

16-Bit 1.8-2.5V to 3.3V Level Shifting Transceiver with 3-State Outputs

Product Features

- PI74AVC164245 is designed for low voltage operation: 1.8V-2.5V to 3.3V
- Industrial operation at -40°C to $+85^{\circ}\text{C}$
- Packages available:
 - 48-pin plastic 300 mil SSOP (V)
 - 48-pin plastic 240 mil TSSOP (A)
 - 48-pin plastic 173 mil TVSOP (K)

Product Description

Pericom Semiconductor's AVC series of logic circuits are produced using the Company's advanced 0.35 micron CMOS technology, achieving industry leading performance.

Pericom Semiconductor's PI74AVC164245, a 16-bit (dual-octal) noninverting bus transceiver, contains two separate supply rails: B port (V_{CCB}), set at 3.3V, and A port (V_{CCA}), set to operate at 1.8-2.5V. This arrangement permits translation from a 1.8-2.5V to 3.3V environment and vice versa.

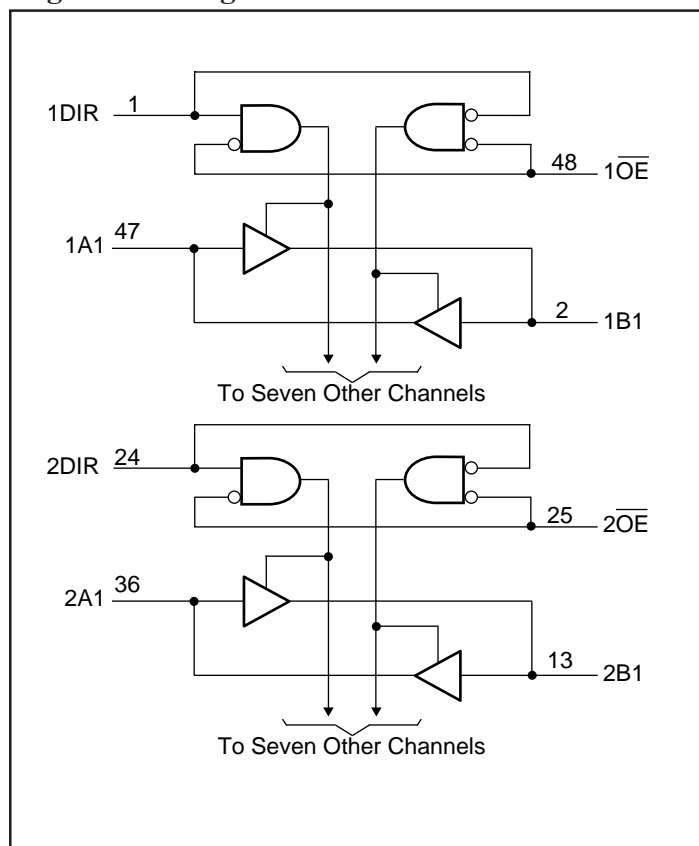
The PI74AVC164245 is designed for asynchronous communication between data buses.

To ensure the high impedance state during power up or power down, the output-enable (OE) input 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.

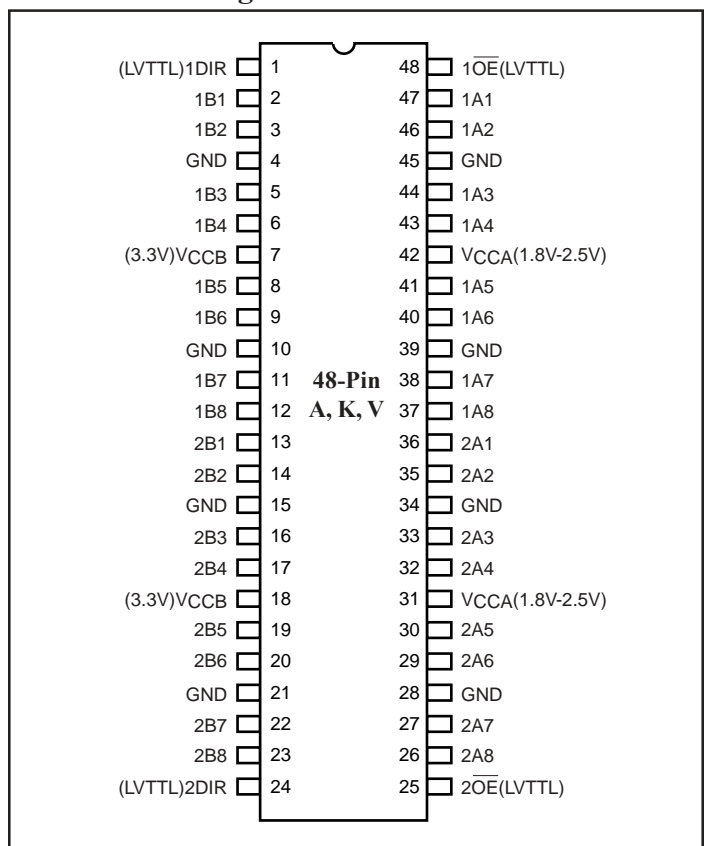
Truth Table (each 8-bit section)

| Inputs | | Operation |
|------------------------|-----|-----------------|
| $\overline{\text{OE}}$ | DIR | |
| L | L | B data to A bus |
| L | H | A data to B bus |
| H | X | Isolation |

