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

Check for Samples: TRS3318E

FEATURES

- **ESD Protection for RS-232 I/O Pins**
  - **±15 kV (Human-Body Model)**
  - **±8 kV (IEC 61000-4-2, Contact Discharge)**
  - **±15 kV (IEC 61000-4-2, Air-Gap Discharge)**
- **300-µA Operating Supply Current**
- **1-µA Low-Power Standby Mode (With Receivers Active)**
- **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**
- **Designed to be Interchangeable With Industry Standard '3318 Devices**

APPLICATIONS

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

DESCRIPTION

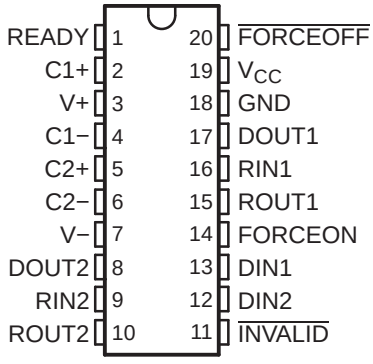
The TRS3318E is a dual-driver, dual-receiver, RS-232-compatible transceiver. The device features auto-powerdown plus and enhanced electrostatic discharge (ESD) protection integrated into the chip. Driver output and receiver input are protected to ±15 kV using the IEC 61000-4-2 Air-Gap Discharge method, ±8 kV using the IEC 61000-4-2 Contact Discharge method, and ±15 kV using the Human-Body Model (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 TRS3318E 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.

DB OR PW PACKAGE
(TOP VIEW)



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DETAILED DESCRIPTION

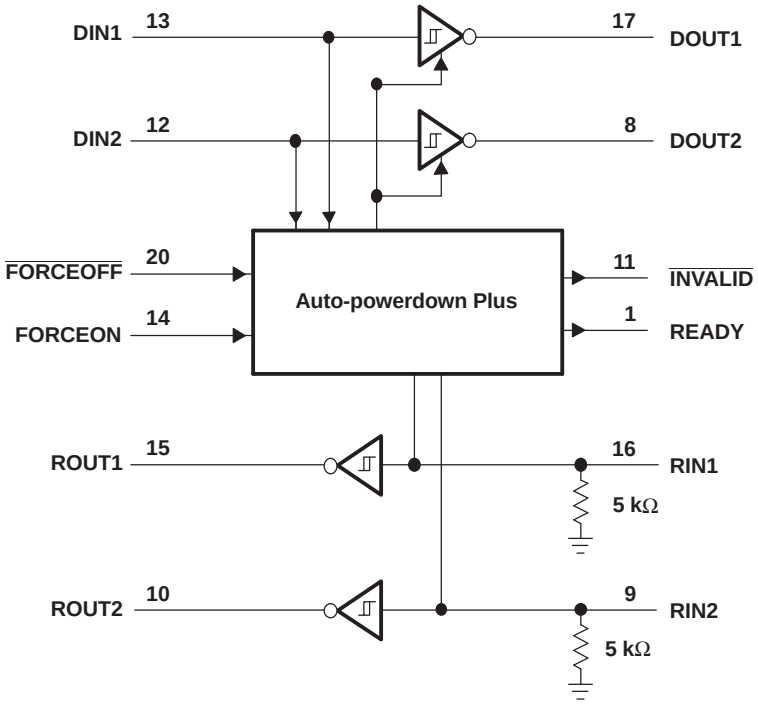
Flexible control options for power management are featured when the serial port and driver inputs are inactive. The auto-powerdown plus feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense valid signal transitions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

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 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 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 × V_{CC} generated by the charge pump
V–	7	–2 × 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)	20-pin SSOP (derate 8 mW/°C above 70°C)		640	mW
	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	TRS3318EC		0		70	°C
		TRS3318EI		–40		85	

Supply Current 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)

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	HBM	±15	kV
	IEC 61000-4-2 Air-Gap Discharge method	±15	
	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
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.

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 × V_{CC}	V
Input threshold high	T_A = 25°C	0.7 × 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 × V_{CC}	V
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 (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-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

