

## DS75176B/DS75176BT Multipoint RS-485/RS-422 Transceivers

Check for Samples: [DS75176B](#), [DS75176BT](#)

### FEATURES

- Meets EIA Standard RS485 for Multipoint Bus Transmission and is Compatible with RS-422.
- Small Outline (SOIC) Package Option Available for Minimum Board Space.
- 22 ns Driver Propagation Delays.
- Single +5V Supply.
- -7V to +12V Bus Common Mode Range Permits  $\pm 7V$  Ground Difference Between Devices on the Bus.
- Thermal Shutdown Protection.
- High Impedance to Bus with Driver in TRI-STATE or with Power Off, Over the Entire Common Mode Range Allows the Unused Devices on the Bus to be Powered Down.
- Pin Out Compatible with DS3695/A and SN75176A/B.
- Combined Impedance of a Driver Output and Receiver Input is Less Than One RS485 Unit Load, Allowing up to 32 Transceivers on the Bus.
- 70 mV Typical Receiver Hysteresis.

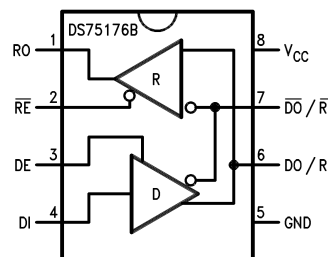
### DESCRIPTION

The DS75176B is a high speed differential TRI-STATE<sup>®</sup> bus/line transceiver designed to meet the requirements of EIA standard RS485 with extended common mode range (+12V to -7V), for multipoint data transmission. In addition, it is compatible with RS-422.

The driver and receiver outputs feature TRI-STATE capability, for the driver outputs over the entire common mode range of +12V to -7V. Bus contention or fault situations that cause excessive power dissipation within the device are handled by a thermal shutdown circuit, which forces the driver outputs into the high impedance state.

DC specifications are guaranteed over the 0 to 70°C temperature and 4.75V to 5.25V supply voltage range.

### Connection and Logic Diagram



**Figure 1. Top View**  
See Package Number P0008E or D0008A



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



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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**Absolute Maximum Ratings** <sup>(1)(2)</sup>

|                                            |                  |                       |
|--------------------------------------------|------------------|-----------------------|
| Supply Voltage, $V_{CC}$                   |                  | 7V                    |
| Control Input Voltages                     |                  | 7V                    |
| Driver Input Voltage                       |                  | 7V                    |
| Driver Output Voltages                     |                  | +15V/ -10V            |
| Receiver Input Voltages (DS75176B)         |                  | +15V/ -10V            |
| Receiver Output Voltage                    |                  | 5.5V                  |
| Continuous Power Dissipation @ 25°C        | for SOIC Package | 675 mW <sup>(3)</sup> |
|                                            | for PDIP Package | 900 mW <sup>(4)</sup> |
| Storage Temperature Range                  |                  | -65°C to +150°C       |
| Lead Temperature<br>(Soldering, 4 seconds) |                  | 260°C                 |
| ESD Rating (HBM)                           |                  | 500V                  |

- (1) "Absolute Maximum Ratings" are those beyond which the safety of the device cannot be verified. They are not meant to imply that the device should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
- (3) Derate linearly @ 6.11 mW/°C to 400 mW at 70°C.
- (4) Derate linearly at 5.56 mW/°C to 650 mW at 70°C.

