

# MAX220–MAX249

# +5V-Powered, Multichannel RS-232 Drivers/Receivers

## General Description

The MAX220–MAX249 family of line drivers/receivers is intended for all EIA/TIA-232E and V.28/V.24 communications interfaces, particularly applications where  $\pm 12V$  is not available.

The MAX225, MAX233, MAX235, and MAX245/MAX246/MAX247 use no external components and are recommended for applications where printed circuit board space is critical.

The MAX220–MAX249 are offered in 26 different packages with temperatures from 0 to +70°C up to -55°C to +125°C. See ordering information table at the end of the data sheet for all package and temperature options.

## Applications

- Interface Translation
- Multidrop RS-232 Networks
- Portable Diagnostics Equipment

## Benefits and Features

Saves Board Space

- Integrated Charge Pump Circuitry
  - Eliminates the Need for a Bipolar  $\pm 12V$  Supply
  - Enables Single Supply Operation from +5V Supply
- Integrated Capacitors (MAX223, MAX233, MAX235, MAX245–MAX247)

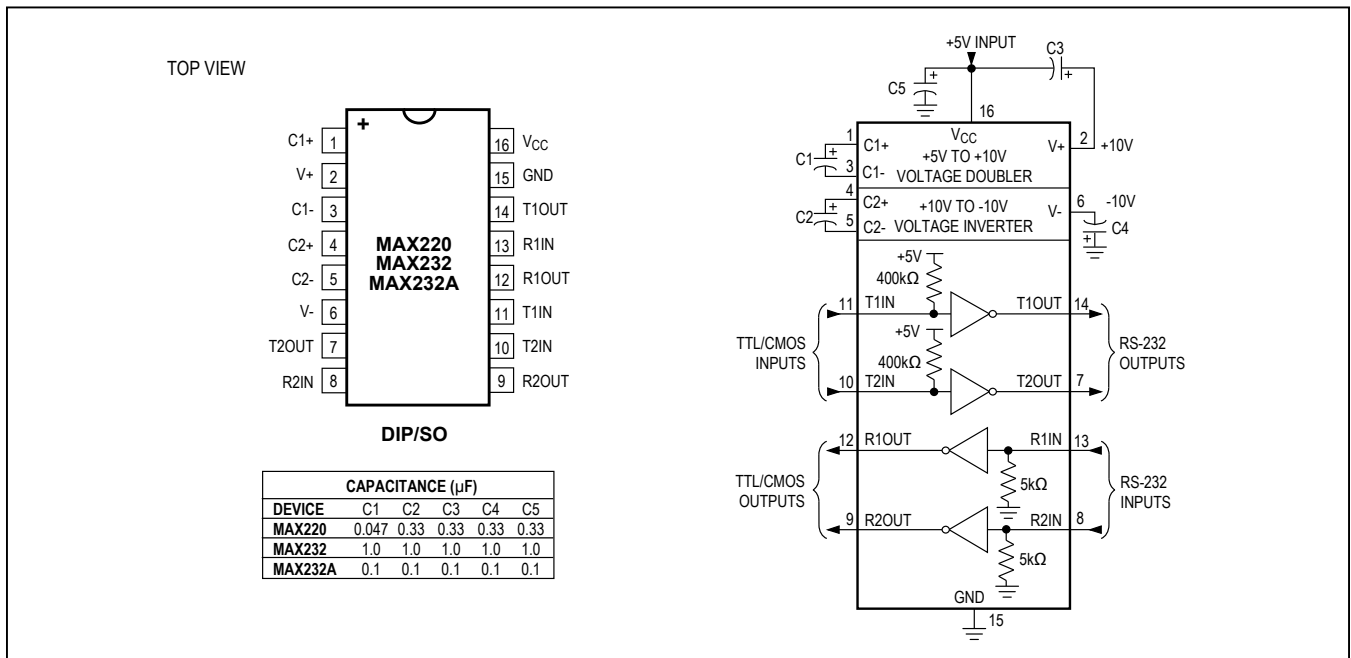
Saves Power for Reduced Power Requirements

- 5 $\mu$ W Shutdown Mode

*Ordering Information and Selection Table appears at end of data sheet.*

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## MAX220/MAX232/MAX232A Pin Configuration and Typical Operating Circuit



**Absolute Maximum Ratings—MAX220/222/232A/233A/242/243**

(Voltages referenced to GND.)

|   |                                   |
|---|-----------------------------------|
| V <sub>CC</sub> .....                                       | -0.3V to +6V                      |
| V+ (Note 1).....  | (V <sub>CC</sub> - 0.3V) to +14V  |
| V- (Note 1).....  | +0.3V to -14V                     |
| <b>Input Voltages</b>                                       |                                   |
| TIN.....  | -0.3V to (V <sub>CC</sub> - 0.3V) |
| RIN (Except MAX220).....                                    | ±30V                              |
| RIN (MAX220).....   | ±25V                              |
| TOUT (Except MAX220) (Note 2).....                          | ±15V                              |
| TOUT (MAX220).....  | ±13.2V                            |
| <b>Output Voltages</b>                                      |                                   |
| TOUT.....   | ±15V                              |
| ROUT.....   | -0.3V to (V <sub>CC</sub> + 0.3V) |
| <b>Driver/Receiver Output Short Circuited to GND.....</b>   |                                   |
| Continuous  |                                   |
| <b>Continuous Power Dissipation (T<sub>A</sub> = +70°C)</b> |                                   |
| 16-Pin Plastic DIP (derate 10.53mW/°C above +70°C) ...      | 842mW                             |
| 18-Pin Plastic DIP (derate 11.11mW/°C above +70°C) ...      | 889mW                             |
| 20-Pin Plastic DIP (derate 8.00mW/°C above +70°C) ....      | 440mW                             |

|  |                 |
|--|-----------------|
| 16-Pin Narrow SO (derate 8.70mW/°C above +70°C)....  | 696mW           |
| 16-Pin Wide SO (derate 9.52mW/°C above +70°C) .....  | 762mW           |
| 18-Pin Wide SO (derate 9.52mW/°C above +70°C) .....  | 762mW           |
| 20-Pin Wide SO (derate 10.00mW/°C above +70°C) ..... | 800mW           |
| 20-Pin SSOP (derate 8.00mW/°C above +70°C).....      | 640mW           |
| 16-Pin CERDIP (derate 10.00mW/°C above +70°C).....   | 800mW           |
| 18-Pin CERDIP (derate 10.53mW/°C above +70°C).....   | 842mW           |
| <b>Operating Temperature Ranges</b>                  |                 |
| MAX2_AC_, MAX2_C_.....                               | 0°C to +70°C    |
| MAX2_AE_, MAX2_E_.....                               | -40°C to +85°C  |
| MAX2_AM_, MAX2_M_.....                               | -55°C to +125°C |
| <b>Storage Temperature Range.....</b>                | -65°C to +160°C |
| <b>Lead Temperature (soldering, 10s).....</b>        | +300°C          |
| <b>Soldering Temperature (reflow)</b>                |                 |
| 20 PDIP (P20M+1).....                                | +225°C          |
| All other lead(Pb)-free packages.....                | +260°C          |
| All other packages containing lead(Pb).....          | +240°C          |

**Note 1:** For the MAX220, V+ and V- can have a maximum magnitude of 7V, but their absolute difference cannot exceed 13V.

**Note 2:** Input voltage measured with TOUT in high-impedance state, V<sub>SHDN</sub> or V<sub>CC</sub> = 0V.

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—MAX220/222/232A/233A/242/243**

(V<sub>CC</sub> = +5V ±10%, C1–C4 = 0.1µF, MAX220, C1 = 0.047µF, C2–C4 = 0.33µF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Note 3)

| PARAMETER                            | CONDITIONS  | MIN                             | TYP   | MAX  | UNITS |   |
|--------------------------------------|---|---------------------------------|-------|------|-------|---|
| <b>RS-232 TRANSMITTERS</b>           |   |                                 |       |      |       |   |
| Output Voltage Swing                 | All transmitter outputs loaded with 3kΩ to GND  | ±5                              | ±8    |      | V     |   |
| Input Logic-Low Voltage              |   |                                 | 1.4   | 0.8  | V     |   |
| Input Logic-High Voltage             | All devices except MAX220   | 2                               | 1.4   |      | V     |   |
|                                      | MAX220: V <sub>CC</sub> = +5.0V   | 2.4                             |       |      |       |   |
| Logic Pullup/Input Current           | All except MAX220, normal operation   |                                 | 5     | 40   | µA    |   |
|                                      | V <sub>SHDN</sub> = 0V, MAX222/MAX242, shutdown, MAX220                                 |                                 | ±0.01 | ±1   |       |   |
| Output Leakage Current               | V <sub>CC</sub> = +5.5V, V <sub>SHDN</sub> = 0V, V <sub>OUT</sub> = ±15V, MAX222/MAX242 |                                 | ±0.01 | ±10  | µA    |   |
|                                      | V <sub>CC</sub> = V <sub>SHDN</sub> = 0V  | V <sub>OUT</sub> = ±15V         | ±0.01 | ±10  |       |   |
|                                      |   | MAX220, V <sub>OUT</sub> = ±12V |       | ±25  |       |   |
| Data Rate                            |   |                                 | 200   | 116  | kbps  |   |
| Transmitter Output Resistance        | V <sub>CC</sub> = V+ = V- = 0V, V <sub>OUT</sub> = ±2V                                  | 300                             | 10M   |      | Ω     |   |
| Output Short-Circuit Current         | V <sub>OUT</sub> = 0V   | V <sub>OUT</sub> = 0V           | ±7    | ±22  | mA    |   |
|                                      |   | MAX220                          |       | ±60  |       |   |
| <b>RS-232 RECEIVERS</b>              |   |                                 |       |      |       |   |
| RS-232 Input Voltage Operating Range |   |                                 |       | ±30  | V     |   |
|                                      |   |                                 |       | ±25  |       |   |
| RS-232 Input Threshold Low           | V <sub>CC</sub> = +5V   | All except MAX243 R2IN          | 0.8   | 1.3  | V     |   |
|                                      |   | MAX243 R2IN (Note 4)            | -3    |      |       |   |
| RS-232 Input Threshold High          | V <sub>CC</sub> = +5V   | All except MAX243 R2IN          |       | 1.8  | 2.4   | V |
|                                      |   | MAX243 R2IN (Note 4)            |       | -0.5 | -0.1  |   |

