

## FEATURES

- ESD Protection for RS-232 Bus Pins
  - $\pm 15$ -kV Human-Body Model (HBM)
- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates at 5-V  $V_{CC}$  Supply
- Four Drivers and Five Receivers
- Operates up to 120 kbit/s
- Low Supply Current in Shutdown Mode . . . 15  $\mu$ A Typ
- External Capacitors . . .  $4 \times 0.1$  F
- Designed to Be Interchangeable With Industry Standard '213 Devices
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II

## APPLICATIONS

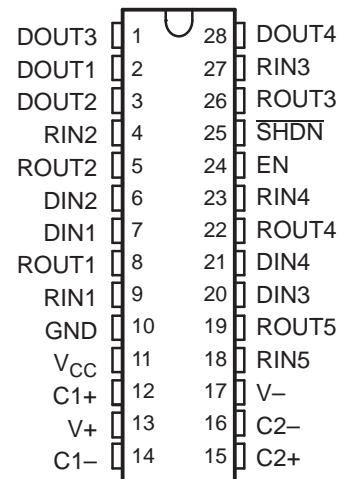
- Battery-Powered Systems
- PDAs
- Notebooks
- Laptops
- Palmtop PCs
- Hand-Held Equipment

## DESCRIPTION/ ORDER INFORMATION

The TRS213 device consists of four line drivers, five line receivers, and a dual charge-pump circuit with  $\pm 15$ -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 5-V supply. The devices operate at data signaling rates up to 120 kbit/s and a maximum of 30-V/ $\mu$ s driver output slew rate.

The TRS213 has an active-low shutdown ( $\overline{\text{SHDN}}$ ) and an active-high enable control (EN). In shutdown mode, the charge pumps are turned off, V+ is pulled down to  $V_{CC}$ , V– is pulled to GND, and the transmitter outputs are disabled. This reduces supply current typically to 1  $\mu$ A. Two receivers of the TRS213 are active during shutdown.

DB, DW, OR PW PACKAGE  
(TOP VIEW)



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.

**TRS213**  
**5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -kV ESD PROTECTION**

SLLS807–JUNE 2007

**ORDERING INFORMATION**

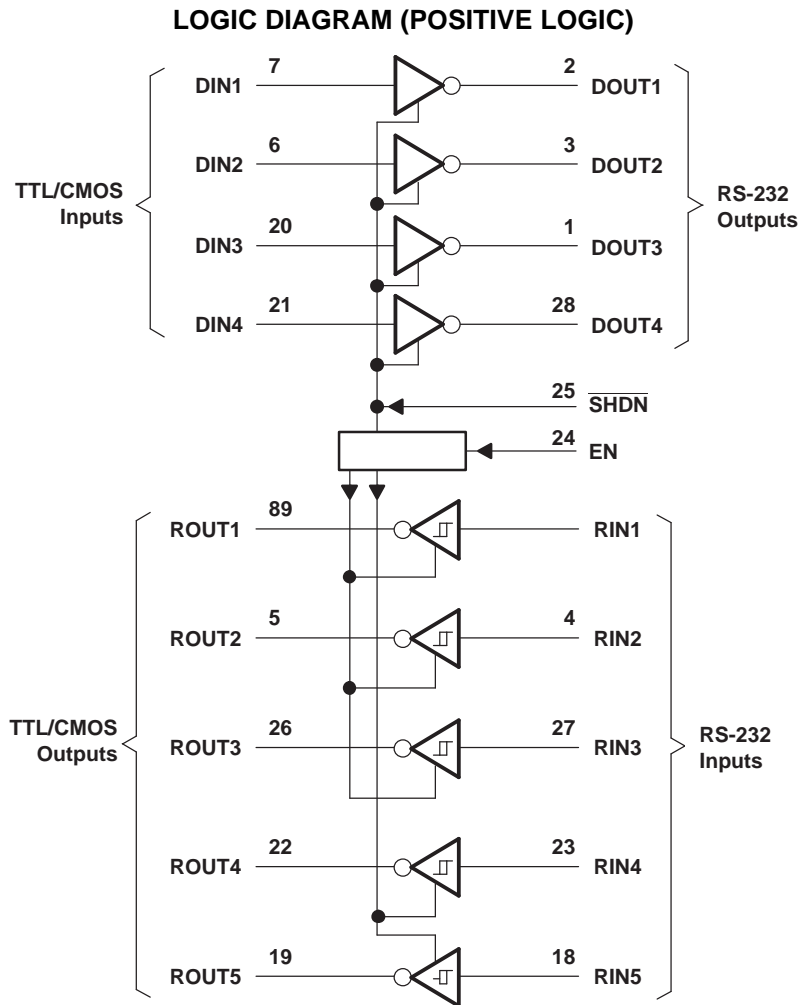
T <sub>A</sub>	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC – DW	Tube of 20	TRS213CDW	TRS213C
		Reel of 1000	TRS213CDWR	
	SSOP – DB	Tube of 50	TRS213CDB	TRS213C
		Reel of 2000	TRS213CDBR	
	TSSOP – PW	Tape and reel	TRS213CPWR	TRS213C
	–40°C to 85°C	SOIC – DW	Tube of 20	TRS213IDW
Reel of 1000			TRS213IDWR	
SSOP – DB		Tube of 50	TRS213IDB	TRS213I
		Reel of 2000	TRS213IDBR	
TSSOP – PW		Tape and reel	TRS213IPWR	TRS213I

