The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

The MAX232 is characterized for operation from 0°C to 70°C. The MAX232I is characterized for operation from −40°C to 85°C.

**Description**

- Operates with single 5-V Power Supply
- LinBiCMOS™ Process Technology
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current...8 mA Typical
- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Designed to be Interchangeable With Maxim MAX232
- Applications
  - TIA/EIA-232-F
  - Battery-Powered Systems
  - Terminals
  - Modems
  - Computers
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015
- Package Options Include Plastic Small-Outline (D, DW) Packages and Standard Plastic (N) DIPs

**Available Options**

<table>
<thead>
<tr>
<th>TA</th>
<th>SMALL OUTLINE (D)</th>
<th>SMALL OUTLINE (DW)</th>
<th>PLASTIC DIP (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to 70°C</td>
<td>MAX232D ‡</td>
<td>MAX232DW ‡</td>
<td>MAX232N</td>
</tr>
<tr>
<td>−40°C to 85°C</td>
<td>MAX232ID ‡</td>
<td>MAX232IDW ‡</td>
<td>MAX232IN</td>
</tr>
</tbody>
</table>

‡ This device is available taped and reeled by adding an R to the part number (i.e., MAX232DR).
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

- Input supply voltage range, \( V_{CC} \) (see Note 1): \(-0.3 \text{ V to } 6 \text{ V}\)
- Positive output supply voltage range, \( V_{S+} \): \(-0.3 \text{ V to } 15 \text{ V}\)
- Negative output supply voltage range, \( V_{S–} \): \(-15 \text{ V}\)
- Input voltage range, \( V_i \): Driver: \(-0.3 \text{ V to } V_{CC} + 0.3 \text{ V}\)
- Receiver: \(\pm 30 \text{ V}\)
- Output voltage range, \( V_O \): \(T_{1OUT}, T_{2OUT} \): \(-0.3 \text{ V to } V_{S+} + 0.3 \text{ V}\)
- \(R_{1OUT}, R_{2OUT} \): \(-0.3 \text{ V to } V_{CC} + 0.3 \text{ V}\)
- Short-circuit duration: \(T_{1OUT}, T_{2OUT}\): Unlimited
- Package thermal impedance, \(\theta_{JA}\) (see Note 2): D package: 113°C/W
  DW package: 105°C/W
  N package: 78°C/W
- Storage temperature range, \(T_{stg}\): \(-65\degree \text{C to } 150\degree \text{C}\)
- Lead temperature, 1.6 mm (1/16 inch) from case for 10 seconds: 260°C

† 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.

NOTE 1: All voltage values are with respect to network ground terminal.

The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

recommended operating conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, ( V_{CC} )</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>High-level input voltage, ( V_{IH} ) (( T_{1IN}, T_{2IN} ))</td>
<td>2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Low-level input voltage, ( V_{IL} ) (( T_{1IN}, T_{2IN} ))</td>
<td></td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Receiver input voltage, ( R_{1IN}, R_{2IN} )</td>
<td></td>
<td>(\pm 30 )</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating free-air temperature, ( T_A )</td>
<td>Maximum 232</td>
<td>0</td>
<td>70</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Maximum 232I</td>
<td>-40</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>
### Electrical Characteristics

#### DUAL EIA-232 DRIVER/RECEIVER

**MAX232, MAX232I**


**POST OFFICE BOX 655303 • DALLAS, TEXAS 75265**

**POST OFFICE BOX 655303 • DALLAS, TEXAS 75265**

#### MAX232, MAX232I

**POST OFFICE BOX 655303 • DALLAS, TEXAS 75265**

**POST OFFICE BOX 655303 • DALLAS, TEXAS 75265**

---------------

**MIN** | **TYP†** | **MAX**
---|---|---

**VOH** | High-level output voltage | T1OUT, T2OUT | \( R_L = 3 \, k\Omega \) to GND | 5 | 7 | V

**VOL** | Low-level output voltage‡ | T1OUT, T2OUT | \( R_L = 3 \, k\Omega \) to GND | –7 | –5 | V

**VT+** | Receiver positive-going input threshold voltage | R1IN, R2IN | \( V_{CC} = 5 \, V, \quad T_A = 25°C \) | 1.7 | 2.4 | V

