

## FEATURES

- ESD Protection for RS-232 Bus Pins  
–  $\pm 15$ -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  $\mu$ A Typ
- External Capacitors . . .  $4 \times 0.1$  F
- Designed to Be Interchangeable With Maxim MAX213
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II

## APPLICATIONS

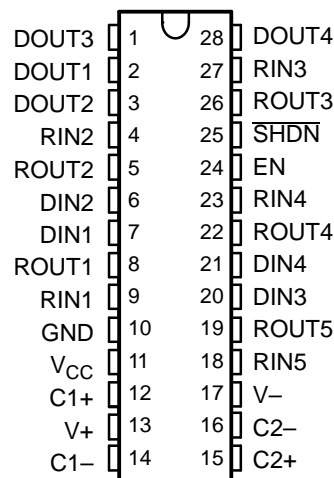
- Battery-Powered Systems
- PDAs
- Notebooks
- Laptops
- Palmtop PCs
- Hand-Held Equipment

## DESCRIPTION/ ORDER INFORMATION

The MAX213 device consists of four line drivers, five line receivers, and a dual charge-pump circuit with  $\pm 15$ -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 MAX213 has an active-low shutdown ( $\overline{\text{SHDN}}$ ) 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  $\mu$ A. Two receivers of the MAX213 are active during shutdown.

DB, DW, OR PW PACKAGE  
(TOP VIEW)



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**MAX213**  
**5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER**  
**WITH  $\pm 15$ -kV ESD PROTECTION**

SLLS680–DECEMBER 2005

**ORDERING INFORMATION**

$T_A$	PACKAGE <sup>(1)</sup>		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	

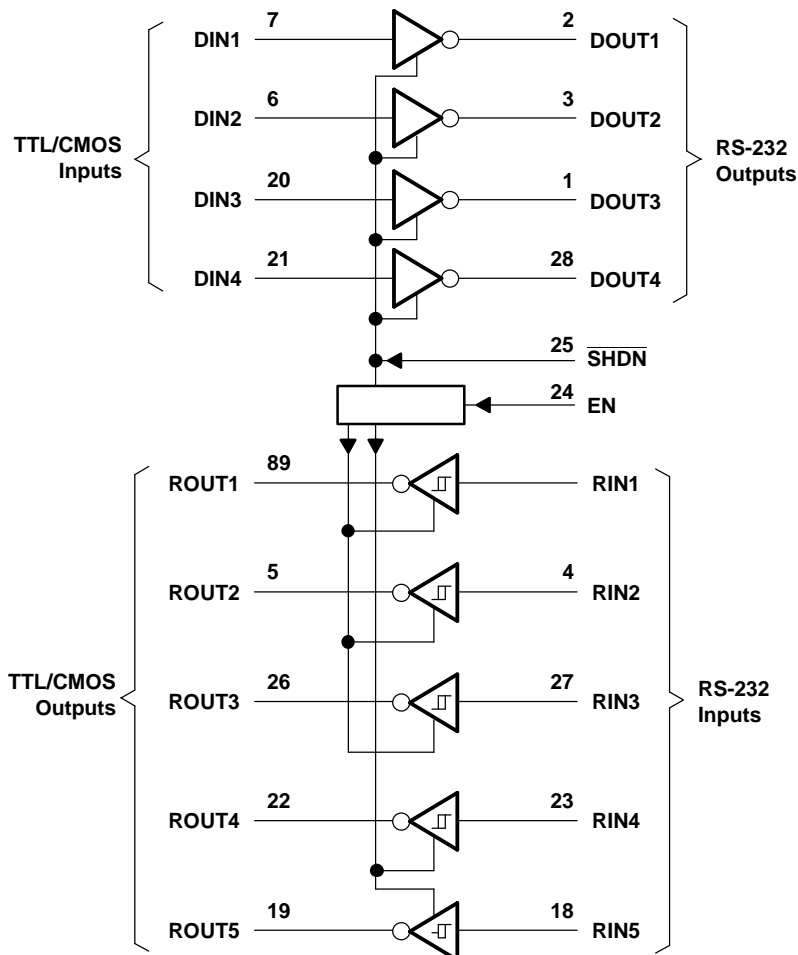
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

**FUNCTION TABLE**

INPUTS		DRIVER D1–D4	RECEIVER		DEVICE STATUS
$\overline{\text{SHDN}}$	EN		R1–R3	R4–R5	
L	L	Z	Z	Z	Shutdown
L	H	Z	Z	Active <sup>(1)</sup>	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)



# MAX213

## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

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

SLLS680–DECEMBER 2005

### Absolute Maximum Ratings<sup>(1)</sup>

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

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range		−0.3	6	V
V+	Positive charge-pump voltage range <sup>(2)</sup>		V <sub>CC</sub> − 0.3	14	V
V−	Negative charge-pump voltage range <sup>(2)</sup>		0.3	−14	V
V <sub>I</sub>	Input voltage range	Drivers	−0.3	V+ + 0.3	V
		Receivers	±30		
V <sub>O</sub>	Output voltage range	Drivers	V− − 0.3	V+ + 0.3	V
		Receivers	−0.3	V <sub>CC</sub> + 0.3	
DOUT	Short-circuit duration		Continuous		
θ <sub>JA</sub>	Package thermal impedance <sup>(3)(4)</sup>	DB package	62		C°/W
		DW package	46		
		PW package			
T <sub>J</sub>	Operating virtual junction temperature		150		C°
T <sub>sta</sub>	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  $T_J(\text{max})$ ,  $\theta_{JA}$ , 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.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

### Recommended Operating Conditions<sup>(1)</sup>

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, $\overline{\text{SHDN}}$	2.4			
$V_{IL}$	Driver and control low-level input voltage	DIN, EN, $\overline{\text{SHDN}}$			0.8	V
$V_I$	Driver and control input voltage	DIN, EN, $\overline{\text{SHDN}}$	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  $\mu\text{F}$  at  $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$ .

