

TRS3243E 3-V to 5.5-V Multichannel RS-232 Line Driver or Receiver With ± 15 -kV IEC ESD Protection

1 Features

- Single-chip and single-supply interface for IBM™ PC/AT™ serial port
- ESD Protection for RS-232 bus pins
 - ± 15 -kV Human-body model (HBM)
 - ± 8 -kV IEC61000-4-2, Contact discharge
 - ± 15 -kV IEC61000-4-2, Air-gap discharge
- Meets or exceeds requirements of TIA/EIA-232-F and ITU v.28 standards
- Operates with 3-V to 5.5-V V_{CC} supply
- Always-active noninverting receiver output (ROUT2B)
- Designed to transmit at a data rate up to 500 kbit/s
- Low standby current: 1 μ A typical
- External capacitors: $4 \times 0.1 \mu$ F
- Accepts 5-V logic input with 3.3-V supply
- Designed to be interchangeable with industry standard '3243E devices
- Serial-mouse driveability
- Auto-powerdown feature to disable driver outputs when no valid RS-232 signal is sensed
- Package options include plastic small-outline (DW), shrink small-outline (DB), and thin shrink small-outline (PW)

2 Applications

- [Battery-powered systems](#)
- [Personal electronics](#)
- [Notebooks](#)
- [Laptops](#)
- [Palmtop PCs](#)
- [Hand-held equipment](#)

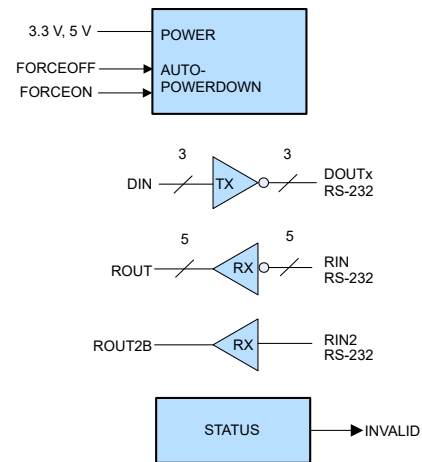
3 Description

The TRS3243E device consists of three line drivers, five line receivers, and a dual charge-pump circuit with ± 15 -kV ESD (HBM and IEC61000-4-2, Air-Gap Discharge) and ± 8 -kV ESD (IEC61000-4-2, Contact Discharge) protection on serial-port connection pins. 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. This combination of drivers and receivers matches that needed for the typical serial port used in an IBM PC/AT, or compatible. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. In addition, the device includes an always-active noninverting output (ROUT2B), which allows applications using the ring indicator to transmit data while the device is powered down. The device operates at data signaling rates up to 250 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

Package Information

| PART NUMBER | PACKAGE ⁽¹⁾ | BODY SIZE (NOM) |
|-------------|------------------------|---------------------------|
| TRS3243E | SSOP (DB) | 10.20 mm \times 5.30 mm |
| | SOIC (DW) | 17.90 mm \times 7.50mm |
| | TSSOP (PW) | 9.70 mm \times 4.40 mm |
| | VQFN (RHB) | 5.00 mm \times 5.00 mm |

- (1) For all available packages, see the orderable addendum at the end of the data sheet.



Simplified Circuit



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4 Revision History

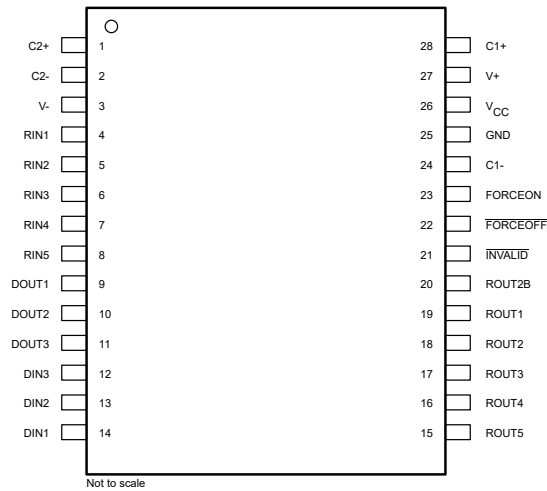
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision D (October 2022) to Revision E (December 2022) | Page |
|--|-------------|
| • Changed Table 9-1 to match revision C of the data sheet. V_{CC} column: 3 V \pm 5.5 V to: 3 V to 5.5 V and C1 column value: 0.47 μ F to: 0.047 μ F | 15 |

| Changes from Revision C (September 2011) to Revision D (October 2022) | Page |
|---|-------------|
| • Deleted the <i>Ordering Information</i> table..... | 1 |
| • Added <i>Device Information</i> table, <i>Pin Configuration and Functions</i> section, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section. | 1 |
| • Changed the front page image from Block Diagram to Simplified Circuit..... | 1 |
| • Added the <i>ESD Ratings - IEC Specifications</i> table..... | 6 |
| • Changed the I_{CC} Supply current auto-powerdown disabled MAX value from 1 mA to 1.2 mA in the <i>Electrical Characteristics</i> | 8 |

| Changes from Revision B (July 2009) to Revision C (September 2011) | Page |
|--|-------------|
| • Deleted "VALID RIN RS-232 LEVEL" from INPUTS..... | 14 |
| • Deleted "ROUT2B is active" RECEIVER STATUS and combined ROUT outputs..... | 14 |
| • Added table "ROUT2B and INVALID Outputs" defining truth for ROUT2B and INVALID outputs. | 14 |

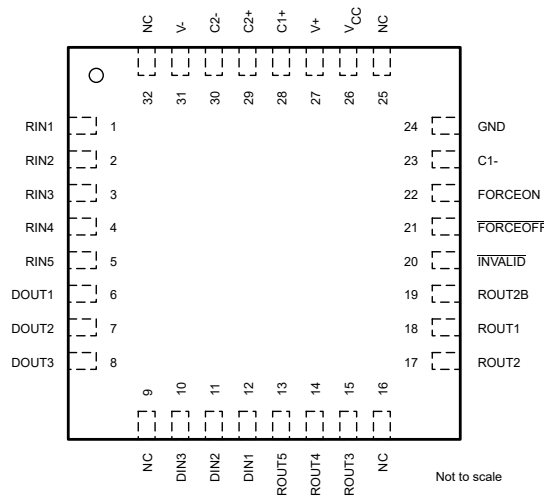
5 Pin Configuration and Functions



**Figure 5-1. DB, DW, or PW Package, 28 Pin (SSOP, SOIC, TSSOP)
(Top View)**

Table 5-1. Pin Functions

| PIN | | TYPE | DESCRIPTION |
|-----|-----------------|------|--|
| NO. | NAME | | |
| 1 | C2+ | — | Positive terminal of the voltage-doubler charge-pump capacitor |
| 2 | C2- | — | Negative terminal of the voltage-doubler charge-pump capacitor |
| 3 | V- | | Negative charge pump output voltage |
| 4 | RIN1 | I | RS-232 receiver inputs |
| 5 | RIN2 | | |
| 6 | RIN3 | | |
| 7 | RIN4 | | |
| 8 | RIN5 | | |
| 9 | DOUT1 | O | RS-232 driver outputs |
| 10 | DOUT2 | | |
| 11 | DOUT3 | | |
| 12 | DIN3 | I | Driver inputs |
| 13 | DIN2 | | |
| 14 | DIN1 | | |
| 15 | ROUT5 | O | Receiver outputs |
| 16 | ROUT4 | | |
| 17 | ROUT3 | | |
| 18 | ROUT2 | | |
| 19 | ROUT1 | | |
| 20 | ROUT2B | — | Always-active noninverting receiver output; |
| 21 | INVALID | O | Invalid Output Pin |
| 22 | FORCEOFF | I | Auto Powerdown Control input (Refer to Truth Table) |
| 23 | FORCEON | I | Auto Powerdown Control input (Refer to Truth Table) |
| 24 | C1- | — | Negative terminal of the voltage-doubler charge-pump capacitor |
| 25 | GND | — | Ground |
| 26 | V _{CC} | — | 3-V to 5.5-V supply voltage |
| 27 | V+ | — | Positive charge pump output voltage |
| 28 | C1+ | — | Positive terminal of the voltage-doubler charge-pump capacitor |



