

## FEATURES:

- Typical  $t_{sk(o)}$  (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC} = 3.3V \pm 0.3V$ , Normal Range
- $V_{CC} = 2.7V$  to  $3.6V$ , Extended Range
- CMOS power levels (0.4μ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Available in SSOP and TSSOP packages

## DRIVE FEATURES:

- Balanced Output Drivers:  $\pm 12mA$
- Low switching noise

## APPLICATIONS:

- 5V and 3.3V mixed voltage systems
- Data communication and telecommunication systems

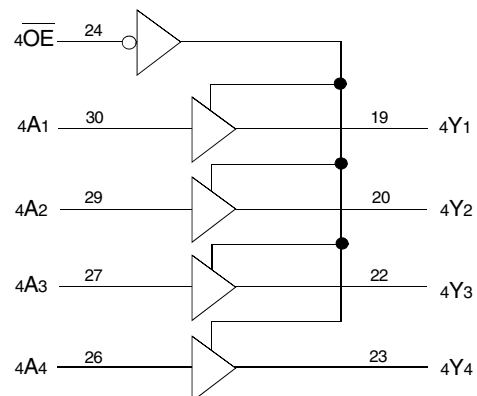
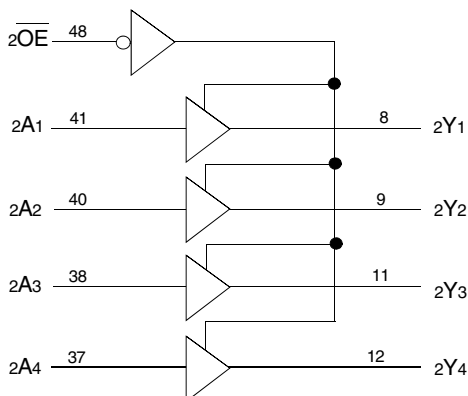
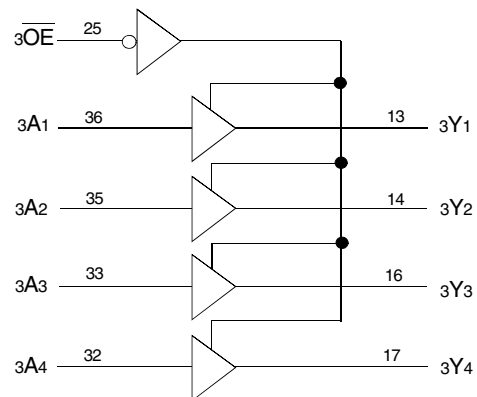
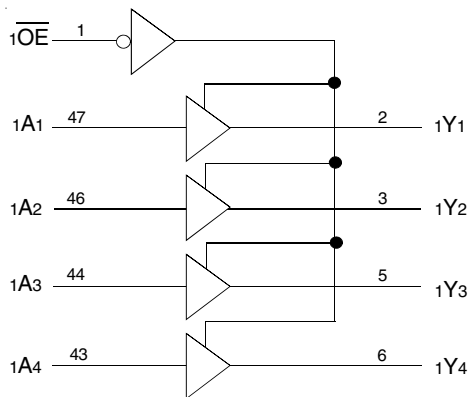
## DESCRIPTION:

The LVC162244A 16-bit buffer/driver is built using advanced dual metal CMOS technology. The LVC162244A is designed specifically to improve both the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters. The device can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. This device provides true outputs and symmetrical active-low output-enable ( $\overline{OE}$ ) inputs.