### Electrical Characteristics<sup>(1)</sup>

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
$I_{CC}$	Supply current	No load, See <a href="#">Figure 6</a>	14	20	mA
$I_{SHDN}$	Shutdown supply current	$T_A = 25^\circ\text{C}$ , See <a href="#">Figure 1</a>	15	50	$\mu\text{A}$

- (1) Test conditions are C1–C4 = 0.1  $\mu\text{F}$  at  $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$ .
- (2) All typical values are at  $V_{CC} = 5 \text{ V}$ , and  $T_A = 25^\circ\text{C}$ .

## DRIVER SECTION

### Electrical Characteristics<sup>(1)</sup>

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	5	9		V
V <sub>OL</sub>	Low-level output voltage	DOUT at R <sub>L</sub> = 3 k $\Omega$ to GND	–5	–9		V
I <sub>IH</sub>	Control high-level input current	EN, $\overline{\text{SHDN}}$ = 5 V		3	10	$\mu$ A
I <sub>IL</sub>	Driver low-level input current	DIN = 0 V		–15	–200	$\mu$ A
	Control low-level input current	EN, $\overline{\text{SHDN}}$ = 0 V		–3	–10	
I <sub>OS</sub> <sup>(3)</sup>	Short-circuit output current	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V		$\pm 10$	$\pm 60$	mA
r <sub>o</sub>	Output resistance	V <sub>CC</sub> , V <sub>+</sub> , and V <sub>–</sub> = 0 V, V <sub>O</sub> = $\pm 2$ V	300			$\Omega$

(1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V

(2) All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 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<sup>(1)</sup>

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

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
Maximum data rate		C <sub>L</sub> = 50 pF to 1000 pF, One DOUT switching, R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$ , See <a href="#">Figure 3</a>	120			kbit/s
t <sub>PLH(D)</sub>	Propagation delay time, low- to high-level output	C <sub>L</sub> = 2500 pF, All drivers loaded, R <sub>L</sub> = 3 k $\Omega$ , See <a href="#">Figure 3</a>		2		$\mu$ s
t <sub>PHL(D)</sub>	Propagation delay time, high- to low-level output	C <sub>L</sub> = 2500 pF, All drivers loaded, R <sub>L</sub> = 3 k $\Omega$ , See <a href="#">Figure 3</a>		2		$\mu$ s
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup>	C <sub>L</sub> = 150 pF to 2500 pF, See <a href="#">Figure 3</a> R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$ ,		300		ns
SR(tr)	Slew rate, transition region (see <a href="#">Figure 2</a> )	C <sub>L</sub> = 50 pF to 1000 pF, V <sub>CC</sub> = 5 V R <sub>L</sub> = 3 k $\Omega$ to 7 k $\Omega$ ,	3	6	30	V/ $\mu$ s

(1) Test conditions are C1–C4 = 0.1  $\mu$ F at V<sub>CC</sub> = 5 V  $\pm$  0.5 V.

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

(3) Pulse skew is defined as (t<sub>PLH</sub> – t<sub>PHL</sub>) 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	$\pm 15$	kV

# MAX213

## 5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

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

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## RECEIVER SECTION

### Electrical Characteristics<sup>(1)</sup>

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub> High-level output voltage	I <sub>OH</sub> = –1 mA	V <sub>CC</sub> – 0.4			V
V <sub>OL</sub> Low-level output voltage	I <sub>OH</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	Active mode		1.7	2.4
		Shutdown mode (R4–R5)		1.5	2.4
V <sub>IT–</sub> Negative-going input threshold voltage	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	Active mode		0.8	1.2
		Shutdown mode (R4–R5)		0.6	1.5
V <sub>hys</sub> <sup>(3)</sup> Input hysteresis (V <sub>IT+</sub> , V <sub>IT–</sub> )	V <sub>CC</sub> = 5 V	0.5			1
r <sub>i</sub> Input resistance	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C	3	5	7	kΩ
Output leakage current	EN = 0 V, 0 ≤ ROUT ≤ V <sub>CC</sub> , R1–R3	±0.05			±10

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

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

(3) No hysteresis in shutdown mode

### Switching Characteristics<sup>(1)</sup>

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
t <sub>PLH(R)</sub> Propagation delay time, low- to high-level output	C <sub>L</sub> = 150 pF, See <a href="#">Figure 4</a>	$\overline{\text{SHDN}} = V_{CC}$		0.5	10
		$\overline{\text{SHDN}} = 0$ V, R4–R5		4	40
t <sub>PHL(R)</sub> Propagation delay time, high- to low-level output	C <sub>L</sub> = 150 pF, See <a href="#">Figure 4</a>	0.5			10
t <sub>en</sub> Output enable time	C <sub>L</sub> = 150 pF, See <a href="#">Figure 5</a>	600			ns
t <sub>dis</sub> Output disable time	C <sub>L</sub> = 150 pF, See <a href="#">Figure 5</a>	200			ns

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 5 V ± 0.5 V.

