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March 1995
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74LCX138
Low Voltage 1-of-8 Decoder/Demultiplexer with 5V Tolerant Inputs

General Description

The LCX138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three LCX138 devices or a 1-of-32 decoder using four LCX138 devices and one inverter.

The 74LCX138 is fabricated with advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs
- 2.3V to 3.6V V_{CC} specifications provided
- 6.0 ns t_{PD} max (V_{CC} = 3.3V), 10 µA I_{CC} max
- Power down high impedance inputs and outputs
- ±24 mA output drive (V_{CC} = 3.0V)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V
- Leadless DQFN package

Ordering Code:

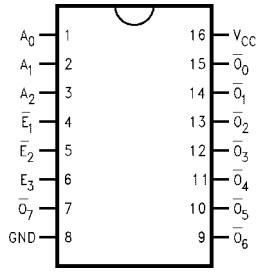
Order Number	Package Number	Package Description
74LCX138M (Note 1)	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74LCX138SJ (Note 1)	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74LCX138BQX (Note 2)	MLP016E	16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm
74LCX138MTC (Note 1)	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

Note 1: Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

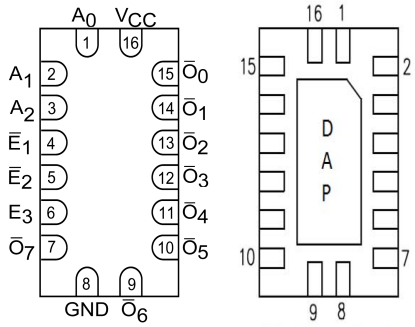
Note 2: DQFN package available in Tape and Reel only.

Connection Diagrams

Pin Assignments for SOIC, SOP, and TSSOP



Pad Assignments for DQFN



(Top Through View) **(Bottom View)**

Pin Descriptions

Pin Names	Description
A_0–A_2	Address Inputs
$\overline{E}_1$–$\overline{E}_2$	Enable Inputs
E_3	Enable Input
$\overline{O}_0$–$\overline{O}_7$	Outputs
DAP	No Connect

Note: DAP (Die Attach Pad)

Functional Description

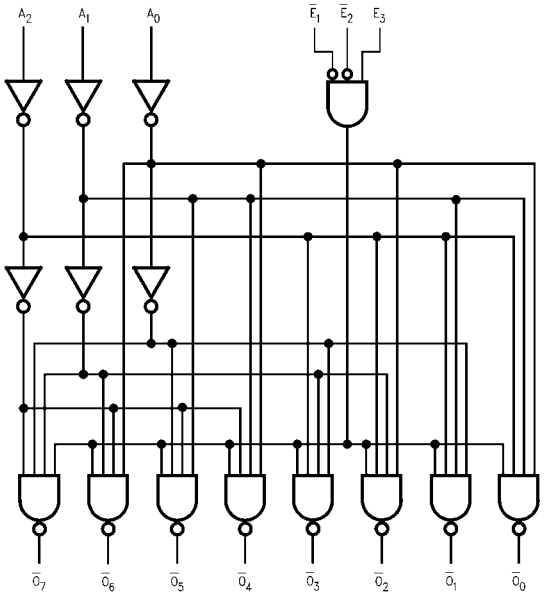
The LCX138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs (A_0, A_1, A_2) and, when enabled, provides eight mutually exclusive active-LOW outputs ($\overline{O}_0$–$\overline{O}_7$). The LCX138 features three Enable inputs, two active-LOW ($\overline{E}_1$, $\overline{E}_2$) and one active-HIGH (E_3). All outputs will be HIGH unless $\overline{E}_1$ and $\overline{E}_2$ are LOW and E_3 is HIGH. The LCX138 can be used as an 8-output demultiplexer by using one of the active LOW Enable inputs as the data input and the other Enable inputs as strobes. The Enable inputs which are not used must be permanently tied to their appropriate active-HIGH or active-LOW state.

