MAX3318
2.5-V 460-kbps RS-232 TRANSCEIVER WITH ±15-kV ESD PROTECTION

SLLS687–OCTOBER 2005

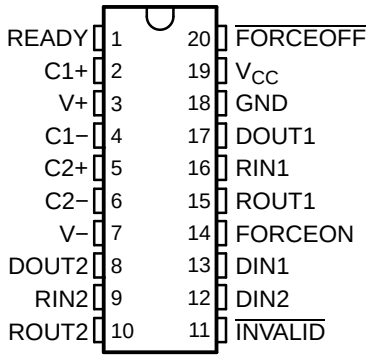
FEATURES

- **ESD Protection for RS-232 I/O Pins**
  - **±15 kV (Human-Body Model)**
  - **±8 kV (IEC 61000, Contact Discharge)**
  - **±8 kV (IEC 61000, 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-Power-Down Plus Option Features Flexible Power-Saving Mode**
- **Operates From a Single 2.25-V to 3-V V_{CC} Supply**

APPLICATIONS

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

DB OR PW PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The MAX3318 is a dual-driver, dual-receiver, RS-232 compatible transceiver. The device features auto-power-down 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 Air-Gap Discharge method, ±8 kV using the IEC 61000 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 MAX3318 achieves a 1-μA supply current using the auto-power-down 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 power down 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.

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	SSOP – DB	Tube of 70	MAX3318CDB	MA3318C
		Reel of 2000	MAX3318CDBR	
	TSSOP – PW	Tube of 70	MAX3318CPW	MA3318C
		Reel of 2000	MAX3318CPWR	
–40°C to 85°C	SSOP – DB	Tube of 70	MAX3318IDB	MA3318I
		Reel of 2000	MAX3318IDBR	
	TSSOP – PW	Tube of 70	MAX3318IPW	MA3318I
		Reel of 2000	MAX3318IPWR	

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

DETAILED DESCRIPTION

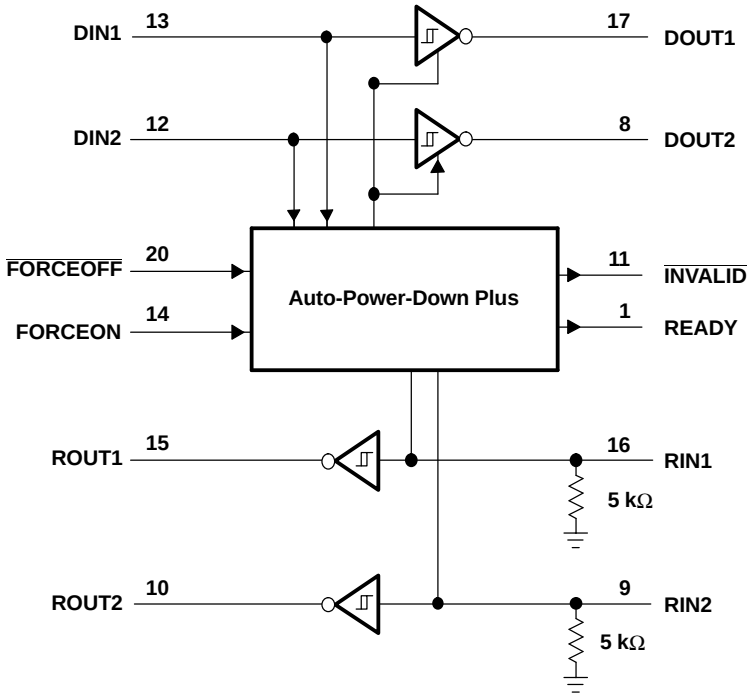
Flexible control options for power management are featured when the serial port and driver inputs are inactive. The auto-power-down plus feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense valid signal transitions 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-power-down plus can be disabled when FORCEON and $\overline{\text{FORCEOFF}}$ are high. With auto-power-down 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).

