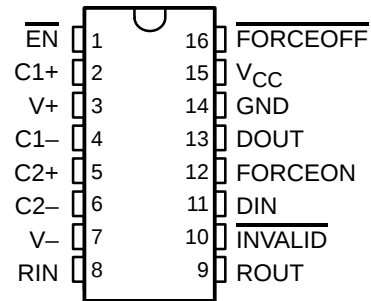


SN65C3221, SN75C3221 3-V TO 5.5-V SINGLE-CHANNEL RS-232 COMPATIBLE LINE DRIVER/RECEIVER

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- Operate With 3-V to 5.5-V V_{CC} Supply
- Operate up to 1 Mbit/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
- 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, Sub-Notebooks, and Laptops
 - Digital Cameras
 - Mobile Phones and Wireless Devices
- Package Options Include Plastic Shrink Small-Outline (DB) and Thin Shrink Small-Outline (PW) Packages

DB OR PW PACKAGE
(TOP VIEW)



description

The SN65C3221 and SN75C3221 consist 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). These devices provide 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 1 Mbit/s and a driver output slew rate of 24 V/ μ s to 150 V/ μ s.

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 devices do not sense a valid RS-232 signal on the receiver input, the driver output is disabled. If FORCEOFF is set low and EN is high, both the driver and receiver 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 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 μ s. 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 SN65C3221 is characterized for operation from -40°C to 85°C. The SN75C3221 is characterized for operation from 0°C to 70°C.



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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.

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SN65C3221, SN75C3221
3-V TO 5.5-V SINGLE-CHANNEL RS-232 COMPATIBLE LINE DRIVER/RECEIVER

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AVAILABLE OPTIONS

T _A	PACKAGED DEVICES	
	SHRINK SMALL OUTLINE (DB)	THIN SHRINK SMALL OUTLINE (PW)
–40°C to 85°C	SN65C3221DB	SN65C3221PW
0°C to 70°C	SN75C3221DB	SN75C3221PW

The DB and PW packages are available taped and reeled. Add the suffix R to device type (e.g., SN65C3221DBR).

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	

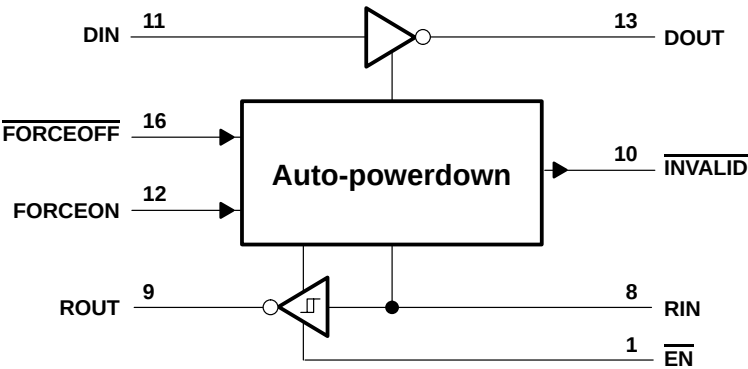
H = high level, L = low level, X = irrelevant, Z = high impedance

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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3-V TO 5.5-V SINGLE-CHANNEL RS-232 COMPATIBLE LINE DRIVER/RECEIVER

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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 51-7.

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	SN65C3221		–40		85	°C
	SN75C3221		0		70	

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	$\overline{\text{FORCEOFF}}$, FORCEON , $\overline{\text{EN}}$		± 0.01	± 1	μA
I_{CC}	Supply current ($T_A = 25^\circ\text{C}$)	Auto-powerdown disabled	No load, $\overline{\text{FORCEOFF}}$ and FORCEON at V_{CC}	0.3	1	μA
		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 $V_{CC} = 3.3 \text{ V}$ 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 $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$.



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3-V TO 5.5-V SINGLE-CHANNEL RS-232 COMPATIBLE LINE DRIVER/RECEIVER

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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		±35	±75	
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 (see Figure 1)	R _L = 3 kΩ	C _L = 1000 pF	250		kbit/s
		C _L = 250 pF, V _{CC} = 3 V to 4.5 V	1000		
		C _L = 1000 pF, V _{CC} = 4.5 V to 5.5 V	1000		
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	24	150	V/μs

[†] 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	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

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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)

