**FAIRCHILD**

SEMICONDUCTOR®

February 2006

# 74LCX541
# Low Voltage Octal Buffer/Line Driver
# with 5V Tolerant Inputs and Outputs

## Features

■ 5V tolerant input and outputs

■ 2.3V–3.6V $V_{CC}$ specifications provided

■ 6.5ns $t_{PD}$ max ($V_{CC}$ = 3.3V), 10µA $I_{CC}$ max

■ Power-down high impedance inputs and outputs

■ Supports live insertion/withdrawal[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

## General Description

The LCX541 is an octal buffer/line driver designed to be employed as memory and address drivers, clock drivers and bus oriented transmitter/receivers. The LCX541 is a non inverting option of the LCX540.

This device is similar in function to the LCX244 while providing flow-through architecture (inputs on opposite side from outputs). This pinout arrangement makes this device especially useful as an output port for microprocessors, allowing ease of layout and greater PC board density.

The LCX541 is designed for low voltage applications with capability of interfacing to a 5V signal environment. The LCX541 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.
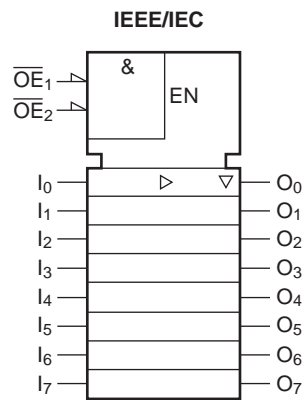
## Ordering Information

| Order Number | Package Number | Package Description |
|---|---|---|
| 74LCX541WM | M20B | 20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide |
| 74LCX541SJ | M20D | 20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide |
| 74LCX541BQX[2] | MLP020B | Pb-Free 20-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 4.5mm |
| 74LCX541MSA | MSA20 | 20-Lead Shrink Small Outline Package (SSOP), JEDEC MO-150, 5.3mm Wide |
| 74LCX541MTC | MTC20 | 20-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |
| 74LCX541MTC_NL[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 the suffix letter "X" to the ordering code.
Pb-Free package per JEDED J-STD-020B.

**Notes:**
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 of the resistor is determined by the current-sourcing capability of the driver.
2. DQFN package available in Tape and Reel only.
3. "_NL" indicates Pb-Free package (per JEDEC J-STD-020B). Device available in Tape and Reel only.

## Logic Symbol

### IEEE/IEC



## Connection Diagrams

### Pin Assignments for SOIC, SOP, SSOP, TSSOP
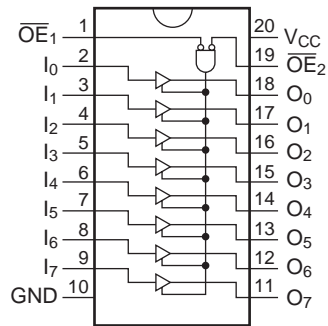


### Pad Assignment for DQFN



**(Top View)**

## Pin Descriptions

| Pin Names | Description |
|---|---|
| $\overline{OE}_1$, $\overline{OE}_2$ | 3-STATE Output Enable Inputs |
| $I_0$–$I_7$ | Inputs |
| $O_0$–$O_7$ | Outputs |

## Truth Table

| Inputs | | | Outputs |
|---|---|---|---|
| $\overline{OE}_1$ | $\overline{OE}_2$ | I | $O_n$ |
| L | L | H | H |
| H | X | X | Z |
| X | H | X | Z |
| L | L | L | L |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
Z = High Impedance
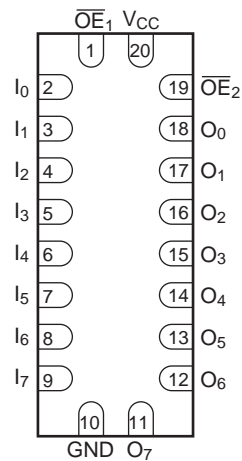
## Absolute Maximum Ratings

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.

