

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

Check for Samples: [TRS3243E](#)

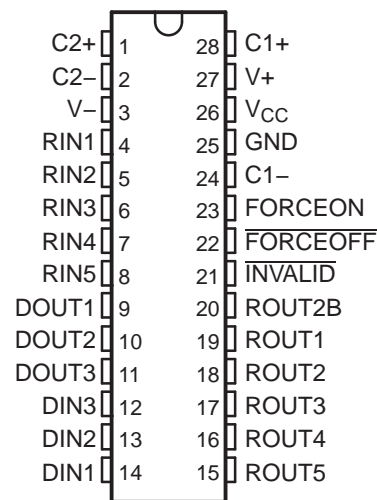
FEATURES

- **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 Typ**
- **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) Packages**

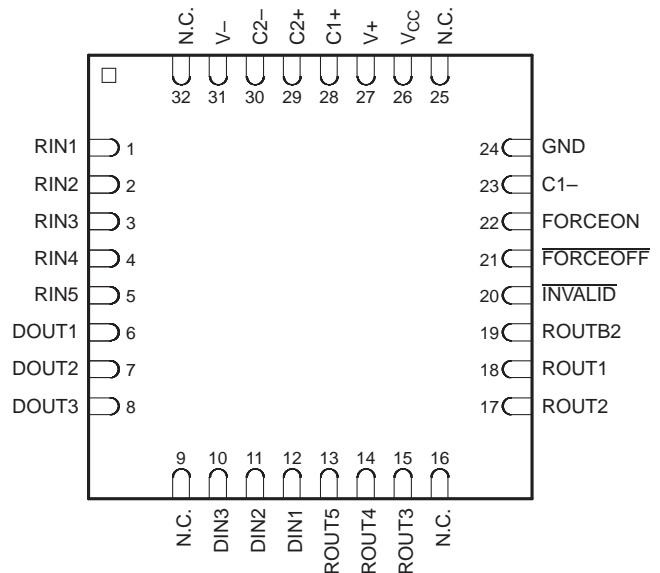
APPLICATIONS

- **Battery-Powered Systems**
- **PDA's**
- **Notebooks**
- **Laptops**
- **Palmtop PCs**
- **Hand-Held Equipment**

DB, DW, OR PW PACKAGE
(TOP VIEW)



QFN PACKAGE
(TOP VIEW)



N.C. – Not internally connected



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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/ μ s driver output slew rate.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and 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 FORCEOFF is set low, both drivers and receivers (except ROUT2B) are shut off, and the supply current is reduced to 1 μ A. Disconnecting the serial port or turning off the peripheral drivers causes the auto-powerdown condition to occur.

Auto-powerdown can be disabled when 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 INVALID output is used to notify the user if an RS-232 signal is present at any receiver input. 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 μ s. INVALID is low (invalid data) if all receiver input voltages are between -0.3 V and 0.3 V for more than 30 μ 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.

Table 1. ORDERING INFORMATION

| T _A | PACKAGE ⁽¹⁾ | | 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.

FUNCTION TABLES
Each Driver⁽¹⁾

| INPUTS | | | | OUTPUT | | DRIVER STATUS |
|--------|---------|------------------------------|------------------------|--------|---|---------------|
| DIN | FORCEON | $\overline{\text{FORCEOFF}}$ | 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

Each Receiver⁽¹⁾

| INPUTS | | | OUTPUT | | RECEIVER STATUS |
|--------|---------|------------------------------|--------|---|-----------------|
| RIN | FORCEON | $\overline{\text{FORCEOFF}}$ | 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 | | |

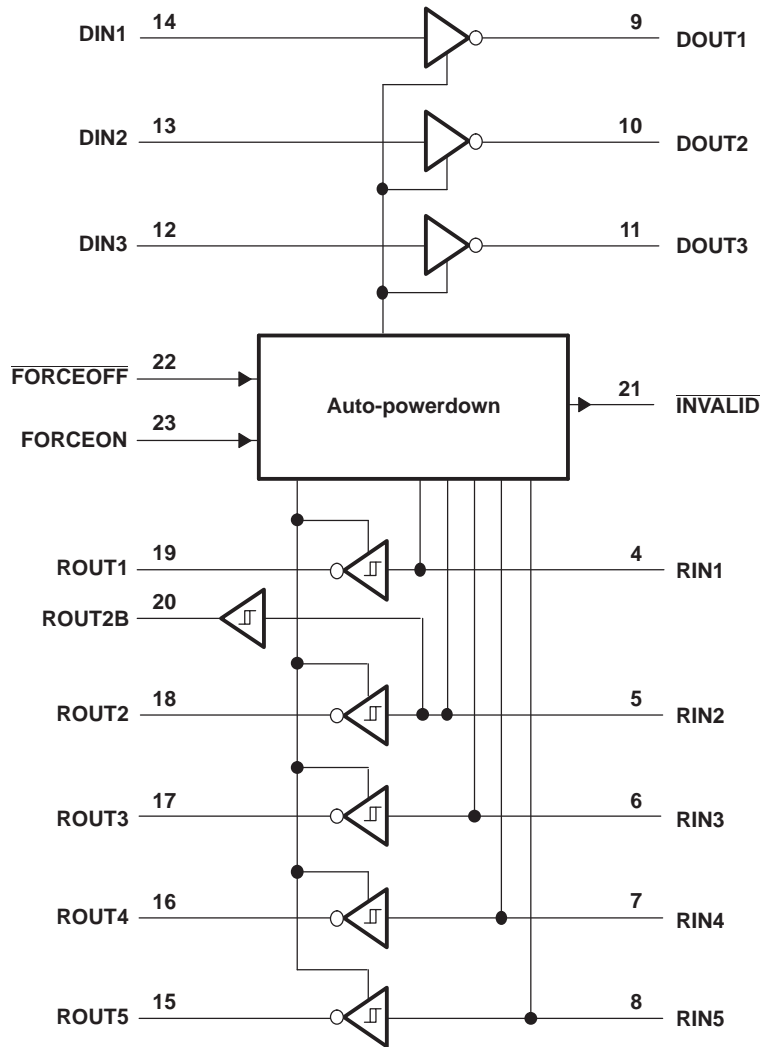
(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

