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RS-232 TRANSCEIVER WITH SPLIT SUPPLY PIN FOR LOGIC SIDE

Check for Samples: [MAX3386E](#)

FEATURES

- **V_L Pin for Compatibility With Mixed-Voltage Systems Down to 2.5 V on Logic Side**
- **Enhanced ESD Protection on RIN Inputs and DOUT Outputs**
 - ±15-kV Human-Body Model
 - ±15-kV IEC 61000-4-2, Air-Gap Discharge
 - ±8-kV IEC 61000-4-2, Contact Discharge
- **Low 300-µA Supply Current**
- **Specified 250-kbps Data Rate**
- **1-µA Low-Power Shutdown**
- **Meets EIA/TIA-232 Specifications Down to 3 V**

APPLICATIONS

- Hand-Held Equipment
- PDAs
- Cell Phones
- Battery-Powered Equipment
- Data Cables

DESCRIPTION/ORDERING INFORMATION

The MAX3386E is a three-driver and two-receiver RS-232 interface device, with split supply pins for mixed-signal operations. All RS-232 inputs and outputs are protected to ±15 kV using the IEC 61000-4-2 Air-Gap Discharge method, ±8 kV using the IEC 61000-4-2 Contact Discharge method, and ±15 kV using the Human-Body Model.

The charge pump requires only four small 0.1-µF capacitors for operation from a 3.3-V supply. The MAX3386E is capable of running at data rates up to 250 kbps, while maintaining RS-232-compliant output levels.

The MAX3386E has a unique V_L pin that allows operation in mixed-logic voltage systems. Both driver in (DIN) and receiver out (ROUT) logic levels are pin programmable through the V_L pin. The MAX3386E is available in a space-saving thin shrink small-outline package (TSSOP).

ORDERING INFORMATION

T _A	PACKAGE ⁽¹⁾ (2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	TSSOP – PW	MAX3386ECPWR	MP386EC
	SOIC – DW	MAX3386ECDW	MAX3386EC
–40°C to 85°C	TSSOP – PW	MAX3386EIPWR	MP386EI
	SOIC – DW	MAX3386EIDW	MAX3386EI

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

(2) 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.

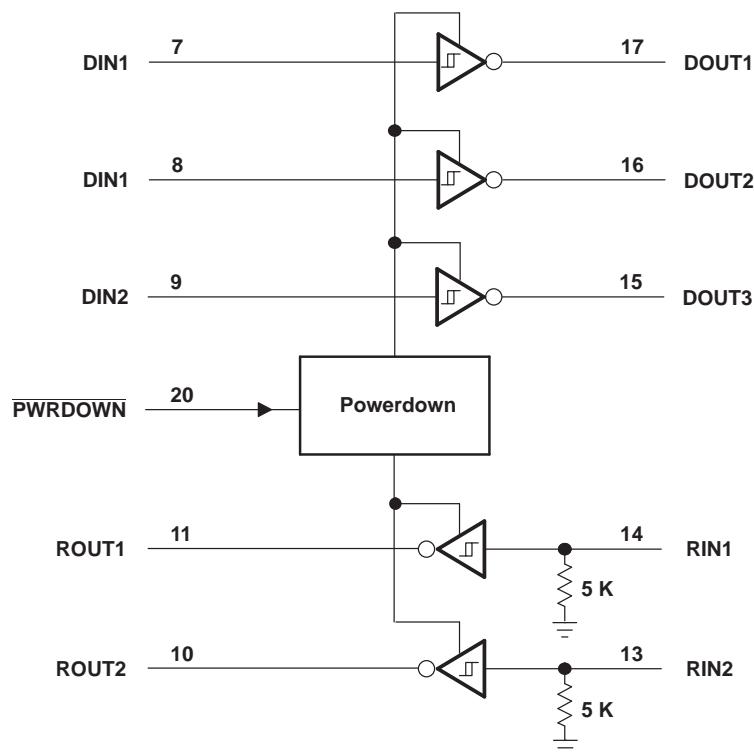


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Table 1. TRUTH TABLE (SHUTDOWN FUNCTION)

PWRDWN	DRIVER OUTPUTS	RECEIVER OUTPUTS	CHARGE PUMP
L	High-Z	High-Z	Inactive
H	Active	Active	Active

FUNCTIONAL BLOCK DIAGRAM



TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION
NAME	NO.	
C1+	1	Positive terminal of the voltage-doubler charge-pump capacitor
V+	2	5.5-V supply generated by the charge pump
C1-	3	Negative terminal of the voltage-doubler charge-pump capacitor
C2+	4	Positive terminal of the inverting charge-pump capacitor
C2-	5	Negative terminal of the inverting charge-pump capacitor
V-	6	-5.5-V supply generated by the charge pump
DIN1	7	Driver inputs
DIN2	8	
DIN3	9	
ROUT2	10	Receiver outputs. Swing between 0 and V_L .
ROUT1	11	
V_L	12	Logic-level supply. All CMOS inputs and outputs are referenced to this supply.
RIN2	13	RS-232 receiver inputs
RIN1	14	
DOUT3	15	RS-232 driver outputs
DOUT2	16	
DOUT1	17	
GND	18	Ground