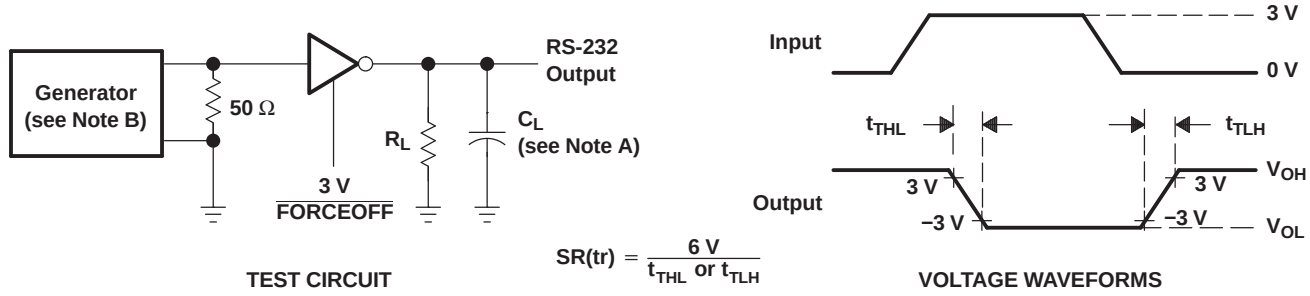
Switching Characteristics

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

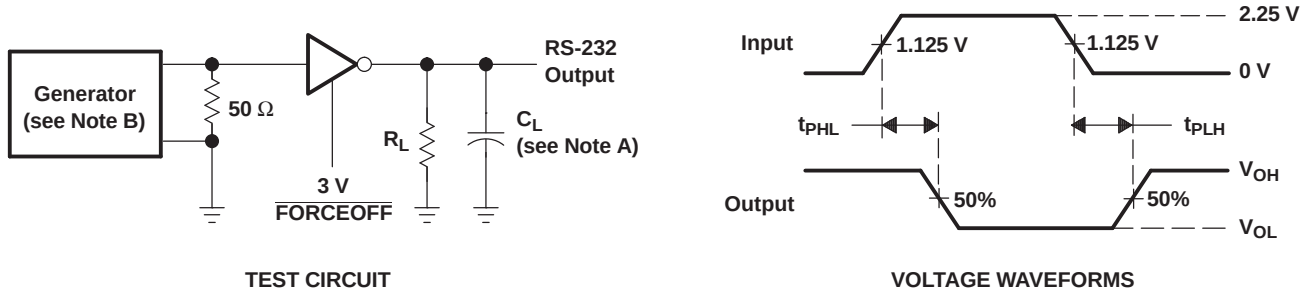
(1) Typical values are at V_{CC} = 2.5 V, T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



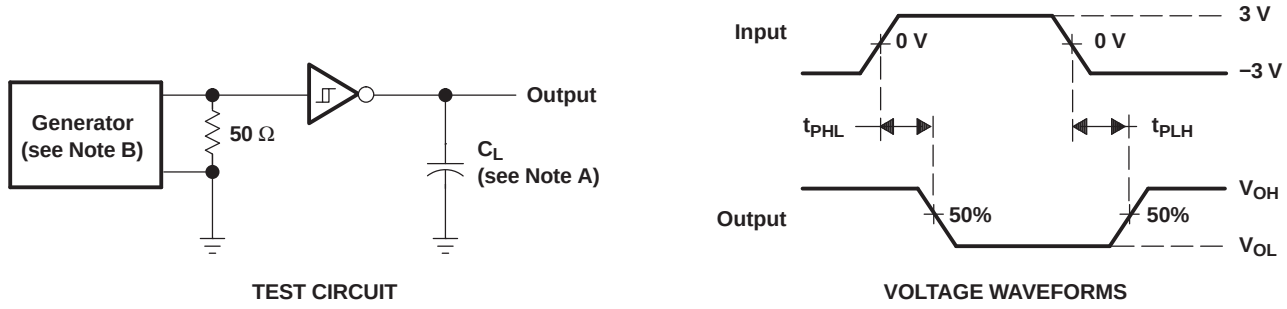
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

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.

