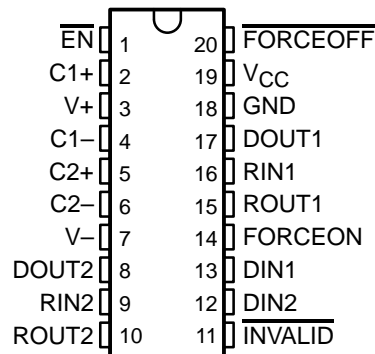


- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates With 3-V to 5.5-V  $V_{CC}$  Supply
- Operates up to 250 kbit/s
- Two Drivers and Two Receivers
- Low Standby Current . . . 1  $\mu$ A Typical
- External Capacitors . . . 4  $\times$  0.1  $\mu$ F
- Accepts 5-V Logic Input With 3.3-V Supply
- Designed to Be Interchangeable With Maxim MAX3223
- RS-232 Bus-Pin ESD Protection Exceeds  $\pm$ 15 kV Using Human-Body Model (HBM)
- Applications
  - Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment

DB, DW, OR PW PACKAGE  
(TOP VIEW)

### description/ordering information

The MAX3223 consists of two line drivers, two line receivers, and a dual charge-pump circuit with  $\pm$ 15-kV ESD protection pin to pin (serial-port connection pins, including GND). The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 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/ $\mu$ s driver output slew rate.

### ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	SOIC (DW)	Tube	MAX3223CDW	MAX3223C
		Tape and reel	MAX3223CDWR	
	SSOP (DB)	Tape and reel	MAX3223CDBR	MA3223C
	TSSOP (PW)	Tape and reel	MAX3223CPWR	MA3223C
–40°C to 85°C	SOIC (DW)	Tube	MAX3223IDW	MAX3223I
		Tape and reel	MAX3223IDWR	
	SSOP (DB)	Tape and reel	MAX3223IDBR	MB3223I
	TSSOP (PW)	Tape and reel	MAX3223IPWR	MB3223I

† 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).



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# MAX3223

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

SLLS409D – JANUARY 2000 – REVISED AUGUST 2002

### description/ordering information (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 and EN is high, both drivers and receivers are shut off, and the supply current is reduced to 1 μA. Disconnecting the serial port or turning off the peripheral drivers causes auto-powerdown 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 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 the receiver input voltage is between -0.3 V and 0.3 V for more than 30 μs. Refer to Figure 4 for receiver input levels.

### 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	

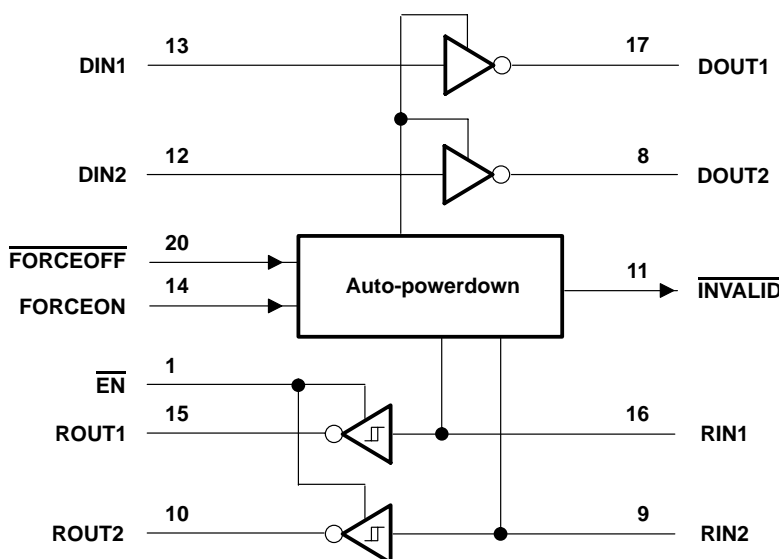
H = high level, L = low level, X = irrelevant, Z = high impedance

EACH RECEIVER

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

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

## logic diagram (positive logic)

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

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, $\overline{\text{FORCEOFF}}$ , $\text{FORCEON}$ , $\overline{\text{EN}}$	–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	70°C/W
DW package	58°C/W
PW package	83°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

<sup>†</sup> 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.

