TRSF3243E 3-V to 5.5-V Multichannel RS-232 Compatible Line Driver and Receiver with ±15-kV IEC ESD protection

1 Features

- ESD protection for RS-232 bus pins
  - ±15-kV Human-body model (HBM)
  - ±8-kV IEC61000-4-2, Contact discharge
  - ±15-kV IEC61000-4-2, Air-gap discharge
- Operates with single 3-V to 5.5-V V_{CC} supply
- Always-active noninverting receiver output (ROUT2B)
- Low standby current: 1 µA typical
- External capacitors: 4 × 0.1 µF
- Accepts 5-V logic input with 3.3-V supply
- Serial-mouse driveability
- Supports operation up to 1 Mbit/s
- Auto-powerdown feature to disable driver outputs when no valid RS-232 signal is sensed
- Available in space-saving RHB (5 mm x 5 mm QFN-32) package

2 Applications

- Industrial PCs
- Wired networking
- Data center and networking equipment
- Notebooks
- Hand-held equipment

3 Description

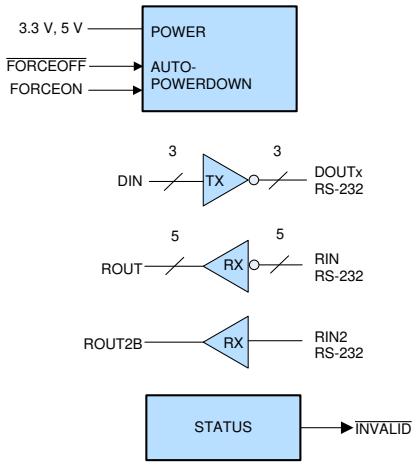
The TRSF3243E consists of three line drivers, five line receivers, and a dual charge-pump circuit with ±15-kV ESD (HBM and IEC61000-4-2, Air-Gap Discharge) and ±8-kV ESD (IEC61000-4-2, Contact Discharge) protection on serial-port connection pins. This device provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. In addition, this device includes an always-active noninverting output (ROUT2B), which allows applications using the ring indicator to transmit data while the device is powered down. The device operates at data signaling rates up to 1 Mbit/s and an increased slew-rate range of 18 V/µs to 150 V/µs.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. During this mode of operation, if the device does not sense a valid RS-232 signal, the driver outputs are disabled. If $\overline{\text{FORCEOFF}}$ is set low, both drivers and receivers (except ROUT2B) are shut off, and the supply current is reduced to 1 µA. Disconnecting the serial port or turning off the peripheral drivers causes the auto-powerdown condition to occur.

Packaging Information

PART NUMBER	PACKAGE(1)	BODY SIZE (NOM)
TRSF3243E	VQFN (RHB) (32)	5,00 mm × 5,00 mm
	TSSOP (PW) (28)	9,70 mm × 4,40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



Simplified Circuit

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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (November 2021) to Revision A (September 2022)	Page
• Deleted the Product Preview note from TSSOP (PW) in the *Package Information* table	1

5 Pin Configuration and Functions

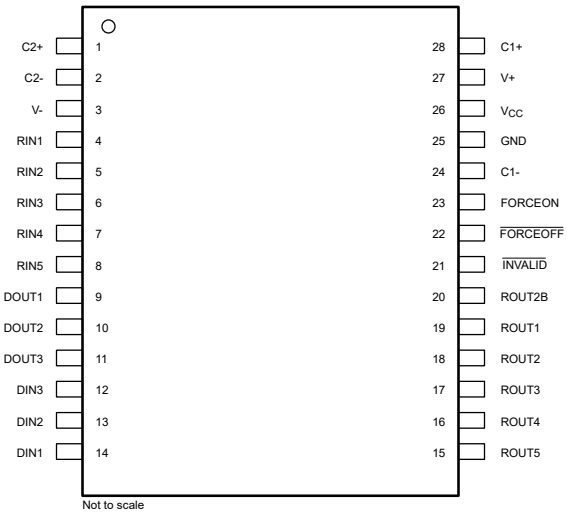


Figure 5-1. PW (TSSOP) Packages, 28 Pin, Top View

Table 5-1. Pin Functions

PIN		TYPE(1)	DESCRIPTION
NO.	NAME		
1	C2+	—	Positive terminal of the charge-pump capacitor
2	C2-	—	Negative terminal of the charge-pump capacitor
3	V-		Negative charge-pump rail
4	RIN1	I	RS-232 receiver inputs
5	RIN2		
6	RIN3		
7	RIN4		
8	RIN5		
9	DOUT1	O	RS-232 driver outputs
10	DOUT2		
11	DOUT3		
12	DIN3	I	Driver logic inputs
13	DIN2		
14	DIN1		
15	ROUT5	O	Receiver logic outputs
16	ROUT4		
17	ROUT3		
18	ROUT2		
19	ROUT1		
20	ROUT2B	—	Always-active non-inverting receiver logic output
21	$\overline{\text{INVALID}}$	O	Invalid Output Pin
22	$\overline{\text{FORCEOFF}}$	I	Auto Powerdown Control input (Refer to Truth Table)
23	FORCEON	I	Auto Powerdown Control input (Refer to Truth Table)
24	C1-	—	Negative terminal of the charge-pump capacitor
25	GND	—	Ground
26	V_{CC}	—	3-V to 5.5-V supply voltage
27	V+	—	Positive charge-pump rail
28	C1+	—	Positive terminal of the charge-pump capacitor

(1) Signal Types: I = Input, O = Output, I/O = Input or Output.

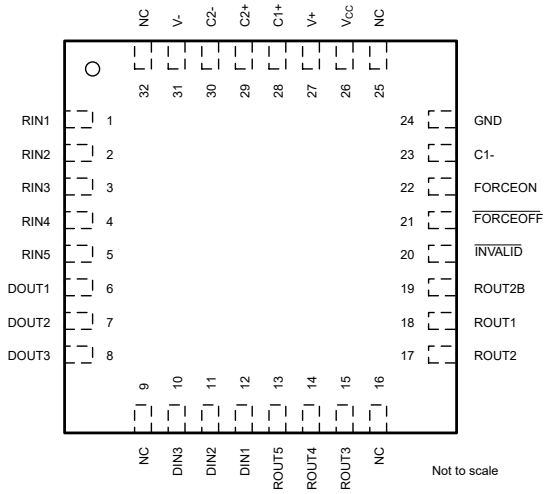


Figure 5-2. RHB (VQFN) Package, 32 Pin, Top View

Table 5-2. Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	RIN1	I	RS-232 receiver inputs
2	RIN2		
3	RIN3		
4	RIN4		
5	RIN5		
6	DOUT1	O	RS-232 driver outputs
7	DOUT2		
8	DOUT3		
9	NC	—	No internal connection
10	DIN3	I	Driver logic inputs
11	DIN2		
12	DIN1		
13	ROUT5	O	Receiver logic outputs
14	ROUT4		
15	ROUT3		
16	NC	—	No internal connection
17	ROUT2	O	Receiver outputs
18	ROUT1		
19	ROUT2B	O	Always-active non-inverting receiver output
20	$\overline{\text{INVALID}}$	O	Invalid Output Pin
21	$\overline{\text{FORCEOFF}}$	I	Auto Powerdown Control input (Refer to Truth Table)
22	FORCEON	I	Auto Powerdown Control input (Refer to Truth Table)
23	C1-	—	Negative terminal of the charge-pump capacitor
24	GND	—	Ground
25	NC	—	No internal connection
26	V_{CC}	—	3-V to 5.5-V supply voltage
27	V+	—	Positive charge-pump rail
28	C1+	—	Positive terminal of the charge-pump capacitor
29	C2+	—	
30	C2-	—	Negative terminal of the charge-pump capacitor
31	V-	—	Negative charge-pump rail
32	NC	—	No internal connection

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) (1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage range(2)		–0.3	6	V
V+	Positive-output supply voltage range(2)		–0.3	7	V
V–	Negative-output supply voltage range(2)		0.3	–7	V
V+ – V–	Supply voltage difference(2)			13	V
V_I	Input voltage range	Driver ($\overline{\text{FORCEOFF}}$, FORCEON)	–0.3	6	V
		Receiver	–25	25	
V_O	Output voltage range	Driver	–13.2	13.2	V
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) All voltages are with respect to network GND.

