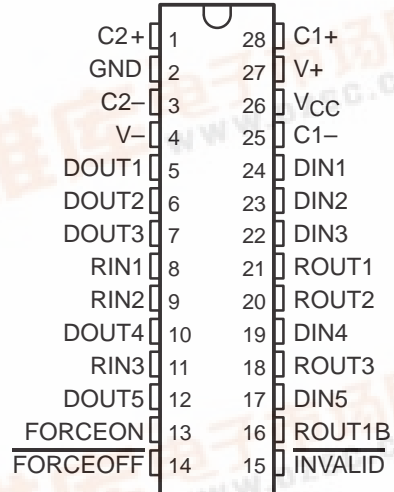


3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

SLLS349B – 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**
- **Always-Active Noninverting Receiver Output (ROUT1B)**
- **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 MAX3238**
- **RS-232 Bus-Pin ESD Protection Exceeds ± 15 -kV Using Human-Body Model (HBM)**
- **Applications**
 - **Battery-Powered Systems, PDAs, Notebooks, Subnotebooks, Laptops, Palmtop PCs, Hand-Held Equipment, Modems, and Printers**
- **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)



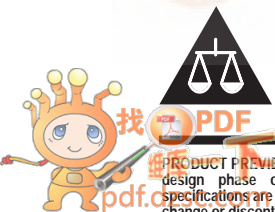
description

The MAX3238 device consists of five line drivers, three line receivers, 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 notebook and subnotebook computer applications. 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 (ROUT1B), which allows applications using the ring indicator to transmit data while the device is powered down. 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 featured when the serial port and driver inputs are inactive. The auto-powerdown plus feature functions when FORCEON is low and FORCEOFF is high. During this mode of operation, if the device does not sense valid signal transitions on all receiver and driver inputs for 30 s, the built-in charge-pump and drivers are powered down, reducing the supply current to 1 μ A. By disconnecting the serial port or placing the peripheral drivers off, auto-powerdown plus occurs if there is no activity in the logic levels for the driver inputs. Auto-powerdown plus can be disabled when FORCEON and FORCEOFF are high. With auto-powerdown plus enabled, the device automatically activates once a valid signal is applied to any receiver or driver 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 μ s. INVALID is low (invalid data) if all receiver input voltages are between -0.3 V and 0.3 V for more than 30 μ s. Refer to Figure 5 for receiver input levels.

The MAX3238C is characterized for operation from 0°C to 70°C. The MAX3238I is characterized for operation from -40°C to 85°C.

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.



MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 2000

AVAILABLE OPTIONS

T _A	PACKAGED DEVICES		
	SHRINK SMALL OUTLINE (DB)	SMALL OUTLINE (DW)	THIN SHRINK SMALL OUTLINE (PW)
0°C to 70°C	MAX3238CDB	MAX3238CDW	MAX3238CPW
-40°C to 85°C	MAX3238IDB	MAX3238IDW	MAX3238IPW

The DB, DW, and PW packages are available taped and reeled. Add the suffix R to device type (e.g., MAX3238CDBR).

Function Tables

EACH DRIVER

INPUTS				OUTPUT DOUT	DRIVER STATUS
DIN	FORCEON	FORCEOFF	TIME ELAPSED SINCE LAST RIN OR DIN TRANSITION		
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with auto-powerdown plus disabled
H	H	H	X	L	
L	L	H	<30 s	H	Normal operation with auto-powerdown plus enabled
H	L	H	<30 s	L	
L	L	H	>30 s	Z	Powered off by auto-powerdown plus feature
H	L	H	>30 s	Z	

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

EACH RECEIVER

INPUTS				OUTPUTS		RECEIVER STATUS
RIN2	RIN1, RIN3-RIN5	FORCEOFF	TIME ELAPSED SINCE LAST RIN OR DIN TRANSITION	ROUT1B	ROUT	
L	X	L	X	L	Z	Powered off while ROUT1B is active
H	X	L	X	H	Z	
L	L	H	<30 s	L	H	Normal operation with auto-powerdown plus disabled/enabled
L	H	H	<30 s	L	L	
H	L	H	<30 s	H	H	
H	H	H	<30 s	H	L	
Open	Open	H	>30 s	L	H	

