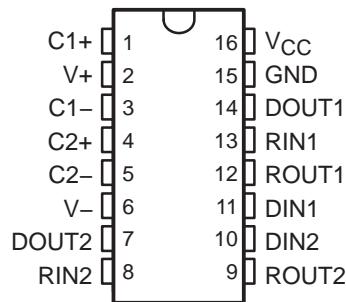


MAX202
5-V DUAL RS-232 LINE DRIVER/RECEIVER
WITH $\pm 15\text{-kV}$ ESD PROTECTION
SLLS576D – JULY 2003 – REVISED JANUARY 2004

- **ESD Protection for RS-232 Bus Pins**
 - $\pm 15\text{-kV}$ – 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 $\pm 15\text{-kV}$ 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/ μs driver output slew rate.

ORDERING INFORMATION

TA	PACKAGE [†]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube of 25	MAX202CN	MAX202C
	SOIC (D)	Tube of 40	MAX202CD	MAX202C
		Reel of 2500	MAX202CDR	
	SOIC (DW)	Tube of 40	MAX202CDW	MAX202C
		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
	SOIC (D)	Tube of 40	MAX202ID	MAX202I
		Reel of 2500	MAX202IDR	
	SOIC (DW)	Tube of 40	MAX202IDW	MAX202I
		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.



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MAX202

5-V DUAL RS-232 LINE DRIVER/RECEIVER

WITH $\pm 15\text{-kV}$ ESD PROTECTION

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Function Tables

EACH DRIVER

INPUT DIN	OUTPUT DOUT
L	H
H	L

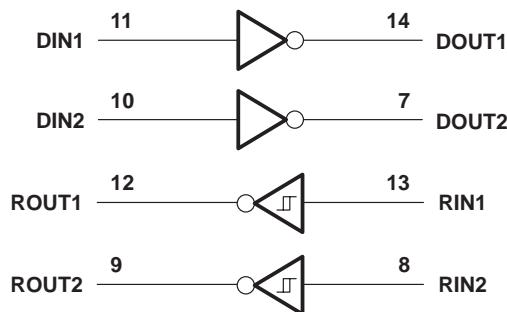
H = high level, L = low level

EACH RECEIVER

INPUT RIN	OUTPUT ROUT
L	H
H	L
Open	H

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

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

† 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 $T_J(\max)$, θ_{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
VIH	Driver high-level input voltage	DIN	2			V
VIL	Driver low-level input voltage	DIN			0.8	V
VI	Driver input voltage	DIN	0		5.5	V
	Receiver input voltage		-30		30	
TA	Operating free-air temperature		MAX202C	0	70	°C
			MAX202I	-40	85	

NOTE 4: Test conditions are C1–C4 = 0.1 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 4 and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP [‡]	MAX	UNIT
I _{CC}	Supply current	No load, V _{CC} = 5 V		8	15	mA

[‡] 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 μ F at $V_{CC} = 5$ V \pm 0.5 V.

MAX202**5-V DUAL RS-232 LINE DRIVER/RECEIVER****WITH $\pm 15\text{-kV}$ ESD PROTECTION**

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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_{OH}	High-level output voltage D_{OUT} at $R_L = 3\text{ k}\Omega$ to GND, $D_{IN} = \text{GND}$	5	9		V
V_{OL}	Low-level output voltage D_{OUT} at $R_L = 3\text{ k}\Omega$ to GND, $D_{IN} = V_{CC}$	-5	-9		V
I_{IH}	High-level input current $V_I = V_{CC}$		15	200	μA
I_{IL}	Low-level input current V_I at 0 V		-15	-200	μA
I_{OS}^{\ddagger}	Short-circuit output current $V_{CC} = 5.5\text{ V}$, $V_O = 0\text{ V}$		± 10	± 60	mA
r_o	Output resistance V_{CC} , V_+ , and $V_- = 0\text{ V}$, $V_O = \pm 2\text{ V}$	300			Ω

