

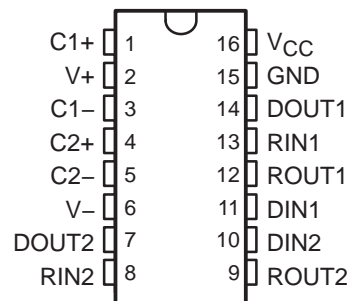
# MAX202

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

SLLS576D – JULY 2003 – REVISED JANUARY 2004

- **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**
- **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

D, DW, N, OR PW PACKAGE  
(TOP VIEW)



### description/ordering information

The MAX202 device consists of two line drivers, two 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 device operates 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 <sub>A</sub>	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube of 25	MAX202CN	MAX202C
		Tube of 40	MAX202CD	MAX202C
	SOIC (D)	Reel of 2500	MAX202CDR	
		SOIC (DW)	Tube of 40	MAX202CDW
	Reel of 2000		MAX202CDWR	
	TSSOP (PW)	Tube of 90	MAX202CPW	MAX202C
Reel of 2000		MAX202CPWR		
–40°C to 85°C	PDIP (N)	Tube of 25	MAX202IN	MAX202I
		Tube of 40	MAX202ID	MAX202I
	SOIC (D)	Reel of 2500	MAX202IDR	
		SOIC (DW)	Tube of 40	MAX202IDW
	Reel of 2000		MAX202IDWR	
	TSSOP (PW)	Tube of 90	MAX202IPW	MAX202I
Reel of 2000		MAX202IPWR		

† 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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**Function Tables**

**EACH DRIVER**

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

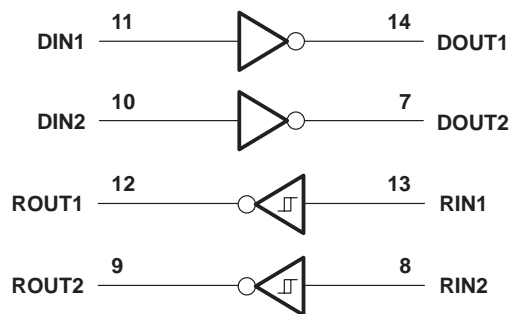
H = high level, L = low level

**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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### 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
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): D package	73°C/W
DW package	57°C/W
N package	67°C/W
PW package	108°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.

### 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	2			V
$V_{IL}$	Driver low-level input voltage			0.8	V
$V_I$	Driver input voltage	0		5.5	V
	Receiver input voltage	–30		30	
$T_A$	Operating free-air temperature	MAX202C		0	°C
		MAX202I		–40	

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 and Figure 4)

PARAMETER		TEST CONDITIONS		MIN	TYP <sup>‡</sup>	MAX	UNIT
$I_{CC}$	Supply current	No load, $V_{CC} = 5$ V			8	15	mA

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

NOTE 4: 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 4 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> ‡	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

† All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 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 4: 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 4 and Figure 4)**

PARAMETER		TEST CONDITIONS	MIN	TYP†	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, R <sub>L</sub> = 3 kΩ, All drivers loaded, See Figure 1		2		μs
t <sub>PHL</sub> (D)	Propagation delay time, high- to low-level output	C <sub>L</sub> = 2500 pF, R <sub>L</sub> = 3 kΩ, All drivers loaded, See Figure 1		2		μs
t <sub>sk(p)</sub>	Pulse skew§	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 1000 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, V <sub>CC</sub> = 5 V	3	6	30	V/μs

† 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 4: 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



## RECEIVER 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 <sub>OH</sub> High-level output voltage	I <sub>OH</sub> = -1 mA	3.5V	V <sub>CC</sub> -0.4 V		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> )		0.2	0.5	1	V
r <sub>i</sub> Input resistance	V <sub>I</sub> = ±3 V to ±25 V	3	5	7	kΩ

