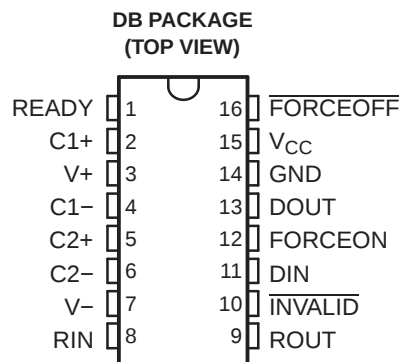


FEATURES

- 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 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 '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



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/ μ s 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- μ A 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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

FUNCTION TABLE⁽¹⁾

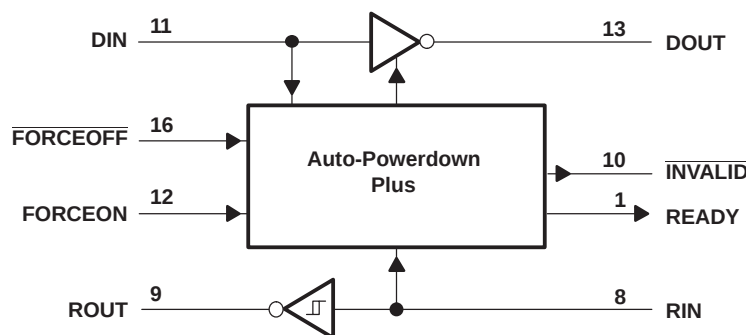
INPUT CONDITIONS				OUTPUT STATES				OPERATING MODE
FORCEON	$\overline{\text{FORCEOFF}}$	RECEIVER OR DRIVER EDGE WITHIN 30 s	VALID RS-232 LEVEL PRESENT AT RECEIVER	DRIVER	RECEIVER	$\overline{\text{INVALID}}$	READY	
Auto-Powerdown Plus Conditions								
H	H	NO	NO	Active	Active	L	H	Normal operation, auto-powerdown 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	$+2 \times V_{\text{CC}}$ generated by the charge pump
V–	7	$-2 \times V_{\text{CC}}$ 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		
θ _{JA}	Package thermal impedance ⁽³⁾			82	°C/W
	Lead temperature 1,6 mm (1/16 in) from case for 10 s			260	°C
T _{std}	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, 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, 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 μ F at V_{CC} = 3.3 V $\pm$ 0.3 V; C1 = 0.047 μ F, C2–C4 = 0.33 μ F at V_{CC} = 5 V $\pm$ 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	FORCEOFF, FORCEON		± 0.01	± 1	μ A
I _{CC}	Supply current (T _A = 25°C)	Auto-powerdown plus disabled	No load, FORCEOFF and FORCEON at V _{CC}	0.3	2	μ A
		Powered off	No load, FORCEOFF at GND	1	10	
		Auto-powerdown plus enabled	No load, FORCEOFF at V _{CC} , FORCEON at GND, All RIN are open or grounded	1	10	

(1) Test conditions are C1–C4 = 0.1 μ F at V_{CC} = 3.3 V $\pm$ 0.3 V; C1 = 0.047 μ F, C2–C4 = 0.33 μ F at V_{CC} = 5 V $\pm$ 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 k Ω to GND, DIN = GND	5	5.4		V
V _{OL} Low-level output voltage	DOUT at R _L = 3 k Ω to GND, DIN = V _{CC}	–5	–5.4		V
I _{IH} High-level input current	V _I = V _{CC}		± 0.01	± 1	μ A
I _{IL} Low-level input current	V _I at GND		± 0.01	± 1	μ A
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	μ A

(1) Test conditions are C1–C4 = 0.1 μ F at V_{CC} = 3.3 V $\pm$ 0.3 V; C1 = 0.047 μ F, C2–C4 = 0.33 μ F at V_{CC} = 5 V $\pm$ 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, R _L = 3 k Ω , One DIN switching, See Figure 1	250			kbit/s
	C _L = 1000 pF, R _L = 3 k Ω , V _{CC} = 4.5 V, See Figure 1 One DIN switching,	1000			
	C _L = 250 pF, R _L = 3 k Ω , V _{CC} = 3 V, See Figure 1 One DIN switching,	1000			
t _{sk(p)} Pulse skew ⁽³⁾	C _L = 150 pF to 2500 pF, R _L = 3 k Ω to 7 k Ω , See Figure 2		25		ns
SR(tr) Slew rate, transition region	V _{CC} = 3.3 V, R _L = 3 k Ω to 7 k Ω , C _L = 150 pF to 1000 pF, See Figure 1	24		150	V/ μ s

