



# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

MAX3218

## General Description

The MAX3218 RS-232 transceiver is intended for battery-powered EIA/TIA-232E and V.28/V.24 communications interfaces that need two drivers and two receivers with minimum power consumption from a single low-voltage supply. It provides a wide +1.8V to +4.25V operating voltage range while maintaining true RS-232 and EIA/TIA-562 voltage levels. The MAX3218 runs from two alkaline, NiCd, or NiMH cells without any form of voltage regulator. A guaranteed 120kbps data rate provides compatibility with popular software for communicating with personal computers.

Supply current is reduced to 1  $\mu$ A with Maxim's new AutoShutdown™ feature. When the MAX3218 does not sense a valid signal level on the receiver inputs, the on-board power-supply and drivers shut down. This occurs if the RS-232 cable is disconnected or if the transmitters of the connected peripheral are turned off. The system turns on again when a valid level is applied to either RS-232 receiver input. As a result, the system saves power without changes to the existing software. Additionally, the MAX3218 can be forced into or out of shutdown, under logic control.

While shut down, all receivers can remain active or can be disabled under logic control, permitting a system incorporating the CMOS MAX3218 to monitor external devices while in low-power shutdown. Three-state drivers are provided on both receiver outputs so that multiple receivers, generally of different interface standards, can be on the same bus. The MAX3218 is available in 20-pin DIP and SSOP packages.

## Applications

Battery-Powered Equipment  
Subnotebook Computers  
PDAs  
Hand-Held Equipment  
Peripherals  
Cellular Phones

## Features

### BETTER THAN BIPOLAR!

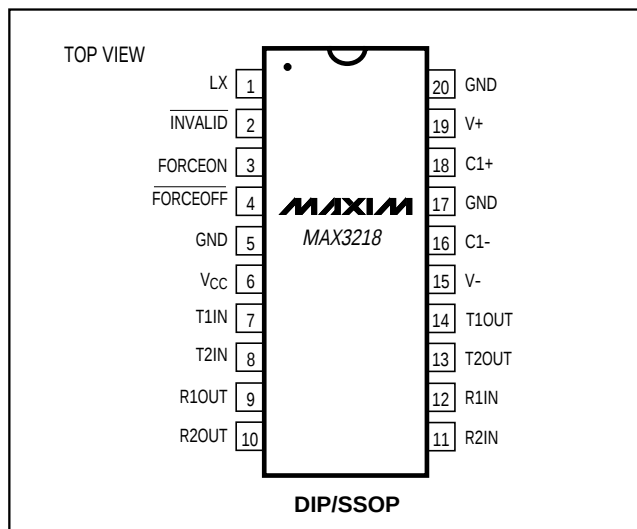
- ♦ 1 $\mu$ A Supply Current Using AutoShutdown™
- ♦ Operates Directly from Two Alkaline, NiCd or NiMH Cells
- ♦ +1.8V to +4.25V Single-Supply Voltage Range
- ♦ 120kbps Data Rate Guaranteed
- ♦ Low-Cost Surface-Mount Components
- ♦ Meets EIA/TIA-232E Specifications
- ♦ Three-State Receiver Outputs
- ♦ Flow-Through Pinout
- ♦ On-Board DC-DC Converters
- ♦ 20-Pin SSOP and DIP Packages

## Ordering Information

| PART       | TEMP. RANGE    | PIN-PACKAGE    |
|------------|----------------|----------------|
| MAX3218CPP | 0°C to +70°C   | 20 Plastic DIP |
| MAX3218CAP | 0°C to +70°C   | 20 SSOP        |
| MAX3218C/D | 0°C to +70°C   | Dice†          |
| MAX3218EPP | -40°C to +85°C | 20 Plastic DIP |
| MAX3218EAP | -40°C to +85°C | 20 SSOP        |

† Contact factory for dice specifications.

## Pin Configuration



™ AutoShutdown is a trademark of Maxim Integrated Products.



Maxim Integrated Products 1

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

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## ABSOLUTE MAXIMUM RATINGS

|                                         |                                   |                                                       |                 |
|-----------------------------------------|-----------------------------------|-------------------------------------------------------|-----------------|
| Supply Voltages                         |                                   | Short-Circuit Duration, R_OUT, T_OUT to GND .....     | Continuous      |
| V <sub>CC</sub> .....                   | -0.3V to +4.6V                    | Continuous Power Dissipation (T <sub>A</sub> = +70°C) |                 |
| V <sub>+</sub> .....                    | (V <sub>CC</sub> - 0.3V) to +7.5V | Plastic DIP (derate 11.11mW/°C above +70°C) .....     | 889mW           |
| V <sub>-</sub> .....                    | +0.3V to -7.4V                    | SSOP (derate 8.00mW/°C above +70°C) .....             | 640mW           |
| V <sub>CC</sub> to V <sub>-</sub> ..... | +12V                              | Operating Temperature Ranges                          |                 |
| LX .....                                | -0.3V to (1V + V <sub>+</sub> )   | MAX3218C_P .....                                      | 0°C to +70°C    |
| Input Voltages                          |                                   | MAX3218E_P .....                                      | -40°C to +85°C  |
| T_IN, FORCEON, FORCEOFF .....           | -0.3V to +7V                      | Storage Temperature Range .....                       | -65°C to +150°C |
| R_IN .....                              | ±25V                              | Lead Temperature (soldering, 10sec) .....             | +300°C          |
| Output Voltages                         |                                   |                                                       |                 |
| T_OUT .....                             | ±15V)                             |                                                       |                 |
| R_OUT .....                             | -0.3V to (V <sub>CC</sub> + 0.3V) |                                                       |                 |

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

(Circuit of Figure 1, V<sub>CC</sub> = 1.8V to 4.25V, C1 = 0.47 $\mu$ F, C2 = C3 = C4 = 1 $\mu$ F, L1 = 15 $\mu$ H, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = 3.0V, T<sub>A</sub> = +25°C.)