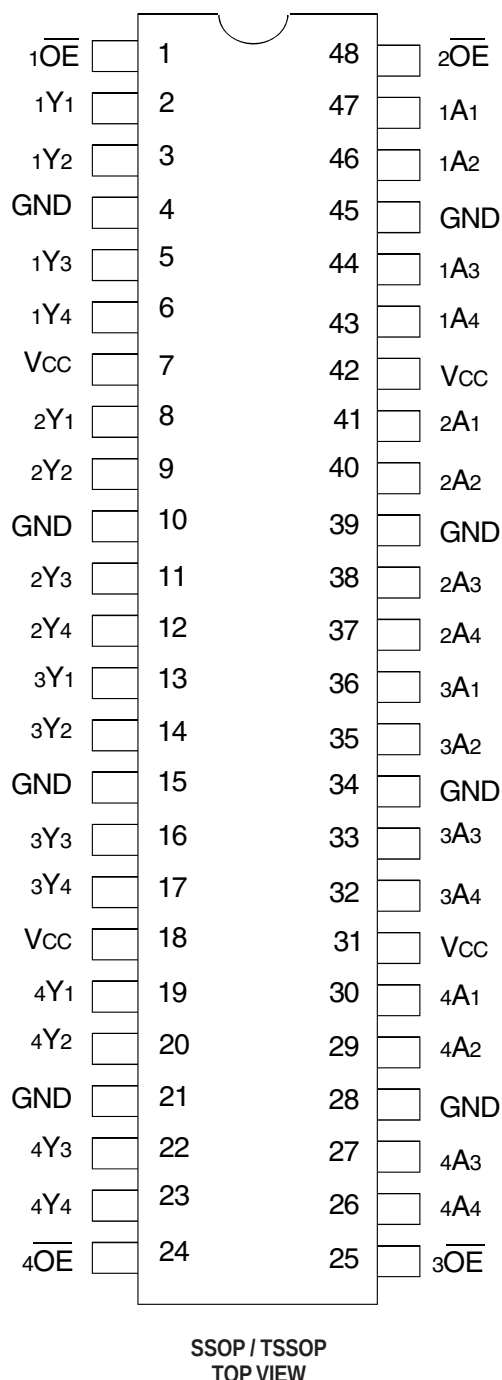
All pins of this 16-bit buffer/driver can be driven from either 3.3V or 5V devices. This feature allows the use of the device as a translator in a mixed 3.3V/5V supply system.

The LVC162244A has series resistors in the device output structure which will significantly reduce line noise when used with light loads. This driver has been developed to drive  $\pm 12mA$  at the designated threshold levels.

## FUNCTIONAL BLOCK DIAGRAM



## PIN CONFIGURATION



## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

| Symbol               | Description                                   | Max          | Unit |
|----------------------|-----------------------------------------------|--------------|------|
| VTERM <sup>(2)</sup> | Terminal Voltage with Respect to GND          | -0.5 to +6.5 | V    |
| VTERM <sup>(3)</sup> | Terminal Voltage with Respect to GND          | -0.5 to +6.5 | V    |
| TSTG                 | Storage Temperature                           | -65 to +150  | °C   |
| IOUT                 | DC Output Current                             | -50 to +50   | mA   |
| IIK<br>IOK           | Continuous Clamp Current,<br>Vi < 0 or Vo < 0 | -50          | mA   |
| ICC<br>ISS           | Continuous Current through each<br>Vcc or GND | ±100         | mA   |

### NOTES:

- Stresses greater than those listed under ABSOLUTE 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.
- Vcc terminals.
- All terminals except Vcc.

## CAPACITANCE (TA = +25°C, F = 1.0MHz)

| Symbol | Parameter <sup>(1)</sup> | Conditions | Typ. | Max. | Unit |
|--------|--------------------------|------------|------|------|------|
| CIN    | Input Capacitance        | VIN = 0V   | 4.5  | 6    | pF   |
| COUT   | Output Capacitance       | VOU = 0V   | 6.5  | 8    | pF   |
| Ci/O   | I/O Port Capacitance     | VIN = 0V   | 6.5  | 8    | pF   |

### NOTE:

- As applicable to the device type.

