

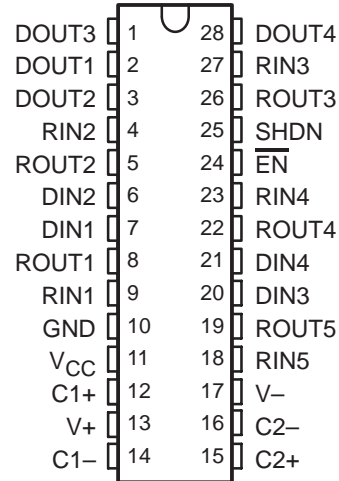
# MAX211

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

SLLS567C – MAY 2003 – REVISED AUGUST 2003

- ESD Protection for RS-232 Bus 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 Five Receivers
- Operates Up To 120 kbit/s
- Low Supply Current in Shutdown Mode . . . 1  $\mu$ A Typical
- External Capacitors . . .  $4 \times 0.1 \mu$ F
- Designed to Be Interchangeable With Maxim MAX211
- 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 OR DW PACKAGE  
(TOP VIEW)



### description/ordering information

The MAX211 device consists of four line drivers, five line receivers, and a dual charge-pump circuit with  $\pm 15$ -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 5-V supply. The devices operate at data signaling rates up to 120 kbit/s and a maximum of 30-V/ $\mu$ s driver output slew rate.

The MAX211 has both shutdown (SHDN) and enable control ( $\overline{EN}$ ). In shutdown mode, the charge pumps are turned off, V+ is pulled down to  $V_{CC}$ , V- is pulled to GND, and the transmitter outputs are disabled. This reduces supply current typically to 1  $\mu$ A.  $\overline{EN}$  is used to put the receiver outputs into the high-impedance state to allow wired-OR connection of two RS-232 ports. It has no effect on the RS-232 drivers or the charge pumps.

### ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC (DW)	Tube of 20	MAX211CDW	MAX211C
		Reel of 1000	MAX211CDWR	
	SSOP (DB)	Tube of 50	MAX211CDB	MAX211C
		Reel of 2000	MAX211CDBR	
-40°C to 85°C	SOIC (DW)	Tube of 20	MAX211IDW	MAX211I
		Reel of 1000	MAX211IDWR	
	SSOP (DB)	Tube of 50	MAX211IDB	MAX211I
		Reel of 2000	MAX211IDBR	

† 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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**TEXAS  
INSTRUMENTS**

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**Function Tables**

INPUTS		DRIVER	RECEIVER	DEVICE STATUS
SHDN	$\overline{\text{EN}}$			
L	L	All active	All active	Normal operation
L	H	All active	Z	Normal operation
H	X	Z	Z	Shutdown

X = don't care, Z = high impedance

**EACH DRIVER**

INPUTS		OUTPUT DOUT	DRIVER STATUS
DIN	SHDN		
L	L	H	Normal operation
H	L	L	
X	H	Z	Powered off