# MAX3223

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

SLLS409D – JANUARY 2000 – REVISED AUGUST 2002

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

			MIN	NOM	MAX	UNIT
Supply voltage		$V_{CC} = 3.3\text{ V}$	3	3.3	3.6	V
		$V_{CC} = 5\text{ V}$	4.5	5	5.5	
$V_{IH}$	Driver and control high-level input voltage	DIN, $\overline{EN}$ , $\overline{FORCEOFF}$ , FORCEON	$V_{CC} = 3.3\text{ V}$	2		V
			$V_{CC} = 5\text{ V}$	2.4		
$V_{IL}$	Driver and control low-level input voltage	DIN, $\overline{EN}$ , $\overline{FORCEOFF}$ , FORCEON			0.8	V
$V_I$	Driver and control input voltage	DIN, $\overline{EN}$ , $\overline{FORCEOFF}$ , FORCEON	0		5.5	V
	Receiver input voltage		-25		25	
$T_A$	Operating free-air temperature	MAX3223C	0		70	°C
		MAX3223I	-40		85	

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

### 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	$\overline{EN}$ , $\overline{FORCEOFF}$ , FORCEON		$\pm 0.01$	$\pm 1$	$\mu\text{A}$	
$I_{CC}$	Supply current	Auto-powerdown disabled	No load, $\overline{FORCEOFF}$ , FORCEON at $V_{CC}$		0.3	1	mA
		Powered off	No load, $\overline{FORCEOFF}$ at GND		1	10	
		Auto-powerdown enabled	No load, $\overline{FORCEOFF}$ at $V_{CC}$ , FORCEON at GND, All RIN are open or grounded		1	10	$\mu\text{A}$

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

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



## 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	DOUT at R <sub>L</sub> = 3 kΩ to GND	5	5.4		V
V <sub>OL</sub> Low-level output voltage	DOUT at R <sub>L</sub> = 3 kΩ to GND	-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‡	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	±60	
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, V <sub>O</sub> = ±12 V, V <sub>CC</sub> = 0 to 5.5 V			±25	μA

† 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 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 and Figure 6)

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Maximum data rate	C <sub>L</sub> = 1000 pF, R <sub>L</sub> = 3 kΩ, One DOUT switching, See Figure 1	150	250		kbit/s
t <sub>sk(p)</sub> Pulse skew§	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	6	30	V/μs
		C <sub>L</sub> = 150 pF to 2500 pF	4	30	

† 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.

# MAX3223

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

SLLS409D – JANUARY 2000 – REVISED AUGUST 2002

### 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 <sub>CC</sub> -0.1		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	$\overline{EN} = V_{CC}$		±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 C<sub>1</sub>-C<sub>4</sub> = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C<sub>1</sub> = 0.047 µF, C<sub>2</sub>-C<sub>4</sub> = 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	C <sub>L</sub> = 150 pF, See Figure 3		150		ns
t <sub>en</sub>	Output enable time	C <sub>L</sub> = 150 pF, See Figure 4 R <sub>L</sub> = 3 kΩ,		200		ns
t <sub>dis</sub>	Output disable time	C <sub>L</sub> = 150 pF, See Figure 4 R <sub>L</sub> = 3 kΩ,		200		ns
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 C<sub>1</sub>-C<sub>4</sub> = 0.1 µF at V<sub>CC</sub> = 3.3 V ± 0.3 V; C<sub>1</sub> = 0.047 µF, C<sub>2</sub>-C<sub>4</sub> = 0.33 µF at V<sub>CC</sub> = 5 V ± 0.5 V.