## PIN DESCRIPTION

| Pin Names | Description                               |
|-----------|-------------------------------------------|
| xOE       | 3-State Output Enable Inputs (Active LOW) |
| xAx       | Data Inputs                               |
| Yx        | 3-State Outputs                           |

## FUNCTION TABLE (EACH 4-BIT BUFFER)<sup>(1)</sup>

| Inputs |     | Outputs |
|--------|-----|---------|
| xOE    | xAx | Yx      |
| L      | H   | H       |
| L      | L   | L       |
| H      | X   | Z       |

### NOTE:

- H = HIGH Voltage Level  
X = Don't Care  
L = LOW Voltage Level  
Z = High-Impedance

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Operating Condition:  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

| Symbol                              | Parameter                                              | Test Conditions                                                       |                                          | Min. | Typ. <sup>(1)</sup> | Max.     | Unit          |
|-------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------|------|---------------------|----------|---------------|
| $V_{IH}$                            | Input HIGH Voltage Level                               | $V_{CC} = 2.3\text{V}$ to $2.7\text{V}$                               |                                          | 1.7  | —                   | —        | V             |
|                                     |                                                        | $V_{CC} = 2.7\text{V}$ to $3.6\text{V}$                               |                                          | 2    | —                   | —        |               |
| $V_{IL}$                            | Input LOW Voltage Level                                | $V_{CC} = 2.3\text{V}$ to $2.7\text{V}$                               |                                          | —    | —                   | 0.7      | V             |
|                                     |                                                        | $V_{CC} = 2.7\text{V}$ to $3.6\text{V}$                               |                                          | —    | —                   | 0.8      |               |
| $I_{IH}$<br>$I_{IL}$                | Input Leakage Current                                  | $V_{CC} = 3.6\text{V}$                                                | $V_I = 0$ to $5.5\text{V}$               | —    | —                   | $\pm 5$  | $\mu\text{A}$ |
| $I_{OZH}$<br>$I_{OZL}$              | High Impedance Output Current<br>(3-State Output pins) | $V_{CC} = 3.6\text{V}$                                                | $V_O = 0$ to $5.5\text{V}$               | —    | —                   | $\pm 10$ | $\mu\text{A}$ |
| $I_{OFF}$                           | Input/Output Power Off Leakage                         | $V_{CC} = 0\text{V}$ , $V_{IN}$ or $V_O \leq 5.5\text{V}$             |                                          | —    | —                   | $\pm 50$ | $\mu\text{A}$ |
| $V_{IK}$                            | Clamp Diode Voltage                                    | $V_{CC} = 2.3\text{V}$ , $I_{IN} = -18\text{mA}$                      |                                          | —    | -0.7                | -1.2     | V             |
| $V_H$                               | Input Hysteresis                                       | $V_{CC} = 3.3\text{V}$                                                |                                          | —    | 100                 | —        | mV            |
| $I_{CCL}$<br>$I_{CCH}$<br>$I_{CCZ}$ | Quiescent Power Supply Current                         | $V_{CC} = 3.6\text{V}$                                                | $V_{IN} = \text{GND}$ or $V_{CC}$        | —    | —                   | 10       | $\mu\text{A}$ |
|                                     |                                                        |                                                                       | $3.6 \leq V_{IN} \leq 5.5\text{V}^{(2)}$ | —    | —                   | 10       |               |
| $\Delta I_{CC}$                     | Quiescent Power Supply Current Variation               | One input at $V_{CC} - 0.6\text{V}$ , other inputs at $V_{CC}$ or GND |                                          | —    | —                   | 500      | $\mu\text{A}$ |

### NOTES:

- Typical values are at  $V_{CC} = 3.3\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.
- This applies in the disabled state only.

