

## FEATURES

- RS-232 Bus-Pin ESD Protection Exceeds  $\pm 15$  kV Using 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 . . . 1  $\mu$ A Typical
- External Capacitors . . .  $4 \times 0.1 \mu$ F
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II

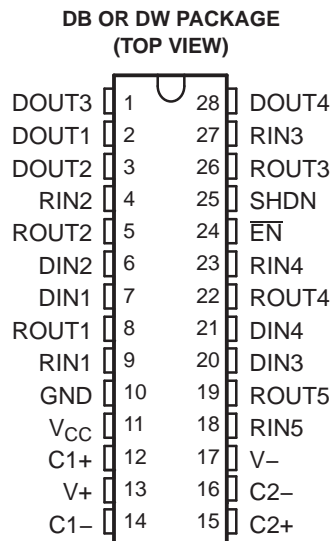
## APPLICATIONS

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

## DESCRIPTION/ORDERING INFORMATION

The TRS211 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 TRS211 has both shutdown (SHDN) and enable control ( $\overline{EN}$ ). 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.  $\overline{EN}$  is used to put the receiver outputs into the high-impedance state to allow wired-OR connection of two RS-232 ports. It has no effect on the RS-232 drivers or the charge pumps.



## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC – DW	Tube of 20	TRS211CDW	TRS211C
		Reel of 1000	TRS211CDWR	
	SSOP – DB	Tube of 50	TRS211CDB	TRS211C
		Reel of 2000	TRS211CDBR	
–40°C to 85°C	SOIC – DW	Tube of 20	TRS211IDW	TRS211I
		Reel of 1000	TRS211IDWR	
	SSOP – DB	Tube of 50	TRS211IDB	TRS211I
		Reel of 2000	TRS211IDBR	

(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).



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 TABLES<sup>(1)</sup>**

INPUTS		DRIVER	RECEIVER	DEVICE STATUS
SHDN	EN			
L	L	All active	All active	Normal operation
L	H	All active	Z	Normal operation
H	X	Z	Z	Shutdown

(1) X = don't care, Z = high impedance

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

INPUTS		OUTPUT DOUT	DRIVER STATUS
DIN	SHDN		
L	L	H	Normal operation
H	L	L	
X	H	Z	Powered off

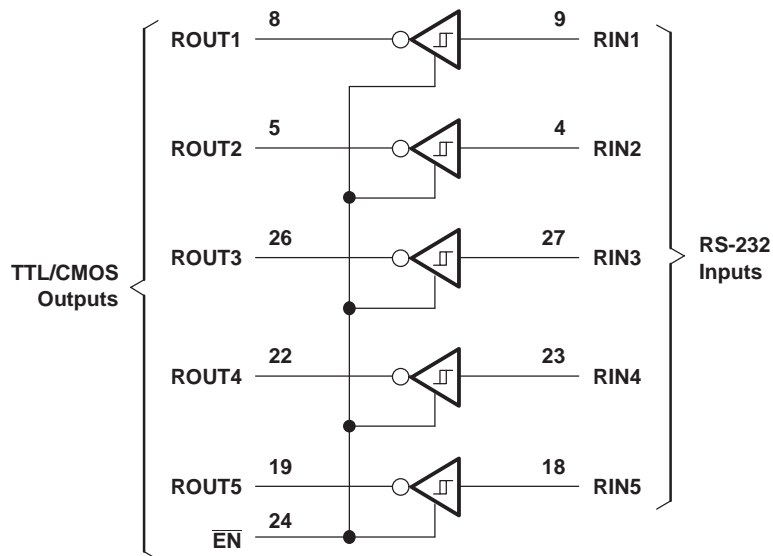
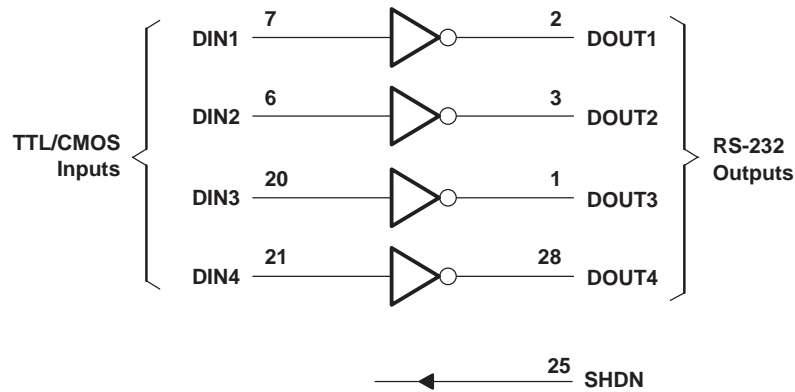
(1) X = don't care, Z = high impedance

