

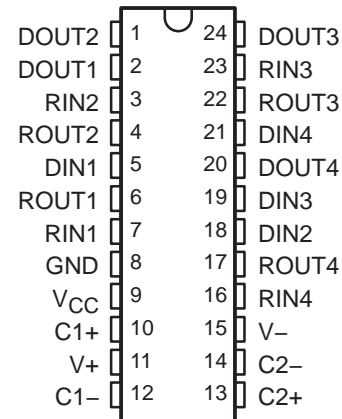
# MAX208

## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

SLLS596A – OCTOBER 2003 – REVISED JANUARY 2004

- ESD Protection for RS-232 I/O Pins
  - $\pm 15$  kV – Human-Body Model
- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates at 5-V  $V_{CC}$  Supply
- Four Drivers and Four Receivers
- Operates Up To 120 kbit/s
- External Capacitors . . .  $4 \times 0.1 \mu\text{F}$
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- Applications
  - Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment

DB, DW, OR NT PACKAGE  
(TOP VIEW)



### description/ordering information

The MAX208 device consists of four line drivers, four line receivers, and a dual charge-pump circuit with  $\pm 15$ -kV HBM 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 5-V supply. The devices operate at data signaling rates up to 120 kbit/s and a maximum of 30-V/ $\mu\text{s}$  driver output slew rate.

### ORDERING INFORMATION

$T_A$	PACKAGE <sup>†</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (NT)	Tube of 15	MAX208CNT	MAX208CNT
	SOIC (DW)	Tube of 25	MAX208CDW	MAX208C
		Reel of 2000	MAX208CDWR	
	SSOP (DB)	Tube of 60	MAX208CDB	MA208C
Reel of 2000		MAX208CDBR		
–40°C to 85°C	PDIP (NT)	Tube of 15	MAX208INT	MAX208INT
	SOIC (DW)	Tube of 25	MAX208IDW	MAX208I
		Reel of 2000	MAX208IDWR	
	SSOP (DB)	Tube of 60	MAX208IDB	MB208I
		Reel of 2000	MAX208IDBR	

<sup>†</sup> 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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**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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**MAX208**  
**5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH ±15-kV ESD PROTECTION**

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**Function Tables**

**EACH DRIVER**

INPUT D <sub>IN</sub>	OUTPUT D <sub>OUT</sub>
L	H
H	L

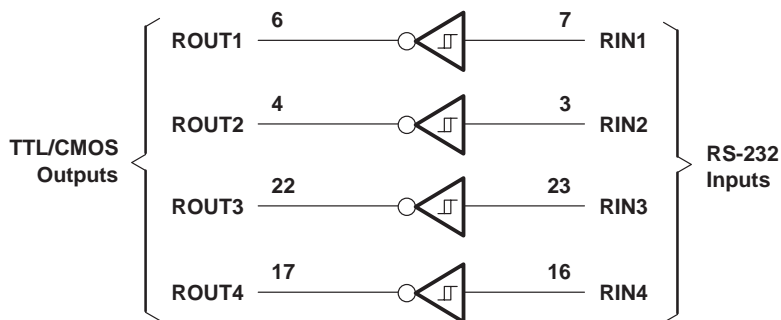
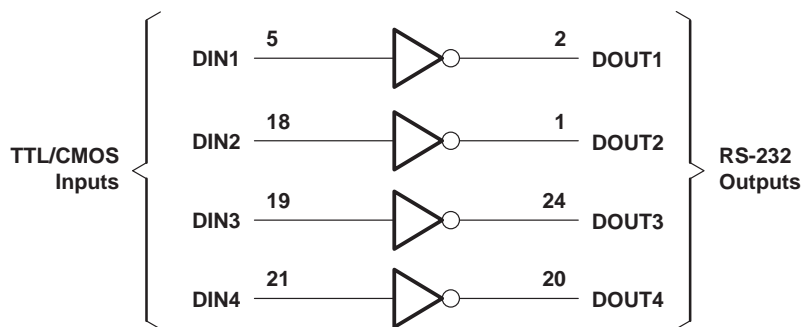
H = high level, L = low level

