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MAX213
5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER
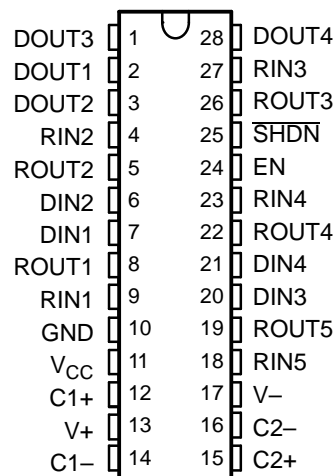WITH ±15-kV ESD PROTECTION
SLLS680−DECEMBER 2005

FEATURES

- **ESD Protection for RS-232 Bus Pins**
  - **±15-kV Human-Body Model (HBM)**
- **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 . . . 15 μA Typ**
- **External Capacitors . . . 4 × 0.1 F**
- **Designed to Be Interchangeable With Maxim MAX213**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**

DB, DW, OR PW PACKAGE
(TOP VIEW)

DOUT3	1	28 DOUT4
DOUT1	2	27 RIN3
DOUT2	3	26 ROUT3
RIN2	4	25 $\overline{SHDN}$
ROUT2	5	24 EN
DIN2	6	23 RIN4
DIN1	7	22 ROUT4
ROUT1	8	21 DIN4
RIN1	9	20 DIN3
GND	10	19 ROUT5
V_{CC}	11	18 RIN5
C1+	12	17 V−
V+	13	16 C2−
C1−	14	15 C2+

APPLICATIONS

- **Battery-Powered Systems**
- **PDAs**
- **Notebooks**
- **Laptops**
- **Palmtop PCs**
- **Hand-Held Equipment**

DESCRIPTION/ ORDER INFORMATION

The MAX213 device consists of four line drivers, five 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 5-V supply. The devices operate at data signaling rates up to 120 kbit/s and a maximum of 30-V/μs driver output slew rate.

The MAX213 has an active-low shutdown ($\overline{SHDN}$) and an active-high enable control (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 μA. Two receivers of the MAX213 are active during shutdown.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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ORDERING INFORMATION

| T_A	PACKAGE[1]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SOIC – DW	Tube of 20	MAX213CDW	
		Reel of 1000	MAX213CDWR	
	SSOP – DB	Tube of 50	MAX213CDB	
		Reel of 2000	MAX213CDBR	
	TSSOP – PW	Tape and reel	MAX213CPWR	
−40°C to 85°C	SOIC – DW	Tube of 20	MAX213IDW	
		Reel of 1000	MAX213IDWR	
	SSOP – DB	Tube of 50	MAX213IDB	
		Reel of 2000	MAX213IDBR	
	TSSOP – PW	Tape and reel	MAX213IPWR	

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

FUNCTION TABLE

INPUTS		DRIVER	RECEIVER		DEVICE STATUS
$\overline{SHDN}$	EN	D1−D4	R1−R3	R4−R5	
L	L	Z	Z	Z	Shutdown
L	H	Z	Z	Active[1]	Shutdown
H	L	All active	Z	Z	Normal operation
H	H	All active	Active	Active	Normal operation

(1)   See the V_{IT+} and $V_{IT−}$ change in the *Electrical Characteristics* table.

