

## FEATURES

- $V_L$  Pin for Compatibility With Mixed-Voltage Systems Down to 1.8 V on Logic Side
- Enhanced ESD Protection on RIN Inputs and DOUT Outputs
  - $\pm 15$ -kV Human-Body Model
  - $\pm 15$ -kV IEC 61000-4-2, Air-Gap Discharge
  - $\pm 8$ -kV IEC 61000-4-2, Contact Discharge
- Low 300- $\mu$ A Supply Current
- Specified 250-kbps Data Rate
- 1- $\mu$ A Low-Power Shutdown
- Meets EIA/TIA-232 Specifications Down to 3 V

## APPLICATIONS

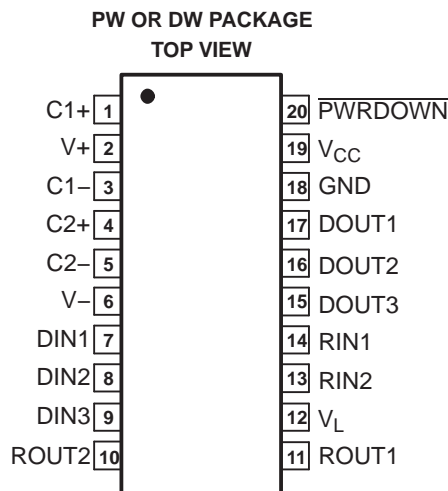
- Hand-Held Equipment
- PDAs
- Cell Phones
- Battery-Powered Equipment
- Data Cables

## 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  $\pm 15$  kV using the IEC 61000-4-2 Air-Gap Discharge method,  $\pm 8$  kV using the IEC 61000-4-2 Contact Discharge method, and  $\pm 15$  kV using the Human-Body Model.

The charge pump requires only four small 0.1- $\mu$ F 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 <sub>A</sub>	PACKAGE <sup>(1)(2)</sup>	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](http://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](http://www.ti.com).

## TRUTH TABLE (SHUTDOWN FUNCTION)

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

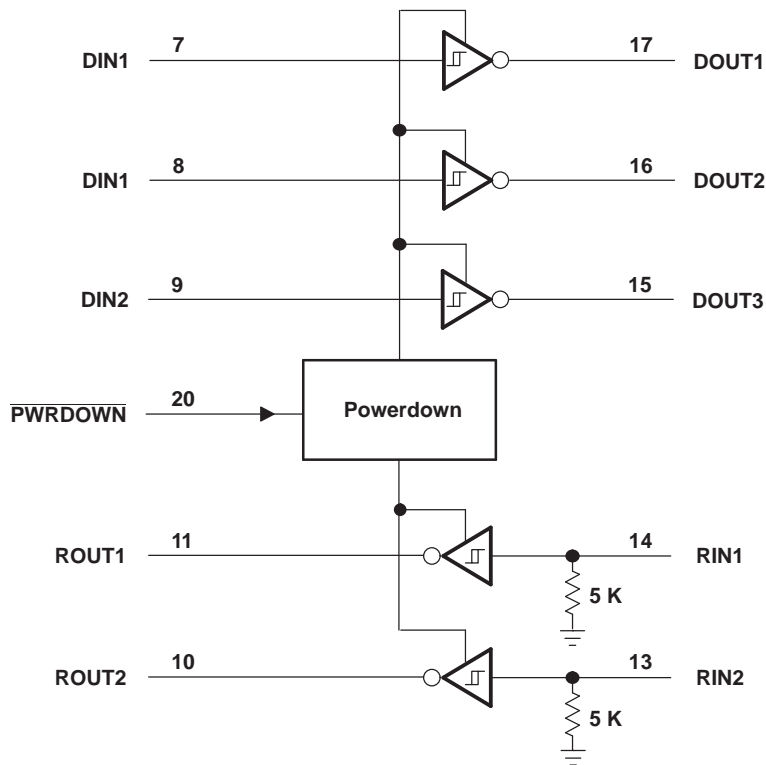


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**MAX3386E**  
**RS-232 TRANSCEIVER**  
**WITH SPLIT SUPPLY PIN FOR LOGIC SIDE**