**Recommended Operating Conditions**

|                                                          | Min  | Max  | Units |
|----------------------------------------------------------|------|------|-------|
| Supply Voltage, $V_{CC}$                                 | 4.75 | 5.25 | V     |
| Voltage at Any Bus Terminal<br>(Separate or Common Mode) | -7   | +12  | V     |
| Operating Free Air Temperature $T_A$                     |      |      |       |
| DS75176B                                                 | 0    | +70  | °C    |
| DS75176BT                                                | -40  | +85  | °C    |
| Differential Input Voltage, $V_{ID}$ <sup>(1)</sup>      | -12  | +12  | V     |

- (1) Differential - Input/Output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

**Electrical Characteristics** <sup>(1) (2)</sup>

0°C ≤  $T_A$  ≤ 70°C, 4.75V <  $V_{CC}$  < 5.25V unless otherwise specified

| Symbol           | Parameter                                                                                 | Conditions                       | Min | Typ | Max | Units |
|------------------|-------------------------------------------------------------------------------------------|----------------------------------|-----|-----|-----|-------|
| $V_{OD1}$        | Differential Driver Output Voltage (Unloaded)                                             | $I_O = 0$                        |     |     | 5   | V     |
| $V_{OD2}$        | Differential Driver Output Voltage (with Load)                                            | See (Figure 2)                   |     |     |     |       |
|                  |                                                                                           | R = 50Ω; (RS-422) <sup>(3)</sup> | 2   |     |     | V     |
|                  |                                                                                           | R = 27Ω; (RS-485)                | 1.5 |     |     | V     |
| $\Delta V_{OD}$  | Change in Magnitude of Driver Differential Output Voltage For Complementary Output States | See (Figure 2)                   |     |     | 0.2 | V     |
| $V_{OC}$         | Driver Common Mode Output Voltage                                                         |                                  |     |     | 3.0 | V     |
| $\Delta V_{OC} $ | Change in Magnitude of Driver Common Mode Output Voltage For Complementary Output States  |                                  |     |     | 0.2 | V     |

- (1) All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.
- (2) All typicals are given for  $V_{CC} = 5V$  and  $T_A = 25^\circ C$ .
- (3) All worst case parameters for which this note is applied, must be increased by 10% for DS75176BT. The other parameters remain valid for -40°C <  $T_A$  < +85°C.

## Electrical Characteristics <sup>(1) (2)</sup> (continued)

 $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ ,  $4.75\text{V} < V_{CC} < 5.25\text{V}$  unless otherwise specified

| Symbol          | Parameter                                             |                                      | Conditions                                                       | Min  | Typ | Max      | Units         |
|-----------------|-------------------------------------------------------|--------------------------------------|------------------------------------------------------------------|------|-----|----------|---------------|
| $V_{IH}$        | Input High Voltage                                    | $D_I, D_E, RE, E$                    |                                                                  | 2    |     |          | V             |
| $V_{IL}$        | Input Low Voltage                                     |                                      |                                                                  |      |     | 0.8      |               |
| $V_{CL}$        | Input Clamp Voltage                                   |                                      | $I_{IN} = -18\text{ mA}$                                         |      |     | -1.5     |               |
| $I_{IL}$        | Input Low Current                                     |                                      | $V_{IL} = 0.4\text{V}$                                           |      |     | -200     | $\mu\text{A}$ |
| $I_{IH}$        | Input High Current                                    |                                      | $V_{IH} = 2.4\text{V}$                                           |      |     | 20       | $\mu\text{A}$ |
| $I_{IN}$        | Input Current                                         | $DO/RI, \overline{DO}/\overline{RI}$ | $V_{CC} = 0\text{V or } 5.25\text{V}$<br>$DE = 0\text{V}$        |      |     | +1.0     | mA            |
|                 |                                                       |                                      | $V_{IN} = -7\text{V}$                                            |      |     | -0.8     | mA            |
| $V_{TH}$        | Differential Input Threshold Voltage for Receiver     |                                      | $-7\text{V} \leq V_{CM} \leq +12\text{V}$                        | -0.2 |     | +0.2     | V             |
| $\Delta V_{TH}$ | Receiver Input Hysteresis                             |                                      | $V_{CM} = 0\text{V}$                                             |      | 70  |          | mV            |
| $V_{OH}$        | Receiver Output High Voltage                          |                                      | $I_{OH} = -400\text{ }\mu\text{A}$                               | 2.7  |     |          | V             |
| $V_{OL}$        | Output Low Voltage                                    | RO                                   | $I_{OL} = 16\text{ mA}^{(3)}$                                    |      |     | 0.5      | V             |
| $I_{OZR}$       | OFF-State (High Impedance) Output Current at Receiver |                                      | $V_{CC} = \text{Max}$<br>$0.4\text{V} \leq V_O \leq 2.4\text{V}$ |      |     | $\pm 20$ | $\mu\text{A}$ |
| $R_{IN}$        | Receiver Input Resistance                             |                                      | $-7\text{V} \leq V_{CM} \leq +12\text{V}$                        | 12   |     |          | k $\Omega$    |
| $I_{CC}$        | Supply Current                                        |                                      | No Load <sup>(3)</sup>                                           |      |     | 55       | mA            |
|                 |                                                       |                                      | Driver Outputs Enabled                                           |      |     | 35       | mA            |
|                 |                                                       |                                      | Driver Outputs Disabled                                          |      |     |          |               |
| $I_{OSD}$       | Driver Short-Circuit Output Current                   |                                      | $V_O = -7\text{V}^{(3)}$                                         |      |     | -250     | mA            |
|                 |                                                       |                                      | $V_O = +12\text{V}^{(3)}$                                        |      |     | +250     | mA            |
| $I_{OSR}$       | Receiver Short-Circuit Output Current                 |                                      | $V_O = 0\text{V}$                                                | -15  |     | -85      | mA            |

