# 3.3V CMOS 16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS AND BUS-HOLD

**IDT74ALVCH162374**

## FEATURES:

- 0.5 MICRON CMOS Technology
- 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 ± 0.3V, Normal Range
- $V_{CC}$ = 2.7V to 3.6V, Extended Range
- $V_{CC}$ = 2.5V ± 0.2V
- CMOS power levels (0.4µ W typ. static)
- Rail-to-Rail output swing for increased noise margin
- Available in TSSOP package

## DRIVE FEATURES:

- Balanced Output Drivers: ±12mA
- Low switching noise

## APPLICATIONS:

- 3.3V high speed systems
- 3.3V and lower voltage computing systems

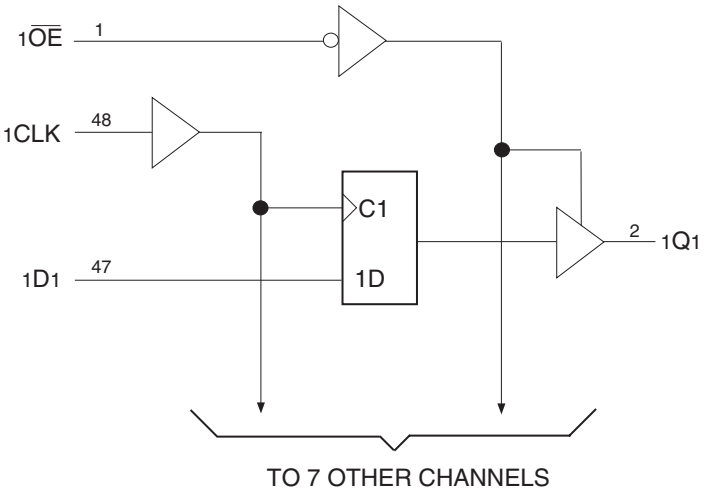
## DESCRIPTION:

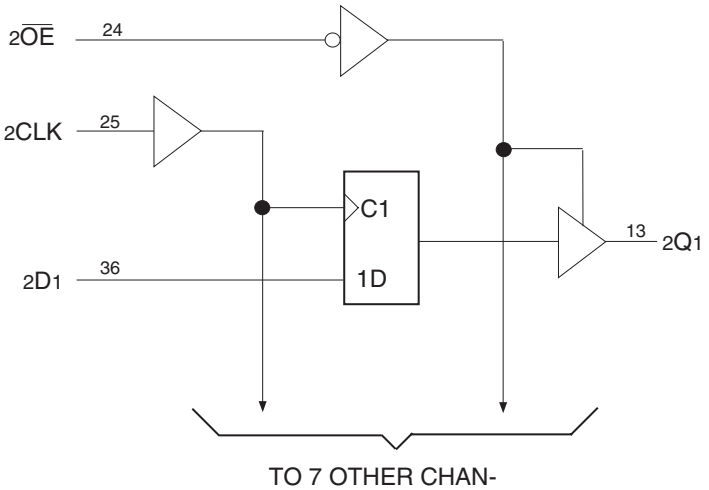
This 16-bit edge-triggered D-type flip-flop is built using advanced dual metal CMOS technology. The ALVCH162374 is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CLK) input, the Q outputs of the flip-flop take on the logic levels set up at the data (D) inputs. $\overline{OE}$ can be used to place the eight outputs in either a normal logic state (high or low logic levels) 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 the increased drive provide the capability to drive bus lines without need for interface or pullup components. $\overline{OE}$ does not affect internal operations of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

The ALVCH162374 has series resistors in the device output structure which will significantly reduce line noise when used with light loads. This driver has been designed to drive ±12mA at the designated threshold levels.

The ALVCH162374 has "bus-hold" which retains the inputs' last state whenever the input goes to a high impedance. This prevents floating inputs and eliminates the need for pull-up/down resistor.

