

DATA SHEET

74LVT646

**3.3V Octal bus transceiver/register
(3-State)**

Product specification
Supersedes data of 1994 May 20
IC23 Data Handbook

1998 Feb 19

3.3V Octal bus transceiver/register (3-State)

74LVT646

FEATURES

- Combines 74LVT245 and 74LVT574 type functions in one device
- Independent registers for A and B buses
- Multiplexed real-time and stored data
- Output capability: +64mA/–32mA
- TTL input and output switching levels
- Input and output interface capability to systems at 5V supply
- Bus-hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- No bus current loading when output is tied to 5V bus
- Latch-up protection exceeds 500mA per JEDEC Std 17
- Power-up 3-State
- Power-up reset
- ESD protection exceeds 2000V per MIL STD 883 Method 3015 and 200V per Machine Model

DESCRIPTION

The LVT646 is a high-performance BiCMOS product designed for V_{CC} operation at 3.3V.

This device consists 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 the internal registers.

Data on the A or B bus will be clocked into the registers as the appropriate clock pin goes High.

Output Enable (\overline{OE}) and DIR pins are provided to control the transceiver function. In the transceiver mode, data present at the high impedance port may be stored in either the A or B register or both.

The Select (SAB, SBA) pins determine whether data is stored or transferred through the device in real-time. The DIR determines which bus will receive data when the \overline{OE} is active (Low).

In the isolation mode ($\overline{OE} = \text{High}$), data from Bus A may be stored in the B register and/or data from Bus B may be stored in the A 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 examples on the next page demonstrate the four fundamental bus management functions that can be performed with the 74LVT646.

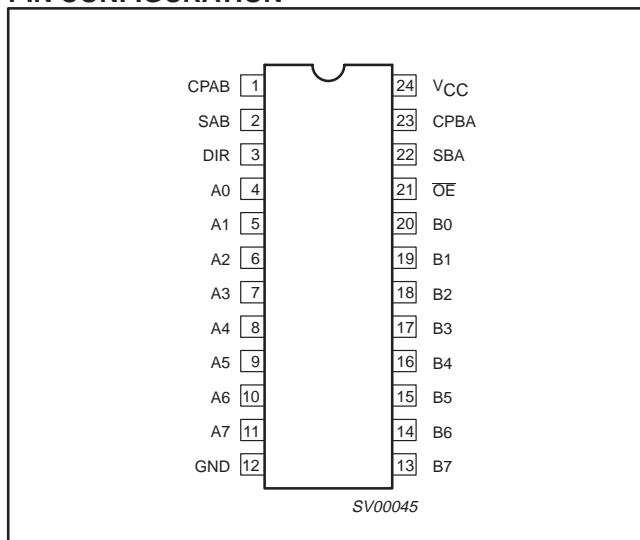
QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS $T_{amb} = 25^{\circ}\text{C}; \text{GND} = 0\text{V}$ | TYPICAL | UNIT |
|------------------------|---------------------------------------------------|----------------------------------------------------------------------|------------|------|
| t_{PLH} t_{PHL} | Propagation delay An to Bn or Bn to An | $C_L = 50\text{pF}; V_{CC} = 3.3\text{V}$ | 2.8 2.7 | ns |
| C_{IN} | Input capacitance CP, S, \overline{OE} , DIR | $V_{I/O} = 0\text{V}$ or 3.0V | 4 | pF |
| $C_{I/O}$ | I/O capacitance | Outputs disabled; $V_{I/O} = 0\text{V}$ or 3.0V | 10 | pF |
| I_{CCZ} | Total supply current | Outputs disabled; $V_{CC} = 3.6\text{V}$ | 0.13 | mA |

ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | OUTSIDE NORTH AMERICA | NORTH AMERICA | DWG NUMBER |
|-----------------------------|-------------------|-----------------------|---------------|------------|
| 24-Pin Plastic SOL | –40°C to +85°C | 74LVT646 D | 74LVT646 D | SOT163-1 |
| 24-Pin Plastic SSOP Type II | –40°C to +85°C | 74LVT646 DB | 74LVT646 DB | SOT399-1 |
| 24-Pin Plastic TSSOP Type I | –40°C to +85°C | 74LVT646 PW | 74LVT646PW DH | SOT360-1 |

PIN CONFIGURATION



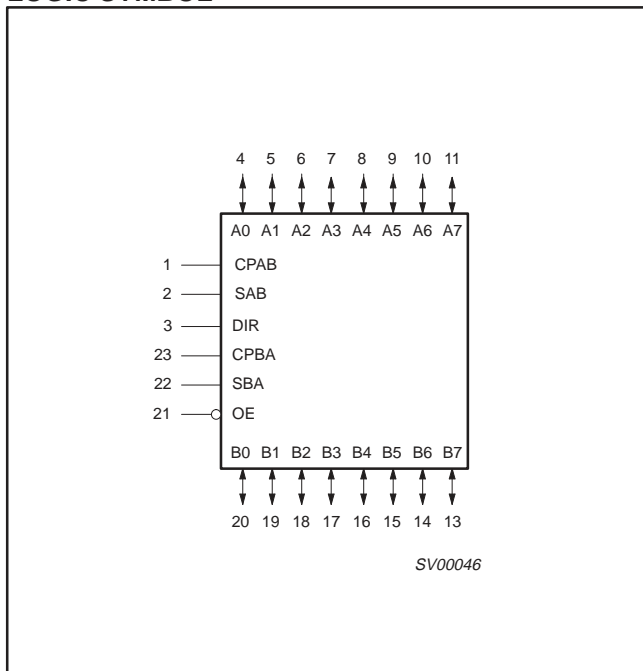
PIN DESCRIPTION

| PIN NUMBER | SYMBOL | FUNCTION |
|--------------------------------|-----------------|-------------------------------------------|
| 1, 23 | CPAB / CPBA | A to B clock input / B to A clock input |
| 2, 22 | SAB / SBA | A to B select input / B to A select input |
| 3 | DIR | Direction control input |
| 4, 5, 6, 7, 8, 9, 10, 11 | A0 – A7 | Data inputs/outputs (A side) |
| 20, 19, 18, 17, 16, 15, 14, 13 | B0 – B7 | Data inputs/outputs (B side) |
| 21 | \overline{OE} | Output enable input (active-low) |
| 12 | GND | Ground (0V) |
| 24 | V_{CC} | Positive supply voltage |