LOGIC DIAGRAM (POSITIVE LOGIC)
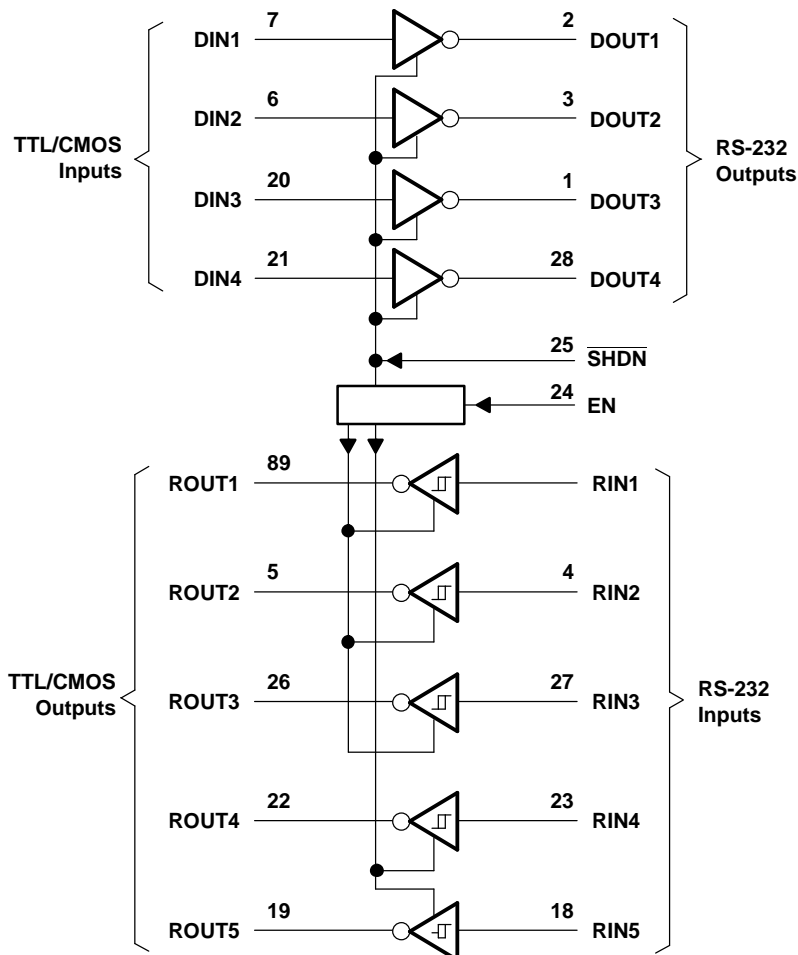
Absolute Maximum Ratings[1]

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		−0.3	6	V
V+	Positive charge-pump voltage range[2]		V_{CC} − 0.3	14	V
V−	Negative charge-pump voltage range[2]		0.3	−14	V
V_I	Input voltage range	Drivers	−0.3	V+ + 0.3	V
		Receivers		±30	
V_O	Output voltage range	Drivers	V− − 0.3	V+ + 0.3	V
		Receivers	−0.3	V_{CC} + 0.3	
DOUT	Short-circuit duration		Continuous		
θ_{JA}	Package thermal impedance[3][4]	DB package		62	C°/W
		DW package		46	
		PW package			
T_J	Operating virtual junction temperature			150	C°
T_{stg}	Storage temperature range		−65	150	C°

(1) 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.
(2) All voltages are with respect to network GND.
(3) 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.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions[1]

See 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	EN, $\overline{SHDN}$	2.4			
V_{IL}	Driver and control low-level input voltage	DIN, EN, $\overline{SHDN}$			0.8	V
V_I	Driver and control input voltage	DIN, EN, $\overline{SHDN}$	0		5.5	V
	Receiver input voltage	RIN	−30		30	
T_A	Operating free-air temperature	MAX213C	0		70	°C
		MAX213I	−40		85	

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.

Electrical Characteristics[1]

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

PARAMETER		TEST CONDITIONS		MIN	TYP[2]	MAX	UNIT
I_{CC}	Supply current	No load,	See Figure 6		14	20	mA
I_{SHDN}	Shutdown supply current	T_A = 25°C,	See Figure 1		15	50	µA

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V, and T_A = 25°C.

DRIVER SECTION

Electrical Characteristics[1]

over operating free-air temperature range (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS		MIN	TYP[2]	MAX	UNIT
V_{OH}	High-level output voltage	DOUT at R_L = 3 kΩ to GND		5	9		V
V_{OL}	Low-level output voltage	DOUT at R_L = 3 kΩ to GND		−5	−9		V
I_{IH}	Control high-level input current	EN, $\overline{SHDN}$ = 5 V			3	10	µA
I_{IL}	Driver low-level input current	DIN = 0 V			−15	−200	µA
	Control low-level input current	EN, $\overline{SHDN}$ = 0 V			−3	−10	
I_{OS}[3]	Short-circuit output current	V_{CC} = 5.5 V,	V_O = 0 V		±10	±60	mA
r_o	Output resistance	V_{CC}, V+, and V− = 0 V,	V_O = ±2 V	300			Ω

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V
(2) All typical values are at V_{CC} = 5 V, and T_A = 25°C.
(3) 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.

Switching Characteristics[1]

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

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

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V, and T_A = 25°C.
(3) Pulse skew is defined as (t_{PLH} − t_{PHL}) of each channel of the same device.

