

## Excellent Integrated System Limited

Stocking Distributor

Click to view price, real time Inventory, Delivery & Lifecycle Information:

[Texas Instruments](#)  
[TRSF3221ECDB](#)

For any questions, you can email us directly:

[sales@integrated-circuit.com](mailto:sales@integrated-circuit.com)

## FEATURES

- **ESD Protection for RS-232 Pins**
  - ±15-kV Human-Body Model (HBM)
  - ±8-kV IEC 61000-4-2 Contact Discharge
  - ±15-kV IEC 61000-4-2 Air-Gap Discharge
- **Operates With 3-V to 5.5-V V<sub>CC</sub> Supply**
- **Operates up to 1 Mbit/s**
- **Low Standby Current . . . 1 µA Typ**
- **External Capacitors . . . 4 × 0.1 µF**
- **Accepts 5-V Logic Input With 3.3-V Supply**
- **RS-232 Bus-Pin ESD Protection Exceeds ±15 kV Using HBM**
- **Auto-Powerdown Feature Automatically Disables Drivers for Power Savings**

## APPLICATIONS

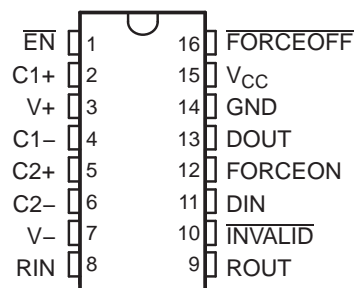
- **Battery-Powered, Hand-Held, and Portable Equipment**
- **PDA's and Palmtop PC's**
- **Notebooks, Sub-Notebooks, and Laptops**
- **Digital Cameras**
- **Mobile Phones and Wireless Devices**

## DESCRIPTION/ORDERING INFORMATION

The TRSF3221E consists of one line driver, one line receiver, and a dual charge-pump circuit with ±15-kV IEC ESD protection pin to pin (serial-port connection pins, including GND). The TRSF3221E 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 TRSF3221E operates at data signaling rates up to 1 Mbit/s and a driver output slew rate of 24 V/µs to 150 V/µs.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and FORCEOFF is high. During this mode of operation, if the TRSF3221E does not sense a valid RS-232 signal on the receiver input, the driver output is disabled. If FORCEOFF is set low and the enable ( $\overline{\text{EN}}$ ) input is high, both the driver and receiver are shut off, and the supply current is reduced to 1 µA. Disconnecting the serial port or turning off the peripheral drivers causes the auto-powerdown condition to occur. Auto-powerdown can be disabled when FORCEON and FORCEOFF are high. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to the receiver input. The INVALID output notifies the user if an RS-232 signal is present at the receiver input. INVALID is high (valid data) if the receiver input voltage is greater than 2.7 V or less than -2.7 V, or has been between -0.3 V and 0.3 V for less than 30 µs. INVALID is low (invalid data) if the receiver input voltage is between -0.3 V and 0.3 V for more than 30 µs. See Figure 5 for receiver input levels.

DB 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.

**TRSF3221E**
**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION**

SLLS822–JULY 2007

**ORDERING INFORMATION**

T <sub>A</sub>	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SSOP – DB	Reel of 2000	TRSF3221ECDBR	RT21EC
	TSSOP – PW	Tube of 90	TRSF3221ECPW	RT21EC
		Reel of 2000	TRSF3221ECPWR	
–40°C to 85°C	SSOP – DB	Reel of 2000	TRSF3221EIDBR	RT21EI
	TSSOP – PW	Tube of 90	TRSF3221EIPW	RT21EI
		Reel of 2000	TRSF3221EIPWR	

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

INPUTS				OUTPUT DOUT	DRIVER STATUS
DIN	FORCEON	FORCEOFF	VALID RIN RS-232 LEVEL		
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with auto-powerdown disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with auto-powerdown enabled
H	L	H	Yes	L	
L	L	H	No	Z	Powered off by auto-powerdown feature
H	L	H	No	Z	

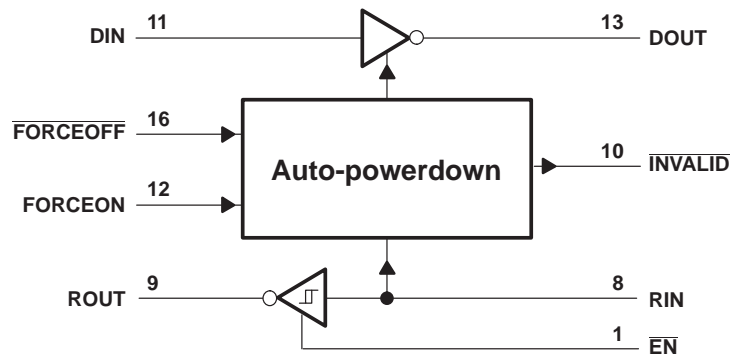
- (1) H = high level, L = low level, X = irrelevant, Z = high impedance