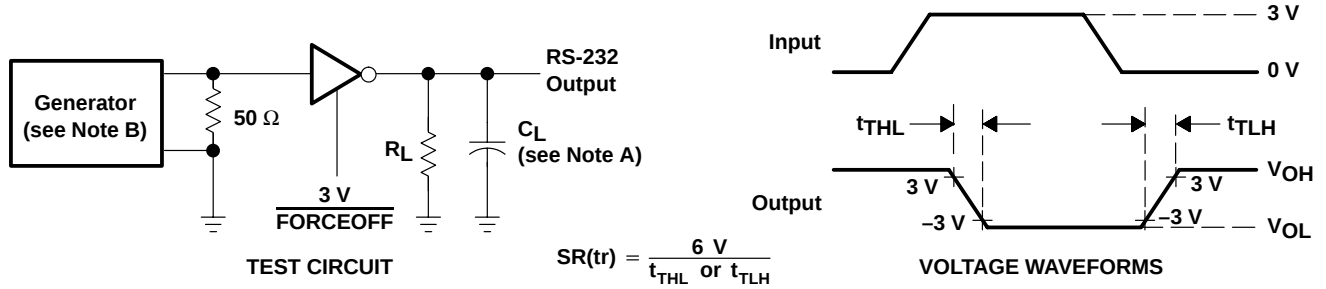
PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	$\text{FORCEON} = \text{GND}$, $\overline{\text{FORCEOFF}} = V_{CC}$		2.7	V
$V_{T-}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	$\text{FORCEON} = \text{GND}$, $\overline{\text{FORCEOFF}} = V_{CC}$	-2.7		V
$V_{T}(\text{invalid})$	Receiver input threshold for $\overline{\text{INVALID}}$ low-level output voltage	$\text{FORCEON} = \text{GND}$, $\overline{\text{FORCEOFF}} = V_{CC}$	-0.3	0.3	V
V_{OH}	$\overline{\text{INVALID}}$ high-level output voltage	$I_{OH} = -1 \text{ mA}$, $\text{FORCEON} = \text{GND}$, $\overline{\text{FORCEOFF}} = V_{CC}$	$V_{CC}-0.6$		V
V_{OL}	$\overline{\text{INVALID}}$ low-level output voltage	$I_{OL} = 1.6 \text{ mA}$, $\text{FORCEON} = \text{GND}$, $\overline{\text{FORCEOFF}} = V_{CC}$		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 $V_{CC} = 3.3 \text{ V}$ or $V_{CC} = 5 \text{ V}$, and $T_A = 25^\circ\text{C}$.