**EACH RECEIVER**

INPUT R <sub>IN</sub>	OUTPUT R <sub>OUT</sub>
L	H
H	L
Open	H

H = high level, L = low level, Open = input disconnected or connected driver off

**logic diagram (positive logic)**



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## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

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### 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 charge pump voltage range, $V+$ (see Note 1)	$V_{CC}$ –0.3 V to 14 V
Negative charge pump voltage range, $V-$ (see Note 1)	–14 V to 0.3 V
Supply voltage difference, $V+ - V-$ (see Note 1)	13 V
Input voltage range, $V_I$ : Drivers	–0.3 V to $V+ + 0.3$ V
Receivers	$\pm 30$ V
Output voltage range, $V_O$ : Drivers	$V- - 0.3$ V to $V+ + 0.3$ V
Receivers	–0.3 V to $V_{CC} + 0.3$ V
Short-circuit duration: $D_{OUT}$	Continuous
Package thermal impedance, $\theta_{JA}$ (see Notes 2 and 3): DB package	63°C/W
(see Notes 2 and 3): DW package	46°C/W
(see Notes 2 and 4): NT package	67°C/W
Operating virtual junction temperature, $T_J$	150°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. Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  3. The package thermal impedance is calculated in accordance with JESD 51-7.
  4. The package thermal impedance is calculated in accordance with JESD 51-3.

### recommended operating conditions (see Note 5 and Figure 4)

			MIN	NOM	MAX	UNIT
Supply voltage			4.5	5	5.5	V
$V_{IH}$	Driver high-level input voltage	$D_{IN}$	2.4			V
$V_{IL}$	Driver low-level input voltage	$D_{IN}$			0.8	V
$V_I$	Driver input voltage	$D_{IN}$	0		5.5	V
	Receiver input voltage		–30		30	
$T_A$	Operating free-air temperature	MAX208C	0		70	°C
		MAX208I	–40		85	

NOTE 5: Test conditions are C1–C4 = 0.1  $\mu$ 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 5 and Figure 4)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{CC}$ Supply current	No load, $V_{CC} = 5$ V, $T_A = 25^\circ$ C		11	20	mA

NOTE 5: Test conditions are C1–C4 = 0.1  $\mu$ 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 5 and Figure 4)**

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	D <sub>OUT</sub> at R <sub>L</sub> = 3 kΩ to GND, D <sub>IN</sub> = GND	5	9		V
V <sub>OL</sub>	Low-level output voltage	D <sub>OUT</sub> at R <sub>L</sub> = 3 kΩ to GND, D <sub>IN</sub> = V <sub>CC</sub>	-5	-9		V
I <sub>IH</sub>	High-level input current	V <sub>I</sub> = V <sub>CC</sub>		15	200	μA
I <sub>IL</sub>	Low-level input current	V <sub>I</sub> at 0 V		-15	-200	μA
I <sub>OS</sub> <sup>†</sup>	Short-circuit output current	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V		±10	±60	mA
r <sub>o</sub>	Output resistance	V <sub>CC</sub> , V+, and V- = 0 V, V <sub>O</sub> = ±2 V	300			Ω

<sup>†</sup> 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 5: Test conditions are C1–C4 = 0.1 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 5 and Figure 4)**

