# TRS202E 5-V Dual RS-232 Line Driver and Receiver With ±15-kV IEC ESD Protection

## 1 Features

- IEC61000-4-2 (Level 4) ESD protection for RS-232 bus pins:
  - ±8kV Contact discharge
  - ±15k-V Air-gap discharge
  - ±15kV Human-body model
- Meets or exceeds the requirements of TIA/EIA-232-F and ITU v.28 standards
- Operates at 5V $V_{CC}$ supply
- Operates Up to 120kbit/s
- External capacitors: 4 × 0.1µF or 4 × 1µF
- Latch-up performance exceeds 100mA per JESD 78, class II

## 2 Applications

- Battery-powered systems
- Notebooks
- Laptops
- Set-Top Boxes
- Hand-held equipment

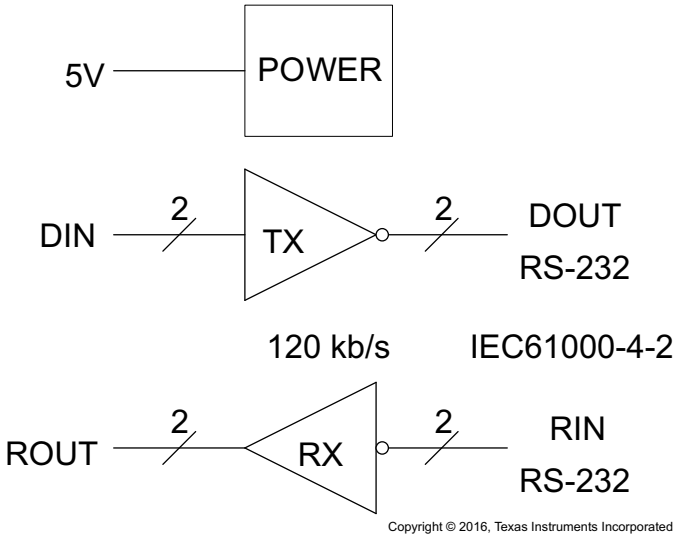
## 3 Description

The TRS202E consists of two line drivers, two line receivers, and a dual charge-pump circuit. TRS202E has IEC61000-4-2 (Level 4) ESD protection pin-to-pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 5V supply. The device operates at data signaling rates up to 120kbit/s and a maximum of 30V/µs driver output slew rate.

**Package Information**

| PART NUMBER | PACKAGE(1) | PACKAGE SIZE(2) |
|---|---|---|
| TRS202E | SOIC (D) (16) | 9.9mm × 6mm |
| | SOIC (DW) (16) | 10.4mm × 10.3mm |
| | PDIP (N) (16) | 19.3mm × 9.4mm |
| | TSSOP (PW) (16) | 5mm x 6.4mm |

(1) For more Information, see Section 10.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.




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**Logic Diagram (Positive Logic)**

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# 4 Pin Configuration and Functions

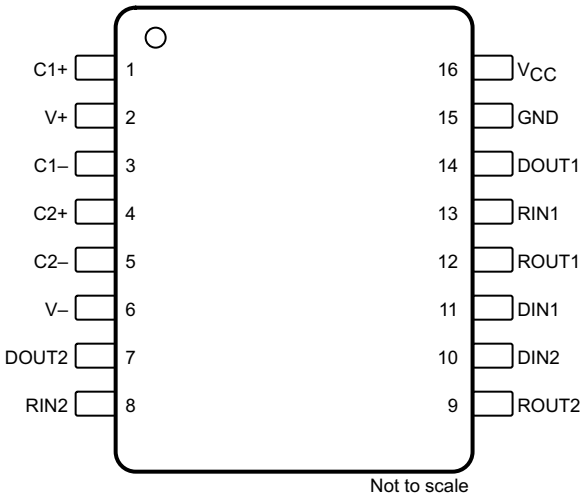



**Figure 4-1. D, DW, N or PW Package, 16-Pin SOIC or TSSOP (Top View)**

**Table 4-1. Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| 1 | C1+ | — | Positive lead of C1 capacitor |
| 2 | V+ | O | Positive charge pump output for storage capacitor only |
| 3 | C1– | — | Negative lead of C1 capacitor |
| 4 | C2+ | — | Positive lead of C2 capacitor |
| 5 | C2– | — | Negative lead of C2 capacitor |
| 6 | V– | O | Negative charge pump output for storage capacitor only |
| 7 | DOUT2 | O | RS-232 line data output (to remote RS-232 system) |
| 8 | RIN2 | I | RS-232 line data input (from remote RS-232 system) |
| 9 | ROUT2 | O | Logic data output (to UART) |
| 10 | DIN2 | I | Logic data input (from UART) |
| 11 | DIN1 | I | Logic data input (from UART) |
| 12 | ROUT1 | O | Logic data output (to UART) |
| 13 | RIN1 | I | RS-232 line data input (from remote RS-232 system) |
| 14 | DOUT1 | O | RS-232 line data output (to remote RS-232 system) |
| 15 | GND | — | Ground |
| 16 | $V_{CC}$ | — | Supply voltage, connect to external 5-V power supply |

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# 5 Specifications

## 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1) (2)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ (2) | | –0.3 | 6 | V |
| Positive charge pump voltage, V+(2) | | $V_{CC}$ – 0.3 | 14 | V |
| Negative charge pump voltage, V– | | –14 | 0.3 | V |
| Input voltage, $V_I$ | Drivers | –0.3 | V+ + 0.3 | V |
| | Receivers | | ±30 | |
| Output voltage, $V_O$ | Drivers | V– – 0.3 | V+ + 0.3 | V |
| | Receivers | –0.3 | $V_{CC}$ + 0.3 | |
| Short-circuit duration, $D_{OUT}$ | | Continuous | | |
| Operating virtual junction temperature, $T_J$ | | | 150 | °C |
| Storage temperature, $T_{stg}$ | | –65 | 150 | °C |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network GND.

## 5.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | Pins 7, 8, 13, 14, 15 | ±15000 | V |
| | | All other pins | ±2000 | |
| | Charged-device model (CDM), per JEDEC specification JESD22-C101(2) | All pins | ±1500 | |
| | IEC 61000-4-2 contact discharge | Pins 7, 8, 13, 14, 15 | ±8000 | |
| | IEC 61000-4-2 air-gap discharge | Pins 7, 8, 13, 14, 15 | ±15000 | |

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

## 5.3 Recommended Operating Conditions

see Figure 7-1 (1)

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| | Supply voltage | | 4.5 | 5 | 5.5 | V |
| $V_{IH}$ | Driver high-level input voltage ($D_{IN}$) | | 2 | | | V |
| $V_{IL}$ | Driver low-level input voltage ($D_{IN}$) | | | | 0.8 | V |
| $V_I$ | Driver input voltage ($D_{IN}$) | | 0 | | 5.5 | V |
| | Receiver input voltage | | –30 | | 30 | |
| $T_A$ | Operating free-air temperature | TRS202EC | 0 | | 70 | °C |
| | | TRS202EI | –40 | | 85 | |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V ±0.5V.


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## 5.4 Thermal Information

| THERMAL METRIC[1] | | D (SOIC) | DW (SOIC) | N (PDIP) | PW (TSSOP) | UNIT |
|---|---|---|---|---|---|---|
| | | 16 PINS | 16 PINS | 16 PINS | 16 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 84.6 | 77.1 | 44.1 | 107.5 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 43.5 | 39.9 | 30.8 | 38.4 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 43.2 | 41.8 | 24.2 | 53.7 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 10.4 | 12.9 | 15.2 | 3.2 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 42.8 | 41.3 | 24 | 53.1 | °C/W |

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

## 5.5 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted; see Figure 7-1)[1]

| PARAMETER | | TEST CONDITIONS | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{CC}$ | Supply current | No load, $V_{CC}$ = 5V | | 8 | 15 | mA |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V + 0.5V.
(2) All typical values are at $V_{CC}$ = 5V and $T_A$ = 25°C.

