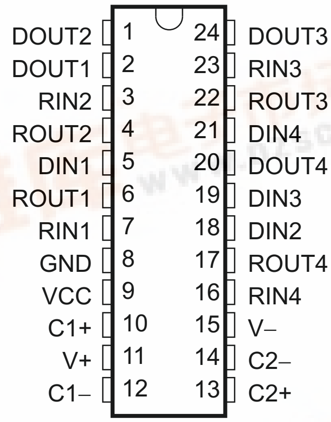
TRS208
5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

SLLS810 – JULY 2007

FEATURES

- **ESD Protection for RS-232 I/O Pins**
  - **±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 Four Receivers**
- **Operates up to 120 kbit/s**
- **External Capacitors . . . 4 × 0.1 µF**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**

DB, DW, OR NT PACKAGE (TOP VIEW)



APPLICATIONS

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

DESCRIPTION/ORDERING INFORMATION

The TRS208 device consists of four line drivers, four line receivers, and a dual charge-pump circuit with ±15-kV HBM 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/µs driver output slew rate.

ORDERING INFORMATION

T_A	PACKAGE(1)(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – NT	Tube of 15	TRS208CNT	PREVIEW
	SOIC – DW	Tube of 25	TRS208CDW	TRS208C
		Reel of 2000	TRS208CDWR	
	SSOP – DB	Tube of 60	TRS208CDB	RU08C
		Reel of 2000	TRS208CDBR	
–40°C to 85°C	PDIP – NT	Tube of 15	TRS208INT	PREVIEW
	SOIC – DW	Tube of 25	TRS208IDW	TRS208I
		Reel of 2000	TRS208IDWR	
	SSOP – DB	Tube of 60	TRS208IDB	RU08I
		Reel of 2000	TRS208IDBR	

(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 TABLES

Each Driver(1)

INPUT DIN	OUTPUT DOUT
L	H
H	L

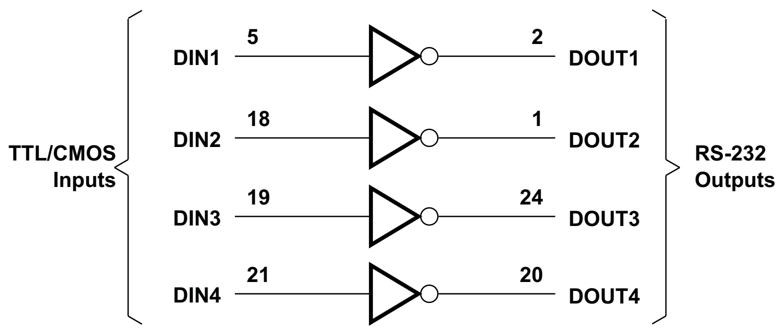
(1) H = high level, L = low level

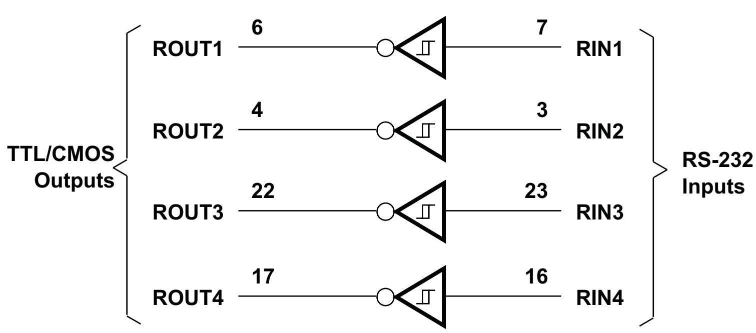
Each Receiver(1)

INPUT RIN	OUTPUT ROUT
L	H
H	L
Open	H

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

LOGIC DIAGRAM (POSITIVE LOGIC)





Absolute Maximum Ratings[1]

