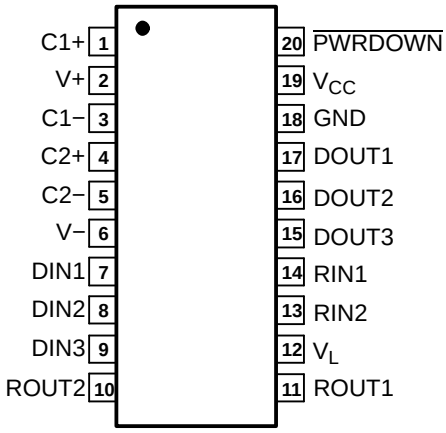
MAX3386E
RS-232 TRANSCEIVER WITH SPLIT SUPPLY PIN FOR LOGIC SIDE

SLLS659 – MAY 2006

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**
  - **– ±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**

TSSOP OR SSOP PACKAGE
TOP VIEW



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

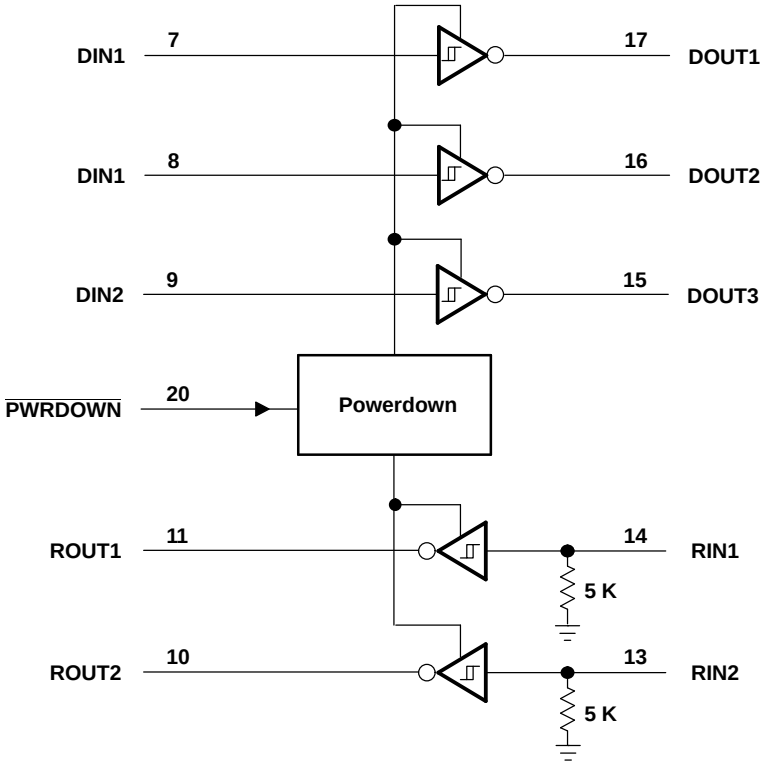
T_A	PACKAGE(1)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	TSSOP	MAX3386ECPWR	MP386EC
	SSOP	MAX3386ECDBR	MAX3386EC
–40°C to 85°C	TSSOP	MAX3386EIPWR	MP386EI
	SSOP	MAX3386EIDBR	MAX3386EI

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

TRUTH TABLE (SHUTDOWN FUNCTION)

$\overline{\text{PWRDWN}}$	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 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
$\overline{\text{PWRDWN}}$	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, $\overline{PWRDWN}$ to GND	–0.3	6	V
		RIN to GND		±25	
V_O	Output voltage	DOUT to GND		±13.2	V
		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	°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_{CC}	Supply voltage			3	5.5	V
V_L	Supply voltage			1.65	V_{CC}	V
	Input logic threshold low	DIN, $\overline{PWRDWN}$	V_L = 3 V or 5.5 V		0.8	V
			V_L = 2.3 V		0.6	
			V_L = 1.65 V		0.5	
	Input logic threshold high	DIN, $\overline{PWRDWN}$	V_L = 5.5 V	2.4		V
			V_L = 3 V	2.0		
			V_L = 2.7 V	1.4		
			V_L = 1.95 V	0.9		
	Operating temperature		MAX3386ECPWR	0	70	°C
			MAX3386EIPWR	–40	85	
	Receiver input voltage			–25	25	V

