

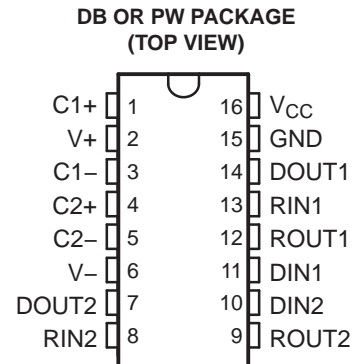
## 3-V TO 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH $\pm 15$ -kV ESD PROTECTION

### FEATURES

- RS-232 Bus-Pin ESD Protection Exceeds  $\pm 15$  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  $\mu$ A Typical
- External Capacitors . . .  $4 \times 0.1 \mu$ F
- 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



### SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- Controlled Baseline
- One Assembly/Test Site
- One Fabrication Site
- Available in Military ( $-55^{\circ}\text{C}/125^{\circ}\text{C}$ ) Temperature Range<sup>(1)</sup>
- Extended Product Life Cycle
- Extended Product-Change Notification
- Product Traceability

(1) Additional temperature ranges are available - contact factory

### ORDERING INFORMATION<sup>(1)</sup>

$T_A$	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-55°C to 125°C	SSOP (DB)	Reel of 2000	MAX3232MDBREP	MB3232M
	TSSOP(PW)	Reel of 2000	MAX3232MPWREP	

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

### DESCRIPTION

The MAX3232 device consists of two line drivers, two 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 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/ $\mu$ s driver output slew rate.



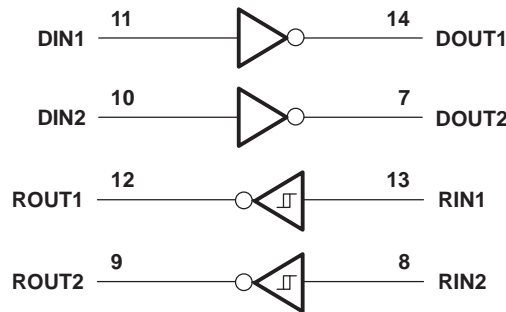
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FUNCTION TABLE

EACH DRIVER		EACH RECEIVER	
INPUT DIN	OUTPUT DOUT	INPUT RIN	OUTPUT ROUT
L	H	L	H
H	L	H	L
		Open	H

H = high level, L = low level, Open = input disconnected or connected driver off

LOGIC DIAGRAM (POSITIVE LOGIC)



ABSOLUTE MAXIMUM RATINGS

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

		VALUE	UNIT
$V_{CC}$	Supply voltage range <sup>(1)</sup>	-0.3 to 6	V
$V+$	Positive output supply voltage range <sup>(1)</sup>	-0.3 to 7	V
$V-$	Negative output supply voltage range <sup>(1)</sup>	0.3 to -7	V
$V+ - V-$	Supply voltage difference <sup>(1)</sup>	13	V
$V_I$	Input voltage range	Drivers	-0.3 to 6
		Receivers	-25 to 25
$V_O$	Output voltage range	Drivers	-13.2 to 13.2
		Receivers	-0.3 to $V_{CC} + 0.3$
$\theta_{JA}$	Package thermal impedance <sup>(2)</sup>	DB package	82
		PW package	108
$T_J$	Operating virtual junction temperature	150	°C
$T_{stg}$	Storage temperature range	-65 to 150	°C

(1) All voltages are with respect to network GND.

(2) Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , 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.

RECOMMENDED OPERATING CONDITIONS (see <sup>(1)</sup>and Figure 4)

		MIN	NOM	MAX	UNIT
Supply voltage		$V_{CC} = 3.3\text{ V}$	3	3.3	3.6
		$V_{CC} = 5\text{ V}$	4.5	5	5.5
$V_{IH}$	Driver high-level input voltage	DIN	$V_{CC} = 3.3\text{ V}$	2	
			$V_{CC} = 5\text{ V}$	2.4	
$V_{IL}$	Driver low-level input voltage	DIN		0.8	V

(1) Test conditions are C1–C4 = 0.1  $\mu\text{F}$  at  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ ; C1 = 0.047  $\mu\text{F}$ , C2–C4 = 0.33  $\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

**RECOMMENDED OPERATING CONDITIONS (see and [Figure 4](#)) (continued)**

				MIN	NOM	MAX	UNIT
V <sub>I</sub>	Driver input voltage	DIN		0		5.5	V
	Receiver input voltage			-25		25	
T <sub>A</sub>	Operating free-air temperature	MAX3232M		-55		125	°C

