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# 74LCX112

## Low Voltage Dual J-K Negative Edge-Triggered Flip-Flop with 5V Tolerant Inputs

### General Description

The LCX112 is a dual J-K flip-flop. Each flip-flop has independent J, K, PRESET, CLEAR, and CLOCK inputs with Q, Q outputs. These devices are edge sensitive and change state on the negative going transition of the clock pulse. Clear and preset are independent of the clock and accomplished by a low logic level on the corresponding input. LCX devices are designed for low voltage (3.3V or 2.5) operation with the added capability of interfacing to a 5V signal environment.

The 74LCX112 is fabricated with advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

### Features

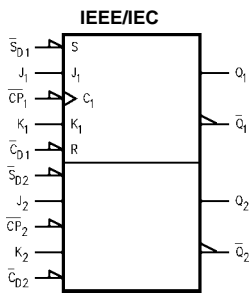
- 5V tolerant inputs
- 2.3V–3.6V  $V_{CC}$  specifications provided
- 7.5 ns  $t_{PD}$  max ( $V_{CC} = 3.3V$ ), 10  $\mu A$   $I_{CC}$  max
- Power down high impedance inputs and outputs
- $\pm 24$  mA output drive ( $V_{CC} = 3.0V$ )
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 2000V

### Ordering Code:

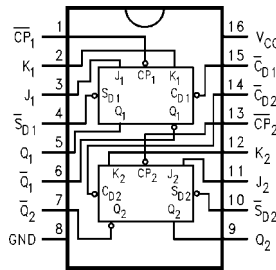
| Order Number | Package Number | Package Description   |
|--------------|----------------|---|
| 74LCX112M    | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow |
| 74LCX112SJ   | M16D           | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide               |
| 74LCX112MTC  | MTC16          | 16-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.

### Logic Symbol



### Connection Diagram



### Pin Descriptions

| Pin Names                                  | Description                              |
|--|--|
| $J_1, J_2, K_1, K_2$                       | Data Inputs                              |
| $\overline{CP}_1, \overline{CP}_2$         | Clock Pulse Inputs (Active Falling Edge) |
| $\overline{CD}_1, \overline{CD}_2$         | Direct Clear Inputs (Active LOW)         |
| $\overline{SD}_1, \overline{SD}_2$         | Direct Set Inputs (Active LOW)           |
| $Q_1, Q_2, \overline{Q}_1, \overline{Q}_2$ | Outputs                                  |

## Truth Table

(Each half)

| Inputs           |                  |                  |   |   | Outputs          |                  |
|------------------|------------------|------------------|---|---|------------------|------------------|
| $\overline{S_D}$ | $\overline{C_D}$ | $\overline{C_P}$ | J | K | Q                | $\overline{Q}$   |
| L                | H                | X                | X | X | H                | L                |
| H                | L                | X                | X | X | L                | H                |
| L                | L                | X                | X | X | H                | H                |
| H                | H                | ~                | h | h | $\overline{Q_0}$ | $Q_0$            |
| H                | H                | ~                | l | h | L                | H                |
| H                | H                | ~                | h | l | H                | L                |
| H                | H                | ~                | l | l | $Q_0$            | $\overline{Q_0}$ |
| H                | H                | H                | X | X | $Q_0$            | $\overline{Q_0}$ |

H(h) = HIGH Voltage Level

L(l) = LOW Voltage Level

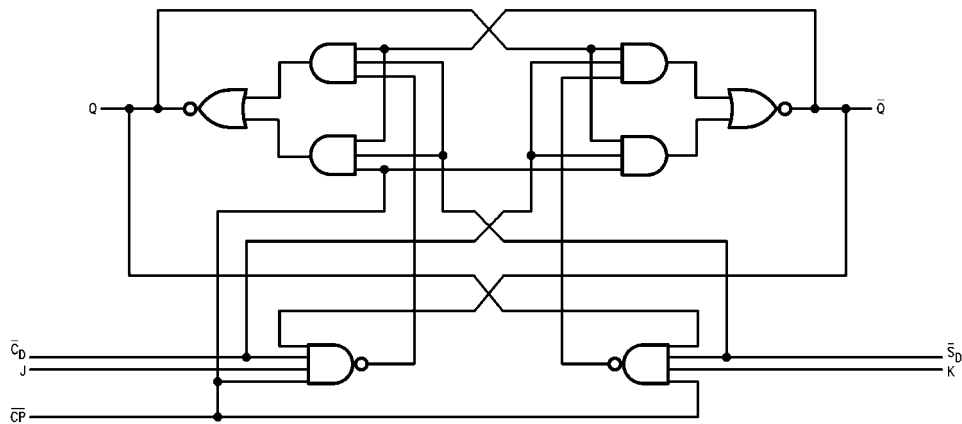
X = Immaterial

~ = HIGH-to-LOW Clock Transition

 $Q_0(\overline{Q_0})$  = Before HIGH-to-LOW Transition of Clock

Lower case letters indicate the state of the referenced input or output one setup time prior to the HIGH-to-LOW clock transition.