SLLS659A—MAY 2006—REVISED APRIL 2007

**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 DIN2 DIN3	7 8 9	Driver inputs
ROUT2 ROUT1	10 11	Receiver outputs. Swing between 0 and $V_L$ .
$V_L$	12	Logic-level supply. All CMOS inputs and outputs are referenced to this supply.
RIN2 RIN1	13 14	RS-232 receiver inputs
DOUT3 DOUT2 DOUT1	15 16 17	RS-232 driver outputs
GND	18	Ground
$V_{CC}$	19	3-V to 5.5-V supply voltage
$\overline{PWRDWN}$	20	Powerdown input L = Powerdown H = Normal operation

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

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

		MIN	MAX	UNIT
V <sub>CC</sub> to GND		-0.3	6	V
V <sub>L</sub> to GND		-0.3	V <sub>CC</sub> + 0.3	V
V+ to GND		-0.3	7	V
V- to GND		0.3	-7	V
V+ +  V-  <sup>(2)</sup>			13	V
V <sub>I</sub>	Input voltage	DIN, $\overline{\text{PWRDWN}}$ to GND		V
		RIN to GND		
V <sub>O</sub>	Output voltage	DOUT to GND		V
		ROUT		
Short-circuit duration DOUT to GND		Continuous		
Continuous power dissipation		T <sub>A</sub> = 70°C, 20-pin TSSOP (derate 7 mW/°C above 70°C)		mW
T <sub>J</sub>	Junction temperature		150	°C
T <sub>stg</sub>	Storage temperature range	-65	150	°C
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 <sub>CC</sub>	Supply voltage	3	5.5	V
V <sub>L</sub>	Supply voltage	1.65	V <sub>CC</sub>	V
Input logic threshold low	DIN, $\overline{\text{PWRDWN}}$	V <sub>L</sub> = 3 V or 5.5 V		V
		V <sub>L</sub> = 2.3 V		
		V <sub>L</sub> = 1.65 V		
Input logic threshold high	DIN, $\overline{\text{PWRDWN}}$	V <sub>L</sub> = 5.5 V		V
		V <sub>L</sub> = 3 V		
		V <sub>L</sub> = 2.7 V		
		V <sub>L</sub> = 1.95 V		
Operating temperature	MAX3386ECPWR		0	°C
	MAX3386EIPWR		-40	
Receiver input voltage		-25	25	V

## Electrical Characteristics

 over operating free-air temperature range, V<sub>CC</sub> = V<sub>L</sub> = 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 <sup>(1)</sup>	MAX	UNIT
<b>DC Characteristics (V<sub>CC</sub> = 3.3 V or 5 V, T<sub>A</sub> = 25°C)</b>					
Powerdown supply current	$\overline{\text{PWRDWN}}$ = GND, All inputs at V <sub>CC</sub> or GND		1	10	μA
Supply current	$\overline{\text{PWRDWN}}$ = V <sub>CC</sub> , No load		0.3	1	mA

- (1) Typical values are at V<sub>CC</sub> = V<sub>L</sub> = 3.3 V, T<sub>A</sub> = 25°C.

**MAX3386E**  
**RS-232 TRANSCEIVER**  
**WITH SPLIT SUPPLY PIN FOR LOGIC SIDE**

SLLS659A–MAY 2006–REVISED APRIL 2007

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**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,  $V_{CC} = V_L = 3\text{ V to }5.5\text{ V}$ ,  $C1\text{--}C4 = 0.1\text{ }\mu\text{F}$  (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  $5\text{ V} \pm 10\%$ ),  $T_A = T_{MIN}$  to  $T_{MAX}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT	
$I_{off}$	Output leakage current	ROUT, receivers disabled		$\pm 0.05$	$\pm 10$	$\mu\text{A}$	
$V_{OL}$	Output voltage low	$I_{OUT} = 1.6\text{ mA}$			0.4	V	
$V_{OH}$	Output voltage high	$I_{OUT} = -1\text{ mA}$	$V_L - 0.6$	$V_L - 0.1$		V	
$V_{IT-}$	Input threshold low	$T_A = 25^\circ\text{C}$	$V_L = 5\text{ V}$	0.8	1.2	V	
			$V_L = 3.3\text{ V}$	0.6	1.5		
$V_{IT+}$	Input threshold high	$T_A = 25^\circ\text{C}$	$V_L = 5\text{ V}$		1.8	2.4	V
			$V_L = 3.3\text{ V}$		1.5	2.4	
$V_{hys}$	Input hysteresis			0.5		V	
	Input resistance	$T_A = 25^\circ\text{C}$	3	5	7	$\text{k}\Omega$	

