

74LCX245

Low Voltage Bidirectional Transceiver with 5V Tolerant Inputs and Outputs

General Description

The LCX245 contains eight non-inverting bidirectional buffers with 3-STATE outputs and is intended for bus oriented applications. The device is designed for low voltage (2.5V and 3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment. The T/\bar{R} input determines the direction of data flow through the device. The \bar{OE} input disables both the A and B ports by placing them in a high impedance state.

The LCX245 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 to 3.6V V_{CC} specifications provided
- 7.0 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 500 mA
- ESD performance:
 - Human body model > 2000V
 - Machine model > 200V
- Leadless DQFN Pb-Free package

Note 1: To ensure the high-impedance state during power up or down, \bar{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 |
|-----------------------------|----------------|---|
| 74LCX245WM (Note 2) | M20B | 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74LCX245WMX_NL (Note 4) | M20B | Pb-Free 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74LCX245SJ (Note 2) | M20D | Pb-Free 20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide |
| 74LCX245BQX (Note 3) | MLP020B | Pb-Free 20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm |
| 74LCX245MSA (Note 2) | MSA20 | 20-Lead Shrink Small Outline Package (SSOP), JEDEC MO-150, 5.3mm Wide |
| 74LCX245MTC (Note 2) | MTC20 | 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |
| 74LCX245MTCX_NL (Note 4) | MTC20 | Pb-Free 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |

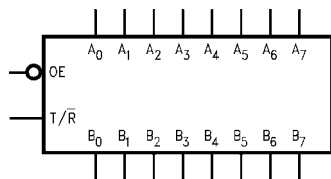
Pb-Free package per JEDEC J-STD-020B.

Note 2: Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Note 3: DQFN package available in Tape and Reel only.

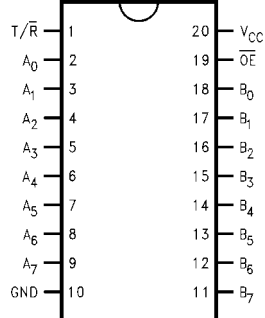
Note 4: "_NL" indicates Pb-Free package (per JEDEC J-STD-020B). Device available in Tape and Reel only.

Logic Symbol

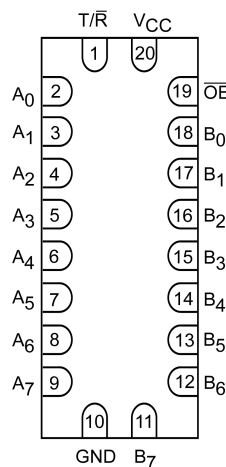


Connection Diagrams

Pin Assignments for SOIC, SOP, SSOP, and TSSOP



Pin Assignment for DQFN



(Top Through View)

Pin Descriptions

| Pin Names | Description |
|------------------|----------------------------------|
| \overline{OE} | Output Enable Input |
| T/\overline{R} | Transmit/Receive Input |
| A_0-A_7 | Side A Inputs or 3-STATE Outputs |
| B_0-B_7 | Side B Inputs or 3-STATE Outputs |

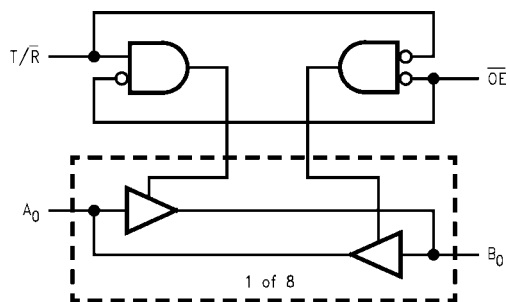
Truth Table

| Inputs | | Outputs |
|-----------------|------------------|---|
| \overline{OE} | T/\overline{R} | |
| L | L | Bus $B_0 - B_7$ Data to Bus $A_0 - A_7$ |
| L | H | Bus $A_0 - A_7$ Data to Bus $B_0 - B_7$ |
| H | X | HIGH Z State on $A_0 - A_7, B_0 - B_7$ (Note 5) |

H = HIGH Voltage Level
 L = LOW Voltage Level
 X = Immaterial
 Z = High Impedance

Note 5: Unused bus terminals during HIGH Z State must be held HIGH or LOW.

