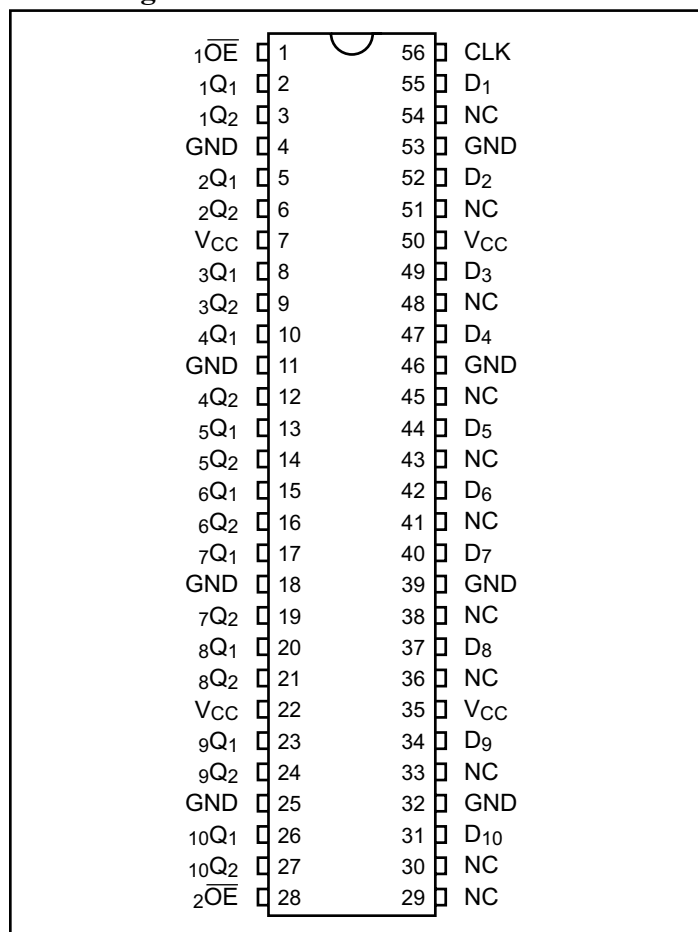


## 2.5V 10-Bit Flip-Flop with Dual and 3-State Outputs

### Features

- PI74AVC+16820 is designed for low-voltage operation,  $V_{CC} = 1.65V$  to  $3.6V$
- True  $\pm 24mA$  Balanced Drive @  $3.3V$
- $I_{OFF}$  supports Partial power-down operation
- $3.6V$  I/O Tolerant inputs and outputs
- All outputs contain a patented DDC (Dynamic Drive-Control) circuit that reduces noise without degrading propagation delay.
- Industrial operation:  $-40^{\circ}C$  to  $+85^{\circ}C$
- Packaging (Pb-free & Green available):
  - 56-pin 240-mil wide plastic TSSOP (A)
  - 56-pin 173-mil wide plastic TVSOP (K)

### Pin Configuration



### Description

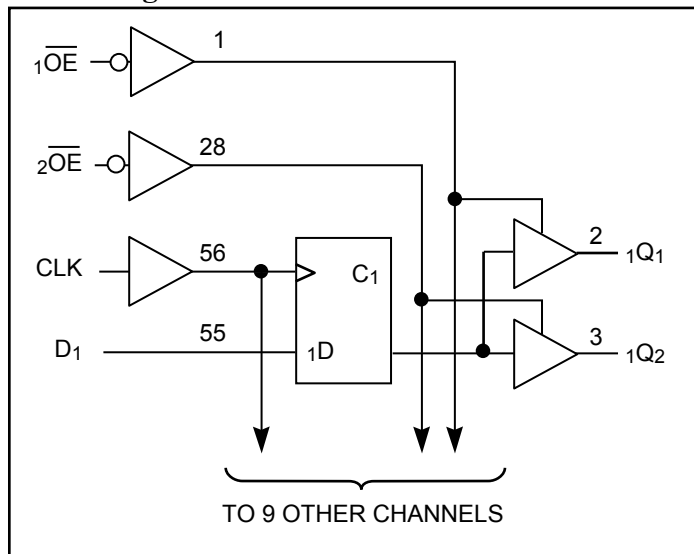
Pericom Semiconductor's PI74AVC+16820, a 10-bit flip-flop designed for  $1.65V$  to  $3.6V$   $V_{CC}$  operation. It is designed with edge-triggered D-type flip-flops. On the positive transition of clock (CLK) input. The device provides true data at the Q outputs.

A buffered output-enable ( $\overline{OE}$ ) input can be used to place the ten outputs in either a normal logic state (HIGH or LOW level) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capacity to drive bus lines without the need for interface or pullup components.

$\overline{OE}$  does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

To ensure the high-impedance state during power-up or power-down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor whose minimum value is determined by the current sinking capability of the driver.

