

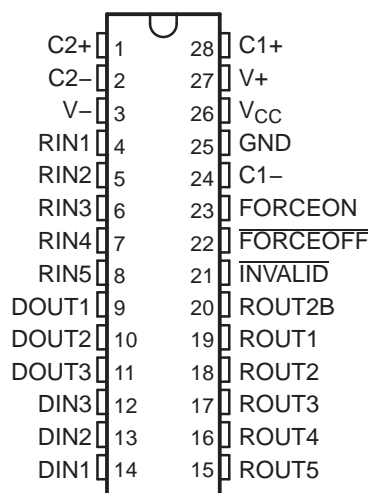
## FEATURES

- 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<sub>CC</sub> Supply
- Always-Active Noninverting Receiver Output (ROUT2B)
- Designed to Transmit at a Data Rate up to 500 kbit/s
- Low Standby Current . . . 1 μA Typ
- External Capacitors . . . 4 × 0.1 μF
- 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) Packages

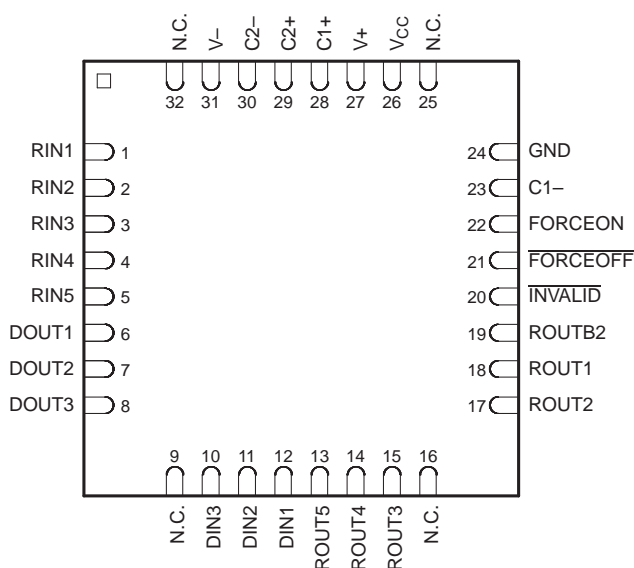
## APPLICATIONS

- Battery-Powered Systems
- PDAs
- Notebooks
- Laptops
- Palmtop PCs
- Hand-Held Equipment

DB, DW, OR PW PACKAGE  
(TOP VIEW)



QFN PACKAGE  
(TOP VIEW)



N.C. – Not internally connected

## DESCRIPTION/ORDERING INFORMATION

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/μs driver output slew rate.



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**TRS3243E**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV IEC ESD PROTECTION**

SLLS789–APRIL 2007

**DESCRIPTION/ORDERING INFORMATION (CONTINUED)**

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 R<sub>OUT2B</sub>) are shut off, and the supply current is reduced to 1  $\mu\text{A}$ . 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  $\mu\text{s}$ .  $\overline{\text{INVALID}}$  is low (invalid data) if all receiver input voltages are between -0.3 V and 0.3 V for more than 30  $\mu\text{s}$ . Refer to Figure 5 for receiver input levels.

The TRS3243EC is characterized for operation from 0°C to 70°C. The TRS3243EI is characterized for operation from -40°C to 85°C.

**ORDERING INFORMATION**

| $T_A$         | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---------------|------------------------|--------------|-----------------------|------------------|
| 0°C to 70°C   | SSOP – DB              | Reel of 2000 | TRS3243ECDBR          | TRS3243EC        |
|               | SOP – DW               | Reel of 2000 | TRS3243ECDWR          | TRS3243EC        |
|               | TSSOP – PW             | Reel of 2000 | TRS3243ECPWR          | RS43EC           |
|               | QFN – RHB              | Reel of 2000 | TRS3243ECRHBR         | RS43EC           |
| -40°C to 85°C | SSOP – DB              | Reel of 2000 | TRS3243EIDBR          | TRS3243ECI       |
|               | SOP – DW               | Reel of 2000 | TRS3243EIDWR          | TRS3243ECI       |
|               | TSSOP – PW             | Reel of 2000 | TRS3243EIPWR          | RS43EI           |
|               | QFN – RHB              | Reel of 2000 | TRS3243EIRHBR         | RS43EI           |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

### FUNCTION TABLES

#### Each Driver<sup>(1)</sup>

| INPUTS |         |          |                        | OUTPUT DOUT | DRIVER STATUS                                 |
|--------|---------|----------|------------------------|-------------|---|
| DIN    | FORCEON | FORCEOFF | VALID RIN RS-232 LEVEL |             |   |
| 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           |   |
| L      | L       | H        | No                     | Z           | Powered off by auto-powerdown feature         |
| H      | L       | H        | No                     | Z           |   |

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

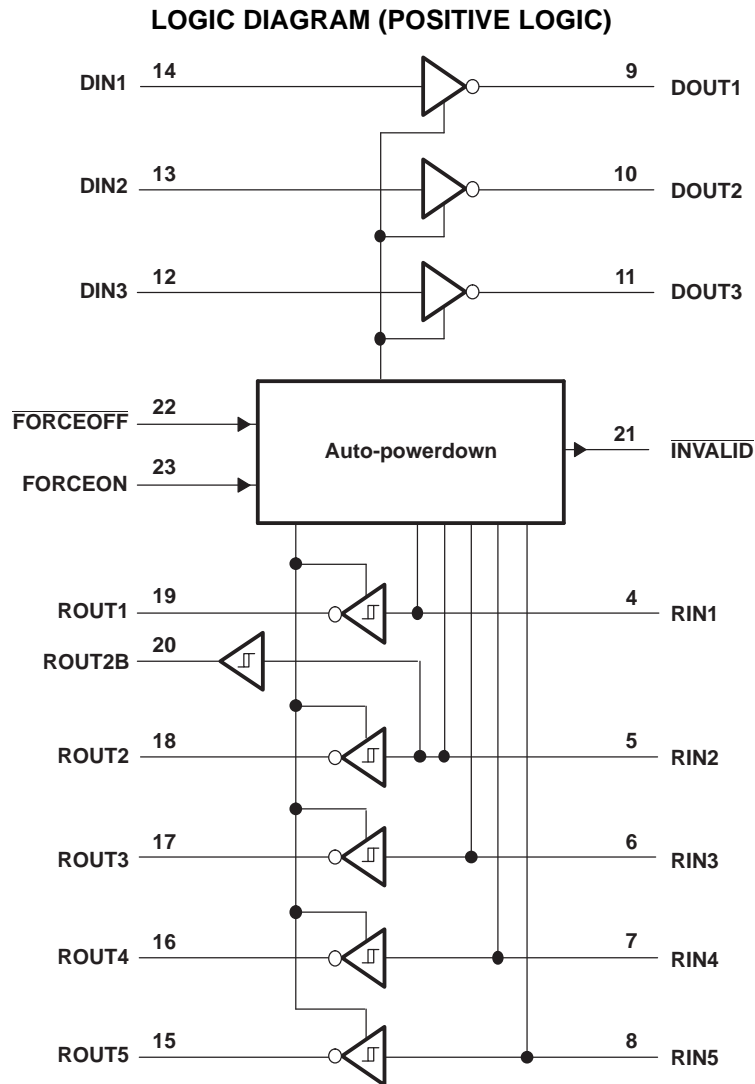
#### Each Receiver<sup>(1)</sup>

| INPUTS |                 |          |                        | OUTPUTS |      | RECEIVER STATUS                                       |
|--------|-----------------|----------|------------------------|---------|------|---|
| RIN2   | RIN1, RIN3–RIN5 | FORCEOFF | VALID RIN RS-232 LEVEL | ROUT2B  | ROUT |   |
| L      | X               | L        | X                      | L       | Z    | Powered off while ROUT2B is active                    |
| H      | X               | L        | X                      | H       | Z    |   |
| L      | L               | H        | Yes                    | L       | H    | Normal operation with auto-powerdown disabled/enabled |
| L      | H               | H        | Yes                    | L       | L    |   |
| H      | L               | H        | Yes                    | H       | H    |   |
| H      | H               | H        | Yes                    | H       | L    |   |
| Open   | Open            | H        | Yes                    | L       | H    |   |