## FUNCTIONAL BLOCK DIAGRAM



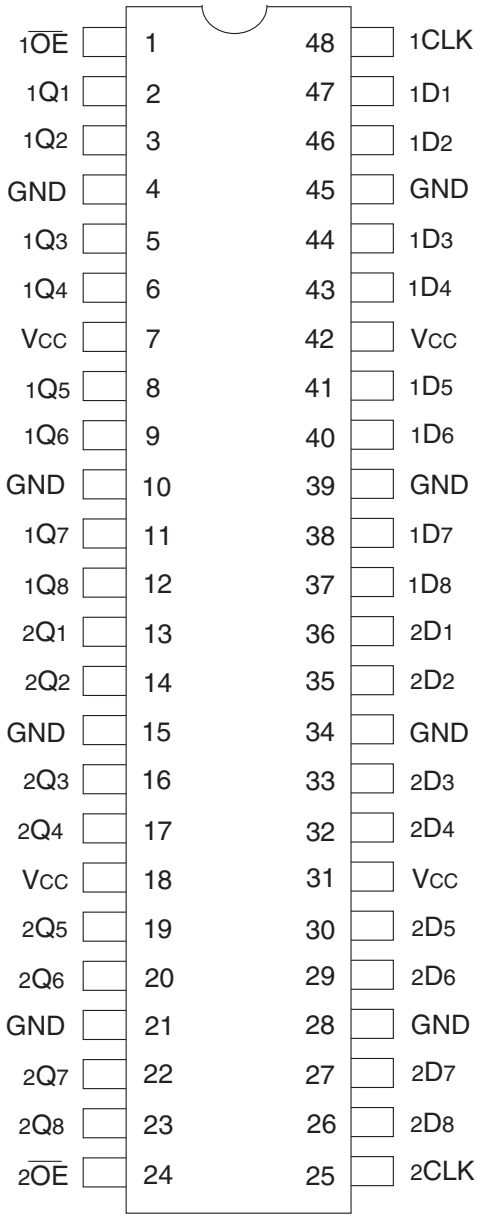




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## PIN CONFIGURATION




**TSSOP**
**TOP VIEW**

## ABSOLUTE MAXIMUM RATINGS(1)

| Symbol | Description | Max | Unit |
|---|---|---|---|
| $V_{TERM}$(2) | Terminal Voltage with Respect to GND | –0.5 to +4.6 | V |
| $V_{TERM}$(3) | Terminal Voltage with Respect to GND | –0.5 to $V_{CC}$+0.5 | V |
| $T_{STG}$ | Storage Temperature | –65 to +150 | ° C |
| $I_{OUT}$ | DC Output Current | –50 to +50 | mA |
| $I_{IK}$ | Continuous Clamp Current, $V_I$ < 0 or $V_I$ > $V_{CC}$ | ±50 | mA |
| $I_{OK}$ | Continuous Clamp Current, $V_O$ < 0 | –50 | mA |
| $I_{CC}$ $I_{SS}$ | Continuous Current through each $V_{CC}$ or GND | ±100 | mA |

**NOTES:**
1. 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.
2. $V_{CC}$ terminals.
3. All terminals except $V_{CC}$.

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

| Symbol | Parameter(1) | Conditions | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 0V | 5 | 7 | pF |
| $C_{OUT}$ | Output Capacitance | $V_{OUT}$ = 0V | 7 | 9 | pF |
| $C_{I/O}$ | I/O Port Capacitance | $V_{IN}$ = 0V | 7 | 9 | pF |

**NOTE:**
1. As applicable to the device type.

## PIN DESCRIPTION

| Pin Names | Description |
|---|---|
| xDx | Data Inputs(1) |
| xCLK | Clock Inputs |
| xQx | 3-State Outputs |
| x$\overline{OE}$ | 3-State Output Enable Input (Active LOW) |

**NOTE:**
1. These pins have "Bus-Hold". All other pins are standard inputs, outputs, or I/Os.

## FUNCTION TABLE (EACH FLIP-FLOP)(1)

| Inputs | | | Outputs |
|---|---|---|---|
| x$\overline{OE}$ | xCLK | xDx | xQx |
| L | ↑ | H | H |
| L | ↑ | L | L |
| L | H or L | X | $Q_0$(2) |
| H | X | X | Z |

**NOTES:**
1. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   Z = High Impedance
   ↑ = LOW-to-HIGH transition
2. Output level before the indicated steady-state input conditions were established.



