

FEATURES

- RS-232 Bus-Pin ESD Protection Exceeds ± 15 kV Using Human-Body Model (HBM)
- 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 up to 250 kbit/s
- Two Drivers and Two Receivers
- Low Standby Current . . . 1 μ A Typical
- External Capacitors . . . $4 \times 0.1 \mu$ F
- Accepts 5-V Logic Input With 3.3-V Supply
- Alternative High-Speed Pin-Compatible Device (1 Mbit/s)
 - TRSF3222

APPLICATIONS

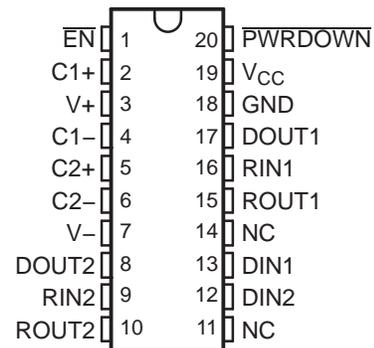
- Battery-Powered Systems
- PDAs
- Notebooks
- Laptops
- Palmtop PCs
- Hand-Held Equipment

DESCRIPTION/ORDERING INFORMATION

The TRS3222 consists of two line drivers, two line receivers, 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. The device operates at data signaling rates up to 250 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

The TRS3222 can be placed in the power-down mode by setting $\overline{\text{PWRDOWN}}$ low, which draws only 1 μ A from the power supply. When the device is powered down, the receivers remain active while the drivers are placed in the high-impedance state. Also, during power down, the onboard charge pump is disabled; $V+$ is lowered to V_{CC} , and $V-$ is raised toward GND. Receiver outputs also can be placed in the high-impedance state by setting $\overline{\text{EN}}$ high.

DB, DW, OR PW PACKAGE
(TOP VIEW)



NC – No internal connection



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.

TRS3222
3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER
WITH ±15-kV ESD PROTECTION

SLLS815–JULY 2007

ORDERING INFORMATION

T _A	PACKAGE ⁽¹⁾⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC – DW	Tube of 25	TRS3222CDW	TRS3222C
		Reel of 2000	TRS3222CDWR	
	SSOP – DB	Tube of 70	TRS3222CDB	RS22C
		Reel of 2000	TRS3222CDBR	
	TSSOP – PW	Tube of 70	TRS3222CPW	RS22C
		Reel of 2000	TRS3222CPWR	
–40°C to 85°C	SOIC – DW	Tube of 25	TRS3222IDW	TRS3222I
		SSOP – DB	TRS3222IDWR	
	SSOP – DB	Tube of 70	TRS3222IDB	RS22I
		Reel of 2000	TRS3222IDBR	
	TSSOP – PW	Tube of 70	TRS3222IPW	RS22I
		Reel of 2000	TRS3222IPWR	

- (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⁾

INPUTS		OUTPUT DOUT
DIN	PWRDOWN	
X	L	Z
L	H	H
H	H	L

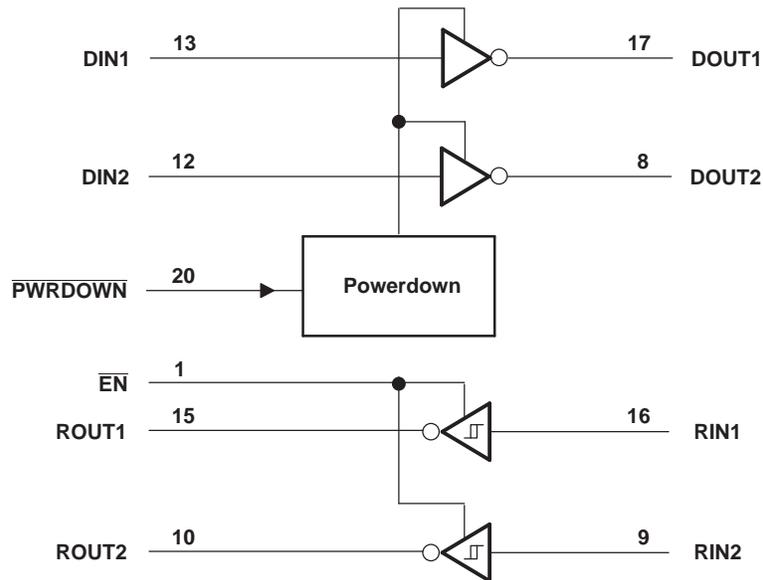
- (1) H = high level, L = low level, X = irrelevant,
Z = high impedance