TERMINAL FUNCTIONS (continued)

TERMINAL	NAME	NO.	DESCRIPTION
V _{CC}		19	3-V to 5.5-V supply voltage
PWRDWN		20	Powerdown input L = Powerdown H = Normal operation

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT	
V _{CC}	to GND	-0.3	6	V	
V _L	to GND	-0.3	V _{CC} + 0.3	V	
V ₊	to GND	-0.3	7	V	
V ₋	to GND	0.3	-7	V	
V ₊ + V ₋ ⁽²⁾			13	V	
V _I	Input voltage	DIN, PWRDWN to GND	-0.3	6	
		RIN to GND		±25	
V _O	Output voltage	DOUT to GND		±13.2	
		ROUT	-0.3	V _L + 0.3	
Short-circuit duration DOUT to GND			Continuous		
Continuous power dissipation		T _A = 70°C, 20-pin TSSOP (derate 7 mW/°C above 70°C)	559	mW	
T _J	Junction temperature		150	°C	
T _{stg}	Storage temperature range		-65	150	
Lead temperature (soldering, 10 s)			300	°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
- (2) V₊ and V₋ can have maximum magnitudes of 7 V, but their absolute difference cannot exceed 13 V.

Recommended Operating Conditions

		MIN	MAX	UNIT	
V _{CC}	Supply voltage	3	5.5	V	
V _L	Supply voltage	2.25	V _{CC}	V	
Input logic threshold low	DIN, PWRDWN	V _L = 3 V or 5.5 V	0.8	V	
		V _L = 2.3 V	0.6		
Input logic threshold high	DIN, PWRDWN	V _L = 5.5 V	2.4	V	
		V _L = 3 V	2.0		
		V _L = 2.7 V	1.4		
Operating temperature		MAX3386ECPWR	0	70	
		MAX3386EIPWR	-40	85	
Receiver input voltage			-25	25	

Electrical Characteristics

over operating free-air temperature range, V_{CC} = V_L = 3 V to 5.5 V, C₁–C₄ = 0.1 µF (tested at 3.3 V ± 10%), C₁ = 0.047 µF, C₂–C₄ = 0.33 µF (tested at 5 V ± 10%) (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
DC Characteristics (V_{CC} = 3.3 V or 5 V, T_A = 25°C)					
Powerdown supply current	PWRDWN = GND, All inputs at V _{CC} or GND	1	10	10	µA

- (1) Typical values are at V_{CC} = V_L = 3.3 V, T_A = 25°C.

Electrical Characteristics (continued)

over operating free-air temperature range, $V_{CC} = V_L = 3\text{ V}$ to 5.5 V , $C1\text{--}C4 = 0.1\text{ }\mu\text{F}$ (tested at $3.3\text{ V} \pm 10\%$), $C1 = 0.047\text{ }\mu\text{F}$, $C2\text{--}C4 = 0.33\text{ }\mu\text{F}$ (tested at $5\text{ V} \pm 10\%$) (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
Supply current	$\overline{\text{PWRDWN}} = V_{CC}$, No load		0.3	1	mA

ESD Protection

PARAMETER	TEST CONDITIONS	TYP	UNIT
RIN, DOUT	Human-Body Model	± 15	kV
	IEC 61000-4-2 Air-Gap Discharge	± 15	
	IEC 61000-4-2 Contact Discharge	± 8	

RECEIVER SECTION

Electrical Characteristics

over operating free-air temperature range, $V_{CC} = V_L = 3$ V to 5.5 V, $C1-C4 = 0.1 \mu F$ (tested at 3.3 V $\pm 10\%$), $C1 = 0.047 \mu F$, $C2-C4 = 0.33 \mu F$ (tested at 5 V $\pm 10\%$), $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted)

PARAMETER	TEST CONDITIONS		MIN	TYP ⁽¹⁾	MAX	UNIT
I_{off}	ROUT, receivers disabled			± 0.05	± 10	μA
V_{OL}	$I_{OUT} = 1.6$ mA				0.4	V
V_{OH}	$I_{OUT} = -1$ mA		$V_L - 0.6$	$V_L - 0.1$		V
V_{IT-}	$T_A = 25^\circ C$	$V_L = 5$ V	0.8	1.2		V
		$V_L = 3.3$ V	0.6	1.5		
V_{IT+}	$T_A = 25^\circ C$	$V_L = 5$ V		1.8	2.4	V
		$V_L = 3.3$ V		1.5	2.4	
V_{hys}	Input hysteresis			0.5		V
Input resistance	$T_A = 25^\circ C$		3	5	7	$k\Omega$

(1) Typical values are at $V_{CC} = V_L = 3.3$ V, $T_A = 25^\circ C$

Switching Characteristics

over operating free-air temperature range, $V_{CC} = V_L = 3$ V to 5.5 V, $C1-C4 = 0.1 \mu F$ (tested at 3.3 V $\pm 10\%$), $C1 = 0.047 \mu F$, $C2-C4 = 0.33 \mu F$ (tested at 5 V $\pm 10\%$), $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TYP ⁽¹⁾	UNIT
t_{PHL}	Receiver propagation delay	Receiver input to receiver output, $C_L = 150$ pF		0.15
		0.15	μs	
$t_{PLH} - t_{PHL}$	Receiver skew			50 ns
t_{en}	Receiver output enable time	From <u>PWRDWN</u>		200 ns
t_{dis}	Receiver output disable time	From <u>PWRDWN</u>		200 ns

(1) Typical values are at $V_{CC} = V_L = 3.3$ V, $T_A = 25^\circ C$.

