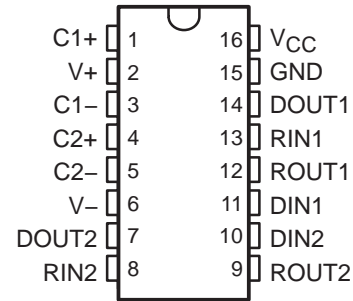


3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

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- RS-232 Bus-Pin ESD Protection Exceeds ±15 kV Using Human-Body Model (HBM)
- 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
- Operates Up To 250 kbit/s
- Two Drivers and Two Receivers
- Low Supply Current . . . 300 μA Typical
- External Capacitors . . . 4 × 0.1 μF
- Accepts 5-V Logic Input With 3.3-V Supply
- Alternative High-Speed Pin-Compatible Device (1 Mbit/s)
 - SNx5C3232
- Applications
 - Battery-Powered Systems, PDAs, Notebooks, Laptops, Palmtop PCs, and Hand-Held Equipment

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



description/ordering information

ORDERING INFORMATION

T _A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	SOIC (D)	Tube of 40	MAX3232CD	MAX3232C
		Reel of 2500	MAX3232CDR	
	SOIC (DW)	Tube of 40	MAX3232CDW	MAX3232C
		Reel of 2000	MAX3232CDWR	
	SSOP (DB)	Tube of 80	MAX3232CDB	MA3232C
		Reel of 2000	MAX3232CDBR	
TSSOP (PW)	Tube of 90	MAX3232CPW	MA3232C	
	Reel of 2000	MAX3232CPWR		
–40°C to 85°C	SOIC (D)	Tube of 40	MAX3232ID	MAX3232I
		Reel of 2500	MAX3232IDR	
	SOIC (DW)	Tube of 40	MAX3232IDW	MAX3232I
		Reel of 2000	MAX3232IDWR	
	SSOP (DB)	Tube of 80	MAX3232IDB	MB3232I
		Reel of 2000	MAX3232IDBR	
	TSSOP (PW)	Tube of 90	MAX3232IPW	MB3232I
		Reel of 2000	MAX3232IPWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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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MAX3232

3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

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description/ordering information (continued)

The MAX3232 device consists of two line drivers, two 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 an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. The devices operate at data signaling rates up to 250 kbit/s and a maximum of 30-V/μs driver output slew rate.

Function Tables

EACH DRIVER

INPUT DIN	OUTPUT DOUT
L	H
H	L

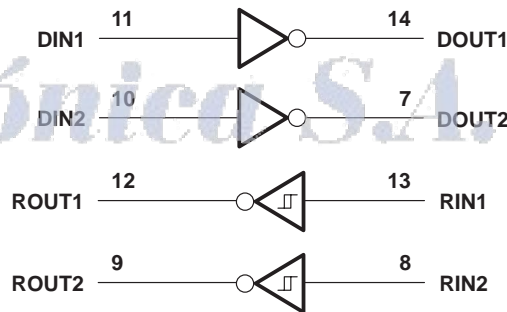
H = high level, L = low level

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)



**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER
WITH ±15-kV ESD PROTECTION**

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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 : Drivers	–0.3 V to 6 V
Receivers	–25 V to 25 V
Output voltage range, V_O : Drivers	–13.2 V to 13.2 V
Receivers	–0.3 V to $V_{CC} + 0.3$ V
Package thermal impedance, θ_{JA} (see Notes 2 and 3): D package	73°C/W
DB package	82°C/W
DW package	57°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

† 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		$V_{CC} = 3.3$ V	3	3.3	3.6	V
		$V_{CC} = 5$ V	4.5	5	5.5	
V_{IH}	Driver high-level input voltage	DIN	$V_{CC} = 3.3$ V	2		V
			$V_{CC} = 5$ V	2.4		
V_{IL}	Driver low-level input voltage	DIN			0.8	V
V_I	Driver input voltage	DIN	0		5.5	V
	Receiver input voltage		–25		25	
T_A	Operating free-air temperature	MAX3232C	0		70	°C
		MAX3232I	–40		85	

