

## FEATURES

- 1.8V to 5.5V Supply Voltage
- Single and Dual Transceivers
- High-Speed Operation
  - 1Mbps for 250pF/3k $\Omega$  Load (LTC2802, LTC2804)
  - 250kbps for 1nF/3k $\Omega$  Load
  - 100kbps for 2.5nF/3k $\Omega$  TIA/EIA-232-F Load
- Low-Power 1 $\mu$ A Shutdown and 15 $\mu$ A Receivers-Active Modes
- No Damage or Latchup to  $\pm 10$ kV ESD on RS-232 Interface
- Logic Supply Pin for Easy Level-Shifting to UART or Microprocessor
- Low-Latency Output Enable Allows Line Sharing and Half-Duplex Operation
- True RS-232 Compliant Output Levels
- Small Footprint:
  - LTC2801/LTC2802 4mm  $\times$  3mm DFN Package
  - LTC2803/LTC2804 Narrow SSOP-16 and 5mm  $\times$  3mm DFN Packages

## APPLICATIONS

- Battery-Powered Systems
- Computers and Consumer Electronics
- Diagnostic Ports

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## DESCRIPTION

The LTC<sup>®</sup>2801/LTC2802/LTC2803/LTC2804 are single and dual RS-232 transceivers in narrow SSOP and chip-scale DFN packages. All operate over a supply range of 1.8V to 5.5V, which permits operation directly from two alkaline, NiCd or NiMH cells. An integrated DC-to-DC converter generates power supplies for driving RS-232 levels. A logic supply pin allows easy interfacing with different logic levels independent of the DC-DC supply.

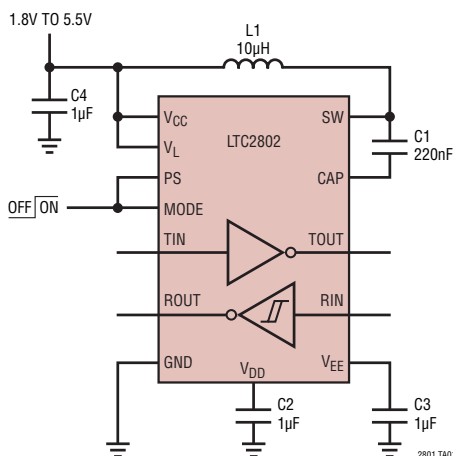
These parts are compatible with the TIA/EIA-232-F standard. Driver outputs are protected from overload and can be shorted to ground or up to  $\pm 15$ V without damage. To extend battery life, receivers can be kept active, operating at reduced speed, with only 15 $\mu$ A current. In shutdown mode, current is further reduced to 1 $\mu$ A.

## PRODUCT SELECTION GUIDE

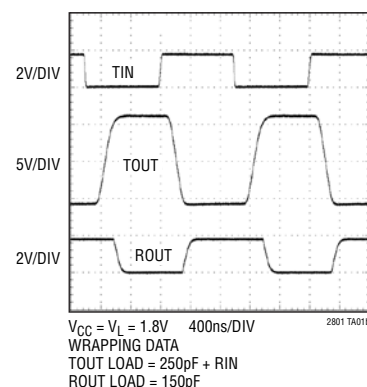
| PART NUMBER | DRIVERS AND RECEIVERS | MAXIMUM DATA RATE | MODES*         | PACKAGE |
|-------------|-----------------------|-------------------|----------------|---------|
| LTC2801     | 1 + 1                 | 0.25Mbps          | SD, RA, DD, AO | DFN-12  |
| LTC2802     | 1 + 1                 | 1Mbps             | SD, RA, DD, AO | DFN-12  |
| LTC2803     | 2 + 2                 | 0.25Mbps          | SD, RA, DD, AO | DFN-16  |
| LTC2803-1   | 2 + 2                 | 0.25Mbps          | SD, AO         | SSOP-16 |
| LTC2804     | 2 + 2                 | 1Mbps             | SD, RA, DD, AO | DFN-16  |
| LTC2804-1   | 2 + 2                 | 1Mbps             | SD, AO         | SSOP-16 |

\*SD = Shutdown, RA = Receiver Active (low power), DD = Drivers Disabled, AO = All On

## TYPICAL APPLICATION



LTC2802 at 1.8V and 1Mbps



# LTC2801/LTC2802/ LTC2803/LTC2804

## ABSOLUTE MAXIMUM RATINGS (Note 1)

### Input Supplies

|                |               |
|----------------|---------------|
| $V_{CC}$ ..... | –0.3V to 7V   |
| $V_L$ .....    | –0.3V to 6.7V |

### Generated Supplies

|                            |                          |
|----------------------------|--------------------------|
| $V_{DD}$ .....             | $V_{CC}$ –0.3V to 7.5V   |
| $V_{EE}$ .....             | 0.3V to –7.5V            |
| $V_{DD} - V_{EE}$ .....    | 14V                      |
| SW.....                    | –0.3V to $V_{DD} + 0.3V$ |
| CAP.....                   | +0.3V to $V_{EE} - 0.3V$ |
| TIN, T1IN, T2IN, MODE..... | –0.3V to 7V              |

PS, ON/OFF.....–0.3V to ( $V_L + 0.3V$ )

RIN, R1IN, R2IN.....–25V to 25V

TOUT, T1OUT, T2OUT.....–15V to 15V

ROUT, R1OUT, R2OUT.....–0.3V to ( $V_L + 0.3V$ )

### Operating Temperature

LTC280XC.....0°C to 70°C

LTC280XI.....–40°C to 85°C

Storage Temperature Range.....–65°C to 125°C

Lead Temperature (Soldering, 10 sec)

GN Package.....300°C

## PIN CONFIGURATION

|                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>LTC2801, LTC2802</b><br/><b>1-Driver/1-Receiver</b></p> <p>TOP VIEW</p> <p>DE PACKAGE<br/>12-LEAD (4mm × 3mm) PLASTIC DFN<br/><math>T_{JMAX} = 125^{\circ}C</math>, <math>\theta_{JA} = 43^{\circ}C/W</math>, <math>\theta_{JC} = 4.3^{\circ}C/W</math> (4 Layer)<br/>EXPOSED PAD (PIN 13) IS <math>V_{EE}</math>, MUST BE SOLDERED TO PCB</p> | <p><b>LTC2803, LTC2804</b><br/><b>2-Driver/2-Receiver</b></p> <p>TOP VIEW</p> <p>DHC PACKAGE<br/>16-LEAD (5mm × 3mm) PLASTIC DFN<br/><math>T_{JMAX} = 125^{\circ}C</math>, <math>\theta_{JA} = 44^{\circ}C/W</math>, <math>\theta_{JC} = 4.3^{\circ}C/W</math> (4 Layer)<br/>EXPOSED PAD (PIN 17) IS <math>V_{EE}</math>, MUST BE SOLDERED TO PCB</p> | <p><b>LTC2803-1, LTC2804-1</b><br/><b>2-Driver/2-Receiver</b></p> <p>TOP VIEW</p> <p>GN PACKAGE<br/>16-LEAD (NARROW 0.150) PLASTIC SSOP<br/><math>T_{JMAX} = 125^{\circ}C</math>, <math>\theta_{JA} = 110^{\circ}C/W</math>, <math>\theta_{JC} = 40^{\circ}C/W</math> (4 Layer)</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## ORDER INFORMATION

