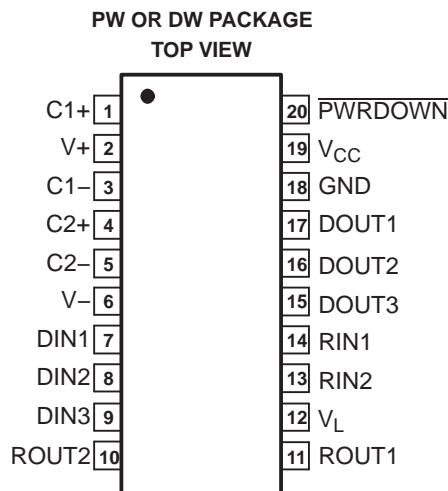


FEATURES

- 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- μ A Supply Current
- Specified 250-kbps Data Rate
- 1- μ A Low-Power Shutdown
- Meets EIA/TIA-232 Specifications Down to 3 V
- Designed to be Interchangeable With Industry Standard '3386 Devices



APPLICATIONS

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

DESCRIPTION/ORDERING INFORMATION

The TRS3386E 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- μ F capacitors for operation from a 3.3-V supply. The TRS3386E is capable of running at data rates up to 250 kbps, while maintaining RS-232-compliant output levels.

The TRS3386E 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 TRS3386E 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	TRS3386ECPWR	RV86EC
	SOIC – DW	TRS3386ECDWR	TRS3386EC
–40°C to 85°C	TSSOP – PW	TRS3386EIPWR	RV86EI
	SOIC – DW	TRS3386EIDWR	TRS3386EI

(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.

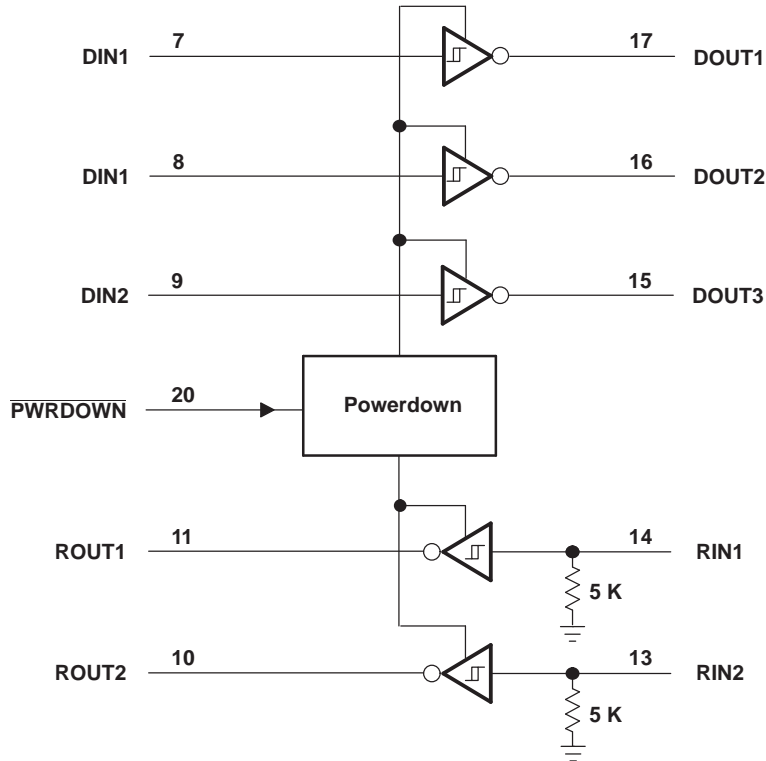


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TRUTH TABLE (SHUTDOWN FUNCTION)

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

FUNCTIONAL BLOCK DIAGRAM



PRODUCT PREVIEW

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
<u>PWRDWN</u>	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, <u>PWRDWN</u> to GND		V
		RIN to GND		
V_o	Output voltage	DOUT to GND		V
		ROUT		
Short-circuit duration DOUT to GND		Continuous		
Continuous power dissipation		$T_A = 70^\circ\text{C}$, 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.

PRODUCT PREVIEW

TRS3386E
RS-232 TRANSCEIVER
WITH SPLIT SUPPLY PIN FOR LOGIC SIDE

SLLS829A – APRIL 2007 – REVISED APRIL 2007

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, $\overline{\text{PWRDWN}}$	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, $\overline{\text{PWRDWN}}$	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		TRS3386ECPWR	0	70	°C
		TRS3386EIPWR	-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	$\overline{\text{PWRDWN}}$ = GND, All inputs at V _{CC} or GND		1	10	μA
Supply current	$\overline{\text{PWRDWN}}$ = 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	

