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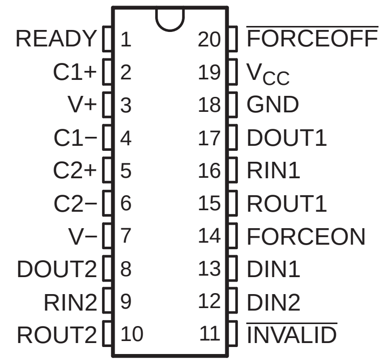
TRS3318
2.5-V 460-kbps RS-232 TRANSCEIVER WITH ±15-kV ESD PROTECTION

SLLS820–AUGUST 2007

FEATURES

- **ESD Protection for RS-232 I/O Pins**
  - **±15 kV Human-Body Model (HBM)**
  - **±8 kV IEC 61000-4-2, Contact Discharge**
  - **±8 kV IEC 61000-4-2, Air-Gap Discharge**
- **300-μA Operating Supply Current**
- **1-μA Low-Power Standby (With Receivers Active) Mode**
- **Designed to Transmit at a Data Rate of 460 kbps**
- **Auto-Powerdown Plus Option Features Flexible Power-Saving Mode**
- **Operates From a Single 2.25-V to 3-V V_{CC} Supply**

DB OR PW PACKAGE
(TOP VIEW)



APPLICATIONS

- **Battery-Powered Systems**
- **PDAs**
- **Cellular Phones**
- **Notebooks**
- **Hand-Held Equipment**
- **Pagers**

DESCRIPTION/ORDERING INFORMATION

The TRS3318 is a dual-driver, dual-receiver, RS-232 compatible transceiver. The device features auto-powerdown plus and enhanced electrostatic discharge (ESD) protection integrated into the chip. Driver output and receiver input are protected to ±8 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 (HBM).

The device operates at a data rate of 460 kbps. The transceiver has a proprietary low-dropout driver output stage enabling RS-232-compatible operation from a 2.25-V to 3-V supply with a dual charge pump. The charge pump requires only four 0.1-μF capacitors and features a logic-level output (READY) that asserts when the charge pump is regulating and the device is ready to begin transmitting.

The TRS3318 achieves a 1-μA supply current using the auto-powerdown feature. This device automatically enters a low-power power-down mode when the RS-232 cable is disconnected or the drivers of the connected peripherals are inactive for more than 30 s. The device turns on again when it senses a valid transition at any driver or receiver input. Auto-powerdown saves power without changes to the existing BIOS or operating system.

This device is available in two space-saving packages: 20-pin SSOP and 20-pin TSSOP.

Flexible control options for power management are featured when the serial port and driver inputs are inactive. The auto-powerdown plus feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense valid signal transitions on all receiver and driver inputs for approximately 30 s, the built-in charge pump and drivers are powered down, reducing the supply current to 1 μA. By disconnecting the serial port or placing the peripheral drivers off, auto-powerdown plus can be disabled when FORCEON and $\overline{\text{FORCEOFF}}$ are high. With auto-powerdown plus enabled, the device activates automatically when a valid signal is applied to any receiver or driver input. $\overline{\text{INVALID}}$ is high (valid data) if any receiver input voltage is greater than 2.7 V or less than –2.7 V, or has been between –0.3 V and 0.3 V for less than 30 μs (typical number). $\overline{\text{INVALID}}$ is low (invalid data) if all receiver input voltage are between –0.3 V and 0.3 V for more than 30 μs (typical number).

ORDERING INFORMATION

T_A	PACKAGE[(1)(2)]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	SSOP – DB	Tube of 70	TRS3318CDB	RV18C
		Reel of 2000	TRS3318CDBR	
	TSSOP – PW	Tube of 70	TRS3318CPW	RV18C
		Reel of 2000	TRS3318CPWR	
–40°C to 85°C	SSOP – DB	Tube of 70	TRS3318IDB	RV18I
		Reel of 2000	TRS3318IDBR	
	TSSOP – PW	Tube of 70	TRS3318IPW	RV18I
		Reel of 2000	TRS3318IPWR	