ROUT2B and Outputs $\overline{\text{INVALID}}$ ⁽¹⁾

| INPUTS | | | | OUTPUTS | | OUTPUT STATUS |
|------------------------|------|---------|------------------------------|-----------------------------|--------|---------------|
| VALID RIN RS-232 LEVEL | RIN2 | FORCEON | $\overline{\text{FORCEOFF}}$ | $\overline{\text{INVALID}}$ | 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

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings⁽¹⁾

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

| | | MIN | MAX | UNIT | |
|--|---|--|-------|-----------------------|------|
| V _{CC} | Supply voltage range ⁽²⁾ | -0.3 | 6 | V | |
| V+ | Positive output supply voltage range ⁽²⁾ | -0.3 | 7 | V | |
| V- | Negative output supply voltage range ⁽²⁾ | 0.3 | -7 | V | |
| V+ – V- | Output supply voltage difference ⁽²⁾ | | 13 | V | |
| V _I | Input voltage range | Driver ($\overline{\text{FORCEOFF}}$, FORCEON) | -0.3 | 6 | V |
| | | Receiver | -25 | 25 | |
| V _O | Output voltage range | Driver | -13.2 | 13.2 | V |
| | | Receiver ($\overline{\text{INVALID}}$) | -0.3 | V _{CC} + 0.3 | |
| θ _{JA} | Package thermal impedance ^{(3) (4)} | DB package | | 62 | °C/W |
| | | DW package | | 46 | |
| | | PW package | | 62 | |
| Lead temperature 1,6 mm (1/16 in) from case for 10 s | | | 260 | °C | |
| T _{stg} | Storage temperature range | -65 | 150 | °C | |

- (1) 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.
- (2) All voltages are with respect to network GND.
- (3) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A)/θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions⁽¹⁾

 See [Figure 6](#)

| | | MIN | NOM | MAX | UNIT |
|---|---|-------------------------|-----|-----|------|
| Supply voltage | V _{CC} = 3.3 V | 3 | 3.3 | 3.6 | V |
| | V _{CC} = 5 V | 4.5 | 5 | 5.5 | |
| V _{IH} Driver and control high-level input voltage | DIN, $\overline{\text{FORCEOFF}}$, FORCEON | V _{CC} = 3.3 V | 2 | | V |
| | | V _{CC} = 5 V | 2.4 | | |
| V _{IL} Driver and control low-level input voltage | DIN, $\overline{\text{FORCEOFF}}$, FORCEON | | | 0.8 | V |
| V _I Driver and control input voltage | DIN, $\overline{\text{FORCEOFF}}$, 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 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

Electrical Characteristics⁽¹⁾

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽²⁾ | MAX | UNIT |
|-----------------|--|--|---|--------------------|-----|------|
| I _I | Input leakage current | $\overline{\text{FORCEOFF}}$, FORCEON | | ±0.01 | ±1 | μA |
| I _{CC} | Supply current (T _A = 25°C) | Auto-powerdown disabled | No load, $\overline{\text{FORCEOFF}}$ and FORCEON at V _{CC} | 0.3 | 1 | mA |
| | | Powered off | No load, $\overline{\text{FORCEOFF}}$ at GND | 1 | 10 | |
| | | Auto-powerdown enabled | No load, $\overline{\text{FORCEOFF}}$ at V _{CC} , FORCEON at GND, All RIN are open or grounded, All DIN are grounded | 1 | 10 | μA |

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

DRIVER SECTION

Electrical Characteristics⁽¹⁾

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

| PARAMETER | TEST CONDITIONS | MIN | TYP ⁽²⁾ | MAX | UNIT |
|---|--|-----|--------------------|-----|------|
| 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 | $\overline{\text{FORCEOFF}}$ = GND, V _O = ±12 V, V _{CC} = 0 to 5.5 V | | | ±25 | μA |

(1) 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.

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

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

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

(1) 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.

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

(3) Pulse skew is defined as |t_{PLH} – t_{PHL}| 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⁽¹⁾

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽²⁾ | MAX | UNIT |
|------------------|---|--------------------------------|-----------------------|-----------------------|-----|------|
| 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 |

(1) 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.

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

Switching Characteristics⁽¹⁾

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

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

(1) 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.