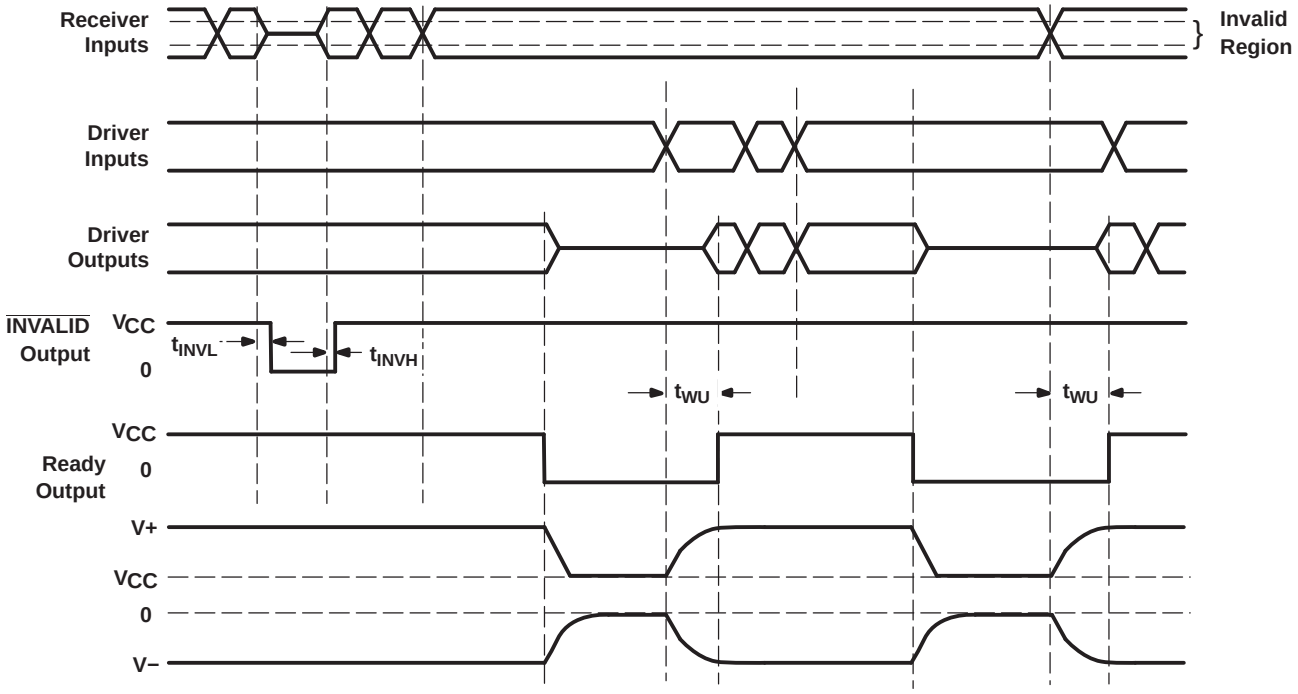
Figure 2. Driver Pulse Skew



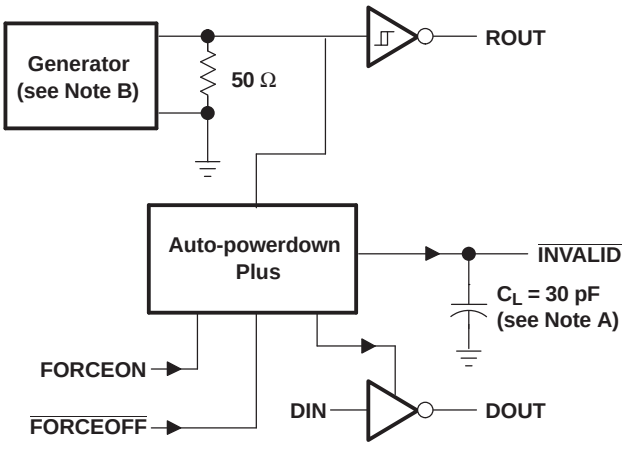
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 3. Receiver Propagation Delay Times

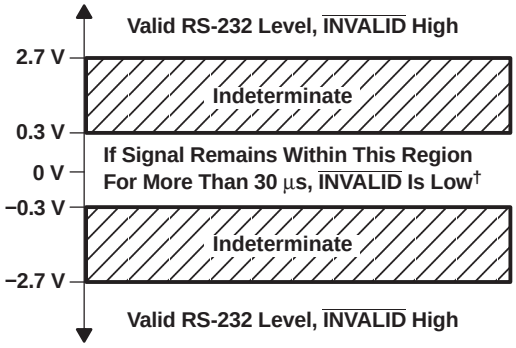
PARAMETER MEASUREMENT INFORMATION (continued)



VOLTAGE WAVEFORMS



TEST CIRCUIT



† Auto-powerdown disables drivers and reduces supply current to 1 μA.