(2) All typical values are at V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 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

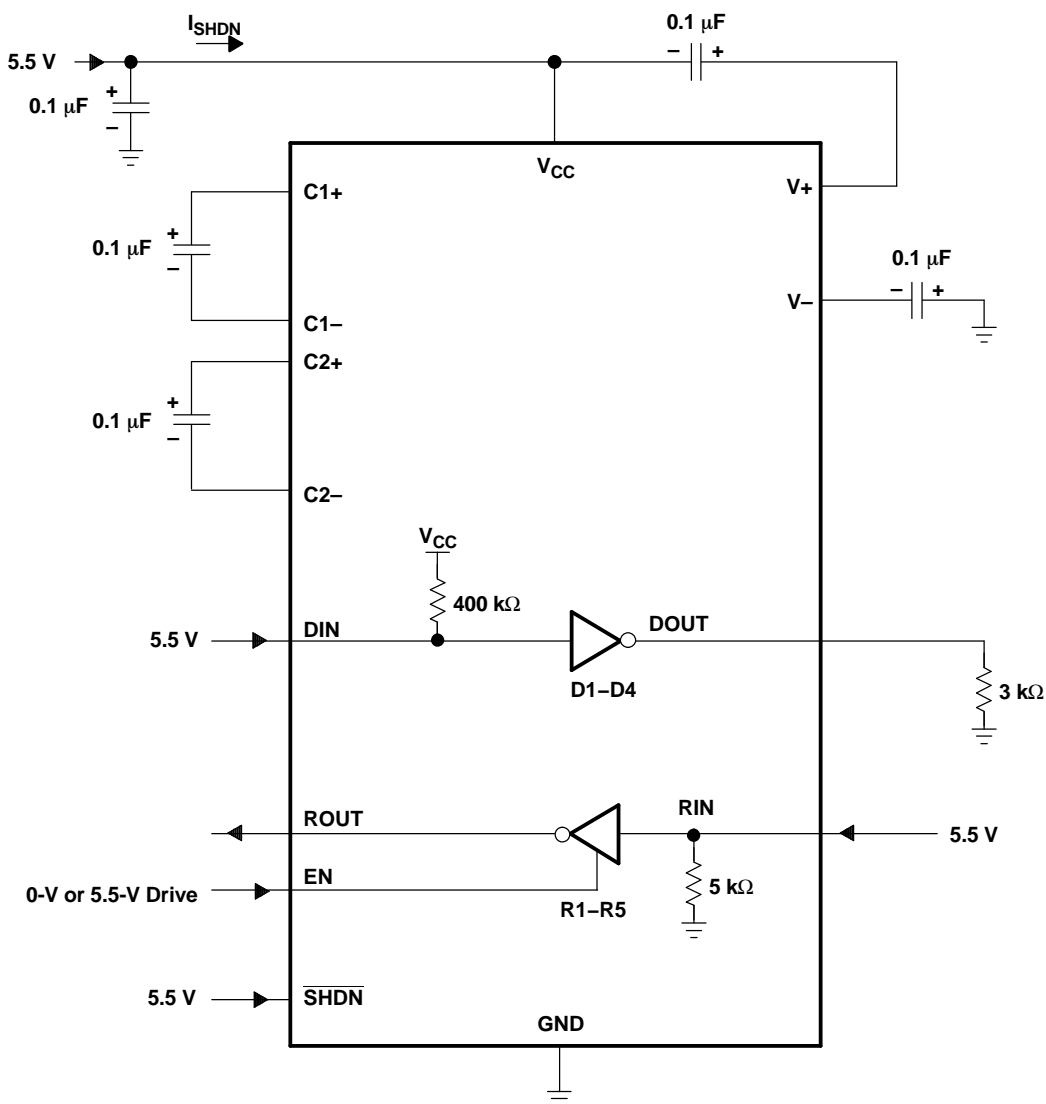
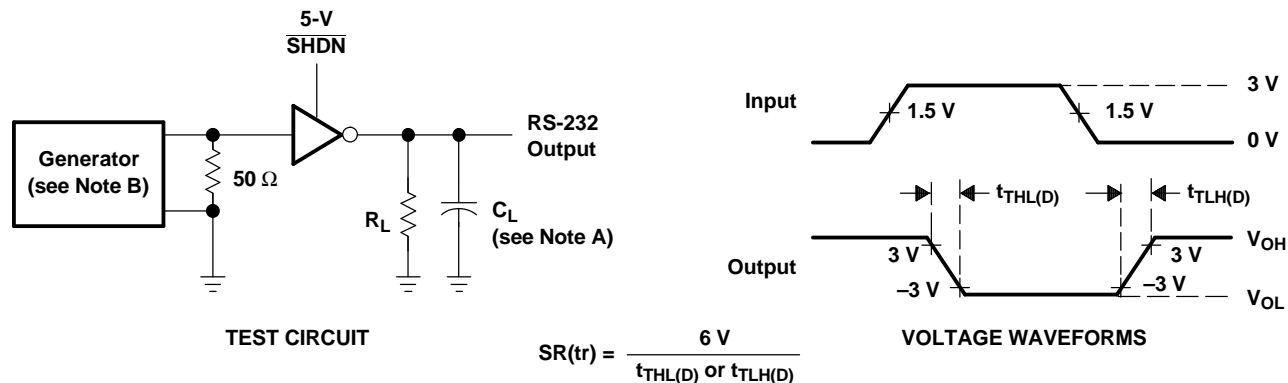


