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# 74LCX374

## Low Voltage Octal D-Type Flip-Flop with 5V Tolerant Inputs and Outputs

### Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 8.5ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 10 $\mu$ A  $I_{CC}$  max
- Power-down high impedance inputs and outputs
- Supports live insertion/withdrawal<sup>(1)</sup>
- $\pm 24mA$  output drive ( $V_{CC} = 3.0V$ )
- Implements proprietary noise/EMI reduction circuitry
- Latch-up performance exceeds JEDEC 78 conditions
- ESD performance
  - Human Body Model > 2000V
  - Machine Model > 200V
- Leadless DQFN package

### Note:

1. To ensure the high impedance state during power up or 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.

### General Description

The LCX374 consists of eight D-type flip-flops featuring separate D-type inputs for each flip-flop and 3-STATE outputs for bus-oriented applications. A buffered clock (CP) and Output Enable ( $\overline{OE}$ ) are common to all flip-flops. The LCX374 is designed for low voltage applications with capability of interfacing to a 5V signal environment.

The LCX374 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.


### Ordering Information

Order Number	Package Number	Package Description
74LCX374WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74LCX374SJ	M20D	20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74LCX374BQX <sup>(2)</sup>	MLP20B	20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm
74LCX374MSA	MSA20	20-Lead Shrink Small Outline Package (SSOP), JEDEC MO-150, 5.3mm Wide
74LCX374MTC	MTC20	20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

### Note:

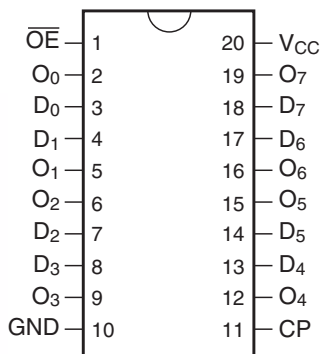
2. DQFN package available in Tape and Reel only.

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

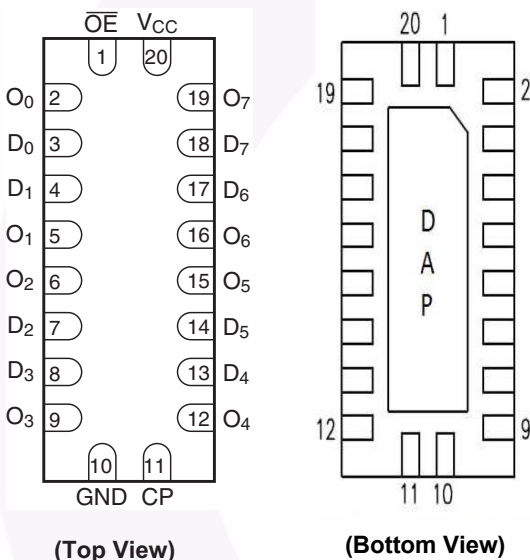
 All packages are lead free per JEDEC: J-STD-020B standard.

## Connection Diagrams

Pin Assignments for SOIC, SOP, SSOP, TSSOP



Pad Assignments for DQFN



(Top View)

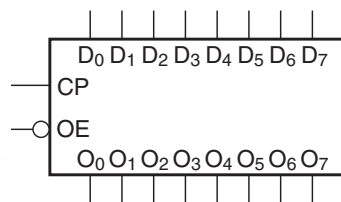
(Bottom View)

## Pin Description

Pin Names	Description
D <sub>0</sub> –D <sub>7</sub>	Data Inputs
CP	Clock Pulse Input
$\overline{OE}$	Output Enable Input
O <sub>0</sub> –O <sub>7</sub>	3-STATE Outputs
DAP	No Connect

Note: DAP (Die Attach Pad)

## Logic Symbol



## Truth Table

Inputs			Outputs
D <sub>n</sub>	CP	$\overline{OE}$	O <sub>n</sub>
H	↗	L	H
L	↗	L	L
X	L	L	O <sub>0</sub>
X	X	H	Z

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

Z = High Impedance

↗ = LOW-to-HIGH Transition

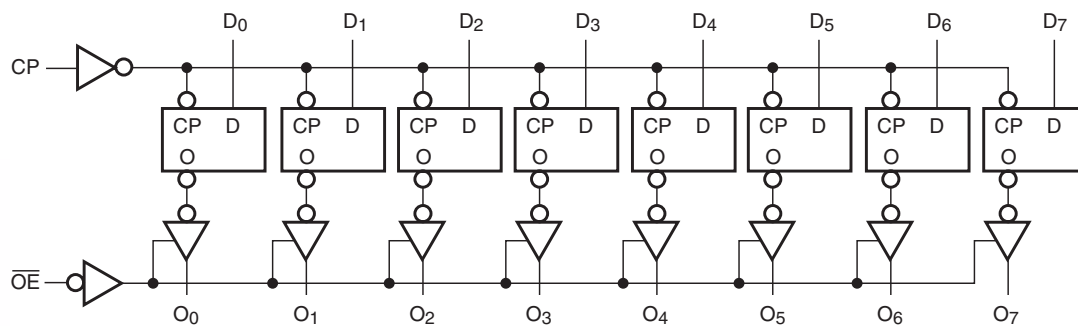
O<sub>0</sub> = Previous O<sub>0</sub> before HIGH-to-LOW of CP