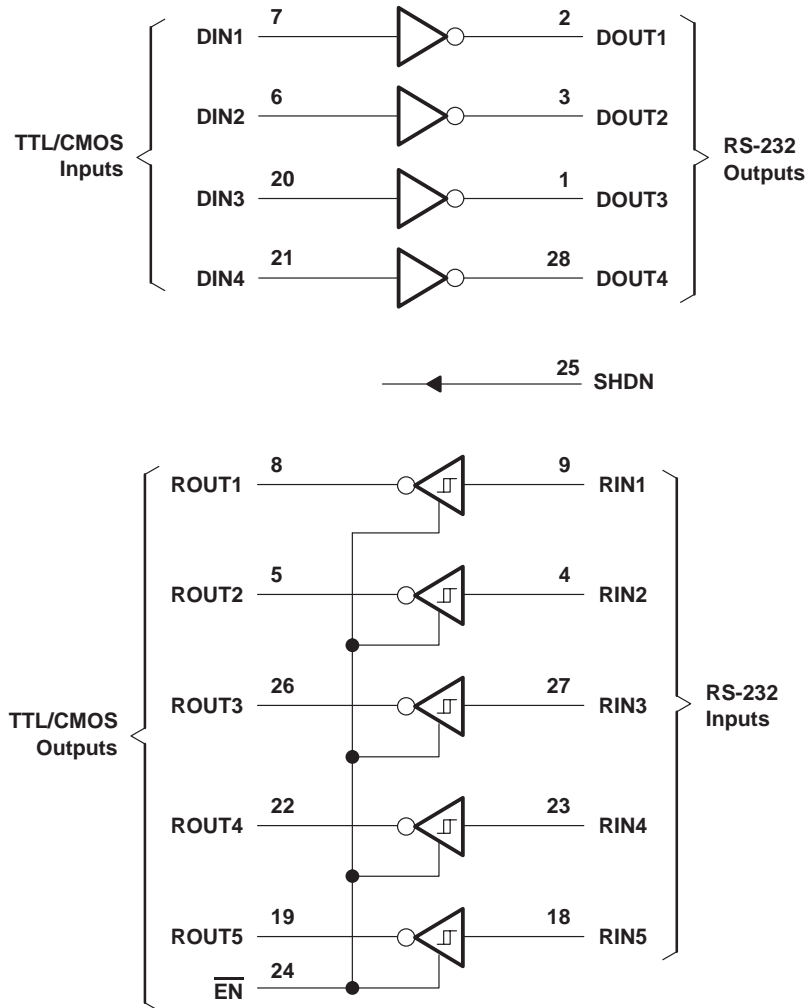
X = don't care, Z = high impedance

**EACH RECEIVER**

INPUTS		OUTPUT ROUT	RECEIVER STATUS
RIN	$\overline{\text{EN}}$		
L	L	H	Normal operation
H	L	L	
X	H	Z	Powered off

X = don't care, Z = high impedance

logic diagram (positive logic)



# MAX211

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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)	0.3 V to –14 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: DOUT	Continuous
Package thermal impedance, $\theta_{JA}$ (see Notes 2 and 3): DB package	62°C/W
DW package	46°C/W
Operating virtual junction temperature, $T_J$	150°C
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

<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  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . 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.

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

			MIN	NOM	MAX	UNIT
Supply voltage			4.5	5	5.5	V
$V_{IH}$	Driver high-level input voltage	DIN	2			V
	Control high-level input voltage	$\overline{EN}$ , SHDN	2.4			
$V_{IL}$	Driver and control low-level input voltage	DIN, $\overline{EN}$ , SHDN			0.8	V
$V_I$	Driver and control input voltage	DIN, $\overline{EN}$ , SHDN	0		5.5	V
	Receiver input voltage		–30		30	
$T_A$	Operating free-air temperature	MAX211C	0		70	°C
		MAX211I	–40		85	

NOTE 4: 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 4)

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>‡</sup>	MAX	UNIT
$I_{CC}$ Supply current	No load, See Figure 6		14	20	mA
Shutdown supply current	$T_A = 25^\circ\text{C}$ , See Figure 1		1	10	$\mu$ A

<sup>‡</sup> All typical values are at  $V_{CC} = 5$  V, and  $T_A = 25^\circ\text{C}$ .

NOTE 4: Test conditions are C1–C4 = 0.1  $\mu$ F at  $V_{CC} = 5$  V  $\pm$  0.5 V.



## DRIVER SECTION

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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{OH}$	High-level output voltage	DOUT at $R_L = 3\text{ k}\Omega$ to GND	5	9		V
$V_{OL}$	Low-level output voltage	DOUT at $R_L = 3\text{ k}\Omega$ to GND	–5	–9		V
$I_{IH}$	Driver high-level input current	$DIN = V_{CC}$		15	200	$\mu\text{A}$
	Control high-level input current	$\overline{EN}$ , SHDN = $V_{CC}$		3	10	
$I_{IL}$	Driver low-level input current	$DIN = 0\text{ V}$		–15	–200	$\mu\text{A}$
	Control low-level input current	$\overline{EN}$ , SHDN = $0\text{ V}$		–3	–10	
$I_{OS}^\ddagger$	Short-circuit output current	$V_{CC} = 5.5\text{ V}$ , $V_O = 0\text{ V}$		$\pm 10$	$\pm 60$	mA
$r_o$	Output resistance	$V_{CC}$ , $V_+$ , and $V_- = 0\text{ V}$ , $V_O = \pm 2\text{ V}$	300			$\Omega$

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

‡ 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 4: Test conditions are C1–C4 =  $0.1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
	Maximum data rate	$C_L = 50\text{ pF}$ to $1000\text{ pF}$ , One DOOUT switching, $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$ , See Figure 2	120			kbit/s
$t_{PLH}\text{ (D)}$	Propagation delay time, low- to high-level output	$C_L = 2500\text{ pF}$ , All drivers loaded, $R_L = 3\text{ k}\Omega$ , See Figure 2		2		$\mu\text{s}$
$t_{PHL}\text{ (D)}$	Propagation delay time, high- to low-level output	$C_L = 2500\text{ pF}$ , All drivers loaded, $R_L = 3\text{ k}\Omega$ , See Figure 2		2		$\mu\text{s}$
$t_{sk(p)}$	Pulse skew§	$C_L = 150\text{ pF}$ to $2500\text{ pF}$ , $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$ , See Figure 3		300		ns
$SR(\text{tr})$	Slew rate, transition region (see Figure 2)	$C_L = 50\text{ pF}$ to $1000\text{ pF}$ , $V_{CC} = 5\text{ V}$ , $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$	3	6	30	V/ $\mu\text{s}$

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

§ Pulse skew is defined as  $|t_{PLH} - t_{PHL}|$  of each channel of the same device.