Logic Diagram



| Absolute Maximum Ratings (Note 6) | | | | | | |
|---|--|--|---|--------------------------------------|-----------|---------|
| 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 7) | 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 8) | | | | | | |
| 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 | HIGH or LOW State | 0 | V_{CC} | V | |
| | | 3-STATE | 0 | 5.5 | | |
| I_{OH}/I_{OL} | Output Current | $V_{CC} = 3.0V$ to $3.6V$ | | ± 24 | mA | |
| | | $V_{CC} = 2.7V$ to $3.0V$ | | ± 12 | | |
| | | $V_{CC} = 2.3V$ to $2.7V$ | | ± 8 | | |
| T_A | Free-Air Operating Temperature | -40 | 85 | °C | | |
| $\Delta t/\Delta V$ | Input Edge Rate, $V_{IN} = 0.8V$ to $2.0V$, $V_{CC} = 3.0V$ | 0 | 10 | ns/V | | |
| <p>Note 6: 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>Note 7: I_O Absolute Maximum Rating must be observed.</p> <p>Note 8: Unused inputs or I/O pins must be held HIGH or LOW. They may not float.</p> | | | | | | |
| DC Electrical Characteristics | | | | | | |
| Symbol | Parameter | Conditions | V_{CC} (V) | $T_A = -40^\circ C$ to $-85^\circ C$ | | 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 | $I_{OH} = -100 \mu A$ | 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 | $I_{OL} = 100 \mu A$ | 2.3 to 3.6 | | 0.2 | V |
| | | $I_{OL} = 8 mA$ | 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 | $0 \leq V_I \leq 5.5V$ | 2.3 to 3.6 | | ± 5.0 | μA |
| I_{OZ} | 3-STATE I/O Leakage | $0 \leq V_O \leq 5.5V$ $V_I = V_{IH}$ or V_{IL} | 2.3 to 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 to 3.6 | | 10 | μA | | |
| | | 3.6V ≤ V _I , V _O ≤ 5.5V (Note 9) | 2.3 to 3.6 | | ±10 | | | |
| ΔI _{CC} | Increase in I _{CC} per Input | V _{IH} = V _{CC} - 0.6V | 2.3 to 3.6 | | 500 | μA | | |
| Note 9: Outputs disabled or 3-STATE only. | | | | | | | | |
| AC Electrical Characteristics | | | | | | | | |
| Symbol | Parameter | T _A = -40°C to +85°C, R _L = 500Ω | | | | | | Units |
| | | V _{CC} = 3.3V ± 0.3V | | V _{CC} = 2.7V | | V _{CC} = 2.5V ± 0.2V | | |
| | | C _L = 50 pF | | C _L = 50 pF | | C _L = 30 pF | | |
| | | Min | Max | Min | Max | Min | Max | |
| t _{PHL} | Propagation Delay | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | ns |
| t _{PLH} | A _n to B _n or B _n to A _n | 1.5 | 7.0 | 1.5 | 8.0 | 1.5 | 8.4 | |
| 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 _{OSSL} | Output to Output Skew | | 1.0 | | | | | ns |
| t _{OSLH} | (Note 10) | | 1.0 | | | | | |
| Note 10: 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 _{OSSL}) 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 C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V | 3.3 2.5 | 0.8 0.6 | | V | | |
| V _{OLV} | Quiet Output Dynamic Valley V _{OL} | C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V | 3.3 2.5 | -0.8 -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 _{IO} | Input/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

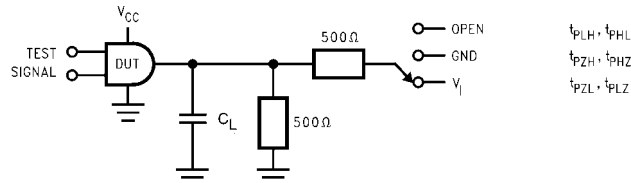
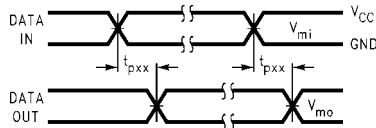
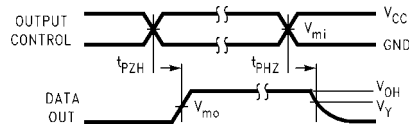


FIGURE 1. AC Test Circuit (C_L includes probe and jig capacitance)

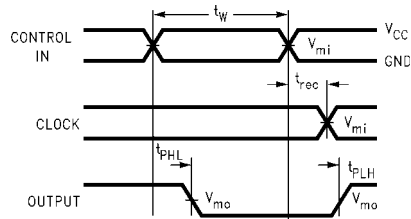
| Test | Switch |
|--------------------|---|
| t_{PLH}, t_{PHL} | Open |
| t_{PZL}, t_{PLZ} | 6V at $V_{CC} = 3.3V \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5V \pm 0.2V$ |
| t_{PZH}, t_{PHZ} | GND |



