

EVALUATION KIT  
AVAILABLE

# MAXIM

## +3V-Powered, Low-Power, True RS-232 Transceiver

MAX212

### General Description

The MAX212 RS-232 transceiver is intended for 3V-powered EIA/TIA-232E and V.28/V.24 communication interfaces where 3 drivers and 5 receivers are needed with minimum power consumption. The operating voltage range extends from 3.6V down to 3.0V while still maintaining true RS-232 and EIA/TIA-562 voltage levels.

A 1 $\mu$ A typical shutdown mode reduces power consumption, extending battery life in portable systems. While shut down, all receivers can remain active or can be disabled under logic control. This enables a system incorporating the CMOS MAX212 to be in low-power shutdown mode and monitor incoming RS-232 activity.

A guaranteed data rate of 120kbps provides compatibility with popular software for communicating with personal computers.

Three-state drivers on all receiver outputs are provided so that multiple receivers, generally of different interface standards, can be wire-ORed at the UART.

The MAX212 is available in both small-outline (SO) and shrink-small-outline (SSOP) packages. The SSOP package occupies less than half of the board area required by the equivalent SO package.

### Applications

Computers  
Notebooks/Palmtops/Subnotebooks  
Printers  
Peripherals  
Instruments

### Ordering Information

| PART      | TEMP. RANGE    | PIN-PACKAGE |
|-----------|----------------|-------------|
| MAX212CWG | 0°C to +70°C   | 24 Wide SO  |
| MAX212CAG | 0°C to +70°C   | 24 SSOP     |
| MAX212C/D | 0°C to +70°C   | Dice*       |
| MAX212EWG | -40°C to +85°C | 24 Wide SO  |
| MAX212EAG | -40°C to +85°C | 24 SSOP     |

\* Dice are tested at  $T_A = +25^\circ\text{C}$  only.

| EV KIT           | TEMP. RANGE  | BOARD TYPE    |
|------------------|--------------|---------------|
| MAX212EVKIT-SSOP | 0°C to +70°C | Surface Mount |

™LapLink is a registered trademark of Traveling Software.

MAXIM

Maxim Integrated Products 2-57

Call toll free 1-800-998-8800 for free samples or literature.

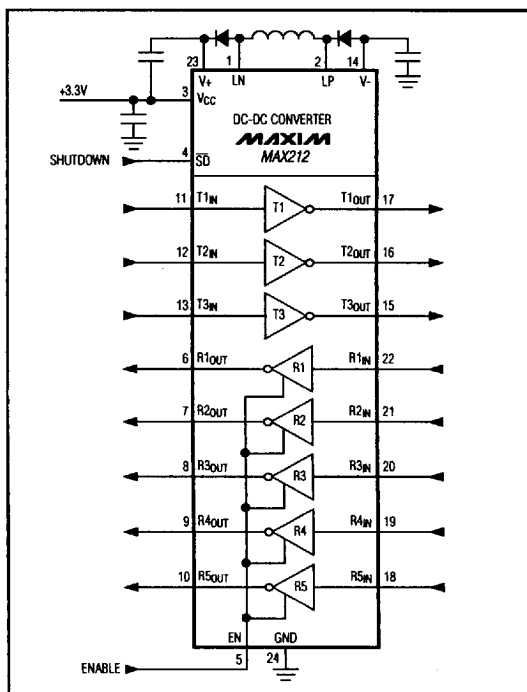
5876651 0009345 732

### Features

#### SUPERIOR TO BIPOLAR:

- ◆ Operates from Single +3.0V to +3.6V Supply
- ◆ 24-Pin SSOP or Wide SO Packages
- ◆ Meets All EIA/TIA-232E & EIA/TIA-562 Specifications
- ◆ 3mA Max Supply Current (Unloaded)
- ◆ 1 $\mu$ A Low-Power Shutdown Mode
- ◆ All Receivers Active During Low-Power Shutdown
- ◆ Mouse Compatible at 3.0V
- ◆ Low-Cost, Surface-Mount External Components
- ◆ 120kbps Guaranteed Data Rate—LapLink™ Compatible
- ◆ Three-State Receiver Outputs
- ◆ Evaluation Kit Available
- ◆ Flow-Through Pinout