† 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 $C1\text{--}C4 = 0.1\text{ }\mu\text{F}$ 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 and Figure 4)**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Maximum data rate	$C_L = 50\text{ to}1000\text{ pF}$, $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, One D_{OUT} switching, See Figure 1	120			kbit/s
$t_{PLH}(\text{D})$	$C_L = 2500\text{ pF}$, $R_L = 3\text{ k}\Omega$, All drivers loaded, See Figure 1		2		μs
$t_{PHL}(\text{D})$	$C_L = 2500\text{ pF}$, $R_L = 3\text{ k}\Omega$, All drivers loaded, See Figure 1		2		μs
$t_{sk(p)}$	$C_L = 150\text{ pF}$ to 2500 pF , $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, See Figure 2	300			ns
$SR(\text{tr})$	Slew rate, transition region (see Figure 1)	3	6	30	$\text{V}/\mu\text{s}$

† 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 $C1\text{--}C4 = 0.1\text{ }\mu\text{F}$ at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.**ESD protection**

PIN	TEST CONDITIONS	TYP	UNIT
D_{OUT} , R_{IN}	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_{OH}	High-level output voltage	$I_{OH} = -1\text{ mA}$	3.5V	$V_{CC} - 0.4\text{ V}$		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	$V_I = \pm 3\text{ V}$ to $\pm 25\text{ V}$	3	5	7	$\text{k}\Omega$

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

NOTE 4: Test conditions are $C1-C4 = 0.1\text{ }\mu\text{F}$ 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 and Figure 3)

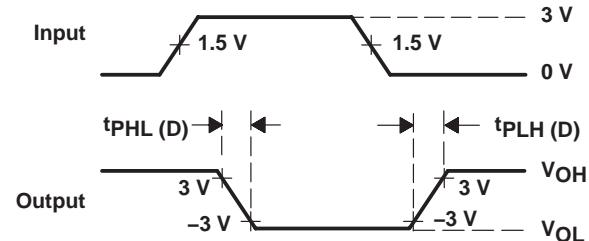
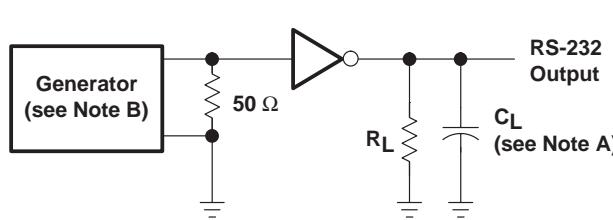
PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PLH}(R)$	Propagation delay time, low- to high-level output	$C_L = 150\text{ pF}$		0.5	10	μs
$t_{PHL}(R)$	Propagation delay time, high- to low-level output	$C_L = 150\text{ pF}$		0.5	10	μs
$t_{sk(p)}$	Pulse skew†			300		ns

† 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 $C1-C4 = 0.1\text{ }\mu\text{F}$, at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.

PARAMETER MEASUREMENT INFORMATION



$$SR(tr) = \frac{6\text{ V}}{t_{PHL}(D) \text{ or } t_{PLH}(D)}$$

NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 120 kbit/s, $Z_0 = 50\text{ }\Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 1. Driver Slew Rate

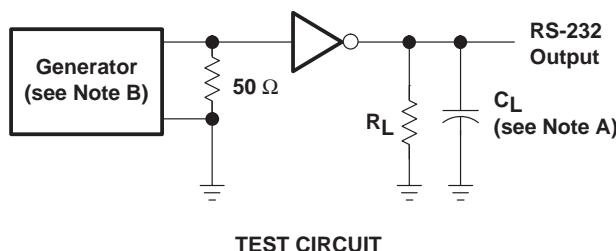
MAX202

5-V DUAL RS-232 LINE DRIVER/RECEIVER

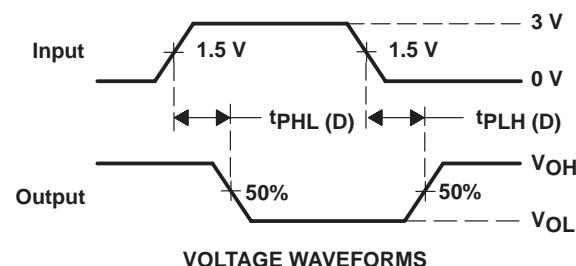
WITH $\pm 15\text{-kV}$ ESD PROTECTION

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PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