### Block Diagram



## Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

|                                                                                                 |                        |
|-------------------------------------------------------------------------------------------------|------------------------|
| Supply voltage range, $V_{CC}$ .....                                                            | -0.5V to +4.6V         |
| Input voltage range, $V_I$ .....                                                                | -0.5V to +4.6V         |
| Voltage range applied to any output in the high-impedance or power-off state, $V_O^{(1)}$ ..... | -0.5V to +4.6V         |
| Voltage range applied to any output in the high or low state, $V_O^{(1,2)}$ .....               | -0.5V to $V_{CC}+0.5V$ |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ ).....                                                | -50mA                  |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ ).....                                               | -50mA                  |
| Continuous output current, $I_O$ .....                                                          | $\pm 50mA$             |
| Continuous current through each $V_{CC}$ or GND.....                                            | $\pm 100mA$            |
| Package thermal impedance, $\theta_{JA}^{(3)}$ : package A.....                                 | 64°C/W                 |
| package K.....                                                                                  | 48°C/W                 |
| Storage Temperature range, $T_{stg}$ .....                                                      | -65°C to 150°C         |

### Notes:

1. Input & output negative-voltage ratings may be exceeded if the input and output current rating are observed.
2. Output positive-voltage rating may be exceeded up to 4.6V maximum if the output current rating is observed.
3. The package thermal impedance is calculated in accordance with JESD 51.
4. 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.

## Truth Table each Flip-Flop<sup>(1)</sup>

| Inputs            |     |       | Outputs |
|-------------------|-----|-------|---------|
| $\overline{OE}_n$ | CLK | $D_n$ | $Q_n$   |
| L                 | ↑   | H     | H       |
| L                 | ↑   | L     | L       |
| L                 | L   | X     | Qo      |
| H                 | X   | X     | Z       |

### Notes:

1. H = High Signal Level, L = Low Signal Level,  
X = Irrelevant; Z = High Impedance, Qo = Output Level before the indicated steady-state conditions were established.

## Pin Description

| Pin Name        | Description                      |
|-----------------|----------------------------------|
| $\overline{OE}$ | Output Enable Input (Active LOW) |
| CLK             | Clock Input (Active HIGH)        |
| $Q_n$           | 3-State Outputs                  |
| $D_n$           | Data Inputs                      |
| GND             | Ground                           |
| $V_{CC}$        | Power                            |

**Recommended Operating Conditions<sup>(1)</sup>**

| Parameters                    | Description                        | Test Conditions                  | Min.                   | Max.                   | Units |
|-------------------------------|------------------------------------|----------------------------------|------------------------|------------------------|-------|
| V <sub>CC</sub>               | Supply Voltage                     | Operating                        | 1.65                   | 3.6                    | V     |
|                               |                                    | Data retention only              | 1.2                    |                        |       |
| V <sub>IH</sub>               | High-level Input Voltage           | V <sub>CC</sub> = 1.2V           | V <sub>CC</sub>        |                        |       |
|                               |                                    | V <sub>CC</sub> = 1.65V to 1.95V | 0.65 x V <sub>CC</sub> |                        |       |
|                               |                                    | V <sub>CC</sub> = 2.3V to 2.7V   | 1.7                    |                        |       |
|                               |                                    | V <sub>CC</sub> = 3V to 3.6V     | 2                      |                        |       |
| V <sub>IL</sub>               | Low-level Input Voltage            | V <sub>CC</sub> = 1.2V           |                        | GND                    |       |
|                               |                                    | V <sub>CC</sub> = 1.65V to 1.95V |                        | 0.35 x V <sub>CC</sub> |       |
|                               |                                    | V <sub>CC</sub> = 2.3V to 2.7V   |                        | 0.7                    |       |
|                               |                                    | V <sub>CC</sub> = 3V to 3.6V     |                        | 0.8                    |       |
| V <sub>I</sub>                | Input Voltage                      |                                  | 0                      | 3.6                    |       |
| V <sub>O</sub>                | Output Voltage                     | Active State                     | 0                      | V <sub>CC</sub>        |       |
|                               |                                    | 3-State                          | 0                      | 3.6                    |       |
| I <sub>OH</sub>               | High-level output current          | V <sub>CC</sub> = 1.65V to 1.95V |                        | - 6                    | mA    |
|                               |                                    | V <sub>CC</sub> = 2.3V to 2.7V   |                        | - 12                   |       |
|                               |                                    | V <sub>CC</sub> = 3V to 3.6V     |                        | - 24                   |       |
| I <sub>OL</sub>               | Low-level output current           | V <sub>CC</sub> = 1.65V to 1.95V |                        | 6                      |       |
|                               |                                    | V <sub>CC</sub> = 2.3V to 2.7V   |                        | 12                     |       |
|                               |                                    | V <sub>CC</sub> = 3V to 3.6V     |                        | 24                     |       |
| Δ <sub>T</sub> Δ <sub>V</sub> | Input transition rise or fall rate | V <sub>CC</sub> = 1.65V to 3.6V  |                        | 5                      | ns/V  |
| T <sub>A</sub>                | Operating free-air temperature     |                                  | -40                    | 85                     | C°    |