NOTE 4: Test conditions are C1–C4 =  $0.1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

## ESD protection

PIN	TEST CONDITIONS	TYP	UNIT
DOOUT, RIN	Human Body Model	$\pm 15$	kV

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**RECEIVER SECTION**

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 4 and Figure 6)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{OH}$ High-level output voltage	$I_{OH} = -1\text{ mA}$	3.5	$V_{CC}-0.4\text{ V}$		V
$V_{OL}$ Low-level output voltage	$I_{OL} = 1.6\text{ mA}$			0.4	V
$V_{IT+}$ Positive-going input threshold voltage	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$		1.7	2.4	V
$V_{IT-}$ Negative-going input threshold voltage	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$	0.8	1.2		V
$V_{hys}$ Input hysteresis ( $V_{IT+} - V_{IT-}$ )		0.2	0.5	1	V
$r_i$ Input resistance	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$	3	5	7	k $\Omega$
Output leakage current	$\overline{EN} = V_{CC}$ , $0 \leq R_{OUT} \leq V_{CC}$		$\pm 0.05$	$\pm 10$	$\mu\text{A}$

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

NOTE 4: Test conditions are C1–C4 = 0.1  $\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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

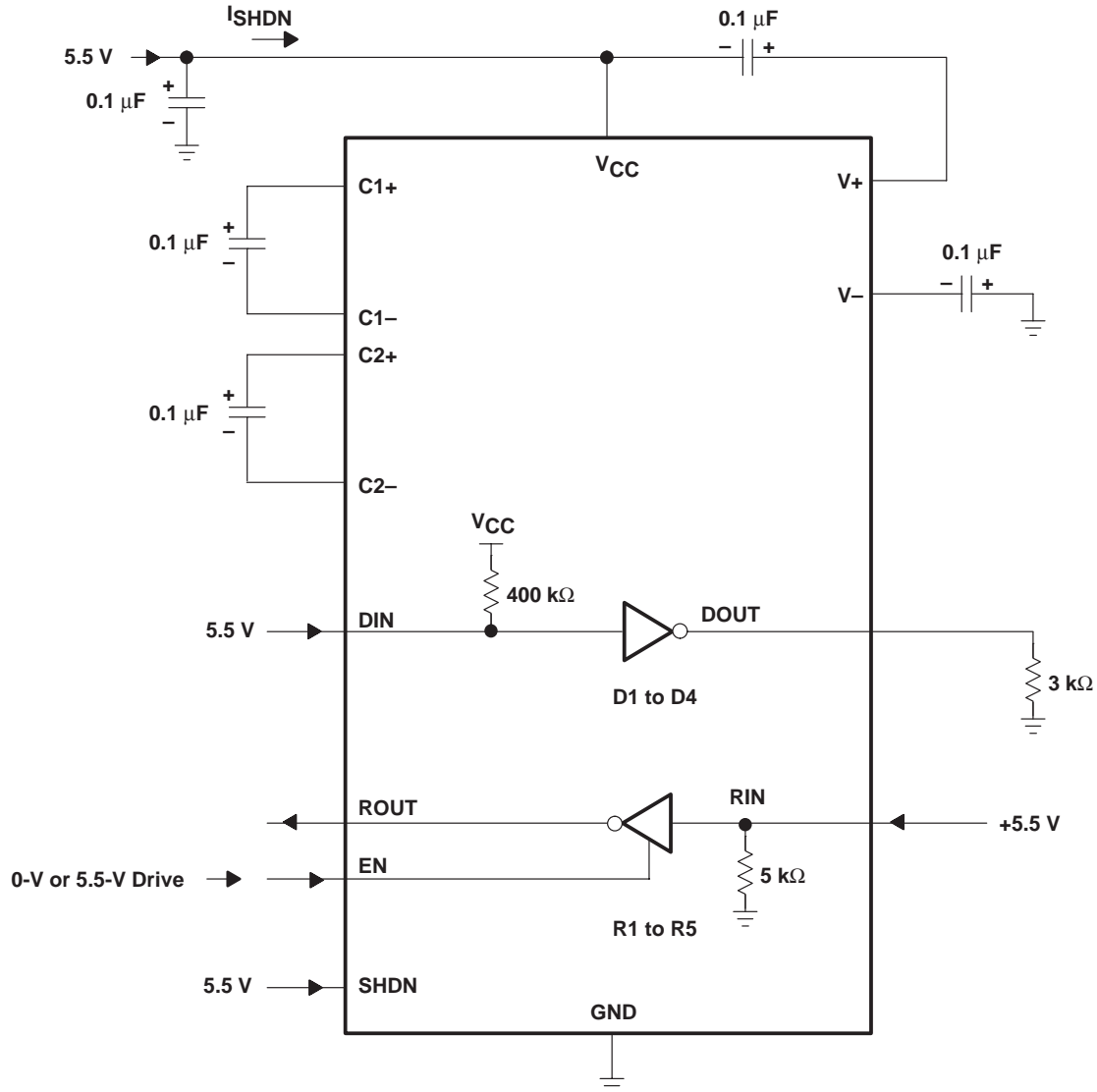
PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PLH}\text{ (R)}$ Propagation delay time, low- to high-level output	$C_L = 150\text{ pF}$ , See Figure 4		0.5	10	$\mu\text{s}$
$t_{PHL}\text{ (R)}$ Propagation delay time, high- to low-level output	$C_L = 150\text{ pF}$ , See Figure 4		0.5	10	$\mu\text{s}$
$t_{en}$ Output enable time	$C_L = 150\text{ pF}$ , $R_L = 1\text{ k}\Omega$ , See Figure 5		600		ns
$t_{dis}$ Output disable time	$C_L = 150\text{ pF}$ , $R_L = 1\text{ k}\Omega$ , See Figure 5		200		ns
$t_{sk(p)}$ Pulse skew‡	See Figure 3		300		ns