## 5.6 Electrical Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 7-1)[1]

| PARAMETER | | TEST CONDITIONS | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $D_{OUT}$ at $R_L$ = 3kΩ to GND, $D_{IN}$ = GND | 5 | 9 | | V |
| $V_{OL}$ | Low-level output voltage | $D_{OUT}$ at $R_L$ = 3kΩ to GND, $D_{IN}$ = $V_{CC}$ | –5 | –9 | | V |
| $I_{IH}$ | High-level input current | $V_I$ = $V_{CC}$ | | 15 | 200 | µA |
| $I_{IL}$ | Low-level input current | $V_I$ at 0V | | –15 | –200 | µA |
| $I_{OS}$ [3] | Short-circuit output current | $V_{CC}$ = 5.5V and $V_O$ = 0V | | ±10 | ±60 | mA |
| $r_o$ | Output resistance | $V_{CC}$, V+, V– = 0V, and $V_O$ = ±2V | 300 | | | Ω |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V + 0.5V.
(2) All typical values are at $V_{CC}$ = 5V and $T_A$ = 25°C.
(3) Short-circuit durations must be controlled to prevent exceeding the device absolute power-dissipation ratings, and not more than one output must be shorted at a time.

## 5.7 Electrical Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted; see Figure 7-1)[1]

| PARAMETER | | TEST CONDITIONS | MIN | TYP[2] | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | $I_{OH}$ = –1mA | 3.5 | $V_{CC}$ – 0.4 | | V |
| $V_{OL}$ | Low-level output voltage | $I_{OL}$ = 1.6mA | | | 0.4 | V |
| $V_{IT+}$ | Positive-going input threshold voltage | $V_{CC}$ = 5V and $T_A$ = 25°C | | 1.7 | 2.4 | V |
| $V_{IT–}$ | Negative-going input threshold voltage | $V_{CC}$ = 5V and $T_A$ = 25°C | 0.8 | 1.2 | | V |
| $V_{hys}$ | Input hysteresis ($V_{IT+}$ – $V_{IT–}$) | | 0.2 | 0.5 | 1 | V |
| $r_i$ | Input resistance | $V_I$ = ±3V to ±25V | 3 | 5 | 7 | kΩ |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V + 0.5V.
(2) All typical values are at $V_{CC}$ = 5V and $T_A$ = 25°C.

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## 5.8 Switching Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted; see Figure 7-1)(1)

| PARAMETER | | TEST CONDITIONS | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|
| | Maximum data rate | $C_L$ = 50 to 1000pF, one $D_{OUT}$ switching, and $R_L$ = 3kΩ to 7kΩ (see Figure 6-1) | 120 | | | kbit/s |
| $t_{PLH(D)}$ | Propagation delay time, low- to high-level output | $C_L$ = 2500pF, all drivers loaded, and $R_L$ = 3kΩ (see Figure 6-1) | | 2 | | µs |
| $t_{PHL(D)}$ | Propagation delay time, high- to low-level output | $C_L$ = 2500pF, all drivers loaded, and $R_L$ = 3kΩ (see Figure 6-1) | | 2 | | µs |
| $t_{sk(p)}$ | Pulse skew(3) | $C_L$ = 150 to 2500pF and $R_L$ = 3kΩ to 7kΩ (see Figure 6-2) | | 300 | | ns |
| SR(tr) | Slew rate, transition region | $C_L$ = 50 to 1000pF, $V_{CC}$ = 5V, and $R_L$ = 3kΩ to 7kΩ (see Figure 6-1) | 3 | 6 | 30 | V/µs |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V + 0.5V.
(2) All typical values are at $V_{CC}$ = 5V and $T_A$ = 25°C.
(3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.

## 5.9 Switching Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted; see Figure 6-3)(1)

| PARAMETER | | TEST CONDITIONS | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{PLH(R)}$ | Propagation delay time, low- to high-level output | $C_L$ = 150pF | | 0.5 | 10 | µs |
| $t_{PHL(R)}$ | Propagation delay time, high- to low-level output | $C_L$ = 150pF | | 0.5 | 10 | µs |
| $t_{sk(p)}$ | Pulse skew(3) | | | 300 | | ns |

(1) Test conditions are C1 to C4 = 0.1µF at $V_{CC}$ = 5V + 0.5V.
(2) All typical values are at $V_{CC}$ = 5V and $T_A$ = 25°C.
(3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.


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## 5.10 Typical Characteristics

$T_A$ = 25°C (unless otherwise noted)