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

INPUTS		OUTPUT ROUT	RECEIVER STATUS
RIN	EN		
L	L	H	Normal operation
H	L	L	
X	H	Z	Powered off

(1) X = don't care, Z = high impedance

**LOGIC DIAGRAM (POSITIVE LOGIC)**



# TRS211

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

SLLS811–JULY 2007

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

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

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range <sup>(2)</sup>	−0.3	6	V
V+	Positive 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	V <sub>CC</sub> + 0.3	
	Short-circuit duration	DOUT		Continuous
θ <sub>JA</sub>	Package thermal impedance <sup>(3)(4)</sup>	DB package		°C/W
		DW 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(max)</sub>, 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(max)</sub> − 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 6](#)

		MIN	NOM	MAX	UNIT
Supply voltage		4.5	5	5.5	V
V <sub>IH</sub>	Driver high-level input voltage	DIN			V
	Control high-level input voltage	EN, SHDN			
V <sub>IL</sub>	Driver and control low-level input voltage	DIN, EN, SHDN			V
V <sub>I</sub>	Driver and control input voltage	DIN, EN, SHDN			V
	Receiver input voltage	−30	30		
T <sub>A</sub>	Operating free-air temperature	TRS211C			°C
		TRS211I			

- (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 recommended ranges of supply voltage and operating free-air temperature (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
	Shutdown supply current	T <sub>A</sub> = 25°C,	See <a href="#">Figure 1</a>	1	10	

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	All DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	5	9		V
V <sub>OL</sub>	Low-level output voltage	All DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	–5	–9		V
I <sub>IH</sub>	Driver high-level input current	DIN = V <sub>CC</sub>		15	200	$\mu$ A
	Control high-level input current	$\overline{\text{EN}}$ , SHDN = V <sub>CC</sub>		3	10	
I <sub>IL</sub>	Driver low-level input current	DIN = 0 V		–15	–200	$\mu$ A
	Control low-level input current	$\overline{\text{EN}}$ , SHDN = 0 V		–3	–10	
I <sub>OS</sub>	Short-circuit output current <sup>(3)</sup>	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 recommended ranges of supply voltage and operating free-air temperature (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, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$ , One DOUT switching, See <a href="#">Figure 2</a>	120			kbit/s
t <sub>PLH(D)</sub>	Propagation delay time, low- to high-level output	C <sub>L</sub> = 2500 pF, R <sub>L</sub> = 3 k $\Omega$ , All drivers loaded, See <a href="#">Figure 2</a>		2		$\mu$ s
t <sub>PHL(D)</sub>	Propagation delay time, high- to low-level output	C <sub>L</sub> = 2500 pF, R <sub>L</sub> = 3 k $\Omega$ , All drivers loaded, See <a href="#">Figure 2</a>		2		$\mu$ s
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup>	C <sub>L</sub> = 150 pF to 2500 pF, See <a href="#">Figure 3</a>		300		ns
SR(tr)	Slew rate, transition region	C <sub>L</sub> = 50 pF to 1000 pF, V <sub>CC</sub> = 5 V	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