Each Receiver⁽¹⁾

INPUTS		OUTPUT ROUT
RIN	$\overline{\text{EN}}$	
L	L	H
H	L	L
X	H	Z
Open	L	H

- (1) H = high level, L = low level, X = irrelevant,
Z = high impedance (off), Open = input
disconnected or connected driver off

LOGIC DIAGRAM (POSITIVE LOGIC)



TRS3222

3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

WITH ± 15 -kV ESD PROTECTION

SLLS815–JULY 2007

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	Drivers, $\overline{\text{EN}}$, $\overline{\text{PWRDOWN}}$	−0.3	6	V
		Receivers	−25	25	
V _O	Output voltage range	Drivers	−13.2	13.2	V
		Receivers	−0.3	V _{CC} + 0.3	
θ_{JA}	Package thermal impedance ⁽³⁾⁽⁴⁾	DB package		70	°C/W
		DW package		58	
		PW package		83	
T _J	Operating virtual junction temperature		150	°C	
T _{stg}	Storage temperature range	−65	150	°C	

- 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.
- All voltages are with respect to network GND.
- 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)/ θ_{JA} . Operating at the absolute maximum T_J of 150°C can affect reliability.
- 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, $\overline{\text{EN}}$, $\overline{\text{PWRDOWN}}$	V _{CC} = 3.3 V	2		V
		V _{CC} = 5 V	2.4		
V _{IL} Driver and control low-level input voltage	DIN, $\overline{\text{EN}}$, $\overline{\text{PWRDOWN}}$			0.8	V
V _I Driver and control input voltage	DIN, $\overline{\text{EN}}$, $\overline{\text{PWRDOWN}}$	0		5.5	V
V _I Receiver input voltage		−25		25	V
T _A Operating free-air temperature	TRS222C	0		70	°C
	TRS222I	−40		85	

- Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V \pm 0.3 V; C1 = 0.047 μF , C2–C4 = 0.33 μF 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 ($\overline{\text{EN}}$, $\overline{\text{PWRDOWN}}$)			± 0.01	± 1	μA
I _{CC}	Supply current	No load, $\overline{\text{PWRDOWN}}$ at V _{CC}		0.3	1	mA
	Supply current (powered off)	No load, $\overline{\text{PWRDOWN}}$ at GND		1	10	μA

- Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V \pm 0.3 V; C1 = 0.047 μF , C2–C4 = 0.33 μF at V_{CC} = 5 V \pm 0.5 V.
- 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 5](#))

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				
r _o	Output resistance	V _{CC} , V ₊ , and V _– = 0 V, V _O = ± 2 V	300	10 M		Ω
I _{off}	Output leakage current	PWRDOWN = GND, V _{CC} = 3 V to 3.6 V, V _O = ± 12 V			± 25	μ A
		PWRDOWN = GND, V _{CC} = 4.5 V to 5.5 V, V _O = ± 10 V			± 25	

(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 5](#))

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
	Maximum data rate	C _L = 1000 pF, One DOUT switching, R _L = 3 k Ω , See Figure 1	150	250		kbit/s
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		300		ns
SR(tr)	Slew rate, transition region (see Figure 1)	R _L = 3 k Ω to 7 k Ω , V _{CC} = 3.3 V, C _L = 150 pF to 1000 pF	6		30	V/ μ s
		C _L = 150 pF to 2500 pF	4		30	

(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.

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SLLS815–JULY 2007

RECEIVER SECTION

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
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 _{OH} = 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-})			0.3		V
I _{off}	Output leakage current	EN = V _{CC}		±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)