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range[2]		–0.3	6	V
V+	Positive charge pump voltage range[2]		V_{CC} – 0.3	14	V
V–	Negative charge pump voltage range[2]		–14	0.3	V
V+ – V–	Supply voltage difference[2]			13	V
V_I	Input voltage range	Drivers	–0.3	V+ + 0.3	V
		Receivers		±30	
V_O	Output voltage range	Drivers	V– – 0.3	V+ + 0.3	V
		Receivers	–0.3	V_{CC} + 0.3	
	Short-circuit duration	DOUT		Continuous	
θ_{JA}	Package thermal impedance	DB package[3][4]		63	°C/W
		DW package[3][4]		46	
		NT package[3][5]		67	
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network GND.
(3) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.
(5) The package thermal impedance is calculated in accordance with JESD 51-3.

Recommended Operating Conditions[1]

See Figure 4

			MIN	NOM	MAX	UNIT
	Supply voltage		4.5	5	5.5	V
V_{IH}	Driver high-level input voltage	DIN	2			V
V_{IL}	Driver low-level input voltage	DIN			0.8	V
V_I	Driver input voltage	DIN	0		5.5	V
	Receiver input voltage		–30		30	
T_A	Operating free-air temperature	TRS208C	0		70	°C
		TRS208I	–40		85	

(1) Test conditions are C1–C4 = 0.1 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 4)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC}	Supply current	No load, V_{CC} = 5 V, T_A = 25°C		11	20	mA

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.

DRIVER SECTION

Electrical Characteristics(1)

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

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	9		V
V_{OL}	Low-level output voltage	DOUT at R_L = 3 kΩ to GND,	DIN = V_{CC}	–5	–9		V
I_{IH}	High-level input current	V_I = V_{CC}			15	200	μA
I_{IL}	Low-level input current	V_I at 0 V			–15	–200	μA
I_{OS}(3)	Short-circuit output current	V_{CC} = 5.5 V,	V_O = 0 V		±10	±60	mA
r_o	Output resistance	V_{CC}, V+, and V– = 0 V,	V_O = ±2 V	300			Ω

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at 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 4)

PARAMETER		TEST CONDITIONS		MIN	TYP(2)	MAX	UNIT
	Maximum data rate	C_L = 50 pF to 1000 pF, One DOUT switching,	R_L = 3 kΩ to 7 kΩ, See Figure 1	120			kbit/s
$t_{PLH(D)}$	Propagation delay time, low- to high-level output	C_L = 2500 pF, All drivers loaded,	R_L = 3 kΩ, See Figure 1		2		μs
$t_{PHL(D)}$	Propagation delay time, high- to low-level output	C_L = 2500 pF, All drivers loaded,	R_L = 3 kΩ, See Figure 1		2		μs
$t_{sk(p)}$	Pulse skew(3)	C_L = 150 pF to 2500 pF, See Figure 2	R_L = 3 kΩ to 7 kΩ,		300		ns
SR(tr)	Slew rate, transition region (see Figure 1)	C_L = 50 pF to 1000 pF, V_{CC} = 5 V	R_L = 3 kΩ to 7 kΩ,	3	6	30	V/μs

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at 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

PIN	TEST CONDITIONS	TYP	UNIT
DOUT, RIN	Human-Body Model (HBM)	±15	kV

RECEIVER SECTION

Electrical Characteristics[1]

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

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –1 mA			3.5			V
V_{OL}	Low-level output voltage	I_{OL} = 1.6 mA					0.4	V
V_{IT+}	Positive-going input threshold voltage	V_{CC} = 5 V,	T_A = 25°C			1.7	2.4	V
V_{IT-}	Negative-going input threshold voltage	V_{CC} = 5 V,	T_A = 25°C		0.8	1.2		V
V_{hys}	Input hysteresis (V_{IT+} – V_{IT-})	V_{CC} = 5 V			0.2	0.5	1	V
r_i	Input resistance	V_I = ±3 V to ±25 V,	V_{CC} = 5 V,	T_A = 25°C	3	5	7	kΩ

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 5 V ± 0.5 V.