Figure 1. Shutdown Current Test Circuit

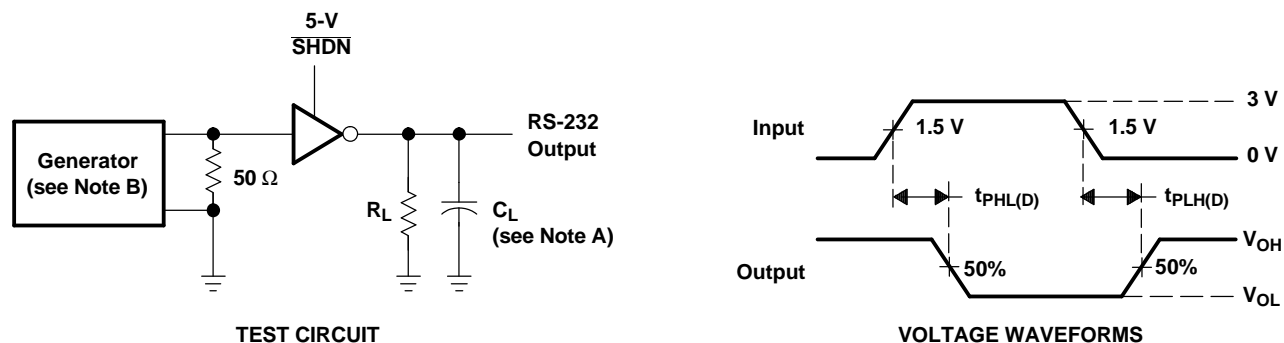
## PARAMETER MEASUREMENT INFORMATION (continued)



NOTES: A.  $C_L$  includes probe and jig capacitance.

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

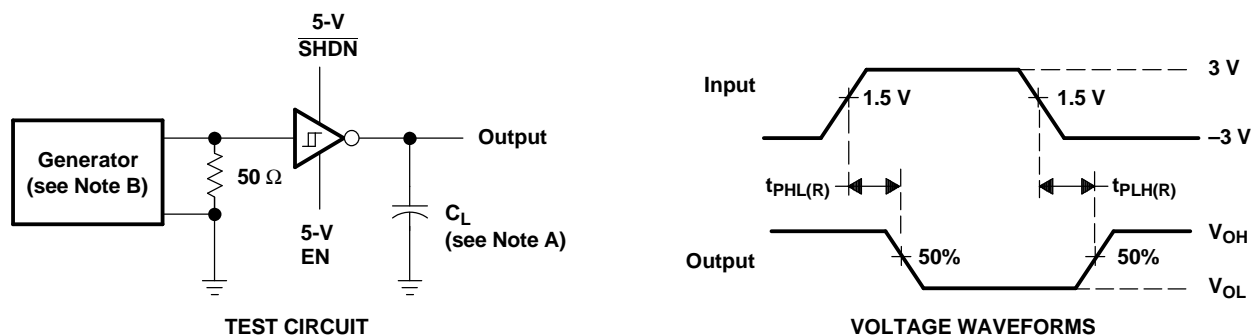
**Figure 2. Driver Slew Rate**



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. Driver Pulse Skew and Propagation Delay Times**



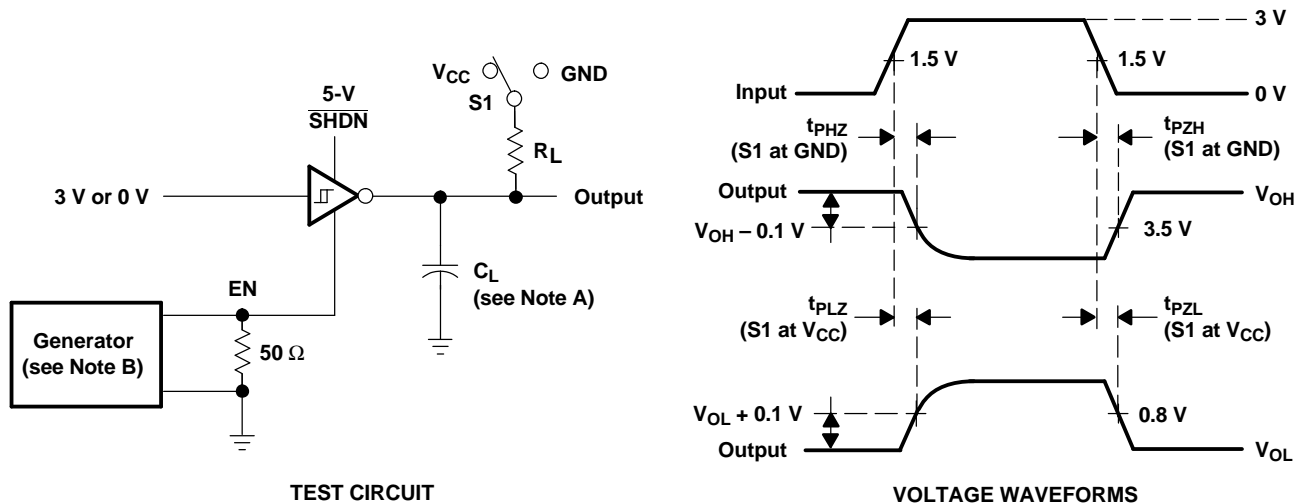
NOTES: A.  $C_L$  includes probe and jig capacitance.

