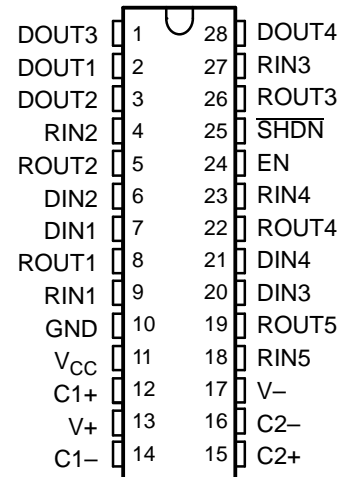


FEATURES

- 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 \times 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 ($\overline{\text{SHDN}}$) 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 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 | |
| Reel of 1000 | | | MAX213IDWR | |
| SSOP – DB | | Tube of 50 | MAX213IDB | |
| | | Reel of 2000 | MAX213IDBR | |
| TSSOP – PW | | Tape and reel | MAX213IPWR | |

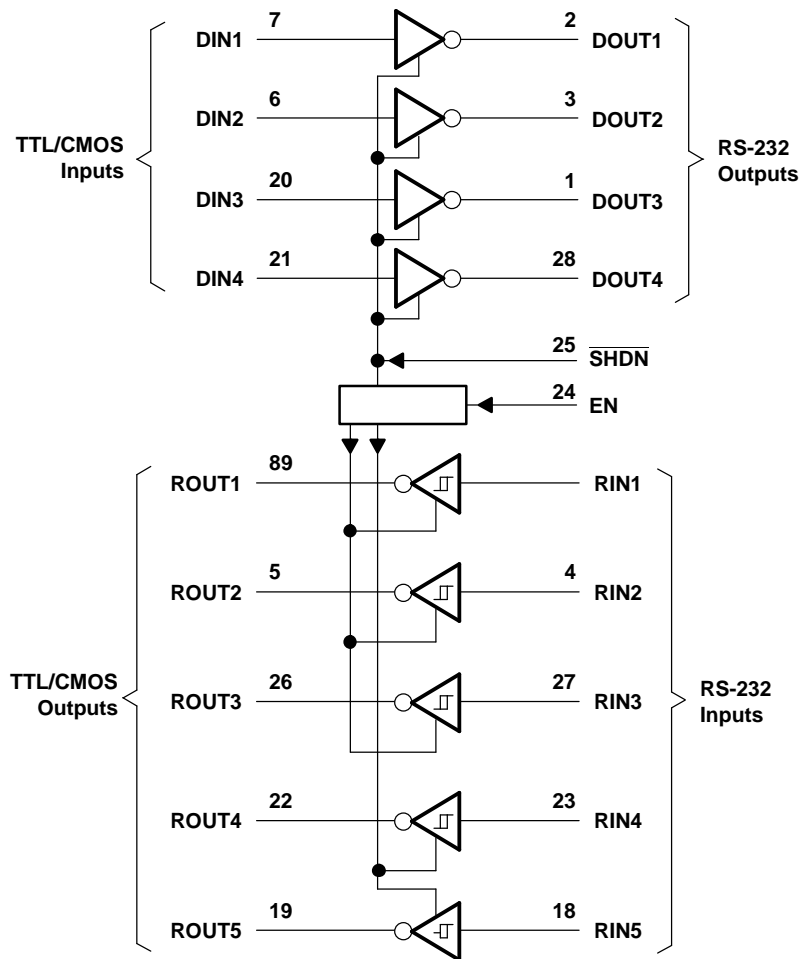
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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

SLLS680–DECEMBER 2005

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 | V+ + 0.3 | V |
| | | Receivers | ±30 | |
| V _O | Output voltage range | Drivers | V- - 0.3 | V |
| | | Receivers | -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)/θ_{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 | | | V |
| | Control high-level input voltage | EN, $\overline{\text{SHDN}}$ | | | |
| V _{IL} | Driver and control low-level input voltage | DIN, EN, $\overline{\text{SHDN}}$ | | | V |
| V _I | Driver and control input voltage | DIN, EN, $\overline{\text{SHDN}}$ | | | V |
| | Receiver input voltage | RIN | | | |
| T _A | Operating free-air temperature | MAX213C | | 70 | °C |
| | | MAX213I | | 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 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 | | 300 | | ns |
| SR(tr) | Slew rate, transition region (see Figure 2) | C _L = 50 pF to 1000 pF, V _{CC} = 5 V | 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