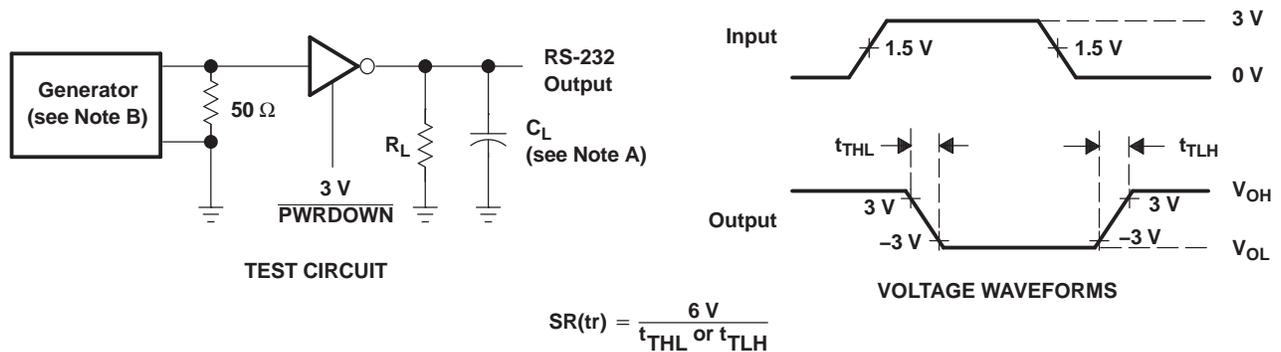
PARAMETER		TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
t _{PLH}	Propagation delay time, low- to high-level output	C _L = 150 pF, See Figure 3		300		ns
t _{PHL}	Propagation delay time, high- to low-level output	C _L = 150 pF, See Figure 3		300		ns
t _{en}	Output enable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 4		200		ns
t _{dis}	Output disable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 4		200		ns
t _{sk(p)}	Pulse skew ⁽³⁾	See Figure 3		300		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.

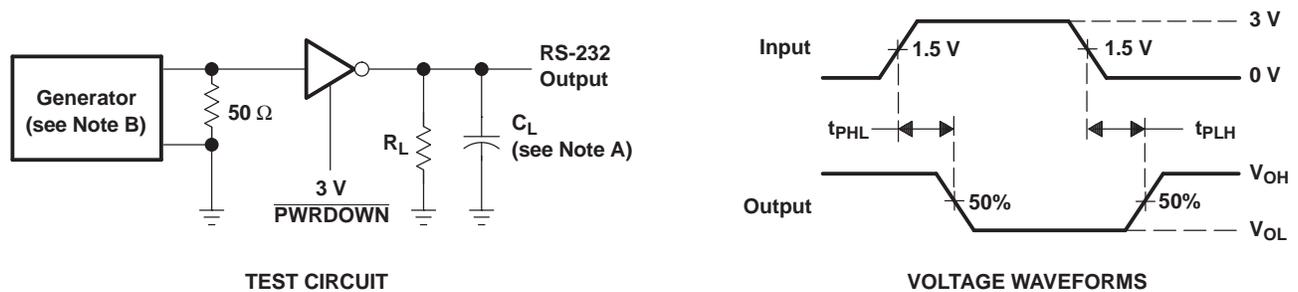
(3) Pulse skew is defined as |t_{PLH} - t_{PHL}| of each channel of the same device.

PARAMETER MEASUREMENT INFORMATION



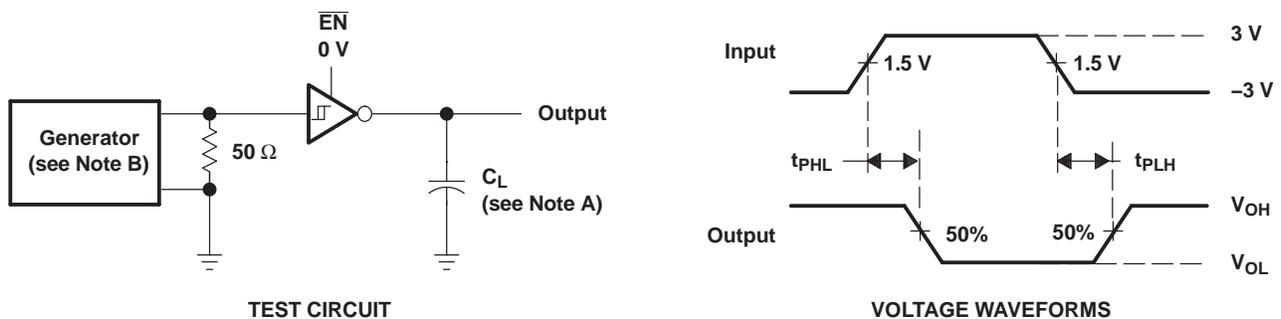
- A. C_L includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 1. Driver Slew Rate



- 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, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