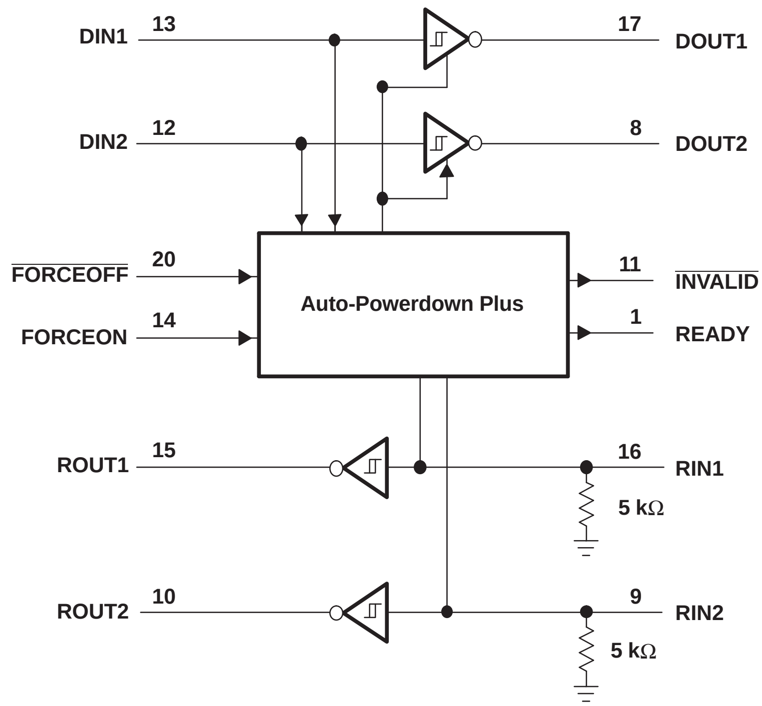
(1) Package drawings,thermal data, and symbolization are available at www.ti.com/packaging.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

FUNCTION TABLE[(1)]

INPUT CONDITIONS				OUTPUT STATES				OPERATING MODE
FORCEON	$\overline{\text{FORCEOFF}}$	RECEIVER OR DRIVER EDGE WITHIN 30 s	VALID RS-232 LEVEL PRESENT AT RECEIVER	DRIVER	RECEIVER	$\overline{\text{INVALID}}$	READY	
Auto-Powerdown Plus Conditions								
H	H	No	No	Active	Active	L	H	Normal operation, auto-powerdown plus disabled
H	H	No	Yes	Active	Active	H	H	Normal operation, auto-powerdown plus disabled
L	H	Yes	No	Active	Active	L	H	Normal operation, auto-powerdown plus enabled
L	H	Yes	Yes	Active	Active	H	H	Normal operation, auto-powerdown plus enabled
L	H	No	No	Z	Active	L	L	Power down, auto-powerdown plus enabled
L	H	No	Yes	Z	Active	H	L	Power down, auto-powerdown plus enabled
X	L	X	No	Z	Active	L	L	Manual power down
X	L	X	Yes	Z	Active	H	L	Manual power down
Auto-Powerdown Conditions								
$\overline{\text{INVALID}}$	$\overline{\text{INVALID}}$	X	No	Z	Active	L	L	Power down, auto-powerdown enabled
$\overline{\text{INVALID}}$	$\overline{\text{INVALID}}$	X	Yes	Active	Active	H	H	Normal operation, auto-powerdown enabled

(1) H = high level, L = low level, X = irrelevant, Z = high impedance

LOGIC DIAGRAM (POSITIVE LOGIC)



TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION
NAME	NO.	
C1+	2	Positive voltage-doubler charge-pump capacitor
C1–	4	Negative voltage-doubler charge-pump capacitor
C2+	5	Positive inverting charge-pump capacitor
C2–	6	Negative inverting charge-pump capacitor
DIN	12, 13	CMOS driver inputs
DOUT	8, 17	RS-232 driver outputs
$\overline{\text{FORCEOFF}}$	20	Force-off input, active low. Drive low to power down transmitters, receivers, and charge pump. This overrides auto-powerdown and FORCEON (see Function Table).
FORCEON	14	Force-on input, active high. Drive high to override auto-powerdown, keeping transmitters and receivers on ($\overline{\text{FORCEOFF}}$ must be high) (see Function Table).
GND	18	Ground
$\overline{\text{INVALID}}$	11	Valid signal detector output, active low. A logic high indicates that a valid RS-232 level is present on a receiver input.
READY	1	Ready to transmit output, active high. READY is enabled high when V– goes below –3.5 V and the device is ready to transmit.
RIN	9, 16	RS-232 receiver inputs
ROUT	10, 15	CMOS receiver outputs
V+	3	$2 \times V_{CC}$ generated by the charge pump
V–	7	$–2 \times V_{CC}$ generated by the charge pump
V_{CC}	19	2.25-V to 3-V single-supply voltage

Absolute Maximum Ratings[1]

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.3	6	V
V+	Positive supply voltage range[2]		–0.3	7	V
V–	Negative supply voltage range[2]		–7	0.3	V
V+ + IV–I	Supply voltage differential[2]			13	V
V_I	Input voltage	DIN, FORCEON, $\overline{\text{FORCEOFF}}$ to GND	–0.3	6	V
		RIN to GND		±25	
V_O	Output voltage	DOUT to GND		±13.2	V
		ROUT, $\overline{\text{INVALID}}$, READY to GND	–0.3	V_{CC} + 0.3	
	Short-circuit duration	DOUT to GND		Continuous	
	Continuous power dissipation (T_A = 70°C)	16-pin SSOP (derate 7.14 mW/°C above 70°C)		571	mW
		20-pin SSOP (derate 8 mW/°C above 70°C		640	
		20-pin TSSOP (derate 7 mW/°C above 70°C)		559	
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 under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated 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