SLLS680–DECEMBER 2005

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 | | |
| 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 ≤ RO _{UT} ≤ 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 | SHDN = V _{CC} | 0.5 | 10 | μs | |
| | | | 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

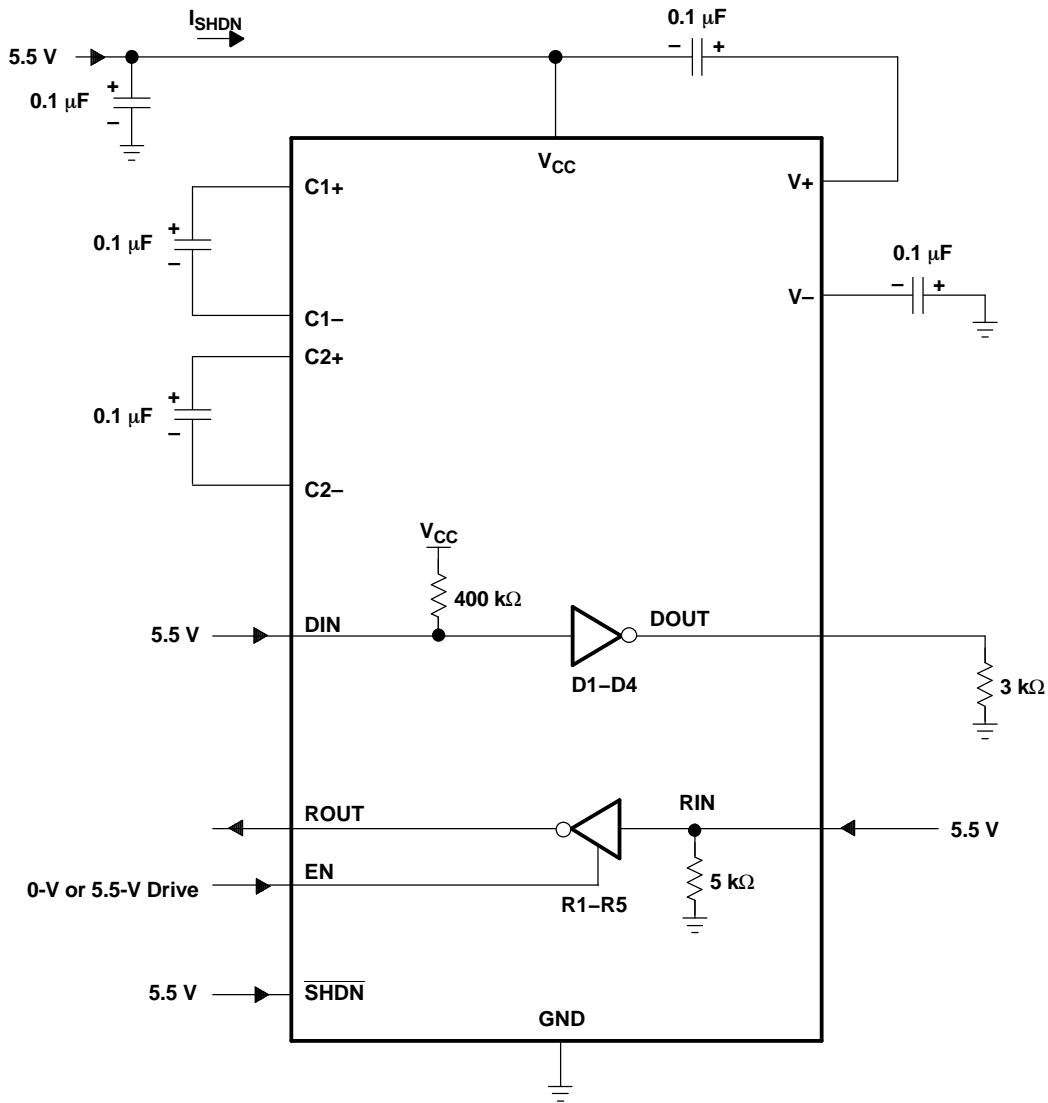
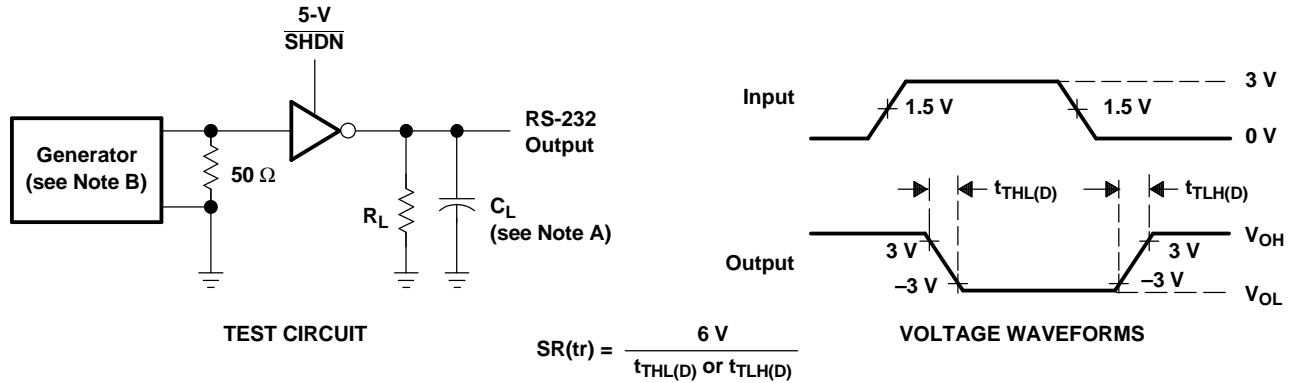


