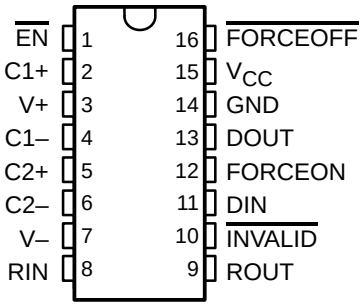
SLLS348G – JUNE 1999 – REVISED AUGUST 2002

- **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**
- **One Driver and One Receiver**
- **Low Standby Current . . . 1 μA Typical**
- **External Capacitors . . . 4 × 0.1 μF**
- **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)**
- **Auto-Powerdown Feature Automatically Disables Drivers for Power Savings**
- **Applications**
  - **Battery-Powered, Hand-Held, and Portable Equipment**
  - **PDAs and Palmtop PCs**
  - **Notebooks, Subnotebooks, and Laptops**
  - **Digital Cameras**
  - **Mobile Phones and Wireless Devices**

DB OR PW PACKAGE
(TOP VIEW)



description/ordering information

The MAX3221 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 a maximum of 30-V/μs driver output slew rate.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	SSOP (DB)	Tape and reel	MAX3221CDBR	MA3221C
	TSSOP (PW)	Tape and reel	MAX3221CPWR	MA3221C
–40°C to 85°C	SSOP (DB)	Tape and reel	MAX3221IDBR	MB3221I
	TSSOP (PW)	Tape and reel	MAX3221IPWR	MB3221I

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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 $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense a valid RS-232 signal on the receiver input, the driver output is disabled. If $\overline{\text{FORCEOFF}}$ is set low and $\overline{\text{EN}}$ 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 $\overline{\text{FORCEOFF}}$ are high. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to the receiver input. The $\overline{\text{INVALID}}$ output notifies the user if an RS-232 signal is present at the receiver input. $\overline{\text{INVALID}}$ 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. $\overline{\text{INVALID}}$ is low (invalid data) if the receiver input voltage is between –0.3 V and 0.3 V for more than 30 μs. Refer to Figure 5 for receiver input levels.

Function Tables

EACH DRIVER

INPUTS				OUTPUT DOUT	DRIVER STATUS
DIN	FORCEON	$\overline{\text{FORCEOFF}}$	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	

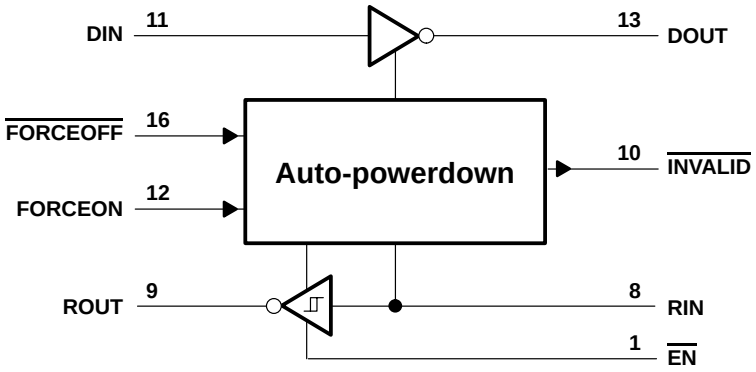
H = high level, L = low level, X = irrelevant, Z = high impedance

EACH RECEIVER

INPUTS			OUTPUT ROUT
RIN	$\overline{\text{EN}}$	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)



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 51-7.

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	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 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.

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	µA
I_{CC}	Supply current (T_A = 25°C)	Auto-powerdown disabled	No load, $\overline{\text{FORCEOFF}}$ and FORCEON at V_{CC}		0.3	1	mA
		Powered off	No load, $\overline{\text{FORCEOFF}}$ at GND		1	10	µA
		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°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.

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		±35	±60	
r_o	Output resistance	V_{CC}, V+, and V– = 0 V,	V_O = ±2 V	300	10M		Ω
I_{off}	Output leakage current	$\overline{\text{FORCEOFF}}$ = 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	150	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	C_L = 150 pF to 1000 pF		6		30	V/µs
			C_L = 150 pF to 2500 pF		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.