Truth Table

Inputs						Outputs							
$\overline{E}_1$	$\overline{E}_2$	E_3	A_0	A_1	A_2	$\overline{O}_0$	$\overline{O}_1$	$\overline{O}_2$	$\overline{O}_3$	$\overline{O}_4$	$\overline{O}_5$	$\overline{O}_6$	$\overline{O}_7$
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	L	X	X	X	H	H	H	H	H	H	H	H
L	L	H	L	L	L	L	H	H	H	H	H	H	H
L	L	H	H	L	L	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	L	H	H	H	H	H
L	L	H	H	H	L	H	H	H	L	H	H	H	H
L	L	H	L	L	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	L	H	H
L	L	H	L	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	L

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

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 3)

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 V_{CC} + 0.5	Output in HIGH or LOW State (Note 4)	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 5)

Symbol	Parameter		Min	Max	Units
V_{CC}	Supply Voltage	Operating	2.0	3.6	V
		Data Retention	1.5	3.6	
V_I	Input Voltage		0.0	5.5	V
V_O	Output Voltage	HIGH or LOW State	0.0	V_{CC}	V
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0V to 3.6V		±24.0	mA
		V_{CC} = 2.7V to 3.0V		±12.0	
		V_{CC} = 2.3V to 2.7V		±8.0	
T_A	Free-Air Operating Temperature		−40.0	85.0	°C
$\Delta t/\Delta V$	Input Edge Rate, V_{IN} = 0.8V to 2.0V, V_{CC} = 3.0V		0.0	10.0	ns/V

Note 3: 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 4: I_O Absolute Maximum Rating must be observed.

Note 5: Unused inputs 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 to 2.7	1.7		V
			2.7 to 3.6	2.0		
V_{IL}	LOW Level Input Voltage		2.3 to 2.7		0.7	V
			2.7 to 3.6		0.8	
V_{OH}	HIGH Level Output Voltage	I_{OH} = −100 µA	2.3 to 3.6	V_{CC} − 0.2		V
		I_{OH} = -8 mA	2.3	1.8		
		I_{OH} = −12 mA	2.7	2.2		
		I_{OH} = −18 mA	3.0	2.4		
		I_{OH} = −24 mA	3.0	2.2		
V_{OL}	LOW Level Output Voltage	I_{OL} = 100 µA	2.3 to 3.6		0.2	V
		I_{OL} = 8mA	2.3		0.6	
		I_{OL} = 12 mA	2.7		0.4	
		I_{OL} = 16 mA	3.0		0.4	
		I_{OL} = 24 mA	3.0		0.55	
I_I	Input Leakage Current	0 ≤ V_I ≤ 5.5V	2.3 to 3.6		±5.0	µA
I_{OFF}	Power-Off Leakage Current	V_I or V_O = 5.5V	0.0		10.0	µA
I_{CC}	Quiescent Supply Current	V_I = V_{CC} or GND	2.3 to 3.6		10.0	µA
		3.6V ≤ V_I ≤ 5.5V	2.3 to 3.6		±10.0	
ΔI_{CC}	Increase in I_{CC} per Input	V_{IH} = V_{CC} −0.6V	2.3 to 3.6		500	µA

AC Electrical Characteristics

Symbol	Parameter	$T_A = -40°C$ to $+85°C$, $R_L = 500\Omega$						Units
		$V_{CC} = 3.3V \pm 0.3V$		$V_{CC} = 2.7V$		$V_{CC} = 2.5V \pm 0.2V$		
		$C_L = 50pF$		$C_L = 50pF$		$C_L = 30pF$		
		Min	Max	Min	Max	Min	Max	
t_{PHL}	Propagation Delay	1.5	6.0	1.5	7.0	1.5	7.2	ns
t_{PLH}	An to $\overline{Qn}$	1.5	6.0	1.5	7.0	1.5	7.2	
t_{PHL}	Propagation Delay	1.5	6.5	1.5	7.5	1.5	8.4	ns
t_{PLH}	E3 to $\overline{Qn}$	1.5	6.5	1.5	7.5	1.5	8.4	
t_{PHL}	Propagation Delay	1.5	6.0	1.5	7.0	1.5	7.2	ns
t_{PLH}	$\overline{E1}$ or $\overline{E2}$ to $\overline{Qn}$	1.5	6.0	1.5	7.0	1.5	7.2	
t_{OSHL}	Output to Output Skew (Note 6)		1.0					ns
t_{OSLH}			1.0					