Logic Block Diagram



Product Pin Configuration



Maximum Ratings

(Absolute maximum ratings over operating free-air temperature range from V_{CCB} at 3.3V & V_{CCA} at 1.5 - 2.5V, unless otherwise noted)

| | | | |
|--|--------------------------------|---|--------------------|
| Supply voltage range: V_{CCA} | -0.5V to 3.8V | Continuous output current, I_O | $\pm 50\text{mA}$ |
| V_{CCB} | -0.5V to 4.6V | Continuous current through each V_{CC} or GND | $\pm 100\text{mA}$ |
| Input Voltage Range, V_I Except I/O ports ⁽¹⁾ | -0.5V to 4.6V | Package thermal impedance, θ_{JA} ⁽³⁾ : A package | 89°C/W |
| I/O port A ⁽²⁾ ... | -0.5V to $V_{CCA}+0.5\text{V}$ | K package | 58°C/W |
| I/O port B ⁽¹⁾ | -0.5V to $V_{CCB}+0.5\text{V}$ | V package | 94°C/W |
| Input clamp current, I_{IK} ($V_I < 0$) | -50mA | Storage temperature range, T_{STG} | -65°C to 150°C |
| Output clamp current, I_{OK} ($V_O < 0$) | -50mA | | |

Note:

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Operating Conditions for V_{CCB} at 3.3V⁽⁴⁾

| | | Min. | Max. | Units |
|---------------------|------------------------------------|------|-----------|-------|
| V_{CCB} | Supply voltage | 3.0 | 3.6 | V |
| V_{IH} | High-level voltage | 2 | | |
| V_{IL} | Low-level voltage | | 0.8 | |
| V_{IB} | Input Voltage | 0 | V_{CCB} | |
| V_{OB} | Output Voltage | 0 | V_{CCB} | |
| I_{OH} | High-level output current | | -12 | mA |
| I_{OL} | Low-level output current | | 12 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | | 10 | ns/V |
| T_A | Operating free-air temperature | -40 | 85 | °C |

Notes:

1. This value is limited to 4.6V maximum.
2. This value is limited to 3.8V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.
4. To ensure proper device operation, all unused device inputs must be held at the associated V_{CC} or GND.

Recommended Operating Conditions for V_{CCA} at 2.5V⁽⁴⁾

| | | Min. | Max. | Units |
|---------------------|------------------------------------|---|-----------|-------|
| V_{CCA} | Supply voltage | 2.3 | 2.7 | V |
| V_{IH} | High-level voltage | $V_{CCA} = 2.3\text{V to } 2.7\text{V}$ | 1.7 | |
| V_{IL} | Low-level voltage | $V_{CCA} = 2.3\text{V to } 2.7\text{V}$ | 0.7 | |
| V_{IA} | Input voltage | 0 | V_{CCA} | |
| V_{OA} | Output voltage | 0 | V_{CCA} | |
| I_{OH} | High-level output current | $V_{CCA} = 2.3\text{V}$ | -8 | mA |
| | | $V_{CCA} = 2.7\text{V}$ | -12 | |
| I_{OL} | Low-level output current | $V_{CCA} = 2.3\text{V}$ | 8 | |
| | | $V_{CCA} = 2.7\text{V}$ | 12 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | | 10 | ns/V |
| T_A | Operating free-air temperature | -40 | 85 | °C |

Recommended Operating Conditions for V_{CCA} at 1.8V⁽⁴⁾

| | | Min. | Max. | Units |
|---------------------|------------------------------------|------------------------------|-----------------------|-------|
| V_{CCA} | Supply voltage | 1.65 | 1.95 | V |
| V_{IH} | High-level voltage | $V_{CCA} = 1.65V$ to $1.95V$ | $0.65 \times V_{CCA}$ | |
| V_{IL} | Low-level voltage | $V_{CCA} = 1.65V$ to $1.95V$ | $0.35 \times V_{CCA}$ | |
| V_{IB} | Input voltage | 0 | V_{CCA} | |
| V_{OA} | Output voltage | 0 | V_{CCA} | |
| I_{OH} | High-level output current | $V_{CCA} = 1.65V$ | -4 | mA |
| | | $V_{CCA} = 1.95V$ | -8 | |
| I_{OL} | Low-level output current | $V_{CCA} = 1.65V$ | 4 | |
| | | $V_{CCA} = 1.95V$ | 8 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | | 10 | ns/V |
| T_A | Operating free-air temperature | -40 | 85 | °C |

Notes:

1. Value limited to 4.6V maximum.
2. Value limited to 3.8V maximum.
3. Package thermal impedance is calculated in accordance with JESD 51.
4. To ensure proper device operation, all unused device inputs must be held at the associated V_{CC} or GND.

