

74LCX374

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

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 (3.3V or 2.5V) V_{CC} 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.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 8.5 ns t_{PD} max ($V_{CC} = 3.3V$), 10 μA I_{CC} max
- Power-down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ± 24 mA output drive ($V_{CC} = 3.0V$)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds JEDEC 78 conditions
- ESD performance:
 - Human Body Model > 2000V
 - Machine Model > 200V
- Leadless Pb-Free 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 or the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

Order Number	Package Number	Package Description
74LCX374WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74LCX374SJ	M20D	Pb-Free 20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74LCX374BQX (Preliminary) (Note 2)	MLP020B	Pb-Free 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
74LCX374MTCX_NL (Note 3)	MTC20	Pb-Free 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

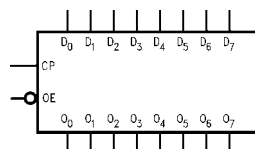
Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.
Pb-Free package per JEDEC J-STD-020B.

Note 2: DQFN package available in Tape and Reel only.

Note 3: "_NL" indicates Pb-Free package (per JEDEC J-STD-020B). Device available in Tape and Reel only.

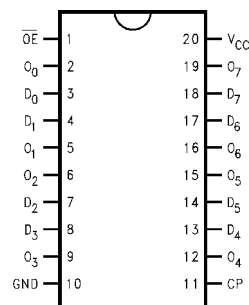
74LCX374 Low Voltage Octal D-Type Flip-Flop with 5V Tolerant Inputs and Outputs

Logic Symbol

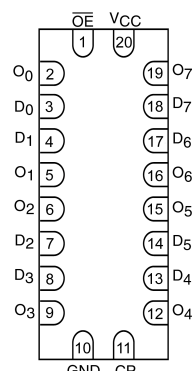


Connection Diagrams

Pin Assignments for
SOIC, SOP, SSOP, TSSOP



Pad Assignments for DQFN



(Top View)

Pin Descriptions

Pin Names	Description
D ₀ –D ₇	Data Inputs
CP	Clock Pulse Input
$\overline{OE}$	Output Enable Input
O ₀ –O ₇	3-STATE Outputs

Truth Table

Inputs			Outputs
D _n	CP	$\overline{OE}$	O _n
H	↗	L	H
L	↗	L	L
X	L	L	O ₀
X	X	H	Z

H = HIGH Voltage Level

L = LOW Voltage Level

X = Immaterial

Z = High Impedance

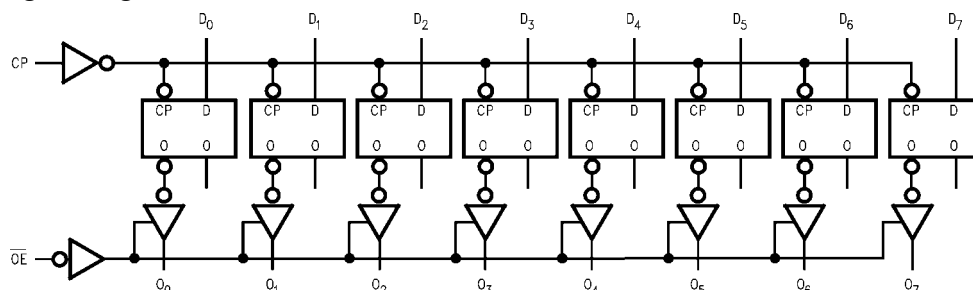
↗ = LOW-to-HIGH Transition

O₀ = Previous O₀ 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.

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 ^(Note 4)				
Symbol	Parameter	Value	Conditions	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	−0.5 to +7.0 −0.5 to V _{CC} + 0.5	Output in 3-STATE Output in HIGH or LOW State (Note 5)	V
I _{IK}	DC Input Diode Current	−50	V _I < GND	mA
I _{OK}	DC Output Diode Current	−50 +50	V _O < GND V _O > V _{CC}	mA
I _O	DC Output Source/Sink Current	±50		mA
I _{CC}	DC Supply Current per Supply Pin	±100		mA
I _{GND}	DC Ground Current per Ground Pin	±100		mA
T _{STG}	Storage Temperature	−65 to +150		°C

Recommended Operating Conditions ^(Note 6)