- (1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://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](http://www.ti.com).

**FUNCTION TABLE**

INPUTS		DRIVER D1–D4	RECEIVER		DEVICE STATUS
$\overline{\text{SHDN}}$	EN		R1–R3	R4–R5	
L	L	Z	Z	Z	Shutdown
L	H	Z	Z	Active <sup>(1)</sup>	Shutdown
H	L	All active	Z	Z	Normal operation
H	H	All active	Active	Active	Normal operation

- (1) See the V<sub>IT+</sub> and V<sub>IT–</sub> change in the Electrical Characteristics table.



# TRS213

## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

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### 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	–0.3	6	V
V+	Positive charge-pump voltage range <sup>(2)</sup>	V <sub>CC</sub> – 0.3	14	V
V–	Negative charge-pump voltage range <sup>(2)</sup>	0.3	–14	V
V <sub>I</sub>	Input voltage range	Drivers	V+ + 0.3	V
		Receivers	±30	
V <sub>O</sub>	Output voltage range	Drivers	V– – 0.3	V
		Receivers	–0.3	
DO <sub>UT</sub>	Short-circuit duration	Continuous		
θ <sub>JA</sub>	Package thermal impedance <sup>(3)(4)</sup>	DB package	62	C°/W
		DW package	46	
		PW package		
T <sub>J</sub>	Operating virtual junction temperature		150	C°
T <sub>stg</sub>	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<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.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

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

See [Figure 4](#)

		MIN	NOM	MAX	UNIT
Supply voltage		4.5	5	5.5	V
V <sub>IH</sub>	Driver high-level input voltage	2			V
	Control high-level input voltage	2.4			
V <sub>IL</sub>	Driver and control low-level input voltage			0.8	V
V <sub>I</sub>	Driver and control input voltage	0		5.5	V
	Receiver input voltage	–30		30	
T <sub>A</sub>	Operating free-air temperature	TRS213C	0	70	°C
		TRS213I	–40	85	

- (1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

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

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
I <sub>CC</sub>	Supply current No load, See <a href="#">Figure 6</a>		14	20	mA
I <sub>SHDN</sub>	Shutdown supply current T <sub>A</sub> = 25°C, See <a href="#">Figure 1</a>		15	50	μA

- (1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.
- (2) All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