# MAX3223

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

SLLS409D – JANUARY 2000 – REVISED AUGUST 2002

### AUTO-POWERDOWN SECTION

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

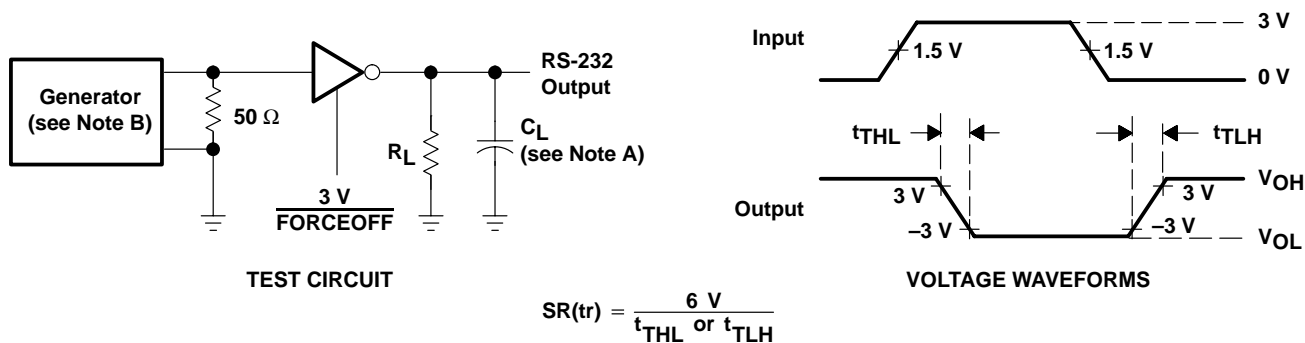
PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+}(\text{valid})$	Receiver input threshold for INVALID high-level output voltage FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		2.7	V
$V_{T-}(\text{valid})$	Receiver input threshold for INVALID high-level output voltage FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	-2.7		V
$V_{T}(\text{invalid})$	Receiver input threshold for INVALID low-level output voltage FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	-0.3	0.3	V
$V_{OH}$	INVALID high-level output voltage $I_{OH} = -1 \text{ mA}$ , FORCEOFF = $V_{CC}$	$V_{CC} - 0.6$		V
$V_{OL}$	INVALID low-level output voltage $I_{OL} = 1.6 \text{ mA}$ , 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†	UNIT
$t_{\text{valid}}$ Propagation delay time, low- to high-level output	1	$\mu\text{s}$
$t_{\text{invalid}}$ Propagation delay time, high- to low-level output	30	$\mu\text{s}$
$t_{\text{en}}$ Supply enable time	100	$\mu\text{s}$

† 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,  $Z_0 = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .

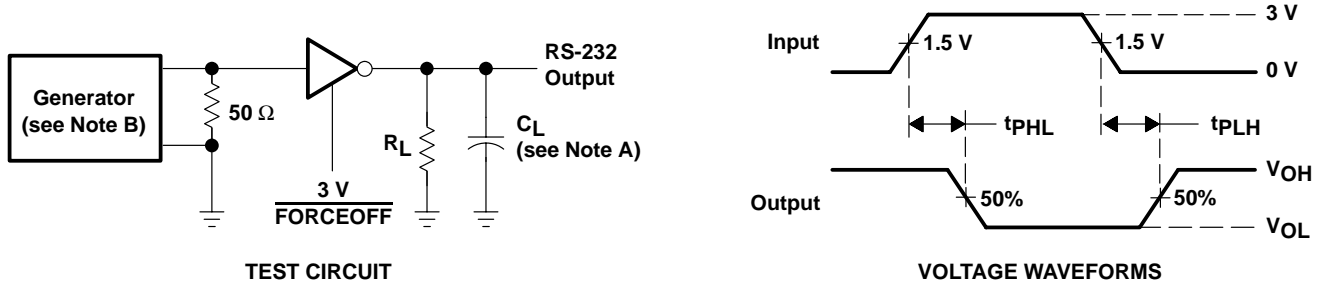
**Figure 1. Driver Slew Rate**

# MAX3223

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

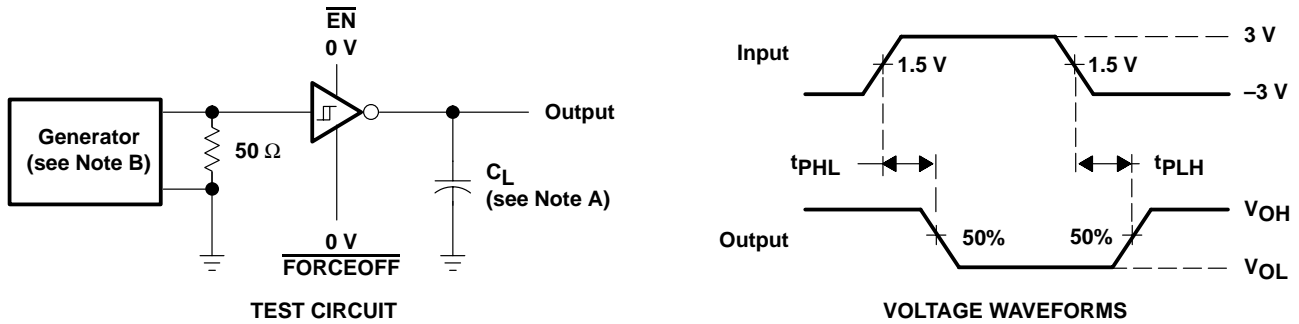
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### PARAMETER MEASUREMENT INFORMATION