See Figure 4

				MIN	NOM	MAX	UNIT
	Supply voltage			2.25	2.5	3	V
V_{IH}	Driver and control high-level input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON	V_{CC} = 2.5 V to 3 V	0.7 × V_{CC}		5.5	V
V_{IL}	Driver and control low-level input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON	V_{CC} = 2.5 V to 3 V	0		0.3 × V_{CC}	V
V_I	Receiver input voltage			–25		25	V
T_A	Operating free-air temperature	TRS3318C		0		70	°C
		TRS3318I		–40		85	

Electrical Characteristics

V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 µF, T_A = T_{MIN} to T_{MAX} (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP[1]	MAX	UNIT
DC Characteristics (V_{CC} = 2.5 V, T_A = 25°C)					
Auto-powerdown plus supply current	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}, All RIN and DIN idle		1	10	µA
Auto-powerdown supply current	$\overline{\text{FORCEOFF}}$ = GND		1	10	µA
Supply current	FORCEON = $\overline{\text{FORCEOFF}}$ = V_{CC}, No load		0.3	2	mA

(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.

ESD Protection

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

DRIVER SECTION

Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 μF, $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
V_{hys}	Driver input hysteresis			0.3		V
I_{on}	Input leakage current	FORCEON, DIN, $\overline{\text{FORCEOFF}}$		±0.01	±1	μA
V_{om}	Output voltage swing	All driver outputs loaded with 3 kΩ to ground	±3.7	±4		V
r_O	Output resistance	V_{CC} = 0, Driver output = ±2 V	300	10M		Ω
I_{OS}	Output short-circuit current(2)			±25	±60	mA
I_{off}	Output leakage current	V_{CC} = 0 or 2.25 V to 3 V, V_{OUT} = ±12 V, Drivers disabled			±25	μA

(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.
(2) 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,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 μF, $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted) (see Figure 1)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
	Maximum data rate	R_L = 3 kΩ, C_L = 1000 pF, One transmitter switching	460			kbps
$\lvert t_{PHL} - t_{PLH} \rvert$	Driver skew(2)			100		ns
SR(tr)	Transition-region slew rate	V_{CC} = 2.5 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 2500 pF	4		30	V/μs

(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.
(2) Pulse skew is defined as $\lvert t_{PLH} - t_{PHL} \rvert$ of each channel of the same device.

RECEIVER SECTION

Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 µF, $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP (1)	MAX	UNIT
V_I	Input voltage range		–25		25	V
V_{IT+}	Input voltage threshold low	T_A = 25°C			0.3 × V_{CC}	V
$V_{IT–}$	Input voltage threshold high	T_A = 25°C	0.7 × V_{CC}			V
V_{hys}	Input hysteresis			0.3		V
r_i	Input resistance	T_A = 25°C	3	5	7	kΩ
I_{off}	Output leakage current			±0.05	±10	µA
V_{OL}	Output voltage low	I_{OUT} = 0.5 mA			0.1 × V_{CC}	V
V_{OH}	Output voltage high	I_{OUT} = –0.5 mA	0.9 × V_{CC}			V

(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.

Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 µF, $T_A = T_{MIN}$ to T_{MAX} (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	TYP (1)	UNIT
t_{PHL}	Receiver propagation delay	RIN to ROUT, C_L = 150 pF	0.175	µs
t_{PLH}	Receiver propagation delay	RIN to ROUT, C_L = 150 pF	0.175	µs
$\lvert t_{PHL} - t_{PLH} \rvert$	Receiver skew (2)		50	ns

(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.
(2) Pulse skew is defined as $\lvert t_{PLH} - t_{PHL} \rvert$ of each channel of the same device.

AUTO-POWERDOWN PLUS SECTION

Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 μF, T_A = T_{MIN} to T_{MAX} (unless otherwise noted) (see Figure 4)

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Receiver input threshold to $\overline{\text{INVALID}}$ high	Positive threshold		2.7	V
	Negative threshold	–2.7		
Receiver input threshold $\overline{\text{INVALID}}$ low		–0.3	0.3	V
$\overline{\text{INVALID}}$, READY voltage low	I_{OUT} = 0.5 mA		0.1 × V_{CC}	V
$\overline{\text{INVALID}}$, READY voltage high	I_{OUT} = –0.5 mA	0.8 × V_{CC}		V