## Logic Diagram



| Absolute Maximum Ratings <sup>(Note 1)</sup>  |   |                           |                                      |                                     |            |         |
|---|---|---------------------------|--------------------------------------|-------------------------------------|------------|---------|
| 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 2) | V                                   |            |         |
| $I_{IK}$  | DC Input Diode Current                                    | -50                       | $V_I < GND$                          | mA                                  |            |         |
| $I_{OK}$  | DC Output Diode Current                                   | -50                       | $V_O < GND$                          | mA                                  |            |         |
|   |   | +50                       | $V_O > V_{CC}$                       |                                     |            |         |
| $I_O$   | 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 (Note 3)   |   |                           |                                      |                                     |            |         |
| 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                         | 5.5                                  | V                                   |            |         |
| $V_O$   | Output Voltage  | 0                         | $V_{CC}$                             | V                                   |            |         |
| $I_{OH}/I_{OL}$   | Output Current  | $V_{CC} = 3.0V - 3.6V$    |                                      | $\pm 24$                            | mA         |         |
|   |   | $V_{CC} = 2.7V - 3.0V$    |                                      | $\pm 12$                            |            |         |
|   |   | $V_{CC} = 2.3V - 2.7V$    |                                      | $\pm 8$                             |            |         |
| $T_A$   | Free-Air Operating Temperature                            | -40                       | 85                                   | °C                                  |            |         |
| $\Delta t/\Delta V$   | Input Edge Rate, $V_{IN} = 0.8V - 2.0V$ , $V_{CC} = 3.0V$ | 0                         | 10                                   | ns/V                                |            |         |
| <p><b>Note 1:</b> 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.</p> <p><b>Note 2:</b> <math>I_O</math> Absolute Maximum rating must be observed.</p> <p><b>Note 3:</b> Unused Inputs must be held HIGH or LOW. They may not float.</p> |   |                           |                                      |                                     |            |         |
| DC Electrical Characteristics   |   |                           |                                      |                                     |            |         |
| Symbol  | Parameter   | Conditions                | $V_{CC}$<br>(V)                      | $T_A = 40^\circ C$ to $+85^\circ C$ |            | Units   |
|   |   |                           |                                      | Min                                 | Max        |         |
| $V_{IH}$  | HIGH Level Input Voltage                                  |                           | 2.3 - 2.7<br>2.7 - 3.6               | 1.7<br>2.0                          |            | V       |
| $V_{IL}$  | LOW Level Input Voltage                                   |                           | 2.3 - 2.7<br>2.7 - 3.6               |                                     | 0.7<br>0.8 | V       |
| $V_{OH}$  | HIGH Level Output Voltage                                 | $I_{OH} = -100\mu A$      | 2.3 - 3.6                            | $V_{CC} - 0.2$                      | 0.7        | V       |
|   |   | $I_{OH} = -8\text{ mA}$   | 2.3                                  | 1.8                                 |            |         |
|   |   | $I_{OH} = -12\text{ mA}$  | 2.7                                  | 2.2                                 |            |         |
|   |   | $I_{OH} = -18\text{ mA}$  | 3.0                                  | 2.4                                 |            |         |
|   |   | $I_{OH} = -24\text{ mA}$  | 3.0                                  | 2.2                                 |            |         |
| $V_{OL}$  | LOW Level Output Voltage                                  | $I_{OL} = 100\mu A$       | 2.3 - 3.6                            |                                     | 0.6        | V       |
|   |   | $I_{OL} = 8\text{ mA}$    | 2.3                                  |                                     | 0.2        |         |
|   |   | $I_{OL} = 12\text{ mA}$   | 2.7                                  |                                     | 0.4        |         |
|   |   | $I_{OL} = 16\text{ mA}$   | 3.0                                  |                                     | 0.4        |         |
|   |   | $I_{OL} = 24\text{ mA}$   | 3.0                                  |                                     | 0.55       |         |
| $I_I$   | Input Leakage Current                                     | $0 \leq I_I \leq 5.5V$    | 2.3 - 3.6                            |                                     | $\pm 5.0$  | $\mu A$ |
| $I_{OFF}$   | Power-Off Leakage Current                                 | $V_I$ or $V_O = 5.5V$     | 0                                    |                                     | 10         | $\mu A$ |
| $I_{CC}$  | Quiescent Supply Current                                  | $V_I = V_{CC}$ or GND     | 2.3 - 3.6                            |                                     | 10         | $\mu A$ |
|   |   | $3.6V \leq V_I \leq 5.5V$ | 2.3 - 3.6                            |                                     | $\pm 10$   | $\mu A$ |
| $\Delta I_{CC}$   | Increase in $I_{CC}$ per Input                            | $V_{IH} = V_{CC} - 0.6V$  | 2.3 - 3.6                            |                                     | 500        | $\mu A$ |