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	$\overline{PWRDWN}$ = GND, All inputs at V_{CC} or GND		1	10	µA
Supply current	$\overline{PWRDWN}$ = V_{CC}, No load		0.3	1	mA

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

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 µF (tested at 3.3 V ± 10%), C1 = 0.047 µF, C2–C4 = 0.33 µF (tested at 5 V ± 10%), T_A = T_{MIN} to T_{MAX} (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
I_{off}	Output leakage current	ROUT, receivers disabled			±0.05	±10	µA
V_{OL}	Output voltage low	I_{OUT} = 1.6 mA				0.4	V
V_{OH}	Output voltage high	I_{OUT} = –1 mA		V_L – 0.6	V_L – 0.1		V
$V_{IT–}$	Input threshold low	T_A = 25°C	V_L = 5 V	0.8	1.2		V
			V_L = 3.3 V	0.6	1.5		
V_{IT+}	Input threshold high	T_A = 25°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°C		3	5	7	kΩ

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

Switching 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%), 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	µs
t_{PLH}			0.15	
t_{PHL} – t_{PLH}	Receiver skew		50	ns
t_{en}	Receiver output enable time	From $\overline{PWRDWN}$	200	ns
t_{dis}	Receiver output disable time	From $\overline{PWRDWN}$	200	ns

(1) Typical values are at V_{CC} = V_L = 3.3 V, T_A = 25°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 µF (tested at 3.3 V ± 10%), C1 = 0.047 µF, C2–C4 = 0.33 µF (tested at 5 V ± 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 kΩ 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} = ±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, $\overline{PWRDWN}$		±0.01	±1	µA

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

Timing Requirements

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%), T_A = T_{MIN} to T_{MAX} (unless otherwise noted)

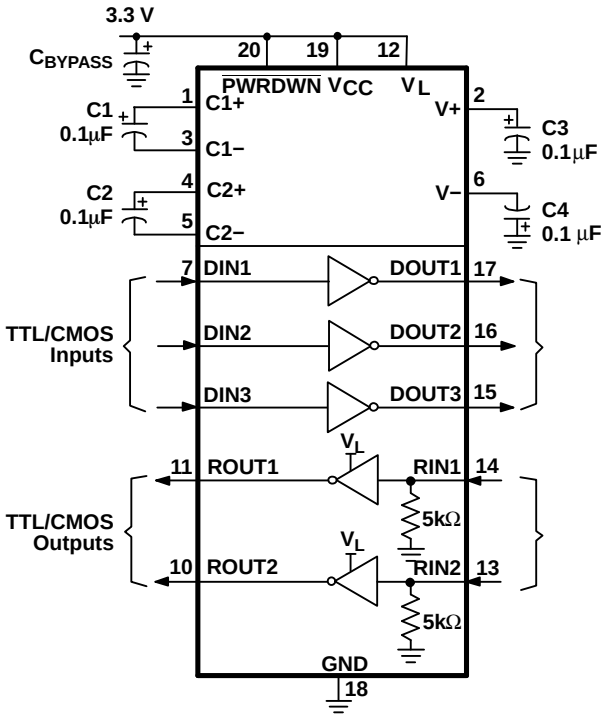
PARAMETER				MIN	TYP(1)	MAX	UNIT
	Maximum data rate	R_L = 3 kΩ, C_L = 1000 pF, One driver switching		250			kbps
	Time-to-exit powerdown	$\|V_{T\_OUT}\|$ > 3.7 V			100		µs
$\|t_{PHL} – t_{PLH}\|$	Driver skew(2)				100		ns
	Transition-region slew rate	V_{CC} = 3.3 V, T_A = 25°C, R_L = 3 kΩ to 7 kΩ, Measured 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°C.
(2) Driver skew is measured at the driver zero crosspoint.