### Typical Operating Circuit



# +3V-Powered, Low-Power, True RS-232 Transceiver

## ABSOLUTE MAXIMUM RATINGS

### Supply Voltages

|                       |                                                    |
|-----------------------|----------------------------------------------------|
| V <sub>CC</sub> ..... | -0.3V to +4.6V                                     |
| V <sub>+</sub> .....  | (V <sub>CC</sub> - 0.3V) to +7.4V                  |
| V <sub>-</sub> .....  | -7.4V to +2.0V                                     |
| LN.....               | -0.3V to (V <sub>+</sub> + 1.0V)                   |
| LP.....               | (V <sub>-</sub> - 1.0V) to (V <sub>+</sub> + 0.3V) |

### Input Voltages

|                                             |                                  |
|---------------------------------------------|----------------------------------|
| T <sub>IN</sub> , $\overline{SD}$ , EN..... | -0.3V to (V <sub>+</sub> + 0.3V) |
| R <sub>IN</sub> .....                       | ±25V                             |

### Output Voltages

|                                                       |                                  |
|-------------------------------------------------------|----------------------------------|
| T <sub>OUT</sub> .....                                | ±15V                             |
| R <sub>OUT</sub> .....                                | -0.3V to (V <sub>+</sub> + 0.3V) |
| Short-Circuit Duration, T <sub>OUT</sub> .....        | Continuous                       |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C) |                                  |
| Wide SO (derate 11.76mW/°C above +70°C).....          | .941mW                           |
| SSOP (derate 8.00mW/°C above +70°C).....              | .640mW                           |
| Lead Temperature (soldering, 10sec).....              | +300°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = 3.0V to 3.6V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                                                    | CONDITIONS                                                                             | MIN                   | TYP                 | MAX  | UNITS |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------|---------------------|------|-------|
| <b>DC CHARACTERISTICS</b>                                    |                                                                                        |                       |                     |      |       |
| Operating Voltage Range                                      | Meets or exceeds EIA/TIA-232E specifications                                           | 3.0                   |                     | 3.6  | V     |
| V <sub>CC</sub> Supply Current                               | No load, V <sub>CC</sub> = 3.3V                                                        |                       | 1.5                 | 3.0  | mA    |
| Shutdown Supply Current                                      | $\overline{SD}$ = EN = GND, R <sub>IN</sub> = GND or V <sub>CC</sub>                   |                       | 1                   | 15   | μA    |
| Shutdown Supply Current with Receivers Active                | $\overline{SD}$ = GND, EN = V <sub>CC</sub> , R <sub>IN</sub> = GND or V <sub>CC</sub> |                       | 1                   | 15   | μA    |
| <b>LOGIC</b>                                                 |                                                                                        |                       |                     |      |       |
| Input Logic Threshold Low                                    | T <sub>IN</sub> , EN, $\overline{SD}$ ; V <sub>CC</sub> = 3.0V to 3.6V                 |                       | V <sub>CC</sub> / 3 |      | V     |
| Input Logic Threshold High                                   | T <sub>IN</sub> , EN, $\overline{SD}$ ; V <sub>CC</sub> = 3.0V to 3.6V                 | 2V <sub>CC</sub> / 3  |                     |      | V     |
| Input Current High                                           | T <sub>IN</sub> , EN, $\overline{SD}$ ; V <sub>IN</sub> = V <sub>CC</sub>              |                       |                     | 1    | μA    |
| Input Current Low                                            | T <sub>IN</sub> , EN, $\overline{SD}$ ; V <sub>IN</sub> = GND                          |                       |                     | 1    | μA    |
| Hysteresis                                                   | T <sub>IN</sub> ; V <sub>CC</sub> = 3.3V                                               |                       | 0.3                 |      | V     |
| Logic Output Voltage Low                                     | I <sub>OUT</sub> = 1.0mA                                                               |                       |                     | 0.25 | V     |
| Logic Output Voltage High                                    | I <sub>OUT</sub> = -1.0mA                                                              | V <sub>CC</sub> - 0.5 |                     |      | V     |
| Logic Output Leakage Current                                 | EN = GND, 0V < R <sub>OUT</sub> < V <sub>CC</sub>                                      |                       |                     | ±10  | μA    |
| <b>EIA/TIA-232E RECEIVERS</b>                                |                                                                                        |                       |                     |      |       |
| EIA/TIA-232E Input Voltage Operating Range                   |                                                                                        | -25                   |                     | +25  | V     |
| EIA/TIA-232E Input Voltage Threshold Low                     |                                                                                        | 0.4                   |                     |      | V     |
| EIA/TIA-232E Input Voltage Threshold High                    |                                                                                        |                       |                     | 2.8  | V     |
| EIA/TIA-232E Input Hysteresis                                |                                                                                        |                       | 0.7                 |      | V     |
| EIA/TIA-232E Input Resistance                                | -15V < V <sub>IN</sub> < 15V                                                           | 3                     | 5                   | 7    | kΩ    |
| <b>EIA/TIA-232E TRANSMITTERS</b>                             |                                                                                        |                       |                     |      |       |
| Output Voltage Swing (V <sub>HIGH</sub> , V <sub>LOW</sub> ) | All transmitters loaded 3kΩ to GND                                                     | ±5.0                  | ±5.5                |      | V     |
| Output Resistance                                            | V <sub>CC</sub> = V <sub>-</sub> = V <sub>+</sub> = 0V, -2V < T <sub>OUT</sub> < 2V    | 300                   |                     |      | Ω     |
| EIA/TIA-232E Short-Circuit Current                           |                                                                                        |                       | 28                  | 100  | mA    |