Figure 4. INVALID Propagation Delay Times and Supply Enabling Time

APPLICATION INFORMATION

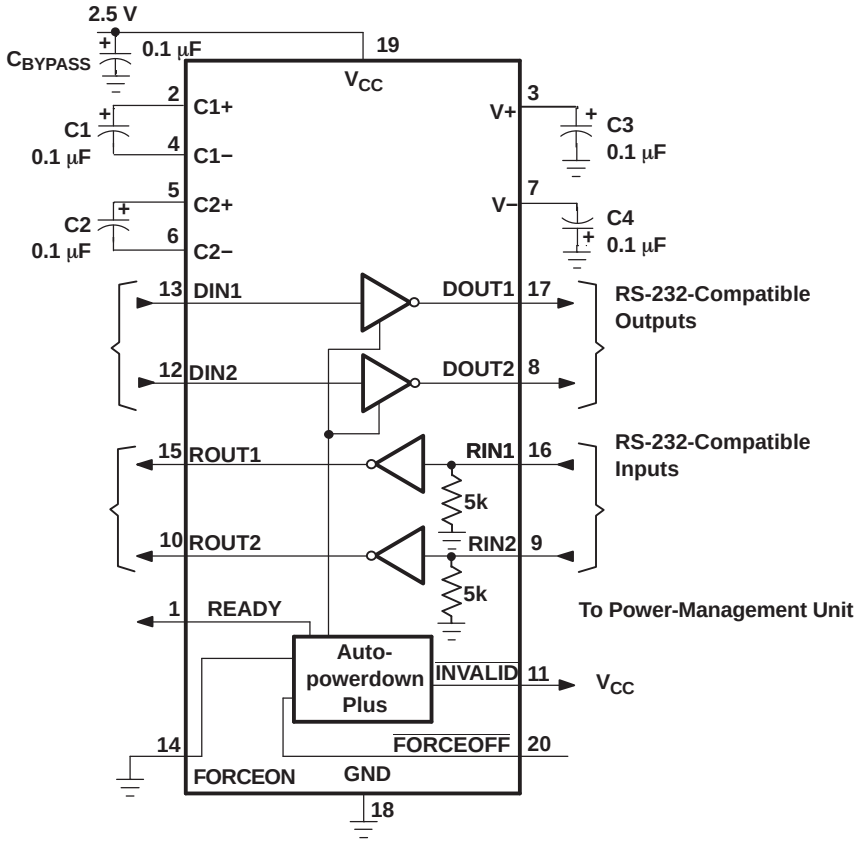


Figure 5. Typical Application Circuit

REVISION HISTORY

Changes from Revision A (April 2010) to Revision B **Page**

- Updated document to new TI datasheet format - no specification changes. 1
- Removed Ordering Information table. 2
- Updated TERMINAL FUNCTIONS table to fix inconsistency. 3

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TRS3318ECDBR	Active	Production	SSOP (DB) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	RV18EC
TRS3318ECDBR.A	Active	Production	SSOP (DB) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	RV18EC
TRS3318ECPW	Obsolete	Production	TSSOP (PW) | 20	-	-	Call TI	Call TI	0 to 70	RV18EC
TRS3318ECPWR	Obsolete	Production	TSSOP (PW) | 20	-	-	Call TI	Call TI	0 to 70	RV18EC
TRS3318EIDBR	Obsolete	Production	SSOP (DB) | 20	-	-	Call TI	Call TI	-40 to 85	RV18EI
TRS3318EIPW	Obsolete	Production	TSSOP (PW) | 20	-	-	Call TI	Call TI	-40 to 85	RV18EI
TRS3318EIPWR	Active	Production	TSSOP (PW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RV18EI
TRS3318EIPWR.A	Active	Production	TSSOP (PW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	RV18EI

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

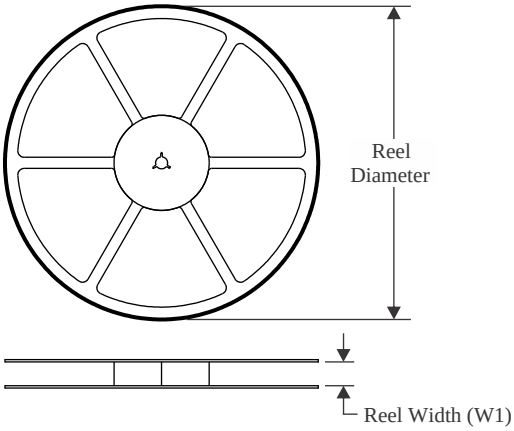
(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

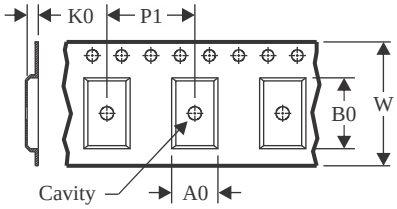
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

