

SN74LVCH16646A

16-BIT BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

- Member of the Texas Instruments *Widebus™* Family
- *EPIC™* (Enhanced-Performance Implanted CMOS) Submicron Process
- Typical V_{OLP} (Output Ground Bounce) $< 0.8\text{ V}$ at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$
- Typical V_{OHV} (Output V_{OH} Undershoot) $> 2\text{ V}$ at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V V_{CC})
- Power Off Disables Outputs, Permitting Live Insertion
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ($C = 200\text{ pF}$, $R = 0$)
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

description

This 16-bit bus transceiver and register is designed for 1.65-V to 3.6-V V_{CC} operation.

The SN74LVCH16646A can be used as two 8-bit transceivers or one 16-bit transceiver. The 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 illustrates the four fundamental bus-management functions that can be performed with the SN74LVCH16646A.

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 register or in both. The select-control (SAB and SBA) inputs 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 can be stored in one register and/or B data can be stored in the other register.

DGG OR DL PACKAGE
(TOP VIEW)

| | | | |
|----------|----|----|-------------------|
| 1DIR | 1 | 56 | 1 \overline{OE} |
| 1CLKAB | 2 | 55 | 1CLKBA |
| 1SAB | 3 | 54 | 1SBA |
| GND | 4 | 53 | GND |
| 1A1 | 5 | 52 | 1B1 |
| 1A2 | 6 | 51 | 1B2 |
| V_{CC} | 7 | 50 | V_{CC} |
| 1A3 | 8 | 49 | 1B3 |
| 1A4 | 9 | 48 | 1B4 |
| 1A5 | 10 | 47 | 1B5 |
| GND | 11 | 46 | GND |
| 1A6 | 12 | 45 | 1B6 |
| 1A7 | 13 | 44 | 1B7 |
| 1A8 | 14 | 43 | 1B8 |
| 2A1 | 15 | 42 | 2B1 |
| 2A2 | 16 | 41 | 2B2 |
| 2A3 | 17 | 40 | 2B3 |
| GND | 18 | 39 | GND |
| 2A4 | 19 | 38 | 2B4 |
| 2A5 | 20 | 37 | 2B5 |
| 2A6 | 21 | 36 | 2B6 |
| V_{CC} | 22 | 35 | V_{CC} |
| 2A7 | 23 | 34 | 2B7 |
| 2A8 | 24 | 33 | 2B8 |
| GND | 25 | 32 | GND |
| 2SAB | 26 | 31 | 2SBA |
| 2CLKAB | 27 | 30 | 2CLKBA |
| 2DIR | 28 | 29 | 2 \overline{OE} |



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

EPIC and Widebus are trademarks of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1998, Texas Instruments Incorporated

SN74LVCH16646A

16-BIT BUS TRANSCEIVER AND REGISTER

WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

description (continued)

When an output function is disabled, the input function is still 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 these devices as translators in a mixed 3.3-V/5-V system environment.

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 floating data inputs at a valid logic level.

The SN74LVCH16646A is characterized for operation from -40°C to 85°C .

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 always are enabled, i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

