

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:
 - ± 8 kV Contact discharge
 - ± 15 k-V Air-gap discharge
 - ± 15 kV 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: $4 \times 0.1\mu\text{F}$ or $4 \times 1\mu\text{F}$
- 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

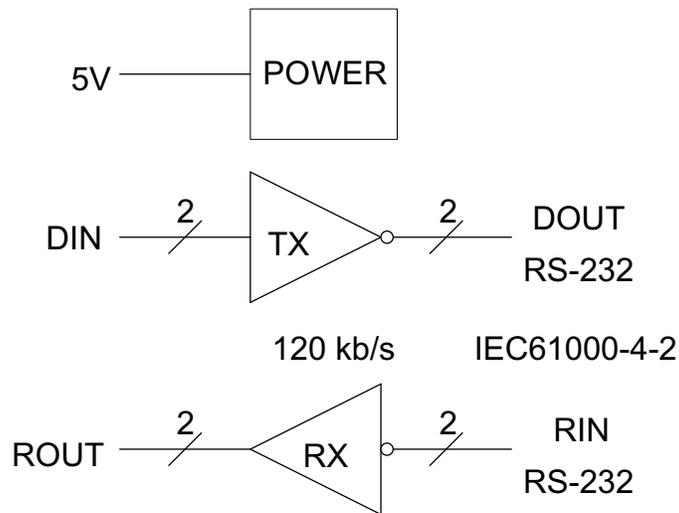
The TRS202E consists of two line drivers, two line receivers, and a dual charge-pump circuit. TRS202E has IEC61000-4-2 (Level 4) ESD protection pin-to-pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an 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 \times 6mm |
| | SOIC (DW) (16) | 10.4mm \times 10.3mm |
| | PDIP (N) (16) | 19.3mm \times 9.4mm |
| | TSSOP (PW) (16) | 5mm \times 6.4mm |

(1) For more information, see [Section 10](#).

(2) The package size (length \times width) is a nominal value and includes pins, where applicable.



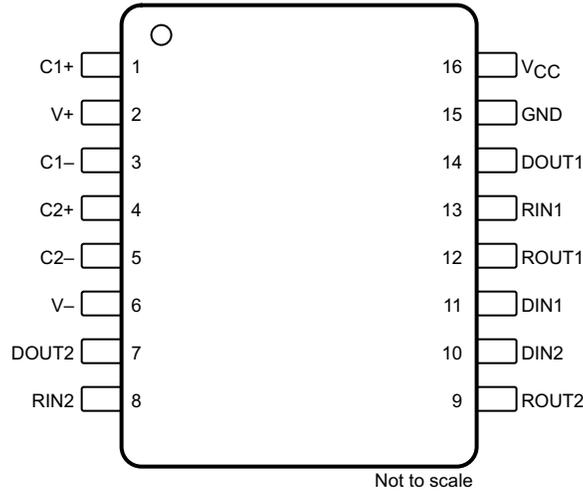
Logic Diagram (Positive Logic)



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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 |

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 | | 70 | °C |
| | | TRS202EI | -40 | 85 | |

- (1) Test conditions are $C1$ to $C4 = 0.1\mu F$ at $V_{CC} = 5V \pm 0.5V$.

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 _{θJA} | Junction-to-ambient thermal resistance | 84.6 | 77.1 | 44.1 | 107.5 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 43.5 | 39.9 | 30.8 | 38.4 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | 43.2 | 41.8 | 24.2 | 53.7 | °C/W |
| Ψ _{JT} | Junction-to-top characterization parameter | 10.4 | 12.9 | 15.2 | 3.2 | °C/W |
| Ψ _{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.

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 $R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ (see Figure 6-1) | 120 | | | kbit/s |
| $t_{PLH(D)}$ | Propagation delay time, low- to high-level output | $C_L = 2500\text{pF}$, all drivers loaded, and $R_L = 3\text{k}\Omega$ (see Figure 6-1) | | 2 | | μs |
| $t_{PHL(D)}$ | Propagation delay time, high- to low-level output | $C_L = 2500\text{pF}$, all drivers loaded, and $R_L = 3\text{k}\Omega$ (see Figure 6-1) | | 2 | | μs |
| $t_{sk(p)}$ | Pulse skew ⁽³⁾ | $C_L = 150$ to 2500pF and $R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ (see Figure 6-2) | | 300 | | ns |
| SR(tr) | Slew rate, transition region | $C_L = 50$ to 1000pF , $V_{CC} = 5\text{V}$, and $R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ (see Figure 6-1) | 3 | 6 | 30 | $\text{V}/\mu\text{s}$ |

- (1) Test conditions are C_1 to $C_4 = 0.1\mu\text{F}$ at $V_{CC} = 5\text{V} + 0.5\text{V}$.
- (2) All typical values are at $V_{CC} = 5\text{V}$ and $T_A = 25^\circ\text{C}$.
- (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 | $C_L = 150\text{pF}$ | | 0.5 | 10 | μs |
| $t_{PHL(R)}$ | Propagation delay time, high- to low-level output | $C_L = 150\text{pF}$ | | 0.5 | 10 | μs |
| $t_{sk(p)}$ | Pulse skew ⁽³⁾ | | | 300 | | ns |

- (1) Test conditions are C_1 to $C_4 = 0.1\mu\text{F}$ at $V_{CC} = 5\text{V} + 0.5\text{V}$.
- (2) All typical values are at $V_{CC} = 5\text{V}$ and $T_A = 25^\circ\text{C}$.
- (3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.

5.10 Typical Characteristics

$T_A = 25^\circ\text{C}$ (unless otherwise noted)