# +3V-Powered, Low-Power, True RS-232 Transceiver

MAX212

## TIMING CHARACTERISTICS

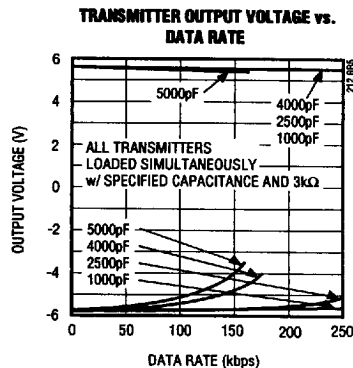
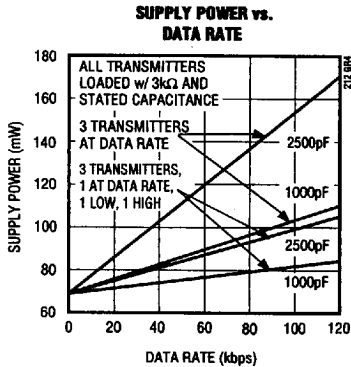
( $V_{CC} = 3.0V$  to  $3.6V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

| PARAMETER                       | SYMBOL     | CONDITIONS                                                                                                    | MIN | TYP | MAX  | UNITS      |
|---------------------------------|------------|---------------------------------------------------------------------------------------------------------------|-----|-----|------|------------|
| Data Rate                       |            | 1000pF    3k $\Omega$ load on each transmitter,<br>150pF load on each receiver                                | 120 | 250 |      | kbps       |
| Receiver Output Enable Time     | $t_{ER}$   |                                                                                                               |     | 70  | 200  | ns         |
| Receiver Output Disable Time    | $t_{DR}$   |                                                                                                               |     | 420 | 700  | ns         |
| Transmitter Output Enable Time  | $t_{ET}$   | Includes power-supply start-up                                                                                |     | 250 |      | $\mu s$    |
| Transmitter Output Disable Time | $t_{DT}$   |                                                                                                               |     | 600 |      | ns         |
| Receiver Propagation Delay      | $t_{PHLR}$ | 150pF load                                                                                                    |     | 300 | 700  | ns         |
|                                 | $t_{PLHR}$ |                                                                                                               |     | 300 | 700  |            |
| Transmitter Propagation Delay   | $t_{PHLT}$ | 2500pF    3k $\Omega$ load                                                                                    |     | 800 | 2000 | ns         |
|                                 | $t_{PLHT}$ |                                                                                                               |     | 800 | 2000 |            |
| Transition-Region Slew Rate     |            | $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 50pF$ to $2500pF$ ,<br>measured from $+3V$ to $-3V$ or $-3V$ to $+3V$ | 4.0 | 10  | 30   | V/ $\mu s$ |

2

## Typical Operating Characteristics

( $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



MAXIM

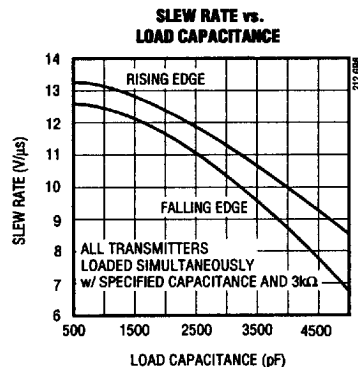
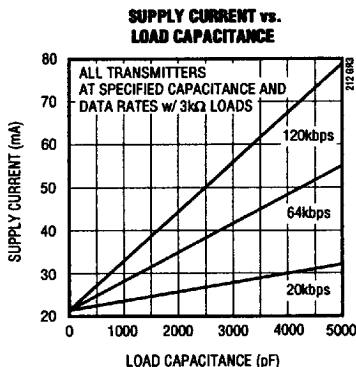
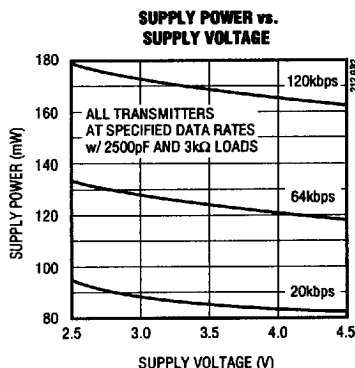
2-59

5876651 0009347 505

# **+3V-Powered, Low-Power, True RS-232 Transceiver**

## **Typical Operating Characteristics (continued)**

( $V_{CC} = 3.3V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