SN74LVCH16646A
16-BIT BUS TRANSCEIVER AND REGISTER
WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

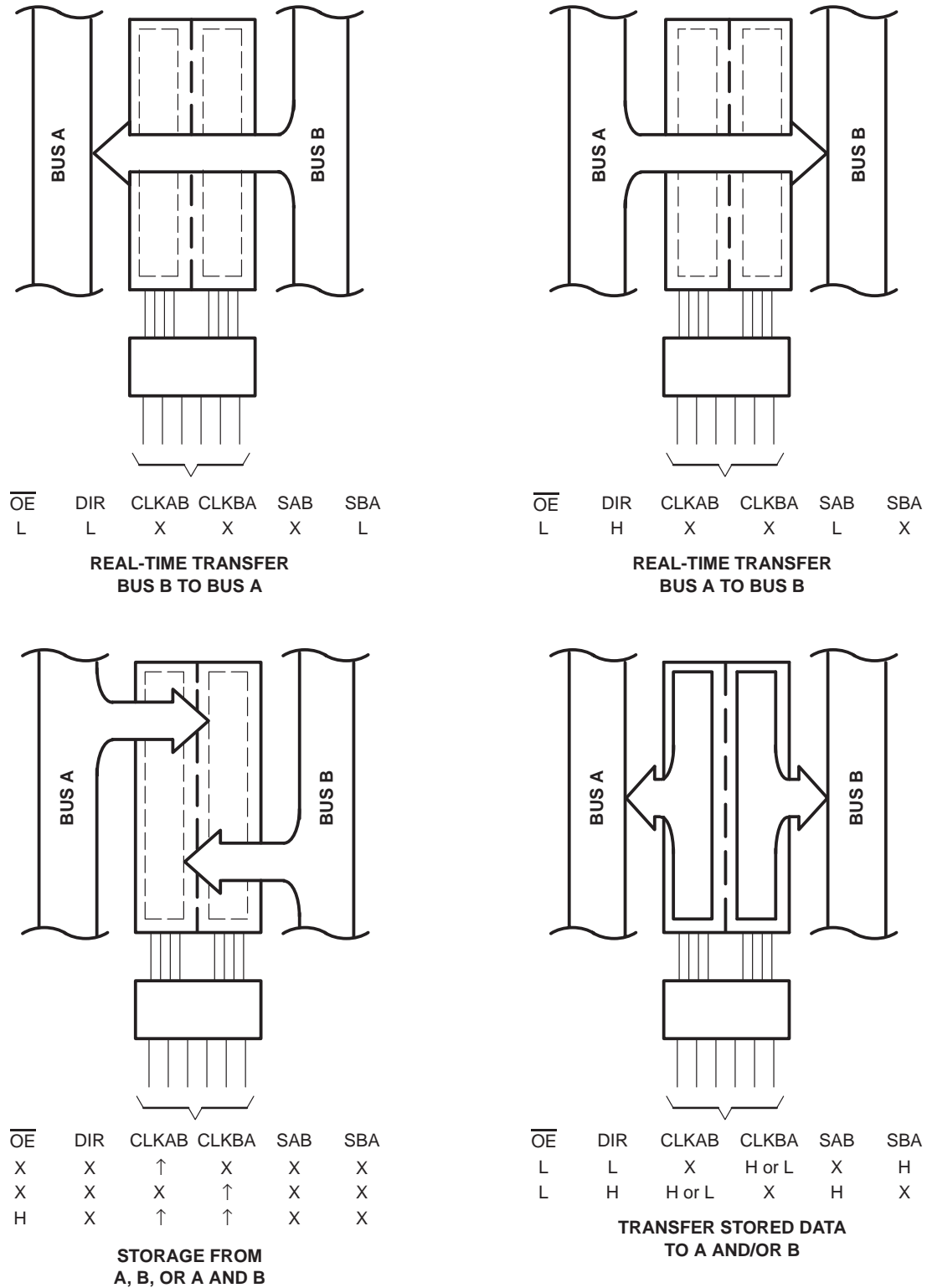


Figure 1. Bus-Management Functions

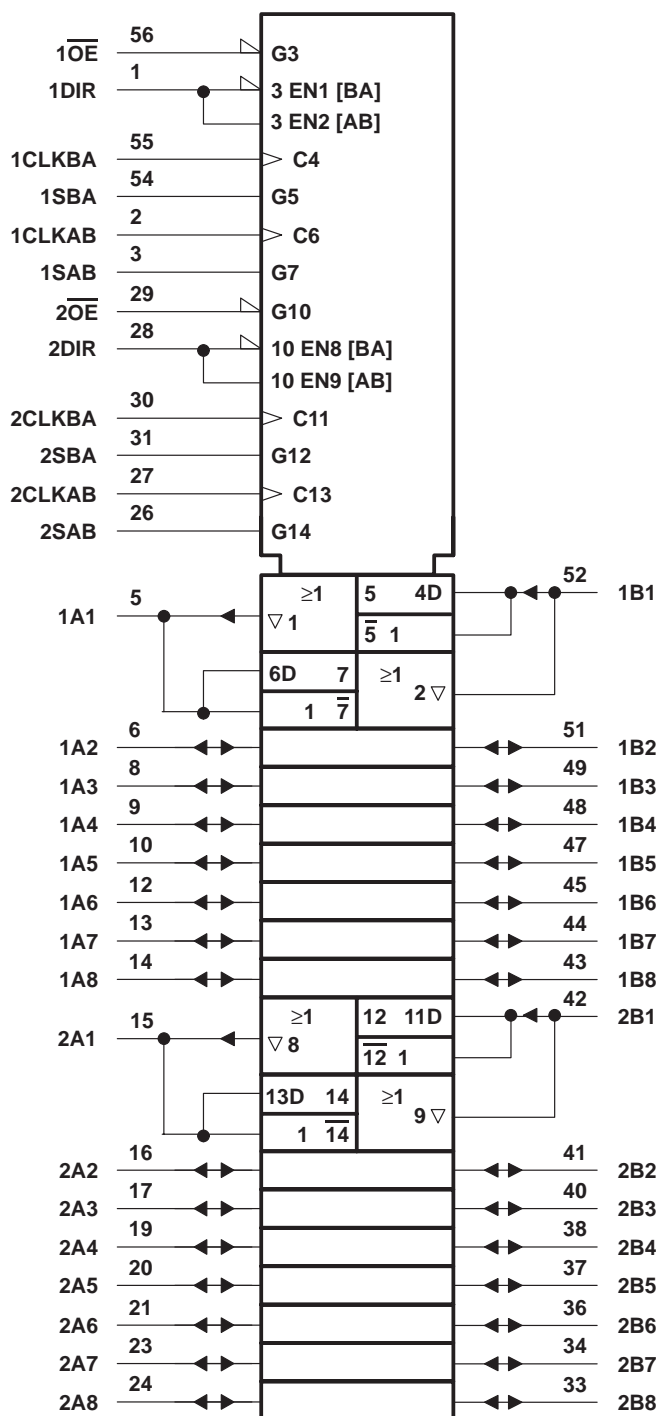
SN74LVCH16646A

16-BIT BUS TRANSCEIVER AND REGISTER

WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

logic symbol†

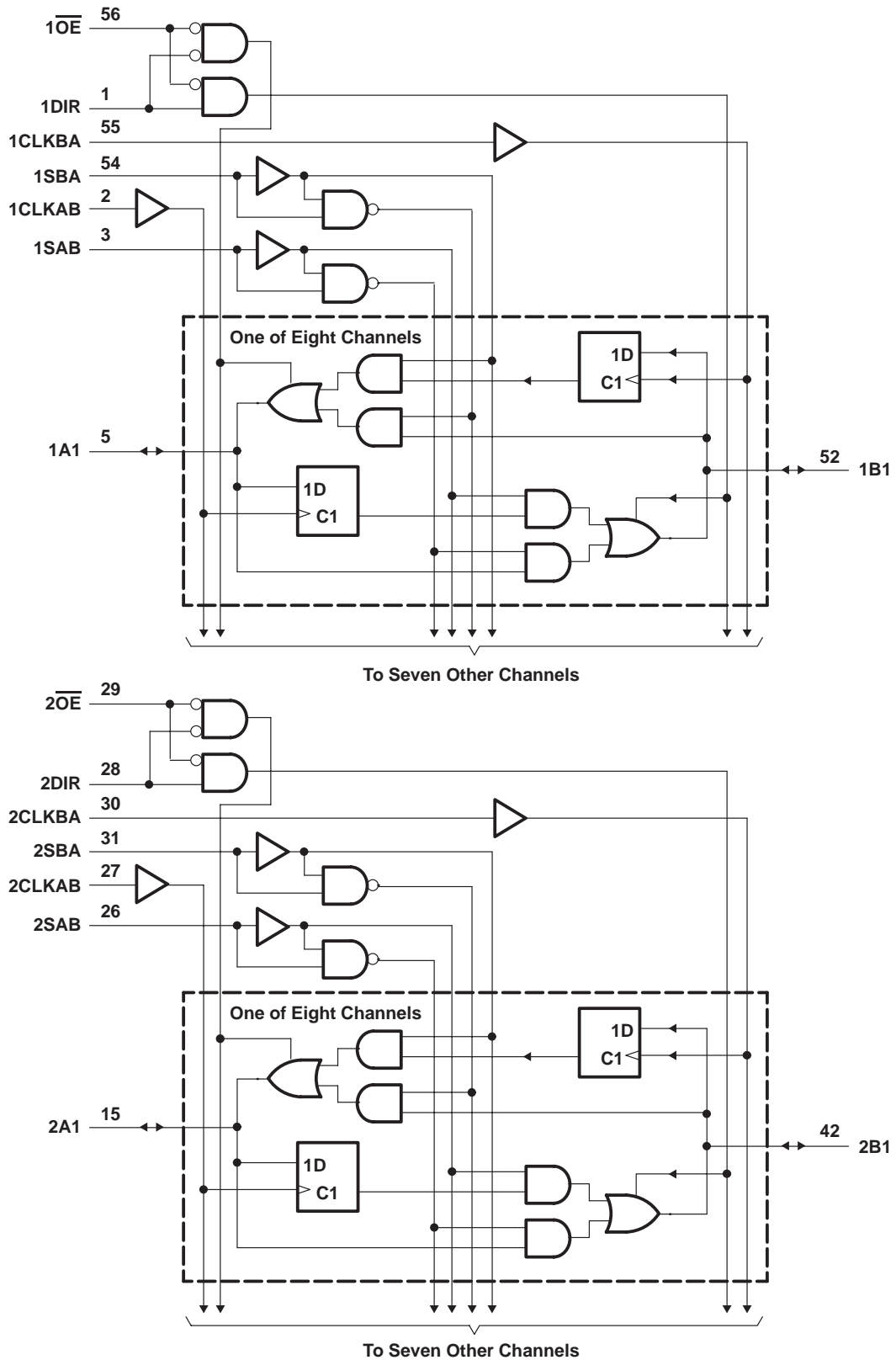


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

SN74LVCH16646A
16-BIT BUS TRANSCEIVER AND REGISTER
WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

logic diagram (positive logic)



SN74LVCH16646A

16-BIT BUS TRANSCEIVER AND REGISTER

WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

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

| | |
|---|----------------------------|
| Supply voltage range, V_{CC} | –0.5 V to 6.5 V |
| Input voltage range, V_I : (see Note 1) | –0.5 V to 6.5 V |
| Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1) | –0.5 V to 6.5 V |