ESD Protection

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

PIN	TEST CONDITIONS	TYP	UNIT
DOUT	Human-Body Model	±15	kV

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RECEIVER SECTION

Electrical Characteristics[1]

over operating free-air temperature range (unless otherwise noted) (see Figure 6)

PARAMETER		TEST CONDITIONS		MIN	TYP[2]	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –1 mA			V_{CC} – 0.4		V
V_{OL}	Low-level output voltage	I_{OH} = 1.6 mA				0.4	V
V_{IT+}	Positive-going input threshold voltage	V_{CC} = 5 V, T_A = 25°C	Active mode		1.7	2.4	V
			Shutdown mode (R4–R5)		1.5	2.4	
V_{IT-}	Negative-going input threshold voltage	V_{CC} = 5 V, T_A = 25°C	Active mode	0.8	1.2		V
			Shutdown mode (R4–R5)	0.6	1.5		
Vhys[3]	Input hysteresis (V_{IT+}, V_{IT-})	V_{CC} = 5 V			0.5	1	V
r_I	Input resistance	V_{CC} = 5 V, T_A = 25°C		3	5	7	kΩ
	Output leakage current	EN = 0 V, 0 ≤ ROUT ≤ V_{CC}, R1–R3			±0.05	±10	µA

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V, and T_A = 25°C.
(3) No hysteresis in shudown mode

Switching Characteristics[1]

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

PARAMETER		TEST CONDITIONS		MIN	TYP[2]	MAX	UNIT
$t_{PLH(R)}$	Propagation delay time, low- to high-level output	C_L = 150 pF,	See Figure 4	$\overline{SHDN}$ = V_{CC}		0.5	10	µs
				$\overline{SHDN}$ = 0 V, R4–R5		4	40	
$t_{PHL(R)}$	Propagation delay time, high- to low-level output	C_L = 150 pF,	See Figure 4			0.5	10	µs
t_{en}	Output enable time	C_L = 150 pF,	See Figure 5			600		ns
t_{dis}	Output disable time	C_L = 150 pF,	See Figure 5			200		ns

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 5 V ± 0.5 V.
(2) All typical values are at V_{CC} = 5 V, and T_A = 25°C.