## DRIVER SECTION

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

over operating free-air temperature range (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	5	9		V
V <sub>OL</sub>	Low-level output voltage	DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	–5	–9		V
I <sub>IH</sub>	Control high-level input current	EN, $\overline{\text{SHDN}}$ = 5 V		3	10	$\mu$ A
I <sub>IL</sub>	Driver low-level input current	DIN = 0 V		–15	–200	$\mu$ A
	Control low-level input current	EN, $\overline{\text{SHDN}}$ = 0 V		–3	–10	
I <sub>OS</sub> <sup>(3)</sup>	Short-circuit output current	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V		$\pm 10$	$\pm 60$	mA
r <sub>o</sub>	Output resistance	V <sub>CC</sub> , V+, and V– = 0 V, V <sub>O</sub> = $\pm 2$ V	300			$\Omega$

(1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V

(2) All typical values are at 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>

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
	Maximum data rate	C <sub>L</sub> = 50 pF to 1000 pF, One DO <sub>UT</sub> switching, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$ , See Figure 3	120			kbit/s
t <sub>PLH(D)</sub>	Propagation delay time, low- to high-level output	C <sub>L</sub> = 2500 pF, All drivers loaded, R <sub>L</sub> = 3 k $\Omega$ , See Figure 3		2		$\mu$ s
t <sub>PHL(D)</sub>	Propagation delay time, high- to low-level output	C <sub>L</sub> = 2500 pF, All drivers loaded, R <sub>L</sub> = 3 k $\Omega$ , See Figure 3		2		$\mu$ s
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup>	C <sub>L</sub> = 150 pF to 2500 pF, See Figure 3, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$		300		ns
SR(tr)	Slew rate, transition region (see Figure 2)	C <sub>L</sub> = 50 pF to 1000 pF, V <sub>CC</sub> = 5 V, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$	3	6	30	V/ $\mu$ s

(1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V.

(2) All typical values are at 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

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

PIN	TEST CONDITIONS	TYP	UNIT
DO <sub>UT</sub>	Human-Body Model	$\pm 15$	kV

# TRS213

## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

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### RECEIVER SECTION

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

over operating free-air temperature range (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> - 0.4			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> = 5 V, T <sub>A</sub> = 25°C	Active mode	1.7		2.4	V
			Shutdown mode (R4–R5)	1.5		2.4	
V <sub>IT-</sub>	Negative-going input threshold voltage	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	Active mode	0.8	1.2		V
			Shutdown mode (R4–R5)	0.6	1.5		
V <sub>hys</sub> <sup>(3)</sup>	Input hysteresis (V <sub>IT+</sub> , V <sub>IT-</sub> )	V <sub>CC</sub> = 5 V		0.5		1	V
r <sub>I</sub>	Input resistance	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C		3	5	7	kΩ
Output leakage current		EN = 0 V, 0 ≤ ROUT ≤ V <sub>CC</sub> , R1–R3		±0.05		±10	μA

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

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

(3) No hysteresis in shutdown mode

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

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

PARAMETER		TEST CONDITIONS		MIN	TYP <sup>(2)</sup>	MAX	UNIT
t <sub>PLH(R)</sub>	Propagation delay time, low- to high-level output	C <sub>L</sub> = 150 pF, See <a href="#">Figure 4</a>	SHDN = V <sub>CC</sub>	0.5	10		μs
			SHDN = 0 V, R4–R5	4		40	
t <sub>PHL(R)</sub>	Propagation delay time, high- to low-level output	C <sub>L</sub> = 150 pF, See <a href="#">Figure 4</a>		0.5	10		μs
t <sub>en</sub>	Output enable time	C <sub>L</sub> = 150 pF, See <a href="#">Figure 5</a>		600			ns
t <sub>dis</sub>	Output disable time	C <sub>L</sub> = 150 pF, See <a href="#">Figure 5</a>		200			ns