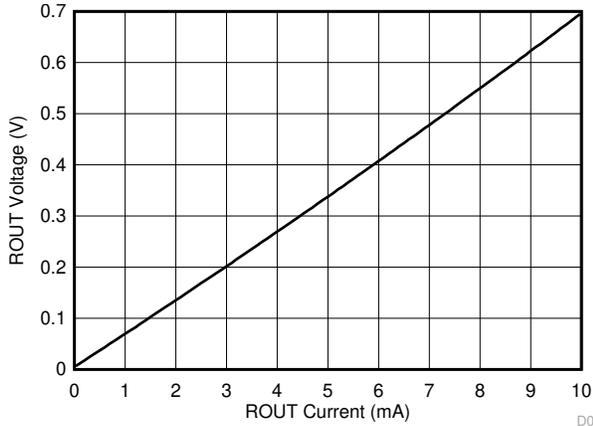


Figure 5-1. Receiver V_{OL} vs Output Current

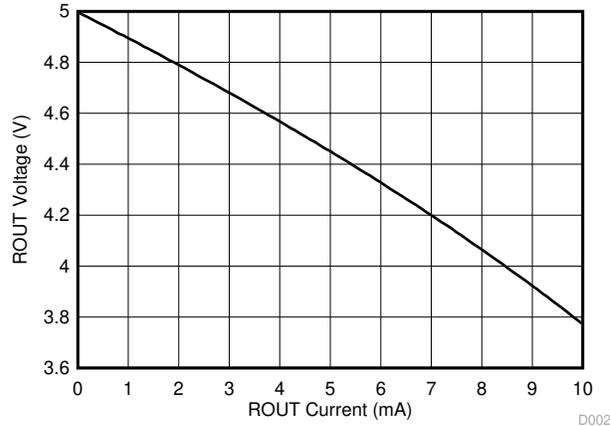


Figure 5-2. Receiver V_{OH} vs Output Current

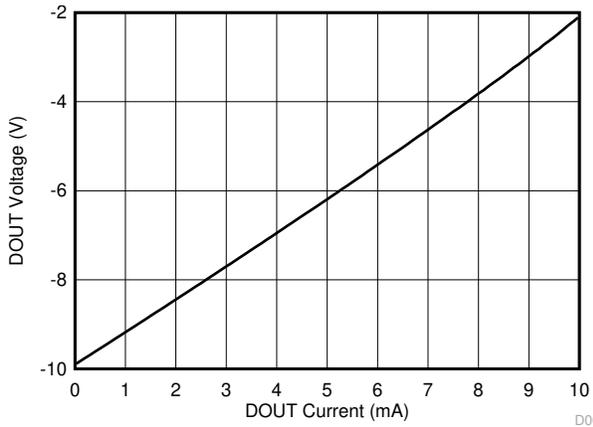


Figure 5-3. Driver V_{OL} vs Output Current

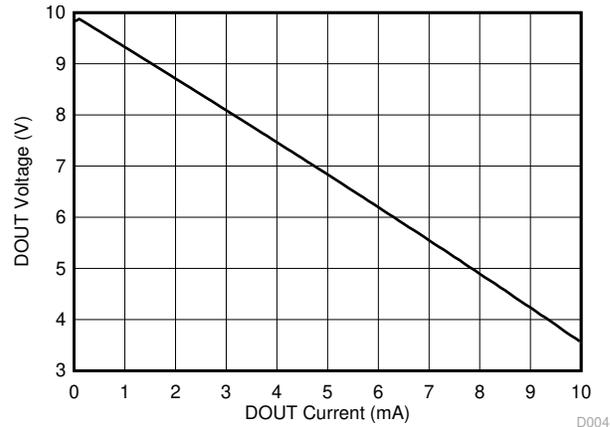


Figure 5-4. Driver V_{OH} vs Output Current

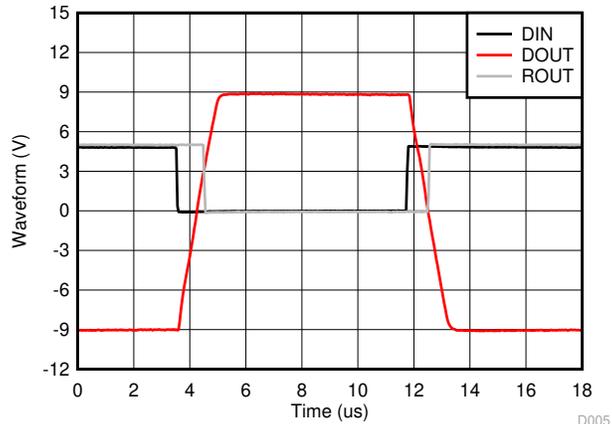
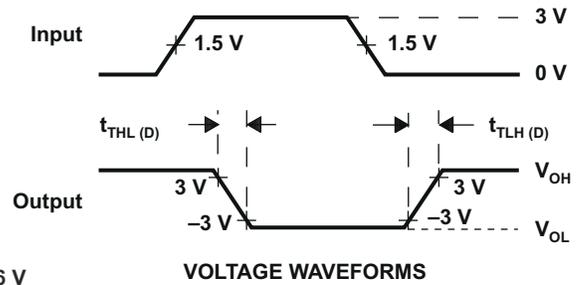
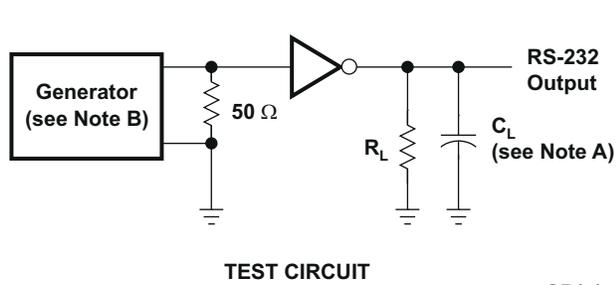


Figure 5-5. Driver and Receiver Loopback Waveforms

Parameter Measurement Information

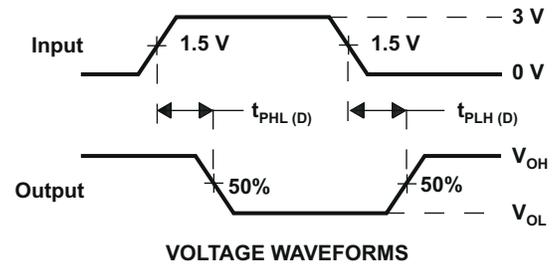
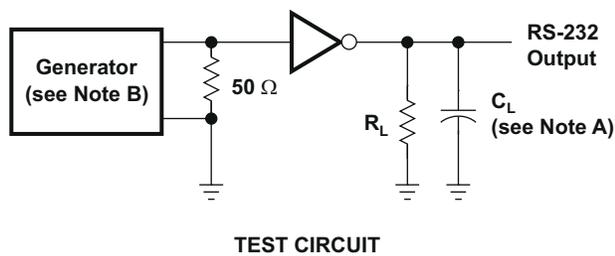


$$SR(t_f) = \frac{6\text{ V}}{t_{THL(D)} \text{ or } t_{TLH(D)}}$$

NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 120 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