**ELECTRICAL CHARACTERISTICS**

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see <sup>(1)</sup> and [Figure 4](#))

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
I <sub>CC</sub>	Supply current	No load, V <sub>CC</sub> = 3.3 V or 5 V		0.3	2	mA

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ±0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

## DRIVER SECTION

### ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see <sup>(1)</sup>and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
V <sub>OH</sub>	High-level output voltage	DOOUT at R <sub>L</sub> = 3 kΩ to GND, DIN = GND	5	5.4		V
V <sub>OL</sub>	Low-level output voltage	DOOUT at R <sub>L</sub> = 3 kΩ to GND, DIN = V <sub>CC</sub>	–5	–5.4		V
I <sub>IH</sub>	High-level input current	V <sub>I</sub> = V <sub>CC</sub>		±0.01	±1	μA
I <sub>IL</sub>	Low-level input current	V <sub>I</sub> at GND		±0.01	±1	μA
I <sub>OS</sub> <sup>(3)</sup>	Short-circuit output current	V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0 V		±35	±60	mA
		V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V				
r <sub>o</sub>	Output resistance	V <sub>CC</sub> , V+, and V– = 0 V, V <sub>O</sub> = ±2 V	300	10M		Ω

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ±0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or 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

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see <sup>(1)</sup>and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
	Maximum data rate	C <sub>L</sub> = 1000 pF, One DOOUT switching, R <sub>L</sub> = 3 kΩ, See Figure 1	150	250		kbit/s
t <sub>sk(p)</sub>	Pulse skew <sup>(1)</sup>	CL = 150 pF to 2500 pF, R <sub>L</sub> = 3 kΩ to 7 kΩ, See Figure 2		300		ns
SR(tr)	Slew rate, transition region (see Figure 1)	RL = 3 kΩ to 7 kΩ, V <sub>CC</sub> = 3.3 V	C <sub>L</sub> = 150 pF to 1000 pF	6	30	V/μs
			C <sub>L</sub> = 150 pF to 2500 pF	4	30	

(1) 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.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V, and T<sub>A</sub> = 25°C.

RECEIVER SECTION

ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted (see <sup>(1)</sup>and Figure 4)

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> -0.6	V <sub>CC</sub> -0.1		V
V <sub>OL</sub>	Low-level output voltage	I <sub>OL</sub> = 1.6 mA			0.4	V
V <sub>IT+</sub>	Positive-going input threshold voltage	V <sub>CC</sub> = 3.3 V		1.5	2.4	V
		V <sub>CC</sub> = 5 V		1.8	2.4	
V <sub>IT-</sub>	Negative-going input threshold voltage	V <sub>CC</sub> = 3.3 V	0.6	1.2		V
		V <sub>CC</sub> = 5 V	0.8	1.5		
V <sub>hys</sub>	Input hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )			0.3		V
r <sub>i</sub>	Input resistance	V <sub>i</sub> = ±3 V to ±25 V	3	5	8	kΩ

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ±0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

SWITCHING CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted (see <sup>(1)</sup>and Figure 3)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(2)</sup>	MAX	UNIT
t <sub>PLH</sub>	Propagation delay time, low- to high-level output	C <sub>L</sub> = 150 pF		300		ns
t <sub>PHL</sub>	Propagation delay time, high- to low-level output			300		ns
t <sub>sk(p)</sub>	Pulse skew <sup>(3)</sup>			300		ns

(1) Test conditions are C1–C4 = 0.1 μF at V<sub>CC</sub> = 3.3 V ±0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V<sub>CC</sub> = 5 V ±0.5 V.

(2) All typical values are at V<sub>CC</sub> = 3.3 V or 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.