| Voltage range applied to any output in the high or low state, V_O (see Notes 1 and 2) | –0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, I_{IK} ($V_I < 0$) | –50 mA |
| Output clamp current, I_{OK} ($V_O < 0$) | –50 mA |
| Continuous output current, I_O | ±50 mA |
| Continuous current through each V_{CC} or GND | ±100 mA |
| Package thermal impedance, θ_{JA} (see Note 3): DGG package | 81°C/W |
| DL package | 74°C/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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The value of V_{CC} is provided in the recommended operating conditions table.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

| | | MIN | MAX | UNIT |
|--|-----------------------------|----------------------|----------------------|------|
| V_{CC} Supply voltage | Operating | 1.65 | 3.6 | V |
| | Data retention only | 1.5 | | |
| V_{IH} High-level input voltage | $V_{CC} = 1.65$ V to 1.95 V | $0.65 \times V_{CC}$ | | V |
| | $V_{CC} = 2.3$ V to 2.7 V | 1.7 | | |
| | $V_{CC} = 2.7$ V to 3.6 V | 2 | | |
| V_{IL} Low-level input voltage | $V_{CC} = 1.65$ V to 1.95 V | | $0.35 \times V_{CC}$ | V |
| | $V_{CC} = 2.3$ V to 2.7 V | | 0.7 | |
| | $V_{CC} = 2.7$ V to 3.6 V | | 0.8 | |
| V_I Input voltage | | 0 | 5.5 | V |
| V_O Output voltage | High or low state | 0 | V_{CC} | V |
| | 3 state | 0 | 5.5 | |
| I_{OH} High-level output current | $V_{CC} = 1.65$ V | | –4 | mA |
| | $V_{CC} = 2.3$ V | | –8 | |
| | $V_{CC} = 2.7$ V | | –12 | |
| | $V_{CC} = 3$ V | | –24 | |
| I_{OL} Low-level output current | $V_{CC} = 1.65$ V | | 4 | mA |
| | $V_{CC} = 2.3$ V | | 8 | |
| | $V_{CC} = 2.7$ V | | 12 | |
| | $V_{CC} = 3$ V | | 24 | |
| $\Delta t/\Delta v$ Input transition rise or fall rate | | 0 | 10 | ns/V |
| T_A Operating free-air temperature | | –40 | 85 | °C |

NOTE 4: 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.



