

TRSF3232E 采用小型封装、具有 $\pm 15\text{kV}$ IEC ESD 保护的 3V 至 5.5V 两通道 RS-232 1Mbit 线路驱动器和接收器

1 特性

- 由 3V 至 5.5V V_{CC} 电源供电
- 速率高达 1Mbit/s
- 低电源电流：300 μA (典型值)
- 外部电容器：4 \times 0.1 μF
- 支持 5V 逻辑输入 (3.3V 电源时)
- 闩锁性能超过 100mA，符合 JESD 78 II 类规范的要求
- 为 RS-232 引脚提供 ESD 保护
 - $\pm 15\text{kV}$ 人体放电模式 (HBM)
 - $\pm 15\text{kV}$ IEC 61000-4-2 气隙放电
 - $\pm 8\text{kV}$ IEC 61000-4-2 接触放电
- 采用近似于芯片级塑封的 QFN (3mmx3mm) 封装 (比 SOIC-16 小 85%)

2 应用

- 工业 PC
- 有线网络
- 数据中心和企业级计算
- 电池供电型系统
- PDA
- 笔记本电脑
- 掌上电脑
- 手持设备

3 说明

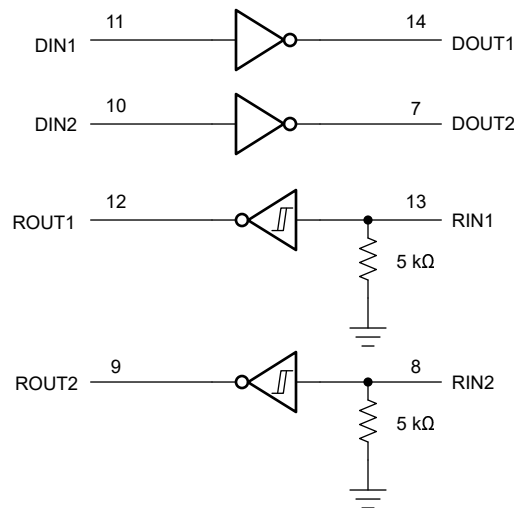
TRSF3232E 器件由两个线路驱动器、两个线路接收器和一个双电荷泵电路组成，具有引脚对引脚 (串行端口连接引脚，包括 GND) $\pm 15\text{kV}$ ESD 保护。该器件可在异步通信控制器和串行端口连接器之间提供电气接口。电荷泵和四个小型外部电容器支持由单个 3V 至 5.5V 电源供电。TRSF3232E 以高达 1Mbit/s 的数据信号传输速率运行，驱动器输出压摆率为 14V/ μs 至 150V/ μs 。

封装信息

| 器件型号 | 封装 ⁽¹⁾ | 封装尺寸 ⁽²⁾ |
|-----------|----------------------|---------------------|
| TRSF3232E | D (SOIC) | 9.9mm x 6mm |
| | DB (SSOP) | 6.2mm x 7.8mm |
| | DW (SOIC) | 10.3mm x 10.3mm |
| | PW (TSSOP) | 5mm x 6.4mm |
| | RGT (VQFN) | 3mm x 3mm |
| | SOT-23-THN (DYY, 16) | 4.2mm x 2mm |

(1) 有关更多信息，请参阅节 11。

(2) 封装尺寸 (长 \times 宽) 为标称值，并包括引脚 (如适用)。



逻辑图 (正逻辑)



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4 Pin Configuration and Functions

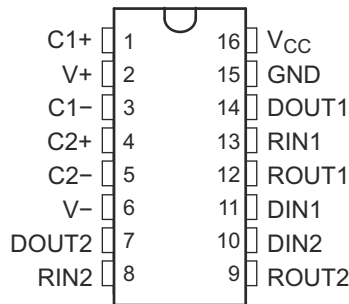


图 4-1. D, DB, DW, PW or DYY Package
16-Pin SSOP, TSSOP, or SOT-23-THN
(Top View)

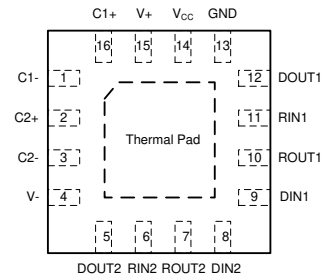


图 4-2. RGT, VQFN Package (Top View)

表 4-1. Pin Functions

| NAME | PIN | | TYPE ⁽¹⁾ | DESCRIPTION |
|-----------------|----------------------|-------------|---------------------|--|
| | D, DB, DW, PW or DYY | RGT | | |
| C1+ | 1 | 16 | - | Positive lead of C1 capacitor |
| V+ | 2 | 15 | O | Positive charge pump output for storage capacitor only |
| C1- | 3 | 1 | - | Negative lead of C1 capacitor |
| C2+ | 4 | 2 | - | Positive lead of C2 capacitor |
| C2- | 5 | 3 | - | Negative lead of C2 capacitor |
| V- | 6 | 4 | O | Negative charge pump output for storage capacitor only |
| DOUT2 | 7 | 5 | O | RS232 line data output (to remote RS232 system) |
| RIN2 | 8 | 6 | I | RS232 line data input (from remote RS232 system) |
| ROUT2 | 9 | 7 | O | Logic data output (to UART) |
| DIN2 | 10 | 8 | I | Logic data input (from UART) |
| DIN1 | 11 | 9 | I | Logic data input (from UART) |
| ROUT1 | 12 | 10 | O | Logic data output (to UART) |
| RIN1 | 13 | 11 | I | RS232 line data input (from remote RS232 system) |
| DOUT1 | 14 | 12 | O | RS232 line data output (to remote RS232 system) |
| GRD | 15 | 13 | - | Ground |
| V _{CC} | 16 | 14 | - | Supply Voltage, Connect to external 3-V to 5.5-V power supply |
| Thermal Pad | - | Thermal Pad | - | Exposed thermal pad. Can be connected to GND or left floating. |

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

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) see note (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 | Drivers | - 0.3 | 6 |
| | | Receivers | - 25 | 25 |
| V_O | Output voltage range | Drivers | - 13.2 | 13.2 |
| | | Receivers | - 0.3 | $V_{CC} + 0.3$ |
| T_J | Operating virtual junction temperature | | 150 | °C |
| T_{stg} | Storage temperature range | - 65 | 150 | °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) All voltages are with respect to network GND.