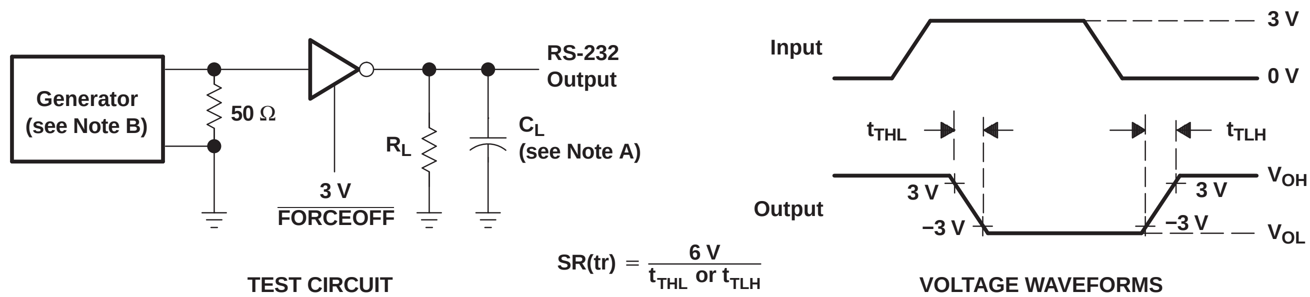
Switching Characteristics

over recommended ranges of supply voltage and operating free-air temperature,
V_{CC} = 2.25 V to 3 V, C1–C4 = 0.1 μF, T_A = T_{MIN} to T_{MAX} (unless otherwise noted) (see Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
t_{INVH}	Receiver positive or negative threshold to $\overline{\text{INVALID}}$ high	V_{CC} = 2.5 V		1		μs
t_{INVL}	Receiver positive or negative threshold to $\overline{\text{INVALID}}$ low	V_{CC} = 2.5 V		30		μs
t_{WU}	Receiver or driver edge to driver enabled	V_{CC} = 2.5 V		100		μs
$t_{AUTOPRDN}$	Receiver or driver edge to driver shutdown	V_{CC} = 2.5 V	15	30	60	s

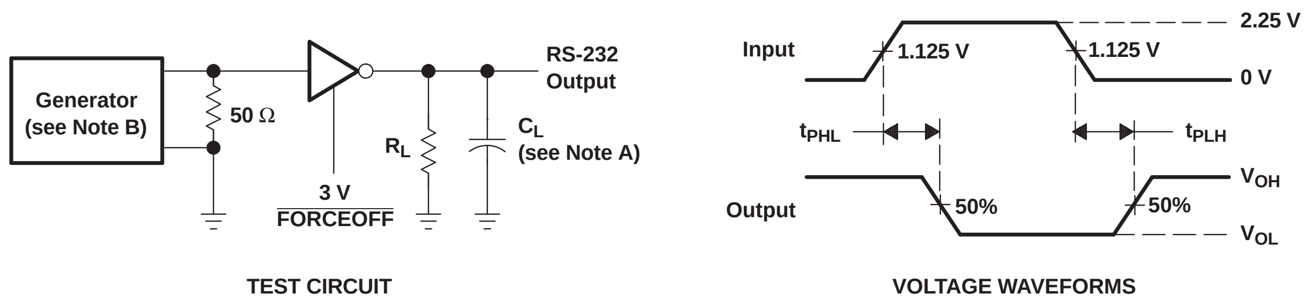
(1) Typical values are at V_{CC} = 2.5 V,T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



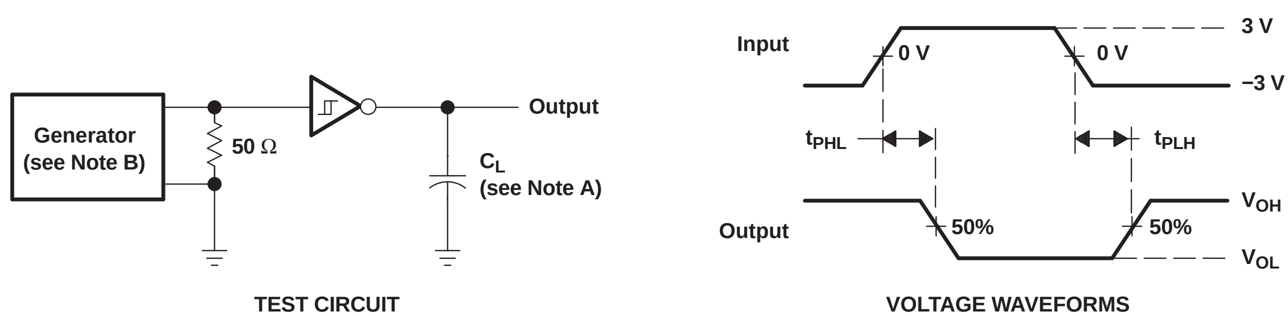
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \leq$ 10 ns, $t_f \leq$ 10 ns.

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 Ω, 50% duty cycle, $t_r \leq$ 10 ns, $t_f \leq$ 10 ns.