SN74LVCH16646A
16-BIT BUS TRANSCEIVER AND REGISTER
WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

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

| PARAMETER | | TEST CONDITIONS | V _{CC} | MIN | TYP† | MAX | UNIT |
|-----------------------|----------------|--|-----------------|-----------------------|------|------|------|
| V _{OH} | | I _{OH} = –100 µA | 1.65 V to 3.6 V | V _{CC} – 0.2 | | | V |
| | | I _{OH} = –4 mA | 1.65 V | 1.2 | | | |
| | | I _{OH} = –8 mA | 2.3 V | 1.7 | | | |
| | | I _{OH} = –12 mA | 2.7 V | 2.2 | | | |
| | | | 3 V | 2.4 | | | |
| | | I _{OH} = –24 mA | 3 V | 2.2 | | | |
| V _{OL} | | I _{OL} = 100 µA | 1.65 V to 3.6 V | | | 0.2 | V |
| | | I _{OL} = 4 mA | 1.65 V | | | 0.45 | |
| | | I _{OL} = 8 mA | 2.3 V | | | 0.7 | |
| | | I _{OL} = 12 mA | 2.7 V | | | 0.4 | |
| | | I _{OL} = 24 mA | 3 V | | | 0.55 | |
| I _I | Control inputs | V _I = 0 to 5.5 V | 3.6 V | | | ±5 | µA |
| I _I (hold) | A or B ports | V _I = 0.58 V | 1.65 V | ‡ | | | µA |
| | | V _I = 1.07 V | | ‡ | | | |
| | | V _I = 0.7 V | 2.3 V | 45 | | | |
| | | V _I = 1.7 V | | –45 | | | |
| | | V _I = 0.8 V | 3 V | 75 | | | |
| | | V _I = 2 V | | –75 | | | |
| | | V _I = 0 to 3.6 V§ | 3.6 V | | | ±500 | |
| I _{off} | | V _I or V _O = 5.5 V | 0 | | | ±10 | µA |
| I _{OZ} ¶ | | V _O = 0 to 5.5 V | 3.6 V | | | ±10 | µA |
| I _{CC} | | V _I = V _{CC} or GND | 3.6 V | | | 20 | µA |
| | | 3.6 V ≤ V _I ≤ 5.5 V# | | | | 20 | |
| ΔI _{CC} | | One input at V _{CC} – 0.6 V, Other inputs at V _{CC} or GND | 2.7 V to 3.6 V | | | 500 | µA |
| C _i | Control inputs | V _I = V _{CC} or GND | 3.3 V | | | 5 | pF |
| C _{io} | A or B ports | V _O = V _{CC} or GND | 3.3 V | | | 8.5 | pF |

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

‡ This information was not available at the time of publication.

§ This is the bus-hold maximum dynamic current required to switch the input from one state to another.

¶ For I/O ports, the parameter I_{OZ} includes the input leakage current, but not I_I(hold).

This applies in the disabled state only.

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figures 2 through 4)

| | | V _{CC} = 1.8 V ± 0.15 V | | V _{CC} = 2.5 V ± 0.2 V | | V _{CC} = 2.7 V | | V _{CC} = 3.3 V ± 0.3 V | | UNIT |
|--------------------|--|-------------------------------------|-----|------------------------------------|-----|-------------------------|-----|------------------------------------|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| f _{clock} | Clock frequency | ‡ | | ‡ | | 150 | | 150 | | MHz |
| t _w | Pulse duration, CLK high or low | ‡ | | ‡ | | 3.3 | | 3.3 | | ns |
| t _{su} | Setup time, A or B before CLKAB↑ or CLKBA↑ | ‡ | | ‡ | | 3.2 | | 2.9 | | ns |
| t _h | Hold time, A or B after CLKAB↑ or CLKBA↑ | ‡ | | ‡ | | 0 | | 0.3 | | ns |

‡ This information was not available at the time of publication.



