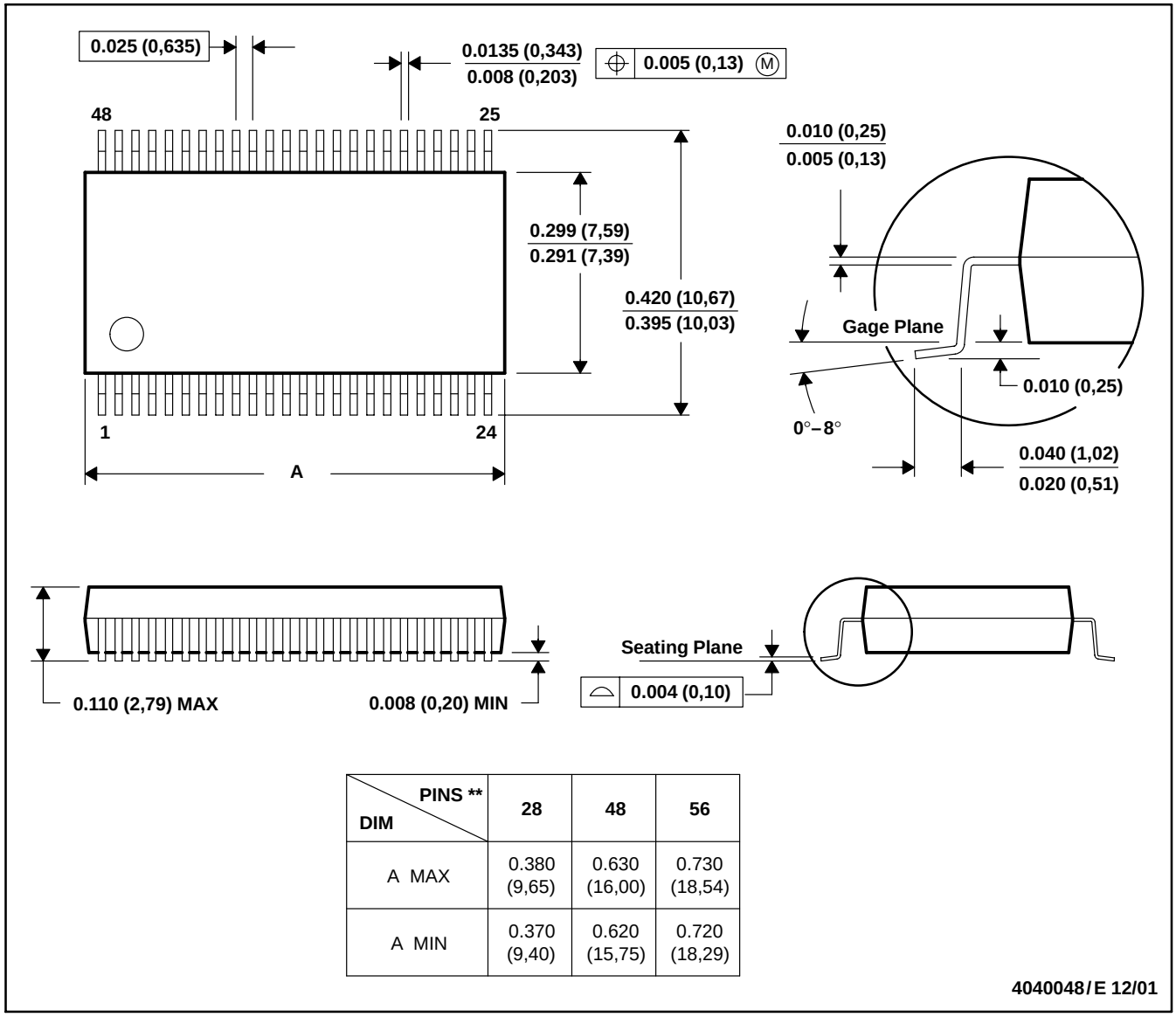
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (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.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

MSSO001C – JANUARY 1995 – REVISED DECEMBER 2001

**DL (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**48 PINS SHOWN**




| DIM \ PINS ** | 28 | 48 | 56 |
|---|---|---|---|
| A MAX | 0.380 (9,65) | 0.630 (16,00) | 0.730 (18,54) |
| A MIN | 0.370 (9,40) | 0.620 (15,75) | 0.720 (18,29) |

**4040048/E 12/01**

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

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| **Products** | | **Applications** | |
|---|---|---|---|
| Amplifiers | amplifier.ti.com | Audio | www.ti.com/audio |
| Data Converters | dataconverter.ti.com | Automotive | www.ti.com/automotive |
| DSP | dsp.ti.com | Broadband | www.ti.com/broadband |
| Interface | interface.ti.com | Digital Control | www.ti.com/digitalcontrol |
| Logic | logic.ti.com | Military | www.ti.com/military |
| Power Mgmt | power.ti.com | Optical Networking | www.ti.com/opticalnetwork |
| Microcontrollers | microcontroller.ti.com | Security | www.ti.com/security |
| | | Telephony | www.ti.com/telephony |
| | | Video & Imaging | www.ti.com/video |
| | | Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265