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

‡ Pulse skew is defined as  $|t_{PLH} - t_{PHL}|$  of each channel of the same device.

NOTE 4: Test conditions are C1–C4 = 0.1  $\mu\text{F}$ , at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

### PARAMETER MEASUREMENT INFORMATION



**Figure 1. Shutdown Current Test Circuit**

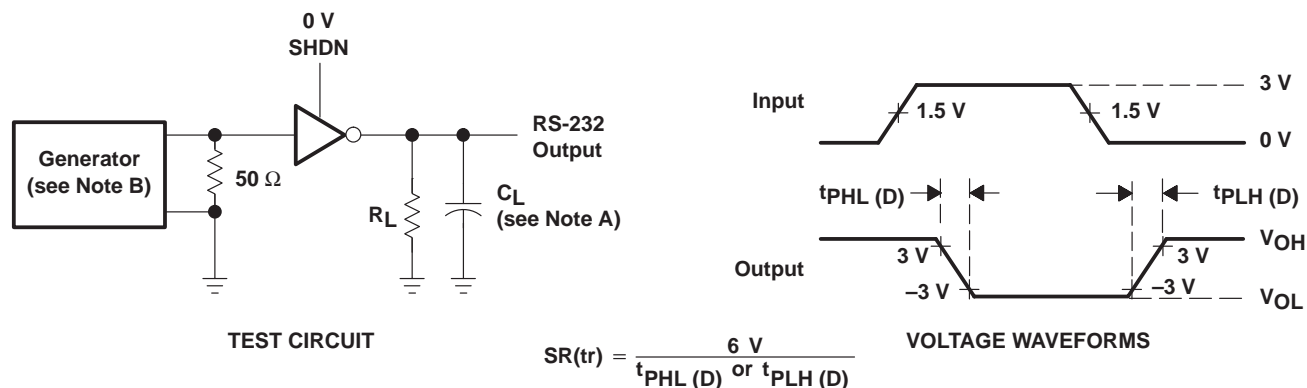
# MAX211

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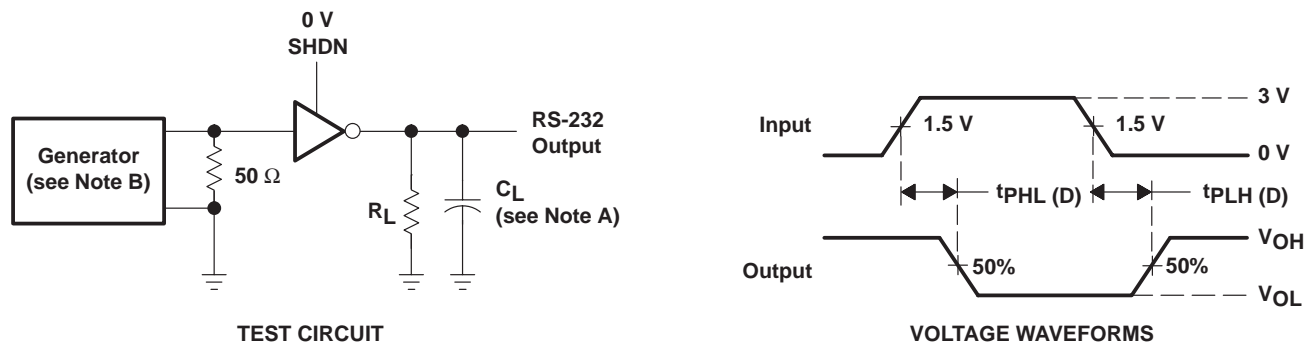
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#### PARAMETER MEASUREMENT INFORMATION