**Figure 5-2. RHB Package, 32 Pin (VQFN)
(Top View)**

Table 5-2. Pin Functions

| PIN | | TYPE | DESCRIPTION |
|-----|-----------------|------|--|
| NO. | NAME | | |
| 1 | RIN1 | I | RS-232 receiver inputs |
| 2 | RIN2 | | |
| 3 | RIN3 | | |
| 4 | RIN4 | | |
| 5 | RIN5 | | |
| 6 | DOUT1 | O | RS-232 driver outputs |
| 7 | DOUT2 | | |
| 8 | DOUT3 | | |
| 9 | NC | — | Not connected internally |
| 10 | DIN3 | I | Driver inputs |
| 11 | DIN2 | | |
| 12 | DIN1 | | |
| 13 | ROUT5 | O | Receiver outputs |
| 14 | ROUT4 | | |
| 15 | ROUT3 | | |
| 16 | NC | — | Not connected internally |
| 17 | ROUT2 | O | Receiver outputs |
| 18 | ROUT1 | | |
| 19 | ROUT2B | O | Always-active noninverting receiver output |
| 20 | INVALID | O | Invalid Output Pin |
| 21 | FORCEOFF | I | Auto Powerdown Control input (Refer to Truth Table) |
| 22 | FORCEON | I | Auto Powerdown Control input (Refer to Truth Table) |
| 23 | C1- | — | Negative terminal of the voltage-doubler charge-pump capacitor |
| 24 | GND | — | Ground |
| 25 | NC | — | Not connected internally |
| 26 | V _{CC} | — | 3-V to 5.5-V supply voltage |
| 27 | V+ | — | Positive charge pump output voltage |

Table 5-2. Pin Functions (continued)

| PIN | | TYPE | DESCRIPTION |
|-----|------|------|--|
| NO. | NAME | | |
| 28 | C1+ | — | Positive terminal of the voltage-doubler charge-pump capacitor |
| 29 | C2+ | — | Positive terminal of the voltage-doubler charge-pump capacitor |
| 30 | C2- | — | Negative terminal of the voltage-doubler charge-pump capacitor |
| 31 | V- | — | Negative charge pump output voltage |
| 32 | NC | — | Not connected internally |

6 Specifications

6.1 Absolute Maximum Ratings

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

| | | MIN | MAX | UNIT |
|------------------|---|-----------------------------|-----|------|
| V _{CC} | Supply voltage ⁽²⁾ | -0.3 | 6 | V |
| V+ | Positive output supply voltage ⁽²⁾ | -0.3 | 7 | V |
| V- | Negative output supply voltage ⁽²⁾ | 0.3 | -7 | V |
| V+ - V- | Output supply voltage difference ⁽²⁾ | | 13 | V |
| V _I | Input voltage | Driver (FORCEOFF, FORCEON) | | V |
| | | | | |
| V _O | Output voltage | Driver | | V |
| | | | | |
| T _{stg} | Storage temperature | -65 | 150 | °C |

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) All voltages are with respect to network GND.

6.2 ESD Ratings

| | | | VALUE | UNIT |
|-------------------------|-------------------------|---|---------|------|
| Driver Section | | | | |
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ Driver output pins | ±15,000 | V |
| Receiver Section | | | | |
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ Receiver input pins | ±15,000 | V |

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

6.3 ESD Ratings - IEC Specifications

| | | | VALUE | UNIT |
|-------------------------|-------------------------|--|-------|------|
| Driver Section | | | | |
| V _(ESD) | Electrostatic discharge | IEC61000-4-2, Air-Gap Discharge ⁽¹⁾ | ±15 | kV |
| | | IEC61000-4-2, Contact Discharge ⁽¹⁾ | | |
| Receiver Section | | | | |
| V _(ESD) | Electrostatic discharge | IEC61000-4-2, Air-Gap Discharge ⁽¹⁾ | ±15 | kV |
| | | IEC61000-4-2, Contact Discharge ⁽¹⁾ | | |

- (1) For the DB, PW and RHB package only: A minimum of 1-μF capacitor between V_{CC} and GND is required to meet the specified IEC 61000-4-2 rating

6.4 Recommended Operating Conditions

See [Figure 9-1](#) (1)

| | | | MIN | NOM | MAX | UNI T |
|----------------|---|-------------------------|-------------------------|-----|-----|----------|
| Supply voltage | | $V_{CC} = 3.3\text{ V}$ | 3 | 3.3 | 3.6 | V |
| | | $V_{CC} = 5\text{ V}$ | 4.5 | 5 | 5.5 | |
| V_{IH} | Driver and control high-level input voltage | DIN, FORCEOFF, FORCEON | $V_{CC} = 3.3\text{ V}$ | 2 | | V |
| | | | $V_{CC} = 5\text{ V}$ | 2.4 | | |
| V_{IL} | Driver and control low-level input voltage | DIN, FORCEOFF, FORCEON | | | 0.8 | V |
| V_I | Driver and control input voltage | DIN, FORCEOFF, FORCEON | 0 | | 5.5 | V |
| V_I | Receiver input voltage | | -25 | | 25 | V |
| T_A | Operating free-air temperature | TRS3243EC | 0 | | 70 | °C |
| | | TRS3243EI | -40 | | 85 | |

(1) Test conditions are C1–C4 = 0.1 μF at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; C1 = 0.047 μF , C2–C4 = 0.33 μF at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.

6.5 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | VQFN (RHB) | TSSOP (PW) | SOIC (DW) | DB (SSOP) | UNIT |
|-------------------------------|--|------------|------------|-----------|-----------|------|
| | | 32 PINS | 28 PINS | 28 PINS | 28 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 34.1 | 70.3 | 59.0 | 76.1 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 25.9 | 21.0 | 28.8 | 35.8 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 14.6 | 29.2 | 30.3 | 37.4 | °C/W |
| ψ_{JT} | Junction-to-top characterization parameter | 0.5 | 1.3 | 7.8 | 7.4 | °C/W |
| ψ_{JB} | Junction-to-board characterization parameter | 14.6 | 28.8 | 30.0 | 37.0 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | 5.1 | N/A | N/A | N/A | °C/W |

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

6.6 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 9-1)⁽²⁾

| PARAMETER | | TEST CONDITIONS | | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|-------------------------------|--|---|--|------------------------------|-----------------------|-----|------|
| I _I | Input leakage current | FORCEOFF, FORCEON | | | ±0.01 | ±1 | µA |
| I _{CC} | Supply current (T _A = 25°C) | Auto-powerdown disabled | No load, FORCEOFF and FORCEON at V _{CC} For DB, PW and RHB package | | 0.3 | 1.2 | mA |
| | | Auto-powerdown disabled | No load, FORCEOFF and FORCEON at V _{CC} For DW package | | 0.3 | 1 | mA |
| | | Powered off | No load, FORCEOFF at GND | | 1 | 10 | µA |
| | | Auto-powerdown enabled | No load, FORCEOFF at V _{CC} , FORCEON at GND, All RIN are open or grounded, All DIN are grounded | | 1 | 10 | |
| DRIVER SECTION | | | | | | | |
| V _{OH} | High-level output voltage | All DOUT at R _L = 3 kΩ to GND | | 5 | 5.4 | | V |
| V _{OL} | Low-level output voltage | All DOUT at R _L = 3 kΩ to GND | | -5 | -5.4 | | V |
| V _O | Output voltage (mouse driveability) | DIN1 = DIN2 = GND, DIN3 = V _{CC} , 3-kΩ to GND at DOUT3, DOUT1 = DOUT2 = 2.5 mA | | ±5 | | | V |
| I _{IH} | High-level input current | V _I = V _{CC} | | | ±0.01 | ±1 | µA |
| I _{IL} | Low-level input current | V _I at GND | | | ±0.01 | ±1 | µA |
| V _{hys} | Input hysteresis | | | | | ±1 | V |
| I _{OS} | Short-circuit output current ⁽³⁾ | V _{CC} = 3.6 V, | V _O = 0 V | | | ±60 | mA |
| | | V _{CC} = 5.5 V, | V _O = 0 V | | | | |
| r _O | Output resistance | V _{CC} , V+, and V- = 0 V, V _O = ±2 V | | 300 | 10M | | Ω |
| I _{off} | Output leakage current | FORCEOFF = GND, | V _O = ±12 V, | V _{CC} = 0 to 5.5 V | | ±25 | µA |
| RECEIVER SECTION | | | | | | | |
| V _{OH} | High-level output voltage | I _{OH} = -1 mA | | V _{CC} - 0.6 | V _{CC} - 0.1 | | V |
| V _{OL} | Low-level output voltage | I _{OH} = 1.6 mA | | | | 0.4 | V |
| V _{IT+} | Positive-going input threshold voltage | V _{CC} = 3.3 V | | | 1.6 | 2.4 | V |
| | | V _{CC} = 5 V | | | 1.9 | 2.4 | |
| V _{IT-} | Negative-going input threshold voltage | V _{CC} = 3.3 V | | 0.6 | 1.1 | | V |
| | | V _{CC} = 5 V | | 0.8 | 1.4 | | |
| V _{hys} | Input hysteresis (V _{IT+} - V _{IT-}) | | | | 0.5 | | V |
| I _{off} | Output leakage current (except ROUT2B) | FORCEOFF = 0 V | | | ±0.05 | ±10 | µA |
| r _i | Input resistance | V _I = ±3 V or ±25 V | | 3 | 5 | 7 | kΩ |
| AUTO-POWERDOWN SECTION | | | | | | | |
| V _{IT+(valid)} | Receiver input threshold for INVALID high-level output voltage | FORCEON = GND, FORCEOFF = V _{CC} | | | | 2.7 | V |
| V _{IT-(valid)} | Receiver input threshold for INVALID high-level output voltage | FORCEON = GND, FORCEOFF = V _{CC} | | -2.7 | | | V |
| V _{T(invalid)} | Receiver input threshold for INVALID low-level output voltage | FORCEON = GND, FORCEOFF = V _{CC} | | -0.3 | | 0.3 | V |
| V _{OH} | INVALID high-level output voltage | I _{OH} = -1 mA, FORCEON = GND, FORCEOFF = V _{CC} | | V _{CC} - 0.6 | | | V |
| V _{OL} | INVALID low-level output voltage | I _{OL} = 1.6 mA, FORCEON = GND, FORCEOFF = V _{CC} | | | | 0.4 | V |