NOTE 4: Test conditions are C1–C4 = 0.1 μ F at $V_{CC} = 3.3$ V \pm 0.3 V; C1 = 0.047 μ F, 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 4 and Figure 4)

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
I_{CC} Supply current	No load, $V_{CC} = 3.3$ V or 5 V		0.3	1	mA

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

NOTE 4: Test conditions are C1–C4 = 0.1 μ F at $V_{CC} = 3.3$ V \pm 0.3 V; C1 = 0.047 μ F, C2–C4 = 0.33 μ F at $V_{CC} = 5$ V \pm 0.5 V.



MAX3232**3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER****WITH ± 15 -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	DOUT at $R_L = 3\text{ k}\Omega$ to GND, DIN = GND	5	5.4		V
V_{OL} Low-level output voltage	DOUT at $R_L = 3\text{ k}\Omega$ to GND, DIN = V_{CC}	-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}^\ddagger Short-circuit output current	$V_{CC} = 3.6\text{ V}$, $V_O = 0\text{ V}$		± 35	± 60	mA
	$V_{CC} = 5.5\text{ V}$, $V_O = 0\text{ V}$				
r_o Output resistance	V_{CC} , V_+ , and $V_- = 0\text{ V}$, $V_O = \pm 2\text{ V}$	300	10M		Ω

† All typical values are at $V_{CC} = 3.3\text{ V}$ or $V_{CC} = 5\text{ V}$, 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 $C_1\text{--}C_4 = 0.1\text{ }\mu\text{F}$ at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; $C_1 = 0.047\text{ }\mu\text{F}$, $C_2\text{--}C_4 = 0.33\text{ }\mu\text{F}$ 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	$C_L = 1000\text{ pF}$, One DOUT switching, $R_L = 3\text{ k}\Omega$, See Figure 1	150	250		kbit/s
$t_{sk(p)}$ Pulse skew§	$C_L = 150\text{ pF}$ to 2500 pF , $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, See Figure 2		300		ns
$SR(tr)$ Slew rate, transition region (see Figure 1)	$R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$, $V_{CC} = 3.3\text{ V}$	$C_L = 150\text{ pF}$ to 1000 pF	6	30	V/ μs
		$C_L = 150\text{ pF}$ to 2500 pF	4	30	

† All typical values are at $V_{CC} = 3.3\text{ V}$ or $V_{CC} = 5\text{ V}$, 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 $C_1\text{--}C_4 = 0.1\text{ }\mu\text{F}$ at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; $C_1 = 0.047\text{ }\mu\text{F}$, $C_2\text{--}C_4 = 0.33\text{ }\mu\text{F}$ at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$.

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3-V TO 5.5-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 4 and Figure 4)

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
r_i Input resistance	$V_I = \pm 3$ V to ± 25 V	3	5	7	k Ω

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

NOTE 4: Test conditions are C_1 – $C_4 = 0.1$ μF at $V_{CC} = 3.3$ V ± 0.3 V; $C_1 = 0.047$ μF , C_2 – $C_4 = 0.33$ 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 4 and Figure 3)