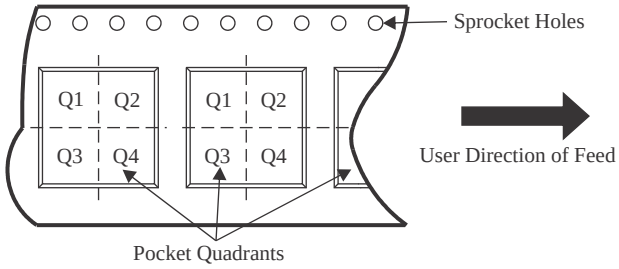


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

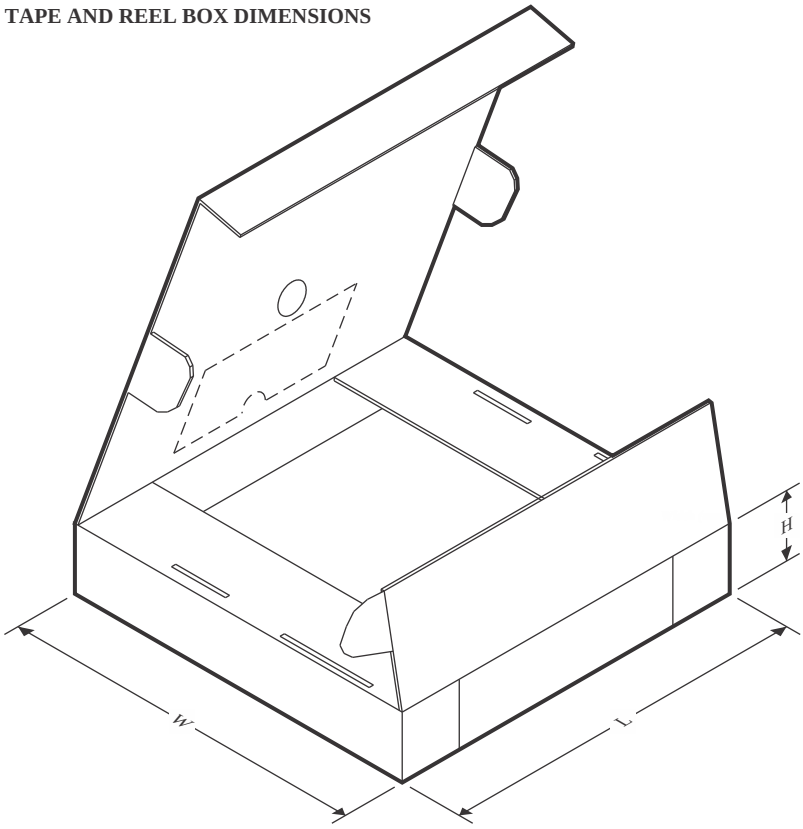
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TRS3318ECDBR	SSOP	DB	20	2000	330.0	16.4	8.2	7.5	2.5	12.0	16.0	Q1
TRS3318EIPWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

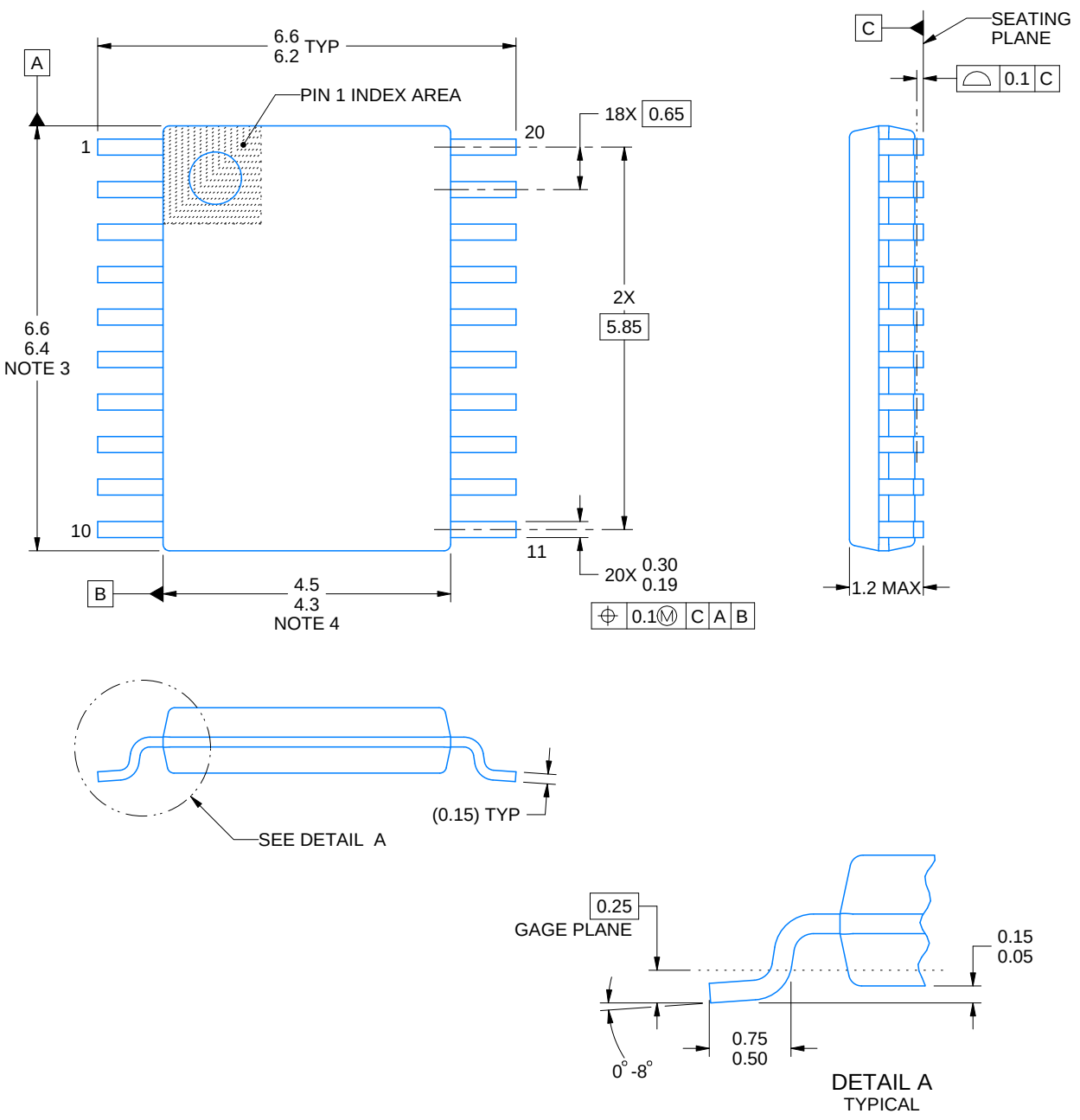
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS3318ECDBR	SSOP	DB	20	2000	353.0	353.0	32.0
TRS3318EIPWR	TSSOP	PW	20	2000	353.0	353.0	32.0

