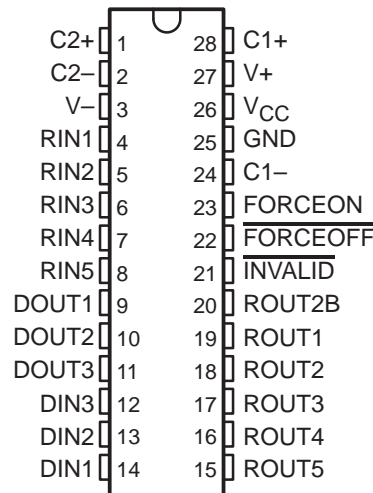


# 3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD (HBM) PROTECTION

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

- **Single-Chip and Single-Supply Interface for IBM™ PC/AT™ Serial Port**
- **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**
- **Always-Active Noninverting Receiver Output (ROUT2B)**
- **Operates up to 250 kbit/s**
- **Designed to Transmit at a Data Rate of 250 kbit/s**
- **Low Standby Current . . . 1  $\mu$ A Typical**
- **External Capacitors . . .  $4 \times 0.1 \mu$ F**
- **Accepts 5-V Logic Input With 3.3-V Supply**
- **Designed to Be Interchangeable With Maxim MAX3243**
- **Serial-Mouse Driveability**
- **RS-232 Bus-Pin ESD Protection Exceeds  $\pm 15$ -kV Using Human-Body Model (HBM)**
- **Auto-Powerdown Feature to Disable Driver Outputs When No Valid RS-232 Signal Is Sensed**
- **Applications**
  - **Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment**
- **Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), and Thin Shrink Small-Outline (PW) Packages**

DB, DW, OR PW PACKAGE  
(TOP VIEW)



## description

The MAX3243 device consists of three line drivers, five line receivers, and a dual charge-pump circuit with  $\pm 15$ -kV ESD (HBM) 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. This combination of drivers and receivers matches that needed for the typical serial port used in an IBM PC/AT, or compatible. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. In addition, the device includes an always-active noninverting output (ROUT2B), which allows applications using the ring indicator to transmit data while the device is powered down. The device operates at data signaling rates up to 250 kbit/s and a maximum of 30-V/ $\mu$ s driver output slew rate.



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.

AT, IBM, and PC are trademarks of International Business Machines Corporation.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2000, Texas Instruments Incorporated

**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**description (continued)**

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 device does not sense a valid RS-232 signal, the driver outputs are disabled. If FORCEOFF is set low, both drivers and receivers (except ROUT2B) 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, and should be done when driving a serial mouse. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to any receiver input. The INVALID output is used to notify the user if an RS-232 signal is present at any receiver input. INVALID is high (valid data) if any 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 all receiver input voltages are between -0.3 V and 0.3 V for more than 30 μs. Refer to Figure 5 for receiver input levels.

The MAX3243C is characterized for operation from 0°C to 70°C. The MAX3243I is characterized for operation from -40°C to 85°C.

**AVAILABLE OPTIONS**

T <sub>A</sub>	PACKAGED DEVICES		
	SHRINK SMALL OUTLINE (DB)	SMALL OUTLINE (DW)	THIN SHRINK SMALL OUTLINE (PW)
0°C to 70°C	MAX3243CDBR	MAX3243CDW	MAX3243CPWR
-40°C to 85°C	MAX3243IDBR	MAX3243IDW	MAX3243IPWR

The DB and PW packages are only available taped and reeled. The DW package is also available taped and reeled. Add the suffix R to device type (e.g., MAX3243CDWR).