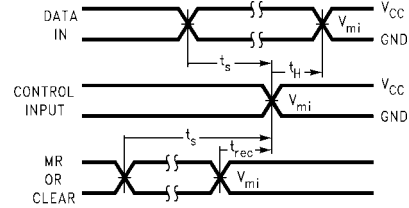
Waveform for Inverting and Non-Inverting Functions



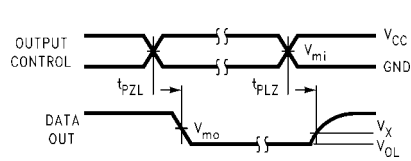
3-STATE Output High Enable and Disable Times for Logic



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

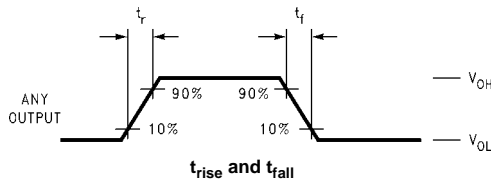
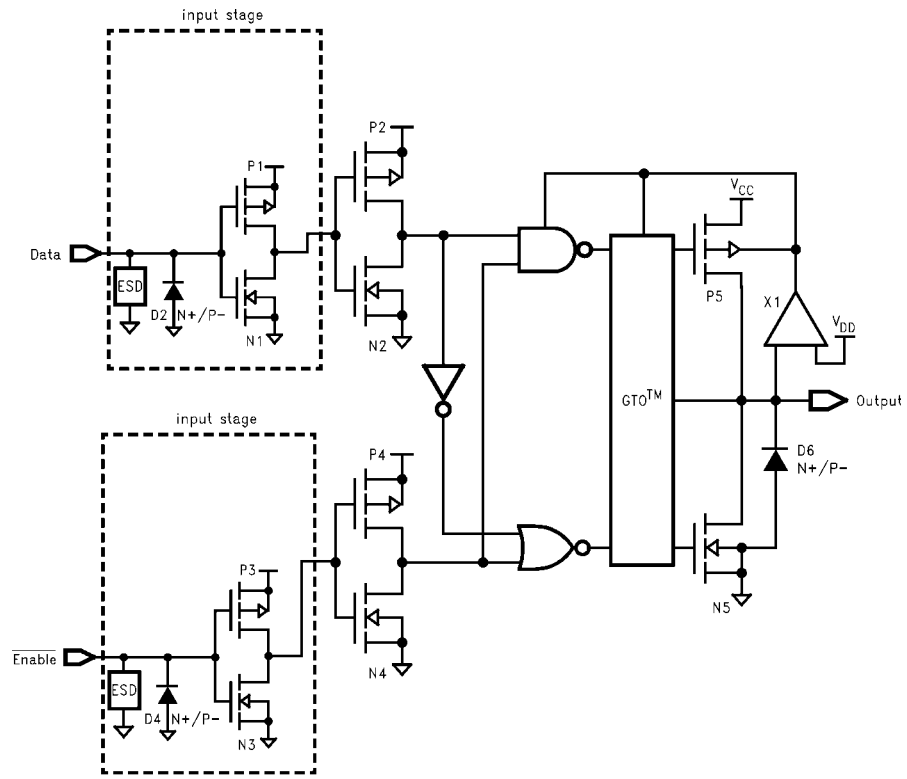


FIGURE 2. Waveforms (Input Characteristics; $f = 1MHz, t_r = t_f = 3ns$)

| 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

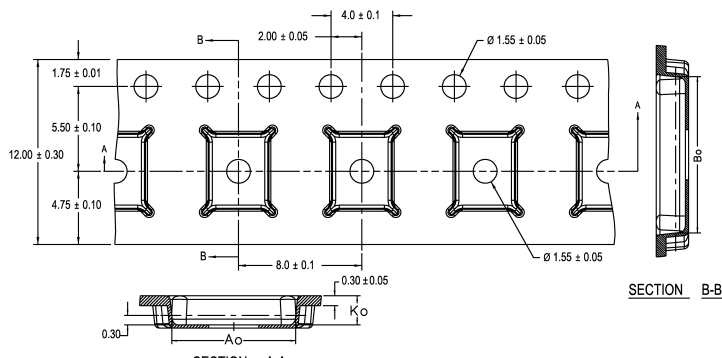


Tape and Reel Specification

Tape Format for DQFN

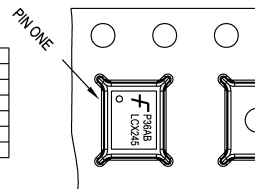
| Package Designator | Tape Section | Number Cavities | Cavity Status | Cover Tape Status |
|--------------------|--------------------|-----------------|---------------|-------------------|
| BQX | Leader (Start End) | 125 (typ) | Empty | Sealed |
| | Carrier | 3000 | Filled | Sealed |
| | Trailer (Hub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