Symbol	Parameter	Min	Max	Units	
V _{CC}	Supply Voltage	Operating Data Retention	2.0 1.5	3.6 3.6	V
V _I	Input Voltage	0	5.5	V	
V _O	Output Voltage	HIGH or LOW State 3-STATE	0 0	V _{CC} 5.5	V
I _{OH} /I _{OL}	Output Current	V _{CC} = 3.0V – 3.6V V _{CC} = 2.7V – 3.0V V _{CC} = 2.3V – 2.7V		±24 ±12 ±8	mA
T _A	Free-Air Operating Temperature	−40	85	°C	
Δt/ΔV	Input Edge Rate, V _{IN} = 0.8V – 2.0V, V _{CC} = 3.0V	0	10	ns/V	

Note 4: 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 5: I_O Absolute Maximum Rating must be observed.

Note 6: Unused inputs or I/Os must be held HIGH or LOW. They may not float.

DC Electrical Characteristics

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = −40° C to +85° C		Units
				Min	Max	
V _{IH}	HIGH Level Input Voltage		2.3 – 2.7 2.7 – 3.6	1.7 2.0		V
V _{IL}	LOW Level Input Voltage		2.3 – 2.7 2.7 – 3.6		0.7 0.8	V
V _{OH}	HIGH Level Output Voltage	I _{OH} = −100 μA I _{OH} = −8 mA I _{OH} = −12 mA I _{OH} = −18 mA I _{OH} = −24 mA	2.3 – 3.6 2.3 2.7 3.0 3.0	V _{CC} − 0.2 1.8 2.2 2.4 2.2		V
V _{OL}	LOW Level Output Voltage	I _{OL} = 100 μA I _{OL} = 8 mA I _{OL} = 12 mA I _{OL} = 16 mA I _{OL} = 24 mA	2.3 – 3.6 2.3 2.7 3.0 3.0		0.2 0.6 0.4 0.4 0.55	V
I _I	Input Leakage Current	0 ≤ V _I ≤ 5.5V	2.3 – 3.6		±5.0	μA
I _{OZ}	3-STATE Output Leakage	0 ≤ V _O ≤ 5.5V V _I = V _{IH} or V _{IL}	2.3 – 3.6		±5.0	μA
I _{OFF}	Power-Off Leakage Current	V _I or V _O = 5.5V	0		10	μA

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = -40°C to +85°C		Units
				Min	Max	
I _{CC}	Quiescent Supply Current	V _I = V _{CC} or GND	2.3 – 3.6		10	μA
		3.6V ≤ V _I , V _O ≤ 5.5V (Note 7)	2.3 – 3.6		±10	
ΔI _{CC}	Increase in I _{CC} per Input	V _{IH} = V _{CC} – 0.6V	2.3 – 3.6		500	μA

Note 7: Outputs disabled or 3-STATE only.

AC Electrical Characteristics

Symbol	Parameter	T _A = -40°C to +85°C, R _L = 500 Ω						Units
		V _{CC} = 3.3V ± 0.3V		V _{CC} = 2.7V		V _{CC} = 2.5 ± 0.2		
		C _L = 50 pF		C _L = 50 pF		C _L = 30 pF		
		Min	Max	Min	Max	Min	Max	
f _{MAX}	Maximum Clock Frequency	150		150		150		MHz
t _{PHL}	Propagation Delay	1.5	8.5	1.5	9.5	1.5	10.5	ns
t _{PLH}	CP to O _n	1.5	8.5	1.5	9.5	1.5	10.5	
t _{PZL}	Output Enable Time	1.5	8.5	1.5	9.5	1.5	10.5	ns
t _{PZH}		1.5	8.5	1.5	9.5	1.5	10.5	
t _{PLZ}	Output Disable Time	1.5	7.5	1.5	8.5	1.5	9.0	ns
t _{PHZ}		1.5	7.5	1.5	8.5	1.5	9.0	
t _S	Setup Time	2.5		2.5		4.0		ns
t _H	Hold Time	1.5		1.5		2.0		ns
t _W	Pulse Width	3.3		3.3		4.0		ns
t _{OSHL}	Output to Output Skew (Note 8)		1.0					ns
t _{OSLH}			1.0					

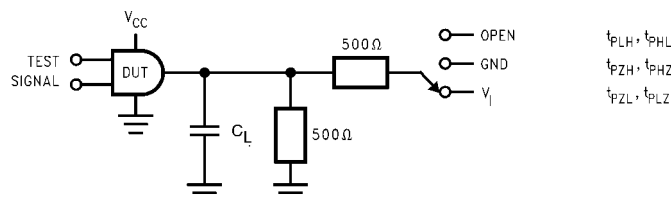
Note 8: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}).