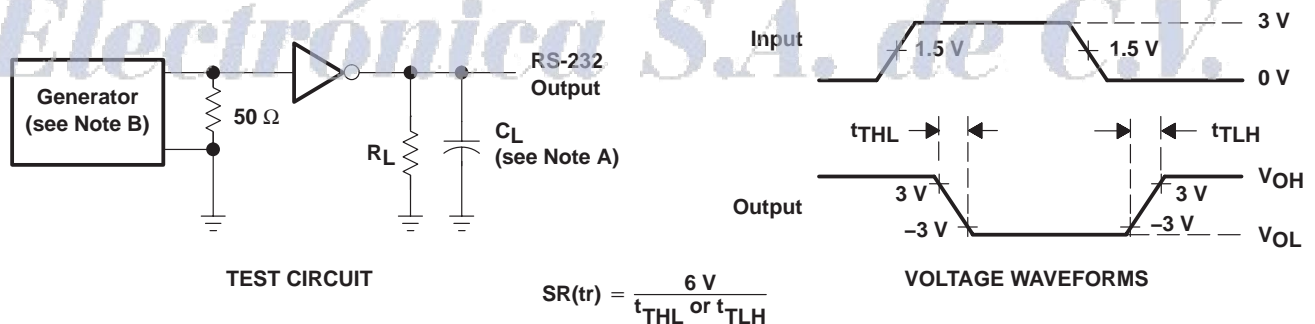
PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_{PLH} Propagation delay time, low- to high-level output	$C_L = 150$ pF		300		ns
t_{PHL} Propagation delay time, high- to low-level output			300		ns
$t_{sk(p)}$ Pulse skew‡				300	

† All typical values are at $V_{CC} = 3.3$ V or $V_{CC} = 5$ 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 C_1 – $C_4 = 0.1$ μF at $V_{CC} = 3.3$ V ± 0.3 V; $C_1 = 0.047$ μF , C_2 – $C_4 = 0.33$ μF at $V_{CC} = 5$ V ± 0.5 V.

PARAMETER MEASUREMENT INFORMATION



NOTES: A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_0 = 50$ Ω , 50% duty cycle, $t_r \leq 10$ ns, $t_f \leq 10$ ns.

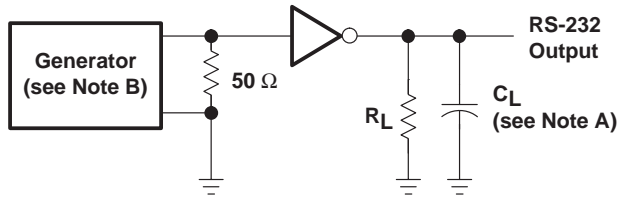
Figure 1. Driver Slew Rate

MAX3232

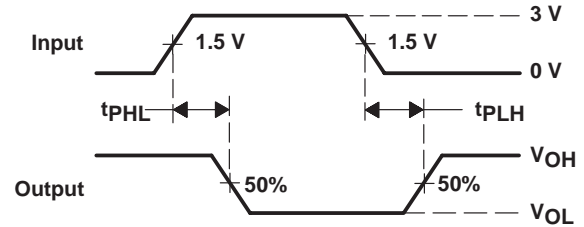
3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

SLLS410I – JANUARY 2000 – REVISED JANUARY 2004

PARAMETER MEASUREMENT INFORMATION



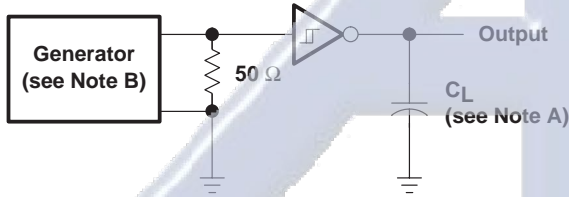
TEST CIRCUIT



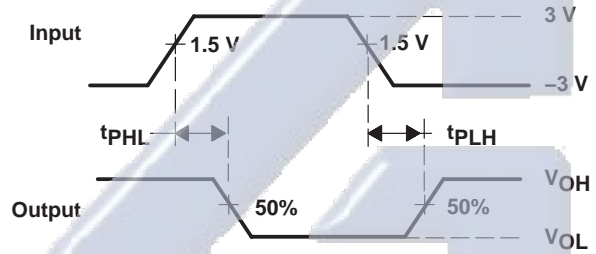
VOLTAGE WAVEFORMS

- NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: PRR = 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



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.

