

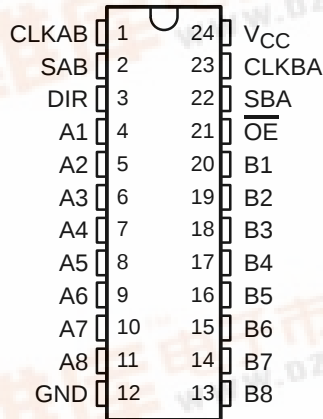
# SN54HCT646, SN74HCT646 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

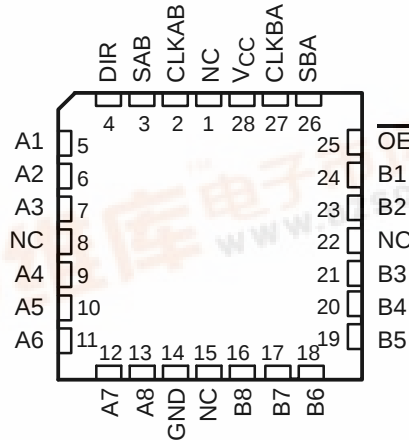
- Operating Voltage Range of 4.5 V to 5.5 V
- Low Power Consumption, 80- $\mu$ A Max  $I_{CC}$
- Typical  $t_{pd} = 12$  ns
- $\pm 6$ -mA Output Drive at 5 V
- Low Input Current of 1  $\mu$ A Max
- Inputs Are TTL-Voltage Compatible

- Independent Registers for A and B Buses
- Multiplexed Real-Time and Stored Data
- True Data Paths
- High-Current 3-State Outputs Can Drive Up To 15 LSTTL Loads

SN54HCT646 . . . JT OR W PACKAGE  
SN74HCT646 . . . DW OR NT PACKAGE  
(TOP VIEW)



SN54HCT646 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

## description/ordering information

The 'HCT646 devices consist of bus-transceiver circuits with 3-state outputs, 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 illustrates the four fundamental bus-management functions that can be performed with the 'HCT646 devices.

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

## ORDERING INFORMATION

| TA             | PACKAGE†  |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|-----------|---------------|-----------------------|------------------|
| –40°C to 85°C  | PDIP – NT | Tube          | SN74HCT646NT          | HCT646           |
|                | SOIC – DW | Tube          | SN74HCT646DW          |                  |
|                |           | Tape and reel | SN74HCT646DWR         |                  |
| –55°C to 125°C | CDIP – JT | Tube          | SNJ54HCT646JT         | SNJ54HCT646JT    |
|                | CFP – W   | Tube          | SNJ54HCT646W          | SNJ54HCT646W     |
|                | LCCC – FK | Tube          | SNJ54HCT646FK         | SNJ54HCT646FK    |

† 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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# SN54HCT646, SN74HCT646

## OCTAL BUS TRANSCEIVERS AND REGISTERS

### WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

#### description/ordering information (continued)

The select-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. DIR determines which bus receives data when  $\overline{OE}$  is active (low). In the isolation mode ( $\overline{OE}$  high), A data can be stored in one register and/or 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 data. Only one of the two buses, A or B, can be driven at a time.

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.