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

**TRS3243E**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
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SLLS789–APRIL 2007



## Absolute Maximum Ratings<sup>(1)</sup>

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

|  |   | MIN                        | MAX | UNIT |
|--|---|----------------------------|-----|------|
| V <sub>CC</sub>                                      | Supply voltage range <sup>(2)</sup>                 | −0.3                       | 6   | V    |
| V+   | Positive output supply voltage range <sup>(2)</sup> | −0.3                       | 7   | V    |
| V−   | Negative output supply voltage range <sup>(2)</sup> | 0.3                        | −7  | V    |
| V+ − V−  | Output supply voltage difference <sup>(2)</sup>     |                            | 13  | V    |
| V <sub>I</sub>                                       | Input voltage range                                 | Driver (FORCEOFF, FORCEON) |     | V    |
|  |   | Receiver                   |     |      |
| V <sub>O</sub>                                       | Output voltage range                                | Driver                     |     | V    |
|  |   | Receiver (INVALID)         |     |      |
| θ <sub>JA</sub>                                      | Package thermal impedance <sup>(3)(4)</sup>         | DB package                 |     | °C/W |
|  |   | DW package                 |     |      |
|  |   | PW package                 |     |      |
| Lead temperature 1,6 mm (1/16 in) from case for 10 s |   |                            | 260 | °C   |
| T <sub>stg</sub>                                     | Storage temperature range                           | −65                        | 150 | °C   |

- Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- All voltages are with respect to network GND.
- Maximum power dissipation is a function of T<sub>J</sub>(max), θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) − T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions<sup>(1)</sup>

See [Figure 6](#)

|                 |   | MIN                     | NOM | MAX | UNIT |   |
|-----------------|---|-------------------------|-----|-----|------|---|
| Supply voltage  |   | V <sub>CC</sub> = 3.3 V | 3   | 3.3 | 3.6  | V |
|                 |   | V <sub>CC</sub> = 5 V   | 4.5 | 5   | 5.5  |   |
| V <sub>IH</sub> | Driver and control high-level input voltage | DIN, FORCEOFF, FORCEON  |     | 2   | V    |   |
|                 |   |                         |     |     |      |   |
| V <sub>IL</sub> | Driver and control low-level input voltage  | DIN, FORCEOFF, FORCEON  |     | 0.8 | V    |   |
|                 |   |                         |     |     |      |   |
| V <sub>I</sub>  | Driver and control input voltage            | DIN, FORCEOFF, FORCEON  |     | 5.5 | V    |   |
| V <sub>I</sub>  | Receiver input voltage                      | −25                     |     | 25  | V    |   |
| T <sub>A</sub>  | Operating free-air temperature              | TRS3243EC               |     | 70  | °C   |   |
|                 |   | TRS3243EI               |     | −40 |      |   |

- Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

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

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

| PARAMETER       |   | TEST CONDITIONS         | MIN  | TYP <sup>(2)</sup> | MAX | UNIT |
|-----------------|---|-------------------------|--|--------------------|-----|------|
| I <sub>I</sub>  | Input leakage current                     | FORCEOFF, FORCEON       |  | ±0.01              | ±1  | μA   |
| I <sub>CC</sub> | Supply current<br>(T <sub>A</sub> = 25°C) | Auto-powerdown disabled | No load,<br>FORCEOFF and FORCEON at V <sub>CC</sub>  | 0.3                | 1   | mA   |
|                 |   | Powered off             | No load, FORCEOFF at GND   | 1                  | 10  |      |
|                 |   | Auto-powerdown enabled  | No load, FORCEOFF at V <sub>CC</sub> ,<br>FORCEON at GND,<br>All RIN are open or grounded,<br>All DIN are grounded | 1                  | 10  | μA   |

- Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.
- All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

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**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
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SLLS789–APRIL 2007

**DRIVER SECTION**

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

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

| PARAMETER   | TEST CONDITIONS  | MIN | TYP <sup>(2)</sup> | MAX | UNIT |
|---|--|-----|--------------------|-----|------|
| V <sub>OH</sub> High-level output voltage                   | All DOUT at R <sub>L</sub> = 3 kΩ to GND   | 5   | 5.4                |     | V    |
| V <sub>OL</sub> Low-level output voltage                    | All DOUT at R <sub>L</sub> = 3 kΩ to GND   | –5  | –5.4               |     | V    |
| V <sub>O</sub> Output voltage (mouse driveability)          | DIN1 = DIN2 = GND, DIN3 = V <sub>CC</sub> , 3-kΩ to GND at DOUT3, DOUT1 = DOUT2 = 2.5 mA | ±5  |                    |     | V    |
| I <sub>IH</sub> High-level input current                    | V <sub>I</sub> = V <sub>CC</sub>   |     | ±0.01              | ±1  | μA   |
| I <sub>IL</sub> Low-level input current                     | V <sub>I</sub> at GND  |     | ±0.01              | ±1  | μA   |
| V <sub>hys</sub> Input hysteresis                           |  |     |                    | ±1  | V    |
| I <sub>OS</sub> Short-circuit output current <sup>(3)</sup> | V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0 V  |     |                    | ±60 | mA   |
|   | V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V  |     |                    |     |      |
| r <sub>O</sub> Output resistance                            | V <sub>CC</sub> , V+, and V– = 0 V, V <sub>O</sub> = ±2 V                                | 300 | 10M                |     | Ω    |
| I <sub>off</sub> Output leakage current                     | FORCEOFF = GND, V <sub>O</sub> = ±12 V, V <sub>CC</sub> = 0 to 5.5 V                     |     |                    | ±25 | μA   |

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

(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.

**Switching Characteristics<sup>(1)</sup>**

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

| PARAMETER  | TEST CONDITIONS   | MIN                                | TYP <sup>(2)</sup> | MAX | UNIT   |
|--|---|------------------------------------|--------------------|-----|--------|
| Maximum data rate                                  | C <sub>L</sub> = 1000 pF, R <sub>L</sub> = 3 kΩ<br>One DOUT switching, See Figure 1 | 250                                | 500                |     | kbit/s |
| t <sub>sk(p)</sub> Pulse skew <sup>(3)</sup>       | C <sub>L</sub> = 150 pF to 2500 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, See Figure 2     |                                    | 100                |     | ns     |
| SR(tr) Slew rate, transition region (see Figure 1) | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 3 kΩ to 7 kΩ, PRR = 250 kbit/s            | C <sub>L</sub> = 150 pF to 1000 pF |                    | 6   | 30     |
|  |   | C <sub>L</sub> = 150 pF to 2500 pF |                    | 4   | 30     |

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

(3) Pulse skew is defined as |t<sub>PLH</sub> – t<sub>PHL</sub>| of each channel of the same device.