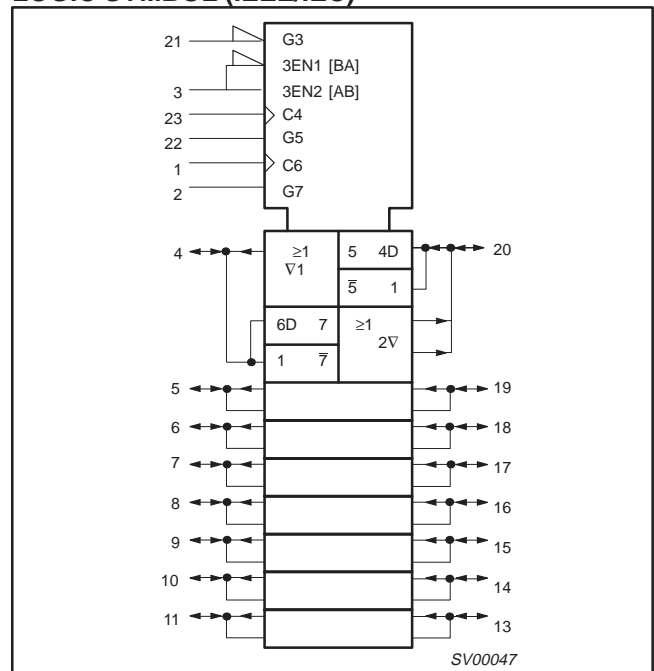
3.3V Octal bus transceiver/register (3-State)

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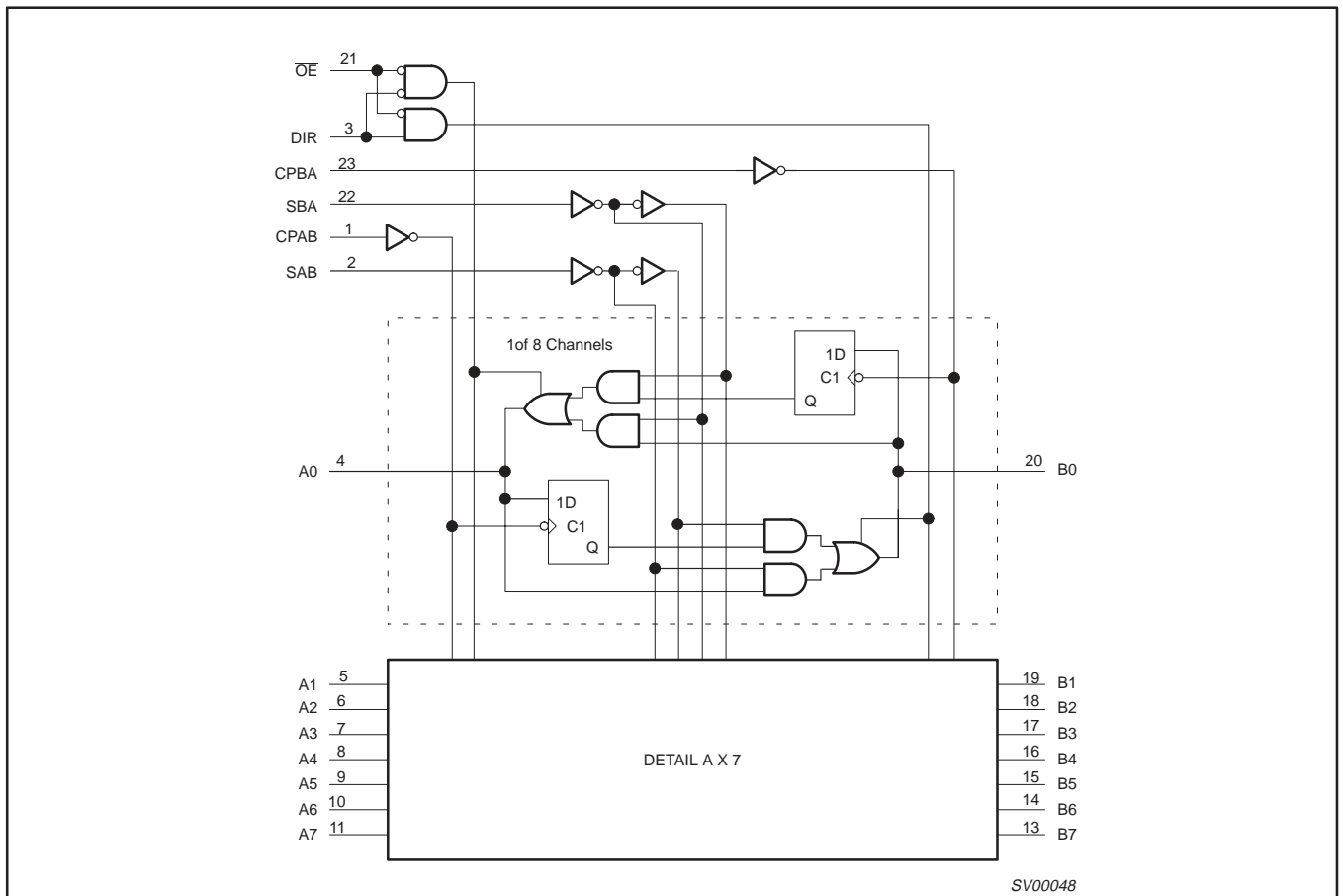
LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)