Electrical Characteristics (V_{CCB}) (Over recommended operating free-air temperature range for $V_{CCB} = 3.3V$)

| Parameters | | Test Conditions | V_{CCB} | Min. | Typ. [†] | Max. | Units |
|---------------------|----------------------|--|--------------|------|-------------------|------|-------|
| V_{OH} (A to B) | $I_{OH} = -100\mu A$ | | 3.0V | 2.8 | | | V |
| | | | 3.6V | 3.4 | | | |
| | $I_{OH} = -12mA$ | | 3.0V | 2.2 | | | |
| | | | 3.6V | 2.8 | | | |
| V_{OL} (A to B) | $I_{OL} = 100\mu A$ | | 3.0V | | | 0.2 | V |
| | | | 3.6V | | | 0.2 | |
| | $I_{OL} = 12mA$ | | 3.0V | | | 0.5 | |
| | | | 3.6V | | | 0.5 | |
| I_I | Control Inputs | $V_I = V_{CCB}$ or GND | 3.6V | | | ±5 | μA |
| I_{OZ}^{\ddagger} | A or B ports | $V_O = V_{CCB}$ or GND | 3.6V | | | ±10 | |
| I_{CC} | | $V_I = V_{CCB}$ or GND, $I_O = 0$ | 3.6V | | | 20 | |
| ΔI_{CC}^* | | One input at $V_{CCB} - 0.6V$, Other inputs at V_{CCB} or GND | 3.0V to 3.6V | | | 500 | |
| C_I | Control Inputs | $V_I = V_{CCB}$ or GND | 3.3V | | 4.5 | | pF |
| C_{IO} | A or B ports | $V_O = V_{CCB}$ or GND | 3.3V | | 6.5 | | |

Notes:

- † Typical values are measured at $V_{CC} = 3.3V$, $T_A = 25^\circ C$
- ‡ 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 at 0 or the associated V_{CC} .

Electrical Characteristics (V_{CCA}) (Over recommended operating free-air temperature range for V_{CCA} = 2.5V)

| Parameters | | Test Conditions | V _{CCA} | Min. | Typ. [†] | Max. | Units |
|-------------------------------|----------------|--|------------------|----------------------|-------------------|------|-------|
| V _{OH} (B to A) | | I _{OH} = -100μA | 2.3V to 2.7V | V _{CC} -0.1 | | | V |
| | | I _{OH} = -8mA | 2.3V | 1.7 | | | |
| | | I _{OH} = -12mA | 2.7V | 2.0 | | | |
| V _{OL} (B to A) | | I _{OL} = 100μA | 2.3V to 2.7V | | | 0.2 | V |
| | | I _{OL} = 8mA | 2.3V | | | 0.4 | |
| | | I _{OL} = 12mA | 2.7V | | | 0.5 | |
| I _I | Control Inputs | V _I = V _{CCA} or GND | 2.7V | | | ±5 | μA |
| I _{OZ} [‡] | A or B ports | V _O = V _{CCA} or GND | 2.7V | | | ±10 | |
| I _{CC} | | V _I = V _{CCA} or GND, I _O = 0 | 2.7V | | | 30 | |
| ΔI _{CC} [*] | | One input at V _{CCA} -0.6V, Other inputs at V _{CCA} or GND | 2.3V to 2.7V | | | 500 | |
| C _I | Control Inputs | V _I = V _{CCA} or GND | 2.5V | | 4.5 | | pF |
| C _{IO} | A or B ports | V _O = V _{CCA} or GND | 2.5V | | 6.5 | | |

Electrical Characteristics (V_{CCA}) (Over recommended operating free-air temperature range for V_{CCA} = 1.8V)

| Parameters | | Test Conditions | V _{CCA} | Min. | Typ. ^{**} | Max. | Units |
|--------------------------------|----------------|--|------------------|----------------------|--------------------|------|-------|
| V _{OH} (B to A) | | I _{OH} = -100μA | 1.65V to 1.95V | V _{CC} -0.1 | | | V |
| | | I _{OH} = -4mA | 1.65V | 1.3 | | | |
| | | I _{OH} = -8mA | 1.95V | 1.4 | | | |
| V _{OL} (B to A) | | I _{OL} = 100μA | 1.65V | | | 0.2 | V |
| | | I _{OL} = 4mA | 1.95V | | | 0.3 | |
| | | I _{OL} = 8mA | 1.95V | | | 0.4 | |
| I _{OZ} ^{***} | A or B ports | V _O = V _{CCA} or GND | 1.95V | | | ±5 | μA |
| I _{CC} | | V _I = V _{CCA} or GND, I _O = 0 | 1.95V | | | ±20 | |
| ΔI _{CC} [*] | | One input at V _{CCA} -0.6V, Other inputs at V _{CCA} or GND | 1.65V to 1.95V | | | 300 | |
| C _I | Control Inputs | V _I = V _{CCA} or GND | 1.8V | | 4.5 | | pF |
| C _{IO} | A or B ports | V _O = V _{CCA} or GND | 1.8V | | 6.5 | | |

Notes:

* The increase in supply current for each input at one of the specified TTL voltage levels rather than at the associated V_{CC}.

