FAIRCHILD SEMICONDUCTOR™

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74VCX16721
Low Voltage 20-Bit D-Type Flip-Flops with 3.6V Tolerant Inputs and Outputs

General Description

The VCX16721 contains twenty non-inverting D-type flip-flops with 3-STATE outputs and is intended for bus oriented applications.

The 74VCX16721 is designed for low voltage (1.4V to 3.6V) V_{CC} applications with I/O compatibility up to 3.6V.

The 74VCX16721 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

Features

- 1.4V to 3.6V V_{CC} supply operation
- 3.6V tolerant inputs and outputs
- t_{PD} (CLK to O_n)
  3.5 ns max for 3.0V to 3.6V V_{CC}
- Power-off high impedance inputs and outputs
- Supports live insertion and withdrawal (Note 1)
- Static Drive (I_{OH}/I_{OL})
  ±24 mA @ 3.0V V_{CC}
- Uses patented noise/EMI reduction circuitry
- Latch-up performance exceeds 300 mA
- ESD performance:
  Human body model > 2000V
  Machine model > 200V

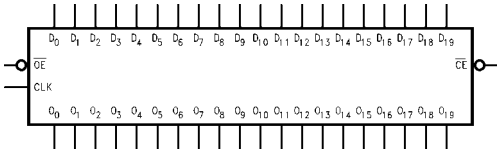
Note 1: To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pull-up resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

Order Number	Package Number	Package Description
74VCX16721MTD	MTD56	56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

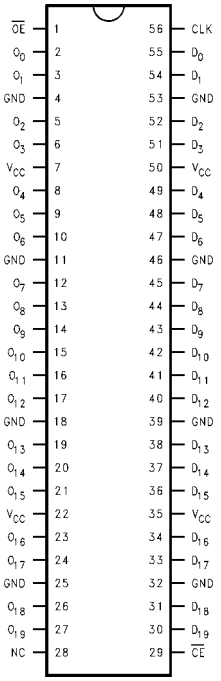
Logic Symbol



Pin Descriptions

Pin Names	Description
$\overline{OE}$	Output Enable Input (Active LOW)
CLK	Clock Input
D_0–D_{19}	Inputs
O_0–O_{19}	Outputs
$\overline{CE}$	Clock Enable Input (Active LOW)

Connection Diagram



Truth Table

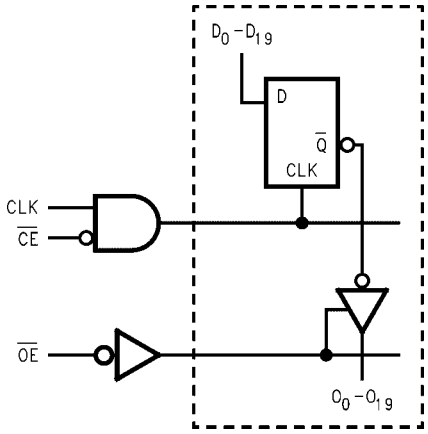
CLK	$\overline{CE}$	$\overline{OE}$	D_0–D_{19}	O_0–O_{19}
X	X	H	X	Z
X	H	L	X	O_0
⌐	L	L	L	L
⌐	L	L	H	H
L or H	L	L	X	O_0

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial (HIGH or LOW, inputs may not float)
Z = High Impedance
O_0 = Previous O_0 before LOW-to-HIGH transition of Clock
⌐ = LOW-to-HIGH transition

Functional Description

The VCX16721 contains twenty D-type flip-flops with 3-STATE standard outputs. The twenty flip-flops will store the state of their individual D-type inputs that meet the setup and hold time requirements on the LOW-HIGH Clock (CLK) transition, when the Clock-Enable ($\overline{CE}$) is LOW. The 3-STATE standard outputs are controlled by the Output-Enable ($\overline{OE}$). When $\overline{OE}$ is HIGH, the standard outputs are in high impedance mode but this does not interfere with entering new data into the flip-flops.