Note 6: 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}	$C_L = 50$ 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}	7.0	pF
C_{OUT}	Output Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}	8.0	pF
C_{PD}	Power Dissipation Capacitance	$V_{CC} = 3.3V$, $V_I = 0V$ or V_{CC}, f = 10 MHz	25.0	pF

AC Loading and Waveforms Generic for LCX Family

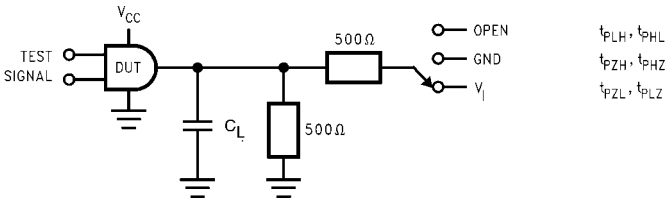
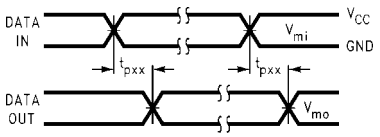
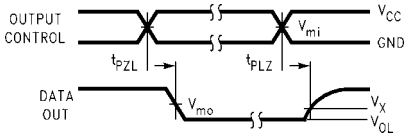


FIGURE 1. AC Test Circuit
(C_L includes probe and jig capacitance)

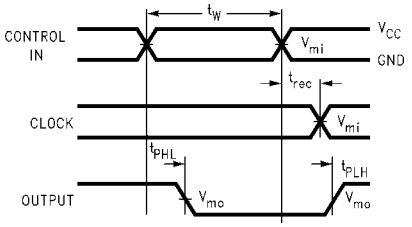
Test	Switch
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ}	6V at V_{CC} = 3.3V ± 0.3V V_{CC} x 2 at V_{CC} = 2.5V ± 0.2V
t_{PZH}, t_{PHZ}	GND



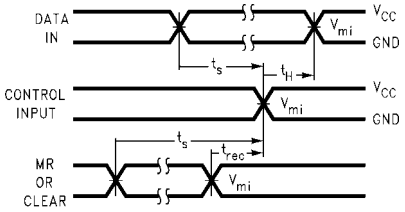
Waveform for Inverting and Non-Inverting Functions



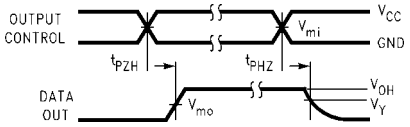
3-STATE Output Low Enable and Disable Times for Logic



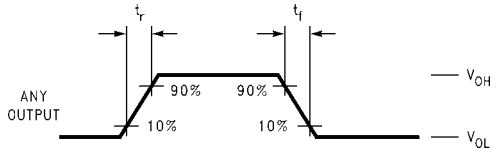
Propagation Delay, Pulse Width and t_{rec} Waveforms