| LEAD FREE FINISH | TAPE AND REEL      | PART MARKING* | PACKAGE DESCRIPTION                 | TEMPERATURE RANGE |
|------------------|--------------------|---------------|-------------------------------------|-------------------|
| LTC2801CDE#PBF   | LTC2801CDE#TRPBF   | 2801          | 12-Lead (4mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2801IDE#PBF   | LTC2801IDE#TRPBF   | 2801          | 12-Lead (4mm × 3mm) Plastic DFN     | –40°C to 85°C     |
| LTC2802CDE#PBF   | LTC2802CDE#TRPBF   | 2802          | 12-Lead (4mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2802IDE#PBF   | LTC2802IDE#TRPBF   | 2802          | 12-Lead (4mm × 3mm) Plastic DFN     | –40°C to 85°C     |
| LTC2803CDHC#PBF  | LTC2803CDHC#TRPBF  | 2803          | 16-Lead (5mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2803IDHC#PBF  | LTC2803IDHC#TRPBF  | 2803          | 16-Lead (5mm × 3mm) Plastic DFN     | –40°C to 85°C     |
| LTC2804CDHC#PBF  | LTC2804CDHC#TRPBF  | 2804          | 16-Lead (5mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2804IDHC#PBF  | LTC2804IDHC#TRPBF  | 2804          | 16-Lead (5mm × 3mm) Plastic DFN     | –40°C to 85°C     |
| LTC2803CGN-1#PBF | LTC2803CGN-1#TRPBF | 28031         | 16-Lead (Narrow 0.150) Plastic SSOP | 0°C to 70°C       |
| LTC2803IGN-1#PBF | LTC2803IGN-1#TRPBF | 280311        | 16-Lead (Narrow 0.150) Plastic SSOP | –40°C to 85°C     |
| LTC2804CGN-1#PBF | LTC2804CGN-1#TRPBF | 28041         | 16-Lead (Narrow 0.150) Plastic SSOP | 0°C to 70°C       |
| LTC2804IGN-1#PBF | LTC2804IGN-1#TRPBF | 280411        | 16-Lead (Narrow 0.150) Plastic SSOP | –40°C to 85°C     |

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container. Consult LTC Marketing for information on non-standard lead based finish parts.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandree/>

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# ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 1.8\text{V}$  to  $5.5\text{V}$ ,  $V_L = 1.8\text{V}$  to  $5.5\text{V}$ , Normal Mode. Typical values are given for  $V_{CC} = V_L = 3.3\text{V}$  and  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

| SYMBOL                 | PARAMETER                                | CONDITIONS                                                                                                                                                                   |                                                                    |                        | MIN                     | TYP                      | MAX      | UNITS                |
|------------------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------|-------------------------|--------------------------|----------|----------------------|
| Power Supplies         |                                          |                                                                                                                                                                              |                                                                    |                        |                         |                          |          |                      |
| I <sub>CC</sub>        | V <sub>CC</sub> Supply Current           | Outputs Unloaded<br>Normal Mode (Note 3)<br>Receivers Active Mode<br>Shutdown Mode                                                                                           | <div><div></div><div></div><div></div><div></div></div>            |                        | 2.3<br>1<br>1           |                          | 10<br>10 | mA<br>μA<br>μA       |
| I <sub>L</sub>         | V <sub>L</sub> Supply Current            | Outputs Unloaded<br>Normal Mode (LTC2801, LTC2802)<br>Normal Mode (LTC2803, LTC2804)<br>Receivers Active Mode<br>Shutdown Mode                                               | <div><div></div><div></div><div></div><div></div><div></div></div> |                        | 0.08<br>0.15<br>15<br>1 | 0.15<br>0.30<br>30<br>10 |          | mA<br>mA<br>μA<br>μA |
| Driver                 |                                          |                                                                                                                                                                              |                                                                    |                        |                         |                          |          |                      |
| V <sub>OLD</sub>       | Output Voltage                           | R <sub>L</sub> = 3kΩ                                                                                                                                                         | Low                                                                | <div><div></div></div> | −5                      | −5.7                     |          | V                    |
| V <sub>OHD</sub>       | Output Voltage                           | R <sub>L</sub> = 3kΩ                                                                                                                                                         | High                                                               | <div><div></div></div> | 5                       | 6.2                      |          | V                    |
| V <sub>HYS</sub>       | Logic Input Hysteresis                   |                                                                                                                                                                              |                                                                    |                        |                         | 0.6                      |          | V                    |
| I <sub>OSD</sub>       | Output Short Circuit Current             | V <sub>L</sub> = V <sub>CC</sub> = 5.5V; V <sub>TOUT</sub> = 0V                                                                                                              | <div><div></div></div>                                             |                        | ±35                     | ±70                      |          | mA                   |
| I <sub>POLD</sub>      | Power-Off Output Leakage Current         | V <sub>L</sub> = V <sub>CC</sub> = V <sub>DD</sub> = V <sub>EE</sub> = 0V; V <sub>TOUT</sub> = ±2V                                                                           | <div><div></div></div>                                             |                        | ±0.1                    | ±10                      |          | μA                   |
| I <sub>OLD</sub>       | Output Leakage Current                   | Shutdown or Receivers Active or<br>Drivers Disabled Modes, −15V ≤ V <sub>TOUT</sub> ≤ 15V                                                                                    | <div><div></div></div>                                             |                        | ±0.1                    | ±10                      |          | μA                   |
| Receiver               |                                          |                                                                                                                                                                              |                                                                    |                        |                         |                          |          |                      |
| V <sub>IR</sub>        | Input Thresholds                         | Receivers Active Mode                                                                                                                                                        | <div><div></div></div>                                             | 0.8                    | 1.5                     | 2.4                      |          | V                    |
| V <sub>ILR</sub>       | Input Thresholds                         | Normal Mode, Input Low                                                                                                                                                       | <div><div></div></div>                                             | 0.8                    | 1.3                     |                          |          | V                    |
| V <sub>IHR</sub>       | Input Thresholds                         | Normal Mode, Input High                                                                                                                                                      | <div><div></div></div>                                             |                        | 1.7                     | 2.5                      |          | V                    |
| V <sub>HYSR</sub>      | Input Hysteresis                         | Normal Mode                                                                                                                                                                  | <div><div></div></div>                                             | 0.1                    | 0.4                     | 1.0                      |          | V                    |
| V <sub>OLR</sub>       | Output Voltage                           | Output Low, I <sub>ROUT</sub> = 1mA (Sinking)                                                                                                                                | <div><div></div></div>                                             |                        | 0.2                     | 0.4                      |          | V                    |
| V <sub>OHR</sub>       | Output Voltage                           | Output High, I <sub>ROUT</sub> = −1mA (Sourcing)                                                                                                                             | <div><div></div></div>                                             | V <sub>L</sub> − 0.4   | V <sub>L</sub> − 0.2    |                          |          | V                    |
| R <sub>IN</sub>        | Input Resistance                         | −15V ≤ V <sub>RIN</sub> ≤ 15V                                                                                                                                                | <div><div></div></div>                                             | 3                      | 5                       | 7                        |          | kΩ                   |
| I <sub>OSR</sub>       | Output Short Circuit Current             | V <sub>L</sub> = 5.5V; 0V ≤ V <sub>ROUT</sub> ≤ V <sub>L</sub>                                                                                                               | <div><div></div></div>                                             |                        | ±25                     | ±50                      |          | mA                   |
| Logic                  |                                          |                                                                                                                                                                              |                                                                    |                        |                         |                          |          |                      |
|                        | Logic Input Voltage Threshold            |                                                                                                                                                                              | <div><div></div></div>                                             | 0.4                    |                         | 0.67 • V <sub>L</sub>    |          | V                    |
| I <sub>IN</sub>        | Logic Input Current                      |                                                                                                                                                                              | <div><div></div></div>                                             |                        |                         | ±1                       |          | μA                   |
| Power Supply Generator |                                          |                                                                                                                                                                              |                                                                    |                        |                         |                          |          |                      |
| V <sub>DD</sub>        | Regulated V <sub>DD</sub> Output Voltage | Driver R <sub>L</sub> = 3kΩ (Note 3)<br>LTC2801, LTC2802: V <sub>TIN</sub> = V <sub>L</sub><br>LTC2803, LTC2804: V <sub>T1IN</sub> = V <sub>L</sub> , V <sub>T2IN</sub> = 0V |                                                                    |                        | 7                       |                          |          | V                    |
| V <sub>EE</sub>        | Regulated V <sub>EE</sub> Output Voltage | Driver R <sub>L</sub> = 3kΩ (Note 3)<br>LTC2801, LTC2802: V <sub>TIN</sub> = V <sub>L</sub><br>LTC2803, LTC2804: V <sub>T1IN</sub> = V <sub>L</sub> , V <sub>T2IN</sub> = 0V |                                                                    |                        | −6.3                    |                          |          | V                    |