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

### Switching Characteristics

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

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

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

**MAX3386E**  
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SLLS659A–MAY 2006–REVISED APRIL 2007

**DRIVER SECTION**

**Electrical Characteristics**

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

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

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

**Timing Requirements**

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

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

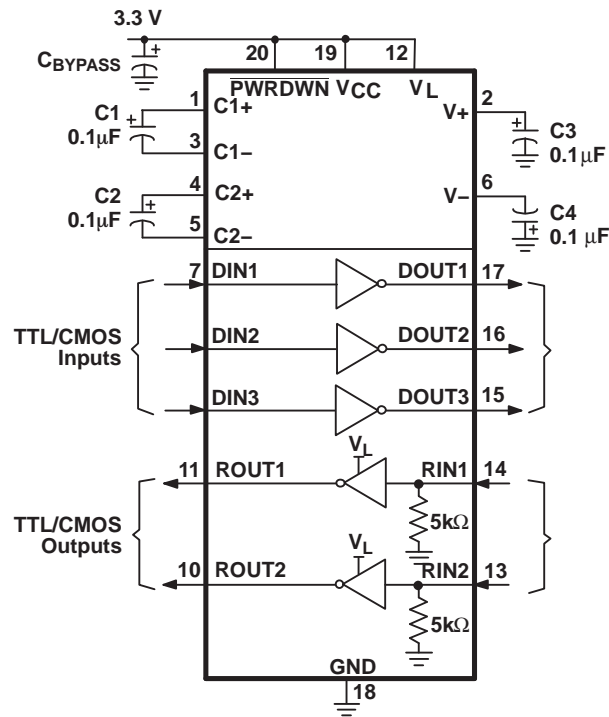
(1) Typical values are at  $V_{CC} = V_L = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

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

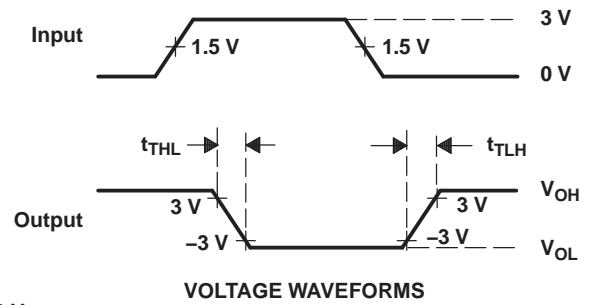
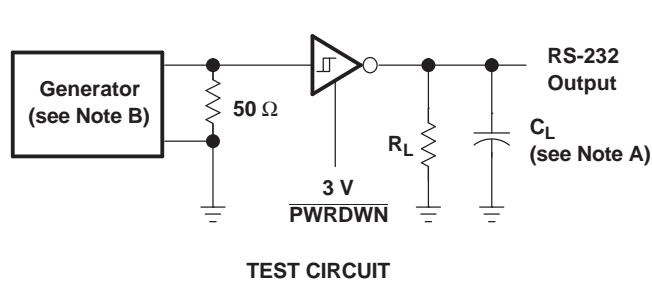
**ESD Protection**

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

### APPLICATION INFORMATION



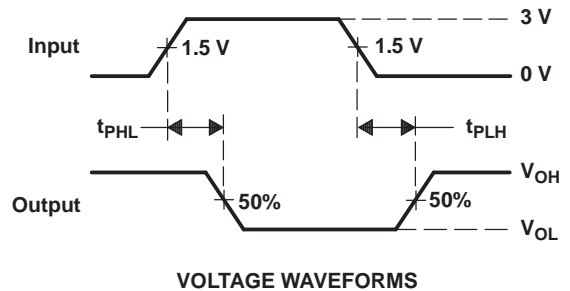
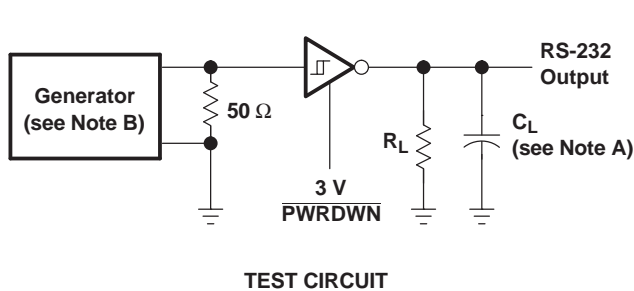
**PARAMETER MEASUREMENT INFORMATION**