(1) Test conditions are C1–C4 = 0.1 μ F at V_{CC} = 3.3 V $\pm$ 0.3 V; C1 = 0.047 μ F, C2–C4 = 0.33 μ F at V_{CC} = 5 V $\pm$ 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 NAME NO.	TEST CONDITIONS	TYP	UNIT
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
$V_{T+}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		2.7	V
$V_{T-}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	–2.7		V
$V_{T(\text{invalid})}$	Receiver input threshold for $\overline{\text{INVALID}}$ low-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	–0.3	0.3	V
V_{OH}	$\overline{\text{INVALID}}$, READY output voltage high	$I_{OH} = -1$ mA, FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	$V_{CC} - 0.6$		V
V_{OL}	$\overline{\text{INVALID}}$, READY output voltage low	$I_{OL} = 1.6$ mA, FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		0.4	V

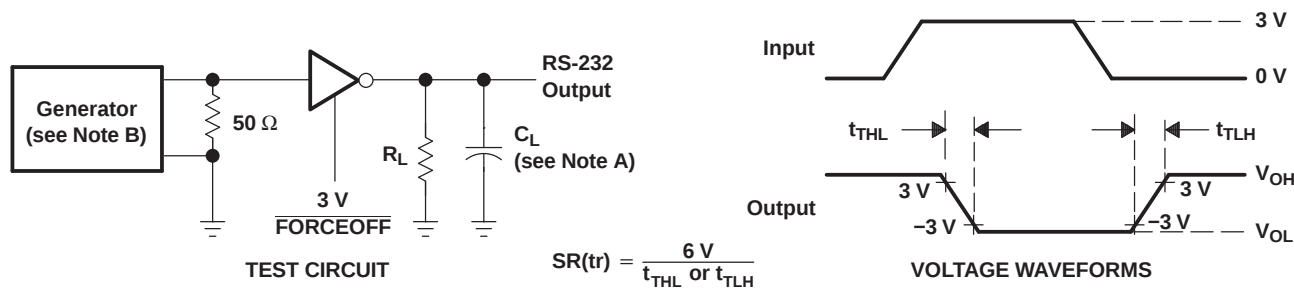
Switching Characteristics

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 $T_A = 25^\circ\text{C}$.