# LTC2801/LTC2802/ LTC2803/LTC2804

**SWITCHING CHARACTERISTICS** The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 1.8\text{V to } 5.5\text{V}$ ,  $V_L = 1.8\text{V to } 5.5\text{V}$ , Normal Mode. Typical values are given for  $V_{CC} = V_L = 3.3\text{V}$  and  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

| SYMBOL | PARAMETER         | CONDITIONS                                     | MIN | TYP  | MAX | UNITS |
|--------|-------------------|------------------------------------------------|-----|------|-----|-------|
|        | Maximum Data Rate | LTC2801, LTC2803 (Note 3)                      |     |      |     |       |
|        |                   | $R_L = 3\text{k}\Omega$ , $C_L = 2.5\text{nF}$ | ●   | 100  |     | kbps  |
|        |                   | $R_L = 3\text{k}\Omega$ , $C_L = 1\text{nF}$   | ●   | 250  |     | kbps  |
|        |                   | LTC2802, LTC2804 (Note 3)                      |     |      |     |       |
|        |                   | $R_L = 3\text{k}\Omega$ , $C_L = 2.5\text{nF}$ | ●   | 100  |     | kbps  |
|        |                   | $R_L = 3\text{k}\Omega$ , $C_L = 1\text{nF}$   | ●   | 250  |     | kbps  |
|        |                   | $R_L = 3\text{k}\Omega$ , $C_L = 250\text{pF}$ | ●   | 1000 |     | kbps  |

## Driver

|                         |                            |                                                                                             |   |     |     |                  |
|-------------------------|----------------------------|---------------------------------------------------------------------------------------------|---|-----|-----|------------------|
| SR(D)                   | Driver Slew Rate           | LTC2801, LTC2803 (Figure 1)                                                                 |   |     |     |                  |
|                         |                            | $V_{CC} = V_L = 1.8\text{V}$ , $R_L = 3\text{k}\Omega$ , $C_L = 2.5\text{nF}$               | ● | 4   |     | V/ $\mu\text{s}$ |
|                         |                            | $V_{CC} = V_L = 5.5\text{V}$ , $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$                | ● |     | 30  | V/ $\mu\text{s}$ |
|                         |                            | LTC2802, LTC2804 (Figure 1)                                                                 |   |     |     |                  |
|                         |                            | $V_{CC} = V_L = 1.8\text{V}$ , $R_L = 3\text{k}\Omega$ , $C_L = 2.5\text{nF}$               | ● | 4   |     | V/ $\mu\text{s}$ |
|                         |                            | $V_{CC} = V_L = 5.5\text{V}$ , $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$                | ● |     | 150 | V/ $\mu\text{s}$ |
| $t_{PHLD}$ , $t_{PLHD}$ | Driver Propagation Delay   | $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$ (Figure 2)                                    |   |     |     |                  |
|                         |                            | LTC2801, LTC2803                                                                            | ● |     |     | $\mu\text{s}$    |
|                         |                            | LTC2802, LTC2804                                                                            | ● |     |     | $\mu\text{s}$    |
|                         |                            |                                                                                             |   | 1   | 2   |                  |
| $t_{SKEWD}$             | Driver Skew                | $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$ (Figure 2)                                    |   |     |     |                  |
|                         |                            | LTC2801, LTC2803                                                                            |   |     |     | ns               |
|                         |                            | LTC2802, LTC2804                                                                            |   |     |     | ns               |
|                         |                            |                                                                                             |   | 100 |     |                  |
| $t_{PZHD}$ , $t_{PZLD}$ | Driver Output Enable Time  | $PS = V_L$ , $MODE = \uparrow$ , $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$ (Figure 4)   | ● |     |     |                  |
|                         |                            |                                                                                             |   | 0.6 | 2   | $\mu\text{s}$    |
|                         |                            |                                                                                             |   |     |     |                  |
|                         |                            |                                                                                             |   |     |     |                  |
| $t_{PHZD}$ , $t_{PLZD}$ | Driver Output Disable Time | $PS = V_L$ , $MODE = \downarrow$ , $R_L = 3\text{k}\Omega$ , $C_L = 50\text{pF}$ (Figure 4) | ● |     |     |                  |
|                         |                            |                                                                                             |   | 0.3 | 2   | $\mu\text{s}$    |
|                         |                            |                                                                                             |   |     |     |                  |
|                         |                            |                                                                                             |   |     |     |                  |