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

NOTE 4: 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 4 and Figure 3)**

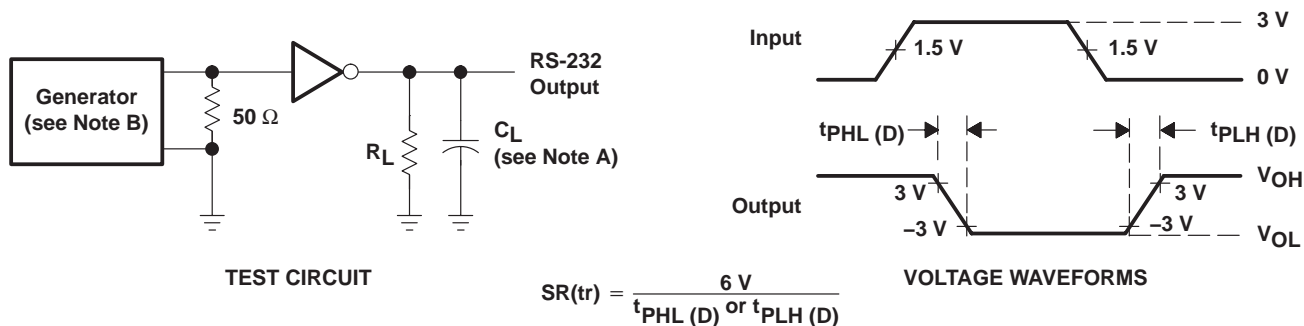
PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t <sub>PLH</sub> (R) Propagation delay time, low- to high-level output	C <sub>L</sub> = 150 pF		0.5	10	μs
t <sub>PHL</sub> (R) Propagation delay time, high- to low-level output	C <sub>L</sub> = 150 pF		0.5	10	μs
t <sub>sk(p)</sub> Pulse skew‡			300		ns

† 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 4: 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.

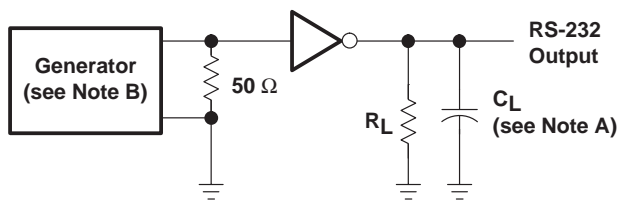
B. The pulse generator has the following characteristics: PRR = 120 kbit/s, Z<sub>O</sub> = 50 Ω, 50% duty cycle, t<sub>r</sub> ≤ 10 ns, t<sub>f</sub> ≤ 10 ns.

**Figure 1. Driver Slew Rate**

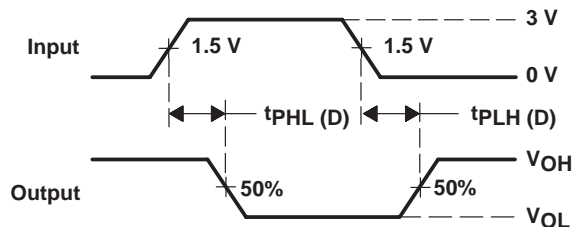
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**WITH  $\pm 15$ -kV ESD PROTECTION**

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**PARAMETER MEASUREMENT INFORMATION**