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

(3) Pulse skew is defined as |t_{PLH} - t_{PHL}| 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 | $I_{OH} = -1\text{ mA}$, FORCEON = GND, FORCEOFF = V_{CC} | $V_{CC} - 0.6$ | | V |
| V_{OL} | $\overline{INVALID}$ low-level output voltage | $I_{OL} = 1.6\text{ mA}$, FORCEON = GND, FORCEOFF = V_{CC} | | 0.4 | V |

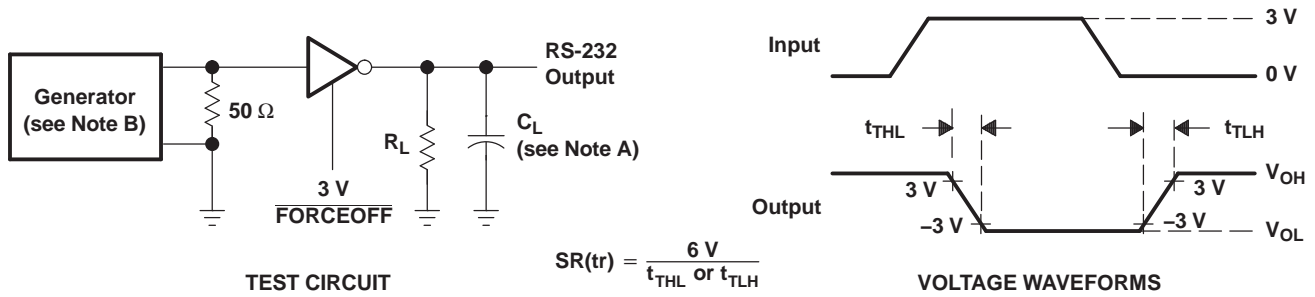
Switching Characteristics

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

| PARAMETER | | TEST CONDITIONS | TYP ⁽¹⁾ | UNIT |
|---------------|---|-----------------------|--------------------|---------------|
| 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 |

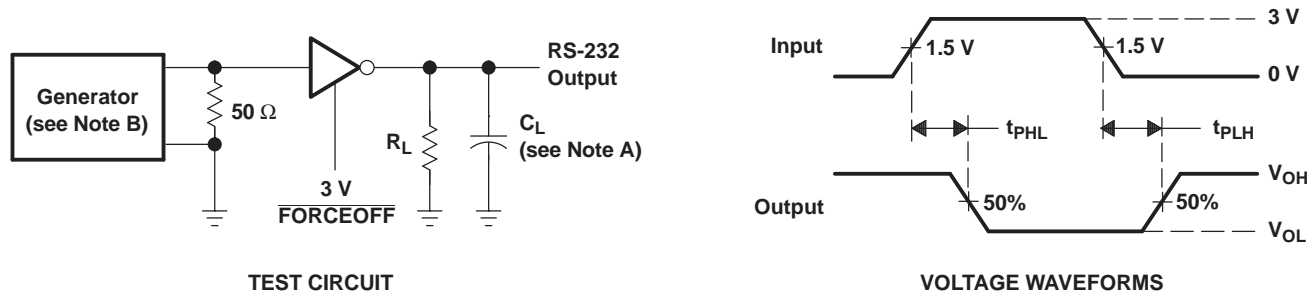
(1) All typical values are at $V_{CC} = 3.3\text{ V}$ or $V_{CC} = 5\text{ V}$, and $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION



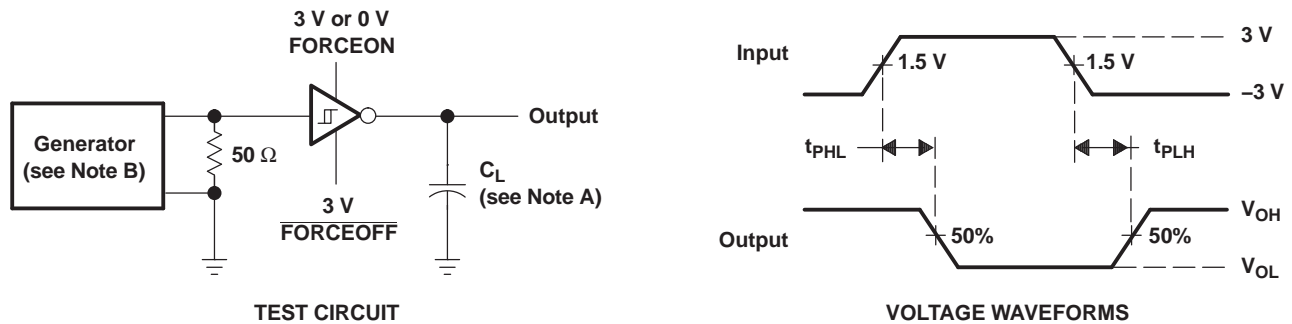
- NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

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, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

