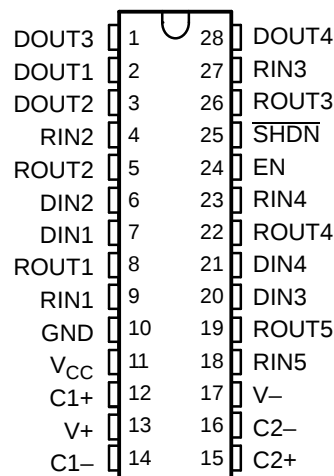


FEATURES

- 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 μ A 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)



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/ μ s 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 μ A. Two receivers of the MAX213 are active during shutdown.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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

SLLS680–DECEMBER 2005

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	

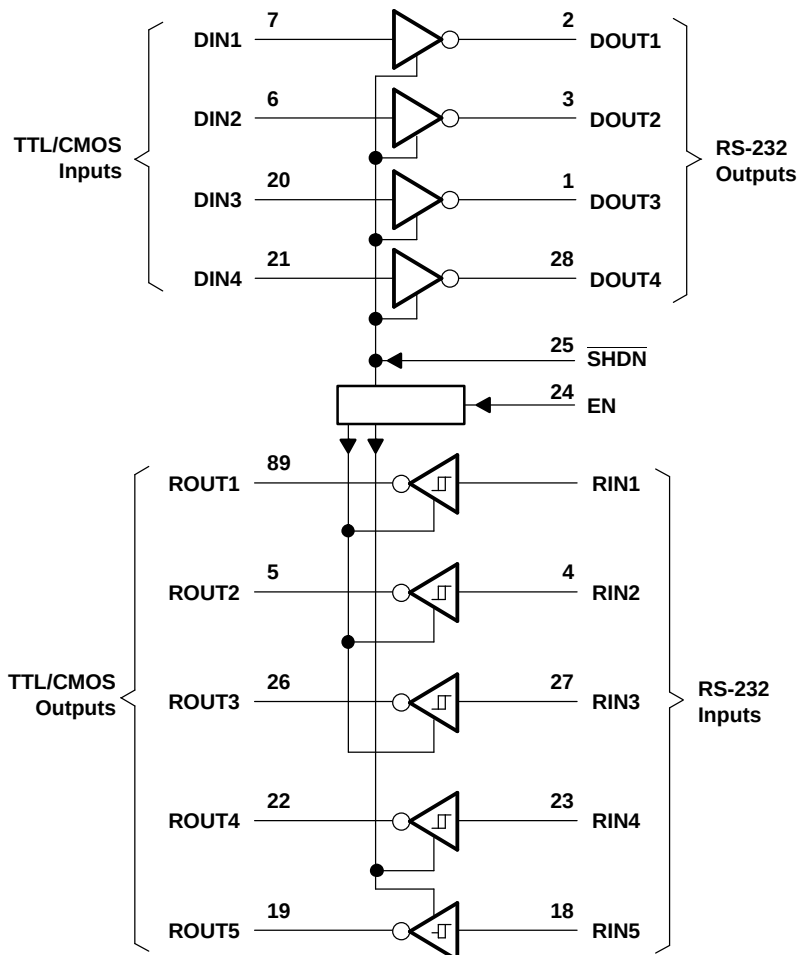
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

INPUTS		DRIVER D1–D4	RECEIVER		DEVICE STATUS
$\overline{\text{SHDN}}$	EN		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)



MAX213

5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

WITH ± 15 -kV ESD PROTECTION

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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 $T_J(\text{max})$, θ_{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⁽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, $\overline{\text{SHDN}}$	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	$^{\circ}\text{C}$
		MAX213I	–40		85	

- (1) Test conditions are C1–C4 = 0.1 μF at $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$.

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 $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$.
- (2) All typical values are at $V_{CC} = 5 \text{ V}$, and $T_A = 25^{\circ}\text{C}$.

