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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 |

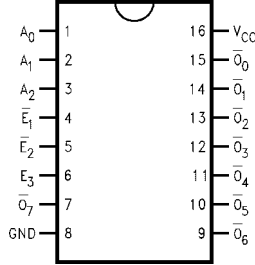
Note 1: Devices also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

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

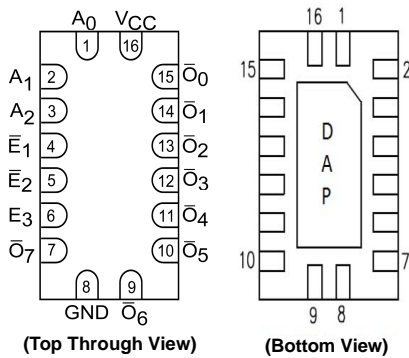
74LCX138 Low Voltage 1-of-8 Decoder/Demultiplexer with 5V Tolerant Inputs

Connection Diagrams

Pin Assignments for SOIC, SOP, and TSSOP



Pad Assignments for DQFN



Pin Descriptions

| Pin Names | Description |
|--------------------------------|----------------|
| A ₀ -A ₂ | Address Inputs |
| \bar{E}_1 - \bar{E}_2 | Enable Inputs |
| E ₃ | Enable Input |
| \bar{O}_0 - \bar{O}_7 | Outputs |
| DAP | No Connect |

Note: DAP (Die Attach Pad)

Functional Description

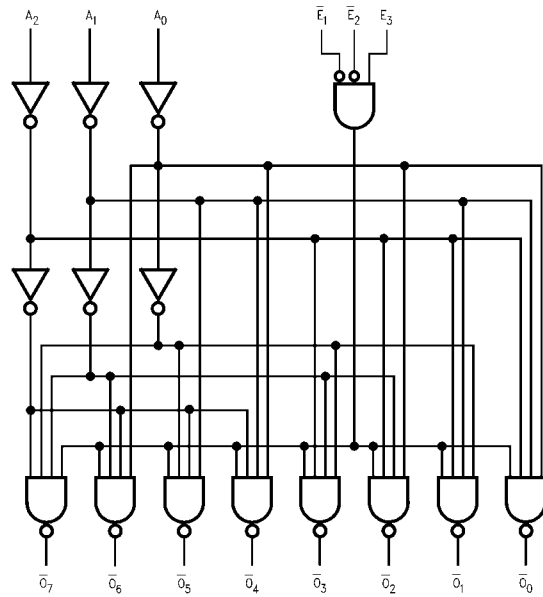
The LCX138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs (A₀, A₁, A₂) and, when enabled, provides eight mutually exclusive active-LOW outputs (\bar{O}_0 - \bar{O}_7). The LCX138 features three Enable inputs, two active-LOW (\bar{E}_1 , \bar{E}_2) and one active-HIGH (E₃). All outputs will be HIGH unless \bar{E}_1 and \bar{E}_2 are LOW and E₃ 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 | | | | | | | |
|-------------|-------------|----------------|----------------|----------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| \bar{E}_1 | \bar{E}_2 | E ₃ | A ₀ | A ₁ | A ₂ | \bar{O}_0 | \bar{O}_1 | \bar{O}_2 | \bar{O}_3 | \bar{O}_4 | \bar{O}_5 | \bar{O}_6 | \bar{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 V _{CC} = 2.7V to 3.0V V _{CC} = 2.3V to 2.7V | | ±24.0 ±12.0 ±8.0 | mA |
| T _A | Free-Air Operating Temperature | -40.0 | 85.0 | °C | |
| Δt/ΔV | 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 2.7 to 3.6 | 1.7 2.0 | | V |
| V _{IL} | LOW Level Input Voltage | | 2.3 to 2.7 2.7 to 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 to 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 to 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 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 3.6V ≤ V _I ≤ 5.5V | 2.3 to 3.6 2.3 to 3.6 | | 10.0 ±10.0 | μA |
| 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 | $T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}, R_L = 500\Omega$ | | | | | | Units |
|------------|--------------------------------|--|-----|---------------------|-----|--------------------------|-----|-------|
| | | $V_{CC} = 3.3V \pm 0.3V$ | | $V_{CC} = 2.7V$ | | $V_{CC} = 2.5V \pm 0.2V$ | | |
| | | $C_L = 50\text{pF}$ | | $C_L = 50\text{pF}$ | | $C_L = 30\text{pF}$ | | |
| | | 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} | E1 or 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) | $T_A = 25^{\circ}\text{C}$ | Units |
|-----------|--------------------------------------|--|-----------------|----------------------------|-------|
| | | | | Typical | |
| V_{OLP} | Quiet Output Dynamic Peak V_{OL} | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$ | 3.3 | 0.8 | V |
| | | $C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 2.5 | 0.6 | |
| V_{OLV} | Quiet Output Dynamic Valley V_{OL} | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$ | 3.3 | -0.8 | V |
| | | $C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 2.5 | -0.6 | |

