• Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
• Operates From a Single 5-V Power Supply
  With 1.0-μF Charge-Pump Capacitors
• Operates Up To 120 kbit/s
• Two Drivers and Two Receivers
• ±30-V Input Levels
• Low Supply Current . . . 8 mA Typical
• ESD Protection Exceeds JESD 22
  – 2000-V Human-Body Model (A114-A)
• Upgrade With Improved ESD (15-kV HBM)
  and 0.1-μF Charge-Pump Capacitors is Available With the MAX202

Applications
– TIA/EIA-232-F, Battery-Powered Systems,
  Terminals, Modems, and Computers

description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>TA</th>
<th>PACKAGE†</th>
<th>ORDERABLE PART NUMBER</th>
<th>TOP-SIDE MARKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to 70°C</td>
<td>PDIP (N) Tube of 25</td>
<td>MAX232N</td>
<td>MAX232N</td>
</tr>
<tr>
<td></td>
<td>SOIC (D) Tube of 40</td>
<td>MAX232D</td>
<td>MAX232</td>
</tr>
<tr>
<td></td>
<td>SOIC (DW) Tube of 40</td>
<td>MAX232DW</td>
<td>MAX232</td>
</tr>
<tr>
<td></td>
<td>SOIC (D) Tube of 40</td>
<td>MAX232DW</td>
<td>MAX232</td>
</tr>
<tr>
<td></td>
<td>SOP (NS) Reel of 2000</td>
<td>MAX232NSR</td>
<td>MAX232</td>
</tr>
<tr>
<td>−40°C to 85°C</td>
<td>PDIP (N) Tube of 25</td>
<td>MAX232IN</td>
<td>MAX232IN</td>
</tr>
<tr>
<td></td>
<td>SOIC (D) Tube of 40</td>
<td>MAX232ID</td>
<td>MAX232I</td>
</tr>
<tr>
<td></td>
<td>SOIC (DW) Tube of 40</td>
<td>MAX232ID</td>
<td>MAX232I</td>
</tr>
</tbody>
</table>

†Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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Function Tables

**EACH DRIVER**

<table>
<thead>
<tr>
<th>INPUT TIN</th>
<th>OUTPUT TOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

H = high level, L = low level

**EACH RECEIVER**

<table>
<thead>
<tr>
<th>INPUT RIN</th>
<th>OUTPUT ROUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

H = high level, L = low level

**logic diagram (positive logic)**

```
T1IN 11  T1OUT 14
      \_/               \_/  \\
     |                   |       \
   T2IN 10  T2OUT 7
       \_/               \_/  \\
      |                   |       \
R1OUT 12  R1IN 13
      \_/               \_/  \\
     |                   |       \
R2OUT  9  R2IN  8
```

T1IN 11  T1OUT 14
      \_/               \_/  \\
     |                   |       \
   T2IN 10  T2OUT 7
       \_/               \_/  \\
      |                   |       \
R1OUT 12  R1IN 13
      \_/               \_/  \\
     |                   |       \
R2OUT  9  R2IN  8
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

- Input supply voltage range, \( V_{CC} \) (see Note 1) ................................................. \(-0.3 \text{ V to } 6 \text{ V}\)
- Positive output supply voltage range, \( V_{S+} \) .................................................. \( V_{CC} - 0.3 \text{ V to } 15 \text{ V}\)
- Negative output supply voltage range, \( V_{S-} \) .................................................. \( -0.3 \text{ V to } -15 \text{ V}\)
- Input voltage range, \( V_I \): Driver .......................................................... \(-0.3 \text{ V to } V_{CC} + 0.3 \text{ V}\)
- Receiver ........................................................................................................... \( \pm 30 \text{ V}\)
- Output voltage range, \( V_O \): \( T1\text{OUT}, T2\text{OUT} \) ......................................... \( V_{S-} - 0.3 \text{ V to } V_{S+} + 0.3 \text{ V}\)
- \( R1\text{OUT}, R2\text{OUT} \) .................................................................................. \( -0.3 \text{ V to } V_{CC} + 0.3 \text{ V}\)
- Short-circuit duration: \( T1\text{OUT}, T2\text{OUT} \) .................................................. Unlimited
- Package thermal impedance, \( \theta_{JA} \) (see Notes 2 and 3): D package .................. \( 73^\circ \text{C/W}\)
- DW package ................................................................. \( 57^\circ \text{C/W}\)
- N package ......................................................................................... \( 67^\circ \text{C/W}\)
- NS package .................................................................................. \( 64^\circ \text{C/W}\)
- Operating virtual junction temperature, \( T_J \) ............................................ \( 150^\circ \text{C}\)
- Storage temperature range, \( T_{stg} \) ......................................................... \(-65^\circ \text{C to } 150^\circ \text{C}\)