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>†</sup>	MAX	UNIT
	Maximum data rate	C <sub>L</sub> = 50 to 1000 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, One D <sub>OUT</sub> switching, See Figure 1	120			kbit/s
t <sub>PLH</sub> (D)	Propagation delay time, low- to high-level output	C <sub>L</sub> = 2500 pF, all drivers loaded, R <sub>L</sub> = 3 kΩ, See Figure 1		2		μs
t <sub>PHL</sub> (D)	Propagation delay time, high- to low-level output	C <sub>L</sub> = 2500 pF, all drivers loaded, R <sub>L</sub> = 3 kΩ, See Figure 1		2		μs
t <sub>sk(p)</sub>	Pulse skew <sup>§</sup>	C <sub>L</sub> = 150 pF to 2500 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, See Figure 2		300		ns
SR(tr)	Slew rate, transition region (see Figure 1)	C <sub>L</sub> = 50 pF to 2500 pF, V <sub>CC</sub> = 5 V, R <sub>L</sub> = 3 kΩ to 7 kΩ	3	6	30	V/μs

<sup>†</sup> All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

<sup>§</sup> Pulse skew is defined as |t<sub>PLH</sub> – t<sub>PHL</sub>| of each channel of the same device.

NOTE 5: Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

**ESD protection**

PIN	TEST CONDITIONS	TYP	UNIT
D <sub>OUT</sub> , R <sub>IN</sub>	Human Body Model	±15	kV



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## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

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### RECEIVER SECTION

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 5 and Figure 4)**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>OH</sub> High-level output voltage	I <sub>OH</sub> = -1 mA	3.5			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> = 5 V, T <sub>A</sub> = 25°C		1.7	2.4	V
V <sub>IT-</sub> Negative-going input threshold voltage	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	0.8	1.2		V
V <sub>hys</sub> Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )	V <sub>CC</sub> = 5 V	0.2	0.5	1	V
r <sub>i</sub> Input resistance	V <sub>I</sub> = ±3 V to ±25 V, V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	3	5	7	kΩ

NOTE 5: Test conditions are C1–C4 = 0.1 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 5 and Figure 3)**

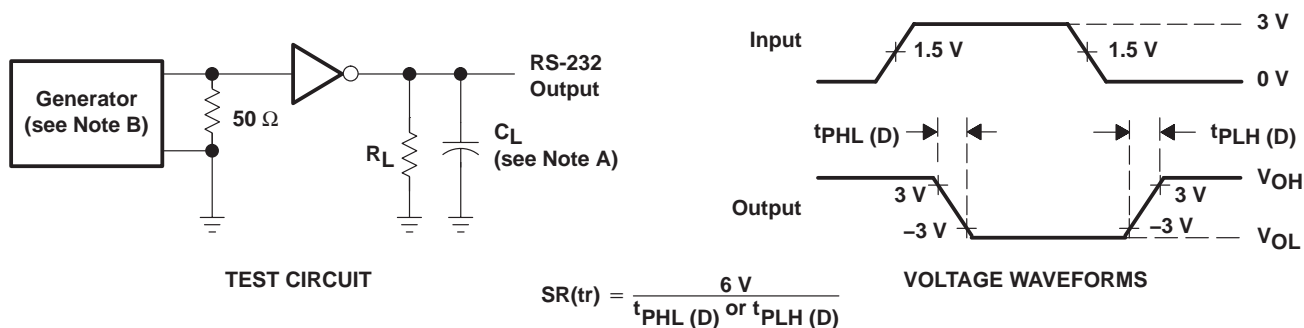
PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t <sub>PLH</sub> (R) Propagation delay time, low- to high-level output	C <sub>L</sub> = 150 pF		0.5	10	μs
t <sub>PHL</sub> (R) Propagation delay time, high- to low-level output			0.5	10	μs
t <sub>sk(p)</sub> Pulse skew‡			300		ns

† All typical values are at 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 5: Test conditions are C1–C4 = 0.1 μF, at V<sub>CC</sub> = 5 V ± 0.5 V.

### PARAMETER MEASUREMENT INFORMATION



NOTES: A. C<sub>L</sub> includes probe and jig capacitance.