5.2 ESD Ratings

| | | VALUE | UNIT |
|-------------|-------------------------|--|-------|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ¹ . | ±3000 |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ² | ±1500 |

5.3 ESD Protection, Driver

| PIN NAME | TEST CONDITIONS | TYP | UNIT |
|-----------------------------|--|-----|------|
| DOUT1, DOUT2 ⁽²⁾ | Human-body model (HBM) | ±15 | kV |
| | IEC 61000-4-2 Air-Gap Discharge ⁽¹⁾ | ±15 | |
| | IEC 61000-4-2 Contact Discharge ⁽¹⁾ | ±8 | |

- (1) For RGT, D and PW packages only: A minimum of 1- μ F capacitor is needed between V_{CC} and GND to meet the specified IEC ESD level.
- (2) For optimized IEC ESD performance for DYY package, the recommendation is to have series resistor ($\geq 50\Omega$), on all logic inputs directly connected to power or ground, to minimize the transient currents going into or out of the logic pins.

5.4 ESD Protection, Receiver

| PIN NAME | TEST CONDITIONS | TYP | UNIT |
|---------------------------|--|-----|------|
| RIN1, RIN2 ⁽²⁾ | HBM | ±15 | kV |
| | IEC 61000-4-2 Air-Gap Discharge ⁽¹⁾ | ±15 | |
| | IEC 61000-4-2 Contact Discharge ⁽¹⁾ | ±8 | |

- (1) For RGT, D and PW packages only: A minimum of 1- μ F capacitor is needed between V_{CC} and GND to meet the specified IEC ESD level.
- (2) For optimized IEC ESD performance for DYY package, the recommendation is to have series resistor ($\geq 50\Omega$), on all logic inputs directly connected to power or ground, to minimize the transient currents going into or out of the logic pins.

5.5 Recommended Operating Conditions

See note (1)

| | | | MIN | NOM | MAX | UNIT |
|----------------|---------------------------------|-------------------------|-------------------------|-----|-----|------|
| Supply voltage | | $V_{CC} = 3.3\text{ V}$ | 3 | 3.3 | 3.6 | V |
| | | $V_{CC} = 5\text{ V}$ | 4.5 | 5 | 5.5 | |
| V_{IH} | Driver high-level input voltage | DIN | $V_{CC} = 3.3\text{ V}$ | | 2 | V |
| | | | $V_{CC} = 5\text{ V}$ | | 2.4 | |
| V_{IL} | Driver low-level input voltage | DIN | | | 0.8 | V |
| V_I | Driver input voltage | DIN | 0 | 5.5 | | V |
| | Receiver input voltage | | - 25 | | 25 | |
| T_A | Operating free-air temperature | TRSF3232EI | - 40 | | 85 | °C |
| | | TRSF3232EC | 0 | | 70 | |

(1) Test conditions are $C1 - C4 = 0.1\ \mu\text{F}$ at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; $C1 = 0.047\ \mu\text{F}$, $C2 - C4 = 0.33\ \mu\text{F}$ at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (see [图 8-1](#)).

5.6 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | TRSF3232E | | | | | | UNIT |
|-------------------------------|--|------------|----------|-----------|-----------|------------|------------------|------|
| | | PW (TSSOP) | D (SOIC) | DW (SOIC) | DB (SSOP) | RGT (VQFN) | DYY (SOT-23-THN) | |
| | | 16 Pins | 16 Pins | 16 Pins | 16 Pins | 16 Pins | 16 Pins | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 108.2 | 85.9 | 57 | 46 | 48.8 | 106.2 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (bottom) thermal resistance | 39.0 | 43.1 | 33.5 | 36.2 | 55.8 | 47.4 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 54.4 | 44.5 | 37.1 | 43.8 | 23.2 | 44.7 | °C/W |
| ψ_{JT} | Junction-to-top characterization parameter | 3.3 | 10.1 | 7.5 | 4.2 | 1.7 | 1.7 | °C/W |
| ψ_{JB} | Junction-to-board characterization parameter | 53.8 | 44.1 | 37.1 | 42.9 | 23.2 | 43.7 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | N/A | N/A | N/A | N/A | 9.0 | N/A | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC package thermal metrics](#) application report.

5.7 Electrical Characteristics

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

| PARAMETER | TEST CONDITIONS ⁽¹⁾ | MIN | TYP ⁽²⁾ | MAX | UNIT |
|-------------------------|--|-----|--------------------|-----|------|
| I_{CC} Supply current | No load, $V_{CC} = 3.3\text{ V}$ or 5 V | | 0.3 | 1 | mA |

(1) Test conditions are $C1 - C4 = 0.1\ \mu\text{F}$ at $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$; $C1 = 0.047\ \mu\text{F}$, $C2 - C4 = 0.33\ \mu\text{F}$ at $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (see [图 8-1](#)).

(2) All typical values are at $V_{CC} = 3.3\text{ V}$ or $V_{CC} = 5\text{ V}$, and $T_A = 25^\circ\text{C}$.

5.8 Electrical Characteristics, Driver

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

| PARAMETER | TEST CONDITIONS ⁽¹⁾ | | MIN | TYP ⁽²⁾ | MAX | UNIT |
|---|---|------------------------|-----|--------------------|-----|------|
| V _{OH} High-level output voltage | DOUT at R _L = 3 kΩ to GND, | DIN = GND | 5 | 5.5 | | V |
| V _{OL} Low-level output voltage | DOUT at R _L = 3 kΩ to GND, | DIN = V _{CC} | -5 | -5.4 | | V |
| I _{IH} High-level input current | V _I = V _{CC} | | | ±0.01 | ±1 | μA |
| I _{IL} Low-level input current | V _I at GND | | | ±0.01 | ±1 | μA |
| I _{OS} ⁽³⁾ Short-circuit output current | V _{CC} = 3.6 V, V _O = 0 V | | | ±35 | ±60 | mA |
| | V _{CC} = 5.5 V, V _O = 0 V | RGT package only | | ±35 | ±60 | |
| | | D, DB, DW, PW packages | | ±35 | ±90 | |
| r _o Output resistance | V _{CC} , V+, and V- = 0 V, | V _O = ±2 V | 300 | 10M | | Ω |

(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 (see 图 8-1).