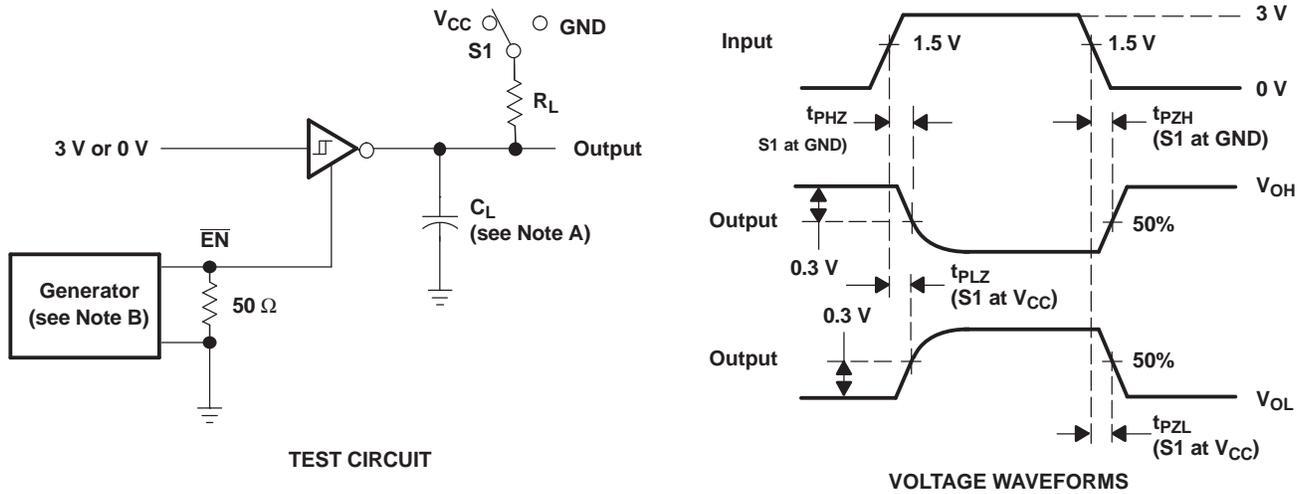
Figure 2. Driver Pulse Skew



- 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

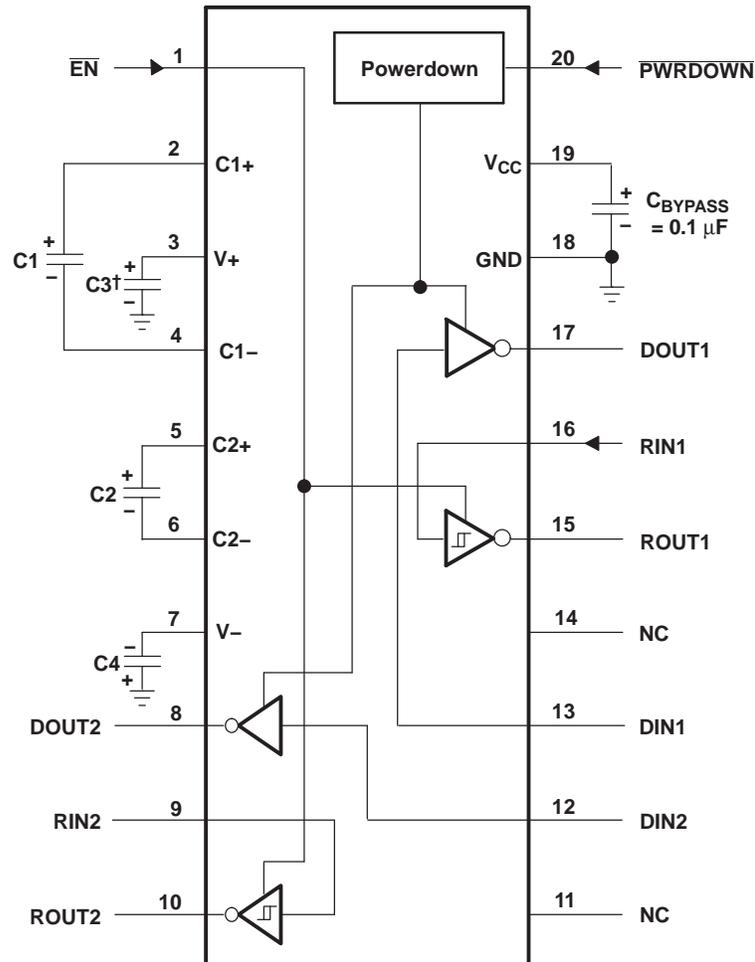
PARAMETER MEASUREMENT INFORMATION (continued)



- 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.