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

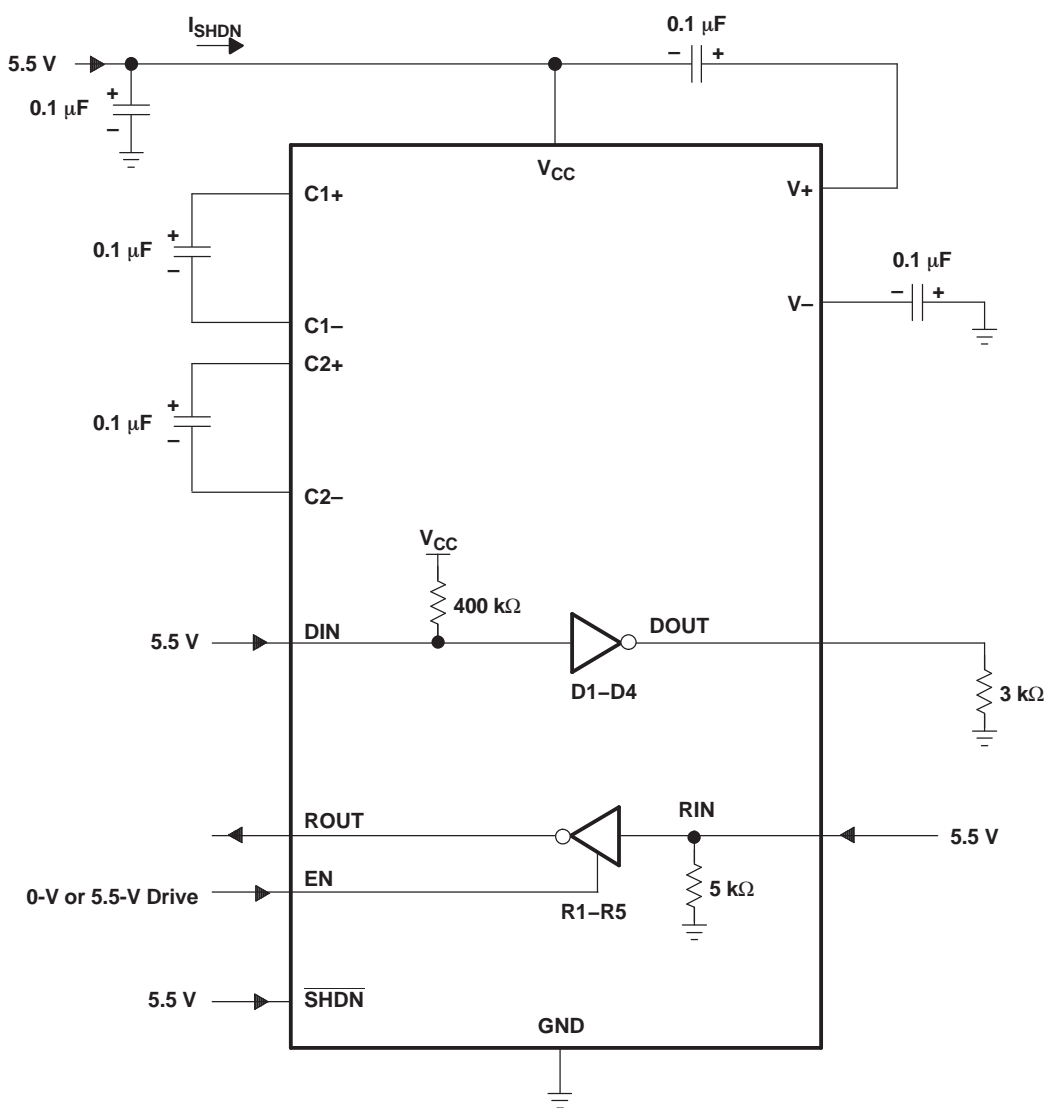
(2) All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