Logic Diagram



Absolute Maximum Ratings (Note 2)

Supply Voltage (V_{CC})	−0.5V to +4.6V
DC Input Voltage (V_I)	−0.5V to +4.6V
Output Voltage (V_O)	
Outputs 3-STATED	−0.5V to +4.6V
Outputs Active (Note 3)	−0.5V to V_{CC} + 0.5V
DC Input Diode Current (I_{IK}) V_I < 0V	−50 mA
DC Output Diode Current (I_{OK})	
V_O < 0V	−50 mA
V_O > V_{CC}	+50 mA
DC Output Source/Sink Current (I_{OH}/I_{OL})	±50 mA
DC V_{CC} or GND Current per Supply Pin (I_{CC} or GND)	±100 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C

Recommended Operating Conditions (Note 4)

Power Supply	
Operating	1.4V to 3.6V
Input Voltage	−0.3V to +3.6V
Output Voltage (V_O)	
Output in Active States	0V to V_{CC}
Output in 3-STATE	0.0V to 3.6V
Output Current in I_{OH}/I_{OL}	
V_{CC} = 3.0V to 3.6V	±24 mA
V_{CC} = 2.3V to 2.7V	±18 mA
V_{CC} = 1.65V to 2.3V	±6 mA
V_{CC} = 1.4V to 1.6V	±2 mA
Free Air Operating Temperature (T_A)	−40°C to +85°C
Minimum Input Edge Rate ($\Delta t/\Delta V$)	
V_{IN} = 0.8V to 2.0V, V_{CC} = 3.0V	10 ns/V

Note 2: The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Note 3: I_O Absolute Maximum Rating must be observed.

Note 4: Floating or unused inputs must be held HIGH or LOW.

DC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	Min	Max	Units
V_{IH}	HIGH Level Input Voltage		2.7 - 3.6	2.0		V
			2.3 - 2.7	1.6		
			1.65 - 2.3	0.65 x V_{CC}		
			1.4 - 1.6	0.65 x V_{CC}		
V_{IL}	LOW Level Input Voltage		2.7 - 3.6		0.8	V
			2.3 - 2.7		0.7	
			1.65 - 2.3		0.35 x V_{CC}	
			1.4 - 1.6		0.35 x V_{CC}	
V_{OH}	HIGH Level Output Voltage	I_{OH} = −100 µA	2.7 - 3.6	V_{CC} - 0.2		V
		I_{OH} = −12 mA	2.7	2.2		
		I_{OH} = −18 mA	3.0	2.4		
		I_{OH} = −24 mA	3.0	2.2		
		I_{OH} = −100 µA	2.3 - 2.7	V_{CC} - 0.2		
		I_{OH} = −6 mA	2.3	2.0		
		I_{OH} = −12 mA	2.3	1.8		
		I_{OH} = −18 mA	2.3	1.7		
		I_{OH} = −100 µA	1.65 - 2.3	V_{CC} - 0.2		
		I_{OH} = −6 mA	1.65	1.25		
		I_{OH} = −100 µA	1.4 - 1.6	V_{CC} - 0.2		
		I_{OH} = −12 mA	1.4	1.05		

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V_{CC} (V)	Min	Max	Units
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 µA	2.7 - 3.6		0.2	
		I_{OL} = 12 mA	2.7		0.4	
		I_{OL} = 18 mA	3.0		0.4	
		I_{OL} = 24 mA	3.0		0.55	
		I_{OL} = 100 µA	2.3 - 2.7		0.2	
		I_{OL} = 12 mA	2.3		0.4	V
		I_{OL} = 18 mA	2.3		0.6	
		I_{OL} = 100 µA	1.65 - 2.3		0.2	
		I_{OL} = 6 mA	1.65		0.3	
		I_{OL} = 100 µA	1.4 - 1.6		0.2	
		I_{OL} = 2 mA	1.4		0.35	
I_I	Input Leakage Current	$0 \le V_I \le 3.6V$	1.4 - 3.6		±5.0	µA
I_{OZ}	3-STATE Output Leakage	$0 \le V_O \le 3.6V$ $V_I = V_{IH}$ or V_{IL}	1.4 - 3.6		±10.0	µA
I_{OFF}	Power-OFF Leakage Current	$0 \le (V_I, V_O) \le 3.6V$	0		10.0	µA
I_{CC}	Quiescent Supply Current	$V_I = V_{CC}$ or GND	1.4 - 3.6		20.0	µA
		$V_{CC} \le (V_I, V_O) \le 3.6V$ (Note 5)	1.4 - 3.6		±20.0	
ΔI_{CC}	Increase in I_{CC} per Input	$V_{IH} = V_{CC} - 0.6V$	2.7 - 3.6		750	µA