**Electrical Characteristics—MAX220/222/232A/233A/242/243 (continued)**(V<sub>CC</sub> = +5V ±10%, C1–C4 = 0.1µF, MAX220, C1 = 0.047µF, C2–C4 = 0.33µF, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Note 3)

| PARAMETER  | CONDITIONS  |  | MIN   | TYP                   | MAX  | UNITS |
|--|---|--|-------|-----------------------|------|-------|
| RS-232 Input Hysteresis  | All except MAX220/MAX243, V <sub>CC</sub> = +5V, no hysteresis in shutdown  |  | 0.2   | 0.5                   | 1.0  | V     |
|  | MAX220  |  | 0.3   |                       |      |       |
|  | MAX243  |  | 1     |                       |      |       |
| RS-232 Input Resistance  | T <sub>A</sub> = +25°C (MAX220)   |  | 3     | 5                     | 7    | kΩ    |
|  |   |  | 3     | 5                     | 7    |       |
| TTL/CMOS Output Voltage Low  | I <sub>OUT</sub> = 3.2mA  |  | 0.2   |                       |      | V     |
|  | I <sub>OUT</sub> = 1.6mA (MAX220)   |  | 0.4   |                       |      |       |
| TTL/CMOS Output Voltage High   | I <sub>OUT</sub> = -1.0mA   |  | 3.5   | V <sub>CC</sub> - 0.2 |      | V     |
| TTL/CMOS Output Short-Circuit Current  | Sourcing V <sub>OUT</sub> = V <sub>GND</sub>  |  | -2    | -10                   |      | mA    |
|  | Sinking V <sub>OUT</sub> = V <sub>CC</sub>  |  | 10    | 30                    |      |       |
| TTL/CMOS Output Leakage Current  | V <sub>SHDN</sub> = V <sub>CC</sub> or V <sub>EN</sub> = V <sub>CC</sub> (V <sub>SHDN</sub> = 0V for MAX222), 0V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub>           |  | ±0.05 |                       | ±10  | µA    |
| EN Input Threshold Low   | MAX242  |  | 1.4   |                       | 0.8  | V     |
| EN Input Threshold High  | MAX242  |  | 2.0   | 1.4                   |      | V     |
| Supply Voltage Range   |   |  | 4.5   |                       | 5.5  | V     |
| V <sub>CC</sub> Supply Current (V <sub>SHDN</sub> = V <sub>CC</sub> ),<br>Figures 5, 6, 11, 19 | No load   | MAX220                                   | 0.5   |                       | 2    | mA    |
|  |   | MAX222/MAX232A/MAX233A/<br>MAX242/MAX243 | 4     |                       | 10   |       |
|  | 3kΩ load<br>both inputs   | MAX220                                   | 12    |                       |      |       |
|  |   | MAX222/MAX232A/MAX233A/<br>MAX242/MAX243 | 15    |                       |      |       |
| Shutdown Supply Current  | MAX222/<br>MAX242   | T <sub>A</sub> = +25°C                   | 0.1   |                       | 10   | µA    |
|  |   | T <sub>A</sub> = 0°C to +70°C            | 2     |                       | 50   |       |
|  |   | T <sub>A</sub> = -40°C to +85°C          | 2     |                       | 50   |       |
|  |   | T <sub>A</sub> = -55°C to +125°C         | 35    |                       | 100  |       |
| SHDN Input Leakage Current   | MAX222/MAX242   |  |       |                       | ±1   | µA    |
| SHDN Threshold Low   | MAX222/MAX242   |  | 1.4   |                       | 0.8  | V     |
| SHDN Threshold High  | MAX222/MAX242   |  | 2.0   | 1.4                   |      | V     |
| Transition Slew Rate   | C <sub>L</sub> = 50pF to 2500pF,<br>R <sub>L</sub> = 3kΩ to 7kΩ, V <sub>CC</sub><br>= +5V, T <sub>A</sub> = +25°C,<br>measured from +3V to<br>-3V or -3V to +3V | MAX222/MAX232A/<br>MAX233/MAX242/MAX243  | 6     | 12                    | 30   | V/µs  |
|  |   | MAX220                                   | 1.5   | 3                     | 30.0 |       |
| Transmitter Propagation Delay TLL to<br>RS-232 (Normal Operation)                              | t <sub>PHLT</sub> , Figure 1  | MAX222/MAX232A/<br>MAX233/MAX242/MAX243  | 1.3   |                       | 3.5  | µs    |
|  |   | MAX220                                   | 4     |                       | 10   |       |
|  | t <sub>PLHT</sub> , Figure 1  | MAX222/MAX232A/<br>MAX233/MAX242/MAX243  | 1.5   |                       | 3.5  |       |
|  |   | MAX220                                   | 5     |                       | 10   |       |

**Electrical Characteristics—MAX220/222/232A/233A/242/243 (continued)**

( $V_{CC} = +5V \pm 10\%$ ,  $C1-C4 = 0.1\mu F$ , MAX220,  $C1 = 0.047\mu F$ ,  $C2-C4 = 0.33\mu F$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Note 3)

| PARAMETER  | CONDITIONS            |   | MIN | TYP  | MAX | UNITS   |
|--|-----------------------|---|-----|------|-----|---------|
| Receiver Propagation Delay RS-232 to TLL (Normal Operation)        | $t_{PHLR}$ , Figure 2 | MAX222/MAX232A/MAX233/MAX242/MAX243                                       |     | 0.5  | 1   | $\mu s$ |
|  |                       | MAX220  |     | 0.6  | 3   |         |
|  | $t_{PLHR}$ , Figure 2 | MAX222/MAX232A/MAX233/MAX242/MAX243                                       |     | 0.6  | 1   |         |
|  |                       | MAX220  |     | 0.8  | 3   |         |
| Receiver Propagation Delay RS-232 to TLL (Shutdown)                | $t_{PHLS}$ , Figure 2 | MAX242  |     | 0.5  | 10  | $\mu s$ |
|  | $t_{PLHS}$ , Figure 2 | MAX242  |     | 2.5  | 10  |         |
| Receiver-Output Enable Time  | $t_{ER}$              | MAX242, Figure 3  |     | 125  | 500 | ns      |
| Receiver-Output Disable Time                                       | $t_{DR}$              | MAX242, Figure 3  |     | 160  | 500 | ns      |
| Transmitter-Output Enable Time (SHDN Goes High)                    | $t_{ET}$              | MAX222/MAX242, 0.1 $\mu F$ caps (includes charge-pump start-up), Figure 4 |     | 250  |     | $\mu s$ |
| Transmitter-Output Disable Time (SHDN Goes Low)                    | $t_{DT}$              | MAX222/MAX242, 0.1 $\mu F$ caps, Figure 4                                 |     | 600  |     | ns      |
| Transmitter + to - Propagation Delay Difference (Normal Operation) | $t_{PHLT} - t_{PLHT}$ | MAX222/MAX232A/MAX233/MAX242/MAX243                                       |     | 300  |     | ns      |
|  |                       | MAX220  |     | 2000 |     |         |
| Receiver + to - Propagation Delay Difference (Normal Operation)    | $t_{PHLR} - t_{PLHR}$ | MAX222/MAX232A/MAX233/MAX242/MAX243                                       |     | 100  |     | ns      |
|  |                       | MAX220  |     | 225  |     |         |

**Note 3:** All units are production tested at hot. Specifications over temperature are guaranteed by design.

**Note 4:** MAX243 R2OUT is guaranteed to be low when R2IN  $\geq 0V$  or is unconnected.

**Typical Operating Characteristics**

**MAX220/MAX222/MAX232A/MAX233A/MAX242/MAX243**



**Absolute Maximum Ratings—MAX223/MAX230–MAX241**

(Voltages referenced to GND.)

V<sub>CC</sub>.....-0.3V to +6V  
 V+ ..... (V<sub>CC</sub> - 0.3V) to +14V  
 V- .....+0.3V to -14V

**Input Voltages**

TIN .....-0.3V to (V<sub>CC</sub> + 0.3V)  
 RIN.....±30V

**Output Voltages**

TOUT .....(V+ + 0.3V) to (V- - 0.3V)  
 ROUT.....-0.3V to (V<sub>CC</sub> + 0.3V)

Short-Circuit Duration, TOUT to GND..... Continuous

**Continuous Power Dissipation (T<sub>A</sub> = +70°C)**

14-Pin Plastic DIP (derate 10.00mW/°C above +70°C)... 800mW  
 16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)... 842mW  
 20-Pin Plastic DIP (derate 11.11mW/°C above +70°C)... 889mW  
 24-Pin Narrow Plastic DIP (derate 13.33mW/°C above +70°C) ..... 1.07W  
 24-Pin Plastic DIP (derate 9.09mW/°C above +70°C) 500mW  
 16-Pin Wide SO (derate 9.52mW/°C above +70°C) ...762mW  
 20-Pin Wide SO (derate 10.00mW/°C above +70°C) .800mW  
 24-Pin Wide SO (derate 11.76mW/°C above +70°C)..941mW

28-Pin Wide SO (derate 12.50mW/°C above +70°C) .....1W  
 44-Pin Plastic FP (derate 11.11mW/°C above +70°C) 889mW  
 14-Pin CERDIP (derate 9.09mW/°C above +70°C) ....727mW  
 16-Pin CERDIP (derate 10.00mW/°C above +70°C) ..800mW  
 20-Pin CERDIP (derate 11.11mW/°C above +70°C)...889mW  
 24-Pin Narrow CERDIP (derate 12.50mW/°C above +70°C) ..... 1W  
 24-Pin Sidebrazed (derate 20.0mW/°C above +70°C) ..... 1.6W  
 28-Pin SSOP (derate 9.52mW/°C above +70°C)..... 762mW

**Operating Temperature Ranges**

MAX2 \_\_ C \_\_ .....0°C to +70°C  
 MAX2 \_\_ E \_\_ .....-40°C to +85°C  
 MAX2 \_\_ M \_\_ .....-55°C to +125°C

Storage Temperature Range ..... -65°C to +160°C

Lead Temperature (soldering, 10s) .....+300°C

**Soldering Temperature (reflow)**

20 PDIP (P20M+1) .....+225°C  
 24 PDIP (P24M-1) .....+225°C  
 All other lead(Pb)-free packages.....+260°C  
 All other packages containing lead(Pb).....+240°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—MAX223/MAX230–MAX241**

(MAX223/230/232/234/236/237/238/240/241, V<sub>CC</sub> = +5V ±10%; MAX233/MAX235, V<sub>CC</sub> = +5V ±5%, C1–C4 = 1.0µF; MAX231/MAX239, V<sub>CC</sub> = +5V ±10%; V+ = +7.5V to +13.2V; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>; unless otherwise noted.) (Note 5)

| PARAMETER                              | CONDITIONS   |                            | MIN  | TYP  | MAX | UNITS |
|--|--|----------------------------|------|------|-----|-------|
| Output Voltage Swing                   | All transmitter outputs loaded with 3kΩ to ground    |                            | ±5.0 | ±7.3 |     | V     |
| V <sub>CC</sub> Supply Current         | No load, T <sub>A</sub> = +25°C                      | MAX232/233                 |      | 5    | 10  | mA    |
|  |  | MAX223/230/234–238/240/241 |      | 7    | 15  |       |
|  |  | MAX231/239                 |      | 0.4  | 1   |       |
| V+ Supply Current                      |  | MAX231                     |      | 1.8  | 5   | mA    |
|  |  | MAX239                     |      | 5    | 15  |       |
| Shutdown Supply Current                | T <sub>A</sub> = +25°C                               | MAX223                     |      | 15   | 50  | µA    |
|  |  | MAX230/235/236/240/241     |      | 1    | 10  |       |
| Input Logic-Low Voltage                | TIN, EN, SHDN (MAX233); EN, SHDN (MAX230/235–241)    |                            |      |      | 0.8 | V     |
| Input Logic-High Voltage               | TIN  |                            | 2.0  |      |     | V     |
|  | EN, SHDN (MAX233); EN, SHDN (MAX230/235/236/240/241) |                            | 2.4  |      |     |       |
| Logic Pullup Current                   | V <sub>TIN</sub> = 0V                                |                            |      | 1.5  | 200 | µA    |
| Receiver Input Voltage Operating Range |  |                            | -30  |      | +30 | V     |