PIN	TEST CONDITIONS	TYP	UNIT
DOUT, RIN	Human-Body Model	$\pm 15$	kV

**TRS211**  
**5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD PROTECTION**

SLLS811–JULY 2007

**RECEIVER SECTION**

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

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	I <sub>OH</sub> = -1 mA	3.5	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		1.7	2.4	V
V <sub>IT-</sub>	Negative-going input threshold voltage	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	0.8	1.2		V
V <sub>hys</sub>	Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )		0.2	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	$\overline{EN} = V_{CC}$ , 0 ≤ R <sub>OUT</sub> ≤ V <sub>CC</sub>		±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.

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

over recommended ranges of supply voltage and operating free-air temperature (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>		0.5	10	µs
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, R <sub>L</sub> = 1 kΩ, See <a href="#">Figure 5</a>		600		ns
t <sub>dis</sub>	Output disable time	C <sub>L</sub> = 150 pF, R <sub>L</sub> = 1 kΩ, See <a href="#">Figure 5</a>		200		ns
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup>	See <a href="#">Figure 3</a>		300		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.

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

PARAMETER MEASUREMENT INFORMATION

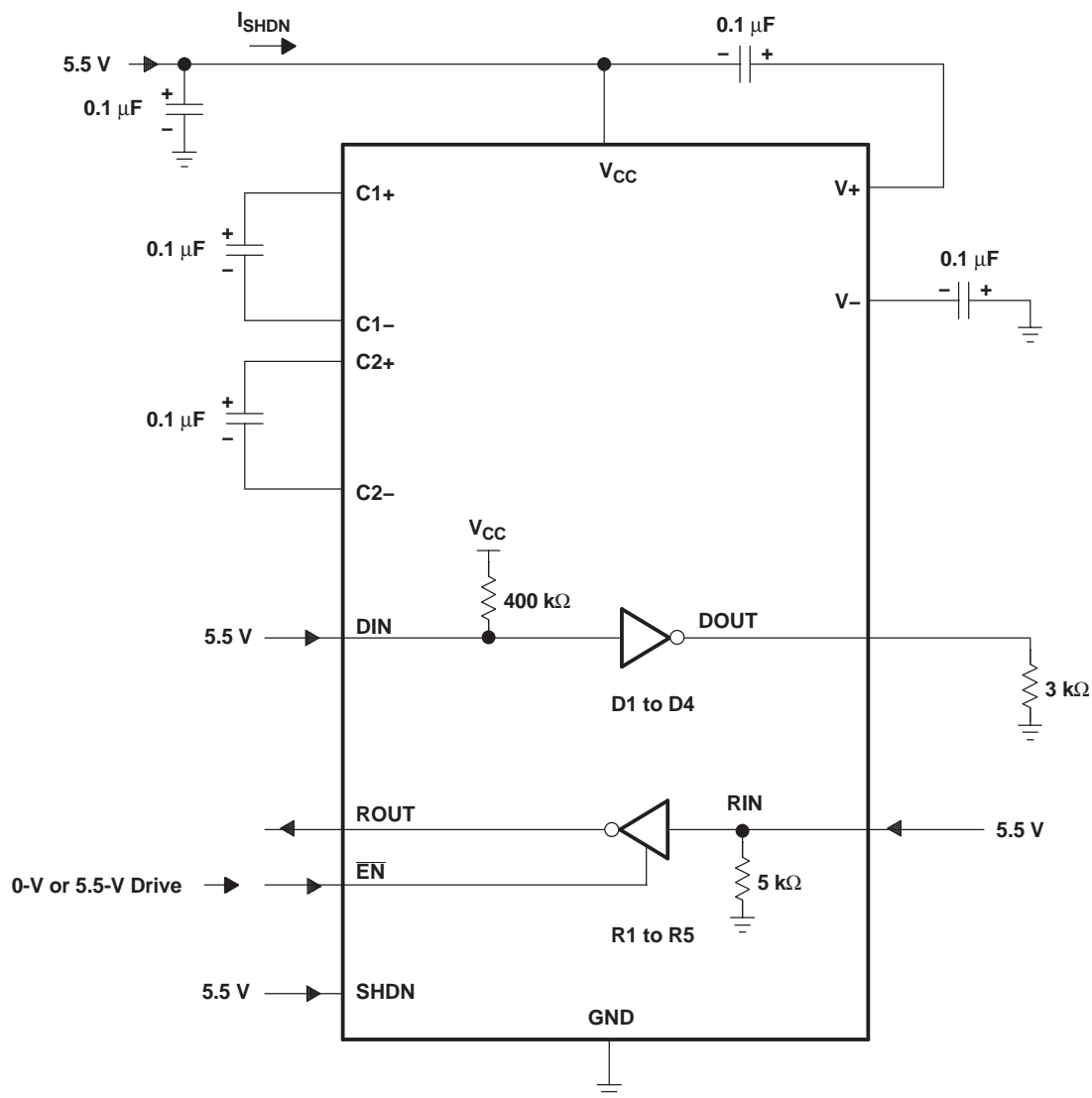
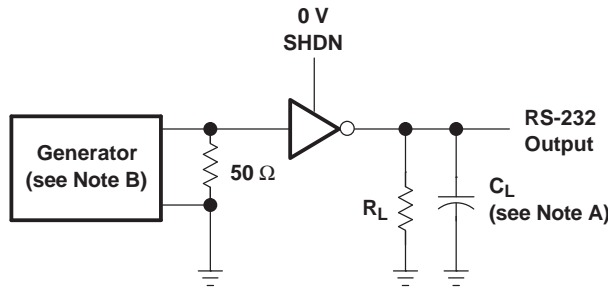
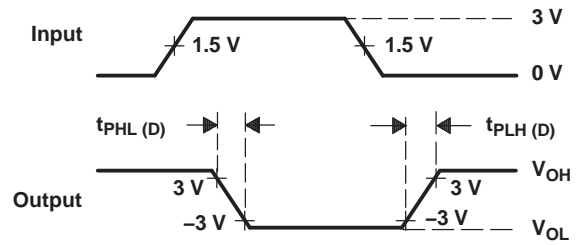