6.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	All pins except RIN1, RIN2, RIN3, RIN4, RIN5, DOUT1, DOUT2 and DOUT3 pins	±3000	V
			RIN1, RIN2, RIN3, RIN4, RIN5, DOUT1, DOUT2 and DOUT3 pins to GND	±15000	
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	All pins	±1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 ESD Ratings - IEC Specifications

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	IEC 61000-4-2 Contact Discharge (1)	RIN1, RIN2, RIN3, RIN4, RIN5, DOUT1, DOUT2 and DOUT3 pins	±8,000	V
		IEC 61000-4-2 Air-gap Discharge (1)		±15,000	

(1) A minimum of 1-µF capacitor between V_{CC} and GND is required to meet the specified IEC 61000-4-2 rating.

6.4 Recommended Operating Conditions

see (1)

				MIN	NOM	MAX	UNIT
	Supply voltage		V_{CC} = 3.3 V	3	3.3	3.6	V
			V_{CC} = 5 V	4.5	5	5.5	
V_{IH}	Driver and control high-level input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON	V_{CC} = 3.3 V	2			V
			V_{CC} = 5 V	2.4			
V_{IL}	Driver and control low-level input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON				0.8	V
V_I	Driver and control input voltage	DIN, $\overline{\text{FORCEOFF}}$, FORCEON		0		5.5	V
V_I	Receiver input voltage			–25		25	V
T_A	Operating free-air temperature			–40		85	°C

(1) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.5 Thermal Information

THERMAL METRIC(1)		TRSF3243E		UNIT
		VQFN (RHB)	TSSOP (PW)	
		32 PINS	28 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	34.1	70.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	25.9	21.0	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	14.6	29.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	0.5	1.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	14.6	28.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	5.1	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

6.6 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER			TEST CONDITIONS(2)	MIN	TYP(1)	MAX	UNIT
I_I	Input leakage current	$\overline{\text{FORCEOFF}}$, FORCEON			±0.01	±1	µA
I_{CC}	Supply current	Auto-powerdown disabled	No load, $\overline{\text{FORCEOFF}}$ and FORCEON = V_{CC}		0.3	1.2	mA
		Powered off	No load, $\overline{\text{FORCEOFF}}$ = GND		1	10	µA
		Auto-powerdown enabled	No load, $\overline{\text{FORCEOFF}}$ = V_{CC}, FORCEON = GND, All RIN are open or grounded, All DIN are grounded		1	10	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.7 Electrical Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS[3]			MIN	TYP[1]	MAX	UNIT
V_{OH}	High-level output voltage	All DOUT at R_L = 3 kΩ to GND			5	5.4		V
V_{OL}	Low-level output voltage	All DOUT at R_L = 3 kΩ to GND				–5.4	-5	V
V_O	Output voltage (mouse driveability)	DIN1 = DIN2 = GND, DIN3 = V_{CC}, 3-kΩ to GND at DOUT3, DOUT1 = DOUT2 = 2.5 mA			±5			V
I_{IH}	High-level input current	$V_I = V_{CC}$				±0.01	±1	µA
I_{IL}	Low-level input current	V_I = GND				±0.01	±1	µA
I_{OS}	Short-circuit output current[2]	V_{CC} = 3.6 V,	V_O = 0 V			±35	±60	mA
		V_{CC} = 5.5 V,	V_O = 0 V					
r_o	Output resistance	V_{CC}, V+, and V– = 0 V,	V_O = ±2 V		300	10M		Ω
I_{off}	Output leakage current	$\overline{FORCEOFF}$ = GND	V_O = ±12 V,	V_{CC} = 3 V to 3.6 V			±25	µA
			V_O = ±10 V,	V_{CC} = 4.5 V to 5.5 V			±25	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and 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.
(3) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.8 Switching Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS[3]			MIN	TYP[1]	MAX	UNIT
	Maximum data rate (see Figure 7-1)	R_L = 3 kΩ, One DOUT switching	C_L = 1000 pF		250			kbit/s
			C_L = 250 pF,	V_{CC} = 3 V to 4.5 V	1000			
			C_L = 1000 pF,	V_{CC} = 4.5 V to 5.5 V	1000			
$t_{sk(p)}$	Pulse skew[2]	C_L = 150 pF to 2500 pF,	R_L = 3 kΩ to 7 kΩ,	See Figure 7-2		25		ns
SR(tr)	Slew rate, transition region (see Figure 7-1)	C_L = 150 pF to 1000 pF,	R_L = 3 kΩ to 7 kΩ,	V_{CC} = 3.3 V	18		150	V/µs

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Pulse skew is defined as $|t_{PLH} – t_{PHL}|$ of each channel of the same device.
(3) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.9 Electrical Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS[2]	MIN	TYP[1]	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –1 mA	V_{CC} – 0.6	V_{CC} – 0.1		V
V_{OL}	Low-level output voltage	I_{OL} = 1.6 mA			0.4	V
V_{IT+}	Positive-going input threshold voltage	V_{CC} = 3.3 V		1.6	2.4	V
		V_{CC} = 5 V		1.9	2.4	
$V_{IT–}$	Negative-going input threshold voltage	V_{CC} = 3.3 V	0.6	1.1		V
		V_{CC} = 5 V	0.8	1.4		
V_{hys}	Input hysteresis ($V_{IT+} – V_{IT–}$)			0.5		V
I_{off}	Output leakage current (except ROUT2B)	$\overline{FORCEOFF}$ = 0 V		±0.05	±10	µA
r_i	Input resistance	V_I = ±3 V to ±25 V	3	5	7	kΩ

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.10 Switching Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS(3)	TYP(1)	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	C_L = 150 pF, See Figure 7-3	150	ns
t_{PHL}	Propagation delay time, high- to low-level output	C_L = 150 pF, See Figure 7-3	150	ns
t_{en}	Output enable time	C_L = 150 pF, R_L = 3 kΩ, See Figure 7-4	200	ns
t_{dis}	Output disable time	C_L = 150 pF, R_L = 3 kΩ, See Figure 7-4	200	ns
$t_{sk(p)}$	Pulse skew(2)	See Figure 7-3	50	ns

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.
(3) Test conditions are C1–C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2–C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.11 Electrical Characteristics: Auto-Powerdown

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 7-5)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+(valid)}$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}		2.7	V
$V_{T-(valid)}$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}	–2.7		V
$V_{T(invalid)}$	Receiver input threshold for $\overline{\text{INVALID}}$ low-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}	–0.3	0.3	V
V_{OH}	$\overline{\text{INVALID}}$ high-level output voltage	I_{OH} = –1 mA, FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}	V_{CC} – 0.6		V
V_{OL}	$\overline{\text{INVALID}}$ low-level output voltage	I_{OL} = 1.6 mA, FORCEON = GND, $\overline{\text{FORCEOFF}}$ = V_{CC}		0.4	V