| Symbol | Parameter | Conditions | Value | 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 | Output in 3-STATE | −0.5 to +7.0 | V |
| | | Output in HIGH or LOW State[4] | −0.5 to $V_{CC}$ + 0.5 | |
| $I_{IK}$ | DC Input Diode Current | $V_I$ < GND | −50 | mA |
| $I_{OK}$ | DC Output Diode Current | $V_O$ < GND | −50 | mA |
| | | $V_O$ > $V_{CC}$ | +50 | |
| $I_O$ | 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[5]

| Symbol | Parameter | Conditions | 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 − 3.6V | | ±24 | mA |
| | | $V_{CC}$ = 2.7V − 3.0V | | ±12 | |
| | | $V_{CC}$ = 2.3V − 2.7V | | ±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 |

**Notes:**
4.   $I_O$ Absolute Maximum Rating must be observed.
5.   Unused inputs or I/O's 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 Min. | T$_A$ = −40°C to +85°C Max. | Units |
|---|---|---|---|---|---|---|
| V$_{IH}$ | HIGH Level Input Voltage | | 2.3 – 2.7 | 1.7 | | V |
| | | | 2.7 – 3.6 | 2.0 | | |
| V$_{IL}$ | LOW Level Input Voltage | | 2.3 – 2.7 | | 0.7 | V |
| | | | 2.7 – 3.6 | | 0.8 | |
| V$_{OH}$ | HIGH Level Output Voltage | I$_{OH}$ = −100μA | 2.3 – 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$_{OL}$ = 100μA | 2.3 – 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 – 3.6 | | ±5.0 | μA |
| I$_{OFF}$ | Power-Off Leakage Current | V$_I$ or V$_O$ = 5.5V | 0 | | 10 | μA |
| 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[6] | 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 |

## AC Electrical Characteristics

| Symbol | Parameter | T$_A$ = −40°C to +85°C, R$_L$ = 500Ω V$_{CC}$ = 3.3V ± 0.3V C$_L$ = 50pF Min. | Max. | V$_{CC}$ = 2.7V C$_L$ = 50pF Min. | Max. | V$_{CC}$ = 2.5V ± 0.2V C$_L$ = 30pF Min. | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| t$_{PHL}$, t$_{PLH}$ | Propagation Delay | 1.5 | 6.5 | 1.5 | 7.5 | 1.5 | 7.8 | ns |
| t$_{PZL}$, t$_{PZH}$ | Output Enable Time | 1.5 | 8.5 | 1.5 | 9.5 | 1.5 | 10.5 | ns |
| t$_{PLZ}$, t$_{PHZ}$ | Output Disable Time | 1.5 | 7.5 | 1.5 | 8.5 | 1.5 | 9.0 | ns |
| t$_{OSHL}$, t$_{OSLH}$ | Output to Output Skew[7] | | 1.0 | | | | | ns |

**Notes**
6. Outputs disabled or 3-STATE only.
7. 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 | 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)
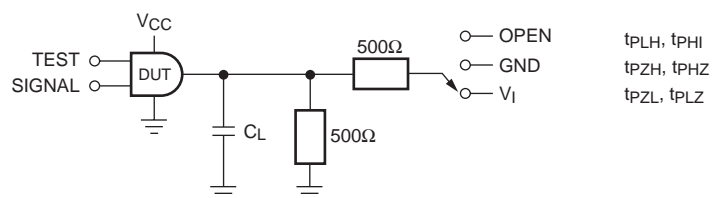


**Figure 1. AC Test Circuit (C$_L$ includes probe and jig capacitance)**

| Test | Switch |
|------|--------|
| t$_{PLH}$, t$_{PHL}$ | Open |
| t$_{PZL}$, t$_{PLZ}$ | 6V at V$_{CC}$ = 3.3 ± 0.3V<br>V$_{CC}$ x 2 at V$_{CC}$ = 2.5 ± 0.2V |
| t$_{PZH}$, t$_{PHZ}$ | GND |
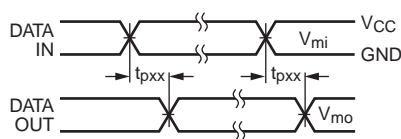