## OUTPUT DRIVE CHARACTERISTICS

| Symbol   | Parameter           | Test Conditions <sup>(1)</sup>          |                          | Min.           | Max. | Unit |
|----------|---------------------|-----------------------------------------|--------------------------|----------------|------|------|
| $V_{OH}$ | Output HIGH Voltage | $V_{CC} = 2.3\text{V}$ to $3.6\text{V}$ | $I_{OH} = -0.1\text{mA}$ | $V_{CC} - 0.2$ | —    | V    |
|          |                     | $V_{CC} = 2.3\text{V}$                  | $I_{OH} = -4\text{mA}$   | 1.9            | —    |      |
|          |                     |                                         | $I_{OH} = -6\text{mA}$   | 1.7            | —    |      |
|          |                     |                                         | $I_{OH} = -8\text{mA}$   | 2              | —    |      |
|          |                     | $V_{CC} = 2.7\text{V}$                  | $I_{OH} = -4\text{mA}$   | 2.2            | —    |      |
|          |                     |                                         | $I_{OH} = -8\text{mA}$   | 2              | —    |      |
|          |                     | $V_{CC} = 3\text{V}$                    | $I_{OH} = -6\text{mA}$   | 2.4            | —    |      |
|          |                     |                                         | $I_{OH} = -12\text{mA}$  | 2              | —    |      |
| $V_{OL}$ | Output LOW Voltage  | $V_{CC} = 2.3\text{V}$ to $3.6\text{V}$ | $I_{OL} = 0.1\text{mA}$  | —              | 0.2  | V    |
|          |                     | $V_{CC} = 2.3\text{V}$                  | $I_{OL} = 4\text{mA}$    | —              | 0.4  |      |
|          |                     |                                         | $I_{OL} = 6\text{mA}$    | —              | 0.55 |      |
|          |                     |                                         | $I_{OL} = 8\text{mA}$    | —              | 0.6  |      |
|          |                     | $V_{CC} = 2.7\text{V}$                  | $I_{OL} = 4\text{mA}$    | —              | 0.4  |      |
|          |                     |                                         | $I_{OL} = 8\text{mA}$    | —              | 0.55 |      |
|          |                     | $V_{CC} = 3\text{V}$                    | $I_{OL} = 6\text{mA}$    | —              | 0.55 |      |
|          |                     |                                         | $I_{OL} = 12\text{mA}$   | —              | 0.8  |      |

### NOTE:

- $V_{IH}$  and  $V_{IL}$  must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate  $V_{CC}$  range.  
 $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

## OPERATING CHARACTERISTICS, $T_A = 25^\circ\text{C}$

| Symbol | Parameter                                                        | Test Conditions                         | Typical | Unit |
|--------|------------------------------------------------------------------|-----------------------------------------|---------|------|
| CPD    | Power Dissipation Capacitance per Buffer/Driver Outputs enabled  | $C_L = 0\text{pF}$ , $f = 10\text{MHz}$ | 35      | pF   |
| CPD    | Power Dissipation Capacitance per Buffer/Driver Outputs disabled |                                         | 4       |      |

## SWITCHING CHARACTERISTICS<sup>(1)</sup>

| Symbol                               | Parameter                                              | V <sub>CC</sub> = 2.7V |      | V <sub>CC</sub> = 3.3V ± 0.3V |      | Unit |
|--------------------------------------|--------------------------------------------------------|------------------------|------|-------------------------------|------|------|
|                                      |                                                        | Min.                   | Max. | Min.                          | Max. |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>xAx to xYx                        | —                      | 5.6  | 1.1                           | 4.4  | ns   |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>x $\overline{\text{OE}}$ to xYx  | —                      | 6.9  | 1                             | 5.5  | ns   |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>x $\overline{\text{OE}}$ to xYx | —                      | 6.8  | 1.8                           | 6.3  | ns   |
| t <sub>SK(o)</sub>                   | Output Skew <sup>(2)</sup>                             | —                      | —    | —                             | 500  | ps   |

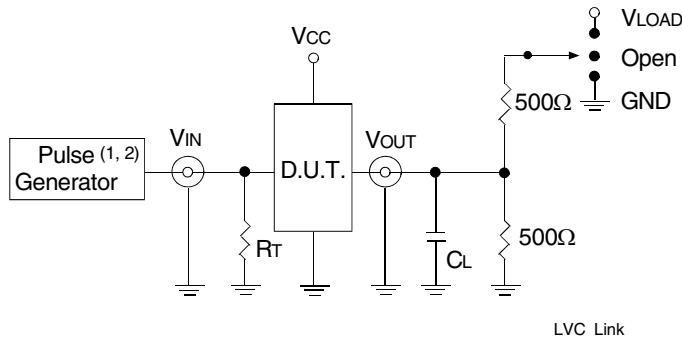
### NOTES:

- See TEST CIRCUITS AND WAVEFORMS.  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .
- Skew between any two outputs of the same package and switching in the same direction.