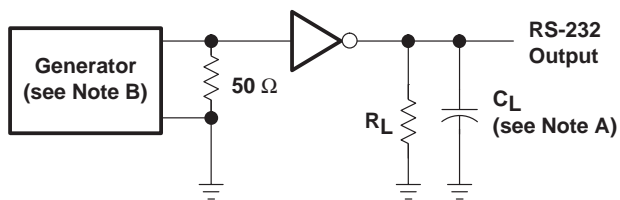
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, Z<sub>0</sub> = 50 Ω, 50% duty cycle, t<sub>r</sub> ≤ 10 ns, t<sub>f</sub> ≤ 10 ns.

**Figure 1. Driver Slew Rate**

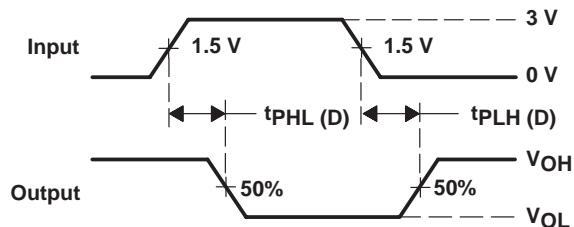
**MAX208**  
**5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -kV ESD PROTECTION**

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**PARAMETER MEASUREMENT INFORMATION**



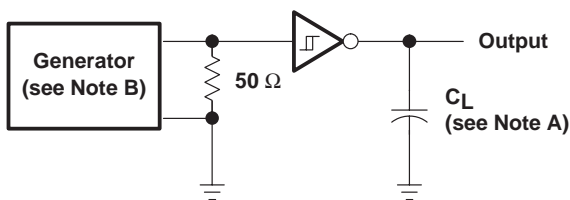
**TEST CIRCUIT**



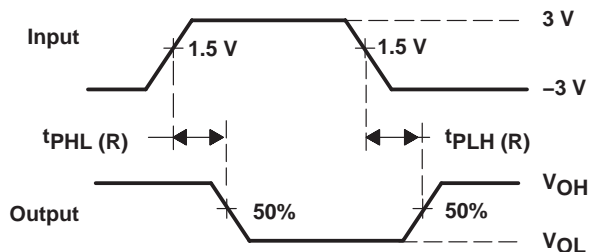
**VOLTAGE WAVEFORMS**

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics: PRR = 120 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**Figure 2. Driver Pulse Skew**



**TEST CIRCUIT**



**VOLTAGE WAVEFORMS**

- 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.