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES:
1. All voltages are with respect to network GND.
2. Maximum power dissipation is a function of \( T_J(\text{max}) \), \( \theta_{JA} \), and \( T_A \). The maximum allowable power dissipation at any allowable ambient temperature is \( P_D = (T_J(\text{max}) - T_A)/\theta_{JA} \). Operating at the absolute maximum \( T_J \) of \( 150^\circ \text{C} \) can affect reliability.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} )</td>
<td>Supply voltage</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>( V_{IH} )</td>
<td>High-level input voltage (T1IN, T2IN)</td>
<td>2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( V_{IL} )</td>
<td>Low-level input voltage (T1IN, T2IN)</td>
<td></td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>R1IN, R2IN</td>
<td>Receiver input voltage</td>
<td>MAX232</td>
<td></td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>( T_A )</td>
<td>Operating free-air temperature</td>
<td>MAX232I</td>
<td></td>
<td>-40</td>
<td>85</td>
</tr>
</tbody>
</table>

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 4 and Figure 4)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP†</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{CC} )</td>
<td>Supply current</td>
<td>( V_{CC} = 5.5 \text{ V}, T_A = 25^\circ \text{C} )</td>
<td>All outputs open,</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

† All typical values are at \( V_{CC} = 5 \text{ V} \) and \( T_A = 25^\circ \text{C} \).

NOTE 4: Test conditions are C1−C4 = 1 \( \mu \text{F} \) at \( V_{CC} = 5 \text{ V} \pm 0.5 \text{ V} \).
**DRIVER SECTION**

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP†</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OH}$ High-level output voltage</td>
<td>T1OUT, T2OUT $R_L = 3 , k\Omega$ to GND</td>
<td>5</td>
<td>7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$ Low-level output voltage‡</td>
<td>T1OUT, T2OUT $R_L = 3 , k\Omega$ to GND</td>
<td>$-7$</td>
<td>$-5$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_O$ Output resistance</td>
<td>T1OUT, T2OUT $V_{S+} = V_{S-} = 0, \quad V_O = \pm 2 , V$</td>
<td>300</td>
<td>$\Omega$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{OS}$ Short-circuit output current</td>
<td>T1OUT, T2OUT $V_{CC} = 5.5 , V, \quad V_O = 0$</td>
<td>$\pm 10$</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IS}$ Short-circuit input current</td>
<td>T1IN, T2IN $V_I = 0$</td>
<td>200</td>
<td>$\mu A$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† All typical values are at $V_{CC} = 5 \, V, \, T_A = 25^\circ C$.
‡ The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
§ Not more than one output should be shorted at a time.
NOTE 4: Test conditions are C1–C4 = 1 $\mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.

switching characteristics, $V_{CC} = 5 \, V, \, T_A = 25^\circ C$ (see Note 4)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP†</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SR$ Driver slew rate</td>
<td>$R_L = 3 , k\Omega$ to 7 $k\Omega$, See Figure 2</td>
<td>30</td>
<td>V/$\mu s$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$SR(t)$ Driver transition region slew rate</td>
<td>See Figure 3</td>
<td>3</td>
<td>V/$\mu s$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data rate</td>
<td>One TOUT switching</td>
<td>120</td>
<td>kbit/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE 4: Test conditions are C1–C4 = 1 $\mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.