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

INPUTS			OUTPUT ROUT
RIN	EN	VALID RIN RS-232 LEVEL	
L	L	X	H
H	L	X	L
X	H	X	Z
Open	L	No	H

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

**LOGIC DIAGRAM (POSITIVE LOGIC)**



**TRSF3221E**
**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH  $\pm 15$ -kV IEC ESD PROTECTION**

SLLS822–JULY 2007

**Table 1. 1-Mbit/s RS-232 Parts**

PART NO.	TEMPERATURE RANGE	DRIVER NO.	RECEIVER NO.	ESD	SUPPLY $V_{CC}$ (V)	FEATURE	PIN/PACKAGE
TRSF3221E	0°C to 70°C	1	1	$\pm 15$ -kV Air-Gap, $\pm 8$ -kV Contact, $\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	16-pin SOIC, SSOP, TSSOP
TRSF3232E		2	2	$\pm 15$ -kV Air-Gap, $\pm 8$ -kV Contact, $\pm 15$ -kV HBM	3.3 or 5	Low pin count	16-pin SOIC, SSOP, TSSOP
TRS3227		1	1	$\pm 8$ -kV Air-Gap, $\pm 8$ -kV Contact, $\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown plus, ready signal	16-pin SSOP
TRSF3221		1	1	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	16-pin SOIC, SSOP, TSSOP
TRSF3223		2	2	$\pm 15$ -kV HBM	3.5 or 5	Auto-powerdown, enable signal	20-pin SOIC, SSOP, TSSOP
TRSF3222		2	2	$\pm 15$ -kV HBM	3.3 or 5	Enable, powerdown signal	20-pin SOIC, SSOP, TSSOP
TRSF3232		2	2	$\pm 15$ -kV HBM	3.3 or 5	Low pin count	16-pin SOIC, SSOP, TSSOP
TRSF3238		5	3	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown plus	28-pin SOIC, SSOP, TSSOP
TRSF3243		3	5	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	28-pin SOIC, SSOP, TSSOP
TRSF3221E	–40°C to 85°C	1	1	$\pm 15$ -kV Air-Gap, $\pm 8$ -kV Contact, $\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	16-pin SOIC, SSOP, TSSOP
TRSF3232E		2	2	$\pm 15$ -kV Air-Gap, $\pm 8$ -kV Contact, $\pm 15$ -kV HBM	3.3 or 5	Low pin count	16-pin SOIC, SSOP, TSSOP
TRS3227		1	1	$\pm 8$ -kV Air-Gap, $\pm 8$ -k V Contact, $\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown plus, ready signal	16-pin SSOP
TRSF3221		1	1	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	16-pin SOIC, SSOP, TSSOP
TRSF3223		2	2	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown, enable signal	20-pin SOIC, SSOP, TSSOP
TRSF3222		2	2	$\pm 15$ -kV HBM	3.3 or 5	Enable, powerdown signal	20-pin SOIC, SSOP, TSSOP
TRSF3232		2	2	$\pm 15$ -kV HBM	3.3 or 5	Low pin count	16-pin SOIC, SSOP, TSSOP
TRSF3238		5	3	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown plus	28-pin SOIC, SSOP, TSSOP
TRSF3243		3	5	$\pm 15$ -kV HBM	3.3 or 5	Auto-powerdown	28-pin SOIC, SSOP, TSSOP

### 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 output supply voltage range <sup>(2)</sup>	-0.3	7	V	
V-	Negative output supply voltage range <sup>(2)</sup>	0.3	-7	V	
V+ - V-	Supply voltage difference <sup>(2)</sup>		13	V	
V <sub>I</sub>	Input voltage range	Driver ( $\overline{\text{FORCEOFF}}$ , FORCEON, $\overline{\text{EN}}$ )	-0.3	6	V
		Receiver	-25	25	
V <sub>O</sub>	Output voltage range	Driver	-13.2	13.2	V
		Receiver (INVALID)	-0.3	V <sub>CC</sub> + 0.3	
$\theta_{JA}$	Package thermal impedance <sup>(3)(4)</sup>	DB package		82	°C/W
		PW package		108	
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>,  $\theta_{JA}$ , 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>)/ $\theta_{JA}$ . 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	V <sub>CC</sub> = 3.3 V	3	3.3	3.6	V
	V <sub>CC</sub> = 5 V	4.5	5	5.5	
V <sub>IH</sub>	Driver and control high-level input voltage DIN, $\overline{\text{FORCEOFF}}$ , FORCEON, $\overline{\text{EN}}$	V <sub>CC</sub> = 3.3 V	2		V
		V <sub>CC</sub> = 5 V	2.4		
V <sub>IL</sub>	Driver and control low-level input voltage DIN, $\overline{\text{FORCEOFF}}$ , FORCEON, EN			0.8	V
V <sub>I</sub>	Driver and control input voltage DIN, $\overline{\text{FORCEOFF}}$ , FORCEON	0		5.5	V
V <sub>I</sub>	Receiver input voltage	-25		25	V
T <sub>A</sub>	Operating free-air temperature	TRSF3221EI	-40	85	°C
		TRSF3221EC	0	70	

- (1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 3.3 V  $\pm$  0.3 V; C1 = 0.047  $\mu$ F, C2–C4 = 0.33  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V.

### 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
I <sub>I</sub>	Input leakage current	$\overline{\text{FORCEOFF}}$ , FORCEON, $\overline{\text{EN}}$		$\pm 0.01$	$\pm 1$	$\mu$ A
I <sub>CC</sub>	Supply current (T <sub>A</sub> = 25°C)	Auto-powerdown disabled	No load, $\overline{\text{FORCEOFF}}$ and FORCEON at V <sub>CC</sub>	0.3	1	mA
		Powered off	No load, $\overline{\text{FORCEOFF}}$ at GND	1	10	
		Auto-powerdown enabled	No load, $\overline{\text{FORCEOFF}}$ at V <sub>CC</sub> , FORCEON at GND, All RIN are open or grounded	1	10	$\mu$ A

- (1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 3.3 V  $\pm$  0.3 V; C1 = 0.047  $\mu$ F, C2–C4 = 0.33  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V.
- (2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