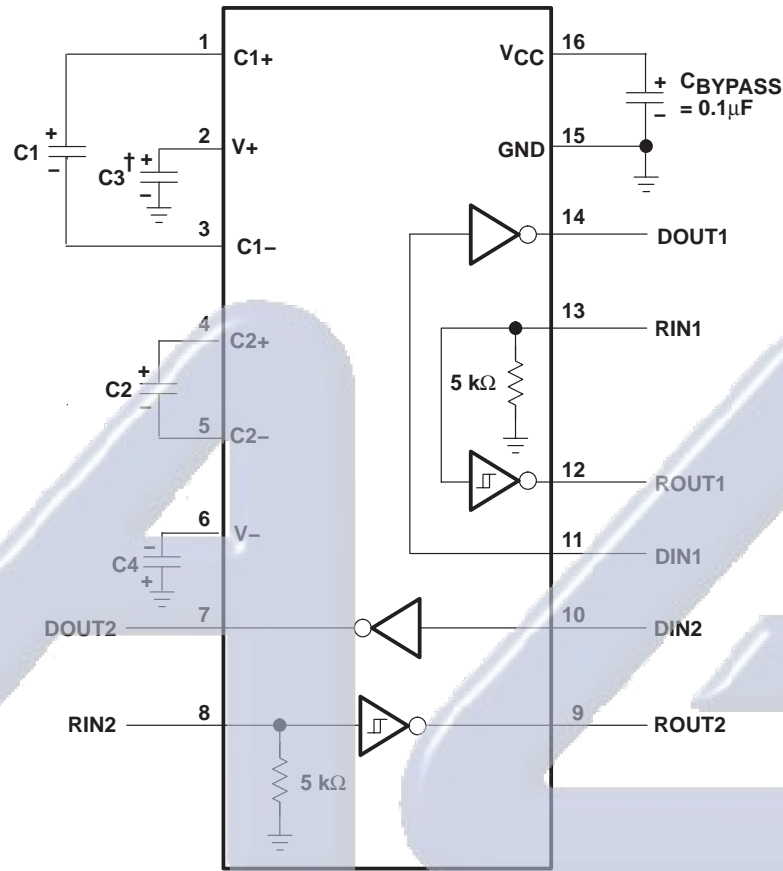
Figure 3. Receiver Propagation Delay Times

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3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER
WITH ±15-kV ESD PROTECTION

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APPLICATION INFORMATION



† C3 can be connected to VCC 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.

VCC vs CAPACITOR VALUES

VCC	C1	C2, C3, C4
3.3 V ± 0.3 V	0.1 μF	0.1 μF
5 V ± 0.5 V	0.047 μF	0.33 μF
3 V to 5.5 V	0.1 μF	0.47 μF

Figure 4. Typical Operating Circuit and Capacitor Values

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
MAX3232CD	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CDB	ACTIVE	SSOP	DB	16	80	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CDBR	ACTIVE	SSOP	DB	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CDR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CDW	ACTIVE	SOIC	DW	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CDWR	ACTIVE	SOIC	DW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX3232CPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX3232CPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX3232ID	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IDB	ACTIVE	SSOP	DB	16	80	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IDBR	ACTIVE	SSOP	DB	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IDR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IDW	ACTIVE	SOIC	DW	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IDWR	ACTIVE	SOIC	DW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
MAX3232IPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
MAX3232IPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-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 - 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.