| PARAMETER                                                      | CONDITIONS                                                                                               | MIN                    | TYP                    | MAX                    | UNITS   |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------|------------------------|------------------------|---------|
| <b>DC CHARACTERISTICS</b>                                      |                                                                                                          |                        |                        |                        |         |
| Operating Voltage Range                                        |                                                                                                          | 1.8                    |                        | 4.25                   | V       |
| Supply Current, AutoShutdown™                                  | V <sub>CC</sub> = 3.0V, T <sub>A</sub> = +25°C, all R_IN open, FORCEON = GND, FORCEOFF = V <sub>CC</sub> |                        | 1.0                    | 10                     | $\mu$ A |
| Supply Current, Shutdown                                       | FORCEOFF = GND, T <sub>A</sub> = +25°C, V <sub>CC</sub> = 3.0V                                           |                        | 1.0                    | 10                     | $\mu$ A |
| Supply Current, AutoShutdown™ Disabled                         | FORCEON = FORCEOFF = V <sub>CC</sub> = 3.0V, no load                                                     |                        | 2.0                    | 3.0                    | mA      |
| <b>LOGIC INPUTS AND RECEIVER OUTPUTS</b>                       |                                                                                                          |                        |                        |                        |         |
| Input Logic Threshold Low                                      | T_IN, FORCEON, FORCEOFF                                                                                  |                        |                        | 0.33 x V <sub>CC</sub> | V       |
| Input Logic Threshold High                                     | T_IN, FORCEON, FORCEOFF                                                                                  | 0.67 x V <sub>CC</sub> |                        |                        | V       |
| Input Leakage Current                                          | T_IN, FORCEON = FORCEOFF = 0V or V <sub>CC</sub>                                                         |                        | 0.001                  | ±1                     | $\mu$ A |
| Output Voltage Low                                             | R_OUT, I <sub>OUT</sub> = 1.0mA                                                                          |                        |                        | 0.4                    | V       |
| Output Voltage High                                            | R_OUT, I <sub>OUT</sub> = -0.4mA                                                                         | V <sub>CC</sub> - 0.25 | V <sub>CC</sub> - 0.08 |                        | V       |
| Output Leakage Current                                         | R_OUT, 0V ≤ R_OUT ≤ V <sub>CC</sub> , FORCEON = FORCEOFF = 0V                                            |                        | 0.05                   | ±10                    | $\mu$ A |
| <b>AUTOSHUTDOWN (FORCEON = GND, FORCEOFF = V<sub>CC</sub>)</b> |                                                                                                          |                        |                        |                        |         |
| Receiver Input Thresholds, Transmitters Enabled                | Figure 4a                                                                                                | Positive threshold     |                        | 2.8                    | V       |
|                                                                |                                                                                                          | Negative threshold     | -2.8                   |                        |         |
| Receiver Input Thresholds Transmitters Disabled                | 1 $\mu$ A supply current, Figure 4a                                                                      | -0.3                   |                        | 0.3                    | V       |
| INVALID Output Low Voltage                                     | I <sub>OUT</sub> = 1.0mA, -0.3V < R_IN < 0.3V                                                            |                        |                        | 0.4                    | V       |
| INVALID Output High Voltage                                    | I <sub>OUT</sub> = -0.4mA,  R_IN  > 2.8V                                                                 | V <sub>CC</sub> - 0.25 |                        |                        | V       |

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

## ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1,  $V_{CC} = 1.8V$  to  $4.25V$ ,  $C1 = 0.47\mu F$ ,  $C2 = C3 = C4 = 1\mu F$ ,  $L1 = 15\mu H$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ .)

| PARAMETER                               | CONDITIONS                                               | MIN     | TYP      | MAX       | UNITS      |
|-----------------------------------------|----------------------------------------------------------|---------|----------|-----------|------------|
| <b>EIA/TIA-232E RECEIVER INPUTS</b>     |                                                          |         |          |           |            |
| Input Voltage Range                     |                                                          | -25     |          | +25       | V          |
| Input Threshold Low                     | $V_{CC} = 2.0V$ to $4.25V$                               | 0.4     |          |           | V          |
|                                         | $V_{CC} = 1.8V$ to $4.25V$                               | 0.3     |          |           |            |
| Input Threshold High                    | $V_{CC} = 1.8V$ to $4.25V$                               |         |          | 3.0       | V          |
|                                         | $V_{CC} = 1.8V$ to $3.6V$                                |         |          | 2.8       |            |
| Input Hysteresis                        |                                                          |         | 0.7      |           | V          |
| Input Resistance                        | $-15V < R_{IN} < 15V$                                    | 3       | 5        | 7         | k $\Omega$ |
| <b>EIA/TIA-232E TRANSMITTER OUTPUTS</b> |                                                          |         |          |           |            |
| Output Voltage Swing                    | All transmitter outputs loaded with $3k\Omega$ to ground | $\pm 5$ | $\pm 6$  |           | V          |
| Output Resistance                       | $V_{CC} = 0V$ , $-2V < T_{OUT} < 2V$                     | 300     |          |           | $\Omega$   |
| Output Short-Circuit Current            |                                                          |         | $\pm 24$ | $\pm 100$ | mA         |