## Functional Description

The LCX374 consists of eight edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The buffered clock and buffered Output Enable are common to all flip-flops. The eight flip-flops will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP) transition. With the Output Enable ( $\overline{OE}$ ) LOW, the contents of the eight flip-flops are available at the outputs. When the  $\overline{OE}$  is HIGH, the outputs go to the high impedance state. Operation of the  $\overline{OE}$  input does not affect the state of the flip-flops.

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Logic Diagram**



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.



## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Conditions	Value	Units
$V_{CC}$	Supply Voltage		-0.5 to +7.0	V
$V_I$	DC Input Voltage		-0.5 to +7.0	V
$V_O$	DC Output Voltage	Output in 3-STATE	-0.5 to +7.0	V
		Output in HIGH or LOW State <sup>(3)</sup>	-0.5 to $V_{CC} + 0.5$	
$I_{IK}$	DC Input Diode Current	$V_I < \text{GND}$	-50	mA
$I_{OK}$	DC Output Diode Current	$V_O < \text{GND}$	-50	mA
		$V_O > V_{CC}$	+50	
$I_O$	DC Output Source/Sink Current		$\pm 50$	mA
$I_{CC}$	DC Supply Current per Supply Pin		$\pm 100$	mA
$I_{GND}$	DC Ground Current per Ground Pin		$\pm 100$	mA
$T_{STG}$	Storage Temperature		-65 to +150	°C

## Recommended Operating Conditions<sup>(4)</sup>

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Conditions	Min.	Max.	Units
$V_{CC}$	Supply Voltage	Operating	2.0	3.6	V
		Data Retention	1.5	3.6	
$V_I$	Input Voltage		0	5.5	V
$V_O$	Output Voltage	HIGH or LOW State	0	$V_{CC}$	V
		3-STATE	0	5.5	
$I_{OH}/I_{OL}$	Output Current	$V_{CC} = 3.0\text{V}-3.6\text{V}$		$\pm 24$	mA
		$V_{CC} = 2.7\text{V}-3.0\text{V}$		$\pm 12$	
		$V_{CC} = 2.3\text{V}-2.7\text{V}$		$\pm 8$	
$T_A$	Free-Air Operating Temperature		-40	85	°C
$\Delta t/\Delta V$	Input Edge Rate	$V_{IN} = 0.8\text{V}-2.0\text{V}, V_{CC} = 3.0\text{V}$	0	10	ns/V

### Notes:

- $I_O$  Absolute Maximum Rating must be observed.
- Unused inputs must be held HIGH or LOW. They may not float.

## DC Electrical Characteristics

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = -40°C to +85°C		Units
				Min.	Max.	
V <sub>IH</sub>	HIGH Level Input Voltage	2.3–2.7		1.7		V
		2.7–3.6		2.0		
V <sub>IL</sub>	LOW Level Input Voltage	2.3–2.7			0.7	V
		2.7–3.6			0.8	
V <sub>OH</sub>	HIGH Level Output Voltage	2.3–3.6	I <sub>OH</sub> = -100μA	V <sub>CC</sub> - 0.2		V
		2.3	I <sub>OH</sub> = -8mA	1.8		
		2.7	I <sub>OH</sub> = -12mA	2.2		
		3.0	I <sub>OH</sub> = -18mA	2.4		
			I <sub>OH</sub> = -24mA	2.2		
V <sub>OL</sub>	LOW Level Output Voltage	2.3–3.6	I <sub>OL</sub> = 100μA		0.2	V
		2.3	I <sub>OL</sub> = 8mA		0.6	
		2.7	I <sub>OL</sub> = 12mA		0.4	
		3.0	I <sub>OL</sub> = 16mA		0.4	
			I <sub>OL</sub> = 24mA		0.55	
I <sub>I</sub>	Input Leakage Current	2.3–3.6	0 ≤ V <sub>I</sub> ≤ 5.5V		±5.0	μA
I <sub>OZ</sub>	3-STATE Output Leakage	2.3–3.6	0 ≤ V <sub>O</sub> ≤ 5.5V, V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>		±5.0	μA
I <sub>OFF</sub>	Power-Off Leakage Current	0	V <sub>I</sub> or V <sub>O</sub> = 5.5V		10	μA
I <sub>CC</sub>	Quiescent Supply Current	2.3–3.6	V <sub>I</sub> = V <sub>CC</sub> or GND		10	μA
			3.6V ≤ V <sub>I</sub> , V <sub>O</sub> ≤ 5.5V <sup>(5)</sup>		±10	
ΔI <sub>CC</sub>	Increase in I <sub>CC</sub> per Input	2.3–3.6	V <sub>IH</sub> = V <sub>CC</sub> - 0.6V		500	μA