Setup Time, Hold TIme and Recovery TIme for Logic



3-STATE Output High Enable and Disable Times for Logic

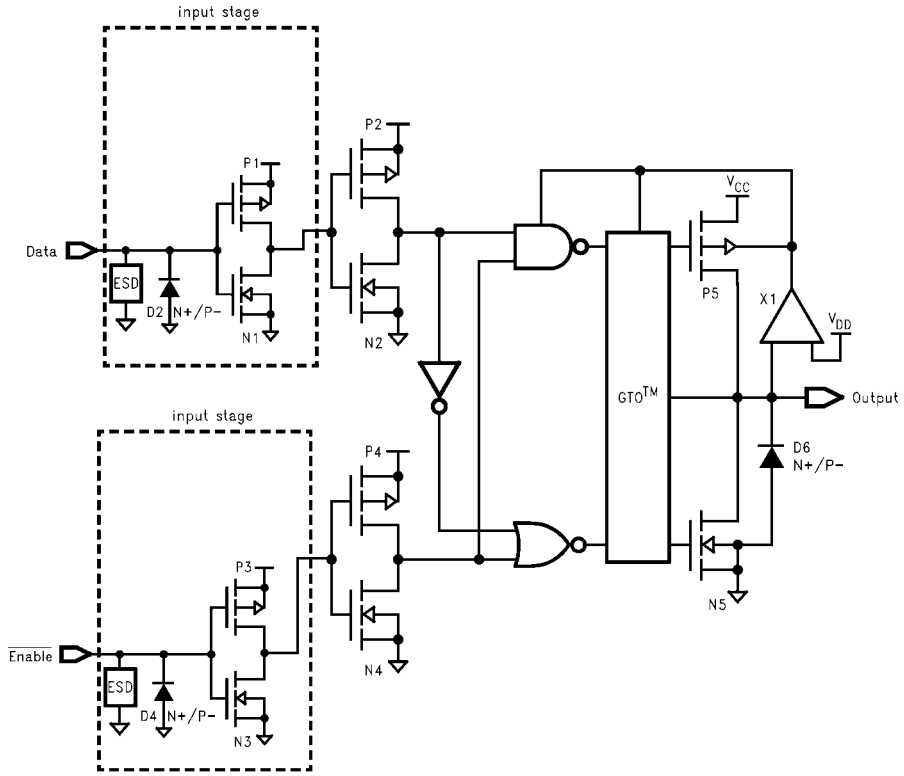


t_{rise} and t_{fall}

Symbol	V_{CC}		
	3.3V ± 0.3V	**2.7V**	**2.5V ± 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

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

Schematic Diagram Generic for LCX Family

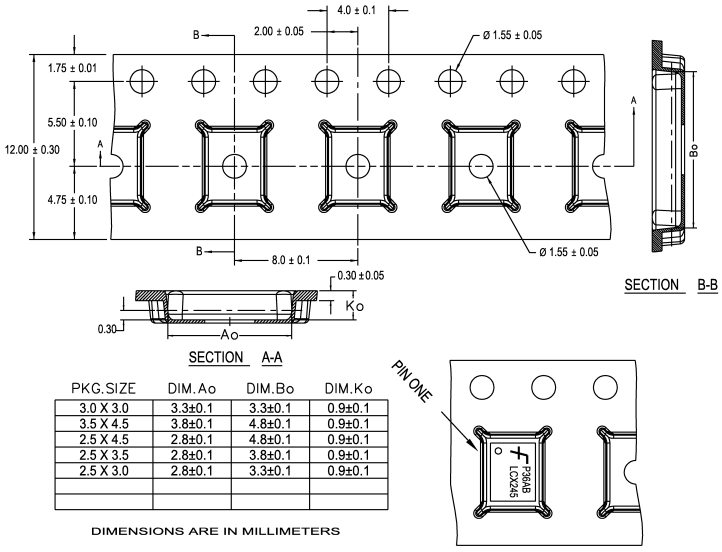


Tape and Reel Specification

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)