## TIMING CHARACTERISTICS

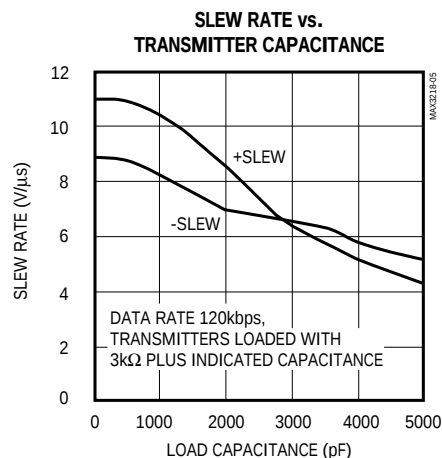
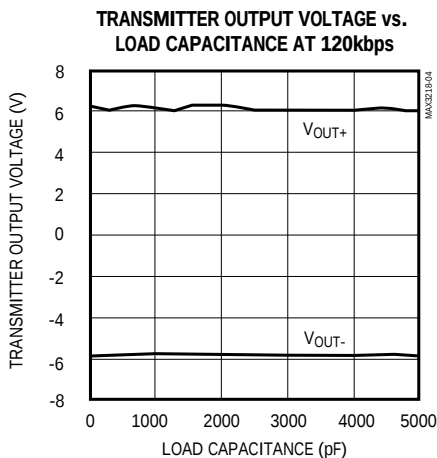
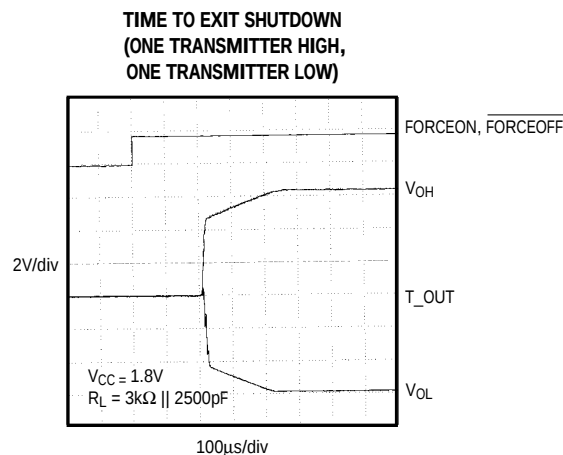
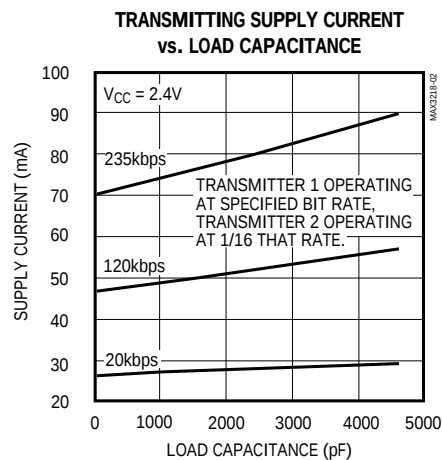
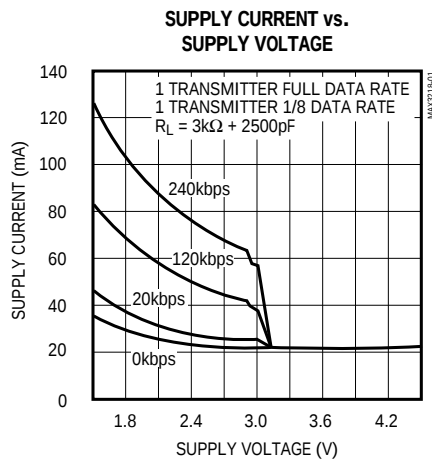
(Circuit of Figure 1,  $V_{CC} = 1.8V$  to  $4.25V$ ,  $C1 = 0.47\mu F$ ,  $C2 = C3 = C4 = 1\mu F$ ,  $L1 = 15\mu H$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ .)

| PARAMETER                                               | SYMBOL     | CONDITIONS                                                                                                                                         | MIN | TYP | MAX  | UNITS      |
|---------------------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------------|
| Data Rate                                               |            | 2500pF    $3k\Omega$ load each transmitter, one transmitter switching, 150pF load each receiver                                                    | 120 | 235 |      | kbps       |
| Receiver Output Enable Time                             | $t_{ER}$   |                                                                                                                                                    |     | 90  | 300  | ns         |
| Receiver Output Disable Time                            | $t_{DR}$   |                                                                                                                                                    |     | 200 | 500  | ns         |
| Transmitter Output Enable Time                          | $t_{ET}$   |                                                                                                                                                    |     | 250 | 450  | $\mu s$    |
| Transmitter Output Disable Time                         | $t_{DT}$   |                                                                                                                                                    |     | 500 |      | ns         |
| Receiver Propagation Delay                              | $t_{PHLR}$ | 150pF load                                                                                                                                         |     | 290 | 1000 | ns         |
|                                                         | $t_{PLHR}$ | 150pF load                                                                                                                                         |     | 260 | 1000 |            |
| Transmitter Propagation Delay                           | $t_{PHLT}$ | 2500pF    $3k\Omega$ load                                                                                                                          |     | 1.9 | 2.7  | $\mu s$    |
|                                                         | $t_{PLHT}$ | 2500pF    $3k\Omega$ load                                                                                                                          |     | 1.8 | 2.7  |            |
| Transition Region Slew Rate                             |            | $T_A = +25^\circ C$ , $V_{CC} = 3.0V$ , $R_L = 3k\Omega$ to $7k\Omega$ , $C_L = 50pF$ to $2500pF$ , measured from $+3V$ to $-3V$ or $-3V$ to $+3V$ | 3.0 |     | 30   | V/ $\mu s$ |
| <b>AUTOSHUTDOWN TIMING</b>                              |            |                                                                                                                                                    |     |     |      |            |
| Receiver Threshold to Transmitters Enabled              | $t_{WU}$   | Figure 4b                                                                                                                                          |     | 250 |      | $\mu s$    |
| Receiver Positive or Negative Threshold to INVALID High | $t_{INVH}$ | Figure 4b                                                                                                                                          |     | 1   |      | $\mu s$    |
| Receiver Positive or Negative Threshold to INVALID Low  | $t_{INVL}$ | Figure 4b                                                                                                                                          |     | 30  |      | $\mu s$    |

# 1μA Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

## Typical Operating Characteristics

(Circuit of Figure 1,  $V_{CC} = 1.8V$ , all transmitter outputs loaded with  $3k\Omega$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

## Pin Description

| PIN       | NAME                         | FUNCTION                                                                                                            |
|-----------|------------------------------|---------------------------------------------------------------------------------------------------------------------|
| 1         | LX                           | Inductor/Diode Connection Point                                                                                     |
| 2         | $\overline{\text{INVALID}}$  | Output of Invalid Signal Detector. Low if invalid RS-232 levels are present on all receiver inputs, otherwise high. |
| 3         | FORCEON                      | Drive high when $\overline{\text{FORCEOFF}}$ = high to override automatic circuitry, keeping transmitters on.       |
| 4         | $\overline{\text{FORCEOFF}}$ | Drive low to shut down transmitters and on-board power supply, overriding all automatic circuitry and FORCEON.      |
| 5, 17, 20 | GND                          | Ground                                                                                                              |
| 6         | VCC                          | Supply Voltage Input, 1.8V to 4.25V. Bypass to GND with at least 1 $\mu$ F.                                         |
| 7, 8      | T1IN, T2IN                   | Transmitter Inputs                                                                                                  |
| 9, 10     | R1OUT, R2OUT                 | Receiver Outputs                                                                                                    |
| 11, 12    | R2IN, R1IN                   | Receiver Inputs                                                                                                     |
| 13, 14    | T2OUT, T1OUT                 | Transmitter Outputs, swing between V+ and V-                                                                        |
| 15        | V-                           | Negative Supply generated on-board                                                                                  |
| 16, 18    | C1-, C1+                     | Terminal for Charge-Pump Capacitor                                                                                  |
| 19        | V+                           | Positive Supply generated on-board                                                                                  |