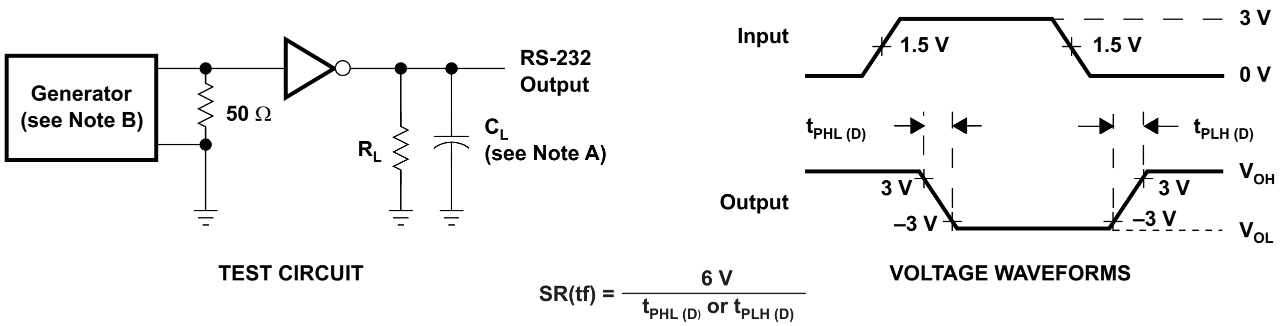
Switching Characteristics[1]

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
$t_{PLH(R)}$	Propagation delay time, low- to high-level output	C_L = 150 pF		0.5	10	μs
$t_{PHL(R)}$	Propagation delay time, high- to low-level output	C_L = 150 pF		0.5	10	μs
$t_{sk(p)}$	Pulse skew[3]			300		ns

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at 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.

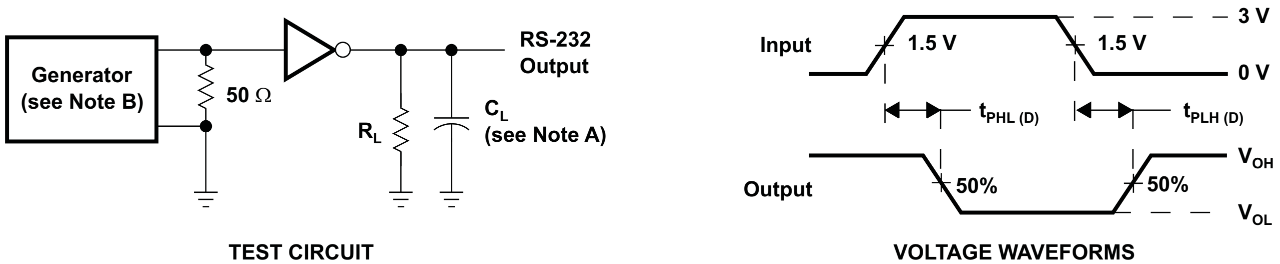
PARAMETER MEASUREMENT INFORMATION



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

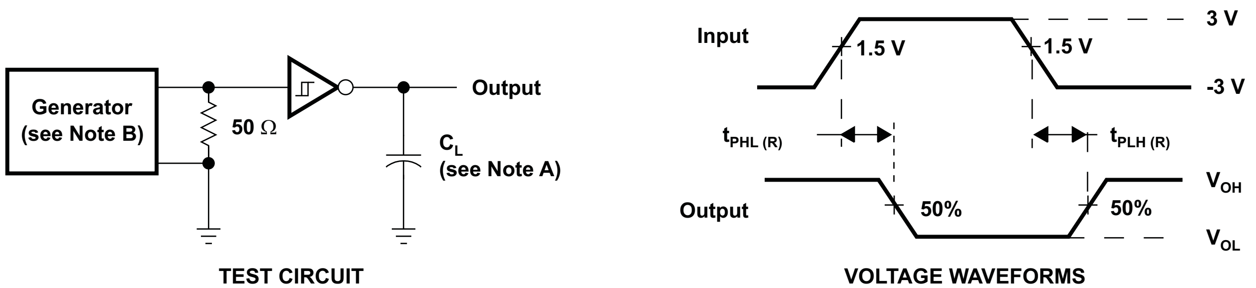
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 1. Driver Slew Rate



NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

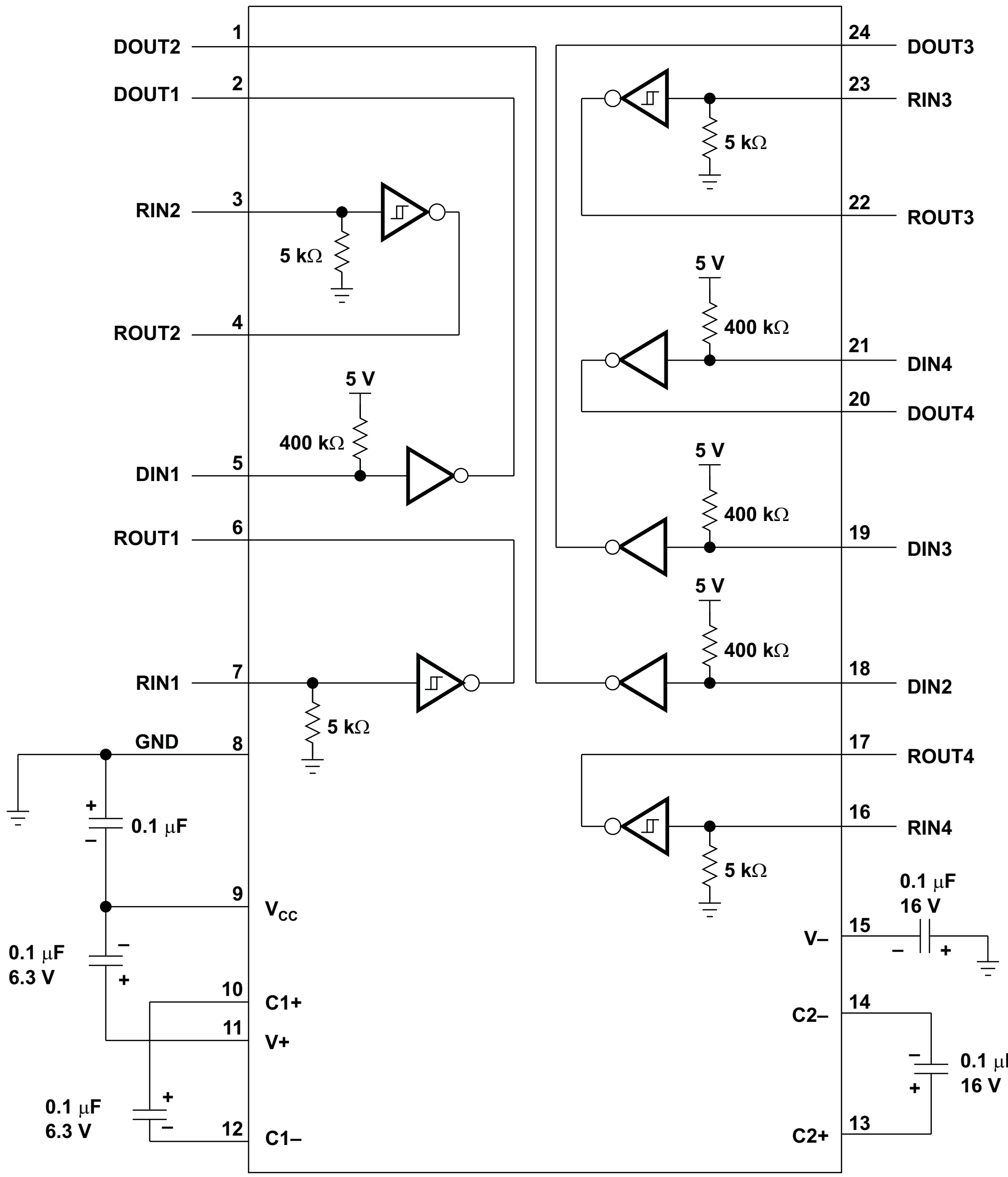
Figure 2. Driver Pulse Skew



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

APPLICATION INFORMATION



NOTES: A. Resistor values shown are nominal.