DRIVER SECTION

Electrical Characteristics

over operating free-air temperature range, $V_{CC} = V_L = 3$ V to 5.5 V, $C1-C4 = 0.1 \mu F$ (tested at 3.3 V $\pm 10\%$), $C1 = 0.047 \mu F$, $C2-C4 = 0.33 \mu F$ (tested at 5 V $\pm 10\%$), $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
V_{OH}	Output voltage swing	All driver outputs loaded with 3 k Ω to ground	± 5	± 5.4	V
r_o	Output resistance	$V_{CC} = V+ = V- = 0$, Driver output = ± 2 V	300	10M	Ω
I_{OS}	Output short-circuit current	$V_{T_OUT} = 0$		± 60	mA
I_{OZ}	Output leakage current	$V_{T_OUT} = \pm 12$ V, Driver disabled, $V_{CC} = 0$ or 3 V to 5.5 V		± 25	μA
Driver input hysteresis				0.5	V
Input leakage current	DIN, PWRDWN		± 0.01	± 1	μA

(1) Typical values are at $V_{CC} = V_L = 3.3$ V, $T_A = 25^\circ C$

Timing Requirements

over operating free-air temperature range, $V_{CC} = V_L = 3$ V to 5.5 V, $C1-C4 = 0.1 \mu F$ (tested at 3.3 V $\pm 10\%$), $C1 = 0.047 \mu F$, $C2-C4 = 0.33 \mu F$ (tested at 5 V $\pm 10\%$), $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted)

PARAMETER		MIN	TYP ⁽¹⁾	MAX	UNIT
Maximum data rate	$R_L = 3$ k Ω , $C_L = 1000$ pF, One driver switching	250			kbps
Time-to-exit powerdown	$ V_{T_OUT} > 3.7$ V		100		μs
$ t_{PHL} - t_{PLH} $	Driver skew ⁽²⁾		100		ns
Transition-region slew rate	$V_{CC} = 3.3$ V, $T_A = 25^\circ C$, $R_L = 3$ k Ω to 7 k Ω , Measured from 3 V to -3 V or -3 V to 3 V	$C_L = 150$ pF to 1000 pF	6	30	V/ μs
		$C_L = 150$ pF to 2500 pF	4	30	

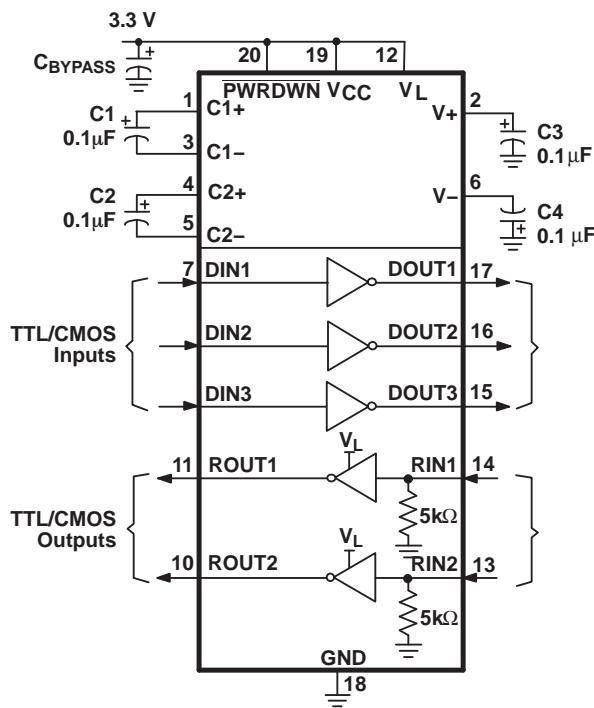
(1) Typical values are at $V_{CC} = V_L = 3.3$ V, $T_A = 25^\circ C$.

(2) Driver skew is measured at the driver zero crosspoint.

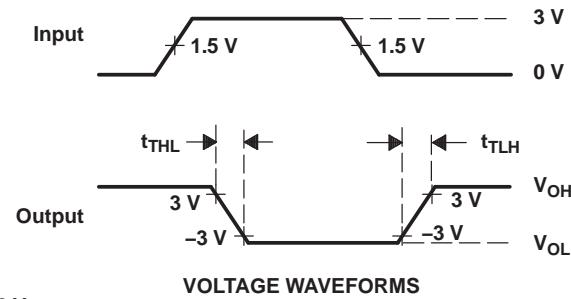
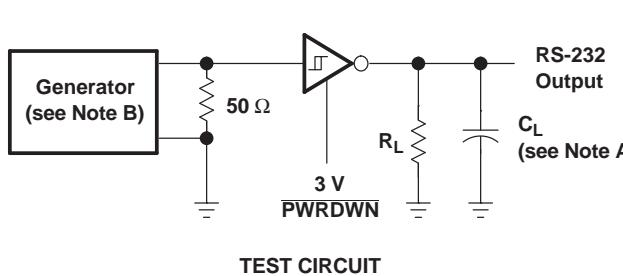
ESD Protection