## AC Electrical Characteristics

| Symbol     | Parameters  | $T_A = 40^\circ\text{C to } 85^\circ\text{C}, R_L = 500\Omega$ |     |                      |     |                          |     | 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 |       |
| $f_{MAX}$  | Maximum Clock Frequency   | 150  |     | 150                  |     | 150                      |     | MHz   |
| $t_{PHL}$  | Propagation Delay   | 1.5  | 7.5 | 1.5                  | 8.0 | 1.5                      | 9.0 | ns    |
| $t_{PLH}$  | $\overline{CP}_n$ to $Q_n$ or $\overline{Q}_n$                      | 1.5  | 7.5 | 1.5                  | 8.0 | 1.5                      | 9.0 |       |
| $t_{PHL}$  | Propagation Delay   | 1.5  | 7.0 | 1.5                  | 8.0 | 1.5                      | 8.4 | ns    |
| $t_{PLH}$  | $\overline{CD}_n$ or $\overline{SD}_n$ to $Q_n$ or $\overline{Q}_n$ | 1.5  | 7.0 | 1.7                  | 8.0 | 1.5                      | 8.4 |       |
| $t_S$      | Setup Time  | 2.5  |     | 2.5                  |     | 4.0                      |     | ns    |
| $t_H$      | Hold Time   | 1.5  |     | 1.5                  |     | 2.0                      |     | ns    |
| $t_W$      | Pulse Width $\overline{CP}$   | 3.3  |     | 3.3                  |     | 4.0                      |     | ns    |
| $t_W$      | Pulse Width ( $\overline{CD}$ , $\overline{SD}$ )                   | 3.3  |     | 3.3                  |     | 4.0                      |     | ns    |
| $t_{REC}$  | Recovery Time   | 2.0  |     | 2.5                  |     | 4.5                      |     | ns    |
| $t_{OSHL}$ | Output to Output Skew   |  | 1.0 |                      |     |                          |     | ns    |
| $t_{OSLH}$ | (Note 4)  |  | 1.0 |                      |     |                          |     |       |

**Note 4:** 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 ( $t_{OSLH}$ ).

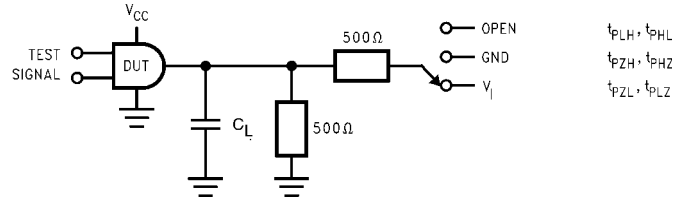
## Dynamic Switching Characteristics

| Symbol    | Parameter                            | Conditions   | $V_{CC}$<br>(V) | $T_A = 25^\circ\text{C}$ | Units |
|-----------|--------------------------------------|--|-----------------|--------------------------|-------|
|           |                                      |  |                 | Typical                  |       |
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$   | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$<br>$C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 3.3<br>2.5      | 0.8<br>0.6               | V     |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L = 50\text{ pF}, V_{IH} = 3.3V, V_{IL} = 0V$<br>$C_L = 30\text{ pF}, V_{IH} = 2.5V, V_{IL} = 0V$ | 3.3<br>2.5      | -0.8<br>-0.6             | V     |