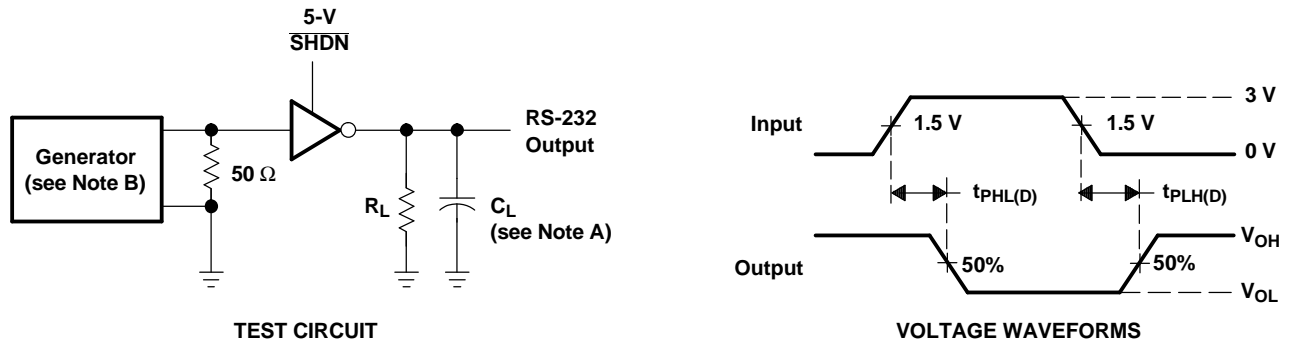
Figure 1. Shutdown Current Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



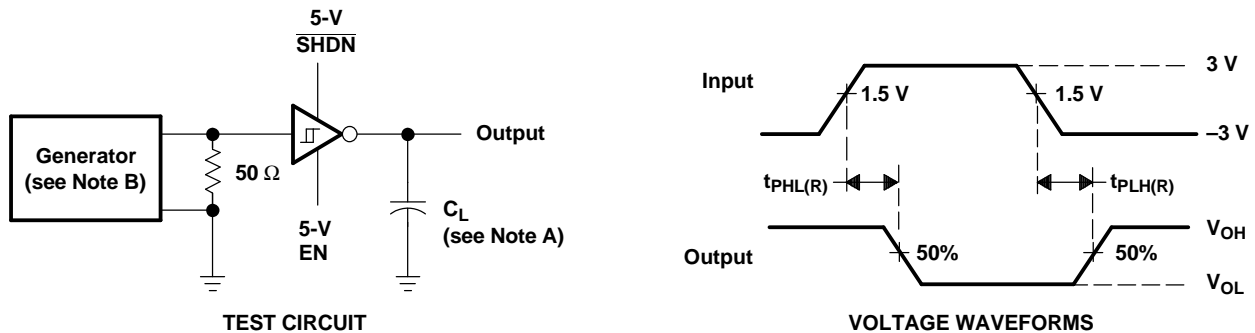
NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generator has the following characteristics: $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10 \text{ ns}$, $t_f \leq 10 \text{ ns}$.