SN74LVCH16646A

16-BIT BUS TRANSCEIVER AND REGISTER

WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 2 through 4)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 1.8\text{ V}$ $\pm 0.15\text{ V}$ | | $V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$ | | $V_{CC} = 2.7\text{ V}$ | | $V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$ | | UNIT |
|-----------|-----------------|----------------|--|-----|---|-----|-------------------------|-----|---|-----|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| f_{max} | | | † | | † | | 150 | | 150 | | MHz |
| t_{pd} | A or B | B or A | † | † | † | † | 6.8 | | 1.3 | 5.7 | ns |
| | CLKAB or CLKBA | | † | † | † | † | 7.9 | | 1.8 | 6.7 | |
| | SAB or SBA | A or B | † | † | † | † | 9.2 | | 1.7 | 7.7 | |
| t_{en} | \overline{OE} | A or B | † | † | † | † | 8.5 | | 1.3 | 6.9 | ns |
| t_{dis} | | | † | † | † | † | 7.7 | | 2.1 | 6.9 | |
| t_{en} | DIR | A or B | † | † | † | † | 8.5 | | 1.4 | 7.2 | ns |
| t_{dis} | | | † | † | † | † | 7.8 | | 2 | 7 | |

† This information was not available at the time of publication.

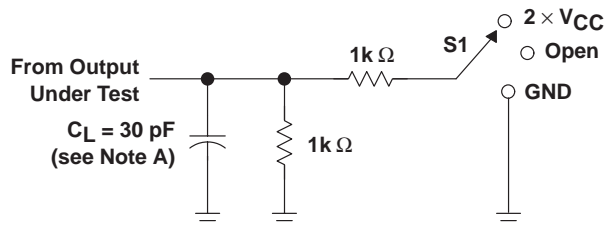
operating characteristics, $T_A = 25^\circ\text{C}$

| PARAMETER | | | TEST CONDITIONS | $V_{CC} = 1.8\text{ V}$ $\pm 0.15\text{ V}$ | $V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$ | $V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$ | UNIT |
|-----------|--|------------------|---------------------|--|---|---|------|
| | | | | TYP | TYP | TYP | |
| C_{pd} | Power dissipation capacitance per transceiver | Outputs enabled | $f = 10\text{ MHz}$ | † | † | 60 | pF |
| | | Outputs disabled | | † | † | 12 | |

† This information was not available at the time of publication.

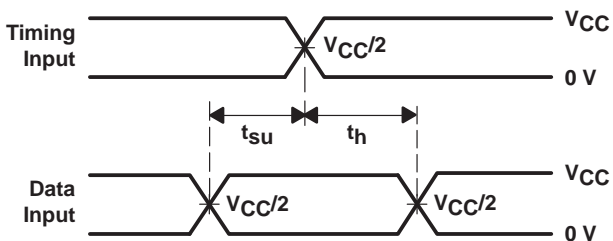
PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 1.8 \text{ V} \pm 0.15 \text{ V}$$

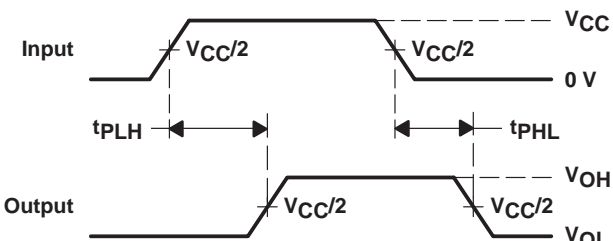


LOAD CIRCUIT

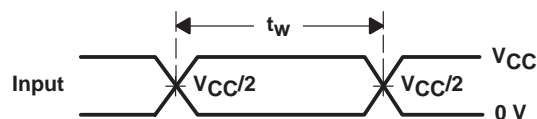
| TEST | S1 |
|-------------------|-------------------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | 2 $\times V_{CC}$ |
| t_{PHZ}/t_{PZH} | Open |