Capacitance

| Symbol | Parameter | Conditions | Typical | Units |
|-----------|-------------------------------|---|---------|-------|
| C_{IN} | Input Capacitance | $V_{CC} = \text{Open}, V_I = 0V \text{ or } V_{CC}$ | 7.0 | pF |
| C_{OUT} | Output Capacitance | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}$ | 8.0 | pF |
| C_{PD} | Power Dissipation Capacitance | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}, f = 10\text{ MHz}$ | 25.0 | pF |

AC Loading and Waveforms Generic for LCX Family

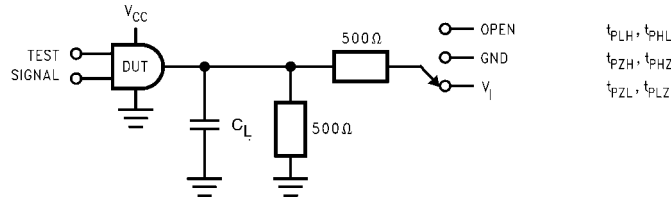
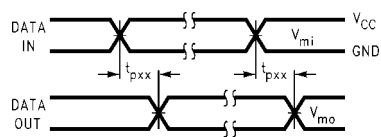
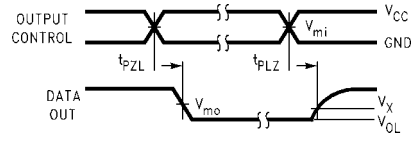


FIGURE 1. AC Test Circuit
(C_L includes probe and jig capacitance)

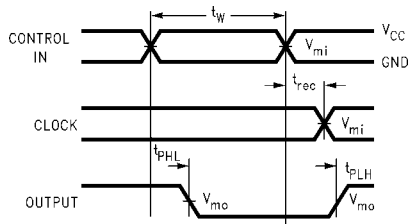
| Test | Switch |
|--------------------|---|
| t_{PLH}, t_{PHL} | Open |
| t_{PZL}, t_{PLZ} | 6V at $V_{CC} = 3.3V \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5V \pm 0.2V$ |
| t_{PZH}, t_{PHZ} | GND |



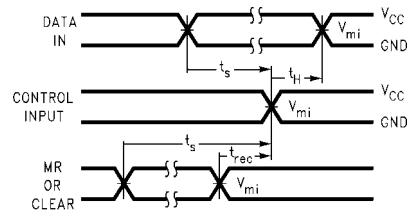
Waveform for Inverting and Non-Inverting Functions



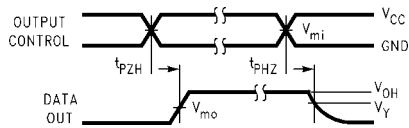
3-STATE Output Low Enable and Disable Times for Logic



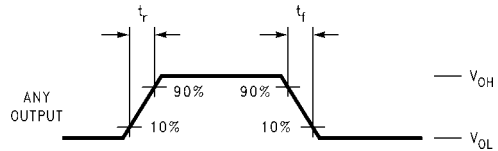
Propagation Delay, Pulse Width and t_{rec} Waveforms