PARAMETER	TEST CONDITIONS	TYP	UNIT
RIN, DOUT	Human-Body Model	± 15	kV
	IEC 61000-4-2 Air-Gap Discharge	± 15	
	IEC 61000-4-2 Contact Discharge	± 8	

APPLICATION INFORMATION



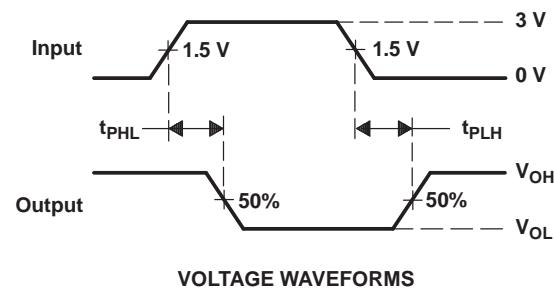
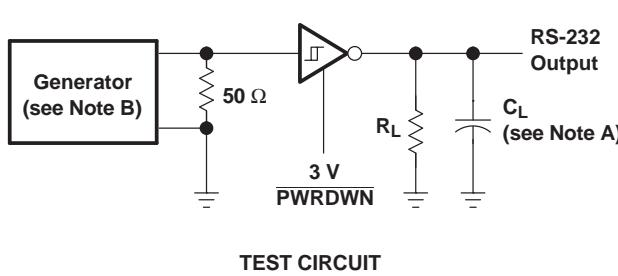
PARAMETER MEASUREMENT INFORMATION



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

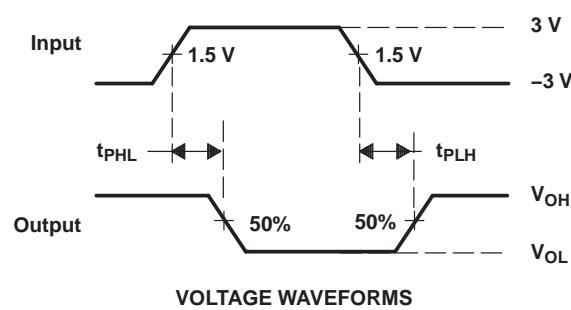
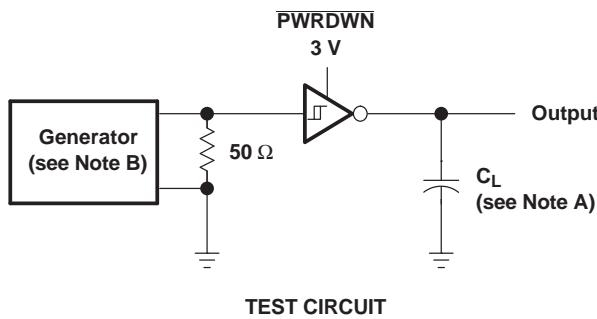
- NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

Figure 1. Driver Slew Rate



- NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

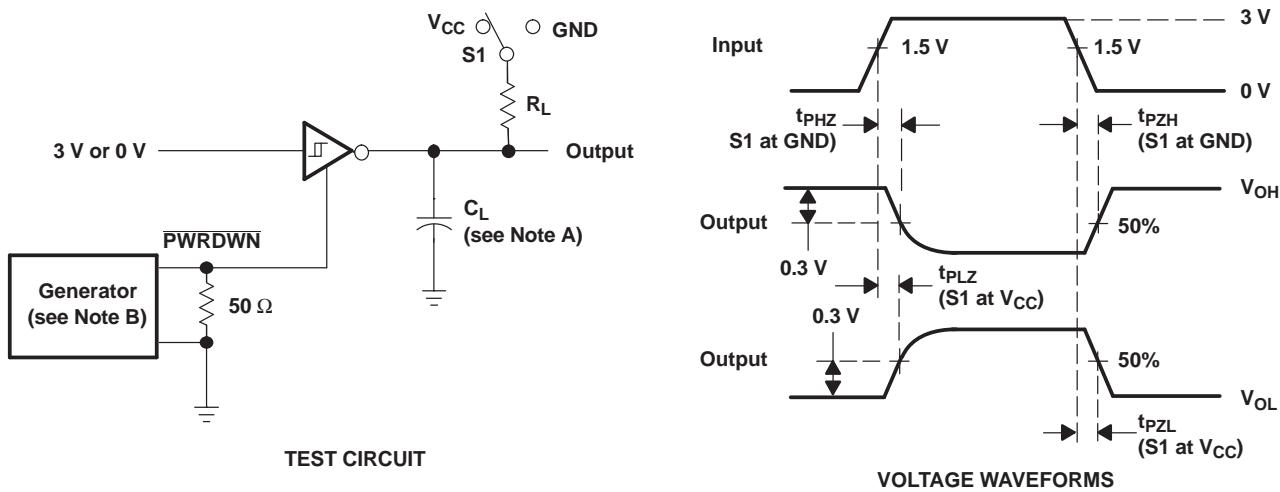
Figure 2. Driver Pulse Skew



- NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, t_r ≤ 10 ns, t_f ≤ 10 ns.