## **Pin Description**

| PIN   | NAME            | FUNCTION                                                                                                                                                                                    |
|-------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | LN              | Inductor/Diode Connection Point                                                                                                                                                             |
| 2     | LP              | Inductor/Diode Connection Point                                                                                                                                                             |
| 3     | V <sub>CC</sub> | Supply Voltage Input, 3.0V to 3.6V                                                                                                                                                          |
| 4     | $\overline{SD}$ | Shutdown Control. Connect to V <sub>CC</sub> for normal operation. Connect to GND to shut down the power supply and to disable the drivers. Receiver status is not changed by this control. |
| 5     | EN              | Receiver Enable Control. Connect to V <sub>CC</sub> for normal operation. Connect to GND to force the receiver outputs into a high-Z state.                                                 |
| 6-10  | R1OUT-R5OUT     | Receiver Outputs, swing GND to V <sub>CC</sub>                                                                                                                                              |
| 11-13 | T1IN-T3IN       | Transmitter Inputs                                                                                                                                                                          |
| 14    | V-              | Negative Supply generated on-board                                                                                                                                                          |
| 15-17 | T3OUT-T1OUT     | Transmitter Outputs                                                                                                                                                                         |
| 18-22 | R5IN-R1IN       | Receiver Inputs                                                                                                                                                                             |
| 23    | V+              | Positive Supply generated on-board                                                                                                                                                          |
| 24    | GND             | Ground                                                                                                                                                                                      |

## **Detailed Description**

The MAX212 line driver/receiver is intended for 3V-powered EIA/TIA-232E and V.28/V.24 communications interfaces where 3 drivers and 5 receivers are required. The operating voltage range extends from 3.6V down to 3.0V while still maintaining true RS-232 and EIA/TIA-562 transmitter output voltage levels.