**ESD Protection**

| PARAMETER                  | TEST CONDITIONS                 | TYP | UNIT |
|----------------------------|---------------------------------|-----|------|
| Driver outputs (pins 9–11) | HBM                             | ±15 | kV   |
|                            | IEC61000-4-2, Air-Gap Discharge | ±15 |      |
|                            | IEC61000-4-2, Contact Discharge | ±8  |      |

## RECEIVER SECTION

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

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

| PARAMETER        |   | TEST CONDITIONS                | MIN                   | TYP <sup>(2)</sup>    | MAX | UNIT |
|------------------|---|--------------------------------|-----------------------|-----------------------|-----|------|
| V <sub>OH</sub>  | High-level output voltage                               | I <sub>OH</sub> = -1 mA        | V <sub>CC</sub> - 0.6 | V <sub>CC</sub> - 0.1 |     | V    |
| V <sub>OL</sub>  | Low-level output voltage                                | I <sub>OH</sub> = 1.6 mA       |                       |                       | 0.4 | V    |
| V <sub>IT+</sub> | Positive-going input threshold voltage                  | V <sub>CC</sub> = 3.3 V        |                       | 1.6                   | 2.4 | V    |
|                  |   | V <sub>CC</sub> = 5 V          |                       | 1.9                   | 2.4 |      |
| V <sub>IT-</sub> | Negative-going input threshold voltage                  | V <sub>CC</sub> = 3.3 V        | 0.6                   | 1.1                   |     | V    |
|                  |   | V <sub>CC</sub> = 5 V          | 0.8                   | 1.4                   |     |      |
| V <sub>hys</sub> | Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> ) |                                |                       | 0.5                   |     | V    |
| I <sub>off</sub> | Output leakage current (except ROUT2B)                  | FORCEOFF = 0 V                 |                       | ±0.05                 | ±10 | µA   |
| r <sub>i</sub>   | Input resistance  | V <sub>i</sub> = ±3 V or ±25 V | 3                     | 5                     | 7   | kΩ   |

(1) Test conditions are C1–C4 = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

### Switching Characteristics<sup>(1)</sup>

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

| PARAMETER          |   | TEST CONDITIONS  | TYP <sup>(2)</sup> | UNIT |
|--------------------|---|--|--------------------|------|
| t <sub>PLH</sub>   | Propagation delay time, low- to high-level output | C <sub>L</sub> = 150 pF, See Figure 3                        | 150                | ns   |
| t <sub>PHL</sub>   | Propagation delay time, high- to low-level output |  | 150                | ns   |
| t <sub>en</sub>    | Output enable time                                | C <sub>L</sub> = 150 pF, R <sub>L</sub> = 3 kΩ, See Figure 4 | 200                | ns   |
| t <sub>dis</sub>   | Output disable time                               |  | 200                | ns   |
| t <sub>sk(p)</sub> | Pulse skew <sup>(3)</sup>                         | See Figure 3   | 50                 | ns   |

(1) Test conditions are C1–C4 = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

(3) Pulse skew is defined as |t<sub>PLH</sub> - t<sub>PHL</sub>| of each channel of the same device.

## ESD Protection

| PARAMETER                 | TEST CONDITIONS                 | TYP | UNIT |
|---------------------------|---------------------------------|-----|------|
| Driver outputs (pins 4–8) | HBM                             | ±15 | kV   |
|                           | IEC61000-4-2, Air-Gap Discharge | ±15 |      |
|                           | IEC61000-4-2, Contact Discharge | ±8  |      |

## AUTO-POWERDOWN SECTION

### Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

| PARAMETER        |   | TEST CONDITIONS                                       | MIN            | MAX | UNIT |
|------------------|---|---|----------------|-----|------|
| $V_{IT+(valid)}$ | Receiver input threshold for $\overline{INVALID}$ high-level output voltage | FORCEON = GND, FORCEOFF = $V_{CC}$                    |                | 2.7 | V    |
| $V_{IT-(valid)}$ | Receiver input threshold for $\overline{INVALID}$ high-level output voltage | FORCEON = GND, FORCEOFF = $V_{CC}$                    | -2.7           |     | V    |
| $V_{T(invalid)}$ | Receiver input threshold for $\overline{INVALID}$ low-level output voltage  | FORCEON = GND, FORCEOFF = $V_{CC}$                    | -0.3           | 0.3 | V    |
| $V_{OH}$         | $\overline{INVALID}$ high-level output voltage                              | $I_{OH} = -1$ mA, FORCEON = GND, FORCEOFF = $V_{CC}$  | $V_{CC} - 0.6$ |     | V    |
| $V_{OL}$         | $\overline{INVALID}$ low-level output voltage                               | $I_{OL} = 1.6$ mA, FORCEON = GND, FORCEOFF = $V_{CC}$ |                | 0.4 | V    |

### Switching Characteristics

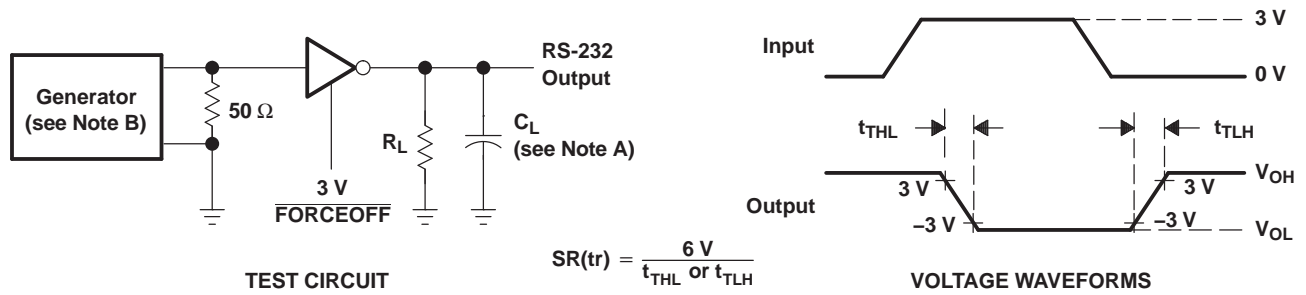
over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

| PARAMETER     |   | TEST CONDITIONS | TYP <sup>(1)</sup> | UNIT    |
|---------------|---|-----------------|--------------------|---------|
| $t_{valid}$   | Propagation delay time, low- to high-level output | $V_{CC} = 5$ V  | 1                  | $\mu$ s |
| $t_{invalid}$ | Propagation delay time, high- to low-level output | $V_{CC} = 5$ V  | 30                 | $\mu$ s |
| $t_{en}$      | Supply enable time                                | $V_{CC} = 5$ V  | 100                | $\mu$ s |