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

(3) 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.

5.9 Electrical Characteristics, Receiver

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

| PARAMETER | TEST CONDITIONS ⁽¹⁾ | | MIN | TYP ⁽²⁾ | 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 | | | 1.5 | 2.4 | V |
| | V _{CC} = 5 V | | | 1.8 | 2.4 | |
| V _{IT-} Negative-going input threshold voltage | V _{CC} = 3.3 V | | 0.6 | 1.2 | | V |
| | V _{CC} = 5 V | | 0.8 | 1.5 | | |
| V _{hys} Input hysteresis (V _{IT+} - V _{IT-}) | | | | 0.3 | | V |
| r _i Input resistance | V _I = ±3 V to ±25 V | | 3 | 5 | 7 | kΩ |

(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 (see 图 8-1).

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

5.10 Switching Characteristics, Driver

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

| | | TEST CONDITIONS ⁽¹⁾ | | MIN | TYP ⁽²⁾ | MAX | UNIT |
|---|--|--|--|------|--------------------|-----|--------|
| Maximum data rate (see 图 6-1) | R _L = 3 kΩ, One DOUT switching | C _L = 250 pF, V _{CC} = 3 V to 4.5 V | | 1000 | | | kbit/s |
| | | C _L = 1000 pF, V _{CC} = 3.5 V to 5.5 V | | 1000 | | | |
| t _{sk(p)} Pulse skew ⁽³⁾ | C _L = 1000 pF, R _L = 3 kΩ, V _{cc} = 5 V (see 图 6-2) | RGT package only | | 70 | | | ns |
| | C _L = 150 pF to 2500 pF, R _L = 3 kΩ to 7 kΩ (see 图 6-2) | D, DB, DW, PW packages | | 300 | | | |
| SR(tr) Slew rate, transition region (see 图 6-1) | R _L = 3 kΩ to 7 kΩ, C _L = 150 pF to 1000 pF, V _{CC} = 3.3 V | | | 14 | | 150 | V/μs |

(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 (see 图 8-1).

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

(3) Pulse skew is defined as |t_{PLH} - t_{PHL}| of each channel of the same device.

5.11 Switching Characteristics, Receiver

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

| | | TEST CONDITIONS ⁽¹⁾ | | MIN | TYP ⁽²⁾ | MAX | UNIT |
|--|-------------------------|--------------------------------|--|-----|--------------------|-----|------|
| t _{PLH} Propagation delay time, low- to high-level output | C _L = 150 pF | RGT package | | 85 | | | ns |
| | | D, DB, DW, PW packages | | 300 | | | |
| t _{PHL} Propagation delay time, high- to low-level output | C _L = 150 pF | RGT package | | 110 | | | ns |
| | | D, DB, DW, PW packages | | 300 | | | |
| t _{sk(p)} Pulse skew ⁽³⁾ | | RGT package | | 25 | | | ns |
| | | D, DB, DW, PW packages | | 300 | | | |

(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 (see 图 8-1).

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

(3) Pulse skew is defined as |t_{PLH} - t_{PHL}| of each channel of the same device.

5.12 Typical Characteristics

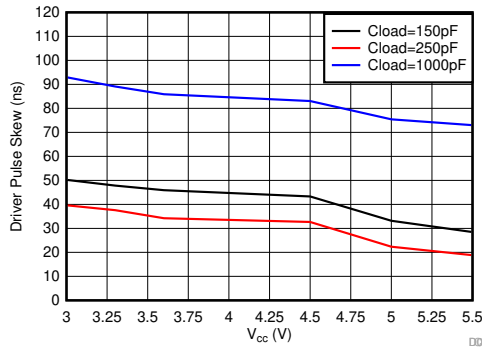


图 5-1. Driver pulse skew at $T_A = 25^\circ\text{C}$ (RGT package)

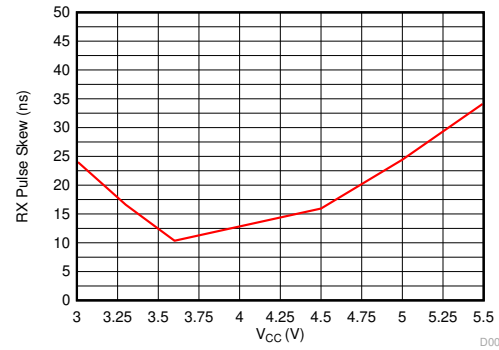


图 5-2. Receiver path skew at $T_A = 25^\circ\text{C}$ ($t_{pHL}-t_{pLH}$) (RGT package)

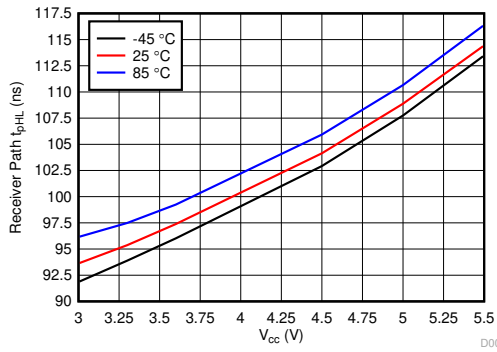


图 5-3. Receiver path high-to-low propagation delay, $C_L = 150\text{pF}$ (RGT package)

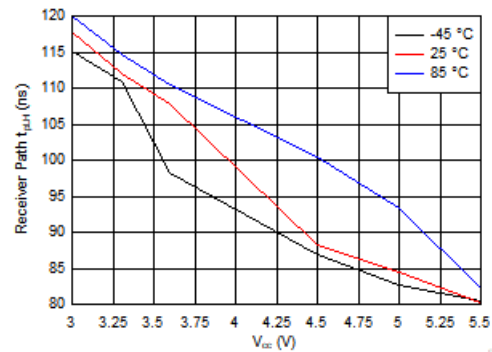
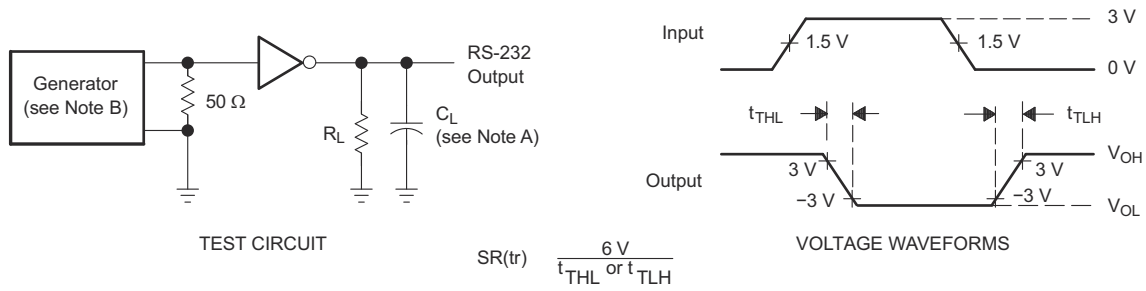