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

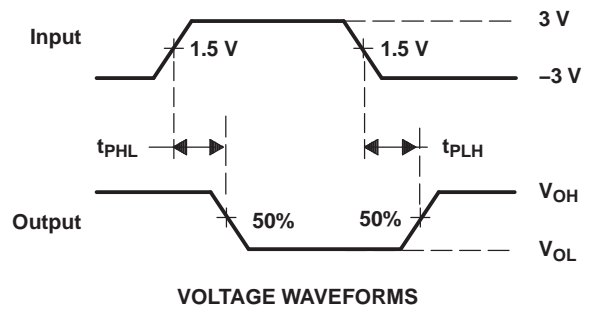
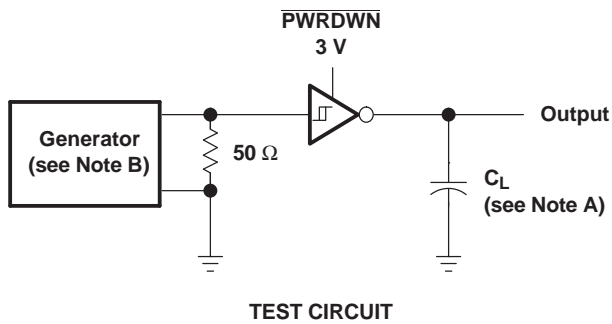
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics: PRR = 250 kbit/s,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**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,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**Figure 2. Driver Pulse Skew**

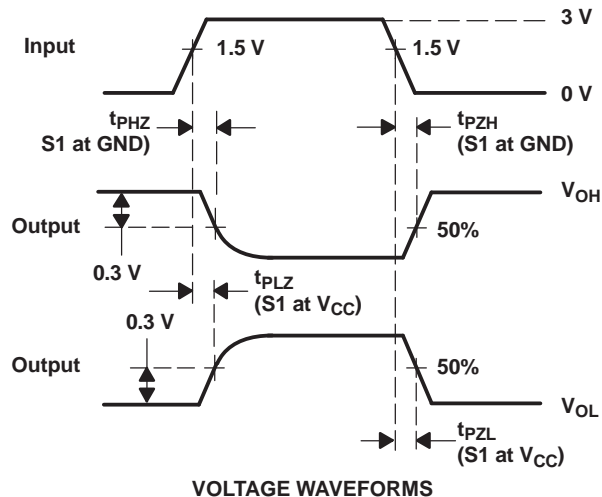
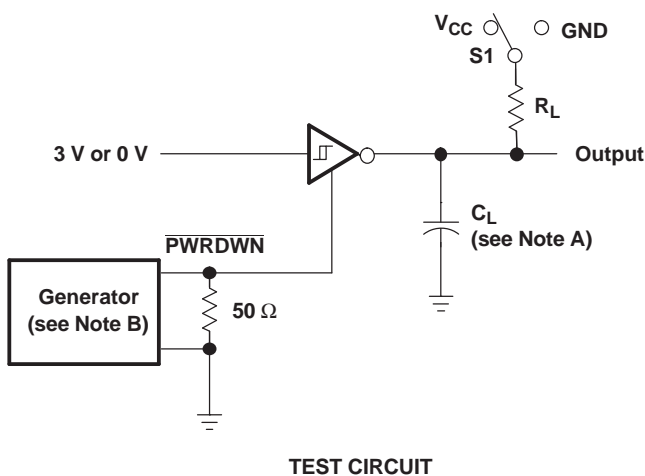


- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**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,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.