**TRSF3221E**
**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION**

SLLS822–JULY 2007

**DRIVER 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 DOUT at R <sub>L</sub> = 3 kΩ to GND, DIN = GND	5	5.4		V
V <sub>OL</sub>	Low-level output voltage DOUT at R <sub>L</sub> = 3 kΩ to GND, DIN = V <sub>CC</sub>	–5	–5.4		V
I <sub>IH</sub>	High-level input current V <sub>I</sub> = V <sub>CC</sub>		±0.01	±1	μA
I <sub>IL</sub>	Low-level input current V <sub>I</sub> at GND		±0.01	±1	μA
I <sub>OS</sub>	Short-circuit output current <sup>(3)</sup> V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0 V		±35	±60	mA
	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V		±35	±90	
r <sub>o</sub>	Output resistance V <sub>CC</sub> , V <sub>+</sub> , and V <sub>–</sub> = 0 V, V <sub>O</sub> = ±2 V	300	10M		Ω
I <sub>off</sub>	Output leakage current FORCEOFF = GND			±25	μA
	V <sub>O</sub> = ±12 V, V <sub>CC</sub> = 3 V to 3.6 V			±25	
	V <sub>O</sub> = ±10 V, V <sub>CC</sub> = 4.5 V to 5.5 V			±25	

 (1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

 (2) All typical values are at V<sub>CC</sub> = 3.3 V or 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) (see Figure 6)

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
Maximum data rate (see Figure 1)	R <sub>L</sub> = 3 kΩ	C <sub>L</sub> = 1000 pF	250		kbit/s
		C <sub>L</sub> = 250 pF, V <sub>CC</sub> = 3 V to 4.5 V	1000		
		C <sub>L</sub> = 1000 pF, V <sub>CC</sub> = 4.5 V to 5.5 V	1000		
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup> C <sub>L</sub> = 150 pF to 2500 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, See Figure 2		100		ns
SR(tr)	Slew rate, transition region (see Figure 1) V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 3 kΩ to 7 kΩ, C <sub>L</sub> = 150 pF to 1000 pF	18		150	V/μs

 (1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

 (2) All typical values are at V<sub>CC</sub> = 3.3 V or 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**

TERMINAL		TEST CONDITIONS	TYP	UNIT
NAME	NO.			
DOUT	13	HBM	±15	kV
		IEC 61000-4-2 Contact Discharge	±8	
		IEC 61000-4-2 Air-Gap Discharge	±15	

## 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	V <sub>CC</sub> - 0.6 V	V <sub>CC</sub> - 0.1 V		V
V <sub>OL</sub>	Low-level output voltage I <sub>OL</sub> = 1.6 mA			0.4	V
V <sub>IT+</sub>	Positive-going input threshold voltage	V <sub>CC</sub> = 3.3 V	1.6	2.4	V
		V <sub>CC</sub> = 5 V	1.9	2.4	
V <sub>IT-</sub>	Negative-going input threshold voltage	V <sub>CC</sub> = 3.3 V	0.6	1.1	V
		V <sub>CC</sub> = 5 V	0.8	1.4	
V <sub>hys</sub>	Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )		0.5		V
I <sub>off</sub>	Output leakage current	FORCEOFF = 0 V	±0.05	±10	µA
r <sub>i</sub>	Input resistance	V <sub>I</sub> = ±3 V to ±25 V	3	5	7 kΩ

(1) Test conditions are C1–C4 = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or 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) (see Figure 6)

PARAMETER	TEST CONDITIONS	TYP <sup>(2)</sup>	UNIT
t <sub>PLH</sub>	Propagation delay time, low- to high-level output C <sub>L</sub> = 150 pF, See Figure 3	150	ns
t <sub>PHL</sub>	Propagation delay time, high- to low-level output C <sub>L</sub> = 150 pF, See Figure 3	150	ns
t <sub>en</sub>	Output enable time C <sub>L</sub> = 150 pF, R <sub>L</sub> = 3 kΩ, See Figure 4	200	ns
t <sub>dis</sub>	Output disable time C <sub>L</sub> = 150 pF, R <sub>L</sub> = 3 kΩ, See Figure 4	200	ns
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup> See Figure 3	50	ns

(1) Test conditions are C1–C4 = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or 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

TERMINAL		TEST CONDITIONS	TYP	UNIT
NAME	NO.			
RIN	8	HBM	±15	kV
		IEC 61000-4-2 Contact Discharge	±8	
		IEC 61000-4-2 Air-Gap Discharge	±15	



**TRSF3221E**

**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION**



SLLS822–JULY 2007

**AUTO-POWERDOWN SECTION**

**Electrical Characteristics**

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+}$ (valid)	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		2.7	V
$V_{T-}$ (valid)	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	-2.7		V
$V_{T}$ (invalid)	Receiver input threshold for $\overline{\text{INVALID}}$ low-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	-0.3	0.3	V
$V_{OH}$	$\overline{\text{INVALID}}$ high-level output voltage	$I_{OH} = -1 \text{ mA}$ , FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	$V_{CC} - 0.6$		V
$V_{OL}$	$\overline{\text{INVALID}}$ low-level output voltage	$I_{OL} = 1.6 \text{ mA}$ , FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		0.4	V

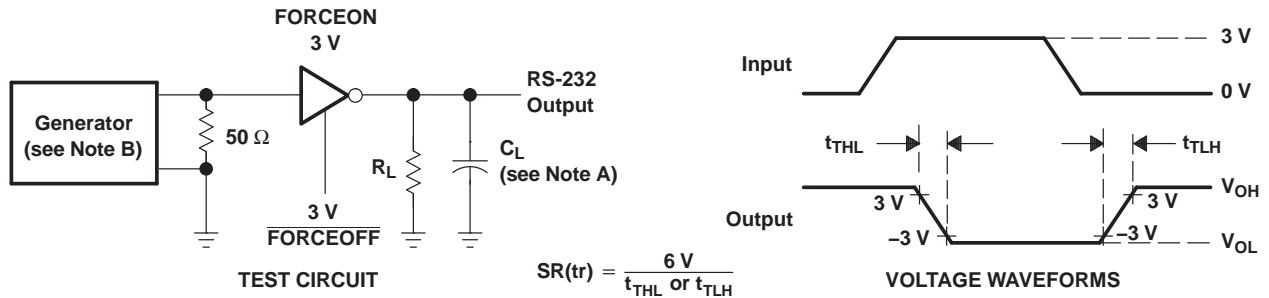
**Switching Characteristics**

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

PARAMETER		TYP <sup>(1)</sup>	UNIT
$t_{\text{valid}}$	Propagation delay time, low- to high-level output	1	μs
$t_{\text{invalid}}$	Propagation delay time, high- to low-level output	30	μs
$t_{\text{en}}$	Supply enable time	100	μs