**Function Tables**

**EACH DRIVER**

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	

H = high level, L = low level, X = irrelevant, Z = high impedance



**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -KV ESD (HBM) PROTECTION**

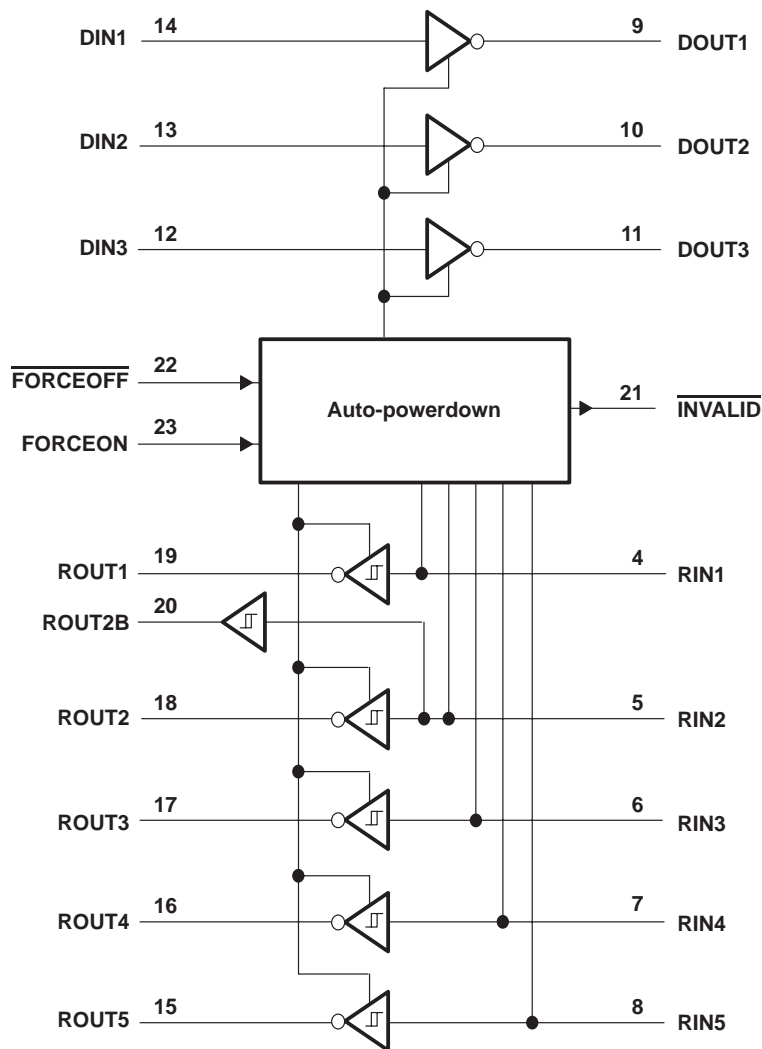
SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**EACH RECEIVER**

INPUTS				OUTPUTS		RECEIVER STATUS
RIN2	RIN1, RIN3–RIN5	$\overline{\text{FORCEOFF}}$	VALID RIN RS-232 LEVEL	ROUT2B	ROUT	
L	X	L	X	L	Z	Powered off while ROUT2B is active
H	X	L	X	H	Z	
L	L	H	Yes	L	H	Normal operation with auto-powerdown disabled/enabled
L	H	H	Yes	L	L	
H	L	H	Yes	H	H	
H	H	H	Yes	H	L	
Open	Open	H	No	L	H	

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

**logic diagram (positive logic)**



**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Supply voltage range, $V_{CC}$ (see Note 1)	–0.3 V to 6 V
Positive output supply voltage range, $V+$ (see Note 1)	–0.3 V to 7 V
Negative output supply voltage range, $V-$ (see Note 1)	0.3 V to –7 V
Supply voltage difference, $V+ - V-$ (see Note 1)	13 V
Input voltage range, $V_I$ : Driver ( $\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$ )	–0.3 V to 6 V
Receiver	–25 V to 25 V
Output voltage range, $V_O$ : Driver	–13.2 V to 13.2 V
Receiver ( $\overline{\text{INVALID}}$ )	–0.3 V to $V_{CC} + 0.3$ V
Package thermal impedance, $\theta_{JA}$ (see Note 2): DB package	62°C/W
DW package	46°C/W
PW package	62°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
Storage temperature range, $T_{stg}$	–65°C to 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.