Setup Time, Hold Time and Recovery Time for Logic



3-STATE Output High Enable and Disable Times for Logic

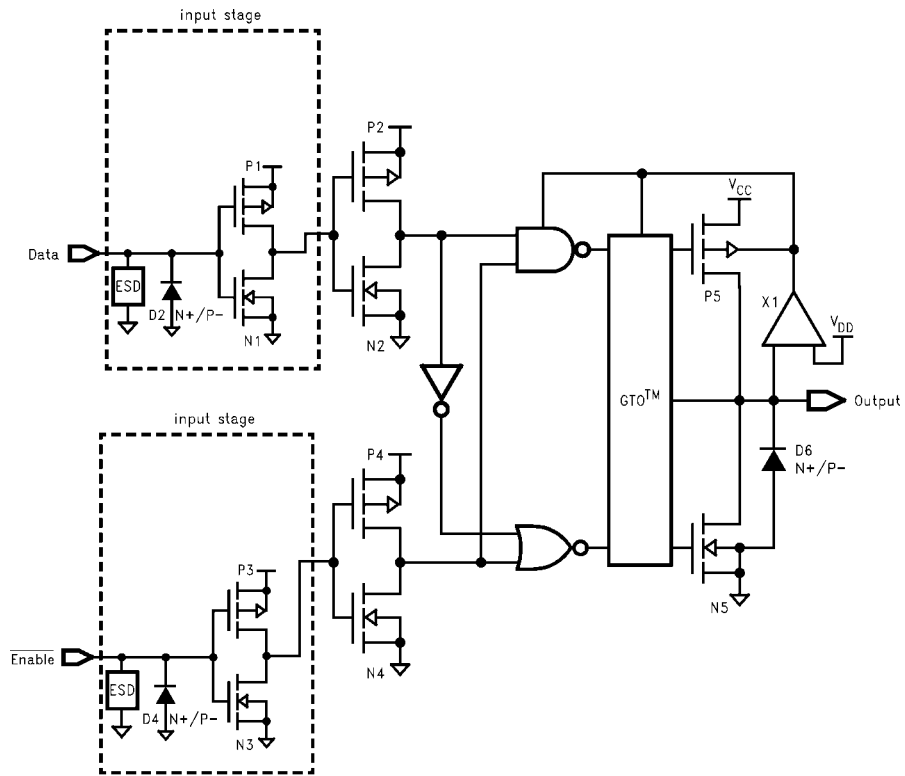


t_{rise} and t_{fall}

| Symbol | V_{CC} | | |
|----------|-----------------|-----------------|------------------|
| | $3.3V \pm 0.3V$ | 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 | $V_{OH} - 0.3V$ | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ |

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

Schematic Diagram Generic for LCX Family



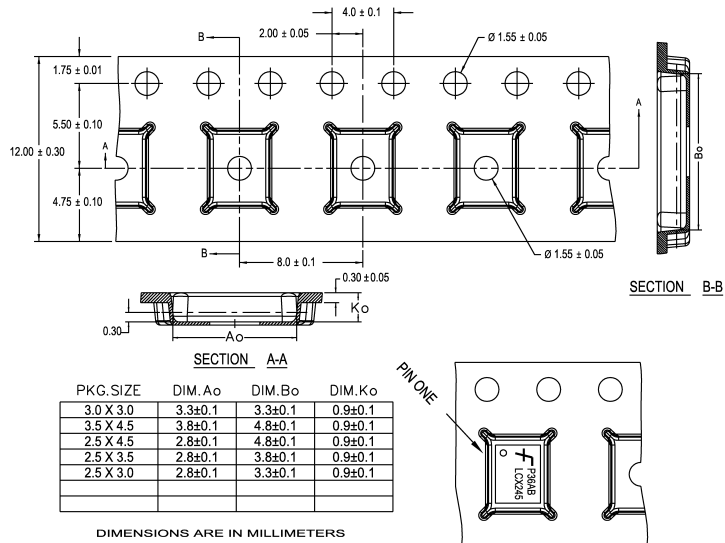
74LCX138

Tape and Reel Specification

Tape Format for DQFN

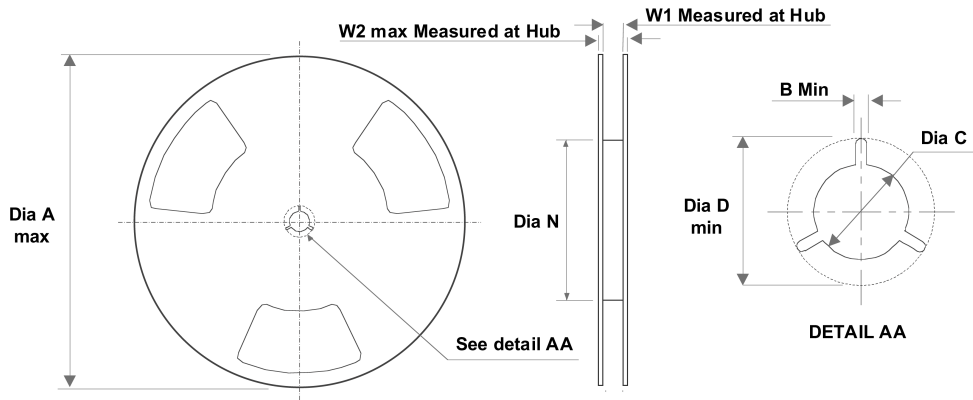
| Package Designator | Tape Section | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| BQX | Leader (Start End) | 125 (typ) | Empty | Sealed |
| | Carrier | 3000 | Filled | Sealed |
| | Trailer (Hub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

TAPE DIMENSIONS inches (millimeters)



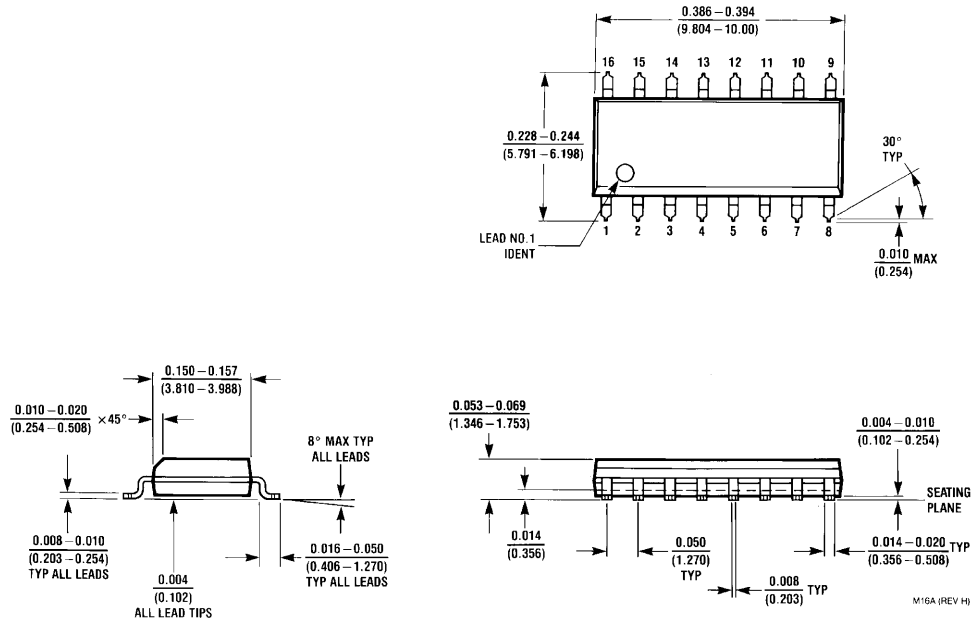
FSC MLP/DQFN CARRIER TAPE SPECIFICATIONS