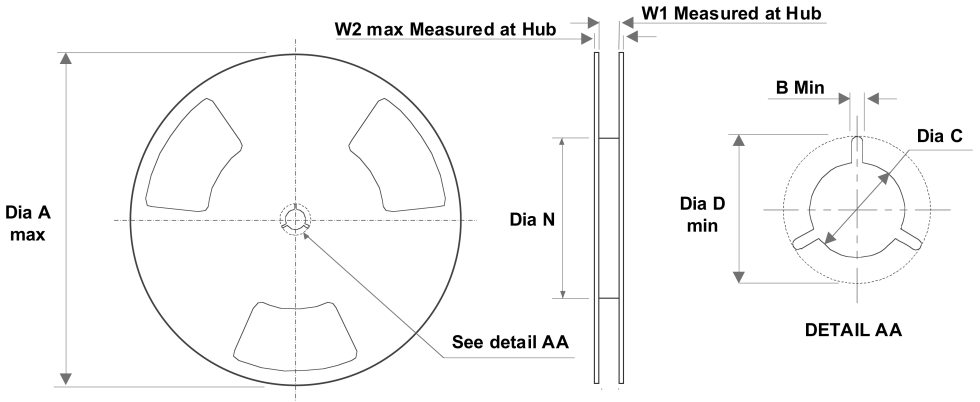


PKG.SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.0 X 3.0	3.3±0.1	3.3±0.1	0.9±0.1
3.5 X 4.5	3.8±0.1	4.8±0.1	0.9±0.1
2.5 X 4.5	2.8±0.1	4.8±0.1	0.9±0.1
2.5 X 3.5	2.8±0.1	3.8±0.1	0.9±0.1
2.5 X 3.0	2.8±0.1	3.3±0.1	0.9±0.1

DIMENSIONS ARE IN MILLIMETERS

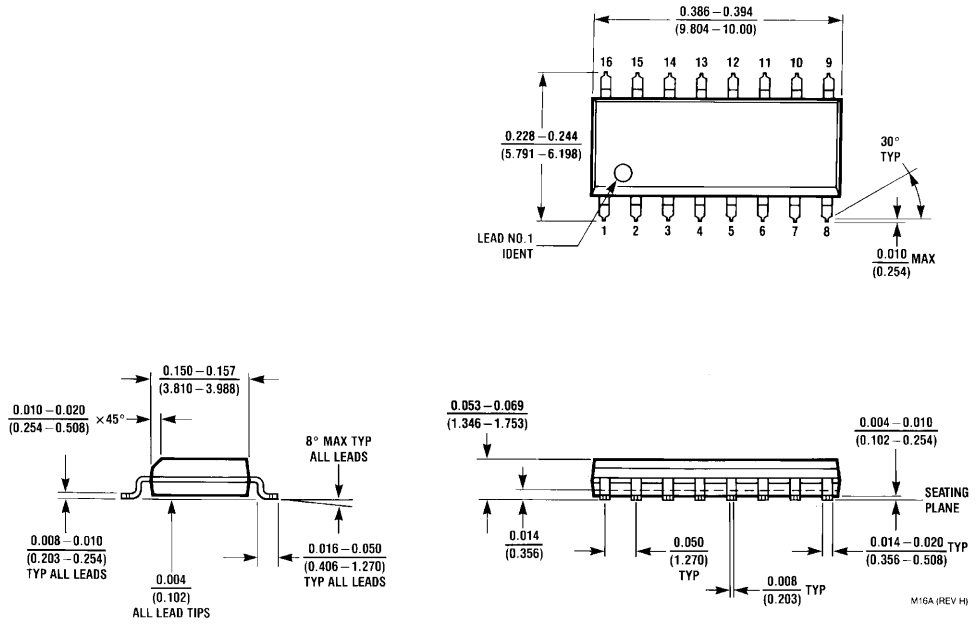
FSC MLP/DQFN CARRIER TAPE SPECIFICATIONS

REEL DIMENSIONS inches (millimeters)