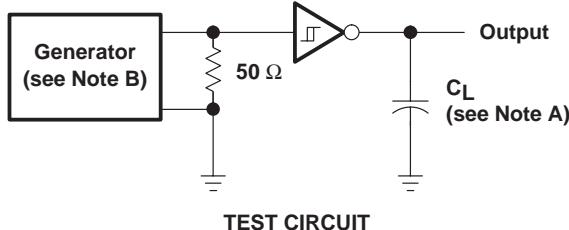


VOLTAGE WAVEFORMS

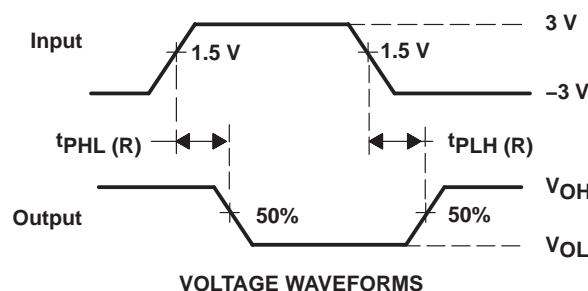
NOTES: A. C_L includes probe and jig capacitance.

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

Figure 2. Driver Pulse Skew



TEST CIRCUIT



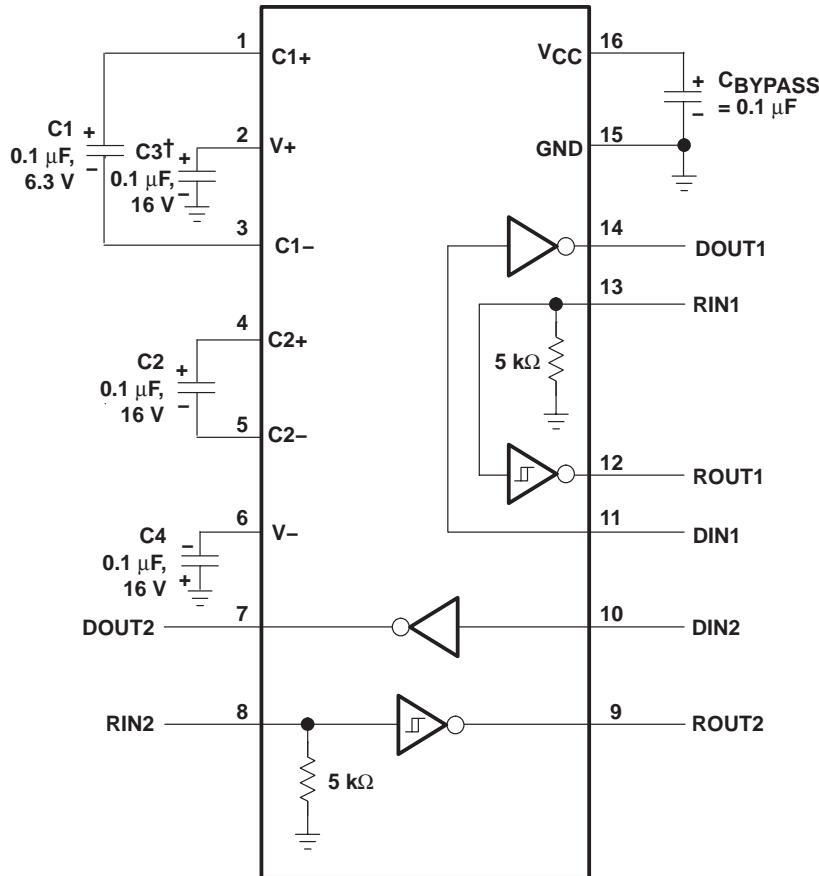
VOLTAGE WAVEFORMS

NOTES: A. C_L includes probe and jig capacitance.