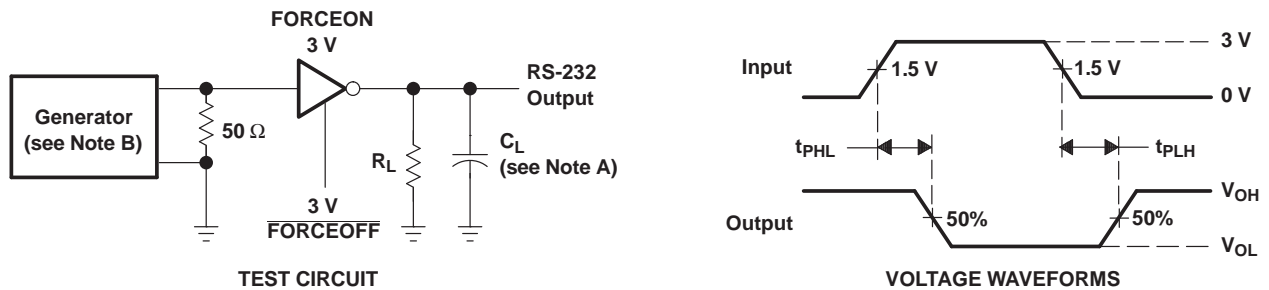
(1) All typical values are at  $V_{CC} = 3.3 \text{ V}$  or  $V_{CC} = 5 \text{ V}$ , and  $T_A = 25^\circ\text{C}$ .

**PARAMETER MEASUREMENT INFORMATION**



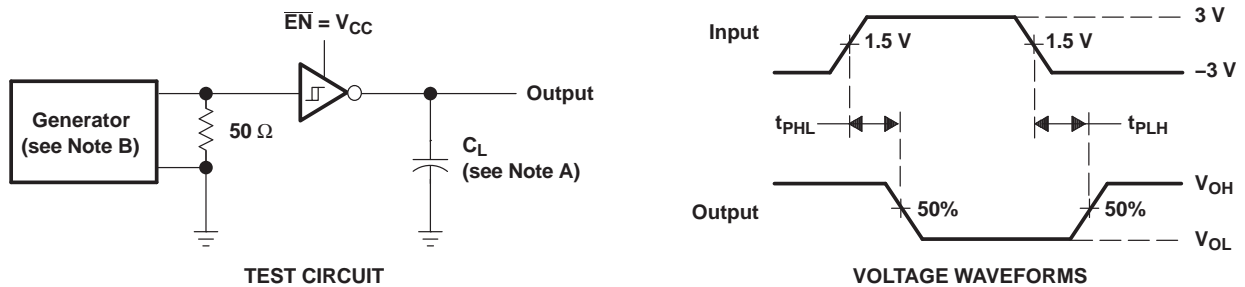
NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics: PRR = 250 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**Figure 1. Driver Slew Rate**



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

**Figure 2. Driver Pulse Skew**



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

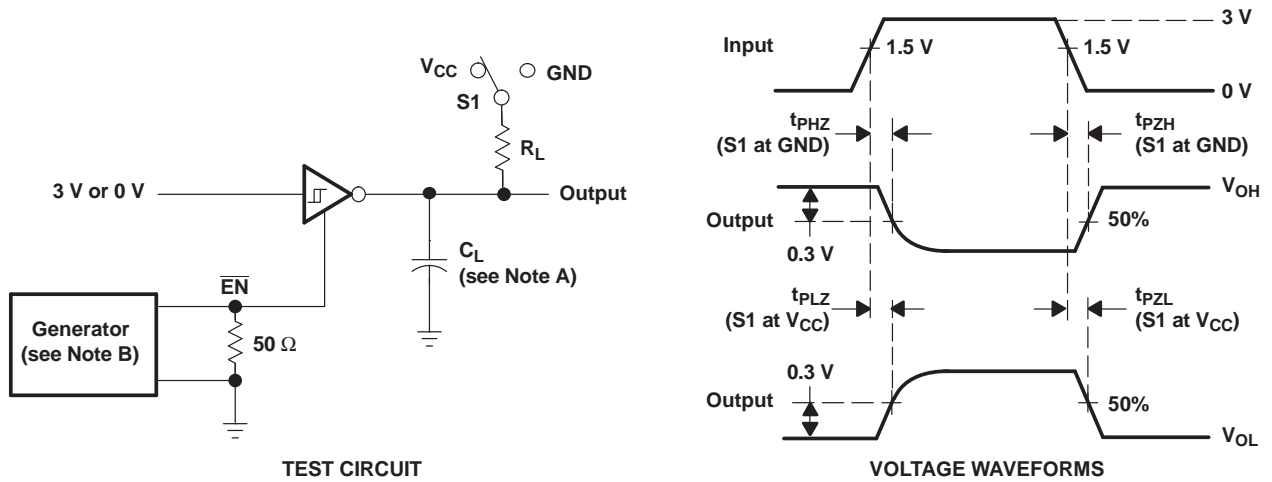
**Figure 3. Receiver Propagation Delay Times**