#### ESD Protection

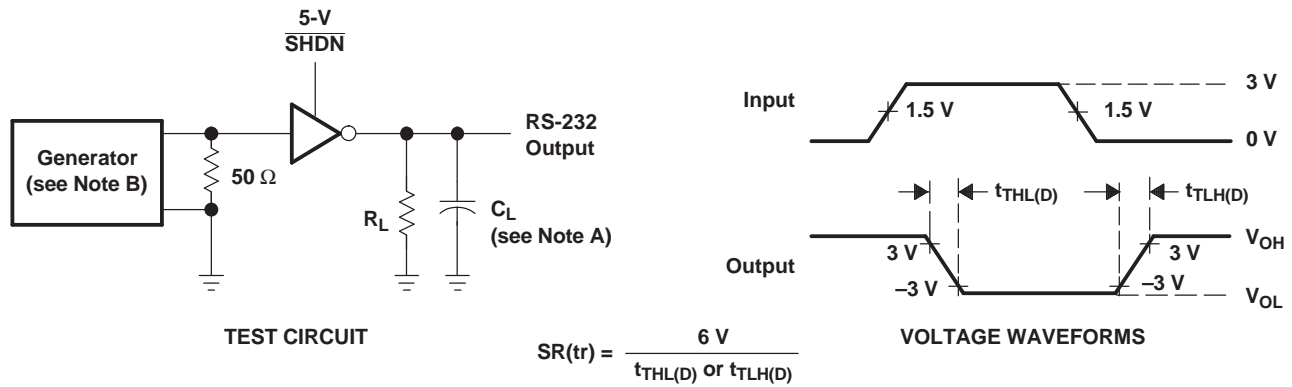
over operating free-air temperature range (unless otherwise noted)

PIN	TEST CONDITIONS	TYP	UNIT
RIN	Human-Body Model	±15	kV

**PARAMETER MEASUREMENT INFORMATION**

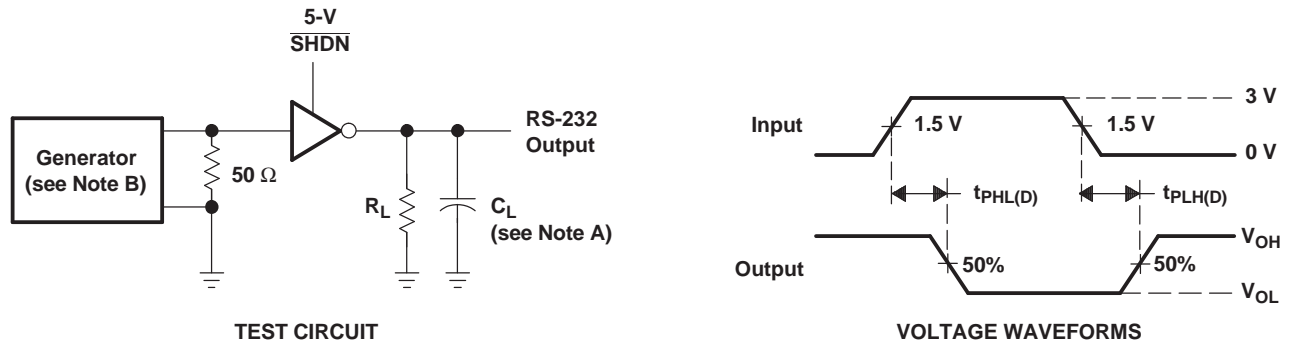


**Figure 1. Shutdown Current Test Circuit**



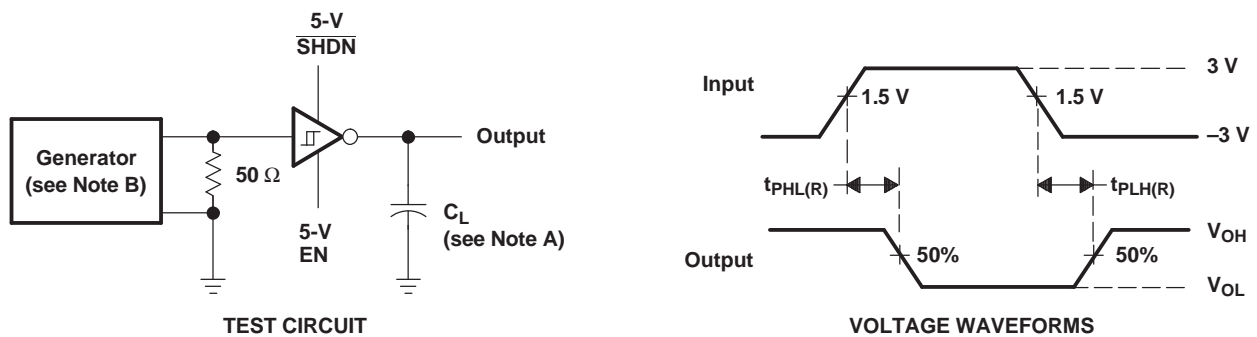
NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50\ \Omega$ , 50% duty cycle,  $t_r \leq 10\text{ ns}$ ,  $t_f \leq 10\text{ ns}$ .