**RECEIVER SECTION**

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP†</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OH}$ High-level output voltage</td>
<td>R1OUT, R2OUT $I_{OH} = -1 , mA$</td>
<td>3.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$ Low-level output voltage‡</td>
<td>R1OUT, R2OUT $I_{OL} = 3.2 , mA$</td>
<td>0.4</td>
<td>$V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{IT+}$ Receiver positive-going input threshold voltage</td>
<td>R1IN, R2IN $V_{CC} = 5 , V, \quad T_A = 25^\circ C$</td>
<td>1.7</td>
<td>2.4 $V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{IT-}$ Receiver negative-going input threshold voltage</td>
<td>R1IN, R2IN $V_{CC} = 5 , V, \quad T_A = 25^\circ C$</td>
<td>0.8</td>
<td>1.2 $V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{hys}$ Input hysteresis voltage</td>
<td>R1IN, R2IN $V_{CC} = 5 , V$</td>
<td>0.2</td>
<td>0.5</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>$R_I$ Receiver input resistance</td>
<td>R1IN, R2IN $V_{CC} = 5, \quad T_A = 25^\circ C$</td>
<td>3</td>
<td>5</td>
<td>7 $k\Omega$</td>
<td></td>
</tr>
</tbody>
</table>

† All typical values are at $V_{CC} = 5 \, V, \, T_A = 25^\circ C$.
‡ The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
NOTE 4: Test conditions are C1–C4 = 1 $\mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.

switching characteristics, $V_{CC} = 5 \, V, \, T_A = 25^\circ C$ (see Note 4 and Figure 1)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TYP</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{PLH}(R)$ Receiver propagation delay time, low- to high-level output</td>
<td>500</td>
<td>ns</td>
</tr>
<tr>
<td>$I_{PHL}(R)$ Receiver propagation delay time, high- to low-level output</td>
<td>500</td>
<td>ns</td>
</tr>
</tbody>
</table>

NOTE 4: Test conditions are C1–C4 = 1 $\mu F$ at $V_{CC} = 5 \, V \pm 0.5 \, V$.
PARAMETER MEASUREMENT INFORMATION

\[ V_{CC} \]
\[ R_{IN} \text{ or } R_{2IN} \]
\[ R_{OUT} \text{ or } R_{2OUT} \]
\[ R_{L} = 1.3 \, k\Omega \]
\[ C_{L} = 50 \, pF \text{ (see Note B)} \]

TEST CIRCUIT

\[ \leq 10 \, ns \]
\[ \leq 10 \, ns \]
\[ 3 \, V \]
\[ 0 \, V \]

WAVEFORMS

NOTES:
A. The pulse generator has the following characteristics: \( Z_{O} = 50 \, \Omega \), duty cycle \( \leq 50\% \).
B. \( C_{L} \) includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.

Figure 1. Receiver Test Circuit and Waveforms for \( t_{PHL} \) and \( t_{PLH} \) Measurements
PARAMETER MEASUREMENT INFORMATION

Pulse Generator (see Note A)  T1IN or T2IN  T1OUT or T2OUT  EIA-232 Output

\[ R_L \]
\[ C_L = 10 \text{ pF} \] (see Note B)

\[ \leq 10 \text{ ns} \]  \[ \leq 10 \text{ ns} \]  \[ \leq 10 \text{ ns} \]  \[ 3 \text{ V} \]  \[ 0 \text{ V} \]

\[ \text{Input} \]
\[ \text{Output} \]
\[ t_{PHL} \]
\[ t_{PLH} \]
\[ V_{OL} \]
\[ V_{OH} \]
\[ t_{TLH} \]
\[ t_{THL} \]

\[ SR = \frac{0.8 (V_{OH} - V_{OL})}{t_{TLH}} \text{ or } \frac{0.8 (V_{OL} - V_{OH})}{t_{THL}} \]

NOTES:
A. The pulse generator has the following characteristics: \( Z_O = 50 \Omega \), duty cycle \( \leq 50\% \).
B. \( C_L \) includes probe and jig capacitance.