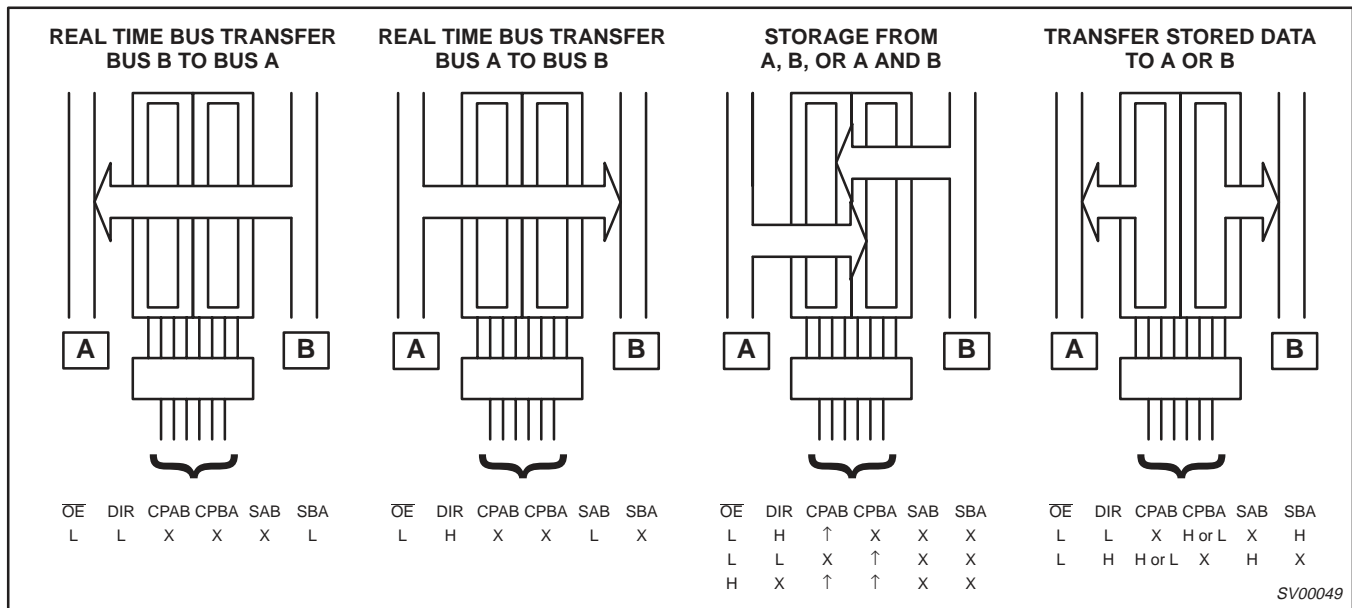


LOGIC DIAGRAM



3.3V Octal bus transceiver/register (3-State)

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FUNCTION TABLE

| INPUTS | | | | | | DATA I/O | | OPERATING MODE |
|--------|--------|-------------|-------------|--------|--------|---------------------|---------------------|-----------------------------------------------------|
| OE | DIR | CPAB | CPBA | SAB | SBA | An | Bn | |
| X | X | ↑ | X | X | X | Input | Unspecified output* | Store A, B unspecified |
| X | X | X | ↑ | X | X | Unspecified output* | Input | Store B, A unspecified |
| H H | X X | ↑ H or L | ↑ H or L | X X | X X | Input | Input | Store A and B data Isolation, hold storage |
| L L | L L | X X | X H or L | X X | L H | Output | Input | Real time B data to A bus Stored B data to A bus |
| L L | H H | X H or L | X X | L H | X X | Input | Output | Real time A data to B bus Stored A data to B bus |

H = High voltage level

L = Low voltage level

X = Don't care

↑ = Low-to-High clock transition

* The data output function may be enabled or disabled by various signals at the OE input. Data input functions are always enabled, i.e., data at the bus pins will be stored on every Low-to-High transition of the clock.

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ABSOLUTE MAXIMUM RATINGS^{1, 2}

| SYMBOL | PARAMETER | CONDITIONS | RATING | UNIT |
|------------------|--------------------------------|-----------------------------|--------------|------|
| V _{CC} | DC supply voltage | | -0.5 to +4.6 | V |
| I _{IK} | DC input diode current | V _I < 0 | -50 | mA |
| V _I | DC input voltage ³ | | -0.5 to +7.0 | V |
| I _{OK} | DC output diode current | V _O < 0 | -50 | mA |
| V _{OUT} | DC output voltage ³ | Output in Off or High state | -0.5 to +7.0 | V |
| I _{OUT} | DC output current | Output in Low state | 128 | mA |
| | | Output in High state | -64 | |
| T _{stg} | Storage temperature range | | -65 to 150 | °C |

NOTES:

1. Stresses beyond those listed 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 performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150°C.
3. The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.

RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | LIMITS | | UNIT |
|------------------|--------------------------------------------------------------|--------|-----|------|
| | | MIN | MAX | |
| V _{CC} | DC supply voltage | 2.7 | 3.6 | V |
| V _I | Input voltage | 0 | 5.5 | V |
| V _{IH} | High-level input voltage | 2.0 | | V |
| V _{IL} | Input voltage | | 0.8 | V |
| I _{OH} | High-level output current | | -32 | mA |
| I _{OL} | Low-level output current | | 32 | mA |
| | Low-level output current; current duty cycle ≤ 50%, f ≥ 1kHz | | 64 | |
| Δt/Δv | Input transition rise or fall rate; Outputs enabled | | 10 | ns/V |
| T _{amb} | Operating free-air temperature range | -40 | +85 | °C |

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DC ELECTRICAL CHARACTERISTICS

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|-----------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------|---------------|-----------|---------|
| | | | Temp = -40°C to +85°C | | | |
| | | | MIN | TYP NO TAG | MAX | |
| V_{IK} | Input clamp voltage | $V_{CC} = 2.7V; I_{IK} = -18mA$ | | -0.9 | -1.2 | V |
| V_{OH} | High-level output voltage | $V_{CC} = 2.7$ to $3.6V; I_{OH} = -100\mu A$ | $V_{CC}-0.2$ | $V_{CC}-0.1$ | | V |
| | | $V_{CC} = 2.7V; I_{OH} = -8mA$ | 2.4 | 2.5 | | |
| | | $V_{CC} = 3.0V; I_{OH} = -32mA$ | 2.0 | 2.2 | | |
| V_{OL} | Low-level output voltage | $V_{CC} = 2.7V; I_{OL} = 100\mu A$ | | 0.1 | 0.2 | V |
| | | $V_{CC} = 2.7V; I_{OL} = 24mA$ | | 0.3 | 0.5 | |
| | | $V_{CC} = 3.0V; I_{OL} = 16mA$ | | 0.25 | 0.4 | |
| | | $V_{CC} = 3.0V; I_{OL} = 32mA$ | | 0.3 | 0.5 | |
| | | $V_{CC} = 3.0V; I_{OL} = 64mA$ | | 0.4 | 0.55 | |
| V_{RST} | Power-up output low voltage ⁵ | $V_{CC} = 3.6V; I_O = 1mA; V_I = GND$ or V_{CC} | | 0.13 | 0.55 | V |
| I_I | Input leakage current | $V_{CC} = 3.6V; V_I = V_{CC}$ or GND | Control pins | ± 0.1 | ± 1 | μA |
| | | $V_{CC} = 0$ or $3.6V; V_I = 5.5V$ | | 1 | 10 | |
| | | $V_{CC} = 3.6V; V_I = 5.5V$ | I/O Data pins ⁴ | 1 | 20 | |
| | | $V_{CC} = 3.6V; V_I = V_{CC}$ | | 0.1 | 1 | |
| | | $V_{CC} = 3.6V; V_I = 0$ | | -1 | -5 | |
| I_{OFF} | Output off current | $V_{CC} = 0V; V_I$ or $V_O = 0$ to $4.5V$ | | 1 | ± 100 | μA |
| I_{HOLD} | Bus Hold current A inputs ⁶ | $V_{CC} = 3V; V_I = 0.8V$ | 75 | 150 | | μA |
| | | $V_{CC} = 3V; V_I = 2.0V$ | -75 | -150 | | |
| | | $V_{CC} = 0V$ to $3.6V; V_{CC} = 3.6V$ | ± 500 | | | |
| I_{EX} | Current into an output in the High state when $V_O > V_{CC}$ | $V_O = 5.5V; V_{CC} = 3.0V$ | | 60 | 125 | μA |
| $I_{PU/PD}$ | Power up/down 3-State output current ³ | $V_{CC} \leq 1.2V; V_O = 0.5V$ to $V_{CC}; V_I = GND$ or $V_{CC}; OE/OE = Don't$ care | | 15 | ± 100 | μA |
| I_{CCH} | Quiescent supply current | $V_{CC} = 3.6V; \text{Outputs High, } V_I = GND$ or $V_{CC}, I_O = 0$ | | 0.13 | 0.19 | mA |
| I_{CCL} | | $V_{CC} = 3.6V; \text{Outputs Low, } V_I = GND$ or $V_{CC}, I_O = 0$ | | 3 | 12 | |
| I_{CCZ} | | $V_{CC} = 3.6V; \text{Outputs Disabled; } V_I = GND$ or $V_{CC}, I_O = 0$ | | 0.13 | 0.19 | |
| ΔI_{CC} | Additional supply current per input pin ² | $V_{CC} = 3V$ to $3.6V; \text{One input at } V_{CC}-0.6V,$ Other inputs at V_{CC} or GND | | 0.1 | 0.2 | mA |

NOTES:

- All typical values are at and $T_{amb} = 25^\circ C$.
- This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND
- This parameter is valid for any V_{CC} between 0V and 1.2V with a transition time of up to 10msec. From $V_{CC} = 1.2V$ to $V_{CC} = 3.3V \pm 0.3V$ a transition time of 100 μ sec is permitted. This parameter is valid for $T_{amb} = 25^\circ C$ only.
- Unused pins at V_{CC} or GND.
- For valid test results, data must not be loaded into the flip-flops (or latches) after applying power.
- This is the bus hold overdrive current required to force the input to the opposite logic state.