**TRSF3221E**

**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION**

SLLS822-JULY 2007

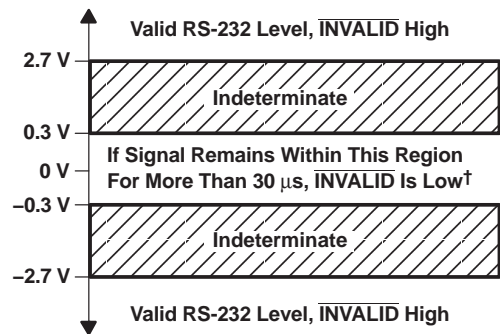
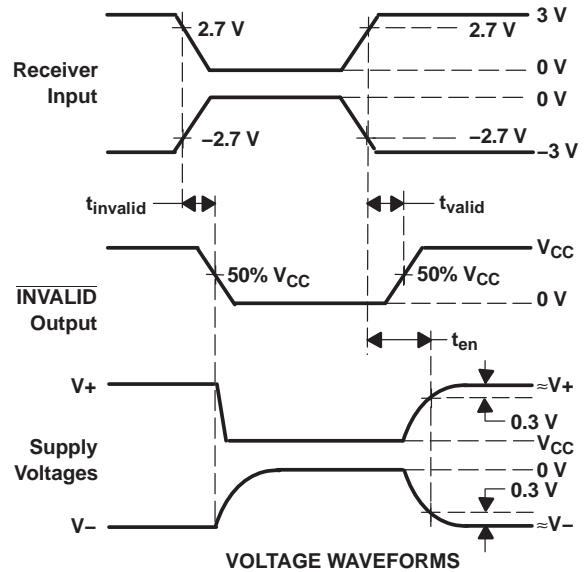
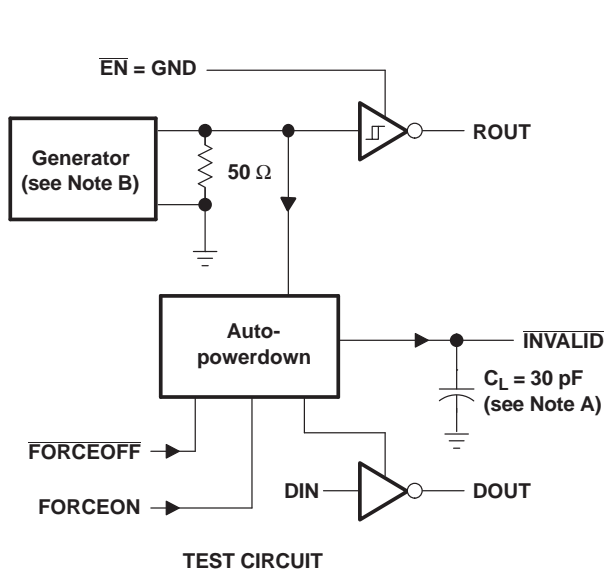
**PARAMETER MEASUREMENT INFORMATION (continued)**



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

PARAMETER MEASUREMENT INFORMATION (continued)



† Auto-powerdown disables drivers and reduces supply current to 1  $\mu$ A.

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics: PRR = 5 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

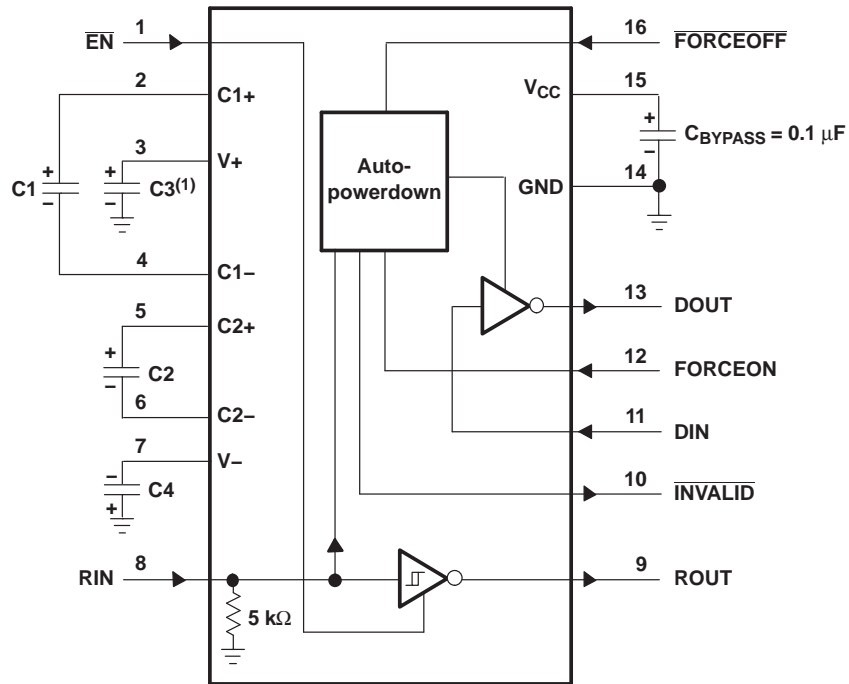
Figure 5.  $\overline{\text{INVALID}}$  Propagation Delay Times and Driver Enabling Time

**TRSF3221E**

**3-V TO 5.5-V SINGLE-CHANNEL RS-232 1-Mbit/s LINE DRIVER/RECEIVER WITH ±15-kV IEC ESD PROTECTION**

SLLS822-JULY 2007

**APPLICATION INFORMATION**



(1) C3 can be connected to V<sub>CC</sub> 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<sub>CC</sub> vs CAPACITOR VALUES**