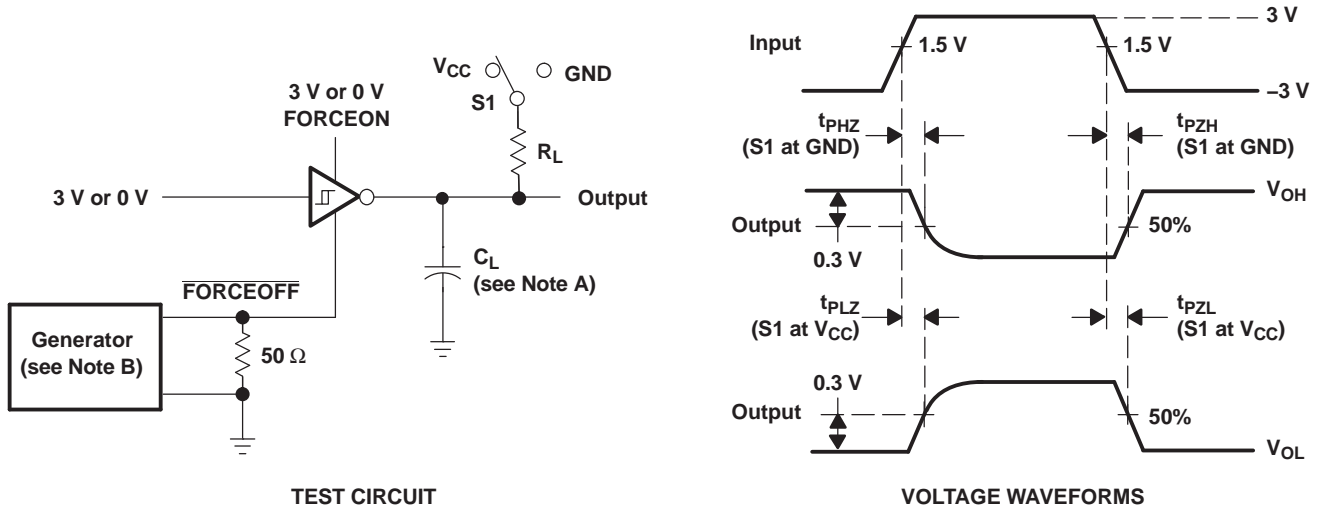
Figure 2. Driver Pulse Skew



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

Figure 3. Receiver Propagation Delay Times

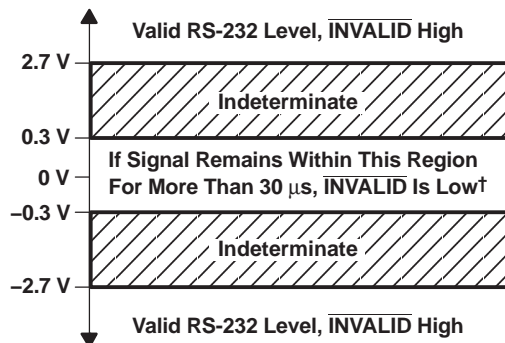
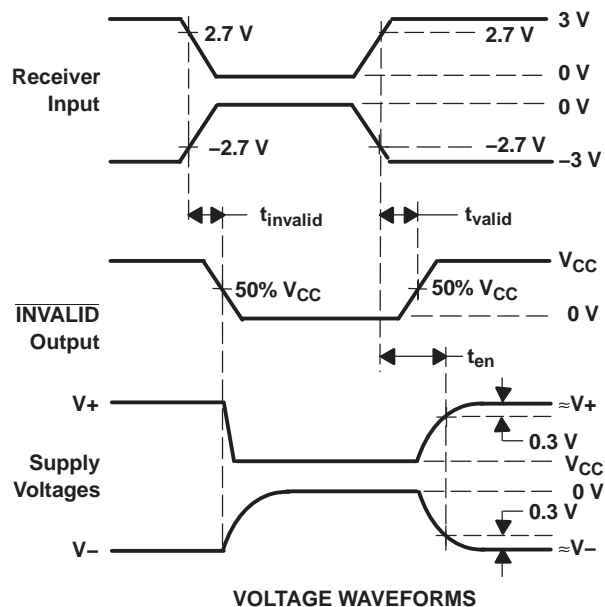
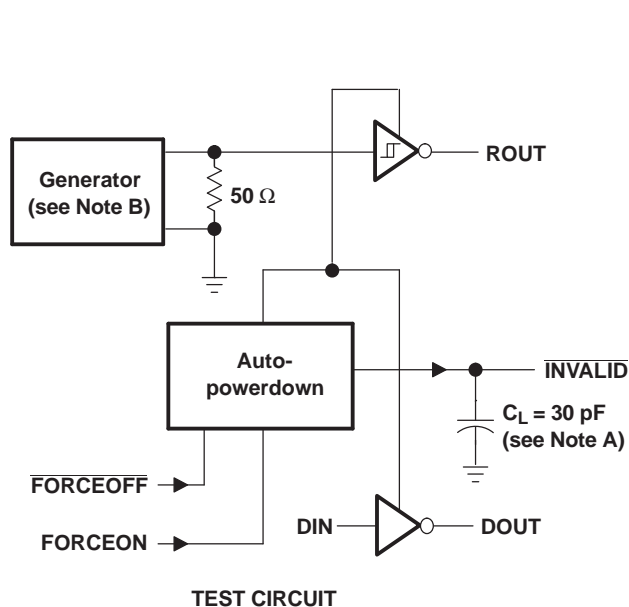
PARAMETER MEASUREMENT INFORMATION