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**



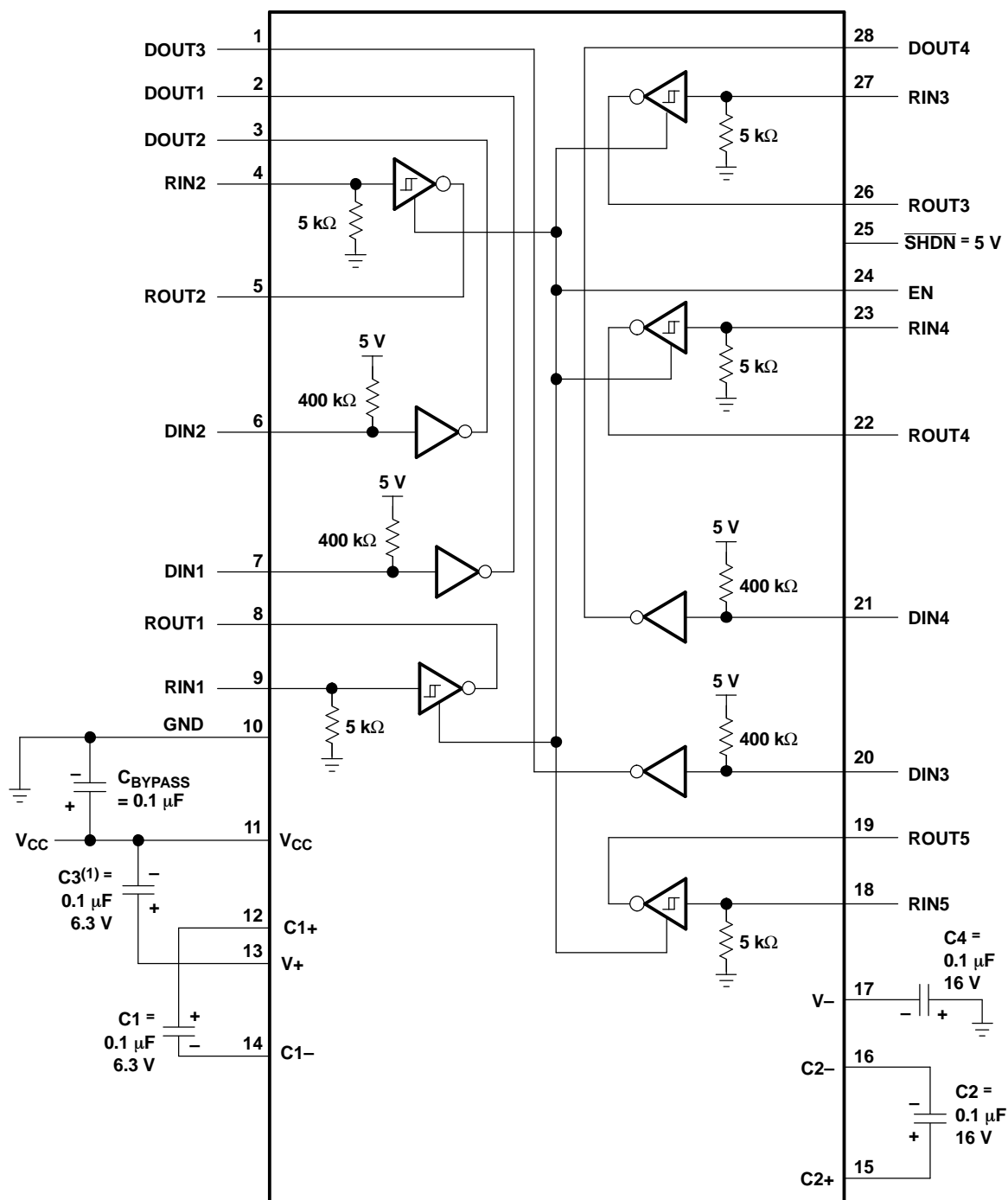
PARAMETER MEASUREMENT INFORMATION (continued)