TAPE DIMENSIONS inches (millimeters)



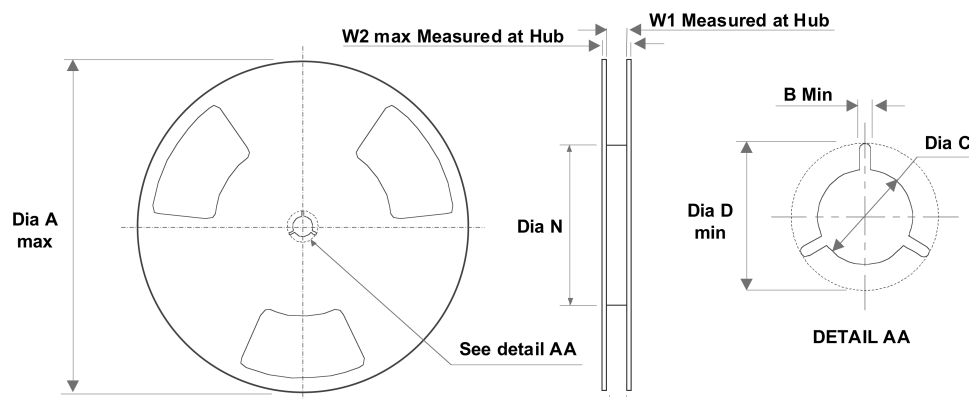
| PKG. SIZE | DIM. A _o | DIM. B _o | DIM. K _o |
|-----------|---------------------|---------------------|---------------------|
| 3.0 X 3.0 | 3.3±0.1 | 3.3±0.1 | 0.9±0.1 |
| 3.5 X 4.5 | 3.8±0.1 | 4.8±0.1 | 0.9±0.1 |
| 2.5 X 4.5 | 2.8±0.1 | 4.8±0.1 | 0.9±0.1 |
| 2.5 X 3.5 | 2.8±0.1 | 3.8±0.1 | 0.9±0.1 |
| 2.5 X 3.0 | 2.8±0.1 | 3.3±0.1 | 0.9±0.1 |

DIMENSIONS ARE IN MILLIMETERS



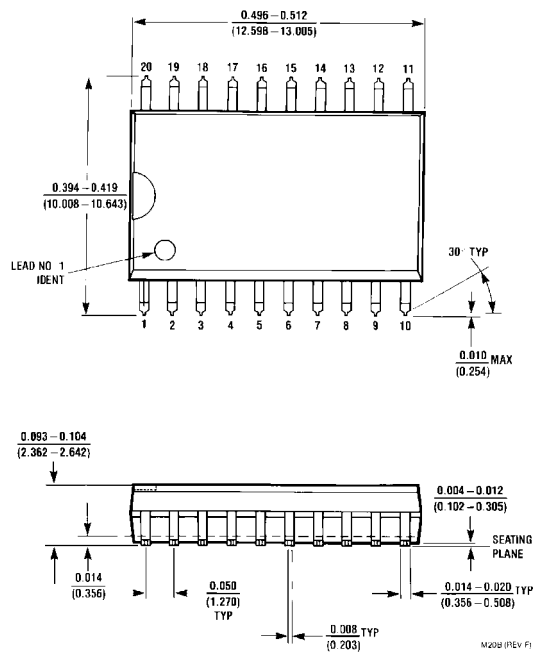
FSC MLP/DQFN CARRIER TAPE SPECIFICATIONS

REEL DIMENSIONS inches (millimeters)