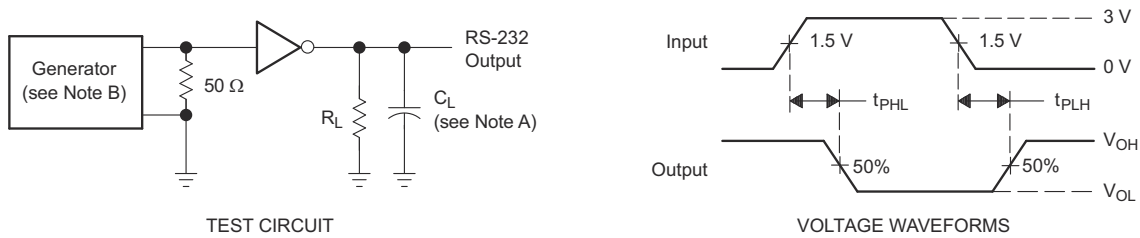
图 5-4. Receiver path low-to-high propagation delay, $C_L = 150\text{pF}$ (RGT package)

6 Parameter Measurement Information



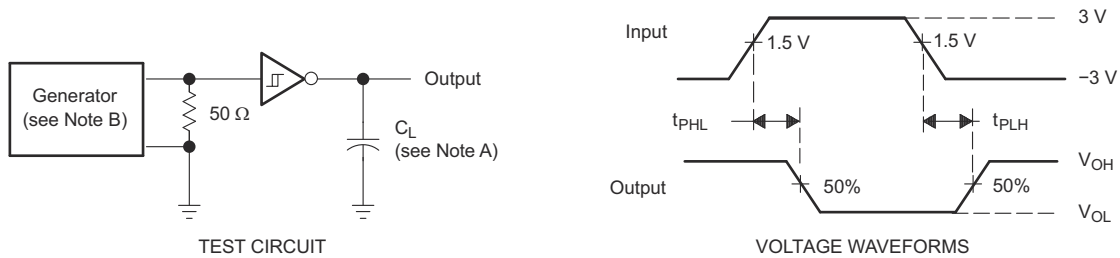
NOTES: A. C_L includes probe and jig capacitance.
B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

图 6-1. Driver Slew Rate



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

图 6-2. Driver Pulse Skew



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

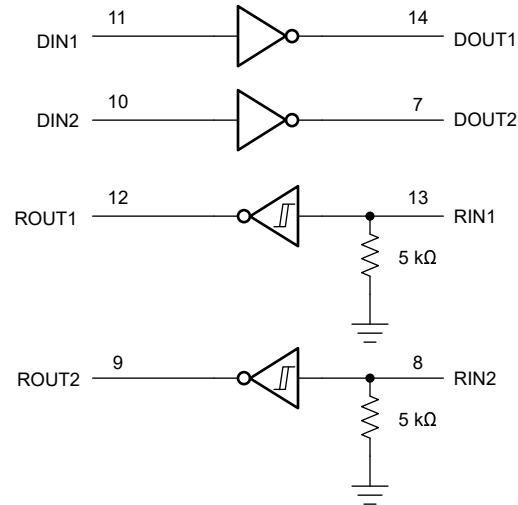
图 6-3. Receiver Propagation Delay Times

7 Detailed Description

7.1 Overview

The TRSF3232E device consists of two line drivers, two line receivers, and a dual charge-pump circuit with $\pm 15\text{kV}$ IEC ESD protection between serial-port connection terminals and GND. 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 one 3V to 5.5V supply. The device operates at data signaling rates up to 1Mbps and a maximum of $150\text{V}/\mu\text{s}$ driver output slew rate. Outputs are protected against shorts to ground.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Power

The power block increases, inverts, and regulates voltage at V+ and V- pins using a charge pump that requires four external capacitors.

7.3.2 RS232 Driver

Two drivers interface the standard logic level to RS232 levels. Both DIN inputs must be valid high or low.

7.3.3 RS232 Receiver

Two receivers interface RS232 levels to standard logic levels. An open input results in a high output on ROUT. Each RIN input includes an internal standard RS232 load.

7.4 Device Functional Modes

表 7-1. Each Driver

| INPUT DIN ⁽¹⁾ | OUTPUT DOUT |
|--------------------------|-------------|
| L | H |
| H | L |

(1) H = high level, L = low level

表 7-2. Each Receiver

| INPUT RIN ⁽¹⁾ | OUTPUT ROUT |
|--------------------------|-------------|
| L | H |
| H | L |
| Open | H |

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

7.4.1 V_{CC} Powered by 3V to 5.5V

The device is in normal operation.

7.4.2 V_{CC} Unpowered, $V_{CC} = 0V$

When the TRSF3232 device is unpowered, it can be safely connected to an active remote RS232 device.