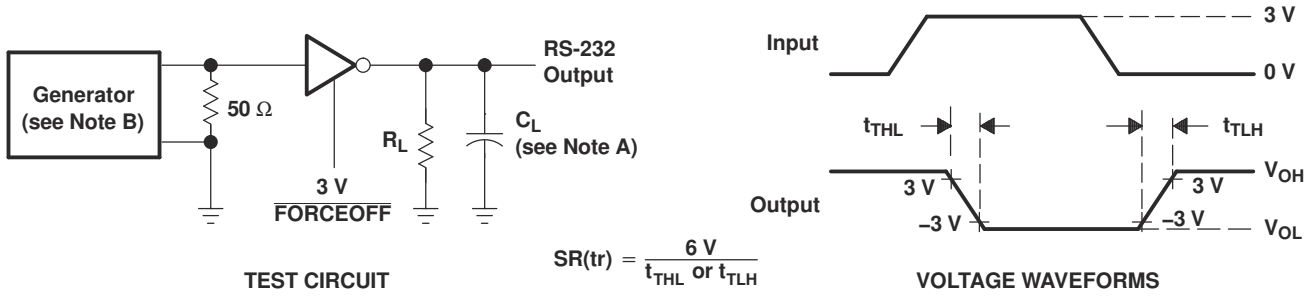
6.12 Switching Characteristics: Auto-Powerdown

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 7-5)

PARAMETER		TYP(1)	UNIT
t_{valid}	Propagation delay time, low- to high-level output	1	µs
$t_{invalid}$	Propagation delay time, high- to low-level output	30	µs
t_{en}	Supply enable time	100	µs

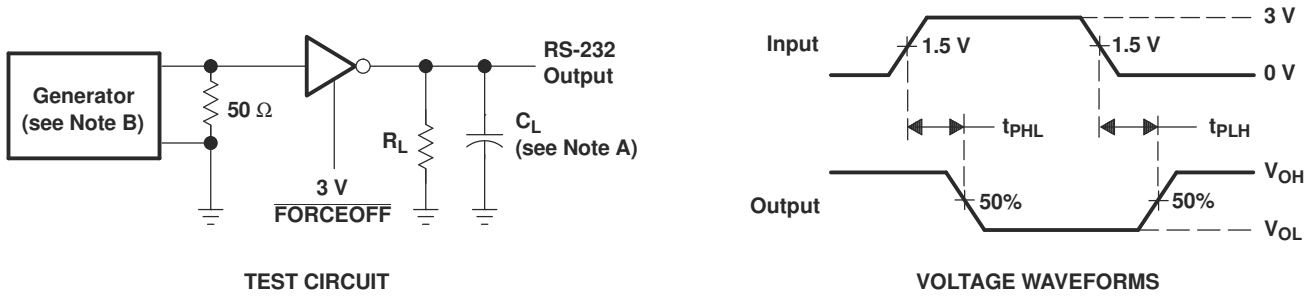
(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

Parameter Measurement Information



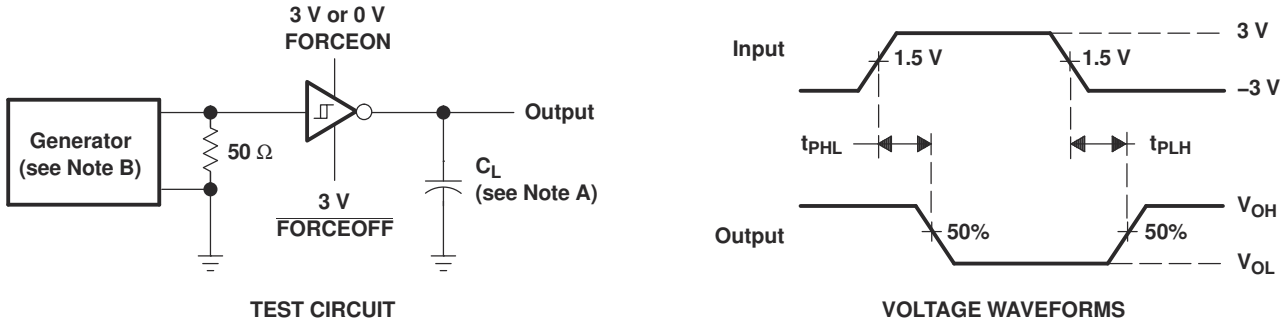
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 1 Mbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 7-1. Driver Slew Rate



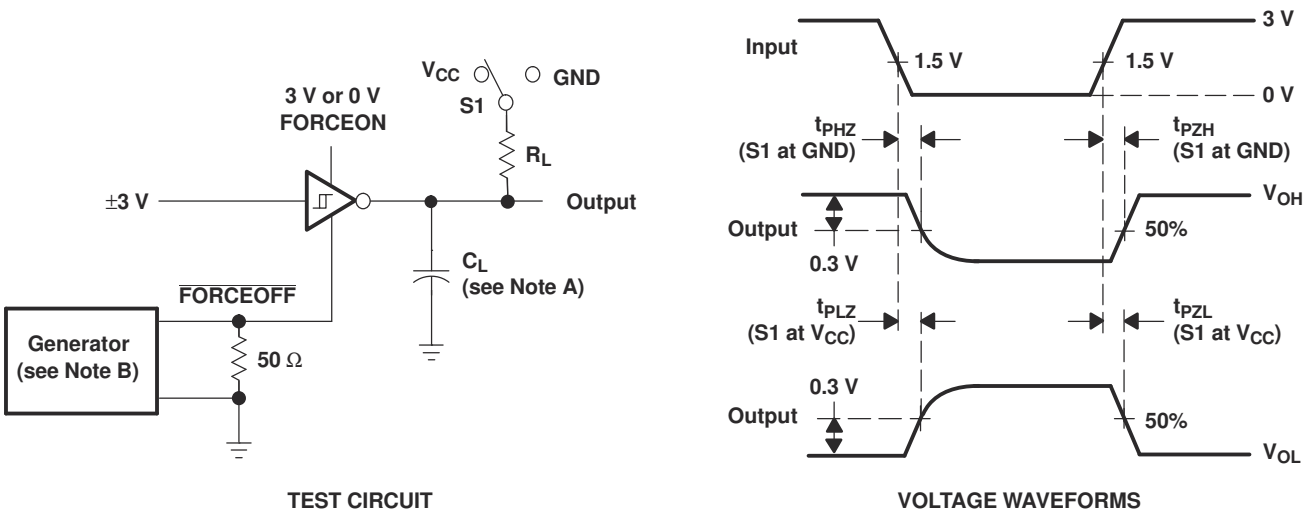
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 1 Mbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 7-2. Driver Pulse Skew



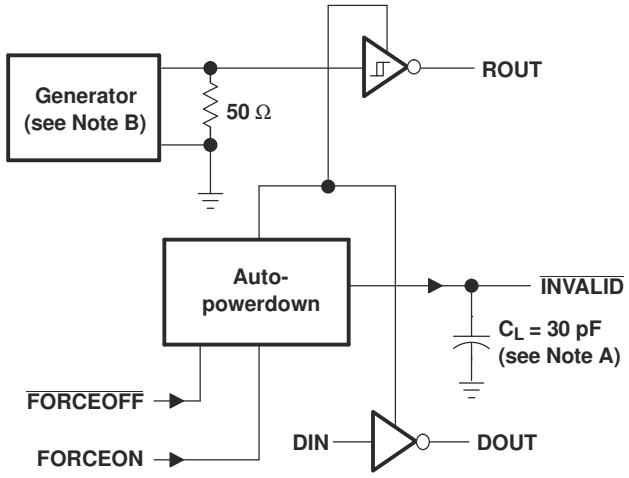
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 7-3. Receiver Propagation Delay Times