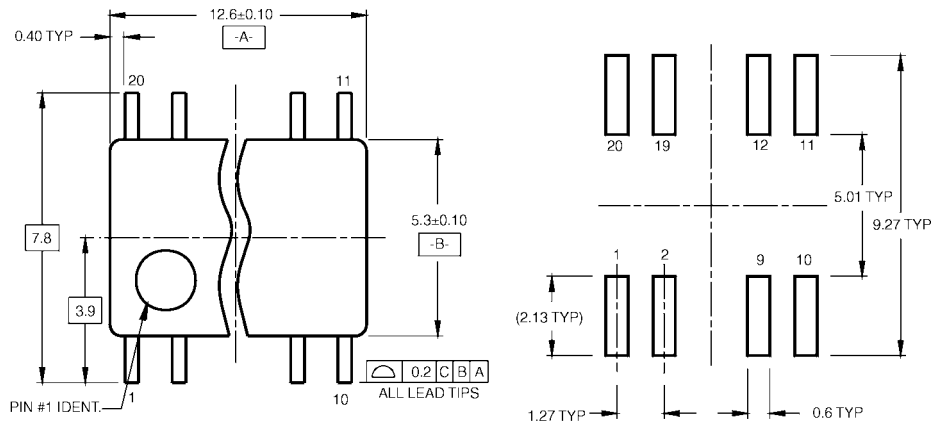
| Tape Size | A | B | C | D | N | W1 | W2 |
|-----------|-----------------|-----------------|------------------|------------------|------------------|-----------------|-----------------|
| 12 mm | 13.0 (330.0) | 0.059 (1.50) | 0.512 (13.00) | 0.795 (20.20) | 2.165 (55.00) | 0.488 (12.4) | 0.724 (18.4)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

Physical Dimensions inches (millimeters) unless otherwise noted

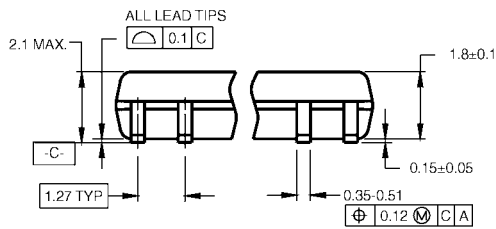


**20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
Package Number M20B**

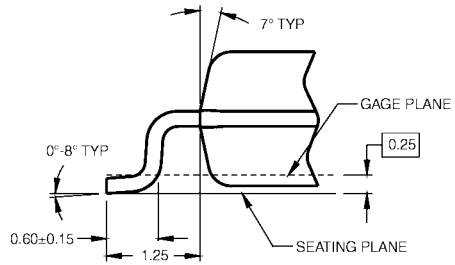
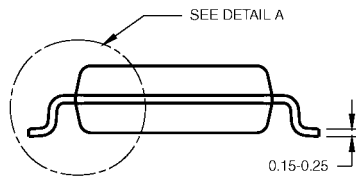
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



LAND PATTERN RECOMMENDATION



DIMENSIONS ARE IN MILLIMETERS



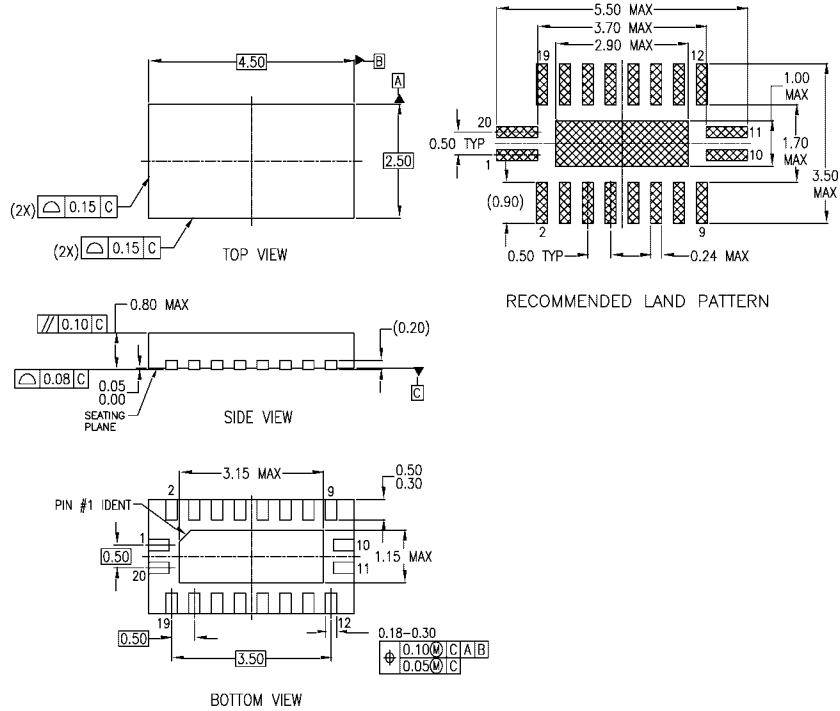
DETAIL A

- NOTES:
- 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.