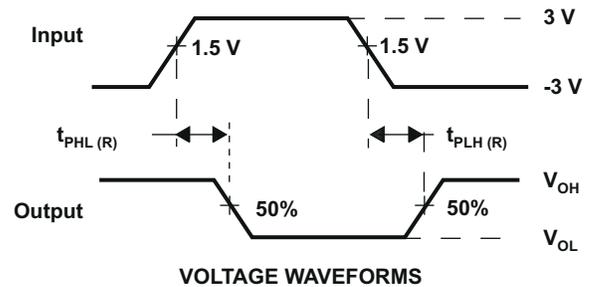
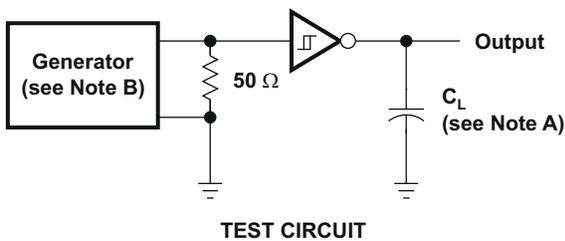
Figure 6-1. Driver Slew Rate



NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 120 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 6-2. Driver Pulse Skew



NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

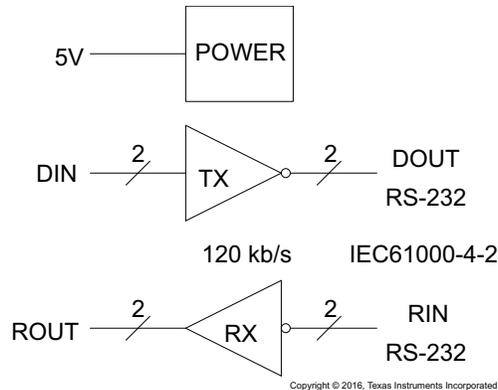
Figure 6-3. Receiver Propagation Delay Times

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 $\pm 30\text{V}$ inputs and decode inputs as low as $\pm 3\text{V}$. 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 0.1 μF or 1 μF 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-k Ω 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.

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

7 Application and Implementation

Note

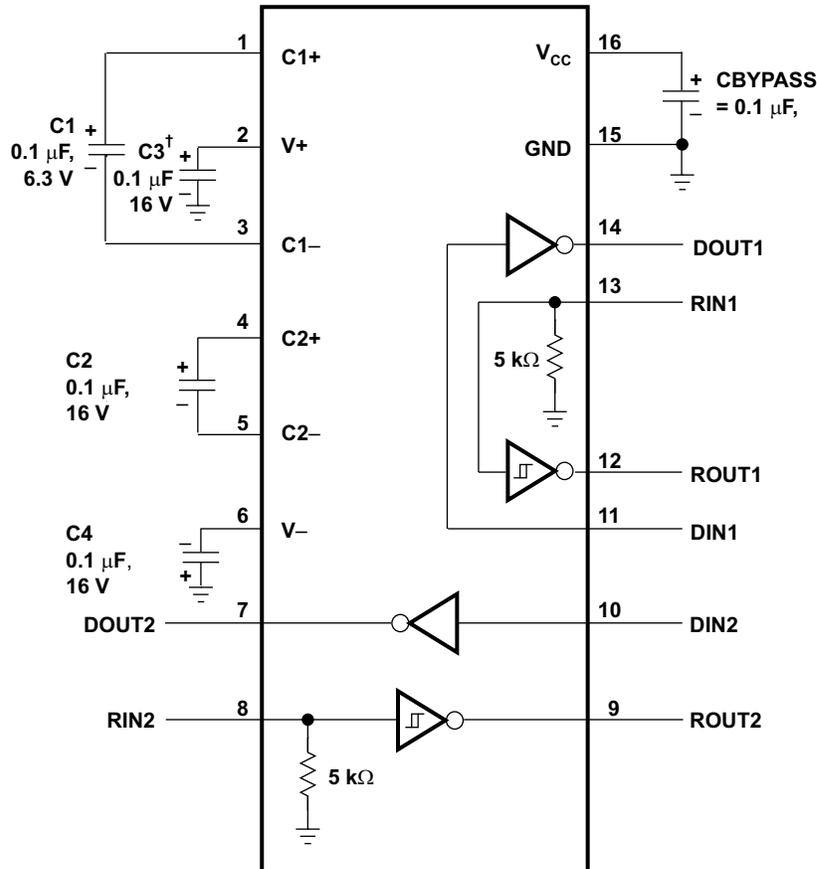
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation 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 TRRS202E requires 0.1 μ F capacitors. 1- μ F 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 \times) 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 0.1 μ F. 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

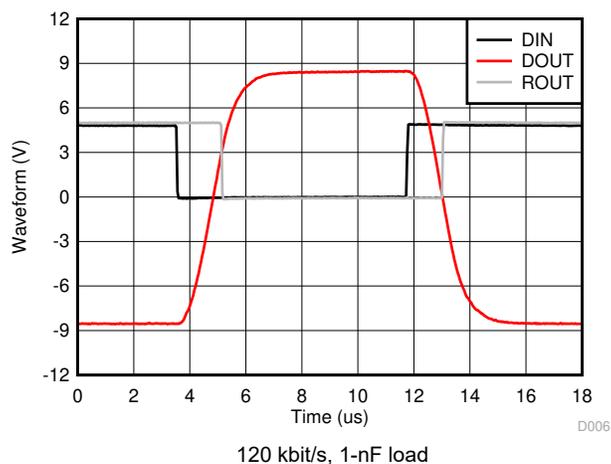


Figure 7-2. Driver and Receiver Loopback Signal

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.

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

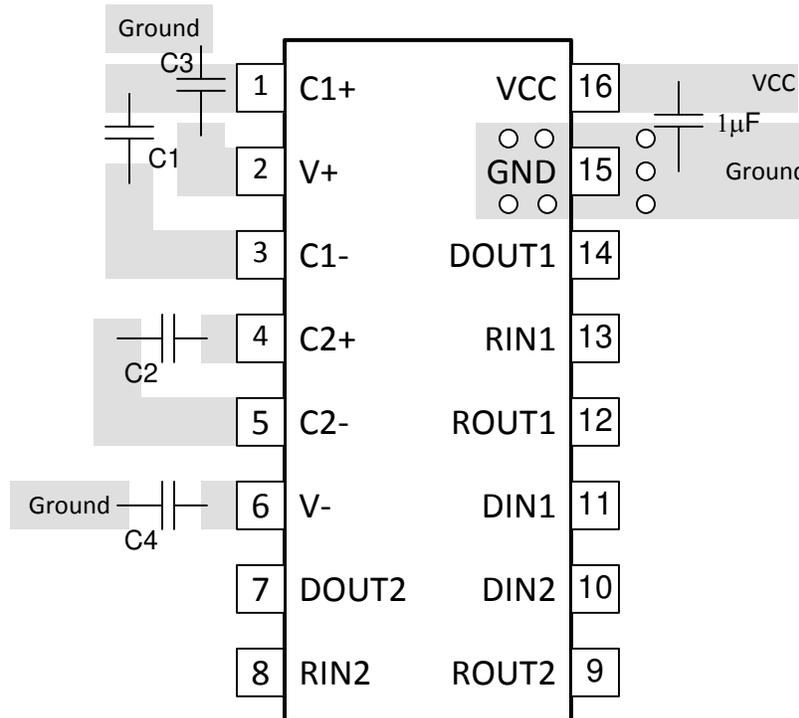


Figure 7-3. TRS202E Layout

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.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