Figure 1. Shutdown Current Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



TEST CIRCUIT

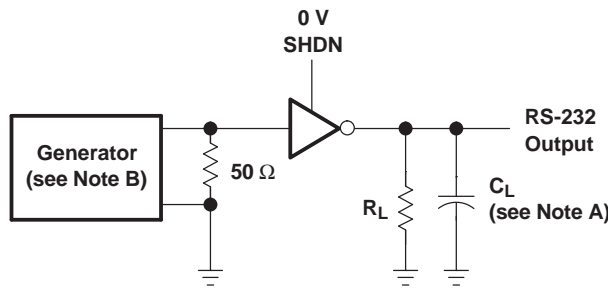


VOLTAGE WAVEFORMS

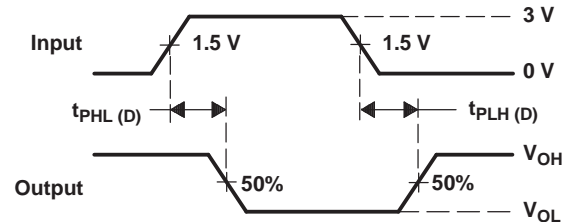
$$SR(tr) = \frac{6\text{ V}}{t_{PHL(D)} \text{ or } t_{PLH(D)}}$$

- A.  $C_L$  includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: PRR = 120 kbit/s,  $Z_O = 50\ \Omega$ , 50% duty cycle,  $t_r \leq 10\text{ ns}$ ,  $t_f \leq 10\text{ ns}$ .