DRIVER SECTION

Electrical Characteristics⁽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 k Ω to GND	5	9		V
V _{OL}	Low-level output voltage	DOUT at R _L = 3 k Ω to GND	–5	–9		V
I _{IH}	Control high-level input current	EN, $\overline{\text{SHDN}}$ = 5 V		3	10	μ A
I _{IL}	Driver low-level input current	DIN = 0 V		–15	–200	μ A
	Control low-level input current	EN, $\overline{\text{SHDN}}$ = 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 μ F at V_{CC} = 5 V $\pm$ 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 k Ω to 7 k Ω , 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 k Ω , See Figure 3		2		μ s
t _{PHL(D)}	Propagation delay time, high- to low-level output	C _L = 2500 pF, All drivers loaded, R _L = 3 k Ω , See Figure 3		2		μ s
t _{sk(p)}	Pulse skew ⁽³⁾	C _L = 150 pF to 2500 pF, See Figure 3 R _L = 3 k Ω to 7 k Ω ,		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 k Ω to 7 k Ω ,	3	6	30	V/ μ s

(1) Test conditions are C1–C4 = 0.1 μ F at V_{CC} = 5 V $\pm$ 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

MAX213

5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER

WITH ± 15 -kV ESD PROTECTION

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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
		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
		Shutdown mode (R4–R5)		0.6	1.5
V _{hys} ⁽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 ≤ R _{OUT} ≤ 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 shutdown 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	$\overline{\text{SHDN}} = V_{CC}$		0.5	10
		$\overline{\text{SHDN}} = 0 \text{ V}$, 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