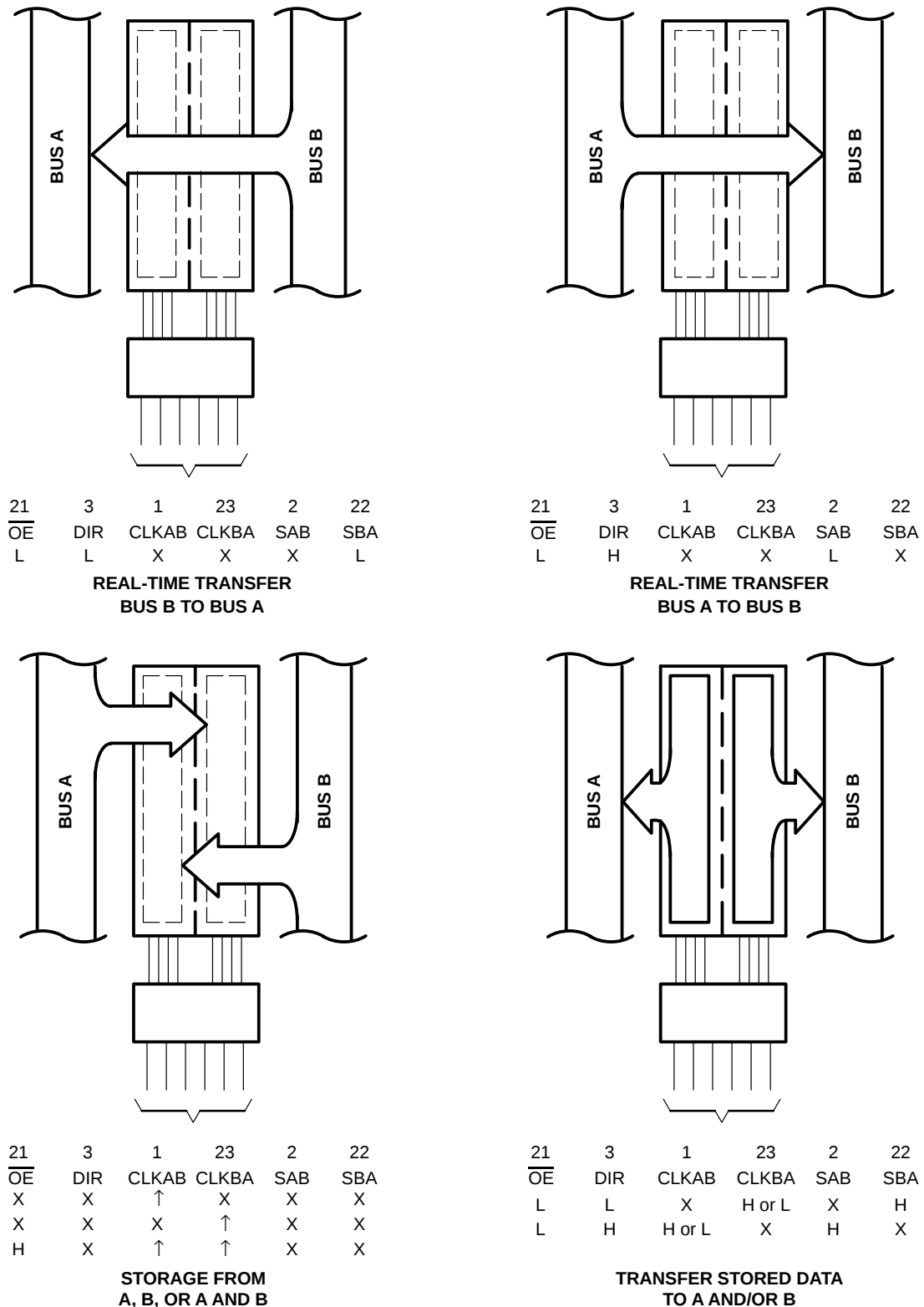
FUNCTION TABLE

| 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 <sup>†</sup> | Store A, B unspecified <sup>†</sup> |
| X               | X   | X      | ↑      | X   | X   | Unspecified <sup>†</sup> | Input                    | Store B, A unspecified <sup>†</sup> |
| H               | X   | ↑      | ↑      | X   | X   | Input                    | Input                    | Store A 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              |

<sup>†</sup> The data-output functions can be enabled or disabled by various signals at  $\overline{OE}$  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.

# SN54HCT646, SN74HCT646 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003



Pin numbers shown are for the DW, JT, NT, and W packages.