## AC Electrical Characteristics

Symbol	Parameter	T <sub>A</sub> = -40°C to +85°C, R <sub>L</sub> = 500Ω						Units
		V <sub>CC</sub> = 3.3V ± 0.3V, C <sub>L</sub> = 50pF		V <sub>CC</sub> = 2.7V, C <sub>L</sub> = 50pF		V <sub>CC</sub> = 2.5V ± 0.2V, C <sub>L</sub> = 30pF		
		Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>MAX</sub>	Maximum Clock Frequency	150		150		150		MHz
t <sub>PHL</sub> , t <sub>PLH</sub>	Propagation Delay CP to O <sub>n</sub>	1.5	8.5	1.5	9.5	1.5	10.5	ns
t <sub>PZL</sub> , t <sub>PZH</sub>	Output Enable Time	1.5	8.5	1.5	9.5	1.5	10.5	ns
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Output Disable Time	1.5	7.5	1.5	8.5	1.5	9.0	ns
t <sub>S</sub>	Setup Time	2.5		2.5		4.0		ns
t <sub>H</sub>	Hold Time	1.5		1.5		2.0		ns
t <sub>W</sub>	Pulse Width	3.3		3.3		4.0		ns
t <sub>OSHL</sub> , t <sub>OSLH</sub>	Output to Output Skew <sup>(6)</sup>		1.0					ns

## Notes:

- Outputs disabled or 3-STATE only.
- 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<sub>OSHL</sub>) or LOW-to-HIGH (t<sub>OSLH</sub>).

**Dynamic Switching Characteristics**

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = 25°C	
				Typical	Units
V <sub>OLP</sub>	Quiet Output Dynamic Peak V <sub>OL</sub>	3.3	C <sub>L</sub> = 50pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	0.8	V
		2.5	C <sub>L</sub> = 30pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V	0.6	
V <sub>OLV</sub>	Quiet Output Dynamic Valley V <sub>OL</sub>	3.3	C <sub>L</sub> = 50pF, V <sub>IH</sub> = 3.3V, V <sub>IL</sub> = 0V	-0.8	V
		2.5	C <sub>L</sub> = 30pF, V <sub>IH</sub> = 2.5V, V <sub>IL</sub> = 0V	-0.6	

**Capacitance**

Symbol	Parameter	Conditions	Typical	Units
C <sub>IN</sub>	Input Capacitance	V <sub>CC</sub> = Open, V <sub>I</sub> = 0V or V <sub>CC</sub>	7	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub>	8	pF
C <sub>PD</sub>	Power Dissipation Capacitance	V <sub>CC</sub> = 3.3V, V <sub>I</sub> = 0V or V <sub>CC</sub> , f = 10 MHz	25	pF



## AC Loading and Waveforms (Generic for LCX Family)

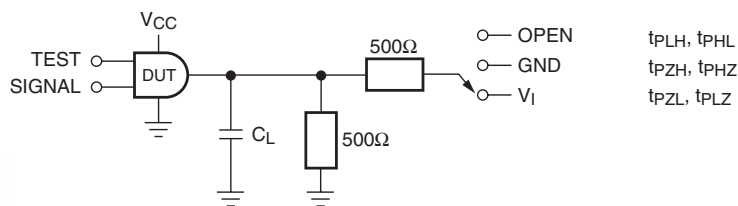
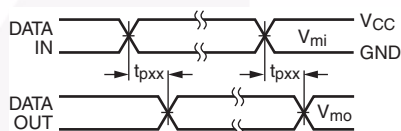
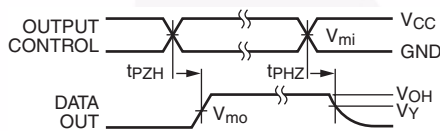


Figure 1. AC Test Circuit ( $C_L$  includes probe and jig capacitance)

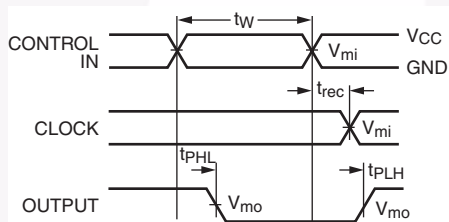
Test	Switch
$t_{PLH}$ , $t_{PHL}$	Open
$t_{PZL}$ , $t_{PLZ}$	6V at $V_{CC} = 3.3 \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$
$t_{PZH}$ , $t_{PHZ}$	GND



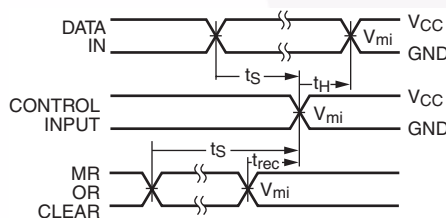
Waveform for Inverting and Non-Inverting Functions