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

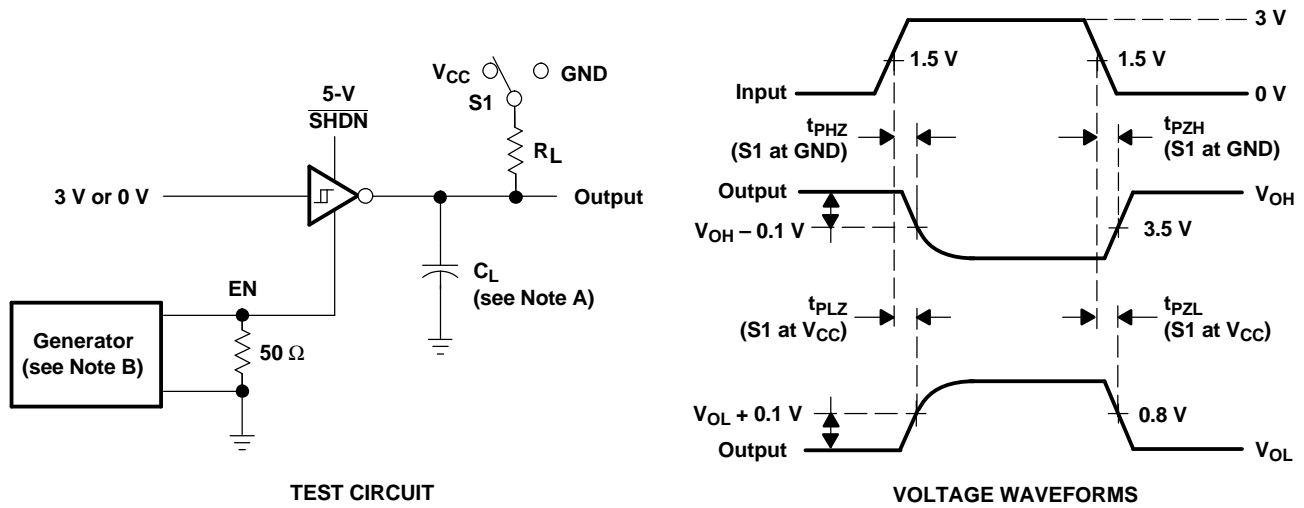
Figure 3. Driver Pulse Skew and Propagation Delay Times



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, $t_r \leq 10$ 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

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| MAX213CDB | ACTIVE | SSOP | DB | 28 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MAX213C | Samples |
| MAX213CDBR | ACTIVE | SSOP | DB | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MAX213C | Samples |
| MAX213CDW | ACTIVE | SOIC | DW | 28 | 20 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MAX213C | Samples |
| MAX213CDWR | ACTIVE | SOIC | DW | 28 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | MAX213C | Samples |
| MAX213IDB | ACTIVE | SSOP | DB | 28 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MAX213I | Samples |
| MAX213IDBR | ACTIVE | SSOP | DB | 28 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MAX213I | Samples |
| MAX213IDWR | ACTIVE | SOIC | DW | 28 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | MAX213I | Samples |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead finish/Ball material - Orderable Devices 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.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| MAX213CDBR | SSOP | DB | 28 | 2000 | 330.0 | 16.4 | 8.2 | 10.5 | 2.5 | 12.0 | 16.0 | Q1 |
| MAX213CDWR | SOIC | DW | 28 | 1000 | 330.0 | 32.4 | 11.35 | 18.67 | 3.1 | 16.0 | 32.0 | Q1 |
| MAX213IDBR | SSOP | DB | 28 | 2000 | 330.0 | 16.4 | 8.2 | 10.5 | 2.5 | 12.0 | 16.0 | 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) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| MAX213CDBR | SSOP | DB | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| MAX213CDWR | SOIC | DW | 28 | 1000 | 350.0 | 350.0 | 66.0 |
| MAX213IDBR | SSOP | DB | 28 | 2000 | 356.0 | 356.0 | 35.0 |
| 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) |
|-----------|--------------|--------------|------|-----|--------|--------|--------|--------|
| MAX213CDB | DB | SSOP | 28 | 50 | 530 | 10.5 | 4000 | 4.1 |
| MAX213CDW | DW | SOIC | 28 | 20 | 506.98 | 12.7 | 4826 | 6.6 |
| MAX213IDB | DB | SSOP | 28 | 50 | 530 | 10.5 | 4000 | 4.1 |