V <sub>CC</sub>	C1	C2, C3, and C4
3.3 V ± 0.3 V	0.1 μF	0.1 μF
5 V ± 0.5 V	0.047 μF	0.33 μF
3 V to 5.5 V	0.1 μF	0.47 μF

**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
TRSF3221ECDB	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221ECDBG4	ACTIVE	SSOP	DB	16	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221ECDBR	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221ECDBG4	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221ECPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221ECPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	RT21EC	<a href="#">Samples</a>
TRSF3221EIDB	OBSOLETE	SSOP	DB	16		TBD	Call TI	Call TI	-40 to 85		
TRSF3221EIDBG4	OBSOLETE	SSOP	DB	16		TBD	Call TI	Call TI	-40 to 85		
TRSF3221EIDBR	ACTIVE	SSOP	DB	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RT21EI	<a href="#">Samples</a>
TRSF3221EIPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RT21EI	<a href="#">Samples</a>
TRSF3221EIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RT21EI	<a href="#">Samples</a>
TRSF3221EIPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RT21EI	<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)

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

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> 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.

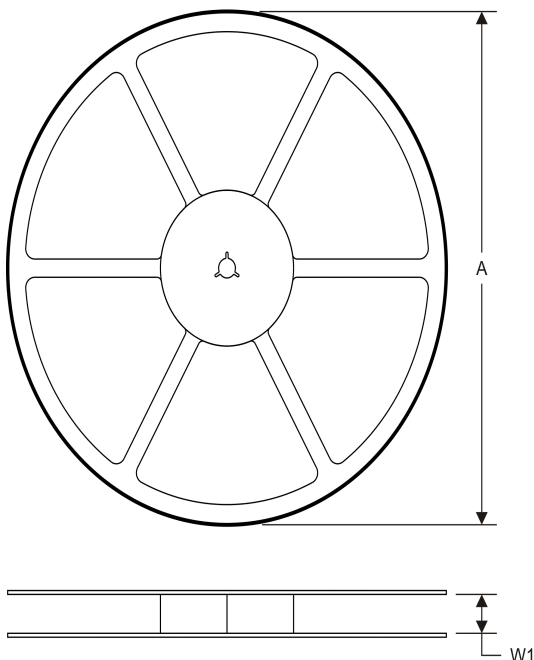
<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

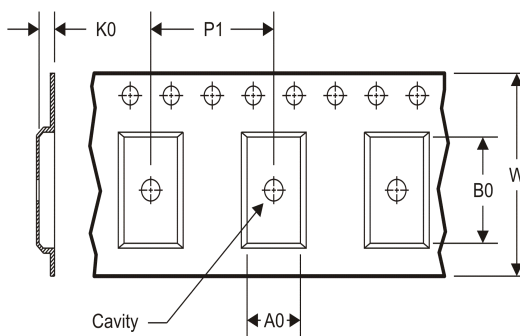
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**

**REEL DIMENSIONS**



**TAPE DIMENSIONS**



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

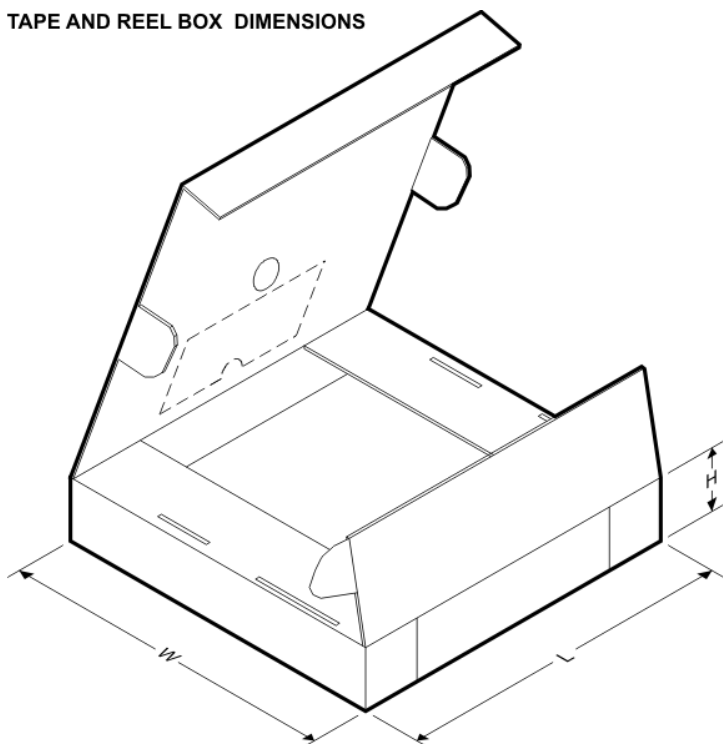
**TAPE AND REEL INFORMATION**

\*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
TRSF3221ECDBR	SSOP	DB	16	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TRSF3221ECPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TRSF3221EIDBR	SSOP	DB	16	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
TRSF3221EIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1