**Waveform for Inverting and Non-Inverting Functions**
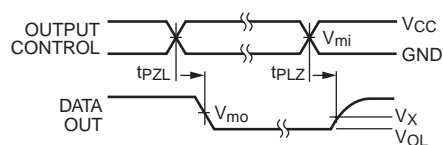


**3-STATE Output High Enable and Disable Times for Logic**
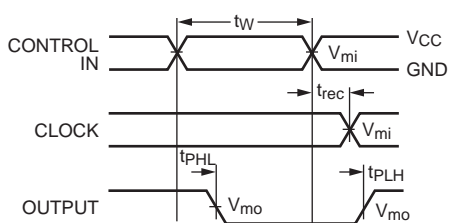


**Propagation Delay, Pulse Width and t$_{rec}$ Waveforms**
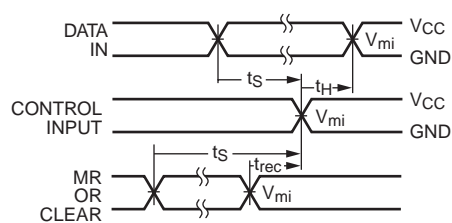


**Setup Time, Hold Time and Recovery Time for Logic**
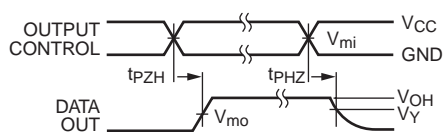


**3-STATE Output Low Enable and Disable Times for Logic**
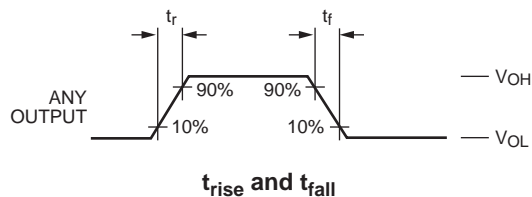


**t$_{rise}$ and t$_{fall}$**

**Figure 2. Waveforms (Input Characteristics; f = 1MHz, t$_r$ = t$_f$ = 3ns)**

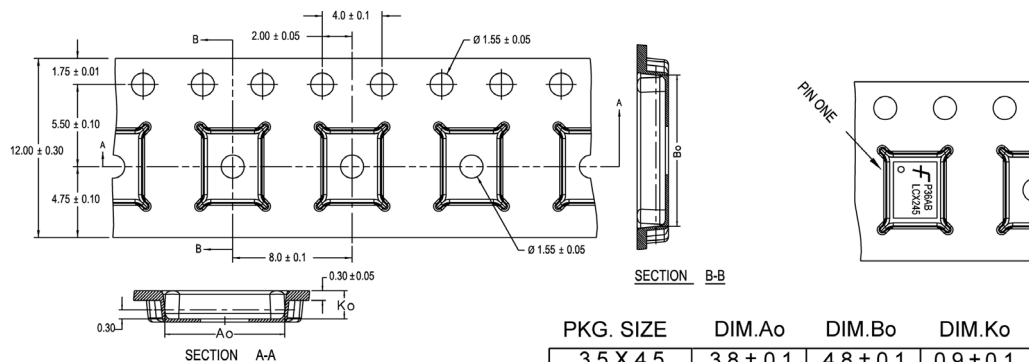| Symbol | V$_{CC}$ | | |
|--------|----------|---|---|
| | 3.3V ± 0.3V | 2.7V | 2.5V ± 0.2V |
| V$_{mi}$ | 1.5V | 1.5V | V$_{CC}$ / 2 |
| V$_{mo}$ | 1.5V | 1.5V | V$_{CC}$ / 2 |
| V$_x$ | V$_{OL}$ + 0.3V | V$_{OL}$ + 0.3V | V$_{OL}$ + 0.15V |
| V$_y$ | V$_{OH}$ − 0.3V | V$_{OH}$ − 0.3V | V$_{OH}$ − 0.15V |