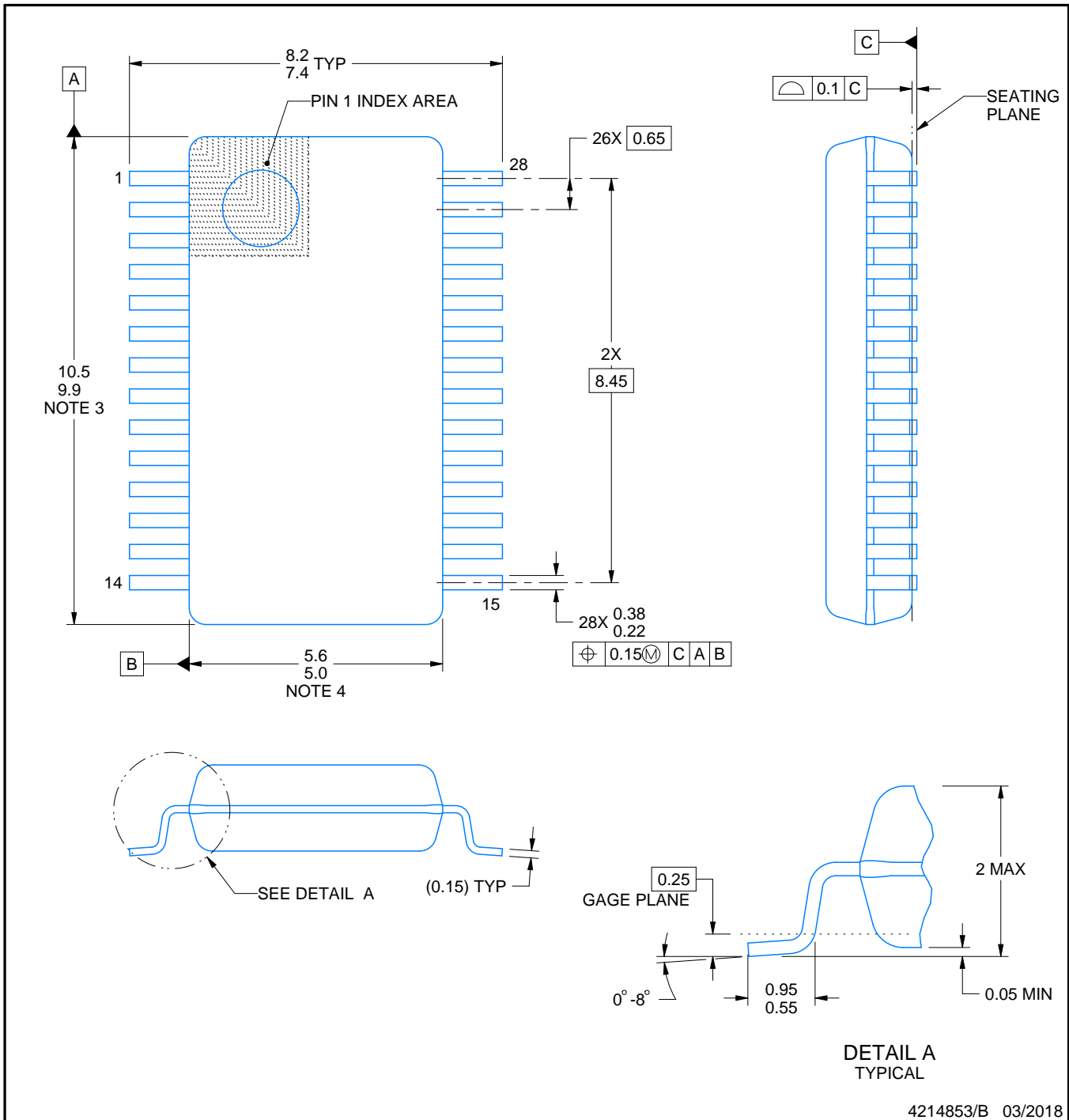
DB0028A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4214853/B 03/2018