REEL DIMENSIONS inches (millimeters)



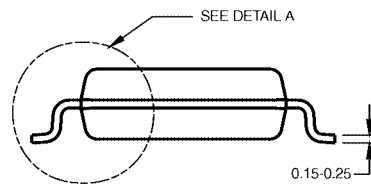
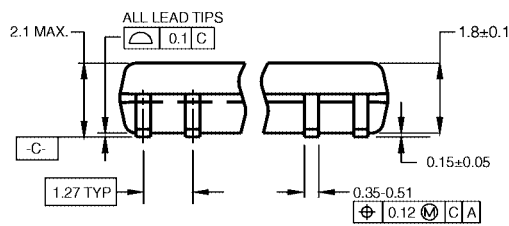
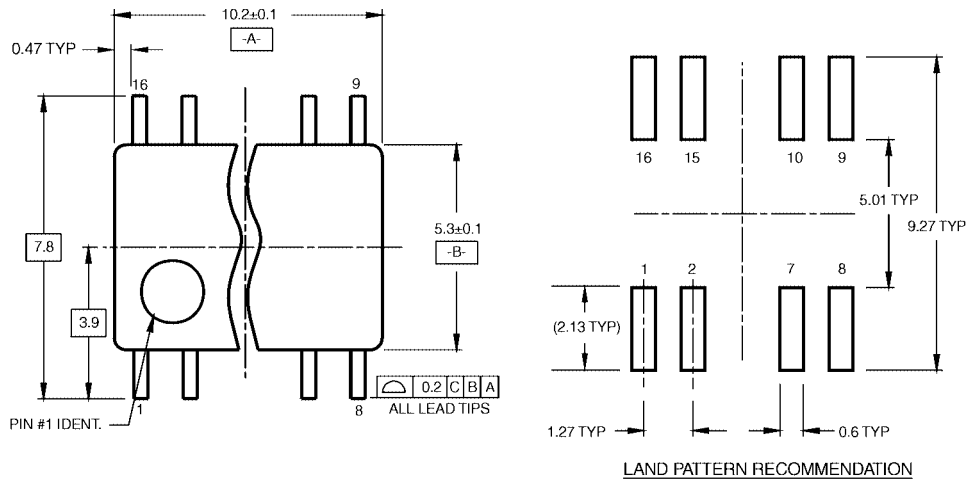
| Tape Size | A | B | C | D | N | W1 | W2 |
|-----------|-----------------|-----------------|------------------|------------------|------------------|-----------------|-----------------|
| 12 mm | 13.0 (330.0) | 0.059 (1.50) | 0.512 (13.00) | 0.795 (20.20) | 2.165 (55.00) | 0.488 (12.4) | 0.724 (18.4)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

Physical Dimensions inches (millimeters) unless otherwise noted



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

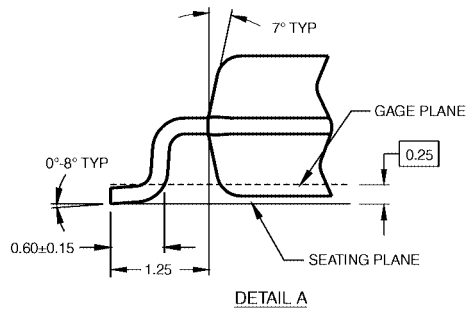
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