Figure 3. Receiver Propagation Delay Times

PARAMETER MEASUREMENT INFORMATION



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 Enable and Disable Times

REVISION HISTORY

Changes from Revision A (November 2008) to Revision B	Page
• Changed V_L Pin for Compatibility With Mixed-Voltage Systems Down to 2.5 V (originally 1.8 V) on the Logic Side	1
• Changed V_L Supply MIN value from 1.65 V to 2.25 V.	3
• Deleted $V_L = 1.65V$ parameter from Input logic threshold low.	3
• Deleted $V_L = 1.95V$ parameter from Input logic threshold high.	3

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
MAX3386ECDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MAX3386EC	Samples
MAX3386ECPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP386EC	Samples
MAX3386ECPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP386EC	Samples
MAX3386ECPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	MP386EC	Samples
MAX3386EIDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX3386EI	Samples
MAX3386EIDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MAX3386EI	Samples
MAX3386EIPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP386EI	Samples
MAX3386EIPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP386EI	Samples
MAX3386EIPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	MP386EI	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) 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.

⁽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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

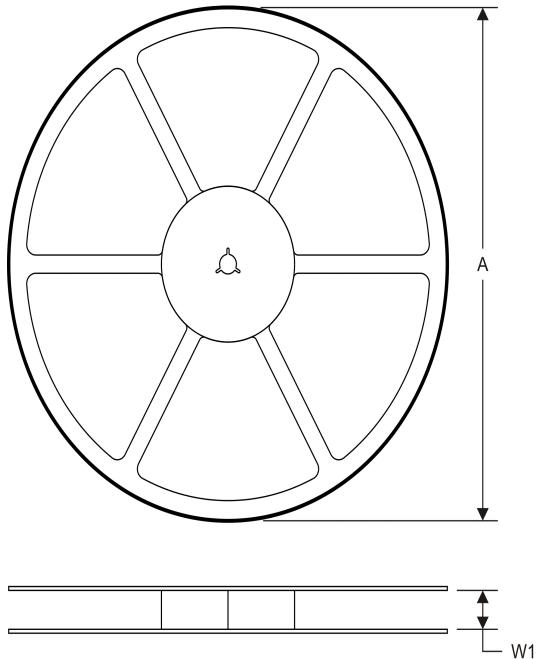
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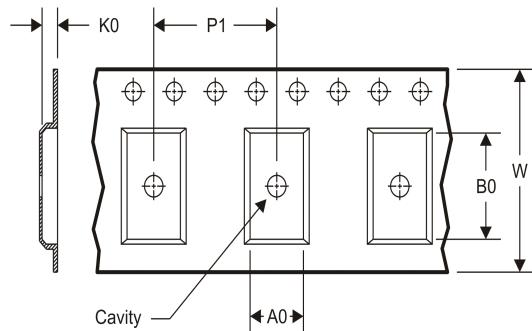
PACKAGE MATERIALS INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



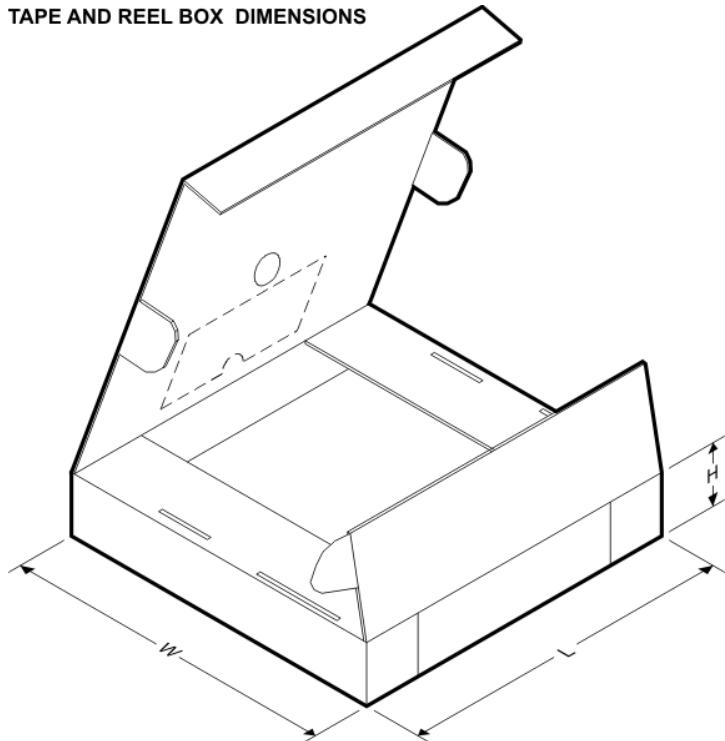
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
MAX3386ECDWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.0	2.7	12.0	24.0	Q1
MAX3386ECPWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
MAX3386EIDWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.0	2.7	12.0	24.0	Q1
MAX3386EIPWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3386ECDWR	SOIC	DW	20	2000	367.0	367.0	45.0
MAX3386ECPWR	TSSOP	PW	20	2000	367.0	367.0	38.0
MAX3386EIDWR	SOIC	DW	20	2000	367.0	367.0	45.0
MAX3386EIPWR	TSSOP	PW	20	2000	367.0	367.0	38.0