The circuit comprises three sections: power supply, transmitters, and receivers. The power-supply section converts the supplied 3V to about  $\pm 6.5V$ , to provide the voltages necessary for the drivers to meet true RS-232 levels. External components are small and inexpensive.

The transmitters and receivers are guaranteed to operate at data rates of 120kbps.

A shutdown mode reduces current to 1 $\mu A$  to extend battery life in portable systems. While shut down, all receivers can remain active or can be disabled under logic control. This enables a system incorporating the MAX212 to be in low-power shutdown mode and still monitor incoming RS-232 activity.

Three-state drivers on all receiver outputs are provided so that multiple receivers, generally of different interface standards, can be wire-ORed at the UART.

# +3V-Powered, Low-Power, True RS-232 Transceiver

MAX212

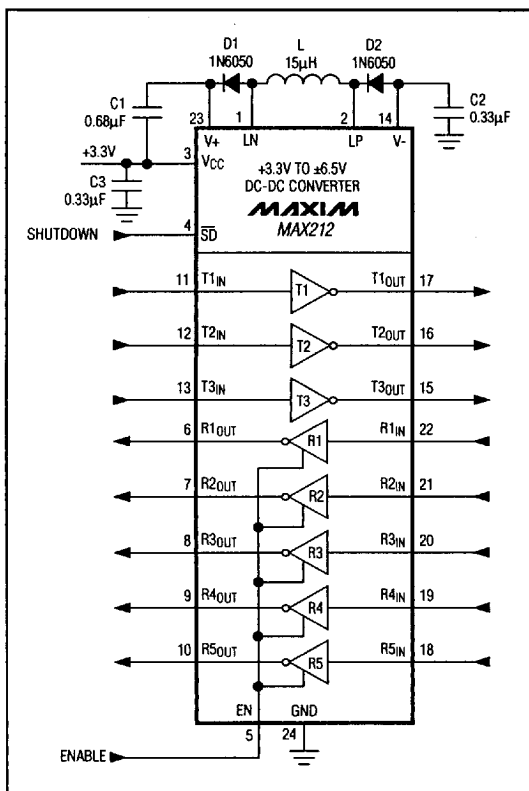


Figure 1. Typical Application Circuit

## Switch-Mode Power Supply

The switch-mode power supply uses a single inductor with two inexpensive diodes and two capacitors to generate  $\pm 6.5\text{V}$  from the 3.0V to 3.6V input. Figure 1 shows the complete circuit for the power supply.

Use a 15µH inductor with a saturation current rating of at least 350mA and under 1Ω resistance. Sample surface-mount inductors are available from Maxim. Use 1N6050 diodes or equivalent. Surface-mount equivalents for the 1N6050 include the Motorola MMBD6050LT1, Philips PMBD6050, and Allegro (formerly Sprague) TMPD6050LT.

For C1 and C2, use ceramic capacitors with values no less than indicated in Figure 1. These capacitors determine the ripple on V+ and V-, but not the absolute voltages. Bypass VCC to GND with at least 0.33µF close to the MAX212. Increase this to 4.7µF if there are no other VCC supply bypass components less than 6 inches (15cm) away from the MAX212.

Component suppliers are listed in Table 1.

## RS-232 Drivers

All three drivers are identical and deliver EIA/TIA-232E and EIA/TIA-562 output voltage levels when VCC is between 3.0V and 3.6V. Disable the drivers by taking the SD pin to GND. The transmitter outputs are forced into a high-impedance state when SD is grounded.