Figure 1. Bus-Management Functions

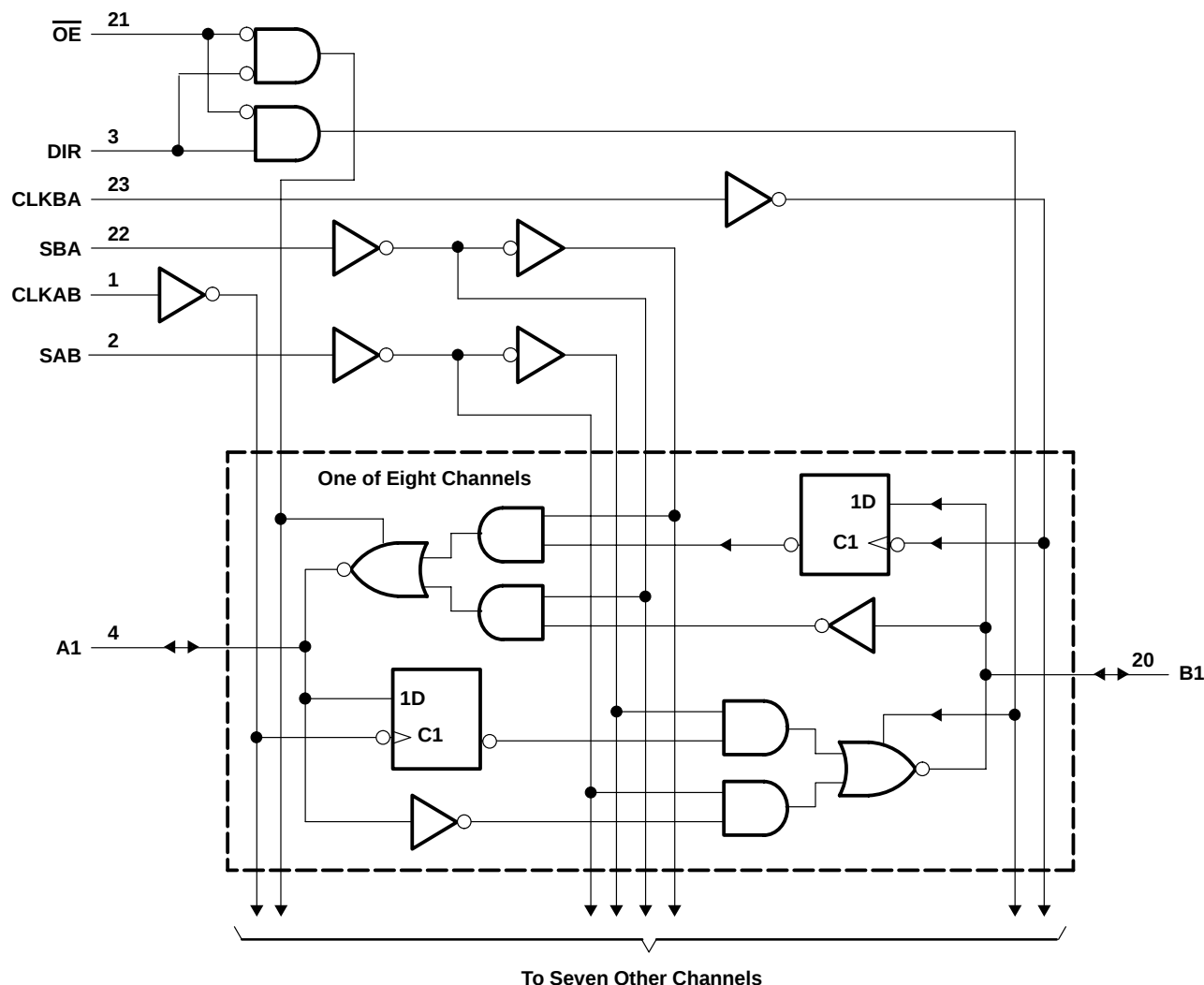
# SN54HCT646, SN74HCT646

## OCTAL BUS TRANSCEIVERS AND REGISTERS

### WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

#### logic diagram (positive logic)



Pin numbers shown are for the DW, JT, NT, and W packages.

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

|                                                                             |                |
|-----------------------------------------------------------------------------|----------------|
| Supply voltage range, $V_{CC}$                                              | –0.5 V to 7 V  |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{CC}$ ) (see Note 1)  | ±20 mA         |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ ) (see Note 1) | ±20 mA         |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ )                  | ±35 mA         |
| Continuous current through $V_{CC}$ or GND                                  | ±70 mA         |
| Package thermal impedance, $\theta_{JA}$ (see Note 2): DW package           | 46°C/W         |
| (see Note 3): NT package                                                    | 67°C/W         |
| Storage temperature range, $T_{stg}$                                        | –65°C to 150°C |

<sup>†</sup> 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 package thermal impedance is calculated in accordance with JESD 51-7.
  3. The package thermal impedance is calculated in accordance with JESD 51-3.

# SN54HCT646, SN74HCT646 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

## recommended operating conditions (see Note 4)

|                 |                                       |                                  | SN54HCT646 |     |                 | SN74HCT646 |     |                 | UNIT |
|-----------------|---------------------------------------|----------------------------------|------------|-----|-----------------|------------|-----|-----------------|------|
|                 |                                       |                                  | MIN        | NOM | MAX             | MIN        | NOM | MAX             |      |
| V <sub>CC</sub> | Supply voltage                        |                                  | 4.5        | 5   | 5.5             | 4.5        | 5   | 5.5             | V    |
| V <sub>IH</sub> | High-level input voltage              | V <sub>CC</sub> = 4.5 V to 5.5 V | 2          |     |                 | 2          |     |                 | V    |
| V <sub>IL</sub> | Low-level input voltage               | V <sub>CC</sub> = 4.5 V to 5.5 V |            |     | 0.8             |            |     | 0.8             | V    |
| V <sub>I</sub>  | Input voltage                         |                                  | 0          |     | V <sub>CC</sub> | 0          |     | V <sub>CC</sub> | V    |
| V <sub>O</sub>  | Output voltage                        |                                  | 0          |     | V <sub>CC</sub> | 0          |     | V <sub>CC</sub> | V    |
| t <sub>t</sub>  | Input transition (rise and fall) time |                                  |            |     | 500             |            |     | 500             | ns   |
| T <sub>A</sub>  | Operating free-air temperature        |                                  | –55        |     | 125             | –40        |     | 85              | °C   |