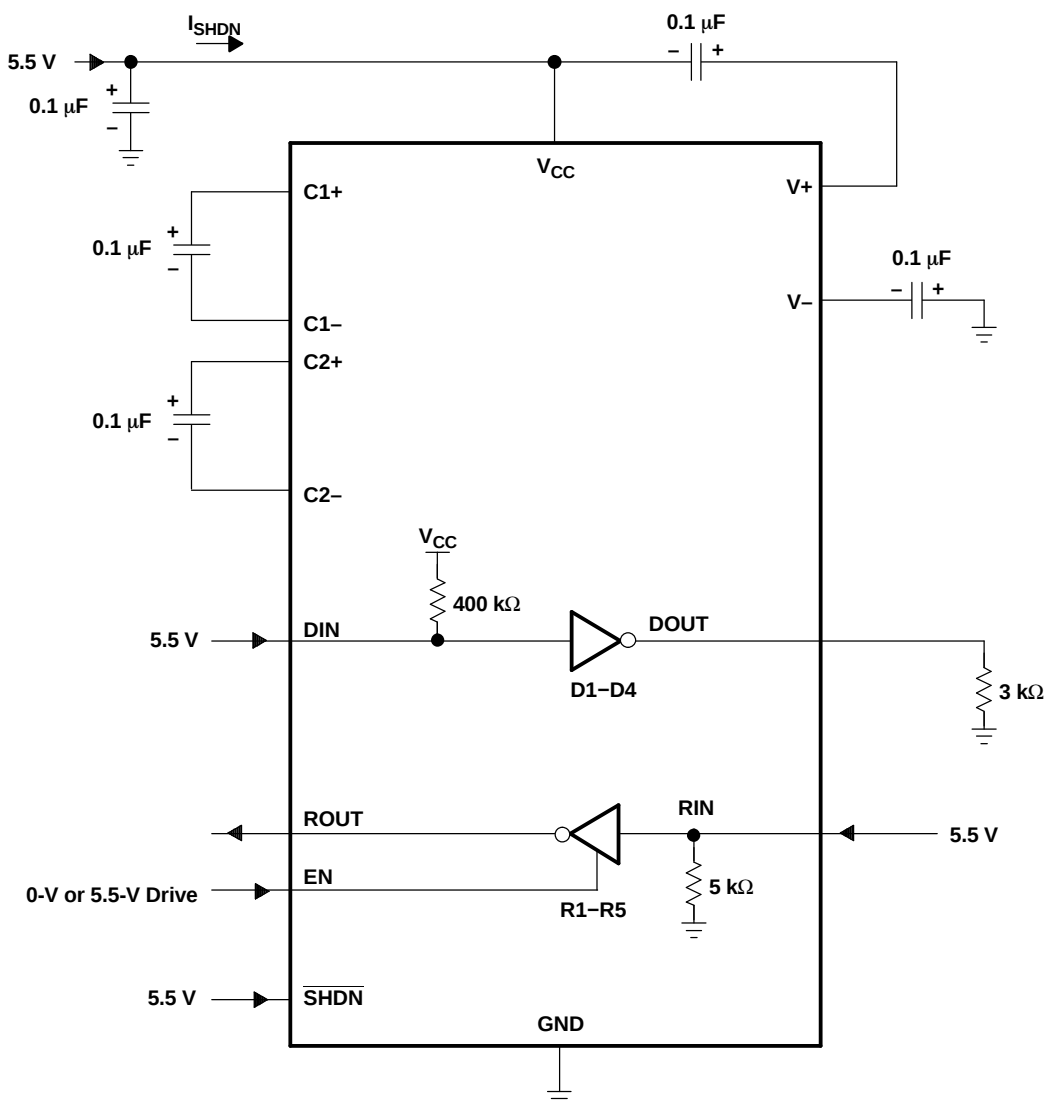
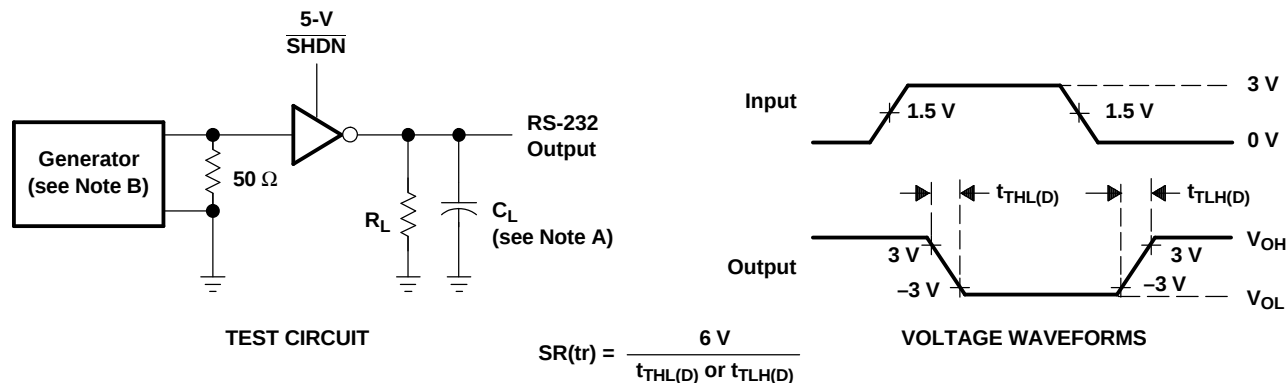


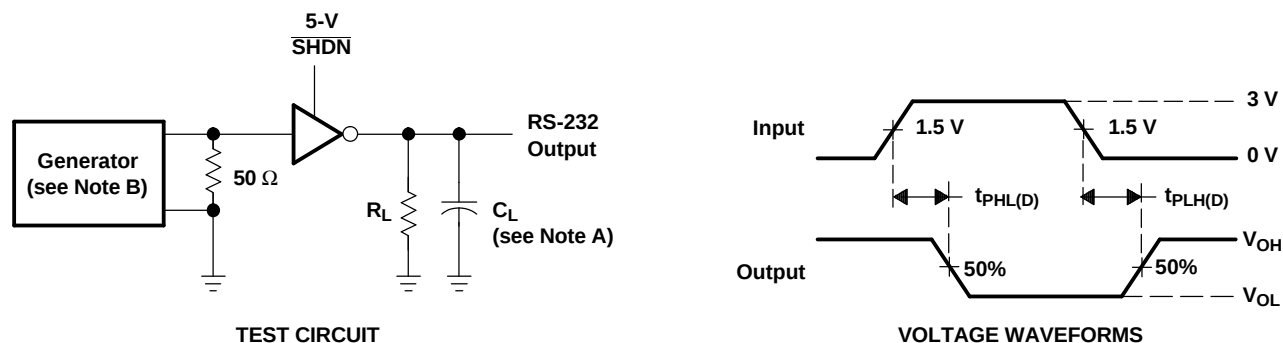
Figure 1. Shutdown Current Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