Dynamic Switching Characteristics

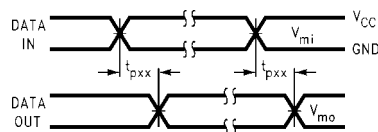
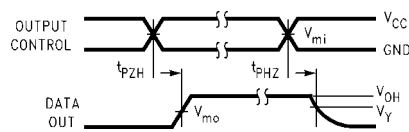
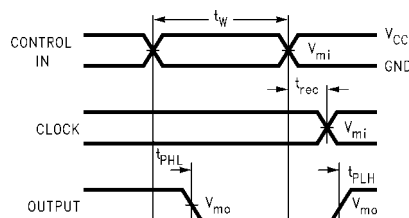
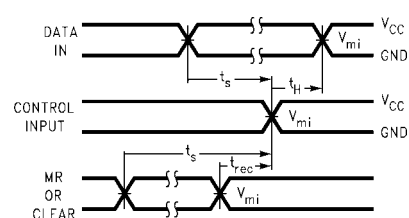
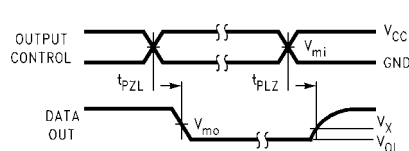
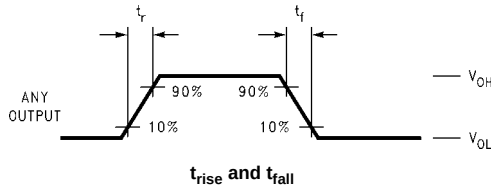
Symbol	Parameter	Conditions	V _{CC} (V)	T _A = 25°C	Units
				Typical	
V _{OLP}	Quiet Output Dynamic Peak V _{OL}	C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V	3.3	0.8	V
		C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V	2.5	0.6	
V _{OLV}	Quiet Output Dynamic Valley V _{OL}	C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V	3.3	-0.8	V
		C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V	2.5	-0.6	

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C _{IN}	Input Capacitance	V _{CC} = Open, V _I = 0V or V _{CC}	7	pF
C _{OUT}	Output Capacitance	V _{CC} = 3.3V, V _I = 0V or V _{CC}	8	pF
C _{PD}	Power Dissipation Capacitance	V _{CC} = 3.3V, V _I = 0V or V _{CC} , f = 10 MHz	25	pF

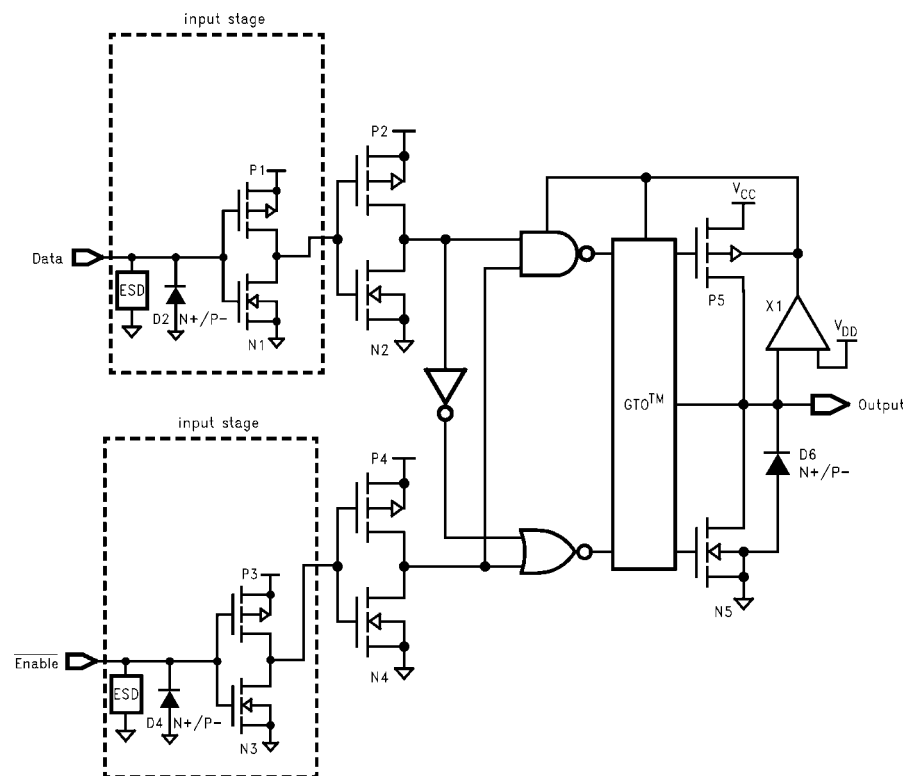
AC LOADING and WAVEFORMS Generic for LCX Family**FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)**