8 Application and Implementation

备注

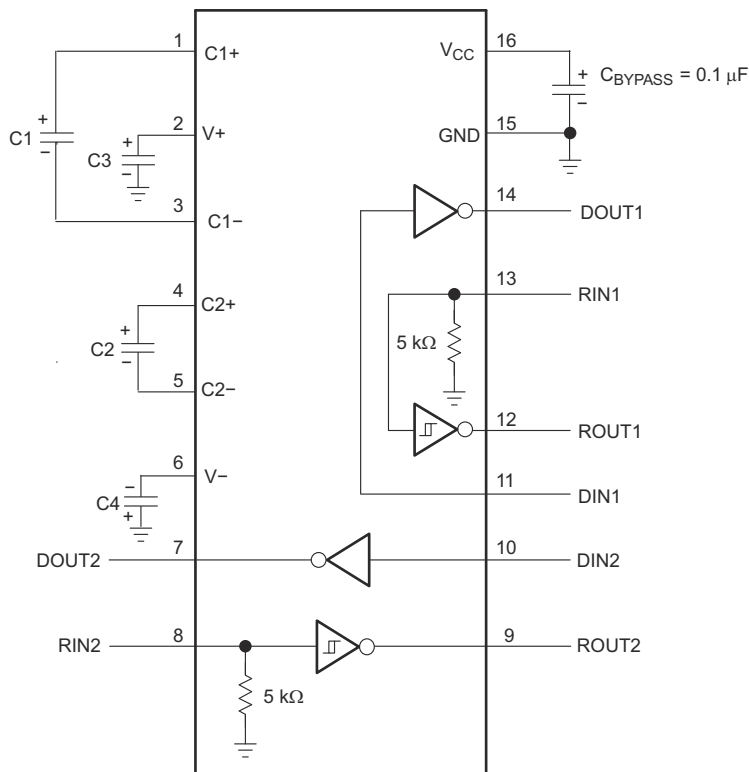
以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

8.1 Application Information

The TRSF3232E device is designed to convert single-ended signals into RS232-compatible signals, and vice-versa. This device can be used in any application where an RS232 line driver or receiver is required.

ROUT and DIN connect to UART or general-purpose logic lines. RIN and DOUT lines connect to a RS232 connector or cable.

8.2 Typical Application



A. C3 can be connected to V_{CC} or GND.

图 8-1. Typical Operating Circuit and Capacitor Values

表 8-1. VCC vs Capacitor Values

| V_{CC} | C1 | C2, C3, C4 |
|-----------------|--------------|-------------|
| $3.3V \pm 0.3V$ | $0.1\mu F$ | $0.1\mu F$ |
| $5V \pm 0.5V$ | $0.047\mu F$ | $0.33\mu F$ |
| 3V to 5.5V | $0.1\mu F$ | $0.47\mu F$ |

8.2.1 Design Requirements

- Recommended V_{CC} is 3.3V or 5V
 - 3V to 5.5V is also possible
- Maximum recommended bit rate is 250kbites

8.2.2 Detailed Design Procedure

All DIN inputs must be connected to valid low or high logic levels. Select capacitor values based on VCC level for best performance.

8.2.3 Application Performance Plots

VCC must be between 3 V and 5.5 V. Charge pump capacitors must be chosen using [表 8-1](#)

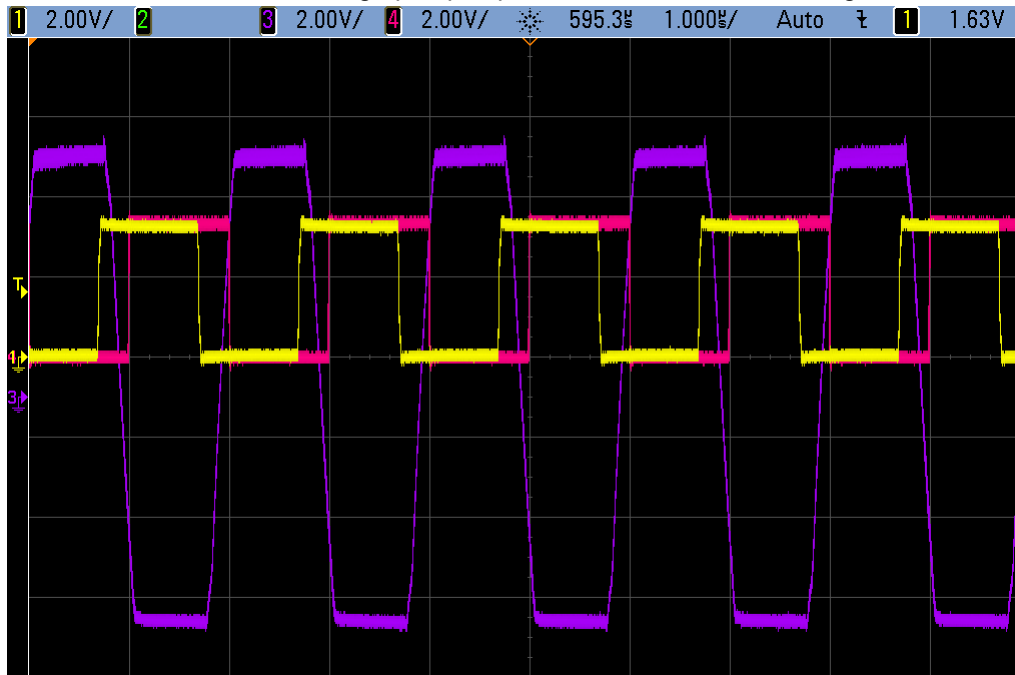


图 8-2. 1Mbps timing waveform from driver input to receiver output loopback. DOUT to RIN trace is in purple, DIN trace is in yellow and ROUT trace is in pink

8.3 Power Supply Recommendations

The supply voltage, V_{CC} , should be between 3V and 5.5V. Select the charge-pump capacitors using [表 8-1](#).

8.4 Layout

8.4.1 Layout Guidelines

Keep the external capacitor traces short, specifically on the C1 and C2 nodes that have the fastest rise and fall times.