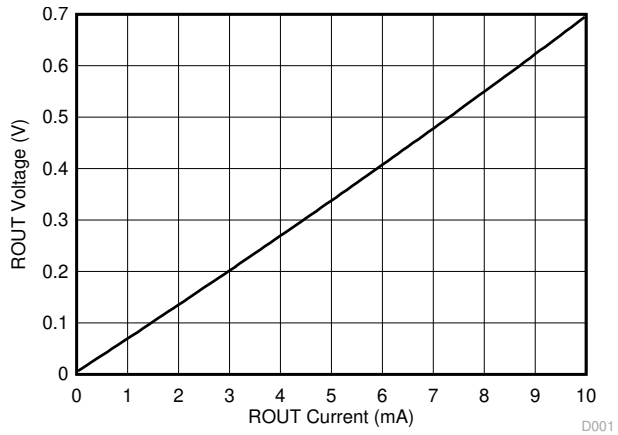



**Figure 5-1. Receiver $V_{OL}$ vs Output Current**

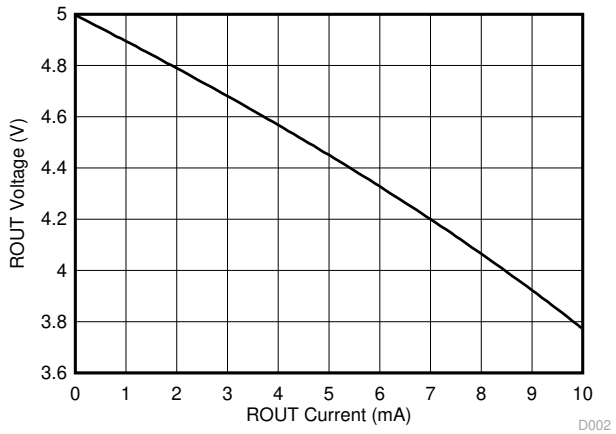



**Figure 5-2. Receiver $V_{OH}$ vs Output Current**

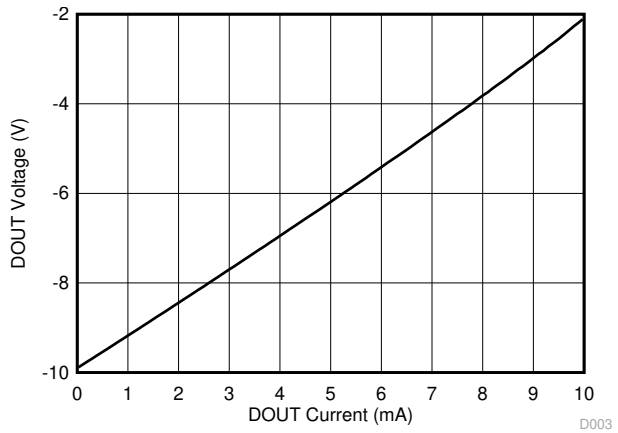



**Figure 5-3. Driver $V_{OL}$ vs Output Current**

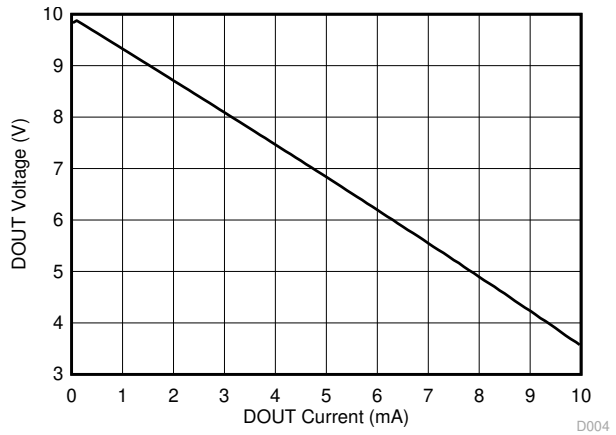



**Figure 5-4. Driver $V_{OH}$ vs Output Current**

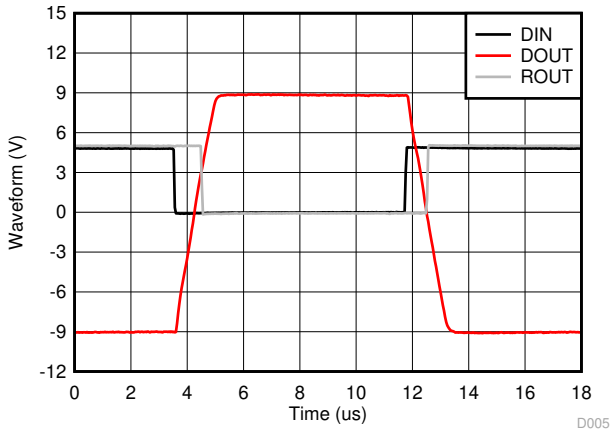
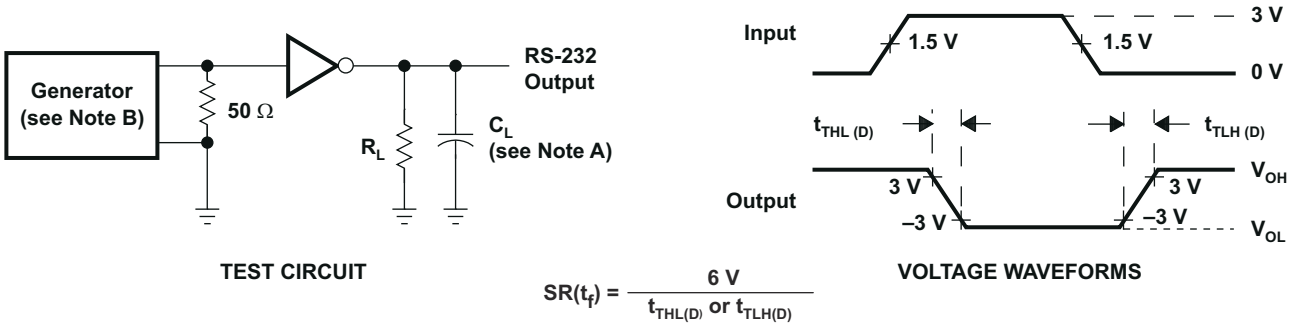



**Figure 5-5. Driver and Receiver Loopback Waveforms**

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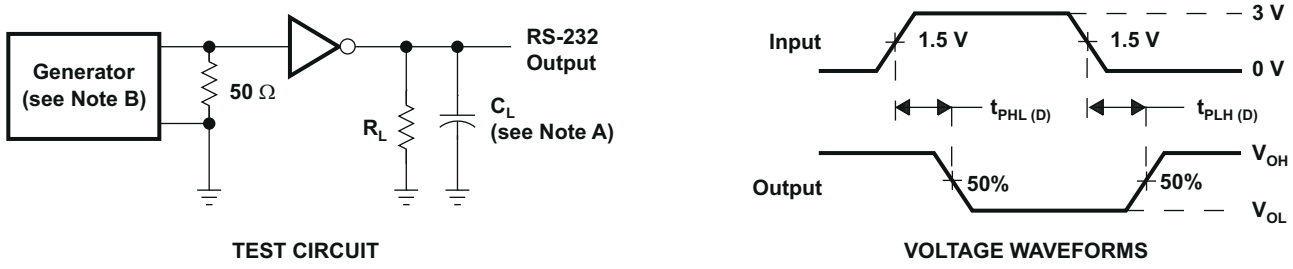
## Parameter Measurement Information




$$SR(t_f) = \frac{6\ V}{t_{THL(D)} \text{ or } t_{TLH(D)}}$$

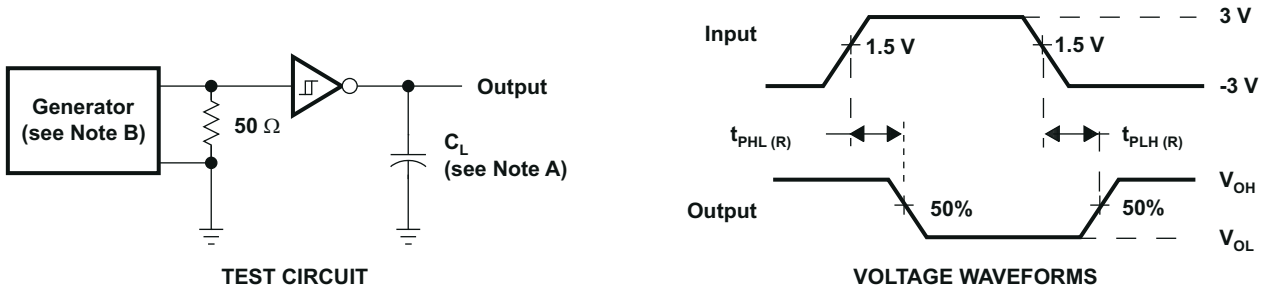
NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 6-1. Driver Slew Rate**




NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 6-2. Driver Pulse Skew**




NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 6-3. Receiver Propagation Delay Times**

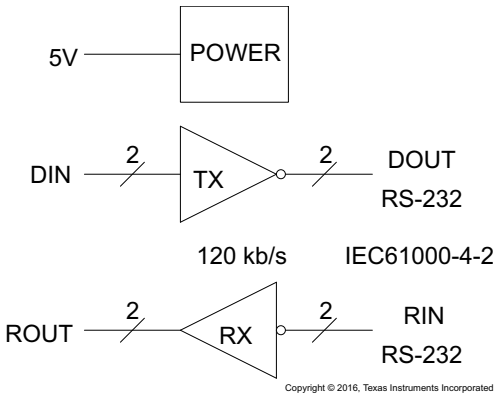

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# 6 Detailed Description

## 6.1 Overview

The TRS202E device is a dual driver and receiver that includes a capacitive voltage generator using four capacitors to supply TIA/EIA-232-F voltage levels from a single 5V supply. All RS-232 pins have 15kV HBM and IEC61000-4-2 Air-Gap discharge protection. RS-232 pins also have 8-kV IEC61000-4-2 contact discharge protection. Each receiver converts TIA/EIA-232-F inputs to 5V TTL/CMOS levels. These receivers have shorted and open fail safe. The receiver can accept up to ±30V inputs and decode inputs as low as ±3V. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. Outputs are protected against shorts to ground.

## 6.2 Functional Block Diagram




## 6.3 Feature Description

### 6.3.1 Power

The power block increases and inverts the 5V supply for the RS-232 driver using a charge pump that requires four 0.1µF or 1µF external capacitors.

### 6.3.2 RS-232 Driver

Two drivers interface standard logic levels to RS-232 levels. The driver inputs do not have internal pullup resistors. Do not float the driver inputs.

### 6.3.3 RS-232 Receiver

Two Schmitt trigger receivers interface RS-232 levels to standard logic levels. Each receiver has an internal 5-kΩ load to ground. An open input results in a high output on $R_{OUT}$.

## 6.4 Device Functional Modes

### 6.4.1 $V_{CC}$ Powered by 5V

The device is in normal operation when powered by 5V.

### 6.4.2 $V_{CC}$ Unpowered

When TRS202E is unpowered, it can be safely connected to an active remote RS-232 device.

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### 6.4.3 Truth Tables

Table 6-1 and Table 6-2 list the function for each driver and receiver (respectively).