FUNCTION TABLE(1)

INPUT CONDITIONS				OUTPUT STATES				
FORCEON	$\overline{\text{FORCEOFF}}$	RECEIVER OR DRIVER EDGE WITHIN 30 s	VALID RS-232 LEVEL PRESENT AT RECEIVER	DRIVER	RECEIVER	$\overline{\text{INVALID}}$	READY	OPERATING MODE
Auto-Power-Down Plus Conditions								
H	H	No	No	Active	Active	L	H	Normal operation, auto-power-down plus disabled
H	H	No	Yes	Active	Active	H	H	Normal operation, auto-power-down plus disabled
L	H	Yes	No	Active	Active	L	H	Normal operation, auto-power-down plus enabled
L	H	Yes	Yes	Active	Active	H	H	Normal operation, auto-power-down plus enabled
L	H	No	No	Z	Active	L	L	Power down, auto-power-down plus enabled
L	H	No	Yes	Z	Active	H	L	Power down, auto-power-down 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-Power-Down Conditions								
$\overline{\text{INVALID}}$	$\overline{\text{INVALID}}$	X	No	Z	Active	L	L	Power down, auto power down enabled
$\overline{\text{INVALID}}$	$\overline{\text{INVALID}}$	X	Yes	Active	Active	H	H	Normal operation, auto power down 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 power down and FORCEON (see Function Table).
FORCEON	14	Force-on input, active high. Drive high to override auto power down, 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} to GND		–0.3	6	V
V+ to GND(2)		–0.3	7	V
V– to GND(2)		–7	0.3	V
V+ + IV-I(2)			13	V
Input voltage	DIN, FORCEON, $\overline{\text{FORCEOFF}}$ to GND	–0.3	6	V
	RIN to GND		±25	
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	
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	MAX3318C		0		70	°C
		MAX3318I		–40		85	

Supply Current Section 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-power-down plus supply current	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}, All RIN and DIN idle		1	10	µA
Auto-power-down 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 G1000-4-2 Air-Gap Discharge method	±8	
	IEC G1000-4-2 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
Driver input hysteresis			0.3		V
Input leakage current	FORCEON, DIN, $\overline{\text{FORCEOFF}}$		±0.01	±1	µA
Output voltage swing	All driver outputs loaded with 3 kΩ to ground	±3.7	±4		V
Output resistance	V_{CC} = 0, Driver output = ±2 V	300	10M		Ω
Output short-circuit current(2)			±25	±60	mA
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.

Driver Section 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
	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
Input voltage range		–25		25	V
Input threshold low	T_A = 25°C			$0.3 \times V_{CC}$	V
Input threshold high	T_A = 25°C	$0.7 \times V_{CC}$			V
Input hysteresis			0.3		V
Input resistance	T_A = 25°C	3	5	7	kΩ
Output leakage current			±0.05	±10	µA
Output voltage low	I_{OUT} = 0.5 mA			$0.1 \times V_{CC}$	V
Output voltage high	I_{OUT} = –0.5 mA	$0.9 \times V_{CC}$			V

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

Receiver Section 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}			0.175	
$\lvert t_{PHL} - t_{PLH} \rvert$	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-Power-Down 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		$0.1 \times V_{CC}$	V
$\overline{\text{INVALID}}$, READY voltage high	I_{OUT} = –0.5 mA	$0.8 \times V_{CC}$		V

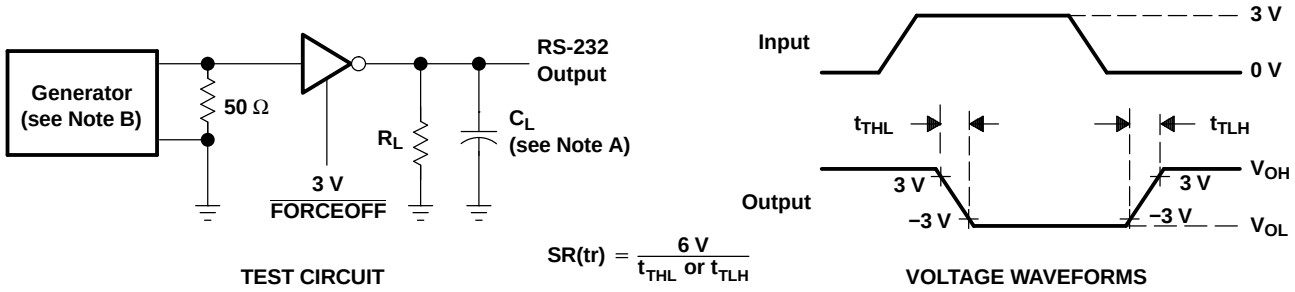
Auto-Power-Down Plus Section Switching Characteristics

