

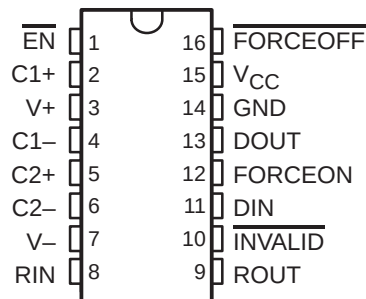
MAX3221

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

SLLS348B – JUNE 1999 – REVISED JANUARY 2000

- 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
- 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
- Designed to Be Interchangeable With Maxim MAX3221
- RS-232 Bus-Pin ESD Protection Exceeds ± 15 -kV Using Human-Body Model (HBM)
- Applications
 - Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment
- Package Options Include Plastic Shrink Small-Outline (DB) and Thin Shrink Small-Outline (PW) Packages

DB OR PW PACKAGE
(TOP VIEW)



description

The MAX3221 device consists of one line driver, one line receiver, 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. These devices operate at data signaling rates up to 250 kbit/s, and at a maximum of 30-V/ μ s driver output slew rate.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense a valid RS-232 signal, the driver outputs are disabled. If $\overline{\text{FORCEOFF}}$ is set low and $\overline{\text{EN}}$ is high, both drivers and receivers are shut off, and the supply current is reduced to 1 μ A. 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 $\overline{\text{FORCEOFF}}$ are high. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to any receiver input. The $\overline{\text{INVALID}}$ output notifies the user if an RS-232 signal is present at any receiver input. $\overline{\text{INVALID}}$ 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 μ s. $\overline{\text{INVALID}}$ is low (invalid data) if the receiver input voltage is between -0.3 V and 0.3 V for more than 30 μ s. Refer to Figure 5 for receiver input levels.

The MAX3221C is characterized for operation from 0°C to 70°C. The MAX3221I is characterized for operation from -40°C to 85°C.



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**TEXAS
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AVAILABLE OPTIONS

T _A	PACKAGED DEVICES	
	SHRINK SMALL OUTLINE (DB)	THIN SHRINK SMALL OUTLINE (PW)
0°C to 70°C	MAX3221CDB	MAX3221CPW
–40°C to 85°C	MAX3221IDB	MAX3221IPW

The DB and PW packages are available taped and reeled. Add the suffix R to device type (e.g., MAX3221CDBR).

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	

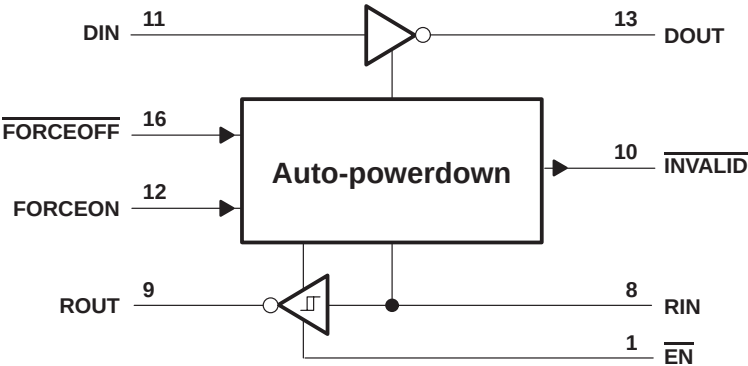
H = high level, L = low level, X = irrelevant, Z = high impedance

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 = disconnected
input or connected driver off

logic diagram (positive logic)



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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 ($\overline{\text{FORCEOFF}}$, 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, θ_{JA} (see Note 2): DB package	82°C/W
PW package	108°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.

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	DIN , $\overline{\text{FORCEOFF}}$, FORCEON , $\overline{\text{EN}}$	$V_{CC} = 3.3$ V	2			V
		$V_{CC} = 5$ V	2.4			
V_{IL} Driver and control low-level input voltage	DIN , $\overline{\text{FORCEOFF}}$, FORCEON , $\overline{\text{EN}}$				0.8	V
V_I Driver and control input voltage	DIN , $\overline{\text{FORCEOFF}}$, FORCEON		0		5.5	V
V_I Receiver input voltage			–25		25	V
T_A Operating free-air temperature		MAX3221C	0		70	°C
		MAX3221I	–40		85	

NOTE 3: 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.