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

PARAMETER MEASUREMENT INFORMATION

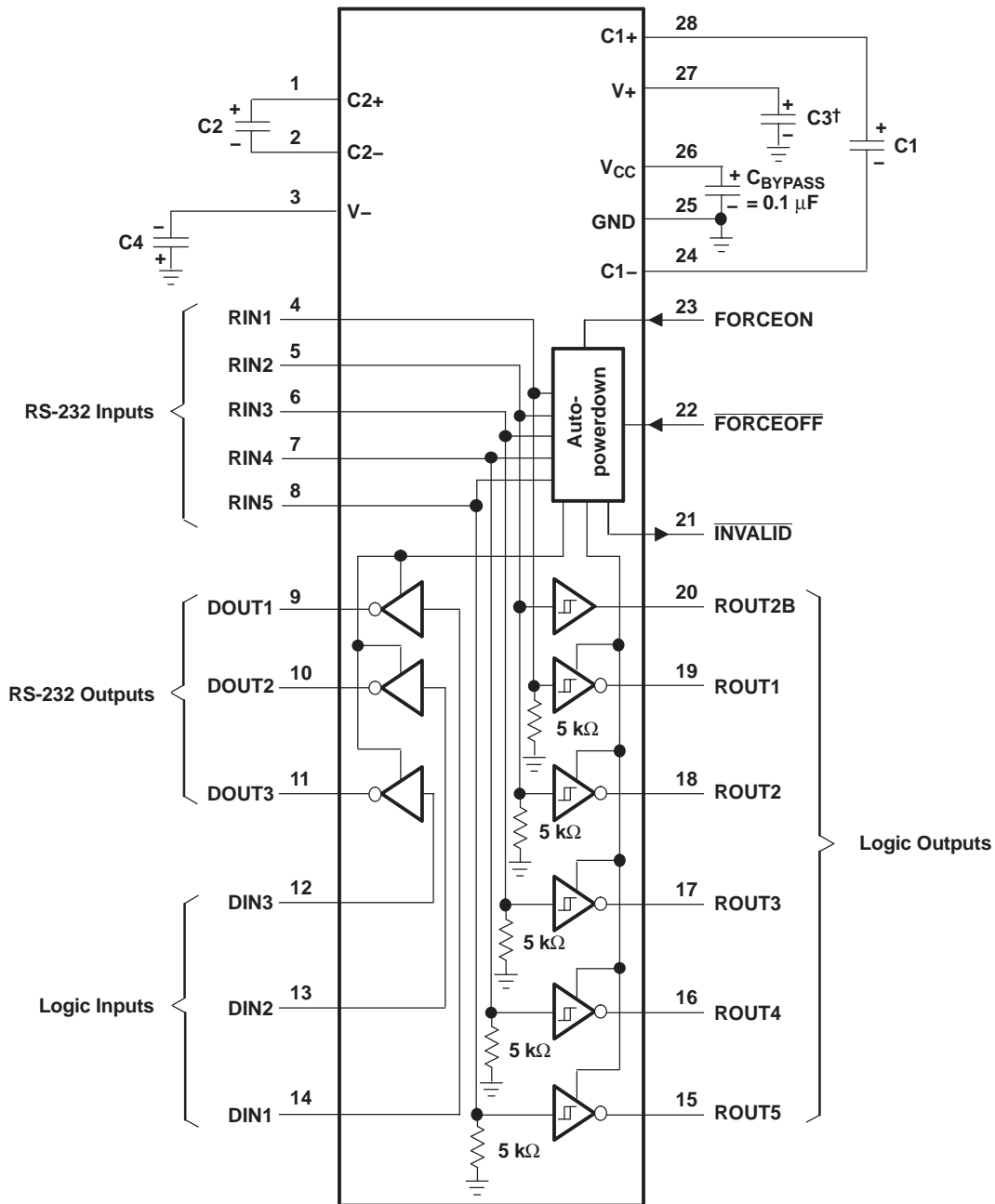


† Auto-powerdown disables drivers and reduces supply current to 1 μ A.

- 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. $\overline{\text{INVALID}}$ Propagation Delay Times and Supply Enabling Time

APPLICATION INFORMATION



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

- NOTES: A. Resistor values are nominal.
 B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

V_{CC} vs CAPACITOR VALUES

| V _{CC} | C1 | C2, C3, and C4 |
|-----------------|----------|----------------|
| 3.3 V ± 0.3 V | 0.1 μF | 0.1 μF |
| 5 V ± 0.5 V | 0.047 μF | 0.33 μF |
| 3 V to 5.5 V | 0.1 μF | 0.47 μF |

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 ± 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

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 Ω resistor.