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## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:
Operating Condition: $T_A$ = –40°C to +85°C

| Symbol | Parameter | Test Conditions | | Min. | Typ.(1) | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage Level | $V_{CC}$ = 2.3V to 2.7V | | 1.7 | — | — | V |
| | | $V_{CC}$ = 2.7V to 3.6V | | 2 | — | — | |
| $V_{IL}$ | Input LOW Voltage Level | $V_{CC}$ = 2.3V to 2.7V | | — | — | 0.7 | V |
| | | $V_{CC}$ = 2.7V to 3.6V | | — | — | 0.8 | |
| $I_{IH}$ | Input HIGH Current | $V_{CC}$ = 3.6V | $V_I$ = $V_{CC}$ | — | — | ±5 | µA |
| $I_{IL}$ | Input LOW Current | $V_{CC}$ = 3.6V | $V_I$ = GND | — | — | ±5 | µA |
| $I_{OZH}$ | High Impedance Output Current | $V_{CC}$ = 3.6V | $V_O$ = $V_{CC}$ | — | — | ±10 | µA |
| $I_{OZL}$ | (3-State Output pins) | | $V_O$ = GND | — | — | ±10 | |
| $V_{IK}$ | Clamp Diode Voltage | $V_{CC}$ = 2.3V, $I_{IN}$ = –18mA | | — | –0.7 | –1.2 | V |
| $V_H$ | Input Hysteresis | $V_{CC}$ = 3.3V | | — | 100 | — | mV |
| $I_{CCL}$<br>$I_{CCH}$<br>$I_{CCZ}$ | Quiescent Power Supply Current | $V_{CC}$ = 3.6V<br>$V_{IN}$ = GND or $V_{CC}$ | | — | 0.1 | 40 | µA |
| $\Delta I_{CC}$ | Quiescent Power Supply Current Variation | One input at $V_{CC}$ - 0.6V, other inputs at $V_{CC}$ or GND | | — | — | 750 | µA |

**NOTE:**
1. Typical values are at $V_{CC}$ = 3.3V, +25°C ambient.

## BUS-HOLD CHARACTERISTICS

| Symbol | Parameter(1) | Test Conditions | | Min. | Typ.(2) | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BHH}$ | Bus-Hold Input Sustain Current | $V_{CC}$ = 3V | $V_I$ = 2V | –75 | — | — | µA |
| $I_{BHL}$ | | | $V_I$ = 0.8V | 75 | — | — | |
| $I_{BHH}$ | Bus-Hold Input Sustain Current | $V_{CC}$ = 2.3V | $V_I$ = 1.7V | –45 | — | — | µA |
| $I_{BHL}$ | | | $V_I$ = 0.7V | 45 | — | — | |
| $I_{BHHO}$ | Bus-Hold Input Overdrive Current | $V_{CC}$ = 3.6V | $V_I$ = 0 to 3.6V | — | — | ±500 | µA |
| $I_{BHLO}$ | | | | | | | |

**NOTES:**
1. Pins with Bus-Hold are identified in the pin description.
2. Typical values are at $V_{CC}$ = 3.3V, +25°C ambient.



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## OUTPUT DRIVE CHARACTERISTICS

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

**NOTE:**
1. $V_{IH}$ 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°C to + 85°C.

## OPERATING CHARACTERISTICS, $T_A$ = 25°C

| Symbol | Parameter | Test Conditions | $V_{CC}$ = 2.5V ± 0.2V | $V_{CC}$ = 3.3V ± 0.3V | Unit |
|---|---|---|---|---|---|
| | | | Typical | Typical | |
| $C_{PD}$ | Power Dissipation Capacitance Outputs enabled | $C_L$ = 0pF, f = 10Mhz | 28 | 31 | pF |
| $C_{PD}$ | Power Dissipation Capacitance Outputs disabled | | 10 | 11 | |

## SWITCHING CHARACTERISTICS[1]

| Symbol | Parameter | $V_{CC}$ = 2.5V ± 0.2V | | $V_{CC}$ = 2.7V | | $V_{CC}$ = 3.3V ± 0.3V | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. | |
| $f_{MAX}$ | | 150 | — | 150 | — | 150 | — | MHz |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>xCLK to xQx | 1 | 5.4 | — | 5.4 | 1 | 4.6 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>x$\overline{OE}$ to xQx | 1 | 6.5 | — | 6.4 | 1 | 5.2 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>x$\overline{OE}$ to xQx | 1 | 5.6 | — | 5 | 1.2 | 4.5 | ns |
| $t_{SU}$ | Setup Time, data before CLK↑ | 2.1 | — | 2.2 | — | 1.9 | — | ns |
| $t_H$ | Hold Time, data after CLK↑ | 0.6 | — | 0.5 | — | 0.5 | — | ns |
| $t_W$ | Pulse Duration, LE HIGH or LOW | 3.3 | — | 3.3 | — | 3.3 | — | ns |
| $t_{SK(O)}$ | Output Skew[2] | — | — | — | — | — | 500 | ps |

**NOTES:**
1. See TEST CIRCUITS AND WAVEFORMS. $T_A$ = – 40°C to + 85°C.
2. Skew between any two outputs of the same package and switching in the same direction.