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

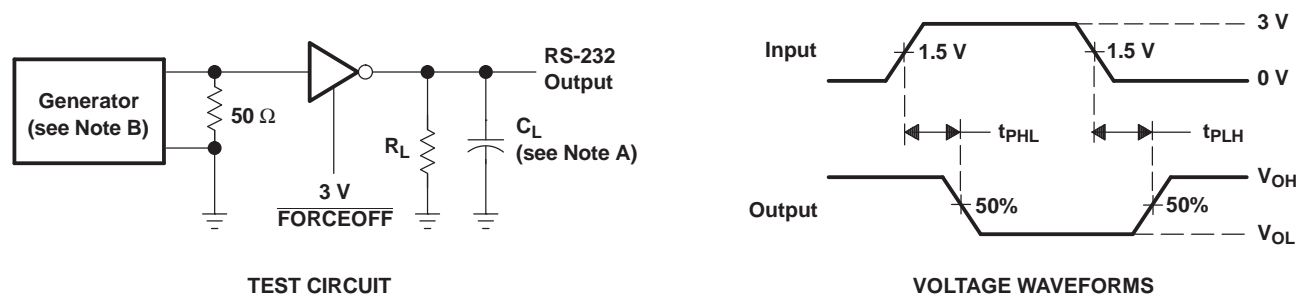


PARAMETER MEASUREMENT INFORMATION



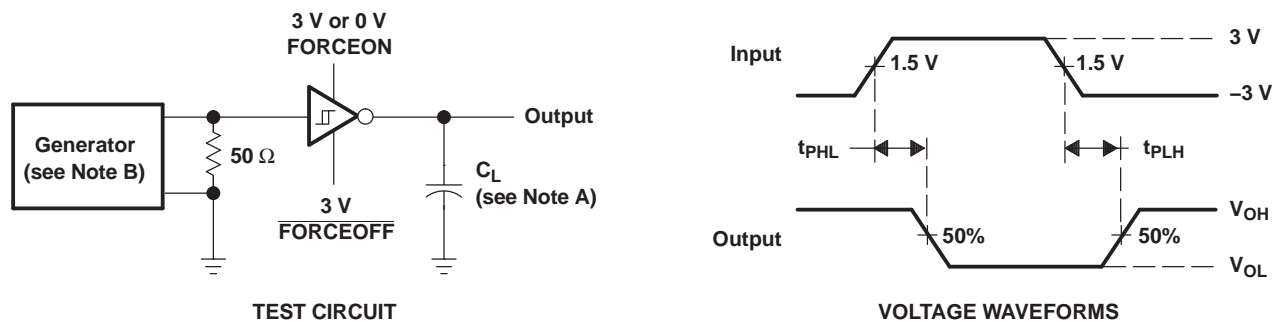
NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

Figure 1. Driver Slew Rate



NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics: PRR = 250 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

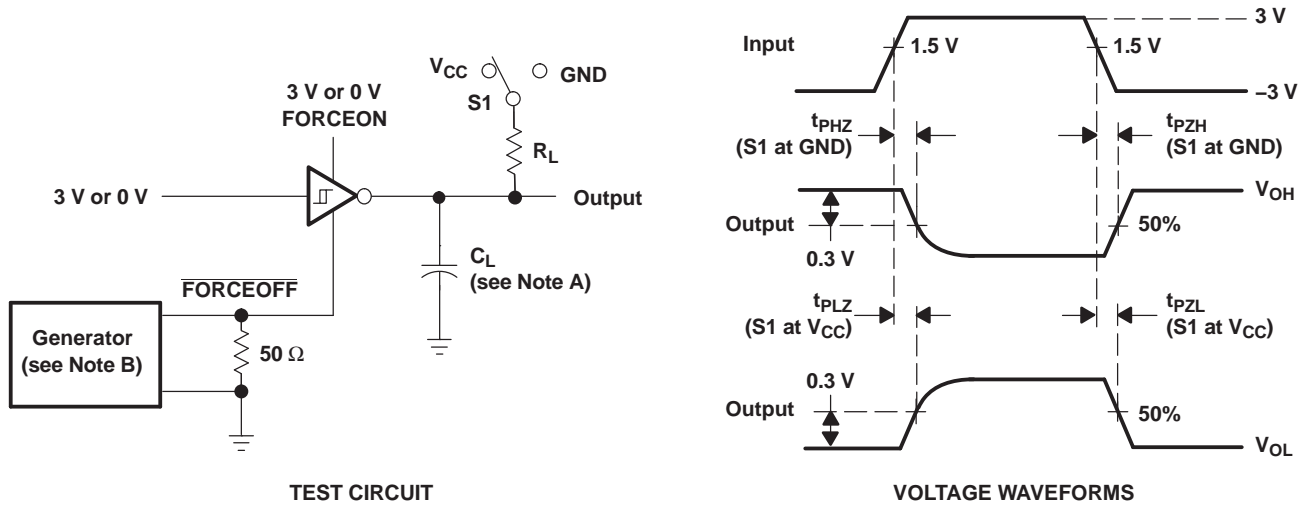
Figure 2. Driver Pulse Skew



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

Figure 3. Receiver Propagation Delay Times

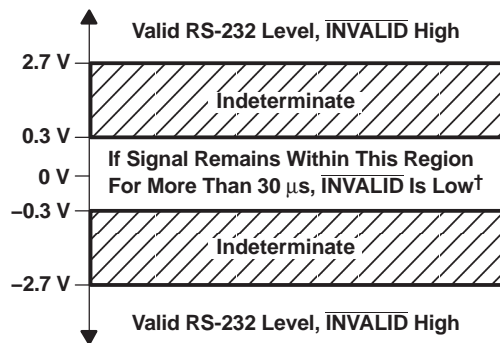
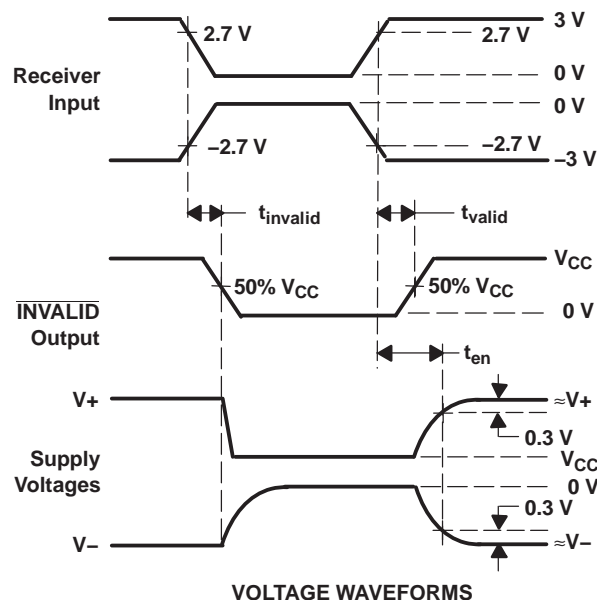
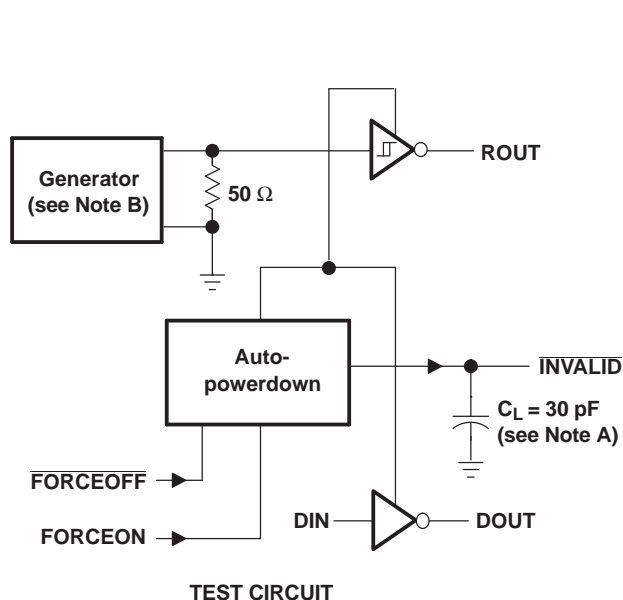
**PARAMETER MEASUREMENT INFORMATION**



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  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 4. Receiver Enable and Disable Times**