## Receiver

|                         |                                       |                                                                                                                          |   |      |     |               |
|-------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---|------|-----|---------------|
| $t_{PHLR}$ , $t_{PLHR}$ | Receiver Propagation Delay            | $C_L = 150\text{pF}$ (Figure 3)                                                                                          | ● | 0.2  | 0.4 | $\mu\text{s}$ |
| $t_{SKEWR}$             | Receiver Skew                         | $C_L = 150\text{pF}$ (Figure 3)                                                                                          |   | 50   |     | ns            |
| $t_{RR}$ , $t_{FR}$     | Receiver Rise or Fall Time            | $C_L = 150\text{pF}$ (Figure 3)                                                                                          | ● | 60   | 200 | ns            |
| $t_{PZHR}$ , $t_{PZLR}$ | Shutdown to Receiver Output Enable    | $PS = MODE = \uparrow$ or $ON/\overline{OFF} = \uparrow$ , $R_L = 1\text{k}\Omega$ , $C_L = 150\text{pF}$ (Figure 5)     | ● | 5    | 15  | $\mu\text{s}$ |
| $t_{PHZR}$ , $t_{PLZR}$ | Receiver Output Disable upon Shutdown | $PS = MODE = \downarrow$ or $ON/\overline{OFF} = \downarrow$ , $R_L = 1\text{k}\Omega$ , $C_L = 150\text{pF}$ (Figure 5) | ● | 0.15 | 0.3 | $\mu\text{s}$ |

## Power Supply Generator

|  |                                  |                 |   |     |   |    |
|--|----------------------------------|-----------------|---|-----|---|----|
|  | $V_{DD}/V_{EE}$ Supply Rise Time | (Notes 3 and 4) | ● | 0.2 | 2 | ms |
|--|----------------------------------|-----------------|---|-----|---|----|

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** All currents into pins are positive; all voltages are referenced to GND unless otherwise specified.

**Note 3:** Guaranteed by other measured parameters and not tested directly.

**Note 4:** Time from  $PS \uparrow$  or  $ON/\overline{OFF} \uparrow$  until  $V_{DD} \geq 5\text{V}$  and  $V_{EE} \leq -5\text{V}$ .

## TEST CIRCUITS

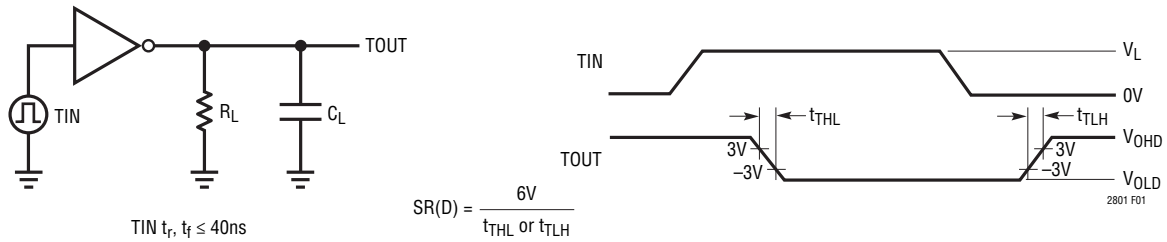


Figure 1. Driver Slew Rate Measurement

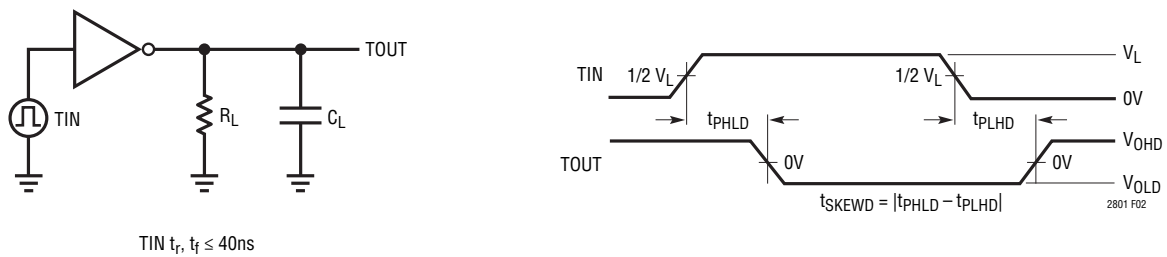


Figure 2. Driver Timing Measurement

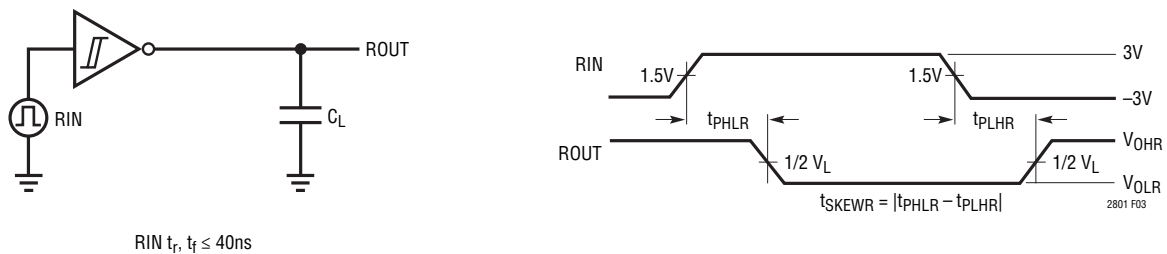


Figure 3. Receiver Timing Measurement

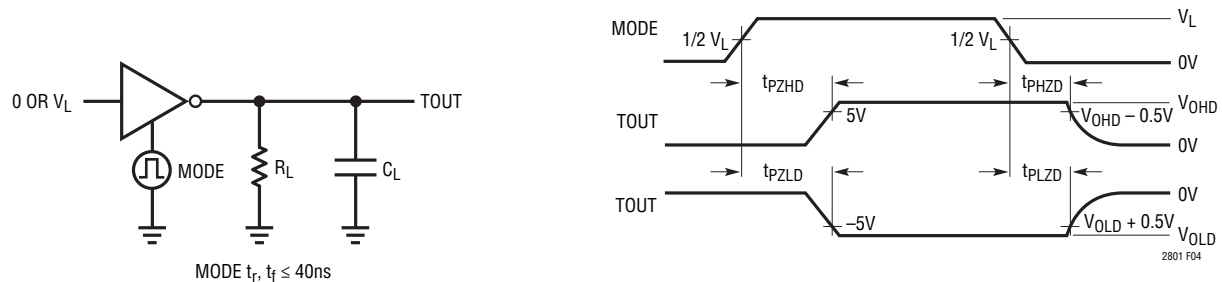


Figure 4. Driver Enable/Disable Times

## TEST CIRCUITS

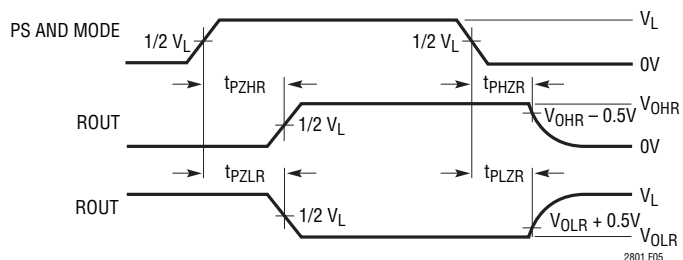
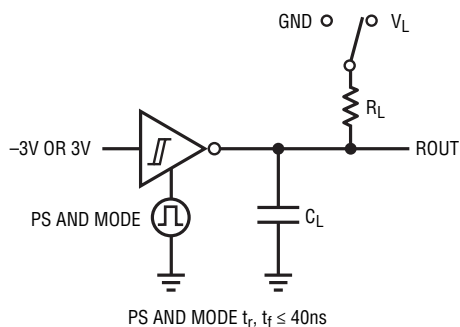
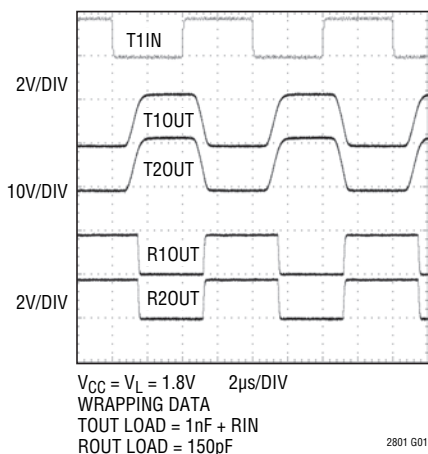