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

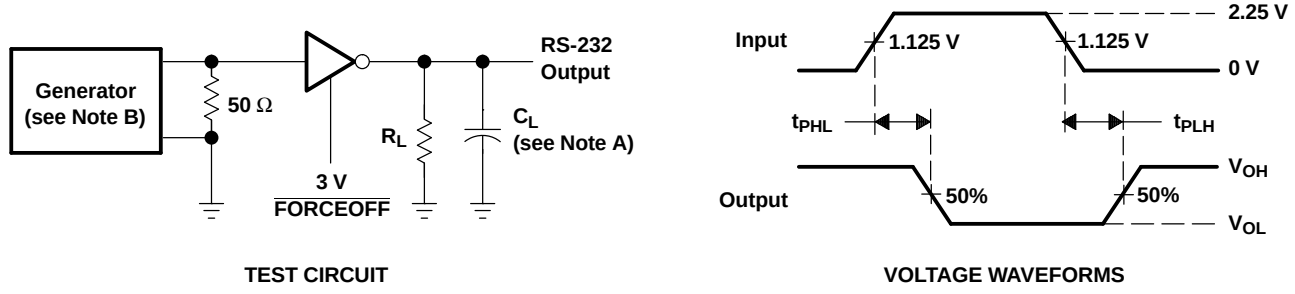
(1) Typical values are at V_{CC} = 2.5 V,T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



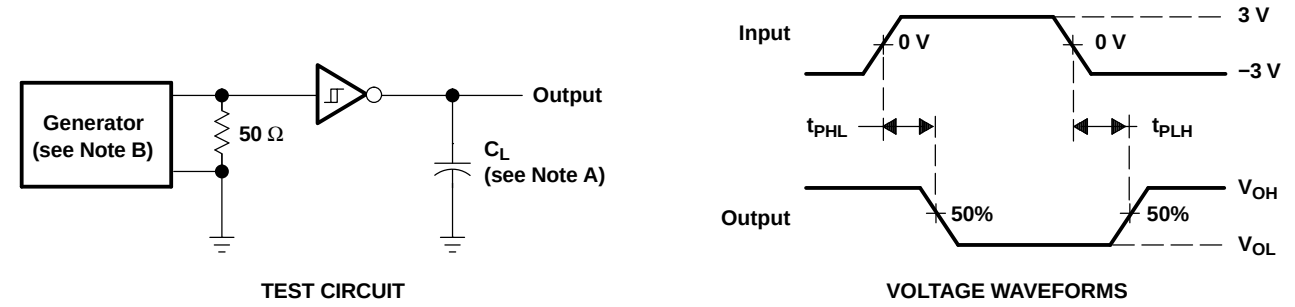
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