NOTE 4: 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>   | T <sub>A</sub> = 25°C |       |      | SN54HCT646 |     | SN74HCT646 |      | UNIT |
|-------------------------------|----------------|---------------------------------------------------------------------------------|-------------------|-----------------------|-------|------|------------|-----|------------|------|------|
|                               |                |                                                                                 |                   | MIN                   | TYP   | MAX  | MIN        | MAX | MIN        | MAX  |      |
| V <sub>OH</sub>               |                | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OH</sub> = –20 µA | 4.5 V             | 4.4                   | 4.499 |      | 4.4        |     | 4.4        |      | V    |
|                               |                |                                                                                 |                   | 3.98                  | 4.3   |      | 3.7        |     | 3.84       |      |      |
| V <sub>OL</sub>               |                | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 20 µA  | 4.5 V             |                       | 0.001 | 0.1  |            | 0.1 |            | 0.1  | V    |
|                               |                |                                                                                 |                   |                       | 0.17  | 0.26 |            | 0.4 |            | 0.33 |      |
| I <sub>I</sub>                | Control inputs | V <sub>I</sub> = V <sub>CC</sub> or 0                                           | 5.5 V             | ±0.1                  | ±100  |      | ±1000      |     | ±1000      |      | nA   |
| I <sub>OZ</sub>               | A or B         | V <sub>O</sub> = V <sub>CC</sub> or 0                                           | 5.5 V             | ±0.01                 | ±0.5  |      | ±10        |     | ±5         |      | µA   |
| I <sub>CC</sub>               |                | V <sub>I</sub> = V <sub>CC</sub> or 0, I <sub>O</sub> = 0                       | 5.5 V             |                       |       | 8    | 160        |     | 80         |      | µA   |
| ΔI <sub>CC</sub> <sup>†</sup> |                | One input at 0.5 V or 2.4 V,<br>Other inputs at 0 or V <sub>CC</sub>            | 5.5 V             |                       | 1.4   | 2.4  |            | 3   |            | 2.9  | mA   |
| C <sub>i</sub>                | Control inputs |                                                                                 | 4.5 V<br>to 5.5 V |                       | 3     | 10   |            | 10  |            | 10   | pF   |

<sup>†</sup> 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<sub>CC</sub>.

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

|                    |                                                                        | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     | SN54HCT646 |     | SN74HCT646 |     | UNIT |
|--------------------|------------------------------------------------------------------------|-----------------|-----------------------|-----|------------|-----|------------|-----|------|
|                    |                                                                        |                 | MIN                   | MAX | MIN        | MAX | MIN        | MAX |      |
| f <sub>clock</sub> | Clock frequency                                                        | 4.5 V           |                       | 31  |            | 22  |            | 27  | MHz  |
|                    |                                                                        | 5.5 V           |                       | 36  |            | 24  |            | 29  |      |
| t <sub>w</sub>     | Pulse duration, CLKBA or CLKAB high or low                             | 4.5 V           | 16                    |     | 23         |     | 19         |     | ns   |
|                    |                                                                        | 5.5 V           | 14                    |     | 21         |     | 17         |     |      |
| t <sub>su</sub>    | Setup time, A before CLKAB <sup>†</sup> or B before CLKBA <sup>†</sup> | 4.5 V           | 20                    |     | 30         |     | 25         |     | ns   |
|                    |                                                                        | 5.5 V           | 18                    |     | 27         |     | 23         |     |      |
| t <sub>h</sub>     | Hold time, A after CLKAB <sup>†</sup> or B after CLKBA <sup>†</sup>    | 4.5 V           | 5                     |     | 5          |     | 5          |     | ns   |
|                    |                                                                        | 5.5 V           | 5                     |     | 5          |     | 5          |     |      |

# SN54HCT646, SN74HCT646

## OCTAL BUS TRANSCEIVERS AND REGISTERS

### WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

switching characteristics over recommended operating free-air temperature range,  $C_L = 50$  pF (unless otherwise noted) (see Figure 2)

