



## 3.3V CMOS 20-BIT FLIP-FLOP WITH 3-STATE OUTPUTS AND BUS-HOLD

IDT74ALVCH162721

### FEATURES:

- 0.5 MICRON CMOS Technology
- Typical  $t_{sk(0)}$  (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015;  
> 200V using machine model (C = 200pF, R = 0)
- 0.635mm pitch SSOP, 0.50mm pitch TSSOP,  
and 0.40mm pitch TVSOP packages
- Extended commercial range of -40°C to +85°C
- $V_{CC} = 3.3V \pm 0.3V$ , Normal Range
- $V_{CC} = 2.7V$  to  $3.6V$ , Extended Range
- $V_{CC} = 2.5V \pm 0.2V$
- CMOS power levels (0.4μW typ. static)
- Rail-to-Rail output swing for increased noise margin

### Drive Features for ALVCH162721:

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

### APPLICATIONS:

- 3.3V High Speed Systems
- 3.3V and lower voltage computing systems

### DESCRIPTION:

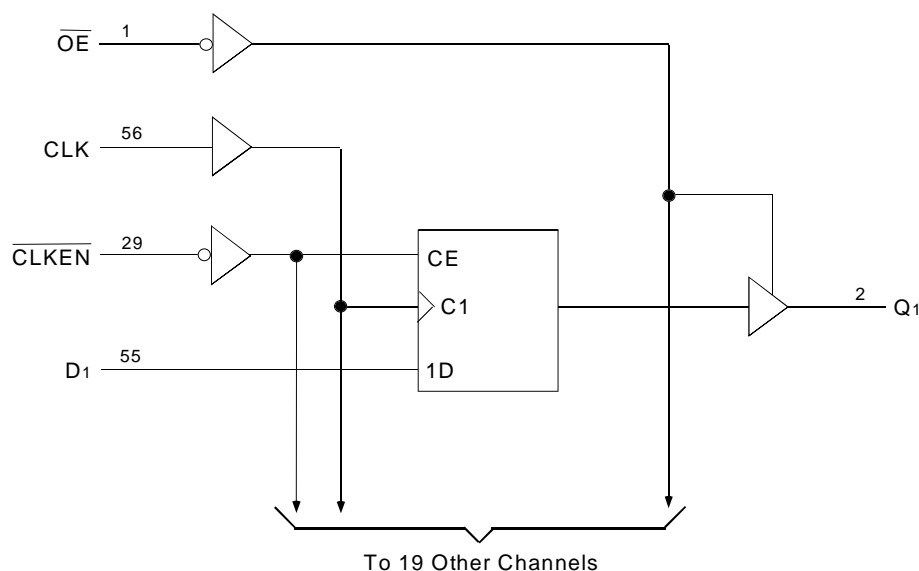
This 20-bit flip-flop is built using advanced dual metal CMOS technology. The 20 flip-flops of the ALVCH162721 are edge-triggered D-type flip-flops with qualified clock storage. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs if the clock-enable ( $\overline{CLKEN}$ ) input is low. If  $\overline{CLKEN}$  is high, no data is stored.

A buffered output-enable ( $\overline{OE}$ ) input places the 20 outputs in either a normal logic state (high or low) 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 capability to drive bus lines without 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.