## Electrical Characteristics—MAX223/MAX230–MAX241 (continued)

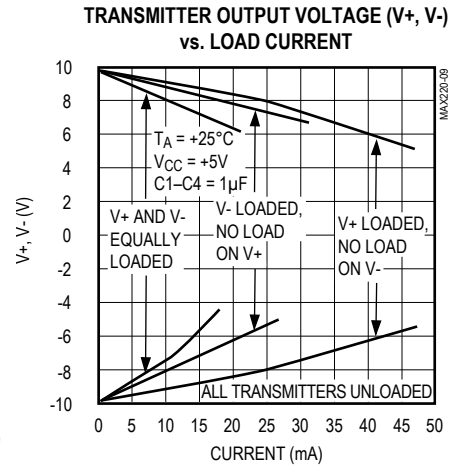
(MAX223/230/232/234/236/237/238/240/241,  $V_{CC} = +5V \pm 10\%$ ; MAX233/MAX235,  $V_{CC} = +5V \pm 5\%$ , C1–C4 = 1.0 $\mu$ F; MAX231/MAX239,  $V_{CC} = +5V \pm 10\%$ ;  $V_+ = +7.5V$  to  $+13.2V$ ;  $T_A = T_{MIN}$  to  $T_{MAX}$ ; unless otherwise noted.) (Note 5)

| PARAMETER                                | CONDITIONS  |  | MIN               | TYP            | MAX      | UNITS            |    |
|--|---|--|-------------------|----------------|----------|------------------|----|
| RS-232 Input Logic-Low Voltage           | $T_A = +25^\circ\text{C}$ ,<br>$V_{CC} = +5V$   | Normal operation<br>$V_{\overline{\text{SHDN}}} = +5V$ (MAX223)<br>$V_{\text{SHDN}} = 0V$ (MAX235/236/240/241) | 0.8               | 1.2            |          | V                |    |
|  |   | Shutdown (MAX223)<br>$V_{\overline{\text{SHDN}}} = 0V$ ,<br>$V_{\text{EN}} = +5V$ (R4IN, R5IN)                 | 0.6               | 1.5            |          |                  |    |
| RS-232 Input Logic-High Voltage          | $T_A = +25^\circ\text{C}$ ,<br>$V_{CC} = +5V$   | Normal operation<br>$V_{\overline{\text{SHDN}}} = 5V$ (MAX223)<br>$V_{\text{SHDN}} = 0V$ (MAX235/236/240/241)  |                   | 1.7            | 2.4      | V                |    |
|  |   | Shutdown (MAX223)<br>$V_{\overline{\text{SHDN}}} = 0V$ ,<br>$V_{\text{EN}} = +5V$ (R4IN, R5IN)                 |                   | 1.5            | 2.4      |                  |    |
| RS-232 Input Hysteresis                  | $V_{CC} = +5V$ , no hysteresis in shutdown  |  | 0.2               | 0.5            | 1.0      | V                |    |
| RS-232 Input Resistance                  | $T_A = +25^\circ\text{C}$ , $V_{CC} = +5V$  |  | 3                 | 5              | 7        | k $\Omega$       |    |
| TTL/CMOS Output Voltage Low              | $I_{\text{OUT}} = 1.6\text{mA}$ (MAX231/232/233, $I_{\text{OUT}} = 3.2\text{mA}$ )  |  |                   |                | 0.4      | V                |    |
| TTL/CMOS Output Voltage High             | $I_{\text{OUT}} = -1\text{mA}$  |  | 3.5               | $V_{CC} - 0.4$ |          | V                |    |
| TTL/CMOS Output Leakage Current          | $0V \leq R_{\text{OUT}} \leq V_{CC}$ ; $V_{\text{EN}} = 0V$ (MAX223);<br>$V_{\overline{\text{EN}}} = V_{CC}$ (MAX235–241)   |  |                   | $\pm 0.05$     | $\pm 10$ | $\mu\text{A}$    |    |
| Receiver Output Enable Time              | Normal operation  | MAX223   |                   | 600            |          | ns               |    |
|  |   | MAX235/236/239/240/241   |                   | 400            |          |                  |    |
| Receiver Output Disable Time             | Normal operation  | MAX223   |                   | 900            |          | ns               |    |
|  |   | MAX235/236/239/240/241   |                   | 250            |          |                  |    |
| Propagation Delay                        | RS-232 IN to<br>TTL/CMOS OUT,<br>$C_L = 150\text{pF}$   | Normal operation   |                   | 0.5            | 10       | $\mu\text{s}$    |    |
|  |   | $V_{\overline{\text{SHDN}}} = 0V$<br>(MAX223)  | $t_{\text{PHLS}}$ |                | 4        |                  | 40 |
|  |   |  | $t_{\text{PLHS}}$ |                | 6        |                  | 40 |
| Transition Region Slew Rate              | MAX223/MAX230/MAX234–241, $T_A = +25^\circ\text{C}$ , $V_{CC} = +5V$ ,<br>$R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ , $C_L = 50\text{pF}$ to $2500\text{pF}$ , measured from<br>$+3V$ to $-3V$ or $-3V$ to $+3V$ |  | 3                 | 5.1            | 30       | V/ $\mu\text{s}$ |    |
|  | MAX231/MAX232/MAX233, $T_A = +25^\circ\text{C}$ , $V_{CC} = +5V$ ,<br>$R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$ , $C_L = 50\text{pF}$ to $2500\text{pF}$ , measured from<br>$+3V$ to $-3V$ or $-3V$ to $+3V$     |  |                   | 4              | 30       |                  |    |
| Transmitter Output Resistance            | $V_{CC} = V_+ = V_- = 0V$ , $V_{\text{OUT}} = \pm 2V$   |  | 300               |                |          | $\Omega$         |    |
| Transmitter Output Short-Circuit Current |   |  | $\pm 10$          |                |          | mA               |    |

**Note 5:** All units are production tested at hot except for the MAX240, which is production tested at  $T_A = +25^\circ\text{C}$ . Specifications over temperature are guaranteed by design.

Typical Operating Characteristics

MAX223/MAX230-MAX241



V<sub>+</sub>, V<sub>-</sub> WHEN EXITING SHUTDOWN (1µF CAPACITORS)



\*SHUTDOWN POLARITY IS REVERSED FOR NON MAX241 PARTS

**Absolute Maximum Ratings—MAX225/MAX244–MAX249**

(Voltages referenced to GND.)

|   |                                   |   |                 |
|---|-----------------------------------|---|-----------------|
| Supply Voltage (V <sub>CC</sub> ).....        | -0.3V to +6V                      | Continuous Power Dissipation (T <sub>A</sub> = +70°C)   |                 |
| Input Voltages                                |                                   | 28-Pin Wide SO (derate 12.50mW/°C above +70°C) .....    | 1W              |
| TIN, ENA, ENB, ENR, ENT, ENRA,                |                                   | 40-Pin Plastic DIP (derate 11.11mW/°C above +70°C)..... | 611mW           |
| ENRB, ENTA, ENTB.....                         | -0.3V to (V <sub>CC</sub> + 0.3V) | 44-Pin PLCC (derate 13.33mW/°C above +70°C) .....       | 1.07W           |
| RIN.....                                      | ±25V                              | Operating Temperature Ranges                            |                 |
| TOUT (Note 6).....                            | ±15V                              | MAX225C_-, MAX24_C_- .....                              | 0°C to +70°C    |
| ROUT.....                                     | -0.3V to (V <sub>CC</sub> + 0.3V) | MAX225E_-, MAX24_E_- .....                              | -40°C to +85°C  |
| Short Circuit Duration (one output at a time) |                                   | Storage Temperature Range .....                         | -65°C to +160°C |
| TOUT to GND .....                             | Continuous                        | Lead Temperature (soldering, 10s) .....                 | +300°C          |
| ROUT to GND .....                             | Continuous                        | Soldering Temperature (reflow)                          |                 |
|   |                                   | 40 PDIP (P40M-2) .....                                  | +225°C          |
|   |                                   | All other lead(Pb)-free packages .....                  | +260°C          |
|   |                                   | All other packages containing lead(Pb) .....            | +240°C          |

**Note 6:** Input voltage measured with transmitter output in a high-impedance state, shutdown, or V<sub>CC</sub> = 0V.

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—MAX225/MAX244–MAX249**

(MAX225, V<sub>CC</sub> = +5.0V ±5%; MAX244–MAX249, V<sub>CC</sub> = +5.0V ±10%, external capacitors C1–C4 = 1µF; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>; unless otherwise noted.) (Note 7)

| PARAMETER                             | CONDITIONS  | MIN  | TYP                   | MAX   | UNITS |    |
|---------------------------------------|---|--|-----------------------|-------|-------|----|
| <b>RS-232 TRANSMITTERS</b>            |   |  |                       |       |       |    |
| Input Logic-Low Voltage               |   |  | 1.4                   | 0.8   | V     |    |
| Input Logic-High Voltage              |   | 2  | 1.4                   |       | V     |    |
| Logic Pullup/Input Current            | Tables 1a–1d  | Normal operation   |                       | 10    | 50    | µA |
|                                       |   | Shutdown   |                       | ±0.01 | ±1    |    |
| Data Rate                             | Tables 1a–1d, normal operation  |  | 120                   | 64    | kbps  |    |
| Output Voltage Swing                  | All transmitter outputs loaded with 3kΩ to GND  | ±5   | ±7.5                  |       | V     |    |
| Output Leakage Current (Shutdown)     | Tables 1a–1d  | V <sub>ENA</sub> , V <sub>ENB</sub> , V <sub>ENT</sub> , V <sub>ENTA</sub> , V <sub>ENTB</sub> = V <sub>CC</sub> , V <sub>OUT</sub> = ±15V |                       | ±0.01 | ±25   | µA |
|                                       |   | V <sub>CC</sub> = 0V, V <sub>OUT</sub> = ±15V  |                       | ±0.01 | ±25   |    |
| Transmitter Output Resistance         | V <sub>CC</sub> = V <sub>+</sub> = V <sub>-</sub> = 0V, V <sub>OUT</sub> = ±2V (Note 8)   | 300  | 10M                   |       | Ω     |    |
| Output Short-Circuit Current          | V <sub>OUT</sub> = 0V   | ±7   | ±30                   |       | mA    |    |
| <b>RS-232 RECEIVERS</b>               |   |  |                       |       |       |    |
| RS-232 Input Voltage Operating Range  |   |  |                       | ±25   | V     |    |
| RS-232 Input Logic-Low Voltage        | V <sub>CC</sub> = +5V   | 0.8  | 1.3                   |       | V     |    |
| RS-232 Input Logic-High Voltage       | V <sub>CC</sub> = +5V   |  | 1.8                   | 2.4   | V     |    |
| RS-232 Input Hysteresis               | V <sub>CC</sub> = +5V   | 0.2  | 0.5                   | 1.0   | V     |    |
| RS-232 Input Resistance               |   | 3  | 5                     | 7     | kΩ    |    |
| TTL/CMOS Output Voltage Low           | I <sub>OUT</sub> = 3.2mA  |  | 0.2                   | 0.4   | V     |    |
| TTL/CMOS Output Voltage High          | I <sub>OUT</sub> = -1.0mA   | 3.5  | V <sub>CC</sub> - 0.2 |       | V     |    |
| TTL/CMOS Output Short-Circuit Current | Sourcing V <sub>OUT</sub> = V <sub>GND</sub>  | -2   | -10                   |       | mA    |    |
|                                       | Sinking V <sub>OUT</sub> = V <sub>CC</sub>  | 10   | 30                    |       |       |    |
| TTL/CMOS Output Leakage Current       | Normal operation, outputs disabled, Tables 1a–1d, 0V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> , V <sub>ENR-</sub> = V <sub>CC</sub> |  | ±0.05                 | ±0.10 | µA    |    |



**Electrical Characteristics—MAX225/MAX244–MAX249 (continued)**

(MAX225,  $V_{CC} = +5.0V \pm 5\%$ ; MAX244–MAX249,  $V_{CC} = +5.0V \pm 10\%$ , external capacitors C1–C4 = 1 $\mu$ F;  $T_A = T_{MIN}$  to  $T_{MAX}$ ; unless otherwise noted.) (Note 7)