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

Figure 4. 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 TRS208 requires 0.1-μF capacitors, although capacitors up to 10 μF can be used without harm. Ceramic dielectrics are suggested for the 0.1-μF capacitors. When using the minimum recommended capacitor values, ensure that the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (e.g., 2×) 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 μF) to reduce the output impedance at V+ and V–.

Bypass V_{CC} to ground with at least 0.1 μF. 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 TRS208 devices have standard ESD protection structures incorporated on the pins to protect against electrostatic discharges encountered during assembly and handling. In addition, the RS-232 bus pins (driver outputs and receiver inputs) of these devices have an extra level of ESD protection. Advanced ESD structures were designed to successfully protect these bus pins against ESD discharge of ±15 kV 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 5, while Figure 6 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-kΩ resistor.

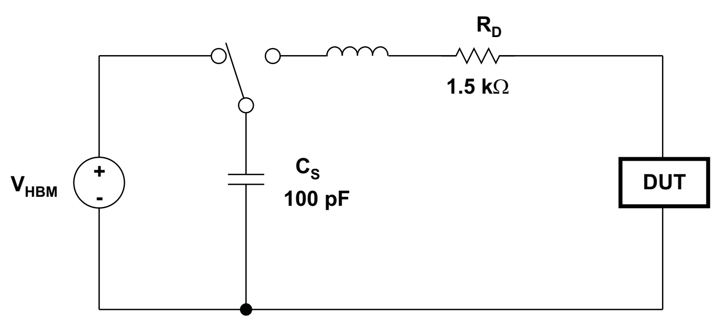


Figure 5. HBM ESD Test Circuit

APPLICATION INFORMATION (continued)

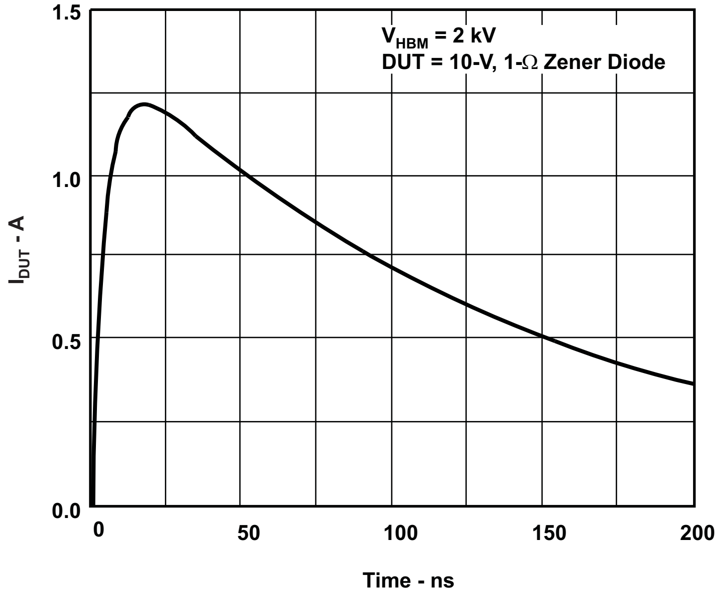


Figure 6. Typical HBM Current Waveform

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 (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Pea
TRS208CDB	ACTIVE	SSOP	DB	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208CDBG4	ACTIVE	SSOP	DB	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208CDBR	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208CDBRG4	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208CDWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208CDWRG4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDB	ACTIVE	SSOP	DB	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDBG4	ACTIVE	SSOP	DB	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDBR	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDBRG4	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260
TRS208IDWRG4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260

(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
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.t
information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.