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

(2) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

(3) Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.

6.7 Switching Characteristics

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 9-1](#)) ⁽²⁾

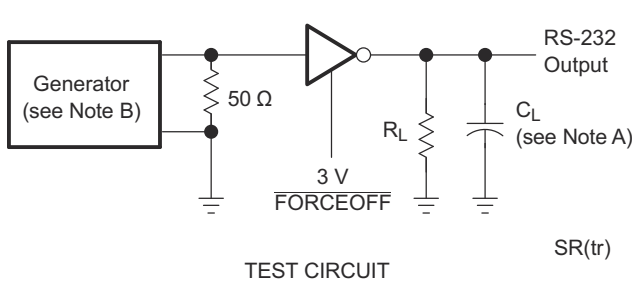
| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT | |
|-------------------------------|--|--|---|--------------------|-----|---------------|------------------|
| DRIVER SECTION | | | | | | | |
| | Maximum data rate | $C_L = 1000\text{ pF}$, One DOUT switching, $R_L = 3\text{ k}\Omega$ See Figure 1 | 250 | 500 | | kbit/s | |
| $t_{sk(p)}$ | Pulse skew ⁽³⁾ | $C_L = 150\text{ pF}$ to 2500 pF , $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, See Figure 2 | | 100 | | ns | |
| $SR^{(tr)}$ | Slew rate, transition region (see Figure 1) | $V_{CC} = 3.3\text{ V}$, $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, PRR = 250 kbit/s | $C_L = 150\text{ pF}$ to 1000 pF | | 6 | 30 | V/ μs |
| | | | $C_L = 150\text{ pF}$ to 2500 pF | | 4 | 30 | |
| RECEIVER SECTION | | | | | | | |
| t_{PLH} | Propagation delay time, low-to high-level output | $C_L = 150\text{ pF}$, See Figure 7-2 | | 150 | | ns | |
| t_{PHL} | Propagation delay time, high-to low-level output | | | 150 | | ns | |
| t_{en} | Output enable time | $C_L = 150\text{ pF}$, $R_L = 3\text{ k}\Omega$, See Figure 7-3 | | 200 | | ns | |
| t_{dis} | Output disable time | | | 200 | | ns | |
| $t_{sk(p)}$ | Pulse skew ⁽³⁾ | See Figure 7-2 | | 50 | | ns | |
| AUTO-POWERDOWN SECTION | | | | | | | |
| t_{valid} | Propagation delay time, low-to high-level output | $V_{CC} = 5\text{ V}$ | | 1 | | μs | |
| $t_{invalid}$ | Propagation delay time, high-to low-level output | $V_{CC} = 5\text{ V}$ | | 30 | | μs | |
| t_{en} | Supply enable time | $V_{CC} = 5\text{ V}$ | | 100 | | μs | |

(1) All typical values are at $V_{CC} = 3.3\text{ V}$ or $V_{CC} = 5\text{ V}$, and $T_A = 25^\circ\text{C}$.

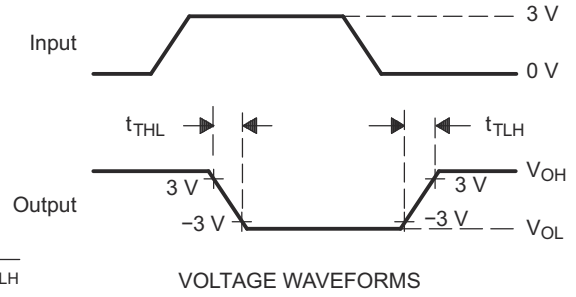
(2) Test conditions are C1–C4 = $0.1\text{ }\mu\text{F}$ at $V_{CC} = 3.3\text{ V} + 0.3\text{ V}$; C1 = $0.047\text{ }\mu\text{F}$, C2–C4 = $0.33\text{ }\mu\text{F}$ at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.

(3) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.

7 Parameter Measurement Information



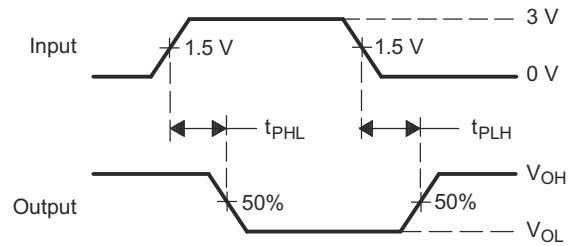
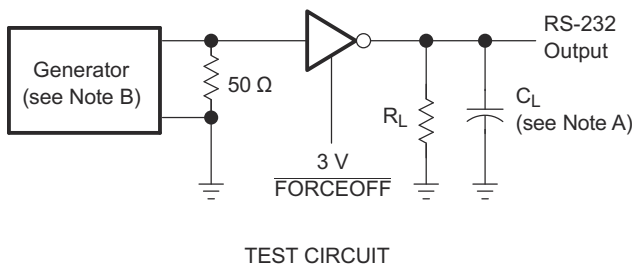
$$SR(tr) = \frac{6V}{t_{THL} \text{ or } t_{TLH}}$$



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- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

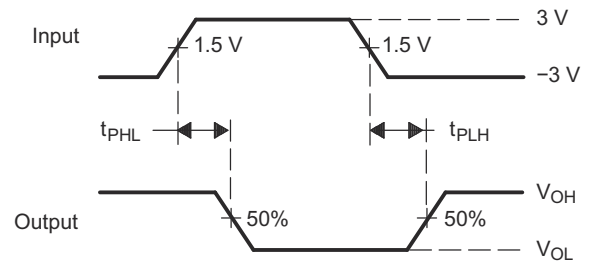
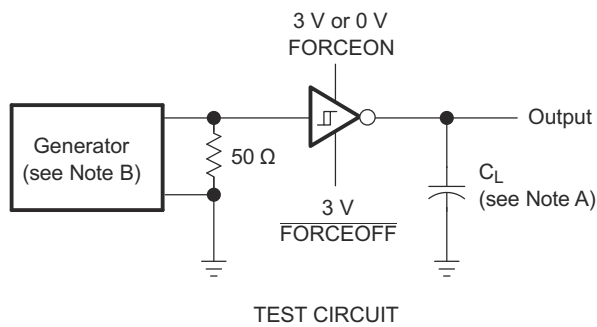
Figure 7-1. Driver Slew Rate



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- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