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

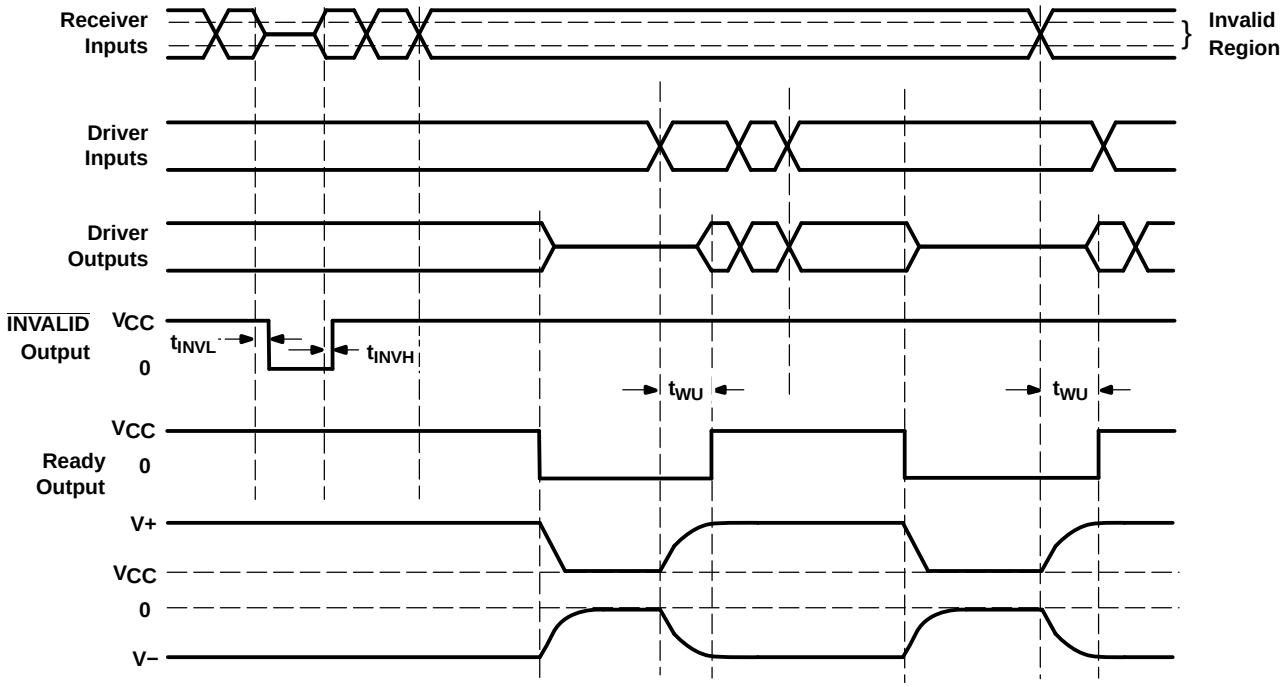
Figure 2. Driver Pulse Skew



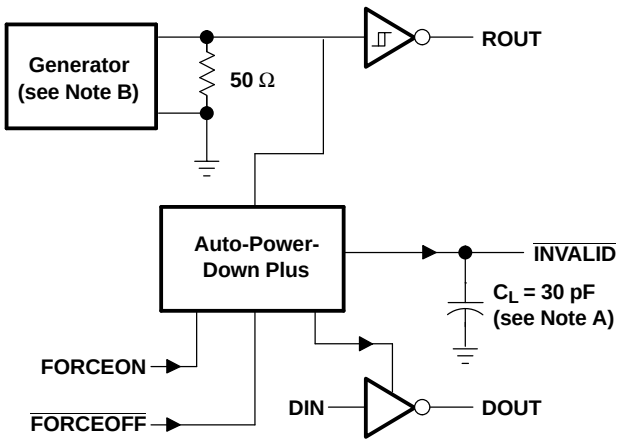
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 3. Receiver Propagation Delay Times