**Schematic Diagram** (Generic for LCX Family)

**7**
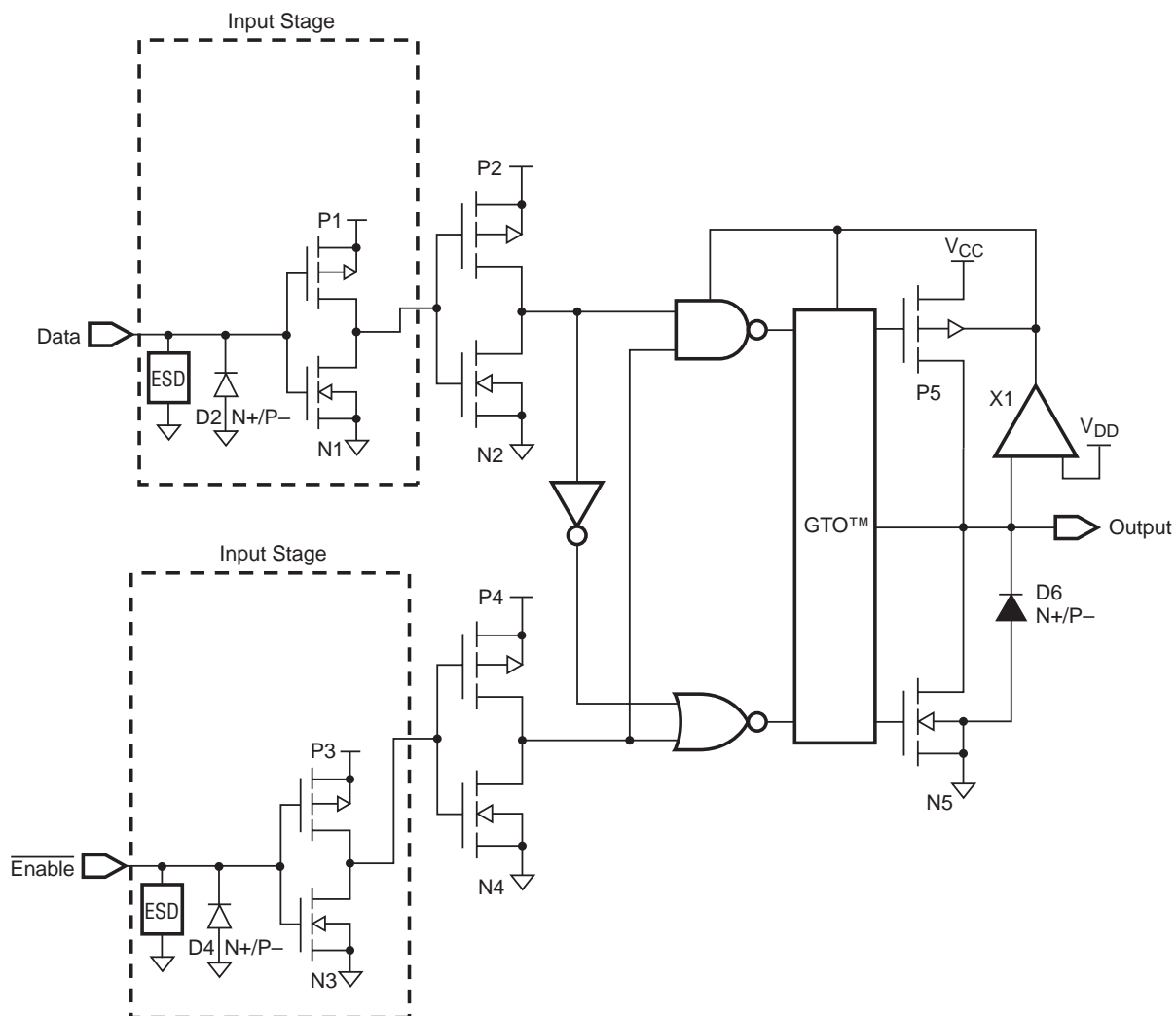
## Tape and Reel Specification

### 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. Cummulative  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. Ao