| PARAMETER   | CONDITIONS  |  | MIN  | TYP | MAX     | UNITS            |
|---|---|--|------|-----|---------|------------------|
| <b>POWER SUPPLY AND CONTROL LOGIC</b>                                 |   |  |      |     |         |                  |
| Supply Voltage Range  |   | MAX225   | 4.75 |     | 5.25    | V                |
|   |   | MAX244–MAX249  | 4.5  |     | 5.5     |                  |
| $V_{CC}$ Supply Current<br>(Normal Operation)                         | No load   | MAX225   |      | 10  | 20      | mA               |
|   |   | MAX244–MAX249  |      | 11  | 30      |                  |
|   | 3k $\Omega$ loads on<br>all outputs   | MAX225   |      | 40  |         |                  |
|   |   | MAX244–MAX249  |      | 57  |         |                  |
| Shutdown Supply Current   | $T_A = +25^\circ\text{C}$   |  |      | 8   | 25      |                  |
|   | $T_A = T_{MIN}$ to $T_{MAX}$  |  |      |     | 50      |                  |
| Control Input   | Leakage current   |  |      |     | $\pm 1$ | $\mu\text{A}$    |
|   | Logic-low voltage   |  |      | 1.4 | 0.8     | V                |
|   | Logic-high voltage  |  | 2.4  | 1.4 |         |                  |
| <b>AC CHARACTERISTICS</b>   |   |  |      |     |         |                  |
| Transition Slew Rate  | $C_L = 50\text{pF}$ to 2500pF, $R_L = 3\text{k}\Omega$ to 7k $\Omega$ , $V_{CC} = +5\text{V}$ ,<br>$T_A = +25^\circ\text{C}$ , measured from +3V to -3V or -3V to +3V |  | 5    | 10  | 30      | V/ $\mu\text{s}$ |
| Transmitter Propagation Delay<br>TLL to RS-232 (Normal Operation)     | $t_{PHLT}$ , Figure 1   |  |      | 1.3 | 3.5     | $\mu\text{s}$    |
|   | $t_{PLHT}$ , Figure 1   |  |      | 1.3 | 3.5     |                  |
| Receiver Propagation Delay<br>TLL to RS-232 (Normal Operation)        | $t_{PHLR}$ , Figure 2   |  |      | 0.6 | 1.5     | $\mu\text{s}$    |
|   | $t_{PLHR}$ , Figure 2   |  |      | 0.6 | 1.5     |                  |
| Receiver Propagation Delay<br>TLL to RS-232 (Low-Power Mode)          | $t_{PHLS}$ , Figure 2   |  |      | 0.6 | 1.5     | $\mu\text{s}$    |
|   | $t_{PLHS}$ , Figure 2   |  |      | 0.6 | 10      |                  |
| Transmitter + to - Propagation<br>Delay Difference (Normal Operation) | $t_{PHLT} - t_{PLHT}$   |  |      | 350 |         | ns               |
| Receiver + to - Propagation<br>Delay Difference (Normal Operation)    | $t_{PHLR} - t_{PLHR}$   |  |      | 350 |         | ns               |
| Receiver-Output Enable Time   | $t_{ER}$ , Figure 3   |  |      | 100 | 500     | ns               |
| Receiver-Output Disable Time  | $t_{DR}$ , Figure 3   |  |      | 100 | 500     | ns               |
| Transmitter Enable Time   | $t_{ET}$  | MAX246–MAX249<br>(excludes charge-pump startup)        |      | 5   |         | $\mu\text{s}$    |
|   |   | MAX225/MAX245–MAX249<br>(includes charge-pump startup) |      | 10  |         | ms               |
| Transmitter Disable Time  | $t_{DT}$ , Figure 4   |  |      | 100 |         | ns               |

**Note 7:** All units production tested at hot. Specifications over temperature are guaranteed by design.

**Note 8:** The 300 $\Omega$  minimum specification complies with EIA/TIA-232E, but the actual resistance when in shutdown mode or  $V_{CC} = 0\text{V}$  is 10M $\Omega$  as is implied by the leakage specification.

Typical Operating Characteristics

MAX225/MAX244–MAX249



Test Circuits/Timing Diagrams



Figure 1. Transmitter Propagation-Delay Timing



Figure 2. Receiver Propagation-Delay Timing



Figure 3. Receiver-Output Enable and Disable Timing



Figure 4. Transmitter-Output Disable Timing

## Control Pin Configuration Tables

Table 1a. MAX245 Control Pin Configurations

| $\overline{\text{ENT}}$ | $\overline{\text{ENR}}$ | OPERATION STATUS | TRANSMITTERS | RECEIVERS                  |
|-------------------------|-------------------------|------------------|--------------|----------------------------|
| 0                       | 0                       | Normal Operation | All Active   | All Active                 |
| 0                       | 1                       | Normal Operation | All Active   | All High-Z                 |
| 1                       | 0                       | Shutdown         | All High-Z   | All Low-Power Receive Mode |
| 1                       | 1                       | Shutdown         | All High-Z   | All High-Z                 |

Table 1b. MAX245 Control Pin Configurations

| $\overline{\text{ENT}}$ | $\overline{\text{ENR}}$ | OPERATION STATUS | TRANSMITTERS |            | RECEIVERS  |  |
|-------------------------|-------------------------|------------------|--------------|------------|--|--|
|                         |                         |                  | TA1–TA4      | TB1–TB4    | RA1–RA5  | RB1–RB5  |
| 0                       | 0                       | Normal Operation | All Active   | All Active | All Active                                       | All Active                                       |
| 0                       | 1                       | Normal Operation | All Active   | All Active | RA1–RA4 High-Z,<br>RA5 Active                    | RA1–RA4 High-Z,<br>RA5 Active                    |
| 1                       | 0                       | Shutdown         | All High-Z   | All High-Z | All Low-Power<br>Receive Mode                    | All Low-Power<br>Receive Mode                    |
| 1                       | 1                       | Shutdown         | All High-Z   | All High-Z | RA1–RA4 High-Z,<br>RA5 Low-Power<br>Receive Mode | RA1–RA4 High-Z,<br>RA5 Low-Power<br>Receive Mode |

Table 1c. MAX246 Control Pin Configurations

| $\overline{\text{ENA}}$ | $\overline{\text{ENB}}$ | OPERATION STATUS | TRANSMITTERS |            | RECEIVERS  |  |
|-------------------------|-------------------------|------------------|--------------|------------|--|--|
|                         |                         |                  | TA1–TA4      | TB1–TB4    | RA1–RA5  | RB1–RB5  |
| 0                       | 0                       | Normal Operation | All Active   | All Active | All Active                                       | All Active                                       |
| 0                       | 1                       | Normal Operation | All Active   | All Active | All Active                                       | RA1–RA4 High-Z,<br>RA5 Active                    |
| 1                       | 0                       | Shutdown         | All High-Z   | All High-Z | RA1–RA4 High-Z,<br>RA5 Active                    | All Low-Power<br>Receive Mode                    |
| 1                       | 1                       | Shutdown         | All High-Z   | All High-Z | RA1–RA4 High-Z,<br>RA5 Low-Power<br>Receive Mode | RA1–RA4 High-Z,<br>RA5 Low-Power<br>Receive Mode |

Table 1d. MAX247/MAX248/MAX249 Control Pin Configurations

| $\overline{\text{ENTA}}$ | $\overline{\text{ENTB}}$ | $\overline{\text{ENRA}}$ | $\overline{\text{ENRB}}$ | OPERATION<br>STATUS | TRANSMITTERS |            |            | RECEIVERS                 |   |
|--------------------------|--------------------------|--------------------------|--------------------------|---------------------|--------------|------------|------------|---------------------------|---|
|                          |                          |                          |                          |                     | MAX247       | TA1–TA4    | TB1–TB4    | RA1–RA4                   | RB1–RB5   |
|                          |                          |                          |                          |                     | MAX248       | TA1–TA4    | TB1–TB4    | RA1–RA4                   | RB1–RB4   |
|                          |                          |                          |                          |                     | MAX249       | TA1–TA3    | TB1–TB3    | RA1–RA5                   | RB1–RB5   |
| 0                        | 0                        | 0                        | 0                        | Normal Operation    |              | All Active | All Active | All Active                | All Active  |
| 0                        | 0                        | 0                        | 1                        | Normal Operation    |              | All Active | All Active | All Active                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 0                        | 0                        | 1                        | 0                        | Normal Operation    |              | All Active | All Active | All High-Z                | All Active  |
| 0                        | 0                        | 1                        | 1                        | Normal Operation    |              | All Active | All Active | All High-Z                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 0                        | 1                        | 0                        | 0                        | Normal Operation    |              | All Active | All High-Z | All Active                | All Active  |
| 0                        | 1                        | 0                        | 1                        | Normal Operation    |              | All Active | All High-Z | All Active                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 0                        | 1                        | 1                        | 0                        | Normal Operation    |              | All Active | All High-Z | All High-Z                | All Active  |
| 0                        | 1                        | 1                        | 1                        | Normal Operation    |              | All Active | All High-Z | All High-Z                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 1                        | 0                        | 0                        | 0                        | Normal Operation    |              | All High-Z | All Active | All Active                | All Active  |
| 1                        | 0                        | 0                        | 1                        | Normal Operation    |              | All High-Z | All Active | All Active                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 1                        | 0                        | 1                        | 0                        | Normal Operation    |              | All High-Z | All Active | All High-Z                | All Active  |
| 1                        | 0                        | 1                        | 1                        | Normal Operation    |              | All High-Z | All Active | All High-Z                | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 1                        | 1                        | 0                        | 0                        | Shutdown            |              | All High-Z | All High-Z | Low-Power<br>Receive Mode | Low-Power<br>Receive Mode                           |
| 1                        | 1                        | 0                        | 1                        | Shutdown            |              | All High-Z | All High-Z | Low-Power<br>Receive Mode | All High-Z, except<br>RB5 stays active on<br>MAX247 |
| 1                        | 1                        | 1                        | 0                        | Shutdown            |              | All High-Z | All High-Z | All High-Z                | Low-Power<br>Receive Mode                           |
| 1                        | 1                        | 1                        | 1                        | Shutdown            |              | All High-Z | All High-Z | All High-Z                | All High-Z, except<br>RB5 stays active on<br>MAX247 |

**Detailed Description**

The MAX220–MAX249 contain four sections: dual charge-pump DC-DC voltage converters, RS-232 drivers, RS-232 receivers, and receiver and transmitter enable control inputs.

**Dual Charge-Pump Voltage Converter**

The MAX220–MAX249 have two internal charge-pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation. The first converter uses capacitor C1 to double the +5V input to +10V on C3 at the V+ output. The second converter uses capacitor C2 to invert +10V to -10V on C4 at the V- output.

A small amount of power may be drawn from the +10V (V+) and -10V (V-) outputs to power external circuitry (see the *Typical Operating Characteristics* section), except on the MAX225 and MAX245–MAX247, where these pins are not available. V+ and V- are not regulated, so the output voltage drops with increasing load current. Do not load V+ and V- to a point that violates the minimum ±5V EIA/TIA-232E driver output voltage when sourcing current from V+ and V- to external circuitry.

When using the shutdown feature in the MAX222, MAX225, MAX230, MAX235, MAX236, MAX240, MAX241, and MAX245–MAX249, avoid using V+ and Vto power external circuitry. When these parts are shut down, V- falls to 0V, and V+ falls to +5V. For applications where a +10V external supply is applied to the V+ pin (instead of using the internal charge pump to generate +10V), the C1 capacitor must not be installed and the SHDN pin must be connected to VCC. This is because V+ is internally connected to VCC in shutdown mode.

**RS-232 Drivers**

The typical driver output voltage swing is ±8V when loaded with a nominal 5kΩ RS-232 receiver and VCC = +5V. Output swing is guaranteed to meet the EIA/TIA-232E and V.28 specification, which calls for ±5V minimum driver output levels under worst-case conditions. These include a minimum 3kΩ load, VCC = +4.5V, and maximum operating temperature. Unloaded driver output voltage ranges from (V+ -1.3V) to (V- +0.5V).

Input thresholds are both TTL and CMOS compatible. The inputs of unused drivers can be left unconnected since 400kΩ input pullup resistors to VCC are built in (except for the MAX220). The pullup resistors force the outputs of unused drivers low because all drivers invert. The internal input pullup resistors typically source 12µA, except in shutdown mode where the pullups are disabled. Driver outputs turn off and enter a high-impedance state—where

leakage current is typically microamperes (maximum 25µA)—when in shutdown mode, in three-state mode, or when device power is removed. Outputs can be driven to ±15V. The powersupply current typically drops to 8µA in shutdown mode. The MAX220 does not have pullup resistors to force the outputs of the unused drivers low. Connect unused inputs to GND or VCC.

The MAX239 has a receiver three-state control line, and the MAX223, MAX225, MAX235, MAX236, MAX240, and MAX241 have both a receiver three-state control line and a low-power shutdown control. Table 2 shows the effects of the shutdown control and receiver three-state control on the receiver outputs.

The receiver TTL/CMOS outputs are in a high-impedance, three-state mode whenever the three-state enable line is high (for the MAX225/MAX235/MAX236/MAX239–MAX241), and are also high-impedance whenever the shutdown control line is high.

When in low-power shutdown mode, the driver outputs are turned off and their leakage current is less than 1µA with the driver output pulled to ground. The driver output leakage remains less than 1µA, even if the transmitter output is backdriven between 0V and (VCC + 6V). Below -0.5V, the transmitter is diode clamped to ground with 1kΩ series impedance. The transmitter is also zener clamped to approximately VCC + 6V, with a series impedance of 1kΩ.

The driver output slew rate is limited to less than 30V/µs as required by the EIA/TIA-232E and V.28 specifications. Typical slew rates are 24V/µs unloaded and 10V/µs loaded with 3Ω and 2500pF.