Figure 2. Driver Slew Rate and Propagation Delay Times



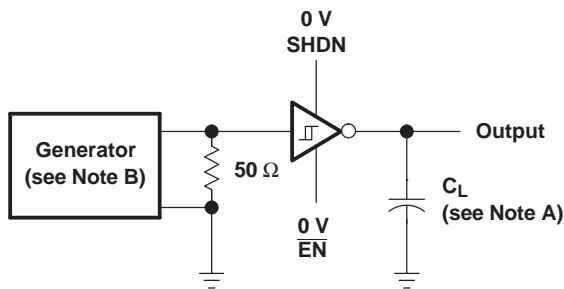
TEST CIRCUIT



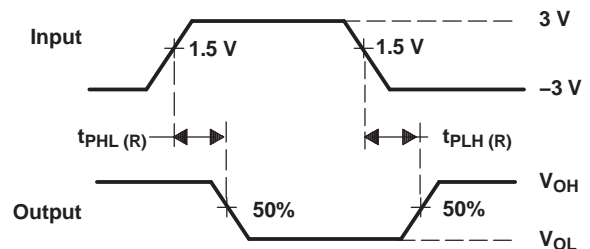
VOLTAGE WAVEFORMS

- A.  $C_L$  includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: PRR = 120 kbit/s,  $Z_O = 50\ \Omega$ , 50% duty cycle,  $t_r \leq 10\text{ ns}$ ,  $t_f \leq 10\text{ ns}$ .