**Figure 2. Driver Slew Rate**



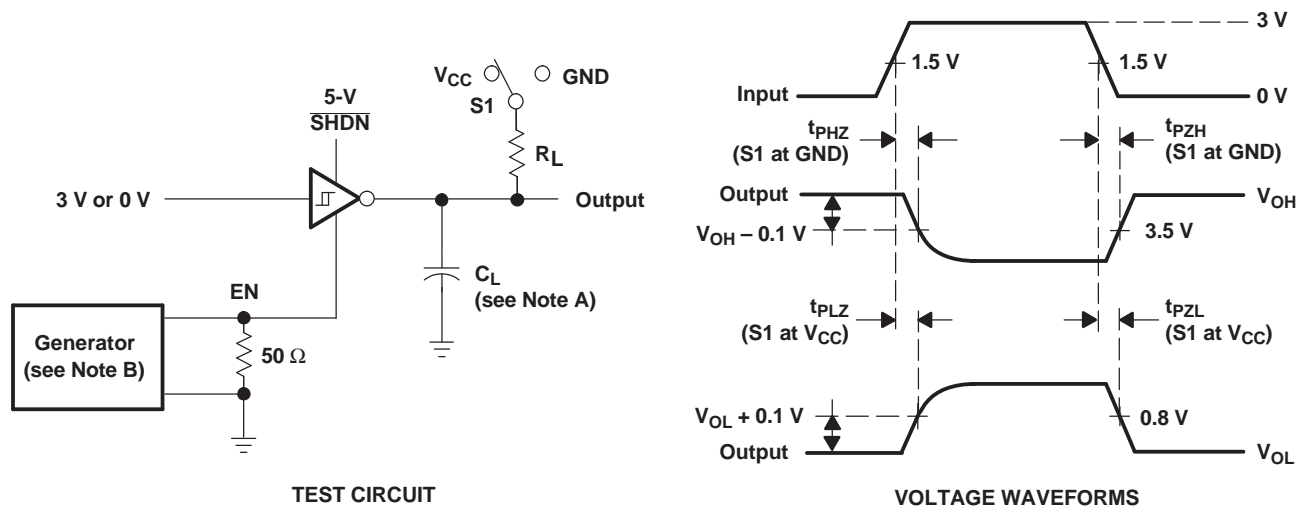
NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50\ \Omega$ , 50% duty cycle,  $t_r \leq 10\text{ ns}$ ,  $t_f \leq 10\text{ ns}$ .