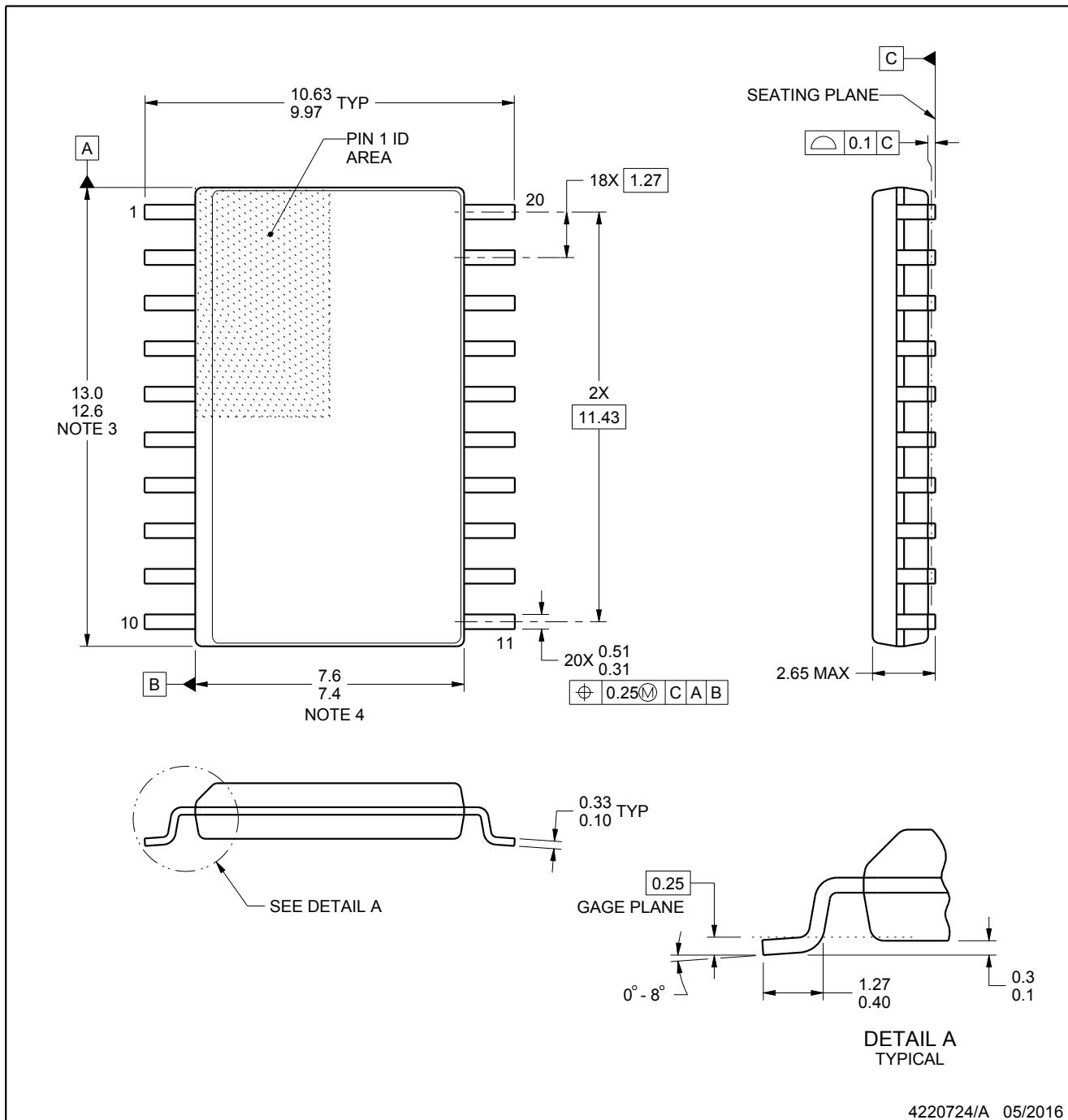
PACKAGE OUTLINE

DW0020A



SOIC - 2.65 mm max height

SOIC



4220724/A 05/2016

NOTES:

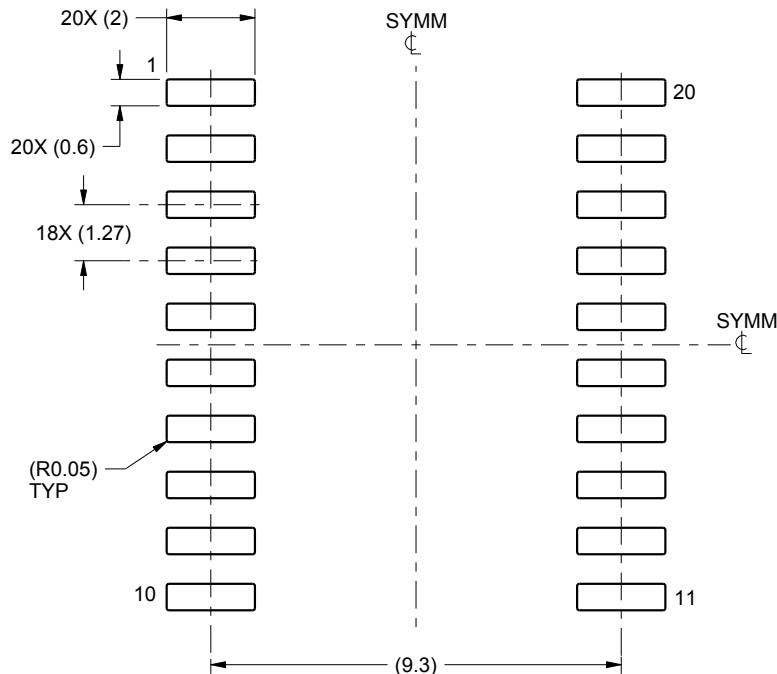
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
 2. This drawing is subject to change without notice.
 3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
 4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
 5. Reference JEDEC registration MS-013.

EXAMPLE BOARD LAYOUT

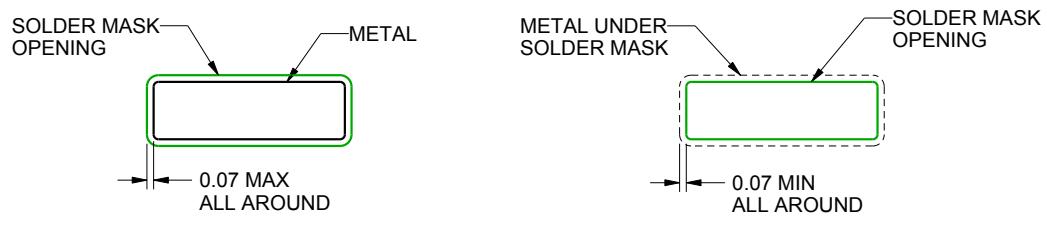
DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

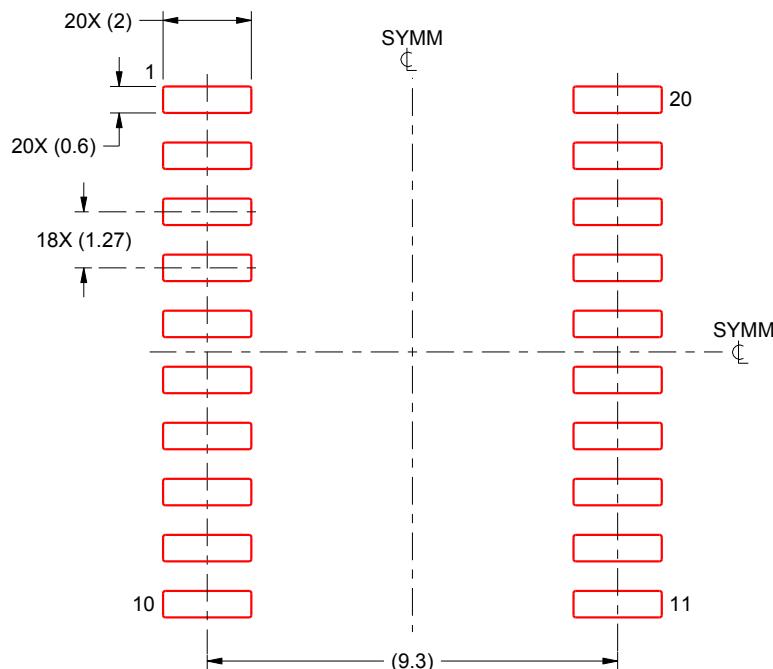
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4220724/A 05/2016