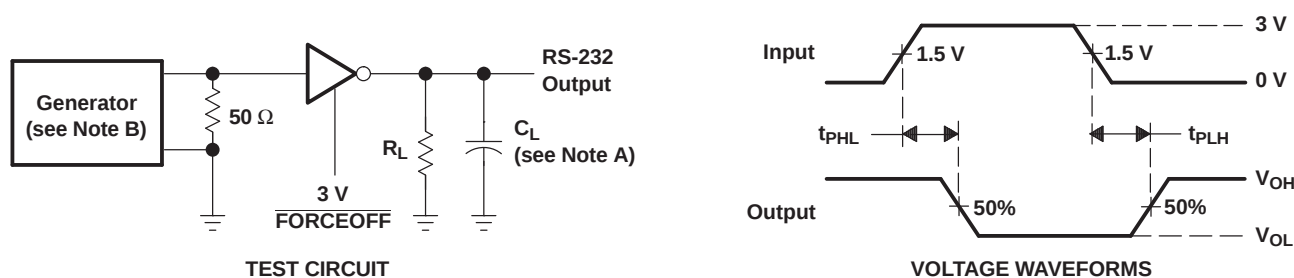
PARAMETER MEASUREMENT INFORMATION



NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

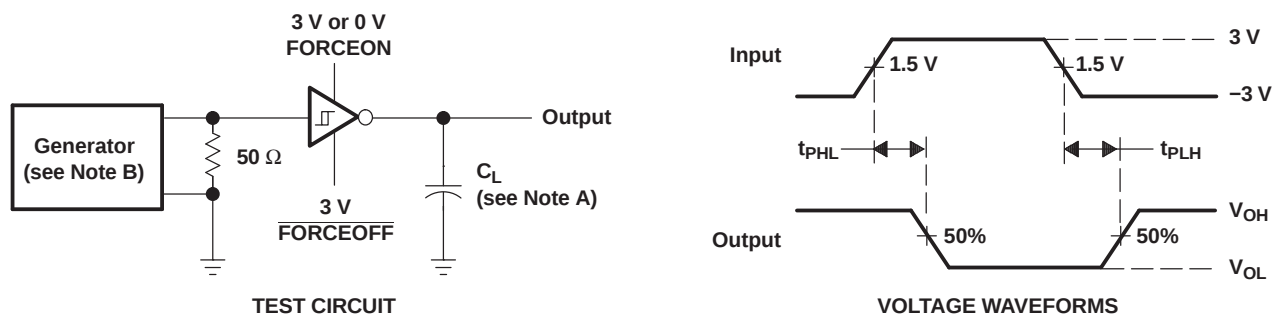
Figure 1. Driver Slew Rate



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

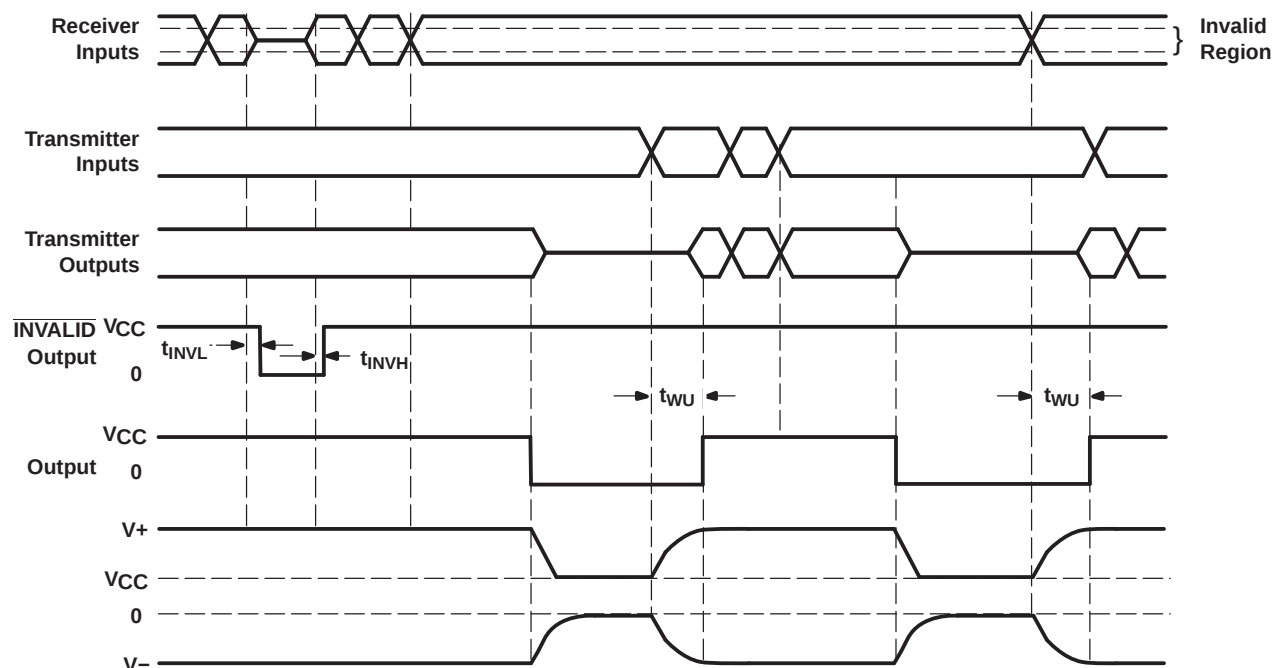


NOTES: A. C_L includes probe and jig capacitance.