ESD protection

TERMINAL		TEST CONDITIONS	TYP	UNIT
NAME	NO.			
DOUT	13	HBM	±15	kV

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	$\overline{\text{FORCEOFF}}$ = 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	C_L = 150 pF, See Figure 3		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	C_L = 150 pF, R_L = 3 kΩ, See Figure 4		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.

ESD protection

TERMINAL		TEST CONDITIONS	TYP	UNIT
NAME	NO.			
RIN	8	HBM	±15	kV

AUTO-POWERDOWN SECTION

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

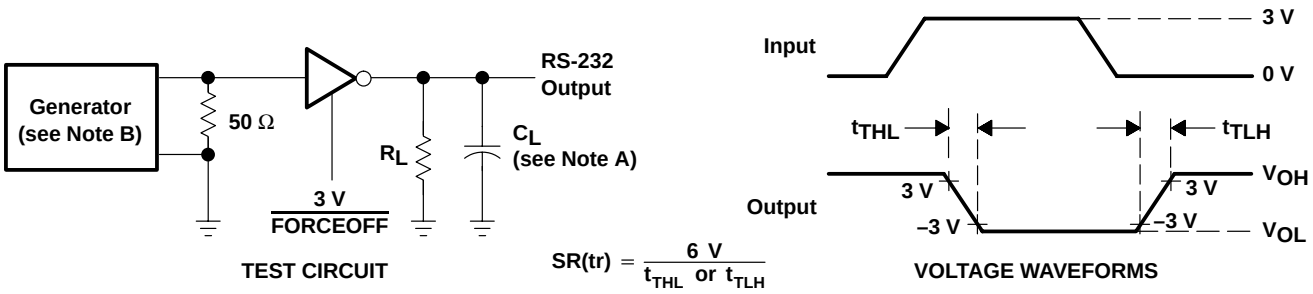
PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+(valid)}$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}		2.7	V
$V_{T-(valid)}$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON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

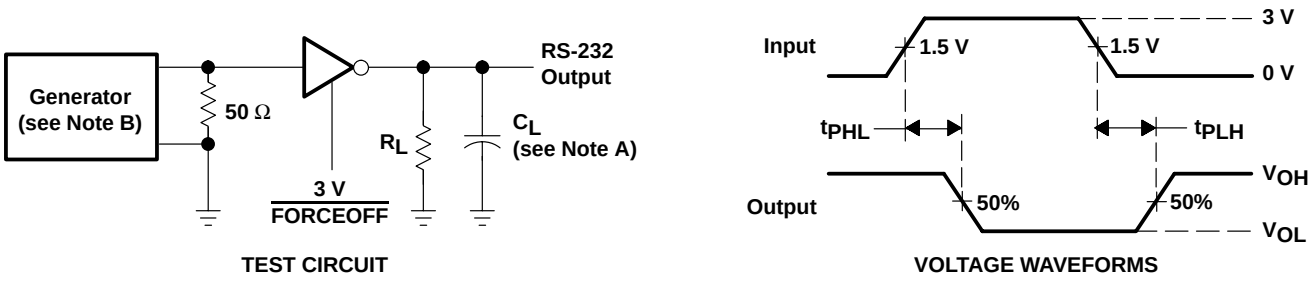
† All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



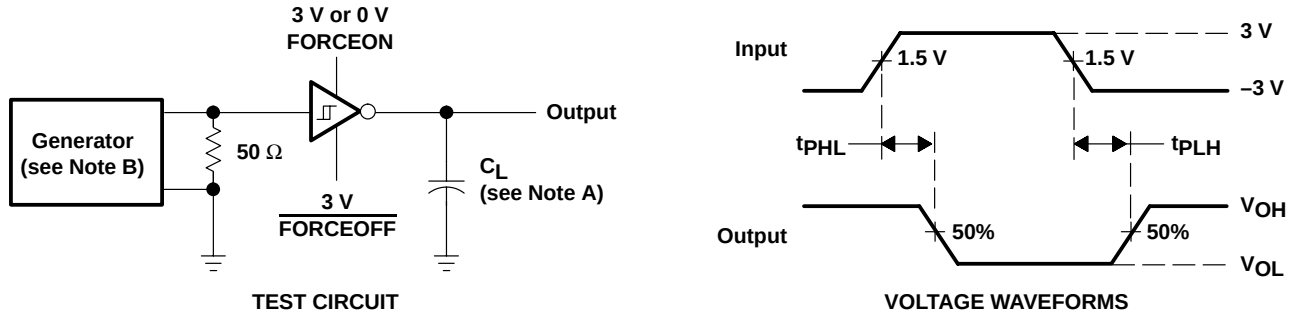
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