ESD Protection

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

PIN	TEST CONDITIONS	TYP	UNIT
RIN	Human-Body Model	±15	kV

PARAMETER MEASUREMENT INFORMATION
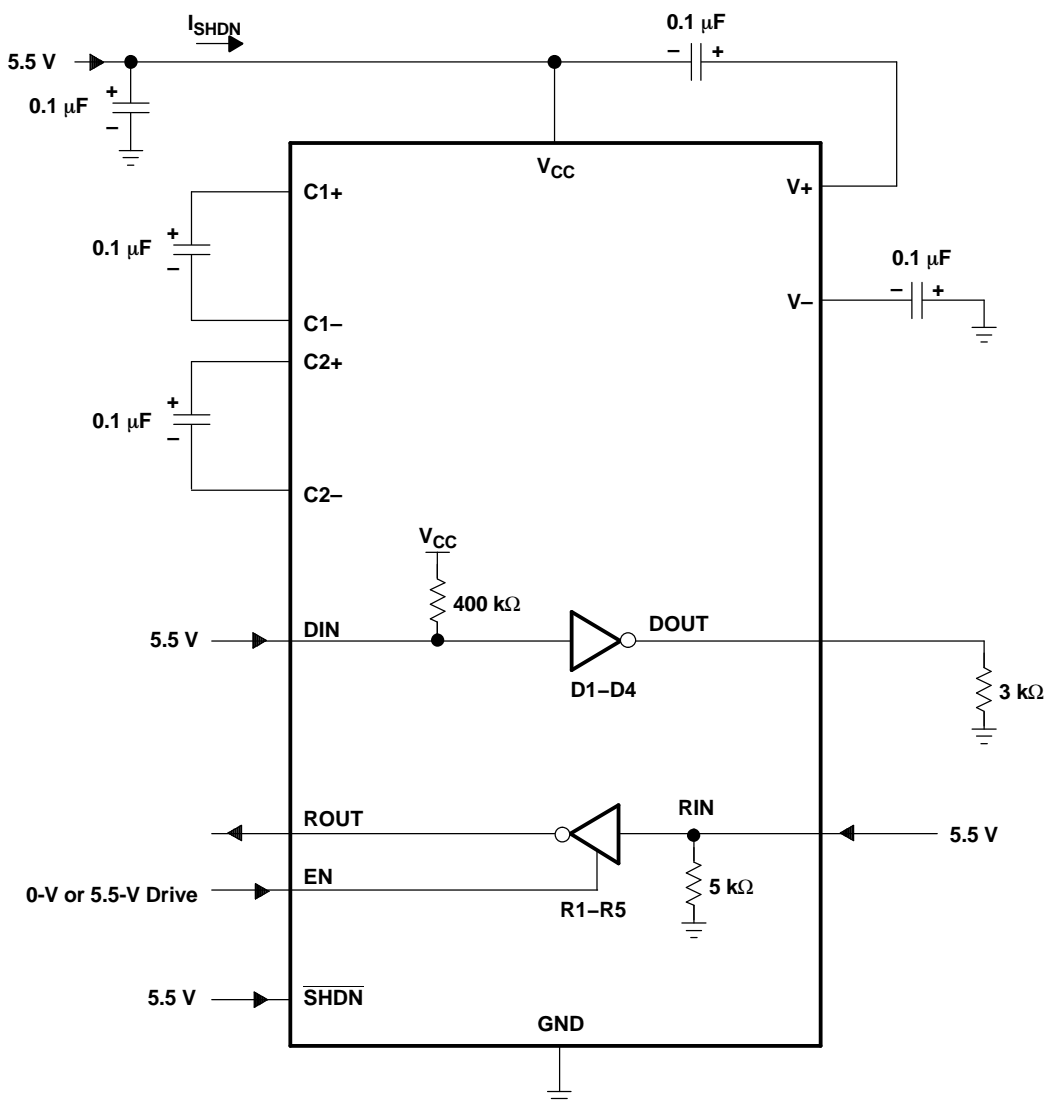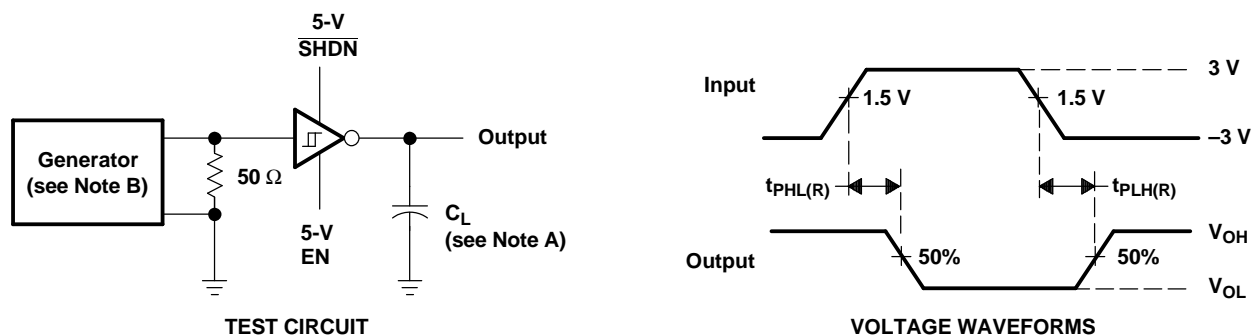

Figure 1. Shutdown Current Test Circuit

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PARAMETER MEASUREMENT INFORMATION (continued)

TEST CIRCUIT

$$SR(tr) = \frac{6\ V}{t_{THL(D)}\ or\ t_{TLH(D)}}$$

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.
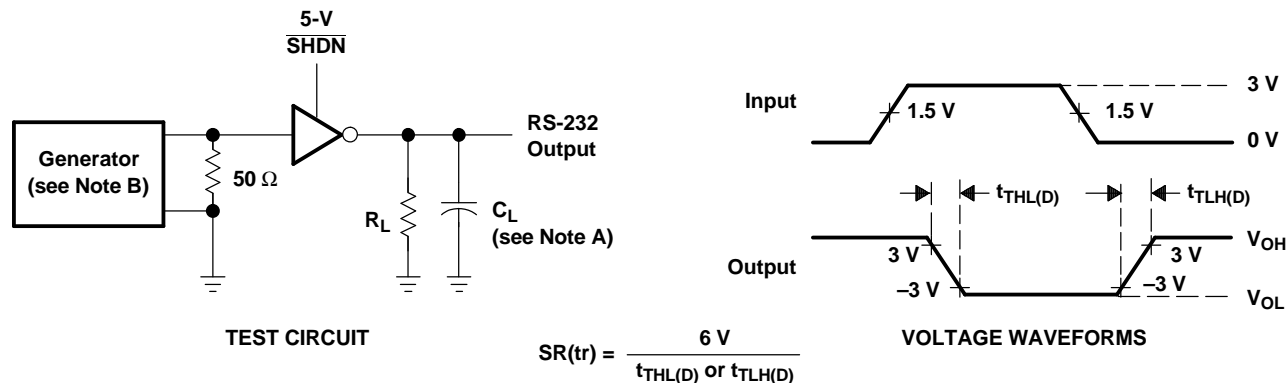
Figure 2. Driver Slew Rate