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AC CHARACTERISTICSGND = 0V, $t_R = t_F = 2.5\text{ns}$, $C_L = 50\text{pF}$, $R_L = 500\Omega$; $T_{\text{amb}} = -40^\circ\text{C}$ to $+85^\circ\text{C}$.

| SYMBOL | PARAMETER | WAVEFORM | LIMITS | | | | UNIT |
|--------------------------------------|-----------------------------------------------|----------|--------------------------|------------------|-----------------|------------|------|
| | | | $V_{CC} = 3.3V \pm 0.3V$ | | $V_{CC} = 2.7V$ | | |
| | | | MIN | TYP ¹ | MAX | MAX | |
| f_{MAX} | Maximum clock frequency | 1 | 150 | 180 | | | MHz |
| t_{PLH} t_{PHL} | Propagation delay CPAB to Bn or CPBA to An | 1 | 1.8 2.1 | 3.8 3.8 | 5.7 5.7 | 6.7 6.4 | ns |
| t_{PLH} t_{PHL} | Propagation delay An to Bn or Bn to An | 2 | 1.3 1.0 | 2.8 2.7 | 4.7 4.6 | 5.4 5.3 | ns |
| t_{PLH} t_{PHL} | Propagation delay SAB to Bn or SBA to An | 2 3 | 1.4 1.4 | 3.7 3.8 | 6.2 6.2 | 7.2 6.8 | ns |
| t_{PZH} t_{PZL} | Output enable time OE to An or Bn | 5 6 | 1.0 1.0 | 4.0 4.1 | 5.8 6.0 | 7.2 7.3 | ns |
| t_{PHZ} t_{PLZ} | Output disable time OE to An or Bn | 5 6 | 2.3 2.2 | 4.3 3.8 | 6.5 5.8 | 6.9 5.9 | ns |
| t_{PZH} t_{PZL} | Output enable time DIR to An or Bn | 5 6 | 1.0 1.2 | 3.4 3.4 | 6.5 6.3 | 7.5 7.1 | ns |
| t_{PHZ} t_{PLZ} | Output disable time DIR to An or Bn | 5 6 | 1.7 1.5 | 4.1 3.5 | 7.2 5.8 | 8.1 6.3 | ns |

NOTE:1. All typical values are at $V_{CC} = 3.3V$ and $T_{\text{amb}} = 25^\circ\text{C}$.**AC SETUP REQUIREMENTS**GND = 0V, $t_R = 2.5\text{ns}$, $t_F = 2.5\text{ns}$, $C_L = 50\text{pF}$, $R_L = 500\Omega$; $T_{\text{amb}} = -40^\circ\text{C}$ to $+85^\circ\text{C}$

| SYMBOL | PARAMETER | WAVEFORM | LIMITS | | | | UNIT |
|------------------------------------|---------------------------------------------------|----------|--------------------------|--------------|-----------------|--|------|
| | | | $V_{CC} = 3.3V \pm 0.3V$ | | $V_{CC} = 2.7V$ | | |
| | | | Min | Typ | Min | | |
| $t_s(\text{H})$ $t_s(\text{L})$ | Setup time ¹ An to CPAB, Bn to CPBA | 4 | 1.5 2.0 | 1.0 1.0 | 1.6 2.4 | | ns |
| $t_h(\text{H})$ $t_h(\text{L})$ | Hold time ¹ An to CPAB, Bn to CPBA | 4 | 0.0 0.0 | -1.0 -1.0 | 0.0 0.0 | | ns |
| $t_w(\text{H})$ $t_w(\text{L})$ | Pulse width, High or Low CPAB or CPBA | 1 | 3.3 3.3 | 1.0 2.0 | 3.3 3.3 | | ns |

NOTE:

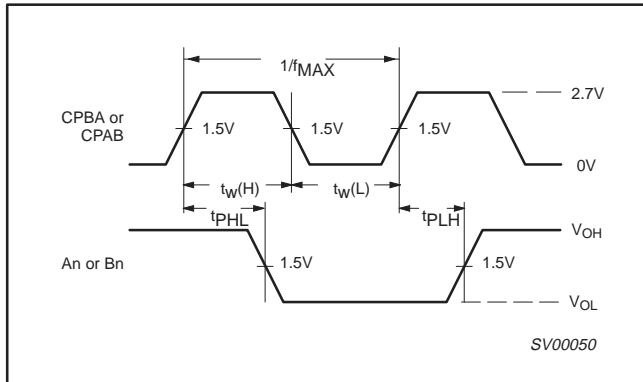
1. This data sheet limit may vary among suppliers.

3.3V Octal bus transceiver/register (3-State)

