**MAX232, MAX232I**

**DUAL EIA-232 DRIVER/RECEIVER**


- 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

**description**

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.

**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).

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input supply voltage range, \( V_{CC} \) (see Note 1) .................................................. \(-0.3\) V to \(6\) V
Positive output supply voltage range, \( V_{S+} \) .................................................. \(-0.3\) V to \(15\) V
Negative output supply voltage range, \( V_{S-} \) .................................................. \(0\) V to \(-15\) V
Input voltage range, \( V_i \): Driver .................................................. \(-0.3\) V to \( V_{CC} + 0.3\) V
Receiver .................................................. \(±30\) V
Output voltage range, \( V_o \): T1OUT, T2OUT .................................................. \( V_{S-} -0.3\) V to \( V_{S+} + 0.3\) V
R1OUT, R2OUT .................................................. \(-0.3\) V to \( V_{CC} + 0.3\) V
Short-circuit duration: T1OUT, T2OUT .................................................. 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, \( T_{stg} \) .................................................. \(-65\)°C to \(150\)°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.

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

recommended operating conditions

<table>
<thead>
<tr>
<th></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} ) (T1IN,T2IN)</td>
<td>2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Low-level input voltage, ( V_{IL} ) (T1IN, T2IN)</td>
<td></td>
<td>0.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Receiver input voltage, ( R1IN, R2IN )</td>
<td>±30</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Operating free-air temperature, ( T_{A} )</td>
<td>MAX232</td>
<td>0</td>
<td>70</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>MAX232I</td>
<td>-40</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>
### Electrical Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ†</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{OH} )</td>
<td>High-level output voltage</td>
<td>T1OUT, T2OUT</td>
<td>( R_L = 3 , \text{k} \Omega ) to GND</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1OUT, R2OUT</td>
<td>( IOH = -1 , \text{mA} )</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>( V_{OL} )</td>
<td>Low-level output voltage‡</td>
<td>T1OUT, T2OUT</td>
<td>( R_L = 3 , \text{k} \Omega ) to GND</td>
<td>–7</td>
<td>–5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1OUT, R2OUT</td>
<td>( IOH = -3.2 , \text{mA} )</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>( V_{IT^+} )</td>
<td>Receiver positive-going input threshold voltage</td>
<td>R1IN, R2IN</td>
<td>( V_{CC} = 5 , \text{V}, , T_A = 25^\circ \text{C} )</td>
<td>1.7</td>
<td>2.4</td>
</tr>
<tr>
<td>( V_{IT^-} )</td>
<td>Receiver negative-going input threshold voltage</td>
<td>R1IN, R2IN</td>
<td>( V_{CC} = 5 , \text{V}, , T_A = 25^\circ \text{C} )</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>( V_{HYS} )</td>
<td>Input hysteresis voltage</td>
<td>R1IN, R2IN</td>
<td>( V_{CC} = 5 , \text{V} )</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>( r_i )</td>
<td>Receiver input resistance</td>
<td>R1IN, R2IN</td>
<td>( V_{CC} = 5 , \text{V}, , T_{A} = 25^\circ \text{C} )</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>( r_o )</td>
<td>Output resistance</td>
<td>T1OUT, T2OUT</td>
<td>( V_{S^+} = V_{S^-} = 0, , V_O = \pm 2 , \text{V} )</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>( I_{O\text{S}} )§</td>
<td>Short-circuit output current</td>
<td>T1OUT, T2OUT</td>
<td>( V_{CC} = 5.5 , \text{V}, , V_O = 0 )</td>
<td>±10</td>
<td></td>
</tr>
<tr>
<td>( I_{IS} )</td>
<td>Short-circuit input current</td>
<td>T1IN, T2IN</td>
<td>( V_I = 0 )</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Supply current</td>
<td>( V_{CC} = 5.5 , \text{V}, , T_{A} = 25^\circ \text{C} ) All outputs open</td>
<td>8</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

† All typical values are at \( V_{CC} = 5 \, \text{V}, \, T_{A} = 25^\circ \text{C} \).
‡ 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, \( V_{CC} = 5 \, \text{V}, \, T_{A} = 25^\circ \text{C} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{PLH(R)} )</td>
<td>Receiver propagation delay time, low- to high-level output</td>
<td>See Figure 1</td>
<td>500</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PHL(R)} )</td>
<td>Receiver propagation delay time, high- to low-level output</td>
<td>See Figure 1</td>
<td>500</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>( SR )</td>
<td>Driver slew rate</td>
<td>( R_L = 3 , \text{k} \Omega ) to 7 kΩ, See Figure 2</td>
<td>30</td>
<td></td>
<td>V/μs</td>
</tr>
<tr>
<td>( SR(tr) )</td>
<td>Driver transition region slew rate</td>
<td>See Figure 3</td>
<td>3</td>
<td></td>
<td>V/μs</td>
</tr>
</tbody>
</table>
PARAMETER MEASUREMENT INFORMATION

TEST CIRCUIT

WAVEFORMS

NOTES:  
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 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

EIA-232 Output

RL

CL = 10 pF
(see Note B)

TEST CIRCUIT

Input

≤ 10 ns

≤ 10 ns

3 V

0 V

Output

tPHL

tPLH

VOL

VOH

tTLH

tTHL

WAVEFORMS

SR = 0.8 (VOL - VOH)

or

0.8 (VOH - VOL)

tTLH

tTHL

NOTES:  
A. The pulse generator has the following characteristics: \( Z_O = 50 \, \Omega \), duty cycle \( \leq 50\% \).
B. \( CL \) includes probe and jig capacitance.

Figure 2. Driver Test Circuit and Waveforms for \( t_{PHL} \) and \( t_{PLH} \) Measurements (5-\( \mu s \) input)

Pulse Generator (see Note A)

3 k\( \Omega \)

EIA-232 Output

CL = 2.5 nF

TEST CIRCUIT

Input

≤ 10 ns

≤ 10 ns

1.5 V

1.5 V

Output

3 V

3 V

-3 V

-3 V

VOL

VOH

tTHL

tTLH

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

WAVEFORMS

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

Figure 3. Test Circuit and Waveforms for \( t_{THL} \) and \( t_{TLH} \) Measurements (20-\( \mu s \) input)
Figure 4. Typical Operating Circuit
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