## Switching Characteristics

 $V_{CC} = 5.0\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ 

| Symbol    | Parameter                      | Conditions                                                    | Min | Typ | Max | Units |
|-----------|--------------------------------|---------------------------------------------------------------|-----|-----|-----|-------|
| $t_{PLH}$ | Driver Input to Output         | $R_{L\text{DIFF}} = 60\Omega$                                 |     | 12  | 22  | ns    |
| $t_{PHL}$ | Driver Input to Output         | $C_{L1} = C_{L2} = 100\text{ pF}$                             |     | 17  | 22  | ns    |
| $t_r$     | Driver Rise Time               | $R_{L\text{DIFF}} = 60\Omega$                                 |     |     | 18  | ns    |
| $t_f$     | Driver Fall Time               | $C_{L1} = C_{L2} = 100\text{ pF}$<br>(Figure 4 and Figure 6)  |     |     | 18  | ns    |
| $t_{ZH}$  | Driver Enable to Output High   | $C_L = 100\text{ pF}$ (Figure 5 and Figure 7) S1 Open         |     | 29  | 100 | ns    |
| $t_{ZL}$  | Driver Enable to Output Low    | $C_L = 100\text{ pF}$ (Figure 5 and Figure 7) S2 Open         |     | 31  | 60  | ns    |
| $t_{LZ}$  | Driver Disable Time from Low   | $C_L = 15\text{ pF}$ (Figure 5 and Figure 7) S2 Open          |     | 13  | 30  | ns    |
| $t_{HZ}$  | Driver Disable Time from High  | $C_L = 15\text{ pF}$ (Figure 5 and Figure 7) S1 Open          |     | 19  | 200 | ns    |
| $t_{PLH}$ | Receiver Input to Output       | $C_L = 15\text{ pF}$ (Figure 3 and Figure 8) S1 and S2 Closed |     | 30  | 37  | ns    |
| $t_{PHL}$ | Receiver Input to Output       |                                                               |     | 32  | 37  | ns    |
| $t_{ZL}$  | Receiver Enable to Output Low  | $C_L = 15\text{ pF}$ (Figure 3 and Figure 9) S2 Open          |     | 15  | 20  | ns    |
| $t_{ZH}$  | Receiver Enable to Output High | $C_L = 15\text{ pF}$ (Figure 3 and Figure 9) S1 Open          |     | 11  | 20  | ns    |
| $t_{LZ}$  | Receiver Disable from Low      | $C_L = 15\text{ pF}$ (Figure 3 and Figure 9) S2 Open          |     | 28  | 32  | ns    |
| $t_{HZ}$  | Receiver Disable from High     | $C_L = 15\text{ pF}$ (Figure 3 and Figure 9) S1 Open          |     | 13  | 35  | ns    |

## AC TEST CIRCUITS

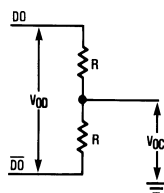


Figure 2.