Note 5: Outputs disabled or 3-STATE only.

AC Electrical Characteristics (Note 6)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40°C$ to $+85°C$		Units	Figure Number
				Min	Max		
f_{MAX}	Maximum Clock Frequency	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	250		MHz	
			2.5 ± 0.2	200			
			1.8 ± 0.15	100			
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	80.0			
t_{PHL} t_{PLH}	Propagation Delay	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.5	ns	Figures 1, 2
			2.5 ± 0.2	1.0	4.4		
			1.8 ± 0.15	1.5	8.8		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	17.6		Figures 7, 8
t_{PZL} t_{PZH}	Output Enable Time	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.8	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	4.9		
			1.8 ± 0.15	1.5	9.8		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	19.6		Figures 7, 9, 10
t_{PLZ} t_{PHZ}	Output Disable Time	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	0.8	3.7	ns	Figures 1, 3, 4
			2.5 ± 0.2	1.0	4.2		
			1.8 ± 0.15	1.5	7.6		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	1.0	15.2		Figures 7, 9, 10
t_S	Setup Time	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	1.5		ns	Figure 6
			2.5 ± 0.2	1.5			
			1.8 ± 0.15	2.5			
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	3.0			
t_H	Hold Time	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	1.0		ns	Figure 6
			2.5 ± 0.2	1.0			
			1.8 ± 0.15	1.0			
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	2.0			
t_W	Pulse Width	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3	1.5		ns	Figure 5
			2.5 ± 0.2	1.5			
			1.8 ± 0.15	4.0			
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1	4.0			
t_{OSHL} t_{OSLH}	Output to Output Skew (Note 7)	$C_L = 30$ pF, $R_L = 500\Omega$	3.3 ± 0.3		0.5	ns	
			2.5 ± 0.2		0.5		
			1.8 ± 0.15		0.75		
		$C_L = 15$ pF, $R_L = 2k\Omega$	1.5 ± 0.1		1.5		

Note 6: For $C_L = 50_P$F, add approximately 300 ps to the AC maximum specification.

Note 7: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}).

Dynamic Switching Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = +25°C$ Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	C_L = 30 pF, $V_{IH} = V_{CC}$, V_{IL} = 0V	1.8	0.25	V
			2.5	0.6	
			3.3	0.8	
V_{OLV}	Quiet Output Dynamic Valley V_{OL}	C_L = 30 pF, $V_{IH} = V_{CC}$, V_{IL} = 0V	1.8	−0.25	V
			2.5	−0.6	
			3.3	−0.8	
V_{OHV}	Quiet Output Dynamic Valley V_{OH}	C_L = 30 pF, $V_{IH} = V_{CC}$, V_{IL} = 0V	1.8	1.5	V
			2.5	1.9	
			3.3	2.2	

Capacitance

Symbol	Parameter	Conditions	$T_A = +25°C$ Typical	Units
C_{IN}	Input Capacitance	V_{CC} = 1.8V, 2.5V or 3.3V, V_I = 0V or V_{CC}	6	pF
C_{OUT}	Output Capacitance	V_I = 0V or V_{CC}, V_{CC} = 1.8V, 2.5V or 3.3V	7	pF
C_{PD}	Power Dissipation Capacitance	V_I = 0V or V_{CC}, f = 10 MHz, V_{CC} = 1.8V, 2.5V or 3.3V	20	pF

AC Loading and Waveforms (V_{CC} 3.3V ± 0.3V to 1.8V ± 0.15V)

