

MAX232E Dual RS-232 Driver and Receiver With IEC61000-4-2 Protection

1 Features

- Meets or Exceeds TIA/RS-232-F and ITU Recommendation V.28
- 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 From a Single 5-V Power Supply With 1-μF Charge-Pump Capacitors
- Operates up to 250 kbit/s
- Two Drivers and Two Receivers
- Low Supply Current: 8 mA Typical

2 Applications

- TIA/RS-232-F
- Battery-Powered Systems
- Terminals
- Modems
- Computers

3 Description

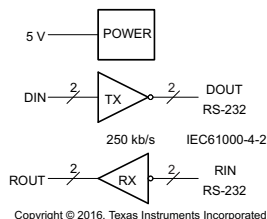
The MAX232E is a dual driver and receiver that includes a capacitive voltage generator to supply RS-232-F compliant voltage levels from a single 5-V supply. Each receiver converts RS-232 inputs to 5-V TTL/CMOS levels. This receiver has a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/RS-232-F levels.

Device Information<sup>(1)</sup>

| PART NUMBER              | PACKAGE (PINS) | BODY SIZE (NOM)    |
|--------------------------|----------------|--------------------|
| MAX232ECD<br>MAX232EID   | SOIC (16)      | 9.90 mm × 3.91 mm  |
| MAX232ECDW<br>MAX232EIDW | SOIC WIDE (16) | 10.30 mm × 7.50 mm |
| MAX232ECN<br>MAX232EIN   | PDIP (16)      | 19.30 mm × 6.35 mm |
| MAX232ECPW<br>MAX232EIPW | TSSOP (16)     | 5.00 mm × 4.40 mm  |

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

Logic Diagram (Positive Logic)



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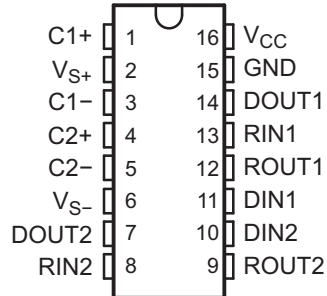
## 4 Revision History

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

| Changes from Revision B (November 2009) to Revision C  | Page |
|--|------|
| • Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section ..... | 1    |
| • Deleted "±30-V Input Levels" from <i>Features</i> .....  | 1    |
| • Deleted <i>Ordering Information</i> table; see POA at the end of the data sheet .....  | 1    |
| • Added MIN value ±3 to "Receiver input voltage (RIN1, RIN2) row in <i>Recommended Operating Conditions</i> .....  | 4    |
| • Changed $R_{\theta JA}$ values in <i>Thermal Information</i> .....   | 4    |
| • Deleted table note 3 from <i>Receiver Section Electrical Characteristics</i> .....   | 5    |
| • Added a new row to the <i>Function Table for Each Receiver</i> .....   | 10   |

## 5 Pin Configuration and Functions

**D, DW, N, or PW Package**  
Add 16-Pin SOIC, PDIP, or TSSOP  
**Top View**



### Pin Functions

| PIN |       | I/O | DESCRIPTION  |
|-----|-------|-----|--|
| NO. | NAME  |     |  |
| 1   | C1+   | —   | Positive lead of C1 capacitor                          |
| 2   | VS+   | O   | Positive charge pump output for storage capacitor only |
| 3   | C1–   | —   | Negative lead of C1 capacitor                          |
| 4   | C2+   | —   | Positive lead of C2 capacitor                          |
| 5   | C2–   | —   | Negative lead of C2 capacitor                          |
| 6   | VS–   | O   | Negative charge pump output for storage capacitor only |
| 7   | DOUT2 | O   | RS-232 line data output (to remote RS-232 system)      |
| 8   | RIN2  | I   | RS-232 line data input (from remote RS-232 system)     |
| 9   | ROUT2 | O   | Logic data output (to UART)                            |
| 10  | DIN2  | I   | Logic data input (from UART)                           |
| 11  | DIN1  | I   | Logic data input (from UART)                           |
| 12  | ROUT1 | O   | Logic data output (to UART)                            |
| 13  | RIN1  | I   | RS-232 line data input (from remote RS-232 system)     |
| 14  | DOUT1 | O   | RS-232 line data output (to remote RS-232 system)      |
| 15  | GND   | —   | Ground   |
| 16  | VCC   | —   | Supply voltage—connect to external 5-V power supply    |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                  |  |          | MIN                   | MAX                   | UNIT |
|------------------|--|----------|-----------------------|-----------------------|------|
| V <sub>CC</sub>  | Input supply voltage <sup>(2)</sup>    |          | –0.3                  | 6                     | V    |
| V <sub>S+</sub>  | Positive output supply voltage         |          | V <sub>CC</sub> – 0.3 | 15                    | V    |
| V <sub>S–</sub>  | Negative output supply voltage         |          | –0.3                  | –15                   | V    |
| V <sub>I</sub>   | Input voltage                          | Driver   | –0.3                  | V <sub>CC</sub> + 0.3 | V    |
|                  |  | Receiver |                       | ±30                   |      |
| V <sub>O</sub>   | Output voltage                         | DOUT     | V <sub>S–</sub> – 0.3 | V <sub>S+</sub> + 0.3 | V    |
|                  |  | ROUT     | –0.3                  | V <sub>CC</sub> + 0.3 |      |
|                  | Short-circuit duration                 | DOUT     |                       | Unlimited             |      |
| T <sub>J</sub>   | Operating virtual junction temperature |          |                       | 150                   | °C   |
| T <sub>stg</sub> | Storage temperature                    |          | –65                   | 150                   | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to network GND.