## Capacitance

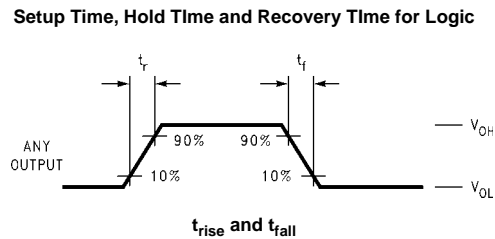
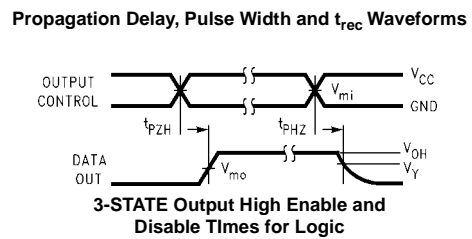
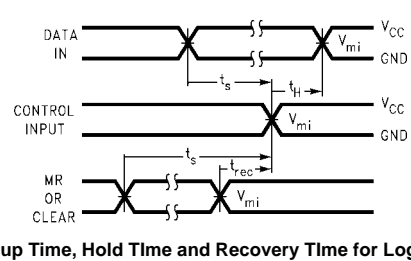
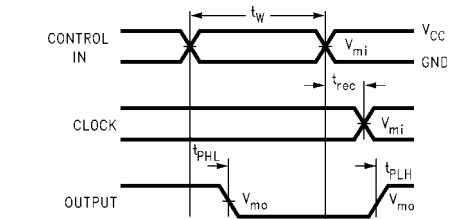
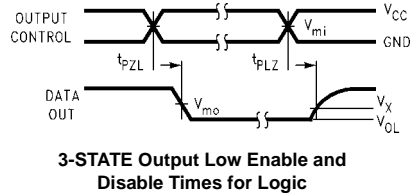
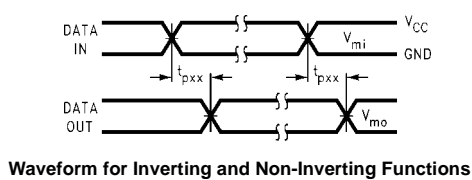
| Symbol    | Parameter                     | Conditions  | Typical | Units |
|-----------|-------------------------------|---|---------|-------|
| $C_{IN}$  | Input Capacitance             | $V_{CC} = \text{Open}, V_I = 0V \text{ or } V_{CC}$             | 7       | pF    |
| $C_{OUT}$ | Output Capacitance            | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}$                    | 8       | pF    |
| $C_{PD}$  | Power Dissipation Capacitance | $V_{CC} = 3.3V, V_I = 0V \text{ or } V_{CC}, f = 10\text{ MHz}$ | 25      | pF    |

**AC Loading and Waveforms** Generic for LCX Family



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

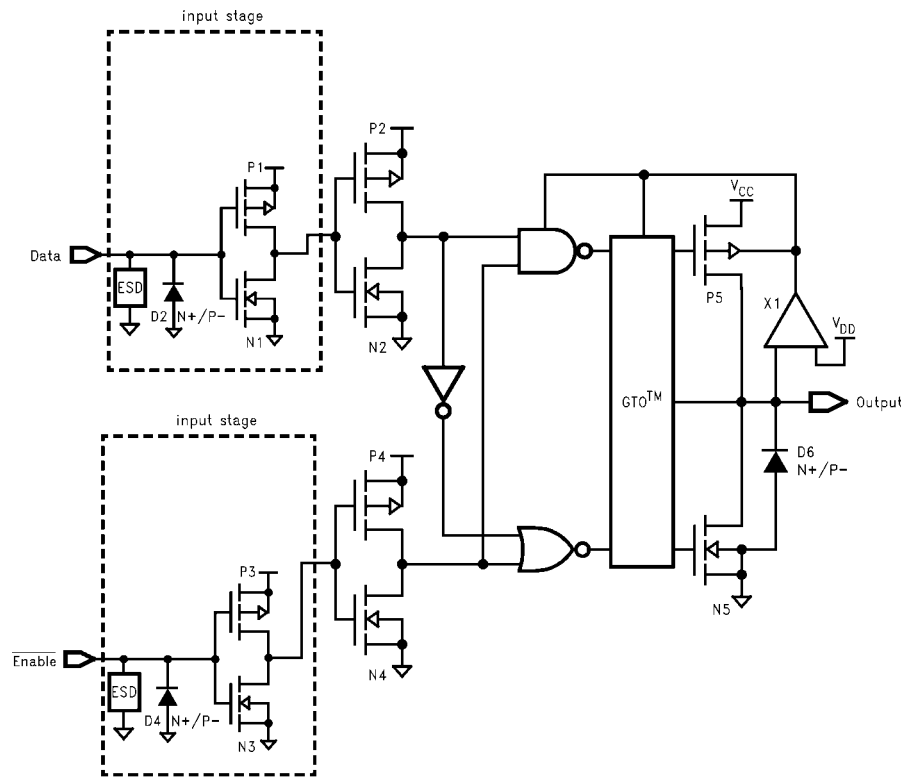
| Test               | Switch  |
|--------------------|---|
| $t_{PLH}, t_{PHL}$ | Open  |
| $t_{PZL}, t_{PLZ}$ | 6V at $V_{CC} = 3.3 \pm 0.3V$<br>$V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$ |
| $t_{PZH}, t_{PHZ}$ | GND   |