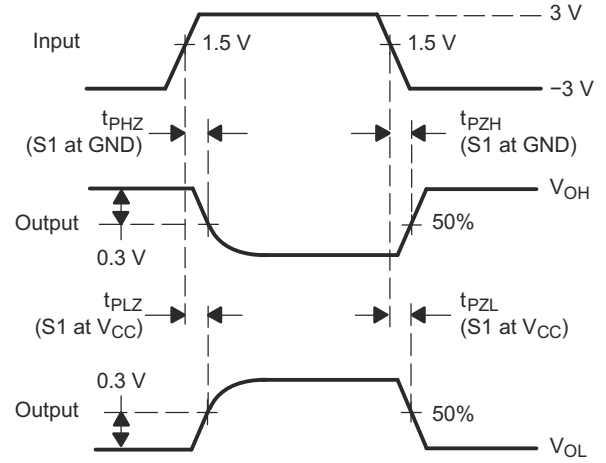
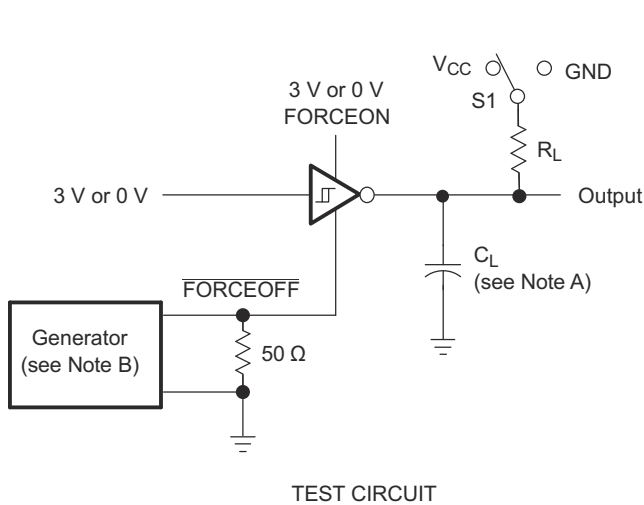
Figure 7-2. Driver Pulse Skew



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- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

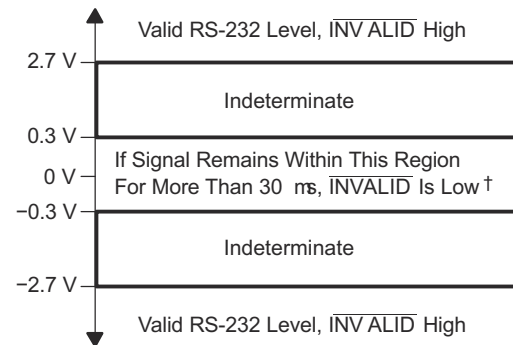
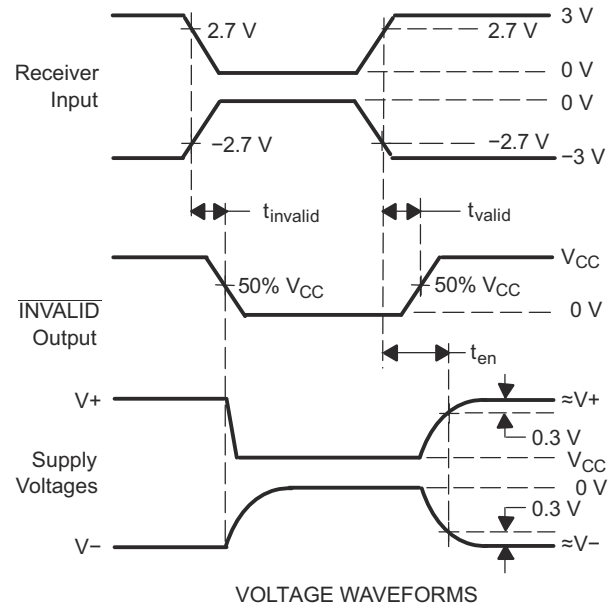
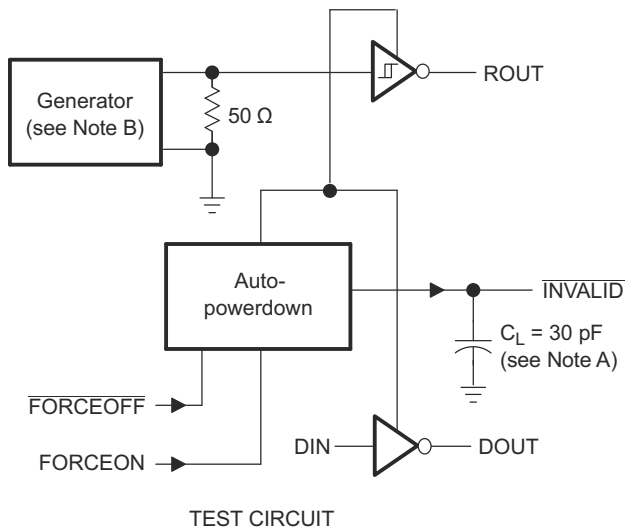
Figure 7-3. Receiver Propagation Delay Times



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- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\ \text{ns}$, $t_f \leq 10\ \text{ns}$.
- C. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
- D. t_{PZL} and t_{PZH} are the same as t_{en} .

Figure 7-4. Receiver Enable And Disable Times



† Auto-powerdown disables drivers and reduces supply current to 1 mA.

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- 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 7-5. $\overline{\text{INVALID}}$ Propagation Delay Times And Supply Enabling Time

8 Detailed Description

8.1 Overview

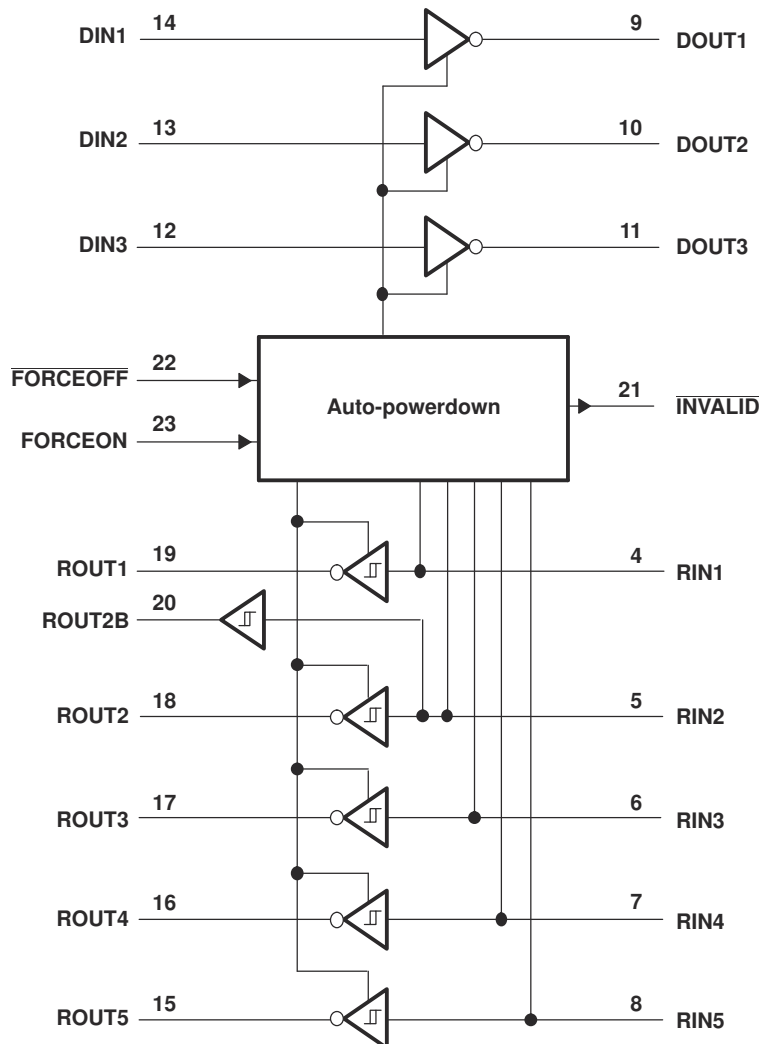
Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when $\overline{\text{FORCEON}}$ is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense a valid RS-232 signal, the driver outputs are disabled. If $\overline{\text{FORCEOFF}}$ is set low, both drivers and receivers (except ROUT2B) are shut off, and the supply current is reduced to 1 μA .