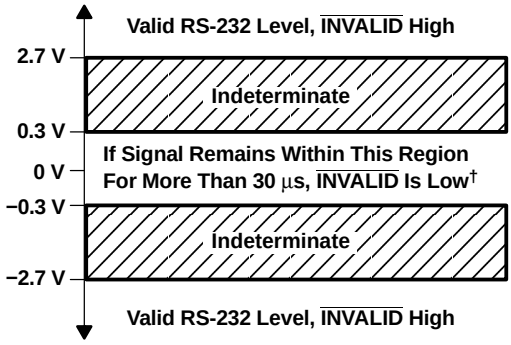
PARAMETER MEASUREMENT INFORMATION



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

PARAMETER MEASUREMENT INFORMATION

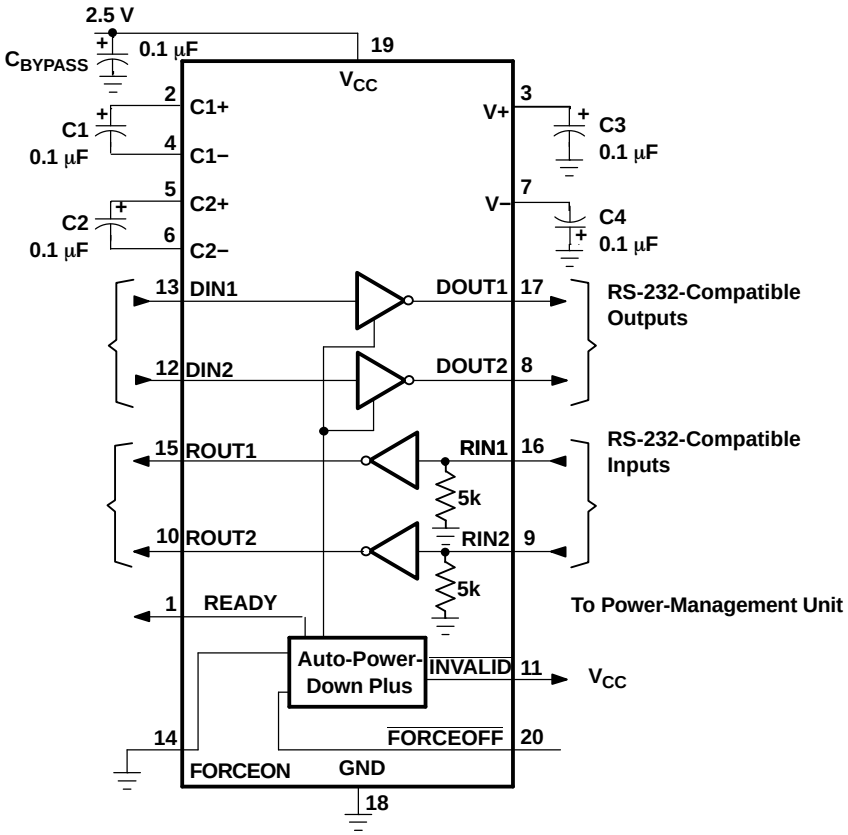


Figure 5. Typical Application Circuit

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
MAX3318CDB	ACTIVE	SSOP	DB	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CDBE4	ACTIVE	SSOP	DB	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CDBR	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CDBRE4	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CPWE4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318CPWRE4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IDB	ACTIVE	SSOP	DB	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IDBE4	ACTIVE	SSOP	DB	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IDBR	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IDBRE4	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IPW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IPWE4	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
MAX3318IPWRE4	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.

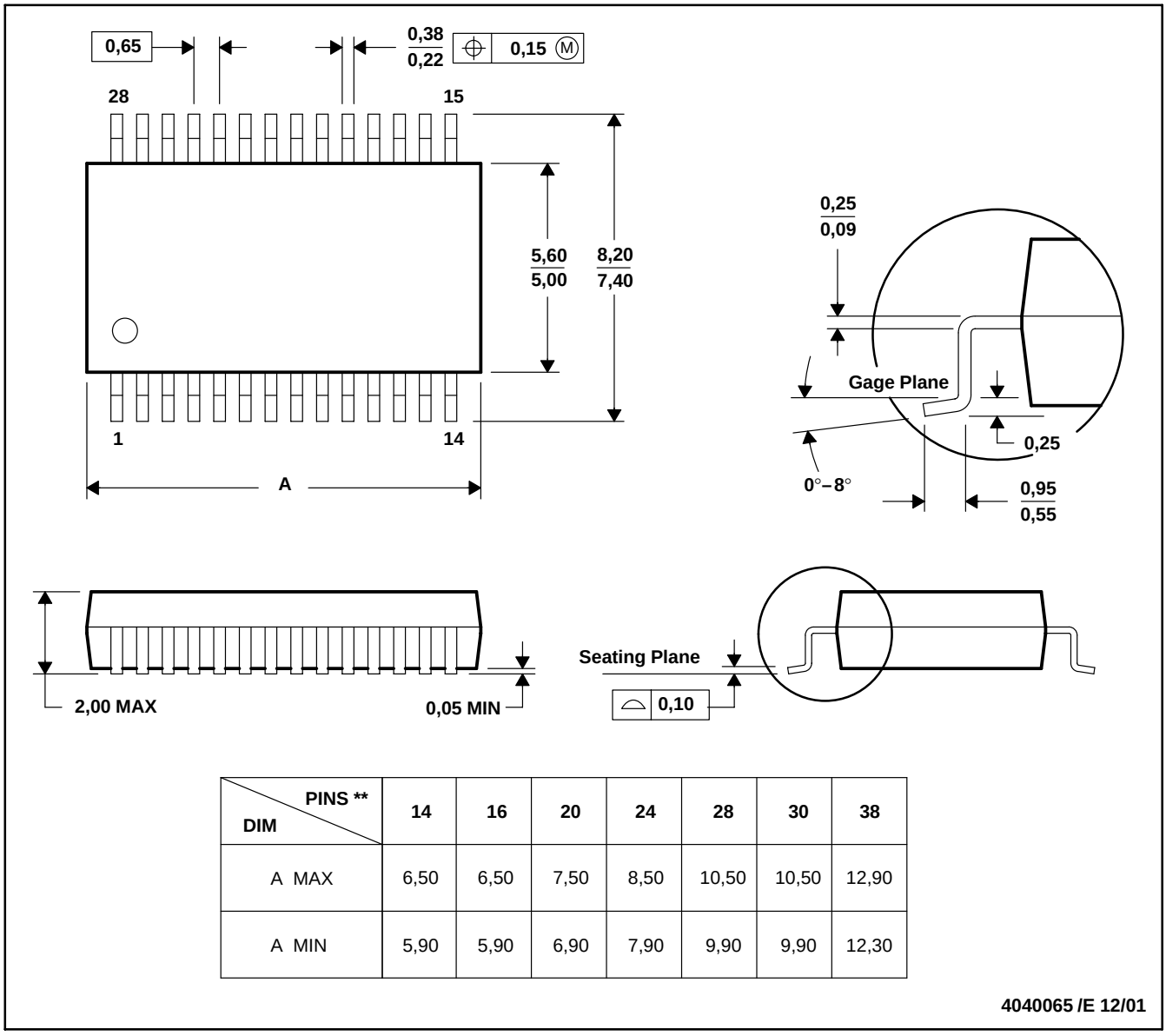
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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.