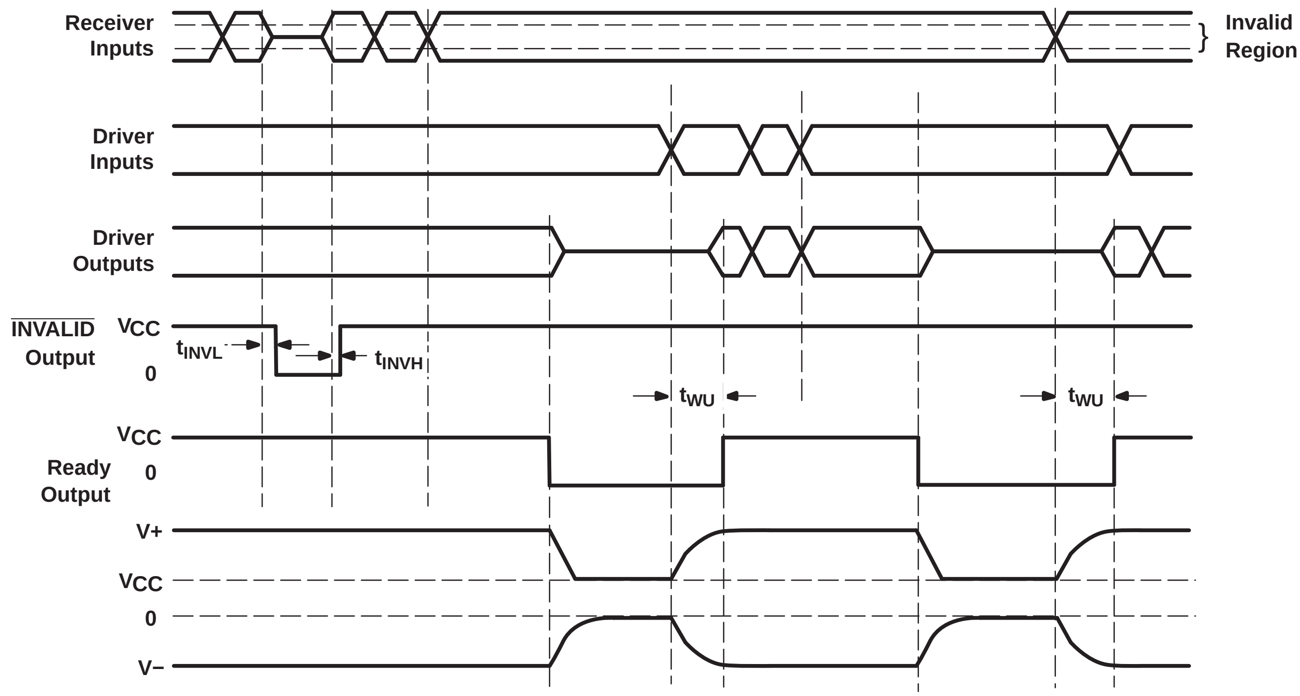
Figure 2. Driver Pulse Skew



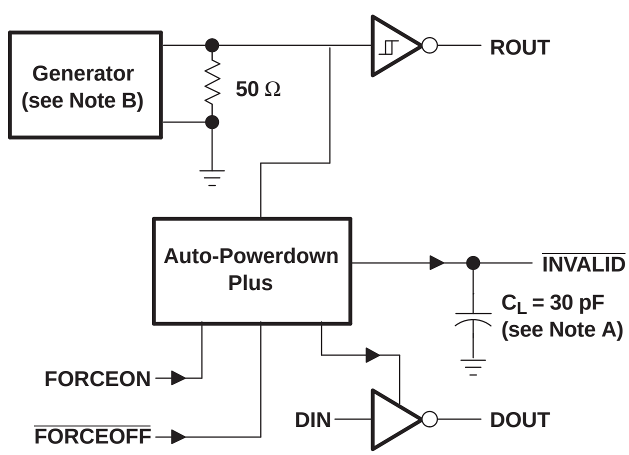
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \leq$ 10 ns, $t_f \leq$ 10 ns.

Figure 3. Receiver Propagation Delay Times

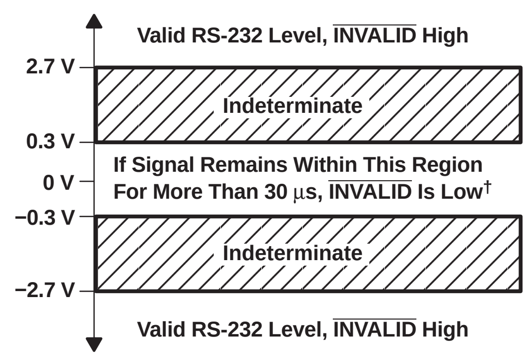
PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS



TEST CIRCUIT



† Auto power down disables drivers and reduces supply current to 1 µA.