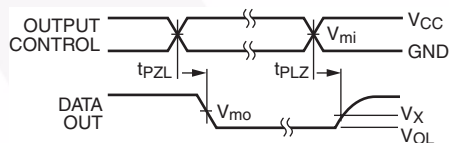
3-STATE Output High Enable and Disable Times for Logic



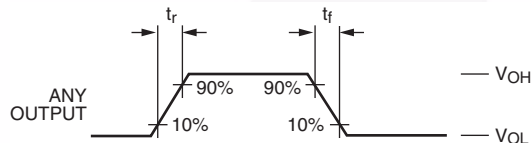
Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output Low Enable and Disable Times for Logic

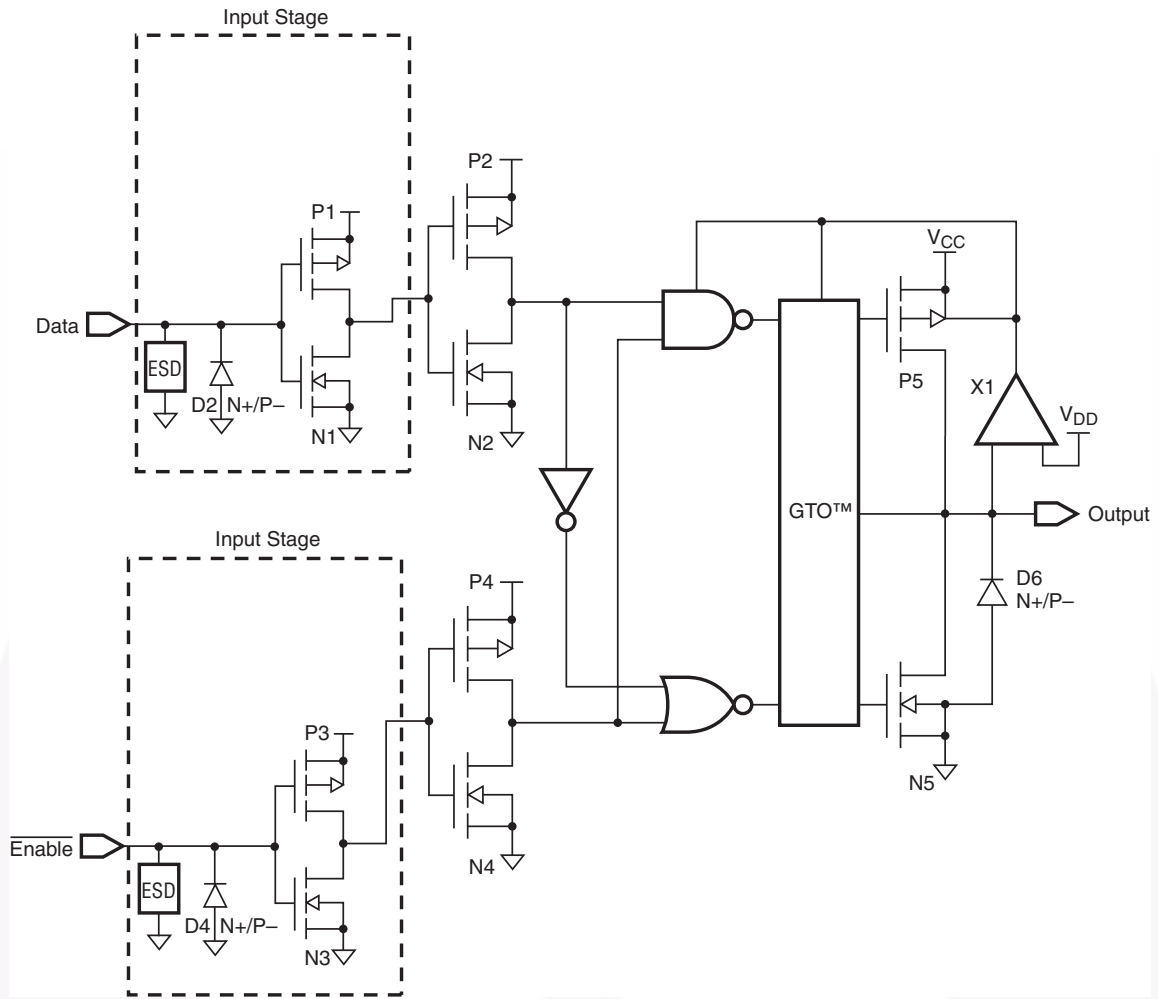


$t_{rise}$  and  $t_{fall}$

Figure 2. Waveforms (Input Characteristics;  $f = 1MHz$ ,  $t_r = t_f = 3ns$ )