PACKAGE OUTLINE

PW0020A

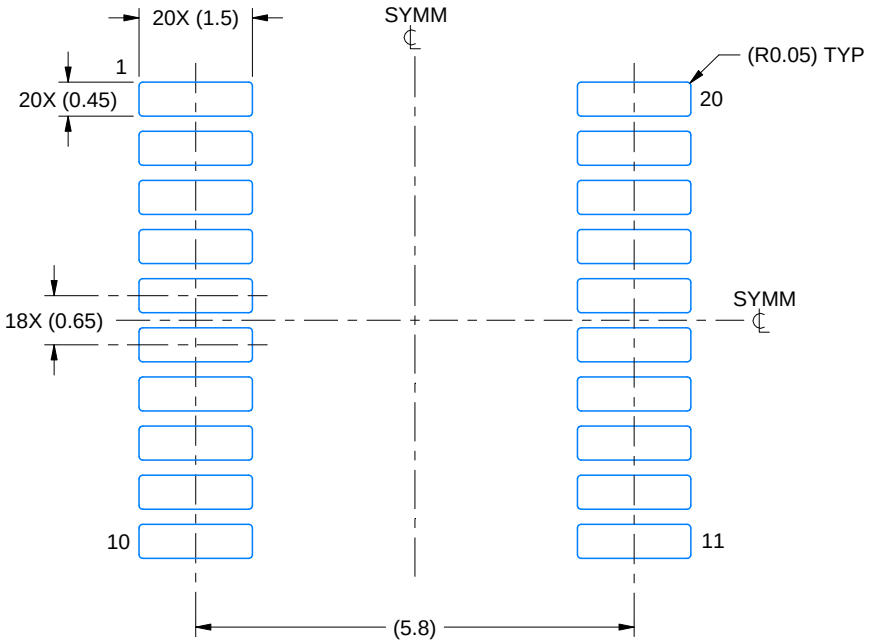
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



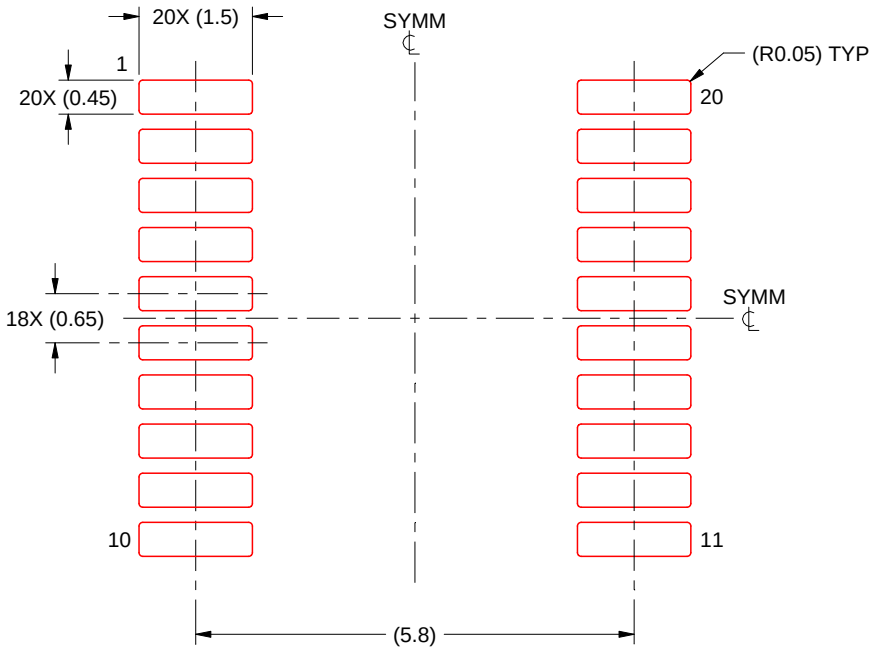
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK DETAILS

4220206/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220206/A 02/2017

NOTES: (continued)