**Figure 3. Driver Pulse Skew and Propagation Delay Times**



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

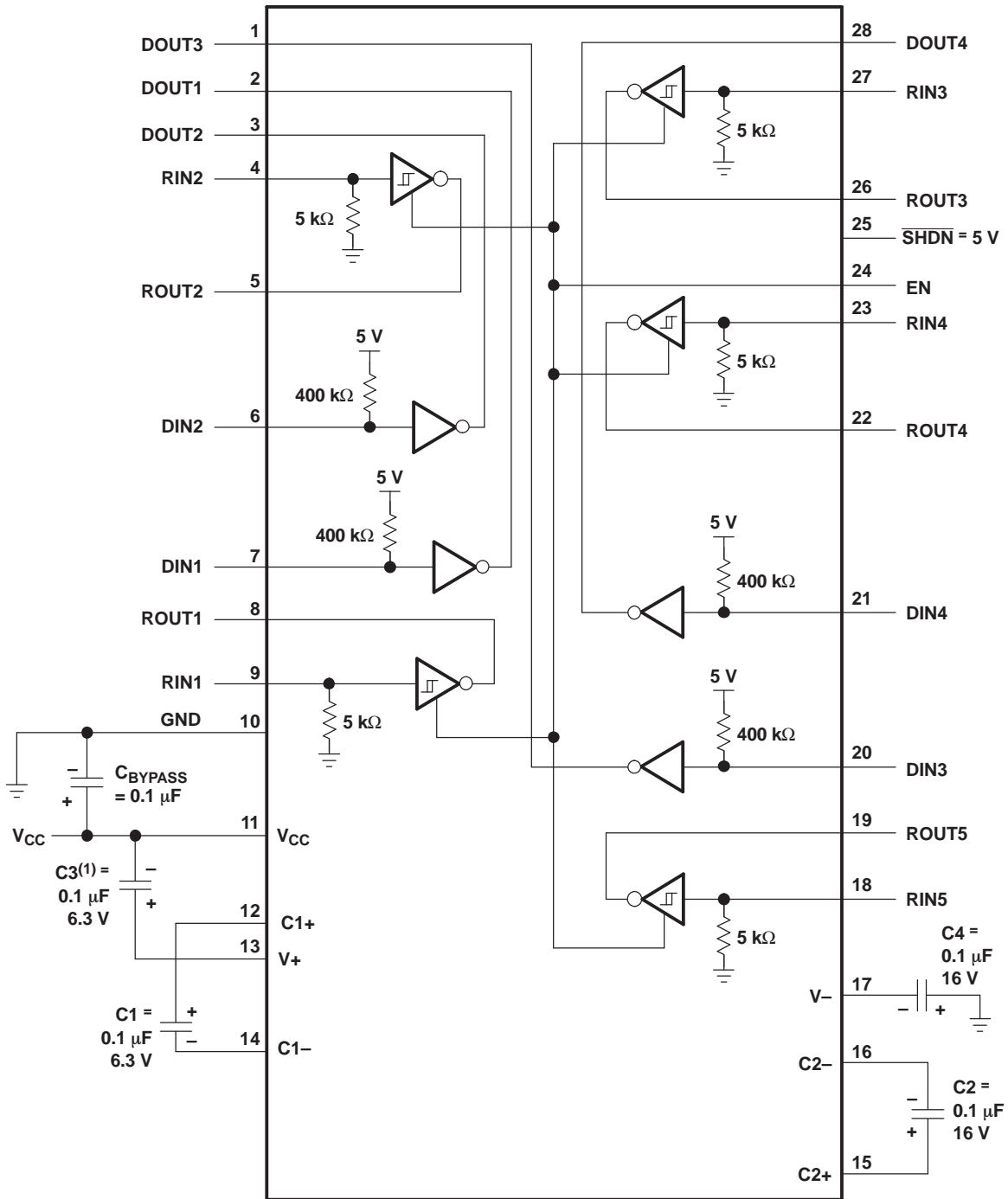
**Figure 4. Receiver Propagation Delay Times**



- 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  $t_{PZH}$  are the same as  $t_{dis}$ .  
 D.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .

Figure 5. Receiver Enable and Disable Times

APPLICATION INFORMATION



(1) 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.

Figure 6. 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 (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TRS213CDB	OBSOLETE	SSOP	DB	28		TBD	Call TI	Call TI	0 to 70		
TRS213CDBG4	OBSOLETE	SSOP	DB	28		TBD	Call TI	Call TI	0 to 70		
TRS213CDBR	ACTIVE	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	TRS213C	<a href="#">Samples</a>
TRS213CDW	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI	0 to 70		
TRS213CDWG4	OBSOLETE	SOIC	DW	28		TBD	Call TI	Call TI	0 to 70		
TRS213IDB	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS213I	<a href="#">Samples</a>
TRS213IDBR	ACTIVE	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS213I	<a href="#">Samples</a>
TRS213IDWR	ACTIVE	SOIC	DW	28	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRS213I	<a href="#">Samples</a>

(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.