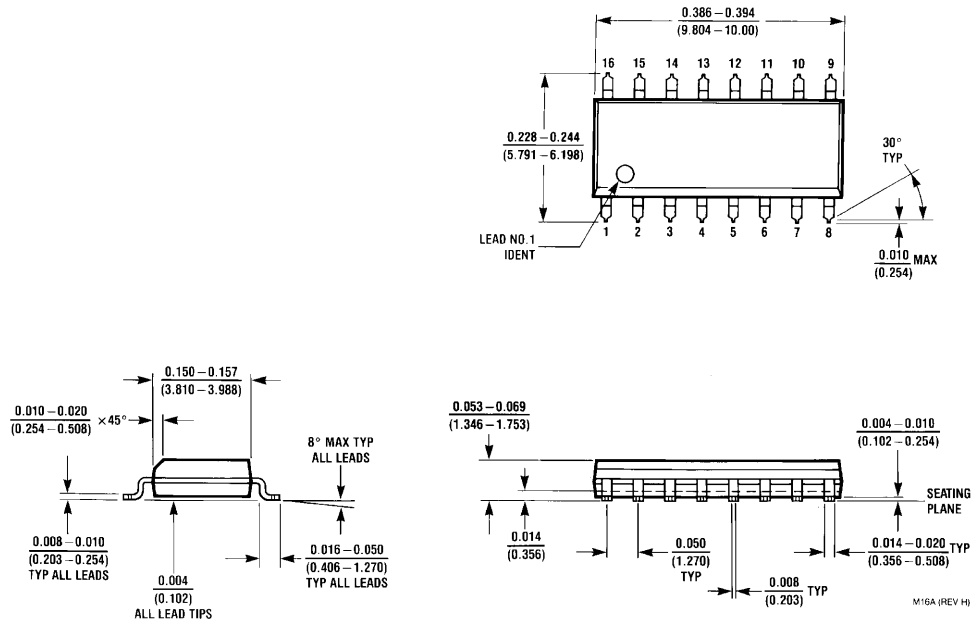
**FIGURE 2. Waveforms**  
(Input Pulse Characteristics;  $f=1MHz, t_r=t_f=3ns$ )

| 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



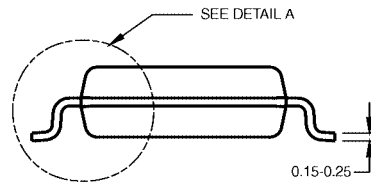
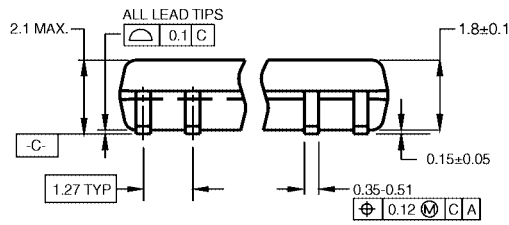
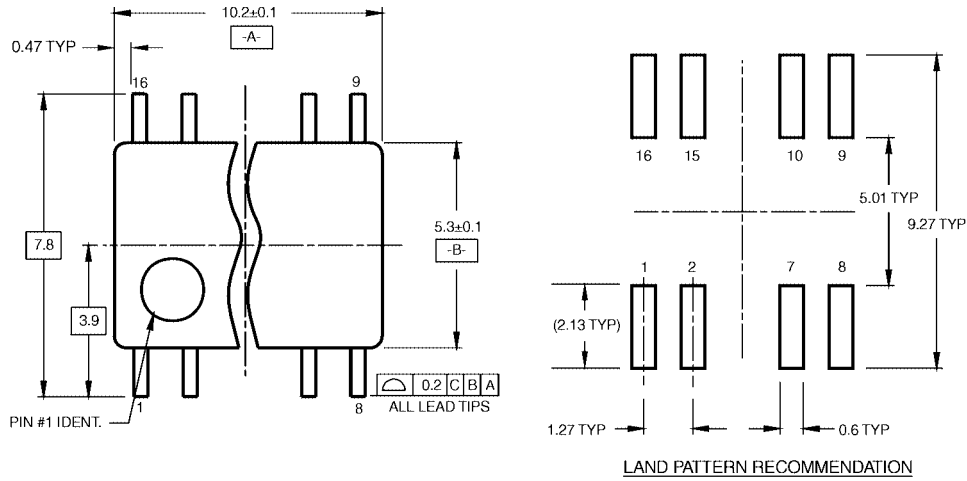
**Physical Dimensions** inches (millimeters) unless otherwise noted