## Detailed Description

The MAX3218 line driver/receiver is intended for battery-powered EIA/TIA-232 and V.28/V.24 communications interfaces that require two drivers and two receivers. The operating voltage extends from 1.8V to 4.25V, yet the device maintains true RS-232 and EIA/TIA-562 transmitter output voltage levels. This wide supply voltage range permits direct operation from a variety of batteries without the need for a voltage regulator. For example, the MAX3218 can be run directly from a single lithium cell or a pair of alkaline cells. It can also be run directly from two NiCd or NiMH cells from full-charge voltage down to the normal 0.9V/cell end-of-life point. The 4.25V maximum supply voltage allows the two rechargeable cells to be trickle- or fast-charged while driving the MAX3218.

The circuit comprises three sections: power supply, transmitters, and receivers. The power-supply section converts the supplied input voltage to 6.5V, providing 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 120kbps data rates, providing compatibility with LapLink™ and other high-speed communications software.

The MAX3218 is equipped with Maxim's new proprietary AutoShutdown™ circuitry. This achieves a 1 $\mu$ A supply current by shutting down the device when the RS-232 cable is disconnected or when the connected peripheral transmitters are turned off. While shut down, both receivers can remain active or can be disabled under logic control. With this feature, the MAX3218 can be in low-power shutdown mode and still monitor activity on external devices. Three-state drivers are provided on both receiver outputs.

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

### Switch-Mode Power Supply

The switch-mode power supply uses a single inductor with one diode and three small capacitors to generate  $\pm 6.5$ V from an input voltage in the 1.8V to 4.25V range.

### Inductor Selection

Use a 15 $\mu$ H inductor with a saturation current rating of at least 350mA and less than 1  $\Omega$  resistance. Table 1 lists suppliers of inductors that meet the 15  $\mu$ H/350mA/1 $\Omega$  specifications.

™ LapLink is a trademark of Traveling Software, Inc.  
AutoShutdown is a trademark of Maxim Integrated Products.

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

**Table 1. Suggested Component Suppliers**

| MANUFACTURER                | PART NUMBER                            | PHONE                                      | FAX                                        |
|-----------------------------|----------------------------------------|--------------------------------------------|--------------------------------------------|
| <b>Inductors</b>            |                                        |                                            |                                            |
| Murata-Erie                 | LQH4N150K-TA                           | USA (814) 237-1431                         | USA (814) 238-0490                         |
| 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 |
| <b>Diodes—Surface-Mount</b> |                                        |                                            |                                            |
| Allegro                     | TMPD6050LT                             | USA (508) 853-5000                         | USA (508) 853-7556                         |
| Central Semiconductor       | CMP5H-3 (Schottky)                     | USA (516) 435-1110                         | USA (516) 435-1824                         |
| Motorola                    | MMBD6050LT1 (silicon)                  | USA (408) 749-0510                         | USA (408) 991-7420                         |
| Philips                     | PMBD6050 (silicon)                     | USA (401) 762-3800                         | USA (401) 767-4493                         |
| <b>Diodes—Through-Hole</b>  |                                        |                                            |                                            |
| Motorola                    | 1N6050 (silicon),<br>1N5817 (Schottky) | USA (408) 749-0510                         | USA (408) 991-7420                         |

## Diode Selection

Key diode specifications are fast recovery time (<10ns), average current rating (>100mA), and peak current rating (>350mA). Inexpensive fast silicon diodes, such as the 1N6050, are generally recommended. More expensive Schottky diodes improve efficiency and give slightly better performance at very low  $V_{CC}$  voltages. Table 1 lists suppliers of both surface-mount and through-hole diodes. 1N914s are usually satisfactory, but specifications and performance vary widely with different manufacturers.

## Capacitor Selection

Use capacitors with values at least as indicated in Figure 1. Capacitor C2 determines the ripple on  $V+$ , but not the absolute voltage. Capacitors C1 and C3 determine both the ripple and the absolute voltage of  $V-$ . Bypass  $V_{CC}$  to GND with at least 1  $\mu$ F (C4) placed close to pins 5 and 6. If the  $V_{CC}$  line is not bypassed elsewhere (e.g., at the power supply), increase C4 to 4.7  $\mu$ F.

You may use ceramic or polarized capacitors in all locations. If you use polarized capacitors, tantalum types are preferred because of the high operating frequency of the power supplies (about 250kHz). If aluminum electrolytics are used, higher capacitance values may be required.