8.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

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 \pm 5

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.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| TRS202ECD | OBSOLETE | SOIC | D | 16 | | TBD | Call TI | Call TI | 0 to 70 | TRS202EC | |
| TRS202ECDR | OBSOLETE | SOIC | D | 16 | | TBD | Call TI | Call TI | 0 to 70 | TRS202EC | |
| TRS202ECDWR | ACTIVE | SOIC | DW | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS202EC | Samples |
| TRS202ECN | ACTIVE | PDIP | N | 16 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | 0 to 70 | TRS202ECN | Samples |
| TRS202ECPWR | OBSOLETE | TSSOP | PW | 16 | | TBD | Call TI | Call TI | 0 to 70 | RU02EC | |
| TRS202EID | OBSOLETE | SOIC | D | 16 | | TBD | Call TI | Call TI | -40 to 85 | TRS202EI | |
| TRS202EIDR | ACTIVE | SOIC | D | 16 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI | Samples |
| TRS202EIDW | ACTIVE | SOIC | DW | 16 | 40 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI | Samples |
| TRS202EIDWR | ACTIVE | SOIC | DW | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS202EI | Samples |
| TRS202EIN | ACTIVE | PDIP | N | 16 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -40 to 85 | TRS202EIN | Samples |
| TRS202EIPWR | ACTIVE | TSSOP | PW | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RU02EI | Samples |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

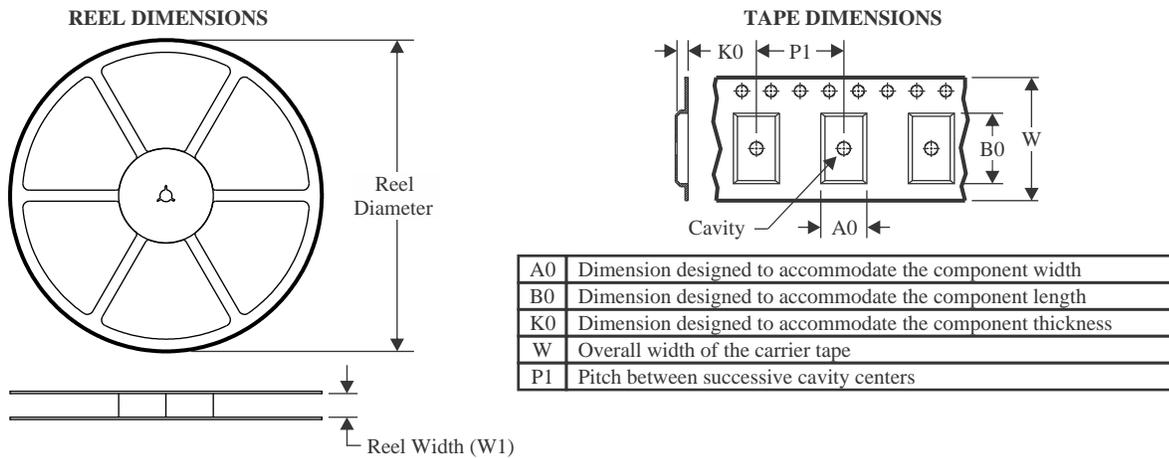
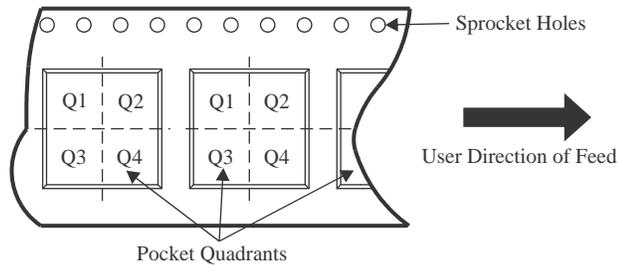
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ 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.

⁽⁶⁾ Lead finish/Ball material - Orderable Devices 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.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