PARAMETER MEASUREMENT INFORMATION

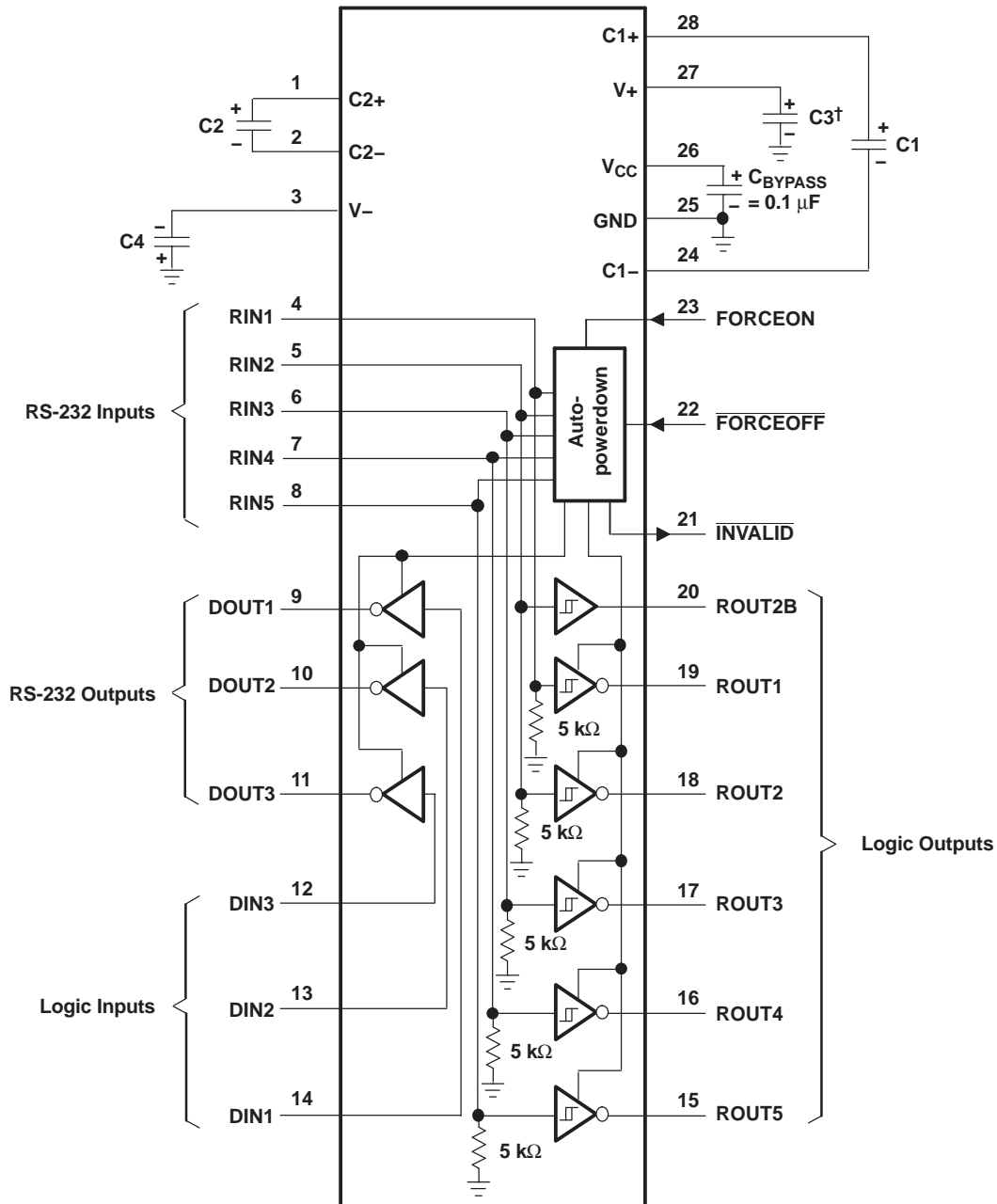


<sup>†</sup> Auto-powerdown disables drivers and reduces supply current to 1  $\mu$ A.

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics: PRR = 5 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

Figure 5.  $\overline{INVALID}$  Propagation Delay Times and Supply Enabling Time

APPLICATION INFORMATION



† C3 can be connected to V<sub>CC</sub> 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.

V<sub>CC</sub> vs CAPACITOR VALUES

| V <sub>CC</sub>   | C1            | C2, C3, and C4 |
|-------------------|---------------|----------------|
| 3.3 V $\pm$ 0.3 V | 0.1 $\mu$ F   | 0.1 $\mu$ F    |
| 5 V $\pm$ 0.5 V   | 0.047 $\mu$ F | 0.33 $\mu$ F   |
| 3 V to 5.5 V      | 0.1 $\mu$ F   | 0.47 $\mu$ F   |

Figure 6. Typical Operating Circuit and Capacitor Values

## APPLICATION INFORMATION

### 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  $\pm 15$ -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:

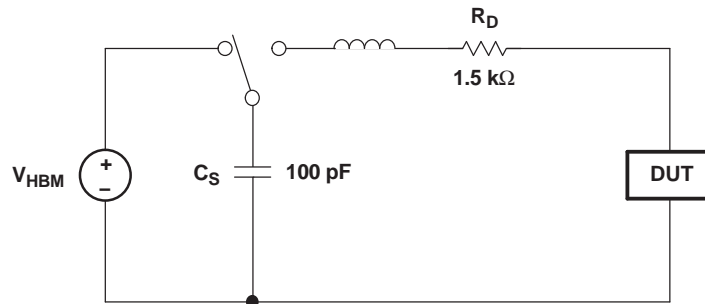
- $\pm 15$ -kV Human-Body Model (HBM)
- $\pm 15$ -kV IEC61000-4-2, Air-Gap Discharge (formerly IEC1000-4-2)
- $\pm 8$ -kV IEC61000-4-2, Contact Discharge

### 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.

### Human-Body Model (HBM)

The HBM of ESD testing is shown in Figure 7, while Figure 8 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 $\Omega$  resistor.



**Figure 7. HBM ESD Test Circuit**

APPLICATION INFORMATION

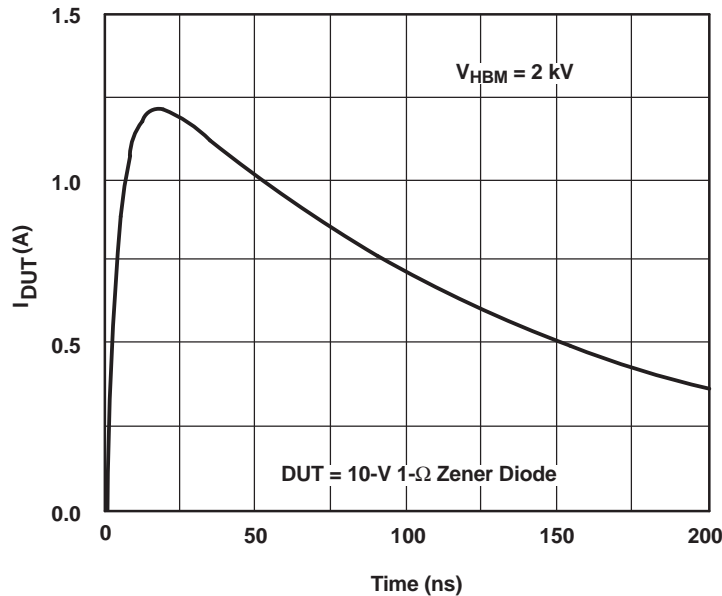


Figure 8. Typical HBM Current Waveform

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 shows the IEC61000-4-2 model, and Figure 10 shows the current waveform for the corresponding  $\pm 8$ -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  $\pm 15$ -kV (Level 4) air-gap discharge test involves approaching the DUT with an already energized probe.