Disconnecting the serial port or turning off the peripheral drivers causes the auto-powerdown condition to occur.

Auto-powerdown can be disabled when $\overline{\text{FORCEON}}$ and $\overline{\text{FORCEOFF}}$ are high, and should be done when driving a serial mouse. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to any receiver input. The $\overline{\text{INVALID}}$ output is used to notify the user if an RS-232 signal is present at any receiver input. $\overline{\text{INVALID}}$ is high (valid data) if any receiver input voltage is greater than 2.7 V or less than -2.7 V or has been between -0.3 V and 0.3 V for less than 30 μs . $\overline{\text{INVALID}}$ is low (invalid data) if all receiver input voltages are between -0.3 V and 0.3 V for more than 30 μs . Refer to Figure 7-5 for receiver input levels.

The TRS3243E is characterized for operation from 0°C to 70°C. The TRS3243EI is characterized for operation from -40°C to +85°C.

8.2 Functional Block Diagram



Logic Diagram (Positive Logic)

8.3 Device Functional Modes

Table 8-1 through Table 8-3 show the device functional modes.

Table 8-1. Each Driver

| INPUTS ⁽¹⁾ | | | | OUTPUT | DRIVER STATUS |
|-----------------------|---------|----------|------------------------|--------|---|
| DIN | FORCEON | FORCEOFF | VALID RIN RS-232 LEVEL | DOUT | |
| X | X | L | X | Z | Powered off |
| L | H | H | X | H | Normal operation with auto-powerdown disabled |
| H | H | H | X | L | |
| L | L | H | Yes | H | Normal operation with auto-powerdown enabled |
| H | L | H | Yes | L | |
| X | L | H | No | Z | Powered off by auto-powerdown feature |

(1) H = high level, L = low level, X = irrelevant, Z = high impedance

Table 8-2. Each Receiver

| INPUTS ⁽¹⁾ | | | OUTPUT | RECEIVER STATUS |
|-----------------------|---------|----------|--------|---|
| RIN | FORCEON | FORCEOFF | ROUT | |
| X | X | L | Z | Powered off |
| L | X | H | H | Normal operation with auto-powerdown disabled/enabled |
| H | X | H | L | |
| Open | X | H | H | |

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

Table 8-3. ROUT2B And Outputs $\overline{\text{INVALID}}$

| INPUTS ⁽¹⁾ | | | | OUTPUTS | | OUTPUT STATUS |
|------------------------|------|---------|----------|-----------------------------|--------|---------------|
| VALID RIN RS-232 LEVEL | RIN2 | FORCEON | FORCEOFF | $\overline{\text{INVALID}}$ | ROUT2B | |
| Yes | L | X | X | H | L | Always active |
| Yes | H | X | X | H | H | |
| Yes | Open | X | X | H | L | |
| No | Open | X | X | L | L | |

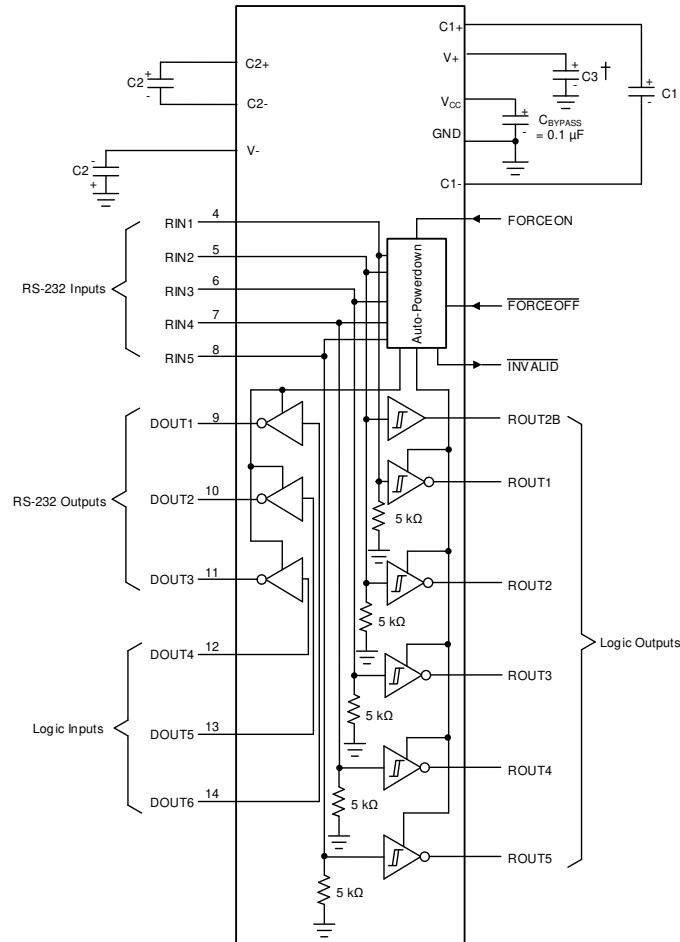
(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

9 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.

9.1 Typical Application



- A. C3 can be connected to V_{CC} or GND.
- B. Resistor values shown are nominal.
- C. Nonpolarized ceramic capacitors are acceptable. If using polarized tantalum or electrolytic capacitors, connect them as shown.

Figure 9-1. Typical Operating Circuit and Capacitor Values

Table 9-1. V_{CC} vs Capacitor Values

| V_{CC} | C1 | C2, C3, and C4 |
|-------------------|---------------|----------------|
| 3.3 V \pm 0.3 V | 0.1 μ F | 0.1 μ F |
| 5 V \pm 0.5 V | 0.047 μ F | 0.33 μ F |
| 3 V to 5.5 V | 0.1 μ F | 0.47 μ F |

9.1.1 Detailed Design Procedure

9.1.1.1 ESD Protection

TI TRS3243E devices have standard ESD protection structures incorporated on the pins to protect against electrostatic discharges encountered during assembly and handling. In addition, the RS232 bus pins (driver outputs and receiver inputs) of these devices have an extra level of ESD protection. Advanced ESD structures were designed to successfully protect these bus pins against ESD discharge of ± 15 -kV in all states: normal operation, shutdown, and powered down. The TRS3243E devices are designed to continue functioning properly after an ESD occurrence without any latchup.

The TRS3243E devices have three specified ESD limits on the driver outputs and receiver inputs, with respect to GND:

- ± 15 -kV Human-Body Model (HBM)
- ± 15 -kV IEC61000-4-2, Air-Gap Discharge (formerly IEC1000-4-2)
- ± 8 -kV IEC61000-4-2, Contact Discharge

9.1.1.2 ESD Test Conditions

ESD testing is stringently performed by TI, based on various conditions and procedures. Please contact TI for a reliability report that documents test setup, methodology, and results.

9.1.1.3 Human-Body Model (HBM)

The HBM of ESD testing is shown in [Figure 9-2](#), while [Figure 9-3](#) shows the current waveform that is generated during a discharge into a low impedance. The model consists of a 100-pF capacitor, charged to the ESD voltage of concern, and subsequently discharged into the DUT through a 1.5-k Ω resistor.