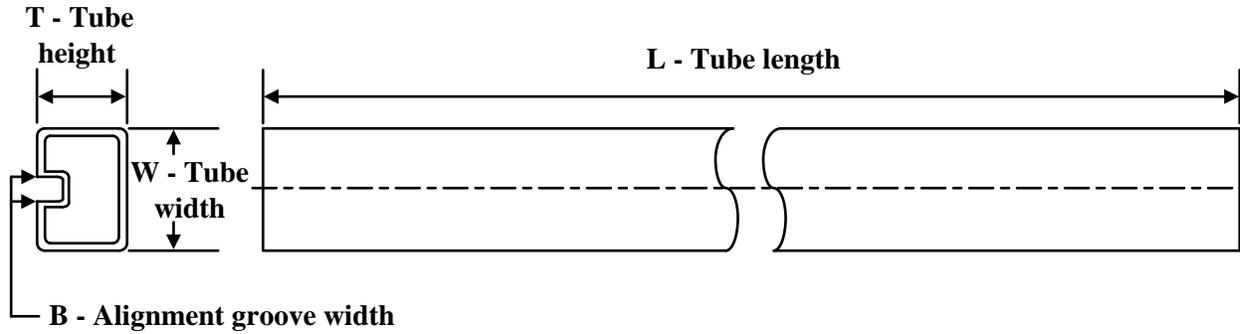
*All dimensions are nominal

| 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 |

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 |

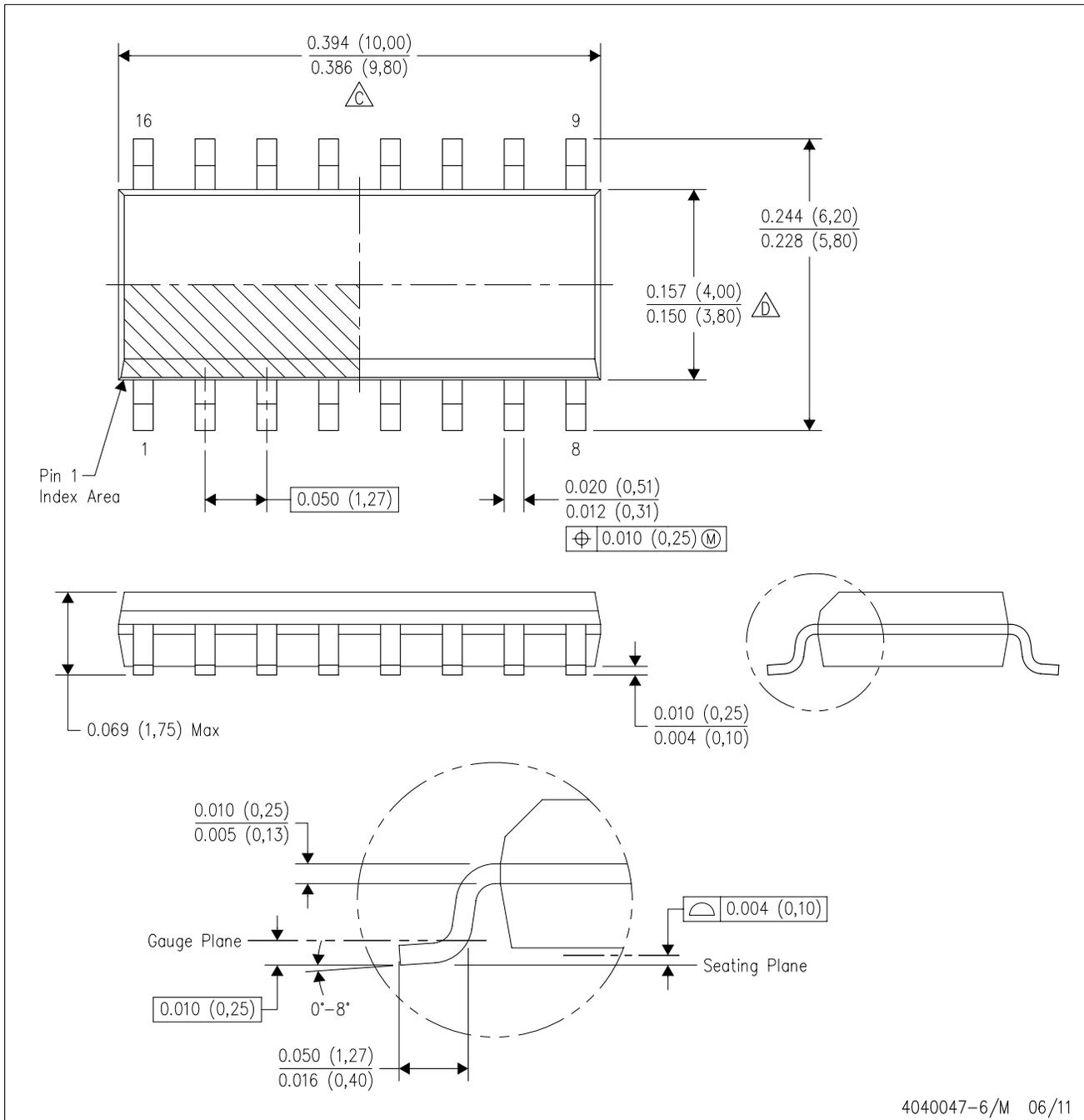
TUBE


*All dimensions are nominal

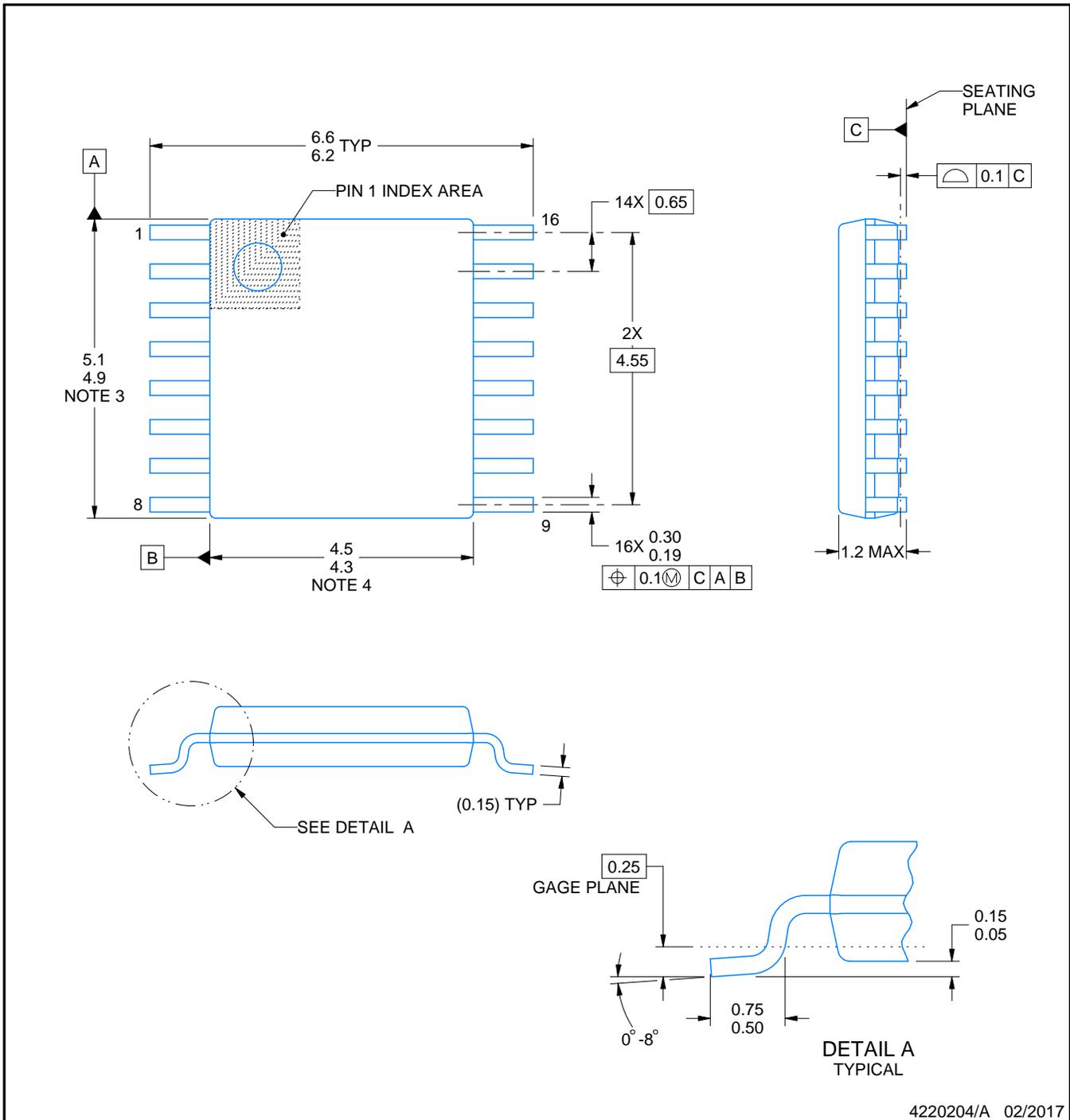
| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TRS202ECN | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| TRS202EIDW | DW | SOIC | 16 | 40 | 506.98 | 12.7 |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