8.4.2 Layout Example

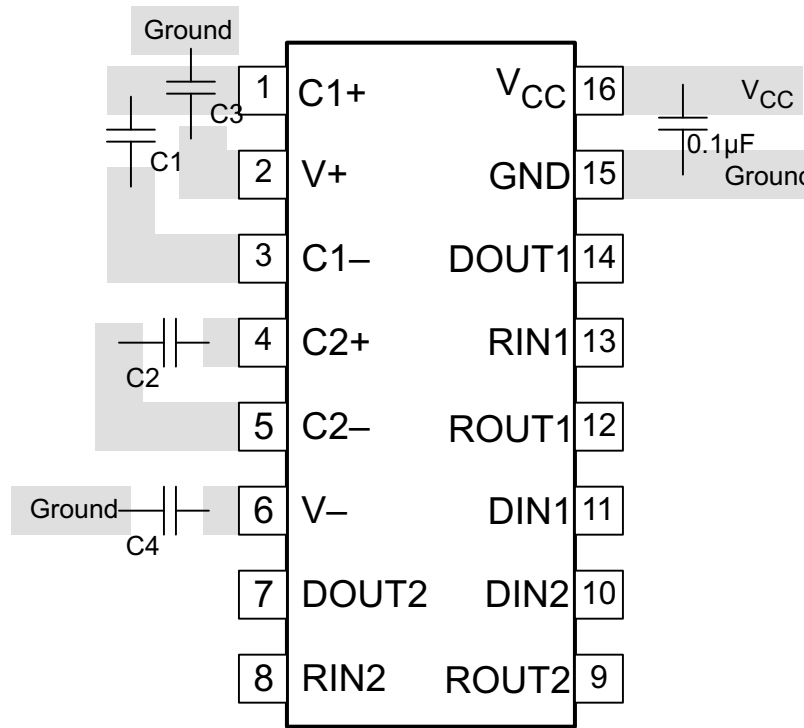


图 8-3. Layout Diagram

9 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

9.1 接收文档更新通知

要接收文档更新通知，请导航至 ti.com 上的器件产品文件夹。点击 [通知](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

9.2 支持资源

[TI E2E™ 中文支持论坛](#) 是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [使用条款](#)。

9.3 商标

TI E2E™ is a trademark of Texas Instruments.
所有商标均为其各自所有者的财产。

9.4 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

9.5 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

10 Revision History

注：以前版本的页码可能与当前版本的页码不同

| Changes from Revision B (June 2021) to Revision C (December 2024) | Page |
|---|------|
| • 将 <i>器件信息</i> 表更改为 <i>封装信息</i> 表..... | 1 |
| • 向数据表中添加了 SOT-23-THN (DYY) 封装..... | 1 |
| • Added Note 2 to the <i>ESD Protection, Driver</i> | 4 |
| • Added Note 2 to the <i>ESD Protection, Receiver</i> | 4 |

| Changes from Revision A (December 2020) to Revision B (June 2021) | Page |
|---|------|
| • 添加了 <i>应用工业 PC、有线网络、数据中心和企业级计算</i> | 1 |
| • Changed the table note in the <i>ESD Protection, Driver</i> table to make it applicable to D and PW packages..... | 4 |
| • Changed the table note in the <i>ESD Protection, Receiver</i> table to make it applicable to D and PW packages.. | 4 |
| • Changed the thermal parameter values for D and PW packages in the <i>Thermal Information</i> table..... | 5 |

| Changes from Revision * (August 2007) to Revision A (December 2020) | Page |
|--|------|
| • 添加了“器件信息”表、“ESD 等级”表、“特性说明”部分、“器件功能模式”、“应用和实施”部分、“电源相关建议”部分、“布局”部分、“器件和文档支持”部分以及“机械、封装和可订购信息”部分..... | 1 |
| • Added Note to the <i>ESD Protection, Driver</i> | 4 |

| | |
|--|---|
| • Added Note to the <i>ESD Protection, Receiver</i> | 4 |
| • Added $t_{sk(p)}$ row for RGT package in the <i>Switching Characteristics, Driver</i> | 7 |
| • Added t_{PLH} and t_{PHL} rows for RGT package in the <i>Switching Characteristics, Receiver</i> | 7 |
| • Added $t_{sk(p)}$ row for RGT package in the <i>Switching Characteristics, Receiver</i> | 7 |

11 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件可用的最新数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。有关此数据表的浏览器版本，请查阅左侧的导航栏。

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) |
|--------------------------------|---------------|----------------------|---------------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TRSF3232ECDBR | Active | Production | SSOP (DB) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | RT32EC |
| TRSF3232ECDBR.A | Active | Production | SSOP (DB) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EC |
| TRSF3232ECDR | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TRSF3232EC |
| TRSF3232ECDR.A | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EC |
| TRSF3232ECDWR | Obsolete | Production | SOIC (DW) 16 | - | - | Call TI | Call TI | 0 to 70 | TRSF3232EC |
| TRSF3232ECPWR | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | 0 to 70 | RT32EC |
| TRSF3232ECPWR.A | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EC |
| TRSF3232EID | Obsolete | Production | SOIC (D) 16 | - | - | Call TI | Call TI | -40 to 85 | TRSF3232EI |
| TRSF3232EIDBR | Active | Production | SSOP (DB) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIDBR.A | Active | Production | SSOP (DB) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIDR | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDR.A | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDRG4.A | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDW | Active | Production | SOIC (DW) 16 | 40 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDW.A | Active | Production | SOIC (DW) 16 | 40 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDWR | Active | Production | SOIC (DW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDWR.A | Active | Production | SOIC (DW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TRSF3232EI |
| TRSF3232EIDYYR | Active | Production | SOT-23-THIN (DYY) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIDYYR.A | Active | Production | SOT-23-THIN (DYY) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIPWR | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIPWR.A | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIPWRG4.A | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | RT32EI |
| TRSF3232EIRGTR | Active | Production | VQFN (RGT) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | F3232 |
| TRSF3232EIRGTR.A | Active | Production | VQFN (RGT) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | F3232 |

⁽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.

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.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TRSF3232ECDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.35 | 6.6 | 2.4 | 12.0 | 16.0 | Q1 |
| TRSF3232ECDR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| TRSF3232ECDR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| TRSF3232ECPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRSF3232ECPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRSF3232EIDBR | SSOP | DB | 16 | 2000 | 330.0 | 16.4 | 8.35 | 6.6 | 2.4 | 12.0 | 16.0 | Q1 |
| TRSF3232EIDR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| TRSF3232EIDR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| TRSF3232EIDWR | SOIC | DW | 16 | 2000 | 330.0 | 16.4 | 10.75 | 10.7 | 2.7 | 12.0 | 16.0 | Q1 |
| TRSF3232EIDYYR | SOT-23-THIN | DYY | 16 | 3000 | 330.0 | 12.4 | 4.8 | 3.6 | 1.6 | 8.0 | 12.0 | Q3 |
| TRSF3232EIPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRSF3232EIPWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TRSF3232EIRGTR | VQFN | RGT | 16 | 3000 | 330.0 | 12.4 | 3.3 | 3.3 | 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) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TRSF3232ECDBR | SSOP | DB | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232ECDR | SOIC | D | 16 | 2500 | 356.0 | 356.0 | 35.0 |
| TRSF3232ECDR | SOIC | D | 16 | 2500 | 356.0 | 356.0 | 35.0 |
| TRSF3232ECPWR | TSSOP | PW | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232ECPWR | TSSOP | PW | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIDBR | SSOP | DB | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIDR | SOIC | D | 16 | 2500 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIDR | SOIC | D | 16 | 2500 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIDWR | SOIC | DW | 16 | 2000 | 350.0 | 350.0 | 43.0 |
| TRSF3232EIDYYR | SOT-23-THIN | DYY | 16 | 3000 | 336.6 | 336.6 | 31.8 |
| TRSF3232EIPWR | TSSOP | PW | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIPWR | TSSOP | PW | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TRSF3232EIRGTR | VQFN | RGT | 16 | 3000 | 367.0 | 367.0 | 35.0 |