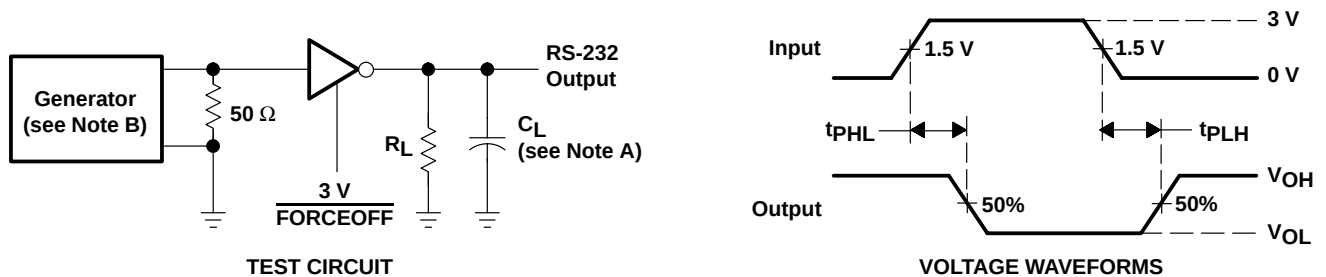
PARAMETER MEASUREMENT INFORMATION



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

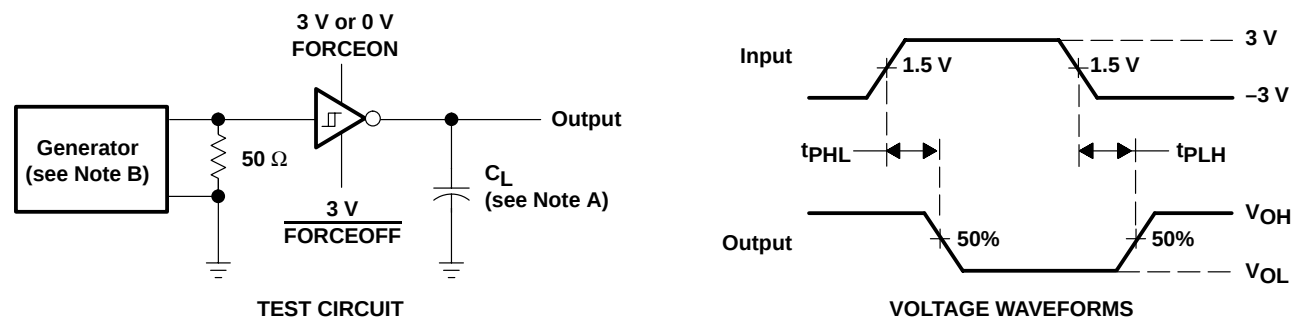
Figure 1. Driver Slew Rate



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

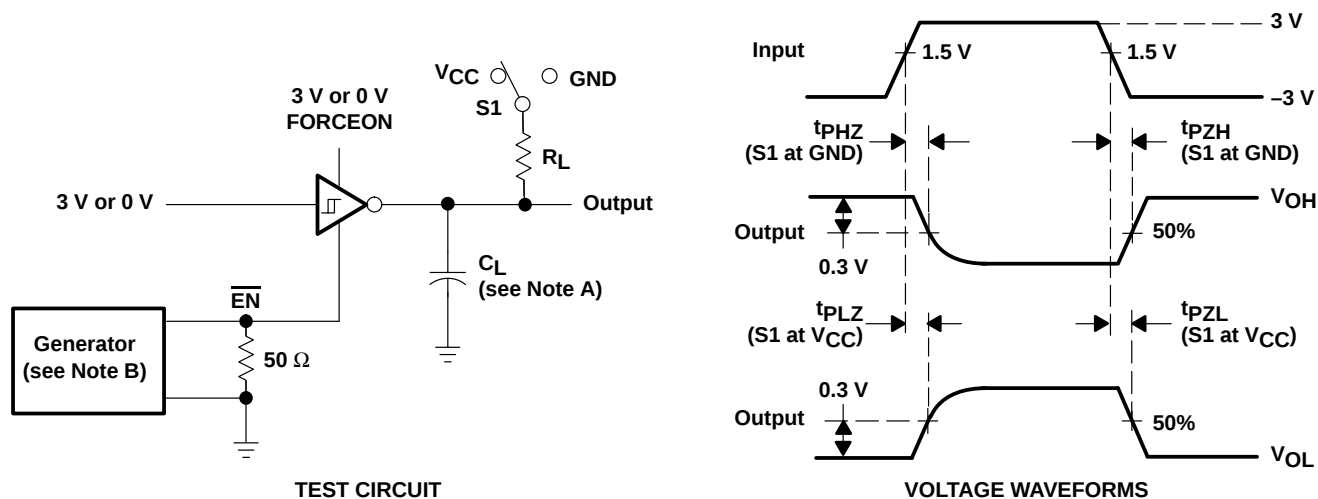
Figure 3. Receiver Propagation Delay Times