**VT–** | Receiver negative-going input threshold voltage | R1IN, R2IN | \( V_{CC} = 5 \, V, \quad T_A = 25°C \) | 0.8 | 1.2 | V

**Vhys** | Input hysteresis voltage | R1IN, R2IN | \( V_{CC} = 5 \, V \) | 0.2 | 0.5 | 1 | V

**RI** | Receiver input resistance | R1IN, R2IN | \( V_{CC} = 5 \, V, \quad T_A = 25°C \) | 3 | 5 | 7 | k\Omega

**RO** | Output resistance | T1OUT, T2OUT | \( V_{S+} = V_{S–} = 0, \quad V_O = \pm 2 \, V \) | 300 | | \( \Omega \)

**IOS§** | Short-circuit output current | T1OUT, T2OUT | \( V_{CC} = 5.5 \, V, \quad V_O = 0 \) | ±10 | | mA

**IDS** | Short-circuit input current | T1IN, T2IN | \( V_I = 0 \) | 200 | | \( \mu A \)

**ICC** | Supply current | \( V_{CC} = 5.5 \, V, \quad T_A = 25°C \) All outputs open | 8 | 10 | mA

† All typical values are at \( V_{CC} = 5 \, V, \quad T_A = 25°C \).

‡ 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.

§ Not more than one output should be shorted at a time.

#### Switching Characteristics, \( V_{CC} = 5 \, V, \quad T_A = 25°C \)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
</table>

**tPLH(R)** | Receiver propagation delay time, low- to high-level output | See Figure 1 | 500 | ns

**tPHL(R)** | Receiver propagation delay time, high- to low-level output | See Figure 1 | 500 | ns

**SR** | Driver slew rate | \( R_L = 3 \, k\Omega \) to 7 \( k\Omega \), See Figure 2 | 30 | | \( \text{V/\mu s} \)

**SR(tr)** | Driver transition region slew rate | See Figure 3 | 3 | | \( \text{V/\mu s} \)
PARAMETER MEASUREMENT INFORMATION

**TEST CIRCUIT**

- **Input**: 0 V, 1.5 V, 50%, 90%
- **Output**: 0 V, 1.5 V, 10%
- **Waveforms**: 500 ns, t_{PHL}, t_{PLH}

**NOTES:**

A. The pulse generator has the following characteristics: Z_{O} = 50 Ω, duty cycle ≤ 50%.
B. C_{L} includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.

Figure 1. Receiver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements
PARAMETER MEASUREMENT INFORMATION

Pulse Generator (see Note A)

T1IN or T2IN

T1OUT or T2OUT

RL

EIA-232 Output

C_L = 10 pF (see Note B)

TEST CIRCUIT

≤ 10 ns

≤ 10 ns

3 V

0 V

Input

Output

t_PHL

t_TLH

V_OH

V_ON

WAVEFORMS

SR = \frac{0.8 (V_{OH} - V_{OL})}{t_{TLH}} \quad \text{or} \quad \frac{0.8 (V_{OL} - V_{OH})}{t_{THL}}

NOTES:

A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

B. C_L includes probe and jig capacitance.

Figure 2. Driver Test Circuit and Waveforms for t_PHL and t_TLH Measurements (5-µs input)

Pulse Generator (see Note A)

3 kΩ

EIA-232 Output

C_L = 2.5 nF

TEST CIRCUIT

Input

Output

3 V

-3 V

3 V

-3 V

t_THL

t_TLH

1.5 V

1.5 V

10% 90%

10% 90%

≤ 10 ns

≤ 10 ns

WAVEFORMS

SR = \frac{6 V}{t_{THL} \text{ or } t_{TLH}}

NOTE A: The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

Figure 3. Test Circuit and Waveforms for t_THL and t_TLH Measurements (20-µs input)
Figure 4. Typical Operating Circuit
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