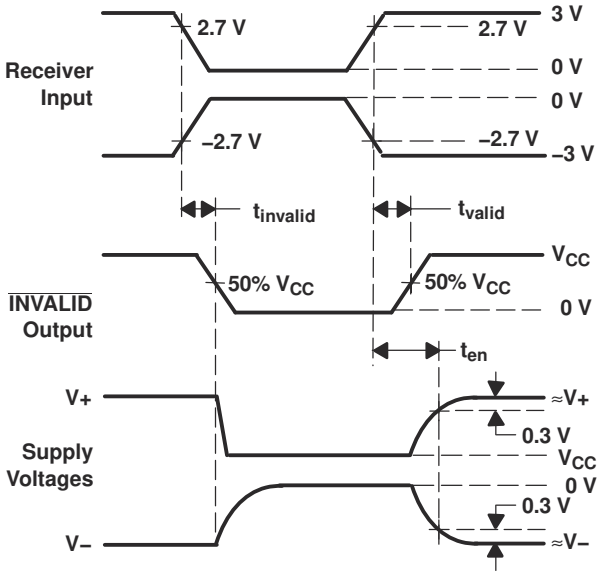


NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \leq 10$ ns, $t_f \leq 10$ ns.
C. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
D. t_{PZL} and t_{PZH} are the same as t_{en}.

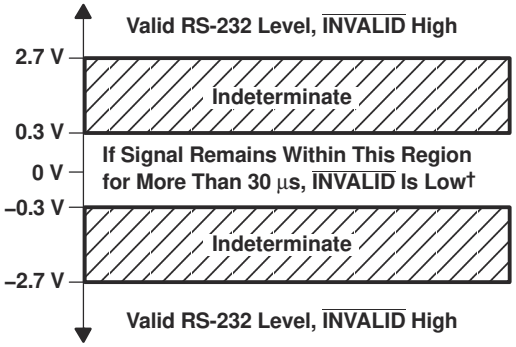
Figure 7-4. Receiver Enable and Disable Times



TEST CIRCUIT



VOLTAGE WAVEFORMS



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

NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 5 kbit/s, Z_O = 50 Ω, 50% duty cycle, $t_r \le 10$ ns, $t_f \le 10$ ns.

Figure 7-5. $\overline{\text{INVALID}}$ Propagation Delay Times and Supply Enabling Time

7 Detailed Description

7.1 Overview

The TRSF3243E device consists of three line drivers, five line receivers, and a dual charge-pump circuit with ±15-kV ESD (HBM and IEC61000-4-2, Air-Gap Discharge) and ±8-kV ESD (IEC61000-4-2, Contact Discharge) protection on serial-port connection pins. The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector.

The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. In addition, the device includes an always-active noninverting output (ROUT2B), which allows applications using the ring indicator to transmit data while the device is powered down. The device operates at data signaling rates up to 500 kbit/s and a maximum of 30-V/µs driver output slew rate.

Functional Block Diagram

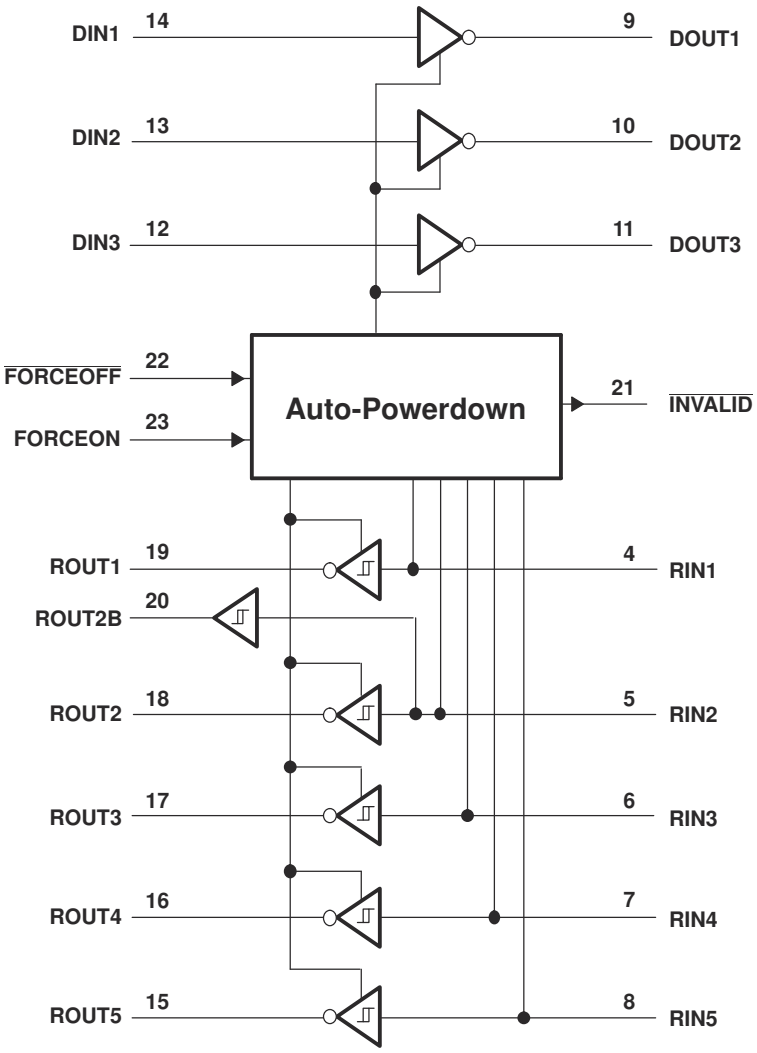


Figure 7-1. Logic Diagram

7.2 Feature Description

Auto-powerdown can be disabled when FORCEON and $\overline{\text{FORCEOFF}}$ are high and should be done when driving a serial mouse. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to any receiver input. The $\overline{\text{INVALID}}$ output is used to notify the user if an RS-232 signal is present at any receiver 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. $\overline{\text{INVALID}}$ is low (invalid data) if all receiver input voltages are between –0.3 V and 0.3 V for more than 30 µs. Refer to Figure 7-5 for receiver input levels.

7.3 Device Functional Modes

Table 7-1 through Table 7-3 show the device functional modes.

Table 7-1. Each Driver

INPUTS(1)				OUTPUT	DRIVER STATUS
DIN	FORCEON	$\overline{\text{FORCEOFF}}$	VALID RIN RS-232 LEVEL	DOUT	
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with auto-powerdown disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with auto-powerdown enabled
H	L	H	Yes	L	
X	L	H	No	Z	Powered off by auto-powerdown feature

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

Table 7-2. Each Receiver

INPUTS(1)			OUTPUT	RECEIVER STATUS
RIN	FORCEON	$\overline{\text{FORCEOFF}}$	ROUT	
X	X	L	Z	Powered off
L	X	H	H	Normal operation with auto-powerdown disabled/enabled
H	X	H	L	
Open	X	H	H	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

Table 7-3. ROUT2B And Outputs $\overline{\text{INVALID}}$

INPUTS(1)				OUTPUTS		OUTPUT STATUS
VALID RIN RS-232 LEVEL	RIN2	FORCEON	$\overline{\text{FORCEOFF}}$	$\overline{\text{INVALID}}$	ROUT2B	
Yes	L	X	X	H	L	Always active
Yes	H	X	X	H	H	
Yes	Open	X	X	H	L	
No	Open	X	X	L	L	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