| PARAMETER        | FROM (INPUT)            | TO (OUTPUT) | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |     |     | SN54HCT646 |     | SN74HCT646 |     | UNIT |
|------------------|-------------------------|-------------|----------|--------------------------|-----|-----|------------|-----|------------|-----|------|
|                  |                         |             |          | MIN                      | TYP | MAX | MIN        | MAX | MIN        | MAX |      |
| $f_{\text{max}}$ |                         |             | 4.5 V    | 31                       | 54  |     | 22         |     | 27         |     | MHz  |
|                  |                         |             | 5.5 V    | 36                       | 64  |     | 24         |     | 29         |     |      |
| $t_{\text{pd}}$  | CLKBA or CLKAB          | A or B      | 4.5 V    |                          | 18  | 36  |            | 54  |            | 45  | ns   |
|                  |                         |             | 5.5 V    |                          | 16  | 32  |            | 49  |            | 41  |      |
|                  | A or B                  | B or A      | 4.5 V    |                          | 14  | 27  |            | 41  |            | 34  |      |
|                  |                         |             | 5.5 V    |                          | 12  | 24  |            | 37  |            | 31  |      |
|                  | SBA or SAB <sup>†</sup> | A or B      | 4.5 V    |                          | 20  | 38  |            | 57  |            | 48  |      |
|                  |                         |             | 5.5 V    |                          | 17  | 34  |            | 51  |            | 43  |      |
| $t_{\text{en}}$  | $\overline{\text{OE}}$  | A or B      | 4.5 V    |                          | 25  | 49  |            | 74  |            | 61  | ns   |
|                  |                         |             | 5.5 V    |                          | 22  | 44  |            | 67  |            | 55  |      |
| $t_{\text{dis}}$ | $\overline{\text{OE}}$  | A or B      | 4.5 V    |                          | 25  | 49  |            | 74  |            | 61  | ns   |
|                  |                         |             | 5.5 V    |                          | 22  | 44  |            | 67  |            | 55  |      |
| $t_{\text{en}}$  | DIR                     | A or B      | 4.5 V    |                          | 25  | 49  |            | 74  |            | 61  | ns   |
|                  |                         |             | 5.5 V    |                          | 22  | 44  |            | 67  |            | 55  |      |
| $t_{\text{dis}}$ | DIR                     | A or B      | 4.5 V    |                          | 25  | 49  |            | 74  |            | 61  | ns   |
|                  |                         |             | 5.5 V    |                          | 22  | 44  |            | 67  |            | 55  |      |
| $t_t$            |                         | Any         | 4.5 V    |                          | 9   | 12  |            | 18  |            | 15  | ns   |
|                  |                         |             | 5.5 V    |                          | 7   | 11  |            | 16  |            | 14  |      |

<sup>†</sup> These parameters are measured with the internal output state of the storage register opposite that of the bus input.

switching characteristics over recommended operating free-air temperature range,  $C_L = 150$  pF (unless otherwise noted) (see Figure 2)

| PARAMETER       | FROM (INPUT)            | TO (OUTPUT) | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |     |     | SN54HCT646 |     | SN74HCT646 |     | UNIT |
|-----------------|-------------------------|-------------|----------|--------------------------|-----|-----|------------|-----|------------|-----|------|
|                 |                         |             |          | MIN                      | TYP | MAX | MIN        | MAX | MIN        | MAX |      |
| $t_{\text{pd}}$ | CLKBA or CLKAB          | A or B      | 4.5 V    |                          | 24  | 53  |            | 80  |            | 66  | ns   |
|                 |                         |             | 5.5 V    |                          | 22  | 47  |            | 52  |            | 60  |      |
|                 | A or B                  | B or A      | 4.5 V    |                          | 22  | 44  |            | 67  |            | 55  |      |
|                 |                         |             | 5.5 V    |                          | 20  | 39  |            | 60  |            | 50  |      |
|                 | SBA or SAB <sup>†</sup> | A or B      | 4.5 V    |                          | 26  | 55  |            | 83  |            | 69  |      |
|                 |                         |             | 5.5 V    |                          | 24  | 49  |            | 74  |            | 62  |      |
| $t_{\text{en}}$ | $\overline{\text{OE}}$  | A or B      | 4.5 V    |                          | 33  | 66  |            | 100 |            | 87  | ns   |
|                 |                         |             | 5.5 V    |                          | 22  | 59  |            | 90  |            | 74  |      |
|                 | DIR                     | A or B      | 4.5 V    |                          | 33  | 66  |            | 100 |            | 87  |      |
|                 |                         |             | 5.5 V    |                          | 22  | 59  |            | 90  |            | 74  |      |
| $t_t$           |                         | Any         | 4.5 V    |                          | 17  | 42  |            | 63  |            | 53  | ns   |
|                 |                         |             | 5.5 V    |                          | 14  | 38  |            | 57  |            | 48  |      |

<sup>†</sup> These parameters are measured with the internal output state of the storage register opposite that of the bus input.