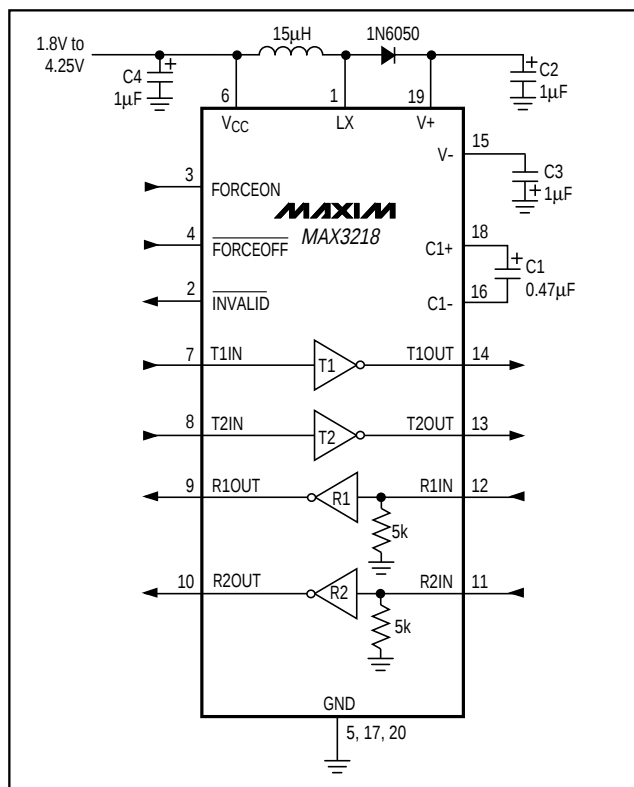


Figure 1. Typical Operating Circuit

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

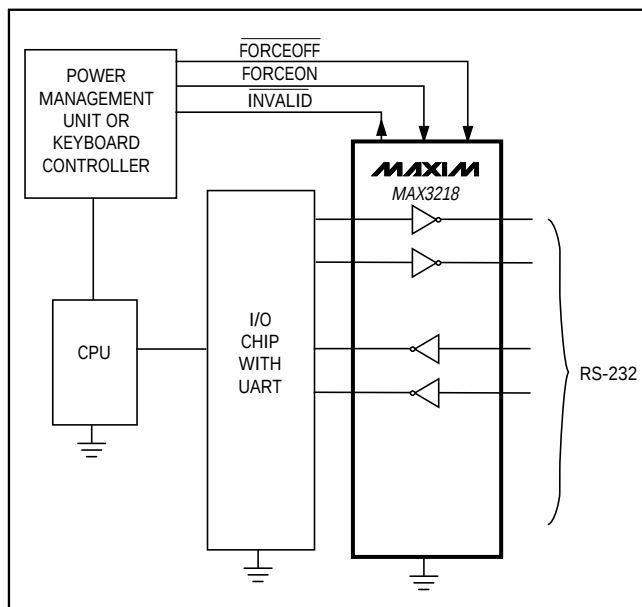


Figure 2. Interface Under Control of PMU

## RS-232 Drivers

The two drivers are identical, and deliver EIA/TIA-232E and EIA/TIA-562 output voltage levels when  $V_{CC}$  is between 1.8V and 4.25V. One transmitter can drive up to 3k $\Omega$  in parallel with 2500pF at up to 120kbps. Connect unused drivers to either GND or  $V_{CC}$ . When  $\overline{\text{FORCEOFF}}$  is driven low, or when AutoShutdown circuitry senses invalid voltage levels at **all** receiver inputs, the drivers are disabled and their outputs are forced into a high-impedance state. Driver inputs do not have internal pull-up resistors.

## RS-232 Receivers

The two receivers are identical, and accept both EIA/TIA-232E and EIA/TIA-562 input signals. The CMOS receiver outputs are inverting and swing rail-to-rail. Receivers are disabled only when  $\text{FORCEON}$  and  $\overline{\text{FORCEOFF}}$  inputs are low. (See Table 2.)

Table 2. Receiver Status

| $\text{FORCEON}$ | $\overline{\text{FORCEOFF}}$ | RECEIVER STATUS   |
|------------------|------------------------------|-------------------|
| X                | H                            | Receiver Enabled  |
| H                | X                            |                   |
| L                | L                            | Receiver Disabled |

## Shutdown

When  $\overline{\text{FORCEOFF}}$  is low, power supplies are disabled and the transmitters are placed in a high-impedance state. Receiver operation is not affected by taking  $\overline{\text{FORCEOFF}}$  low. Power consumption is dramatically reduced in shutdown mode. Supply current is minimized when the receiver inputs are static in any one of three states: floating (ground), GND, or  $V_{CC}$ .

## AutoShutdown™

A 1 $\mu$ A supply current is achieved with Maxim's new AutoShutdown feature, which operates when  $\text{FORCEON}$  is low and  $\overline{\text{FORCEOFF}}$  is high. When the MAX3218 senses no valid signal level on either receiver input for typically 30 $\mu$ s, the on-board power supply and drivers shut down, reducing supply current to 1 $\mu$ A. Internal 5k $\Omega$  resistors pull undriven receiver inputs to ground. This occurs if the RS-232 cable is disconnected or if the connected peripheral transmitters are turned off. The system turns on again when a valid level is applied to either RS-232 receiver input. As a result, the system saves power without changes to the existing BIOS or operating system. When using the AutoShutdown feature,  $\overline{\text{INVALID}}$  is high when the device is on and low when the device is shut down. The  $\overline{\text{INVALID}}$  output indicates the condition of the receiver inputs.

Table 3 summarizes the MAX3218 operating modes.  $\text{FORCEON}$  and  $\overline{\text{FORCEOFF}}$  override the automatic circuitry and force the transceiver into its normal operating state or into its low-power standby state. When neither control is asserted, the IC selects between these states automatically based on receiver input levels. Figure 4 depicts valid and invalid RS-232 receiver levels. The

Table 3. AutoShutdown Logic

| RS-232 SIGNAL PRESENT AT RECEIVER INPUT | $\overline{\text{FORCEOFF}}$ INPUT | $\text{FORCEON}$ INPUT | $\overline{\text{INVALID}}$ OUTPUT | TRANSCIEVER STATUS           |
|-----------------------------------------|------------------------------------|------------------------|------------------------------------|------------------------------|
| Yes                                     | H                                  | X                      | H                                  | Normal Operation             |
| No                                      | H                                  | H                      | L                                  | Normal Operation (Forced On) |
| No                                      | H                                  | L                      | L                                  | Shutdown (AutoShutdown)      |
| Yes                                     | L                                  | X                      | H                                  | Shutdown (Forced Off)        |
| No                                      | L                                  | X                      | L                                  | Shutdown (Forced Off)        |

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

MAX3218 shuts down after sensing invalid RS-232 levels for greater than 30  $\mu$ s, ensuring that the AutoShutdown mode is not enabled for slow-moving signals ( $>1\text{V}/\mu\text{s}$ ).

Another system with AutoShutdown may need a period of time to wake up. Figure 5 shows a circuit that forces the transmitters on for 100ms after start-up, allowing enough time for the other system to realize that the MAX3218 system is awake. If the other system outputs valid RS-232 signals within that time, the RS-232 ports on both systems remain enabled.