### 6.2 ESD Ratings

|                    |                         |  |                       | VALUE  | UNIT |
|--------------------|-------------------------|--|-----------------------|--------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | Pins 7, 8, 13, and 14 | ±15000 | V    |
|                    |                         |  | Other pins            | ±3000  |      |
|                    |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | All pins              | ±1500  |      |
|                    |                         | IEC61000-4-2, air-gap discharge  | Pins 7, 8, 13, and 14 | ±15000 |      |
|                    |                         | IEC61000-4-2, contact discharge  |                       | ±8000  |      |

- (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 Recommended Operating Conditions

|                 |                                       |          | MIN | NOM | MAX | UNIT |
|-----------------|---------------------------------------|----------|-----|-----|-----|------|
| V <sub>CC</sub> | Supply voltage                        |          | 4.5 | 5   | 5.5 | V    |
| V <sub>IH</sub> | High-level input voltage (DIN1, DIN2) |          | 2   |     |     | V    |
| V <sub>IL</sub> | Low-level input voltage (DIN1, DIN2)  |          |     |     | 0.8 | V    |
|                 | Receiver input voltage (RIN1, RIN2)   |          | ±3  |     | ±30 | V    |
| T <sub>A</sub>  | Operating free-air temperature        | MAX232EC | 0   |     | 70  | °C   |
|                 |                                       | MAX232EI | –40 |     | 85  |      |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)(2)(3)</sup> |   | MAX232E     |              |             |               | UNIT |
|-------------------------------------|---|-------------|--------------|-------------|---------------|------|
|                                     |   | D<br>(SOIC) | DW<br>(SOIC) | N<br>(PDIP) | PW<br>(TSSOP) |      |
|                                     |   | 16 PINS     | 16 PINS      | 16 PINS     | 16 PINS       |      |
| R <sub>θJA</sub>                    | Junction-to-ambient thermal resistance    | 73.8        | 73.4         | 43.3        | 101.6         | °C/W |
| R <sub>θJC(top)</sub>               | Junction-to-case (top) thermal resistance | 33.4        | 35.1         | 30          | 29.3          | °C/W |
| R <sub>θJB</sub>                    | Junction-to-board thermal resistance      | 31.4        | 38.3         | 23.3        | 47.3          | °C/W |

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.
- (2) Maximum power dissipation is a function of T<sub>J</sub>(max), R<sub>θJA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J</sub>(max) – T<sub>A</sub>)/R<sub>θJA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

## Thermal Information (continued)

| THERMAL METRIC <sup>(1)(2)(3)</sup> |  | MAX232E     |              |             |               | UNIT |
|-------------------------------------|--|-------------|--------------|-------------|---------------|------|
|                                     |  | D<br>(SOIC) | DW<br>(SOIC) | N<br>(PDIP) | PW<br>(TSSOP) |      |
|                                     |  | 16 PINS     | 16 PINS      | 16 PINS     | 16 PINS       |      |
| $\Psi_{JT}$                         | Junction-to-top characterization parameter   | 5.8         | 9.4          | 14.4        | 1.4           | °C/W |
| $\Psi_{JB}$                         | Junction-to-board characterization parameter | 31.1        | 37.7         | 23.2        | 46.6          | °C/W |

## 6.5 Electrical Characteristics

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 10](#))

| PARAMETER               | TEST CONDITIONS <sup>(1)</sup>                                     | MIN | TYP <sup>(2)</sup> | MAX | UNIT |
|-------------------------|--|-----|--------------------|-----|------|
| $I_{CC}$ Supply current | $V_{CC} = 5.5\text{ V}$ All outputs open, $T_A = 25^\circ\text{C}$ |     | 8                  | 10  | mA   |

(1) Test conditions are  $C1 - C4 = 1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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

## 6.6 Electrical Characteristics: Driver

over recommended ranges of supply voltage and operating free-air temperature range

| PARAMETER  |      | TEST CONDITIONS <sup>(1)</sup>                 | MIN | TYP <sup>(2)</sup> | MAX | UNIT          |
|--|------|--|-----|--------------------|-----|---------------|
| $V_{OH}$ High-level output voltage                   | DOUT | $R_L = 3\text{ k}\Omega$ to GND                | 5   | 7                  |     | V             |
| $V_{OL}$ Low-level output voltage <sup>(3)</sup>     | DOUT | $R_L = 3\text{ k}\Omega$ to GND                |     | -7                 | -5  | V             |
| $r_o$ Output resistance                              | DOUT | $V_{S+} = V_{S-} = 0$ , $V_O = \pm 2\text{ V}$ | 300 |                    |     | $\Omega$      |
| $I_{OS}$ <sup>(4)</sup> Short-circuit output current | DOUT | $V_{CC} = 5.5\text{ V}$ , $V_O = 0$            |     | $\pm 10$           |     | mA            |
| $I_{IS}$ Short-circuit input current                 | DIN  | $V_I = 0$                                      |     |                    | 200 | $\mu\text{A}$ |

(1) Test conditions are  $C1 - C4 = 1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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

(3) The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.

(4) Not more than one output should be shorted at a time.