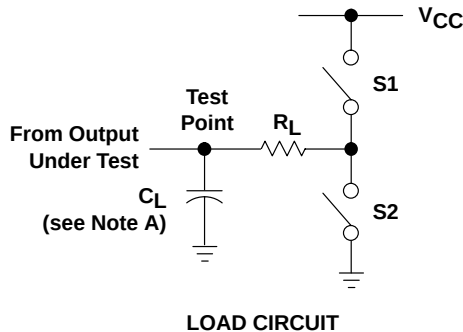
operating characteristics,  $T_A = 25^\circ\text{C}$

| PARAMETER       |                               | TEST CONDITIONS | TYP | UNIT |
|-----------------|-------------------------------|-----------------|-----|------|
| $C_{\text{pd}}$ | Power dissipation capacitance | No load         | 50  | pF   |

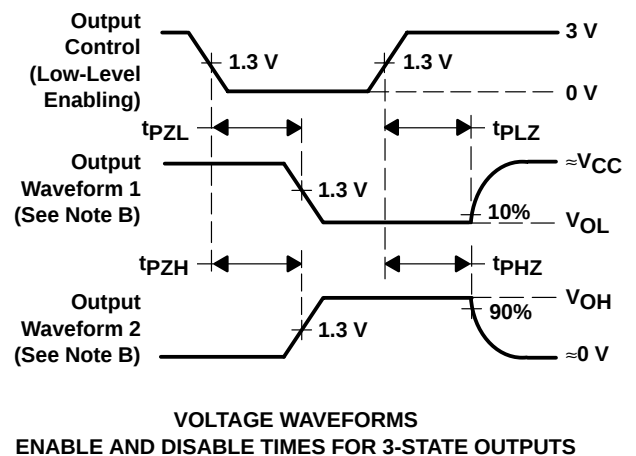
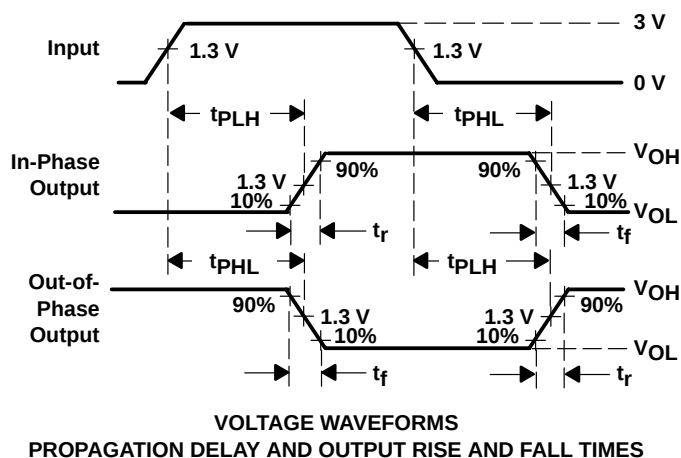
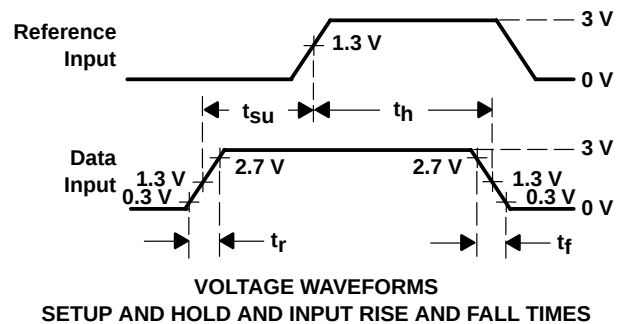
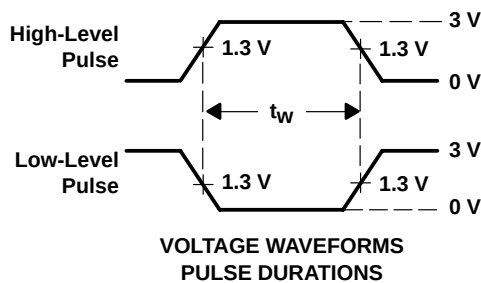
# SN54HCT646, SN74HCT646 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCLS178C – MARCH 1984 – REVISED MARCH 2003

## PARAMETER MEASUREMENT INFORMATION



| PARAMETER         | $R_L$        | $C_L$           | $S1$   | $S2$   |
|-------------------|--------------|-----------------|--------|--------|
| $t_{en}$          | 1 k $\Omega$ | 50 pF or 150 pF | Open   | Closed |
|                   |              |                 | Closed | Open   |
| $t_{dis}$         | 1 k $\Omega$ | 50 pF           | Open   | Closed |
|                   |              |                 | Closed | Open   |
| $t_{pd}$ or $t_t$ | —            | 50 pF or 150 pF | Open   | Open   |