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 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

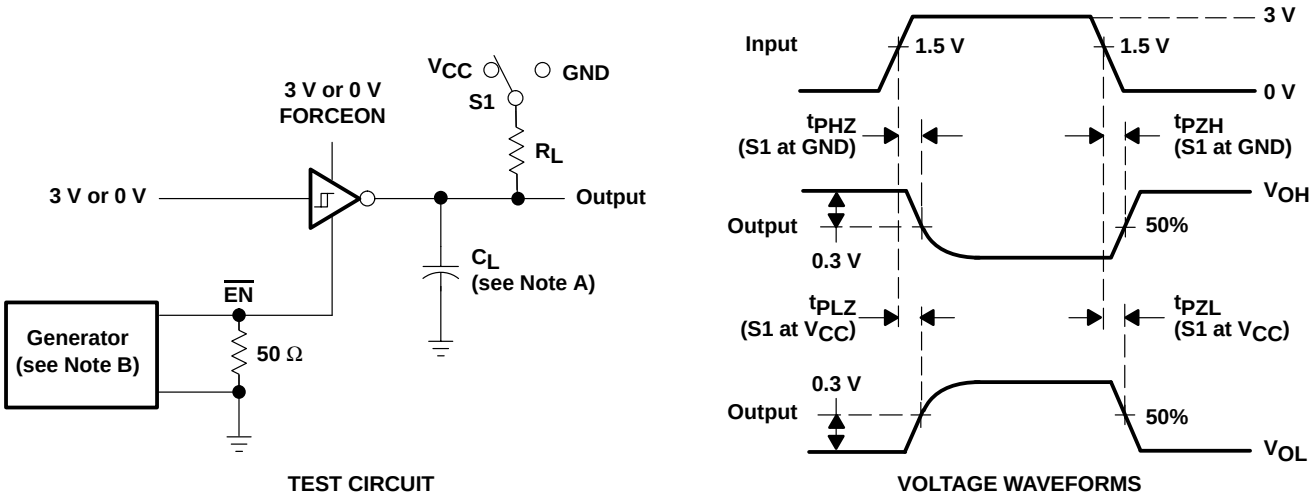
Figure 2. Driver Pulse Skew



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

Figure 3. Receiver Propagation Delay Times

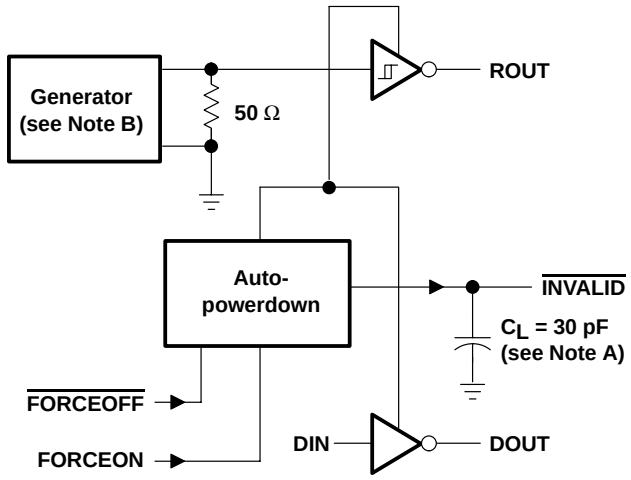
PARAMETER MEASUREMENT INFORMATION



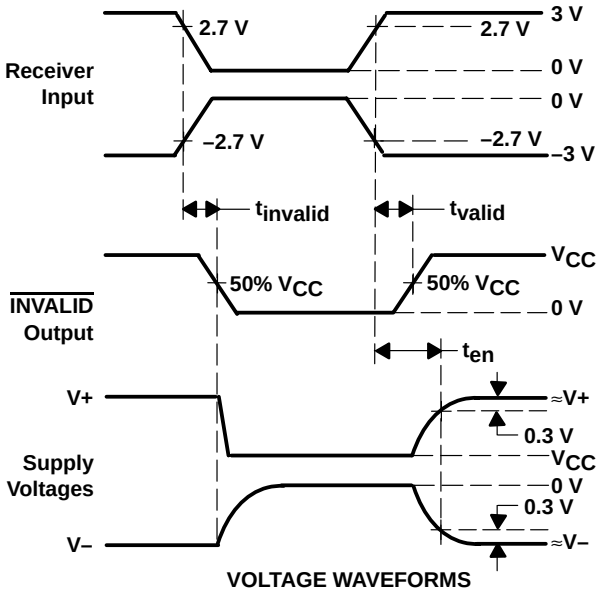
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.
C. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
D. t_{PZL} and t_{PZH} are the same as t_{en}.