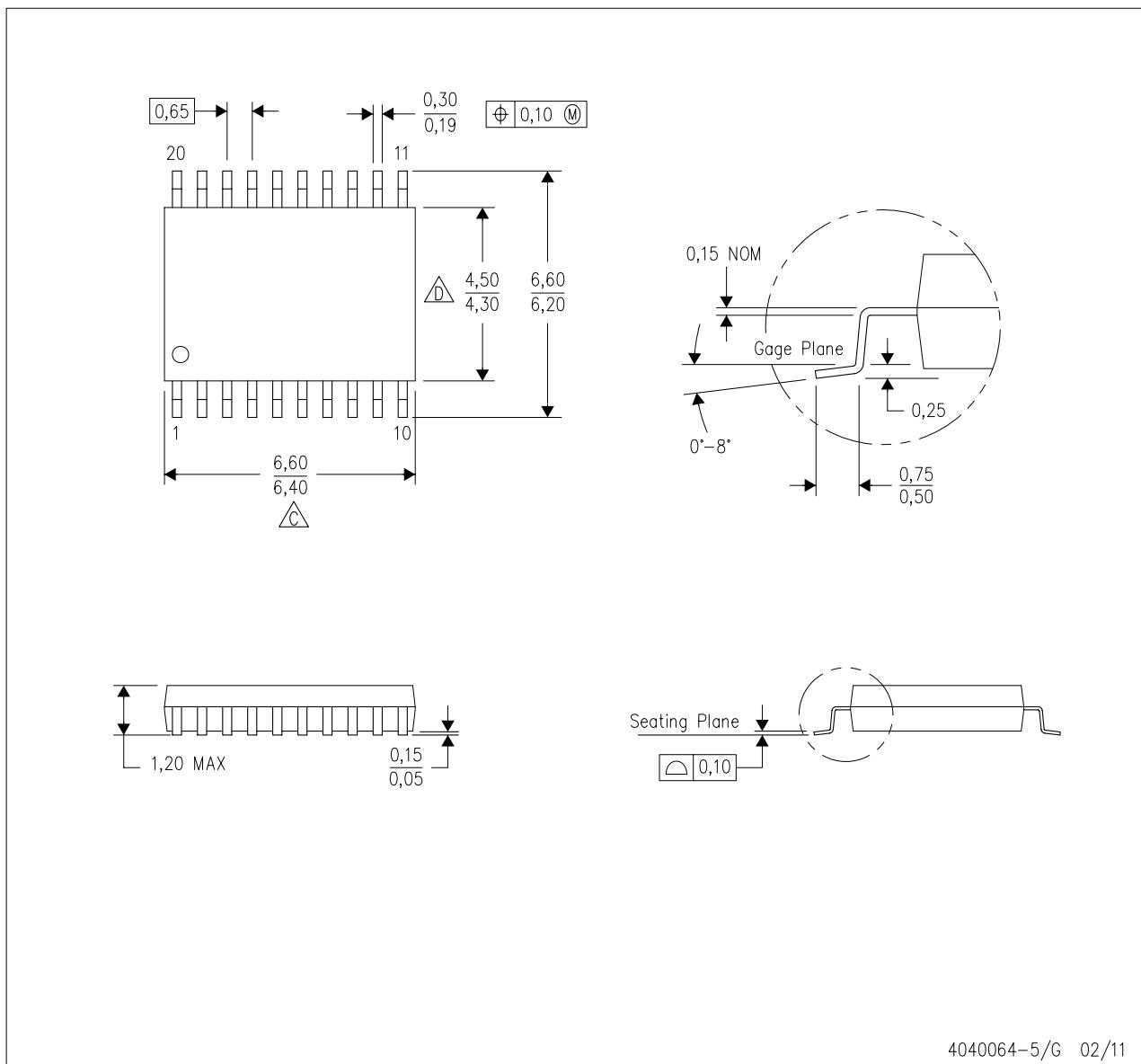
NOTES: (continued)

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.

MECHANICAL DATA

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



4040064-5/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

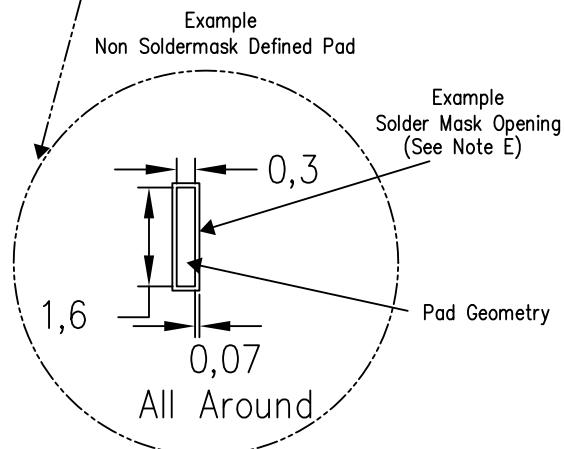
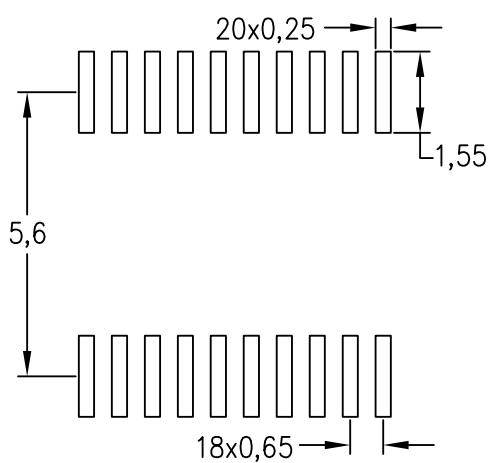
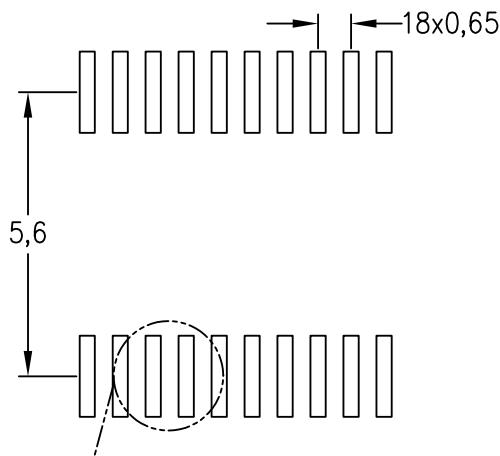
LAND PATTERN DATA

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE

Example Board Layout

Based on a stencil thickness
of .127mm (.005inch).



4211284-5/G 08/15

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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