PARAMETER MEASUREMENT INFORMATION

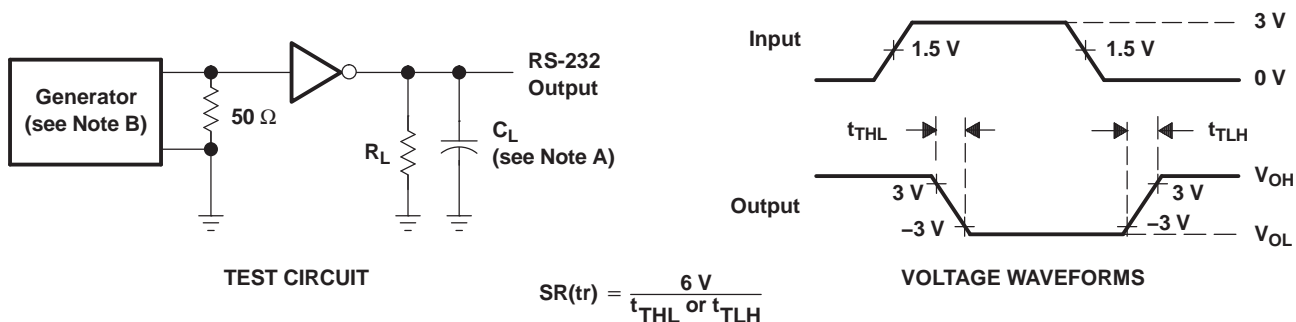
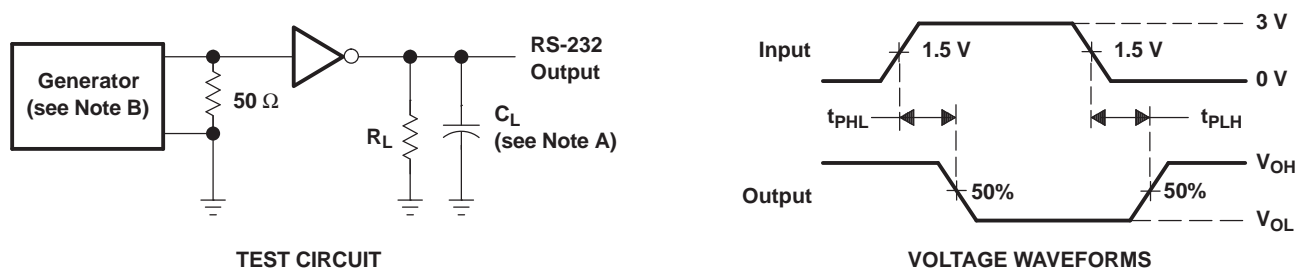


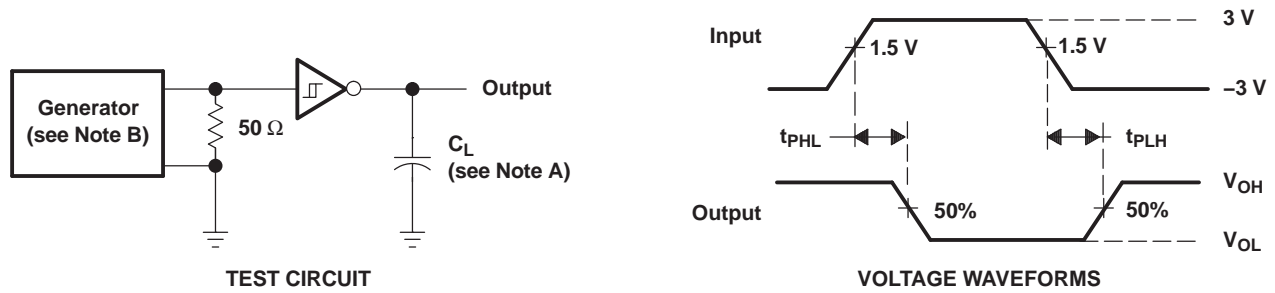
Figure 1. Driver Slew Rate



- A. C<sub>L</sub> includes probe and jig capacitance.
- B. The pulse generator has the following characteristics: Z<sub>O</sub> = 50 Ω, 50% duty cycle, tr ≤ 10 ns, tf ≤ 10 ns.