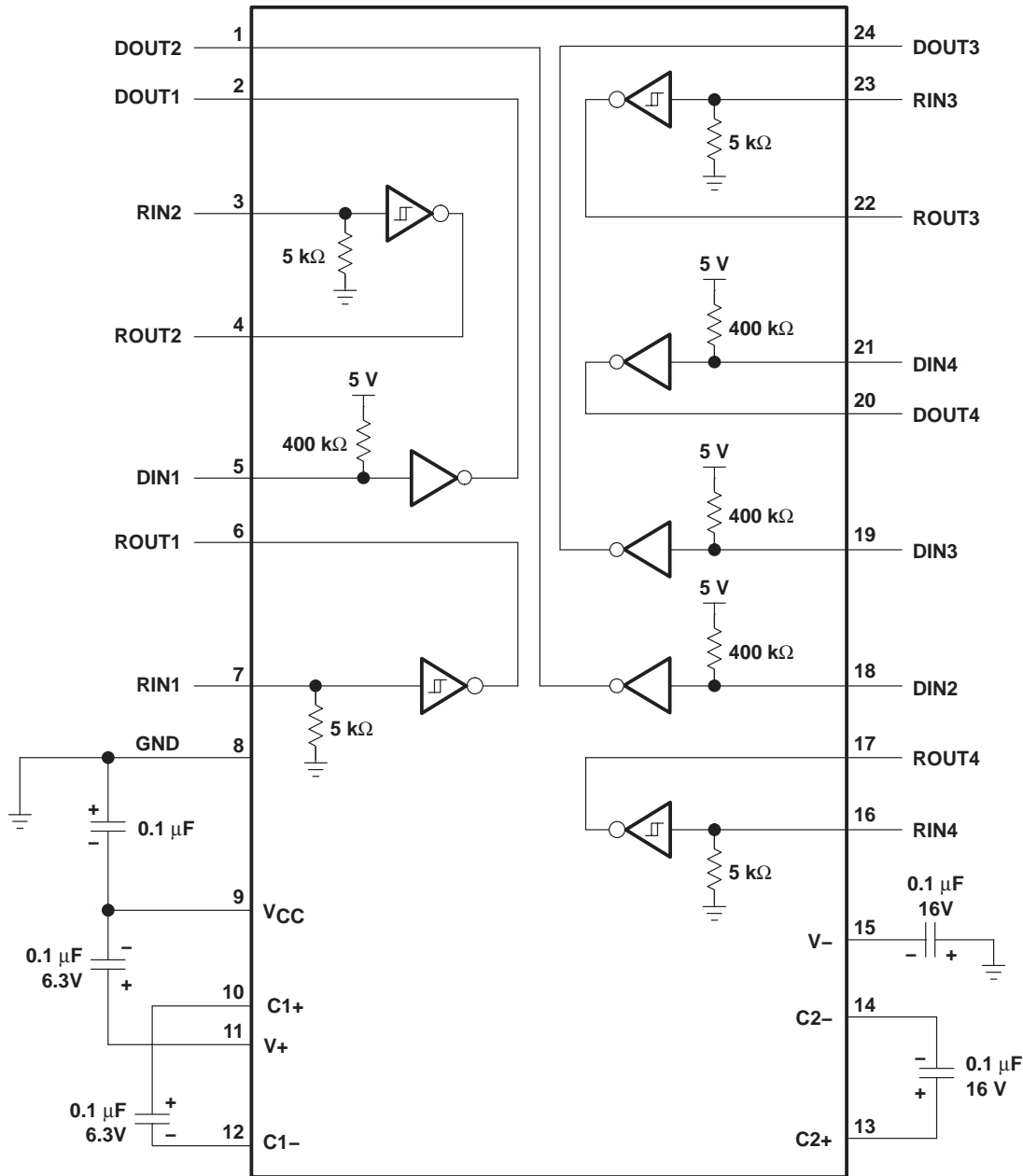
**Figure 3. Receiver Propagation Delay Times**

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## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

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### APPLICATION INFORMATION



- NOTES: A. Resistor values shown are nominal.  
 B. Non-polarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

**Figure 4. Typical Operating Circuit and Capacitor Values**

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### APPLICATION INFORMATION

#### capacitor selection

The capacitor type used for C1–C4 is not critical for proper operation. The MAX208 requires 0.1- $\mu$ F capacitors, although capacitors up to 10  $\mu$ F can be used without harm. Ceramic dielectrics are suggested for the 0.1- $\mu$ F capacitors. When using the minimum recommended capacitor values, ensure that the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (e.g.,  $2\times$ ) nominal value. The capacitors' effective series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on  $V_+$  and  $V_-$ .

Use larger capacitors (up to 10  $\mu$ F) to reduce the output impedance at  $V_+$  and  $V_-$ .

Bypass  $V_{CC}$  to ground with at least 0.1  $\mu$ F. In applications sensitive to power-supply noise generated by the charge pumps, decouple  $V_{CC}$  to ground with a capacitor the same size as (or larger than) the charge-pump capacitors (C1–C4).

#### ESD protection

Texas Instruments MAX208 devices have standard ESD protection structures incorporated on the pins to protect against electrostatic discharges encountered during assembly and handling. In addition, the RS232 bus pins (driver outputs and receiver inputs) of these devices have an extra level of ESD protection. Advanced ESD structures were designed to successfully protect these bus pins against ESD discharge of  $\pm 15$ -kV when powered down.

#### ESD test conditions

ESD testing is stringently performed by TI, based on various conditions and procedures. Please contact Texas Instruments for a reliability report that documents test setup, methodology, and results.