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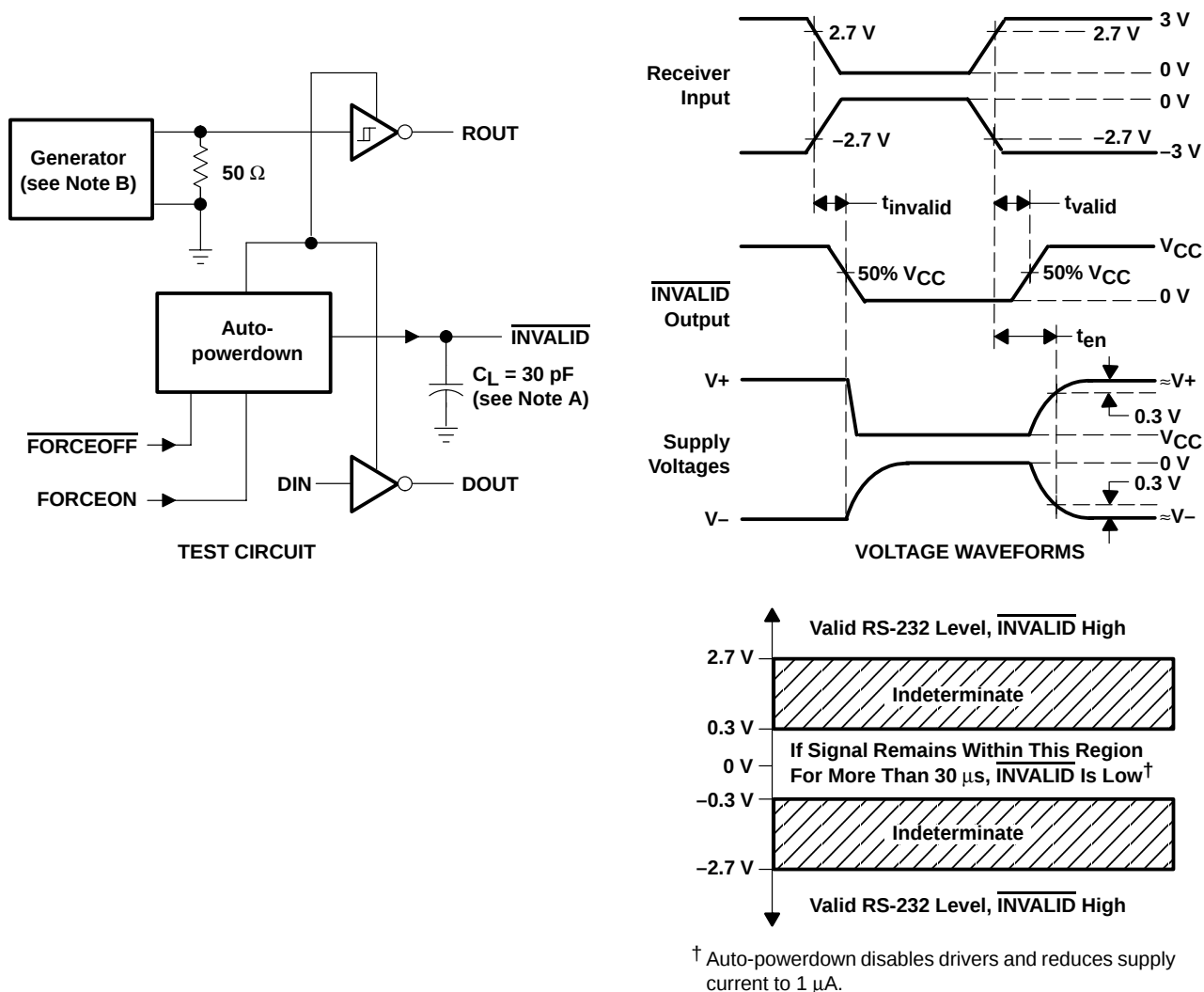
PARAMETER MEASUREMENT INFORMATION



- 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.

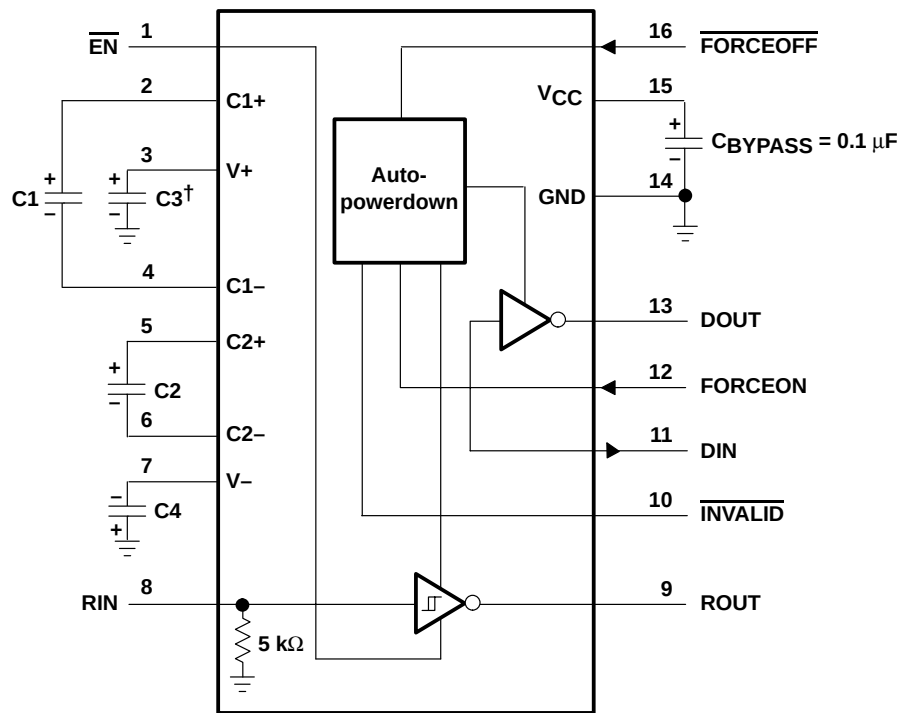
B. The pulse generator has the following characteristics: PRR = 5 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

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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