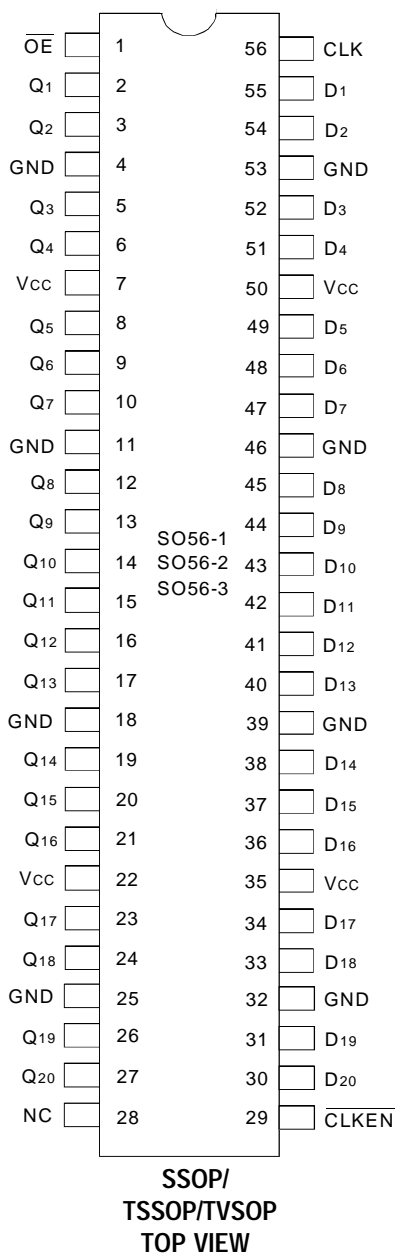
The ALVCH162721 has series resistors in the device output structure which will significantly reduce line noise when used with light loads. This driver has been designed to drive  $\pm 12mA$  at the designated threshold levels.

The ALVCH162721 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



## PIN CONFIGURATION



## PIN DESCRIPTION

Pin Names	Description
$\overline{OE}$	3-State Output Enable Input (Active LOW)
Dx	Data Inputs <sup>(1)</sup>
Qx	3-State Outputs
CLK	Clock Input
$\overline{CLKEN}$	Clock Enable Input (Active LOW)
NC	No Internal Connection

### NOTE:

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

## ABSOLUTE MAXIMUM RATING (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
TSTG	Storage Temperature	- 65 to + 150	°C
I <sub>OUT</sub>	DC Output Current	- 50 to + 50	mA
I <sub>IK</sub>	Continuous Clamp Current, $V_i < 0$ or $V_i > V_{CC}$	± 50	mA
I <sub>OK</sub>	Continuous Clamp Current, $V_o < 0$	- 50	mA
I <sub>CC</sub> I <sub>SS</sub>	Continuous Current through each V <sub>CC</sub> or GND	± 100	mA

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### 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<sub>CC</sub> terminals.
3. All terminals except V<sub>CC</sub>.

## CAPACITANCE (T<sub>A</sub> = +25°C, f = 1.0MHz)

Symbol	Parameter <sup>(1)</sup>	Conditions	Typ.	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V	5	7	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	7	9	pF
C <sub>I/O</sub>	I/O Port Capacitance	V <sub>IN</sub> = 0V	7	9	pF

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### NOTE:

1. As applicable to the device type.

## FUNCTION TABLE (each flip-flop)<sup>(1)</sup>

$\overline{OE}$	Inputs			Output
	$\overline{CLKEN}$	CLK	Dx	Qx
L	H	X	X	Q <sub>0</sub>
L	L	↑	H	H
L	L	↑	L	L
L	L	L or H	X	Q <sub>0</sub>
H	X	X	X	Z

### NOTE:

1. H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
Z = High-Impedance  
↑ = LOW-to-HIGH Transition  
Q<sub>0</sub> = Output level before the indicated steady-state input conditions were established.

**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	
$I_{IH}$	Input HIGH Current	$V_{CC} = 3.6\text{V}$	$V_I = V_{CC}$	—	—	$\pm 5$	$\mu\text{A}$
$I_{IL}$	Input LOW Current	$V_{CC} = 3.6\text{V}$	$V_I = \text{GND}$	—	—	$\pm 5$	
$I_{OZH}$	High Impedance Output Current (3-State Output pins)	$V_{CC} = 3.6\text{V}$	$V_O = V_{CC}$	—	—	$\pm 10$	$\mu\text{A}$
$I_{OZL}$			$V_O = \text{GND}$	—	—	$\pm 10$	
$V_{IK}$	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
$I_{CCL}$ $I_{CCH}$ $I_{CCZ}$	Quiescent Power Supply Current	$V_{CC} = 3.6\text{V}$ $V_{IN} = \text{GND}$ or $V_{CC}$		—	0.1	40	$\mu\text{A}$
$\Delta I_{CC}$	Quiescent Power Supply Current Variation	One input at $V_{CC} - 0.6\text{V}$ , other inputs at $V_{CC}$ or $\text{GND}$		—	—	750	$\mu\text{A}$

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**NOTE:**

- Typical values are at  $V_{CC} = 3.3\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.