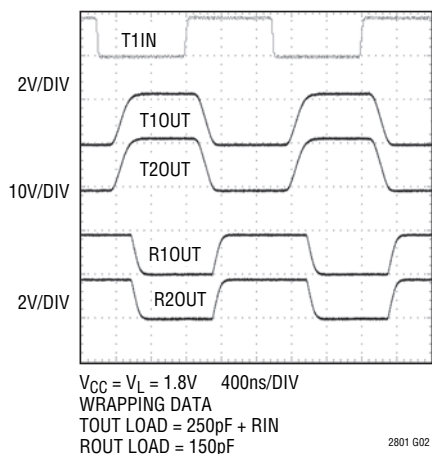
Figure 5. Receiver Enable/Disable Times

## TYPICAL PERFORMANCE CHARACTERISTICS $T_A = 25^\circ\text{C}$ , $V_{CC} = V_L = 3.3\text{V}$ unless otherwise noted.

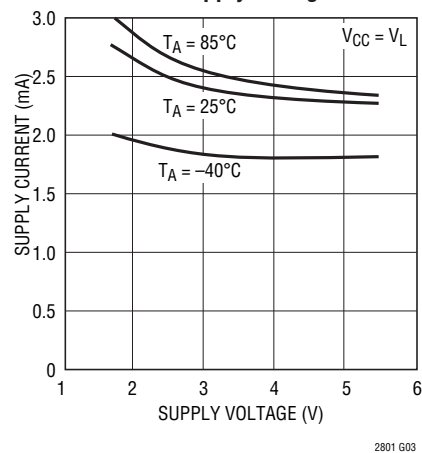
LTC2803 at 1.8V and 250kbps



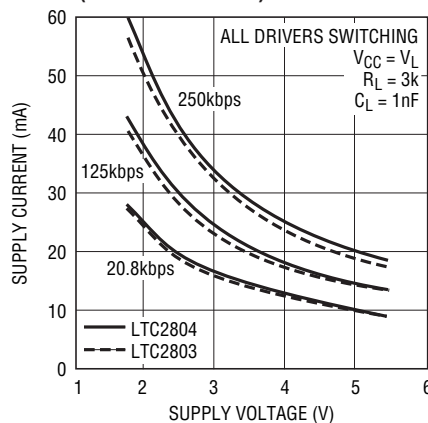
LTC2804 at 1.8V and 1Mbps



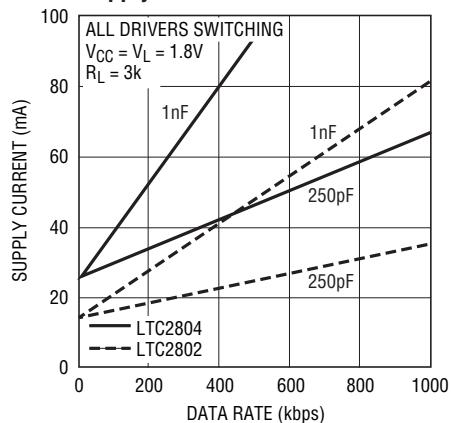
Drivers Disabled Mode Supply Current vs Supply Voltage



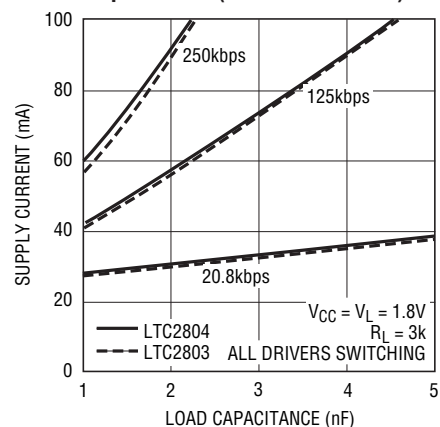
Supply Current vs Supply Voltage (Dual Transceiver)