**Notes:**

1. All unused inputs must be held at V<sub>CC</sub> or GND to ensure proper device operation.

**DC Electrical Characteristics** (Over the Operating Range,  $T_A = -40^{\circ}\text{C} + 85^{\circ}\text{C}$ )

| Parameters       |                | Test Conditions <sup>(1)</sup>                              | V <sub>CC</sub> | Min.                  | Typ. | Max. | Units |
|------------------|----------------|-------------------------------------------------------------|-----------------|-----------------------|------|------|-------|
| V <sub>OH</sub>  |                | I <sub>OH</sub> = −100μA                                    | 1.65V to 3.6V   | V <sub>CC</sub> −0.2V |      |      | V     |
|                  |                | I <sub>OH</sub> = −6mA, V <sub>IH</sub> = 1.07V             | 1.65V           | 1.2                   |      |      |       |
|                  |                | I <sub>OH</sub> = −12mA, V <sub>IH</sub> = 1.7V             | 2.3V            | 1.75                  |      |      |       |
|                  |                | I <sub>OH</sub> = −24mA, V <sub>IH</sub> = 2V               | 3V              | 2                     |      |      |       |
| V <sub>OL</sub>  |                | I <sub>OL</sub> = 100μA                                     | 1.65V to 3.6V   |                       |      | 0.2  | V     |
|                  |                | I <sub>OL</sub> = 6mA, V <sub>IH</sub> = 0.57V              | 1.65V           |                       |      | 0.45 |       |
|                  |                | I <sub>OL</sub> = 12mA, V <sub>IH</sub> = 0.7V              | 2.3V            |                       |      | 0.55 |       |
|                  |                | I <sub>OL</sub> = 24mA, V <sub>IH</sub> = 0.8V              | 3V              |                       |      | 0.8  |       |
| I <sub>I</sub>   |                | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 3.6V            |                       |      | ±2.5 | mA    |
| I <sub>OFF</sub> |                | V <sub>I</sub> or V <sub>O</sub> = 3.6V                     | 0               |                       |      | ±10  |       |
| I <sub>OZ</sub>  |                | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 3.6V            |                       |      | ±10  |       |
| I <sub>CC</sub>  |                | V <sub>O</sub> = V <sub>CC</sub> or GND, V <sub>O</sub> = 0 | 3.6V            |                       | 40   |      |       |
| C <sub>I</sub>   | Control Inputs | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 2.5V            |                       | 4    |      | pF    |
|                  |                |                                                             | 3.3V            |                       | 4    |      |       |
|                  | Data Inputs    |                                                             | 2.5V            |                       | 6    |      |       |
|                  |                |                                                             | 3.3V            |                       | 6    |      |       |
| C <sub>O</sub>   | Outputs        | V <sub>O</sub> = V <sub>CC</sub> or GND                     | 2.5V            |                       | 8    |      |       |
|                  |                |                                                             | 3.3V            |                       | 8    |      |       |

**Note:**

- Typical values are measured at  $T_A = 25^{\circ}\text{C}$ .

### Timing Requirements

(Over recommended operating free-air temperature range, unless otherwise noted, see Figures 1 thru 4)

|                                                | <b>V<sub>CC</sub> = 1.2V</b> |             | <b>V<sub>CC</sub> = 1.5V ± 0.1V</b> |             | <b>V<sub>CC</sub> = 1.8V ± 0.15V</b> |             | <b>V<sub>CC</sub> = 2.5V ± 0.2V</b> |             | <b>V<sub>CC</sub> = 3.3V ± 0.3V</b> |             | <b>Units</b> |
|------------------------------------------------|------------------------------|-------------|-------------------------------------|-------------|--------------------------------------|-------------|-------------------------------------|-------------|-------------------------------------|-------------|--------------|
|                                                | <b>Min.</b>                  | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> | <b>Min.</b>                          | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> |              |
| f <sub>CLOCK</sub> Clock Frequency             |                              |             |                                     |             |                                      | 150         |                                     | 180         |                                     | 180         | MHz          |
| t <sub>W</sub> Pulse duration, CLK high or low |                              |             |                                     |             | 6                                    |             | 3                                   |             | 3                                   |             | ns           |
| t <sub>SU</sub> Setup time, data before CLK    |                              |             |                                     |             | 5.7                                  |             | 3.5                                 |             | 2.5                                 |             |              |
| t <sub>H</sub> Hold time, data after CLK       |                              |             |                                     |             | 1.2                                  |             | 1                                   |             | 1                                   |             |              |

### Switching Characteristics

(Over recommended operating free-air temperature range, unless otherwise noted, see Figures 1 thru 4)