## TEST CIRCUITS AND WAVEFORMS

### TEST CONDITIONS

| Symbol            | V <sub>CC</sub> <sup>(1)</sup> =3.3V±0.3V | V <sub>CC</sub> <sup>(1)</sup> =2.7V | V <sub>CC</sub> <sup>(2)</sup> =2.5V±0.2V | Unit |
|-------------------|-------------------------------------------|--------------------------------------|-------------------------------------------|------|
| V <sub>LOAD</sub> | 6                                         | 6                                    | 2 x V <sub>CC</sub>                       | V    |
| V <sub>IH</sub>   | 2.7                                       | 2.7                                  | V <sub>CC</sub>                           | V    |
| V <sub>T</sub>    | 1.5                                       | 1.5                                  | V <sub>CC</sub> / 2                       | V    |
| V <sub>LZ</sub>   | 300                                       | 300                                  | 150                                       | mV   |
| V <sub>HZ</sub>   | 300                                       | 300                                  | 150                                       | mV   |
| C <sub>L</sub>    | 50                                        | 50                                   | 30                                        | pF   |



Test Circuit for All Outputs

#### DEFINITIONS:

C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.

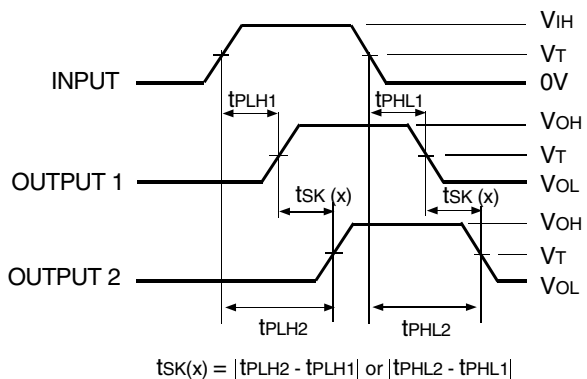
R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> of the Pulse Generator.

#### NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>r</sub> ≤ 2.5ns; t<sub>f</sub> ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>r</sub> ≤ 2ns; t<sub>f</sub> ≤ 2ns.

### SWITCH POSITION

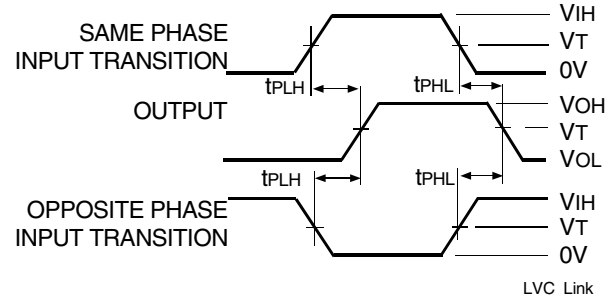
| Test                                    | Switch            |
|-----------------------------------------|-------------------|
| Open Drain<br>Disable Low<br>Enable Low | V <sub>LOAD</sub> |
| Disable High<br>Enable High             | GND               |
| All Other Tests                         | Open              |



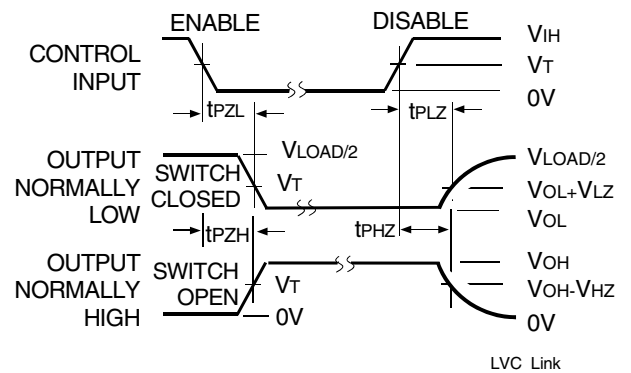
Output Skew - tsK(x)