#### Human-Body Model (HBM)

The Human-Body Model of ESD testing is shown in Figure 5, while Figure 6 shows the current waveform that is generated during a discharge into a low impedance. The model consists of a 100-pF capacitor, charged to the ESD voltage of concern and subsequently discharged into the DUT through a 1.5-k $\Omega$  resistor.

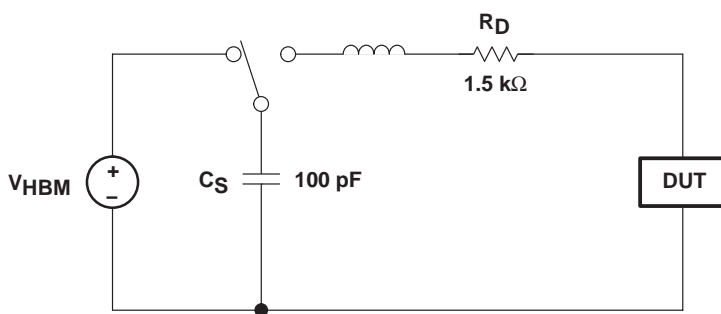


Figure 5. HBM ESD Test Circuit



APPLICATION INFORMATION

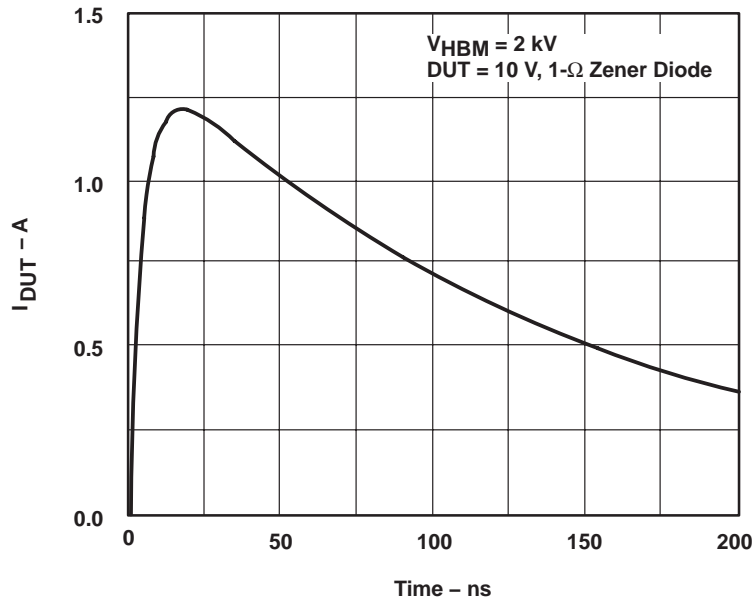


Figure 6. Typical HBM Current Waveform

Machine Model

The Machine Model (MM) ESD test applies to all pins using a 200-pF capacitor with no discharge resistance. The purpose of the MM test is to simulate possible ESD conditions that can occur during the handling and assembly processes of manufacturing. In this case, ESD protection is required for all pins, not just RS-232 pins. However, after PC board assembly, the MM test no longer is as pertinent to the RS-232 pins.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
MAX208CDB	ACTIVE	SSOP	DB	24	60	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX208CDBR	ACTIVE	SSOP	DB	24	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX208CDW	ACTIVE	SOIC	DW	24	25	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX208CDWR	ACTIVE	SOIC	DW	24	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX208CNT	PREVIEW	PDIP	NT	24	15	None	Call TI	Call TI
MAX208IDB	ACTIVE	SSOP	DB	24	60	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX208IDBR	ACTIVE	SSOP	DB	24	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX208IDW	ACTIVE	SOIC	DW	24	25	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX208IDWR	ACTIVE	SOIC	DW	24	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX208INT	PREVIEW	PDIP	NT	24	15	None	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**None:** Not yet available Lead (Pb-Free).