Figure 4. $\overline{\text{INVALID}}$ Propagation Delay Times and Supply Enabling Time

APPLICATION INFORMATION

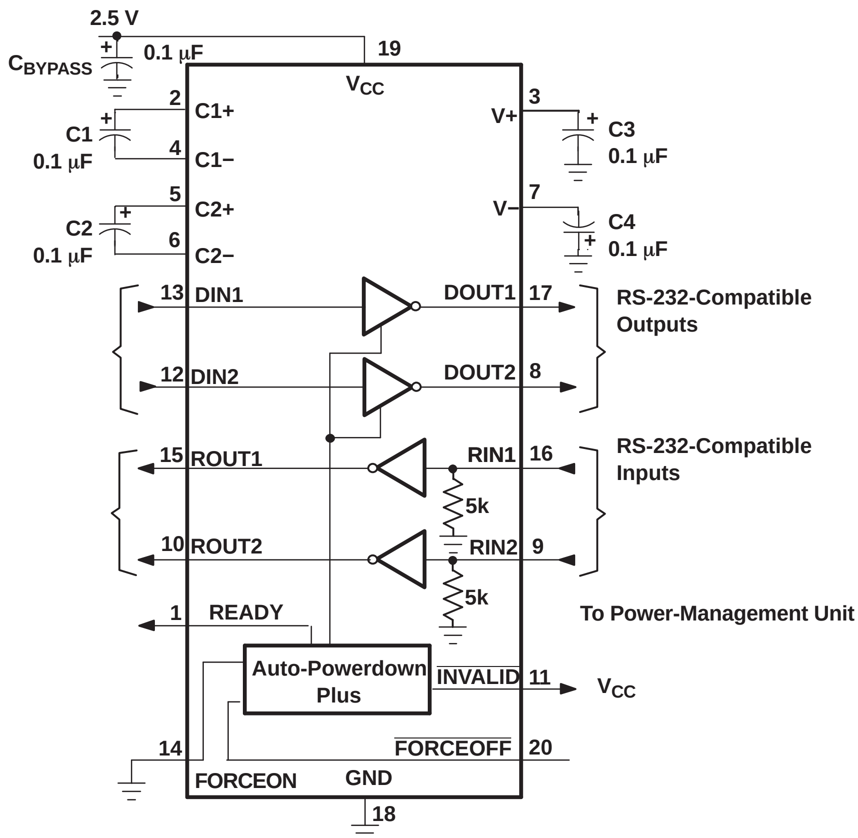


Figure 5. Typical Application Circuit

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
TRS3318CDB	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	0 to 70	RV18C	
TRS3318CDBG4	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	0 to 70		
TRS3318CDBR	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	0 to 70	RV18C	
TRS3318CDBRG4	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	0 to 70		
TRS3318CPW	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	0 to 70	RV18C	
TRS3318CPWG4	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	0 to 70		
TRS3318CPWR	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	0 to 70	RV18C	
TRS3318CPWRG4	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	0 to 70		
TRS3318IDB	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	-40 to 85	RV18I	
TRS3318IDBG4	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	-40 to 85		
TRS3318IDBR	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	-40 to 85	RV18I	
TRS3318IDBRG4	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	-40 to 85		
TRS3318IPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RV18I	Samples
TRS3318IPWG4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	RV18I	Samples
TRS3318IPWR	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	-40 to 85	RV18I	
TRS3318IPWRG4	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	-40 to 85		

(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)