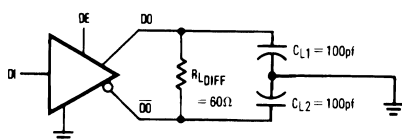
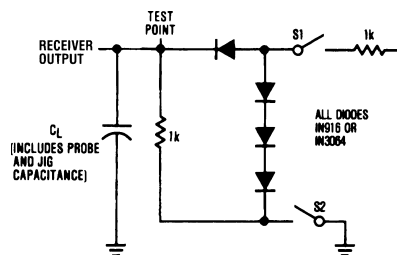
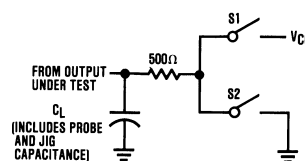


Figure 4.



**Note:** S1 and S2 of load circuit are closed except as otherwise mentioned.

Figure 3.



**Note:** Unless otherwise specified the switches are closed.

Figure 5.

## Switching Time Waveforms

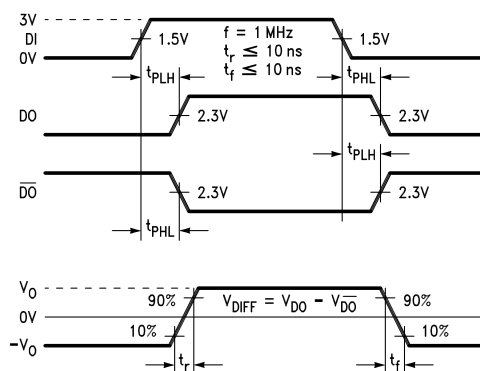


Figure 6. Driver Propagation Delays and Transition Times

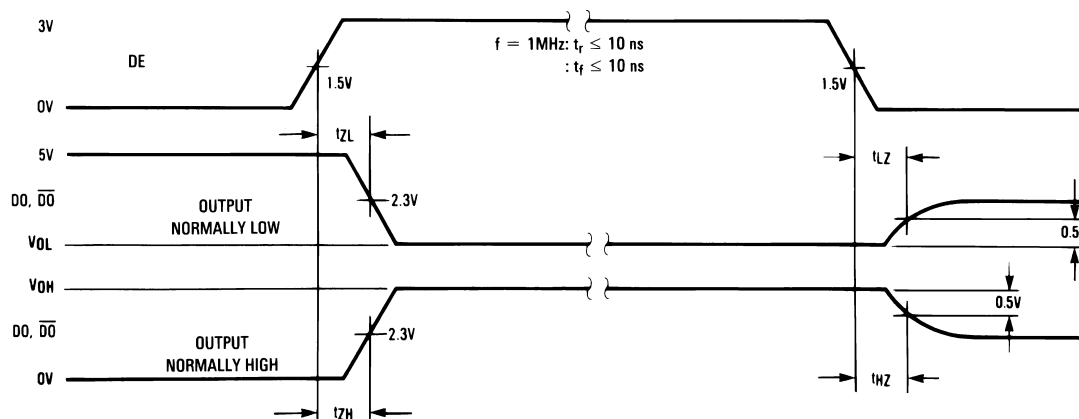
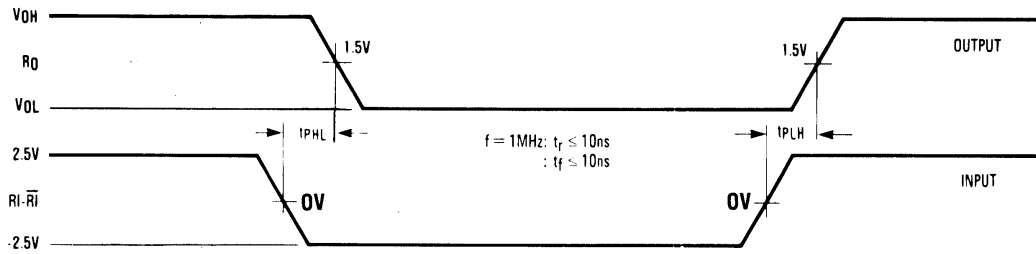