## 6.7 Electrical Characteristics: Receiver

over recommended ranges of supply voltage and operating free-air temperature range

| PARAMETER   |      | TEST CONDITIONS <sup>(1)</sup>                 | MIN | TYP <sup>(2)</sup> | MAX | UNIT       |
|---|------|--|-----|--------------------|-----|------------|
| $V_{OH}$ High-level output voltage                        | ROUT | $I_{OH} = -1\text{ mA}$                        | 3.5 |                    |     | V          |
| $V_{OL}$ Low-level output voltage                         | ROUT | $I_{OL} = 3.2\text{ mA}$                       |     |                    | 0.4 | V          |
| $V_{IT+}$ Receiver positive-going input threshold voltage | RIN  | $V_{CC} = 5\text{ V}$ $T_A = 25^\circ\text{C}$ |     | 1.7                | 2.4 | V          |
| $V_{IT-}$ Receiver negative-going input threshold voltage | RIN  | $V_{CC} = 5\text{ V}$ $T_A = 25^\circ\text{C}$ | 0.8 | 1.2                |     | V          |
| $V_{hys}$ Input hysteresis voltage                        | RIN  | $V_{CC} = 5\text{ V}$                          | 0.2 | 0.5                | 1   | V          |
| $r_i$ Receiver input resistance                           | RIN  | $V_{CC} = 5\text{ V}$ $T_A = 25^\circ\text{C}$ | 3   | 5                  | 7   | k $\Omega$ |

(1) Test conditions are  $C1 - C4 = 1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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

## 6.8 Switching Characteristics: Driver

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER                                | TEST CONDITIONS <sup>(1)</sup>   | MIN | TYP | MAX | UNIT             |
|--|--|-----|-----|-----|------------------|
| SR Driver slew rate                      | $R_L = 3\text{ k}\Omega$ to $7\text{ k}\Omega$ , See <a href="#">Figure 6</a>    |     |     | 30  | V/ $\mu\text{s}$ |
| SR(t) Driver transition region slew rate | $R_L = 3\text{ k}\Omega$ , $C_L = 2.5\text{ nF}$<br>See <a href="#">Figure 7</a> |     | 3   |     | V/ $\mu\text{s}$ |
| Data rate                                | One DOUT switching   |     | 250 |     | kbit/s           |

(1) Test conditions are  $C1 - C4 = 1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

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## 6.9 Switching Characteristics: Receiver

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (see Figure 5)

| PARAMETER   | TEST CONDITIONS <sup>(1)</sup> | TYP | UNIT |
|---|--------------------------------|-----|------|
| $t_{PLH(R)}$ Receiver propagation delay time, low- to high-level output | $C_L = 50\text{ pF}$           | 500 | ns   |
| $t_{PHL(R)}$ Receiver propagation delay time, high- to low-level output | $C_L = 50\text{ pF}$           | 500 | ns   |

(1) Test conditions are  $C_1 - C_4 = 1\text{ }\mu\text{F}$  at  $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ .

## 6.10 Typical Characteristics

$T_A = 25^\circ\text{C}$

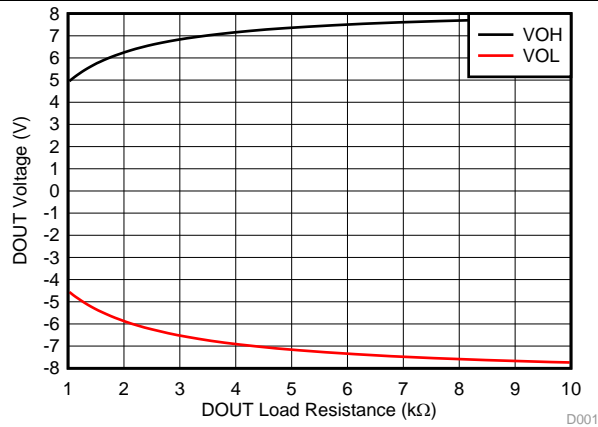


Figure 1. Driver Output Voltage vs Load Resistance

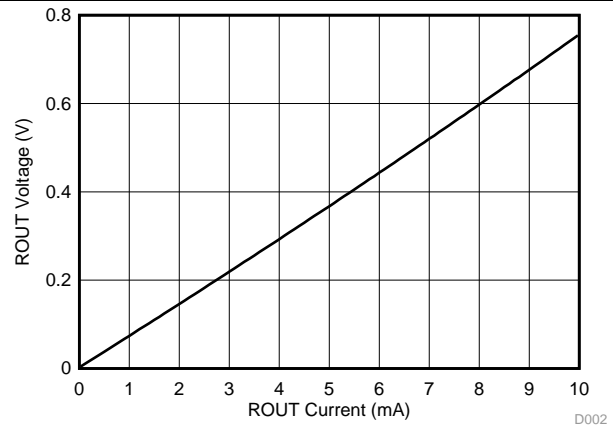


Figure 2. Receiver Low Output Voltage vs Load Current

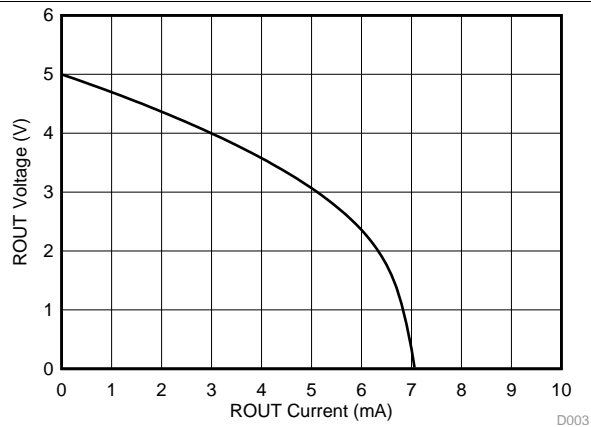


Figure 3. Receiver High Output Voltage vs Load Current

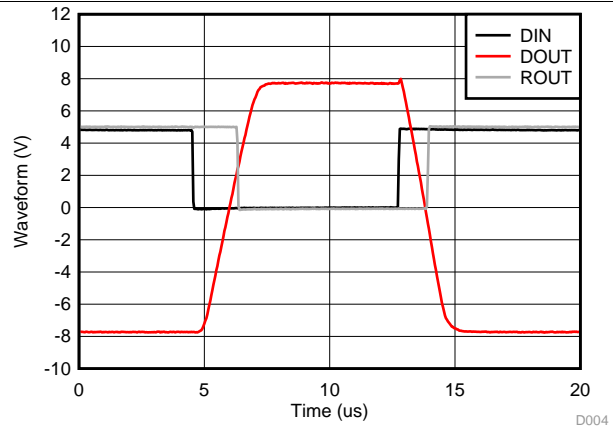
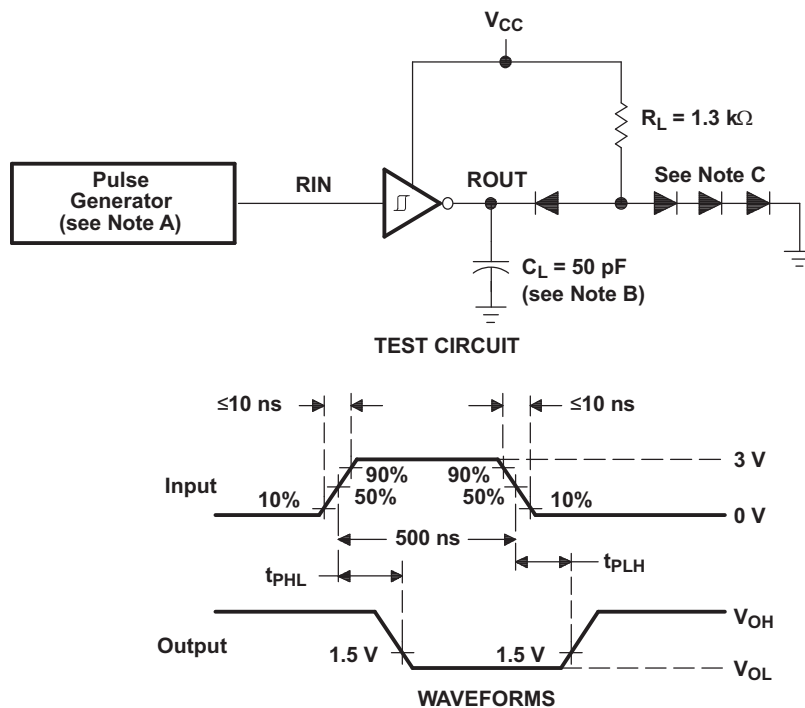


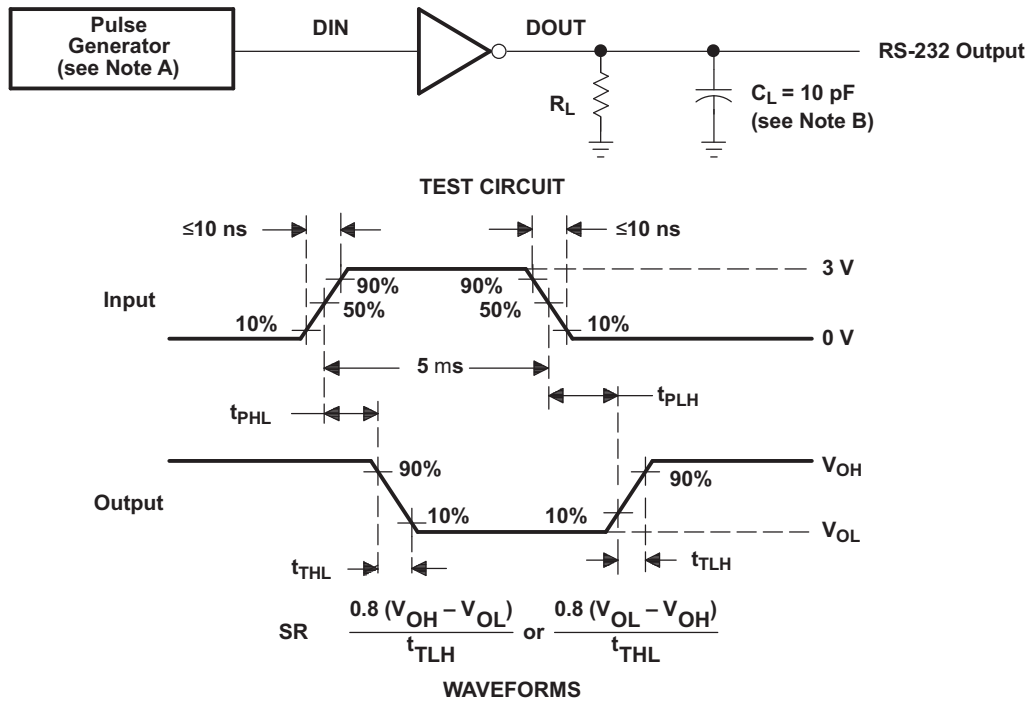
Figure 4. Loopback Waveforms  
Data Rate 120 kbit/s