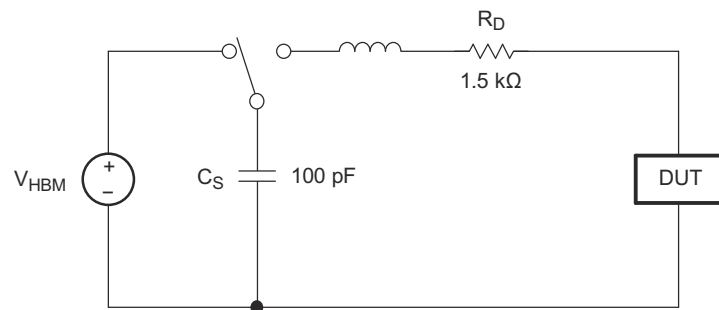


Figure 9-2. HBM ESD Test Circuit

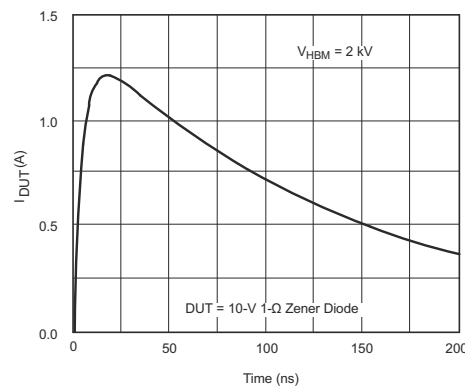
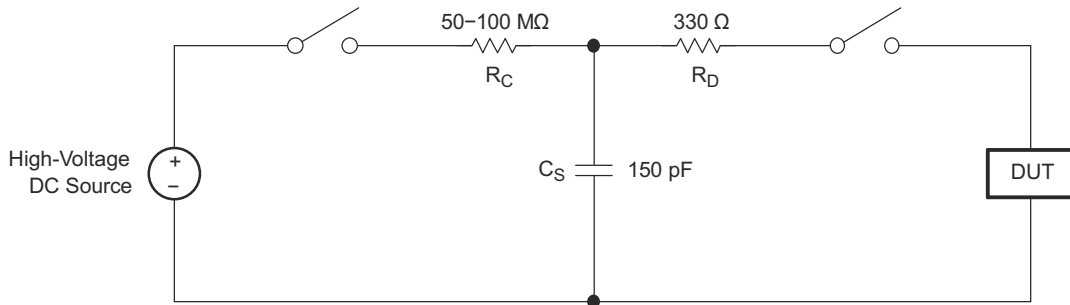


Figure 9-3. Typical HBM Current Waveform

9.1.1.4 IEC61000-4-2 (Formerly Known as IEC1000-4-2)

Unlike the HBM, MM, and CDM ESD tests that apply to component level integrated circuits, the IEC61000-4-2 is a system-level ESD testing and performance standard that pertains to the end equipment. The TRS3243E is designed to enable the manufacturer in meeting the highest level (Level 4) of IEC61000-4-2 ESD protection with no further need of external ESD protection circuitry. The more stringent IEC test standard has a higher peak current than the HBM, due to the lower series resistance in the IEC model.

Figure 9-4 shows the IEC61000-4-2 model, and Figure 9-5 shows the current waveform for the corresponding ± 8 -kV contact-discharge (Level 4) test. This waveform is applied to a probe that has been connected to the DUT. On the other hand, the corresponding ± 15 -kV (Level 4) air-gap discharge test involves approaching the DUT with an already energized probe.



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Figure 9-4. Simplified IEC61000-4-2 ESD Test Circuit

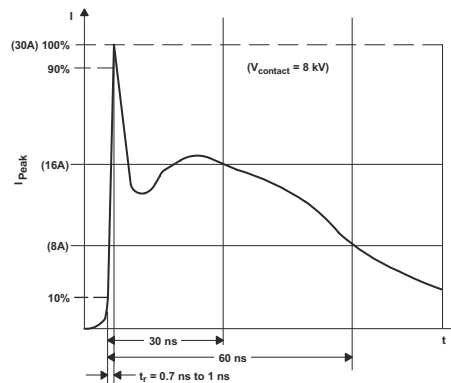


Figure 9-5. Typical Current Waveform Of IEC61000-4-2 ESD Generator

10 Device and Documentation Support

10.1 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.

10.2 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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10.4 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.

10.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

11 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 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TRS3243ECDBR | ACTIVE | SSOP | DB | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECDWR | ACTIVE | SOIC | DW | 28 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECPWR | ACTIVE | TSSOP | PW | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | RS43EC | Samples |
| TRS3243ECRHBR | ACTIVE | VQFN | RHB | 32 | 3000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | RS43EC | Samples |
| TRS3243EIDBR | ACTIVE | SSOP | DB | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIDWR | ACTIVE | SOIC | DW | 28 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIPWR | ACTIVE | TSSOP | PW | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RS43EI | Samples |
| TRS3243EIRHBR | ACTIVE | VQFN | RHB | 32 | 3000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | RS43EI | Samples |
| TRS3243EIRHBRG4 | ACTIVE | VQFN | RHB | 32 | 3000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | RS43EI | 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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TRS3243ECDDBR | SSOP | DB | 28 | 2000 | 330.0 | 16.4 | 8.2 | 10.5 | 2.5 | 12.0 | 16.0 | Q1 |
| TRS3243ECDWR | SOIC | DW | 28 | 1000 | 330.0 | 32.4 | 11.35 | 18.67 | 3.1 | 16.0 | 32.0 | Q1 |
| TRS3243ECPWR | TSSOP | PW | 28 | 2000 | 330.0 | 16.4 | 6.9 | 10.2 | 1.8 | 12.0 | 16.0 | Q1 |
| TRS3243ECRHBR | VQFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.5 | 8.0 | 12.0 | Q2 |
| TRS3243ECRHBR | VQFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.1 | 8.0 | 12.0 | Q2 |
| TRS3243EIDBR | SSOP | DB | 28 | 2000 | 330.0 | 16.4 | 8.2 | 10.5 | 2.5 | 12.0 | 16.0 | Q1 |
| TRS3243EIDWR | SOIC | DW | 28 | 1000 | 330.0 | 32.4 | 11.35 | 18.67 | 3.1 | 16.0 | 32.0 | Q1 |
| TRS3243EIPWR | TSSOP | PW | 28 | 2000 | 330.0 | 16.4 | 6.9 | 10.2 | 1.8 | 12.0 | 16.0 | Q1 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.1 | 8.0 | 12.0 | Q2 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.5 | 8.0 | 12.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TRS3243ECDBR | SSOP | DB | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| TRS3243ECDWR | SOIC | DW | 28 | 1000 | 350.0 | 350.0 | 66.0 |
| TRS3243ECPWR | TSSOP | PW | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| TRS3243ECRHBR | VQFN | RHB | 32 | 3000 | 356.0 | 356.0 | 35.0 |
| TRS3243ECRHBR | VQFN | RHB | 32 | 3000 | 367.0 | 367.0 | 35.0 |
| TRS3243EIDBR | SSOP | DB | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| TRS3243EIDWR | SOIC | DW | 28 | 1000 | 350.0 | 350.0 | 66.0 |
| TRS3243EIPWR | TSSOP | PW | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 367.0 | 367.0 | 35.0 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 356.0 | 356.0 | 35.0 |

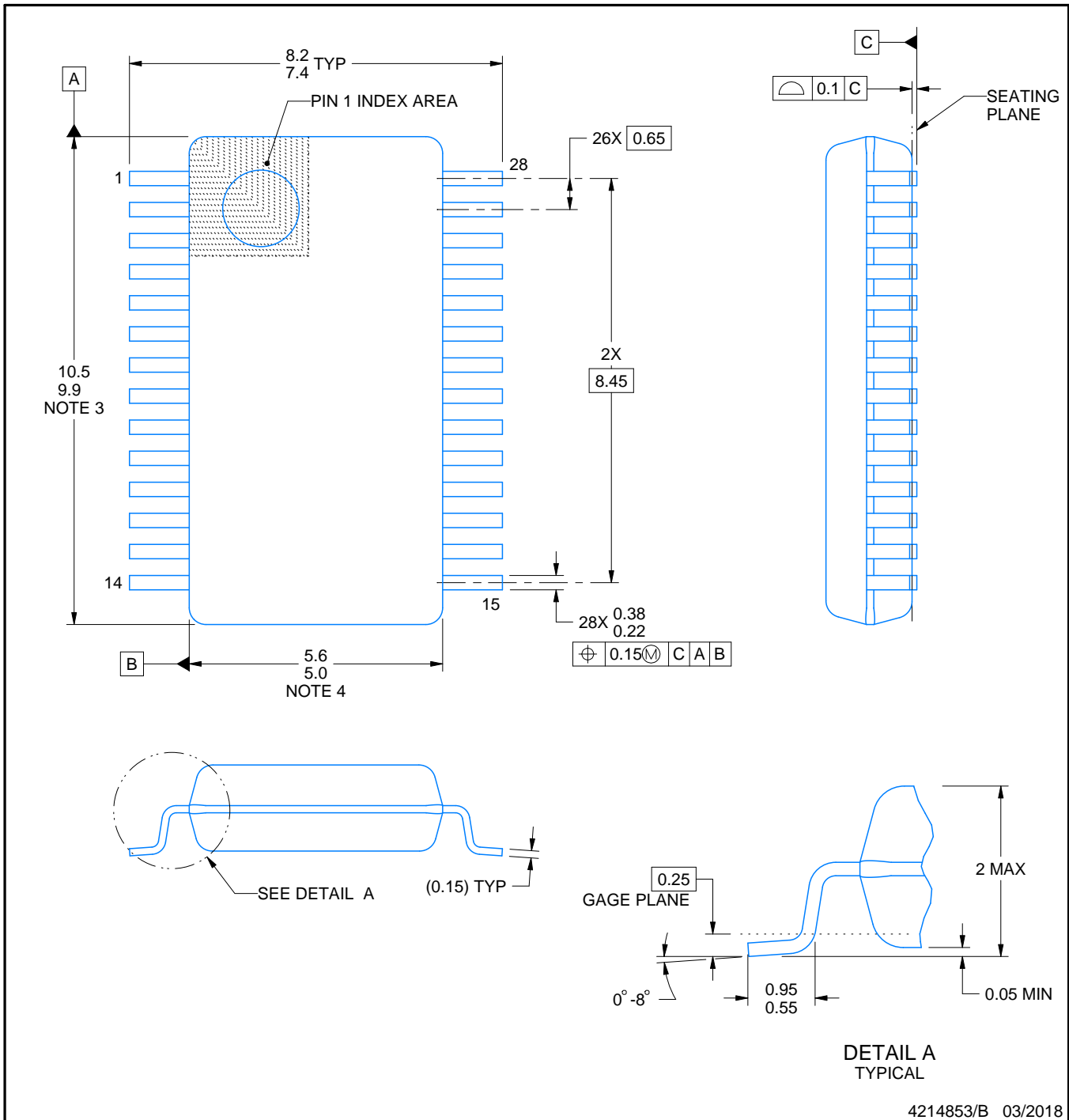
DB0028A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4214853/B 03/2018