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

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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APPLICATION INFORMATION

capacitor selection

The capacitor type used for C1–C4 is not critical for proper operation. The MAX202 requires 0.1- μF capacitors, although capacitors up to 10 μF can be used without harm. Ceramic dielectrics are suggested for the 0.1- μF 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 μF) to reduce the output impedance at V+ and V-.

Bypass V_{CC} to ground with at least 0.1 μF . 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 $\pm 15\text{-kV}$ 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 Ω resistor.

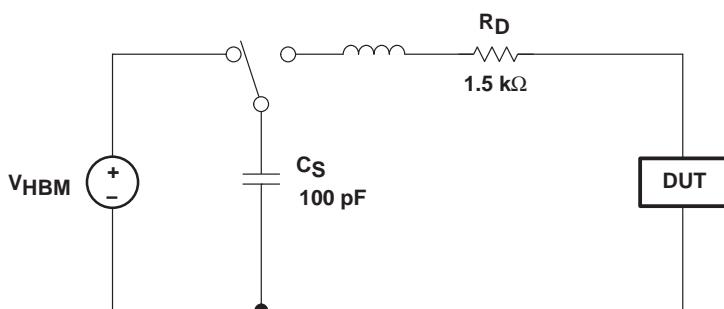


Figure 5. HBM ESD Test Circuit

APPLICATION INFORMATION

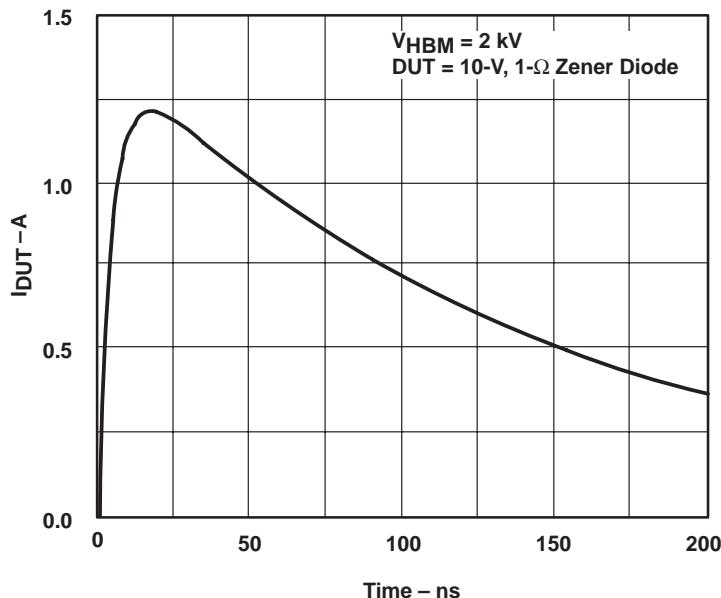


Figure 6. Typical HBM Current Waveform

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 ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
MAX202CD	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDWE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CDWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202CPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202ID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDW	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDWE4	ACTIVE	SOIC	DW	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDWR	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IDWRE4	ACTIVE	SOIC	DW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX202IPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ 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.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

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 (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