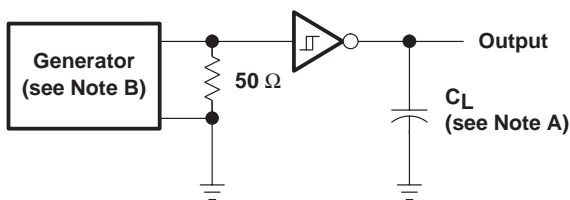
**TEST CIRCUIT**



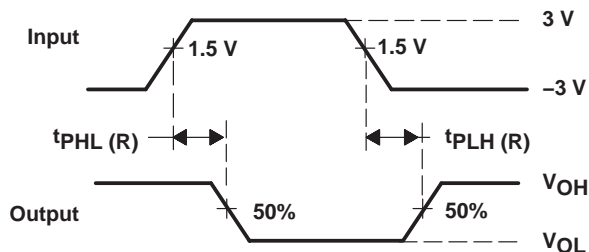
**VOLTAGE WAVEFORMS**

- 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**

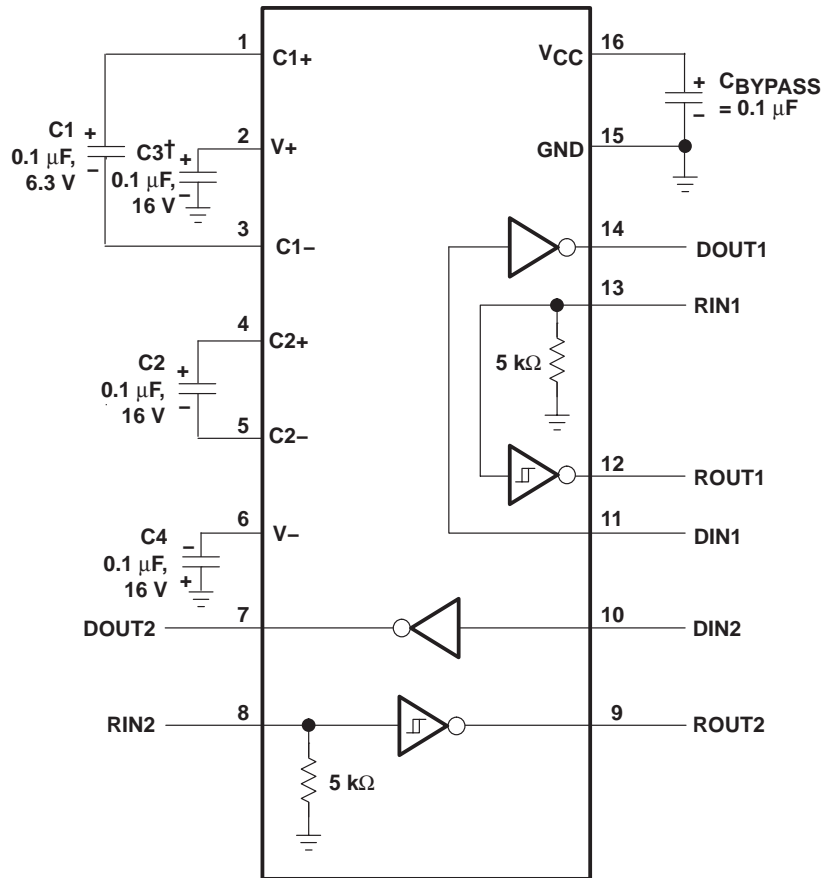


**VOLTAGE WAVEFORMS**

- 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**

**APPLICATION INFORMATION**



† C3 can be connected to  $V_{CC}$  or GND.

NOTES: A. Resistor values shown are nominal.

B. Nonpolarized 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**

# MAX202

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### WITH $\pm 15$ -kV ESD PROTECTION

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## APPLICATION INFORMATION

### capacitor selection

The capacitor type used for C1–C4 is not critical for proper operation. The MAX202 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  $V_{CC}$  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

TI MAX202 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

Stringent ESD testing is 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 5. 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 device under test (DUT) through a 1.5-k $\Omega$  resistor.

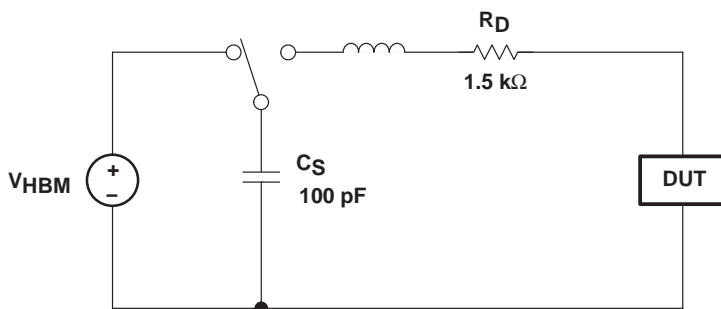


Figure 5. HBM ESD Test Circuit



APPLICATION INFORMATION

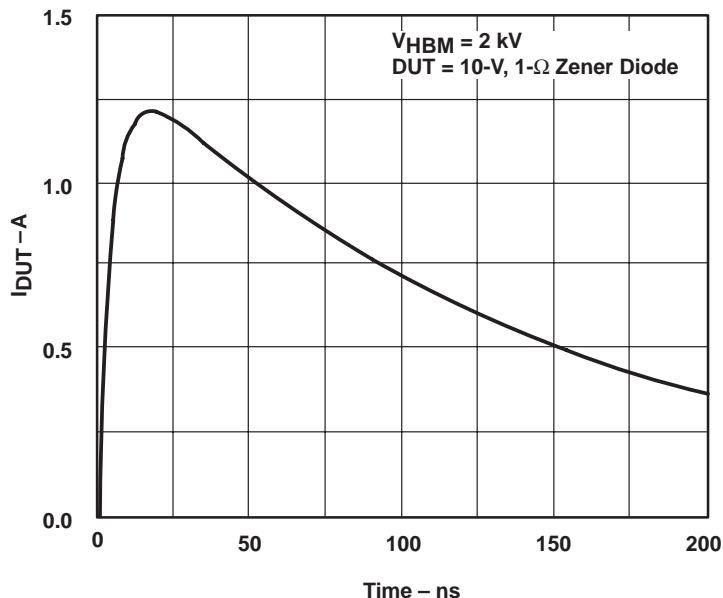


Figure 6. Typical HBM Current Waveform

Machine Model (MM)

