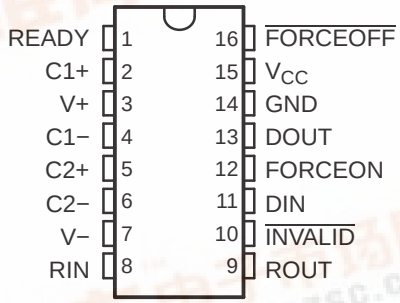
## FEATURES

- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates With 3-V to 5.5-V $V_{CC}$ Supply
- Operates at Least 1 Mbit/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 '3227 Devices
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection for RS-232 I/O Pins
  - ±15 kV – Human-Body Model
  - ±8 kV – IEC61000-4-2, Contact Discharge
  - ±8 kV – IEC61000-4-2, Air-Gap Discharge
- Auto-Powerdown Plus Feature Automatically Disables Drivers for Power Savings
- Packaged in Plastic Shrink Small-Outline Package

## APPLICATIONS

- Battery-Powered, Hand-Held, and Portable Equipment
- PDAs and Palmtop PCs
- Notebooks, Sub-Notebooks, and Laptops
- Digital Cameras
- Mobile Phones and Wireless Devices

DB PACKAGE
(TOP VIEW)




## DESCRIPTION/ORDERING INFORMATION

The TRS3227 consists of one line driver, one line receiver, and a dual charge-pump circuit with ±15-kV ESD protection pin to pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. This device operates at data-signaling rates of 1 Mbit/s in normal operating mode and a maximum of 30-V/µs driver output slew rate. This device also features a logic-level output (READY) that asserts when the charge pump is regulating and the device is ready to begin transmitting.

The TRS3227 achieves a 1-µA supply current using the auto-powerdown plus feature. This device automatically enters a low-power powerdown mode when the RS-232 cable is disconnected or the drivers of the connected peripherals are inactive for more than 30 s. It turns on again when it senses a valid transition at any driver or receiver input. Auto-powerdown saves power without changes to the existing BIOS or operating system.

The TRS3227C is characterized for operation from 0°C to 70°C. The TRS3227I is characterized for operation from –40°C to 85°C.

### ORDERING INFORMATION

| $T_A$ | PACKAGE(1)(2) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| 0°C to 70°C | SSOP – DB | Reel of 2000 | TRS3227CDBR | RS27C |
| –40°C to 85°C | SSOP – DB | Reel of 2000 | TRS3227IDBR | RS27I |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(2) 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 TABLE(1)

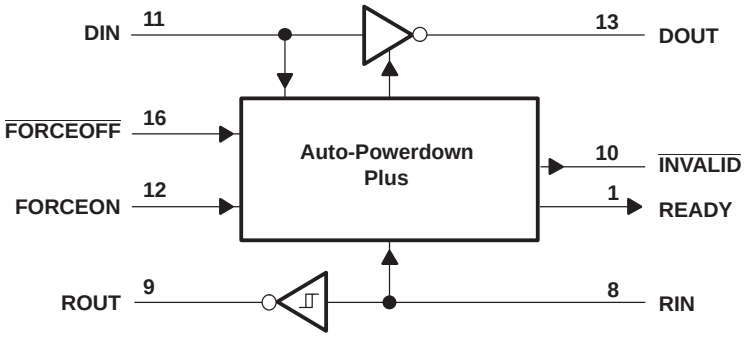
| INPUT CONDITIONS | | | | OUTPUT STATES | | | | OPERATING MODE |
|---|---|---|---|---|---|---|---|---|
| FORCEON | $\overline{\text{FORCEOFF}}$ | RECEIVER OR DRIVER EDGE WITHIN 30 s | VALID RS-232 LEVEL PRESENT AT RECEIVER | DRIVER | RECEIVER | $\overline{\text{INVALID}}$ | READY | |
| **Auto-Powerdown Plus Conditions** | | | | | | | | |
| H | H | NO | NO | Active | Active | L | H | Normal operation, auto-powerdown plus disabled |
| H | H | NO | YES | Active | Active | H | H | Normal operation, auto-powerdown plus disabled |
| L | H | YES | NO | Active | Active | L | H | Normal operation, auto-powerdown plus enabled |
| L | H | YES | YES | Active | Active | H | H | Normal operation, auto-powerdown plus enabled |
| L | H | NO | NO | Z | Active | L | L | Powerdown, auto-powerdown plus enabled |
| L | H | NO | YES | Z | Active | H | L | Powerdown, auto-powerdown plus enabled |
| X | L | X | NO | Z | Active | L | L | Manual powerdown |
| X | L | X | YES | Z | Active | H | L | Manual powerdown |
| **Auto-Powerdown Conditions** | | | | | | | | |
| $\overline{\text{INVALID}}$ | $\overline{\text{INVALID}}$ | X | NO | Z | Active | L | L | Powerdown, auto-powerdown enabled |
| $\overline{\text{INVALID}}$ | $\overline{\text{INVALID}}$ | X | YES | Active | Active | H | H | Normal operation, auto-powerdown enabled |