** Typical values are measured at V_{CC} = 2.5V or 1.8V, T_A = 25°C

*** For I/O ports, the parameter I_{OZ} includes the input leakage current.

Switching Characteristics

(Over recommended operating free-air temperature range, $C_L = 30\text{pF}$ (unless otherwise noted), see Figures 1, 2, 3)

| Parameter | From (Input) | To (Output) | PI74AVC164245 | | | | PI74AVC164245A | | | | Units |
|-------------------|-----------------|-------------|----------------------------|------|---------------------------|------|----------------------------|------|---------------------------|------|-------|
| | | | $V_{CCB} = 3.3V \pm 0.3V$ | | | | $V_{CCB} = 3.3V \pm 0.3V$ | | | | |
| | | | $V_{CCA} = 1.8V \pm 0.15V$ | | $V_{CCA} = 2.5V \pm 0.2V$ | | $V_{CCA} = 1.8V \pm 0.15V$ | | $V_{CCA} = 2.5V \pm 0.2V$ | | |
| | | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | |
| t_{PD} | A | B | 1.5 | 4.6 | 1.5 | 4.2 | 1.5 | 3.5 | 1.0 | 3.0 | ns |
| | B | A | 1.5 | 4.4 | 1.5 | 4.0 | 1.5 | 3.5 | 1.0 | 2.8 | |
| t_{EN} | \overline{OE} | B | 1.7 | 5.5 | 1.7 | 4.5 | 1.7 | 4.5 | 1.2 | 3.5 | |
| t_{DIS} | \overline{OE} | B | 1.5 | 5.5 | 1.5 | 4.5 | 1.5 | 4.5 | 1.0 | 3.5 | |
| t_{EN} | \overline{OE} | A | 1.7 | 5.5 | 1.7 | 4.5 | 1.7 | 4.5 | 1.2 | 3.5 | |
| t_{DIS} | \overline{OE} | A | 2.0 | 5.5 | 2.0 | 4.5 | 2.0 | 4.5 | 1.5 | 3.5 | |
| $t_{sk(o)}^{(1)}$ | | | | | | 0.5 | | | | 0.3 | |
| $t_{sk(b)}^{(1)}$ | | | | | | 0.3 | | | | 0.25 | |

Note:

- This is the skew between any two outputs of the same package, and switching in the same direction. For $t_{sk(o)}$, Output 1 and Output 2 are any two outputs. For $t_{sk(b)}$, Output 1 and Output 2 are in the same bank. These parameters are warranted but not production tested.

Operating Characteristics, $T_A = 25^\circ\text{C}$

| Parameters | | Test Conditions | $V_{CCA} = 2.5V$ $V_{CCB} = 3.3V$ | Units |
|--|--------------------------|---|--------------------------------------|-------|
| | | | Typical | |
| C_{PD} Power Dissipation Capacitance | Outputs Enabled (A or B) | $C_L = 30\text{pF}$, $F = 10\text{MHz}$ | 56 | pF |
| | Outputs Disabled | | 6 | |