## Applications Information

### Operation from Regulated/Unregulated Dual System Power Supplies

The MAX3218 is intended for use with three different power-supply sources: it can be powered directly from a battery, from a 3.0V or 3.3V power supply, or simultaneously from both. Figure 1 shows the single-supply configuration. Figure 6 shows the circuit for operation from both a 3V supply and a raw battery supply—an ideal configuration where a regulated 3V supply is being derived from two cells. In this application, the MAX3218's logic levels remain appropriate for interface with 3V logic, yet most of the power for the MAX3218 is

drawn directly from the battery, without suffering the efficiency losses of the DC-DC converter. This prolongs battery life.

Bypass the input supplies with 0.1 $\mu$ F at  $V_{CC}$  (C4) and at least 1 $\mu$ F at the inductor (C5). Increase C5 to 4.7 $\mu$ F if the power supply has no other bypass capacitor connected to it.

### Low-Power Operation

The following suggestions will help you get maximum life out of your batteries.

Transmit at the highest practical data rate. Although this raises the supply current while transmission is in progress, the transmission will be over sooner. If the MAX3218 is shut down (using  $\overline{\text{FORCEOFF}}$ ) as soon as each transmission ends, this practice will save energy.

Operate your whole system from the raw battery voltage rather than suffer the losses of a regulator or DC-DC converter. If this is not possible, but your system is powered from two cells and employs a 3V DC-DC converter to generate the main logic supply, use the circuit of Figure 6. This circuit draws most of the MAX3218's power straight from the battery, but still provides logic-level compatibility with the 3V logic.