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

## TERMINAL FUNCTIONS

| TERMINAL | | DESCRIPTION |
|---|---|---|
| NAME | NO. | |
| C1+ | 2 | Positive terminal of voltage-doubler charge-pump capacitor |
| C1– | 4 | Negative terminal of voltage-doubler charge-pump capacitor |
| C2+ | 5 | Positive terminal of inverting charge-pump capacitor |
| C2– | 6 | Negative terminal of inverting charge-pump capacitor |
| DIN | 11 | CMOS driver input |
| DOUT | 13 | RS-232 driver output |
| $\overline{\text{FORCEOFF}}$ | 16 | Force-off input, active low. Drive low to shut down drivers, receivers, and charge pump. This overrides auto-shutdown and FORCEON (see Function Table). |
| FORCEON | 12 | Force-on input, active high. Drive high to override powerdown, keeping drivers and receivers on (FORCEOFF must be high) (see Function Table). |
| GND | 14 | Ground |
| $\overline{\text{INVALID}}$ | 10 | Valid signal detector output, active low. A logic high indicates that a valid RS-232 level is present on a receiver input. |
| READY | 1 | Ready to transmit output, active high. READY is enabled high when V– goes below –3.5 V and the device is ready to transmit. |
| RIN | 8 | RS-232 receiver input |
| ROUT | 9 | CMOS receiver output |
| V+ | 3 | $+2 \times V_{CC}$ generated by the charge pump |
| V– | 7 | $-2 \times V_{CC}$ generated by the charge pump |
| $V_{CC}$ | 15 | 3-V to 5.5-V single-supply voltage |

## 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– | 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 ($\overline{\text{INVALID}}$, READY) | –0.3 | $V_{CC}$ + 0.3 | |
| | Short-circuit duration | DOUT to GND | | Unlimited | |
| $\theta_{JA}$ | Package thermal impedance(3) | | | 82 | °C/W |
| | 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) The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions(1)

See Figure 5

| | | | | 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 | | 5.5 | V |
| | | | $V_{CC}$ = 5 V | 2.4 | | 5.5 | |
| $V_{IL}$ | Driver and control low-level input voltage | DIN, $\overline{\text{FORCEOFF}}$, FORCEON | | 0 | | 0.8 | V |
| $V_I$ | Receiver input voltage | | | –25 | | 25 | V |
| $T_A$ | Operating free-air temperature | | TRS3227C | 0 | | 70 | °C |
| | | | TRS3227I | –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 5)

| 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 plus disabled | No load, $\overline{\text{FORCEOFF}}$ and FORCEON at $V_{CC}$ | | 0.3 | 2 | mA |
| | | Powered off | No load, $\overline{\text{FORCEOFF}}$ at GND | | 1 | 10 | µA |
| | | Auto-powerdown plus enabled | No load, $\overline{\text{FORCEOFF}}$ at $V_{CC}$, FORCEON at GND, All RIN are open or grounded | | 1 | 10 | |