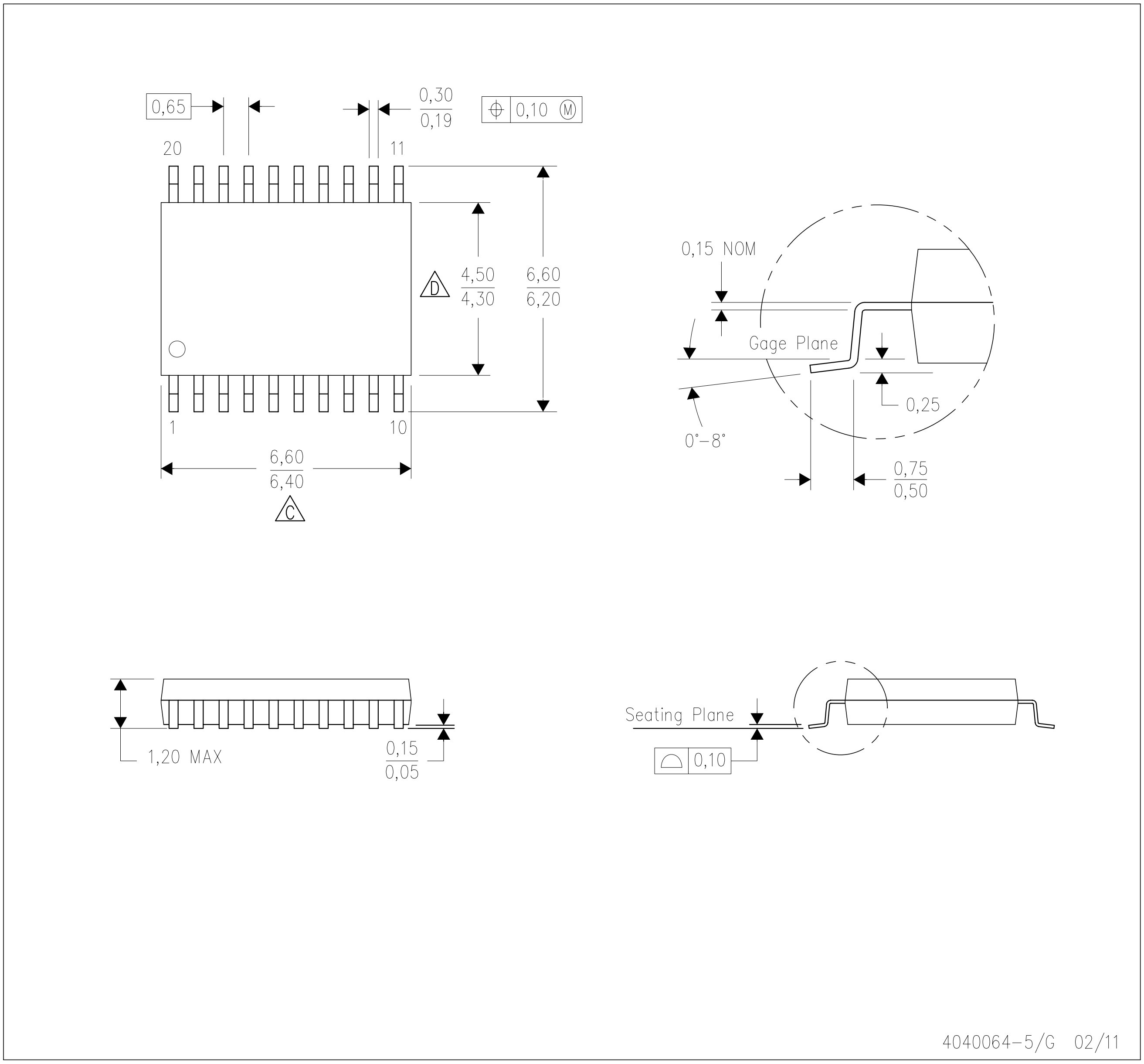
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

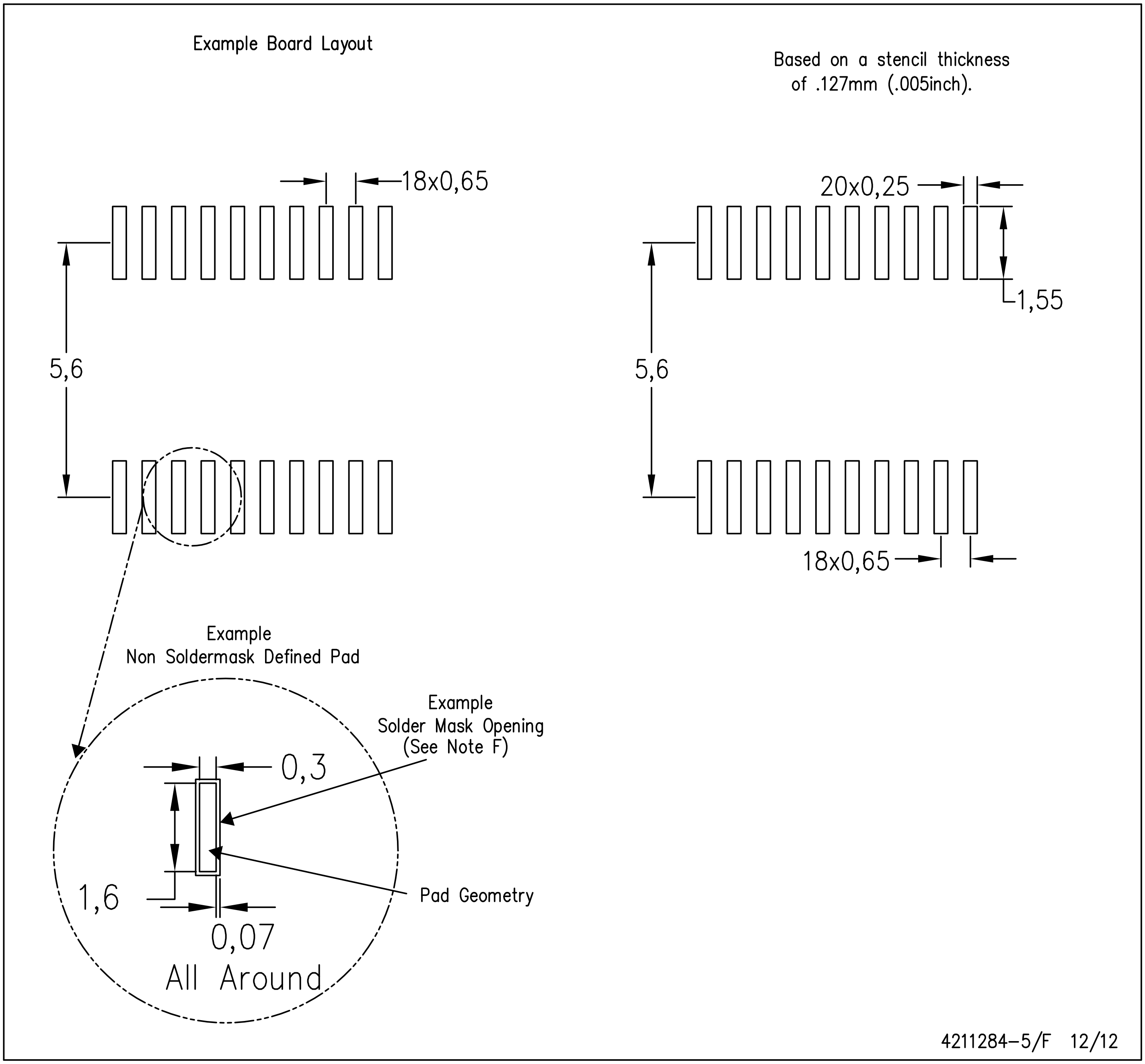
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