**Figure 4. Receiver Enable and Disable Times**

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
MAX3386ECDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECDWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECDWRG4	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECPWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIDWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIDWRG4	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386EIPWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

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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
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	346.0	346.0	41.0
MAX3386ECPWR	TSSOP	PW	20	2000	346.0	346.0	33.0
MAX3386EIDWR	SOIC	DW	20	2000	346.0	346.0	41.0
MAX3386EIPWR	TSSOP	PW	20	2000	346.0	346.0	33.0

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN

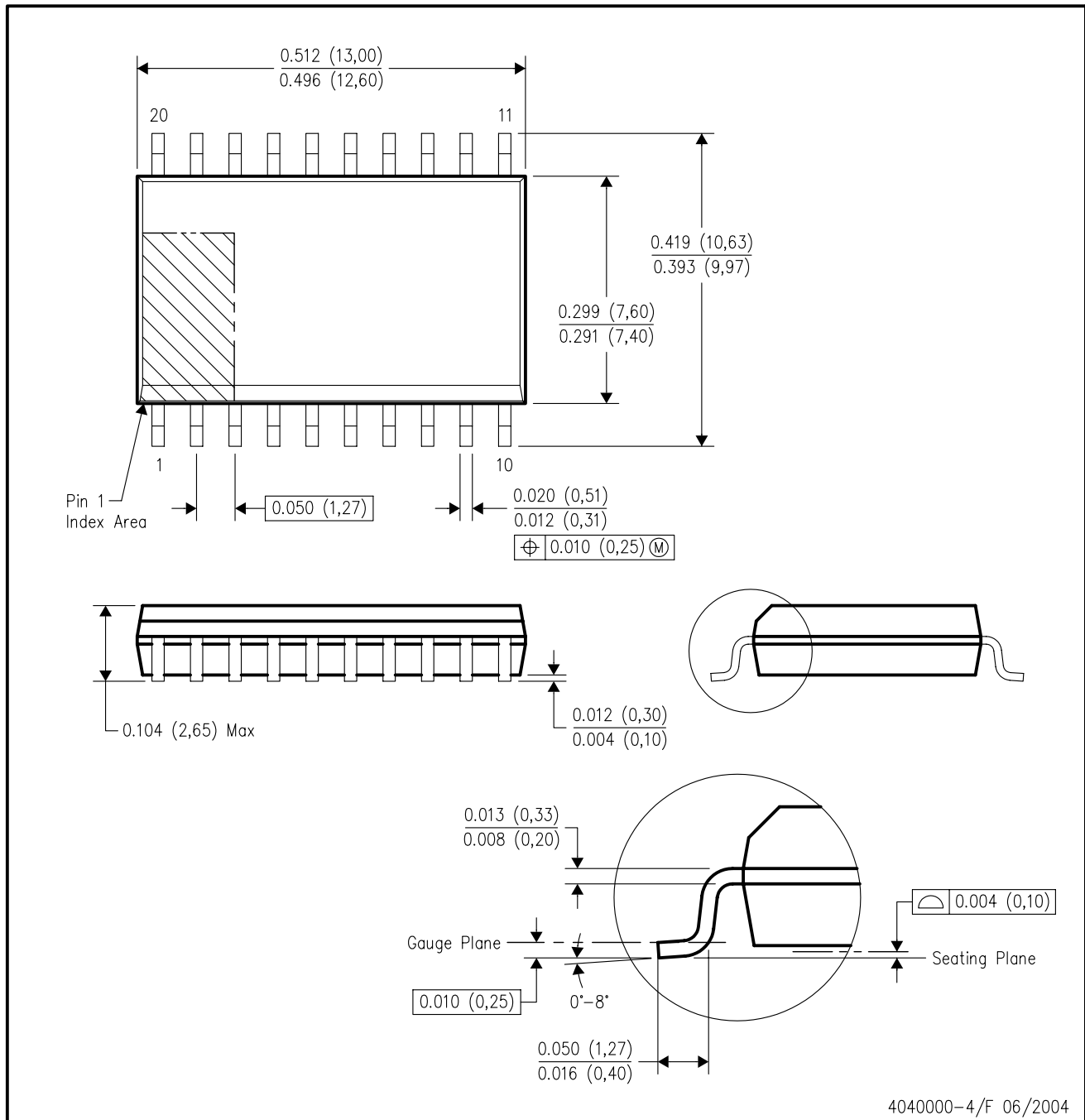


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- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

DW (R-PDSO-G20)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - 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 AC.

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