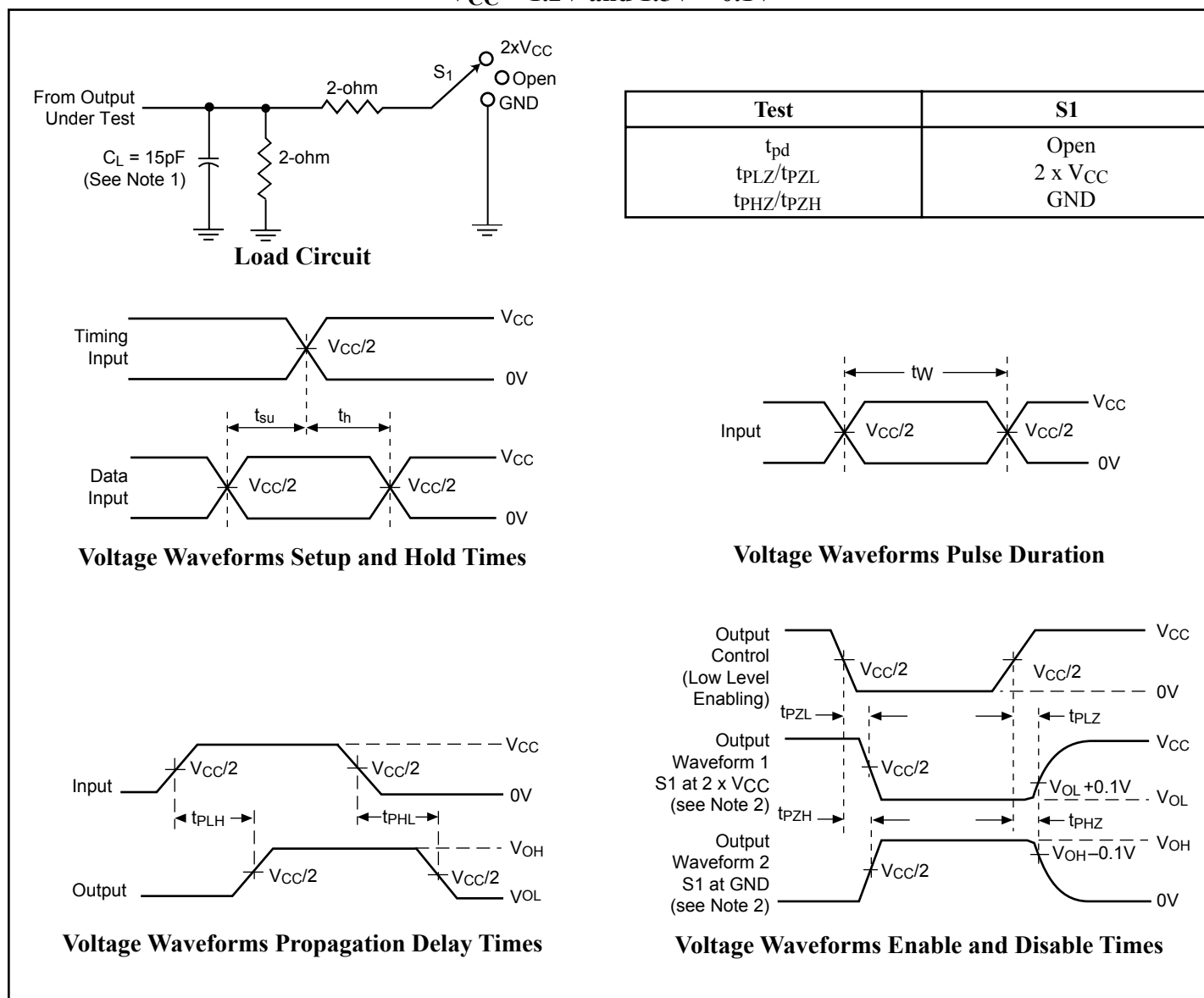
| <b>Parameters</b> | <b>From (Input)</b> | <b>To (Output)</b> | <b>V<sub>CC</sub> = 1.2V</b> |             | <b>V<sub>CC</sub> = 1.5V ± 0.1V</b> |             | <b>V<sub>CC</sub> = 1.8V ± 0.15V</b> |             | <b>V<sub>CC</sub> = 2.5V ± 0.2V</b> |             | <b>V<sub>CC</sub> = 3.3V ± 0.3V</b> |             | <b>Units</b> |
|-------------------|---------------------|--------------------|------------------------------|-------------|-------------------------------------|-------------|--------------------------------------|-------------|-------------------------------------|-------------|-------------------------------------|-------------|--------------|
|                   |                     |                    | <b>Min.</b>                  | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> | <b>Min.</b>                          | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> | <b>Min.</b>                         | <b>Max.</b> |              |
| f <sub>MAX</sub>  |                     |                    |                              |             |                                     |             | 150                                  |             | 180                                 |             | 180                                 |             | MHz          |
| t <sub>PD</sub>   | CLK                 | Q                  |                              |             |                                     |             |                                      | 4           |                                     | 3.2         |                                     | 2.7         | ns           |
| t <sub>EN</sub>   | $\overline{OE}$     | Q                  |                              |             |                                     |             |                                      | 5.8         |                                     | 5.1         |                                     | 4.5         |              |
| t <sub>DIS</sub>  | $\overline{OE}$     | Q                  |                              |             |                                     |             |                                      | 5           |                                     | 4.6         |                                     | 4.2         |              |