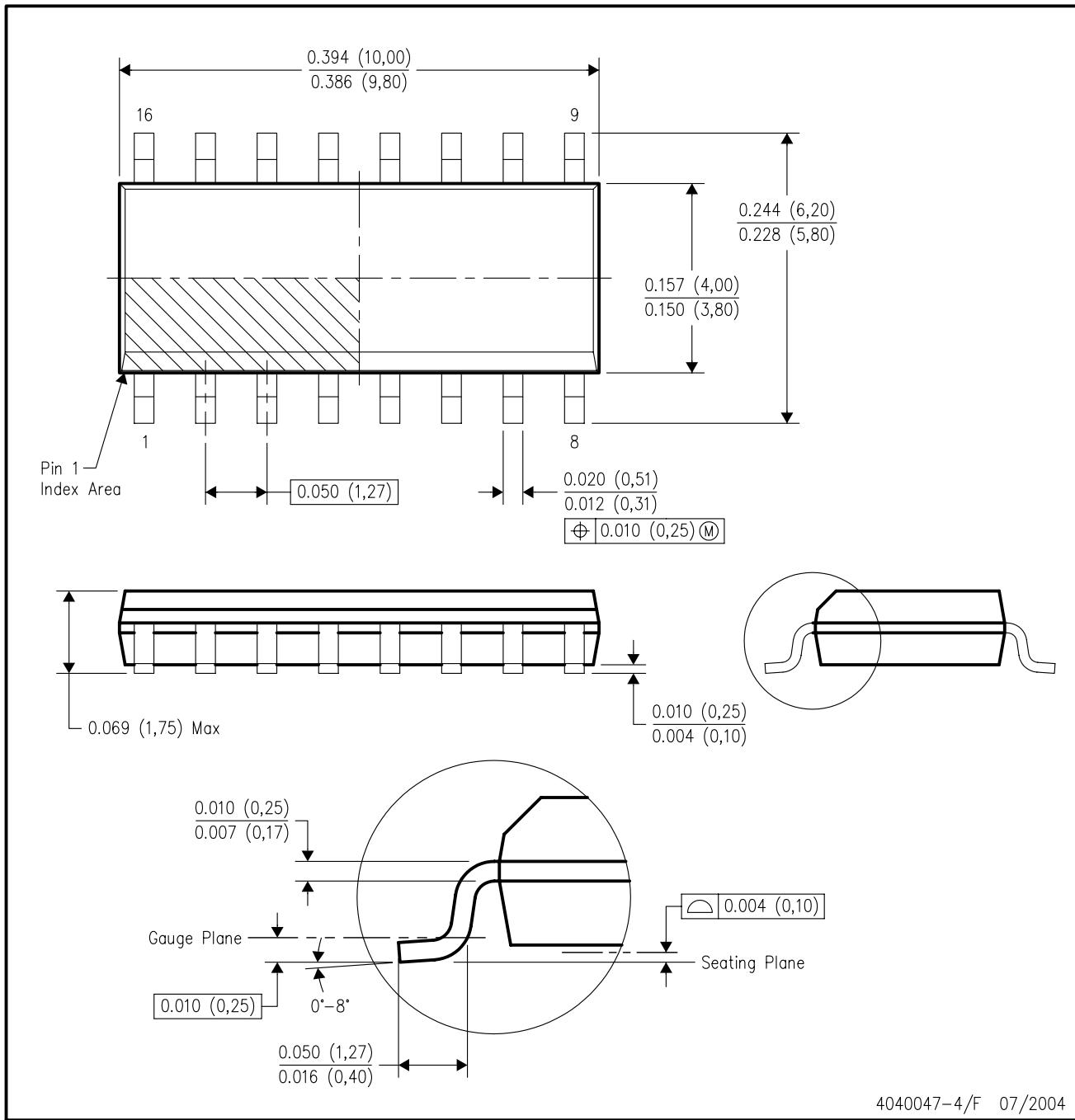
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE

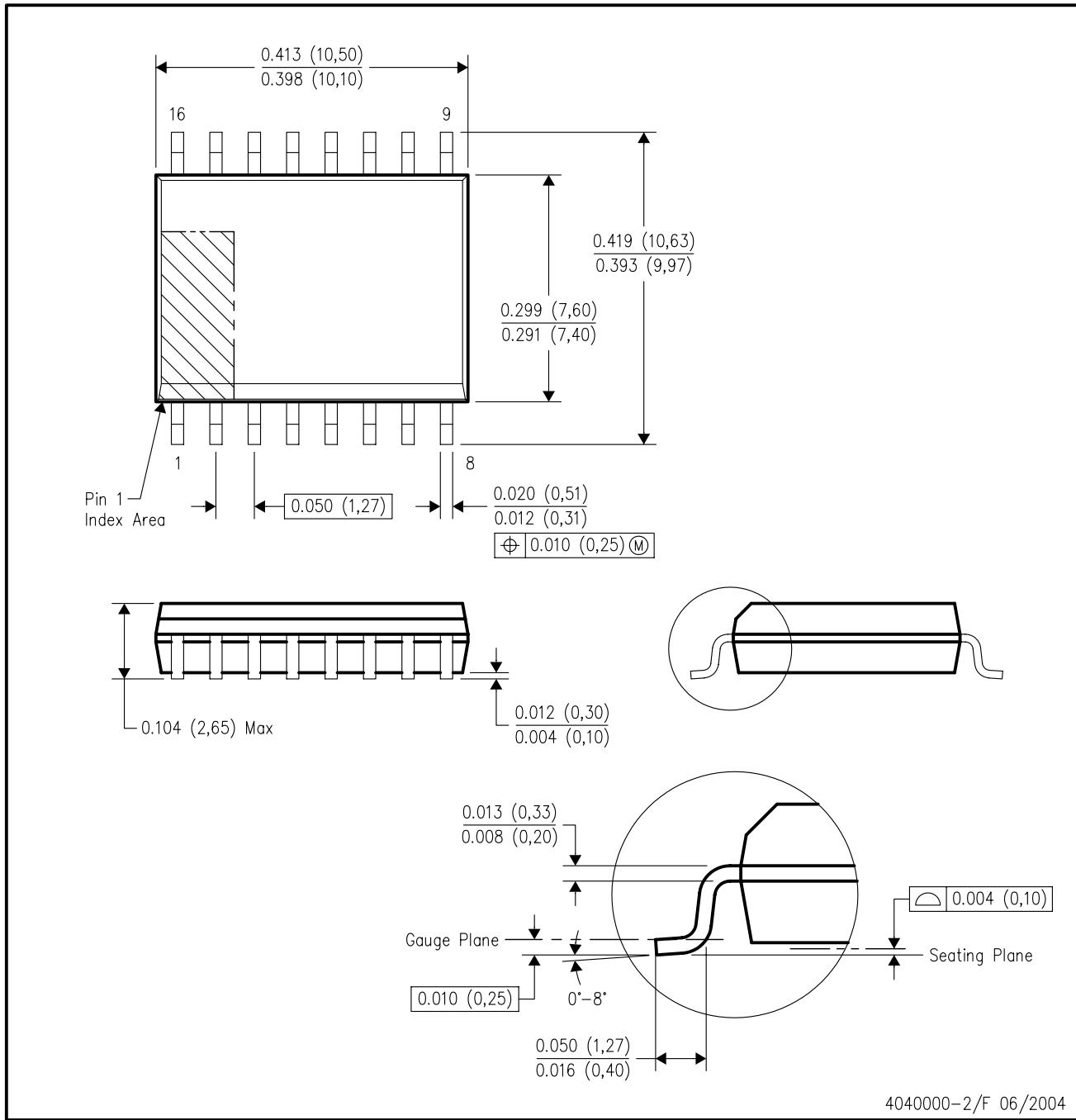


NOTES:

- All linear dimensions are in inches (millimeters).
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- Falls within JEDEC MS-012 variation AC.