and Bo measured on a plane 0.120[0.30] above the bottom of the pocket.
6. Ko 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.
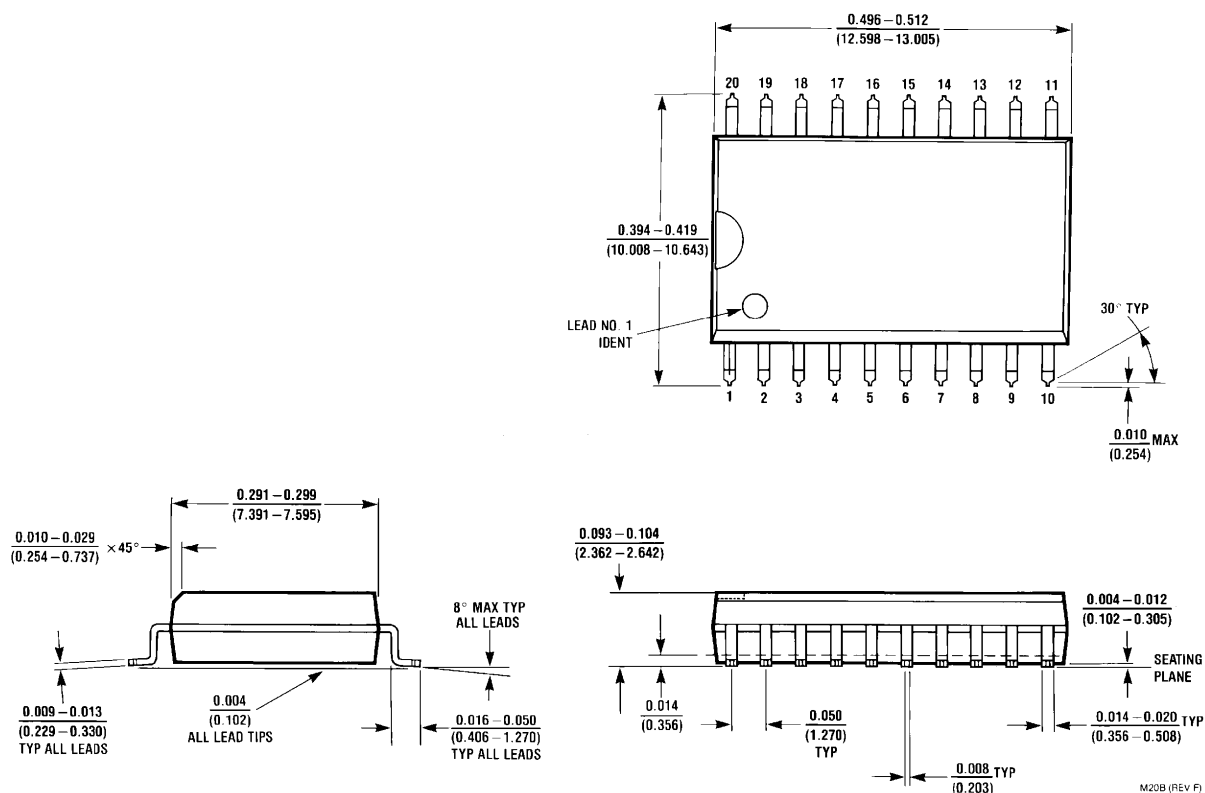8. Controlling dimension is millimeter.  Diemension in inches rounded.