Figure 2. Driver Test Circuit and Waveforms for \( t_{PHL} \) and \( t_{PLH} \) Measurements (5-\( \mu \)s Input)

Pulse Generator (see Note A)  EIA-232 Output

\[ \leq 10 \text{ ns} \]  \[ \leq 10 \text{ ns} \]  \[ \leq 10 \text{ ns} \]  \[ 3 \text{ V} \]  \[ -3 \text{ V} \]

\[ \text{Input} \]
\[ \text{Output} \]
\[ t_{TLH} \]
\[ t_{THL} \]
\[ V_{OH} \]
\[ V_{OL} \]

\[ SR = \frac{6 \text{ V}}{t_{TLH} \text{ or } t_{THL}} \]

Figure 3. Test Circuit and Waveforms for \( t_{THL} \) and \( t_{TLH} \) Measurements (20-\( \mu \)s Input)
APPLICATION INFORMATION

C BYPASS = 1 μF

C1
1 μF
3

C1–
4

C2
1 μF
5

From CMOS or TTL

11

To CMOS or TTL

9

15

GND

16

VCC

C1+

C1–

C2+

C2–

V S+

V S−

5 V

8.5 V

−8.5 V

1 μF

C3†

1 μF

C4

C BYPASS = 1 μF

NOTE: A. Resistor values shown are nominal.
B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown. In addition to the 1-μF capacitors shown, the MAX202 can operate with 0.1-μF capacitors.

† C3 can be connected to VCC or GND.

Figure 4. Typical Operating Circuit
## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX232D</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DR</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DRE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DRG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DW</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DWE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
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<tr>
<td>MAX232DWG4</td>
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<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
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<td>MAX232DWR</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>2000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DWER4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>2000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232DWRG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>16</td>
<td>2000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232ID</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232IDE4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
<tr>
<td>MAX232IDG4</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>16</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
</tr>
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</tr>
</tbody>
</table>

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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### TAPE AND REEL INFORMATION

#### REEL DIMENSIONS

- **Reel Diameter**: [Diagram showing the dimensions of a reel.]

#### TAPE DIMENSIONS

- **A0**: Dimension designed to accommodate the component width
- **B0**: Dimension designed to accommodate the component length
- **K0**: Dimension designed to accommodate the component thickness
- **W**: Overall width of the carrier tape
- **P1**: Pitch between successive cavity centers

#### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

- **Sprocket Holes**: [Diagram showing the sprocket holes.]
- **User Direction of Feed**: [Arrow indicating the direction of feed.]
- **Pocket Quadrants**: [Diagram showing the pocket quadrants.]

### TAPE AND REEL INFORMATION TABLE

<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0 (mm)</th>
<th>B0 (mm)</th>
<th>K0 (mm)</th>
<th>P1 (mm)</th>
<th>W (mm)</th>
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*All dimensions are nominal.*
**TAPE AND REEL BOX DIMENSIONS**

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*All dimensions are nominal*
**MECHANICAL DATA**

**N (R--PDIP--T**) PLASTIC DUAL--IN--LINE PACKAGE

16 PINS SHOWN

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<td>A MAX</td>
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<td>1.060 (26.92)</td>
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<td>0.850 (21.59)</td>
<td>0.940 (23.88)</td>
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</table>

**MS--001 VARIATION**

| AA | BB | AC | AD |

**NOTES:**

A. All linear dimensions are in inches (millimeters).

B. This drawing is subject to change without notice.

\[\text{\textcopyright 015 (0.38)}\]

Falls within JEDEC MS--001, except 18 and 20 pin minimum body length (Dim A).

\[\text{\textcopyright 010 (0.25)}\]

The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0.15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0.43) each side.
E. Reference JEDEC MS-012 variation AC.

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NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC-7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
NOTES:
A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).
D. Falls within JEDEC MS–013 variation AA.
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.15.
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