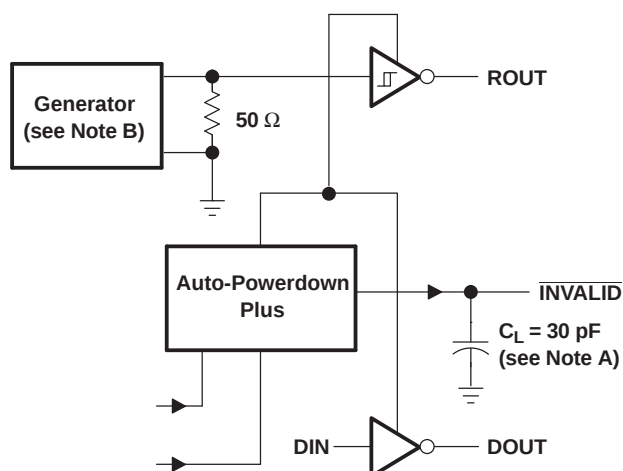
B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 3. Receiver Propagation Delay Times

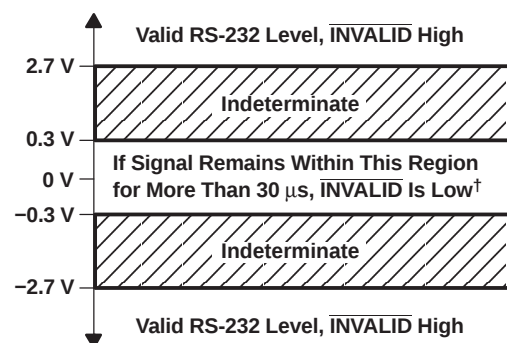
PARAMETER MEASUREMENT INFORMATION (continued)



VOLTAGE WAVEFORMS



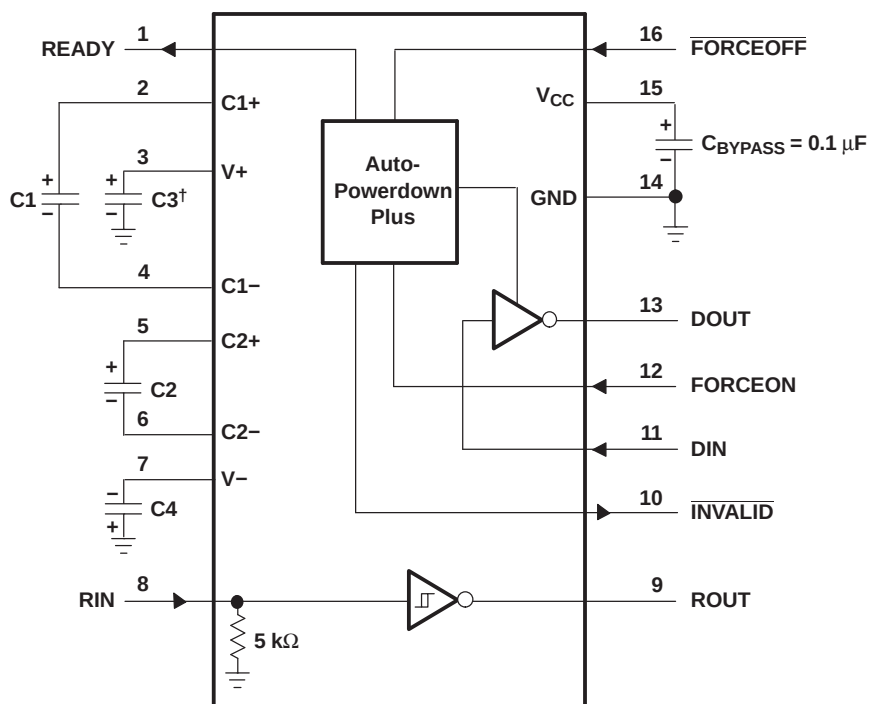
TEST CIRCUIT



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

Figure 4. $\overline{\text{INVALID}}$ 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 $\pm$ 0.3 V	0.1 μ F	0.1 μ F
5 V $\pm$ 0.5 V	0.047 μ F	0.33 μ F
3 V to 5.5 V	0.1 μ F	0.47 μ F

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.