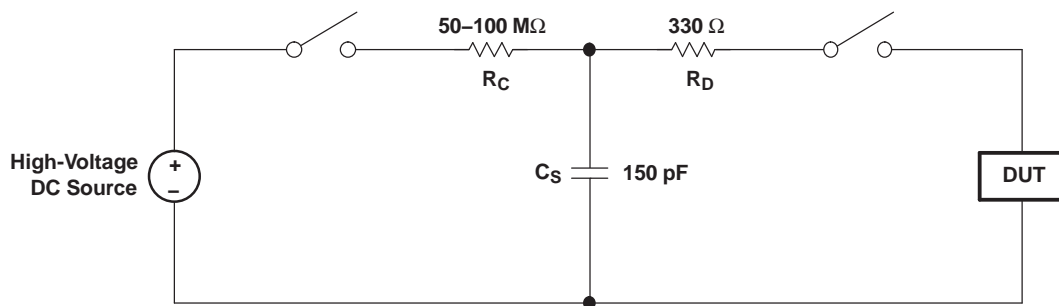
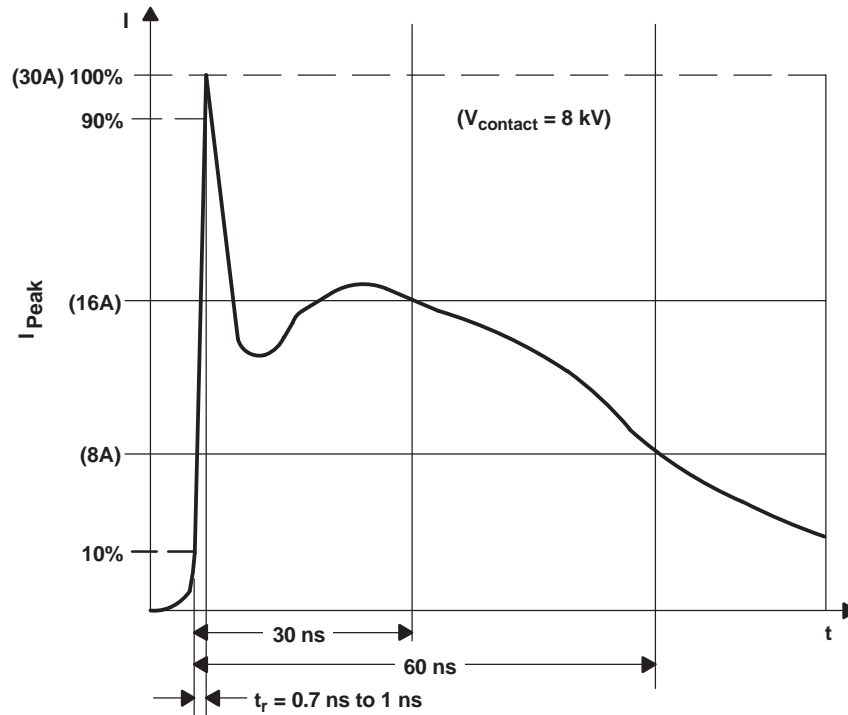


Figure 9. Simplified IEC61000-4-2 ESD Test Circuit

**APPLICATION INFORMATION**



**Figure 10. Typical Current Waveform of IEC61000-4-2 ESD Generator**

**Machine Model (MM)**

The MM ESD test applies to all pins using a 200-pF capacitor with no discharge resistance. The purpose of the MM test is to simulate possible ESD conditions that can occur during the handling and assembly processes of manufacturing. In this case, ESD protection is required for all pins, not just RS-232 pins. However, after PC board assembly, the MM test is no longer as pertinent to the RS-232 pins.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TRS3243ECDB      | ACTIVE                | SSOP         | DB              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDBG4    | ACTIVE                | SSOP         | DB              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDBR     | ACTIVE                | SSOP         | DB              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDBRG4   | ACTIVE                | SSOP         | DB              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDW      | ACTIVE                | SOIC         | DW              | 28   | 20          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDWG4    | ACTIVE                | SOIC         | DW              | 28   | 20          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDWR     | ACTIVE                | SOIC         | DW              | 28   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECDWRG4   | ACTIVE                | SOIC         | DW              | 28   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECPW      | ACTIVE                | TSSOP        | PW              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECPWG4    | ACTIVE                | TSSOP        | PW              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECPWR     | ACTIVE                | TSSOP        | PW              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECPWRG4   | ACTIVE                | TSSOP        | PW              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243ECRHBR    | ACTIVE                | QFN          | RHB             | 32   | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| TRS3243ECRHBRG4  | ACTIVE                | QFN          | RHB             | 32   | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| TRS3243EIDB      | ACTIVE                | SSOP         | DB              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDBG4    | ACTIVE                | SSOP         | DB              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDBR     | ACTIVE                | SSOP         | DB              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDBRG4   | ACTIVE                | SSOP         | DB              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDW      | ACTIVE                | SOIC         | DW              | 28   | 20          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDWG4    | ACTIVE                | SOIC         | DW              | 28   | 20          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDWR     | ACTIVE                | SOIC         | DW              | 28   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIDWRG4   | ACTIVE                | SOIC         | DW              | 28   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIPW      | ACTIVE                | TSSOP        | PW              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIPWG4    | ACTIVE                | TSSOP        | PW              | 28   | 50          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIPWR     | ACTIVE                | TSSOP        | PW              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |



| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TRS3243EIPWRG4   | ACTIVE                | TSSOP        | PW              | 28   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TRS3243EIRHBR    | ACTIVE                | QFN          | RHB             | 32   | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |
| TRS3243EIRHBRG4  | ACTIVE                | QFN          | RHB             | 32   | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-2-260C-1 YEAR          |

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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**TAPE AND REEL INFORMATION**



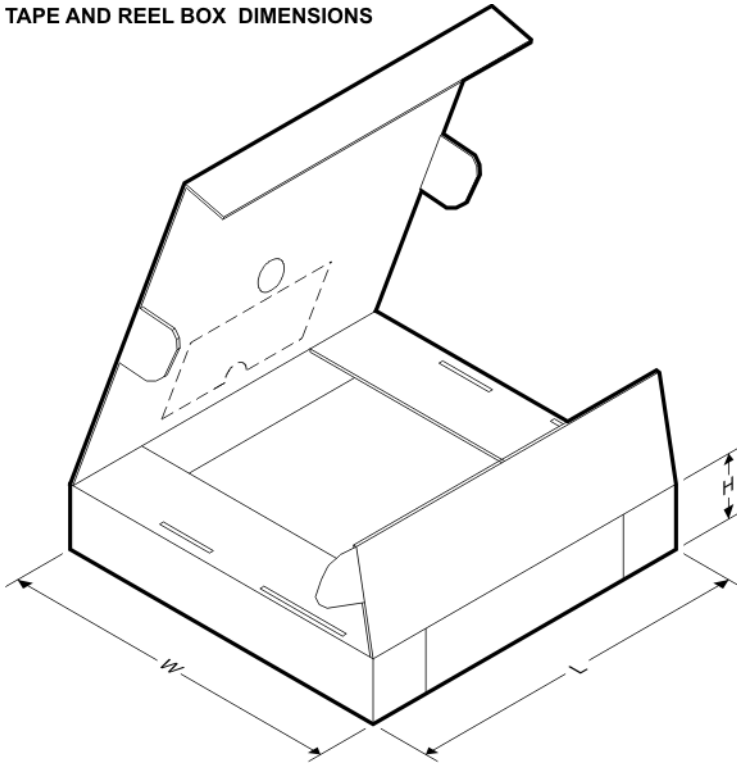
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TRS3243ECDBR  | 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               | 7.1     | 10.4    | 1.6     | 12.0    | 16.0   | Q1            |
| TRS3243ECPWR  | TSSOP        | PW              | 28   | 2000 | 330.0              | 16.4               | 6.9     | 10.2    | 1.8     | 12.0    | 16.0   | Q1            |
| TRS3243ECRHBR | QFN          | RHB             | 32   | 3000 | 330.0              | 12.4               | 5.3     | 5.3     | 1.5     | 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               | 7.1     | 10.4    | 1.6     | 12.0    | 16.0   | Q1            |
| TRS3243EIPWR  | TSSOP        | PW              | 28   | 2000 | 330.0              | 16.4               | 6.9     | 10.2    | 1.8     | 12.0    | 16.0   | Q1            |
| TRS3243EIRHBR | QFN          | 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 | 346.0       | 346.0      | 33.0        |
| TRS3243ECDWR  | SOIC         | DW              | 28   | 1000 | 346.0       | 346.0      | 49.0        |
| TRS3243ECPWR  | TSSOP        | PW              | 28   | 2000 | 346.0       | 346.0      | 33.0        |
| TRS3243ECPWR  | TSSOP        | PW              | 28   | 2000 | 346.0       | 346.0      | 33.0        |
| TRS3243ECRHBR | QFN          | RHB             | 32   | 3000 | 346.0       | 346.0      | 29.0        |
| TRS3243EIDBR  | SSOP         | DB              | 28   | 2000 | 346.0       | 346.0      | 33.0        |
| TRS3243EIDWR  | SOIC         | DW              | 28   | 1000 | 346.0       | 346.0      | 49.0        |
| TRS3243EIPWR  | TSSOP        | PW              | 28   | 2000 | 346.0       | 346.0      | 33.0        |
| TRS3243EIPWR  | TSSOP        | PW              | 28   | 2000 | 346.0       | 346.0      | 33.0        |
| TRS3243EIRHBR | QFN          | RHB             | 32   | 3000 | 346.0       | 346.0      | 29.0        |