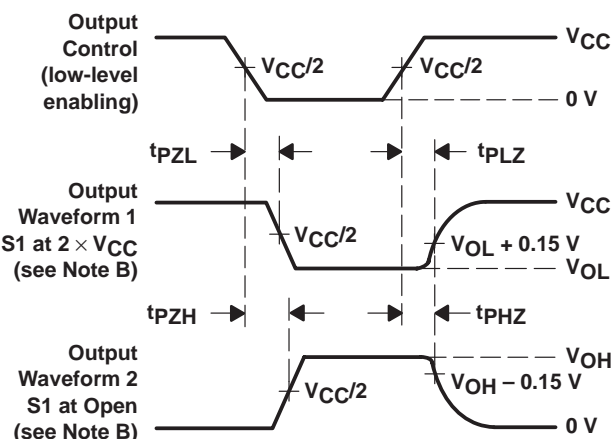
**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS
PULSE DURATION**



**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES**

- 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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2 \text{ ns}$, $t_f \leq 2 \text{ ns}$.
 - 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} .

Figure 2. Load Circuit and Voltage Waveforms

SN74LVCH16646A

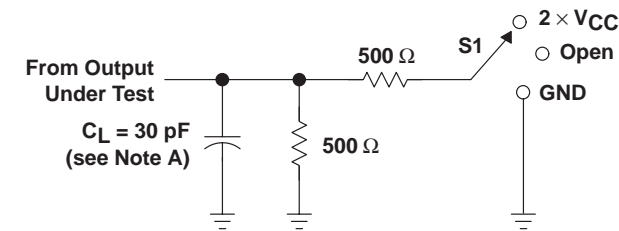
16-BIT BUS TRANSCEIVER AND REGISTER

WITH 3-STATE OUTPUTS

SCAS318H – NOVEMBER 1993 – REVISED JUNE 1998

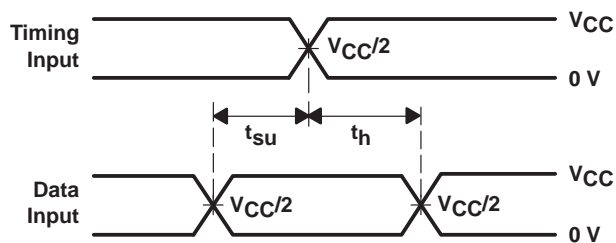
PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$$

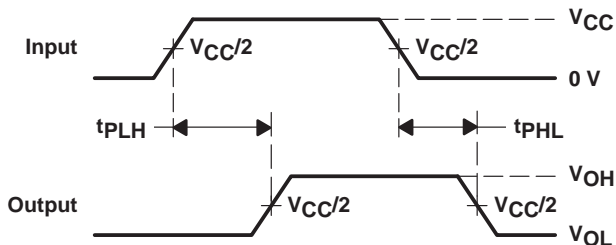


LOAD CIRCUIT

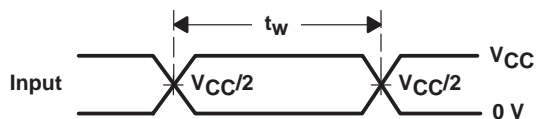
| TEST | S1 |
|-------------------|-------------------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | 2 $\times V_{CC}$ |
| t_{PHZ}/t_{PZH} | GND |



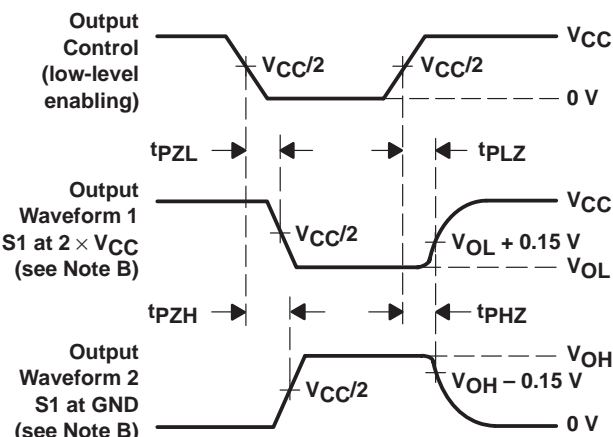
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