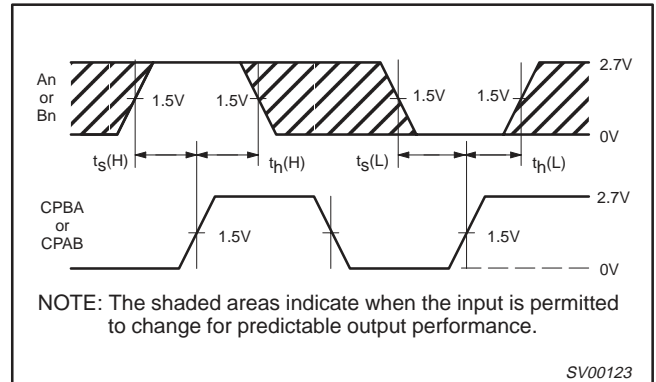
74LVT646

AC WAVEFORMS

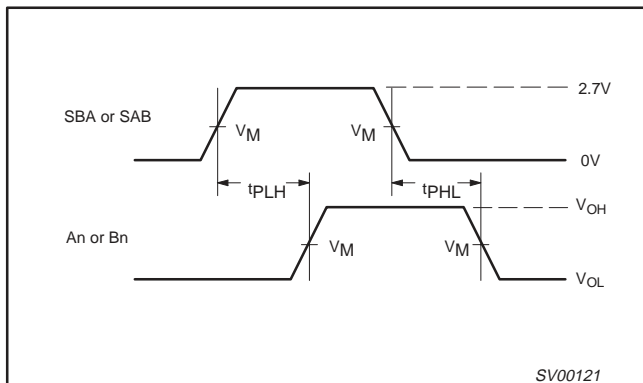
$V_M = 1.5V$, $V_{IN} = GND$ to $2.7V$



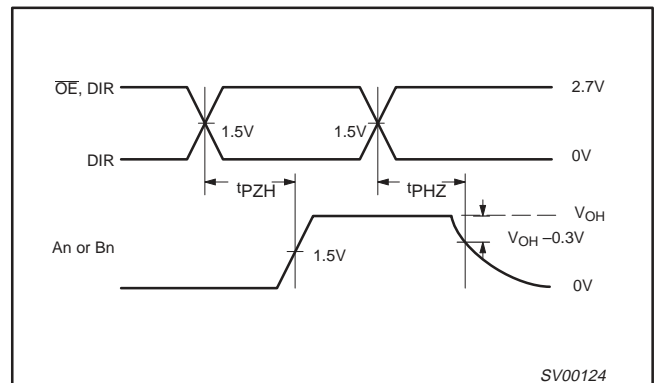
Waveform 1. Propagation Delay, Clock Input to Output, Clock Pulse Width, and Maximum Clock Frequency



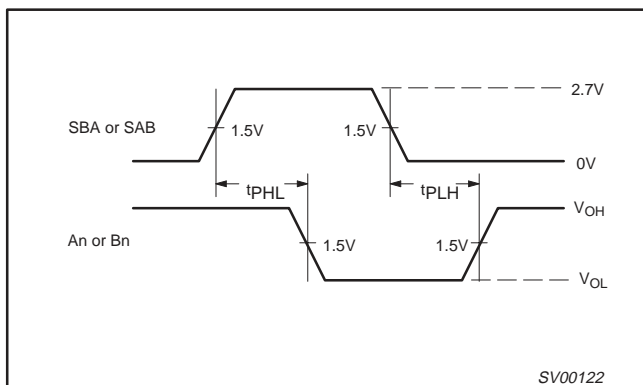
Waveform 4. Data Setup and Hold Times



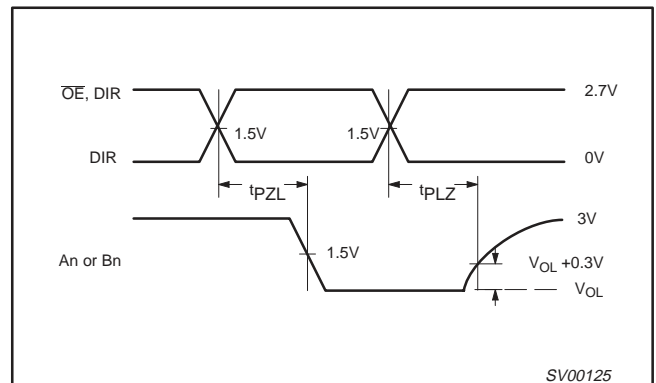
Waveform 2. Propagation Delay, SAB to Bn or SBA to An, An to Bn or Bn to An



Waveform 5. 3-State Output Enable Time to High Level and Output Disable Time from High Level



Waveform 3. Propagation Delay, SBA to An or SAB to Bn



Waveform 6. 3-State Output Enable Time to Low Level and Output Disable Time from Low Level

3.3V Octal bus transceiver/register (3-State)

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TEST CIRCUIT AND WAVEFORM

Test Circuit for 3-State Outputs

$V_M = 1.5V$
Input Pulse Definition

SWITCH POSITION

| TEST | SWITCH |
|-------------------|--------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | 6V |
| t_{PHZ}/t_{PZH} | GND |

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance; see AC CHARACTERISTICS for value.

R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

| FAMILY | INPUT PULSE REQUIREMENTS | | | | |
|--------|--------------------------|---------------------|-------|---------------------|---------------------|
| | Amplitude | Rep. Rate | t_w | t_R | t_F |
| 74LVT | 2.7V | $\leq 10\text{MHz}$ | 500ns | $\leq 2.5\text{ns}$ | $\leq 2.5\text{ns}$ |