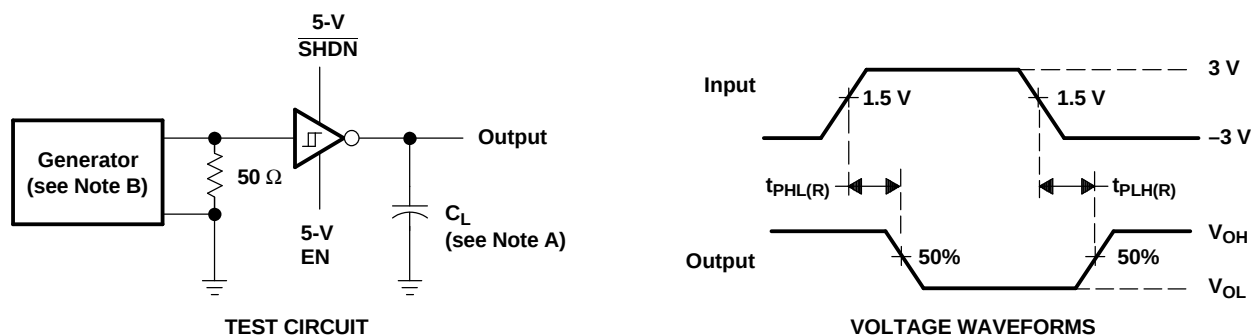
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

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, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

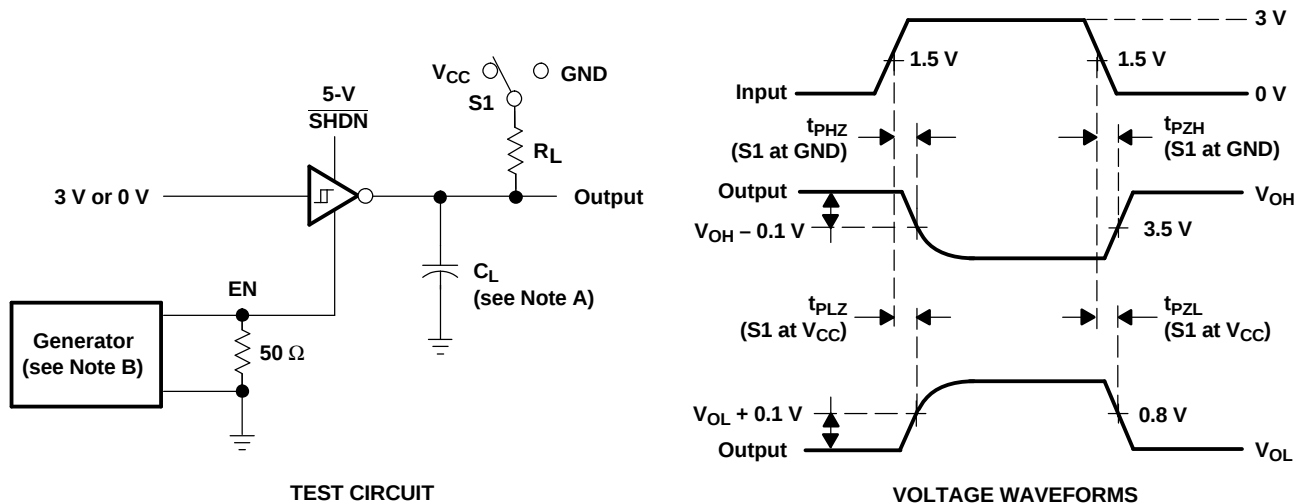
Figure 3. Driver Pulse Skew and Propagation Delay Times