**TAPE AND REEL BOX DIMENSIONS**



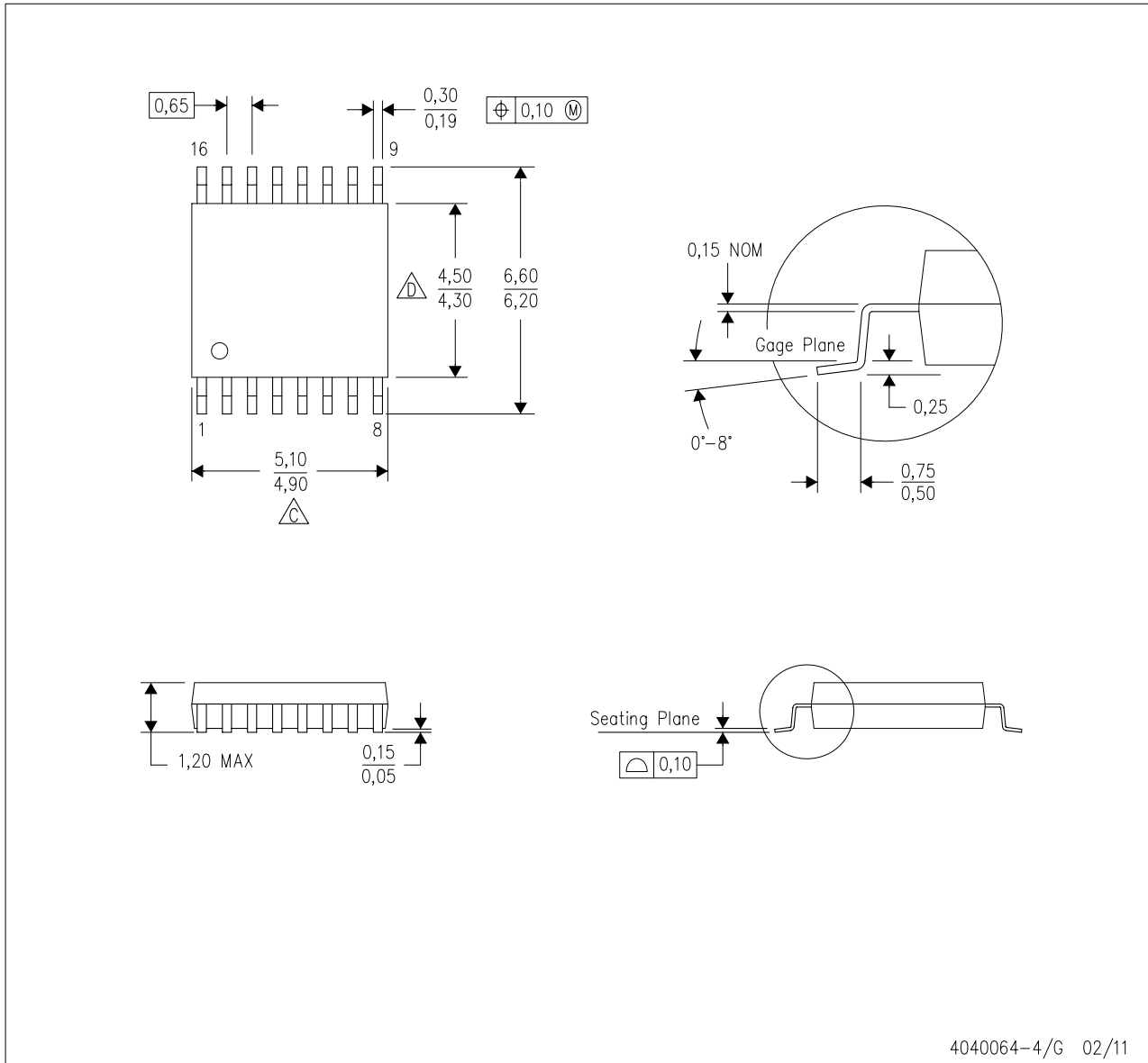
\*All dimensions are nominal



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRSF3221ECDBR	SSOP	DB	16	2000	367.0	367.0	38.0
TRSF3221ECPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
TRSF3221EIDBR	SSOP	DB	16	2000	367.0	367.0	38.0
TRSF3221EIPWR	TSSOP	PW	16	2000	367.0	367.0	35.0