DW (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



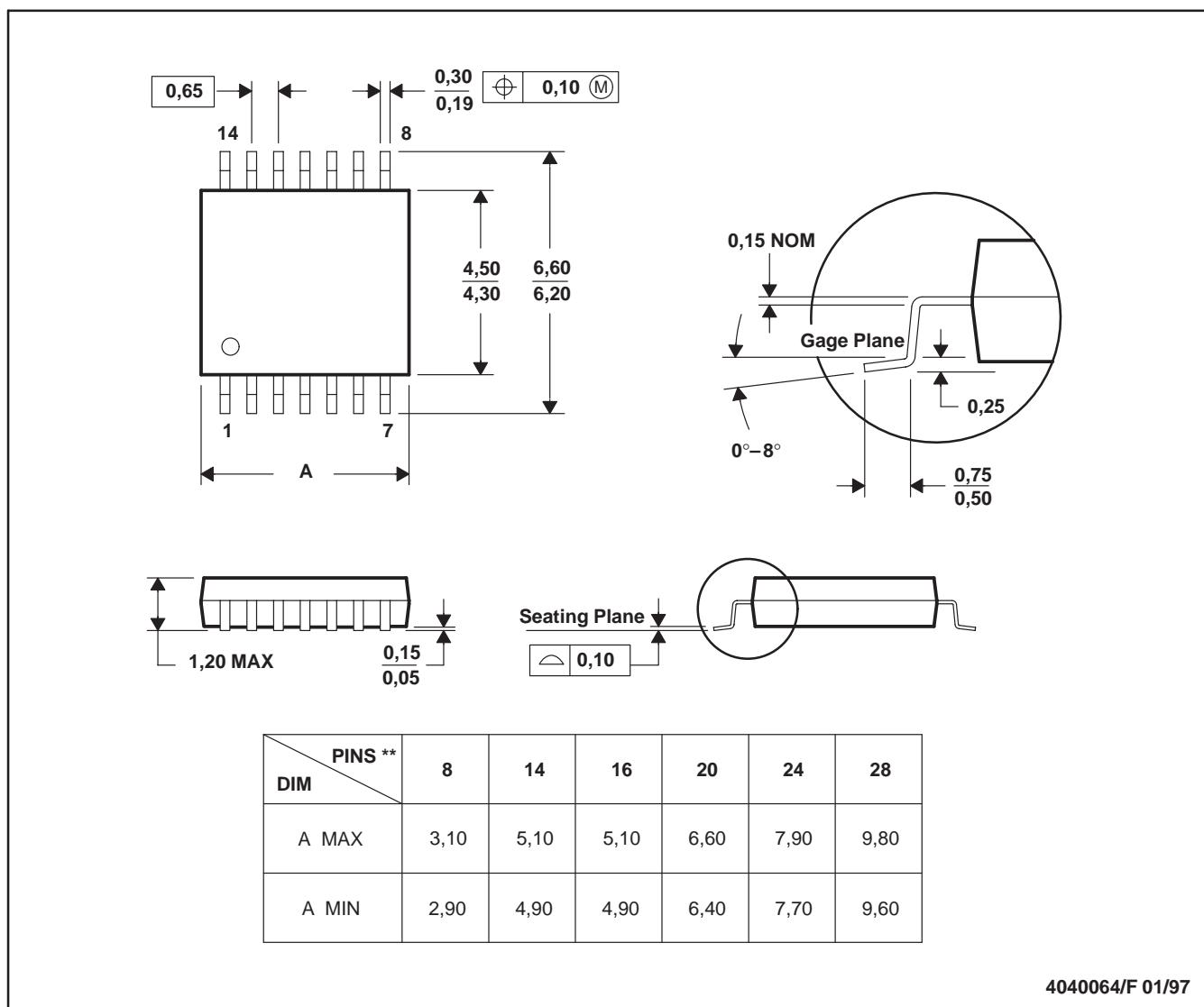
NOTES:

- All linear dimensions are in inches (millimeters).
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).
- Falls within JEDEC MS-013 variation AA.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



NOTES:

- All linear dimensions are in millimeters.
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0,15.
- Falls within JEDEC MO-153

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