**Table 6-1. Function Table for Each Driver**

| INPUT DIN(1) | OUTPUT DOUT |
|---|---|
| L | H |
| H | L |

(1) H = high level, L = low level

**Table 6-2. Function Table for Each Receiver**

| INPUT RIN(1) | OUTPUT ROUT |
|---|---|
| L | H |
| H | L |
| Open | H |

(1) H = high level, L = low level,
Open = input disconnected or connected driver off


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# 7 Application and Implementation

**Note**

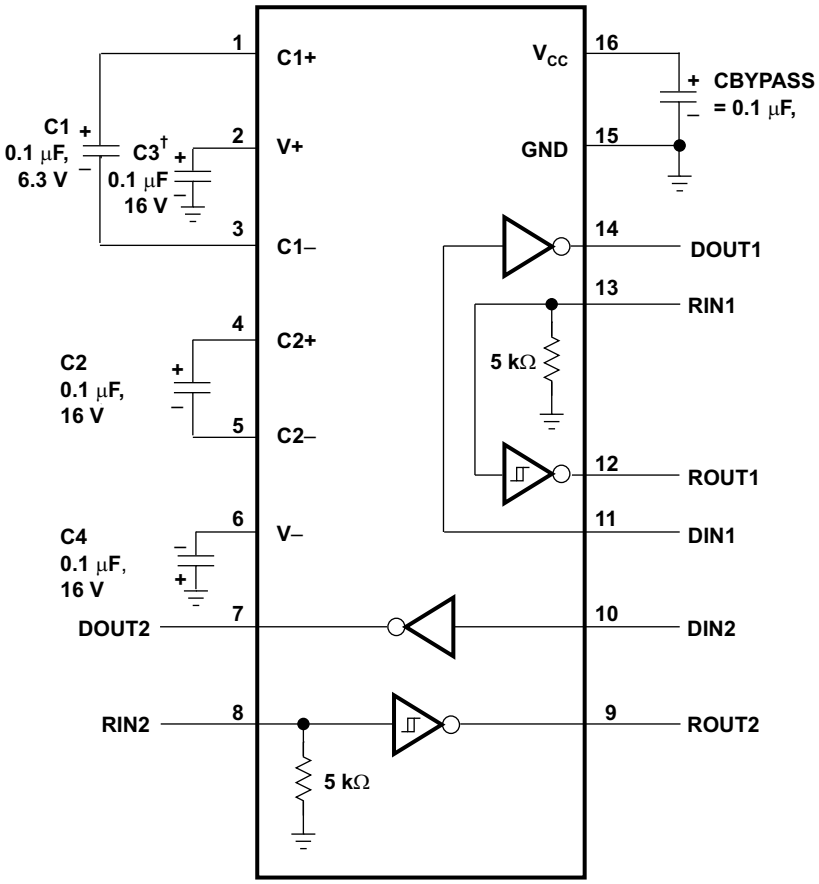
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

## 7.1 Application Information

For proper operation, add capacitors as shown in Figure 7-1. Pins 9 through 12 connect to UART or general purpose logic lines. RS-232 lines on pins 7, 8, 13, and 14 connect to a connector or cable.

## 7.2 Typical Application

Two driver and two receiver channels are supported for full duplex transmission with hardware flow control. The two 5kΩ-resistors are internal to the TRS202E.




† C3 can be connected to $V_{CC}$ or GND.

NOTES: 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.

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**Figure 7-1. Typical Operating Circuit and Capacitor Values**

### 7.2.1 Design Requirements

- $V_{CC}$ minimum is 4.5V and maximum is 5.5V.
- Maximum recommended bit rate is 120kbps.

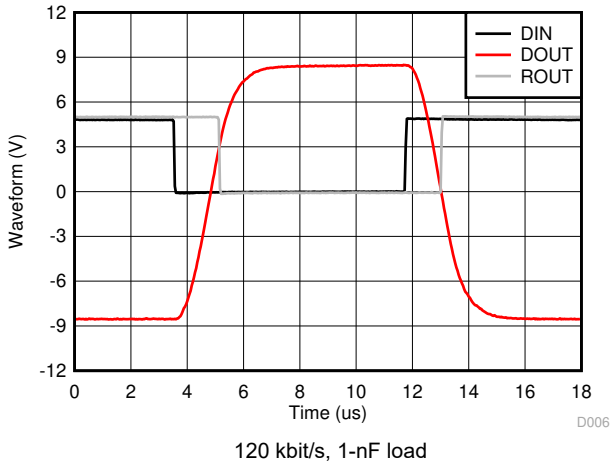
### 7.2.2 Detailed Design Procedure

#### *7.2.2.1 Capacitor Selection*

The capacitor type used for C1 through C4 is not critical for proper operation. The TRS202E requires 0.1µF capacitors. 1-µF capacitors are also acceptable. TI recommends ceramic dielectrics. When using the minimum recommended capacitor values, ensure the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (for example, 2×) nominal value. The capacitors' effective series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V–.

Bypass $V_{CC}$ to ground with at least 0.1µF. In applications sensitive to power-supply noise generated by the charge pumps, decouple $V_{CC}$ to ground with a capacitor the same size as (or larger than) the charge-pump capacitors (C1 to C4).

### 7.2.3 Application Curves




120 kbit/s, 1-nF load

**Figure 7-2. Driver and Receiver Loopback Signal**

## 7.3 Power Supply Recommendations

The $V_{CC}$ voltage must be connected to the same power source used for logic device connected to DIN and ROUT pins. $V_{CC}$ must be between 4.5V and 5.5V.


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## 7.4 Layout

### 7.4.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times. Make the impedance from TRS202E ground pin and circuit boards ground plane as low as possible for best ESD performance. Use wide metal and multiple vias on both sides of ground pin.

### 7.4.2 Layout Example

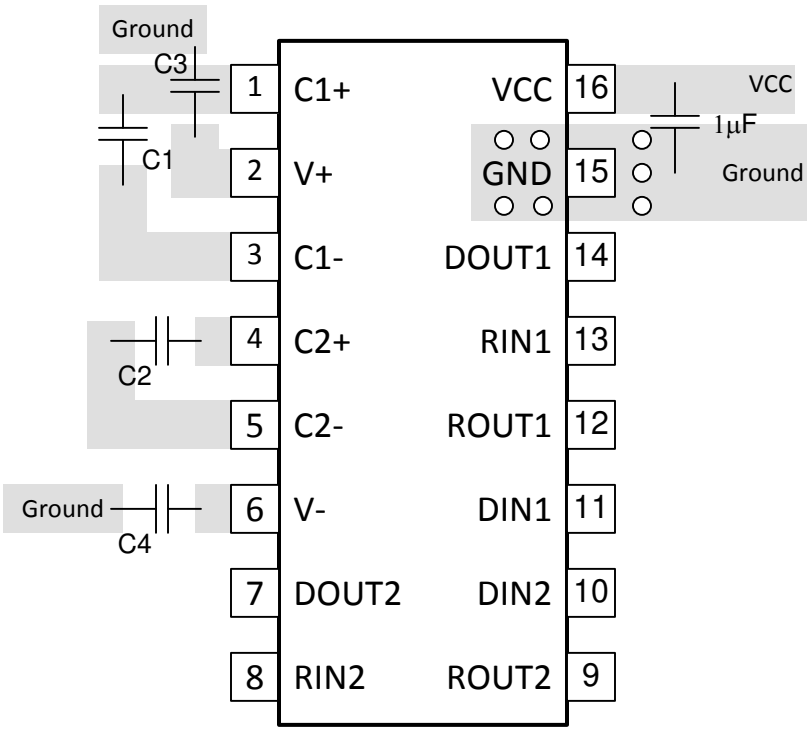



**Figure 7-3. TRS202E Layout**

# 8 Device and Documentation Support

## 8.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 8.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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## 8.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 8.5 Glossary

| | |
|---|---|
| TI Glossary | This glossary lists and explains terms, acronyms, and definitions. |

# 9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision E (November 2016) to Revision F (February 2024) | Page |
|---|---|
| • Changed the *Package Information* table | 1 |
| • Changed the *Thermal Information* table | 5 |

| Changes from Revision D (November 2012) to Revision E (November 2016) | Page |
|---|---|
| • Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section | 1 |
| • Deleted *Ordering Information* table; see *Package Option Addendum* at the end of the data sheet | 1 |
| • Changed Package thermal impedance, $R_{\theta JA}$, values in Thermal Information table From: 73°C/W To: 76.7°C/W (D), From: 57°C/W To: 77.1°C/W (DW), From: 67°C/W To: 44.1°C/W (N), and From: 108°C/W To: 101.7°C/W (PW) | 5 |

| Changes from Revision C (May 2010) to Revision D (November 2012) | Page |
|---|---|
| • Fixed $I_{OS}$ values in *Electrical Characteristics* table, changed – to ± | 5 |