Supply Current vs Data Rate

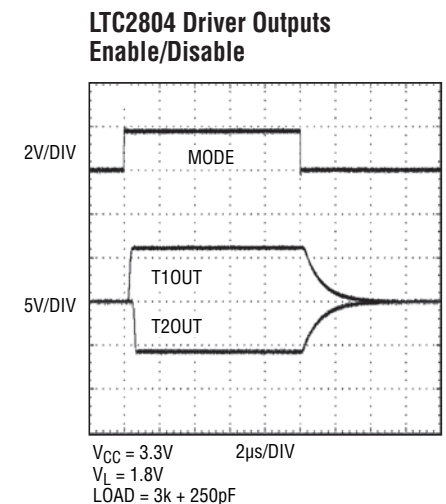
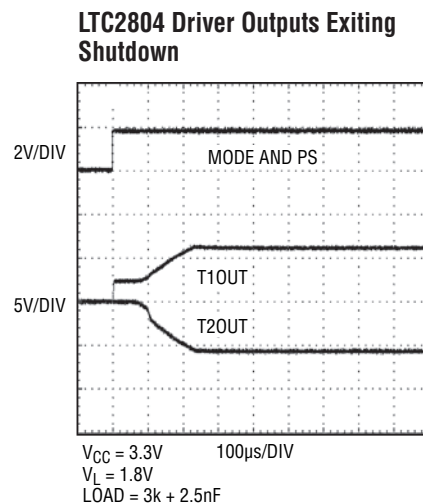
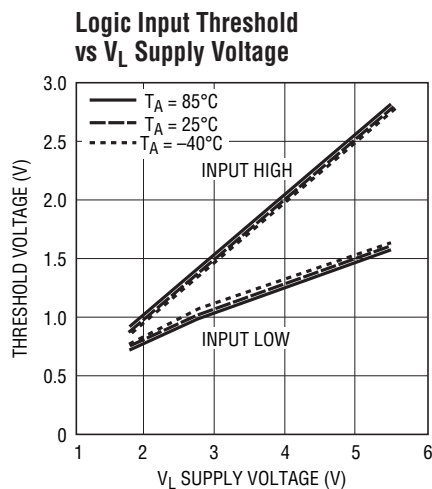
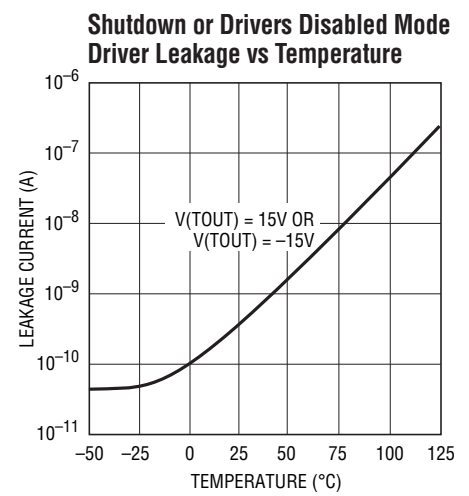
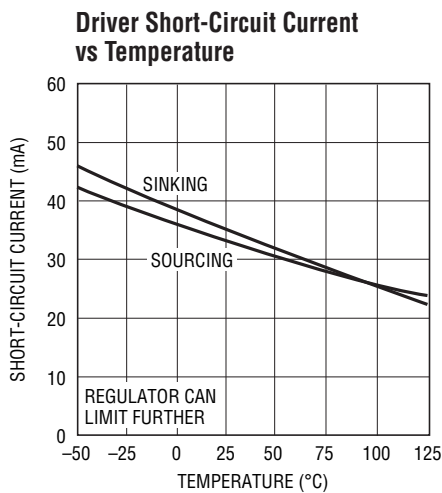
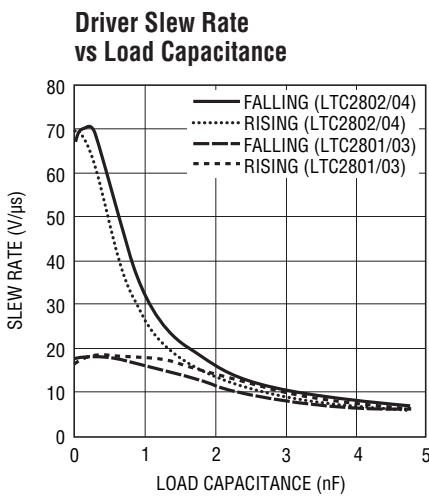
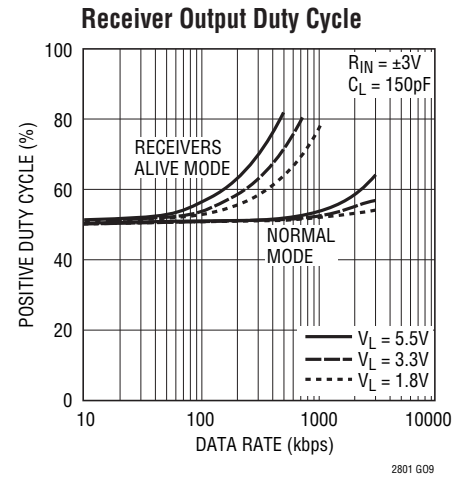
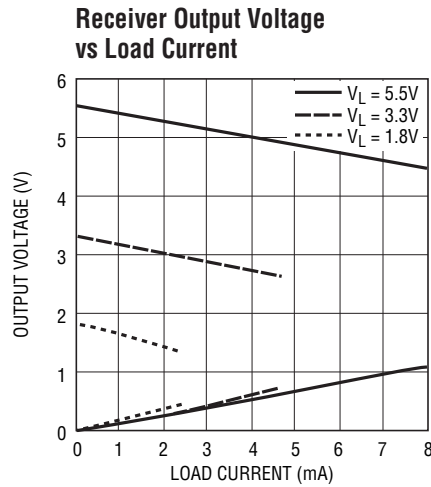
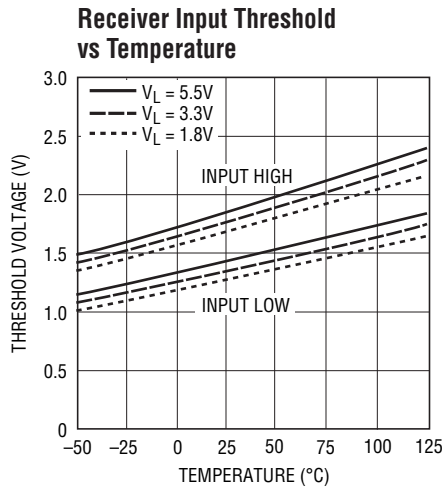


Supply Current vs Load Capacitance (Dual Transceiver)



## TYPICAL PERFORMANCE CHARACTERISTICS

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = V_L = 3.3\text{V}$  unless otherwise noted.



# LTC2801/LTC2802/ LTC2803/LTC2804

## PIN FUNCTIONS

| PIN NAME            | PIN NUMBER   |              |                  | COMMENTS                                                                                                                                                                                          |
|---------------------|--------------|--------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | 2801<br>2802 | 2803<br>2804 | 2803-1<br>2804-1 |                                                                                                                                                                                                   |
| V <sub>CC</sub>     | 3            | 5            | 5                | Input Supply (1.8V-5.5V). Bypass to GND with a 1μF capacitor.                                                                                                                                     |
| V <sub>DD</sub>     | 4            | 6            | 6                | Generated Positive Supply Voltage for RS-232 Driver (7V). Connect a 1μF capacitor between V <sub>DD</sub> and GND.                                                                                |
| V <sub>EE</sub>     | 13*          | 17*          | 9                | Generated Negative Supply Voltage for RS-232 Driver (–6.3V). Connect a 1μF capacitor between V <sub>EE</sub> and GND.                                                                             |
| SW                  | 5            | 7            | 7                | Switch Pin. Connect a 10μH inductor between SW and V <sub>CC</sub> .                                                                                                                              |
| GND                 | 6            | 8            | 8                | Ground.                                                                                                                                                                                           |
| CAP                 | 7            | 9            | 10               | Charge Pump Capacitor for Generated Negative Supply Voltage. Connect a 220nF capacitor between CAP and SW.                                                                                        |
| V <sub>L</sub>      | 10           | 12           | 12               | Logic Supply (1.8V-5.5V) for the receiver outputs, driver inputs, and control inputs. This pin should be bypassed to GND with a 220nF capacitor if it's not tied to V <sub>CC</sub> .             |
| TIN (T1IN, T2IN)    | 11           | 14, 13       | 14, 13           | Driver Input(s), referenced to V <sub>L</sub> .                                                                                                                                                   |
| TOUT (T1OUT, T2OUT) | 2            | 3, 4         | 3, 4             | RS-232 Driver Output(s).                                                                                                                                                                          |
| RIN (R1IN, R2IN)    | 1            | 1, 2         | 1, 2             | RS-232 Receiver Input(s). Includes internal 5kΩ termination resistor(s).                                                                                                                          |
| ROUT (R1OUT, R2OUT) | 12           | 16, 15       | 16, 15           | Receiver Output(s), referenced to V <sub>L</sub> . Output is short-circuit protected to GND/V <sub>CC</sub> /V <sub>L</sub> , and is high impedance in Shutdown mode, allowing data line sharing. |
| PS                  | 8            | 10           | —                | Power Supply control pin, referenced to V <sub>L</sub> . Enables the integrated DC-DC converter.                                                                                                  |
| MODE                | 9            | 11           | —                | Mode control pin, referenced to V <sub>L</sub> . See Table 1 for functionality.                                                                                                                   |
| ON/OFF              | —            | —            | 11               | Transceiver enable pin, referenced to V <sub>L</sub> . A logic low puts the device in Shutdown mode and places both driver and receiver outputs in a high impedance state.                        |