## RS-232 Receivers

All five receivers are identical and accept EIA/TIA-232E and EIA/TIA-562 input signals. The CMOS receiver outputs swing rail-to-rail (0V to VCC). When EN is high, the receivers are active regardless of SD's status. When EN is low, the receivers' outputs are put into a high-impedance state. This allows two RS-232 ports (or two parts of different types) to be wire-ORed at the UART.

Table 1. Suggested Component Suppliers

| MANUFACTURER | PART NUMBER     | PHONE NUMBER                               | FAX NUMBER                                 |
|--------------|-----------------|--------------------------------------------|--------------------------------------------|
| Allegro      | TMPD6050LT      | USA (508) 853-5000                         | USA (508) 853-5049                         |
| Motorola     | MMBD6050LT1     | USA (408) 749-0510                         | USA (408) 991-7420                         |
| Murata       | LQH4N150K-TA    | USA (404) 831-9172<br>Japan (075) 951-9111 | USA (404) 436-3030<br>Japan (075) 955-6526 |
| Philips      | PMBD6050        | USA (401) 762-3800                         | USA (401) 767-4493                         |
| Sumida       | CD43150         | USA (708) 956-0666<br>Japan (03) 3607-5111 | USA (708) 956-0702<br>Japan (03) 3607-5428 |
| TDK          | NLC453232T-150K | USA (708) 803-6100<br>Japan (03) 3278-5111 | USA (708) 803-6296<br>Japan (03) 3278-5358 |

MAXIM

2-61

5876651 0009349 388

# +3V-Powered, Low-Power, True RS-232 Transceiver

## Operating Modes

$\overline{SD}$  and EN determine the operation of the MAX212 as follows:

| $\overline{SD}$ | EN | RECEIVER OUTPUTS | DRIVER OUTPUTS | DC-DC CONVERTER | SUPPLY CURRENT |
|-----------------|----|------------------|----------------|-----------------|----------------|
| L               | L  | High-Z           | High-Z         | Off             | Minimum        |
| L               | H  | Enabled          | High-Z         | Off             | Minimum        |
| H               | L  | High-Z           | Enabled        | On              | Normal         |
| H               | H  | Enabled          | Enabled        | On              | Normal         |

## Shutdown

V+ and V- are disabled and the transmitters are put into a high-impedance state when  $\overline{SD}$  is taken to logic low. Receiver operation is not affected, but power consumption is dramatically reduced while in shutdown mode. Supply current is minimized when the receiver inputs are static in any of three states: floating (ground), less than GND, or greater than VCC. This will be true for all static RS-232 conditions. The presence of AC signals on receiver inputs will increase VCC current in shutdown.

From a low-power system perspective, powering-up with non-critical or unused sections of circuitry shut down or deselected is generally recommended. Activating these sections only when required saves power and reduces power-up current surges. Powering-up the MAX212 in shutdown mode (holding the shutdown pin,  $\overline{SD}$ , low until VCC > 2.7V), helps to achieve this.

## Driving the MAX212 from 5V Logic

The MAX212 can interface with 5V logic while it operates from a 3V supply, however a 200k $\Omega$  series resistor between  $\overline{SD}$  and the +5V logic signal is required (see Figure 2). This protects the MAX212 by preventing  $\overline{SD}$  from sinking current while V+ is powering up. Also, the UART must not be permitted to send a logic high to the MAX212's EN or transmitter input pins until  $\overline{SD}$  is high (not shut down).