- NOTES: 1. All voltages are with respect to network GND.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

**recommended operating conditions (see Note 3 and Figure 6)**

			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	$\overline{\text{DIN}}$ , $\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$	$V_{CC} = 3.3$ V			V
			$V_{CC} = 5$ V			
$V_{IL}$	Driver and control low-level input voltage	$\overline{\text{DIN}}$ , $\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$	0.8			V
$V_I$	Driver and control input voltage	$\overline{\text{DIN}}$ , $\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$	0	5.5		V
$V_I$	Receiver input voltage		–25	25		V
$T_A$	Operating free-air temperature	MAX3243C	0	70		°C
		MAX3243I	–40	85		

NOTE 3: Test conditions are C1–C4 = 0.1  $\mu$ F at  $V_{CC} = 3.3$  V  $\pm$  0.3 V; C1 = 0.047  $\mu$ F, C2–C4 = 0.33  $\mu$ F at  $V_{CC} = 5$  V  $\pm$  0.5 V.

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 3 and Figure 6)**

PARAMETER		TEST CONDITIONS	MIN	TYP‡	MAX	UNIT	
$I_I$	Input leakage current	$\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$		$\pm 0.01$	$\pm 1$	$\mu$ A	
$I_{CC}$	Supply current ( $T_A = 25^\circ\text{C}$ )	Auto-powerdown disabled	No load, $\overline{\text{FORCEOFF}}$ and $\text{FORCEON}$ at $V_{CC}$		0.3	1	mA
		Powered off	No load, $\overline{\text{FORCEOFF}}$ at GND		1	10	
		Auto-powerdown enabled	No load, $\overline{\text{FORCEOFF}}$ at $V_{CC}$ , $\text{FORCEON}$ at GND, All RIN are open or grounded, All DIN are grounded		1	10	$\mu$ A

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

NOTE 3: Test conditions are C1–C4 = 0.1  $\mu$ F at  $V_{CC} = 3.3$  V  $\pm$  0.3 V; C1 = 0.047  $\mu$ F, C2–C4 = 0.33  $\mu$ F at  $V_{CC} = 5$  V  $\pm$  0.5 V.



MAX3243  
3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER  
WITH  $\pm 15$ -KV ESD (HBM) PROTECTION

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**DRIVER SECTION**

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 3 and Figure 6)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V <sub>OH</sub>	High-level output voltage All DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	5	5.4		V
V <sub>OL</sub>	Low-level output voltage All DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	-5	-5.4		V
V <sub>O</sub>	Output voltage (mouse driveability) DIN1 = DIN2 = GND, DIN3 = V <sub>CC</sub> , 3-k $\Omega$ to GND at DOUT3, DOUT1 = DOUT2 = 2.5 mA	$\pm 5$			V
I <sub>IH</sub>	High-level input current V <sub>I</sub> = V <sub>CC</sub>		$\pm 0.01$	$\pm 1$	$\mu$ A
I <sub>IL</sub>	Low-level input current V <sub>I</sub> at GND		$\pm 0.01$	$\pm 1$	$\mu$ A
I <sub>OS</sub>	Short-circuit output current‡	V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0 V		$\pm 35$	$\pm 60$ mA
		V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V			
r <sub>o</sub>	Output resistance V <sub>CC</sub> , V+, and V- = 0 V, V <sub>O</sub> = $\pm 2$ V	300	10M		$\Omega$
I <sub>off</sub>	Output leakage current FORCEOFF = GND, V <sub>O</sub> = $\pm 12$ V, V <sub>CC</sub> = 0 to 5.5 V			$\pm 25$	$\mu$ A

† 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.

‡ 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.

NOTE 3. 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.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 3 and Figure 6)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Maximum data rate	C <sub>L</sub> = 1000 pF, One DOUT switching, R <sub>L</sub> = 3 k $\Omega$ , See Figure 1	150	250		kbit/s
t <sub>sk(p)</sub>	Pulse skew§ C <sub>L</sub> = 150 pF to 2500 pF		100		ns
SR(tr)	Slew rate, transition region (see Figure 1) V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$			30	V/ $\mu$ s
				4	

† 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.

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

NOTE 3. 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.

**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -KV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**RECEIVER SECTION**

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 3 and Figure 6)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	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 (except ROUT2B)	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

† 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.

NOTE 3. 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.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 3)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	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			150		
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			200		
t <sub>sk(p)</sub> Pulse skew‡	See Figure 3		50		ns

† 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.