(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 1 and Figure 2)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | High-level output voltage | DOUT at $R_L$ = 3 kΩ to GND, | DIN = GND | | 5 | 5.4 | | V |
| $V_{OL}$ | Low-level output voltage | DOUT at $R_L$ = 3 kΩ to GND, | DIN = $V_{CC}$ | | –5 | –5.4 | | 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 |
| $I_{OS}$ | Short-circuit output current(3) | $V_{CC}$ = 3.6 V, | $V_O$ = 0 V | | | ±35 | ±60 | mA |
| | | $V_{CC}$ = 5.5 V, | $V_O$ = 0 V | | | ±35 | ±60 | |
| $r_o$ | 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)

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

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP(2) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| Maximum data rate | | $C_L$ = 1000 pF, One DIN switching, | $R_L$ = 3 kΩ, See Figure 1 | | 250 | | | kbit/s |
| | | $C_L$ = 1000 pF, $V_{CC}$ = 4.5 V, | $R_L$ = 3 kΩ, See Figure 1 | One DIN switching, | 1000 | | | |
| | | $C_L$ = 250 pF, $V_{CC}$ = 3 V, | $R_L$ = 3 kΩ, See Figure 1 | One DIN switching, | 1000 | | | |
| $t_{sk(p)}$ | Pulse skew(3) | $C_L$ = 150 pF to 2500 pF, | $R_L$ = 3 kΩ to 7 kΩ, | See Figure 2 | | 25 | | ns |
| SR(tr) | Slew rate, transition region | $V_{CC}$ = 3.3 V, $C_L$ = 150 pF to 1000 pF, | $R_L$ = 3 kΩ to 7 kΩ, See Figure 1 | | 24 | | 150 | V/µs |

(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

| TERMINAL | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| NAME | NO. | | | |
| DOUT | 13 | Human-Body Model | ±15 | kV |
| | | Contact Discharge (IEC61000-4-2) | ±8 | |
| | | Air-Gap Discharge (IEC61000-4-2) | ±8 | |

## RECEIVER SECTION

### Electrical Characteristics(1)

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

| 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 | $I_{OL}$ = 1.6 mA | | | 0.4 | V |
| $V_{IT+}$ | Positive-going input threshold voltage | $V_{CC}$ = 3.3 V | | 1.5 | 2.4 | V |
| | | $V_{CC}$ = 5 V | | 1.8 | 2.4 | |
| $V_{IT–}$ | Negative-going input threshold voltage | $V_{CC}$ = 3.3 V | 0.6 | 1.2 | | V |
| | | $V_{CC}$ = 5 V | 0.8 | 1.5 | | |
| $V_{hys}$ | Input hysteresis ($V_{IT+}$ – $V_{IT–}$) | | | 0.5 | | V |
| $I_{off}$ | Output leakage current | | | ±0.05 | ±10 | µA |
| $r_I$ | Input resistance | $V_I$ = ±3 V to ±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 | $C_L$ = 150 pF, See Figure 3 | 150 | 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

| TERMINAL | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| NAME | NO. | | | |
| RIN | 8 | Human-Body Model | ±15 | kV |
| | | Contact Discharge (IEC61000-4-2) | ±8 | |
| | | Air-Gap Discharge (IEC61000-4-2) | ±15 | |

## AUTO-POWERDOWN SECTION

### Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 4)

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

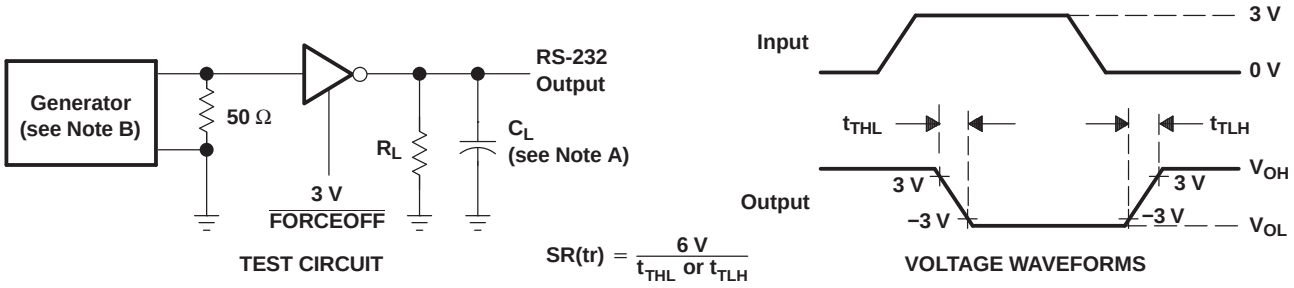
### Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 4)