NOTES:

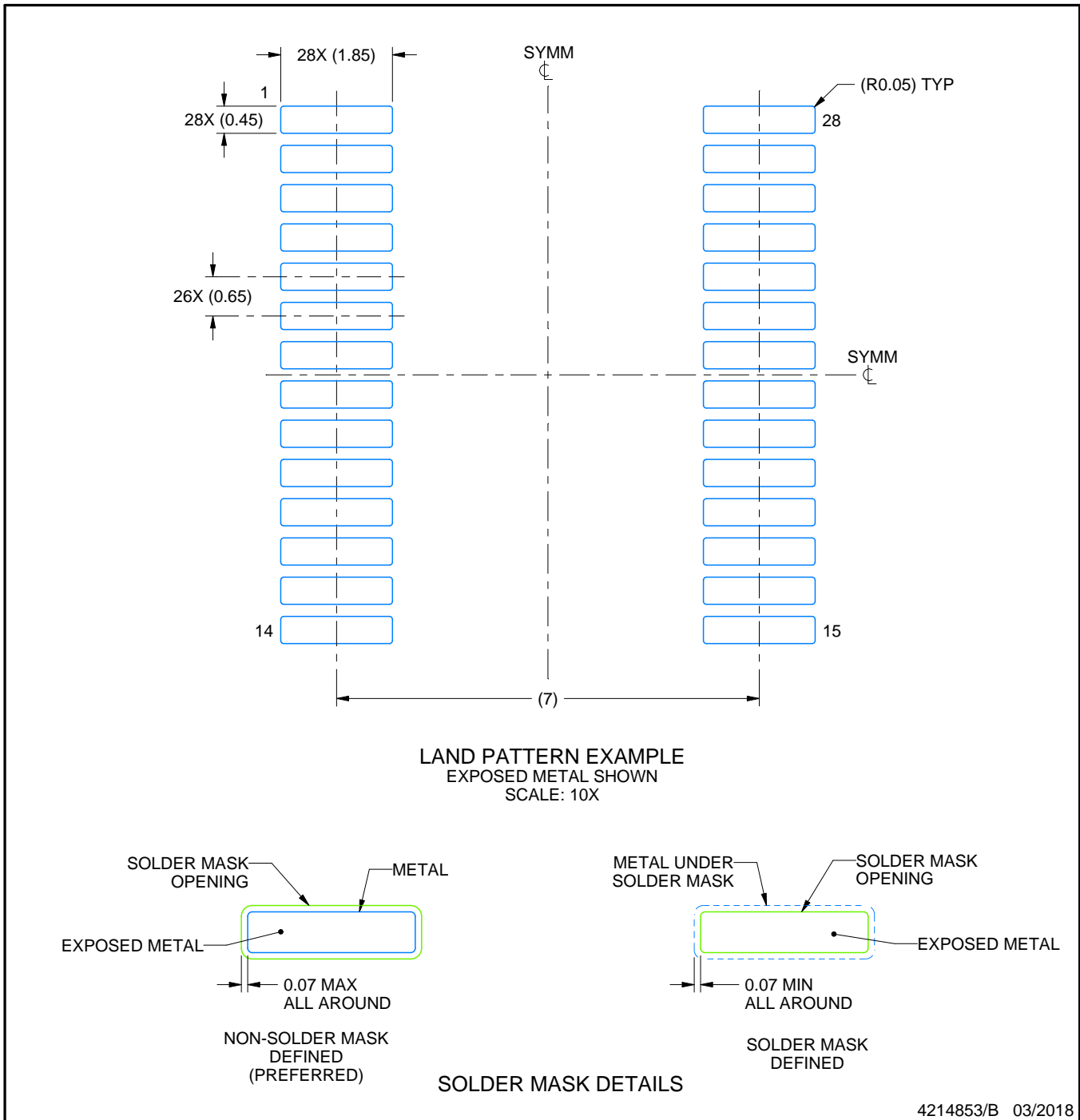
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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-150.

EXAMPLE BOARD LAYOUT

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



NOTES: (continued)

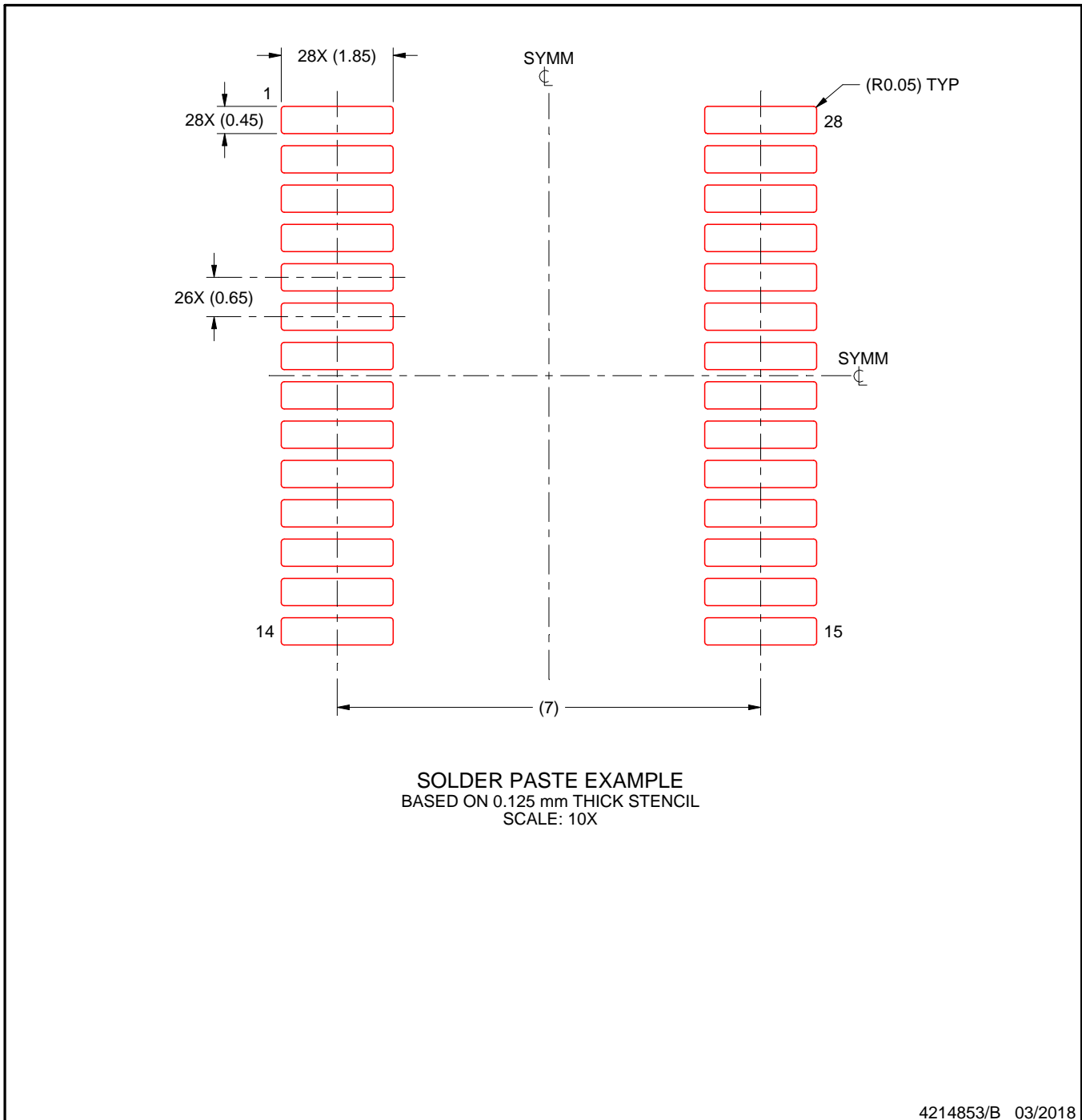
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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.