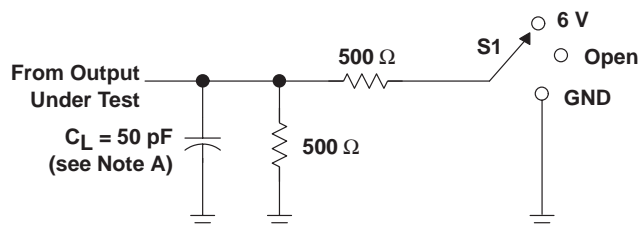
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2 \text{ ns}$, $t_f \leq 2 \text{ ns}$.
 - 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} .

Figure 3. Load Circuit and Voltage Waveforms

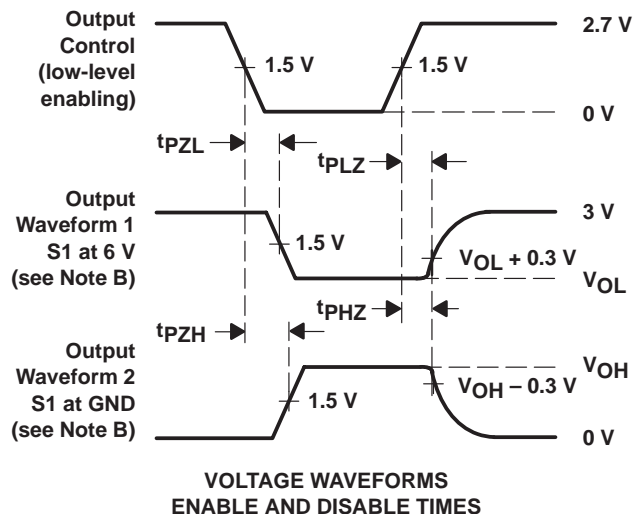
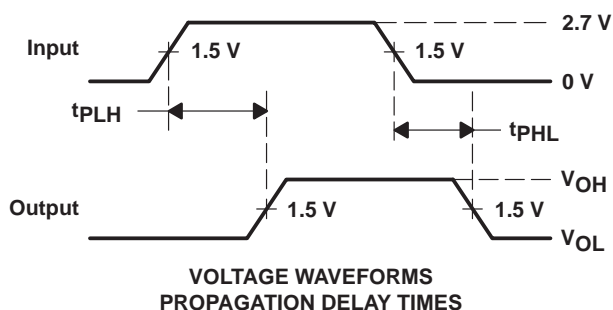
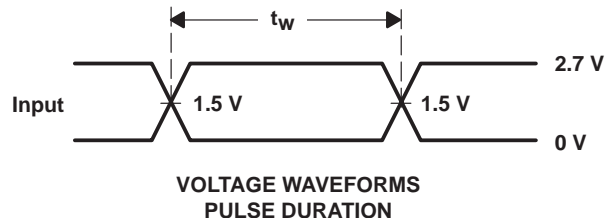
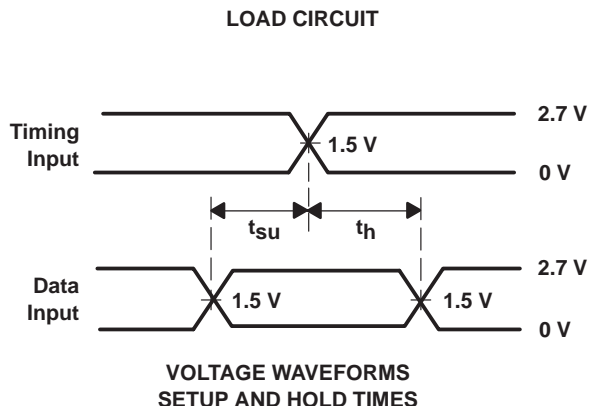
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 2.7\text{ V AND } 3.3\text{ V} \pm 0.3\text{ V}$



LOAD CIRCUIT

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



- NOTES:
- 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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\text{ }\Omega$, $t_r \leq 2.5\text{ ns}$, $t_f \leq 2.5\text{ ns}$.
 - 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} .

Figure 4. Load Circuit and Voltage Waveforms

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

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

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.