**BUS-HOLD CHARACTERISTICS**

Symbol	Parameter <sup>(1)</sup>	Test Conditions		Min.	Typ. <sup>(2)</sup>	Max.	Unit
$I_{BHH}$ $I_{BHL}$	Bus-Hold Input Sustain Current	$V_{CC} = 3.0\text{V}$	$V_I = 2.0\text{V}$	-75	—	—	$\mu\text{A}$
			$V_I = 0.8\text{V}$	75	—	—	
$I_{BHH}$ $I_{BHL}$	Bus-Hold Input Sustain Current	$V_{CC} = 2.3\text{V}$	$V_I = 1.7\text{V}$	-45	—	—	$\mu\text{A}$
			$V_I = 0.7\text{V}$	45	—	—	
$I_{BHHO}$ $I_{BHLO}$	Bus-Hold Input Overdrive Current	$V_{CC} = 3.6\text{V}$	$V_I = 0$ to $3.6\text{V}$	—	—	$\pm 500$	$\mu\text{A}$

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**NOTES:**

- Pins with Bus-hold are identified in the pin description.
- Typical values are at  $V_{CC} = 3.3\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.

**OUTPUT DRIVE CHARACTERISTICS**

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Max.	Unit
VOH	Output HIGH Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OH</sub> = -0.1mA	V <sub>CC</sub> - 0.2	—	V
		V <sub>CC</sub> = 2.3V	I <sub>OH</sub> = -4mA	1.9	—	
			I <sub>OH</sub> = -6mA	1.7	—	
		V <sub>CC</sub> = 2.7V	I <sub>OH</sub> = -4mA	2.2	—	
			I <sub>OH</sub> = -8mA	2	—	
		V <sub>CC</sub> = 3.0V	I <sub>OH</sub> = -6mA	2.4	—	
I <sub>OH</sub> = -12mA	2		—			
VOL	Output LOW Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OL</sub> = 0.1mA	—	0.2	V
		V <sub>CC</sub> = 2.3V	I <sub>OL</sub> = 4mA	—	0.4	
			I <sub>OL</sub> = 6mA	—	0.55	
		V <sub>CC</sub> = 2.7V	I <sub>OL</sub> = 4mA	—	0.4	
			I <sub>OL</sub> = 8mA	—	0.6	
		V <sub>CC</sub> = 3.0V	I <sub>OL</sub> = 6mA	—	0.55	
I <sub>OL</sub> = 12mA	—		0.8			

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**NOTE:**

1. V<sub>IH</sub> and V<sub>IL</sub> must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate V<sub>CC</sub> range. T<sub>A</sub> = -40°C to +85°C.

**OPERATING CHARACTERISTICS, T<sub>A</sub> = 25°C**

Symbol	Parameter	Test Conditions	V <sub>CC</sub> = 2.5V ± 0.2V	V <sub>CC</sub> = 3.3V ± 0.3V	Unit
			Typical	Typical	
CPD	Power Dissipation Capacitance Outputs enabled	C <sub>L</sub> = 0pF, f = 10MHz	55	59	pF
CPD	Power Dissipation Capacitance Outputs disabled		46	49	pF