### Operating Characteristics, T<sub>A</sub> = 25°C

| <b>Parameters</b>                             |                  | <b>Test Conditions</b>                                   | <b>V<sub>CC</sub> = 1.8V ± 0.15V</b> | <b>V<sub>CC</sub> = 2.5V ± 0.2V</b> | <b>V<sub>CC</sub> = 3.3V ± 0.3V</b> | <b>Units</b> |
|-----------------------------------------------|------------------|----------------------------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------|
|                                               |                  |                                                          | <b>Typical</b>                       | <b>Typical</b>                      | <b>Typical</b>                      |              |
| C <sub>pd</sub> Power Dissipation Capacitance | Outputs Enabled  | C <sub>L</sub> = 0pF, f = 10 MHz,<br>2 outputs switching | 40                                   | 48                                  | 55                                  | pF           |
|                                               | Outputs Disabled |                                                          | 23                                   | 27                                  | 32                                  |              |

# PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 1.2V \text{ and } 1.5V \pm 0.1V$



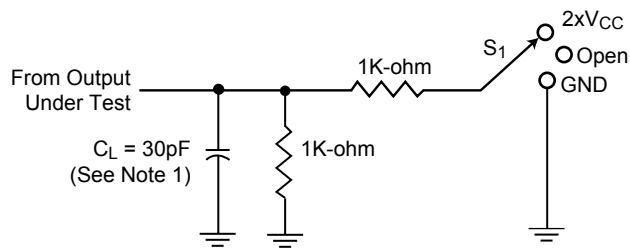
**Figure 1. Load Circuit and Voltage Waveforms**

## 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 impulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.0\text{ns}$ ,  $t_F \leq 2.0\text{ns}$ .
- 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  $t_{pd}$

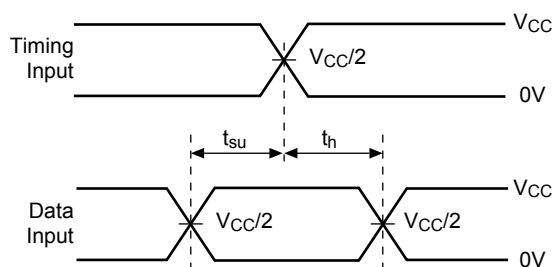
## PARAMETER MEASUREMENT INFORMATION

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

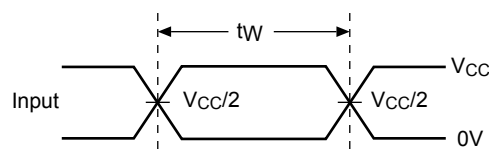


**Load Circuit**

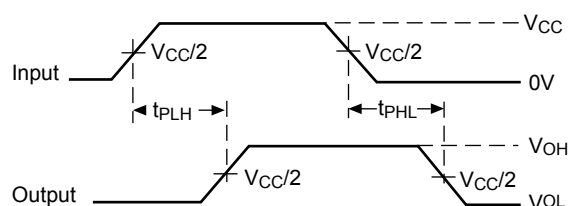
| Test                                               | S1                                 |
|----------------------------------------------------|------------------------------------|
| $t_{pd}$<br>$t_{PLZ}/t_{PZL}$<br>$t_{PHZ}/t_{PZH}$ | Open<br>2 x V <sub>CC</sub><br>GND |



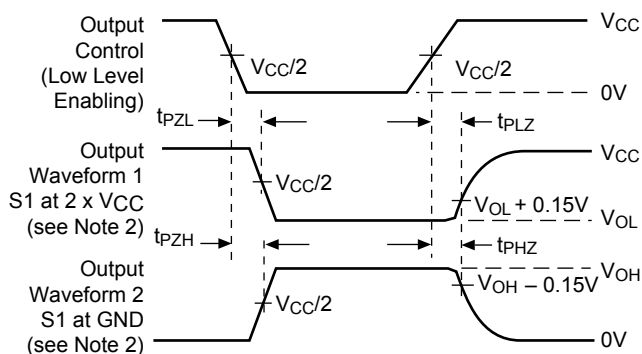
**Voltage Waveforms Setup and Hold Times**