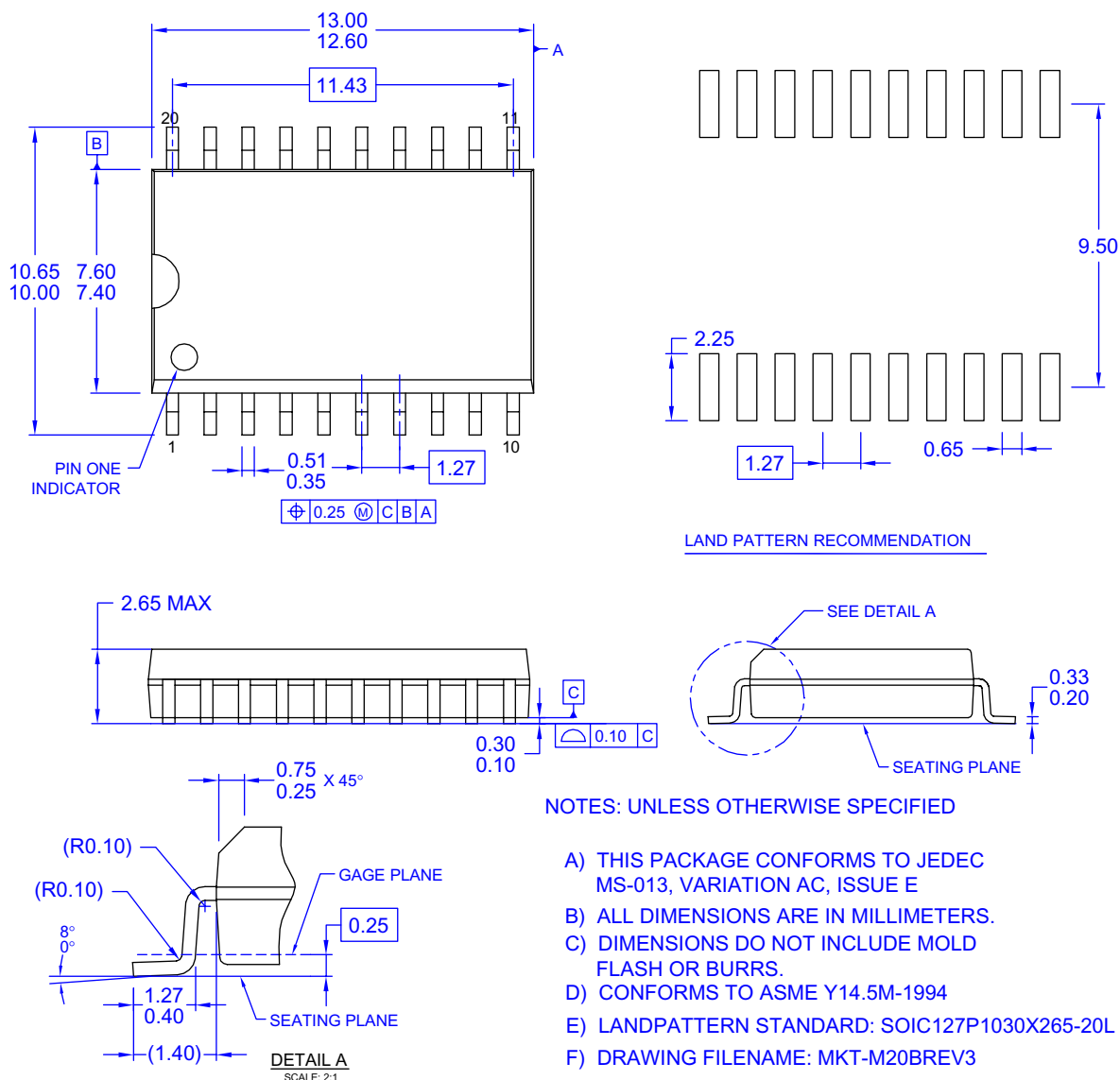
Symbol	$V_{CC}$		
	$3.3V \pm 0.3V$	$2.7V$	$2.5V \pm 0.2V$
$V_{mi}$	1.5V	1.5V	$V_{CC} / 2$
$V_{mo}$	1.5V	1.5V	$V_{CC} / 2$
$V_x$	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
$V_y$	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