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.
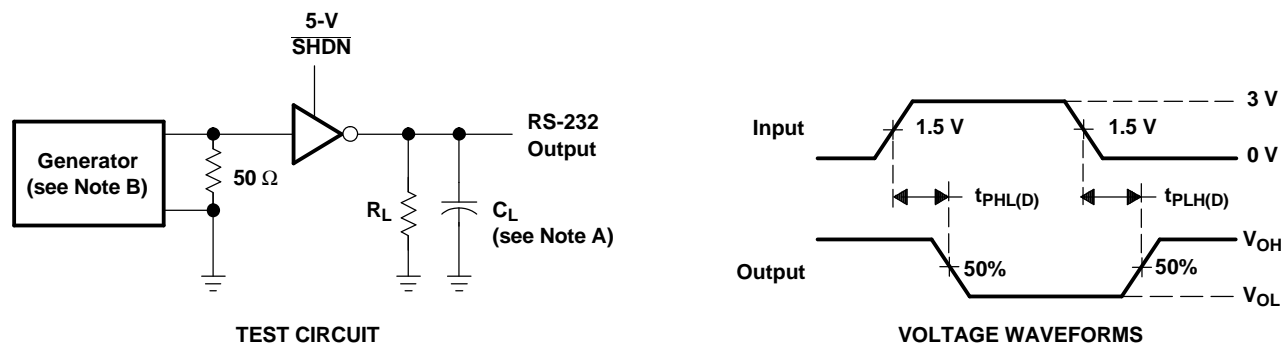
Figure 3. Driver Pulse Skew and Propagation Delay Times

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 4. Receiver Propagation Delay Times

PARAMETER MEASUREMENT INFORMATION (continued)
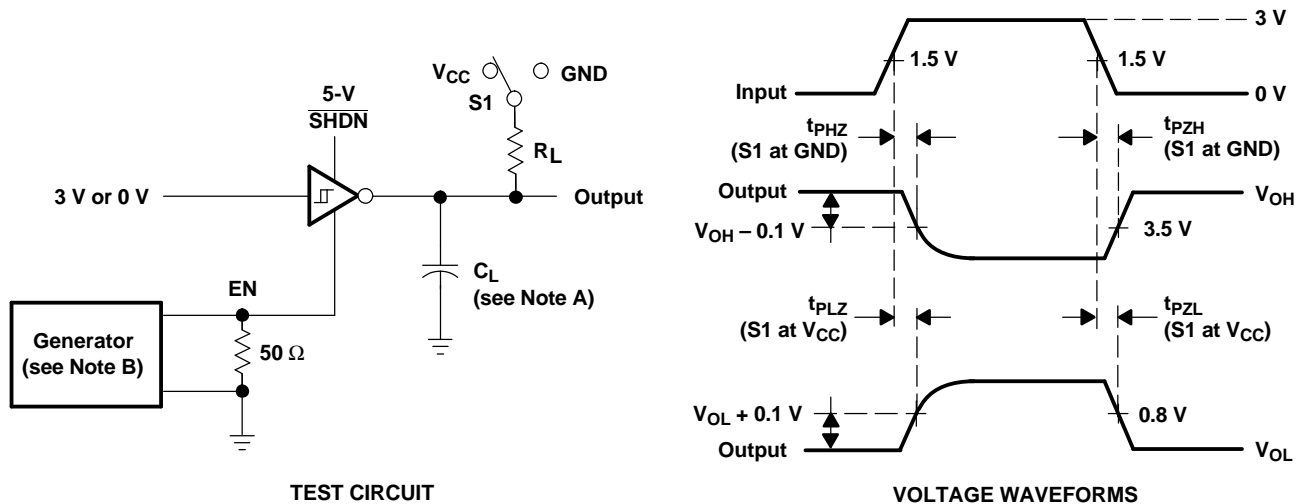
TEST CIRCUIT

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.
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

Pin	Label
1	DOUT3
2	DOUT1
3	DOUT2
4	RIN2
5	ROUT2
6	DIN2
7	DIN1
8	ROUT1
9	RIN1
10	GND
11	V_{CC}
12	C1+
13	V+
14	C1−
28	DOUT4
27	RIN3
26	ROUT3
25	$\overline{SHDN}$ = 5 V
24	EN
23	RIN4
22	ROUT4
21	DIN4
20	DIN3
19	ROUT5
18	RIN5
17	V−
16	C2−
15	C2+