## 7 Parameter Measurement Information

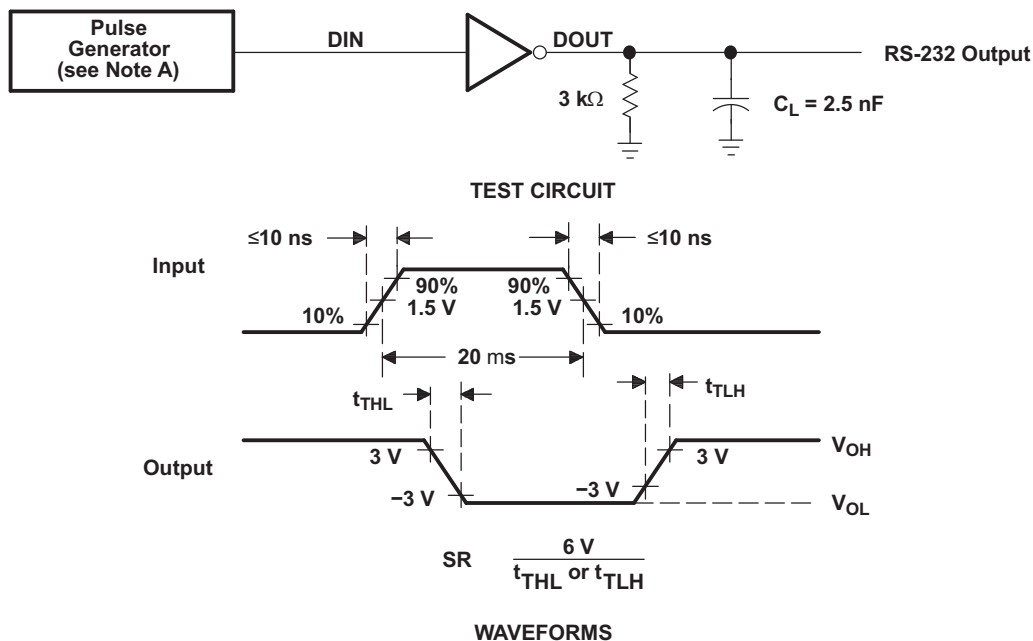


- A. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , duty cycle  $\leq 50\%$ .
- B.  $C_L$  includes probe and jig capacitance.
- C. All diodes are 1N3064 or equivalent.

**Figure 5. Receiver Test Circuit and Waveforms for  $t_{PHL}$  and  $t_{PLH}$  Measurements**

**Parameter Measurement Information (continued)**


- A. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , duty cycle  $\leq 50\%$ .
- B.  $C_L$  includes probe and jig capacitance.

**Figure 6. Driver Test Circuit and Waveforms for  $t_{PHL}$  and  $t_{PLH}$  Measurements (5- $\mu\text{s}$  Input)**


- A. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ , duty cycle  $\leq 50\%$ .

**Figure 7. Test Circuit and Waveforms for  $t_{THL}$  and  $t_{TLH}$  Measurements (20- $\mu\text{s}$  Input)**

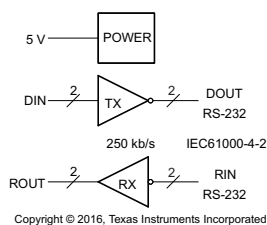


## 8 Detailed Description

### 8.1 Overview

The MAX232E device is a dual driver and receiver that includes a capacitive voltage generator using four capacitors to supply TIA/EIA-232-F voltage levels from a single 5-V supply. All RS-232 pins have 15-kV HBM and IEC61000-4-2 Air-Gap discharge protection. RS-232 pins also have 8-kV IEC61000-4-2 contact discharge protection. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have shorted and open fail safe. The receiver can accept up to  $\pm 30$ -V inputs and decode inputs as low as  $\pm 3$  V. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. Outputs are protected against shorts to ground.

### 8.2 Functional Block Diagram



**Figure 8. Logic Diagram (Positive Logic)**

### 8.3 Feature Description

#### 8.3.1 Power

The power block increases and inverts the 5-V supply for the RS-232 driver using a charge pump that requires four 1- $\mu$ F external capacitors.

#### 8.3.2 RS-232 Driver

Two drivers interface standard logic level to RS-232 levels. Internal pullup resistors on DIN inputs ensures a high input when the line is high impedance.

#### 8.3.3 RS-232 Receiver

Two receivers interface RS-232 levels to standard logic levels. An open or shorted to ground input results in a high output on ROUT.

## 8.4 Device Functional Modes

### 8.4.1 $V_{CC}$ Powered by 5 V

The device is in normal operation.

### 8.4.2 $V_{CC}$ Unpowered

When MAX232E is unpowered, it can be safely connected to an active remote RS-232 device.

### 8.4.3 Truth Tables

[Table 1](#) and [Table 2](#) list the functions of this device.

**Table 1. Function Table for Each Driver<sup>(1)</sup>**

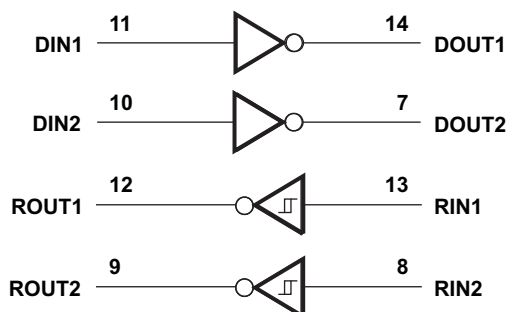
| INPUT<br>DIN | OUTPUT<br>DOUT |
|--------------|----------------|
| L            | H              |
| H            | L              |

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

**Table 2. Function Table for Each Receiver<sup>(1)</sup>**

| INPUT<br>RIN | OUTPUT<br>ROUT |
|--------------|----------------|
| L            | H              |
| H            | L              |
| Open         | H              |