**Voltage Waveforms Pulse Duration**



**Voltage Waveforms Propagation Delay Times**



**Voltage Waveforms Enable and Disable Times**

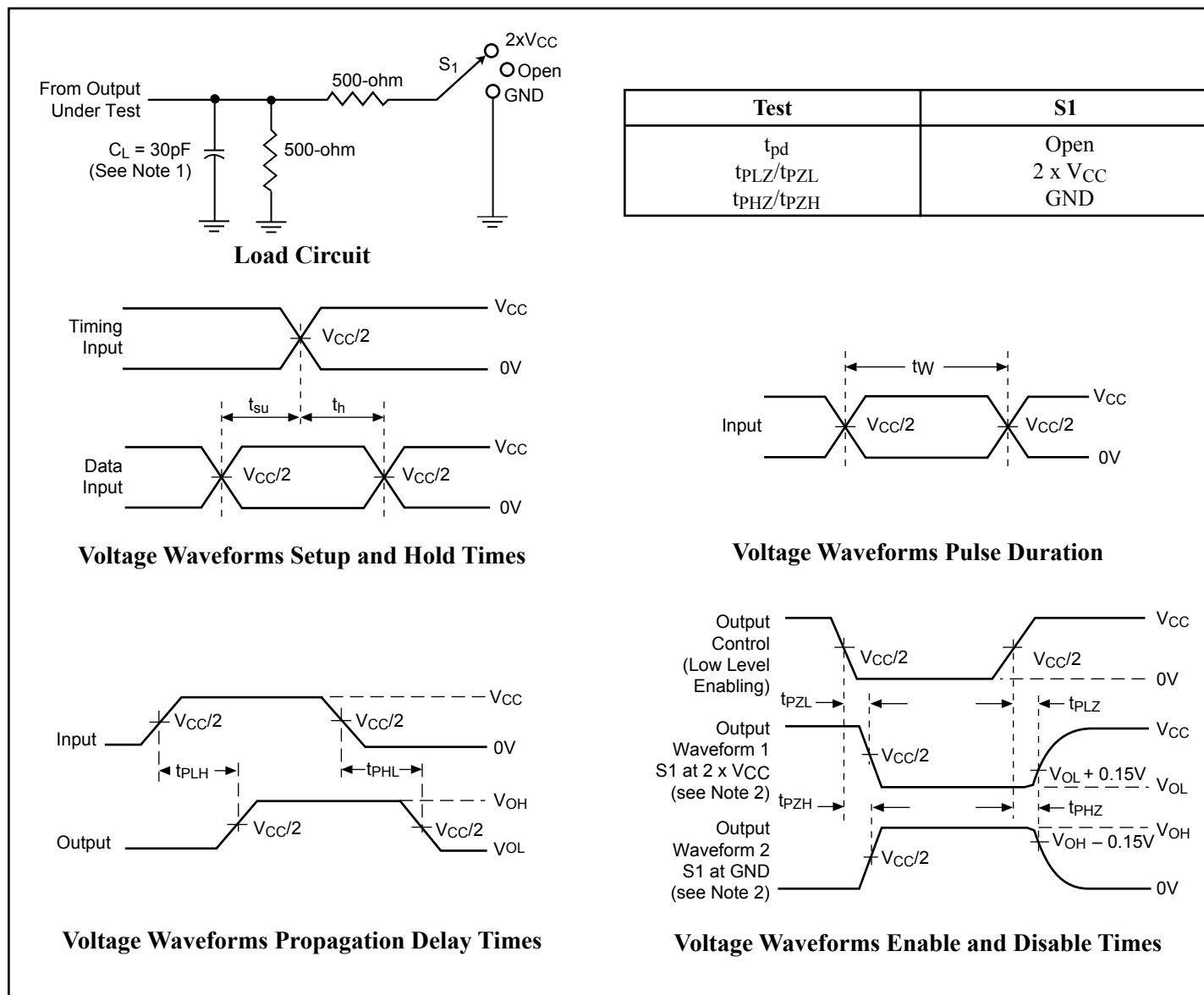
**Figure 2. Load Circuit and Voltage Waveforms**

### Notes:

1.  $C_L$  includes probe and jig capacitance.
2. 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.
3. All input impulses are supplied by generators having the following characteristics: PRR  $\leq$  10 MHz,  $Z_O = 50\Omega$ ,  $t_R \leq 2.0ns$ ,  $t_F \leq 2.0ns$ .
4. The outputs are measured one at a time with one transition per measurement.
5.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$
6.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$
7.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$