5 kΩ (×4), 400 kΩ (×4), 5 V

C_{BYPASS} = 0.1 μF

$C3^{(1)}$ = 0.1 μF 6.3 V

C1 = 0.1 μF 6.3 V

C4 = 0.1 μF 16 V

C2 = 0.1 μF 16 V
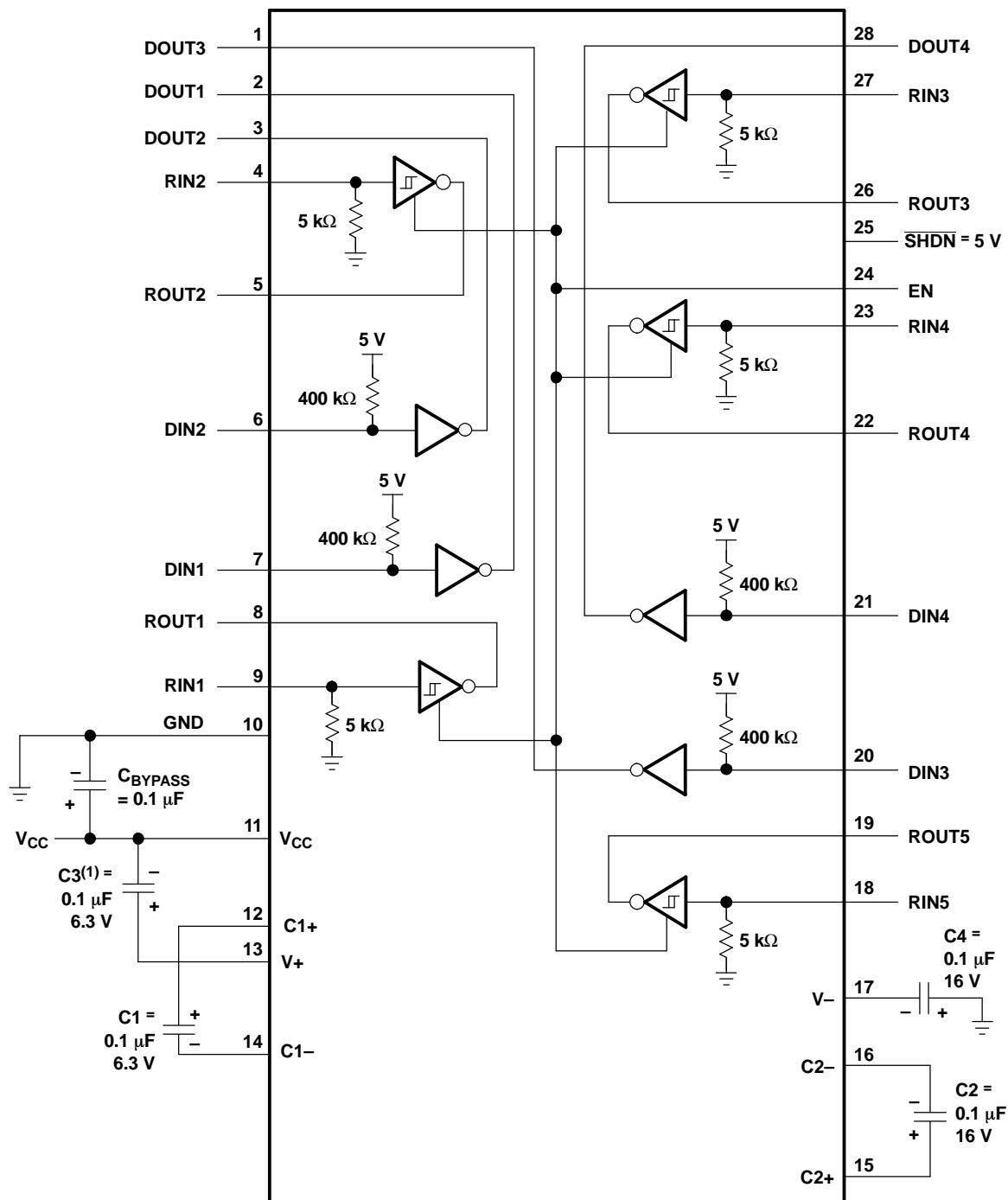
(1) C3 can be connected to V_{CC} or GND.
NOTES: A. Resistor values shown are nominal.
B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