### Reel Dimensions inches (millimeters)
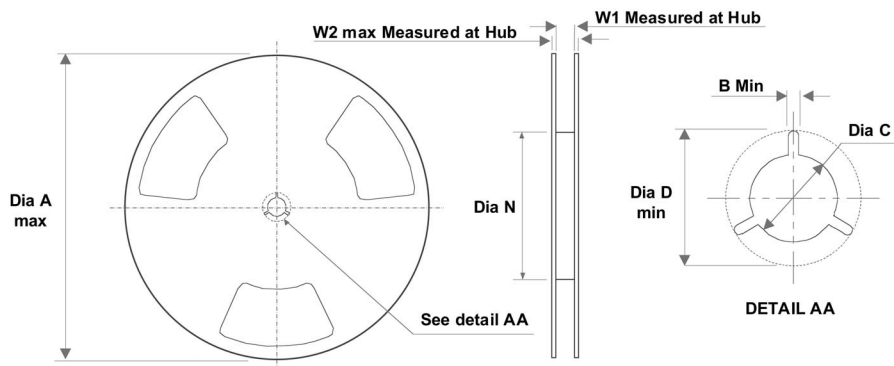


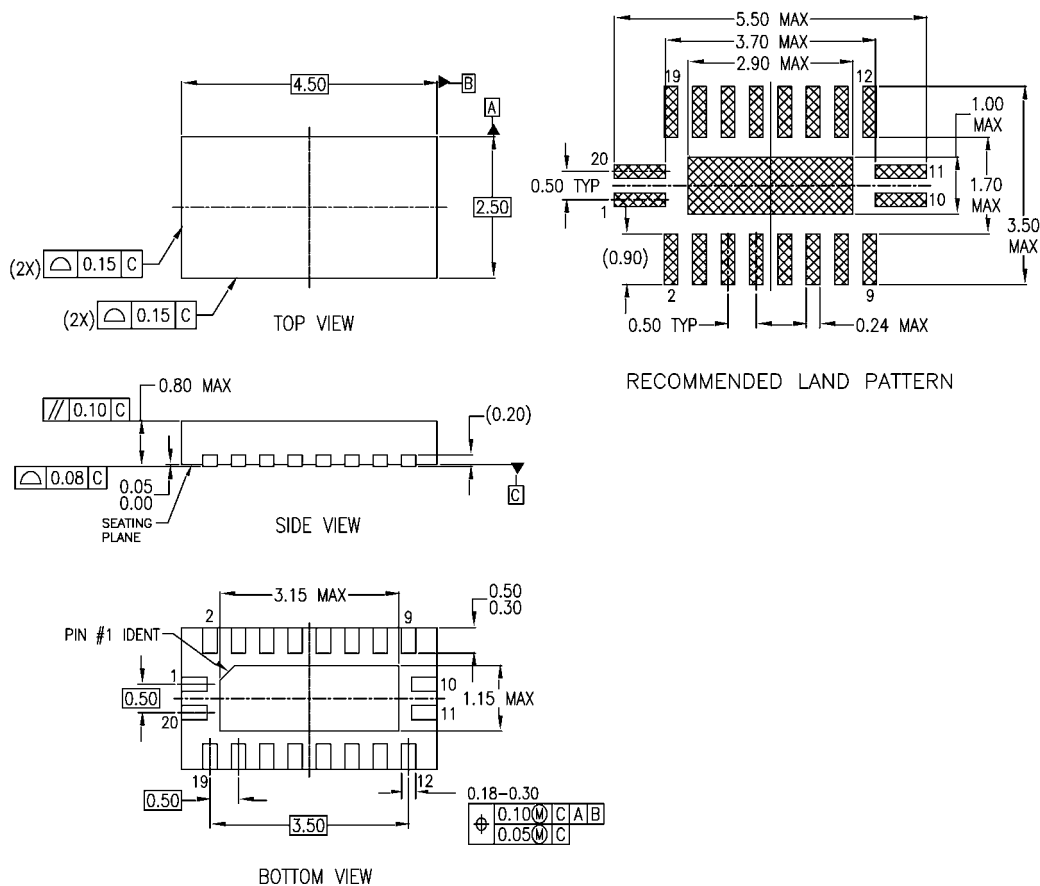| Tape Size | A | B | C | D | N | W1 | W2 |
|---|---|---|---|---|---|---|---|
| 12 mm | 13.0 (330.0) | 0.059 (1.50) | 0.512 (13.00) | 0.795 (20.20) | 2.165 (55.00) | 0.488 (12.4) | 0.724 (18.4) |