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****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

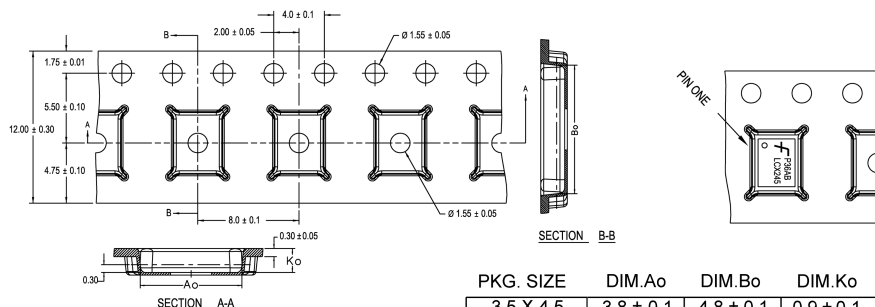


Tape and Reel Specification

Tape Format for DQFN

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
BQX	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

TAPE DIMENSIONS inches (millimeters)



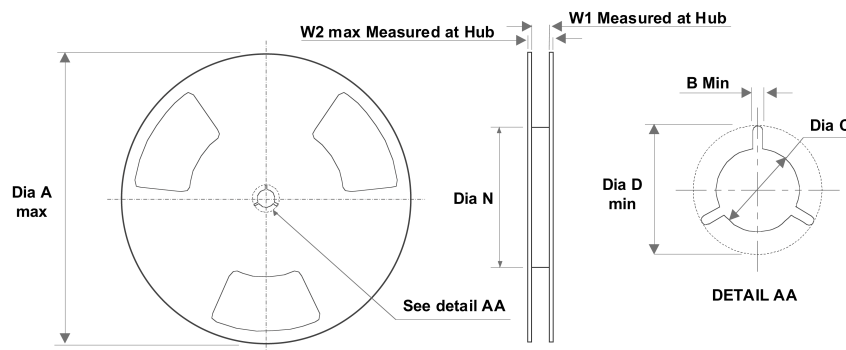
PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

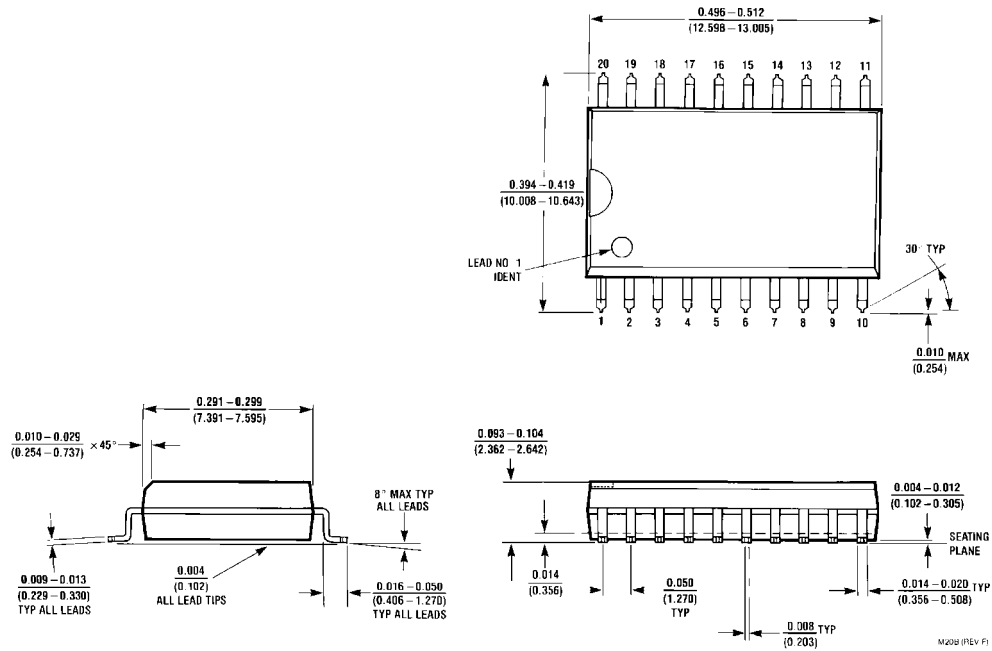
1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. A_o and B_o measured on a plane 0.120[0.30] above the bottom of the pocket.
6. K_o measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
7. Pocket position relative to sprocket hole measured as true position of pocket. Not pocket hole.
8. Controlling dimension is millimeter. Dimension in inches rounded.