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



PACKAGE OPTION ADDENDUM

4-Mar-2005

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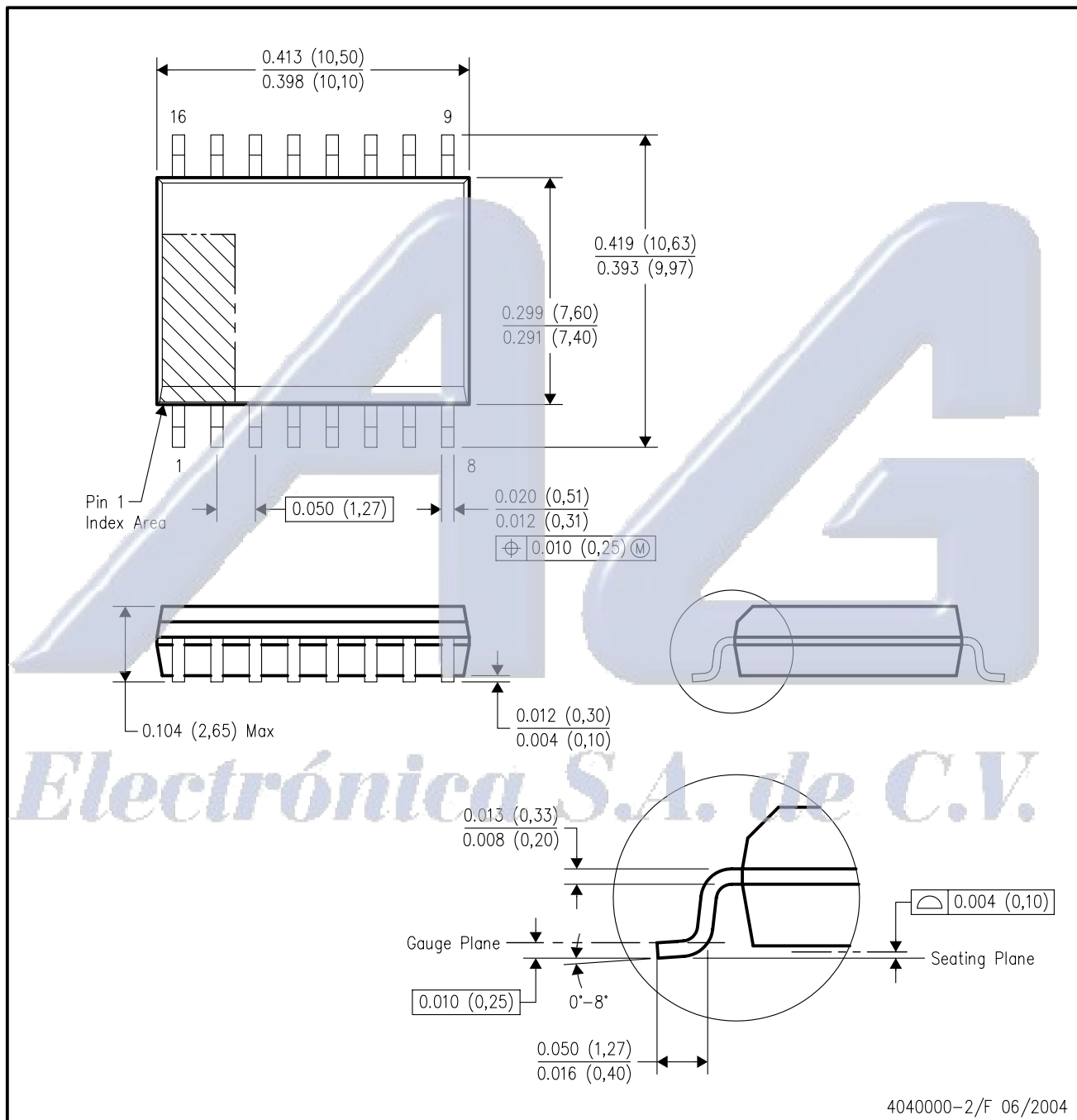
A large, light blue, 3D-style logo consisting of the letters 'A' and 'G' in a bold, sans-serif font. The letters have a slight shadow and a glossy finish, giving them a three-dimensional appearance.

Electrónica S.A. de C.V.