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)



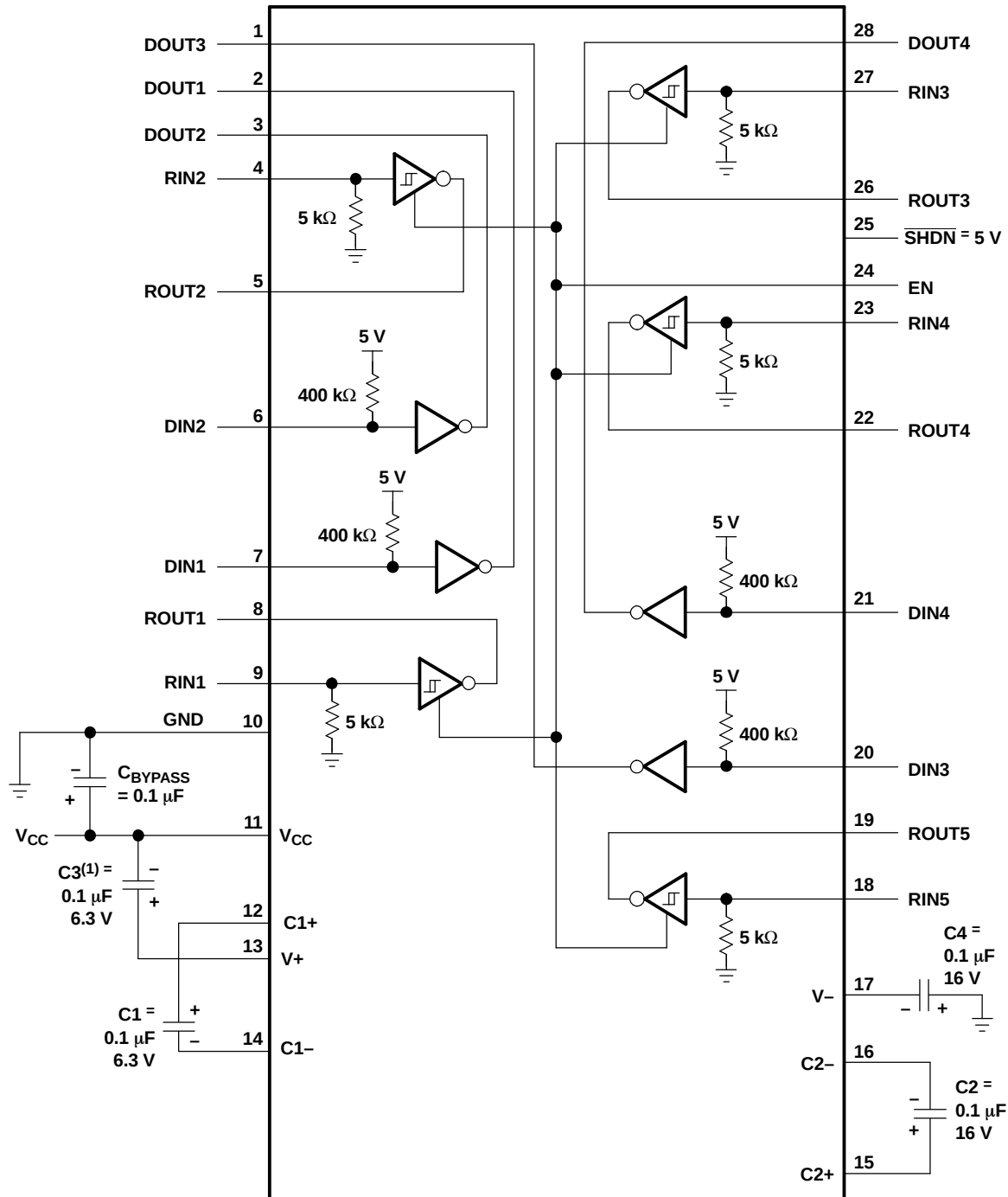
- NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\ \text{ns}$, $t_f \leq 10\ \text{ns}$.
 C. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 D. t_{PZL} and t_{PZH} are the same as t_{en} .