8 Application and Implementation

Note

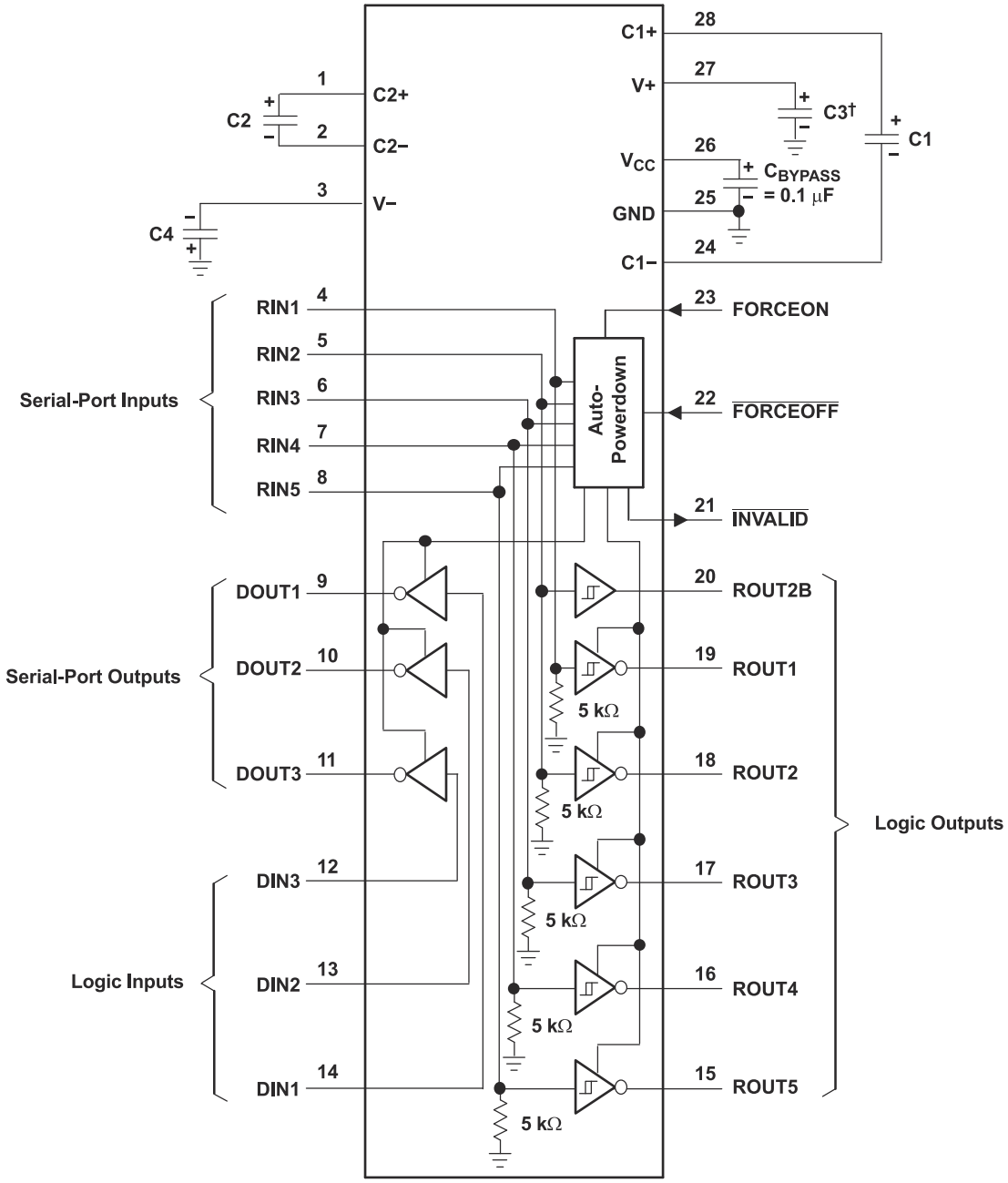
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

8.1 Application Information

For proper operation, add capacitors as shown in Figure 8-1. Pins 12 through 23 connect to UART or general-purpose logic lines. RS-232 lines on Pins 4 through 11 connect to a connector or cable.

8.2 Typical Application

Three driver and five receiver channels are supported for full duplex transmission with hardware flow control. The five 5-kΩ resistors are internal to the device.



A. C3 can be connected to V_{CC} or GND
B. Resistor values shown are nominal.

Figure 8-1. Typical Operating Circuit and Capacitor Values

8.3 Design Requirements

For this design example, use the values in V_{CC} vs Capacitor Values.

- V_{CC} minimum is 3 V and maximum is 5.5 V.
- Maximum recommended bit rate is 1 Mbps.

Table 8-1. V_{CC} vs Capacitor Values

V_{CC}	C1	C2, C3, and C4
3.3 V ± 0.3 V	0.1 µF	0.1 µF
5 V ± 0.5 V	0.047 µF	0.33 µF
3 V to 5.5 V	0.1 µF	0.47 µF

8.4 Detailed Design Procedure

TRSF3243E has integrated charge-pump that generates positive and negative rails needed for RS-232 signal levels. Main design requirement is that charge-pump capacitor terminals must be connected with recommended capacitor values. Charge-pump rail voltages and device supply pin must be properly bypassed with ceramic capacitors.

9 Power Supply Recommendations

The V_{CC} voltage must be connected to the same power source used for logic device connected to DIN and ROUT pins. V_{CC} must be between 3 V and 5.5 V.

10 Layout

10.1 Layout Guidelines

As shown in Layout Example, charge-pump and supply voltage capacitors must be located very close to device pins. Non-polarized ceramic capacitors are recommended. If polarized tantalum or electrolytic capacitors are used, they should be connected as per Typical Operating Circuit and Capacitor Values.

10.2 Layout Example

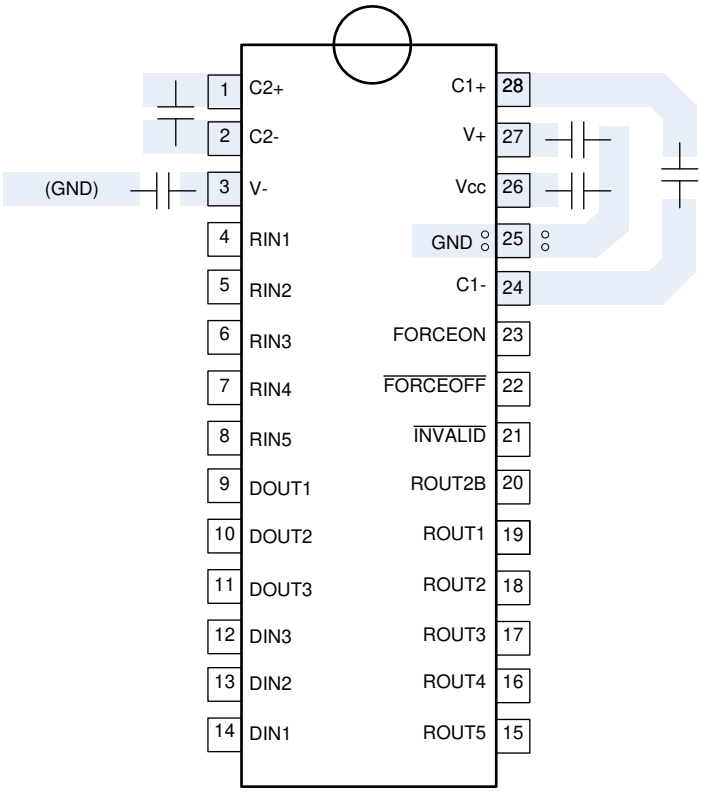


Figure 10-1. Example Layout

Device and Documentation Support

11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

11.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

11.3 Trademarks

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11.4 Electrostatic Discharge Caution

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.