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

## APPLICATION INFORMATION



(1) C3 can be connected to V<sub>CC</sub> 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 part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">MAX213CDB</a>	Obsolete	Production	SSOP (DB)   28	-	-	Call TI	Call TI	0 to 70	MAX213C
<a href="#">MAX213CDBR</a>	Obsolete	Production	SSOP (DB)   28	-	-	Call TI	Call TI	0 to 70	MAX213C
<a href="#">MAX213CDW</a>	Active	Production	SOIC (DW)   28	20   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX213C
MAX213CDW.A	Active	Production	SOIC (DW)   28	20   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX213C
<a href="#">MAX213CDWR</a>	Active	Production	SOIC (DW)   28	1000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX213C
MAX213CDWR.A	Active	Production	SOIC (DW)   28	1000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX213C
<a href="#">MAX213IDB</a>	Obsolete	Production	SSOP (DB)   28	-	-	Call TI	Call TI	-40 to 85	MAX213I
<a href="#">MAX213IDBR</a>	Obsolete	Production	SSOP (DB)   28	-	-	Call TI	Call TI	-40 to 85	MAX213I
<a href="#">MAX213IDWR</a>	Active	Production	SOIC (DW)   28	1000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX213I
MAX213IDWR.A	Active	Production	SOIC (DW)   28	1000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX213I

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MAX213CDWR	SOIC	DW	28	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1
MAX213IDWR	SOIC	DW	28	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX213CDWR	SOIC	DW	28	1000	350.0	350.0	66.0
MAX213IDWR	SOIC	DW	28	1000	350.0	350.0	66.0

## TUBE

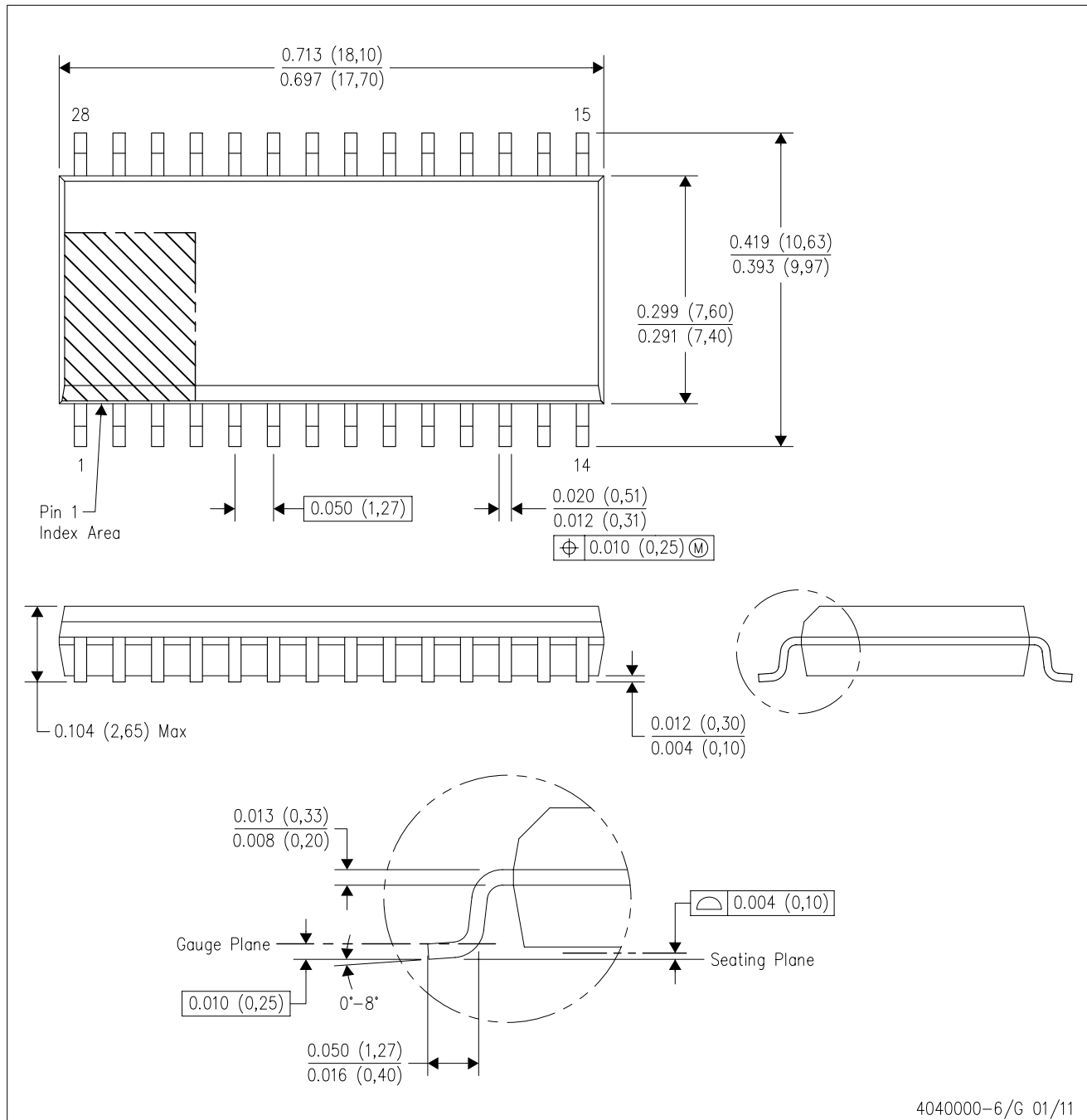


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
MAX213CDW	DW	SOIC	28	20	506.98	12.7	4826	6.6
MAX213CDW.A	DW	SOIC	28	20	506.98	12.7	4826	6.6