Parameter Measurement Information, $V_{CCA} = 1.5V \pm 0.10V$

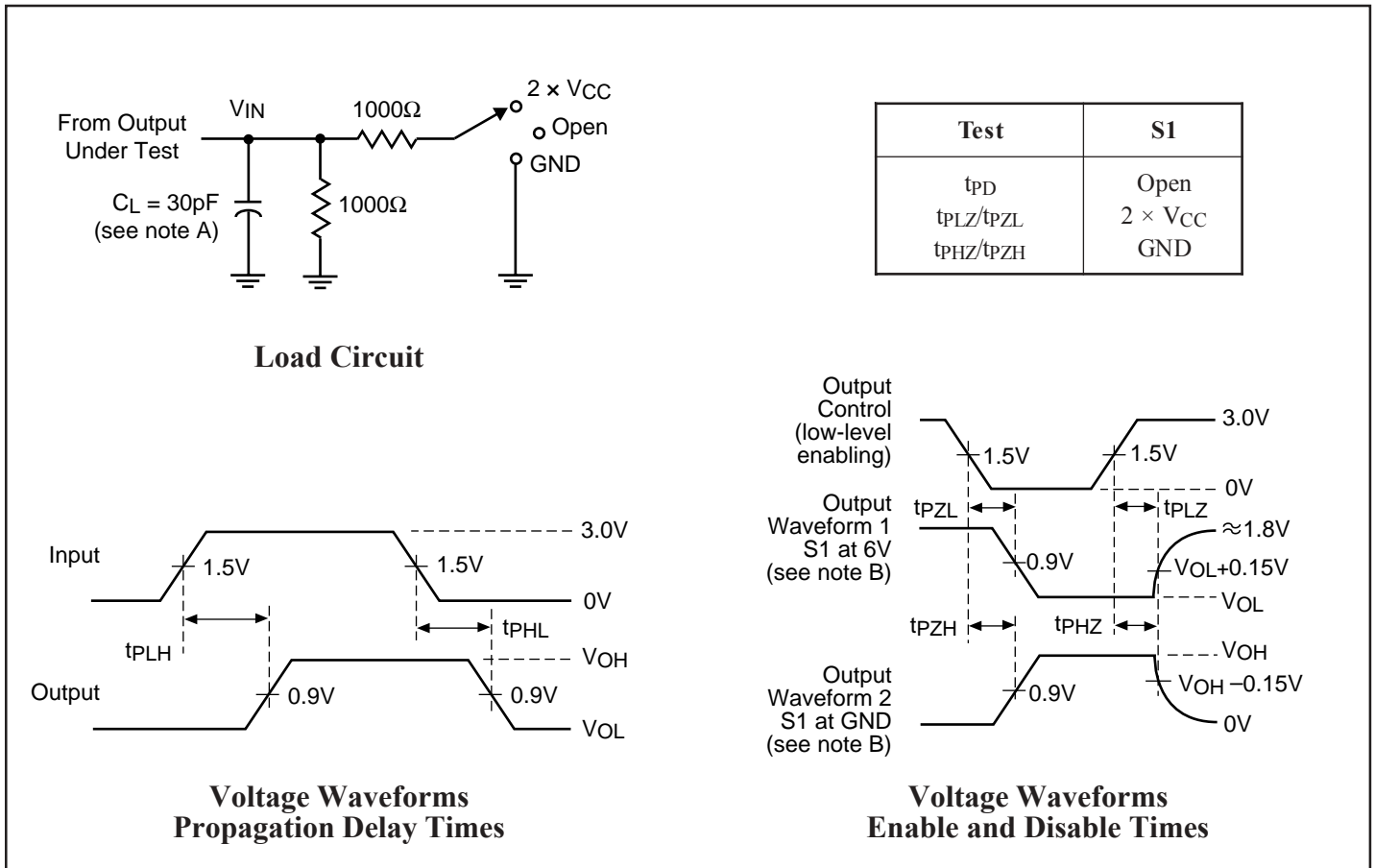


Figure 1. Load Circuit and Voltage Waveforms

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: $PRR \leq 10Mz$, $Z_O = 50\Omega$, $t_R \leq 2.5ns$, $t_F \leq 2.5ns$.
- D. The outputs are measured one at a time with one transition per measurement.
- E. t_{PLZ} and t_{PHZ} are the same as t_{DIS} .
- F. t_{PZL} and t_{PZH} are the same as t_{EN} .
- G. t_{PLH} and t_{PHL} are the same as t_{PD} .