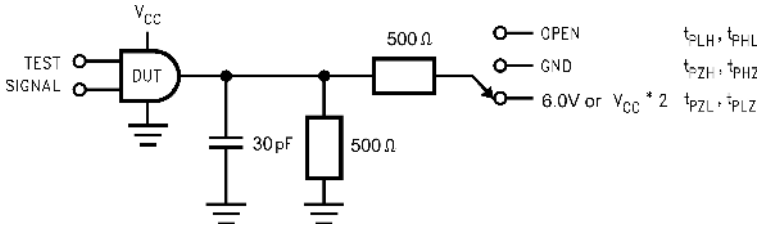


FIGURE 1. AC Test Circuit

TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3V ± 0.3V; V_{CC} x 2 at V_{CC} = 2.5V ± 0.2V; 1.8V ± 0.15V
t_{PZH}, t_{PHZ}	GND

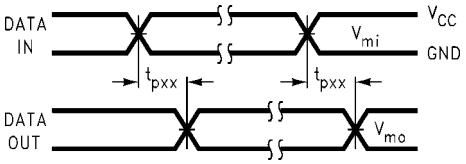


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

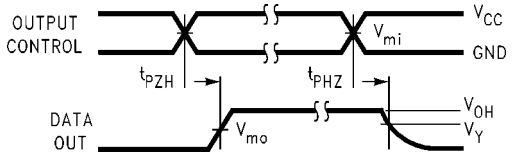


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

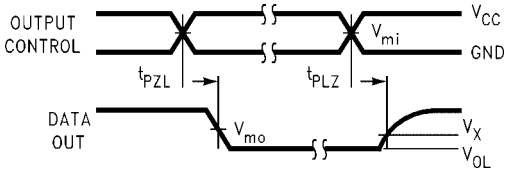


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

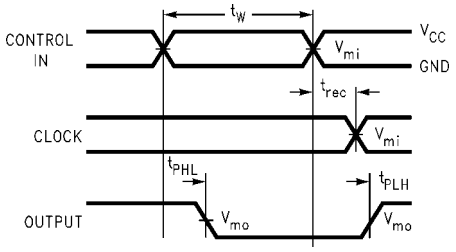


FIGURE 5. Propagation Delay, Pulse Width and t_{rec} Waveforms

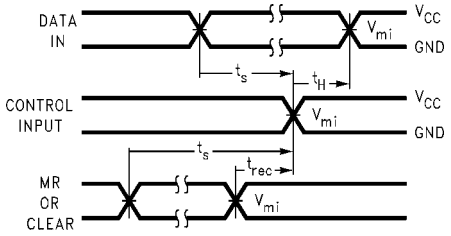
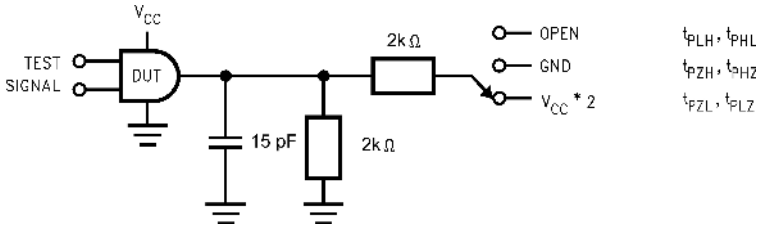


FIGURE 6. Setup Time, Hold Time and Recovery Time for Low Voltage Logic

Symbol	V_{CC}		
	3.3V ± 0.3V	2.5V ± 0.2V	1.8V ± 0.15V
V_{mi}	1.5V	V_{CC}/2	V_{CC}/2
V_{mo}	1.5V	V_{CC}/2	V_{CC}/2
V_X	V_{OL} + 0.3V	V_{OL} + 0.15V	V_{OL} + 0.15V
V_Y	V_{OH} − 0.3V	V_{OH} − 0.15V	V_{OH} − 0.15V

AC Loading and Waveforms (V_{CC} 1.5V ± 0.1V)



TEST	SWITCH
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	V_{CC} x 2 at V_{CC} = 1.5V ± 0.1V
t_{PZH}, t_{PHZ}	GND