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

[‡] 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 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.

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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 _{OH} High-level output voltage	DOUT at R _L = 3 kΩ to GND, DIN = GND	5	5.4		V
V _{OL} Low-level output voltage	DOUT at R _L = 3 kΩ to GND, DIN = V _{CC}	–5	–5.4		V
I _{IH} High-level input current	V _I = V _{CC}		±0.01	±1	μA
I _{IL} Low-level input current	V _I at GND		±0.01	±1	μA
I _{OS} Short-circuit output current [‡]	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	10M		Ω
I _{off} Output leakage current	FORCEOFF = GND, V _O = ±12 V, V _{CC} = 0 to 5.5 V			±25	μA

[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 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_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 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 _L = 1000 pF, R _L = 3 kΩ, See Figure 1	250			kbit/s
t _{sk(p)} Pulse skew [§]	C _L = 150 pF to 2500 pF, R _L = 3 kΩ to 7 kΩ, See Figure 2		100		ns
SR(tr) Slew rate, transition region (see Figure 1)	V _{CC} = 3.3 V, R _L = 3 kΩ to 7 kΩ		6	30	V/μs
			4	30	

[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

[§] Pulse skew is defined as |t_{PLH} – t_{PHL}| of each channel of the same device.

NOTE 3: 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.

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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 _{OH} High-level output voltage	I _{OH} = –1 mA	V _{CC} – 0.6 V	V _{CC} – 0.1 V		V
V _{OL} Low-level output voltage	I _{OL} = 1.6 mA			0.4	V
V _{IT+} Positive-going input threshold voltage	V _{CC} = 3.3 V		1.6	2.4	V
	V _{CC} = 5 V		1.9	2.4	
V _{IT–} Negative-going input threshold voltage	V _{CC} = 3.3 V	0.6	1.1		V
	V _{CC} = 5 V	0.8	1.4		
V _{hys} Input hysteresis (V _{IT+} – V _{IT–})			0.5		V
I _{off} Output leakage current	FORCEOFF = 0 V		±0.05	±10	μA
r _i Input resistance	V _I = ±3 V to ±25 V	3	5	7	kΩ

[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

NOTE 3: 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.

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 _{PLH} Propagation delay time, low- to high-level output	C _L = 150 pF, See Figure 3		150		ns
t _{PHL} Propagation delay time, high- to low-level output			150		ns
t _{en} Output enable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 4		200		ns
t _{dis} Output disable time			200		ns
t _{sk(p)} Pulse skew [‡]	See Figure 3		50		ns

[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

[‡] Pulse skew is defined as |t_{PLH} – t_{PHL}| of each channel of the same device.

NOTE 3: 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.

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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 _{T+(valid)}	Receiver input threshold for <u>INVALID</u> high-level output voltage			2.7	V
V _{T-(valid)}	Receiver input threshold for <u>INVALID</u> high-level output voltage	–2.7			V
V _{T(invalid)}	Receiver input threshold for (INVALID) low-level output voltage	–0.3		0.3	V
V _{OH}	<u>INVALID</u> high-level output voltage			V _{CC} – 0.6	V
V _{OL}	<u>INVALID</u> low-level output voltage			0.4	V

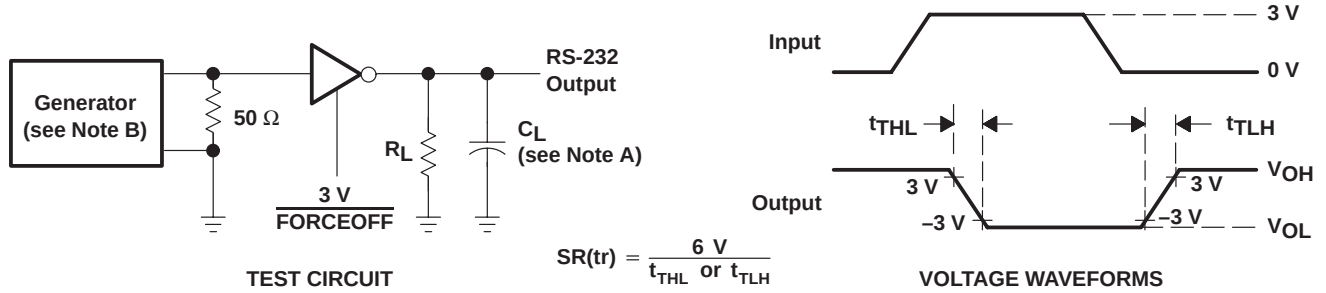
[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