Figure 7. Driver Enable and Disable Times



Note: Differential input voltage may be realized by grounding  $\overline{RI}$  and pulsing  $RI$  between +2.5V and -2.5V

Figure 8. Receiver Propagation Delays

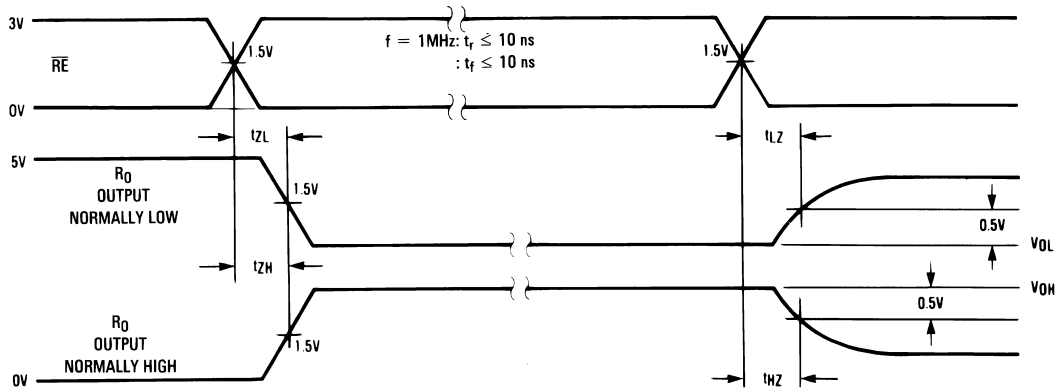


Figure 9. Receiver Enable and Disable Times

## Function Tables

Table 1. DS75176B Transmitting<sup>(1)</sup>

| Inputs          |    |    | Line Condition | Outputs         |    |
|-----------------|----|----|----------------|-----------------|----|
| $\overline{RE}$ | DE | DI |                | $\overline{DO}$ | DO |
| X               | 1  | 1  | No Fault       | 0               | 1  |
| X               | 1  | 0  | No Fault       | 1               | 0  |
| X               | 0  | X  | X              | Z               | Z  |
| X               | 1  | X  | Fault          | Z               | Z  |

- (1) X — Don't care condition  
 Z — High impedance state  
 Fault — Improper line conditions causing excessive power dissipation in the driver, such as shorts or bus contention situations  
 \*\*This is a fail safe condition