**Schematic Diagram** (Generic for LCX Family)





## Physical Dimensions



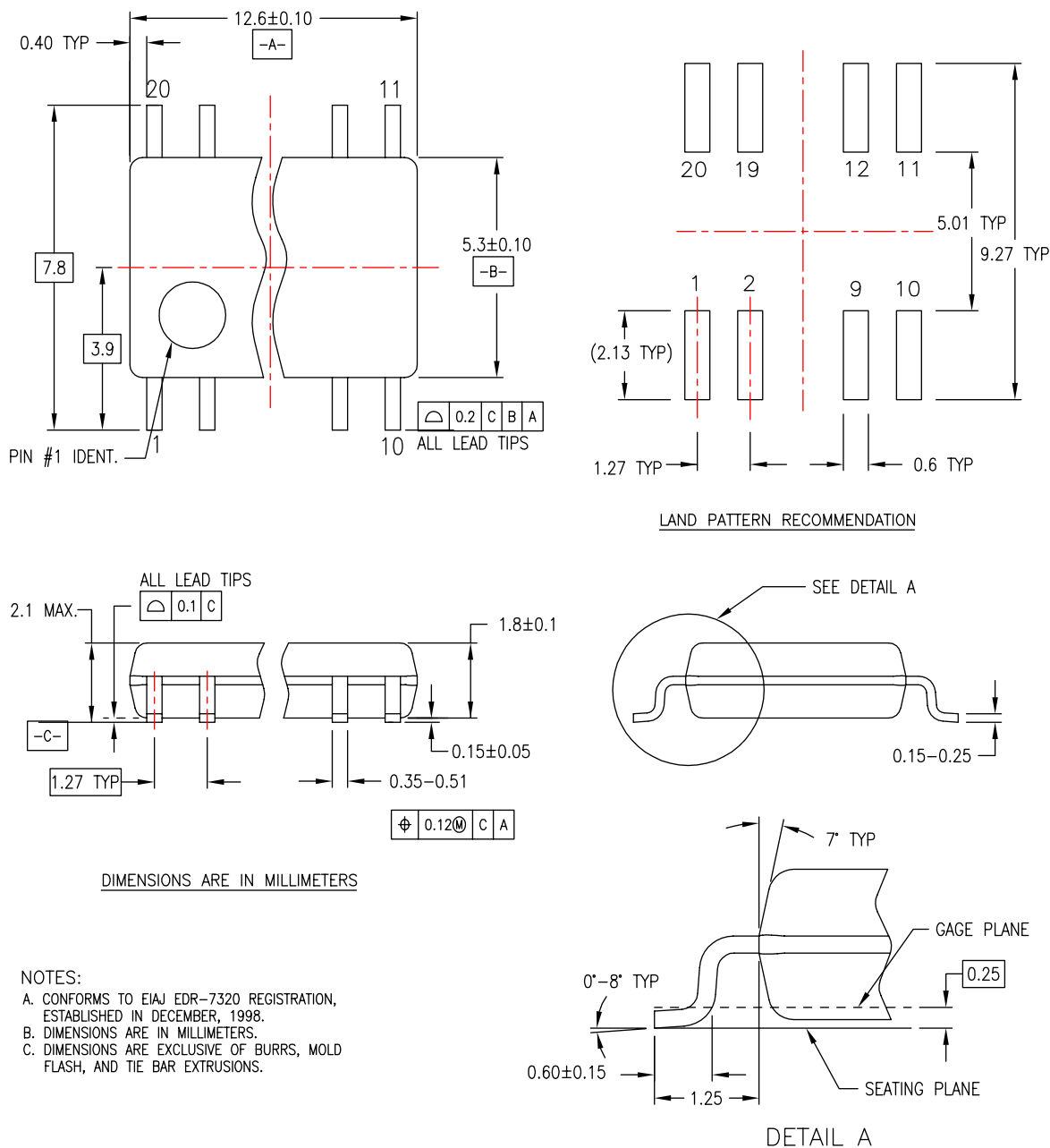
**Figure 3. 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide**

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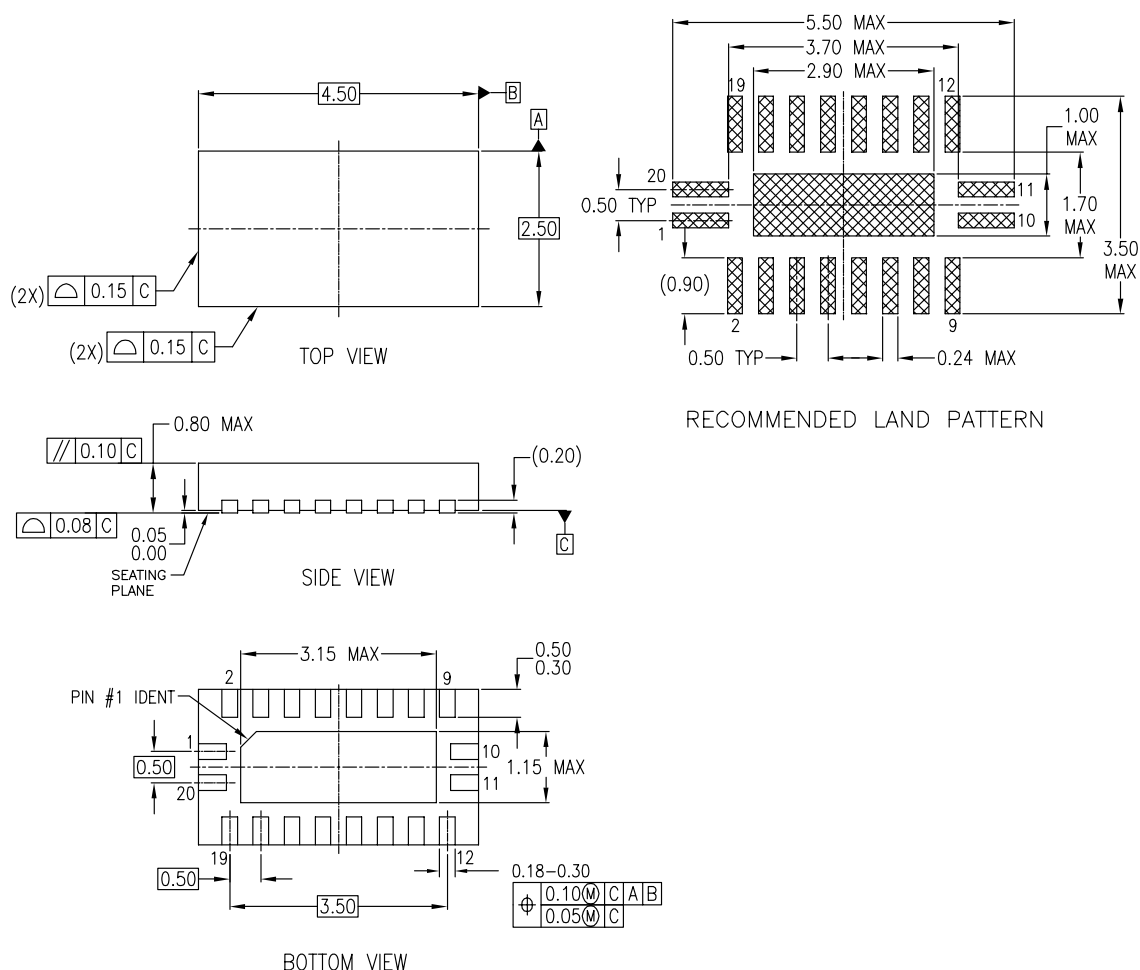
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### Physical Dimensions (Continued)