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 _{valid}		1		μs
t _{invalid}		30		μs
t _{en}		100		μs

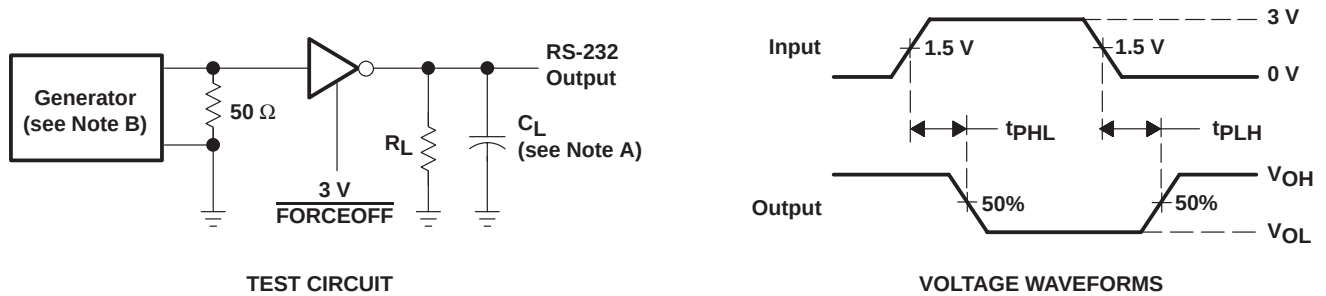
[†] All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



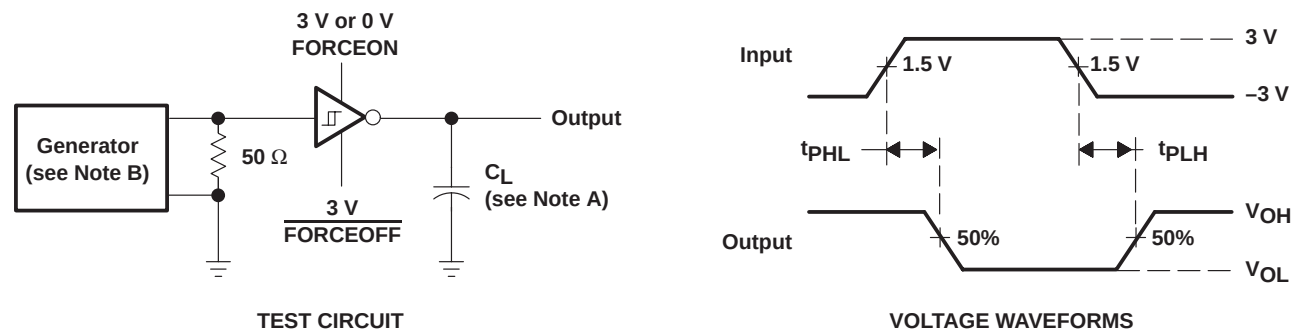
NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