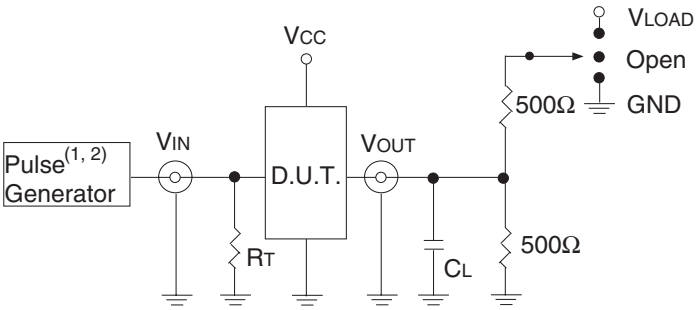


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# TEST CIRCUITS AND WAVEFORMS

## TEST CONDITIONS

| Symbol | $V_{CC}^{(1)}$=3.3V±0.3V | $V_{CC}^{(1)}$=2.7V | $V_{CC}^{(2)}$=2.5V±0.2V | Unit |
|---|---|---|---|---|
| $V_{LOAD}$ | 6 | 6 | 2 x Vcc | V |
| $V_{IH}$ | 2.7 | 2.7 | Vcc | V |
| $V_T$ | 1.5 | 1.5 | Vcc / 2 | V |
| $V_{LZ}$ | 300 | 300 | 150 | mV |
| $V_{HZ}$ | 300 | 300 | 150 | mV |
| $C_L$ | 50 | 50 | 30 | pF |




*Test Circuit for All Outputs*

**DEFINITIONS:**

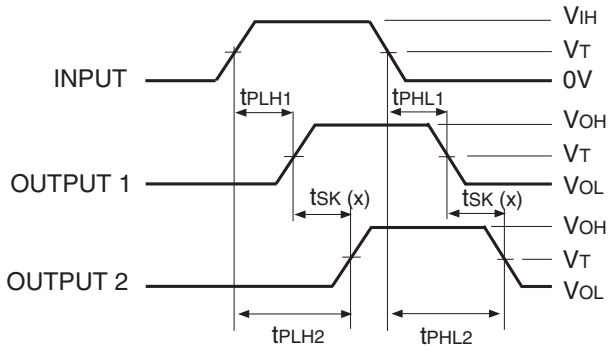
$C_L$ = Load capacitance: includes jig and probe capacitance.
$R_T$ = Termination resistance: should be equal to $Z_{OUT}$ of the Pulse Generator.

**NOTES:**

1. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; $t_F$ ≤ 2.5ns; $t_R$ ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; $t_F$ ≤ 2ns; $t_R$ ≤ 2ns.

## SWITCH POSITION

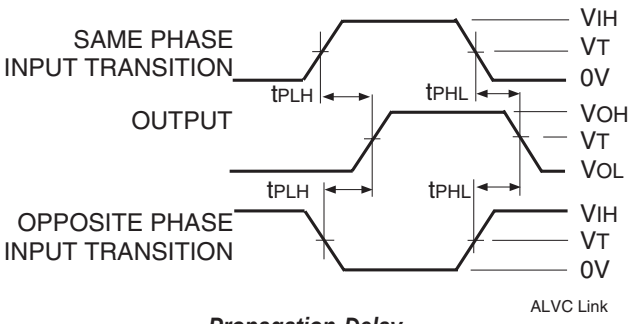
| Test | Switch |
|---|---|
| Open Drain<br>Disable Low<br>Enable Low | $V_{LOAD}$ |
| Disable High<br>Enable High | GND |
| All Other Tests | Open |



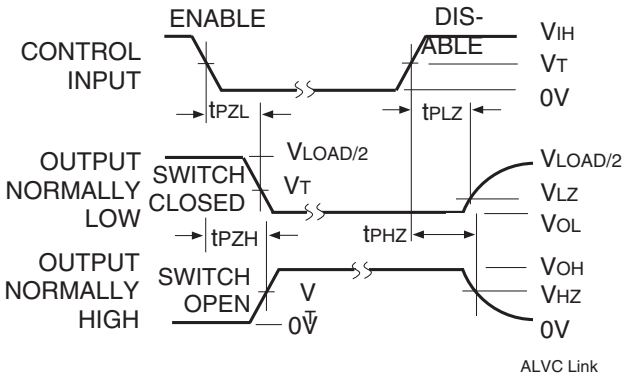

*Output Skew - $t_{SK}(x)$*

**NOTES:**

1. For $t_{SK}$(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For $t_{SK}$(b) OUTPUT1 and OUTPUT2 are in the same bank.