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

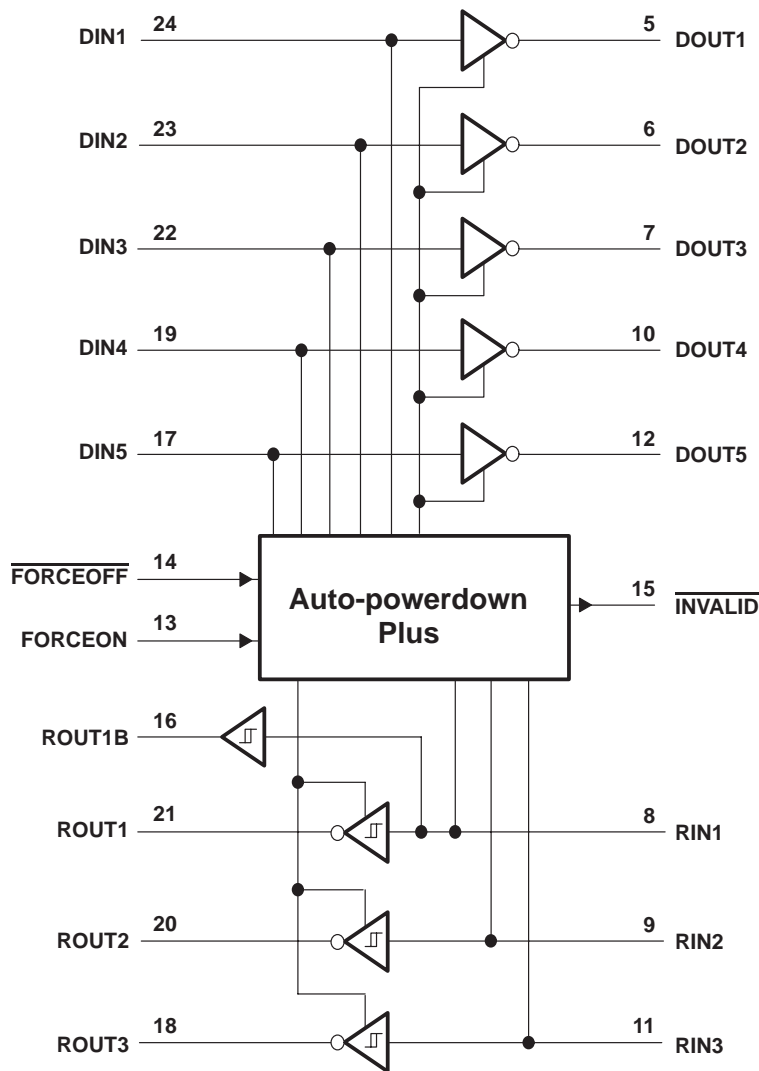
PRODUCT PREVIEW

MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 2000

logic diagram (positive logic)



PRODUCT PREVIEW

MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 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 (<u>FORCEOFF</u> , 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 (INVALID)	.....	-0.3 V to $V_{CC} + 0.3$ V
Package thermal impedance, θ_{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.

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, <u>FORCEOFF</u> , FORCEON	$V_{CC} = 3.3$ V	2		V
			$V_{CC} = 5$ V	2.4		
V_{IL}	Driver and control low-level input voltage	DIN, <u>FORCEOFF</u> , FORCEON			0.8	V
V_I	Driver and control input voltage	DIN, <u>FORCEOFF</u> , FORCEON	0	5.5		V
V_I	Receiver input voltage		-25	25		V
T_A	Operating free-air temperature	MAX3238C	0	70		°C
		MAX3238I	-40	85		