## Physical Dimensions inches (millimeters) unless otherwise noted



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

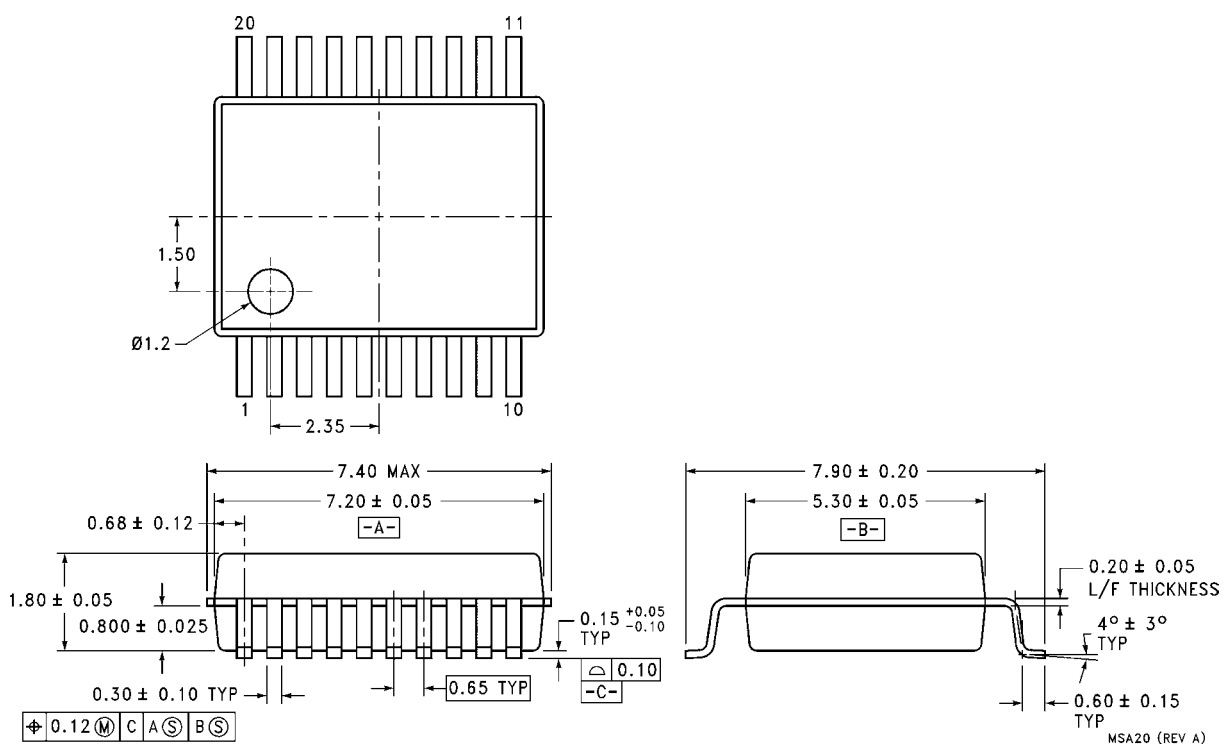## Physical Dimensions (Continued) inches (millimeters) unless otherwise noted

12.6±0.10
-A-

0.40 TYP

20                    11

7.8

3.9

5.3±0.10
-B-

PIN #1 IDENT.          1          10

⌒ 0.2 C B A
ALL LEAD TIPS

5.01 TYP
9.27 TYP

20  19        12  11

1   2        9   10

(2.13 TYP)

1.27 TYP          0.6 TYP

LAND PATTERN RECOMMENDATION

ALL LEAD TIPS
⌒ 0.1 C

2.1 MAX.

-C-

1.27 TYP

1.8±0.1

0.15±0.05

0.35-0.51

⊕ 0.12 Ⓜ C A

DIMENSIONS ARE IN MILLIMETERS

SEE DETAIL A

0.15-0.25

7° TYP

GAGE PLANE

0.25

0°-8° TYP

0.60±0.15
1.25

SEATING PLANE

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

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

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

TOP VIEW

RECOMMENDED LAND PATTERN

SIDE VIEW

BOTTOM VIEW

NOTES:

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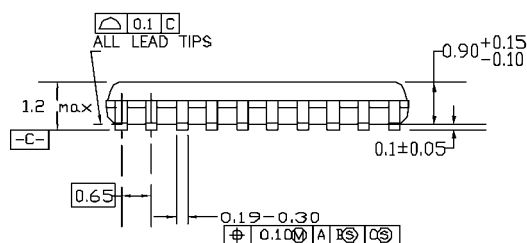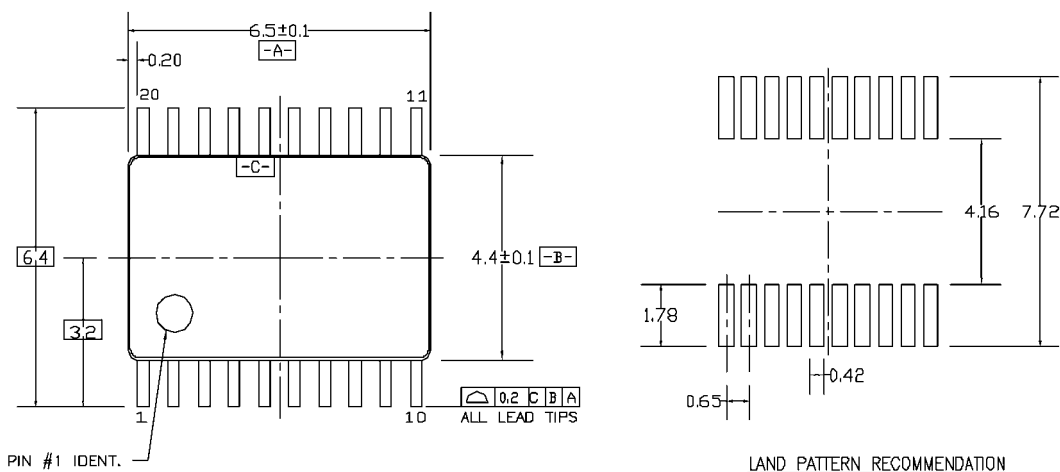C. DIMENSIONS AND TOLERANCES PER
ASME Y14.5M, 1994

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 (Continued) inches (millimeters) unless otherwise noted



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

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



LAND PATTERN RECOMMENDATION

DIMENSIONS ARE IN MILLIMETERS

SEE DETAIL A

DETAIL A

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.
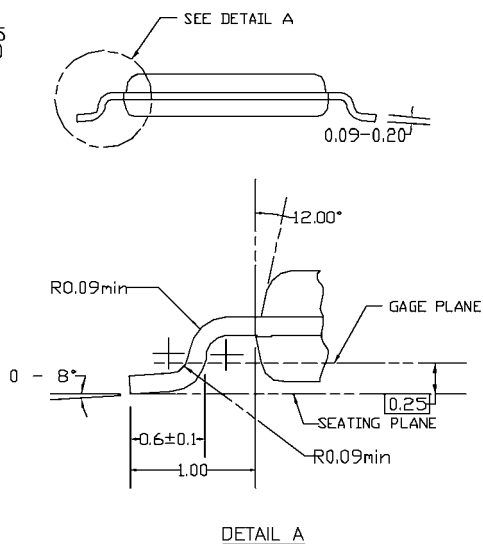
MTC20REVD1

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

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| ActiveArray™ | FASTr™ | LittleFET™ | PowerTrench® | SuperSOT™-8 |
| Bottomless™ | FPS™ | MICROCOUPLER™ | QFET® | SyncFET™ |
| Build it Now™ | FRFET™ | MicroFET™ | QS™ | TCM™ |
| CoolFET™ | GlobalOptoisolator™ | MicroPak™ | QT Optoelectronics™ | TinyLogic® |
| CROSSVOLT™ | GTO™ | MICROWIRE™ | Quiet Series™ | TINYOPTO™ |
| DOME™ | HiSeC™ | MSX™ | RapidConfigure™ | TruTranslation™ |
| EcoSPARK™ | I²C™ | MSXPro™ | RapidConnect™ | UHC™ |
| E²CMOS™ | i-Lo™ | OCX™ | µSerDes™ | UltraFET® |
| EnSigna™ | ImpliedDisconnect™ | OCXPro™ | ScalarPump™ | UniFET™ |
| FACT™ | IntelliMAX™ | OPTOLOGIC® | SILENT SWITCHER® | VCX™ |
| FACT Quiet Series™ | | OPTOPLANAR™ | SMART START™ | Wire™ |
| | | PACMAN™ | SPM™ | |
| Across the board. Around the world.™ | | POP™ | Stealth™ | |
| The Power Franchise® | | Power247™ | SuperFET™ | |
| Programmable Active Droop™ | | PowerEdge™ | SuperSOT™-3 | |

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2. A critical component is 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.

### PRODUCT STATUS DEFINITIONS

**Definition of Terms**

| Datasheet Identification | Product Status | Definition |
|---|---|---|
| Advance Information | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
| No Identification Needed | Full Production | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design. |
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