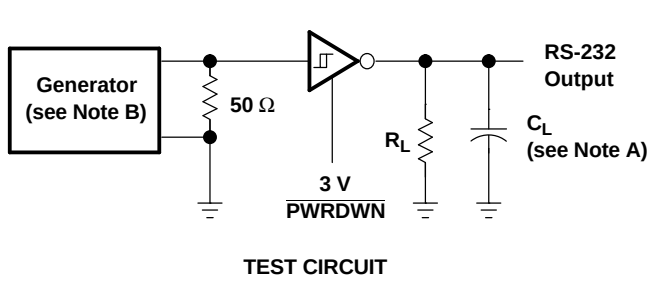
ESD Protection

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	

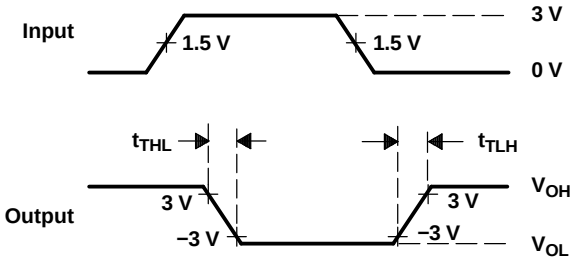
APPLICATION INFORMATION



PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

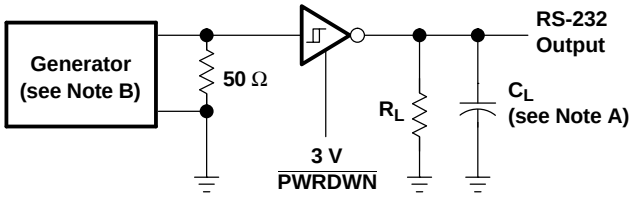


VOLTAGE WAVEFORMS

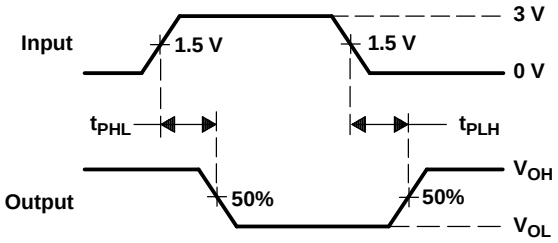
$$SR(tr) = \frac{6\ V}{t_{THL} \text{ or } t_{TLH}}$$

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, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 1. Driver Slew Rate



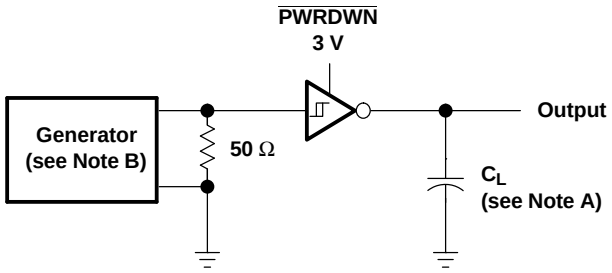
TEST CIRCUIT



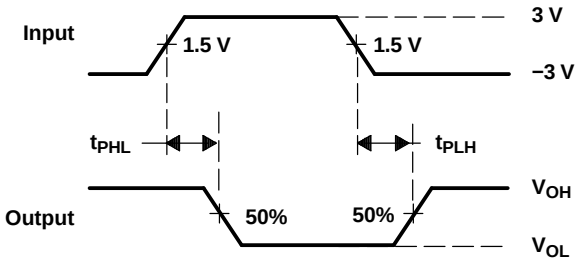
VOLTAGE WAVEFORMS

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, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 2. Driver Pulse Skew