Figure 6. 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]
MAX213CDB	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213CDBR	ACTIVE	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213CDW	ACTIVE	SOIC	DW	28	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213CDWR	ACTIVE	SOIC	DW	28	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213IDB	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213IDBR	ACTIVE	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213IDW	ACTIVE	SOIC	DW	28	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX213IDWR	ACTIVE	SOIC	DW	28	1000	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), Pb-Free (RoHS Exempt), 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.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
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)
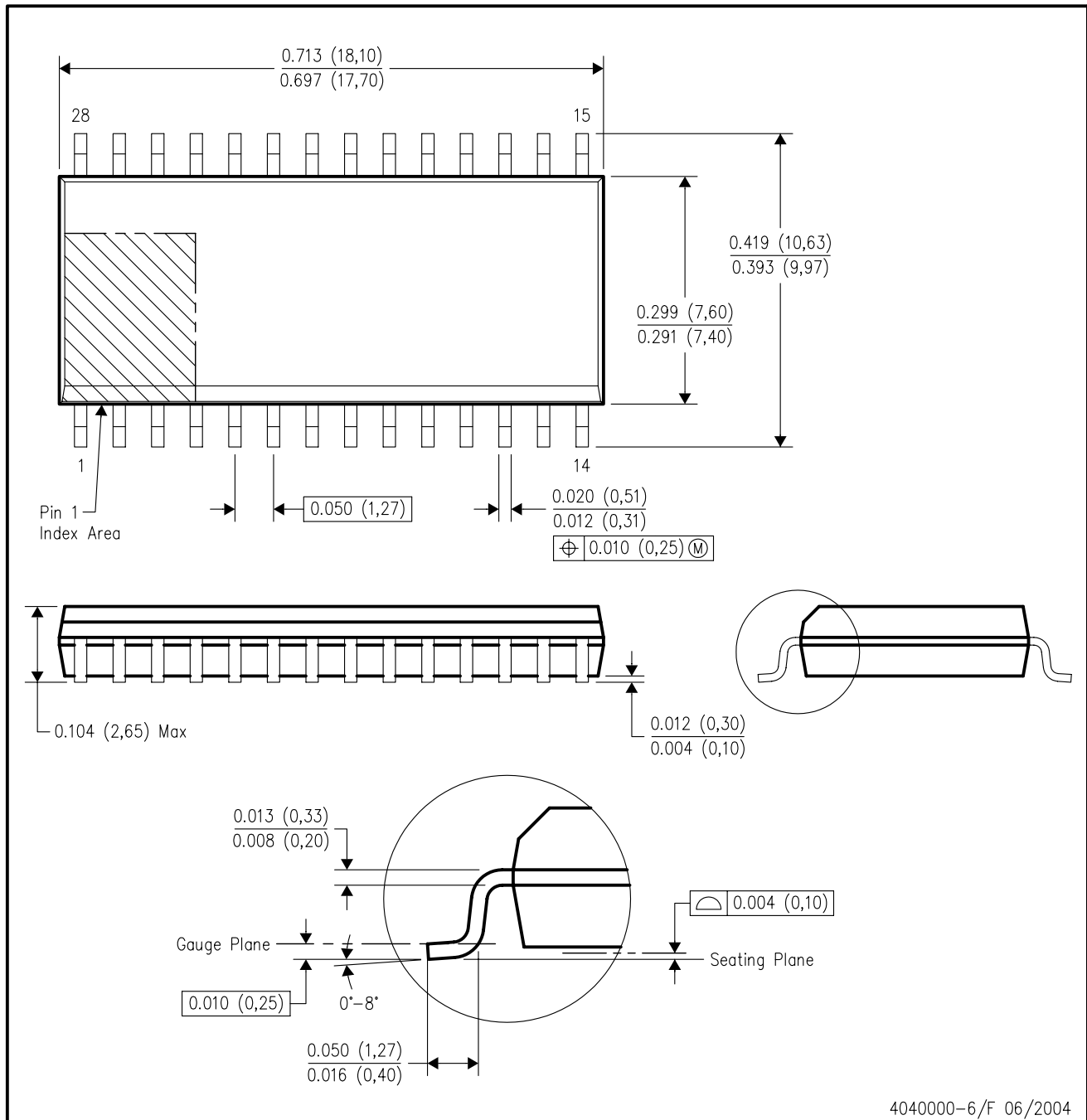