NOTES:

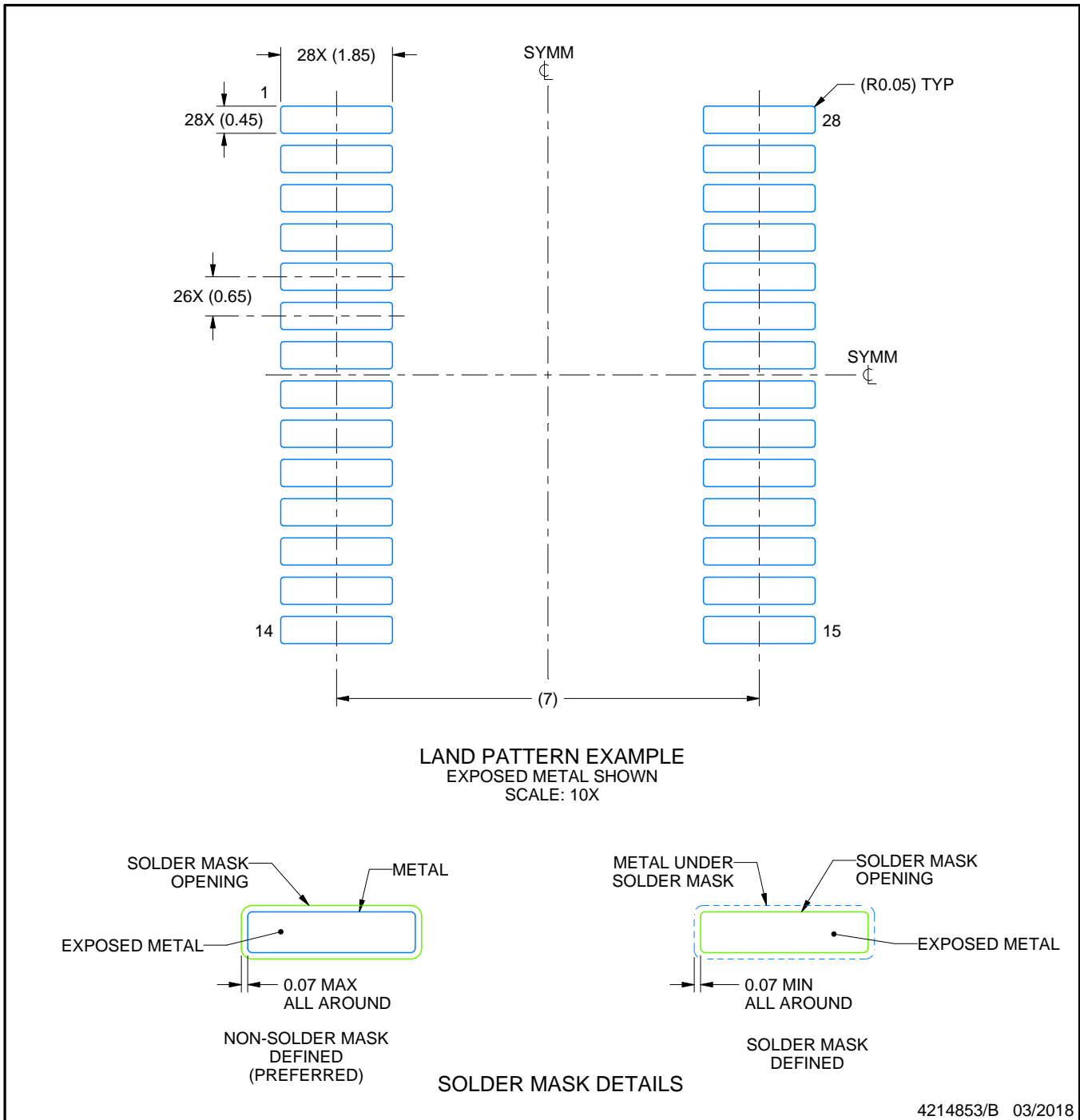
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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