**MECHANICAL DATA**

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE

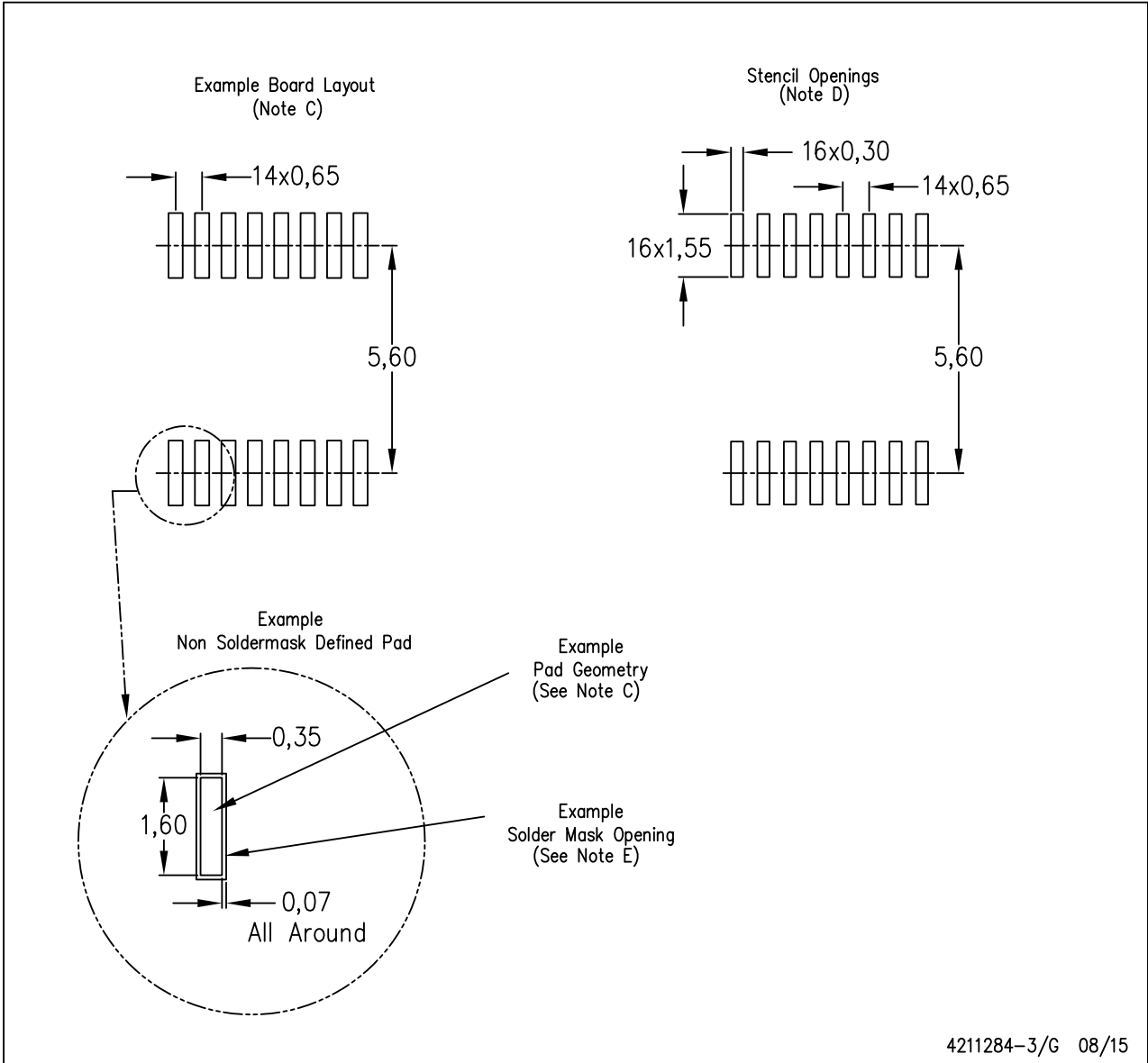


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  -  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  -  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

**LAND PATTERN DATA**

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



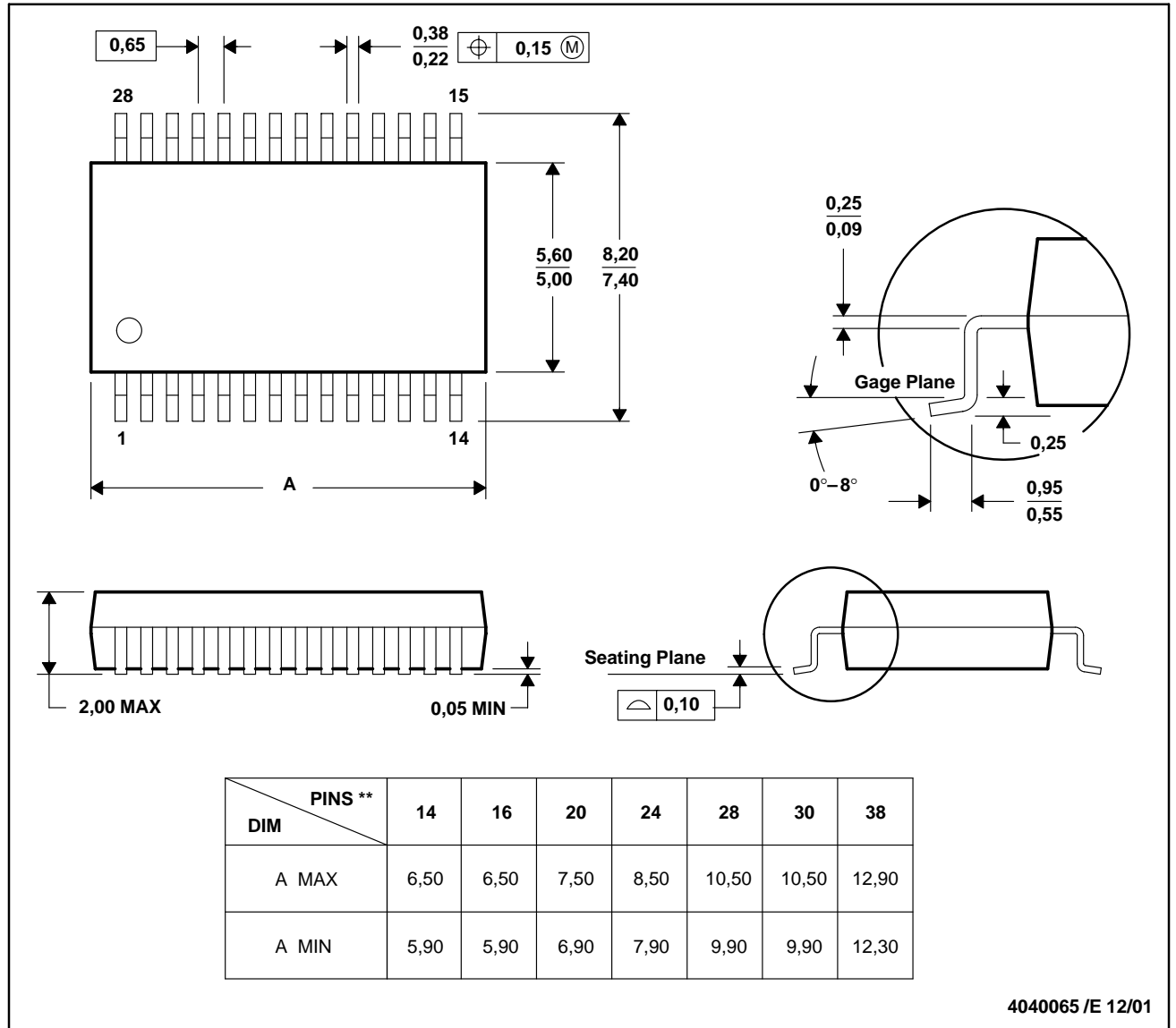
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

MSS0002E - JANUARY 1995 - REVISED DECEMBER 2001

**DB (R-PDSO-G\*\*)**

**PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



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

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

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.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)