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

NOTE 3. 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.



**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**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	TYP†	MAX	UNIT
V <sub>T+(valid)</sub>	Receiver input threshold for <u>INVALID</u> high-level output voltage	FORCEON = GND, FORCEOFF = V <sub>CC</sub>			2.7	V
V <sub>T-(valid)</sub>	Receiver input threshold for <u>INVALID</u> high-level output voltage	FORCEON = GND, FORCEOFF = V <sub>CC</sub>	-2.7			V
V <sub>T(invalid)</sub>	Receiver input threshold for <u>INVALID</u> low-level output voltage	FORCEON = GND, FORCEOFF = V <sub>CC</sub>	-0.3		0.3	V
V <sub>OH</sub>	<u>INVALID</u> high-level output voltage	I <sub>OH</sub> = -1 mA, FORCEON = GND, FORCEOFF = V <sub>CC</sub>	V <sub>CC</sub> - 0.6			V
V <sub>OL</sub>	<u>INVALID</u> low-level output voltage	I <sub>OL</sub> = 1.6 mA, FORCEON = GND, FORCEOFF = V <sub>CC</sub>			0.4	V

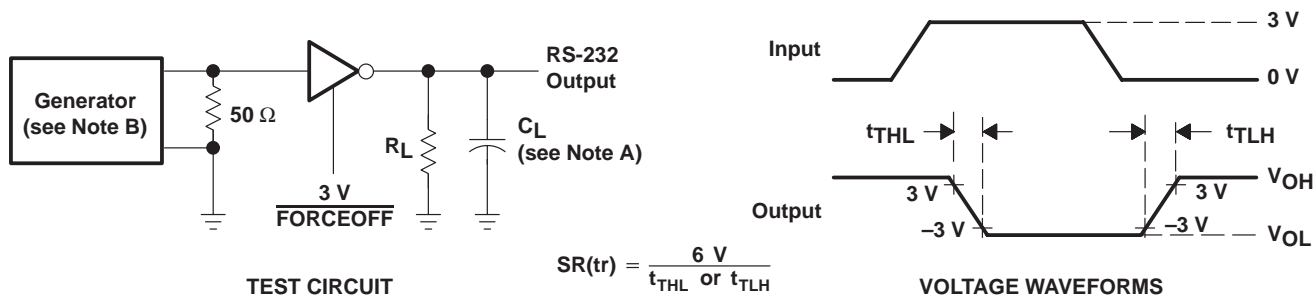
† All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 5)**

PARAMETER		MIN	TYP†	MAX	UNIT
t <sub>valid</sub>	Propagation delay time, low- to high-level output		1		μs
t <sub>invalid</sub>	Propagation delay time, high- to low-level output		30		μs
t <sub>en</sub>	Supply enable time		100		μs

† 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.

**PARAMETER MEASUREMENT INFORMATION**



NOTES: A. C<sub>L</sub> includes probe and jig capacitance.

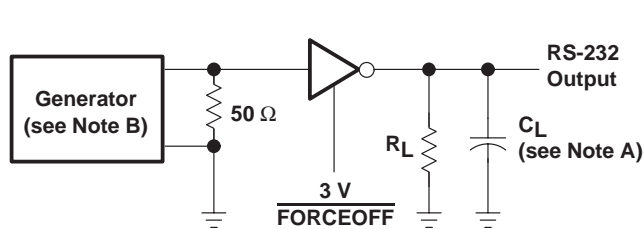
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z<sub>O</sub> = 50 Ω, 50% duty cycle, t<sub>r</sub> ≤ 10 ns, t<sub>f</sub> ≤ 10 ns.