| PARAMETER | | | MIN | TYP(1) | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{INVH}$ | Propagation delay time, low- to high-level output | | | 1 | | µs |
| $t_{INVL}$ | Propagation delay time, high- to low-level output | | | 30 | | µs |
| $t_{WU}$ | Supply enable time | | | 100 | | µs |
| $t_{AUTOPRDN}$ | Driver or receiver edge to driver's shutdown | $V_{CC}$ = 5 V | 15 | 30 | 60 | s |

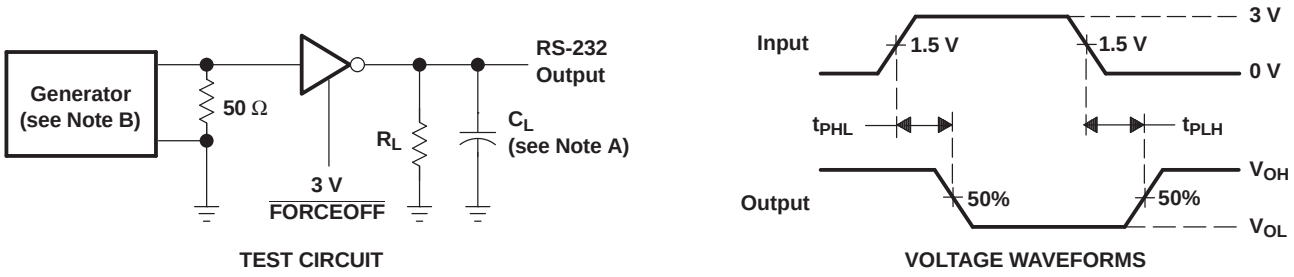
(1) All typical values are at $V_{CC}$ = 3.3 V or $V_{CC}$ = 5 V, and $T_A$ = 25°C.

## PARAMETER MEASUREMENT INFORMATION



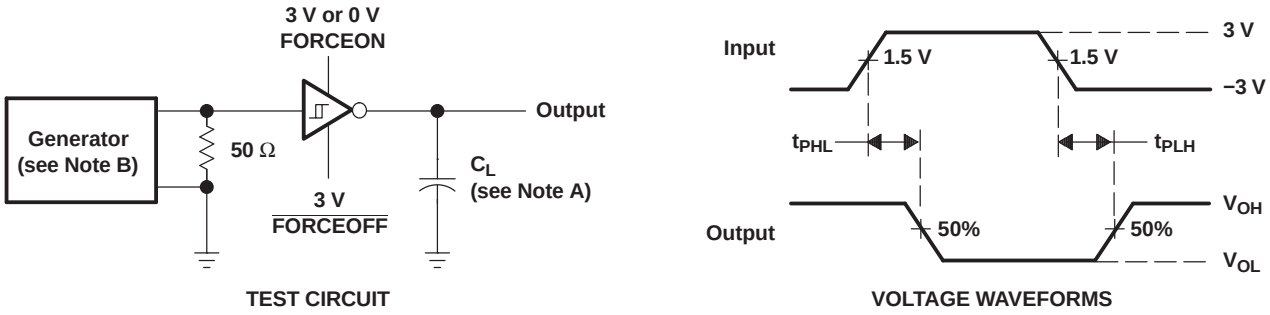

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**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 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