TEST CIRCUIT

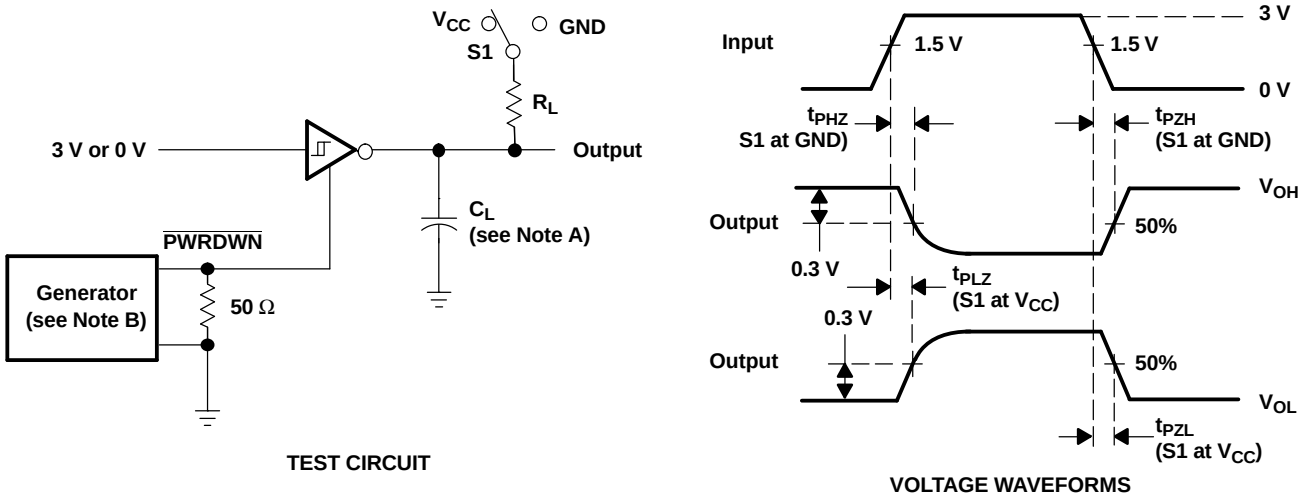


VOLTAGE WAVEFORMS

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

Figure 4. Receiver Enable and Disable Times

PACKAGING INFORMATION

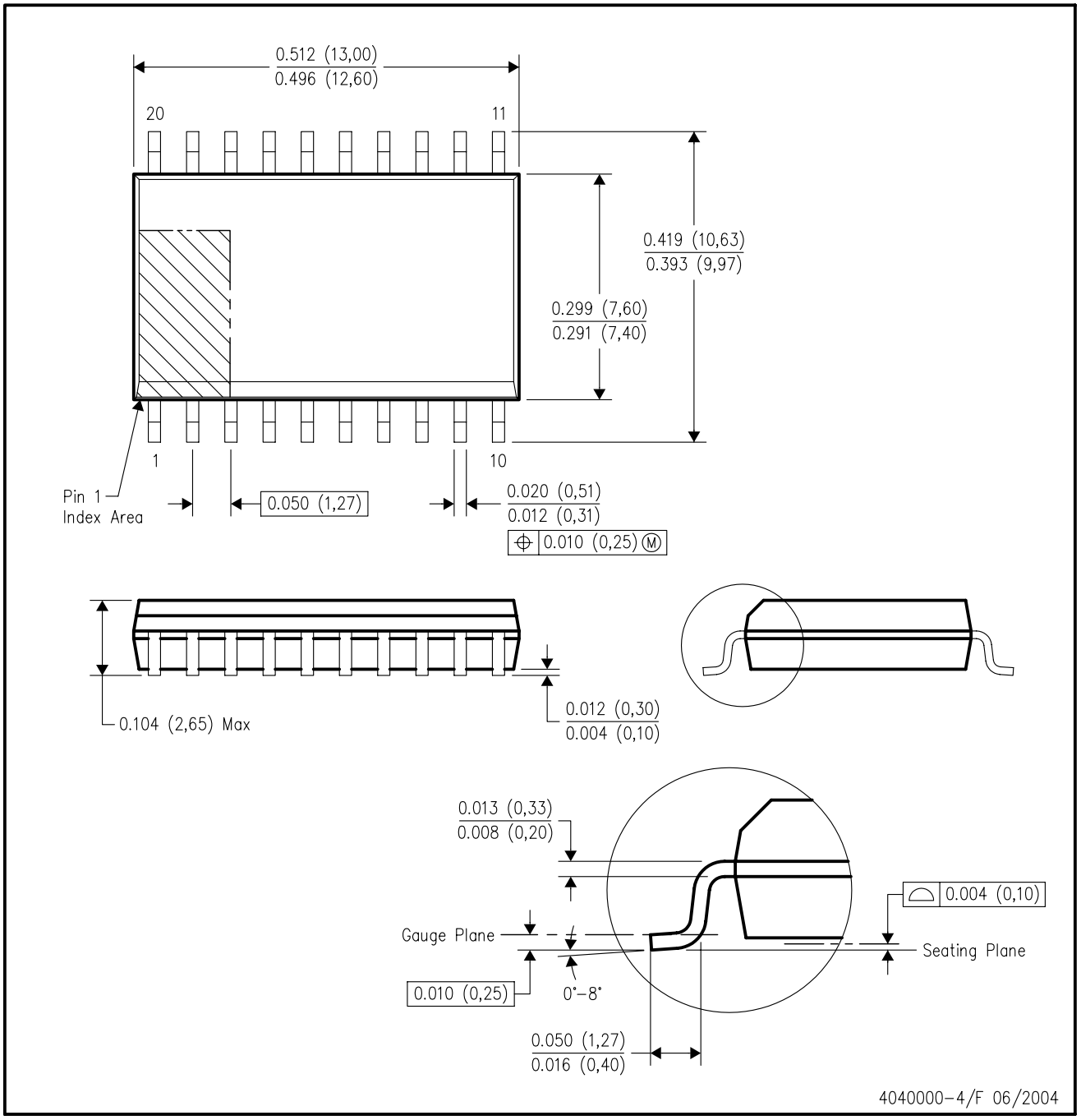
Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
MAX3386ECDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECDWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3386ECDWR	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