Figure 3. Driver Pulse Skew



TEST CIRCUIT



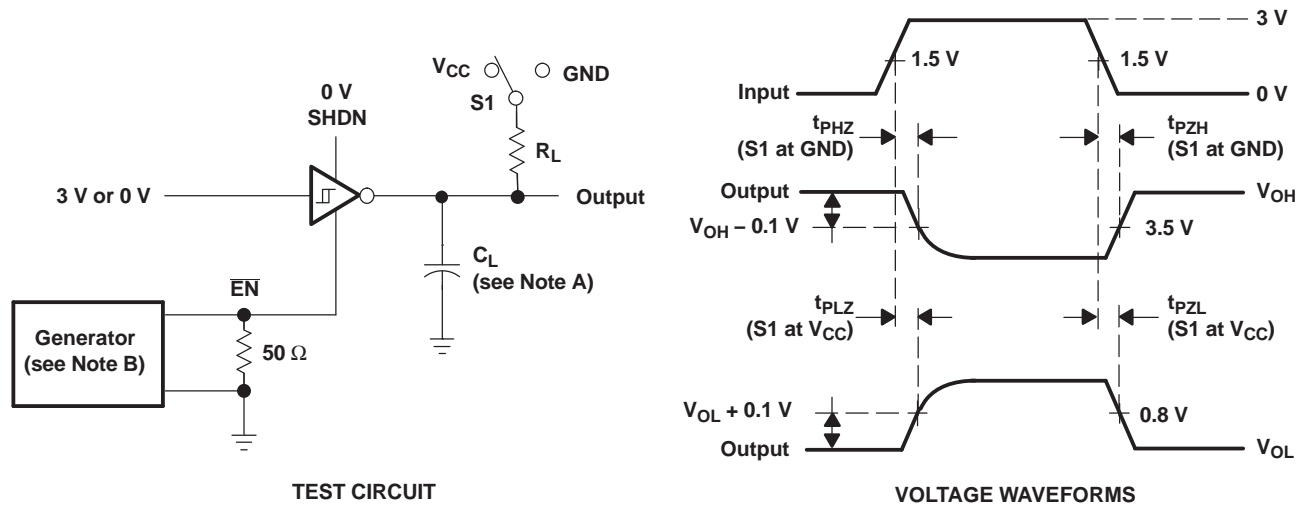
VOLTAGE WAVEFORMS

- 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



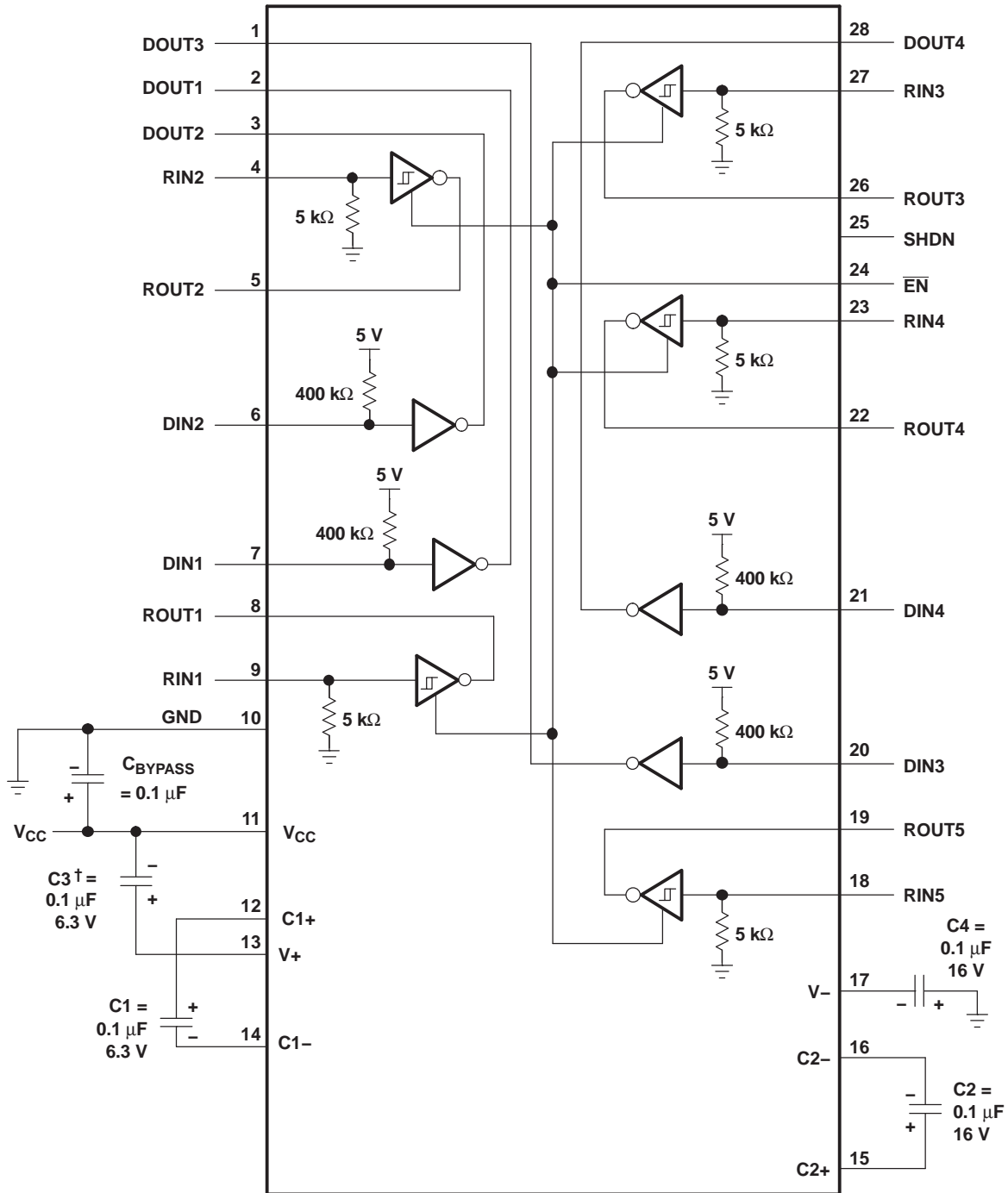
PARAMETER MEASUREMENT INFORMATION (continued)



- 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 5. Receiver Enable and Disable Times

APPLICATION INFORMATION



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

- 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

## APPLICATION INFORMATION (continued)

### Capacitor Selection

The capacitor type used for C1–C4 is not critical for proper operation. The TRS211 requires 0.1- $\mu$ F capacitors, although capacitors up to 10  $\mu$ F can be used without harm. Ceramic dielectrics are suggested for the 0.1- $\mu$ F capacitors. When using the minimum recommended capacitor values, make sure the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (e.g., 2 $\times$ ) nominal value. The capacitors' effective series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V–.