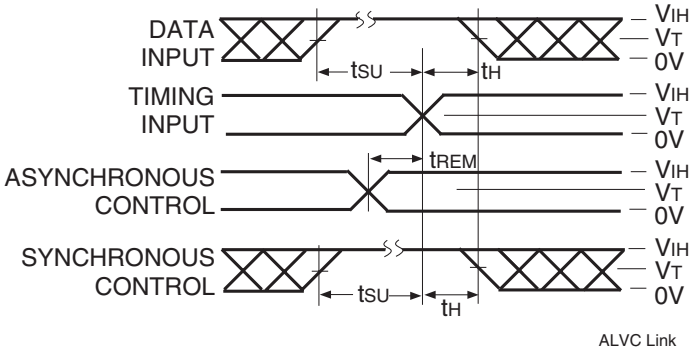

*Propagation Delay*



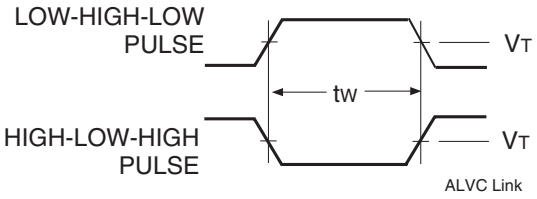

*Enable and Disable Times*

**NOTE:**

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




*Set-up, Hold, and Release Times*

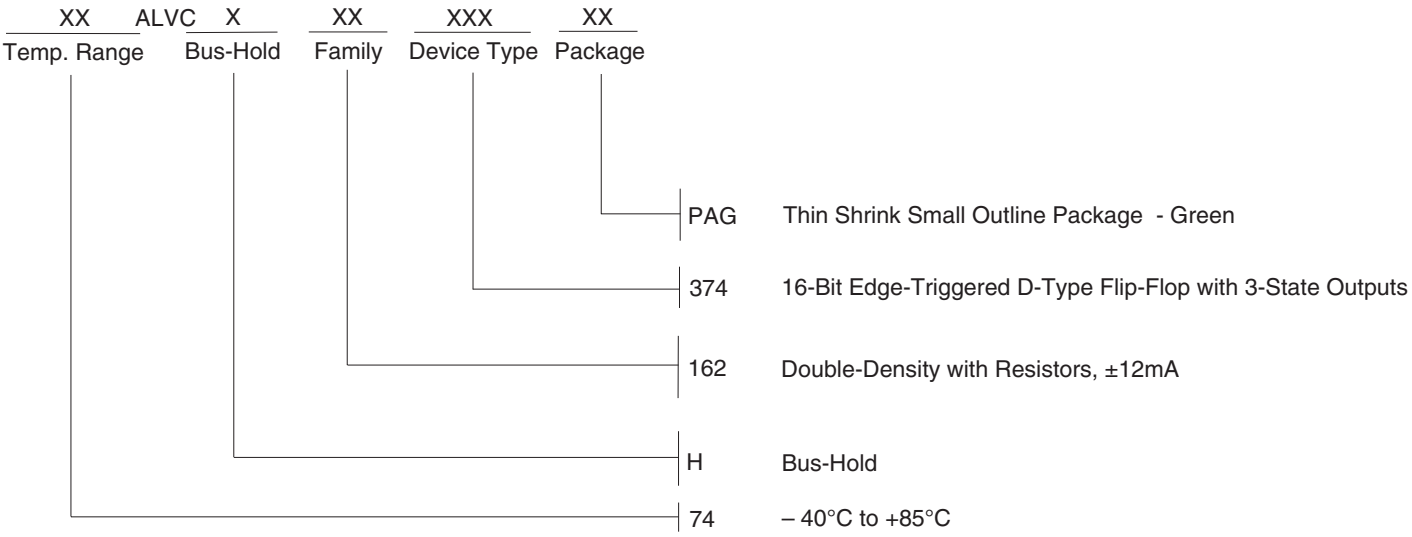



*Pulse Width*



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