PW (R–PDSO–G20) PLASTIC SMALL OUTLINE



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

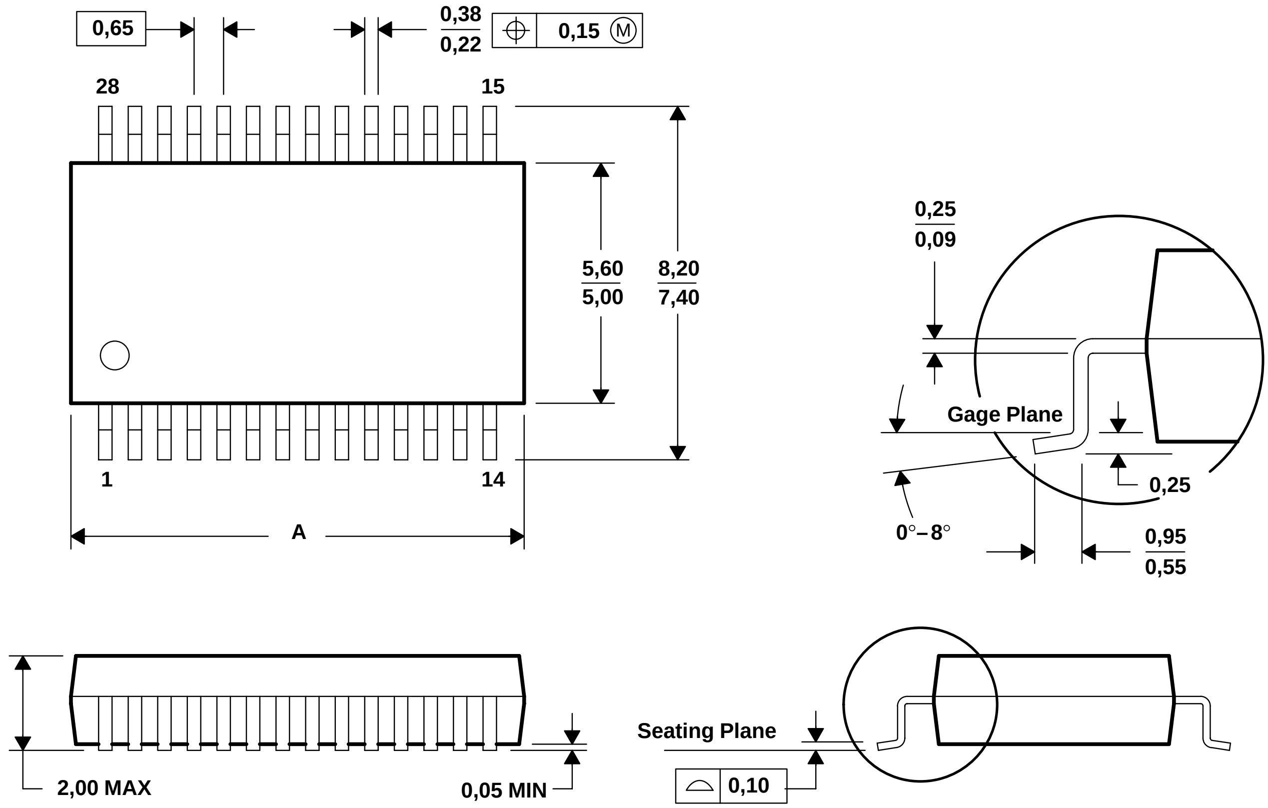
PW (R–PDSO–G20) PLASTIC SMALL OUTLINE



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.

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



PINS ** / DIM	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

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-150

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