M20DRevB1

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

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



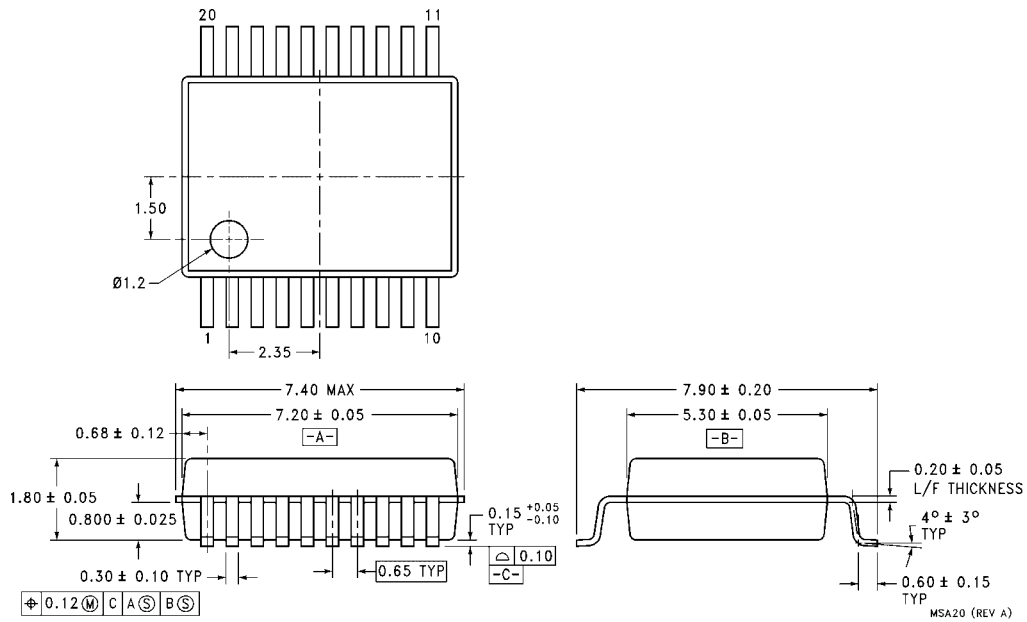
NOTES:

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

MLP020BrevA

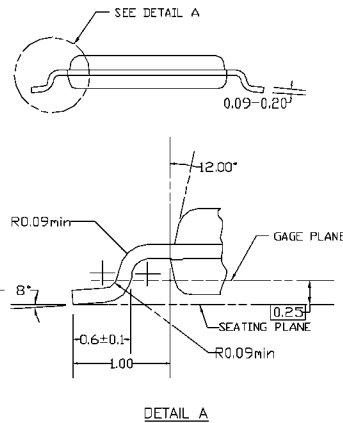
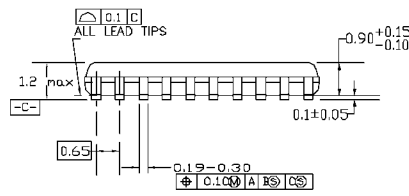
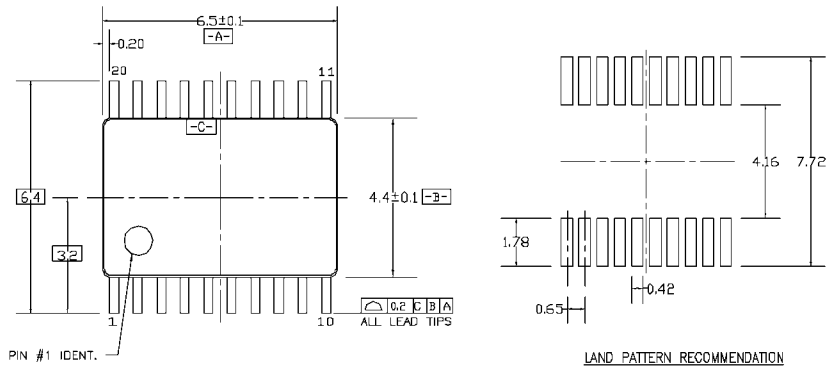
Pb-Free 20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm Package Number MLP020B

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)



DIMENSIONS ARE IN MILLIMETERS

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

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

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