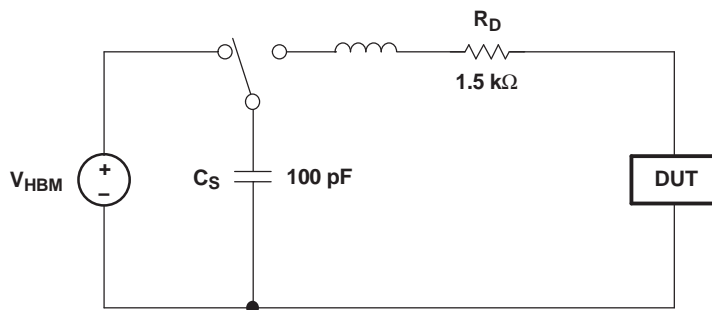


Figure 7. HBM ESD Test Circuit

APPLICATION INFORMATION

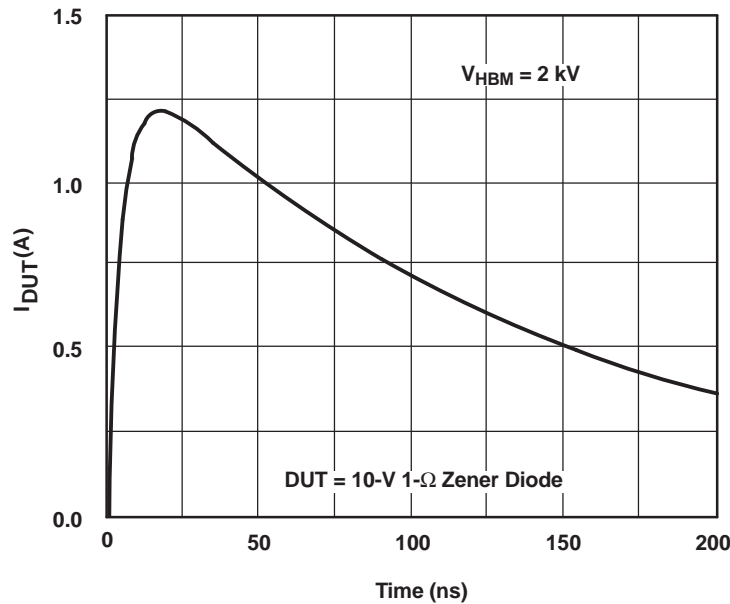


Figure 8. Typical HBM Current Waveform

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 ± 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.

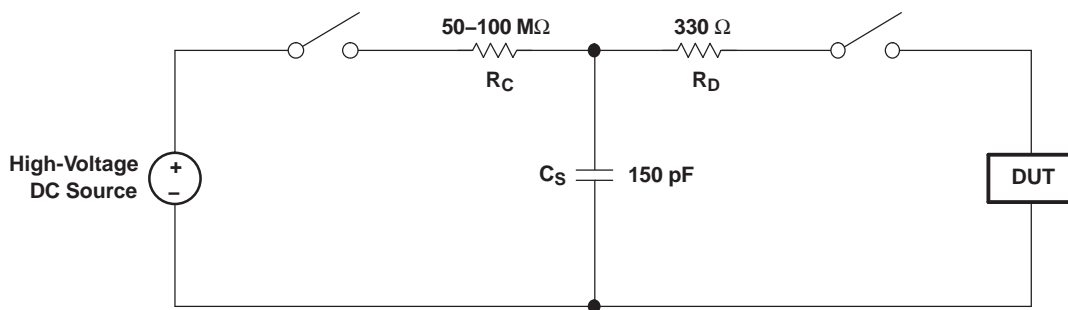


Figure 9. Simplified IEC61000-4-2 ESD Test Circuit

APPLICATION INFORMATION

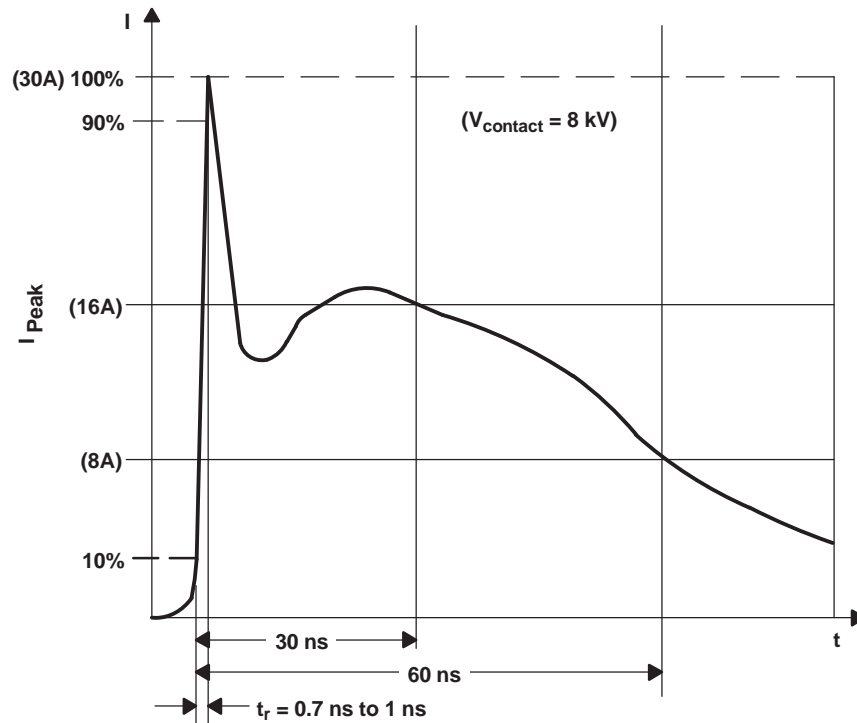


Figure 10. Typical Current Waveform of IEC61000-4-2 ESD Generator

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.