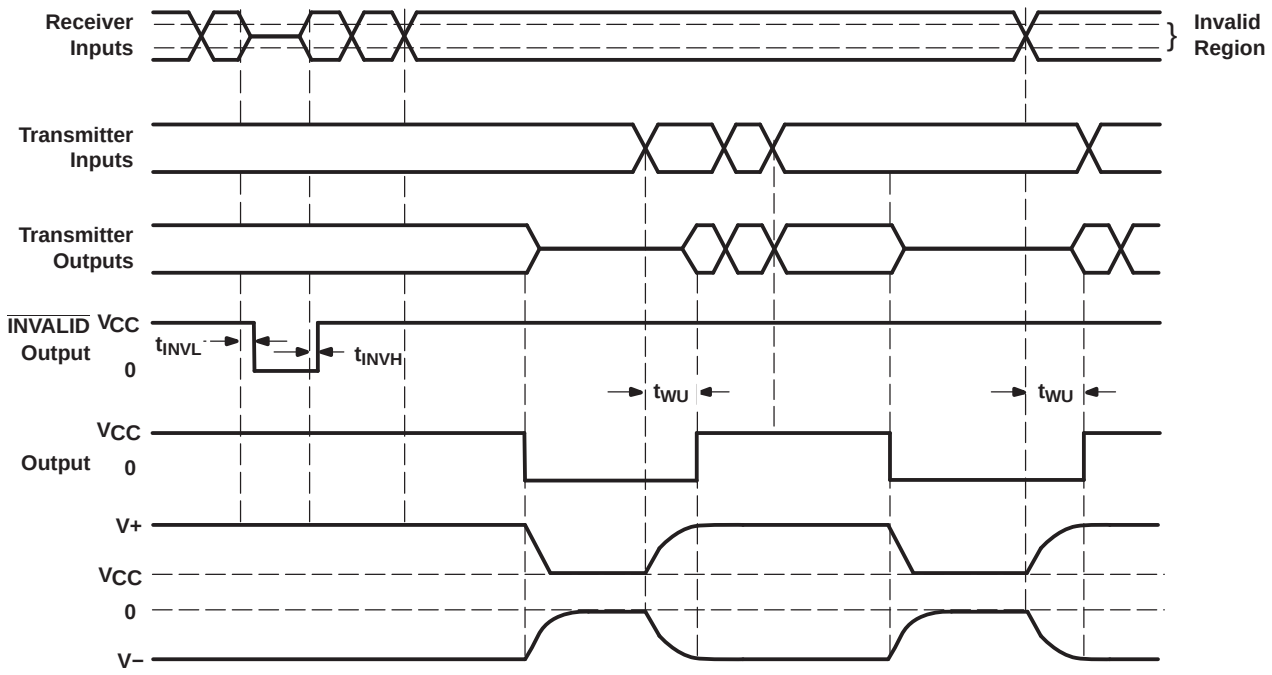
**Figure 2. Driver Pulse Skew**



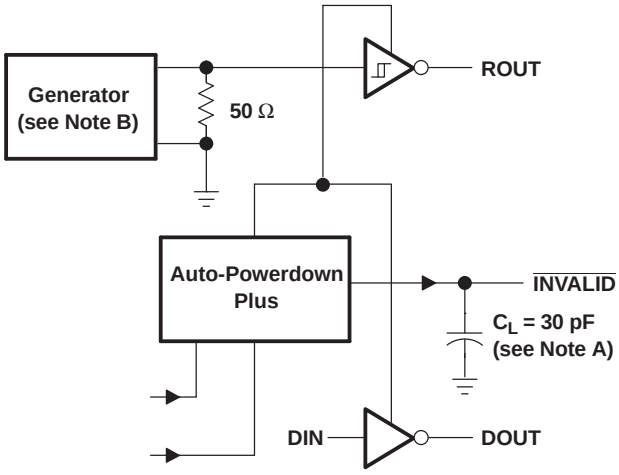

NOTES: A. $C_L$ includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $Z_O$ = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