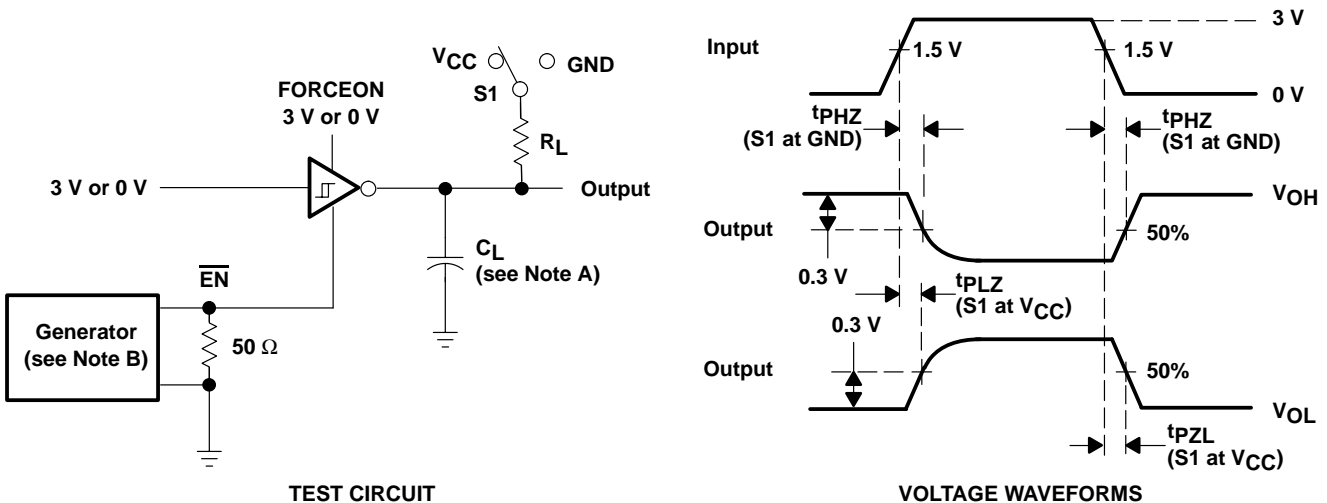
NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics: PRR = 250 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