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www.ti.com

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable fo
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, 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 retard 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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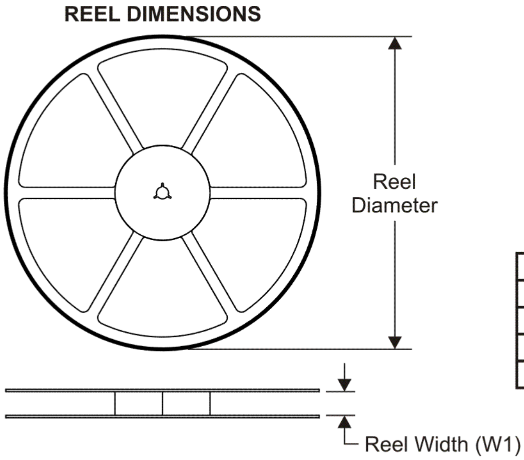
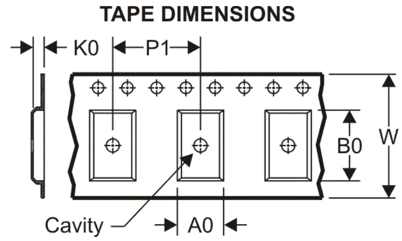
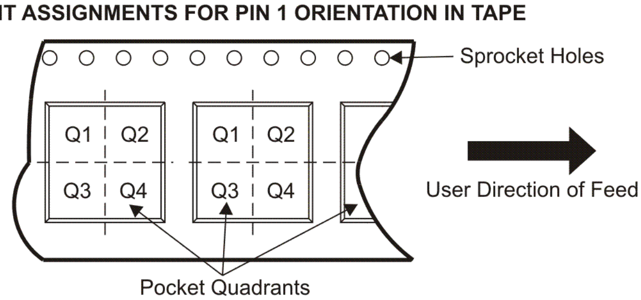
TAPE AND REEL INFORMATION





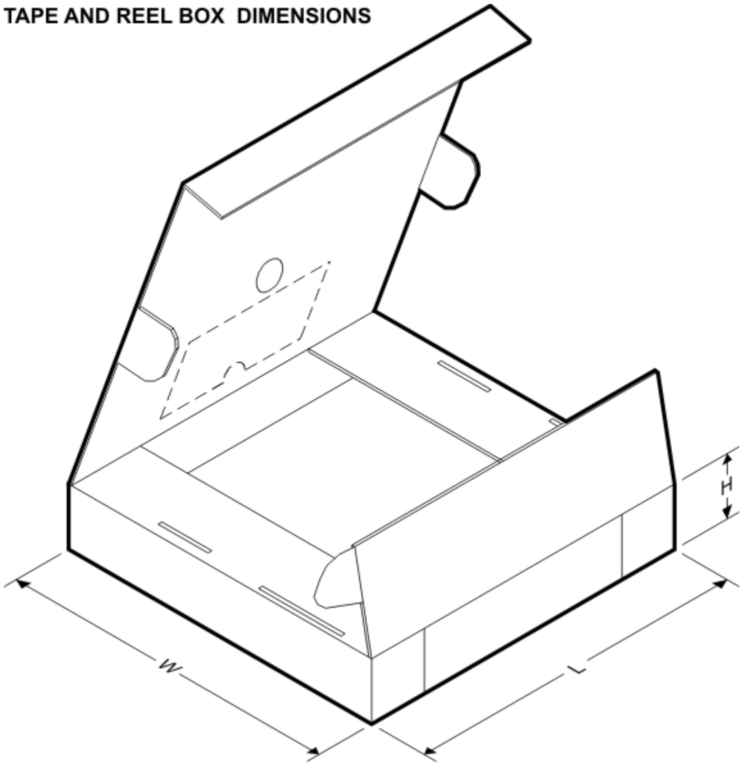
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



*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
TRS208CDBR	SSOP	DB	24	2000	330.0	16.4	8.2	8.8	2.5	12.0	16.0	Q1
TRS208CDWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
TRS208IDBR	SSOP	DB	24	2000	330.0	16.4	8.2	8.8	2.5	12.0	16.0	Q1
TRS208IDWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1