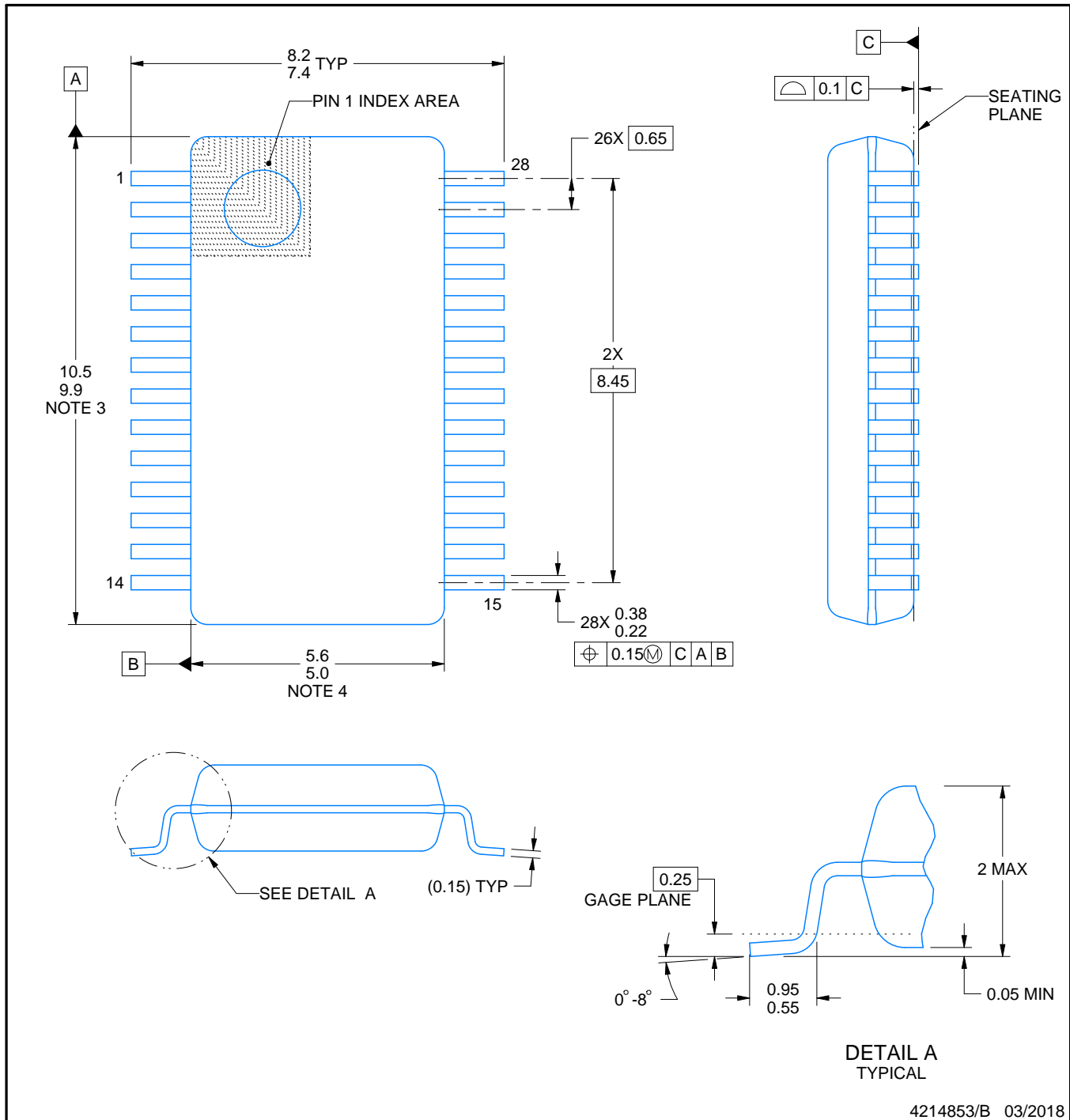
DW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
  - 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.





## NOTES:

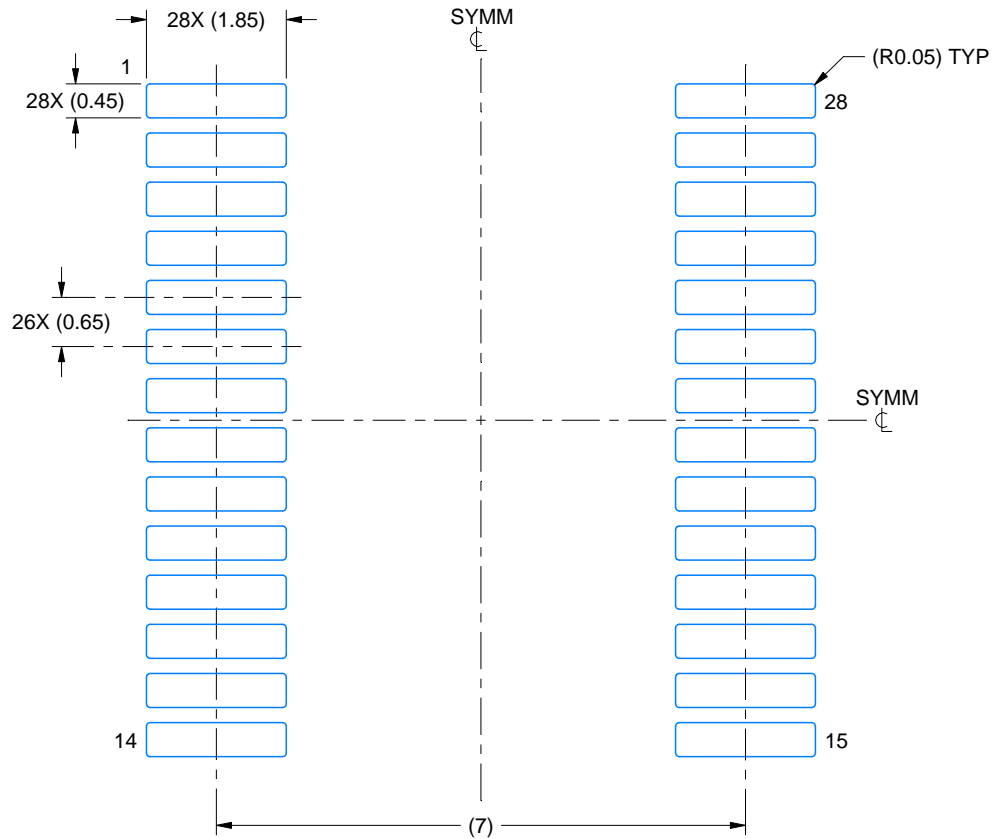
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-150.