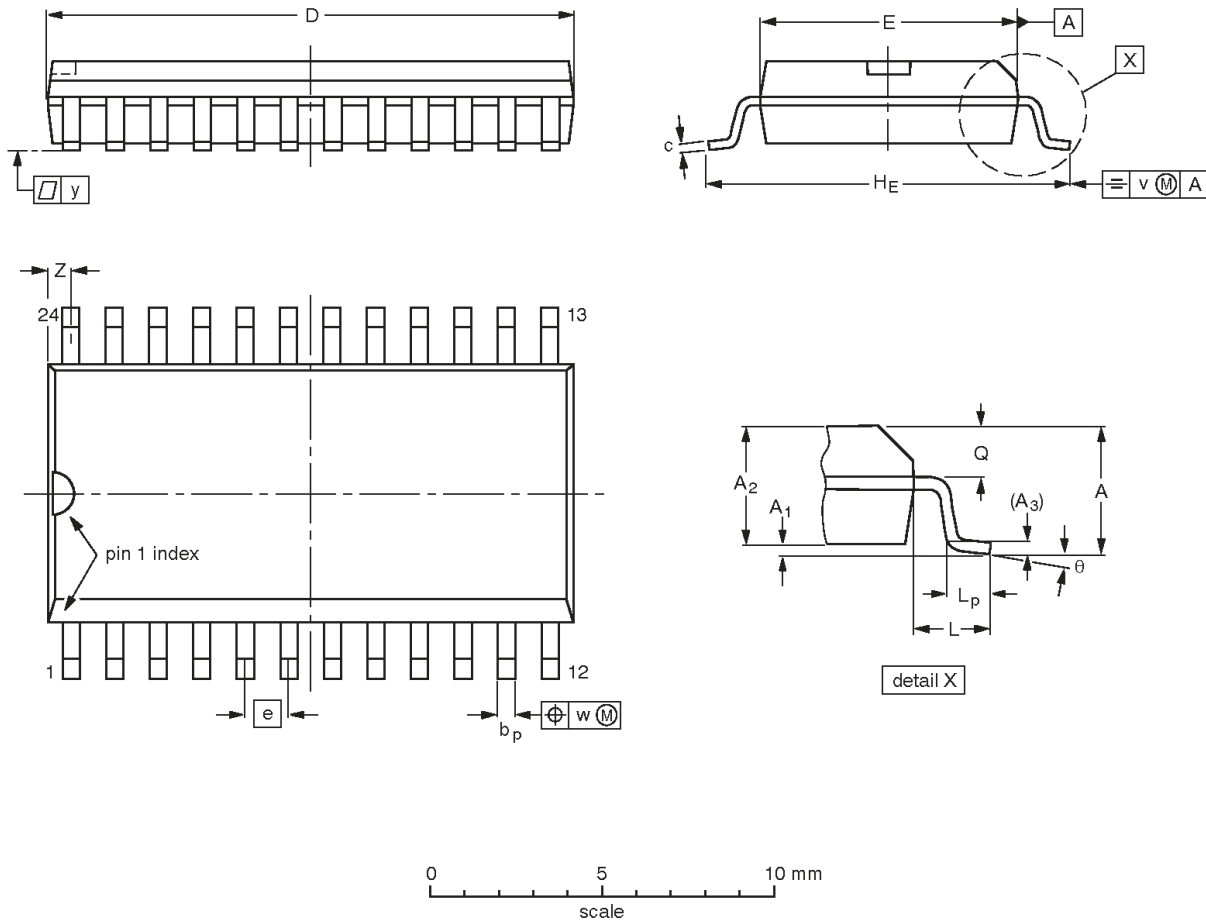
SV00092

3.3V Octal bus transceiver/register (3-State)

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SO24: plastic small outline package; 24 leads; body width 7.5 mm

SOT137-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | z ⁽¹⁾ | θ |
|--------|--------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm | 2.65 | 0.30 0.10 | 2.45 2.25 | 0.25 | 0.49 0.36 | 0.32 0.23 | 15.6 15.2 | 7.6 7.4 | 1.27 | 10.65 10.00 | 1.4 | 1.1 0.4 | 1.1 1.0 | 0.25 | 0.25 | 0.1 | 0.9 0.4 | 8° 0° |
| inches | 0.10 | 0.012 0.004 | 0.096 0.089 | 0.01 | 0.019 0.014 | 0.013 0.009 | 0.61 0.60 | 0.30 0.29 | 0.050 | 0.419 0.394 | 0.055 | 0.043 0.016 | 0.043 0.039 | 0.01 | 0.01 | 0.004 | 0.035 0.016 | |

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

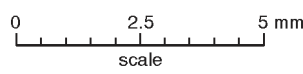
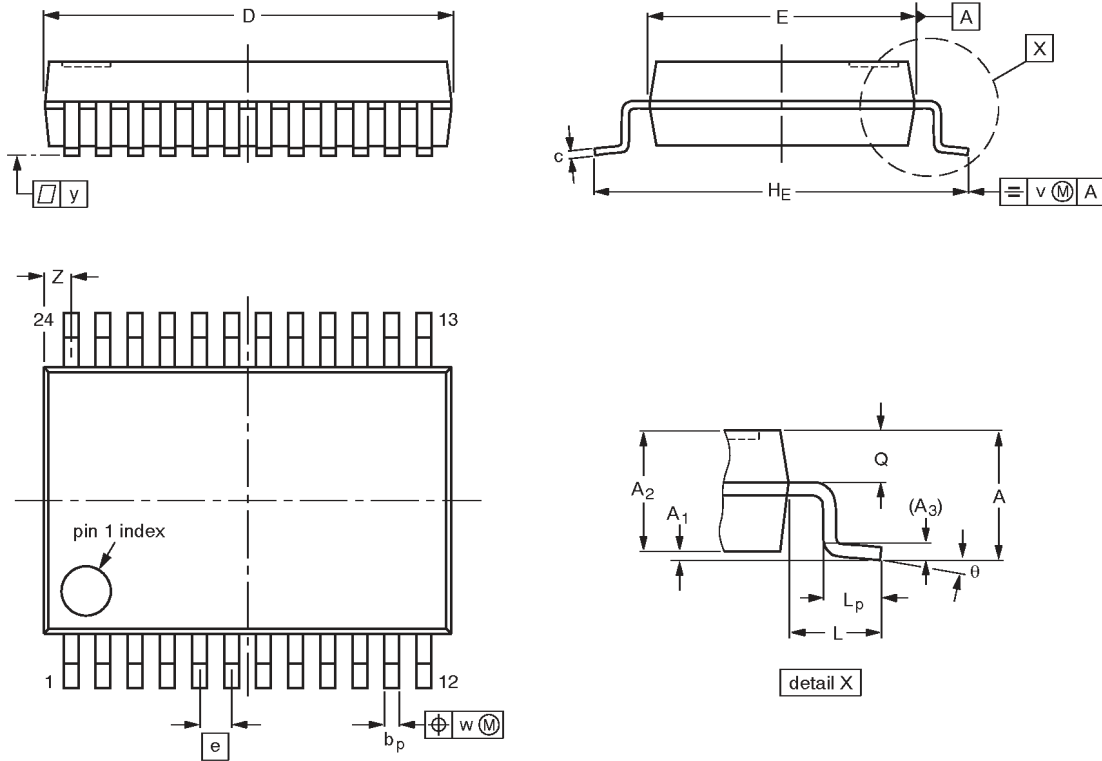
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT137-1 | 075E05 | MS-013AD | | | | 95-01-24 97-05-22 |