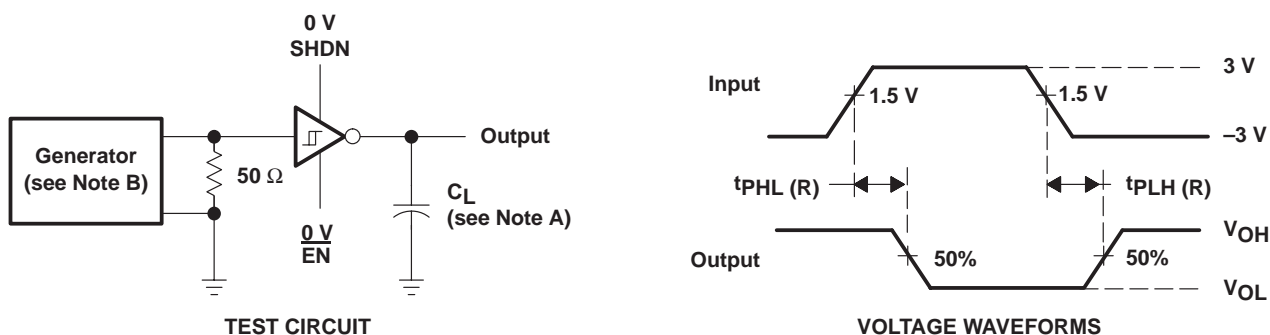
NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics: PRR = 120 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .

Figure 2. Driver Slew Rate and Propagation Delay Times



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

Figure 3. Driver Pulse Skew

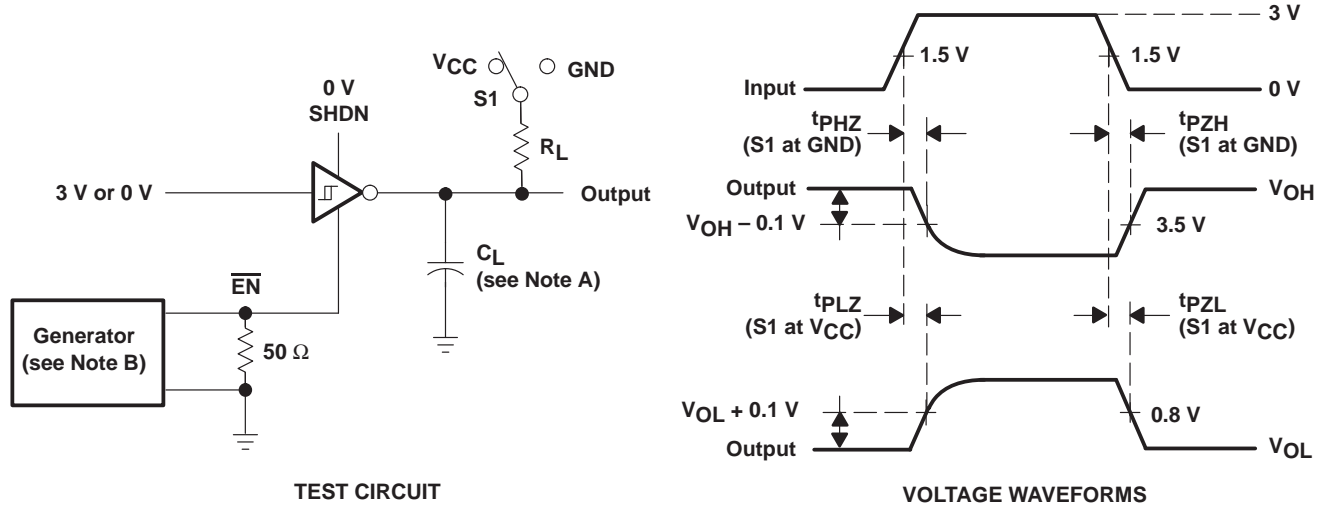


NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .

Figure 4. Receiver Propagation Delay Times



## PARAMETER MEASUREMENT INFORMATION



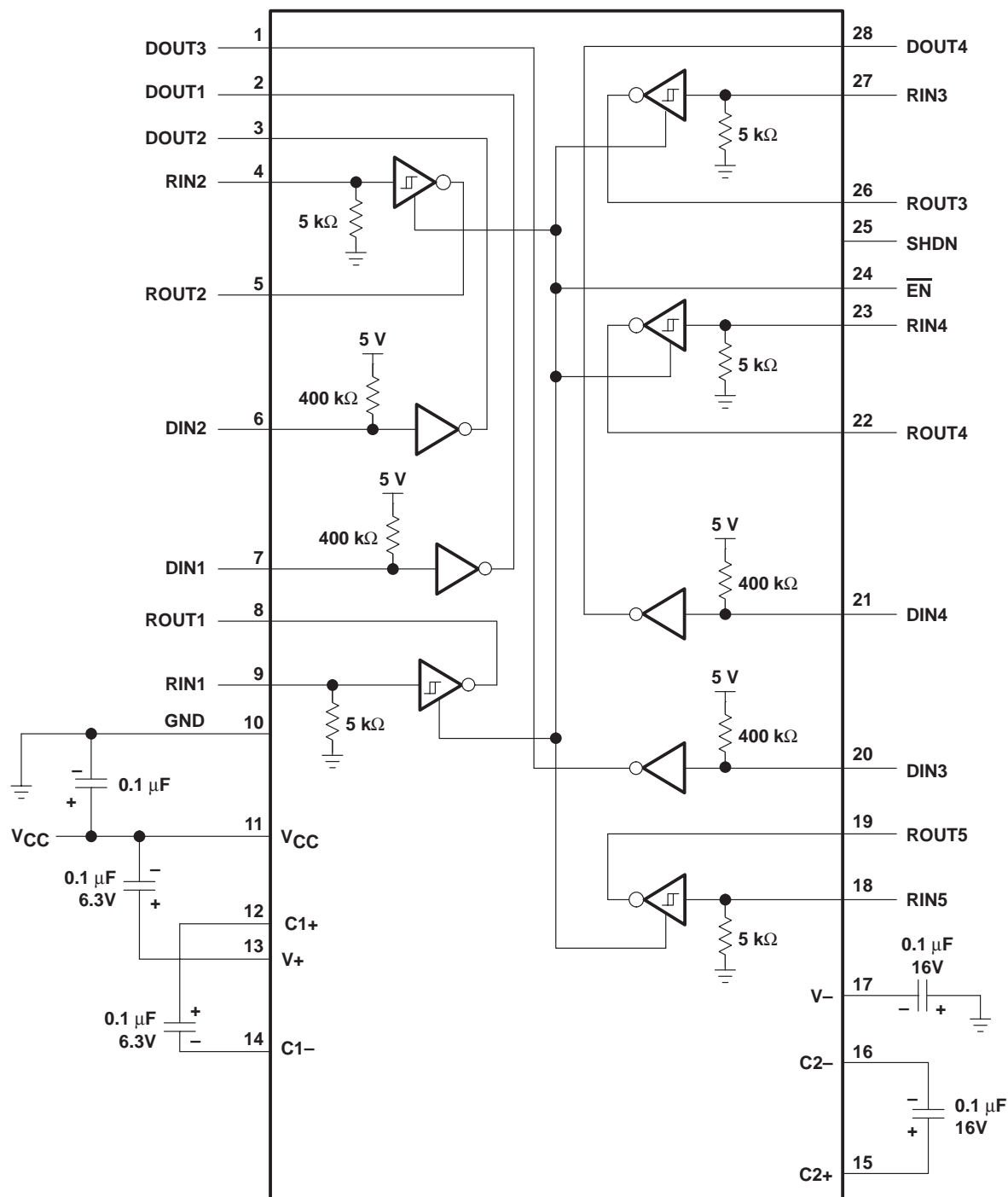
- NOTES:
- A.  $C_L$  includes probe and jig capacitance.
  - B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.
  - C.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - D.  $t_{PZL}$  and  $t_{PZH}$  are the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

**Figure 5. Receiver Enable and Disable Times**

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**APPLICATION INFORMATION**



**Figure 6. Typical Operating Circuit and Capacitor Values**

## APPLICATION INFORMATION

### capacitor selection

The capacitor type used for C1–C4 is not critical for proper operation. The MAX211 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, make sure 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<sub>CC</sub> to ground with at least 0.1  $\mu$ F. In applications sensitive to power-supply noise generated by the charge pumps, decouple V<sub>CC</sub> to ground with a capacitor the same size as (or larger than) the charge-pump capacitors (C1–C4).

### electrostatic discharge (ESD) protection

Texas Instruments MAX211 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 TI for a reliability report that documents test setup, methodology, and results.

### Human Body Model (HBM)

The HBM of ESD testing is shown in Figure 7. Figure 8 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.