#### NOTES:

1. For tsK(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For tsK(b) OUTPUT1 and OUTPUT2 are in the same bank.



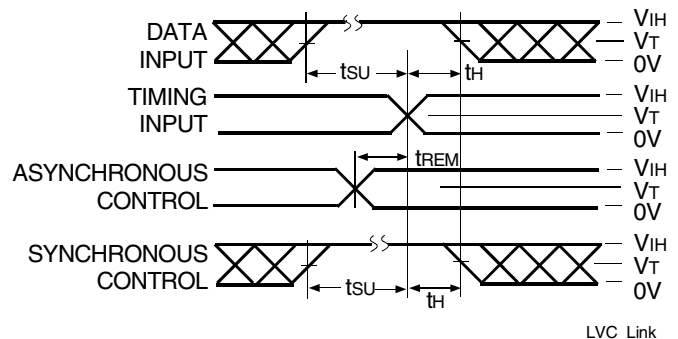
Propagation Delay



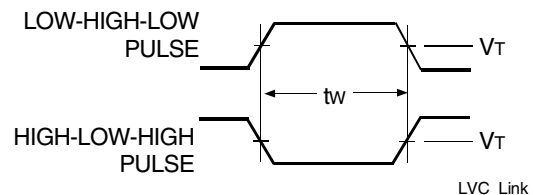
Enable and Disable Times

#### NOTE:

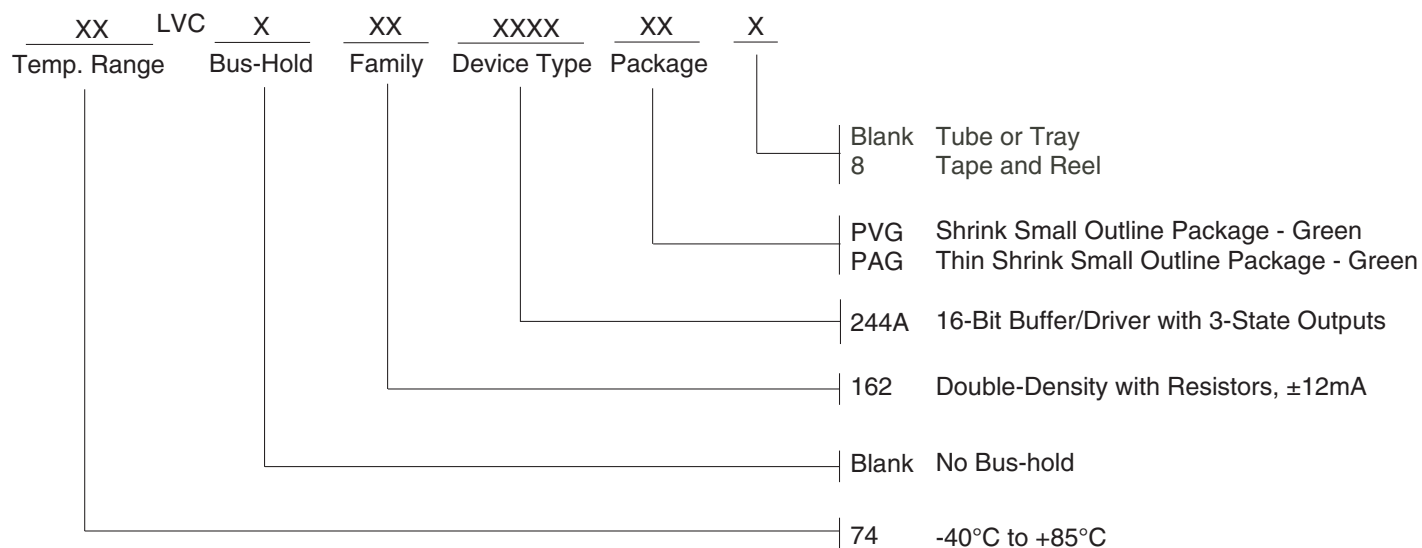
1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.



Set-up, Hold, and Release Times



Pulse Width



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