MECHANICAL DATA

DW (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



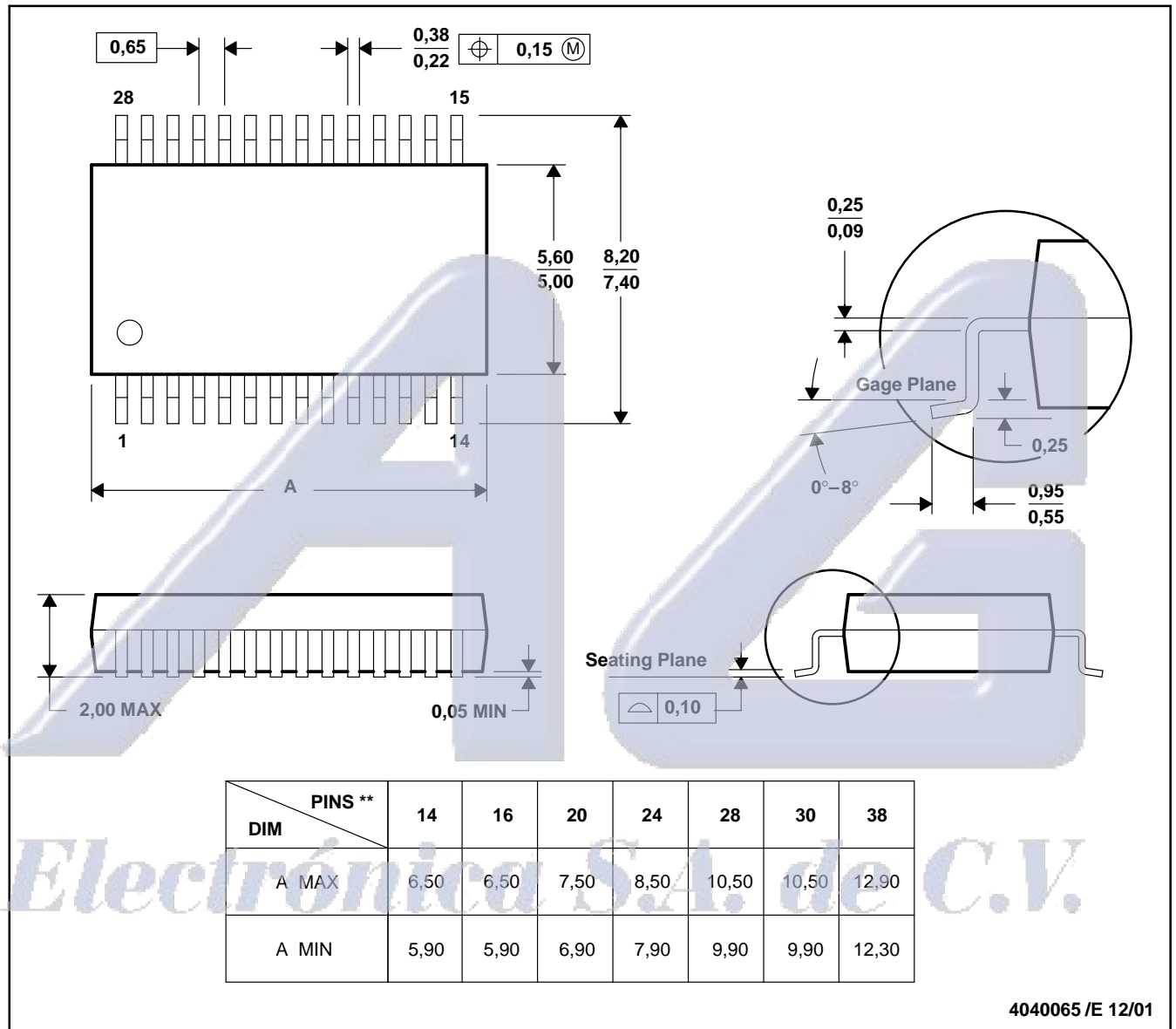
4040000-2/F 06/2004

- 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.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