REEL DIMENSIONS inches (millimeters)



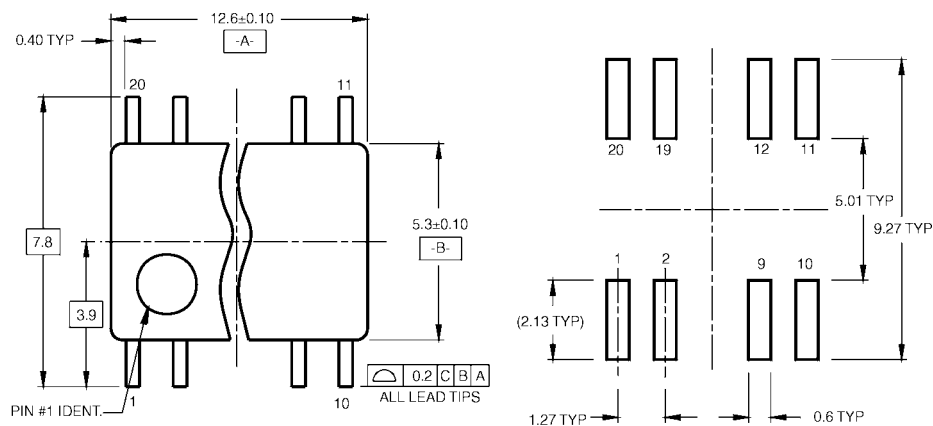
Tape Size	A	B	C	D	N	W1	W2
12 mm	13.0 (330.0)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.488 (12.4)	0.724 (18.4)

Physical Dimensions inches (millimeters) unless otherwise noted

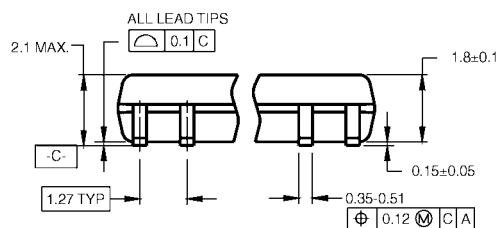


20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
Package Number M20B

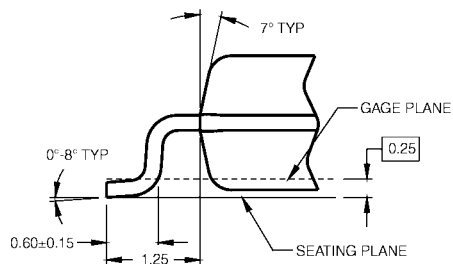
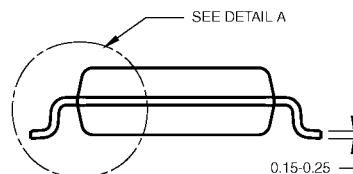
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS



DETAIL A

NOTES:

- CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.
- DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M20DRevB1