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## 10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| TRS202ECD | Obsolete | Production | SOIC (D) \| 16 | - | - | Call TI | Call TI | 0 to 70 | TRS202EC |
| TRS202ECDR | Obsolete | Production | SOIC (D) \| 16 | - | - | Call TI | Call TI | 0 to 70 | TRS202EC |
| TRS202ECDWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS202EC |
| TRS202ECDWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS202EC |
| TRS202ECN | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | 0 to 70 | TRS202ECN |
| TRS202ECN.A | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | 0 to 70 | TRS202ECN |
| TRS202ECPW | Obsolete | Production | TSSOP (PW) \| 16 | - | - | Call TI | Call TI | 0 to 70 | RU02EC |
| TRS202ECPWR | Obsolete | Production | TSSOP (PW) \| 16 | - | - | Call TI | Call TI | 0 to 70 | RU02EC |
| TRS202EID | Obsolete | Production | SOIC (D) \| 16 | - | - | Call TI | Call TI | -40 to 85 | TRS202EI |
| TRS202EIDR | Active | Production | SOIC (D) \| 16 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIDR.A | Active | Production | SOIC (D) \| 16 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIDW | Active | Production | SOIC (DW) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIDW.A | Active | Production | SOIC (DW) \| 16 | 40 \| TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIDWR | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIDWR.A | Active | Production | SOIC (DW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI |
| TRS202EIN | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | -40 to 85 | TRS202EIN |
| TRS202EIN.A | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | -40 to 85 | TRS202EIN |
| TRS202EIPWR | Active | Production | TSSOP (PW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RU02EI |
| TRS202EIPWR.A | Active | Production | TSSOP (PW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RU02EI |
| TRS202EIPWRG4 | Active | Production | TSSOP (PW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RU02EI |
| TRS202EIPWRG4.A | Active | Production | TSSOP (PW) \| 16 | 2000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RU02EI |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

**(4) Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

**(5) MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

**(6) Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

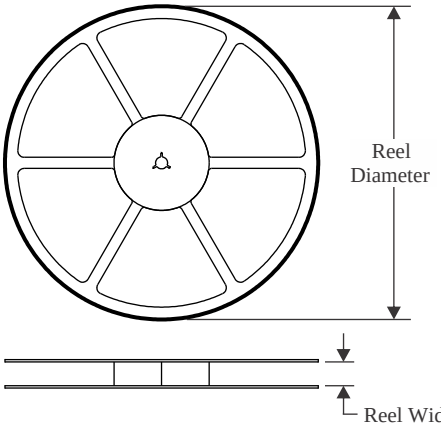
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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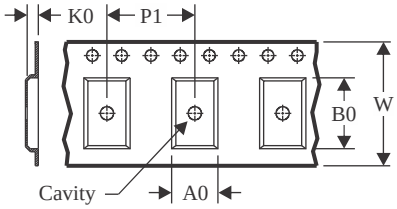
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## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

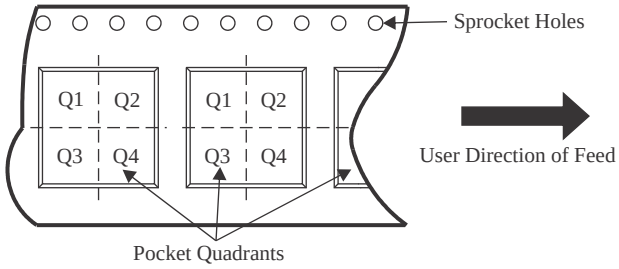



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

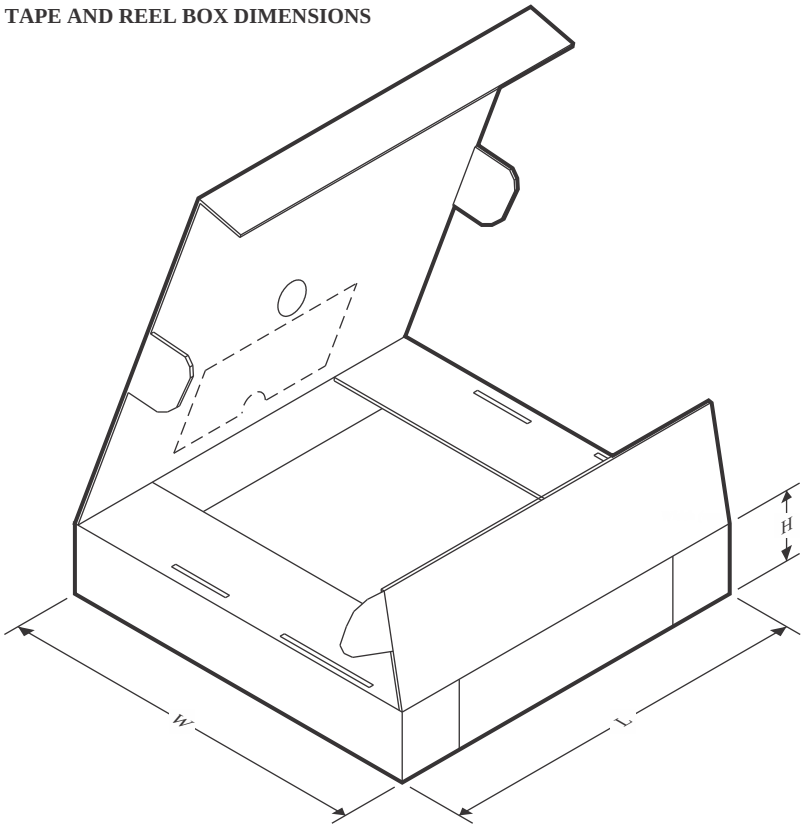
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRS202ECDWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| TRS202EIDR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| TRS202EIDWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| TRS202EIPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRS202EIPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRS202EIPWRG4 | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

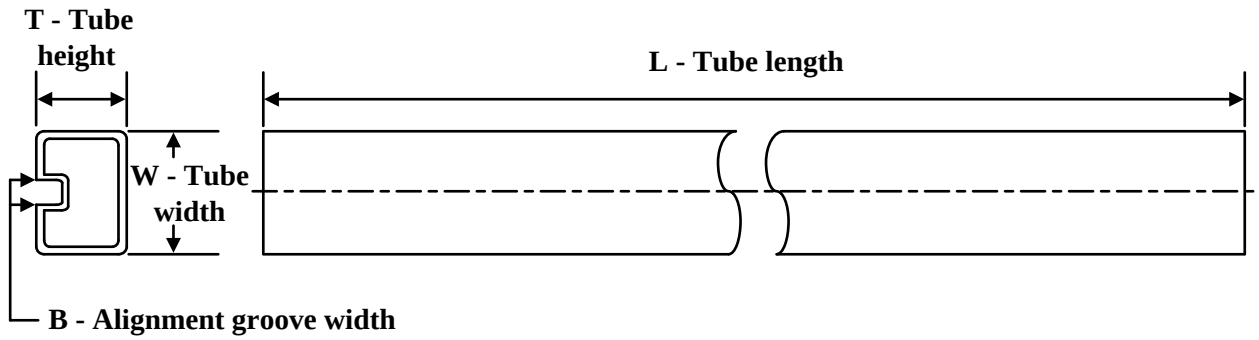
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TRS202ECDWR | SOIC | DW | 16 | 2000 | 350.0 | 350.0 | 43.0 |
| TRS202EIDR | SOIC | D | 16 | 2500 | 340.5 | 336.1 | 32.0 |
| TRS202EIDWR | SOIC | DW | 16 | 2000 | 350.0 | 350.0 | 43.0 |
| TRS202EIPWR | TSSOP | PW | 16 | 2000 | 367.0 | 367.0 | 35.0 |
| TRS202EIPWR | TSSOP | PW | 16 | 2000 | 353.0 | 353.0 | 32.0 |
| TRS202EIPWRG4 | TSSOP | PW | 16 | 2000 | 353.0 | 353.0 | 32.0 |