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN

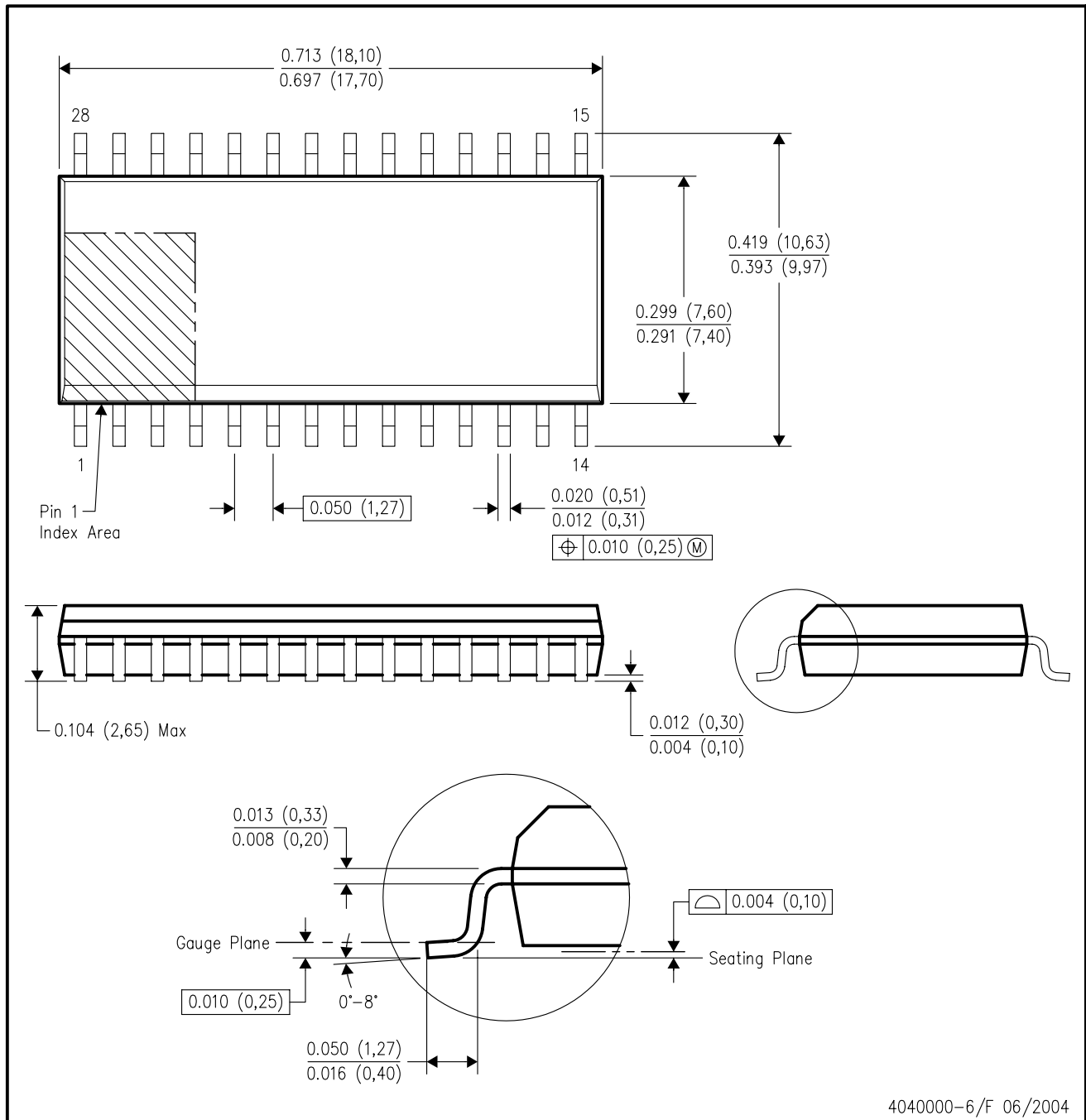


4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

DW (R-PDSO-G28)

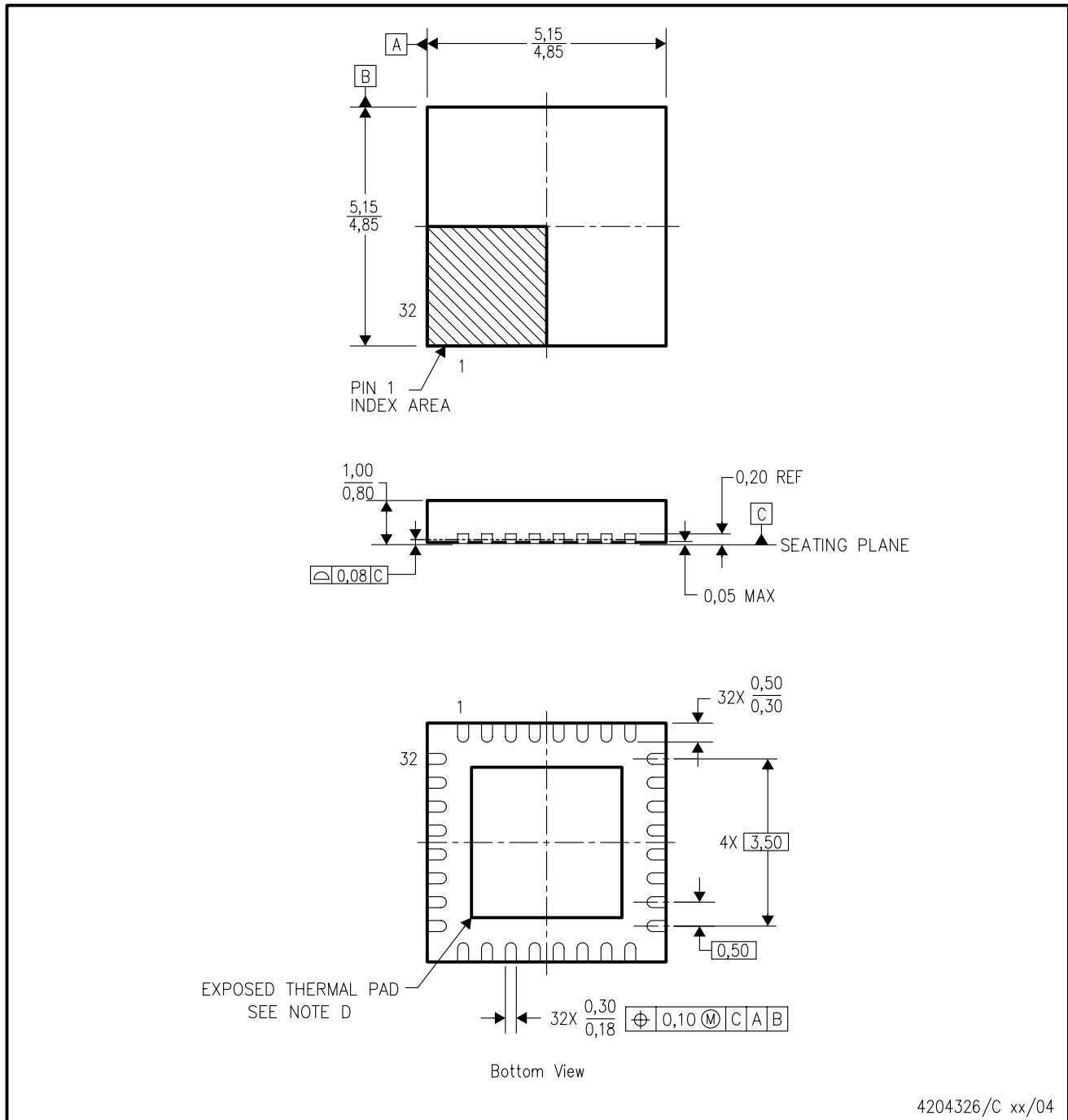
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - 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.