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



**Figure 9. Logic Diagram (Positive Logic)**

## 9 Applications and Implementation

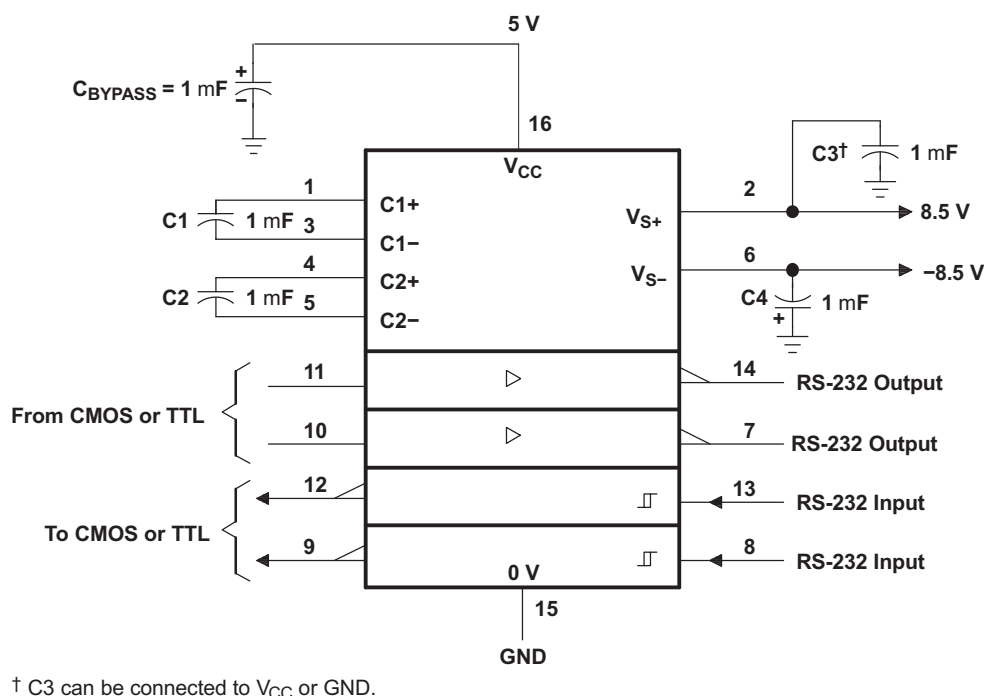
### NOTE

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. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

For proper operation add capacitors as shown in Figure 10. Pins 9 through 12 connect to UART or general purpose logic lines. RS-232 lines on pins 7, 8, 13, and 14 connect to a connector or cable.

### 9.2 Typical Application



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Resistor values shown are nominal.

Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

**Figure 10. Typical Operating Circuit**

#### 9.2.1 Design Requirements

- V<sub>CC</sub> minimum is 4.5 V and maximum is 5.5 V.
- Maximum recommended bit rate is 250 kbit/s.

#### 9.2.2 Detailed Design Procedure

The capacitor type used for C1–C4 is not critical for proper operation. The MAX232E requires 1-μF capacitors, although capacitors up to 10 μF can be used without harm. Ceramic dielectrics are suggested for capacitors. When using the minimum recommended capacitor values, make sure the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (for example, 2x) nominal value. The capacitors' effective series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V–.

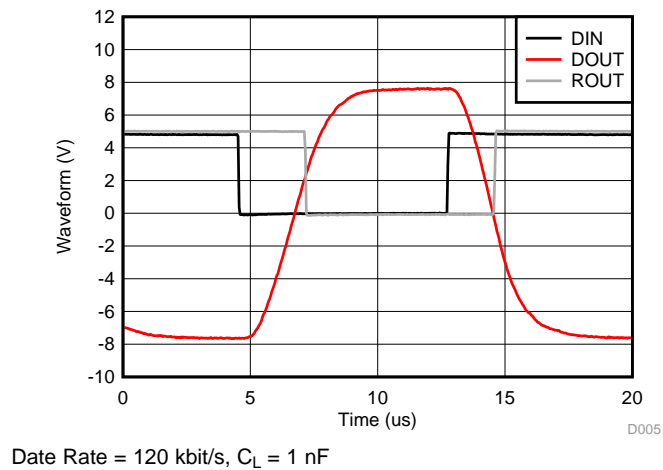
## Typical Application (continued)

Use larger capacitors (up to 10  $\mu\text{F}$ ) to reduce the output impedance at  $V_{S+}$  and  $V_{S-}$ .

Bypass  $V_{CC}$  to ground with at least 1  $\mu\text{F}$ . In applications sensitive to power-supply noise generated by the charge pumps, decouple  $V_{CC}$  to ground with a capacitor the same size as (or larger than) the charge-pump capacitors (C1–C4).

### 9.2.3 Application Curve

Loopback waveform connects DOUT to RIN.