4220204/A 02/2017

NOTES:

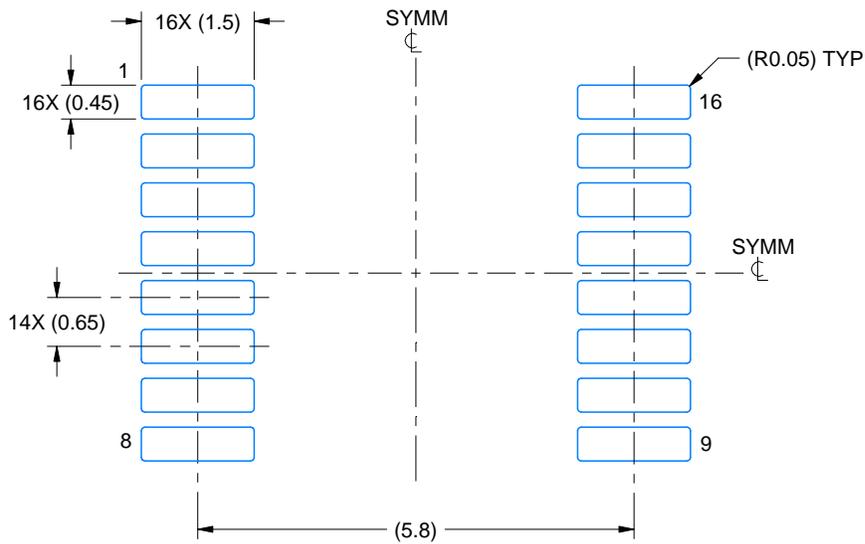
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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.

EXAMPLE BOARD LAYOUT

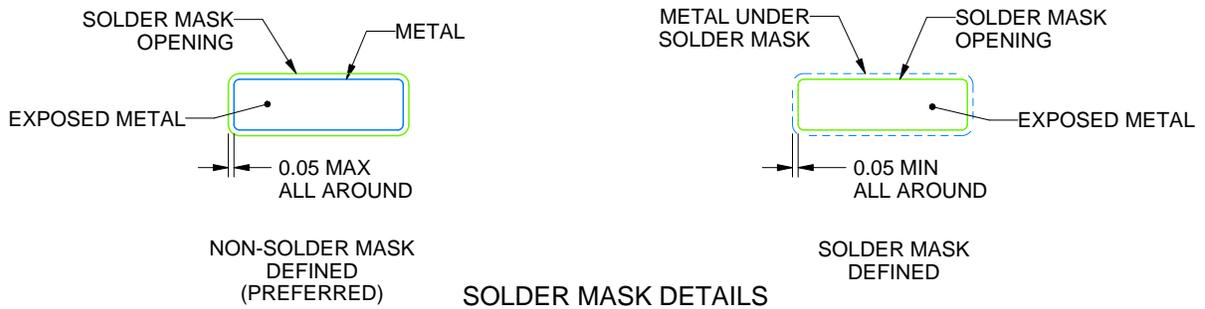
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

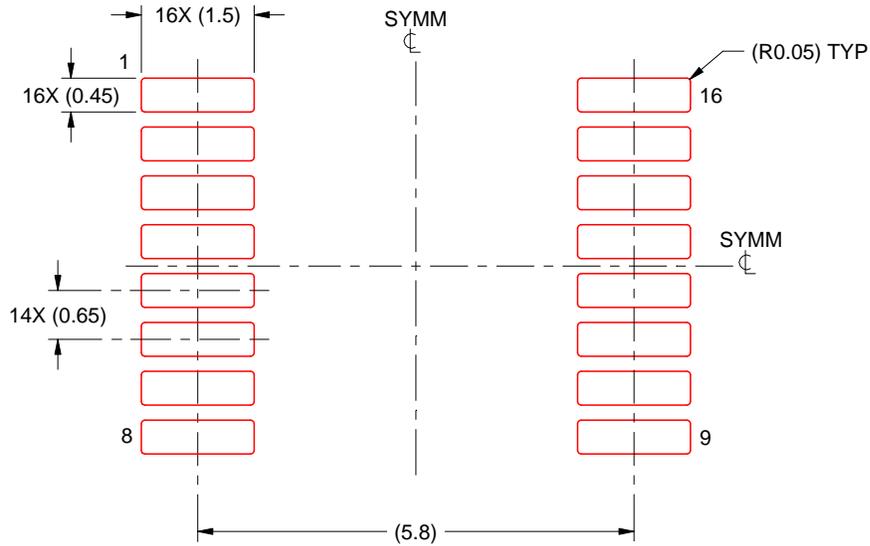
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/A 02/2017

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.

GENERIC PACKAGE VIEW

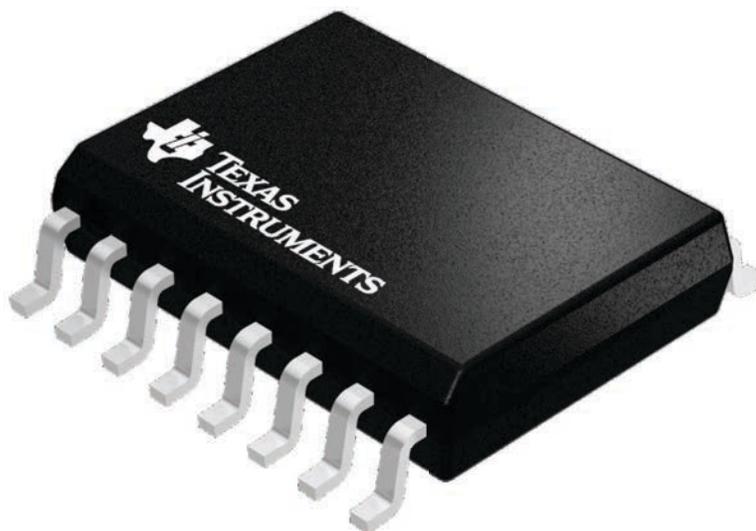
DW 16

SOIC - 2.65 mm max height

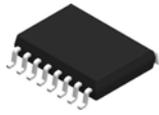
7.5 x 10.3, 1.27 mm pitch

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.