\*Backside thermal pad

## MODE CONTROL

Table 1. LTC2801, LTC2802, LTC2803, LTC2804

| MODE NAME          | PS | MODE | RECEIVER<br>OUTPUT(S) | DC-DC | DRIVER<br>OUTPUT(S) | I <sub>VCC</sub> * | I <sub>VL</sub> * |
|--------------------|----|------|-----------------------|-------|---------------------|--------------------|-------------------|
| SHUTDOWN           | L  | L    | HI-Z                  | OFF   | HI-Z                | 1μA                | 1μA               |
| RECEIVER(S) ACTIVE | L  | H    | ON                    | OFF   | HI-Z                | 1μA                | 15μA              |
| DRIVER(S) DISABLED | H  | L    | ON                    | ON    | HI-Z                | 2.1mA              | 80μA OR<br>150μA  |
| NORMAL             | H  | H    | ON                    | ON    | ON                  | 2.3mA              | 80μA OR<br>150μA  |

Table 2. LTC2803-1, LTC2804-1

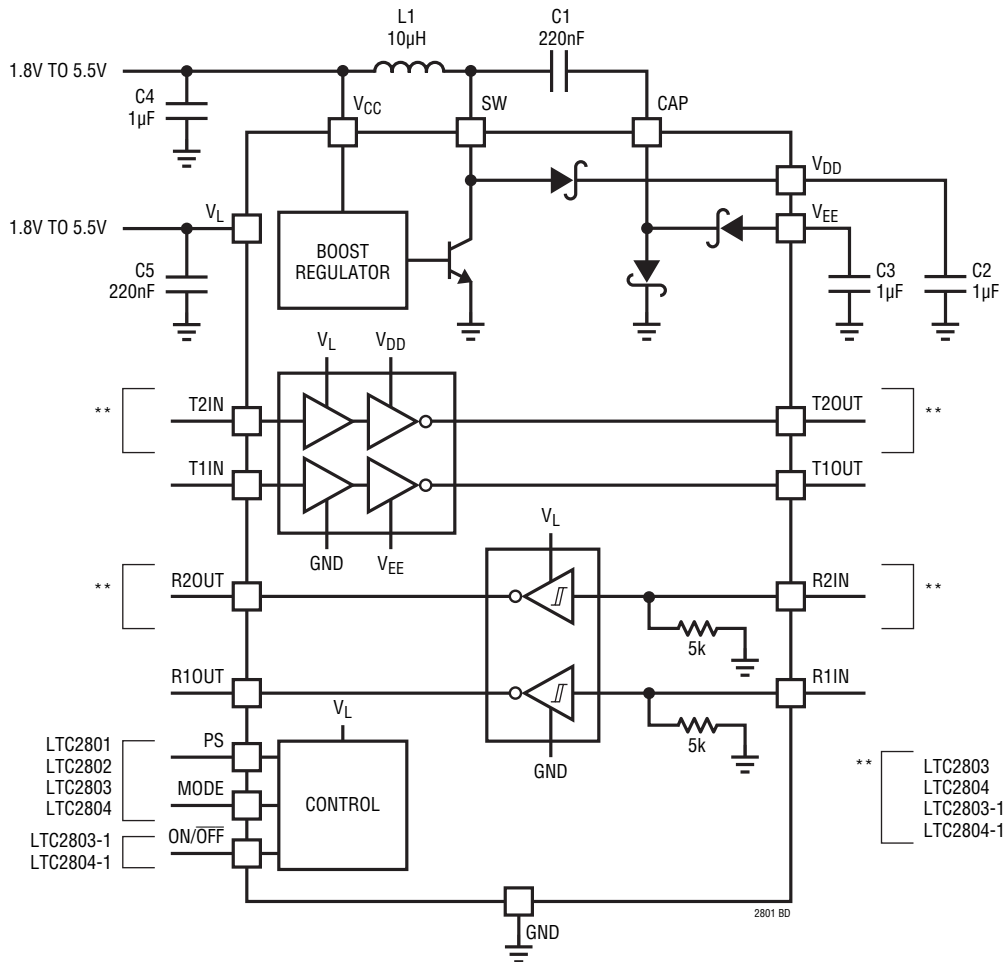
| MODE NAME | ON/OFF | RECEIVER<br>OUTPUTS | DC-DC | DRIVER<br>OUTPUTS | I <sub>VCC</sub> * | I <sub>VL</sub> * |
|-----------|--------|---------------------|-------|-------------------|--------------------|-------------------|
| SHUTDOWN  | L      | HI-Z                | OFF   | HI-Z              | 1μA                | 1μA               |
| NORMAL    | H      | ON                  | ON    | ON                | 2.3mA              | 150μA             |

\*Typical currents for static drivers. Normal mode currents are for unloaded outputs.

## FEATURE SUMMARY

| FEATURE                                      | 2801   | 2802   | 2803   | 2803-1  | 2804   | 2804-1  |
|----------------------------------------------|--------|--------|--------|---------|--------|---------|
| DRIVERS and RECEIVERS                        | 1 + 1  | 1 + 1  | 2 + 2  | 2 + 2   | 2 + 2  | 2 + 2   |
| PACKAGE                                      | DFN-12 | DFN-12 | DFN-16 | SSOP-16 | DFN-16 | SSOP-16 |
| 1.8V - 5.5V OPERATION                        | •      | •      | •      | •       | •      | •       |
| 1.8V - 5.5V LOGIC SUPPLY ( $V_L$ )           | •      | •      | •      | •       | •      | •       |
| SHUTDOWN ( $1\mu A$ )                        | •      | •      | •      | •       | •      | •       |
| RECEIVER(S) ACTIVE ( $15\mu A$ )             | •      | •      | •      | •       | •      | •       |
| DRIVER(S) DISABLE                            | •      | •      | •      | •       | •      | •       |
| 100kb/s for $R_L = 3k\Omega$ , $C_L = 2.5nF$ | •      | •      | •      | •       | •      | •       |
| 250kb/s for $R_L = 3k\Omega$ , $C_L = 1nF$   | •      | •      | •      | •       | •      | •       |
| 1Mb/s for $R_L = 3k\Omega$ , $C_L = 250pF$   | •      | •      | •      | •       | •      | •       |

## BLOCK DIAGRAM



## APPLICATIONS INFORMATION

### Overview

The LTC2801 family of RS-232 transceivers operates on a  $V_{CC}$  supply of 1.8V to 5.5V, utilizing a switching regulator to generate the necessary higher voltage rails for the drivers. The transceivers interface with logic operating on any supply from 1.8V to 5.5V, independent of the  $V_{CC}$  voltage. Depending on the device, one or two control pins are available to invoke Shutdown, Receiver Active and Driver Disable features.