11.5 Glossary

TI Glossary — This glossary lists and explains terms, acronyms, and definitions.

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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)
TRSF3243EIPWR	Active	Production	TSSOP (PW) | 28	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	F3243
TRSF3243EIPWR.A	Active	Production	TSSOP (PW) | 28	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	F3243
TRSF3243EIRHBR	Active	Production	VQFN (RHB) | 32	5000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRSF 3243
TRSF3243EIRHBR.A	Active	Production	VQFN (RHB) | 32	5000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRSF 3243
TRSF3243EIRHBRG4	Active	Production	VQFN (RHB) | 32	5000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRSF 3243
TRSF3243EIRHBRG4.A	Active	Production	VQFN (RHB) | 32	5000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TRSF 3243

(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.

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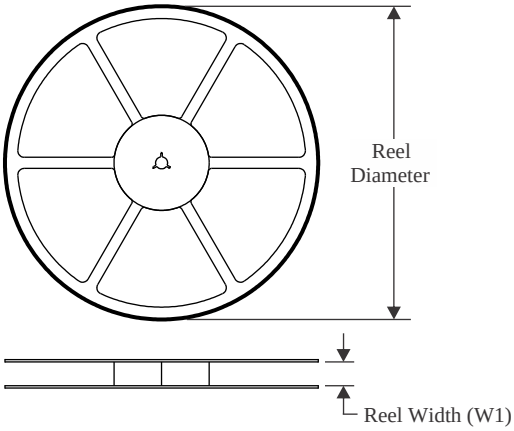
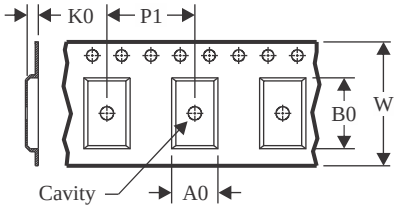
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

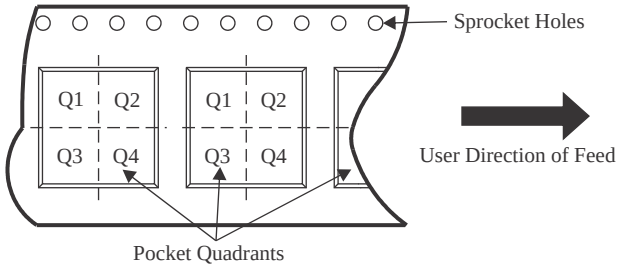


TAPE DIMENSIONS



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

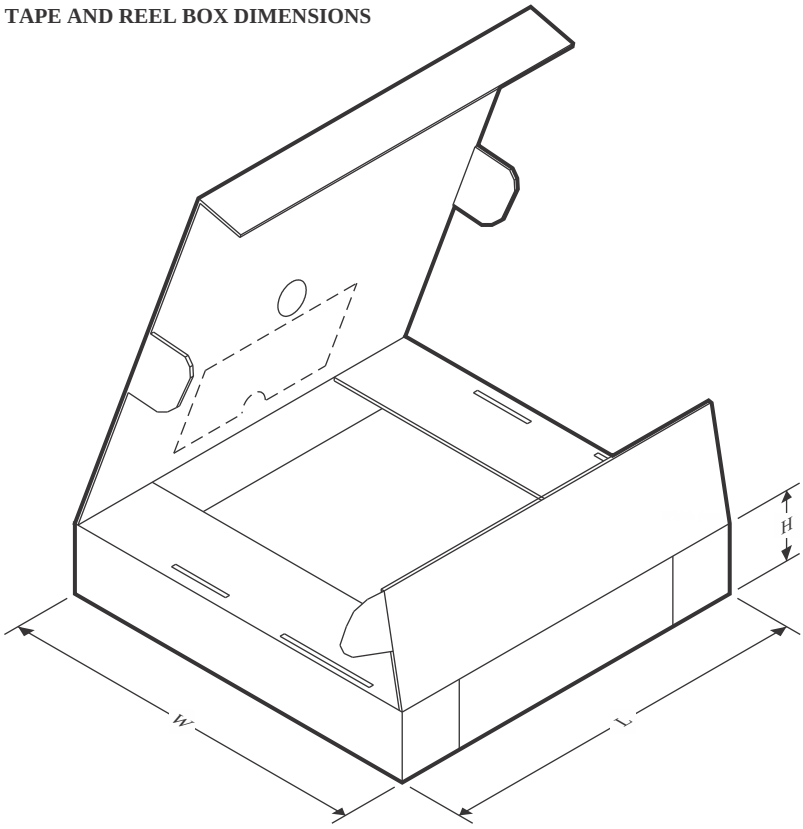
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TRSF3243EIPWR	TSSOP	PW	28	2000	330.0	16.4	6.9	10.2	1.8	12.0	16.0	Q1
TRSF3243EIRHBR	VQFN	RHB	32	5000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
TRSF3243EIRHBRG4	VQFN	RHB	32	5000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2

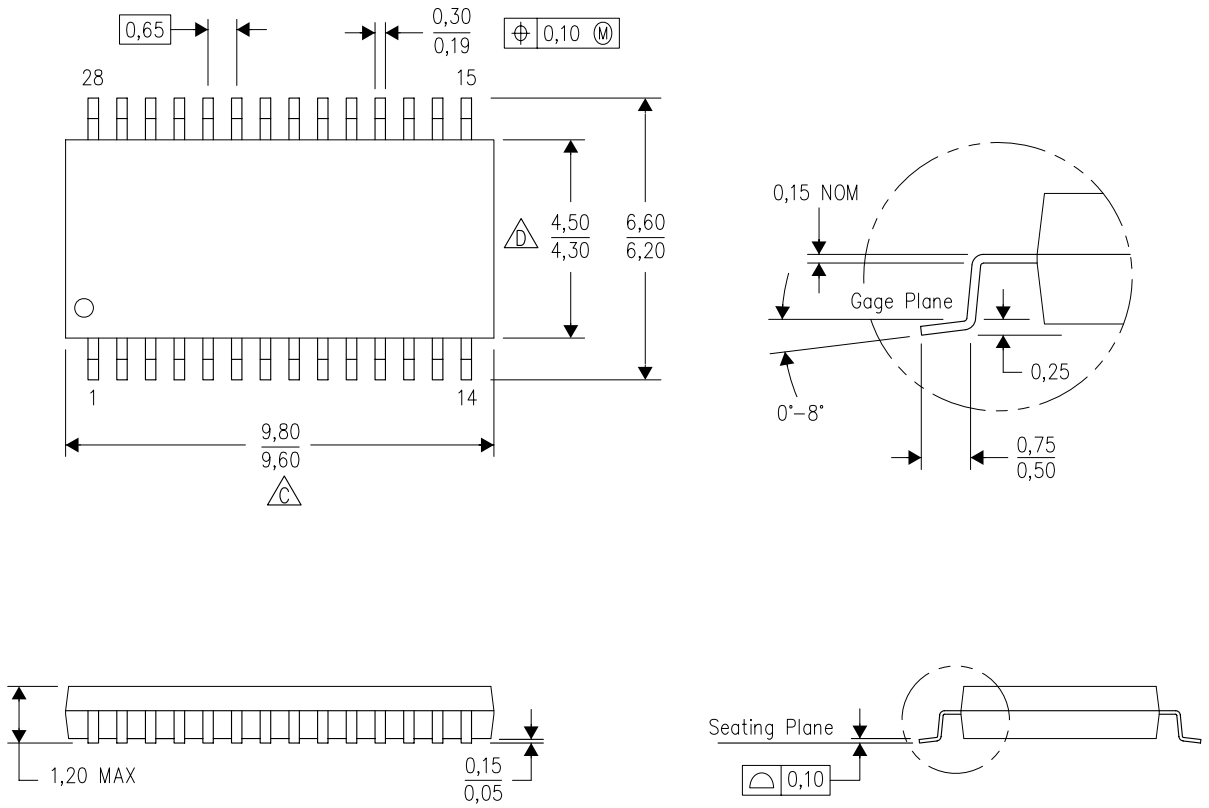
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRSF3243EIPWR	TSSOP	PW	28	2000	356.0	356.0	35.0
TRSF3243EIRHBR	VQFN	RHB	32	5000	367.0	367.0	35.0
TRSF3243EIRHBRG4	VQFN	RHB	32	5000	367.0	367.0	35.0