Parameter Measurement Information, $V_{CCA} = 2.5V \pm 0.2V$

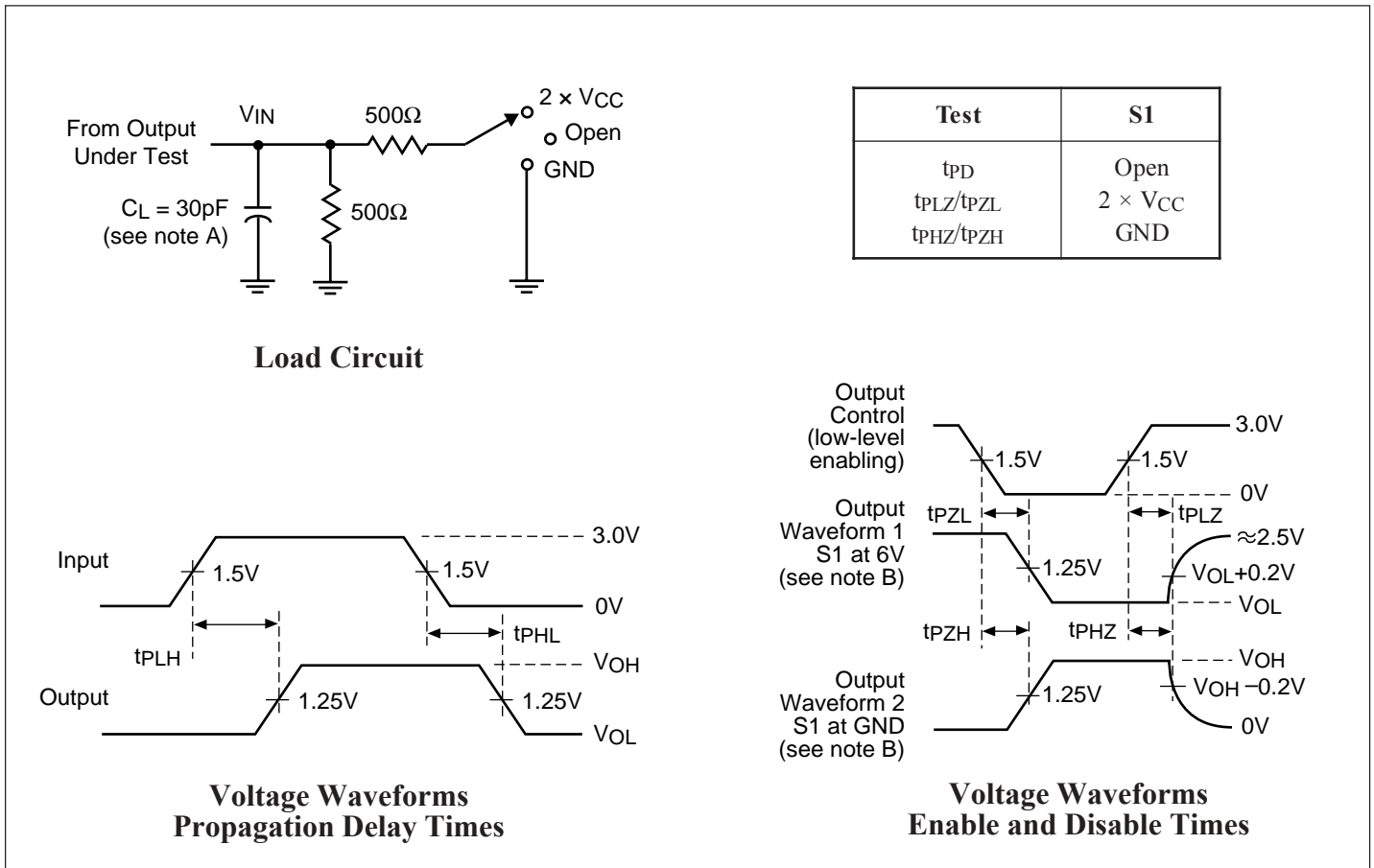


Figure 2. Load Circuit and Voltage Waveforms

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: $PRR \leq 10Mz$, $Z_O = 50\Omega$, $t_R \leq 2.5ns$, $t_F \leq 2.5ns$.
- D. The outputs are measured one at a time with one transition per measurement.
- E. t_{PLZ} and t_{PHZ} are the same as t_{DIS} .
- F. t_{PZL} and t_{PZH} are the same as t_{EN} .
- G. t_{PLH} and t_{PHL} are the same as t_{PD} .

Parameter Measurement Information, $V_{CCB} = 3.3V \pm 0.3V$

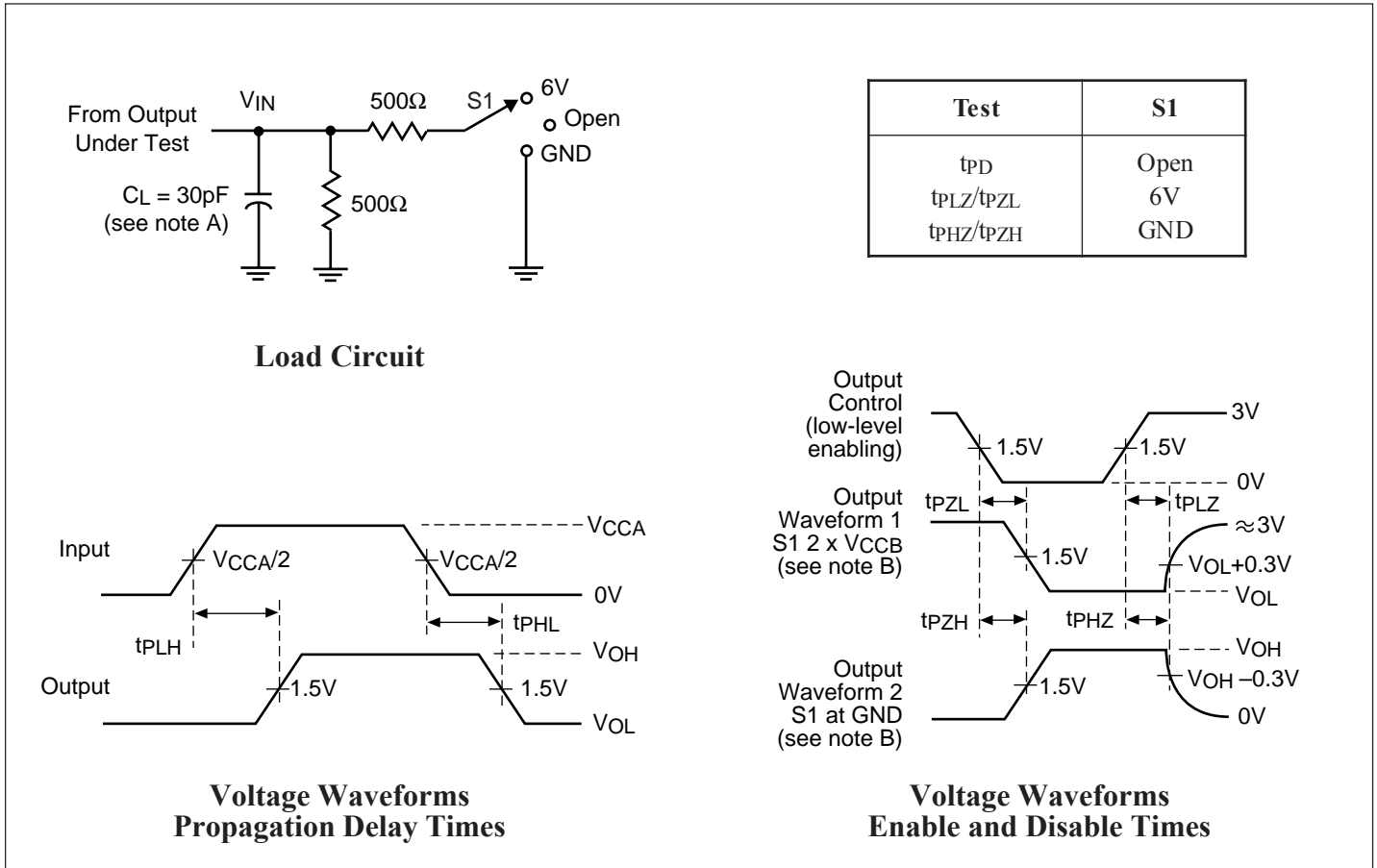
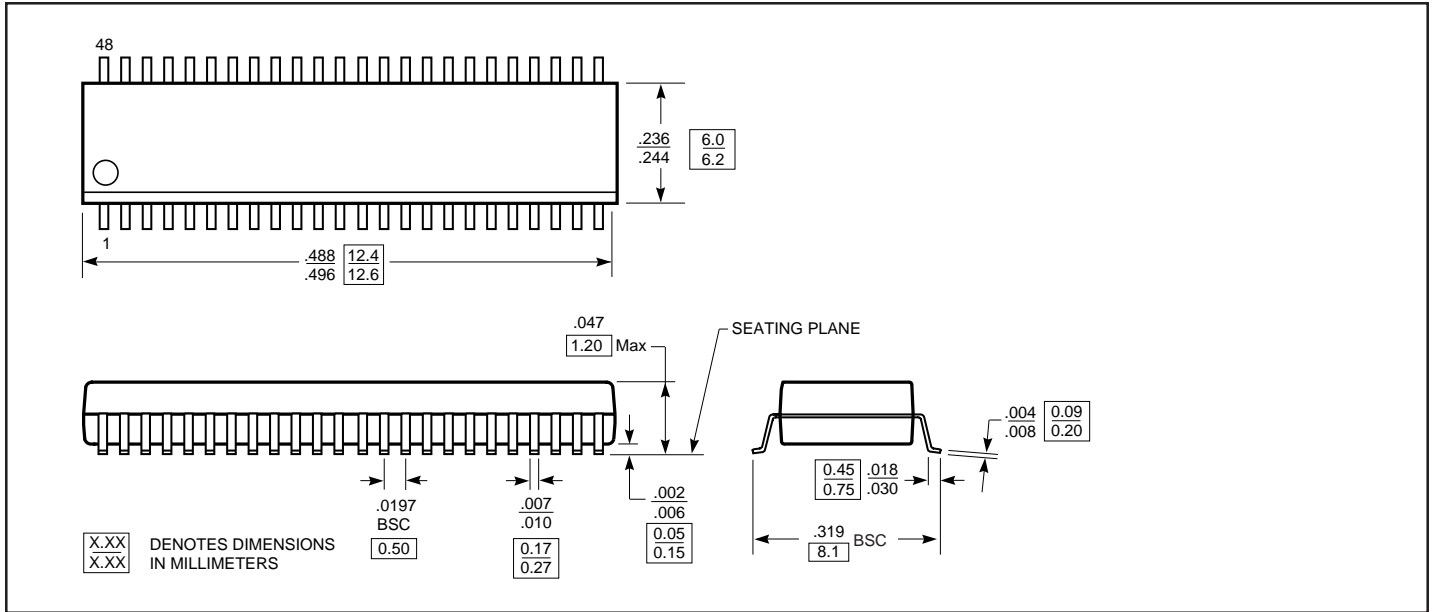