3.3V Octal bus transceiver/register (3-State)

74LVT646

SSOP24: plastic shrink small outline package; 24 leads; body width 5.3 mm

SOT340-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | Z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm | 2.0 | 0.21 0.05 | 1.80 1.65 | 0.25 | 0.38 0.25 | 0.20 0.09 | 8.4 8.0 | 5.4 5.2 | 0.65 | 7.9 7.6 | 1.25 | 1.03 0.63 | 0.9 0.7 | 0.2 | 0.13 | 0.1 | 0.8 0.4 | 8° 0° |

Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

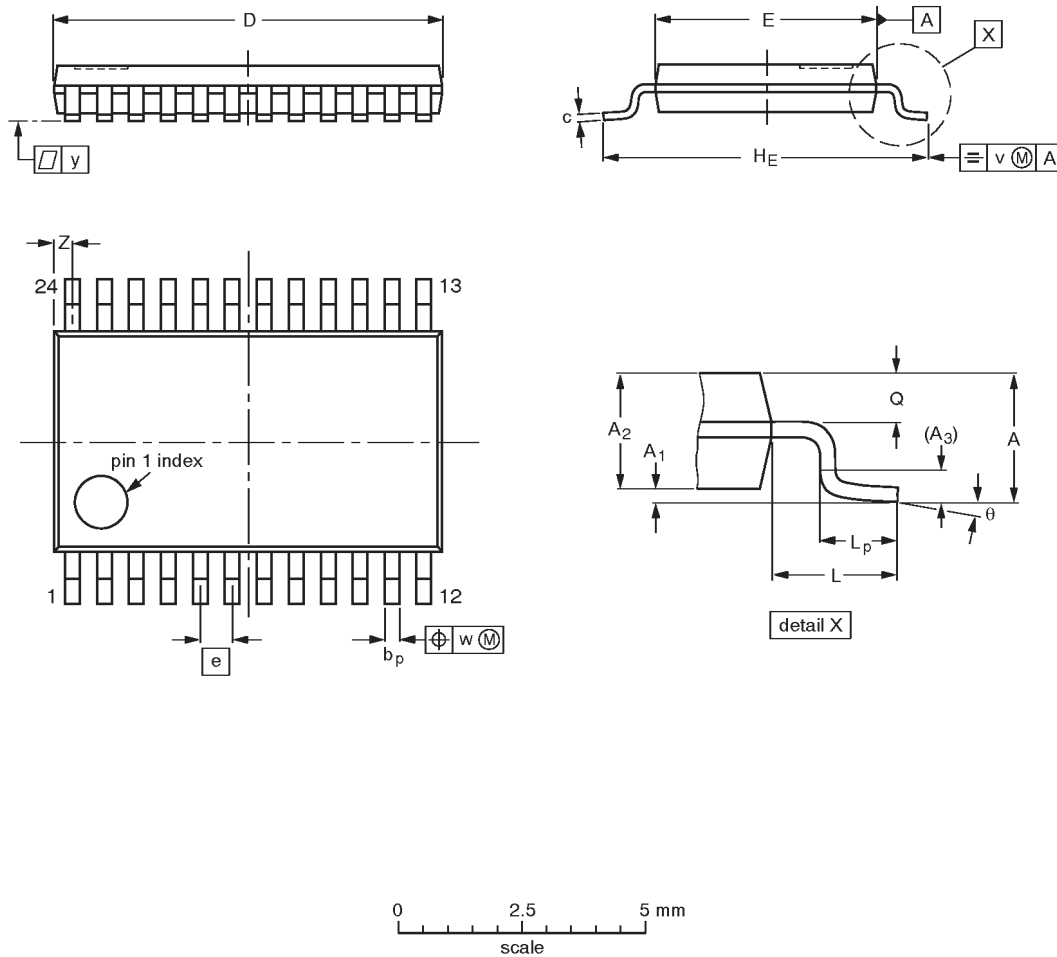
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT340-1 | | MO-150AG | | | | 93-09-08 95-02-04 |

3.3V Octal bus transceiver/register (3-State)

74LVT646

TSSOP24: plastic thin shrink small outline package; 24 leads; body width 4.4 mm

SOT355-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽²⁾ | e | H _E | L | L _p | Q | v | w | y | z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|------------|------------------|------------------|------|----------------|-----|----------------|------------|-----|------|-----|------------------|----------|
| mm | 1.10 | 0.15 0.05 | 0.95 0.80 | 0.25 | 0.30 0.19 | 0.2 0.1 | 7.9 7.7 | 4.5 4.3 | 0.65 | 6.6 6.2 | 1.0 | 0.75 0.50 | 0.4 0.3 | 0.2 | 0.13 | 0.1 | 0.5 0.2 | 8° 0° |

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT355-1 | | MO-153AD | | | | 93-06-16 95-02-04 |

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NOTES

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Data sheet status

| Data sheet status | Product status | Definition [1] |
|---------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Objective specification | Development | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice. |
| Preliminary specification | Qualification | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification | Production | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |

[1] Please consult the most recently issued datasheet before initiating or completing a design.

Definitions

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