**Figure 3. Receiver Propagation Delay Times**

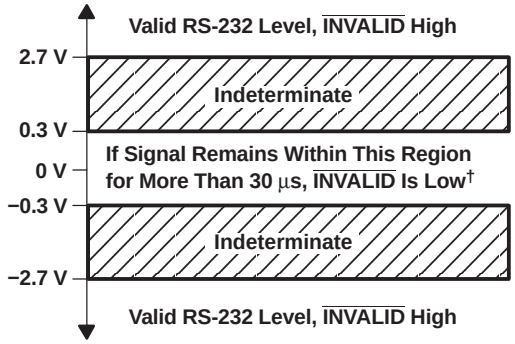
## PARAMETER MEASUREMENT INFORMATION (continued)




VOLTAGE WAVEFORMS



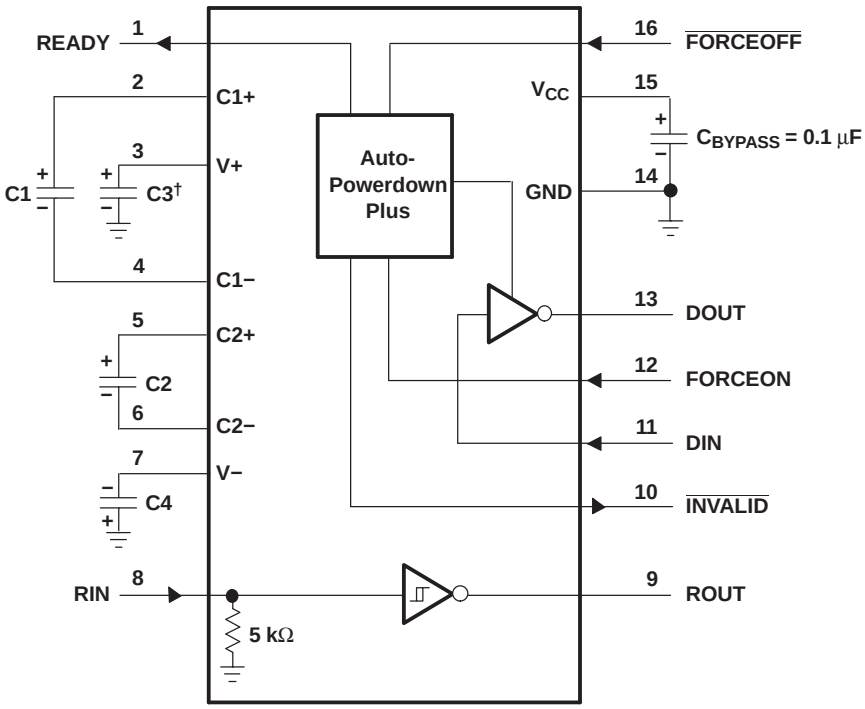

TEST CIRCUIT




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

**Figure 4. INVALID Propagation Delay Times and Driver Enabling Time**

## APPLICATION INFORMATION




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

NOTES: A. Resistor values shown are nominal.

B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

**$V_{CC}$ 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 5. Typical Operating Circuit and Capacitor Values**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| TRS3227CDB | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227CDBG4 | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227CDBR | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227CDBRG4 | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227IDB | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227IDBG4 | ACTIVE | SSOP | DB | 16 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227IDBR | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TRS3227IDBRG4 | ACTIVE | SSOP | DB | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

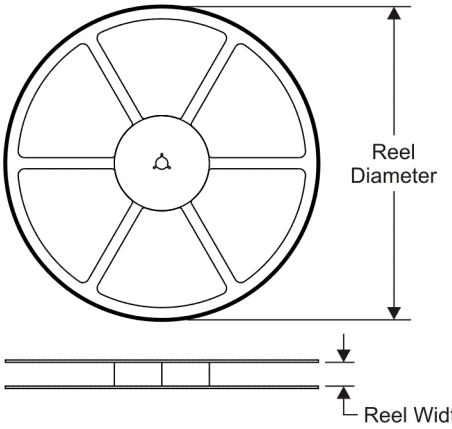
(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing 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) 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)

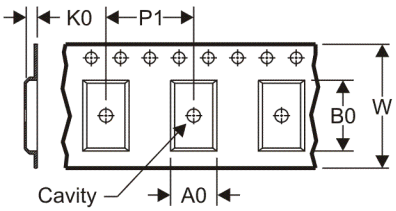
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