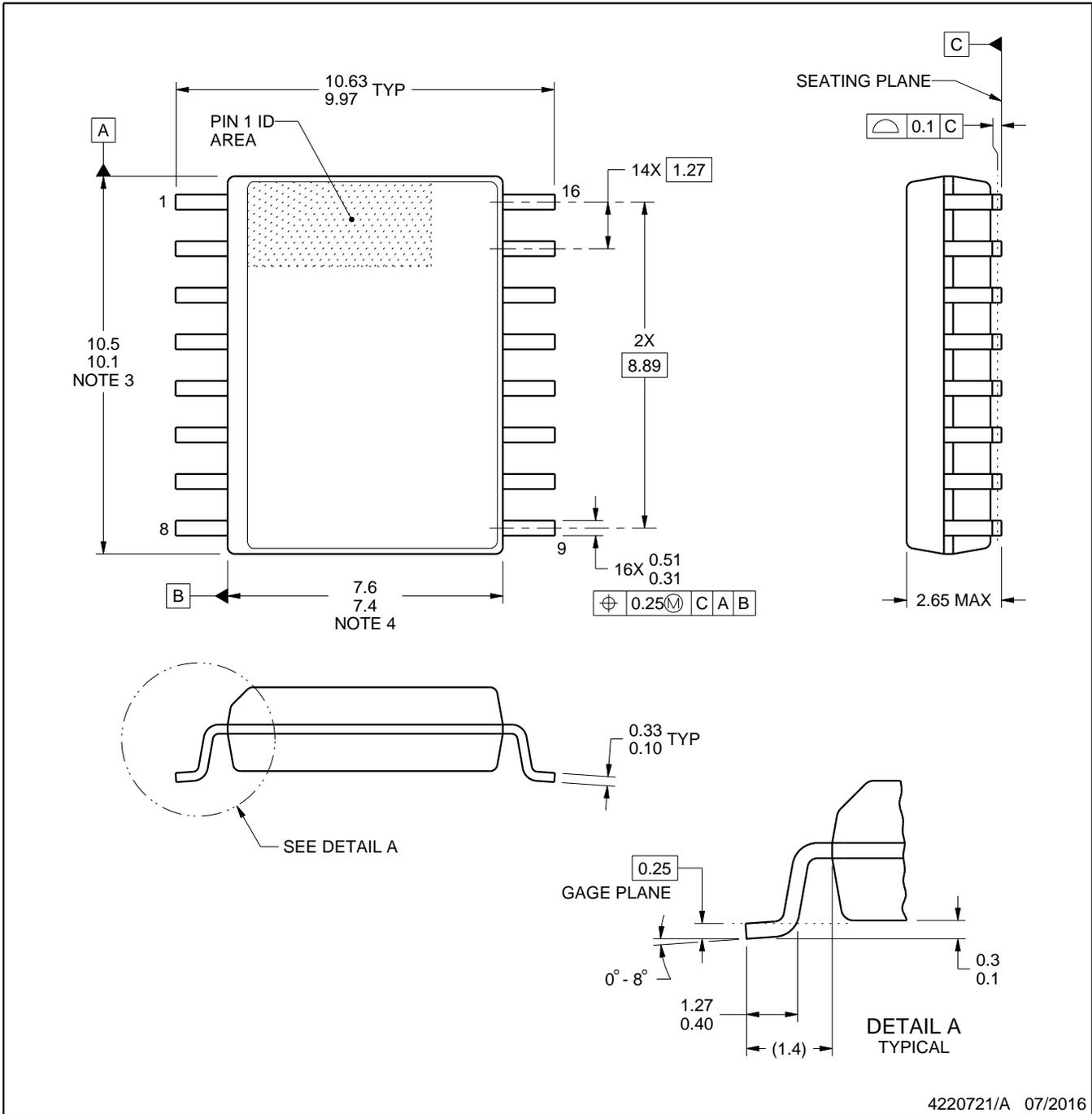
4224780/A



DW0016A

PACKAGE OUTLINE SOIC - 2.65 mm max height

SOIC



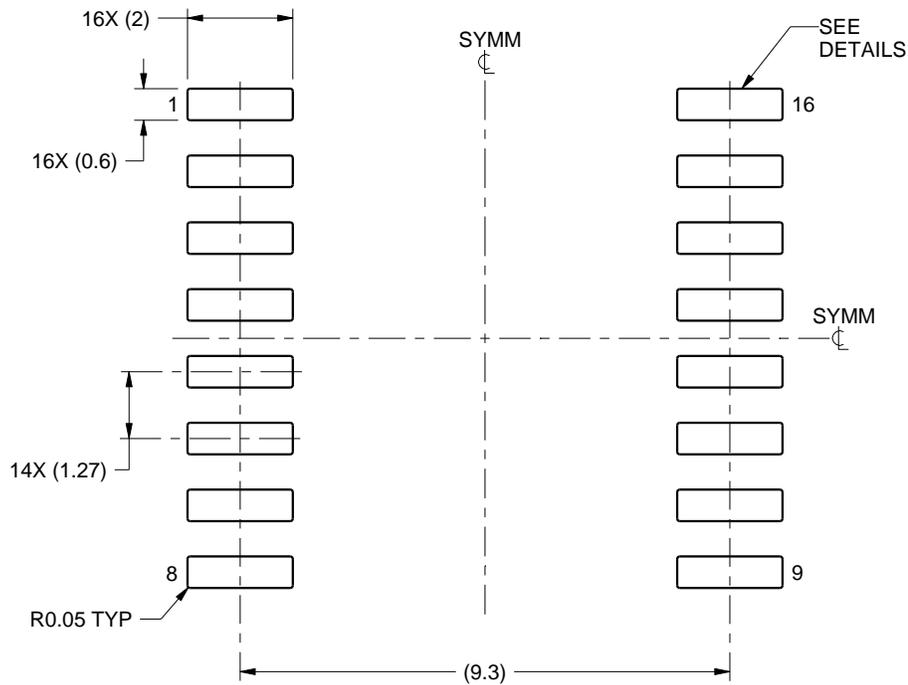
4220721/A 07/2016

EXAMPLE BOARD LAYOUT

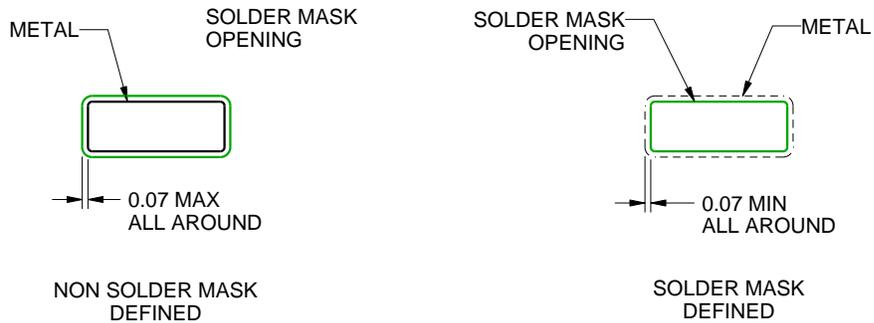
DW0016A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:7X