Figure 4. Receiver Enable and Disable Times

APPLICATION INFORMATION



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

NOTES: A. Resistor values shown are nominal.

B. NC – No internal connection

C. 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 finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TRS3222CDBR	ACTIVE	SSOP	DB	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	RS22C	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

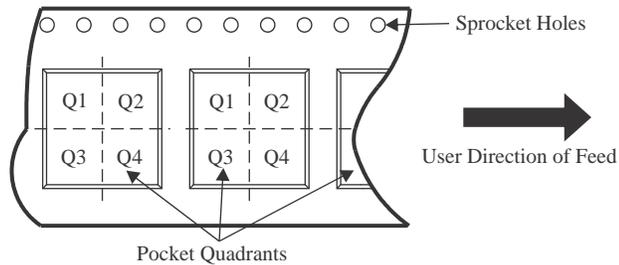
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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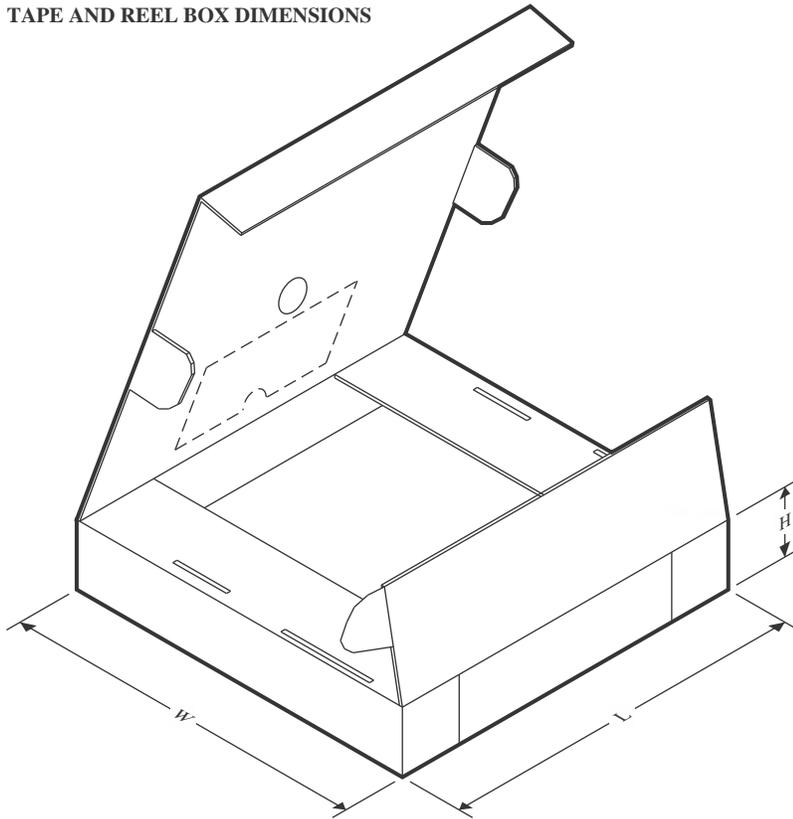
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TAPE AND REEL INFORMATION

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
TRS3222CDBR	SSOP	DB	20	2000	330.0	16.4	8.2	7.5	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)
TRS3222CDBR	SSOP	DB	20	2000	356.0	356.0	35.0