PW (R–PDSO–G28) PLASTIC SMALL OUTLINE



4040064–7/G 02/11

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

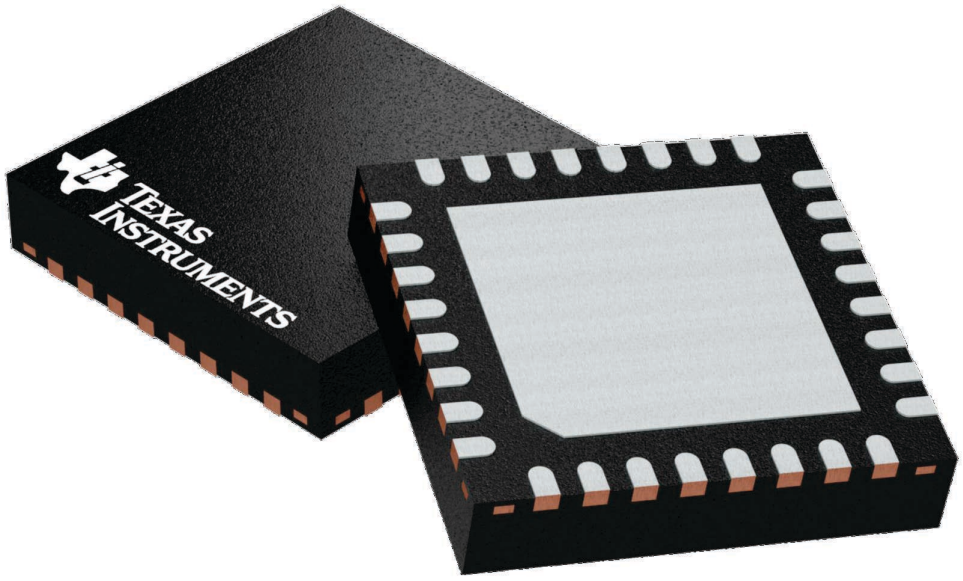
GENERIC PACKAGE VIEW

RHB 32

VQFN - 1 mm max height

5 x 5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

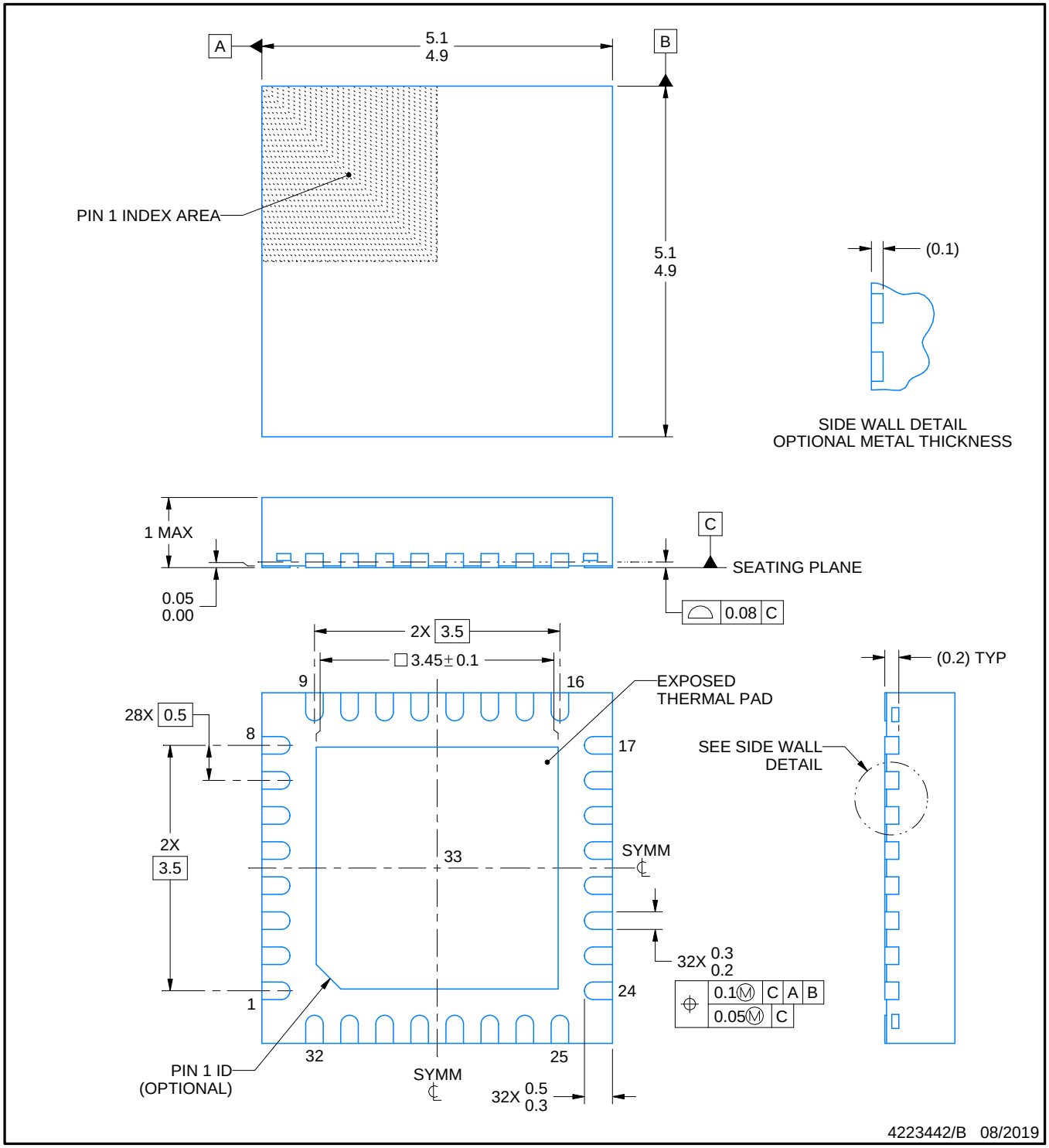
4224745/A

RHB0032E

PACKAGE OUTLINE

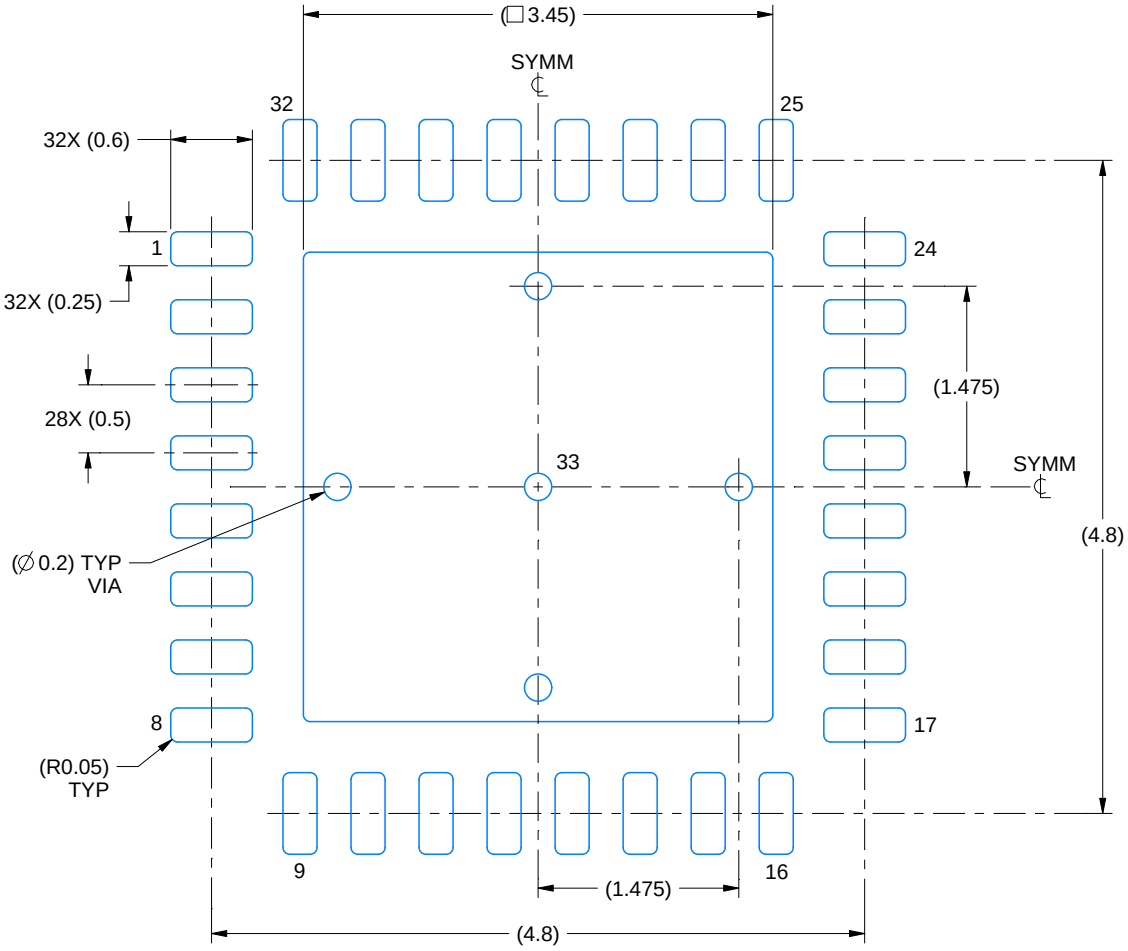
VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