TUBE


*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TRSF3232EIDW | DW | SOIC | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |
| TRSF3232EIDW.A | DW | SOIC | 16 | 40 | 506.98 | 12.7 | 4826 | 6.6 |



4224642/D 07/2024

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 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AA



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 20X



4224642/D 07/2024

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: 20X

4224642/D 07/2024

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.

GENERIC PACKAGE VIEW

DW 16

SOIC - 2.65 mm max height

7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224780/A

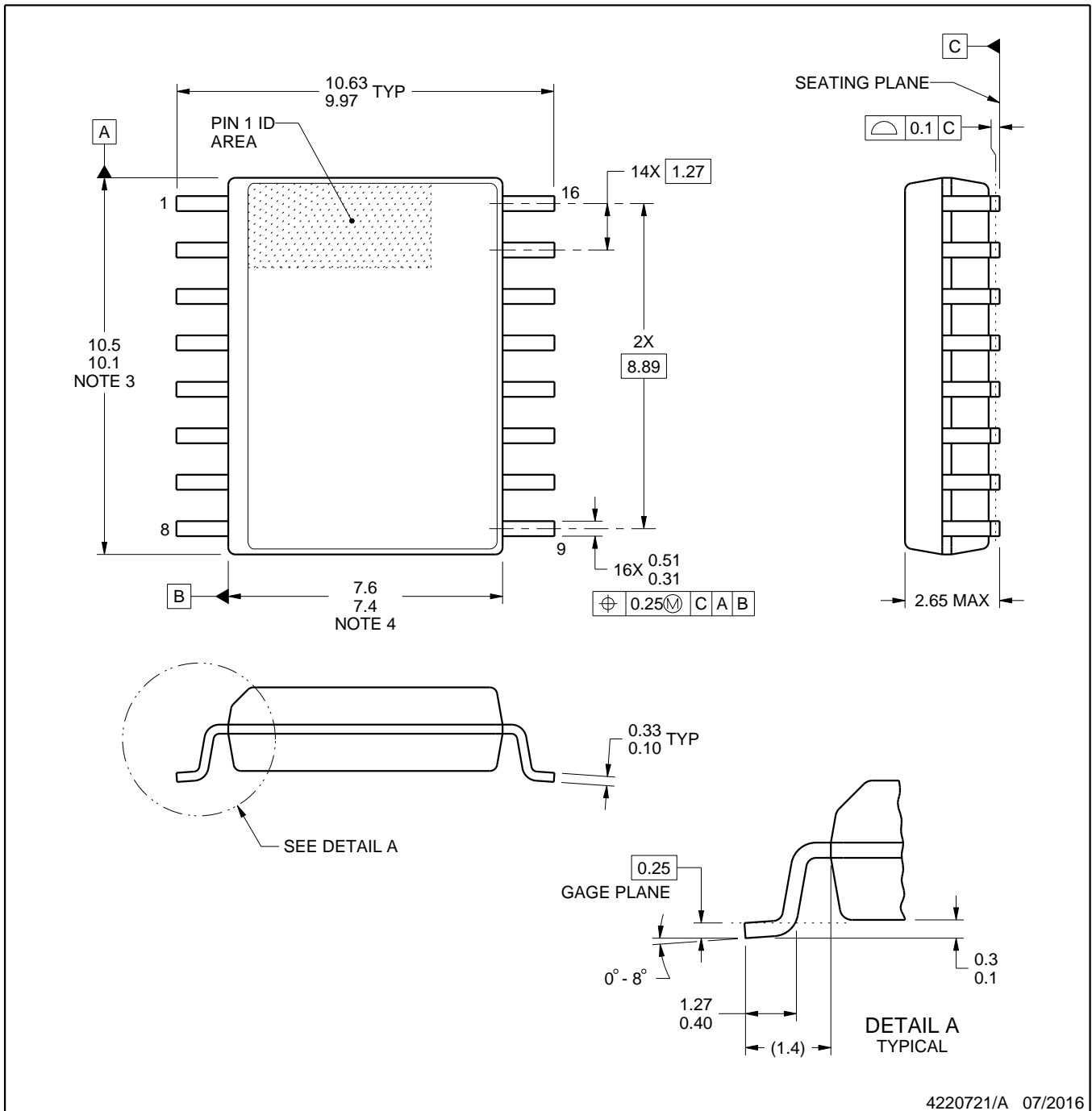


DW0016A

PACKAGE OUTLINE

SOIC - 2.65 mm max height

SOIC



4220721/A 07/2016

NOTES:

1. All linear dimensions are in millimeters. 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 MS-013.

EXAMPLE BOARD LAYOUT

DW0016A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:7X



SOLDER MASK DETAILS

4220721/A 07/2016

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

DW0016A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220721/A 07/2016

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.

RGT 16

GENERIC PACKAGE VIEW

VQFN - 1 mm max height

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.