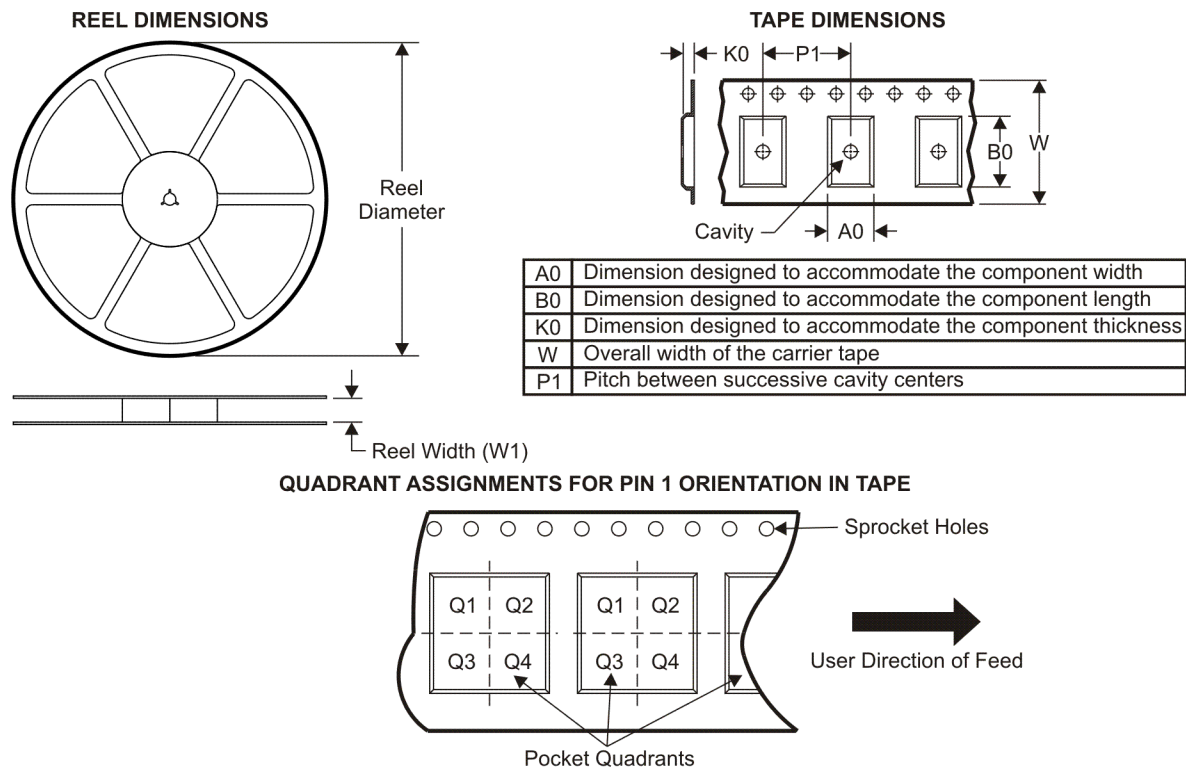
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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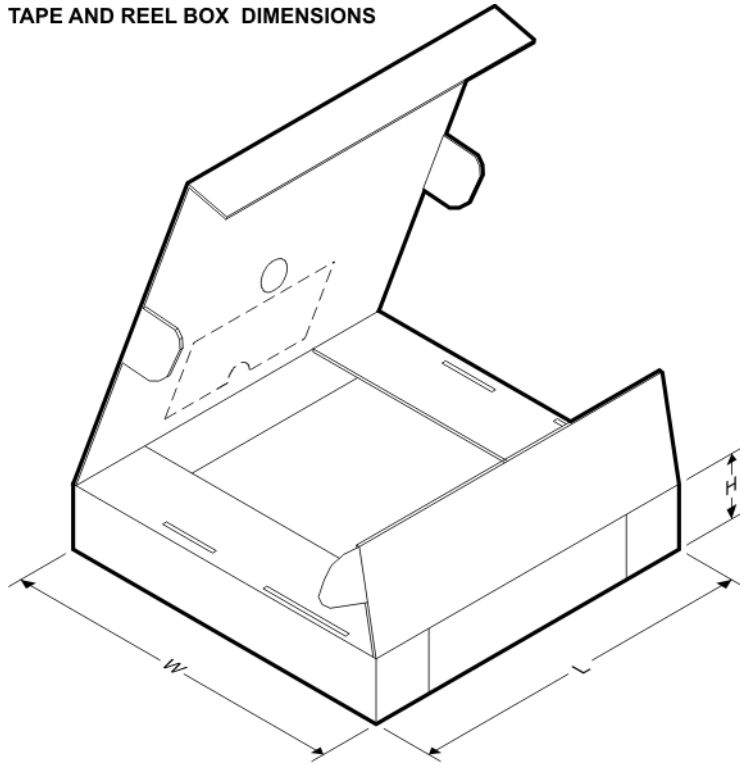
TAPE AND REEL INFORMATION



*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



- 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

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