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

Figure 2. Driver Pulse Skew



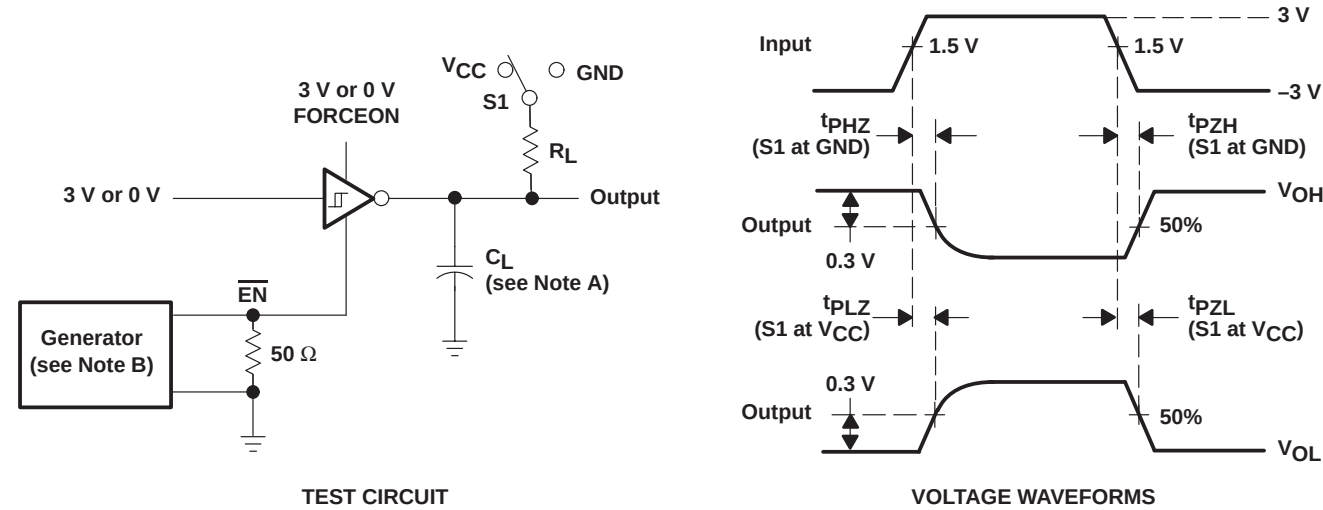
NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 3. Receiver Propagation Delay Times

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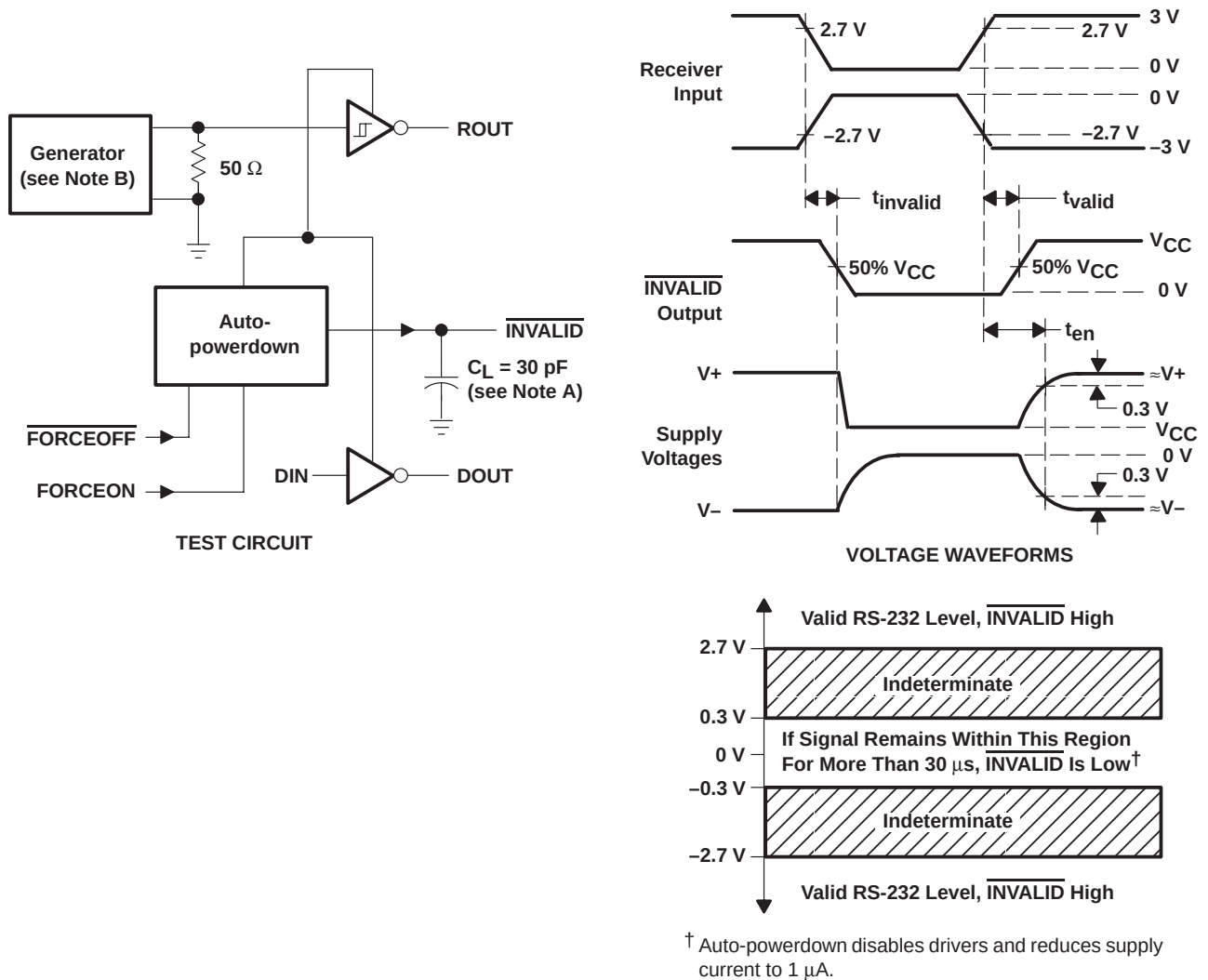
PARAMETER MEASUREMENT INFORMATION