Figure 4. Receiver Enable and Disable Times

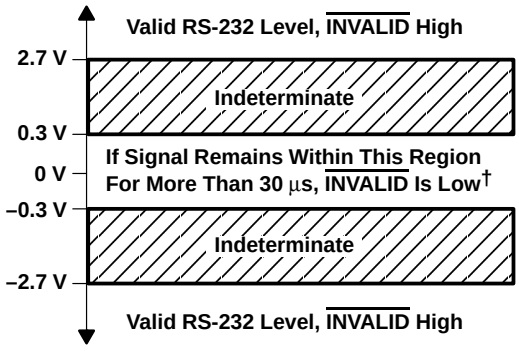
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

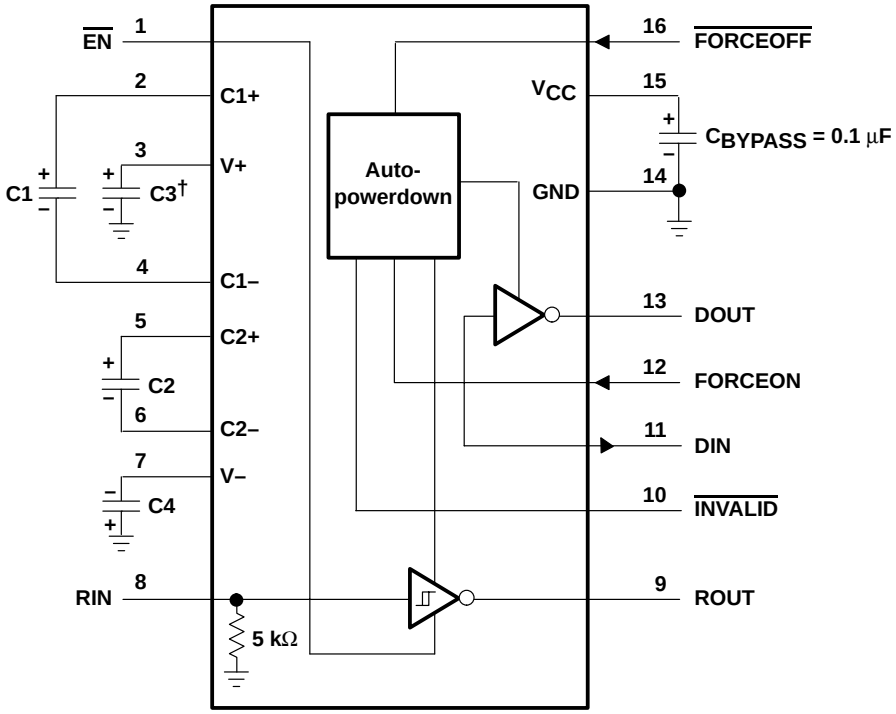


† Auto-powerdown disables drivers and reduces supply current to 1 μA.

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

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

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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Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265