Use larger capacitors (up to 10  $\mu$ F) to reduce the output impedance at V+ and V–.

Bypass  $V_{CC}$  to ground with at least 0.1  $\mu$ F. In applications sensitive to power-supply noise generated by the charge pumps, decouple  $V_{CC}$  to ground with a capacitor the same size as (or larger than) the charge-pump capacitors (C1–C4).

### Electrostatic Discharge (ESD) Protection

TI TRS211 devices have standard ESD protection structures incorporated on the pins to protect against electrostatic discharges encountered during assembly and handling. In addition, the RS232 bus pins (driver outputs and receiver inputs) of these devices have an extra level of ESD protection. Advanced ESD structures were designed to successfully protect these bus pins against ESD discharge of  $\pm 15$  kV when powered down.

### 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](#). [Figure 8](#) shows the current waveform that is generated during a discharge into a low impedance. The model consists of a 100-pF capacitor charged to the ESD voltage of concern and subsequently discharged into the DUT through a 1.5-k $\Omega$  resistor.

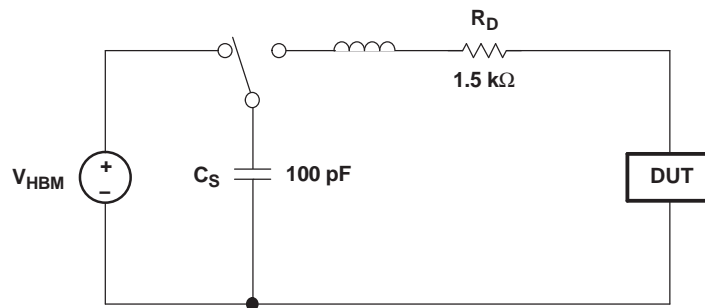


Figure 7. HBM ESD Test Circuit

APPLICATION INFORMATION (continued)

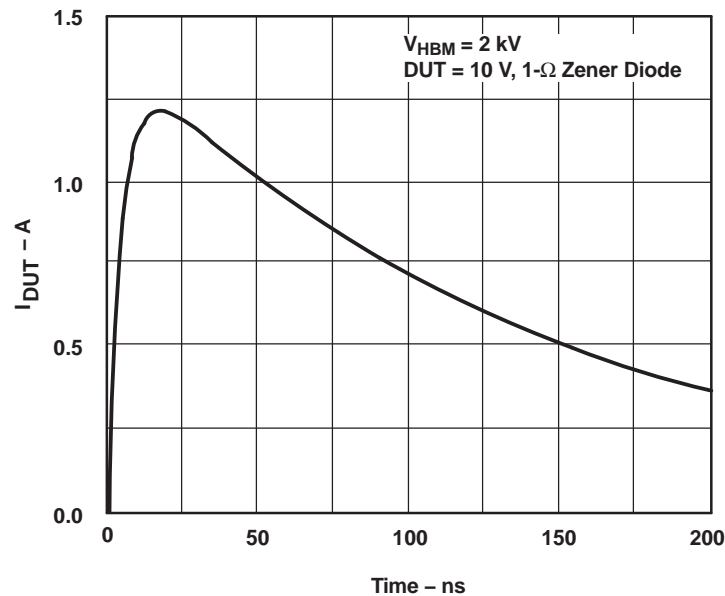


Figure 8. Typical HBM Current Waveform

**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 no longer is as pertinent to the RS-232 pins.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
TRS211CDB	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
TRS211CDBG4	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