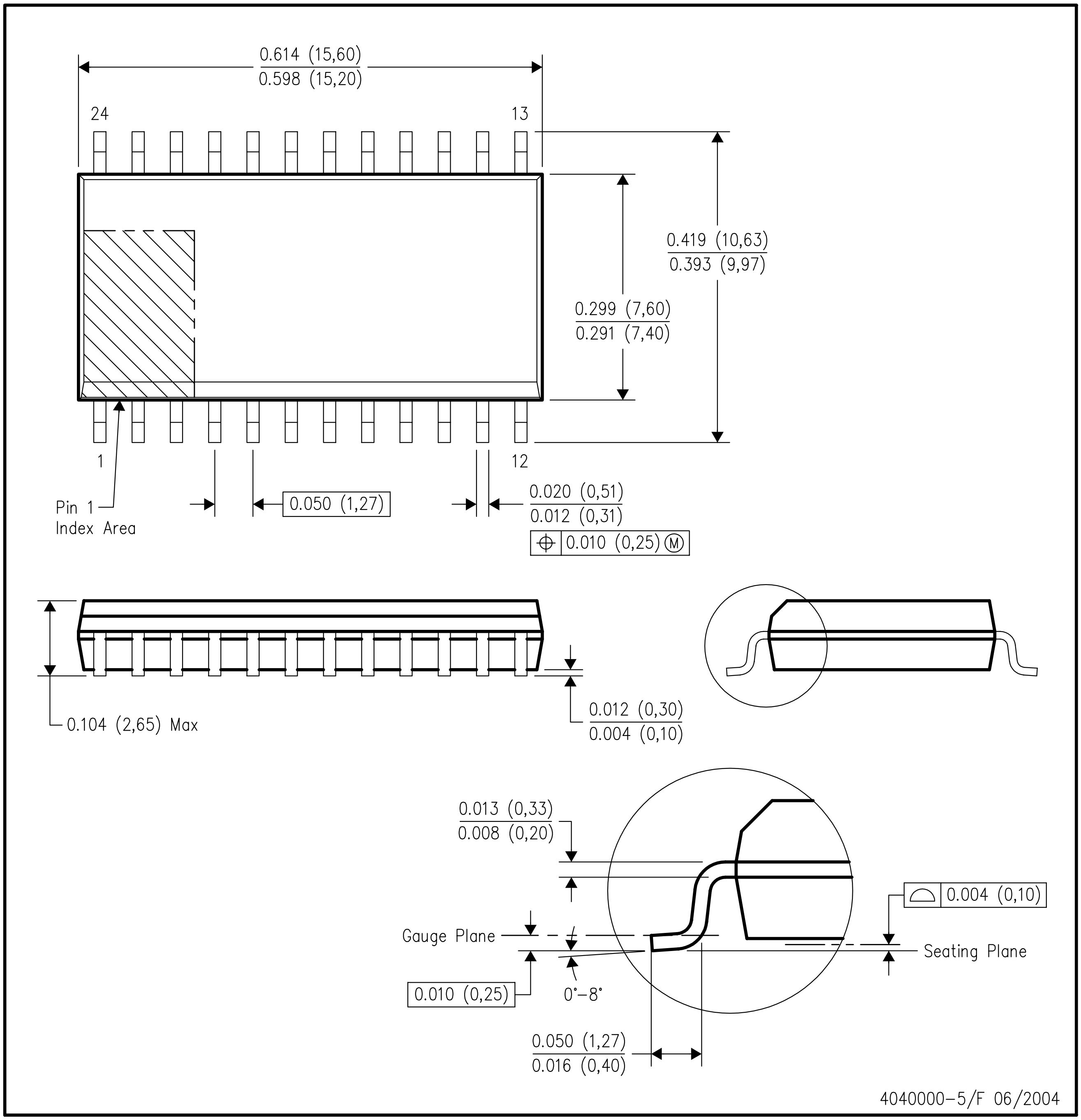
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS208CDBR	SSOP	DB	24	2000	346.0	346.0	33.0
TRS208CDWR	SOIC	DW	24	2000	346.0	346.0	41.0
TRS208IDBR	SSOP	DB	24	2000	346.0	346.0	33.0
TRS208IDWR	SOIC	DW	24	2000	346.0	346.0	41.0