## PARAMETER MEASUREMENT INFORMATION

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



**Figure 3. Load Circuit and Voltage Waveforms**

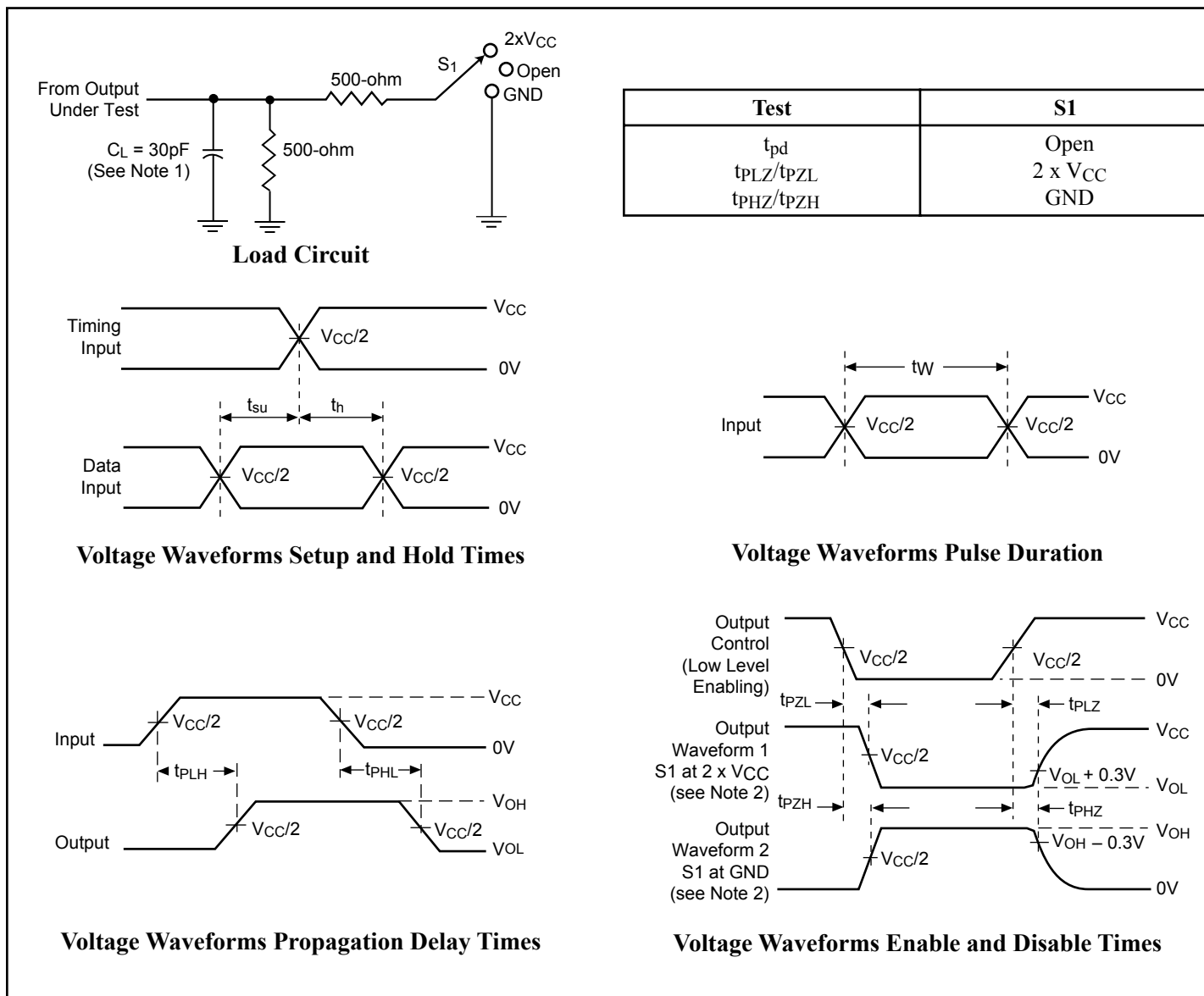
### Notes:

- $C_L$  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 impulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.0\text{ns}$ ,  $t_F \leq 2.0\text{ns}$ .
- 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  $t_{pd}$