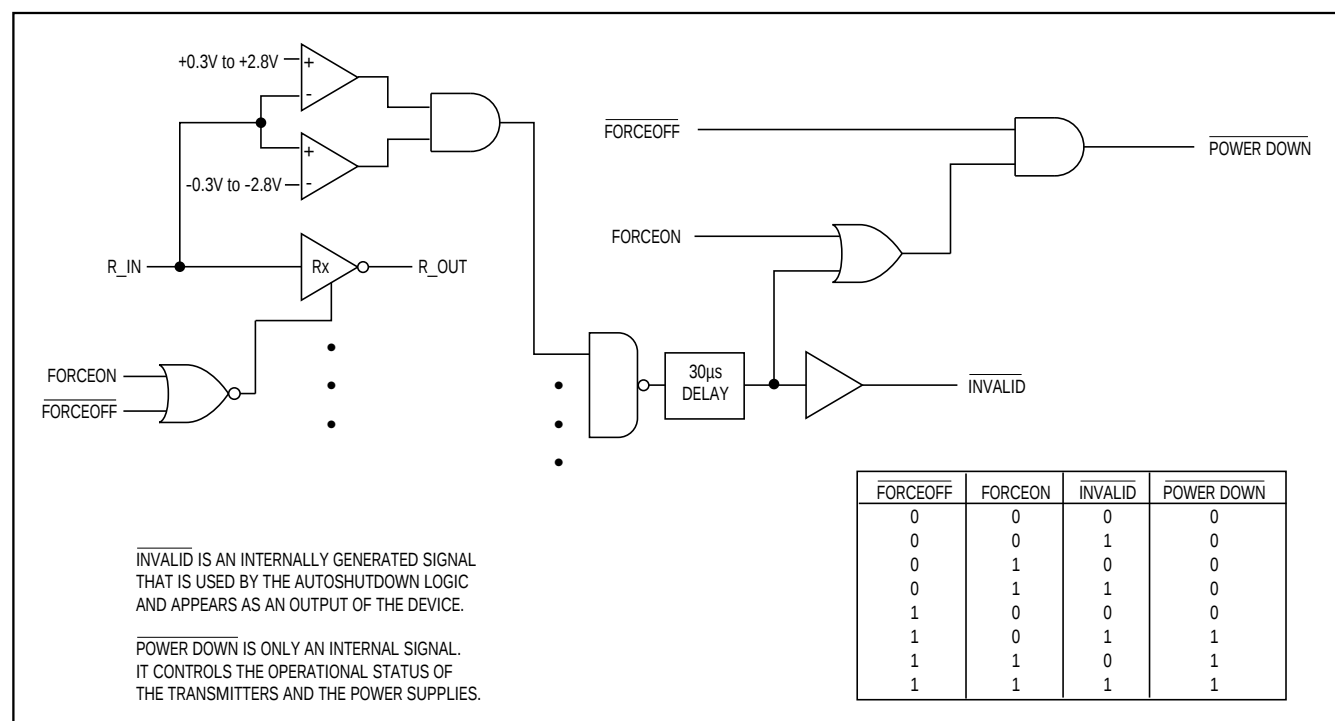


Figure 3. AutoShutdown Logic

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

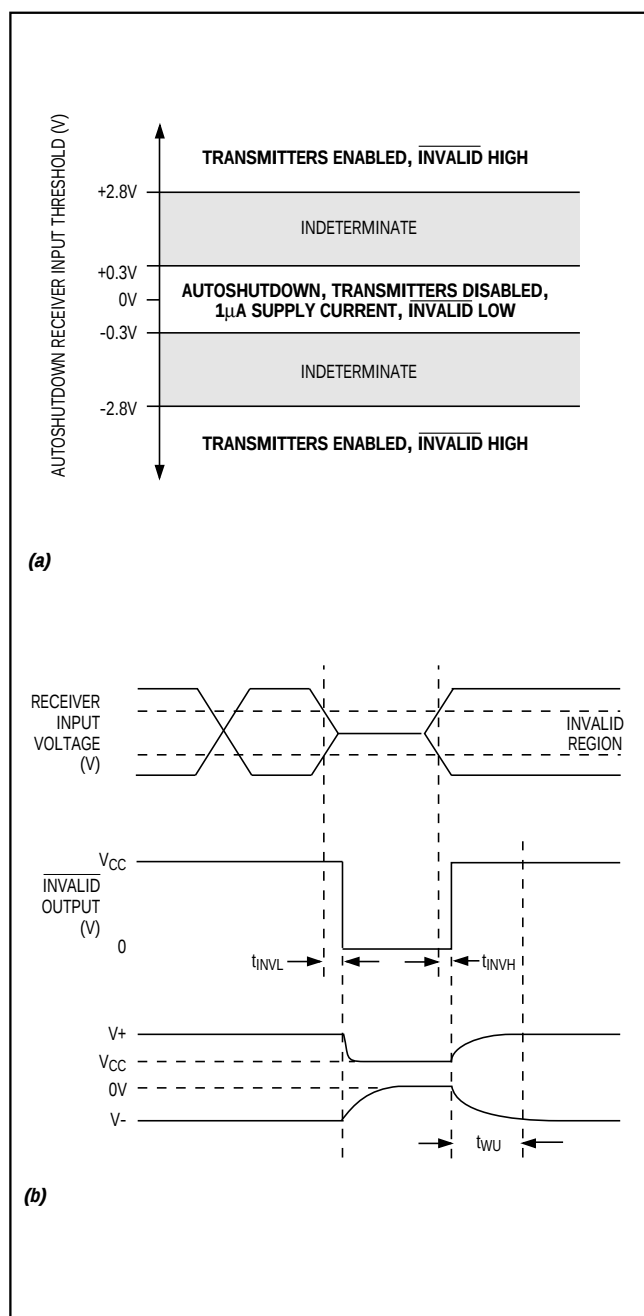


Figure 4. AutoShutdown Trip Levels

Keep communications cables short to minimize capacitive loading. Lowering the capacitive loading on the transmitter outputs reduces the MAX3218's power consumption. Using short, low-capacitance cable also helps transmission at the highest data rates.

## EIA/TIA-232E and EIA/TIA-562 Standards

RS-232 circuits consume much of their power because the EIA/TIA-232E standard demands that the transmitters deliver at least 5V to receivers with impedances that can be as low as 3k $\Omega$ . For applications where power consumption is 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 have to drive the same 3k $\Omega$  receiver loads, the total power consumption is considerably reduced. Since the EIA/TIA-232E and EIA/TIA-562 receiver input voltage thresholds are the same, interoperability between EIA/TIA-232E and EIA/TIA-562 devices is guaranteed. 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.