SOLDER MASK DETAILS

4220721/A 07/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

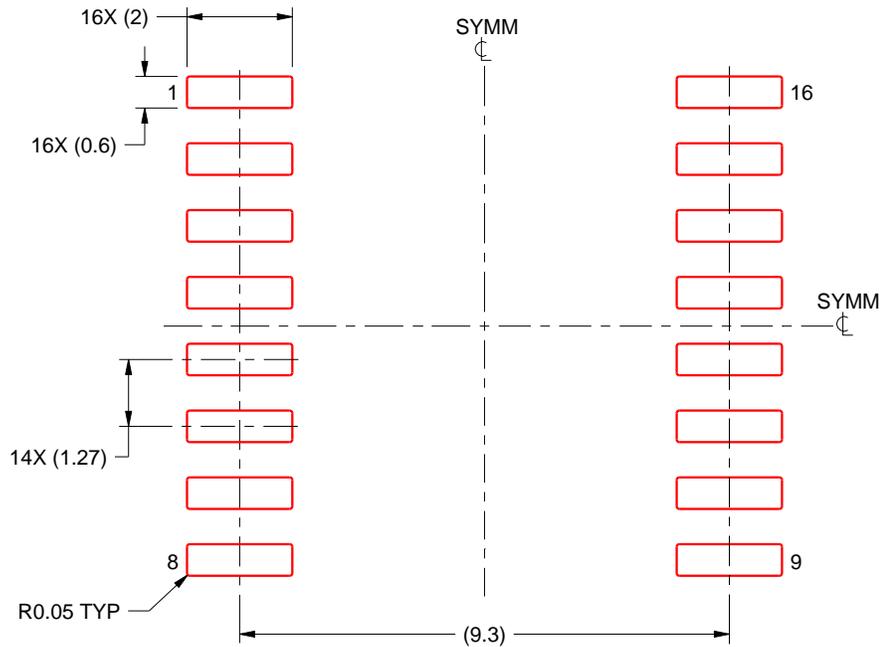
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0016A

SOIC - 2.65 mm max height

SOIC



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

4220721/A 07/2016

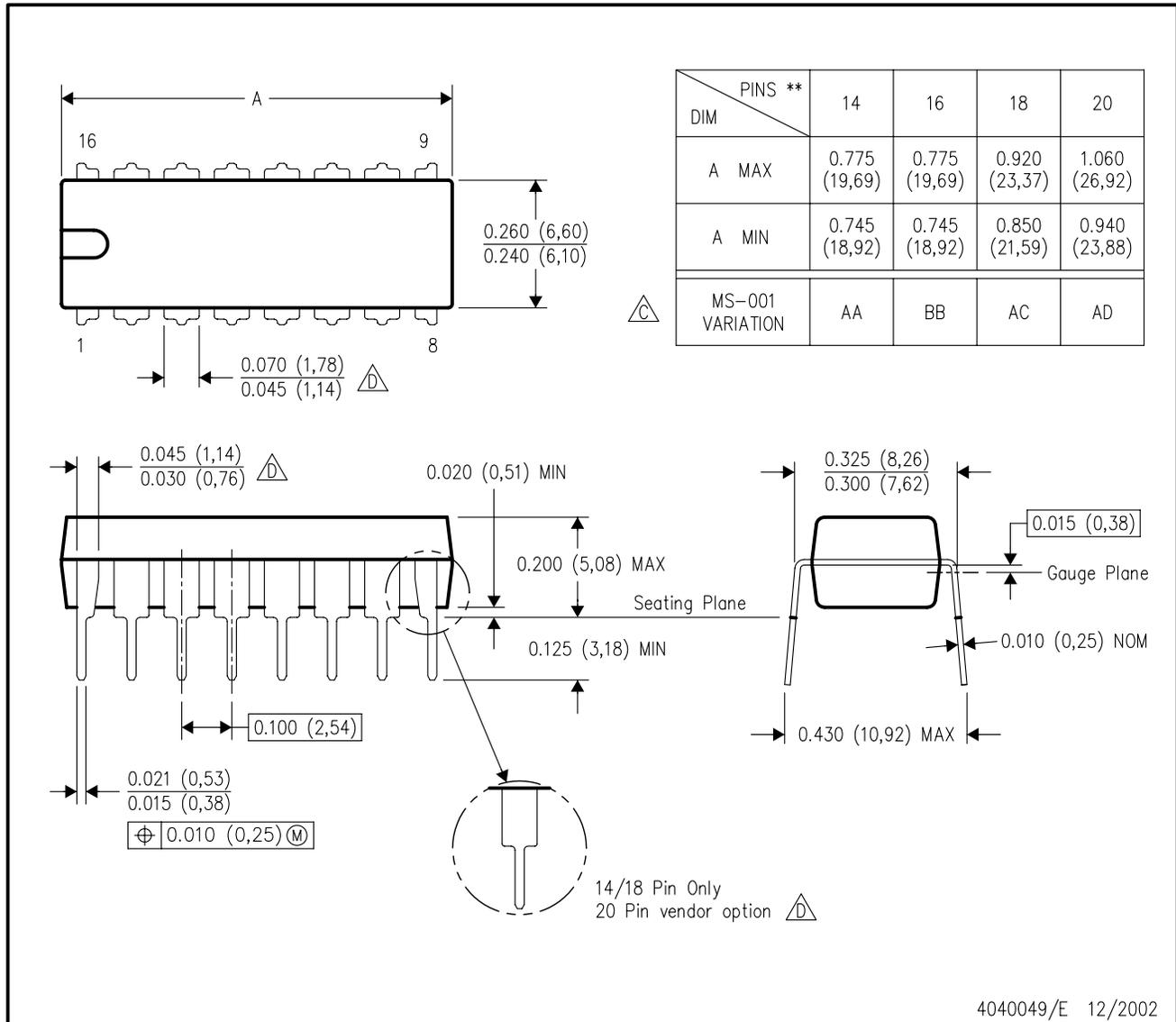
NOTES: (continued)

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.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



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

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