**Figure 1. Driver Slew Rate**

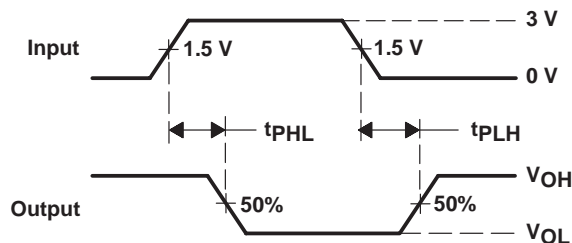
**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**PARAMETER MEASUREMENT INFORMATION**



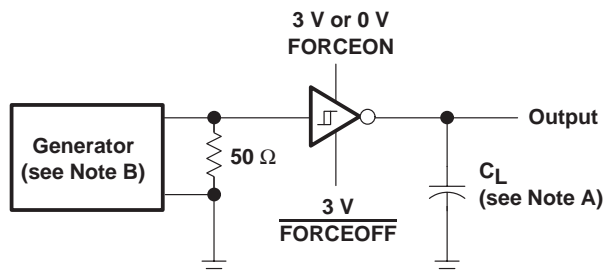
**TEST CIRCUIT**



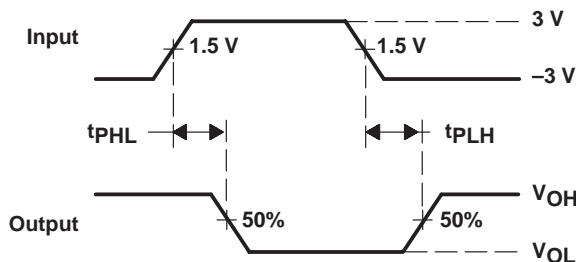
**VOLTAGE WAVEFORMS**

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**



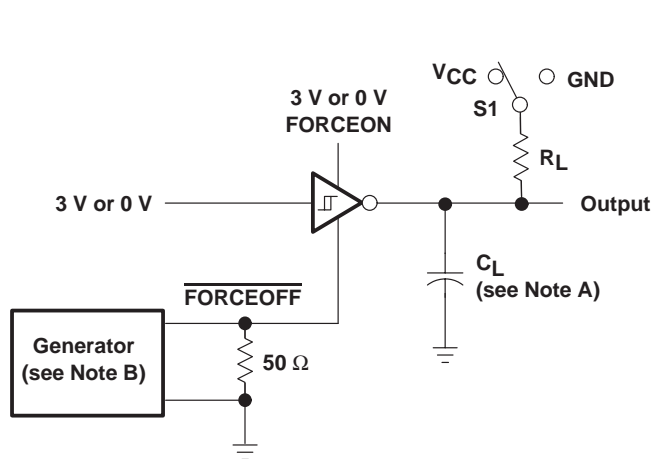
**TEST CIRCUIT**



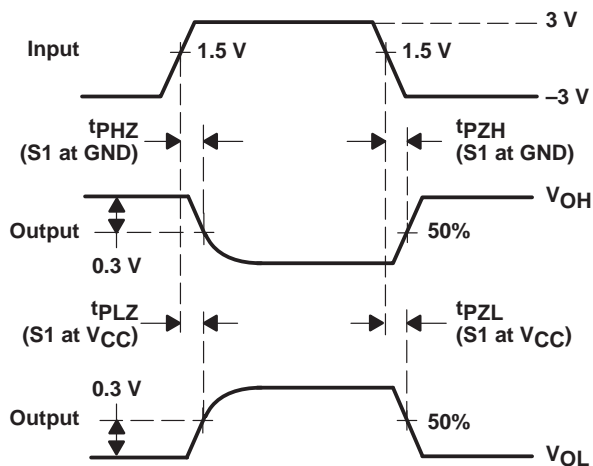