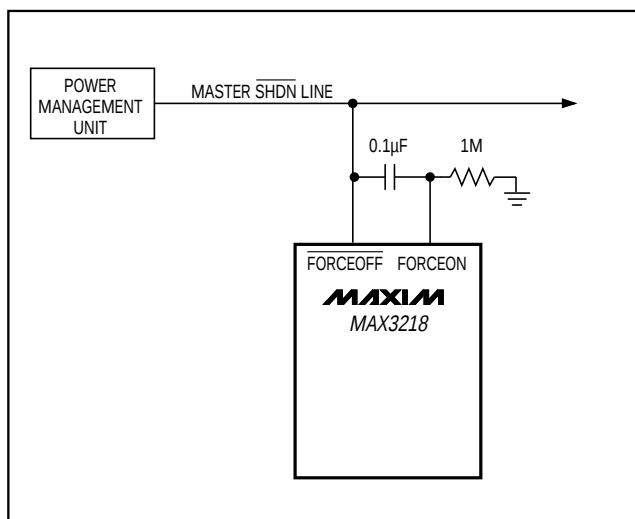


Figure 5. AutoShutdown with Initial Turn-On to Wake Up a System

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

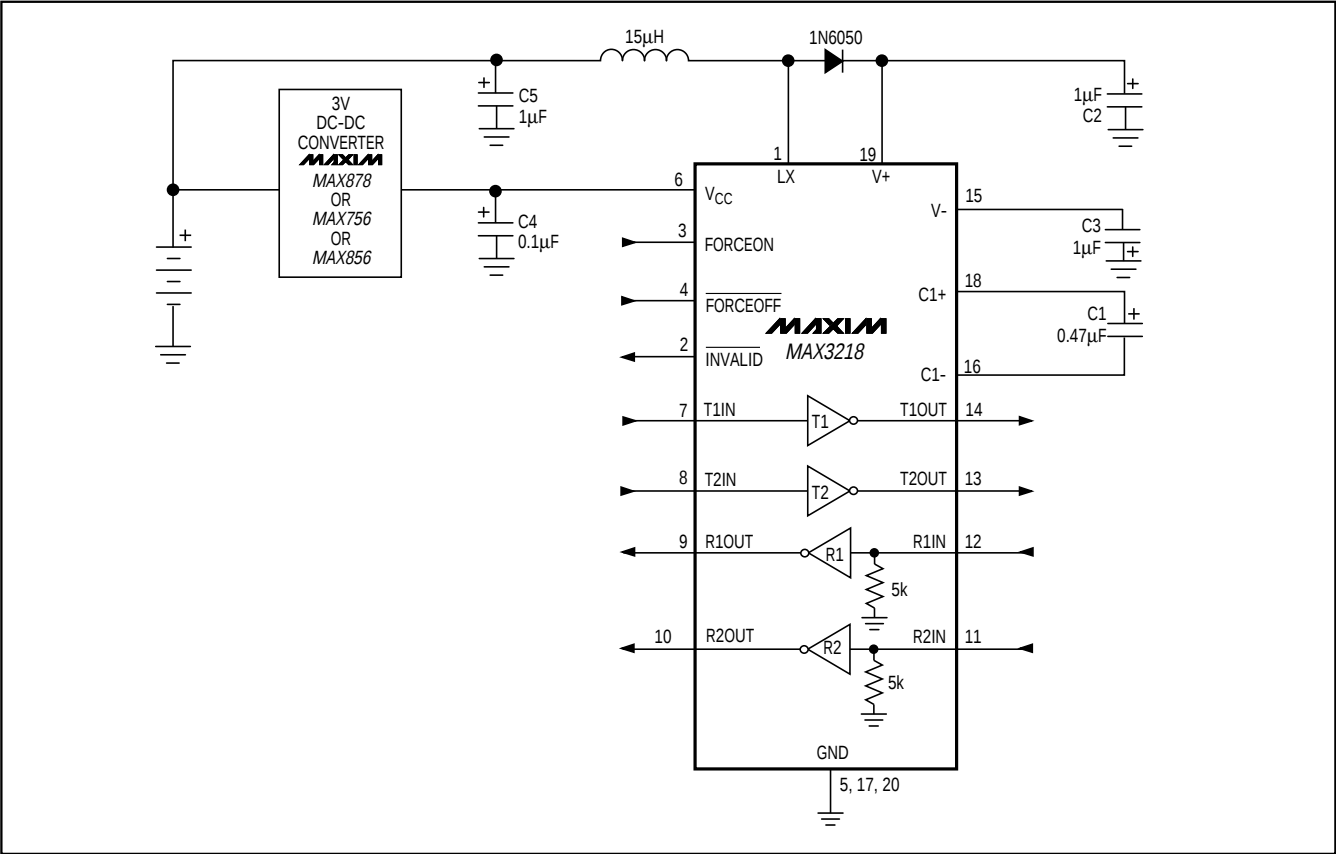


Figure 6. Operating from Unregulated and Regulated Supplies

# 1 $\mu$ A Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

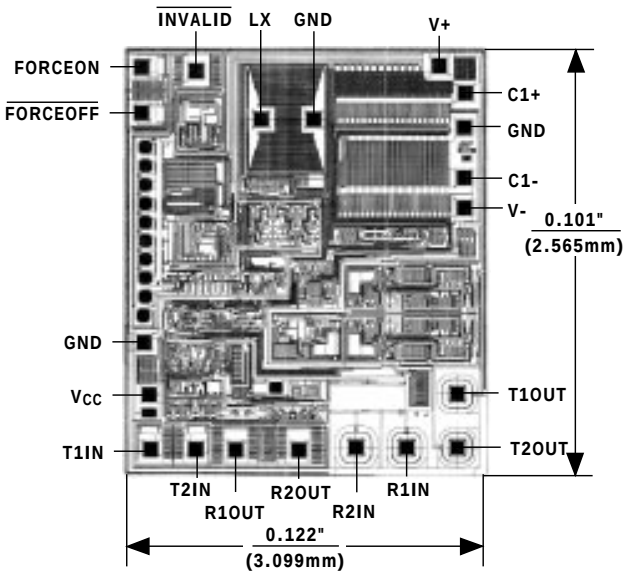
\_\_\_\_+3V-Powered EIA/TIA-232 and EIA/TIA-562 Transceivers from Maxim

MAX3218

| PART    | SUPPLY VOLTAGE (V) | No. OF TRANSMITTERS/RECEIVERS | No. OF RECEIVERS ACTIVE IN SHUTDOWN | GUAR-ANTEED DATA RATE (kbps) | EIA/TIA-232 OR 562 | FEATURES                                                                  |
|---------|--------------------|-------------------------------|-------------------------------------|------------------------------|--------------------|---------------------------------------------------------------------------|
| MAX212  | 3.0 to 3.6         | 3/5                           | 5                                   | 120                          | 232                | Drives mice                                                               |
| MAX3212 | 2.7 to 3.6         | 3/5                           | 5                                   | 120                          | 232                | AutoShutdown, complementary receiver, drives mice, transient detection    |
| MAX218  | 1.8 to 4.25        | 2/2                           | 2                                   | 120                          | 232                | Operates directly from a battery without a voltage regulator              |
| MAX3218 | 1.8 to 4.25        | 2/2                           | 2                                   | 120                          | 232                | Same as MAX218 but with AutoShutdown                                      |
| MAX560  | 3.0 to 3.6         | 4/5                           | 2                                   | 120                          | 562                | Pin-compatible with MAX213                                                |
| MAX561  | 3.0 to 3.6         | 4/5                           | 0                                   | 120                          | 562                | Pin-compatible with MAX214                                                |
| MAX562  | 2.7 to 5.25        | 3/5                           | 5                                   | 230                          | 562                | Wide supply range                                                         |
| MAX563  | 3.0 to 3.6         | 2/2                           | 2                                   | 120                          | 562                | 0.1 $\mu$ F capacitors                                                    |
| MAX3222 | 3.0 to 5.5         | 2/2                           | 2                                   | 120                          | 232                | 0.1 $\mu$ F capacitors                                                    |
| MAX3223 | 3.0 to 5.5         | 2/2                           | 2                                   | 120                          | 232                | AutoShutdown, 0.1 $\mu$ F capacitors                                      |
| MAX3232 | 3.0 to 5.5         | 2/2                           | 2                                   | 120                          | 232                | Pin-compatible with MAX232                                                |
| MAX3241 | 3.0 to 5.5         | 3/5                           | 5                                   | 120                          | 232                | 0.1 $\mu$ F capacitors, 2 complementary receivers, drives mice            |
| MAX3243 | 3.0 to 5.5         | 3/5                           | 1                                   | 120                          | 232                | 0.1 $\mu$ F capacitors, AutoShutdown, complementary receiver, drives mice |

# 1µA Supply Current, 1.8V to 4.25V-Powered RS-232 Transceiver with AutoShutdown™

Chip Topography



TRANSISTOR COUNT: 571  
SUBSTRATE CONNECTED TO GND

## Package Information

SSOP SHRINK SMALL OUTLINE PACKAGE

| DIM | INCHES         |       | MILLIMETERS |      |
|-----|----------------|-------|-------------|------|
|     | MIN            | MAX   | MIN         | MAX  |
| A   | 0.068          | 0.078 | 1.73        | 1.99 |
| A1  | 0.002          | 0.008 | 0.05        | 0.21 |
| B   | 0.010          | 0.015 | 0.25        | 0.38 |
| C   | 0.004          | 0.008 | 0.09        | 0.20 |
| D   | SEE VARIATIONS |       |             |      |
| E   | 0.205          | 0.209 | 5.20        | 5.38 |
| e   | 0.0256 BSC     |       | 0.65 BSC    |      |
| H   | 0.301          | 0.311 | 7.65        | 7.90 |
| L   | 0.025          | 0.037 | 0.63        | 0.95 |
| α   | 0°             | 8°    | 0°          | 8°   |

| DIM | PINS | INCHES |       | MILLIMETERS |       |
|-----|------|--------|-------|-------------|-------|
|     |      | MIN    | MAX   | MIN         | MAX   |
| D   | 14   | 0.239  | 0.249 | 6.07        | 6.33  |
| D   | 16   | 0.239  | 0.249 | 6.07        | 6.33  |
| D   | 20   | 0.278  | 0.289 | 7.07        | 7.33  |
| D   | 24   | 0.317  | 0.328 | 8.07        | 8.33  |
| D   | 28   | 0.397  | 0.407 | 10.07       | 10.33 |

21-0056A