**Table 2. DS75176B Receiving<sup>(1)</sup>**

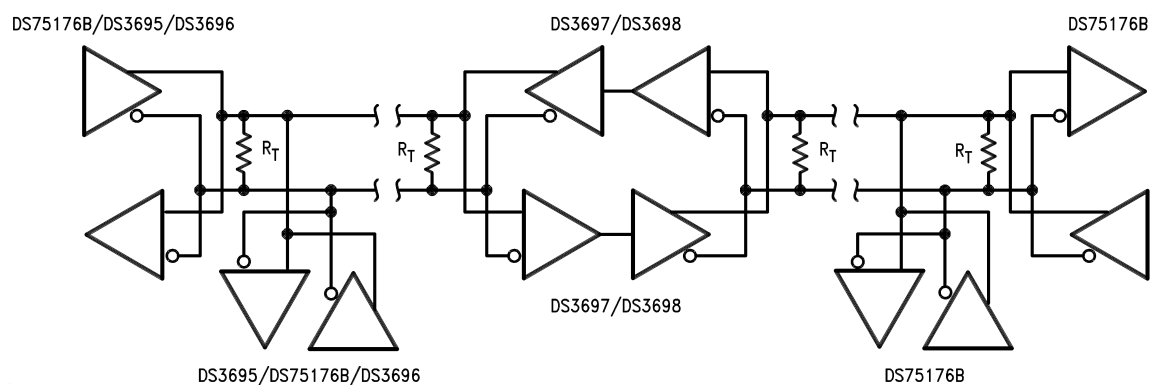
| Inputs          |    |                    | Outputs |
|-----------------|----|--------------------|---------|
| $\overline{RE}$ | DE | $RI-\overline{RI}$ | RO      |
| 0               | 0  | $\geq +0.2V$       | 1       |
| 0               | 0  | $\leq -0.2V$       | 0       |
| 0               | 0  | Inputs Open**      | 1       |
| 1               | 0  | X                  | Z       |

(1) X — Don't care condition

Z — High impedance state

Fault — Improper line conditions causing excessive power dissipation in the driver, such as shorts or bus contention situations

\*\*This is a fail safe condition

**TYPICAL APPLICATION**

## REVISION HISTORY

### Changes from Revision B (April 2013) to Revision C

Page

- Changed layout of National Data Sheet to TI format ..... [6](#)

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| DS75176BM        | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                     | Call TI                 | Call TI              | 0 to 70      | DS75176BM               | <a href="#">Samples</a> |
| DS75176BM/NOPB   | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | 0 to 70      | DS75176BM               | <a href="#">Samples</a> |
| DS75176BMX       | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                     | Call TI                 | Call TI              | 0 to 70      | DS75176BM               | <a href="#">Samples</a> |
| DS75176BMX/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | 0 to 70      | DS75176BM               | <a href="#">Samples</a> |
| DS75176BN        | ACTIVE        | PDIP         | P                  | 8    | 40             | TBD                     | Call TI                 | Call TI              | 0 to 70      | DS75176BN               | <a href="#">Samples</a> |
| DS75176BN/NOPB   | ACTIVE        | PDIP         | P                  | 8    | 40             | Green (RoHS & no Sb/Br) | SN   CU SN              | Level-1-NA-UNLIM     | 0 to 70      | DS75176BN               | <a href="#">Samples</a> |
| DS75176BTM       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                     | Call TI                 | Call TI              | -40 to 85    | DS75176BTM              | <a href="#">Samples</a> |
| DS75176BTM/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | -40 to 85    | DS75176BTM              | <a href="#">Samples</a> |
| DS75176BTMX      | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                     | Call TI                 | Call TI              | -40 to 85    | DS75176BTM              | <a href="#">Samples</a> |
| DS75176BTMX/NOPB | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | -40 to 85    | DS75176BTM              | <a href="#">Samples</a> |
| DS75176BTN       | ACTIVE        | PDIP         | P                  | 8    | 40             | TBD                     | Call TI                 | Call TI              | -40 to 85    | DS75176BTN              | <a href="#">Samples</a> |
| DS75176BTN/NOPB  | ACTIVE        | PDIP         | P                  | 8    | 40             | Green (RoHS & no Sb/Br) | SN   CU SN              | Level-1-NA-UNLIM     | -40 to 85    | DS75176BTN              | <a href="#">Samples</a> |

(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.