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



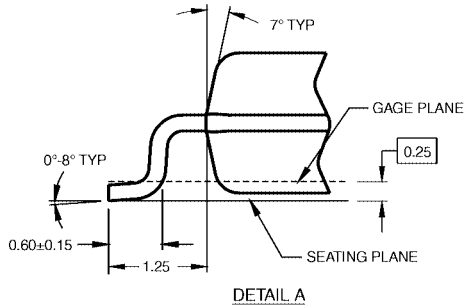
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



DIMENSIONS ARE IN MILLIMETERS

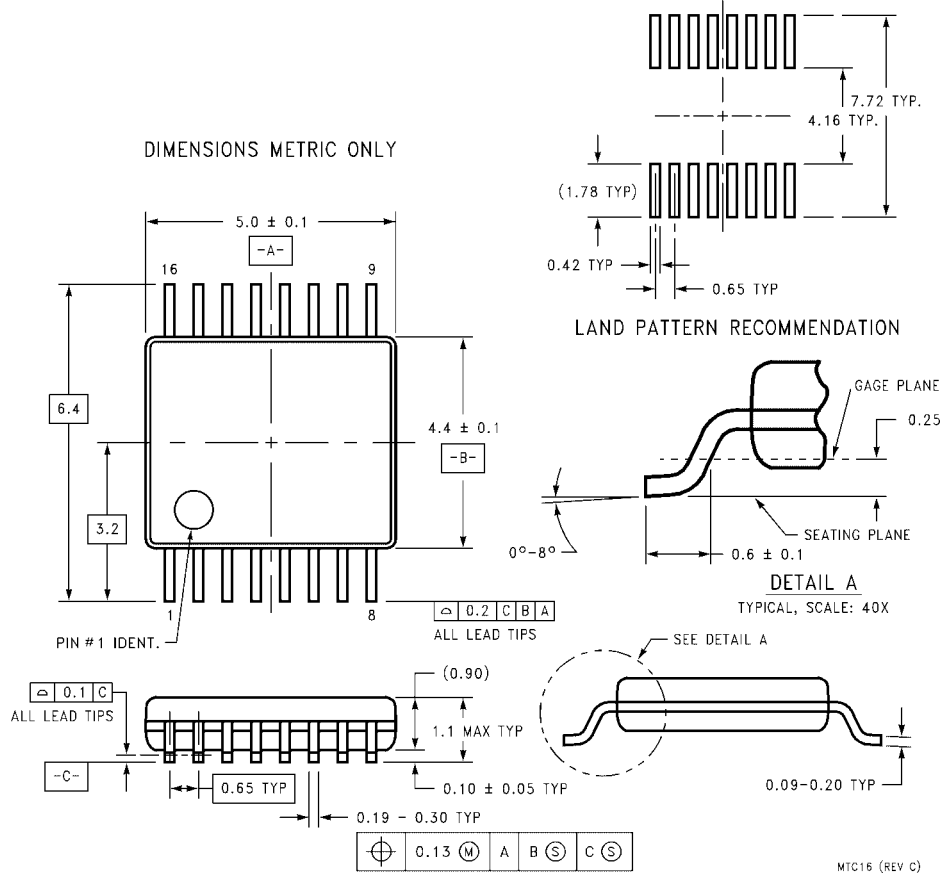
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 C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M16DRevB1



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

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



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

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