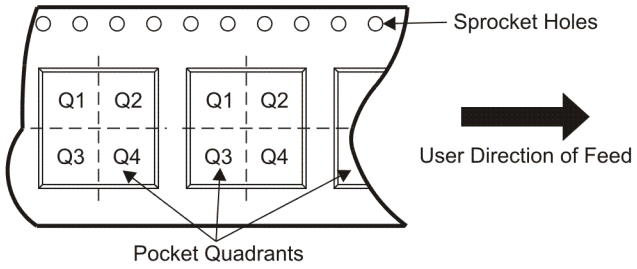



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

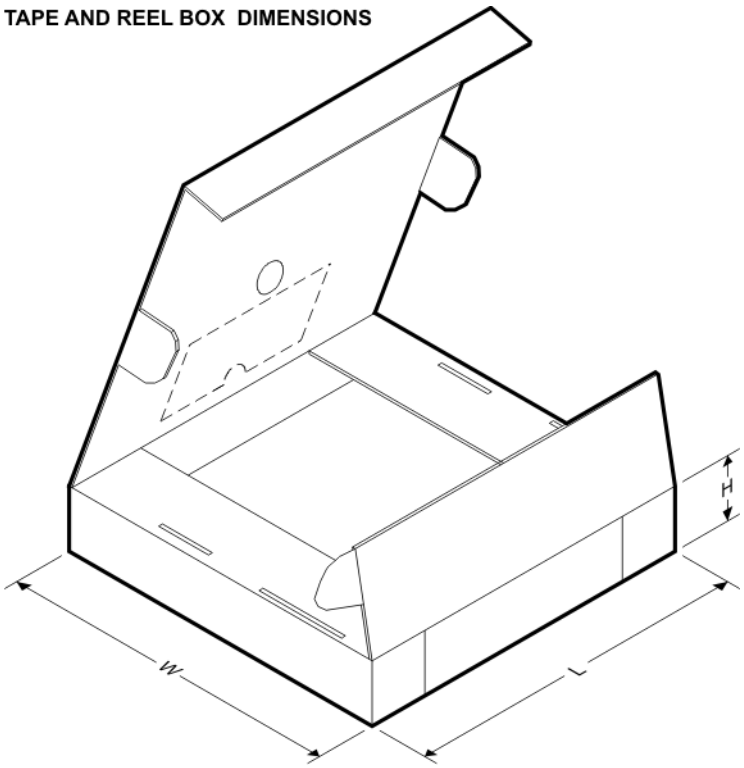
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRS3227CDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| TRS3227IDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