The 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>
MAX202CD	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX202CDR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX202CDW	ACTIVE	SOIC	DW	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX202CDWR	ACTIVE	SOIC	DW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX202CPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX202CPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX202ID	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX202IDR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX202IDW	ACTIVE	SOIC	DW	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX202IDWR	ACTIVE	SOIC	DW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX202IPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX202IPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM

<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.

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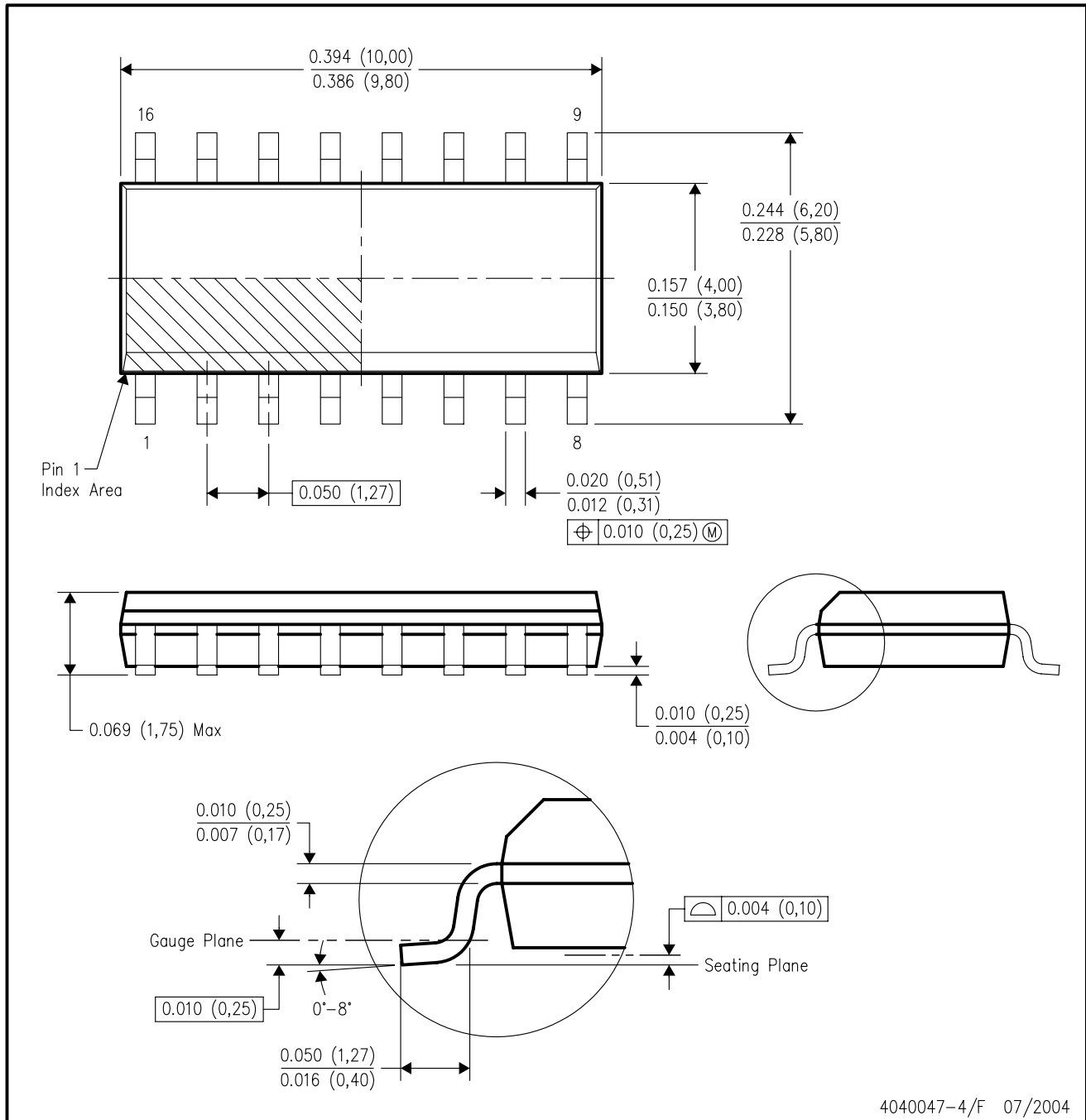
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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D (R-PDSO-G16)