Figure 3. Load Circuit and Voltage Waveforms

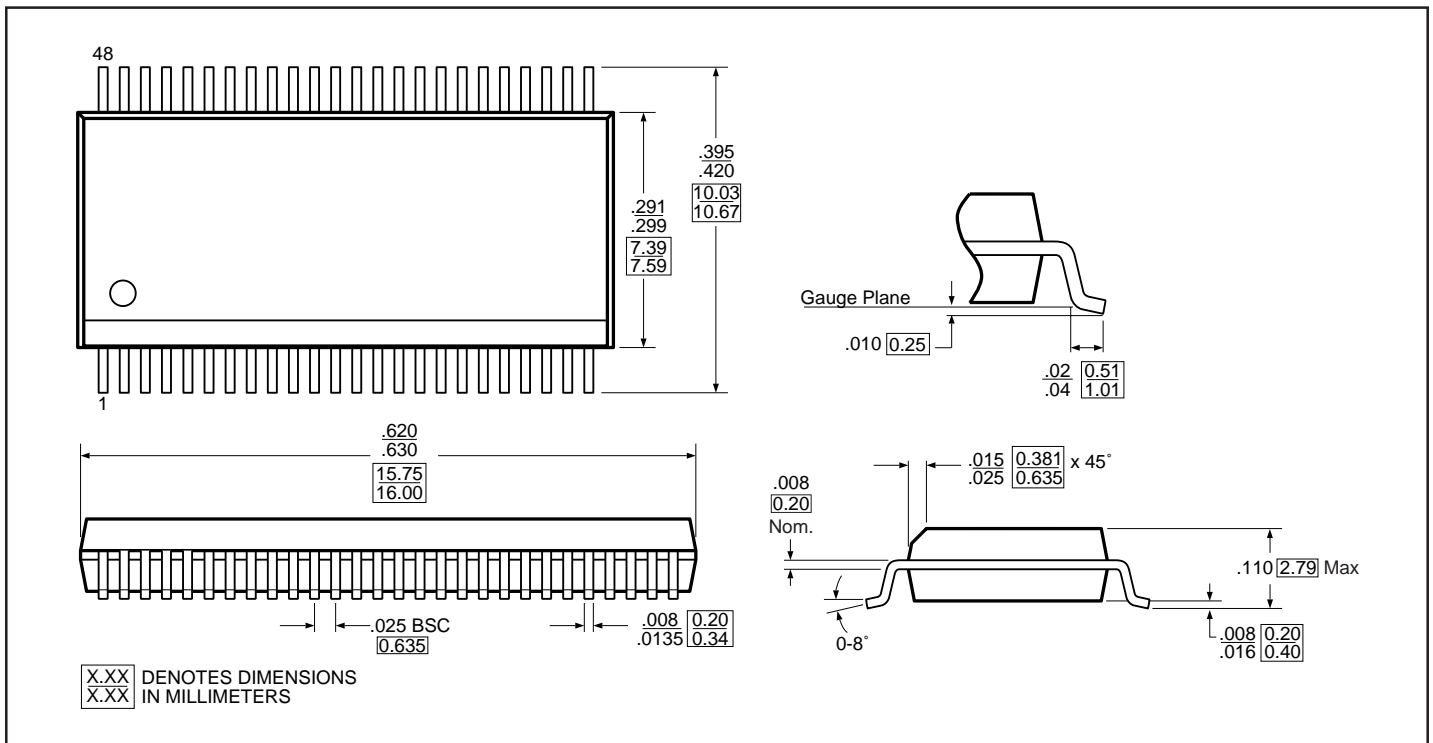
Notes:

- 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: $PRR \leq 10Mz$, $Z_O = 50\Omega$, $t_R \leq 2.5ns$, $t_F \leq 2.5ns$.
- D. The outputs are measured one at a time with one transition per measurement.
- E. t_{PLZ} and t_{PHZ} are the same as t_{DIS} .
- F. t_{PZL} and t_{PZH} are the same as t_{EN} .
- G. t_{PLH} and t_{PHL} are the same as t_{PD} .

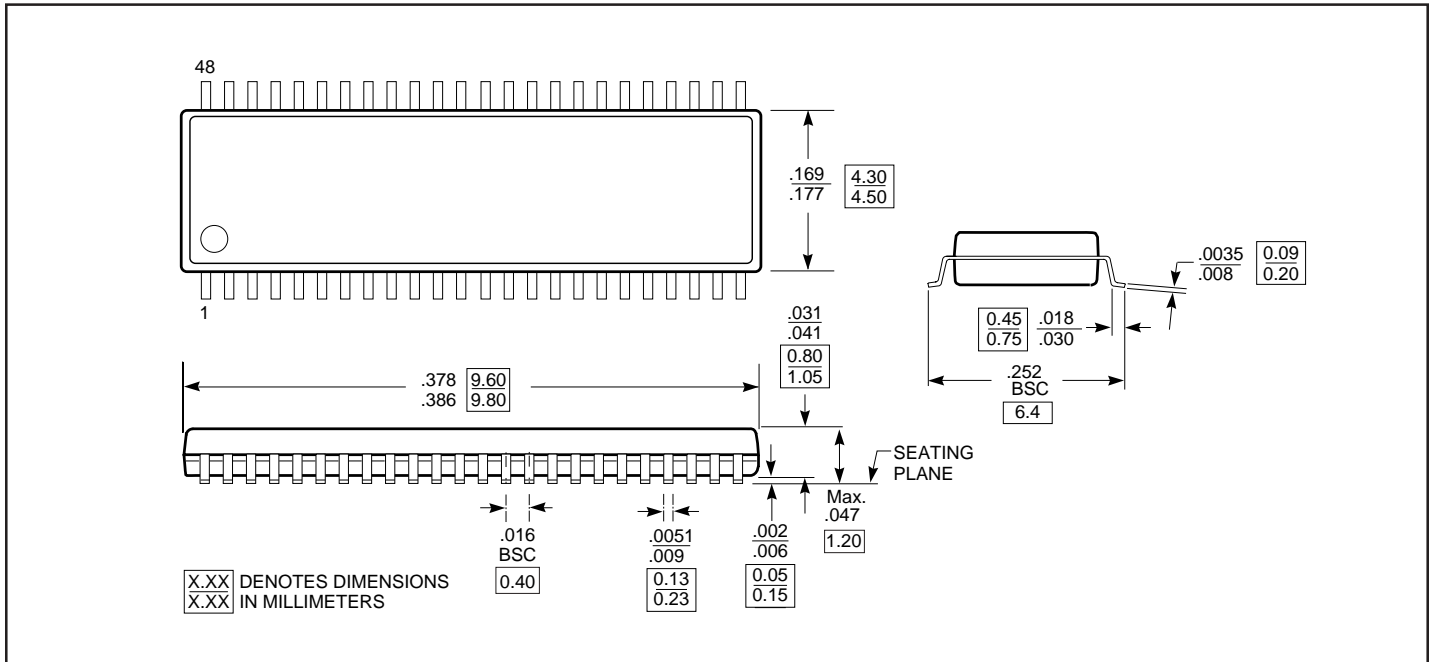
48-Pin TSSOP (A) Package



48-Pin SSOP (V) Package



48-Pin TVSOP (K) Package



Ordering Information

| Ordering Data | | Description |
|----------------|-----------------|------------------------------------|
| Blank Speed | A Speed | |
| PI74AVC164245V | PI74AVC164245AV | 48-pin, 300-mil wide plastic SSOP |
| PI74AVC164245A | PI74AVC164245AA | 48-pin, 240-mil wide plastic TSSOP |
| PI74AVC164245K | PI74AVC164245AK | 48-pin, 173-mil wide plastic TVSOP |

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