REVISION HISTORY

| Changes from Revision B (July 2009) to Revision C | Page |
|---|------|
| • Deleted "VALID RIN RS-232 LEVEL" from INPUTS. | 3 |
| • Deleted "ROUT2B is active" RECEIVER STATUS and combined ROUT outputs. | 3 |
| • Added New Table "ROUT2B and <u>INVALID</u> Outputs" defining truth table for ROUT2B and INVALID outputs. | 3 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| TRS3243ECDB | ACTIVE | SSOP | DB | 28 | 50 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECDBR | ACTIVE | SSOP | DB | 28 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECDW | ACTIVE | SOIC | DW | 28 | 20 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECDWR | ACTIVE | SOIC | DW | 28 | 1000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRS3243EC | Samples |
| TRS3243ECPW | ACTIVE | TSSOP | PW | 28 | 50 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | RS43EC | Samples |
| TRS3243ECPWR | ACTIVE | TSSOP | PW | 28 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | RS43EC | Samples |
| TRS3243ECRHBR | ACTIVE | VQFN | RHB | 32 | 3000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | RS43EC | Samples |
| TRS3243EIDB | ACTIVE | SSOP | DB | 28 | 50 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIDBR | ACTIVE | SSOP | DB | 28 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIDW | ACTIVE | SOIC | DW | 28 | 20 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIDWR | ACTIVE | SOIC | DW | 28 | 1000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRS3243EI | Samples |
| TRS3243EIPW | ACTIVE | TSSOP | PW | 28 | 50 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RS43EI | Samples |
| TRS3243EIPWR | ACTIVE | TSSOP | PW | 28 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RS43EI | Samples |
| TRS3243EIPWRG4 | ACTIVE | TSSOP | PW | 28 | 2000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RS43EI | Samples |
| TRS3243EIRHBR | ACTIVE | VQFN | RHB | 32 | 3000 | Green (RoHS & no Sb/Br) | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | RS43EI | Samples |
| TRS3243EIRHBRG4 | ACTIVE | VQFN | RHB | 32 | 3000 | Green (RoHS & no Sb/Br) | 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.

OBSELETE: 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 ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm 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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

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 | 6.9 | 10.2 | 1.8 | 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 | VQFN | 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 | 6.9 | 10.2 | 1.8 | 12.0 | 16.0 | Q1 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.5 | 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 | 367.0 | 367.0 | 38.0 |
| TRS3243ECDWR | SOIC | DW | 28 | 1000 | 350.0 | 350.0 | 66.0 |
| TRS3243ECPWR | TSSOP | PW | 28 | 2000 | 367.0 | 367.0 | 38.0 |
| TRS3243ECPWR | TSSOP | PW | 28 | 2000 | 350.0 | 350.0 | 43.0 |
| TRS3243ECRHBR | VQFN | RHB | 32 | 3000 | 367.0 | 367.0 | 35.0 |
| TRS3243EIDBR | SSOP | DB | 28 | 2000 | 367.0 | 367.0 | 38.0 |
| TRS3243EIDWR | SOIC | DW | 28 | 1000 | 350.0 | 350.0 | 66.0 |
| TRS3243EIPWR | TSSOP | PW | 28 | 2000 | 367.0 | 367.0 | 38.0 |
| TRS3243EIRHBR | VQFN | RHB | 32 | 3000 | 367.0 | 367.0 | 35.0 |

DB0028A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4214853/B 03/2018

NOTES:

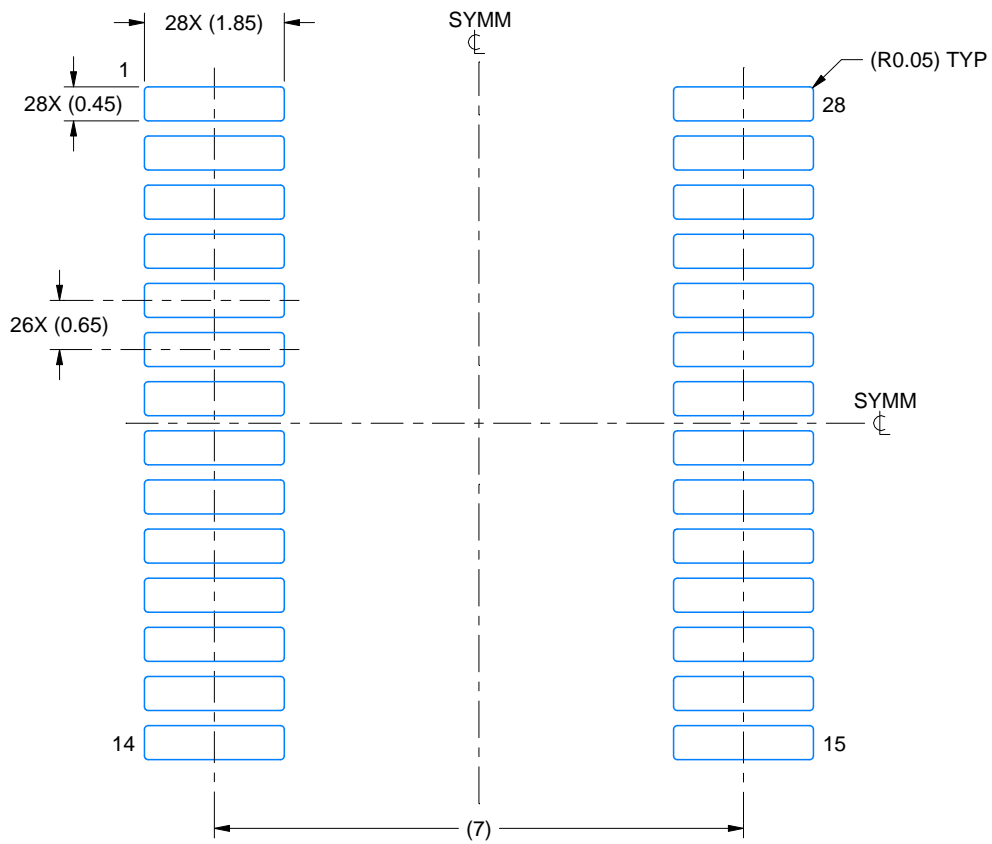
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