NOTE 3: Testing supply conditions are C1–C4 = 0.1 μ F at $V_{CC} = 3.3$ V \pm 0.15 V; C1–C4 = 0.22 μ F at $V_{CC} = 3.3$ V \pm 0.3 V; and C1 = 0.047 μ F and 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_l	Input leakage current	<u>FORCEOFF</u> , FORCEON		\pm 0.01	\pm 1	μ A
I_{CC}	Supply current	Auto-powerdown plus disabled	No load, <u>FORCEOFF</u> and FORCEON at V_{CC}	0.5	2	mA
		Powered off	No load, <u>FORCEOFF</u> at GND	1	10	
		Auto-powerdown plus enabled	No load, <u>FORCEOFF</u> at V_{CC} , FORCEON at GND, All RIN are open or grounded	1	10	μ A

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

NOTE 3: Testing supply conditions are C1–C4 = 0.1 μ F at $V_{CC} = 3.3$ V \pm 0.15 V; C1–C4 = 0.22 μ F at $V_{CC} = 3.3$ V \pm 0.3 V; and C1 = 0.047 μ F and C2–C4 = 0.33 μ F at $V_{CC} = 5$ V \pm 0.5 V.

PRODUCT PREVIEW

MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 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 _{OH}	High-level output voltage	All DOUT at R _L = 3 kΩ to GND	5	5.4		V
V _{OL}	Low-level output voltage	All DOUT at R _L = 3 kΩ to GND	-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		±40	±100	
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: Testing supply conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.15 V; C1–C4 = 0.22 μF at V_{CC} = 3.3 V ± 0.3 V; and C1 = 0.047 μF and 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, One DOUT switching, 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
			C _L = 150 pF to 1000 pF			
			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: Testing supply conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.15 V; C1–C4 = 0.22 μF at V_{CC} = 3.3 V ± 0.3 V; and C1 = 0.047 μF and C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

PRODUCT PREVIEW

MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 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 _{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		1.5	2.4	V
		V _{CC} = 5 V		1.8	2.4	
V _{IT-}	Negative-going input threshold voltage	V _{CC} = 3.3 V	0.6	1.2		V
		V _{CC} = 5 V	0.8	1.5		
V _{hys}	Input hysteresis (V _{IT+} - V _{IT-})			0.3		V
I _{off}	Output leakage current (except ROUT1B)	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: Testing supply conditions are C1-C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.15 V; C1-C4 = 0.22 µF at V_{CC} = 3.3 V ± 0.3 V; and C1 = 0.047 µF and 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: Testing supply conditions are C1-C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.15 V; C1-C4 = 0.22 µF at V_{CC} = 3.3 V ± 0.3 V; and C1 = 0.047 µF and C2-C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

PRODUCT PREVIEW

MAX3238

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

SLLS349B – JUNE 1999 – REVISED JANUARY 2000

AUTO-POWERDOWN PLUS 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
$V_{T+}(\text{valid})$	Receiver input threshold for INVALID high-level output voltage	FORCEON = GND, FORCEOFF = V_{CC}			2.7	V
$V_{T-}(\text{valid})$	Receiver input threshold for INVALID high-level output voltage	FORCEON = GND, FORCEOFF = V_{CC}	-2.7			V
$V_{T}(\text{invalid})$	Receiver input threshold for INVALID low-level output voltage	FORCEON = GND, FORCEOFF = V_{CC}	-0.3		0.3	V
V_{OH}	$\overline{\text{INVALID}}$ high-level output voltage	$I_{OH} = -1 \text{ mA}$, FORCEON = GND, FORCEOFF = V_{CC}	$V_{CC} - 0.6$			V
V_{OL}	$\overline{\text{INVALID}}$ low-level output voltage	$I_{OL} = 1.6 \text{ mA}$, FORCEON = GND, FORCEOFF = V_{CC}			0.4	V