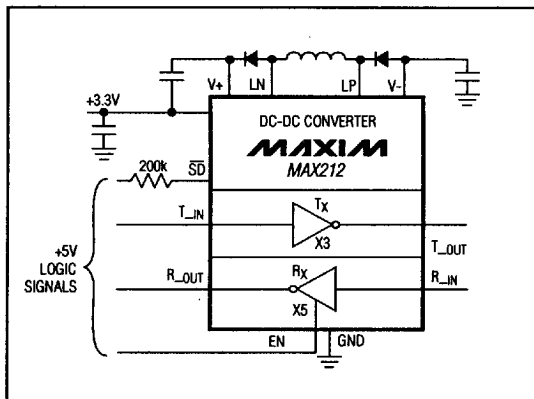


Figure 2. Connecting to +5V Logic

## Mouse Driveability

The MAX212 has been specifically designed to power serial mice while operating from low-voltage power supplies. It has been tested with samples of ten major mouse models from six manufacturers, including the leading three, Logitech (5 models), Mouse Systems, and Microsoft. The MAX212 successfully drove all serial mice and met their respective current and voltage requirements (Figure 1).

Figure 3 shows the transmitter output voltages under increasing load current. The MAX212's switching regulator ensures the transmitters will supply at least  $\pm 5V$  during worst-case load conditions.

## EIA/TIA-232E and 562 Standards

Most of the power drawn by RS-232 circuits is consumed because the EIA/TIA-232E standard demands that at least  $\pm 5V$  be delivered by the transmitters to impedances that can be as low as 3k $\Omega$ . For applica-

## +3V Powered RS-232 Transceivers from Maxim

| PART   | POWER-SUPPLY VOLTAGE (V) | No. OF TRANSMITTERS/RECEIVERS | No. OF RECEIVERS ACTIVE IN SHUTDOWN | DATA RATE (kbps) | FEATURES                       |
|--------|--------------------------|-------------------------------|-------------------------------------|------------------|--------------------------------|
| MAX212 | 3.0 to 3.6               | 3/5                           | 5                                   | 250              | True RS-232 from +3V           |
| MAX560 | 3.0 to 3.6               | 4/5                           | 2                                   | 120              | 2 receivers active in shutdown |
| MAX561 | 3.0 to 3.6               | 4/5                           | 0                                   | 120              | Pin compatible with MAX241     |
| MAX562 | 2.7 to 5.25              | 3/5                           | 5                                   | 250              | Wide supply range              |

## +3V-Powered, Low-Power, True RS-232 Transceiver

MAX212

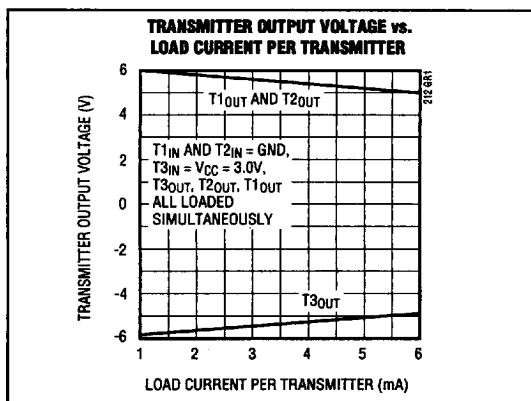


Figure 3. Mouse Emulation Circuit Current

tions where power consumption is especially critical, the EIA/TIA-562 standard provides an alternative.

EIA/TIA-562 transmitter output voltage levels need only reach  $\pm 3.7V$ , and because they need only drive the same  $3k\Omega$  receiver loads specified by RS-232, total power consumption is considerably reduced. Since the EIA/TIA-232E and EIA/TIA-562 receiver input voltage thresholds are the same, interoperability between the two standards is guaranteed and devices from both standards will communicate with each other successfully.

Maxim's MAX560 and MAX561 are EIA/TIA-562 transceivers that operate on a single supply from 3.0V to 3.6V, and the MAX562 transceiver operates from 2.7V to 5.25V while producing EIA/TIA-562 levels.

### Evaluation Kit

The MAX212 evaluation kit (EV kit) is a fully assembled and tested, surface-mount demonstration board that provides quick and easy evaluation of the MAX212.

The MAX212 EV kit is intended for  $3.3V \pm 300mV$ -powered EIA/TIA-232E and V.28/V.24 communications interfaces where 3 drivers and 5 receivers are needed with minimum power consumption.