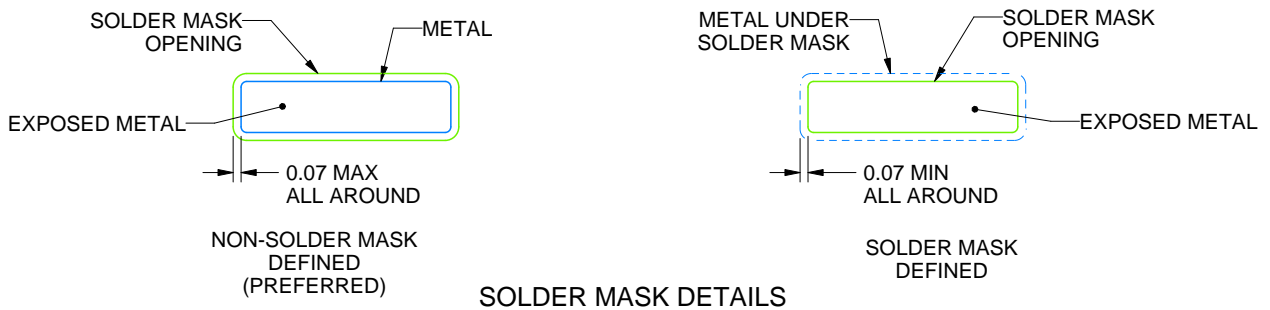
DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4214853/B 03/2018

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



SOLDER MASK DETAILS

4223442/B 08/2019

NOTES: (continued)

4. 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).
5. 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

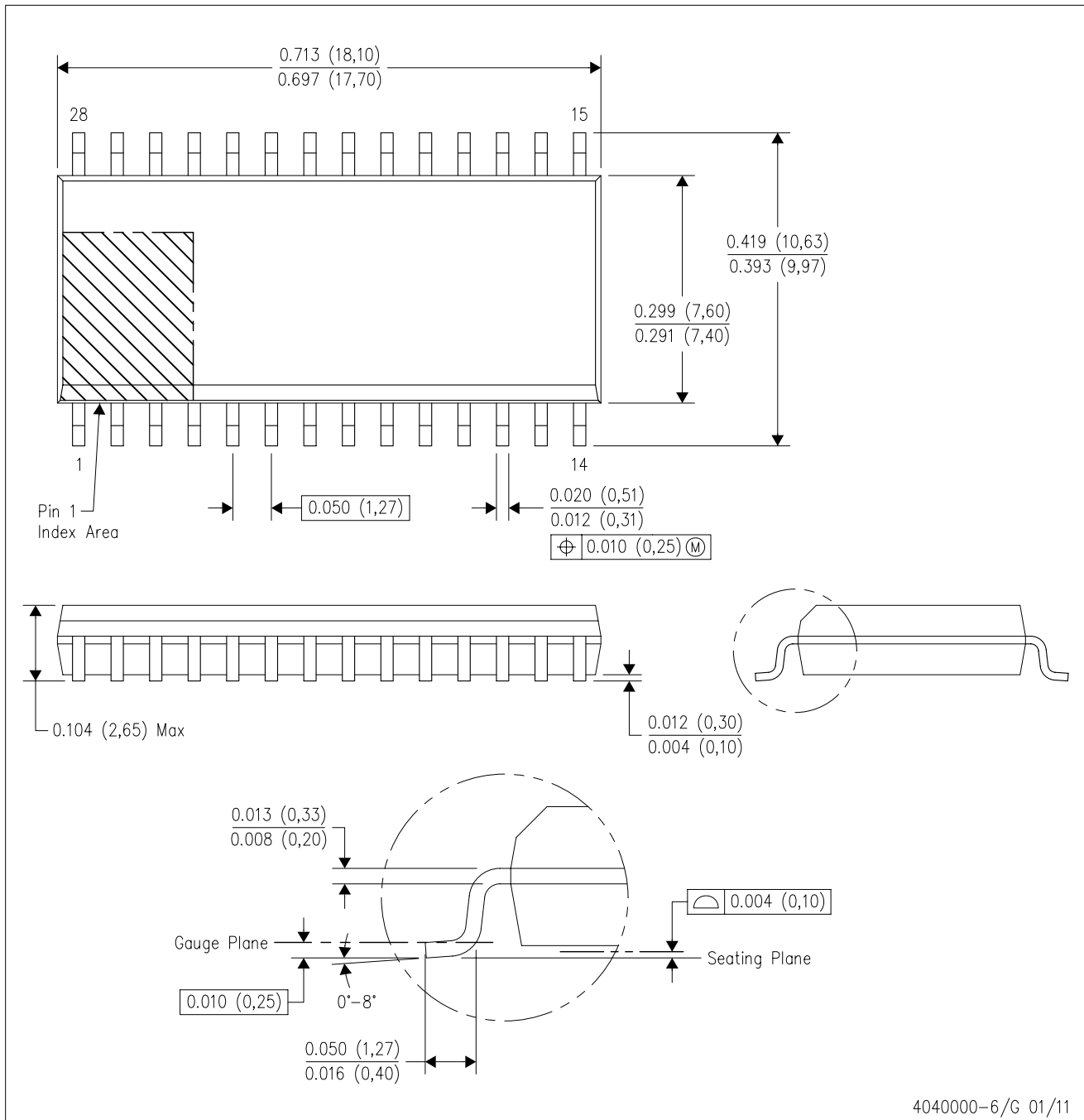
4223442/B 08/2019

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



- 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.

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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