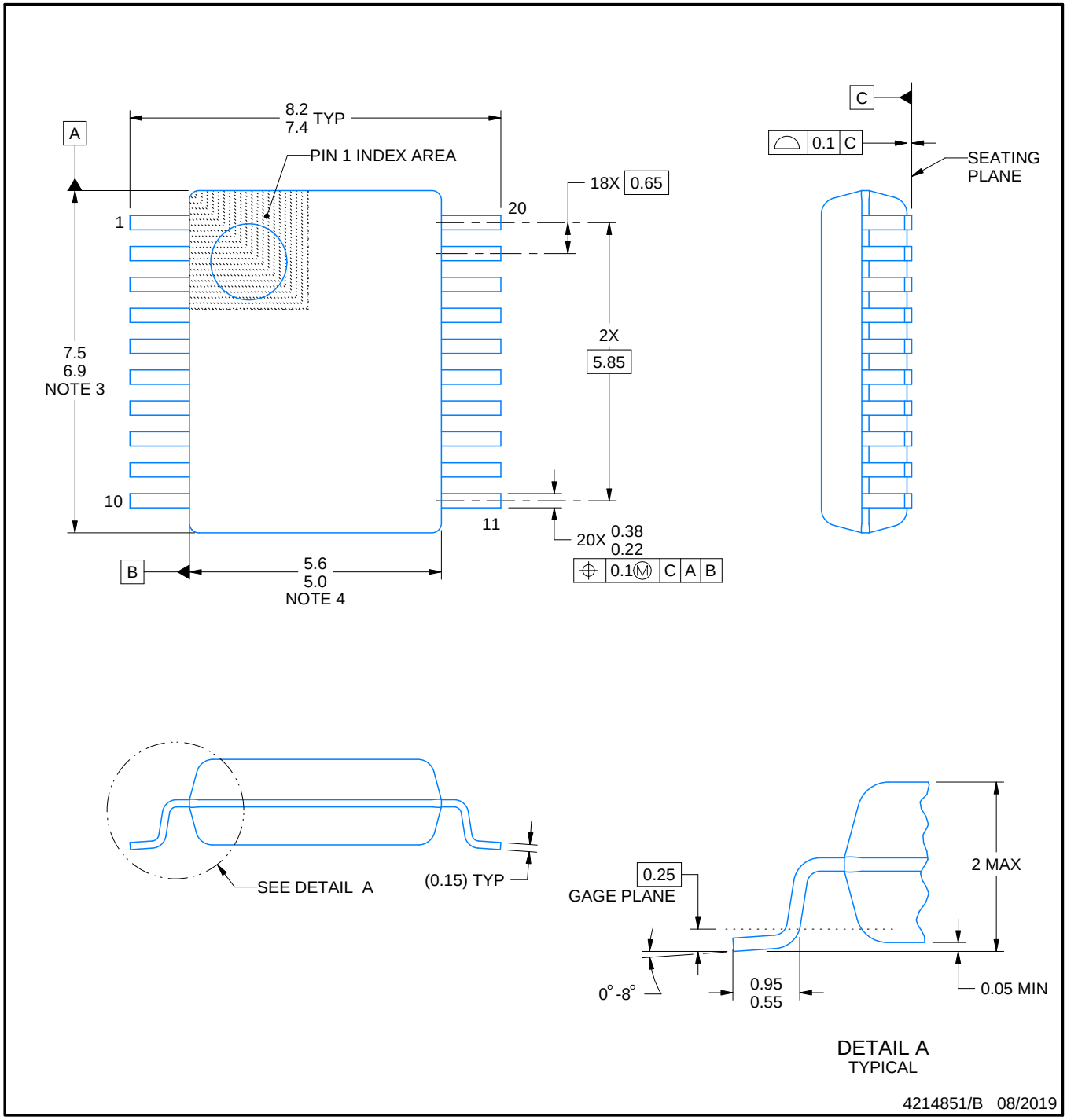
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