# EXAMPLE BOARD LAYOUT

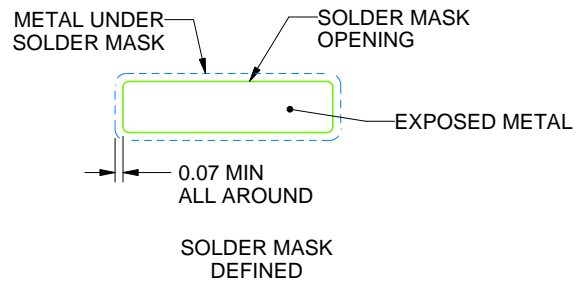
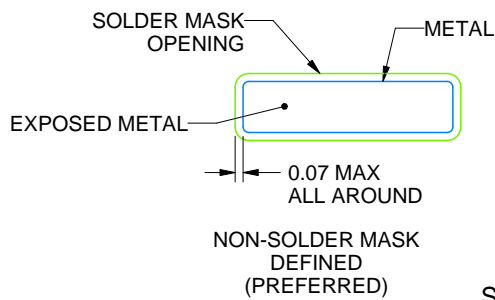
DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4214853/B 03/2018

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

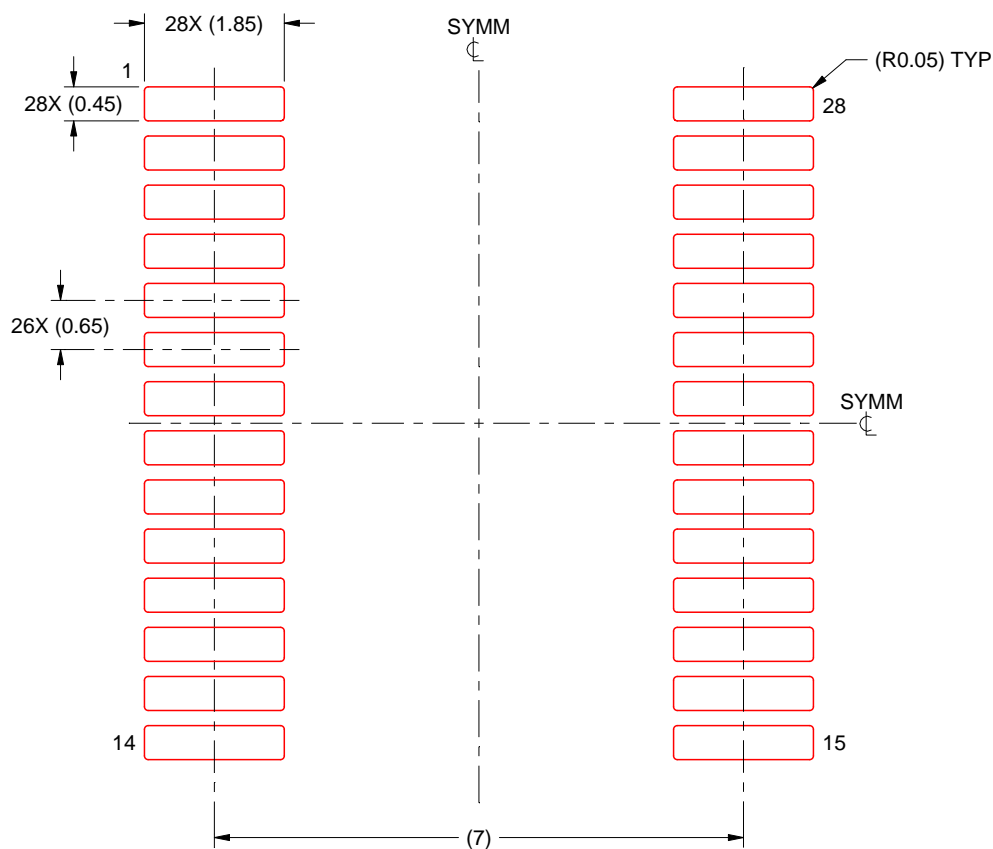
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4214853/B 03/2018

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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