FIGURE 7. AC Test Circuit

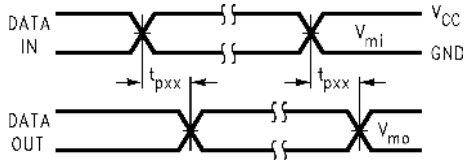


FIGURE 8. Waveform for Inverting and Non-Inverting Functions

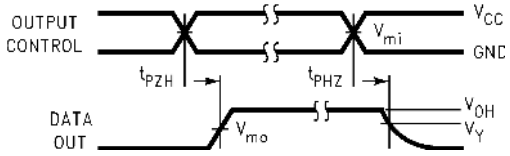


FIGURE 9. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

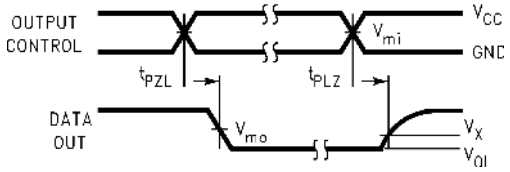
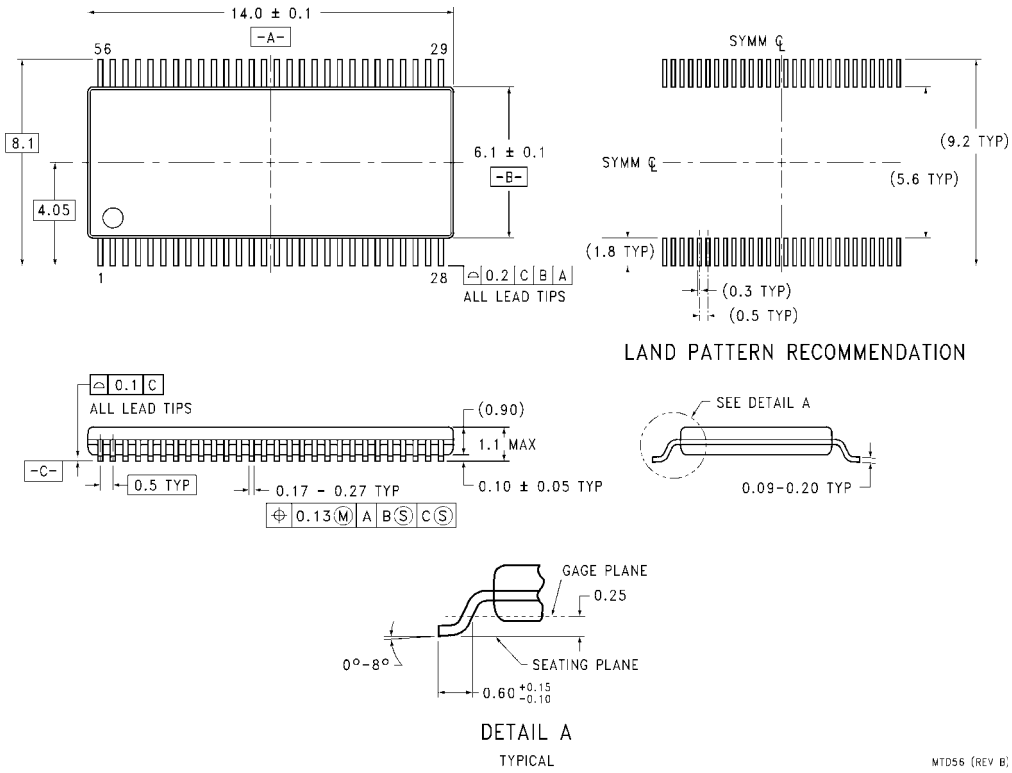


FIGURE 10. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

Symbol	V_{CC}
	1.5V ± 0.1V
V_{mi}	V_{CC}/2
V_{mo}	V_{CC}/2
V_X	V_{OL} + 0.1V
V_Y	V_{OH} − 0.1V

Physical Dimensions inches (millimeters) unless otherwise noted



56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide
Package Number MTD56

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