Figure 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

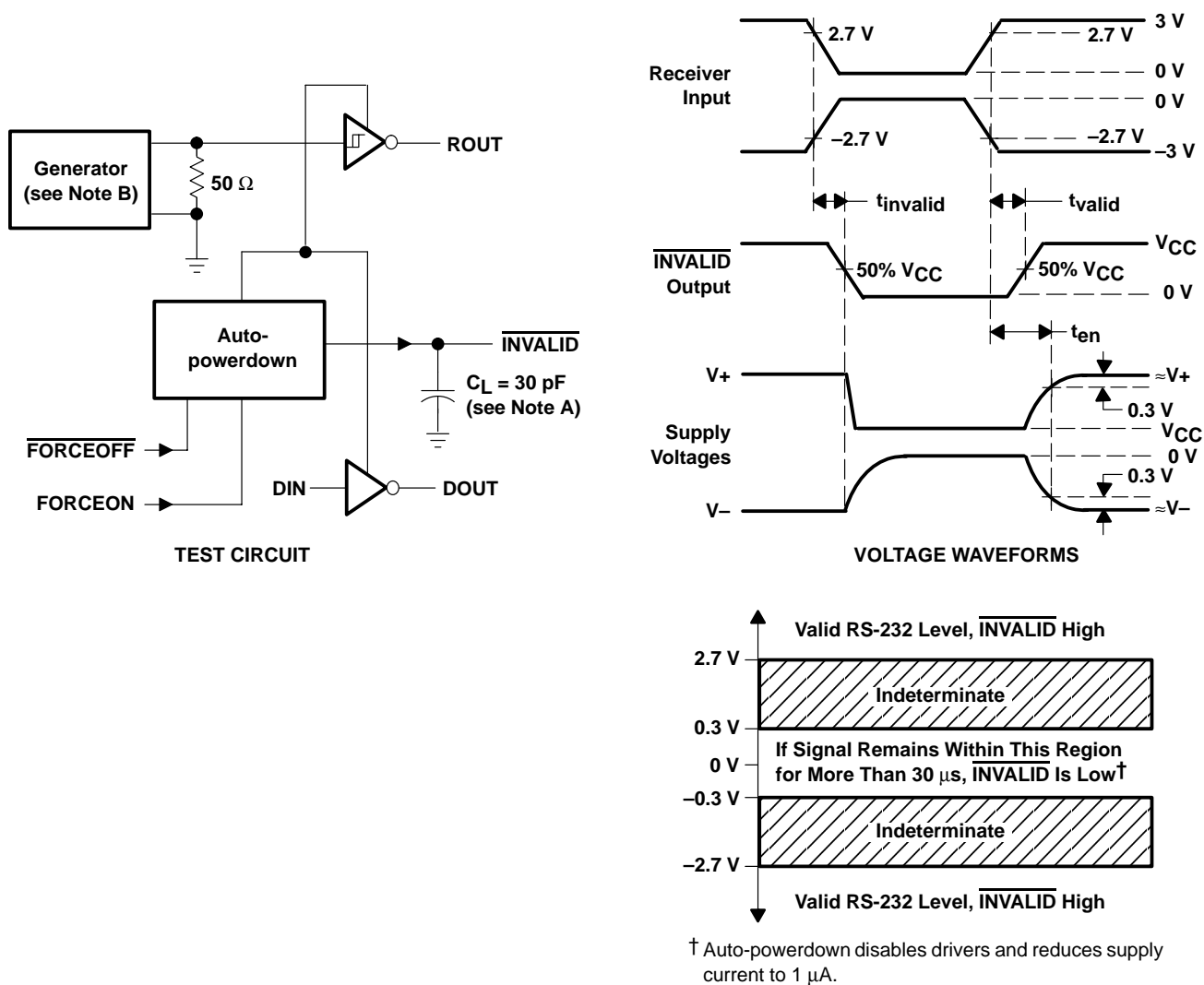


NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

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

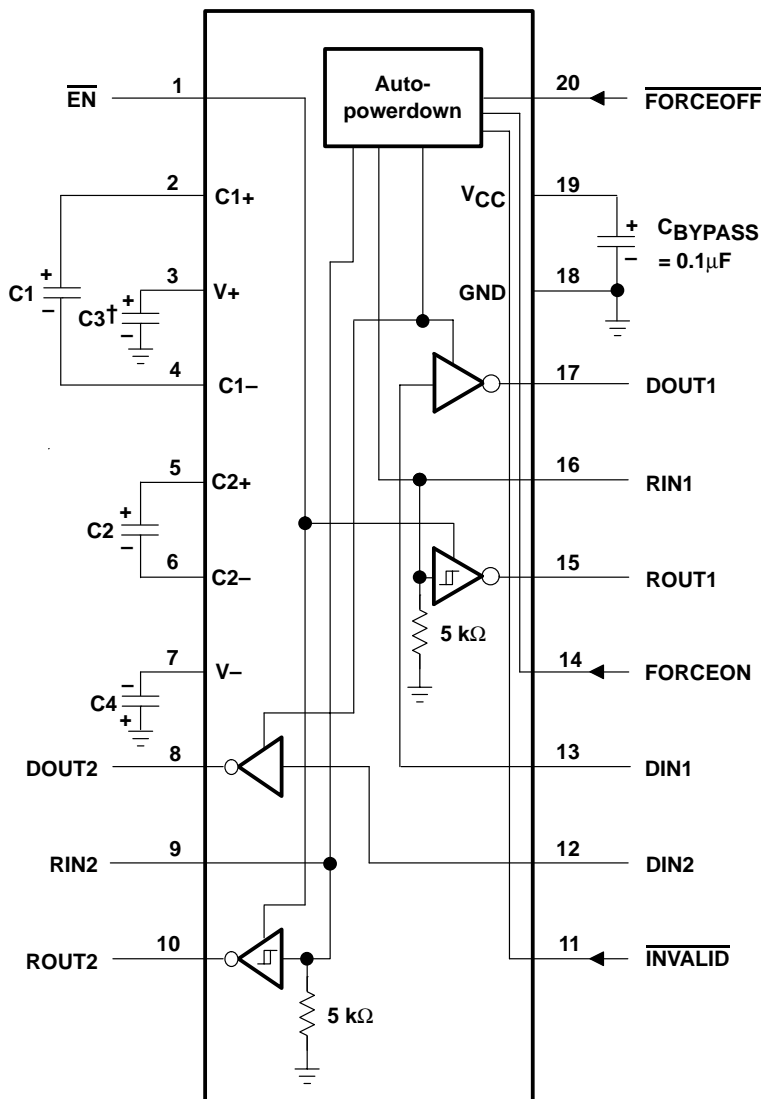
**Figure 5.  $\overline{\text{INVALID}}$  Propagation Delay Times and Supply Enabling Time**

# MAX3223

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

SLLS409D – JANUARY 2000 – REVISED AUGUST 2002

### APPLICATION INFORMATION



† C3 can be connected to V<sub>CC</sub> or GND.  
NOTE A: Resistor values shown are nominal.

V<sub>CC</sub> vs CAPACITOR VALUES

V <sub>CC</sub>	C1	C2, C3, 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



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### Mailing Address:

Texas Instruments  
Post Office Box 655303  
Dallas, Texas 75265