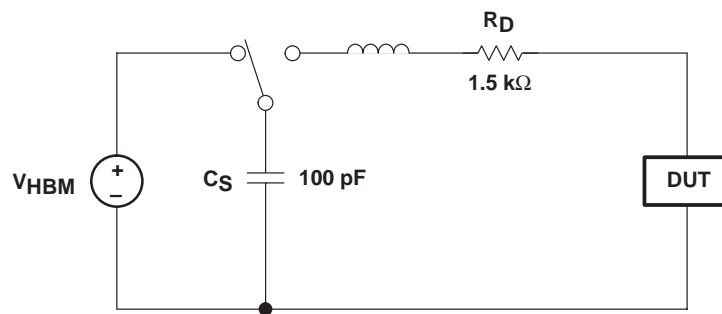
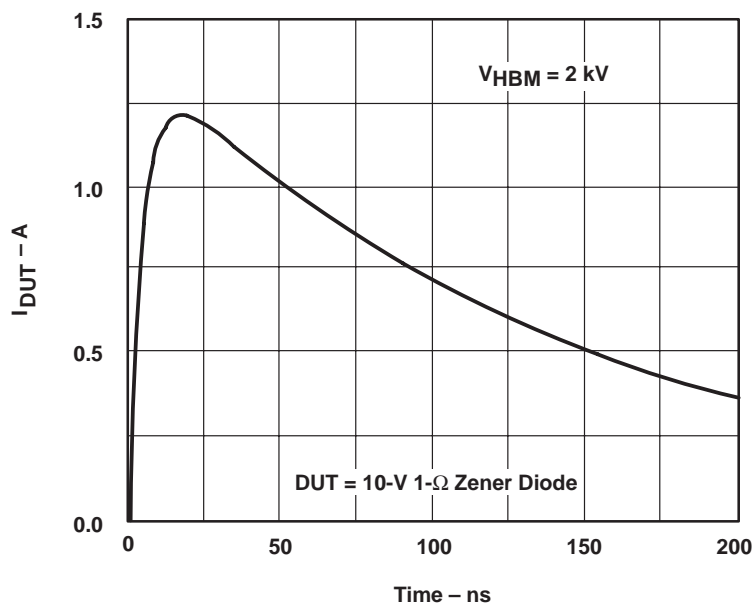