RHB (S-PQFP-N32)

PLASTIC QUAD FLATPACK



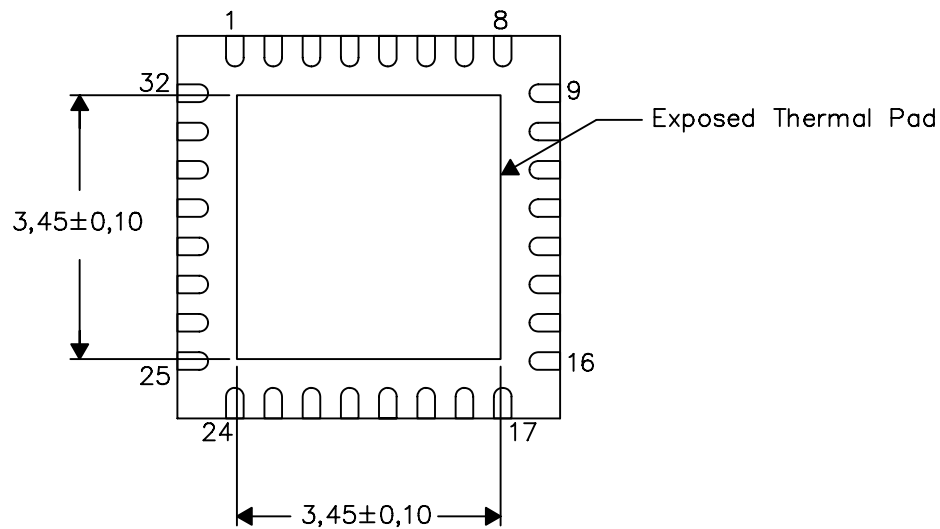
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. QFN (Quad Flatpack No-Lead) Package configuration.
  - D. The Package thermal pad must be soldered to the board for thermal and mechanical performance. See product data sheet for details regarding the exposed thermal pad dimensions.
  - E. Falls within JEDEC MO-220.

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



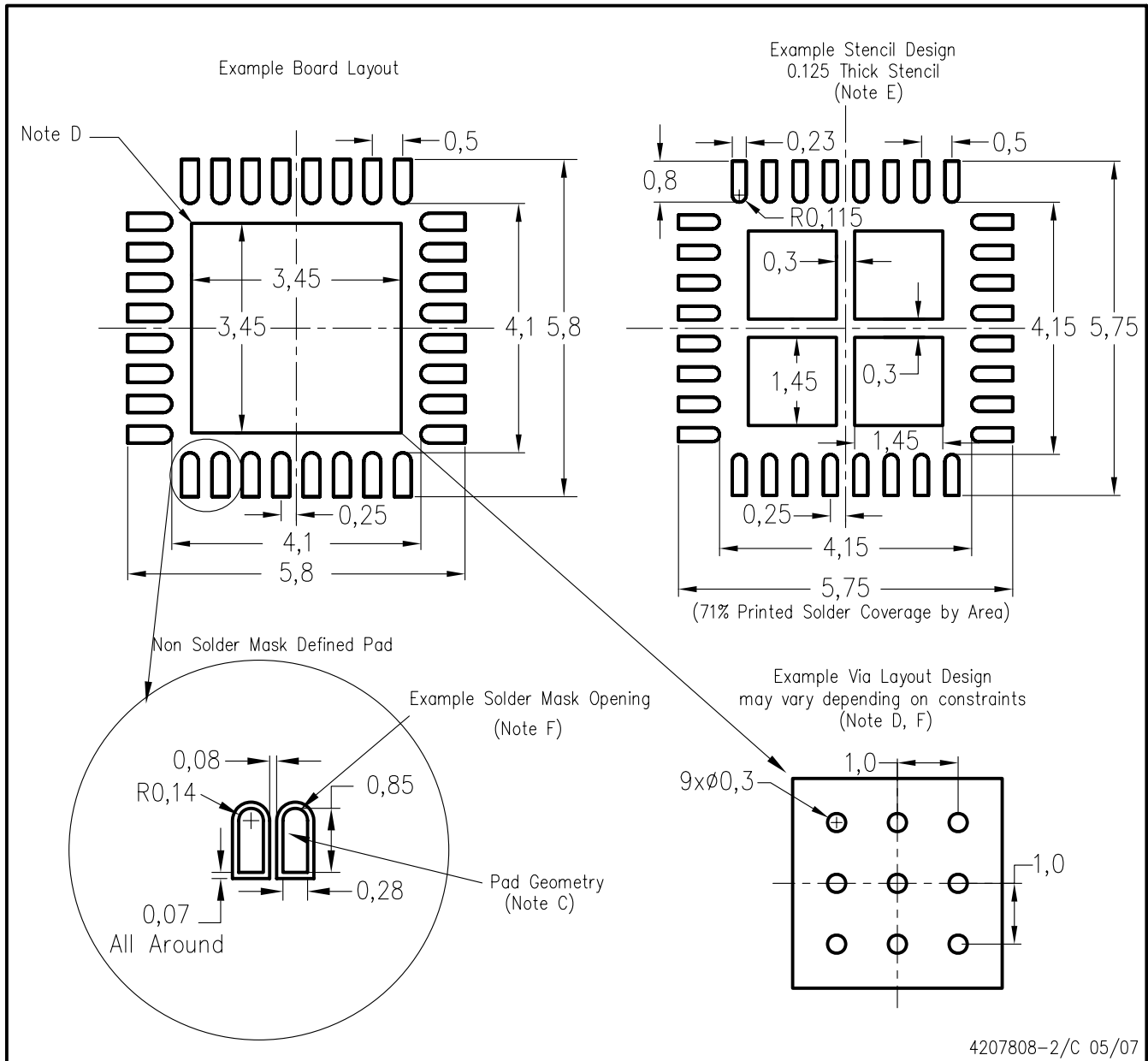
Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions



RHB (S-PQFP-N32)



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SCBA017, SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - E. 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 stencil design considerations.
  - F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

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