**Figure 11. Loopback Waveforms**

## 10 Power Supply Recommendations

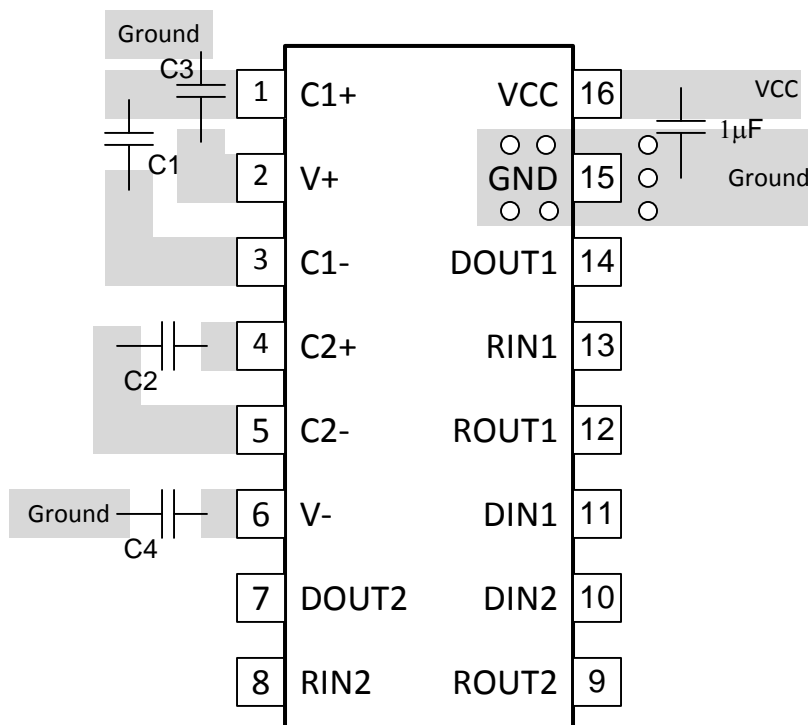
The  $V_{CC}$  voltage should be connected to the same power source used for logic device connected to DIN and ROUT pins.  $V_{CC}$  should be between 4.5 V and 5.5 V.

## 11 Layout

### 11.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times. Make the impedance from MAX232E ground pin and circuit board's ground plane as low as possible for best ESD performance. Use wide metal and multiple vias on both sides of ground pin.

### 11.2 Layout Example



**Figure 12. MAX232E Layout**

## 12 Device and Documentation Support

### 12.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* 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.

### 12.2 Community Resources

The following links connect to TI community resources. Linked contents are 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](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 12.3 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

### 12.4 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.

### 12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 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 Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| MAX232ECD        | ACTIVE        | SOIC         | D                  | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECDR       | ACTIVE        | SOIC         | D                  | 16   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECDW       | ACTIVE        | SOIC         | DW                 | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECDWR      | ACTIVE        | SOIC         | DW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU   CU SN       | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECDWRE4    | ACTIVE        | SOIC         | DW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECDWRG4    | ACTIVE        | SOIC         | DW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECN        | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | MAX232ECN               | <a href="#">Samples</a> |
| MAX232ECNE4      | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | MAX232ECN               | <a href="#">Samples</a> |
| MAX232ECPW       | ACTIVE        | TSSOP        | PW                 | 16   | 90             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECPWR      | ACTIVE        | TSSOP        | PW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU   CU SN       | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232ECPWRG4    | ACTIVE        | TSSOP        | PW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | MAX232EC                | <a href="#">Samples</a> |
| MAX232EID        | ACTIVE        | SOIC         | D                  | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |
| MAX232EIDR       | ACTIVE        | SOIC         | D                  | 16   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |
| MAX232EIDRG4     | ACTIVE        | SOIC         | D                  | 16   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |
| MAX232EIDW       | ACTIVE        | SOIC         | DW                 | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |
| MAX232EIDWG4     | ACTIVE        | SOIC         | DW                 | 16   | 40             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |
| MAX232EIDWR      | ACTIVE        | SOIC         | DW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MAX232EI                | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| MAX232EIN        | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | MAX232EIN               | <a href="#">Samples</a> |
| MAX232EINE4      | ACTIVE        | PDIP         | N                  | 16   | 25             | Pb-Free<br>(RoHS)          | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | MAX232EIN               | <a href="#">Samples</a> |
| MAX232EIPW       | ACTIVE        | TSSOP        | PW                 | 16   | 90             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MB232EI                 | <a href="#">Samples</a> |
| MAX232EIPWR      | ACTIVE        | TSSOP        | PW                 | 16   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | MB232EI                 | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

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**TAPE AND REEL INFORMATION**


\*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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| MAX232ECDR    | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| MAX232ECDWR   | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 16.0   | Q1            |
| MAX232ECDWRG4 | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 16.0   | Q1            |
| MAX232ECPWR   | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| MAX232ECPWR   | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| MAX232ECPWRG4 | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| MAX232EIDR    | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| MAX232EIDWR   | SOIC         | DW              | 16   | 2000 | 330.0              | 16.4               | 10.75   | 10.7    | 2.7     | 12.0    | 16.0   | Q1            |
| MAX232EIPWR   | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| MAX232ECDR    | SOIC         | D               | 16   | 2500 | 367.0       | 367.0      | 38.0        |
| MAX232ECDWR   | SOIC         | DW              | 16   | 2000 | 367.0       | 367.0      | 38.0        |
| MAX232ECDWRG4 | SOIC         | DW              | 16   | 2000 | 367.0       | 367.0      | 38.0        |
| MAX232ECPWR   | TSSOP        | PW              | 16   | 2000 | 364.0       | 364.0      | 27.0        |
| MAX232ECPWR   | TSSOP        | PW              | 16   | 2000 | 367.0       | 367.0      | 35.0        |
| MAX232ECPWRG4 | TSSOP        | PW              | 16   | 2000 | 367.0       | 367.0      | 35.0        |
| MAX232EIDR    | SOIC         | D               | 16   | 2500 | 367.0       | 367.0      | 38.0        |
| MAX232EIDWR   | SOIC         | DW              | 16   | 2000 | 367.0       | 367.0      | 38.0        |
| MAX232EIPWR   | TSSOP        | PW              | 16   | 2000 | 367.0       | 367.0      | 35.0        |

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.
  - $\triangle C$  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.
  - $\triangle D$  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.