- 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



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

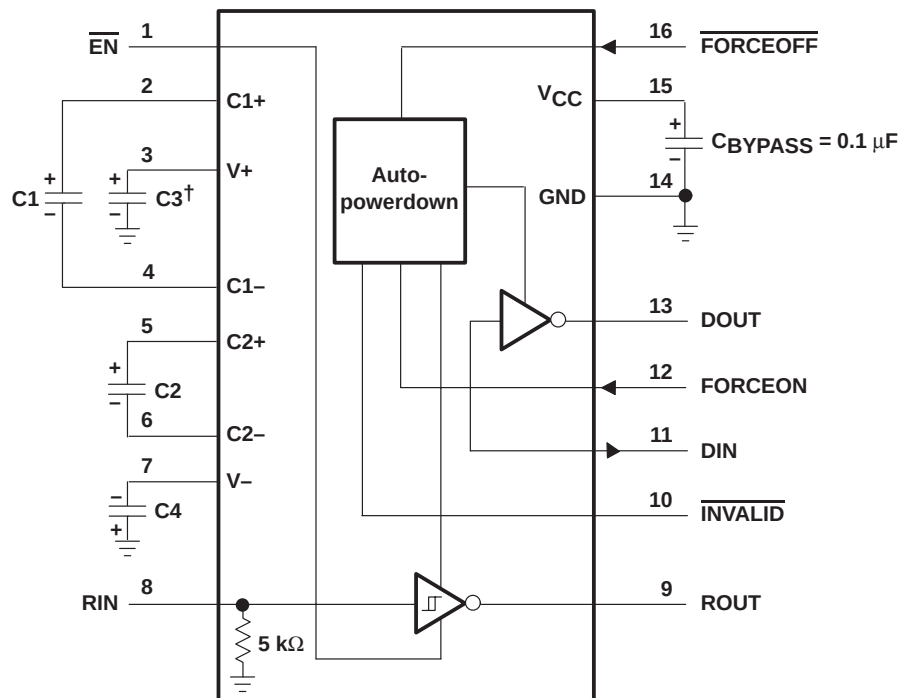
Figure 5. $\overline{\text{INVALID}}$ Propagation Delay Times and Driver Enabling Time

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APPLICATION INFORMATION



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

NOTE A: Resistor values shown are nominal.

V_{CC} vs CAPACITOR VALUES

V _{CC}	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

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