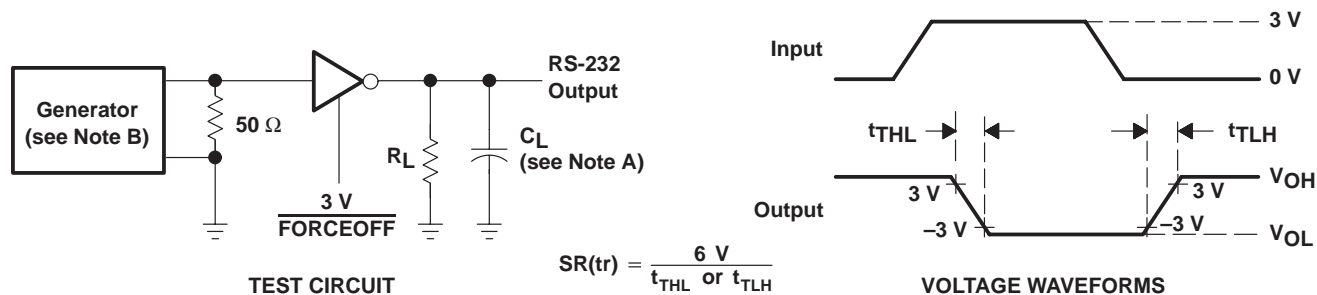
† All typical values are at $V_{CC} = 3.3 \text{ V}$ or $V_{CC} = 5 \text{ V}$, and $T_A = 25^\circ\text{C}$.

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}	Propagation delay time, low- to high-level output		0.1		μs
t_{invalid}	Propagation delay time, high- to low-level output		50		μs
t_{en}	Supply enable time		25		μs
t_{dis}	Receiver or driver edge to auto-powerdown plus	15	30	60	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, $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

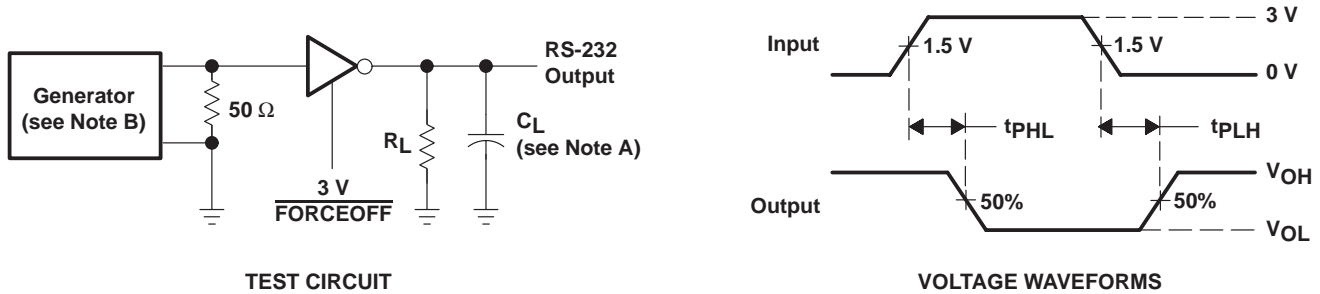
Figure 1. Driver Slew Rate

PRODUCT PREVIEW

MAX3238 3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

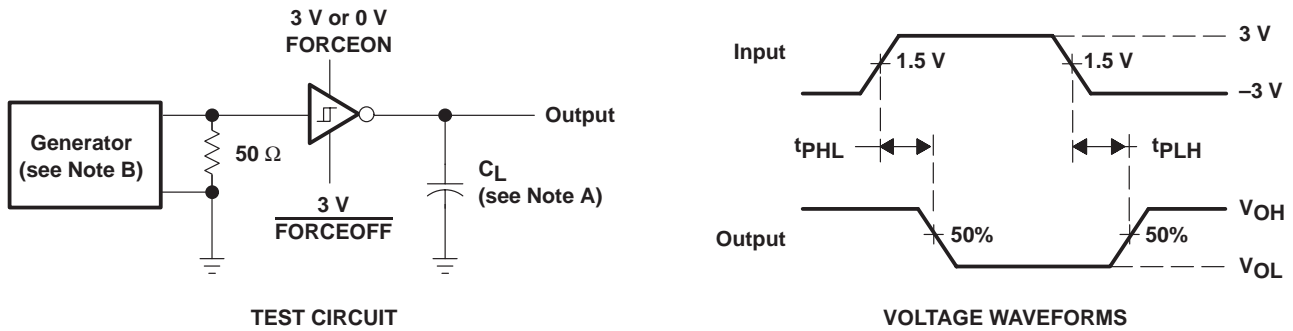
SLLS349B – JUNE 1999 – REVISED JANUARY 2000