Figure 5. Receiver Enable and Disable Times

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WITH ± 15 -kV ESD PROTECTION

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APPLICATION INFORMATION



(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 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)
MAX213CDB	Obsolete	Production	SSOP (DB) 28	-	-	Call TI	Call TI	0 to 70	MAX213C
MAX213CDBR	Obsolete	Production	SSOP (DB) 28	-	-	Call TI	Call TI	0 to 70	MAX213C
MAX213CDW	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	0 to 70	MAX213C
MAX213CDWR	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	0 to 70	MAX213C
MAX213IDB	Obsolete	Production	SSOP (DB) 28	-	-	Call TI	Call TI	-40 to 85	MAX213I
MAX213IDBR	Obsolete	Production	SSOP (DB) 28	-	-	Call TI	Call TI	-40 to 85	MAX213I
MAX213IDWR	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

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

⁽²⁾ **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.

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

⁽⁴⁾ **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.

⁽⁵⁾ **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.

⁽⁶⁾ **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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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

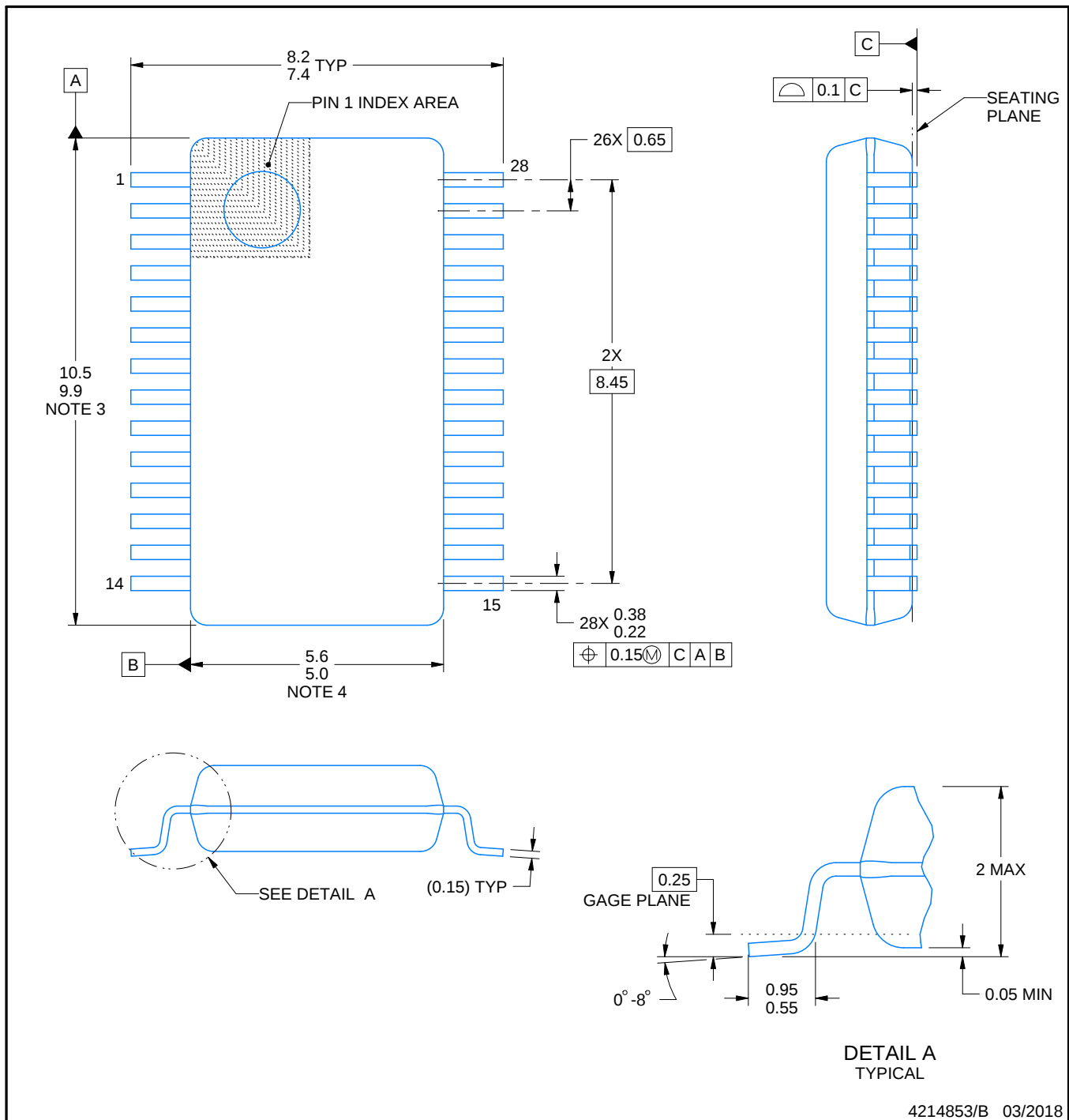
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX213CDWR	SOIC	DW	28	1000	350.0	350.0	66.0
MAX213IDWR	SOIC	DW	28	1000	350.0	350.0	66.0