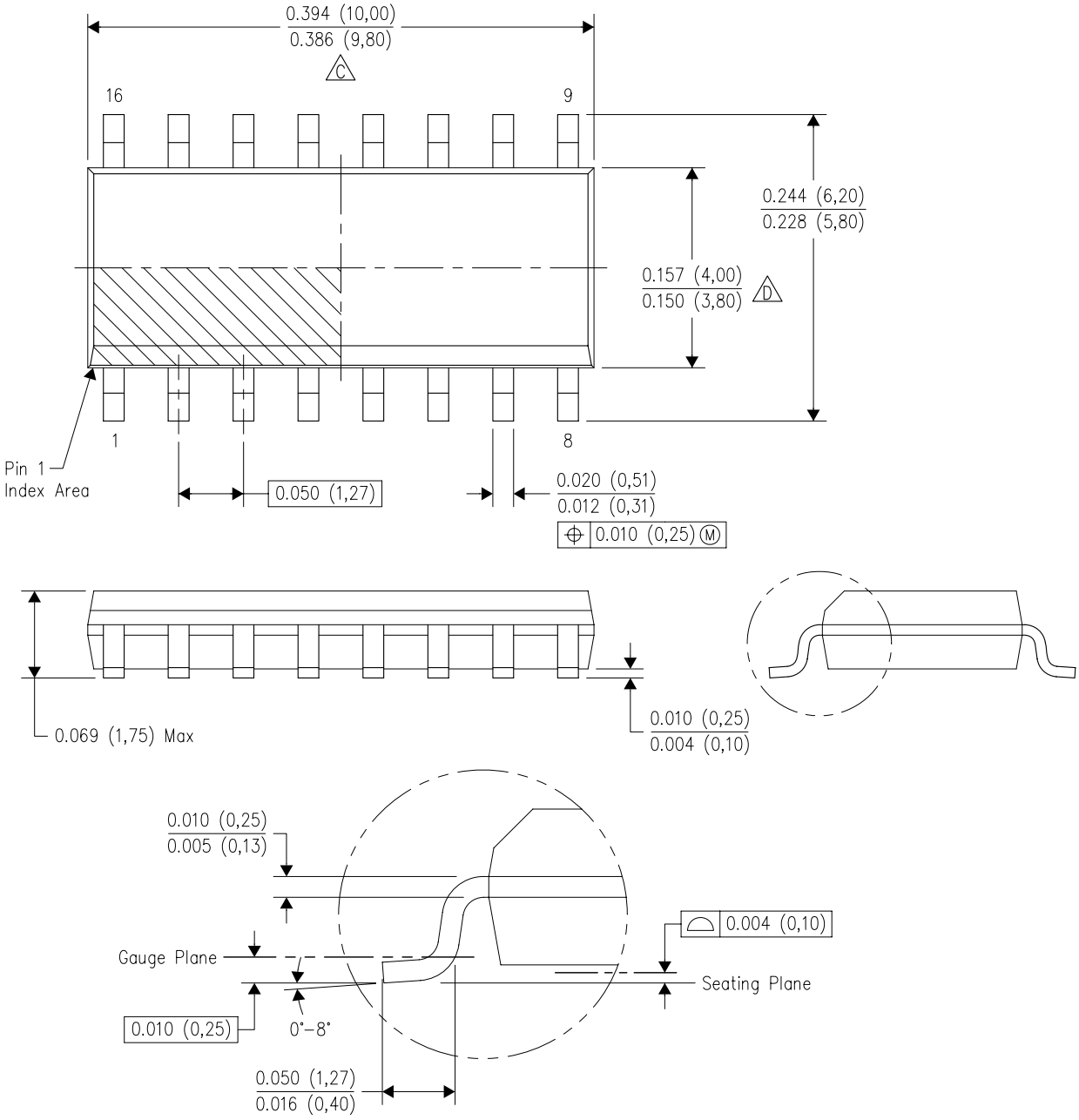
## TUBE




*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| TRS202ECN | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| TRS202ECN.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| TRS202EIDW | DW | SOIC | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| TRS202EIDW.A | DW | SOIC | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| TRS202EIN | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| TRS202EIN.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |

D (R–PDSO–G16) PLASTIC SMALL OUTLINE




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.

# GENERIC PACKAGE VIEW

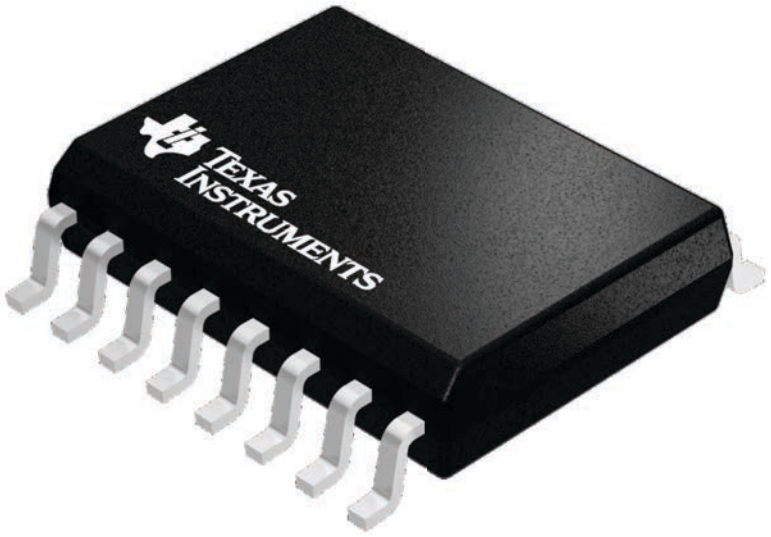
## DW 16

## SOIC - 2.65 mm max height

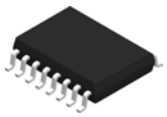
**7.5 x 10.3, 1.27 mm pitch**

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.