Figure 7. HBM ESD Test Circuit

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**APPLICATION INFORMATION**



**Figure 8. Typical HBM Current Waveform**

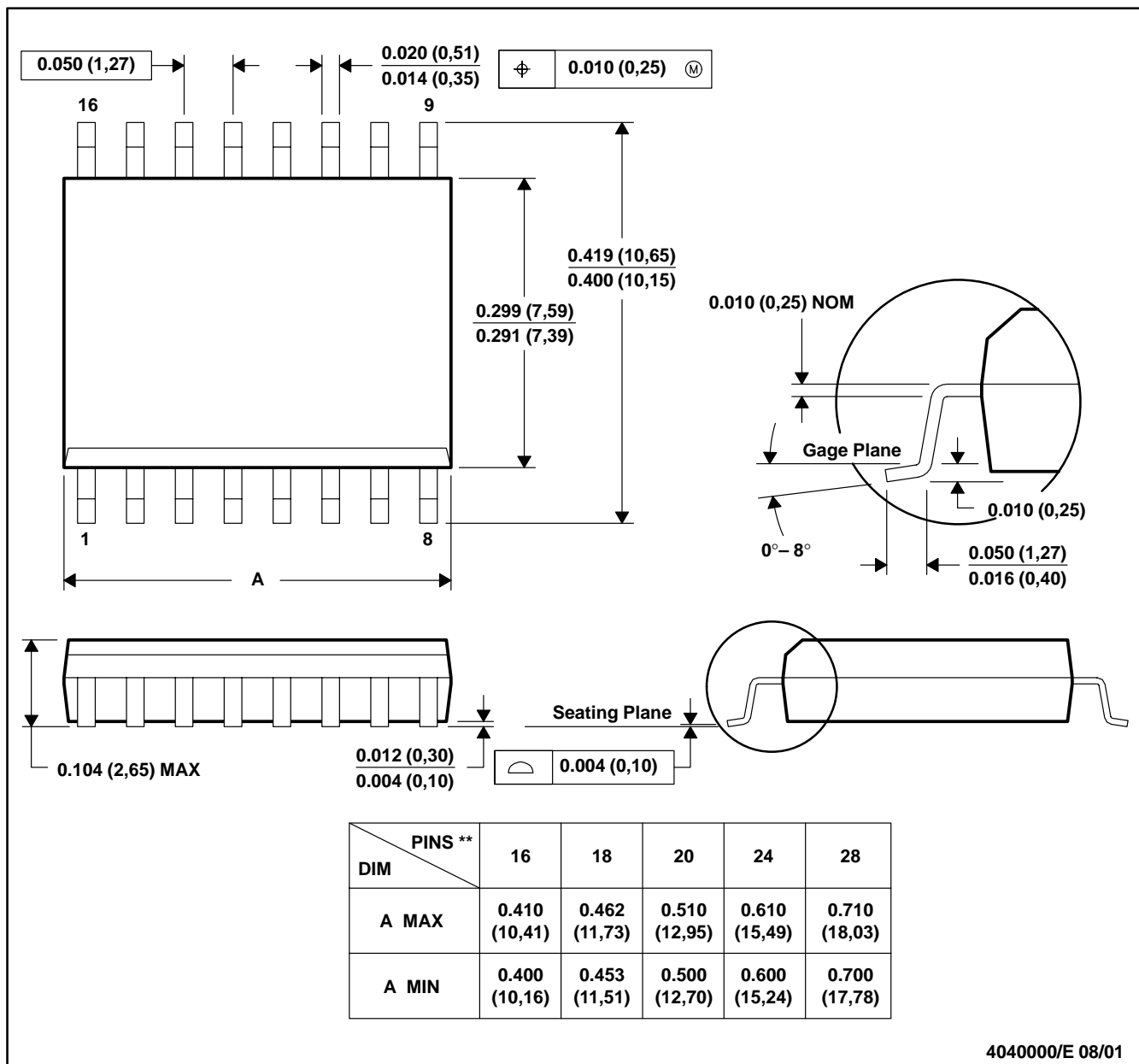
**Machine Model**

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.

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

PLASTIC SMALL-OUTLINE PACKAGE

16 PINS SHOWN

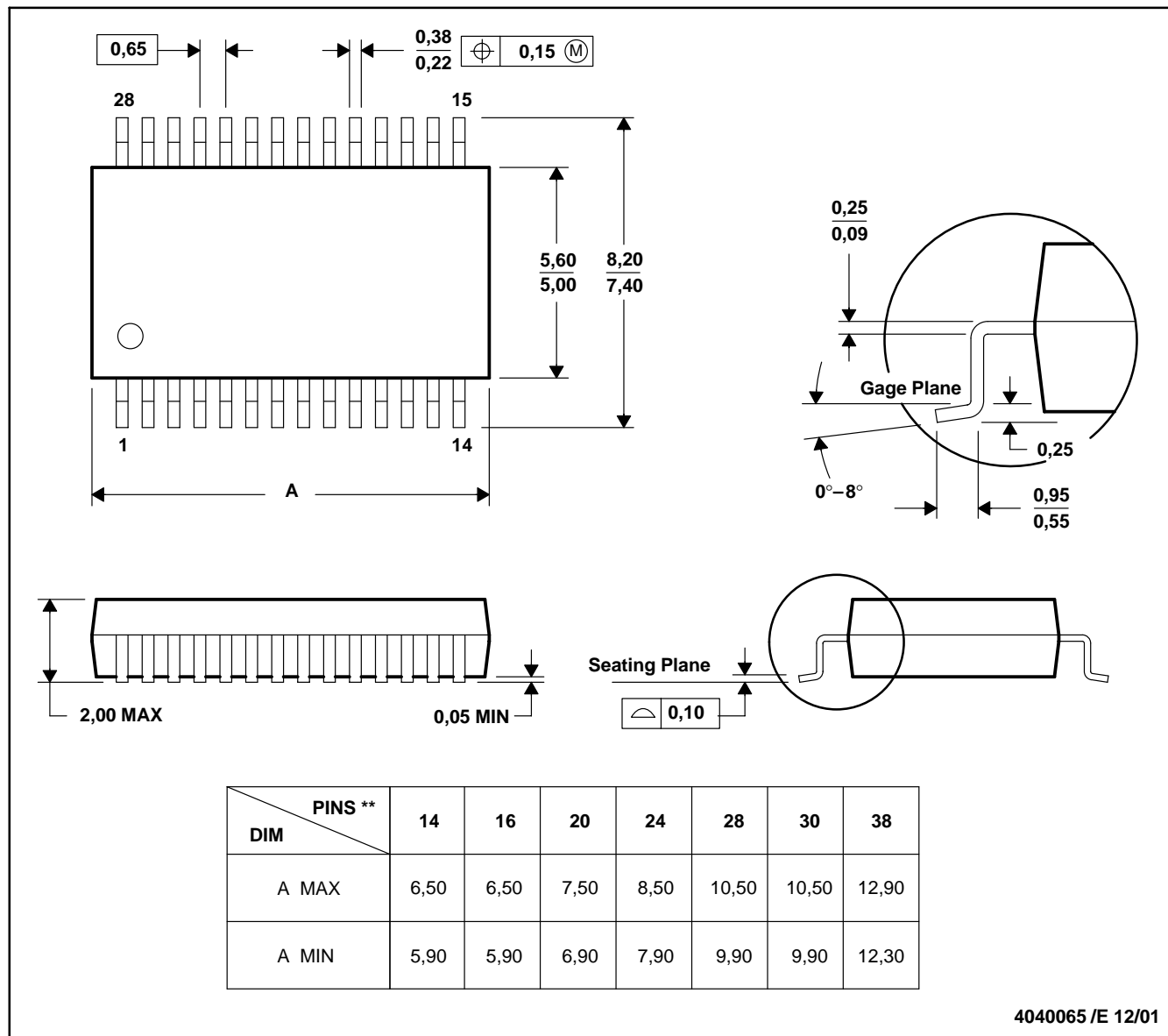


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-013

## 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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