**RS-232 Receivers**

EIA/TIA-232E and V.28 specifications define a voltage level greater than 3V as a logic 0, so all receivers invert. Input thresholds are set at 0.8V and 2.4V, so receivers respond to TTL level inputs as well as EIA/TIA-232E and V.28 levels.

**Table 2. Three-State Control of Receivers**

| PART                       | SHDN               | SHDN                | EN               | EN(R)            | RECEIVERS                                  |
|----------------------------|--------------------|---------------------|------------------|------------------|--|
| MAX223                     | —                  | Low<br>High<br>High | X<br>Low<br>High | —                | High Impedance<br>Active<br>High Impedance |
| MAX225                     | —                  | —                   | —                | Low<br>High      | High Impedance<br>Active                   |
| MAX235<br>MAX236<br>MAX240 | Low<br>Low<br>High | —                   | —                | Low<br>High<br>X | High Impedance<br>Active<br>High Impedance |

The receiver inputs withstand an input overvoltage up to  $\pm 25\text{V}$  and provide input terminating resistors with nominal  $5\text{k}\Omega$  values. The receivers implement Type 1 interpretation of the fault conditions of V.28 and EIA/TIA-232E.

The receiver input hysteresis is typically  $0.5\text{V}$  with a guaranteed minimum of  $0.2\text{V}$ . This produces clear output transitions with slow-moving input signals, even with moderate amounts of noise and ringing. The receiver propagation delay is typically  $600\text{ns}$  and is independent of input swing direction.

### Low-Power Receive Mode

The low-power receive mode feature of the MAX223, MAX242, and MAX245–MAX249 puts the IC into shutdown mode but still allows it to receive information. This is important for applications where systems are periodically awakened to look for activity. Using low-power receive mode, the system can still receive a signal that will activate it on command and prepare it for communication at faster data rates. This operation conserves system power.

### Negative Threshold—MAX243

The MAX243 is pin compatible with the MAX232A, differing only in that RS-232 cable fault protection is removed on one of the two receiver inputs. This means that control lines such as CTS and RTS can either be driven or left unconnected without interrupting communication. Different cables are not needed to interface with different pieces of equipment.

The input threshold of the receiver without cable fault protection is  $-0.8\text{V}$  rather than  $+1.4\text{V}$ . Its output goes positive only if the input is connected to a control line that is actively driven negative. If not driven, it defaults to the 0 or “OK to send” state. Normally, the MAX243’s other receiver ( $+1.4\text{V}$  threshold) is used for the data line (TD or RD), while the negative threshold receiver is connected to the control line (DTR, DTS, CTS, RTS, etc.).

Other members of the RS-232 family implement the optional cable fault protection as specified by EIA/TIA-232E specifications. This means a receiver output goes high whenever its input is driven negative, left unconnected, or shorted to ground. The high output tells the serial communications IC to stop sending data. To avoid this, the control lines must either be driven or connected with jumpers to an appropriate positive voltage level.

### Shutdown—MAX222–MAX242

On the MAX222, MAX235, MAX236, MAX240, and MAX241, all receivers are disabled during shutdown. On the MAX223 and MAX242, two receivers continue to operate in a reduced power mode when the chip is in shutdown. Under these conditions, the propagation delay increases to about  $2.5\mu\text{s}$  for a high-to-low input transition. When in shutdown, the receiver acts as a CMOS inverter with no hysteresis. The MAX223 and MAX242 also have a receiver output enable input ( $\overline{\text{EN}}$  for the MAX242 and EN for the MAX223) that allows receiver output control independent of SHDN (SHDN for MAX241). With all other devices, SHDN (SHDN for MAX241) also disables the receiver outputs.

The MAX225 provides five transmitters and five receivers, while the MAX245 provides ten receivers and eight transmitters. Both devices have separate receiver and transmitter-enable controls. The charge pumps turn off and the devices shut down when a logic high is applied to the ENT input. In this state, the supply current drops to less than  $25\mu\text{A}$  and the receivers continue to operate in a low-power receive mode. Driver outputs enter a high-impedance state (three-state mode). On the MAX225, all five receivers are controlled by the  $\overline{\text{ENR}}$  input. On the MAX245, eight of the receiver outputs are controlled by the  $\overline{\text{ENR}}$  input, while the remaining two receivers (RA5 and RB5) are always active. RA1–RA4 and RB1–RB4 are put in a three-state mode when  $\overline{\text{ENR}}$  is a logic high.

### Receiver and Transmitter Enable Control Inputs

The MAX225 and MAX245–MAX249 feature transmitter and receiver enable controls.

The receivers have three modes of operation: full-speed receive (normal active), three-state (disabled), and low-power receive (enabled receivers continue to function at lower data rates). The receiver enable inputs control the full-speed receive and three-state modes. The transmitters have two modes of operation: full-speed transmit (normal active) and three-state (disabled). The transmitter enable inputs also control the shutdown mode. The device enters shutdown mode when all transmitters are disabled. Enabled receivers function in the low-power receive mode when in shutdown.

Tables 1a–1d define the control states. The MAX244 has no control pins and is not included in these tables.

The MAX246 has ten receivers and eight drivers with two control pins, each controlling one side of the device. A logic high at the A-side control input ( $\overline{ENA}$ ) causes the four A-side receivers and drivers to go into a three-state mode. Similarly, the B-side control input ( $\overline{ENB}$ ) causes the four B-side drivers and receivers to go into a three-state mode. As in the MAX245, one A-side and one B-side receiver (RA5 and RB5) remain active at all times. The entire device is put into shutdown mode when both the A and B sides are disabled ( $ENA = ENB = +5V$ ).

The MAX247 provides nine receivers and eight drivers with four control pins. The  $\overline{ENRA}$  and  $\overline{ENRB}$  receiver enable inputs each control four receiver outputs. The  $\overline{ENTA}$  and  $\overline{ENTB}$  transmitter enable inputs each control four drivers. The ninth receiver (RB5) is always active. The device enters shutdown mode with a logic high on both  $\overline{ENTA}$  and  $\overline{ENTB}$ .

The MAX248 provides eight receivers and eight drivers with four control pins. The  $\overline{ENRA}$  and  $\overline{ENRB}$  receiver enable inputs each control four receiver outputs. The  $\overline{ENTA}$  and  $\overline{ENTB}$  transmitter enable inputs control four drivers each. This part does not have an always-active receiver. The device enters shutdown mode and transmitters go into a three-state mode with a logic high on both  $\overline{ENTA}$  and  $\overline{ENTB}$ .

The MAX249 provides ten receivers and six drivers with four control pins. The  $\overline{ENRA}$  and  $\overline{ENRB}$  receiver enable inputs each control five receiver outputs. The  $\overline{ENTA}$  and  $\overline{ENTB}$  transmitter enable inputs control three drivers each. There is no always-active receiver. The device enters shutdown mode and transmitters go into a three-state mode with a logic high on both  $\overline{ENTA}$  and  $\overline{ENTB}$ . In shutdown mode, active receivers operate in a low-power receive mode at data rates up to 20kb/s.

### Applications Information

Figures 5 through 25 show pin configurations and typical operating circuits. In applications that are sensitive to power-supply noise,  $V_{CC}$  should be decoupled to ground with a capacitor of the same value as C1 and C2 connected as close as possible to the device.