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



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NOTES:

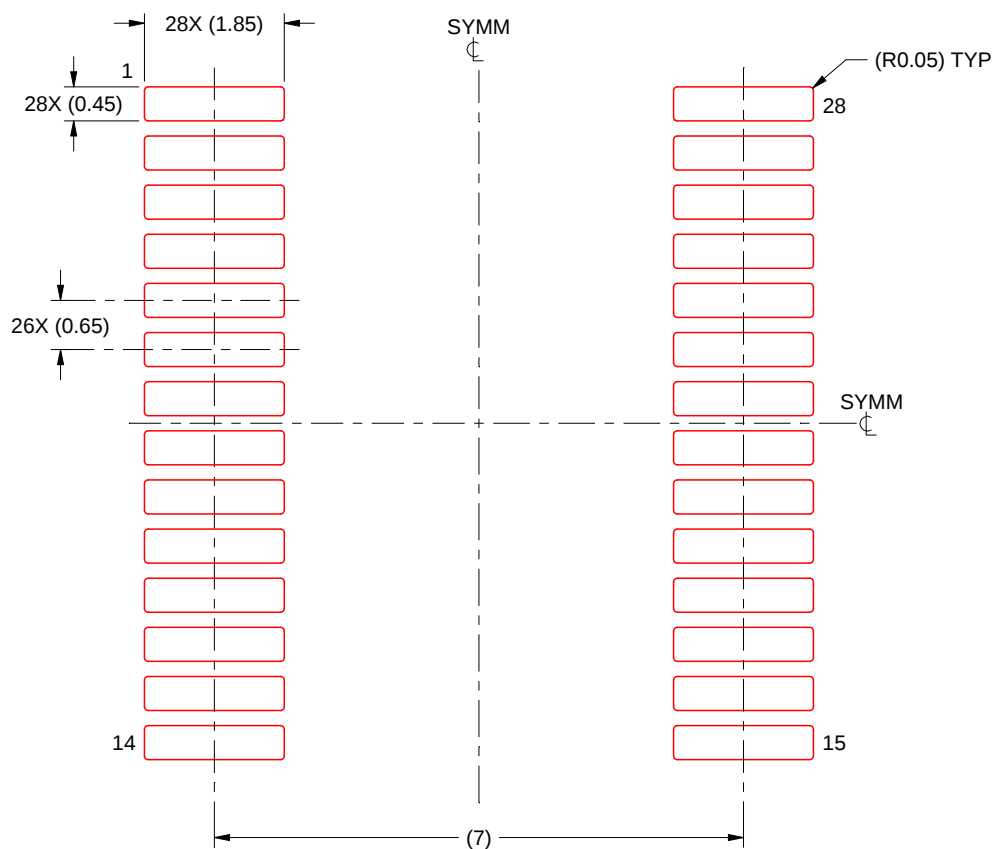
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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 STENCIL DESIGN