4224780/A

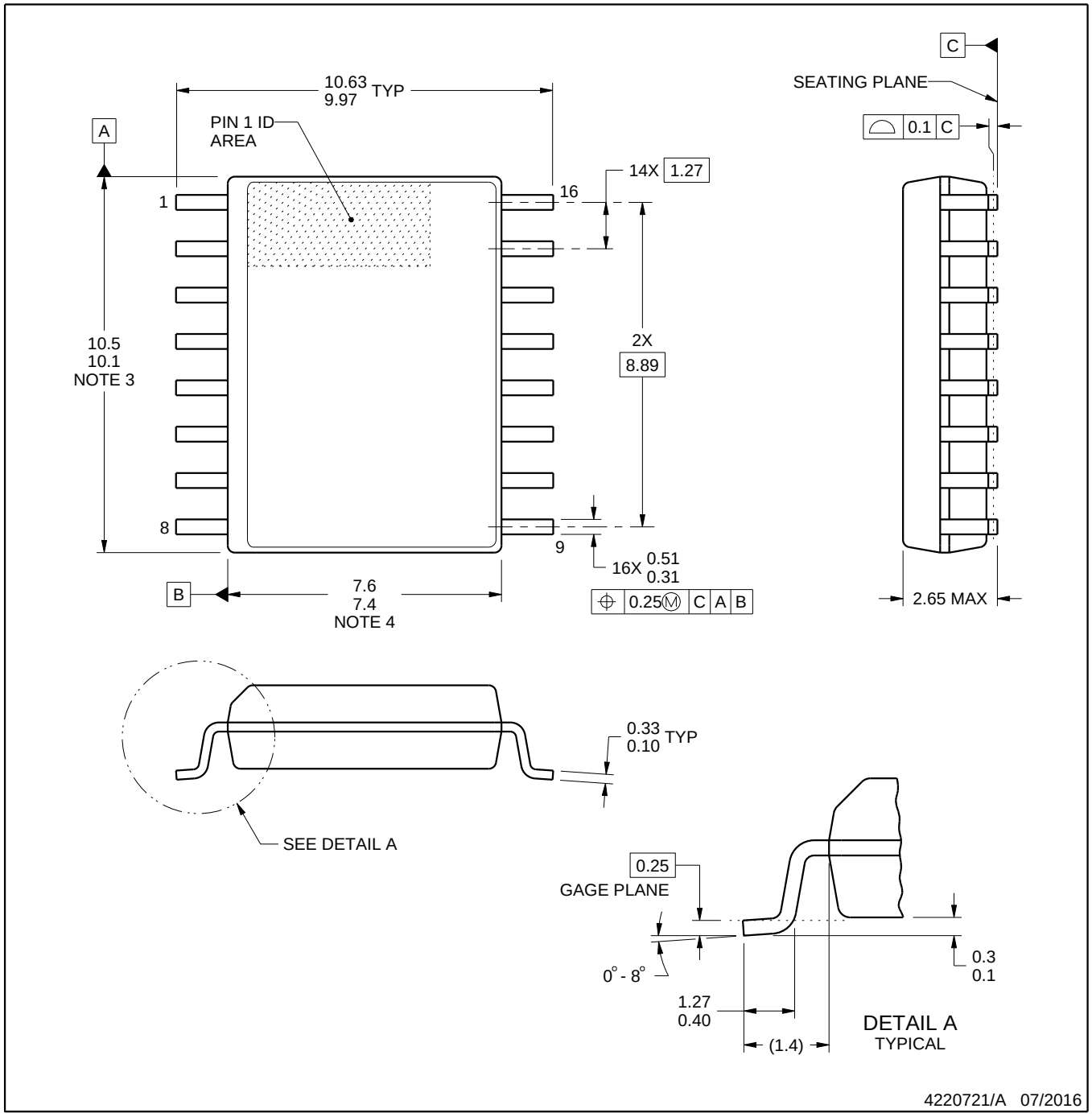


# PACKAGE OUTLINE

## DW0016A

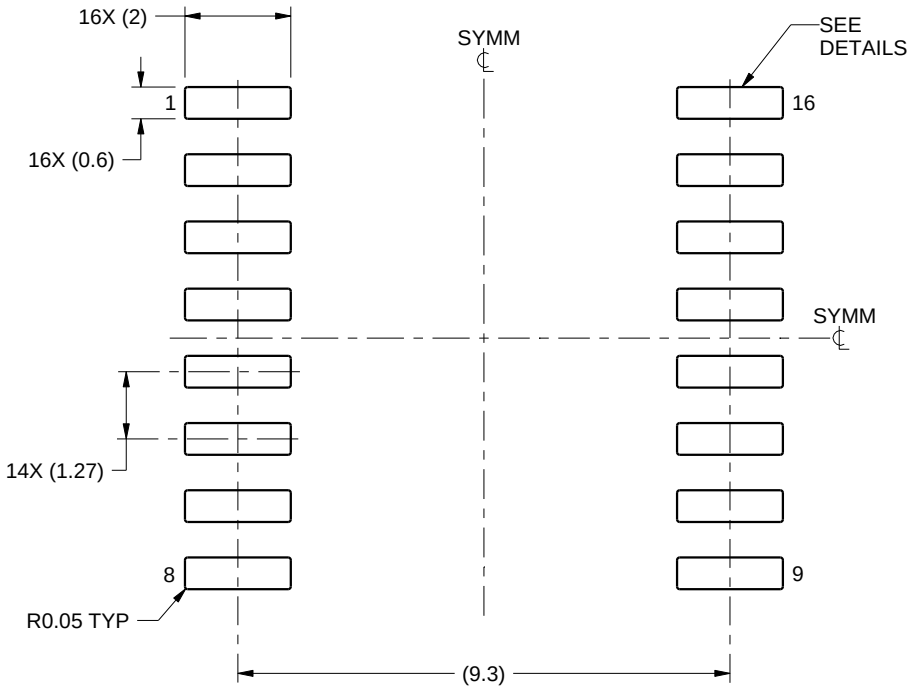
## SOIC - 2.65 mm max height

SOIC

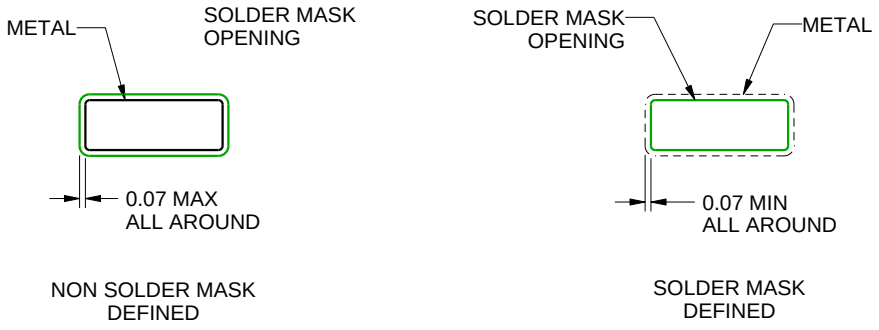



NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.




LAND PATTERN EXAMPLE
SCALE:7X

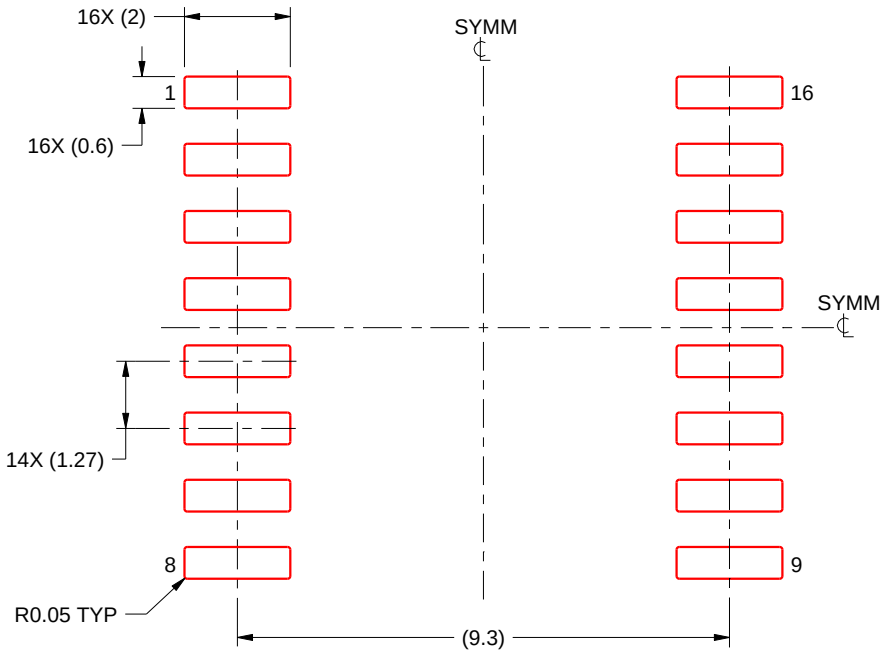



SOLDER MASK DETAILS

4220721/A 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220721/A 07/2016

NOTES: (continued)

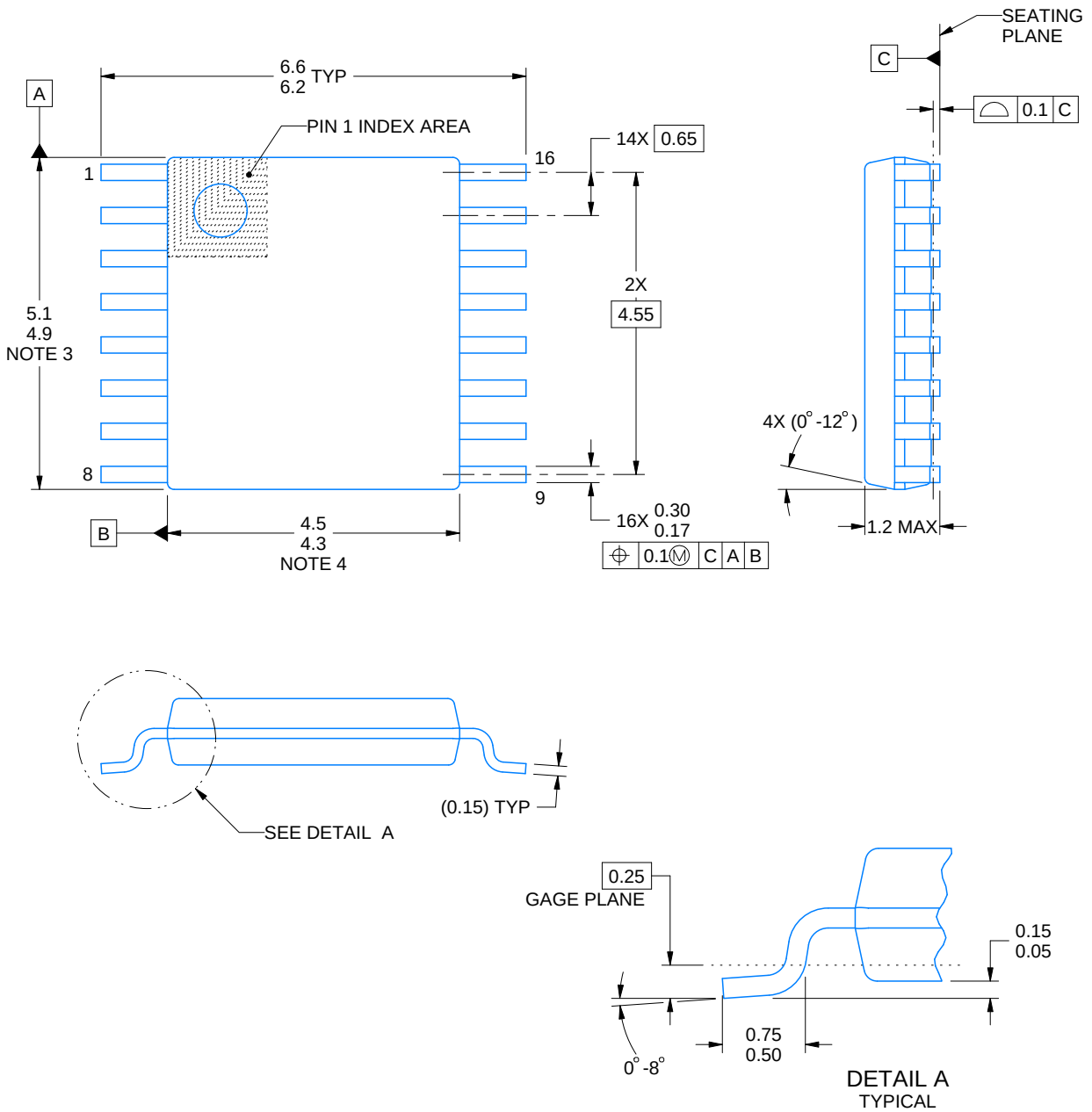
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