[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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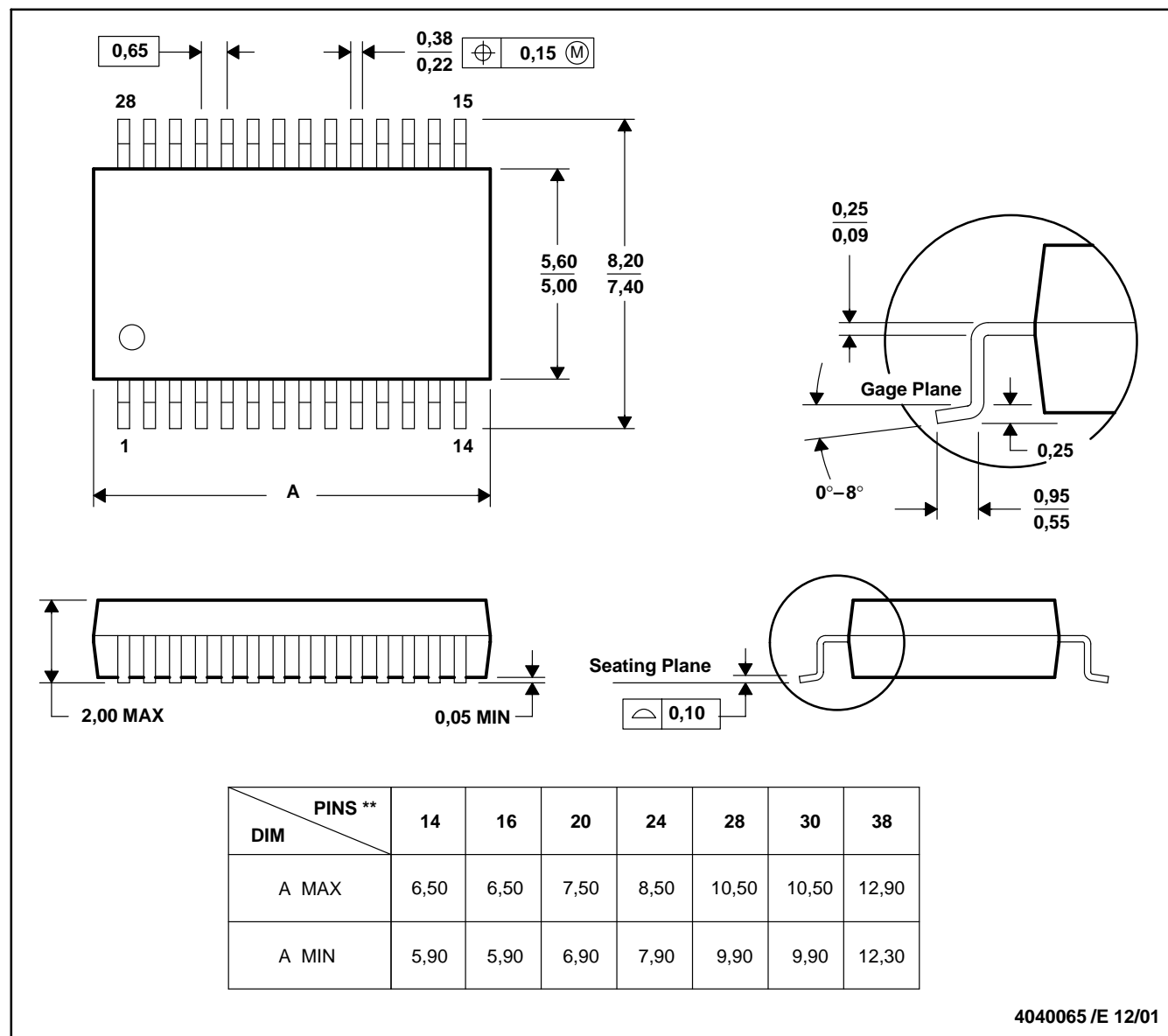DW (R−PDSO−G28)   **PLASTIC SMALL−OUTLINE PACKAGE**

0.713 (18,10)
0.697 (17,70)

28   15

0.419 (10,63)
0.393 (9,97)

0.299 (7,60)
0.291 (7,40)

1   14

Pin 1
Index Area

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ 0.010 (0,25) Ⓜ

0.104 (2,65) Max

0.012 (0,30)
0.004 (0,10)

0.013 (0,33)
0.008 (0,20)

0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)   0°−8°

0.050 (1,27)
0.016 (0,40)

4040000−6/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 AE.

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DB (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN

DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

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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