**Physical Dimensions (Continued)**



**NOTES:**

- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AC
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

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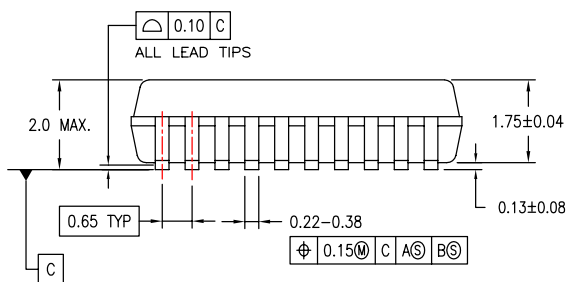
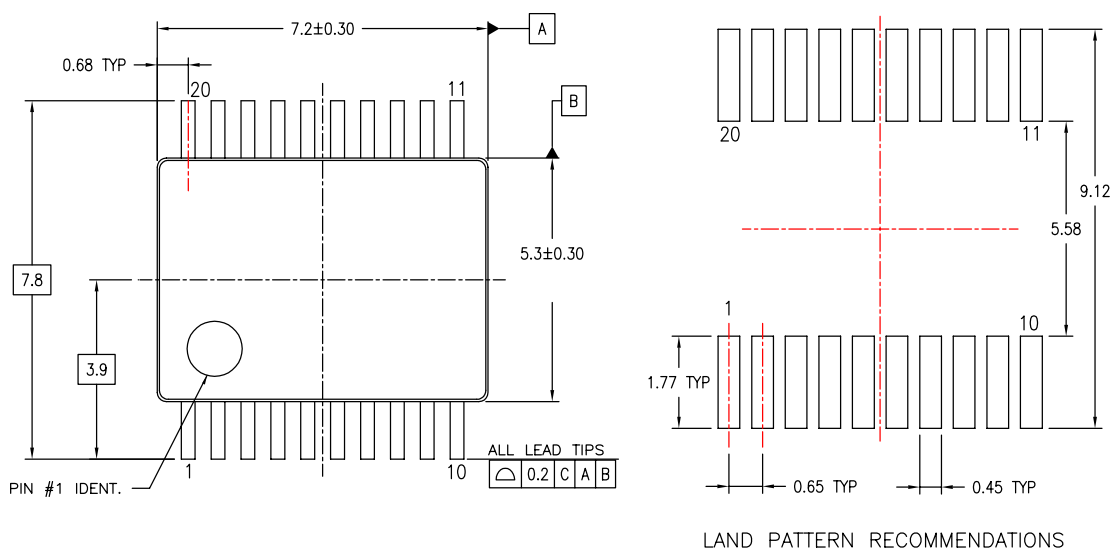
**Figure 5. 20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm**