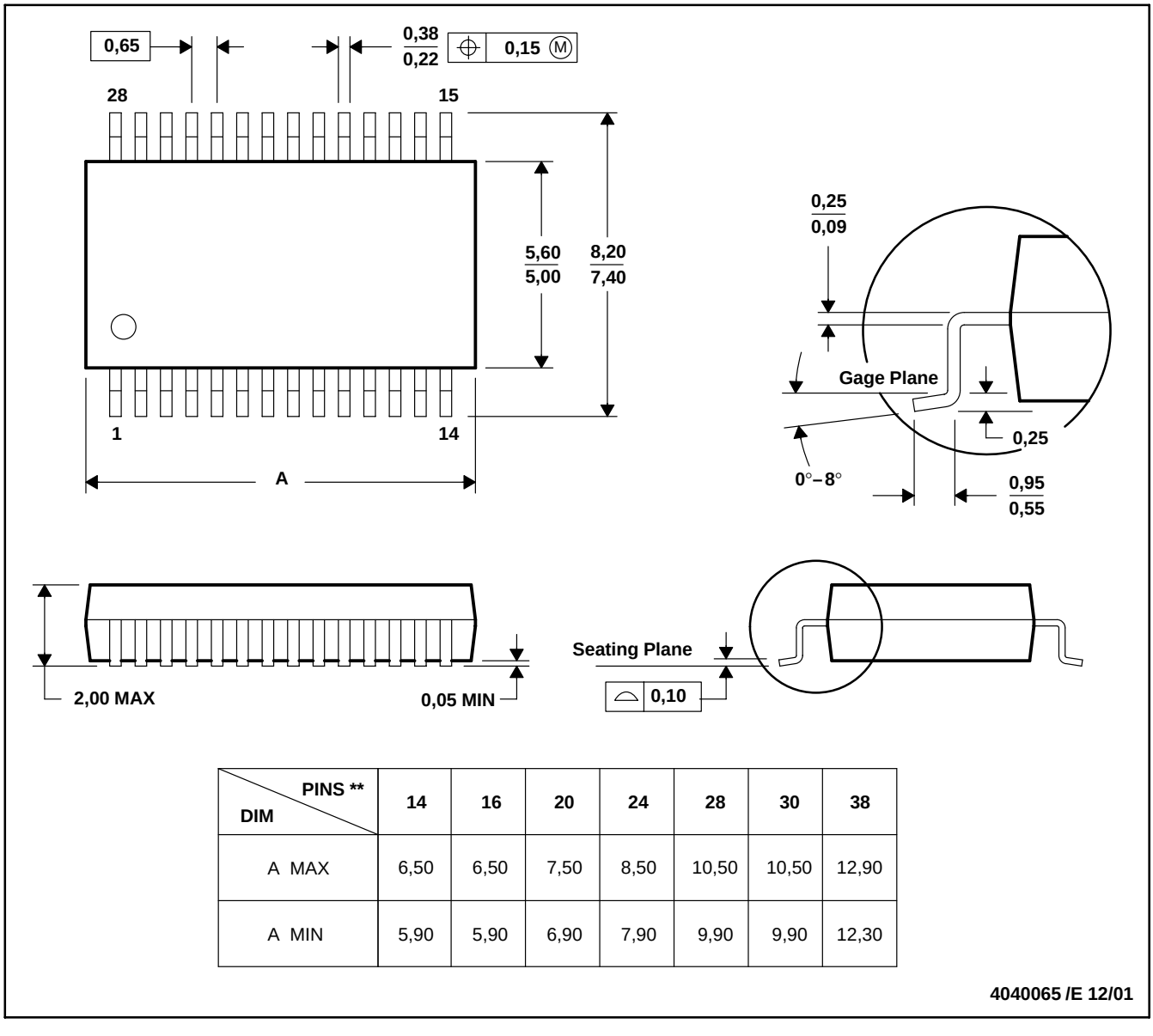



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TRS3227CDBR | SSOP | DB | 16 | 2000 | 346.0 | 346.0 | 33.0 |
| TRS3227IDBR | SSOP | DB | 16 | 2000 | 346.0 | 346.0 | 33.0 |

**DB (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

**28 PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 | 28 | 30 | 38 |
|---|---|---|---|---|---|---|---|
| A MAX | 6,50 | 6,50 | 7,50 | 8,50 | 10,50 | 10,50 | 12,90 |
| A MIN | 5,90 | 5,90 | 6,90 | 7,90 | 9,90 | 9,90 | 12,30 |

**4040065 /E 12/01**

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

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| **Products** | | **Applications** | |
|---|---|---|---|
| Amplifiers | amplifier.ti.com | Audio | www.ti.com/audio |
| Data Converters | dataconverter.ti.com | Automotive | www.ti.com/automotive |
| DLP® Products | www.dlp.com | Broadband | www.ti.com/broadband |
| DSP | dsp.ti.com | Digital Control | www.ti.com/digitalcontrol |
| Clocks and Timers | www.ti.com/clocks | Medical | www.ti.com/medical |
| Interface | interface.ti.com | Military | www.ti.com/military |
| Logic | logic.ti.com | Optical Networking | www.ti.com/opticalnetwork |
| Power Mgmt | power.ti.com | Security | www.ti.com/security |
| Microcontrollers | microcontroller.ti.com | Telephony | www.ti.com/telephony |
| RFID | www.ti-rfid.com | Video & Imaging | www.ti.com/video |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf | Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265