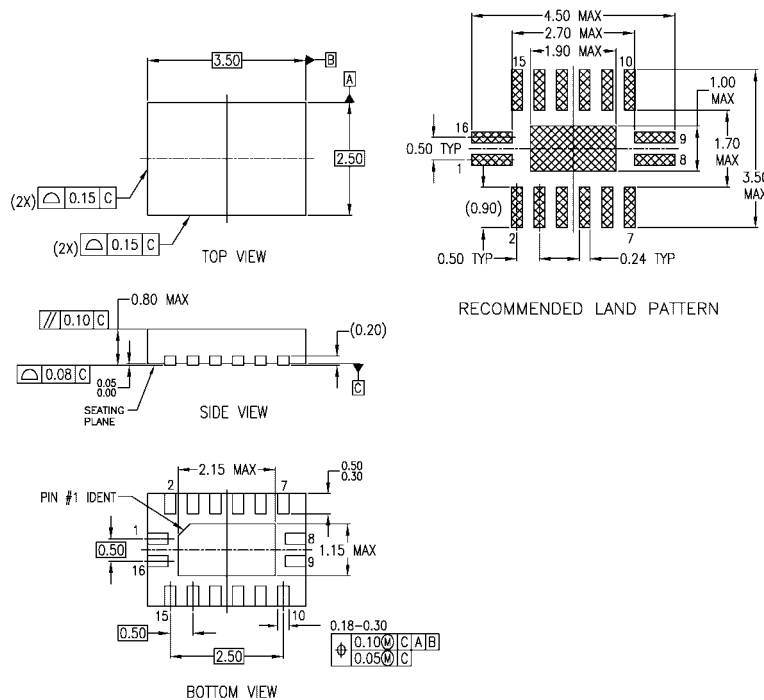
DIMENSIONS ARE IN MILLIMETERS

- 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.

M16DRRevB1



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

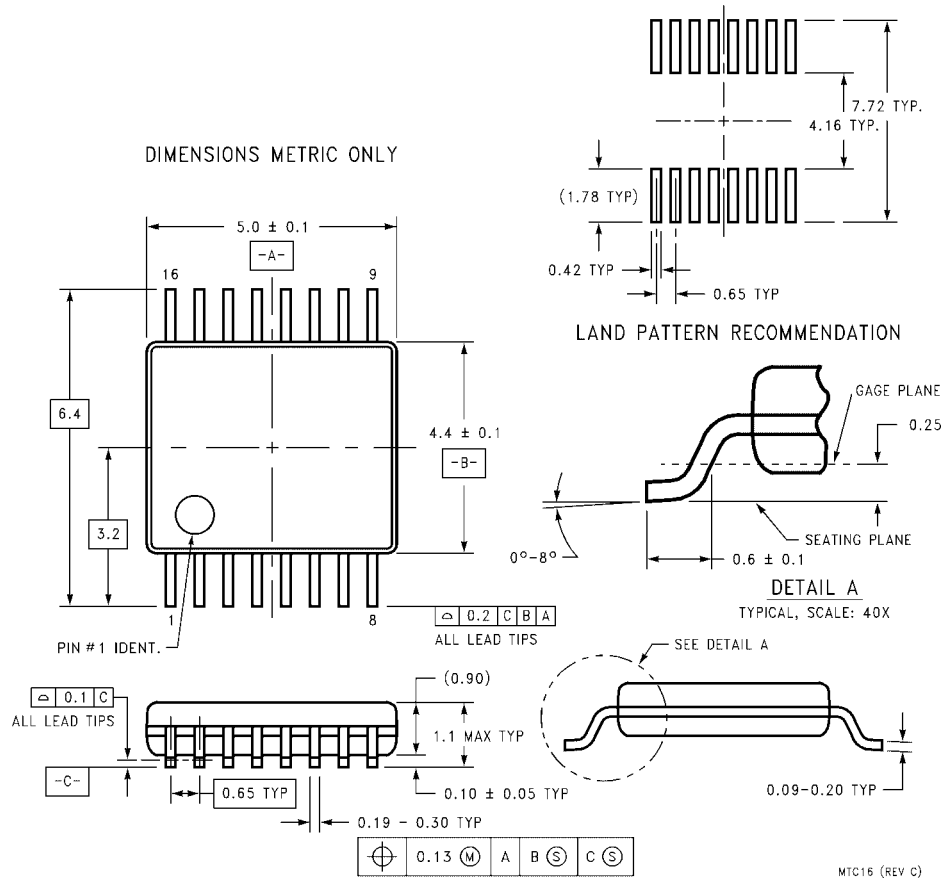
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)**NOTES:**

- 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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