**SWITCHING CHARACTERISTICS (1)**

Symbol	Parameter	V <sub>CC</sub> = 2.5V ± 0.2V		V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 3.3V ± 0.3V		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>MAX</sub>		150	—	150	—	150	—	MHz
t <sub>PLH</sub>	Propagation Delay	1	6.7	—	6.2	1	5.3	ns
t <sub>PHL</sub>	CLK to Qx							
t <sub>PZH</sub>	Output Enable Time	1	7.2	—	7	1	5.8	ns
t <sub>PZL</sub>	$\overline{OE}$ to Qx							
t <sub>PHZ</sub>	Output Disable Time	1	6.3	—	5.4	1	5	ns
t <sub>PLZ</sub>	$\overline{OE}$ to Qx							
t <sub>SU</sub>	Setup Time, data before CLK $\uparrow$	4	—	3.6	—	3.1	—	ns
t <sub>SU</sub>	Setup Time $\overline{CLKEN}$ before CLK $\uparrow$	3.4	—	3.1	—	2.7	—	ns
t <sub>H</sub>	Hold Time, data after CLK $\uparrow$	0	—	0	—	0	—	ns
t <sub>H</sub>	Hold Time, $\overline{CLKEN}$ after CLK $\uparrow$	0	—	0	—	0	—	ns
t <sub>w</sub>	Pulse Width, CLK HIGH or LOW	3.3	—	3.3	—	3.3	—	ns
t <sub>SK(0)</sub>	Output Skew <sup>(2)</sup>	—	—	—	—	—	500	ps

**NOTES:**

1. See test circuits and waveforms. T<sub>A</sub> = -40°C to +85°C.
2. Skew between any two outputs of the same package and switching in the same direction.

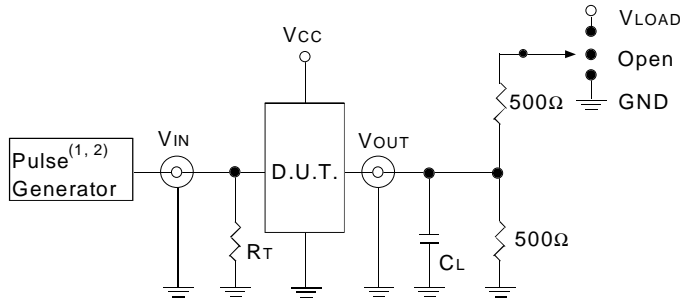
## TEST CIRCUITS AND WAVEFORMS

### TEST CONDITIONS

Symbol	V <sub>CC</sub> (1)= 3.3V±0.3V	V <sub>CC</sub> (1)= 2.7V	V <sub>CC</sub> (2)= 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

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### TEST CIRCUITS FOR ALL OUTPUTS



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#### 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:

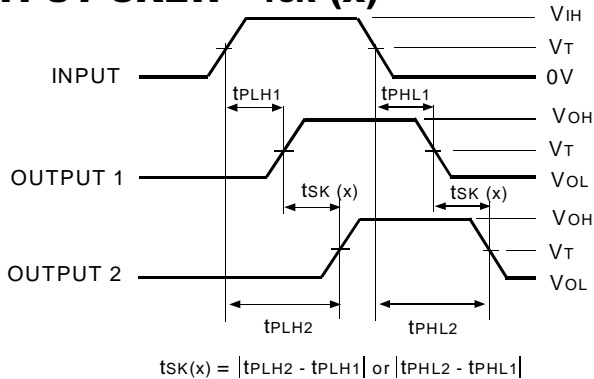
1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>F</sub> ≤ 2.5ns; t<sub>R</sub> ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>F</sub> ≤ 2ns; t<sub>R</sub> ≤ 2ns.

### SWITCH POSITION

Test	Switch
Open Drain Disable Low Enable Low	V <sub>LOAD</sub>
Disable High Enable High	GND
All Other tests	Open

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### OUTPUT SKEW - TSK (x)

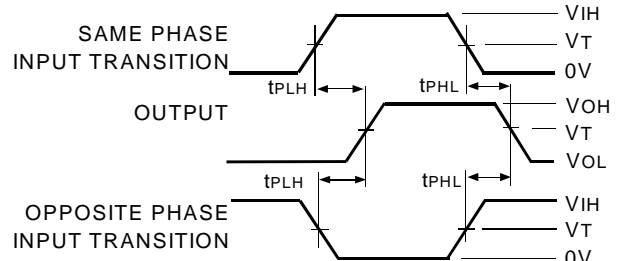


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#### NOTES:

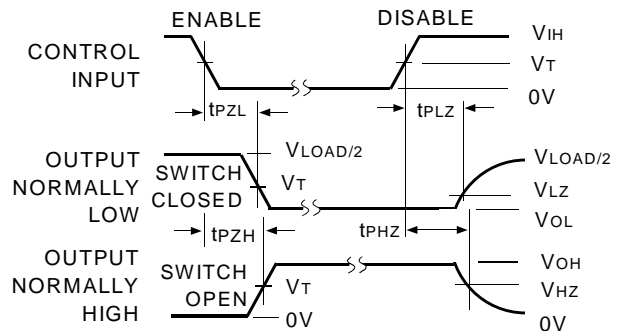
1. For tsk(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For tsk(b) OUTPUT1 and OUTPUT2 are in the same bank.

### PROPAGATION DELAY



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### ENABLE AND DISABLE TIMES

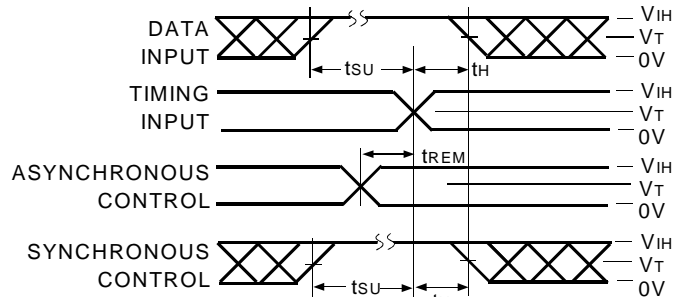


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#### NOTE:

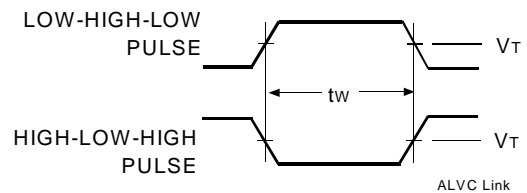
1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.

### SET-UP, HOLD, AND RELEASE TIMES



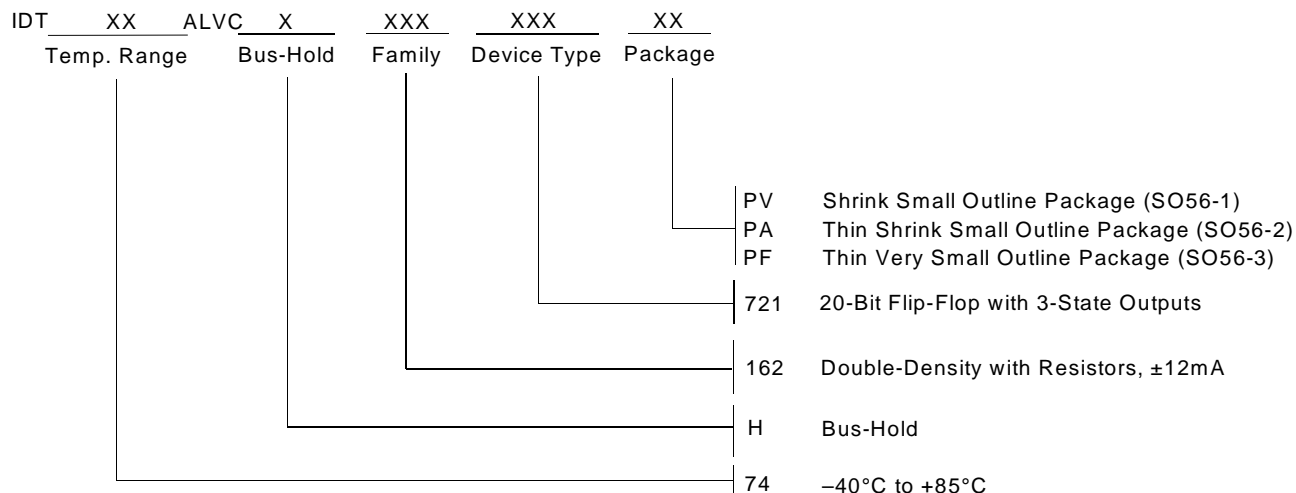
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### PULSE WIDTH



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