PARAMETER MEASUREMENT INFORMATION



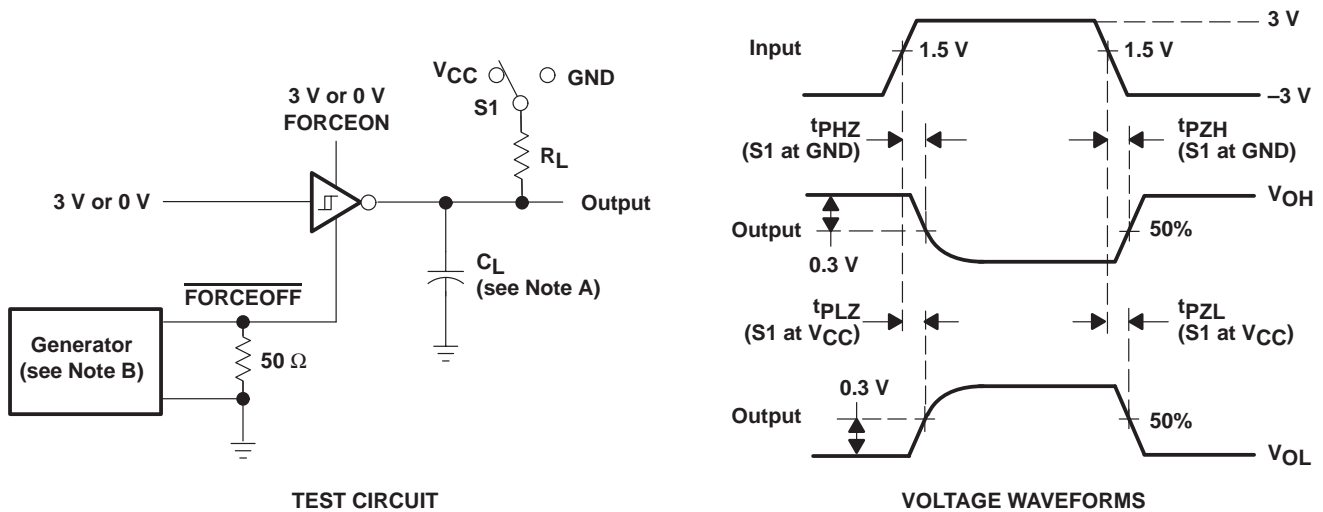
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10$ ns, $t_f \leq 10$ ns.

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.
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

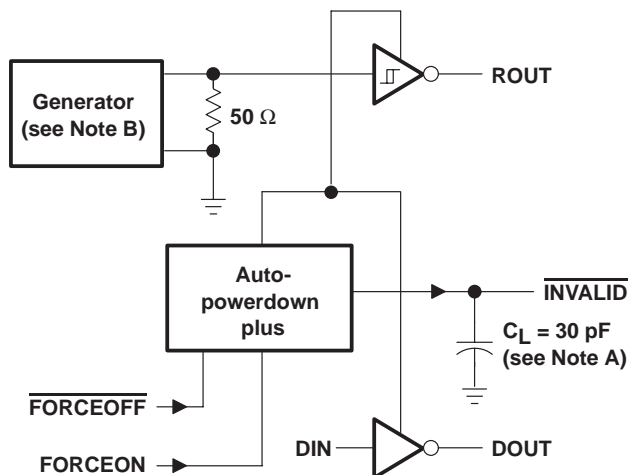
PRODUCT PREVIEW

MAX3238

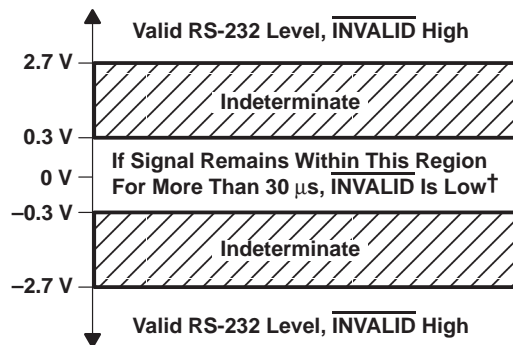
3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

SLLS349B – JUNE 1999 – REVISED JANUARY 2000

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



† Auto-powerdown plus disables drivers and reduces supply current to 1 μ A.