Figure 5. MAX220/MAX232/MAX232A Pin Configuration and Typical Operating Circuit



Figure 6. MAX222/MAX242 Pin Configurations and Typical Operating Circuit

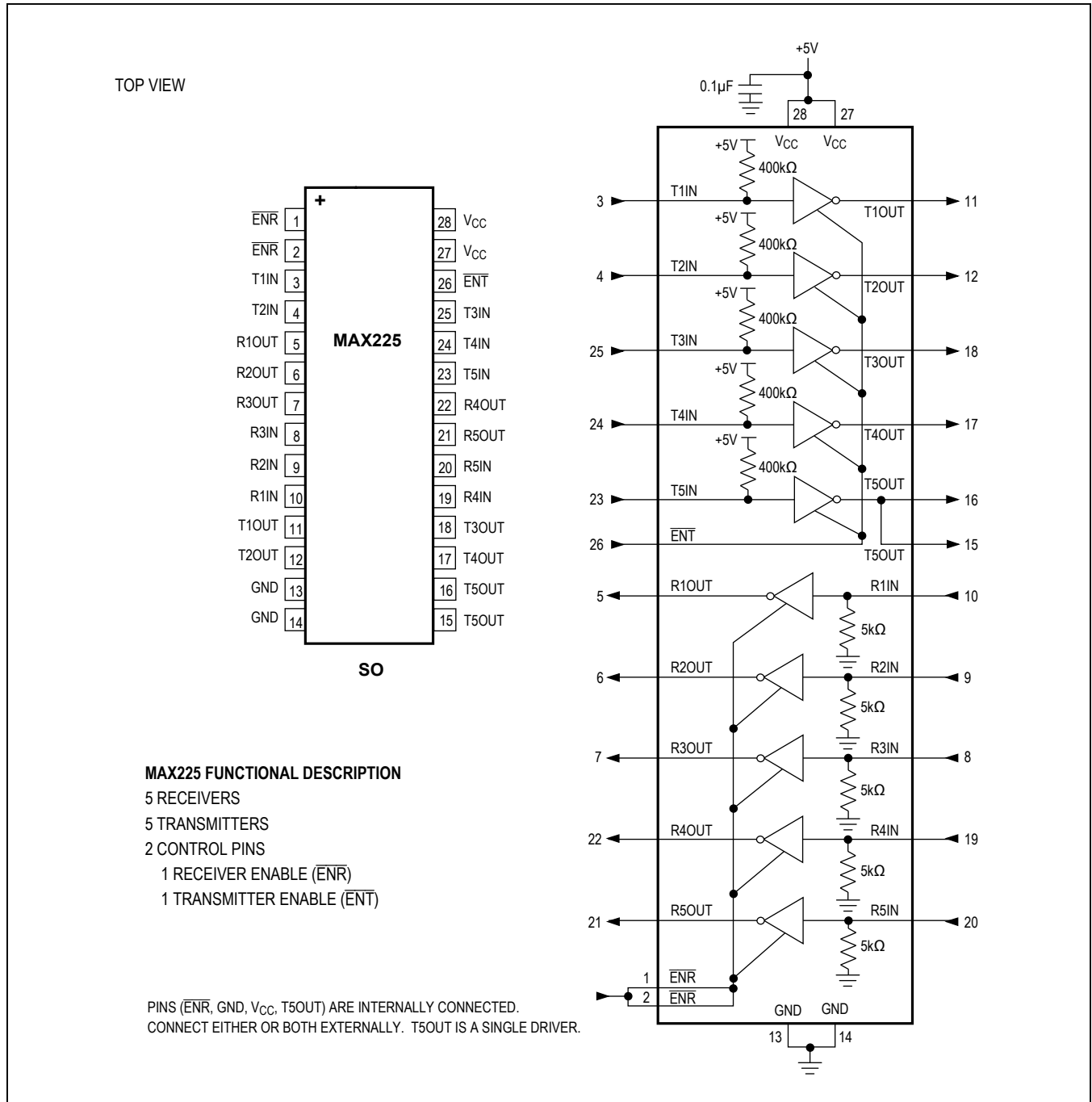


Figure 7. MAX225 Pin Configuration and Typical Operating Circuit



Figure 8. MAX223/MAX241 Pin Configuration and Typical Operating Circuit

# MAX220–MAX249

## +5V-Powered, Multichannel RS-232 Drivers/Receivers



Figure 9. MAX230 Pin Configuration and Typical Operating Circuit



Figure 10. MAX231 Pin Configurations and Typical Operating Circuit

# MAX220–MAX249

# +5V-Powered, Multichannel RS-232 Drivers/Receivers

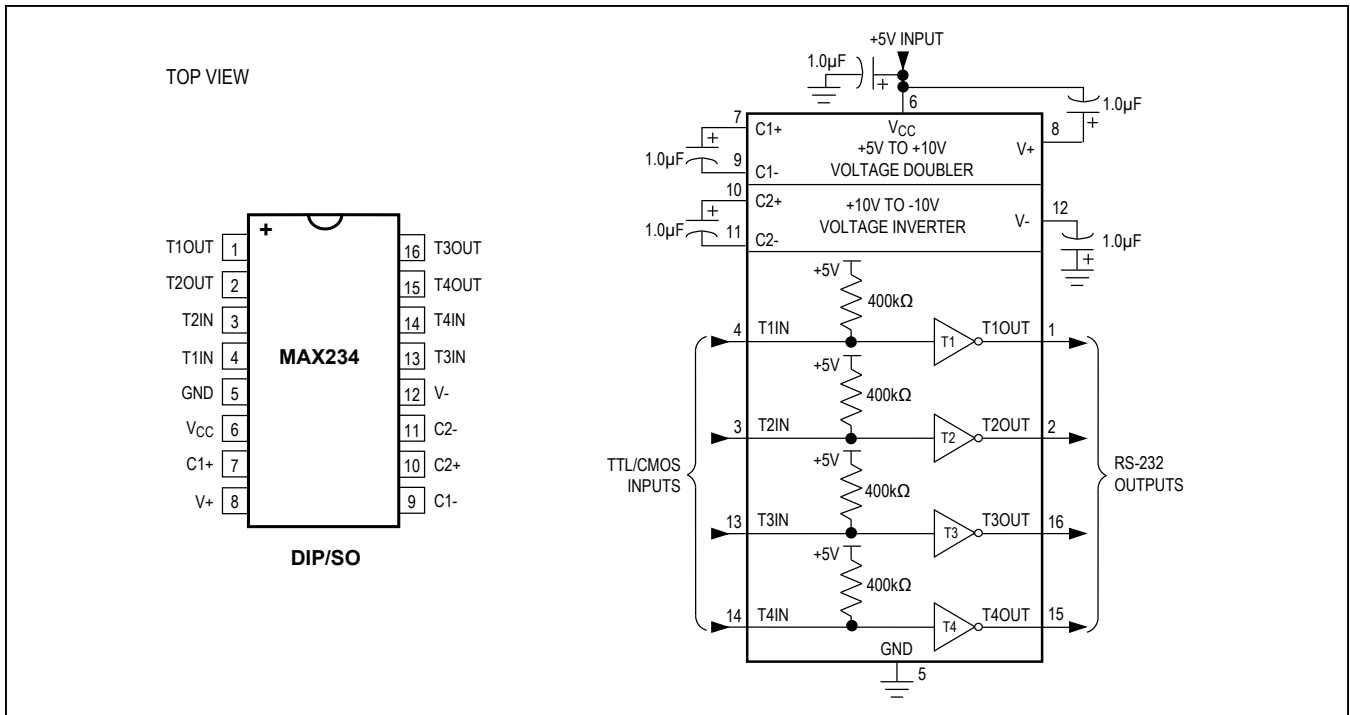






Figure 14. MAX236 Pin Configuration and Typical Operating Circuit



Figure 15. MAX237 Pin Configuration and Typical Operating Circuit





16. MAX238 Pin Configuration and Typical Operating Circuit



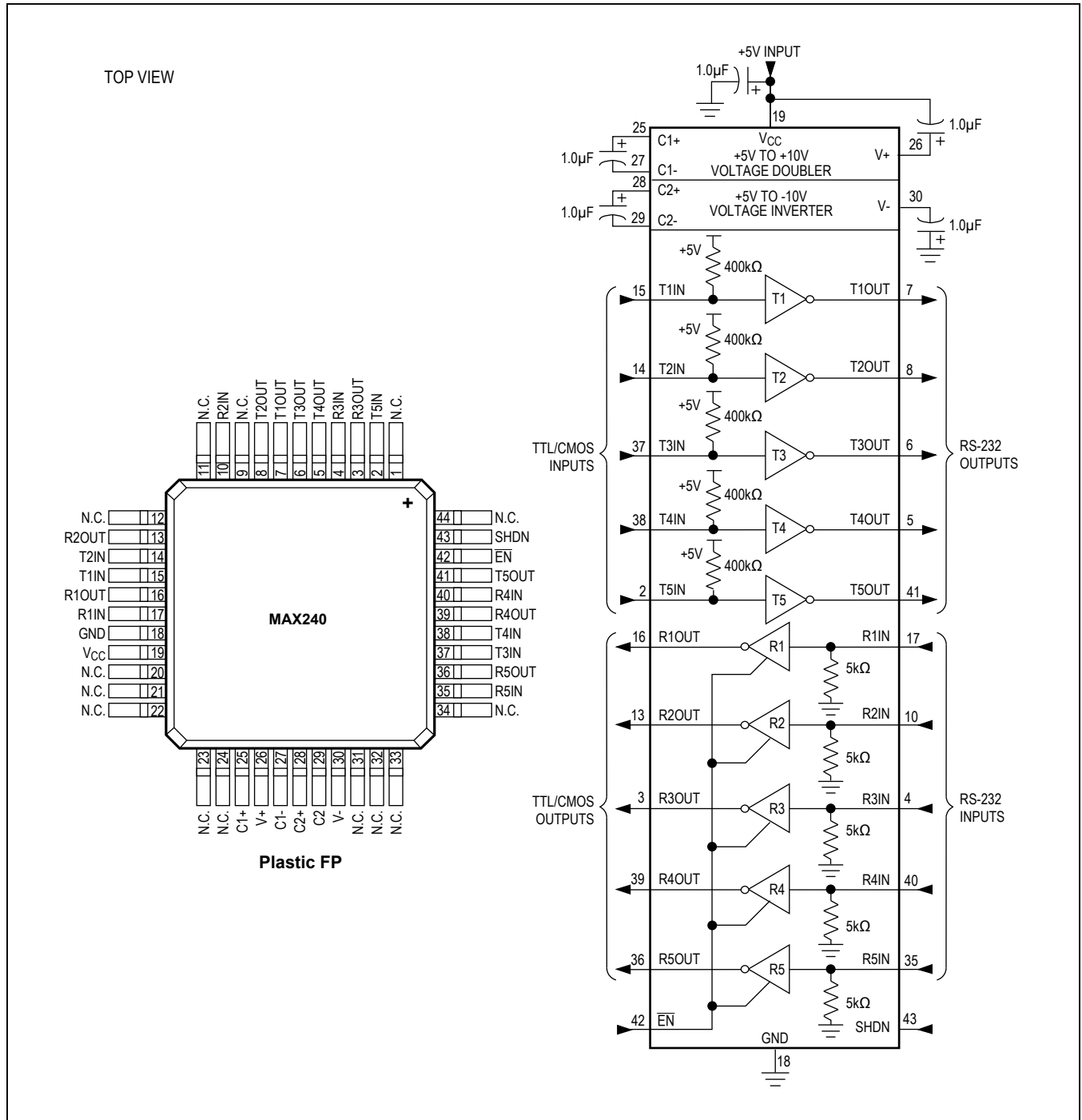


Figure 18. MAX240 Pin Configuration and Typical Operating Circuit

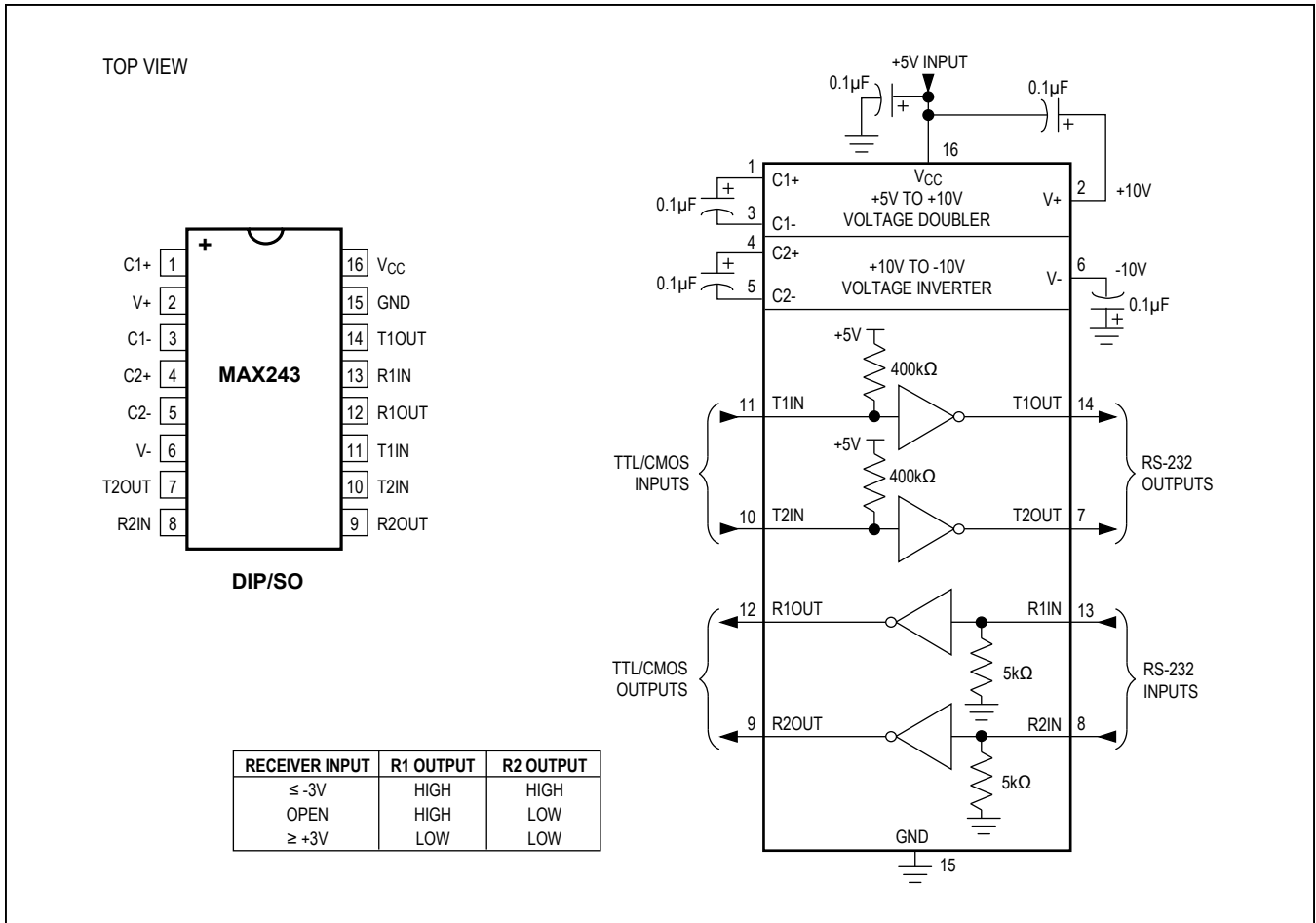


Figure 19. MAX243 Pin Configuration and Typical Operating Circuit



Figure 20. MAX244 Pin Configuration and Typical Operating Circuit



Figure 21. MAX245 Pin Configuration and Typical Operating Circuit



Figure 22. MAX246 Pin Configuration and Typical Operating Circuit



Figure 23. MAX247 Pin Configuration and Typical Operating Circuit





Figure 24. MAX248 Pin Configuration and Typical Operating Circuit

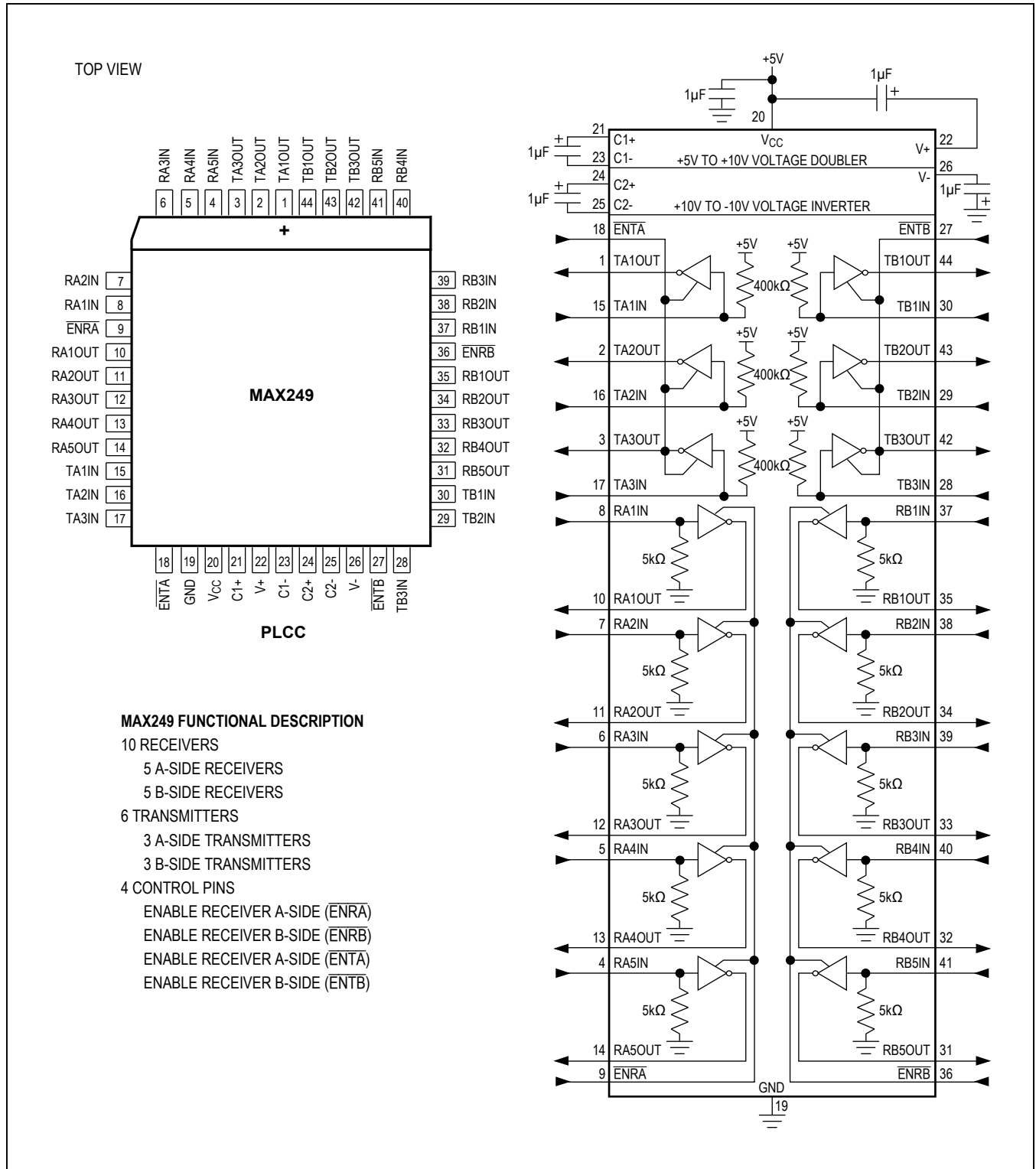


Figure 25. MAX249 Pin Configuration and Typical Operating Circuit

## Ordering Information

| PART               | TEMP RANGE     | PIN-PACKAGE     |
|--------------------|----------------|-----------------|
| <b>MAX220</b> CPE+ | 0°C to +70°C   | 16 Plastic DIP  |
| MAX220CSE+         | 0°C to +70°C   | 16 Narrow SO    |
| MAX220CWE+         | 0°C to +70°C   | 16 Wide SO      |
| MAX220C/D          | 0°C to +70°C   | Dice*           |
| MAX220EPE+         | -40°C to +85°C | 16 Plastic DIP  |
| MAX220ESE+         | -40°C to +85°C | 16 Narrow SO    |
| MAX220EWE+         | -40°C to +85°C | 16 Wide SO      |
| MAX220EJE          | -40°C to +85°C | 16 CERDIP       |
| MAX220MJE          | 55°C to +125°C | 16 CERDIP       |
| <b>MAX222</b> CPN+ | 0°C to +70°C   | 18 Plastic DIP  |
| MAX222CWN+         | 0°C to +70°C   | 18 Wide SO      |
| MAX222C/D          | 0°C to +70°C   | Dice*           |
| MAX222EPN+         | -40°C to +85°C | 18 Plastic DIP  |
| MAX222EWN+         | -40°C to +85°C | 18 Wide SO      |
| MAX222EJN          | -40°C to +85°C | 18 CERDIP       |
| MAX222MJN          | 55°C to +125°C | 18 CERDIP       |
| <b>MAX223</b> CAI+ | 0°C to +70°C   | 28 SSOP         |
| MAX223CWI+         | 0°C to +70°C   | 28 Wide SO      |
| MAX223C/D          | 0°C to +70°C   | Dice*           |
| MAX223EAI+         | -40°C to +85°C | 28 SSOP         |
| MAX223EWI+         | -40°C to +85°C | 28 Wide SO      |
| <b>MAX225</b> CWI+ | 0°C to +70°C   | 28 Wide SO      |
| MAX225EWI+         | -40°C to +85°C | 28 Wide SO      |
| <b>MAX230</b> CPP+ | 0°C to +70°C   | 20 Plastic DIP1 |
| MAX230CWP+         | 0°C to +70°C   | 20 Wide SO      |
| MAX230C/D          | 0°C to +70°C   | Dice*           |
| MAX230EPP+         | -40°C to +85°C | 20 Plastic DIP  |
| MAX230EWP+         | -40°C to +85°C | 20 Wide SO      |
| MAX230EJP          | -40°C to +85°C | 20 CERDIP       |
| MAX230MJP          | 55°C to +125°C | 20 CERDIP       |
| <b>MAX231</b> CPD+ | 0°C to +70°C   | 14 Plastic DIP  |
| MAX231CWE+         | 0°C to +70°C   | 16 Wide SO      |
| MAX231CJD          | 0°C to +70°C   | 14 CERDIP       |
| MAX231C/D          | 0°C to +70°C   | Dice*           |
| MAX231EPD+         | -40°C to +85°C | 14 Plastic DIP  |

| PART                | TEMP RANGE     | PIN-PACKAGE    |
|---------------------|----------------|----------------|
| MAX231EWE+          | -40°C to +85°C | 16 Wide SO     |
| MAX231EJD           | -40°C to +85°C | 14 CERDIP      |
| MAX231MJD           | 55°C to +125°C | 14 CERDIP      |
| <b>MAX232</b> CPE+  | 0°C to +70°C   | 16 Plastic DIP |
| MAX232CSE+          | 0°C to +70°C   | 16 Narrow SO   |