# PACKAGE OUTLINE

## PW0016A

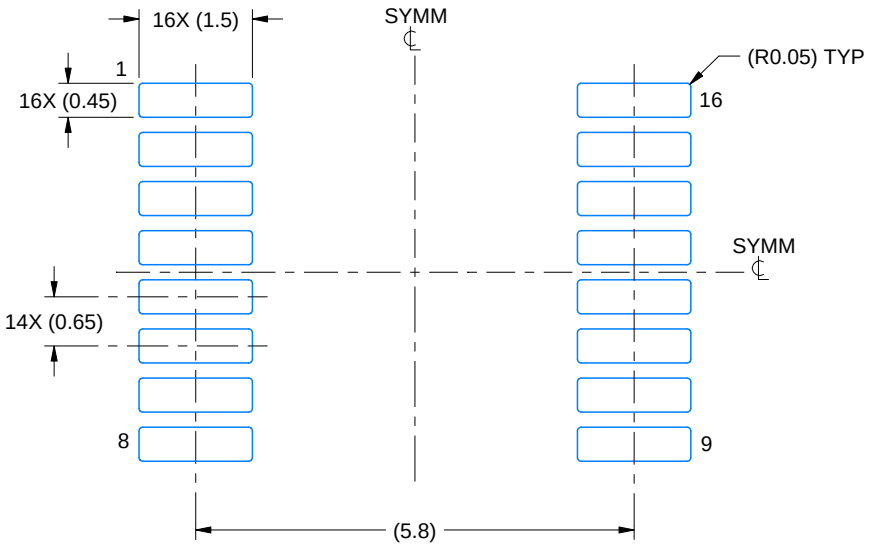
## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE




NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

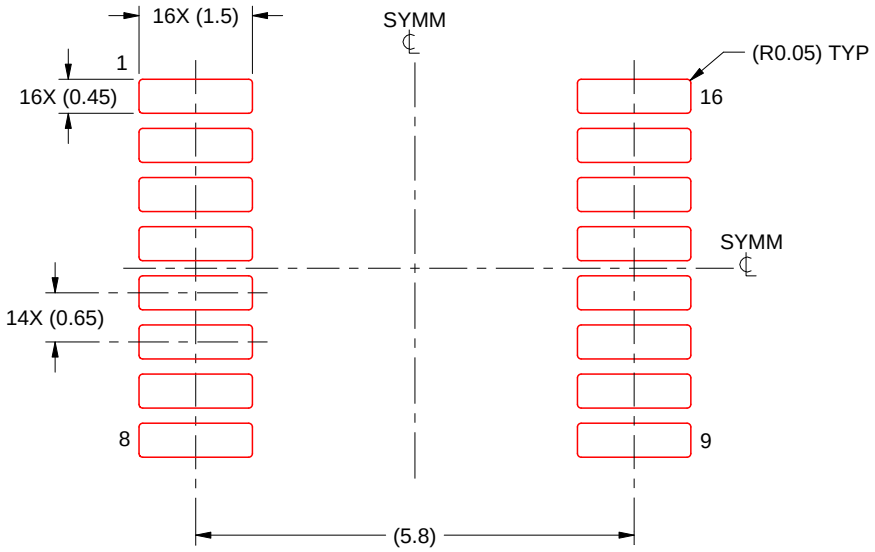



SOLDER MASK DETAILS

4220204/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/B 12/2023

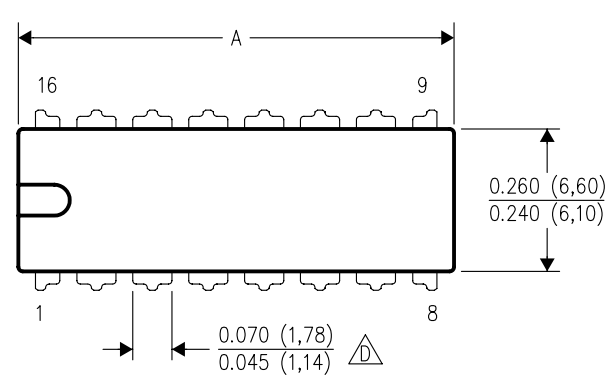
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

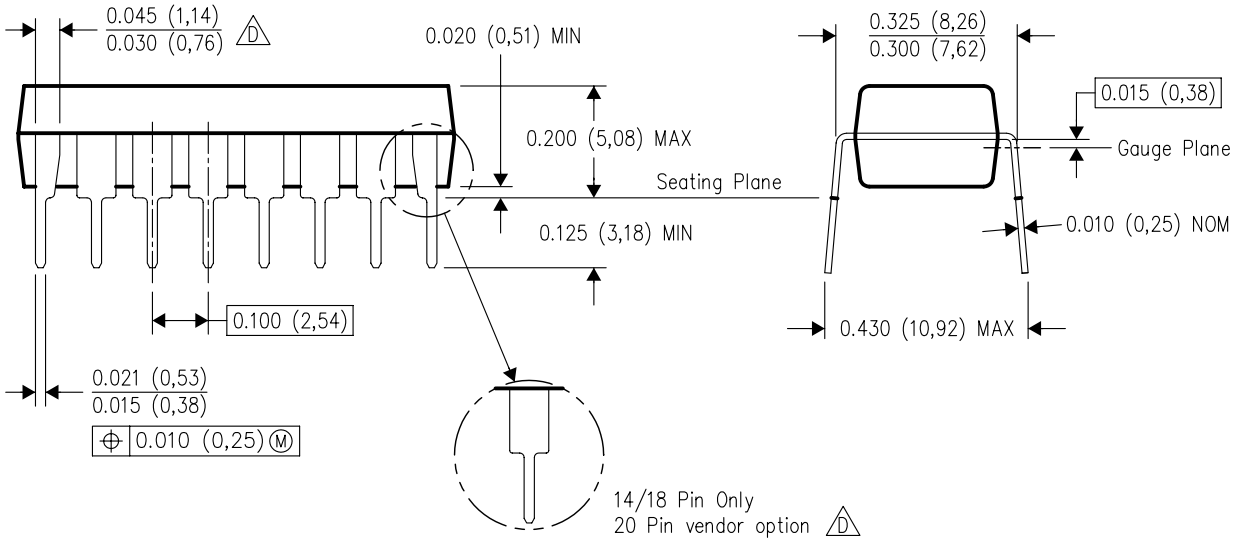
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS–001 VARIATION (C) | AA | BB | AC | AD |




4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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