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

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

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

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

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

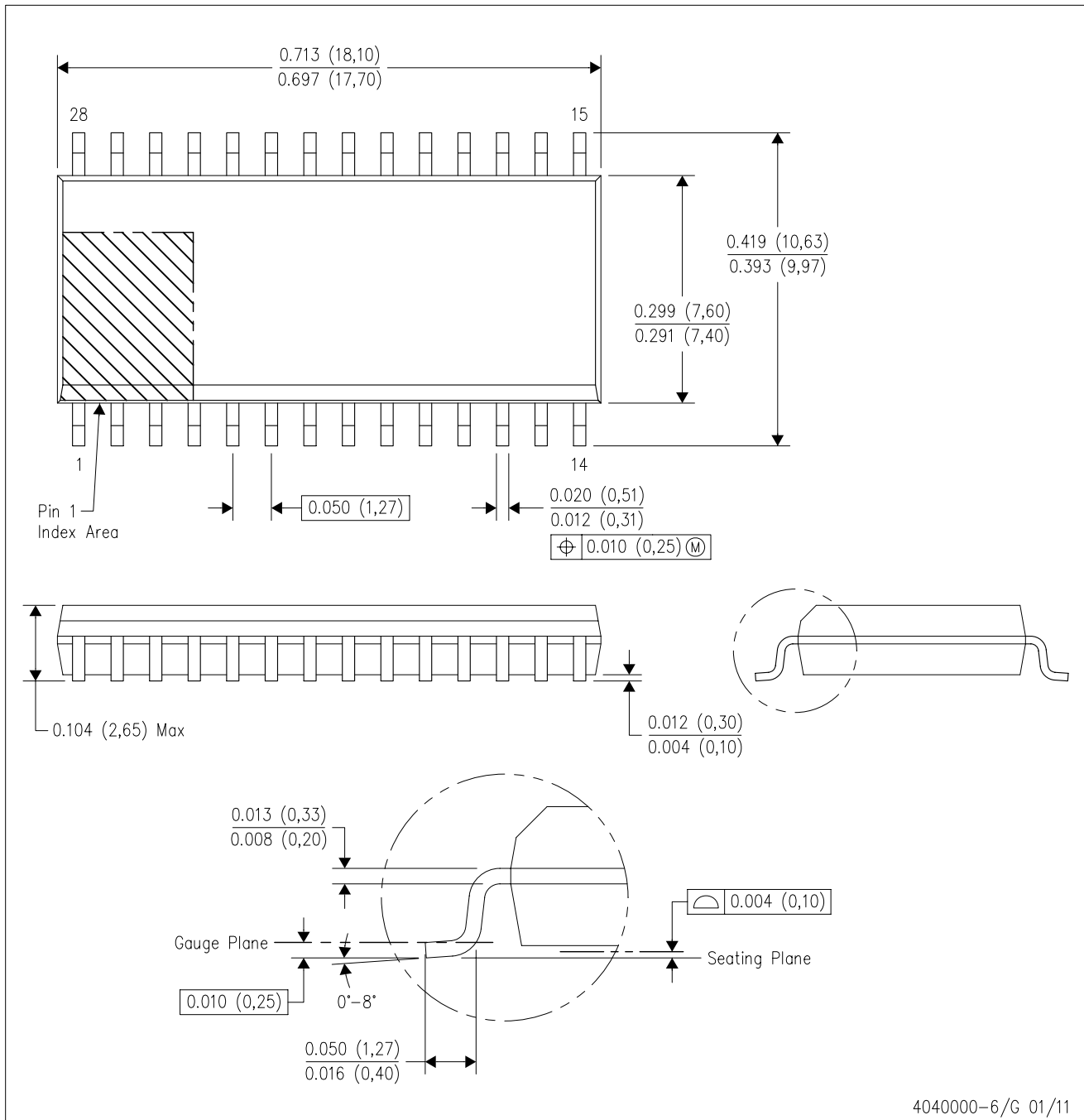
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



4040000-6/G 01/11

- 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.

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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