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**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)

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

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS75176BMX       | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| DS75176BMX/NOPB  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| DS75176BTMX      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| DS75176BTMX/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS75176BMX       | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| DS75176BMX/NOPB  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| DS75176BTMX      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| DS75176BTMX/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

P (R-PDIP-T8)

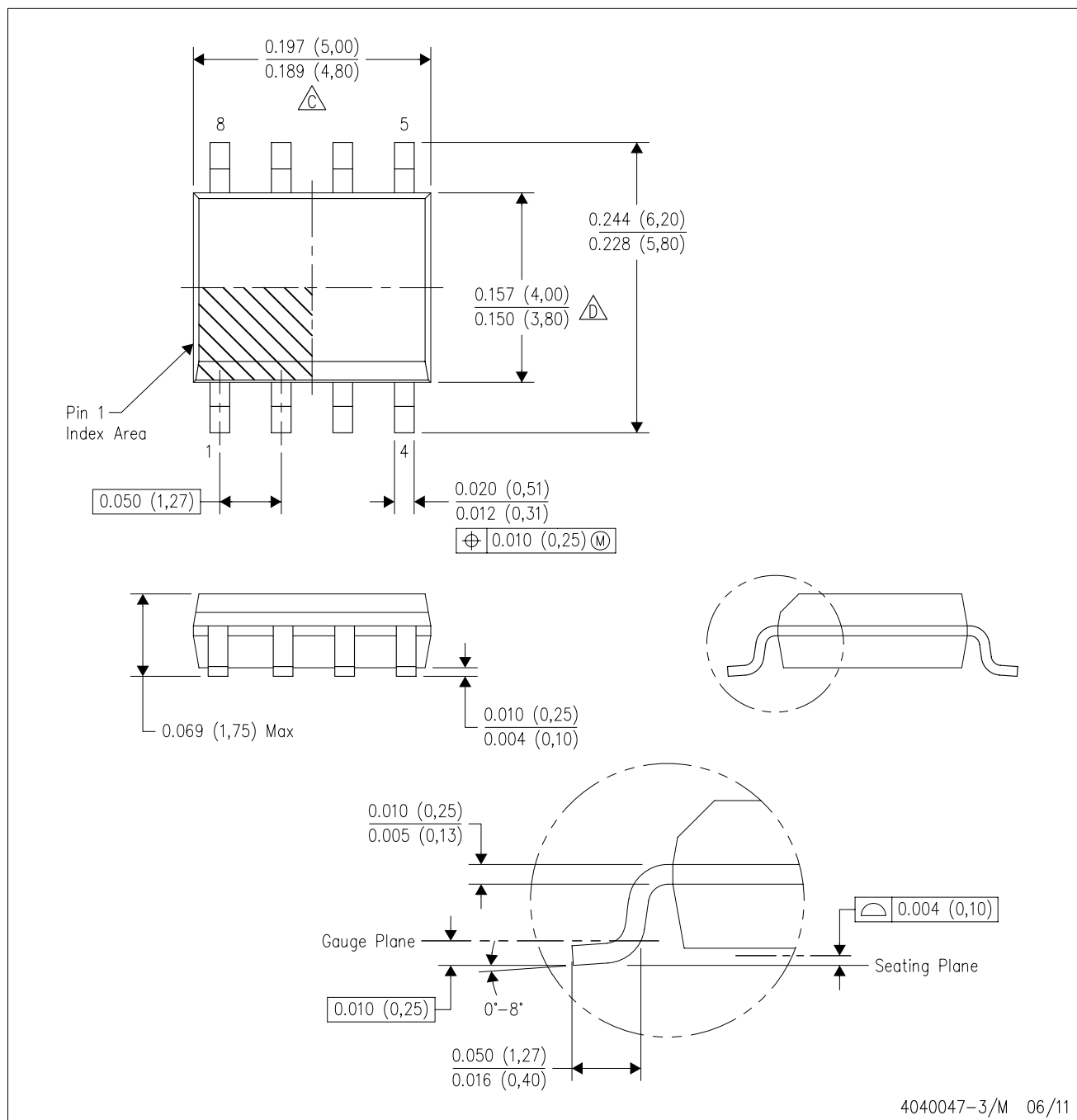
PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  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.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

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|                               |                                                                                          |
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