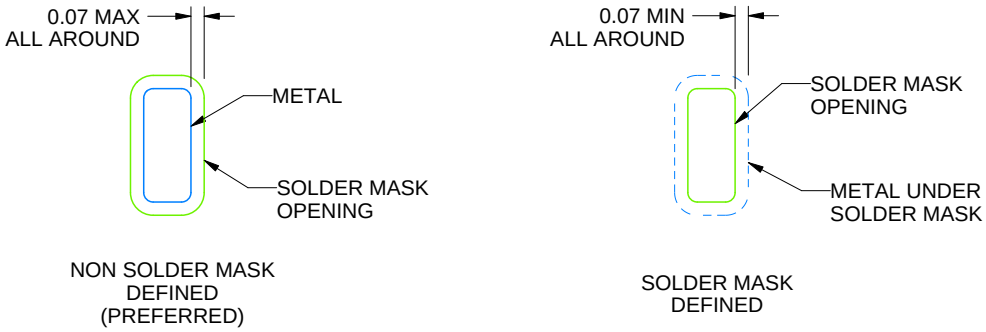


NOTES:

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
SCALE:18X

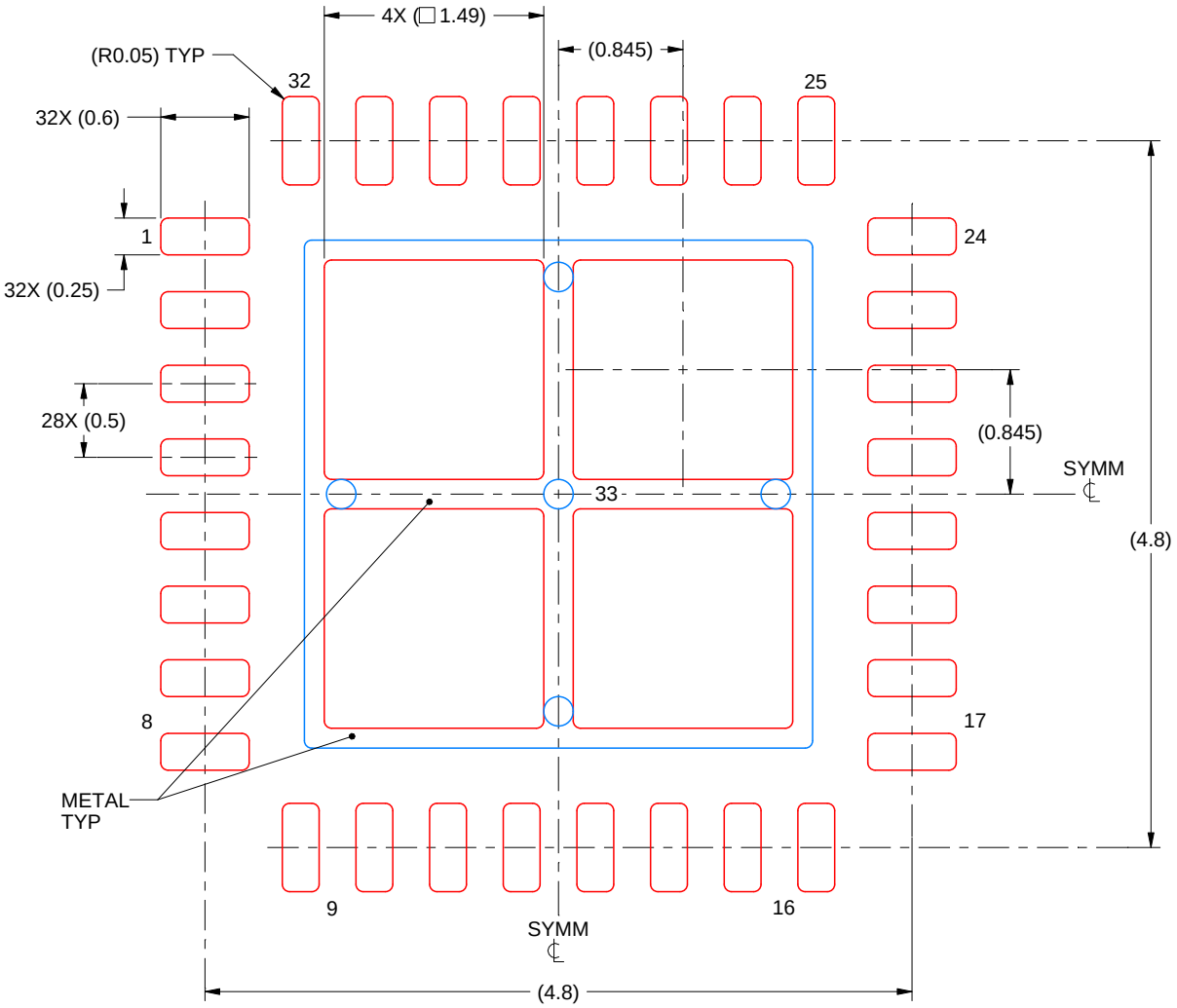


SOLDER MASK DETAILS

4223442/B 08/2019

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:
75% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:20X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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