**VOLTAGE WAVEFORMS**

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**



**TEST CIRCUIT**



**VOLTAGE WAVEFORMS**

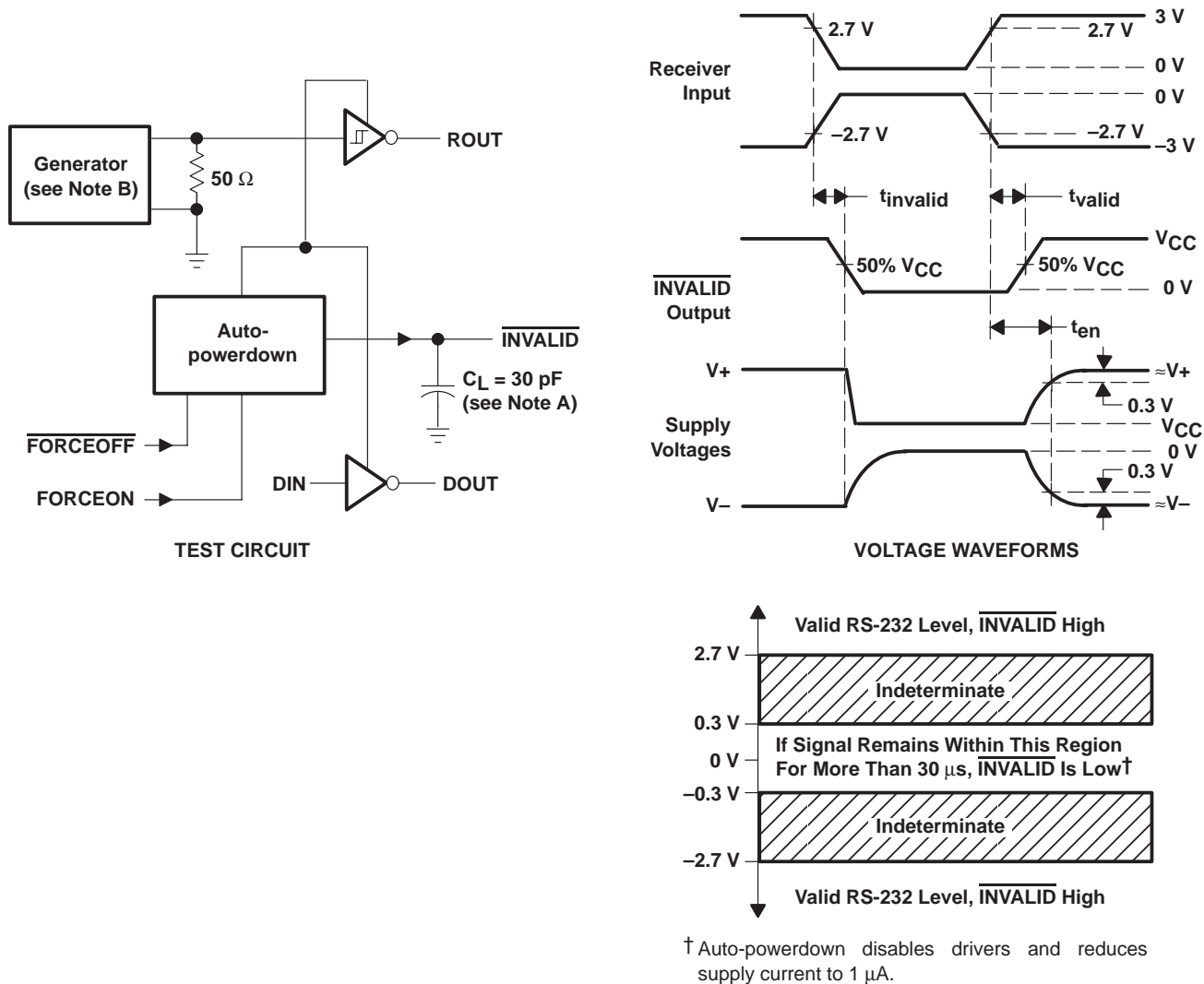
NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.  
 C.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .  
 D.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .

**Figure 4. Receiver Enable and Disable Times**





**PARAMETER MEASUREMENT INFORMATION**



NOTES: A.  $C_L$  includes probe and jig capacitance.