4214853/B 03/2018

NOTES: (continued)

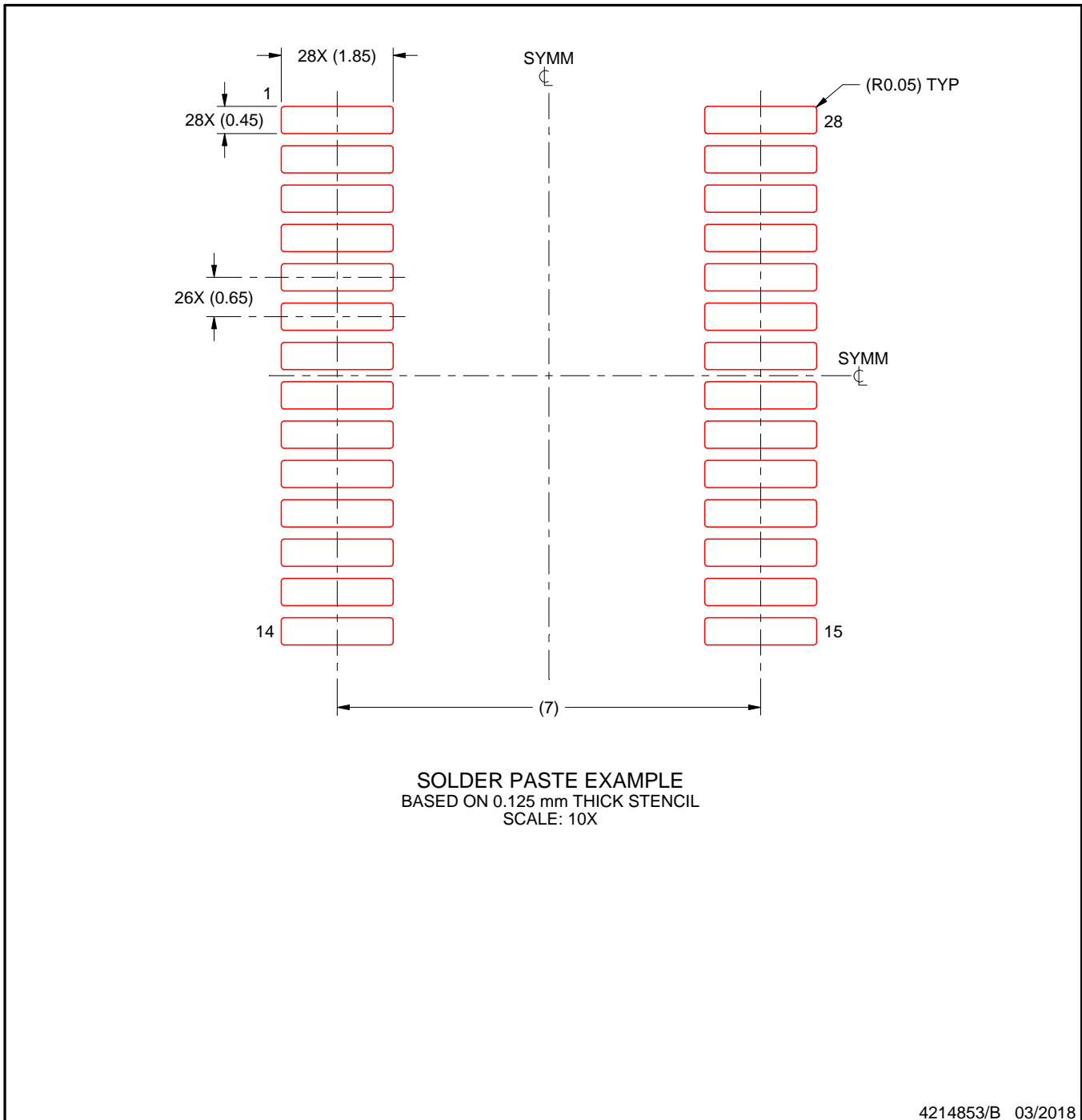
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0028A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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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