**Pb-Free 20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
Package Number M20D**



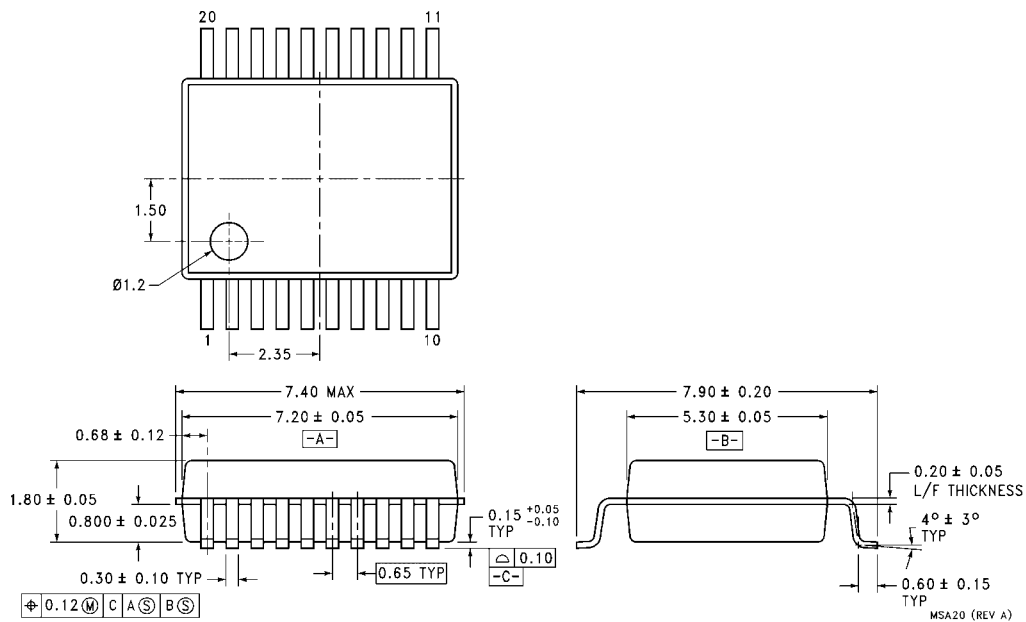
NOTES:

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

MLP020BrevA

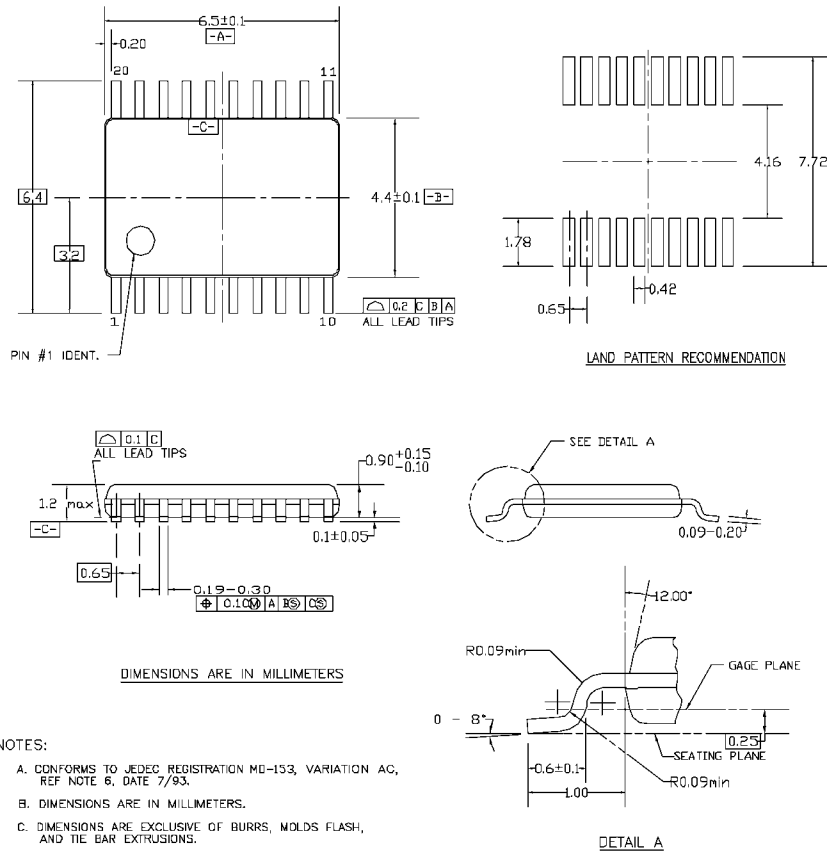
**Pb-Free 20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm
Package Number MLP020B**

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**20-Lead Shrink Small Outline Package (SSOP), JEDEC MO-150, 5.3mm Wide
Package Number MSA20**

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



MTC20REV D1

20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC20

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- A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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