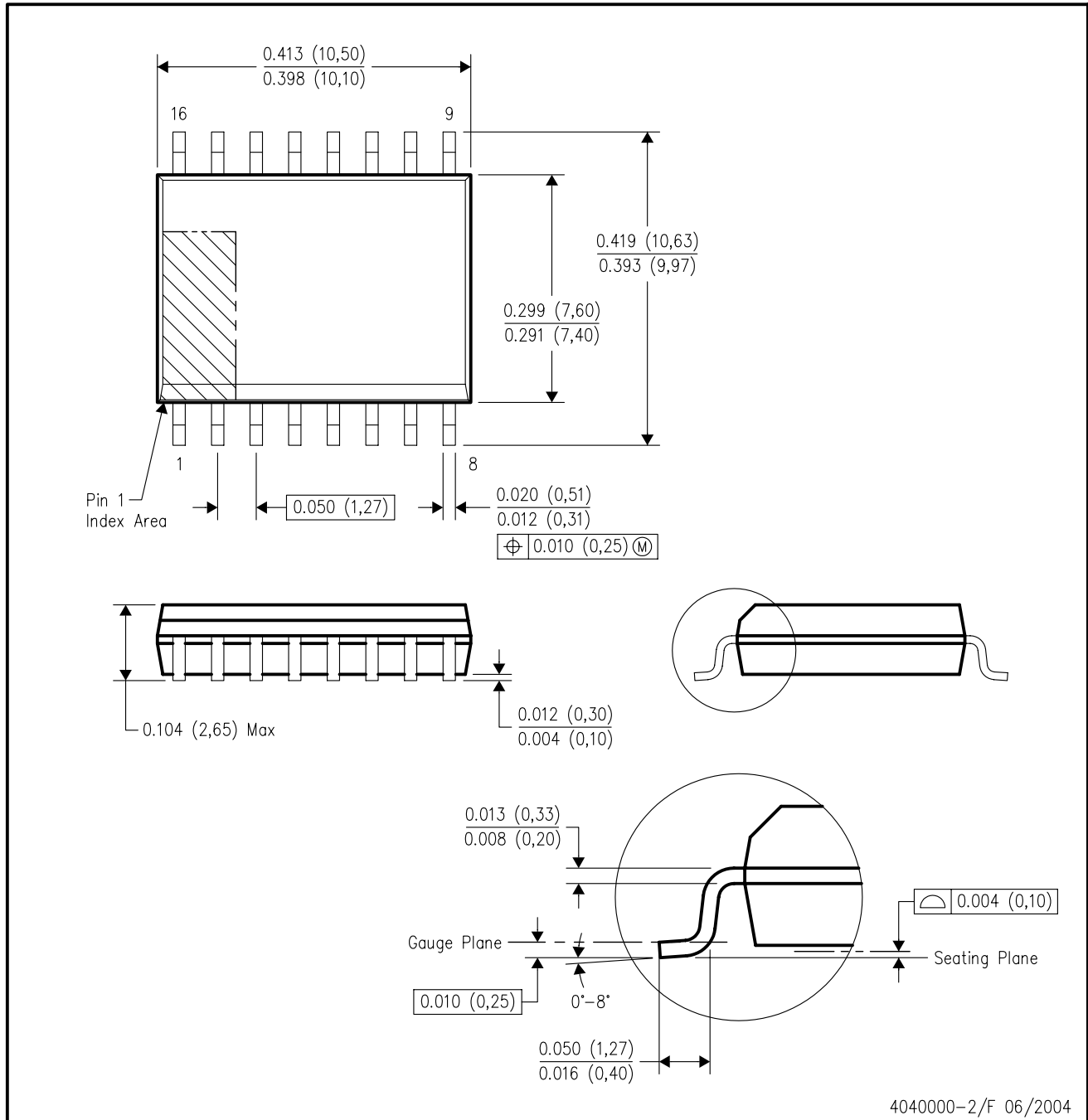
PLASTIC SMALL-OUTLINE PACKAGE



- 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-012 variation AC.

DW (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040000-2/F 06/2004

- 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 AA.

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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-153

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