A logic or pin-selectable shutdown mode reduces current to  $1\mu A$ . While shut down, all receivers can remain active or can be disabled under logic control via the EN input.

2

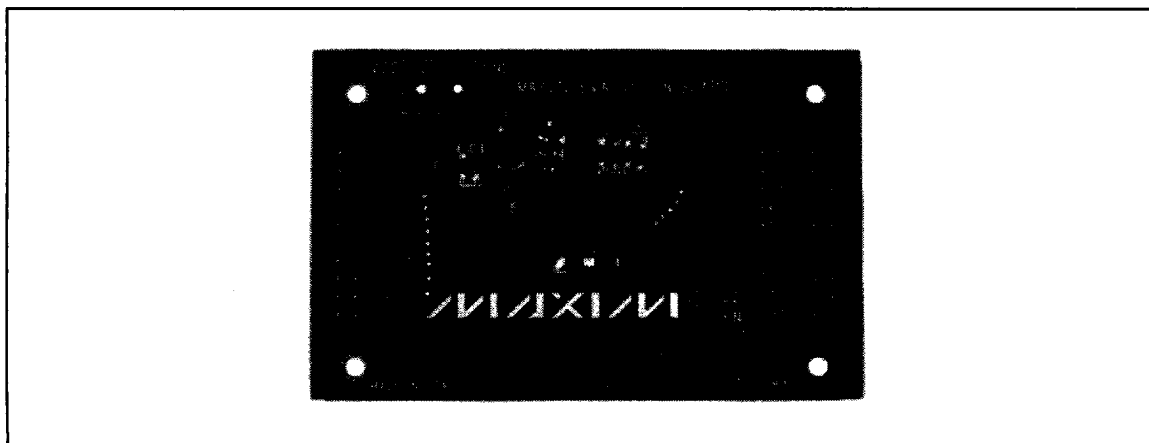


Figure 4. MAX212 Evaluation Kit

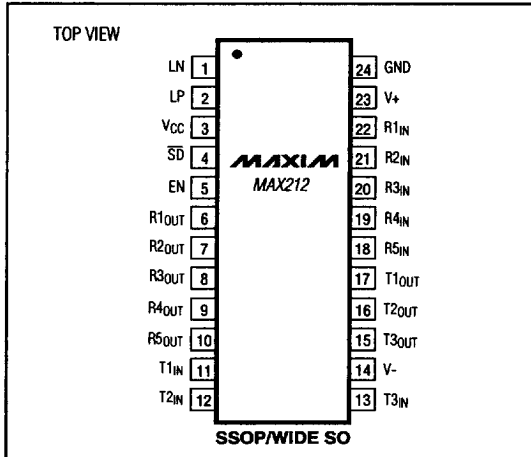
MAXIM

2-63

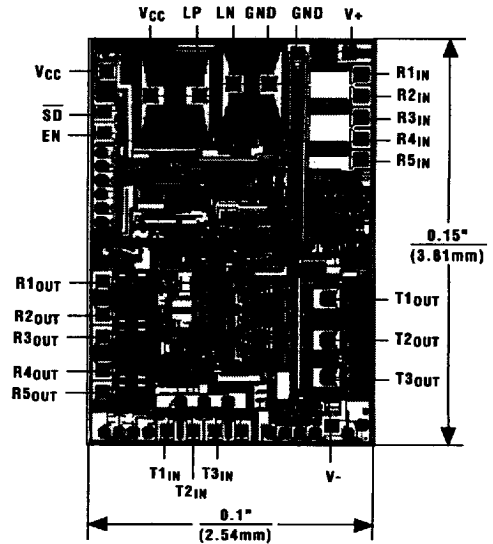
5876651 0009351 T36

# +3V-Powered, Low-Power, True RS-232 Transceiver

## Pin Configuration



## Chip Topography



TRANSISTOR COUNT: 1382 ;  
SUBSTRATE CONNECTED TO V+.