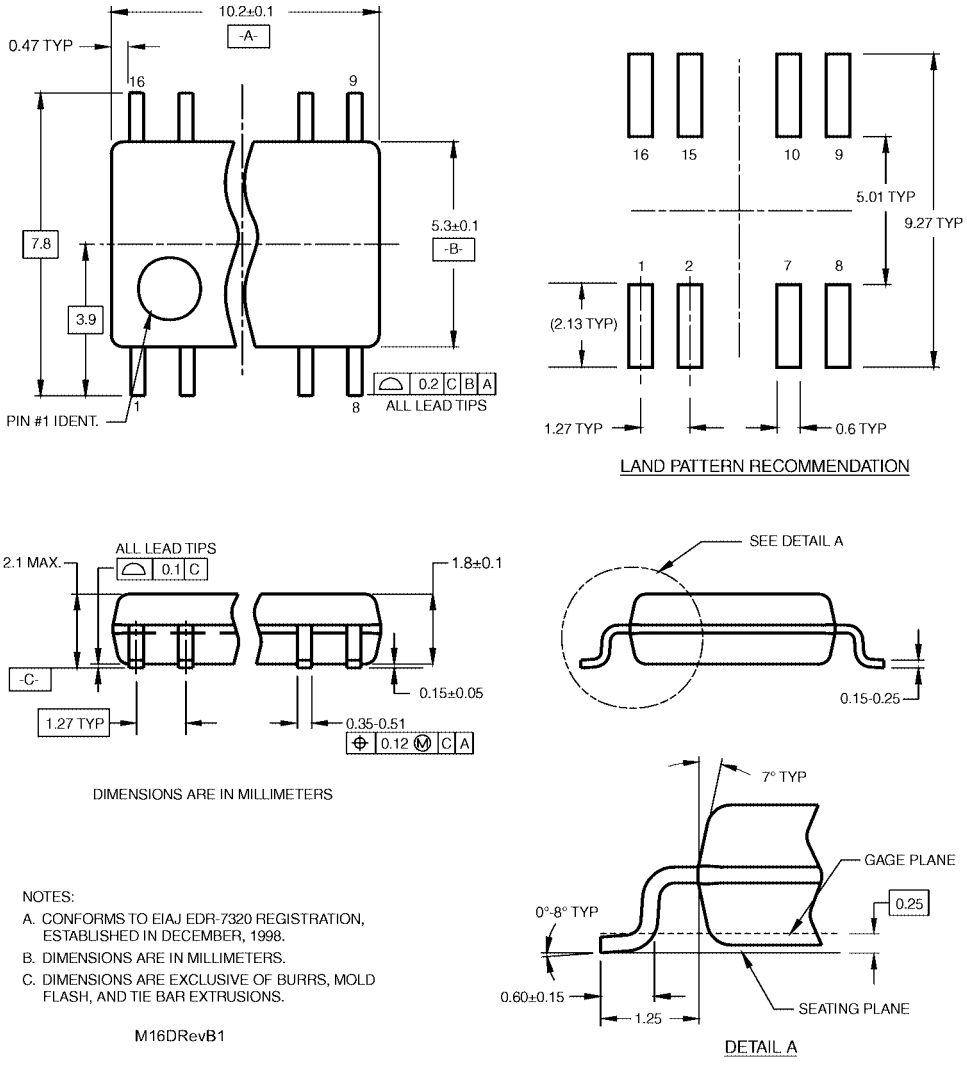
Tape Size	A	B	C	D	N	W1	W2
12 mm	13.0 (330.0)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.488 (12.4)	0.724 (18.4)

Physical Dimensions inches (millimeters) unless otherwise noted



16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
Package Number M16A

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



NOTES:

A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.