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE

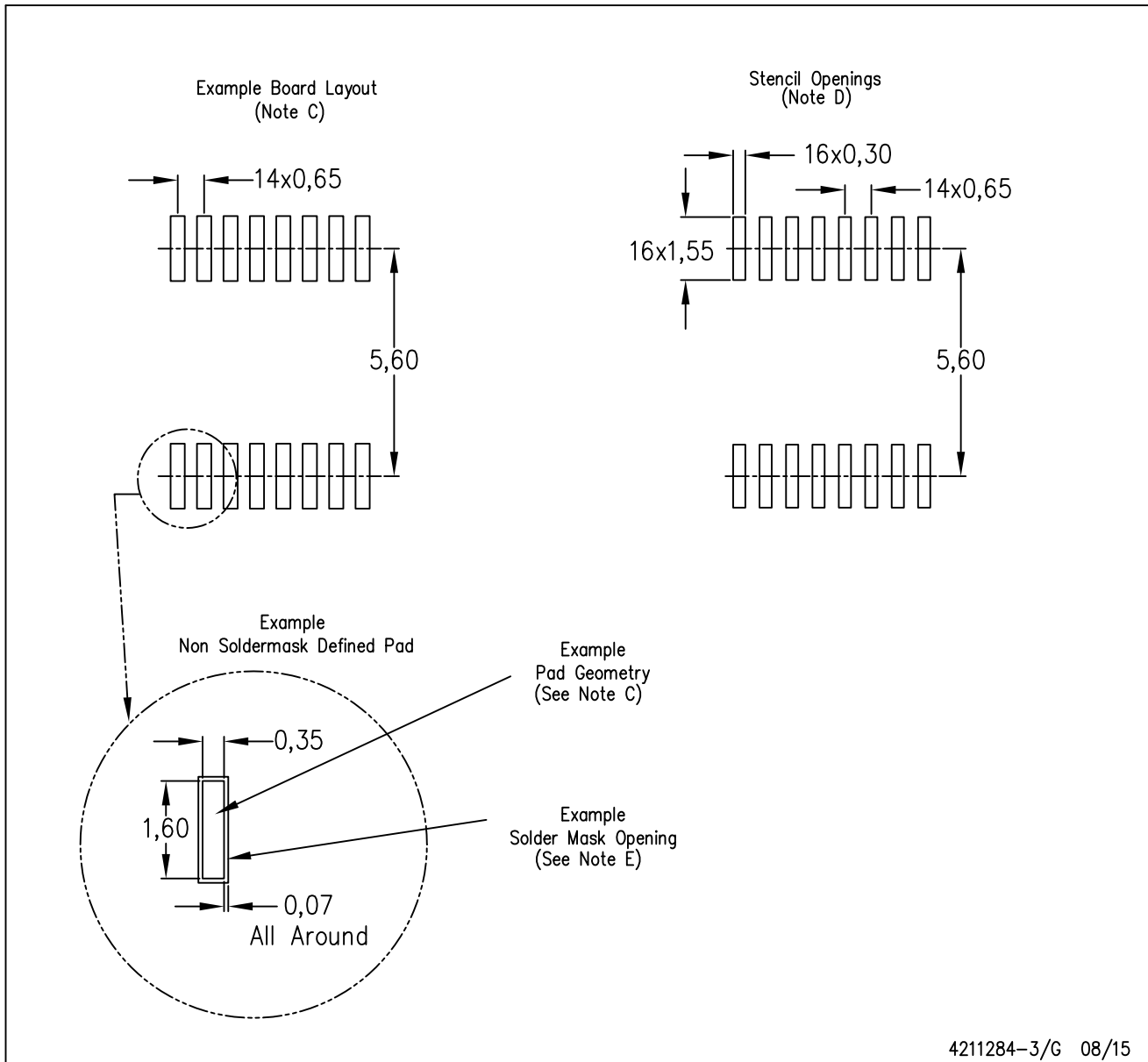


4040064-4/G 02/11

- 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

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



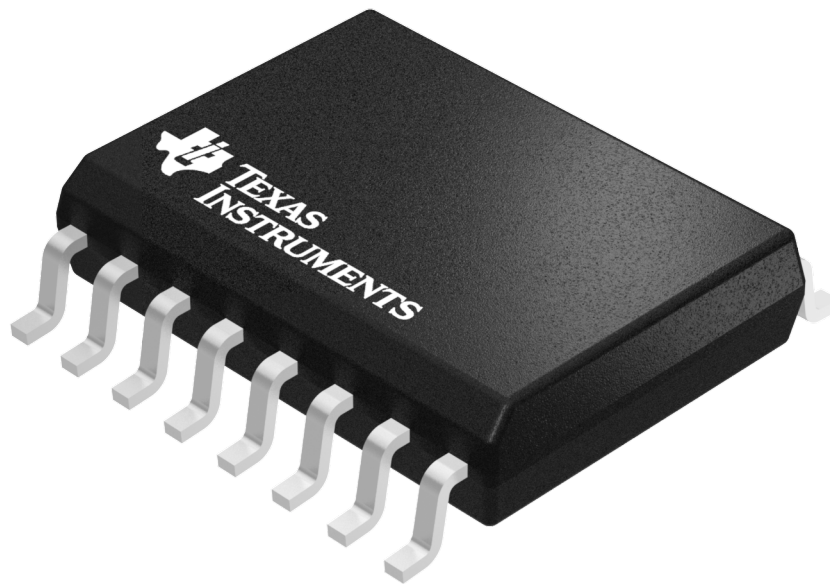
- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

**DW 16**

**GENERIC PACKAGE VIEW**

**SOIC - 2.65 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



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

4040000-2/H



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.

N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **<br>DIM      | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |



4040049/E 12/2002

NOTES:

- A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

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