- NOTES:
- A.  $C_L$  includes probe and test-fixture 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. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1$  MHz,  $Z_O = 50 \Omega$ ,  $t_r = 6$  ns,  $t_f = 6$  ns.
  - D. For clock inputs,  $f_{max}$  is measured when the input duty cycle is 50%.
  - E. The outputs are measured one at a time with one input transition per measurement.
  - F.  $t_{pLZ}$  and  $t_{pHZ}$  are the same as  $t_{dis}$ .
  - G.  $t_{pZL}$  and  $t_{pZH}$  are the same as  $t_{en}$ .
  - H.  $t_{pLH}$  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>               |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|--------------------------------------------|
| SN74HCT646DW     | ACTIVE                | SOIC         | DW              | 24   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | Level-2-250C-1 YEAR/<br>Level-1-235C-UNLIM |
| SN74HCT646DWR    | ACTIVE                | SOIC         | DW              | 24   | 2000        | Pb-Free (RoHS)          | CU NIPDAU        | Level-2-250C-1 YEAR/<br>Level-1-235C-UNLIM |
| SN74HCT646NT     | ACTIVE                | PDIP         | NT              | 24   | 15          | Pb-Free (RoHS)          | CU NIPDAU        | Level-NC-NC-NC                             |
| SN74HCT646NT3    | OBSOLETE              | PDIP         | NT              | 24   |             | 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.

**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)

<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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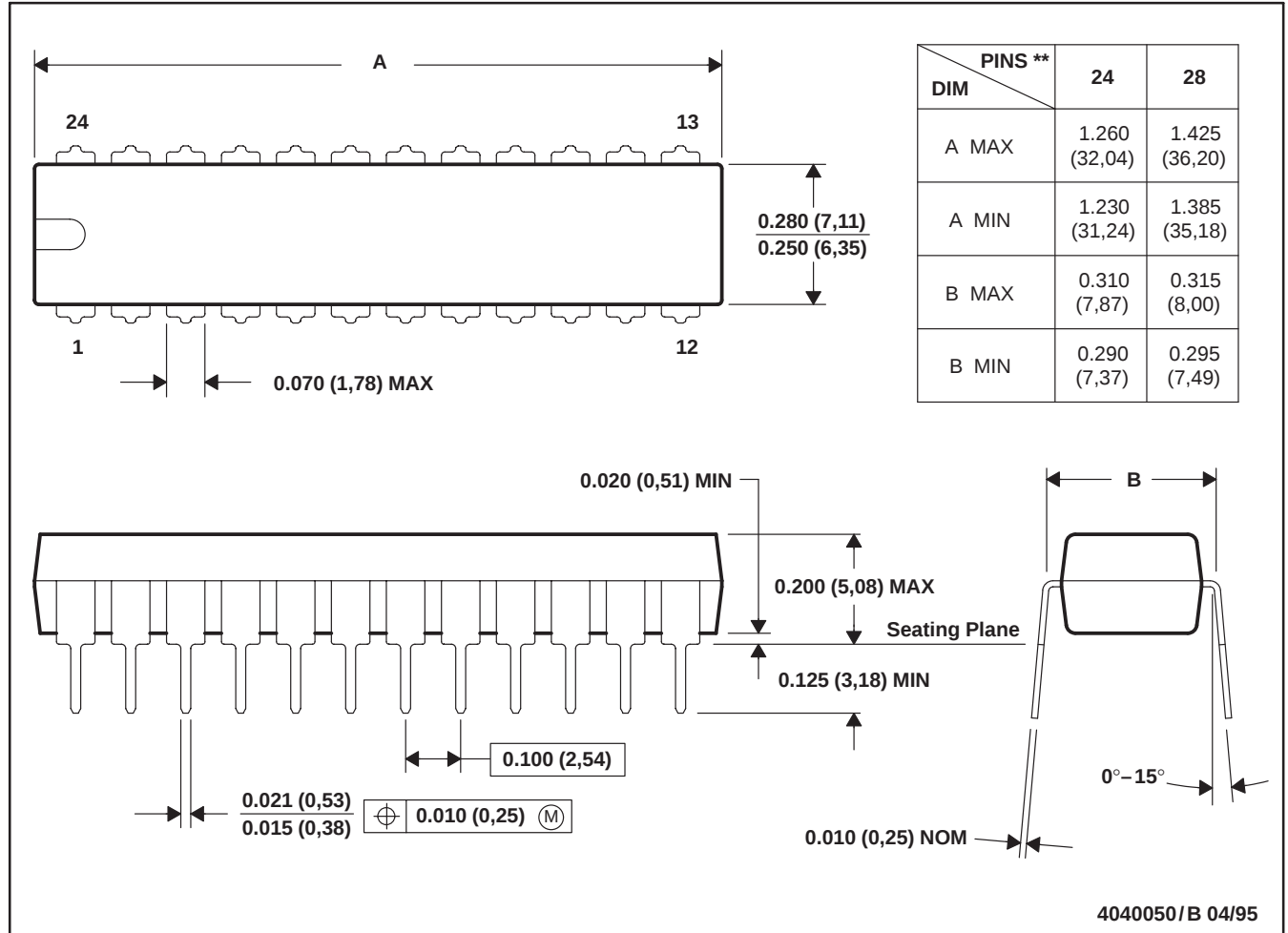
# MECHANICAL DATA