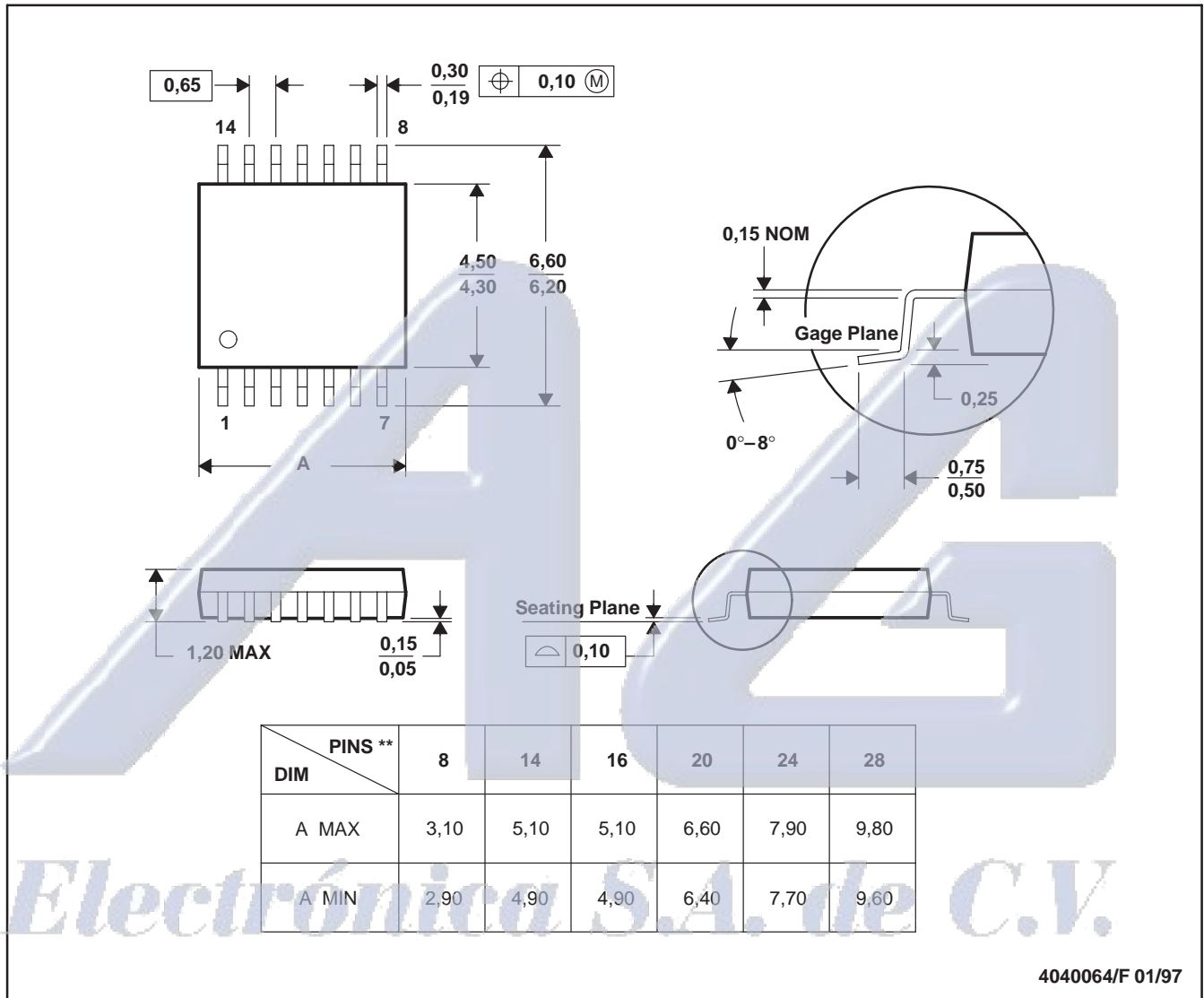
- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

4040065 / E 12/01

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 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-153