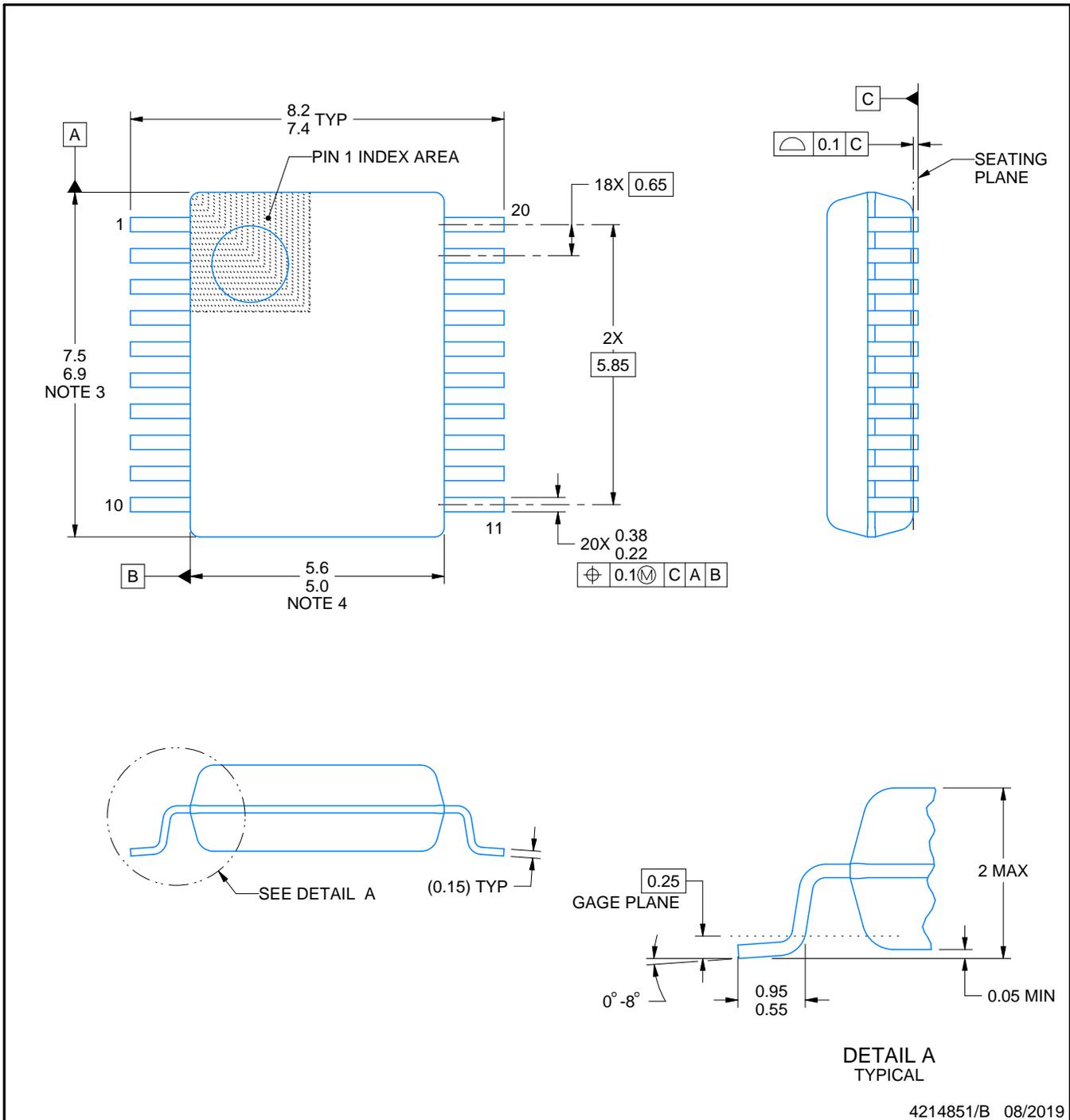
DB0020A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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NOTES:

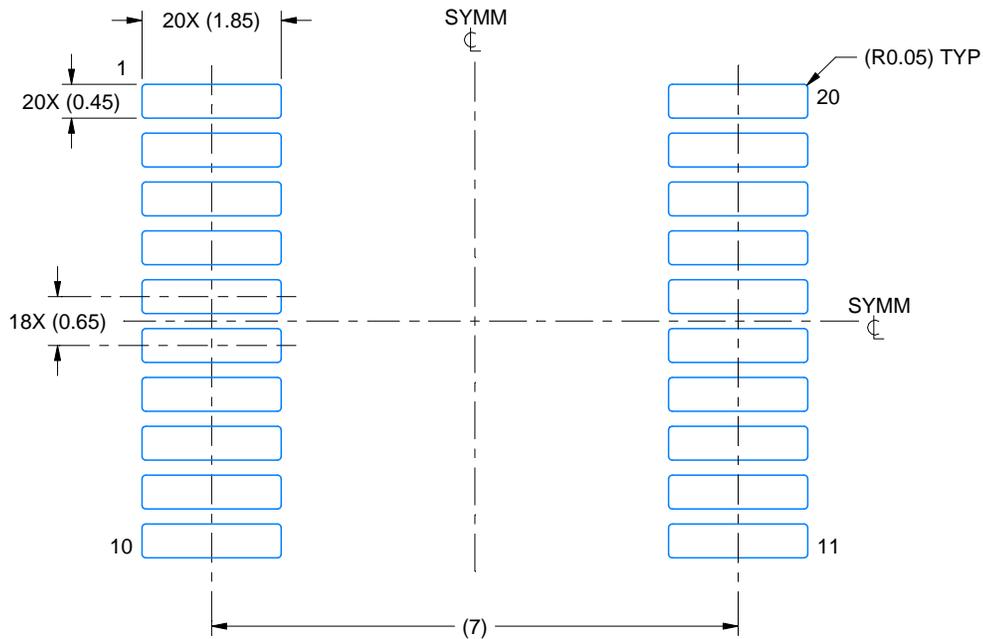
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-150.