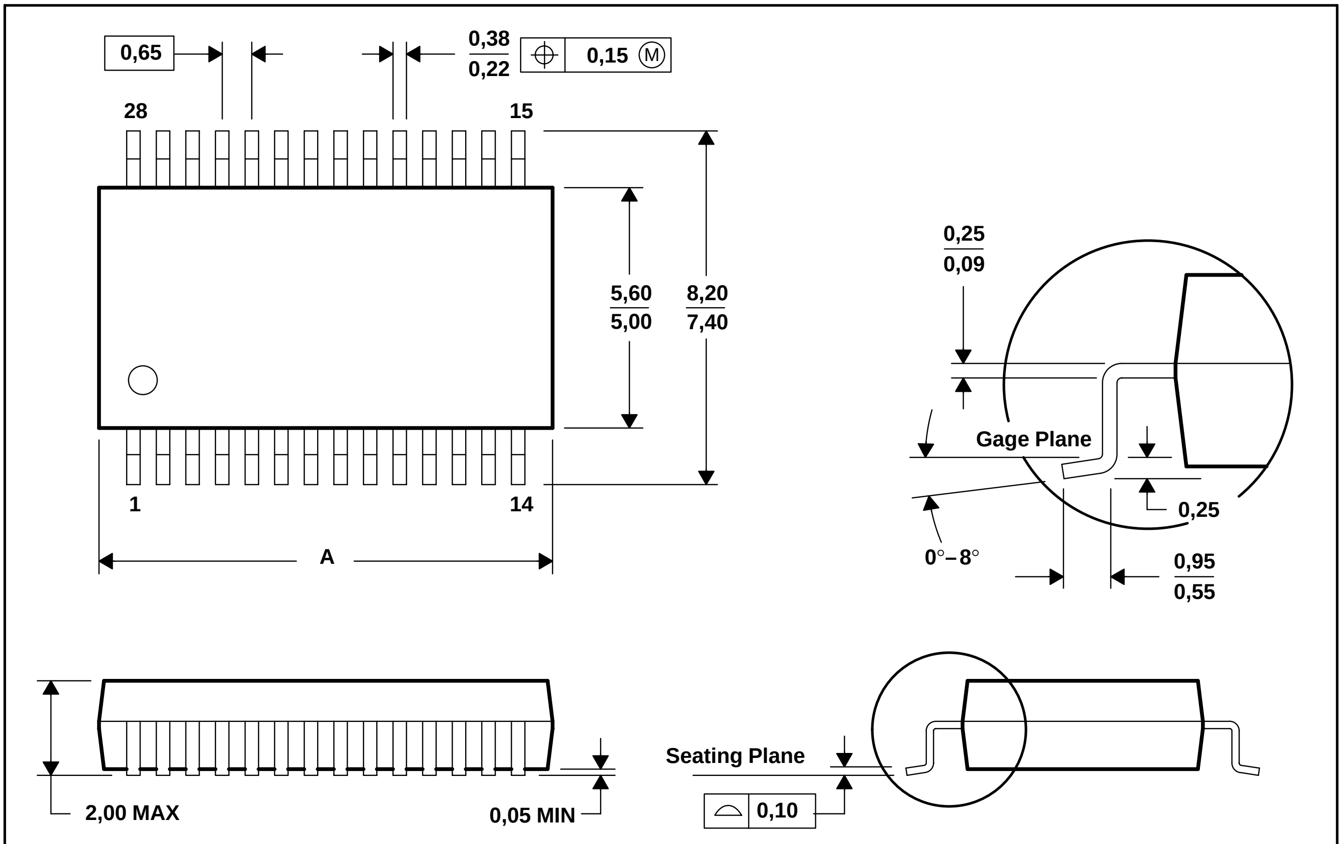
DW (R-PDSO-G24) PLASTIC SMALL-OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-013 variation AD.

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

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