- 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.

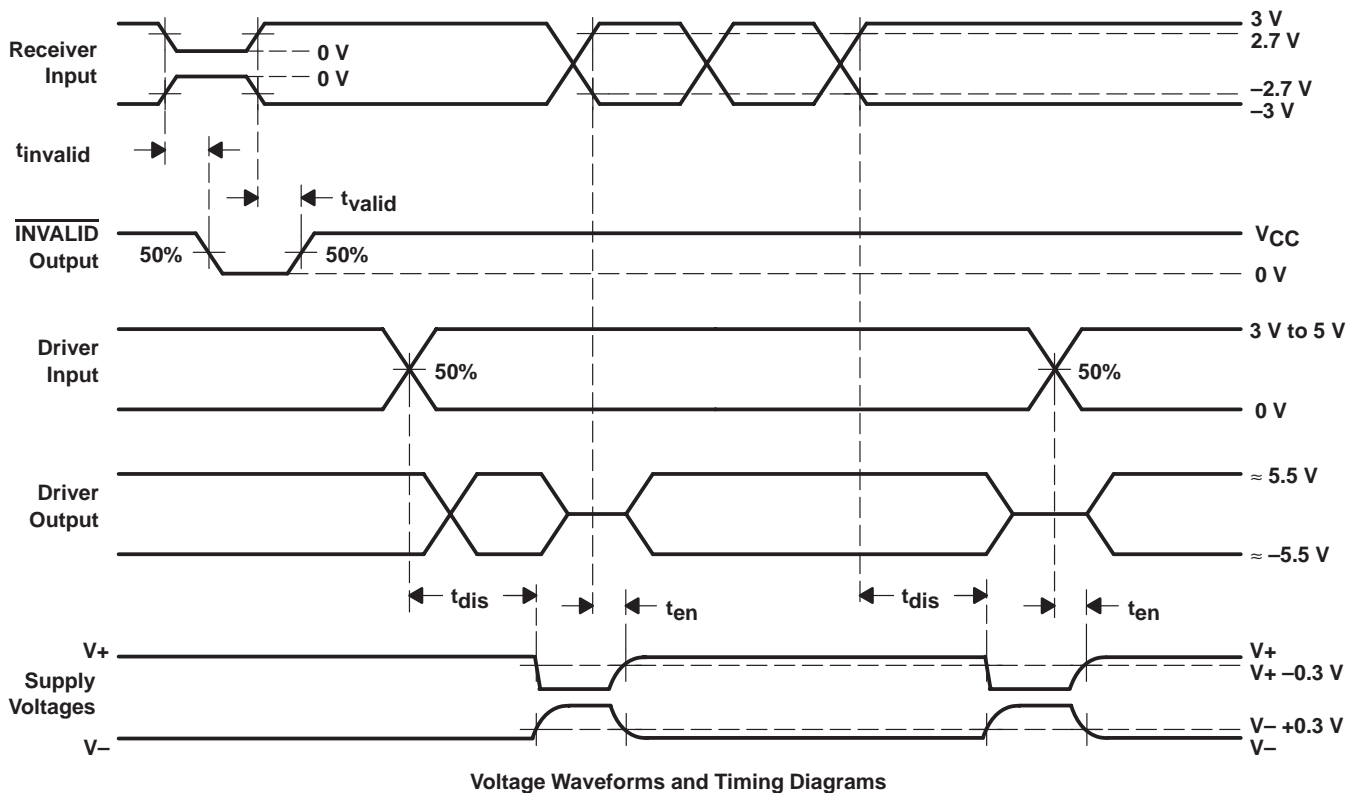


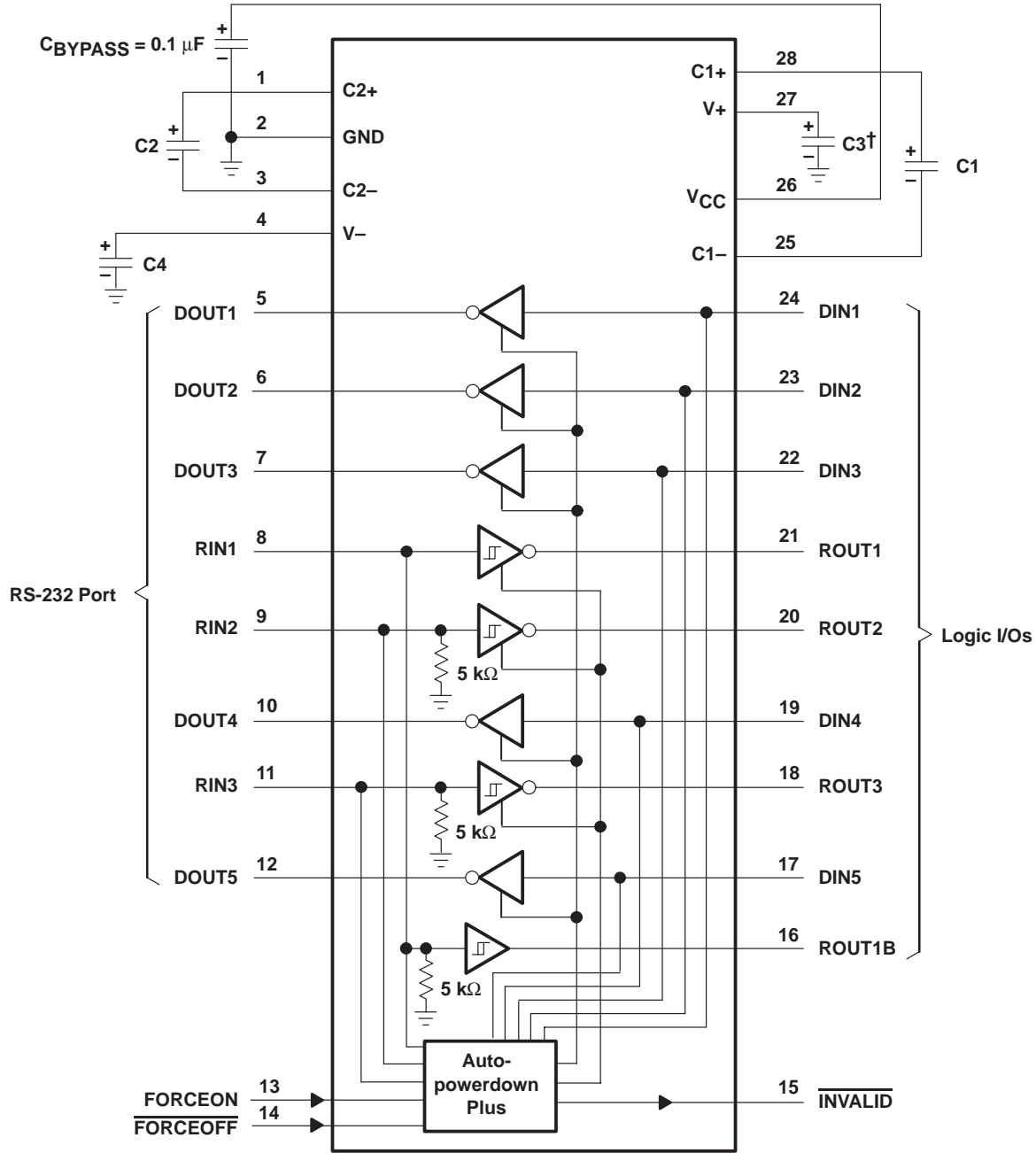
Figure 5. $\overline{\text{INVALID}}$ Propagation Delay Times and Supply Enabling Time

PRODUCT PREVIEW

MAX3238 3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

SLLS349B – JUNE 1999 – REVISED JANUARY 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 ± 0.15 V	0.1 μF	0.1 μF
3.3 V ± 0.3 V	0.22 μF	0.22 μF
5 V ± 0.5 V	0.047 μF	0.33 μF
3 V to 5.5 V	0.22 μF	1 μF

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 acknowledgement, 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.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

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.