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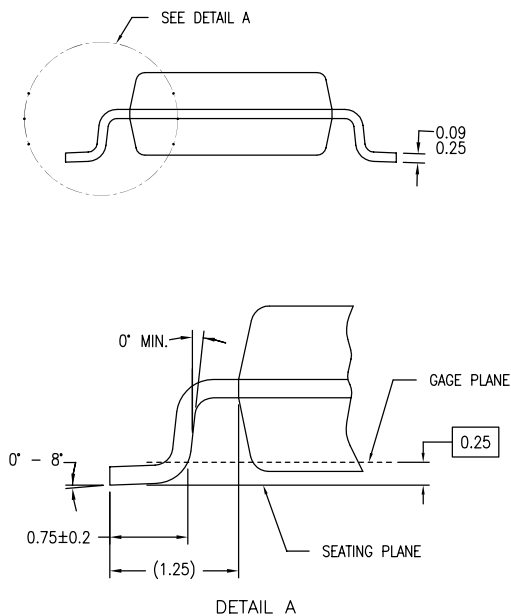
### Physical Dimensions (Continued)



DIMENSIONS ARE IN MILLIMETERS

NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-150, VARIATION AE, DATE 1/94.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ASME Y14.5M - 1994.



MSA20REVB

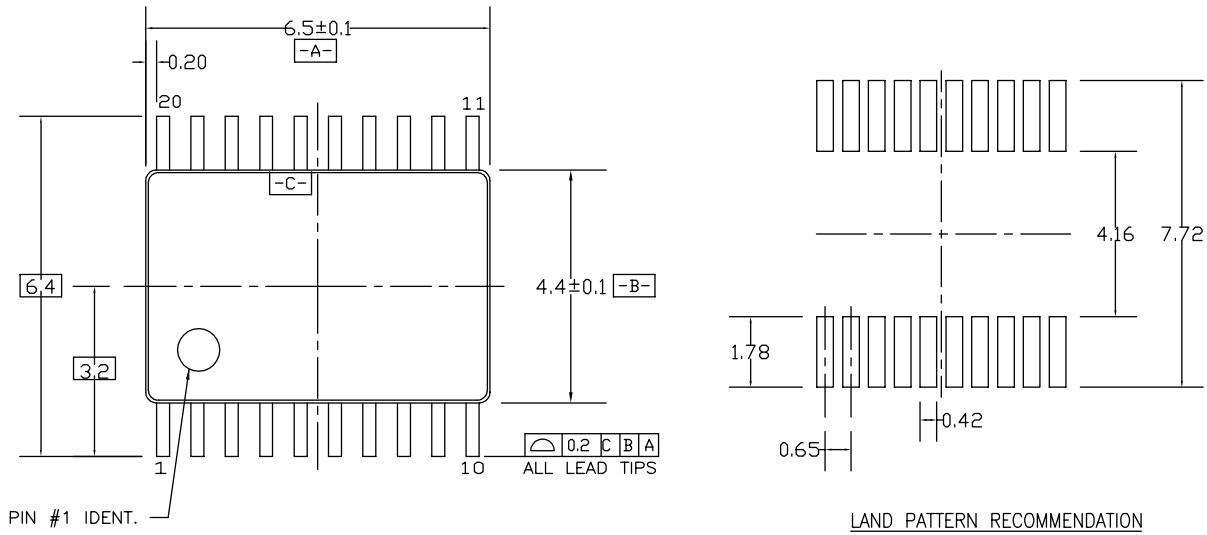
**Figure 6. 20-Lead Shrink Small Outline Package (SSOP), JEDEC MO-150, 5.3mm Wide**

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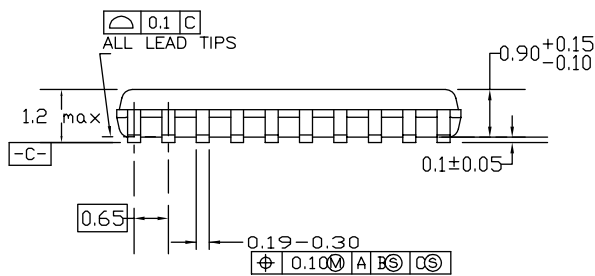
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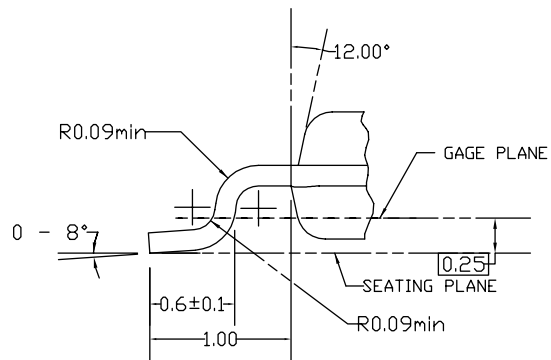
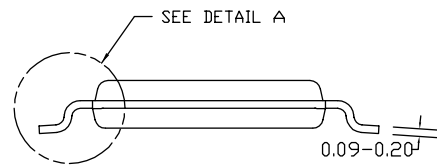
**Physical Dimensions (Continued)**



PIN #1 IDENT.



DIMENSIONS ARE IN MILLIMETERS



DETAIL A

**NOTES:**

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AC, REF NOTE 6, DATE 7/93.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLDS FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTC20REV D1

**Figure 7. 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**

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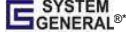



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