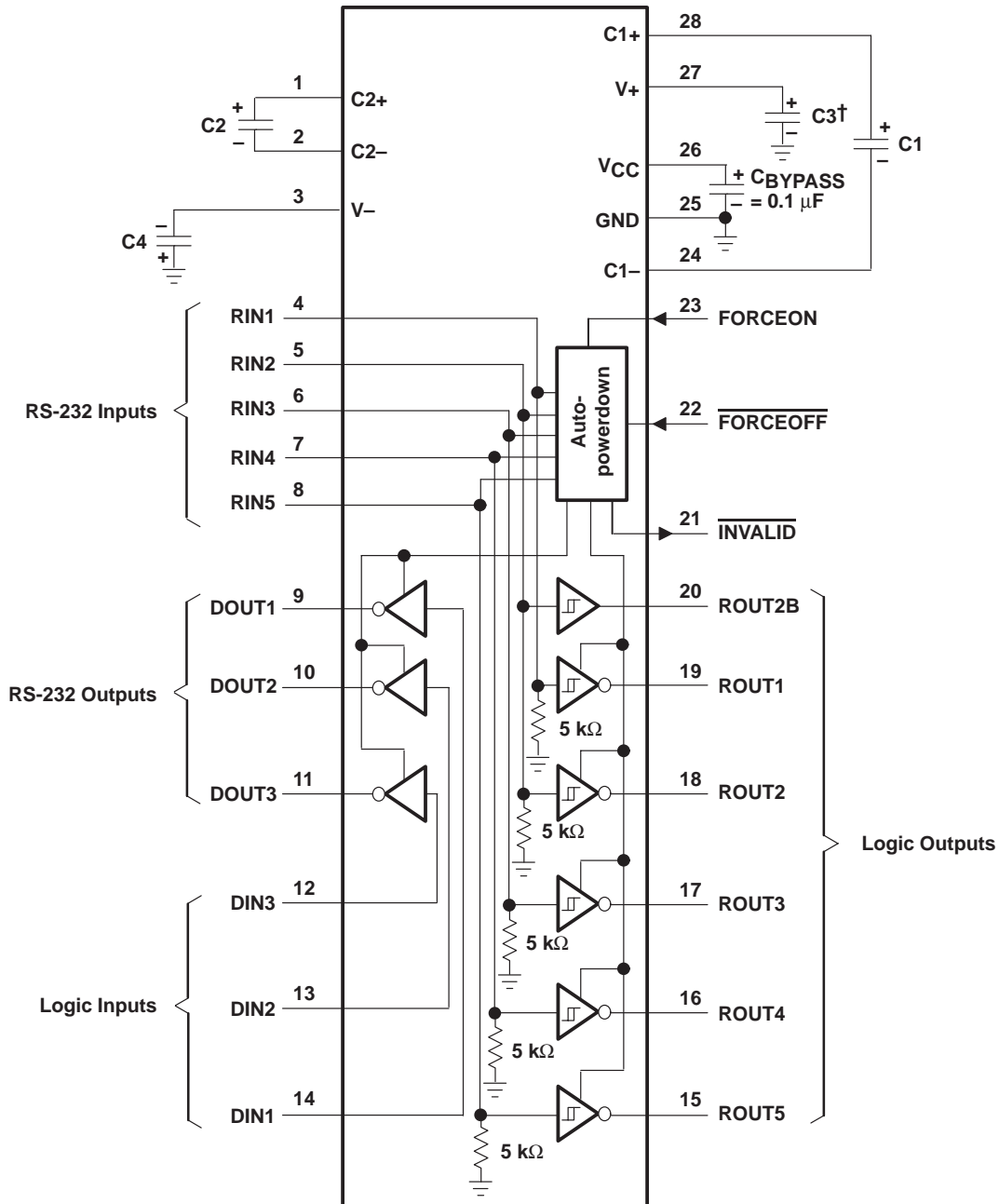
B. The pulse generator has the following characteristics: PRR = 5 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

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

**MAX3243**  
**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -kV ESD (HBM) PROTECTION**

SLLS350E – APRIL 1999 – REVISED OCTOBER 2000

**APPLICATION INFORMATION**



† C3 can be connected to VCC or GND.  
 NOTE A: Resistor values shown are nominal.

**VCC vs CAPACITOR VALUES**

VCC	C1	C2, C3, and C4
3.3 V $\pm$ 0.3 V	0.1 $\mu$ F	0.1 $\mu$ F
5 V $\pm$ 0.5 V	0.047 $\mu$ F	0.33 $\mu$ F
3 V to 5.5 V	0.1 $\mu$ F	0.47 $\mu$ F

**Figure 6. Typical Operating Circuit and Capacitor Values**



## **IMPORTANT NOTICE**

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. 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 of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.