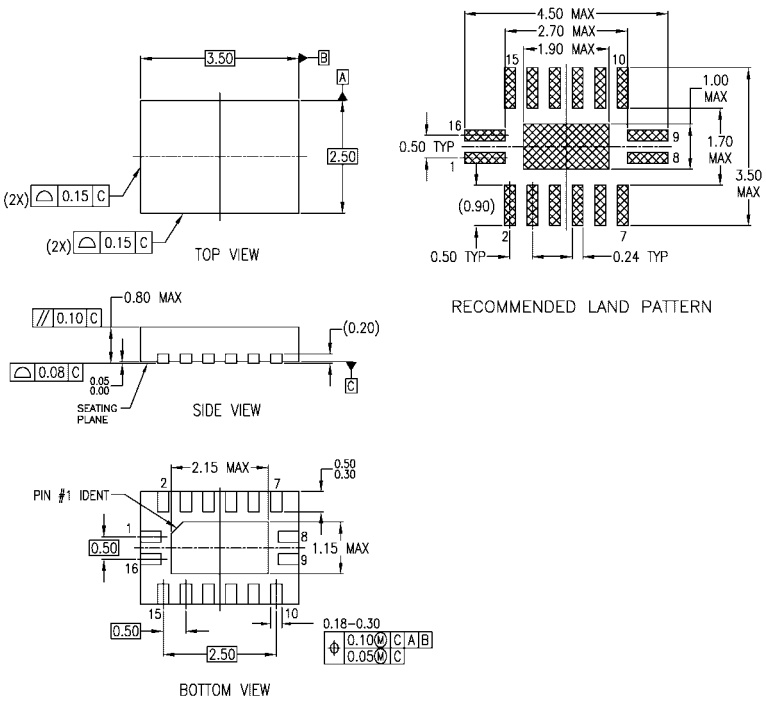
B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M16DRevB1

16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
Package Number M16D

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



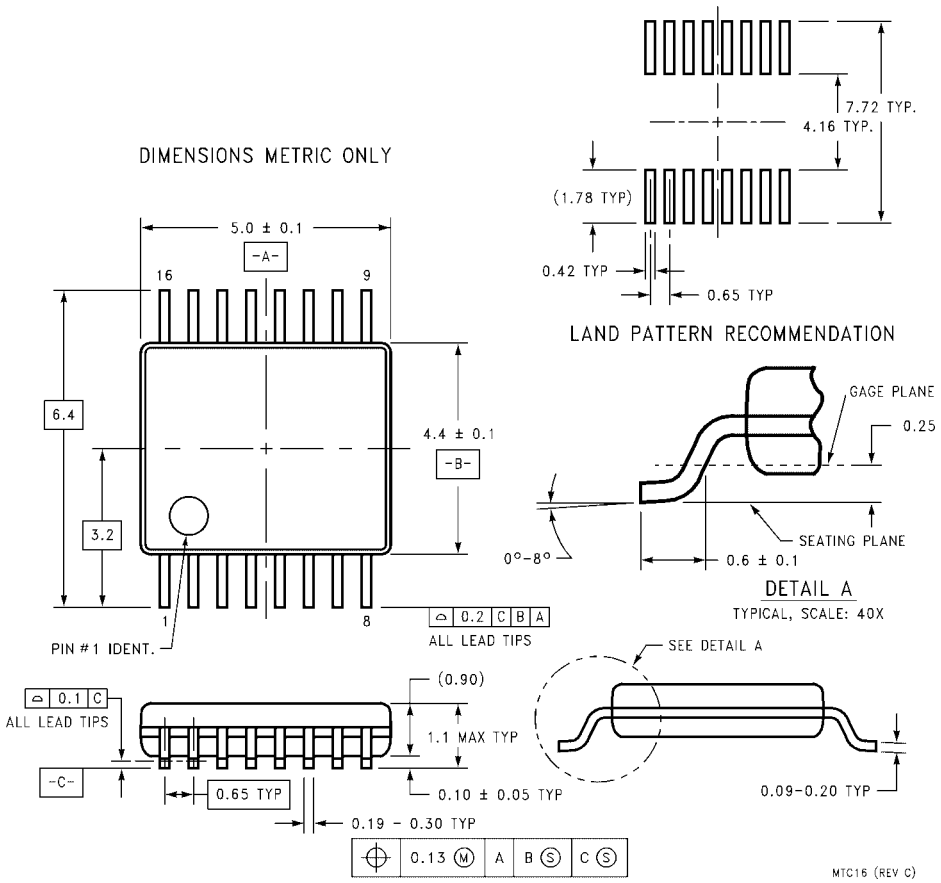
NOTES:

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

MLP016ErevA

16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm
Package Number MLP016E

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



16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
Package Number MTC16

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