MSSO002E – JANUARY 1995 – REVISED DECEMBER 2001

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

28 PINS SHOWN



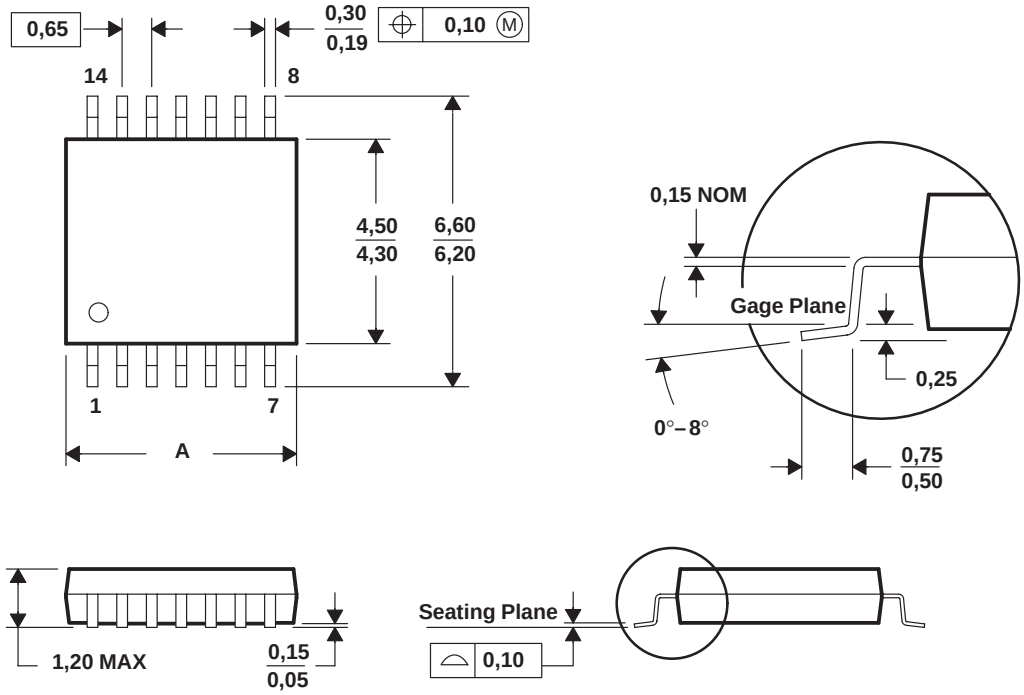
DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

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

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

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

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