MPDI004 – OCTOBER 1994

NT (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

24 PINS SHOWN

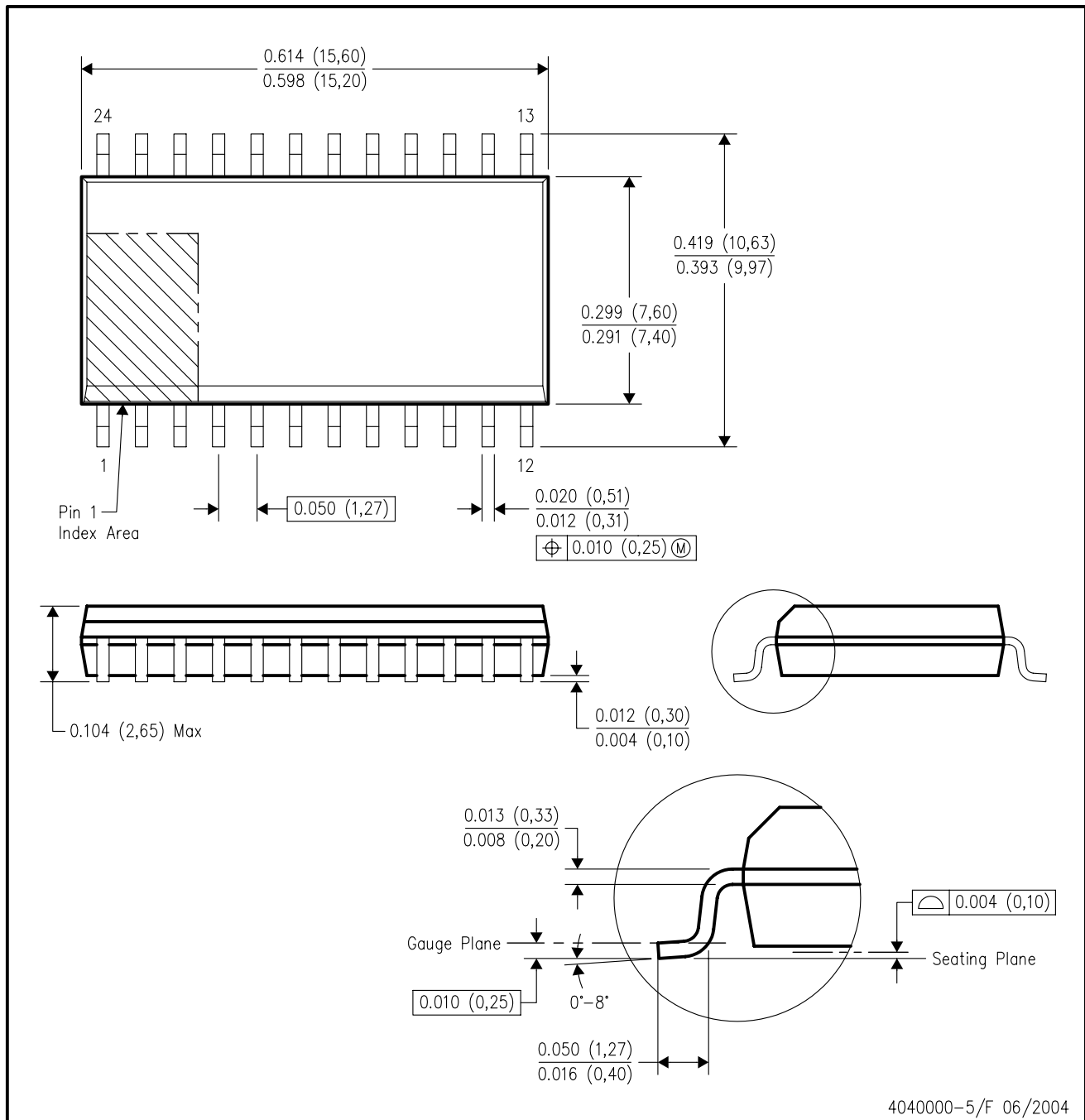


NOTES: A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.

# MECHANICAL DATA

DW (R-PDSO-G24)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - Falls within JEDEC MS-013 variation AD.

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