(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.

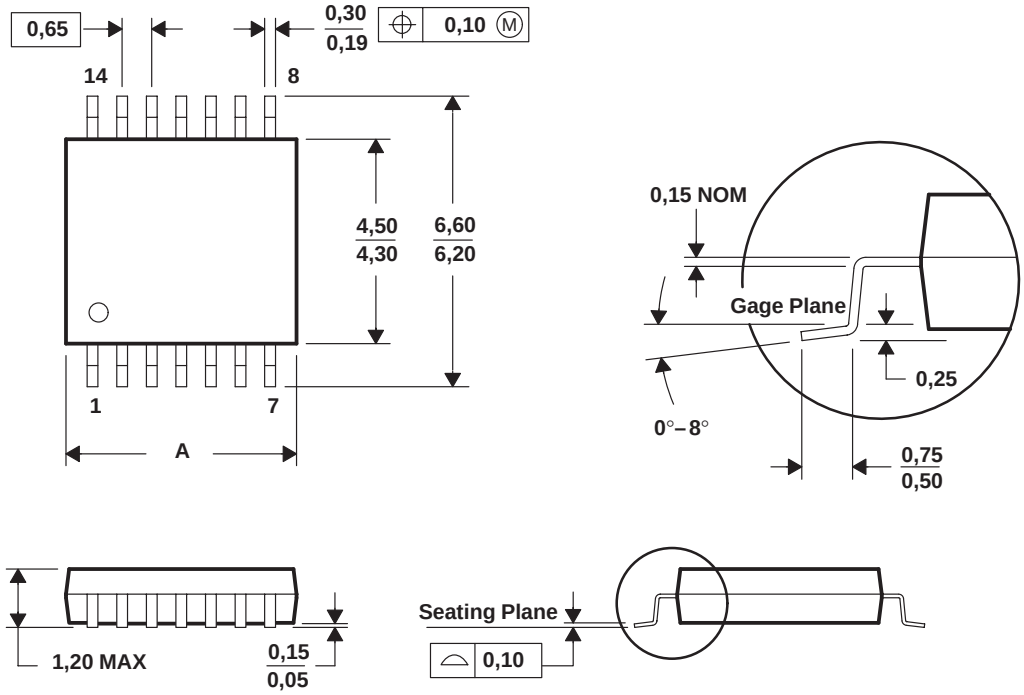
DW (R–PDSO–G20) PLASTIC SMALL–OUTLINE PACKAGE



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.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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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

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265