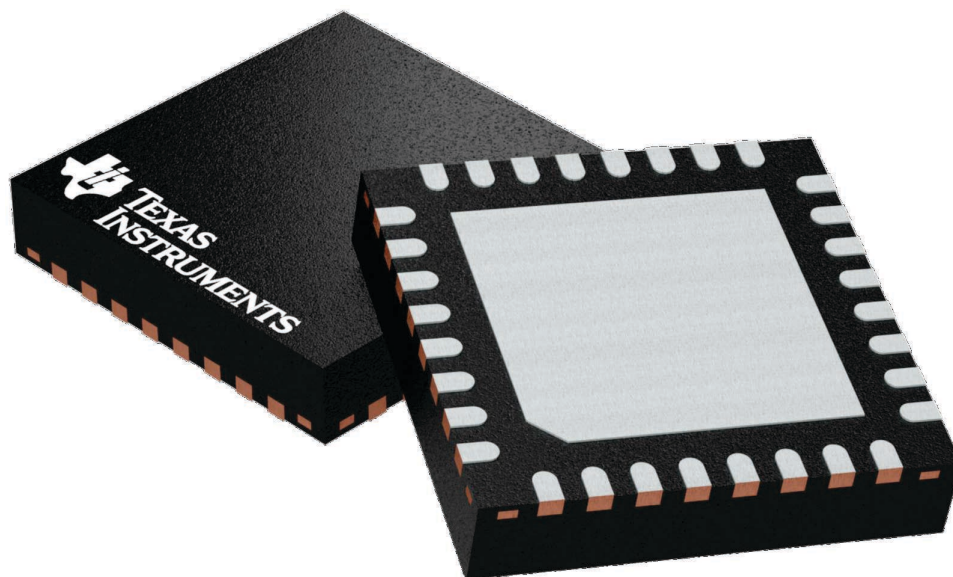
GENERIC PACKAGE VIEW

RHB 32

VQFN - 1 mm max height

5 x 5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4224745/A



4223442/B 08/2019

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

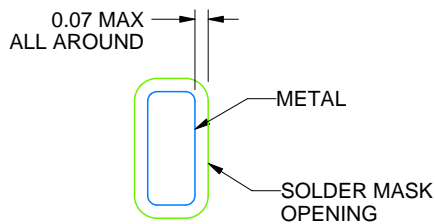
RHB0032E

VQFN - 1 mm max height

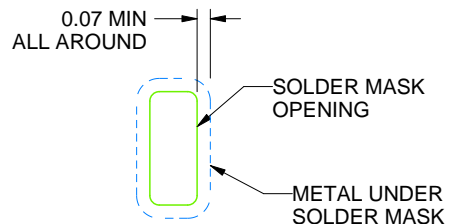
PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
SCALE:18X



NON SOLDER MASK
DEFINED
(PREFERRED)



SOLDER MASK
DEFINED

SOLDER MASK DETAILS

4223442/B 08/2019

NOTES: (continued)

- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

RHB0032E

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:
 75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
 SCALE:20X

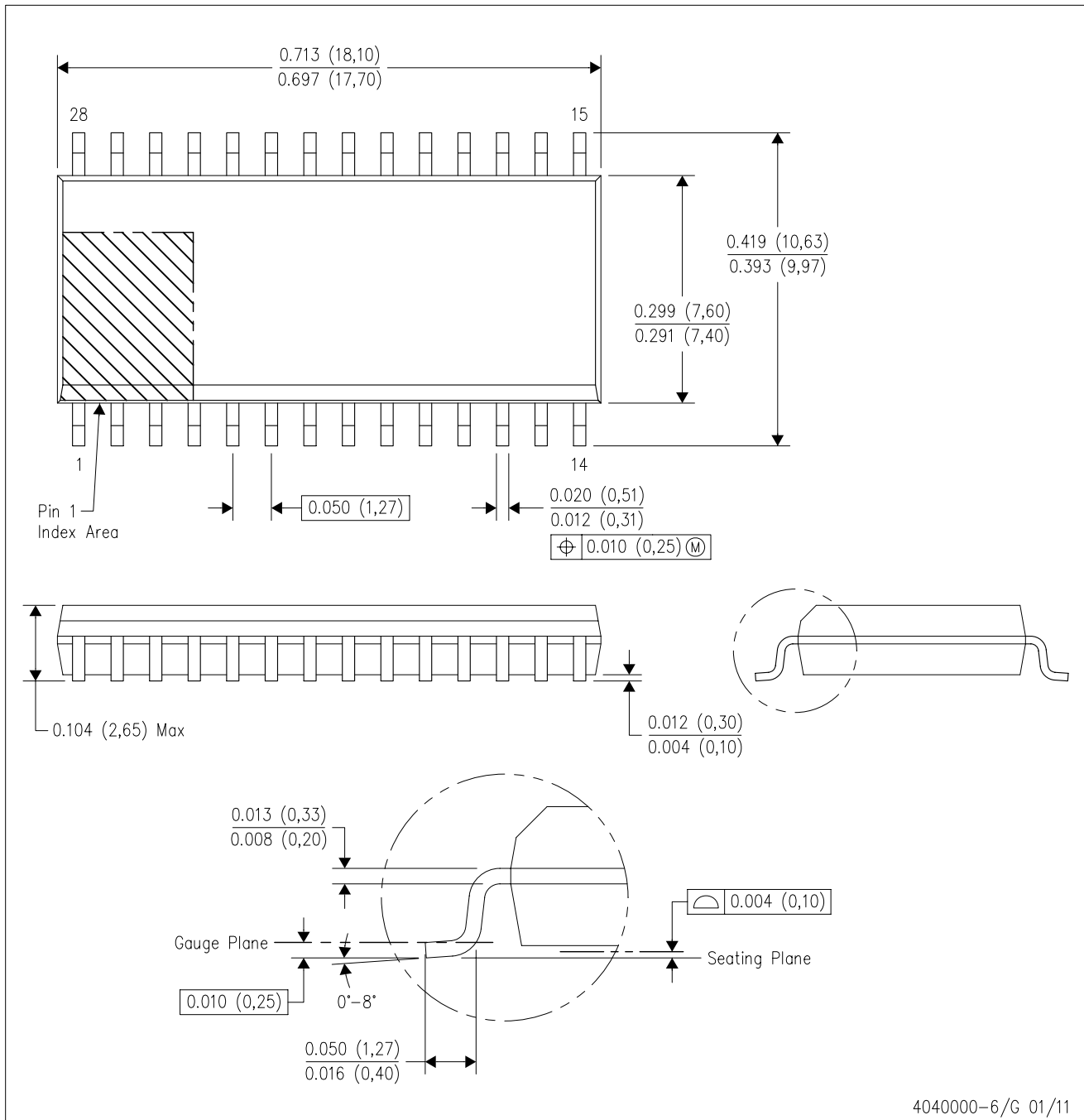
4223442/B 08/2019

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

DW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



4040000-6/G 01/11

- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-013 variation AE.

MECHANICAL DATA

PW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



4040064-7/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - 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 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

PW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate design.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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