## PARAMETER MEASUREMENT INFORMATION

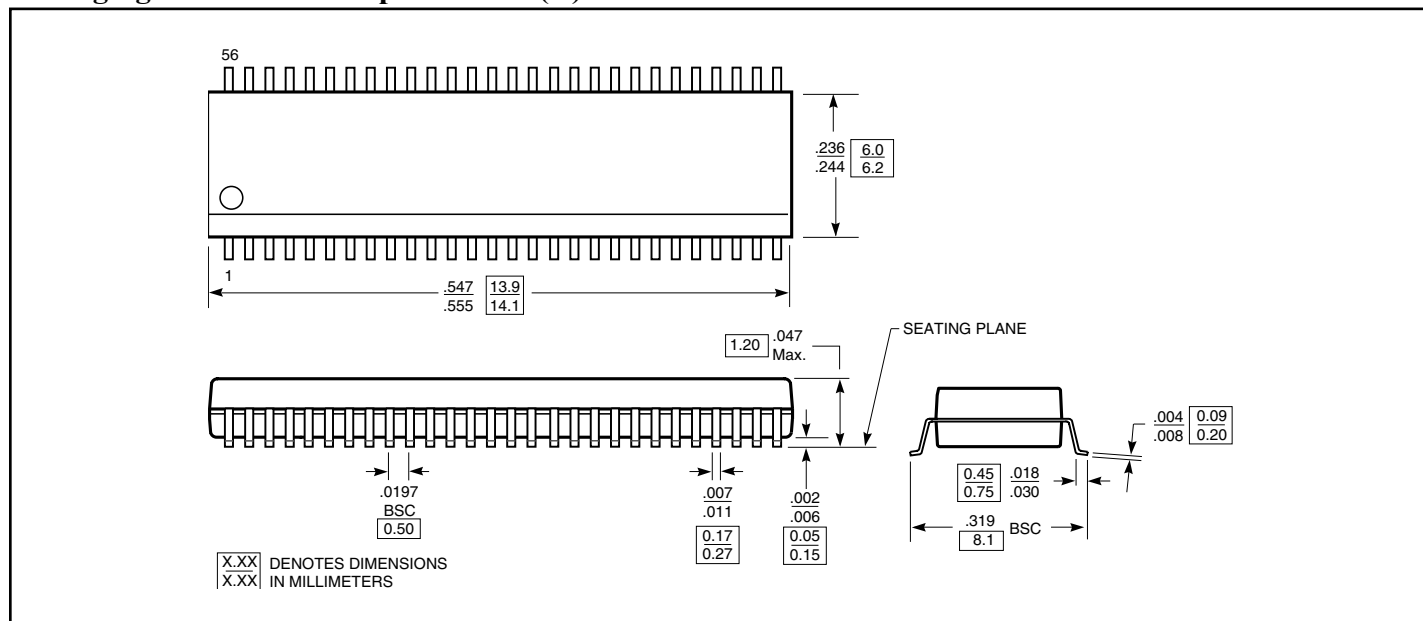
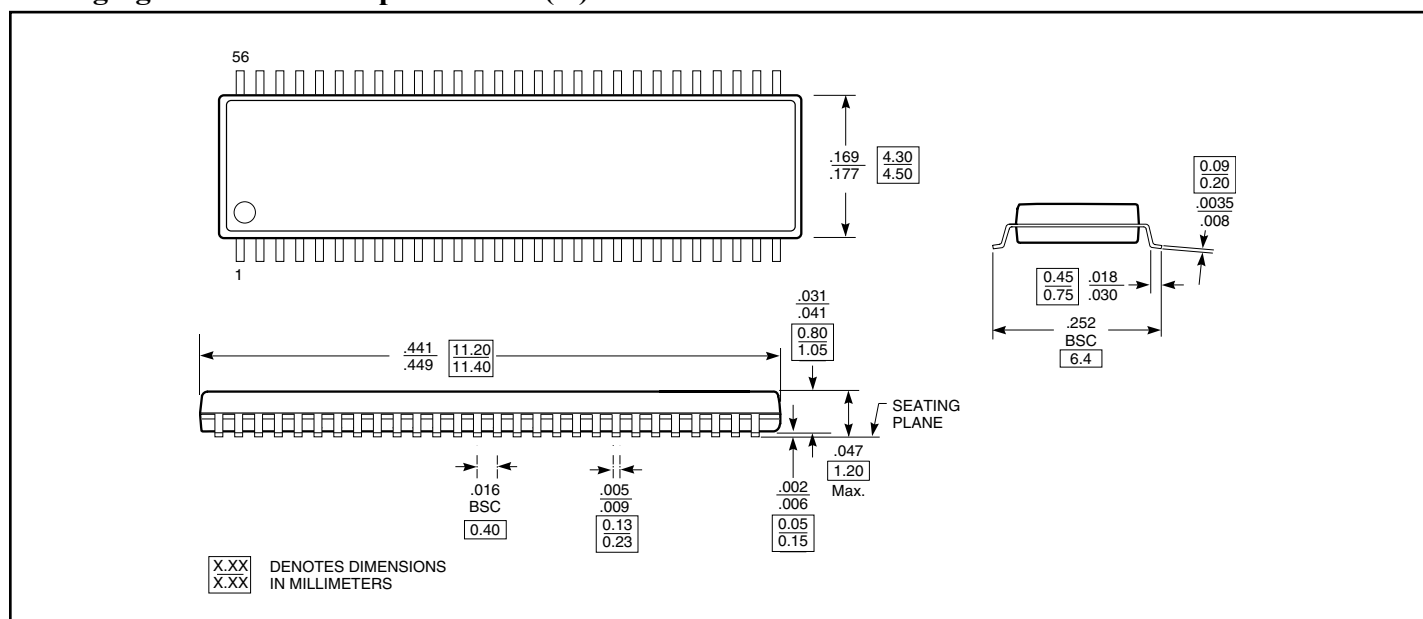
$$V_{CC} = 3.3V \pm 0.3V$$



**Figure 4. Load Circuit and Voltage Waveforms**

### 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 impulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.0\text{ns}$ ,  $t_F \leq 2.0\text{ns}$ .
- 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  $t_{pd}$

**Packaging Mechanical: 56-pin TSSOP (A)**

**Packaging Mechanical: 56-pin TVSOP (K)**




### Ordering Information

| Ordering Code   | Package Code | Package Description                                 |
|-----------------|--------------|-----------------------------------------------------|
| PI74AVC+16820A  | A            | 56-pin, 240-mil wide plastic TSSOP                  |
| PI74AVC+16820AE | A            | Pb-free & Green, 56-pin, 240-mil wide plastic TSSOP |
| PI74AVC+16820K  | K            | 56-pin, 173-mil wide plastic TSSOP                  |
| PI74AVC+16820KE | K            | Pb-free & Green, 56-pin, 173-mil wide plastic TSSOP |

### Notes:

1. Thermal characteristics can be found on the company web site at [www.pericom.com/packaging/](http://www.pericom.com/packaging/)