| MAX232CWE+          | 0°C to +70°C   | 16 Wide SO     |
| MAX232C/D           | 0°C to +70°C   | Dice*          |
| MAX232EPE+          | -40°C to +85°C | 16 Plastic DIP |
| MAX232ESE+          | -40°C to +85°C | 16 Narrow SO   |
| MAX232EWE+          | -40°C to +85°C | 16 Wide SO     |
| MAX232EJE           | -40°C to +85°C | 16 CERDIP      |
| MAX232MJE           | 55°C to +125°C | 16 CERDIP      |
| MAX232MLP+          | 55°C to +125°C | 20 LCC         |
| <b>MAX232A</b> CPE+ | 0°C to +70°C   | 16 Plastic DIP |
| MAX232ACSE+         | 0°C to +70°C   | 16 Narrow SO   |
| MAX232ACWE+         | 0°C to +70°C   | 16 Wide SO     |
| MAX232AC/D          | 0°C to +70°C   | Dice*          |
| MAX232AEPE+         | -40°C to +85°C | 16 Plastic DIP |
| MAX232AESE+         | -40°C to +85°C | 16 Narrow SO   |
| MAX232AEWE+         | -40°C to +85°C | 16 Wide SO     |
| MAX232AEJE          | -40°C to +85°C | 16 CERDIP      |
| MAX232AMJE          | 55°C to +125°C | 16 CERDIP      |
| MAX232AMLP+         | 55°C to +125°C | 20 LCC         |
| <b>MAX233</b> CPP+  | 0°C to +70°C   | 20 Plastic DIP |
| MAX233EPP+          | -40°C to +85°C | 20 Plastic DIP |
| <b>MAX233A</b> CPP+ | 0°C to +70°C   | 20 Plastic DIP |
| MAX233ACWP+         | 0°C to +70°C   | 20 Wide SO     |
| MAX233AEPP+         | -40°C to +85°C | 20 Plastic DIP |
| MAX233AEWP+         | -40°C to +85°C | 20 Wide SO     |
| <b>MAX234</b> CPE+  | 0°C to +70°C   | 16 Plastic DIP |
| MAX234CWE+          | 0°C to +70°C   | 16 Wide SO     |
| MAX234C/D           | 0°C to +70°C   | Dice*          |
| MAX234EPE+          | -40°C to +85°C | 16 Plastic DIP |

+Denotes a lead(Pb)-free/RoHS-compliant package.

\*Contact factory for dice specifications.

## Ordering Information (continued)

| PART               | TEMP RANGE     | PIN-PACKAGE           |
|--------------------|----------------|-----------------------|
| MAX234EWE+         | -40°C to +85°C | 16 Wide SO            |
| MAX234EJE          | -40°C to +85°C | 16 CERDIP             |
| MAX234MJE          | 55°C to +125°C | 16 CERDIP             |
| <b>MAX235</b> CPG+ | 0°C to +70°C   | 24 Wide Plastic DIP   |
| MAX235EPG+         | -40°C to +85°C | 24 Wide Plastic DIP   |
| MAX235EDG          | -40°C to +85°C | 24 Ceramic SB         |
| MAX235MDG          | 55°C to +125°C | 24 Ceramic SB         |
| <b>MAX236</b> CNG+ | 0°C to +70°C   | 24 Narrow Plastic DIP |
| MAX236CWG+         | 0°C to +70°C   | 24 Wide SO            |
| MAX236C/D          | 0°C to +70°C   | Dice*                 |
| MAX236ENG+         | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX236EWG+         | -40°C to +85°C | 24 Wide SO            |
| MAX236ERG          | -40°C to +85°C | 24 Narrow CERDIP      |
| MAX236MRG          | 55°C to +125°C | 24 Narrow CERDIP      |
| <b>MAX237</b> CNG+ | 0°C to +70°C   | 24 Narrow Plastic DIP |
| MAX237CWG+         | 0°C to +70°C   | 24 Wide SO            |
| MAX237C/D          | 0°C to +70°C   | Dice*                 |
| MAX237ENG+         | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX237EWG+         | -40°C to +85°C | 24 Wide SO            |
| MAX237ERG          | -40°C to +85°C | 24 Narrow CERDIP      |
| MAX237MRG          | 55°C to +125°C | 24 Narrow CERDIP      |
| <b>MAX238</b> CNG+ | 0°C to +70°C   | 24 Narrow Plastic DIP |
| MAX238CWG+         | 0°C to +70°C   | 24 Wide SO            |
| MAX238C/D          | 0°C to +70°C   | Dice*                 |
| MAX238ENG+         | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX238EWG+         | -40°C to +85°C | 24 Wide SO            |
| MAX238ERG          | -40°C to +85°C | 24 Narrow CERDIP      |
| MAX238MRG          | 55°C to +125°C | 24 Narrow CERDIP      |
| <b>MAX239</b> CNG+ | 0°C to +70°C   | 24 Narrow Plastic DIP |
| MAX239CWG+         | 0°C to +70°C   | 24 Wide SO            |
| MAX239C/D          | 0°C to +70°C   | Dice*                 |
| MAX239ENG+         | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX239EWG+         | -40°C to +85°C | 24 Wide SO            |
| MAX239ERG          | -40°C to +85°C | 24 Narrow CERDIP      |
| MAX239MRG          | 55°C to +125°C | 24 Narrow CERDIP      |