DB0020A

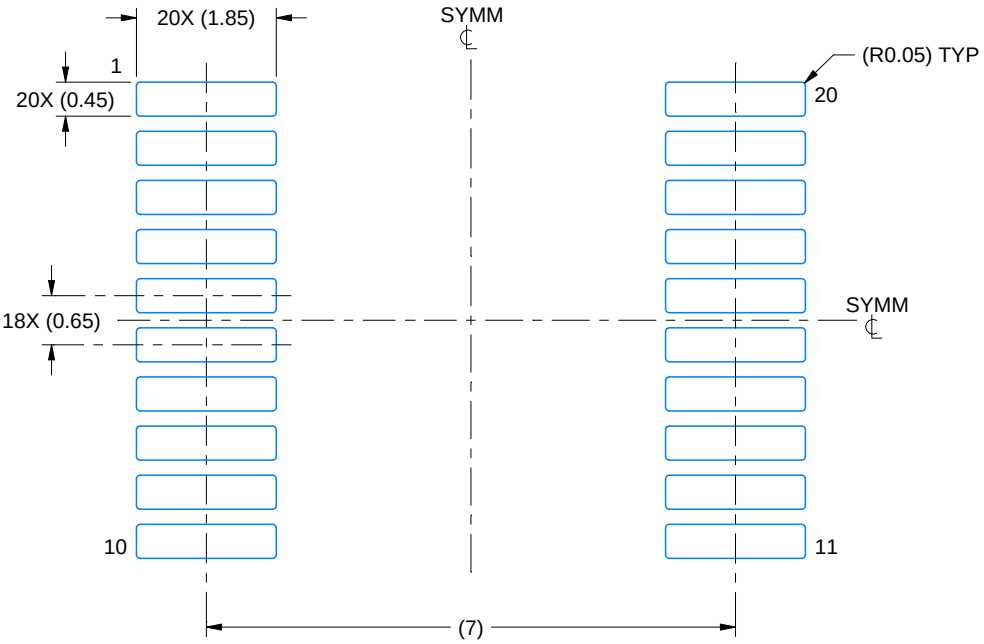
SSOP - 2 mm max height

SMALL OUTLINE PACKAGE

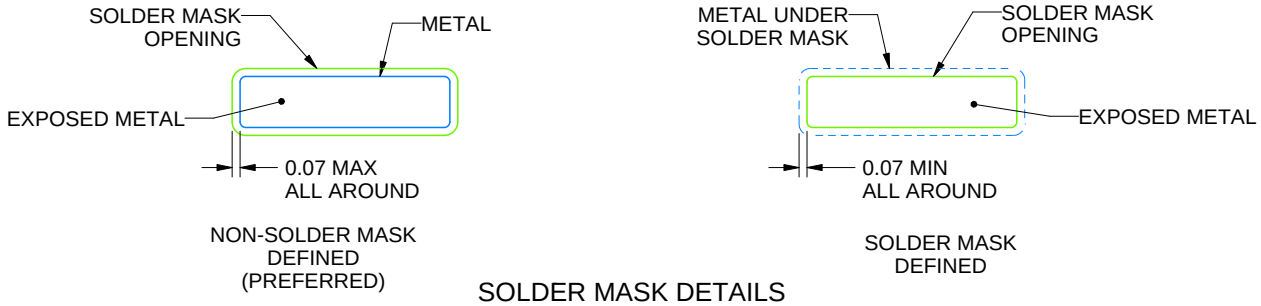


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-150.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4214851/B 08/2019

NOTES: (continued)

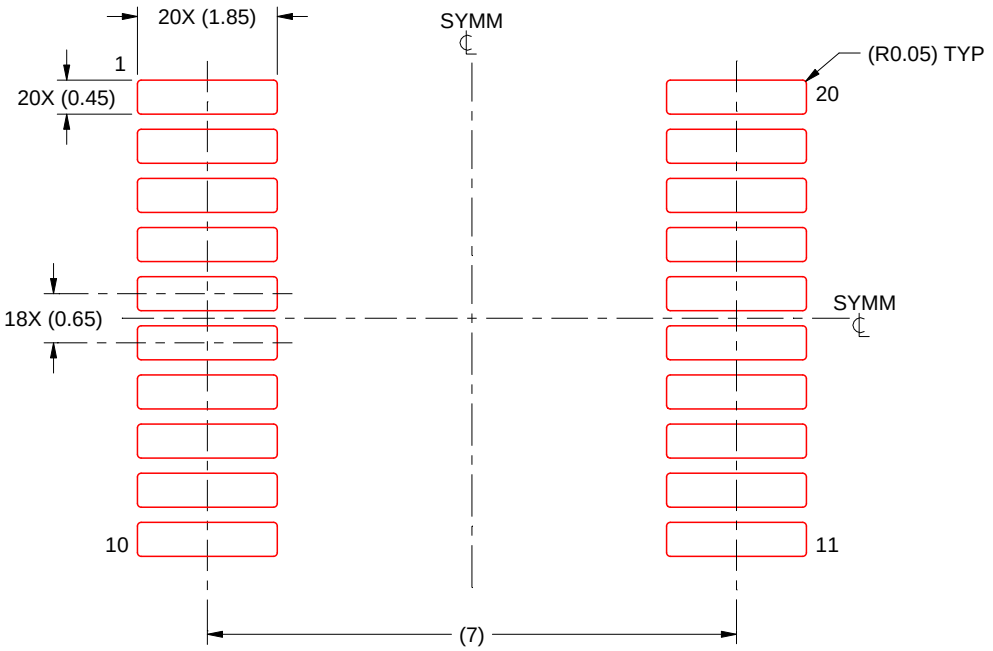
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4214851/B 08/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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