EXAMPLE BOARD LAYOUT

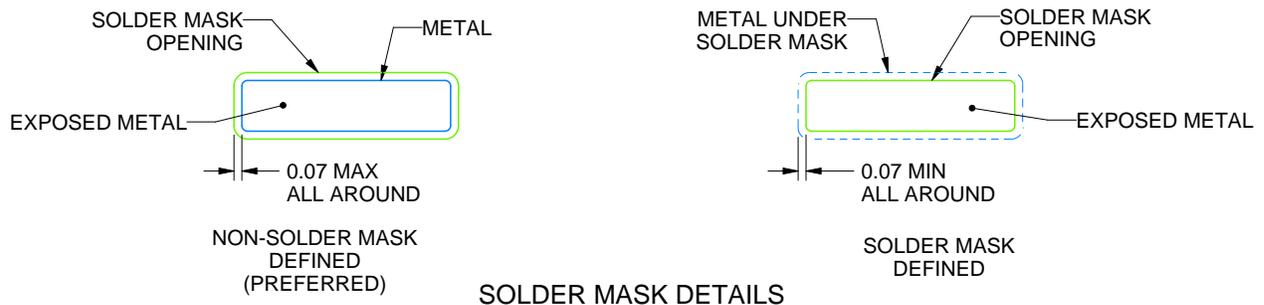
DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



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NOTES: (continued)

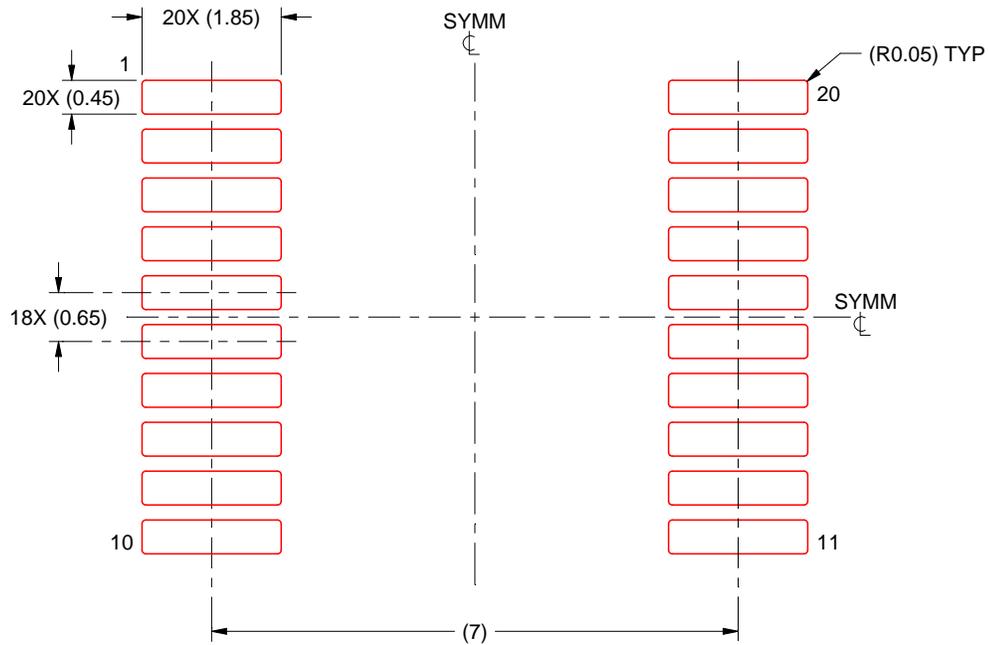
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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