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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NT (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

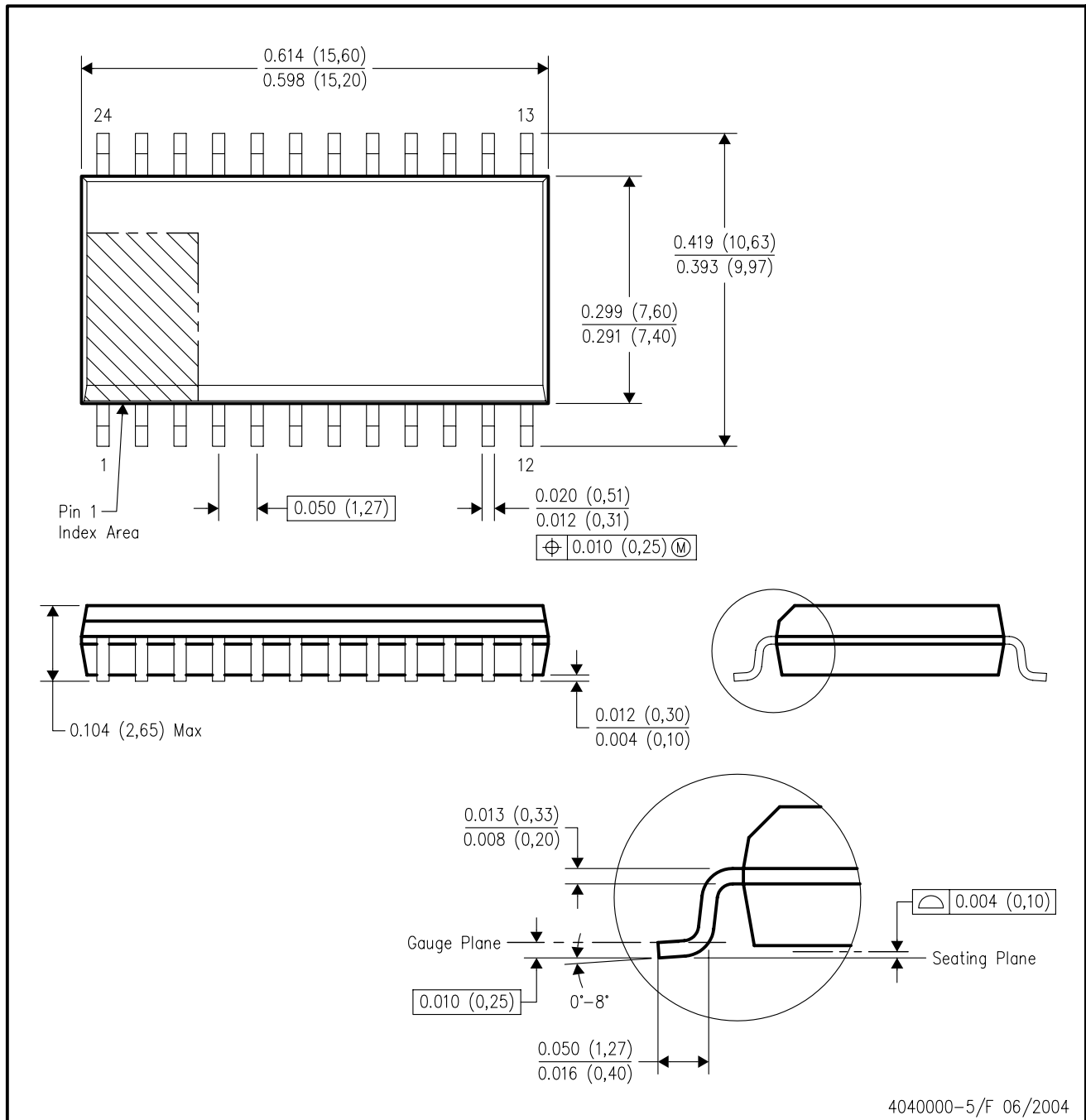
24 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.

DW (R-PDSO-G24)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-013 variation AD.

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

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DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
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