Figure 2. Driver Pulse Skew

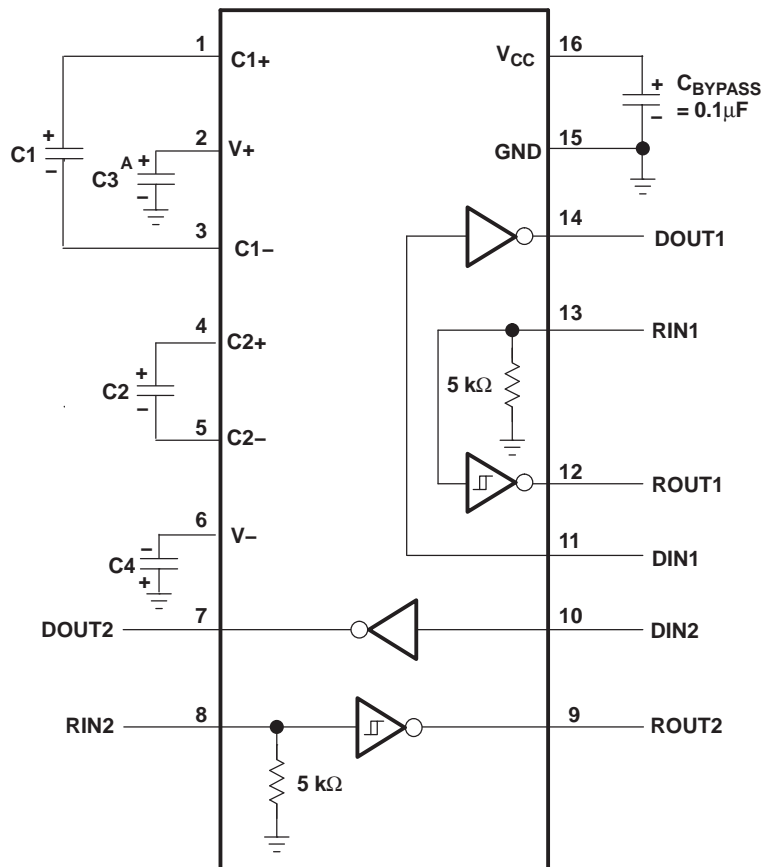
### PARAMETER MEASUREMENT INFORMATION (continued)



- 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. Receiver Propagation Delay Times**

APPLICATION INFORMATION



V<sub>CC</sub> vs CAPACITOR VALUES

V <sub>CC</sub>	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

- A. C3 can be connected to V<sub>CC</sub> or GND.
- B. Resistor values shown are nominal.
- C. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

Figure 4. 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="#">MAX3232MDBREP</a>	Active	Production	SSOP (DB)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M
<a href="#">MAX3232MPWREP</a>	Active	Production	TSSOP (PW)   16	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-55 to 125	MB3232M

(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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**OTHER QUALIFIED VERSIONS OF MAX3232-EP :**

- Catalog : [MAX3232](#)



NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**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
MAX3232MDBREP	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
MAX3232MPWREP	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3232MDBREP	SSOP	DB	16	2000	367.0	367.0	38.0
MAX3232MPWREP	TSSOP	PW	16	2000	356.0	356.0	35.0



4220204/A 02/2017

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-153.

# EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4220204/A 02/2017

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

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/A 02/2017

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.

# DB0016A



# PACKAGE OUTLINE

## SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4220763/A 05/2022

### NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- 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.
- Reference JEDEC registration MO-150.

# EXAMPLE BOARD LAYOUT

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220763/A 05/2022

NOTES: (continued)

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

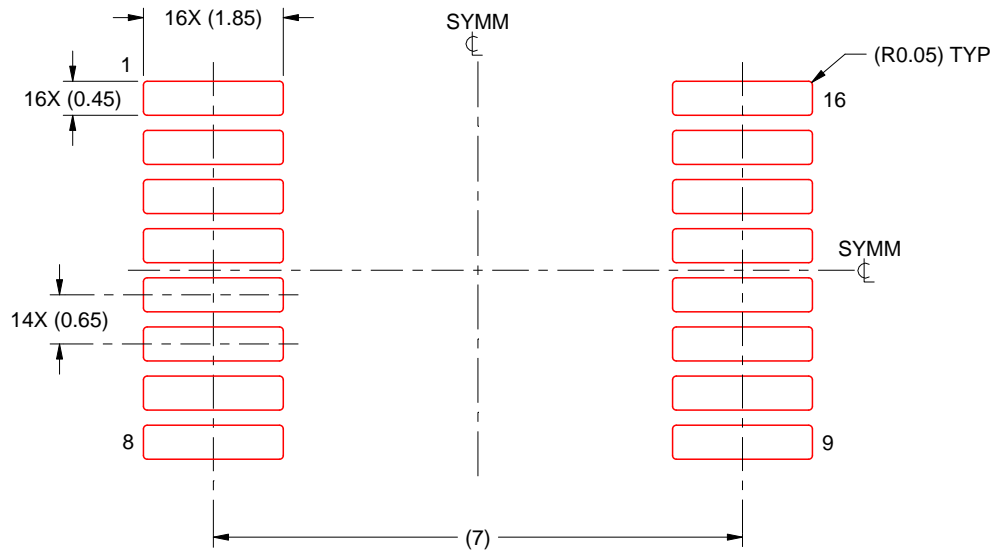


# EXAMPLE STENCIL DESIGN

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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

4220763/A 05/2022

NOTES: (continued)

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

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