PRODUCT PREVIEW

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 ⁽¹⁾	MAX	UNIT	
I_{off}	Output leakage current	ROUT, receivers disabled		± 0.05	± 10	μA	
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 ⁽¹⁾	UNIT
t_{PHL}	Receiver propagation delay	Receiver input to receiver output, $C_L = 150\text{ pF}$	0.15	μs
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 $V_{CC} = V_L = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

DRIVER SECTION

Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽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 = $\pm 2\text{ V}$	300	10M		Ω
I_{OS} Output short-circuit current	$V_{T_OUT} = 0$			± 60	mA
I_{OZ} Output leakage current	$V_{T_OUT} = \pm 12\text{ V}$, 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 $V_{CC} = V_L = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$

Timing Requirements

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

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽¹⁾	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		μs
$ t_{PHL} - t_{PLH} $ Driver skew ⁽²⁾			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 Ω , 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/ μs
		$C_L = 150\text{ pF to }2500\text{ pF}$	4	30	

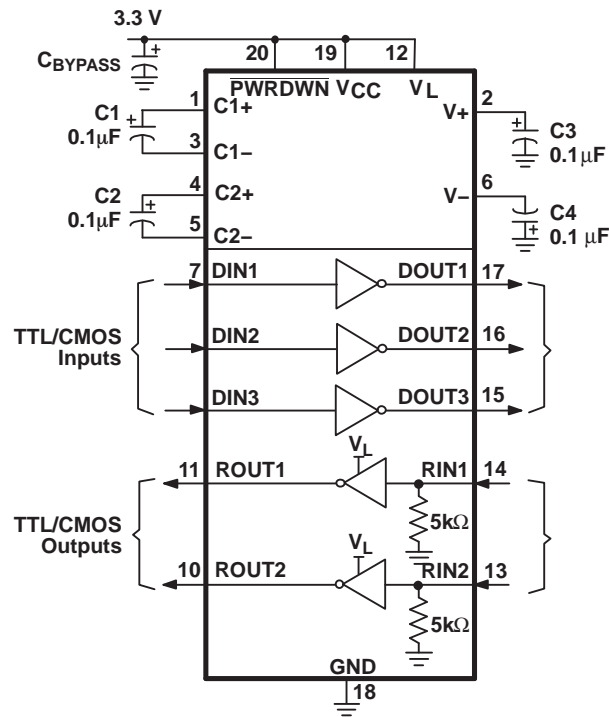
(1) Typical values are at $V_{CC} = V_L = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

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

ESD Protection

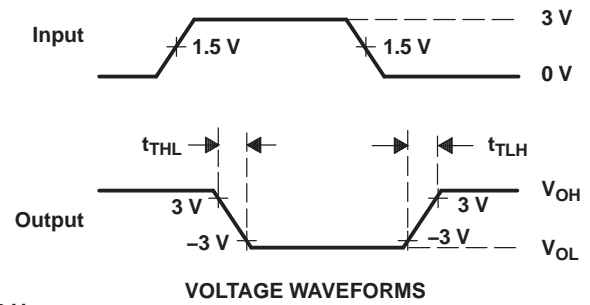
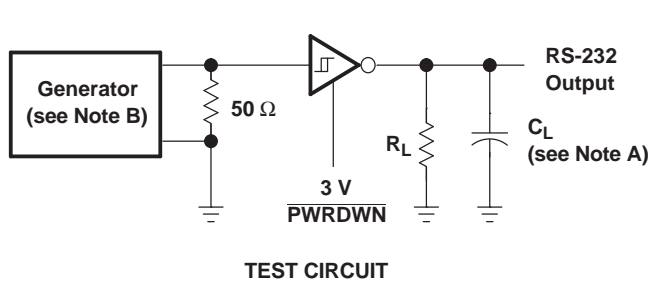
PARAMETER	TEST CONDITIONS	TYP	UNIT
RIN, DOUT	Human-Body Model	± 15	kV
	IEC 61000-4-2 Air-Gap Discharge	± 15	
	IEC 61000-4-2 Contact Discharge	± 8	

APPLICATION INFORMATION



PRODUCT PREVIEW

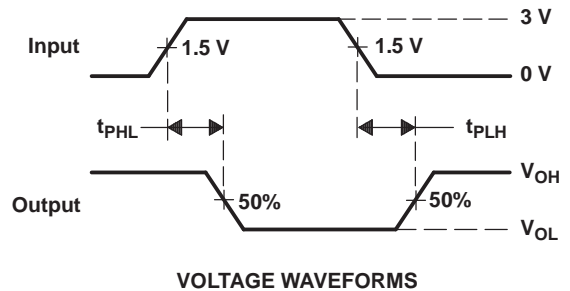
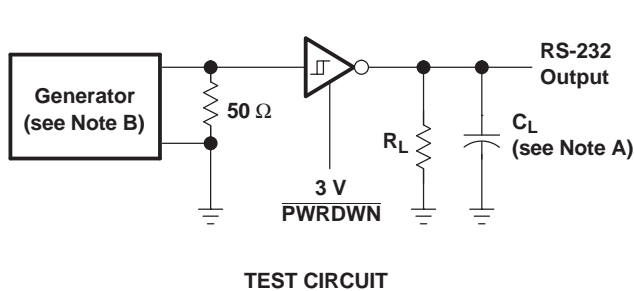
PARAMETER MEASUREMENT INFORMATION