| PART               | TEMP RANGE     | PIN-PACKAGE    |
|--------------------|----------------|----------------|
| <b>MAX240</b> CMH+ | 0°C to +70°C   | 44 Plastic FP  |
| MAX240C/D          | 0°C to +70°C   | Dice*          |
| <b>MAX241</b> CAI+ | 0°C to +70°C   | 28 SSOP        |
| MAX241CWI+         | 0°C to +70°C   | 28 Wide SO     |
| MAX241C/D          | 0°C to +70°C   | Dice*          |
| MAX241EAI+         | -40°C to +85°C | 28 SSOP        |
| MAX241EWI+         | -40°C to +85°C | 28 Wide SO     |
| <b>MAX242</b> CAP+ | 0°C to +70°C   | 20 SSOP        |
| MAX242CPN+         | 0°C to +70°C   | 18 Plastic DIP |
| MAX242CWN+         | 0°C to +70°C   | 18 Wide SO     |
| MAX242C/D          | 0°C to +70°C   | Dice*          |
| MAX242EPN+         | -40°C to +85°C | 18 Plastic DIP |
| MAX242EWN+         | -40°C to +85°C | 18 Wide SO     |
| MAX242EJN          | -40°C to +85°C | 18 CERDIP      |
| MAX242MJN          | 55°C to +125°C | 18 CERDIP      |
| <b>MAX243</b> CPE+ | 0°C to +70°C   | 16 Plastic DIP |
| MAX243CSE+         | 0°C to +70°C   | 16 Narrow SO   |
| MAX243CWE+         | 0°C to +70°C   | 16 Wide SO     |
| MAX243C/D          | 0°C to +70°C   | Dice*          |
| MAX243EPE+         | -40°C to +85°C | 16 Plastic DIP |
| MAX243ESE+         | -40°C to +85°C | 16 Narrow SO   |
| MAX243EWE+         | -40°C to +85°C | 16 Wide SO     |
| MAX243EJE          | -40°C to +85°C | 16 CERDIP      |
| MAX243MJE          | 55°C to +125°C | 16 CERDIP      |
| <b>MAX244</b> CQH+ | 0°C to +70°C   | 44 PLCC        |
| MAX244C/D          | 0°C to +70°C   | Dice*          |
| MAX244EQH+         | -40°C to +85°C | 44 PLCC        |
| <b>MAX245</b> CPL+ | 0°C to +70°C   | 40 Plastic DIP |
| MAX245C/D          | 0°C to +70°C   | Dice*          |
| MAX245EPL+         | -40°C to +85°C | 40 Plastic DIP |
| <b>MAX246</b> CPL+ | 0°C to +70°C   | 40 Plastic DIP |
| MAX246C/D          | 0°C to +70°C   | Dice*          |
| MAX246EPL+         | -40°C to +85°C | 40 Plastic DIP |

+Denotes a lead(Pb)-free/RoHS-compliant package.

\*Contact factory for dice specifications.

## Ordering Information (continued)

| PART              | TEMP RANGE     | PIN-PACKAGE    |
|-------------------|----------------|----------------|
| <b>MAX247CPL+</b> | 0°C to +70°C   | 40 Plastic DIP |
| MAX247C/D         | 0°C to +70°C   | Dice*          |
| MAX247EPL+        | -40°C to +85°C | 40 Plastic DIP |
| <b>MAX248CQH+</b> | 0°C to +70°C   | 44 PLCC        |
| MAX248C/D         | 0°C to +70°C   | Dice*          |
| MAX248EQH+        | -40°C to +85°C | 44 PLCC        |
| <b>MAX249CQH+</b> | 0°C to +70°C   | 44 PLCC        |
| MAX249EQH+        | -40°C to +85°C | 44 PLCC        |

+Denotes a lead(Pb)-free/RoHS-compliant package.

\*Contact factory for dice specifications.

## Selection Table

| PART NUMBER | POWER SUPPLY (V) | NO. OF RS-232 Drivers/Rx | NO. OF EXT CAP | NOMINAL CAPACITOR VALUE (µF) | SHDN AND THREE-STATE | Rx ACTIVE IN SHDN | DATA RATE (kbps) | FEATURES  |
|-------------|------------------|--------------------------|----------------|------------------------------|----------------------|-------------------|------------------|---|
| MAX220      | +5               | 2/2                      | 4              | 0.047, 0.33                  | No                   | No                | 120              | Ultra-low-power, industry-standard pinout                                       |
| MAX222      | +5               | 2/2                      | 4              | 0.1                          | Yes                  | No                | 200              | Low-power shutdown  |
| MAX223      | +5               | 4/5                      | 4              | 1.0, 0.1                     | Yes                  | Yes               | 120              | MAX241 and receivers active in shutdown   |
| MAX225      | +5               | 5/5                      | 0              | —                            | Yes                  | Yes               | 120              | Available in SO   |
| MAX230      | +5               | 5/0                      | 4              | 1.0, 0.1                     | Yes                  | No                | 120              | 5 drivers with shutdown   |
| MAX231      | +5 and +7.5 to   | 2/2                      | 2              | 1.0, 0.1                     | No                   | No                | 120              | Standard +5/+12V or battery supplies; same functions as MAX232                  |
| MAX232      | +5               | 2/2                      | 4              | 1.0, 0.1                     | No                   | No                | 120 (64)         | Industry standard   |
| MAX232A     | +5               | 2/2                      | 4              | 0.1                          | No                   | No                | 200              | Higher slew rate, small caps  |
| MAX233      | +5               | 2/2                      | 0              | —                            | No                   | No                | 120              | No external caps  |
| MAX233A     | +5               | 2/2                      | 0              | —                            | No                   | No                | 200              | No external caps, high slew rate  |
| MAX234      | +5               | 4/0                      | 4              | 1.0, 0.1                     | No                   | No                | 120              | Replaces 1488   |
| MAX235      | +5               | 5/5                      | 0              | —                            | Yes                  | No                | 120              | No external caps  |
| MAX236      | +5               | 4/3                      | 4              | 1.0, 0.1                     | Yes                  | No                | 120              | Shutdown, three state   |
| MAX237      | +5               | 5/3                      | 4              | 1.0, 0.1                     | No                   | No                | 120              | Complements IBM PC serial port  |
| MAX238      | +5               | 4/4                      | 4              | 1.0, 0.1                     | No                   | No                | 120              | Replaces 1488 and 1489  |
| MAX239      | +5 and +7.5 to   | 3/5                      | 2              | 1.0, 0.1                     | No                   | No                | 120              | Standard +5/+12V or battery supplies; single-package solution for IBM PC serial |
| MAX240      | +5               | 5/5                      | 4              | 1.0                          | Yes                  | No                | 120              | DIP or flatpack package   |
| MAX241      | +5               | 4/5                      | 4              | 1.0, 0.1                     | Yes                  | No                | 120              | Complete IBM PC serial port   |
| MAX242      | +5               | 2/2                      | 4              | 0.1                          | Yes                  | Yes               | 200              | Separate shutdown and enable  |
| MAX243      | +5               | 2/2                      | 4              | 0.1                          | No                   | No                | 200              | Open-line detection simplifies cabling  |
| MAX244      | +5               | 8/10                     | 4              | 1.0                          | No                   | No                | 120              | High slew rate  |
| MAX245      | +5               | 8/10                     | 0              | —                            | Yes                  | Yes               | 120              | High slew rate, int. caps, two shutdown   |
| MAX246      | +5               | 8/10                     | 0              | —                            | Yes                  | Yes               | 120              | High slew rate, int. caps, three shutdown                                       |
| MAX247      | +5               | 8/9                      | 0              | —                            | Yes                  | Yes               | 120              | High slew rate, int. caps, nine operating                                       |
| MAX248      | +5               | 8/8                      | 4              | 1.0                          | Yes                  | Yes               | 120              | High slew rate, selective half-chip enables                                     |
| MAX249      | +5               | 6/10                     | 4              | 1.0                          | Yes                  | Yes               | 120              | Available in quad flatpack package  |

**Package Information**

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a “+”, “#”, or “-” in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO. | LAND PATTERN NO. |
|--------------|--------------|-------------|------------------|
| 14 PDIP      | P14+3        | 21-0043     | —                |
| 16 PDIP      | P16+1        |             |                  |
| 16 PDIP      | P16+2        |             |                  |
| 16 PDIP      | P16+3        |             |                  |
| 18 PDIP      | P18+5        |             |                  |
| 20 PDIP      | P20+3        |             |                  |
| 20 PDIP      | P20M+1       |             |                  |
| 24 PDIP      | N24+3        |             |                  |
| 24 PDIP      | P24M+1       | 21-0044     |                  |
| 28 PDIP      | P28+2        |             |                  |
| 40 PDIP      | P40+1        |             |                  |
| 40 PDIP      | P40M+2       |             |                  |
| 14 CERDIP    | J14-3        | 21-0045     |                  |
| 16 CERDIP    | J16-3        |             |                  |
| 18 CERDIP    | J18-2        |             |                  |
| 20 CERDIP    | J20-2        |             |                  |
| 24 CERDIP    | R24-4        |             |                  |
| 16 SO(N)     | S16+3        | 21-0041     | 90-0097          |
| 16 SO(N)     | S16+5        |             |                  |

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO. | LAND PATTERN NO. |
|--------------|--------------|-------------|------------------|
| 16 SO(W)     | W16+1        | 21-0042     | 90-0107          |
| 16 SO(W)     | W16+2        |             |                  |
| 16 SO(W)     | W16+3        |             |                  |
| 18 SO(W)     | W18+1        |             | 90-0181          |
| 20 SO(W)     | W20+3        |             |                  |
| 20 SO(W)     | W20M+1       |             |                  |
| 24 SO(W)     | W24+2        |             |                  |
| 28 SO(W)     | W28+1        |             | 90-0108          |
| 28 SO(W)     | W28+2        |             |                  |
| 28 SO(W)     | W28M+1       |             |                  |
| 20 LCC       | L20+3        | 21-0658     | 90-0177          |
| 20 SSOP      | A20+1        | 21-0658     | 90-0094          |
| 24 SSOP      | A24+2        |             | 90-0110          |
| 28 SSOP      | A28+1        |             | 90-0095          |
| 16 TSSOP     | U16+1        |             | 90-0117          |
| 16 FPCK      | F16-3        | 21-0013     | —                |
| 44 MQFP      | M44+5        | 21-0826     | 90-0169          |
| 44 PLCC      | Q44+1        | 21-0049     | 90-0236          |
| 44 PLCC      | Q44+2        |             |                  |

**Terminal Connections**

|    | 01,03,05 | 01,03,05 | 02    | 02    | 04    | 04    |
|----|----------|----------|-------|-------|-------|-------|
|    | J16      | L20      | J18   | L20   | J18   | L20   |
| 1  | C1+      | NC       | NC    | NC    | EN    | EN    |
| 2  | V+       | C1+      | C1+   | C1+   | C1+   | C1+   |
| 3  | C1-      | V+       | V+    | V+    | V+    | V+    |
| 4  | C2+      | C1-      | C1-   | C1-   | C1-   | C1-   |
| 5  | C2-      | C2+      | C2+   | C2+   | C2+   | C2+   |
| 6  | V-       | NC       | C2-   | NC    | C2-   | NC    |
| 7  | T2OUT    | C2-      | V-    | C2-   | V-    | C2-   |
| 8  | R2IN     | V-       | T2OUT | V-    | T2OUT | V-    |
| 9  | R2OUT    | T2OUT    | R2IN  | T2OUT | R2IN  | T2OUT |
| 10 | T2IN     | R2IN     | R2OUT | R2IN  | R2OUT | R2IN  |

|    | 01,03,05 | 01,03,05 | 02    | 02    | 04    | 04    |
|----|----------|----------|-------|-------|-------|-------|
|    | J16      | L20      | J18   | L20   | J18   | L20   |
| 11 | T1IN     | NC       | T2IN  | NC    | T2IN  | NC    |
| 12 | R1OUT    | R2OUT    | T1IN  | R2OUT | T1IN  | R2OUT |
| 13 | R1IN     | T2IN     | R1OUT | T2IN  | R1OUT | T2IN  |
| 14 | T1OUT    | T1IN     | R1IN  | T1IN  | R1IN  | T1IN  |
| 15 | GND      | R1OUT    | T1OUT | R1OUT | T1OUT | R1OUT |
| 16 | VCC      | NC       | GND   | R1IN  | GND   | R1IN  |
| 17 |          | R1IN     | VCC   | T1OUT | VCC   | T1OUT |
| 18 |          | T1OUT    | SHND  | GND   | SHND  | GND   |
| 19 |          | GND      |       | VCC   |       | VCC   |
| 20 |          | VCC      |       | SHND  |       | SHND  |