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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

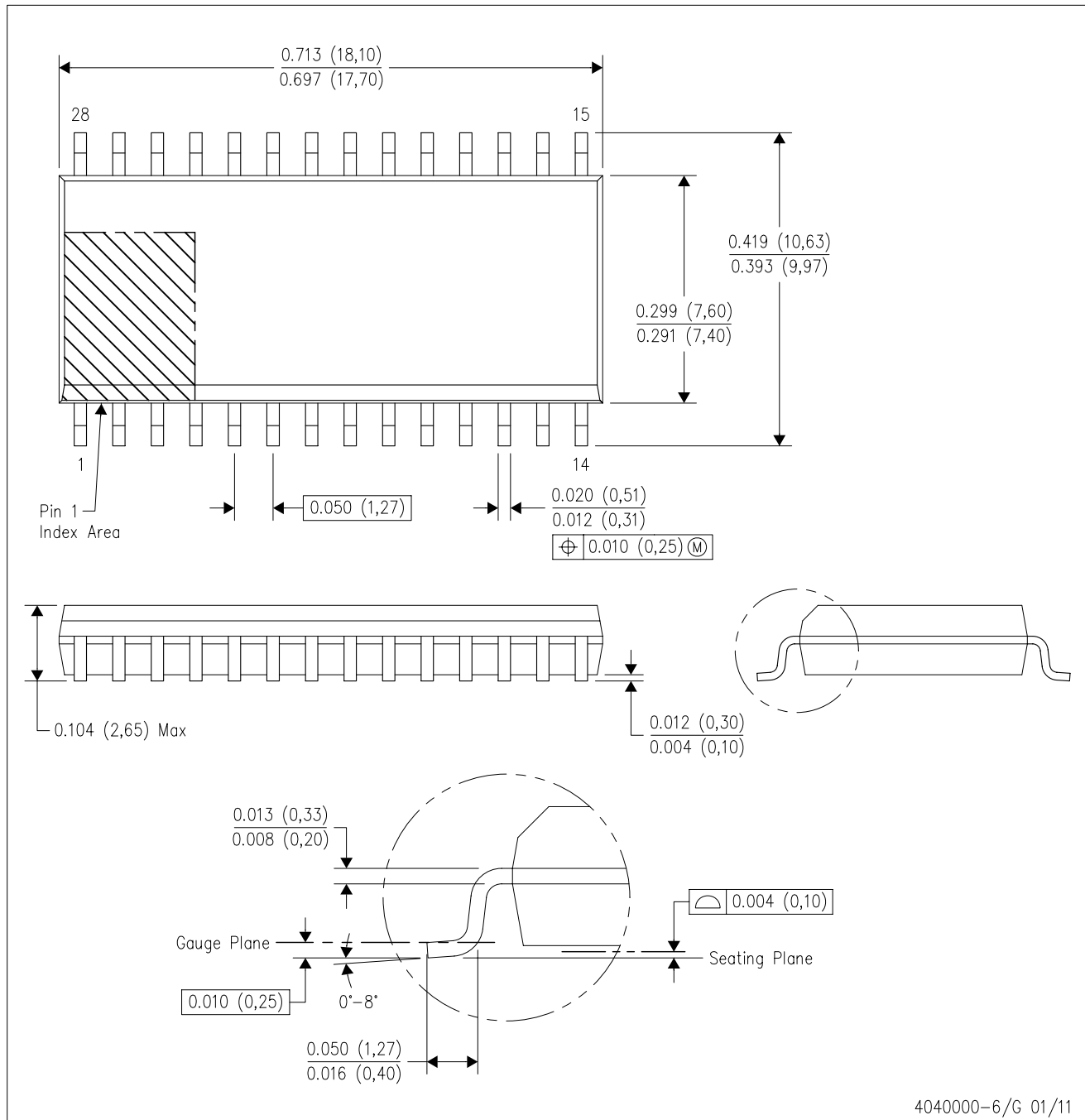
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NOTES: (continued)

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.

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.

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