4203495/1



| SIDE WALL METAL THICKNESS DIM A | |
|---------------------------------|----------|
| OPTION 1 | OPTION 2 |
| 0.1 | 0.2 |



4222419/D 04/2022

NOTES:

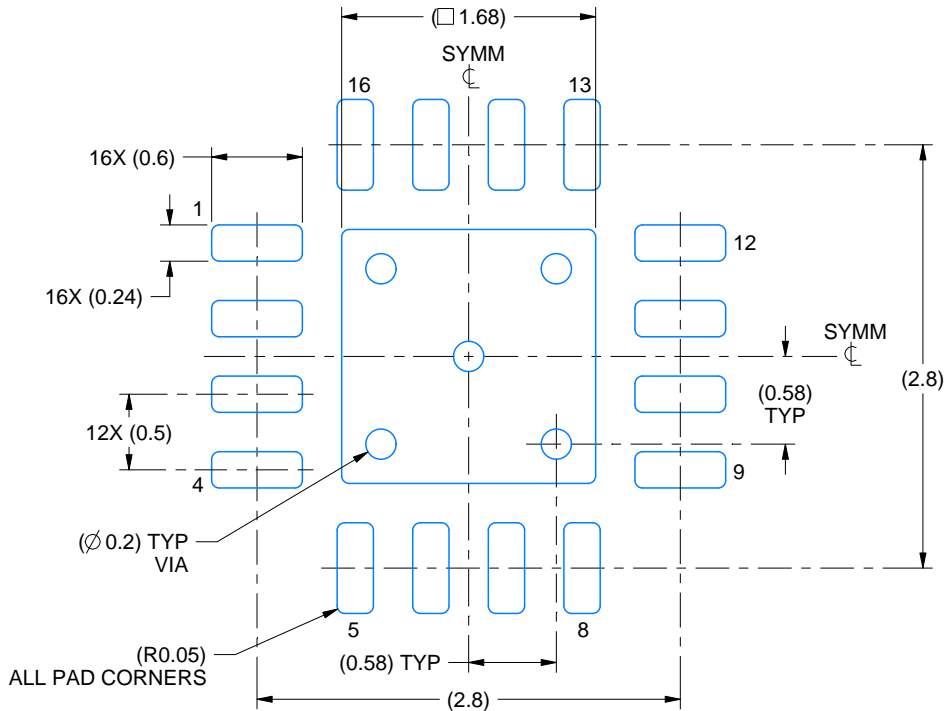
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

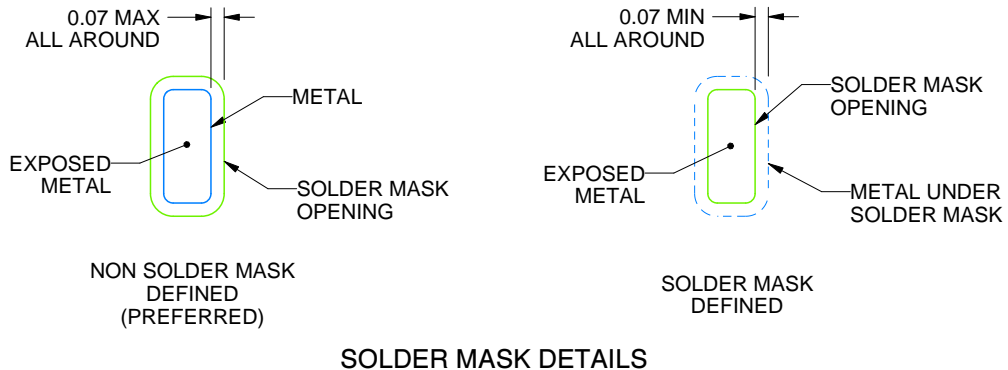
RGT0016C

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X



SOLDER MASK DETAILS

4222419/D 04/2022

NOTES: (continued)

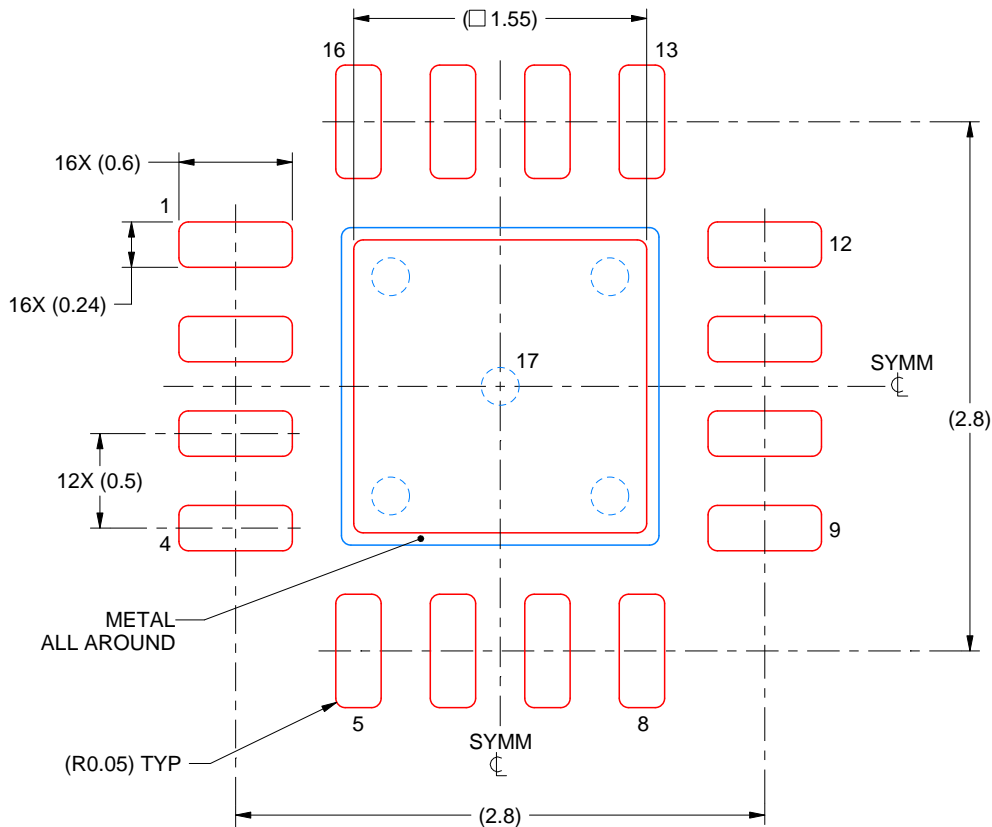
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown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

EXAMPLE STENCIL DESIGN

RGT0016C

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 17:
85% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:25X

4222419/D 04/2022

NOTES: (continued)

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

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.



4220204/A 02/2017

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.

EXAMPLE BOARD LAYOUT

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220204/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.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/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.

DB0016A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4220763/A 05/2022

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. Reference JEDEC registration MO-150.

EXAMPLE BOARD LAYOUT

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220763/A 05/2022

NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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

4220763/A 05/2022

NOTES: (continued)

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

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