(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
TRS213CDBR	SSOP	DB	28	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TRS213IDBR	SSOP	DB	28	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TRS213IDWR	SOIC	DW	28	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

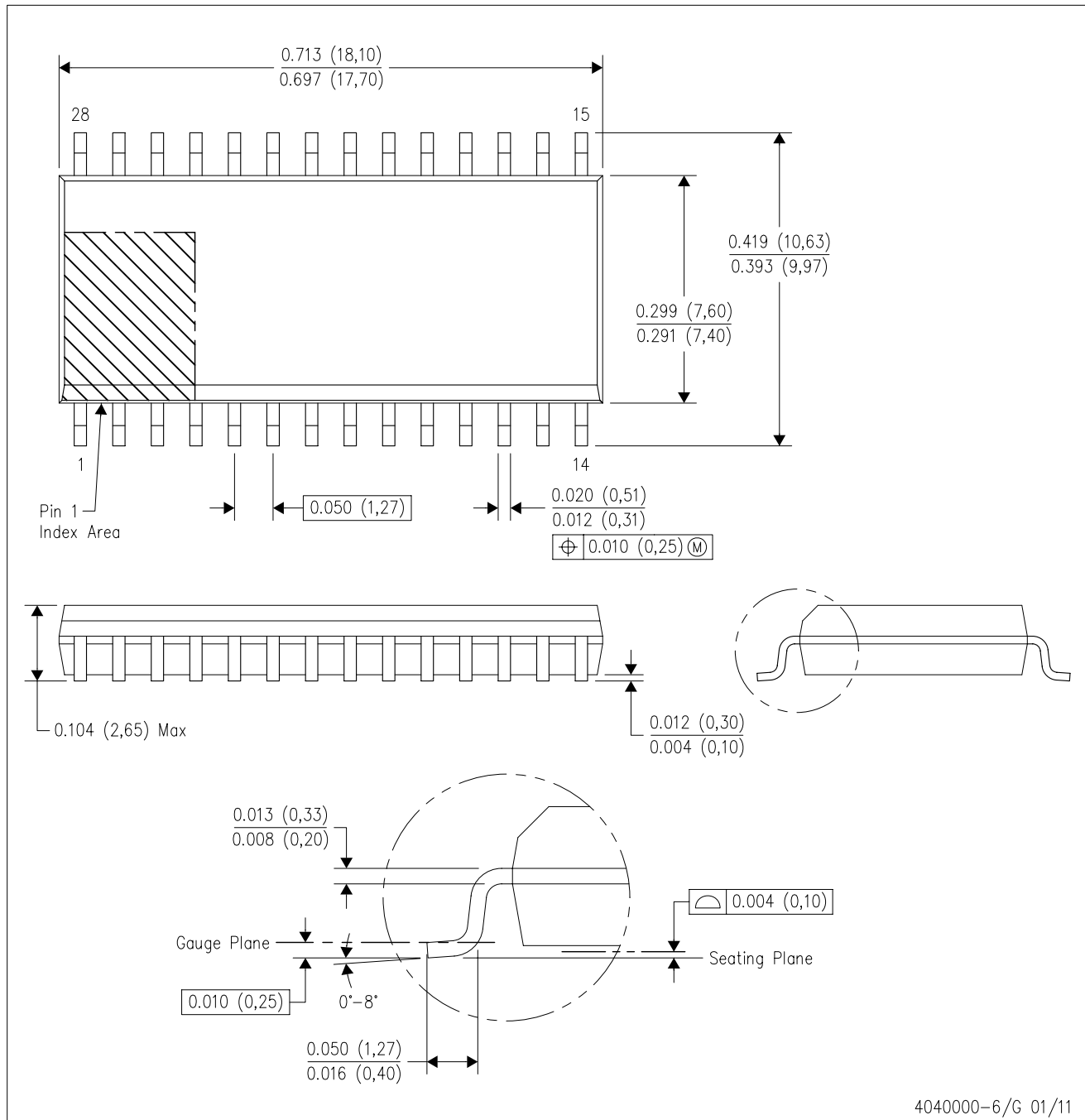
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS213CDBR	SSOP	DB	28	2000	367.0	367.0	38.0
TRS213IDBR	SSOP	DB	28	2000	367.0	367.0	38.0
TRS213IDWR	SOIC	DW	28	1000	367.0	367.0	55.0

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.



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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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