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

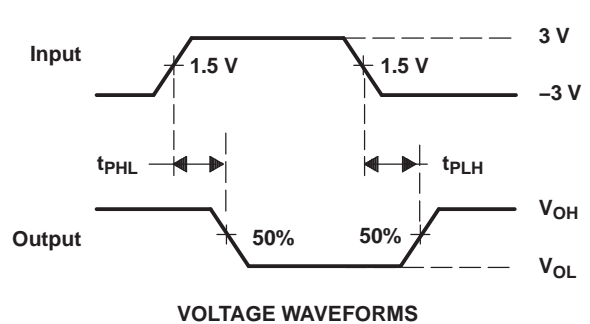
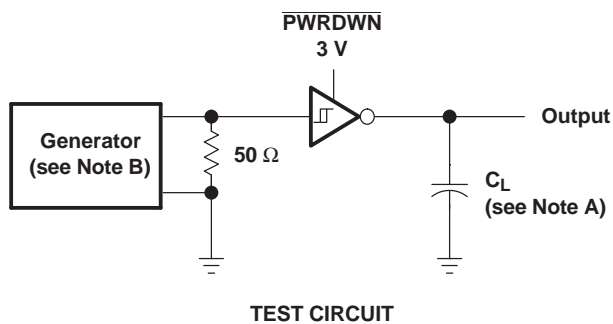
- NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50 \Omega$, 50% duty cycle, $t_r \leq 10$ ns, $t_f \leq 10$ ns.

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.

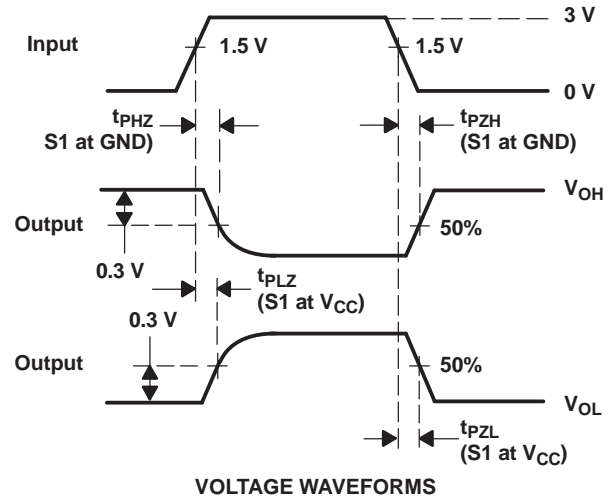
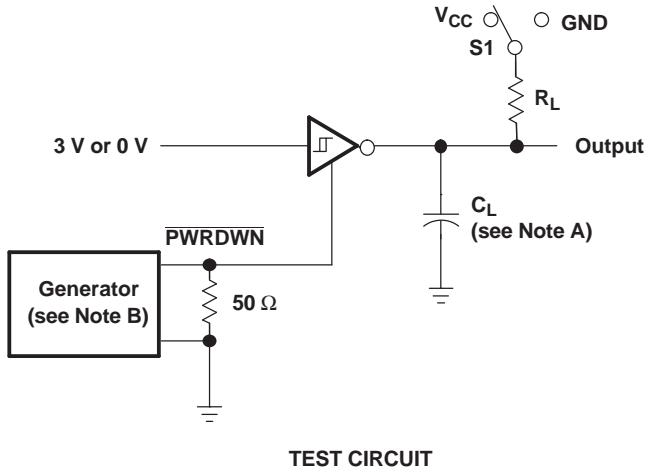
Figure 2. Driver Pulse Skew



- 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 (Continued)



- 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 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⁾
TRS3386ECDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECDWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECDWRG4	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386ECPWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIDW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIDWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIDWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIDWRG4	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TRS3386EIPWRG4	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.

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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
TRS3386ECDWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.0	2.7	12.0	24.0	Q1
TRS3386ECPWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TRS3386EIDWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.0	2.7	12.0	24.0	Q1
TRS3386EIPWR	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)
TRS3386ECDWR	SOIC	DW	20	2000	346.0	346.0	41.0
TRS3386ECPWR	TSSOP	PW	20	2000	346.0	346.0	33.0
TRS3386EIDWR	SOIC	DW	20	2000	346.0	346.0	41.0
TRS3386EIPWR	TSSOP	PW	20	2000	346.0	346.0	33.0

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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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