### DC-DC Converter

The on-chip DC-DC converter operates from the  $V_{CC}$  input, generating a 7V  $V_{DD}$  supply and a charge pumped  $-6.3V$   $V_{EE}$  supply, as shown in Figure 6.  $V_{DD}$  and  $V_{EE}$  power the output stage of the drivers and are regulated to levels that guarantee greater than  $\pm 5V$  output swing. The DC-DC converter requires a 10 $\mu H$  inductor (L1) and a bypass capacitor (C4) of at least 1 $\mu F$ . The recommended size for the charge pump capacitor (C1) is 220nF and for the storage capacitors (C2 and C3) is 1 $\mu F$ . Larger storage capacitors up to 4.7 $\mu F$  may be used if C1 is kept at 20% to 50% their size and C4 is also scaled. Locate C1-C4 close to their associated pins.

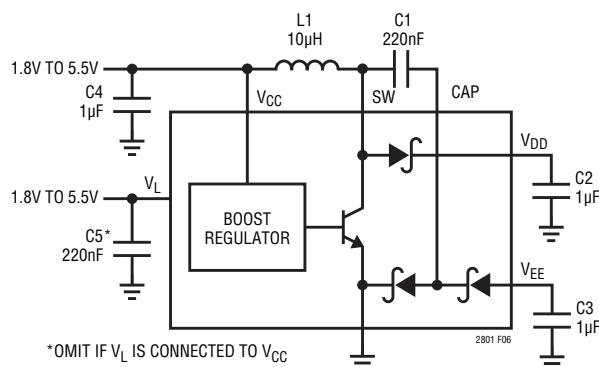


Figure 6. DC/DC Converter and Recommended Bypassing

### $V_L$ Logic Supply

A separate logic supply pin  $V_L$  allows the LTC2801 family to interface with any logic signal from 1.8V to 5.5V, as shown in Figure 7. Simply connect the desired logic supply to  $V_L$ . There is no interdependency between  $V_{CC}$  and  $V_L$ ; they may simultaneously operate at any voltage from 1.8V to 5.5V and sequence in any order. If  $V_L$  is powered separately from  $V_{CC}$ , bypass  $V_L$  with a 220nF capacitor (C5).

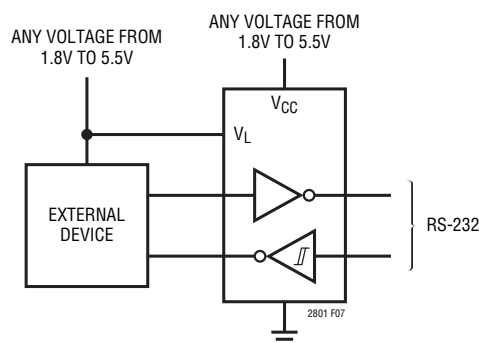


Figure 7.  $V_{CC}$  and  $V_L$  Are Independent

### Power-Saving Modes

When the DC-DC converter and drivers are turned off (PS and MODE or ON/OFF = logic low),  $V_{CC}$  supply current is reduced to 1 $\mu A$ . Tables 1 and 2 summarize the modes for each device.

In Shutdown mode,  $V_L$  supply current is reduced to 1 $\mu A$ , and both receiver and driver outputs assume a high impedance state.

In Receivers Active mode, the quiescent  $V_L$  supply current is reduced to 15 $\mu A$  and the driver outputs assume a high impedance state. The receivers operate at a reduced rate (typically 100 kbps) with hysteresis turned off.

### Half-Duplex Operation

When the DC-DC converter is kept on (PS = logic high), MODE serves as a low-latency driver enable for half-duplex operation. Each driver is enabled and disabled in less than 2 $\mu s$ , while each receiver remains continuously active. This mode of operation is illustrated in Figures 15-17.

### Battery Operation

To maximize battery life, connect  $V_{CC}$  (and L1) directly to the unregulated battery voltage and  $V_L$  to the regulated supply, as shown in Figure 22. This configuration typically minimizes conversion loss while providing compatibility with system logic levels.

### Inductor Selection

A 10 $\mu H$  inductor with a saturation current ( $I_{SAT}$ ) rating of at least 200mA and low DCR (copper wire resistance) is recommended. Some small inductors meeting these requirements are listed in Table 3.

## APPLICATIONS INFORMATION

**Table 3. Recommended Inductors**

| PART NUMBER    | I <sub>SAT</sub> (mA) | MAX DCR (Ω) | SIZE (mm)      | MANUFACTURER                   |
|----------------|-----------------------|-------------|----------------|--------------------------------|
| LQH2MCN100K02L | 225                   | 1.2         | 2 × 1.6 × 0.95 | Murata<br>www.murata.com       |
| LBC2016T100K   | 245                   | 0.85        | 2 × 1.6 × 1.6  | Taiyo Yuden<br>www.t-yuden.com |
| FSLB2520-100K  | 220                   | 1.1         | 2.5 × 2 × 1.6  | Toko<br>www.tokoam.com         |

### Capacitor Selection

The small size of ceramic capacitors makes them ideal for the LTC2801 family. X5R and X7R (preferred) types are recommended because their ESR is low and they retain their capacitance over relatively wide voltage and temperature ranges. Use a voltage rating of at least 10V.

**Table 4. Recommended Ceramic Capacitor Manufacturers**

| MANUFACTURER | URL             |
|--------------|-----------------|
| Murata       | www.murata.com  |
| TDK          | www.tdk.com     |
| Taiyo Yuden  | www.t-yuden.com |
| AVX          | www.avxcorp.com |
| Kemet        | www.kemet.com   |

### Inrush Current and Supply Overshoot Precaution

In certain applications, such as battery-operated and wall-adaptor devices, fast supply slew rates are generated when power is connected. If V<sub>CC</sub>'s voltage is greater than 4.5V and its rise time is faster than 10μs, the pins V<sub>DD</sub> and SW can exceed their ABS MAX values during start-up. When supply voltage is applied to V<sub>CC</sub>, the voltage difference between V<sub>CC</sub> and V<sub>DD</sub> generates inrush current

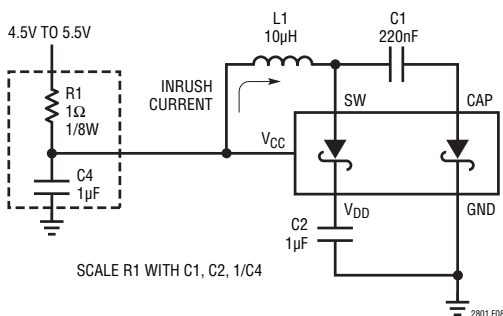


**Figure 8. Supply Overshoot Protection for Input Supplies of 4.5V or Higher**

flowing through inductor L1 and capacitors C1, C2. The peak inrush current must not exceed 2A. To avoid this condition, add a 1Ω resistor as shown in Figure 8. This precaution is not relevant for supply voltages below 4.5V or rise times longer than 10μs.

### Board Layout

The board layout should minimize the length and area of the SW and CAP traces. Suggested compact layouts for the LTC2801 family are shown in Figure 9 (a) and (b).

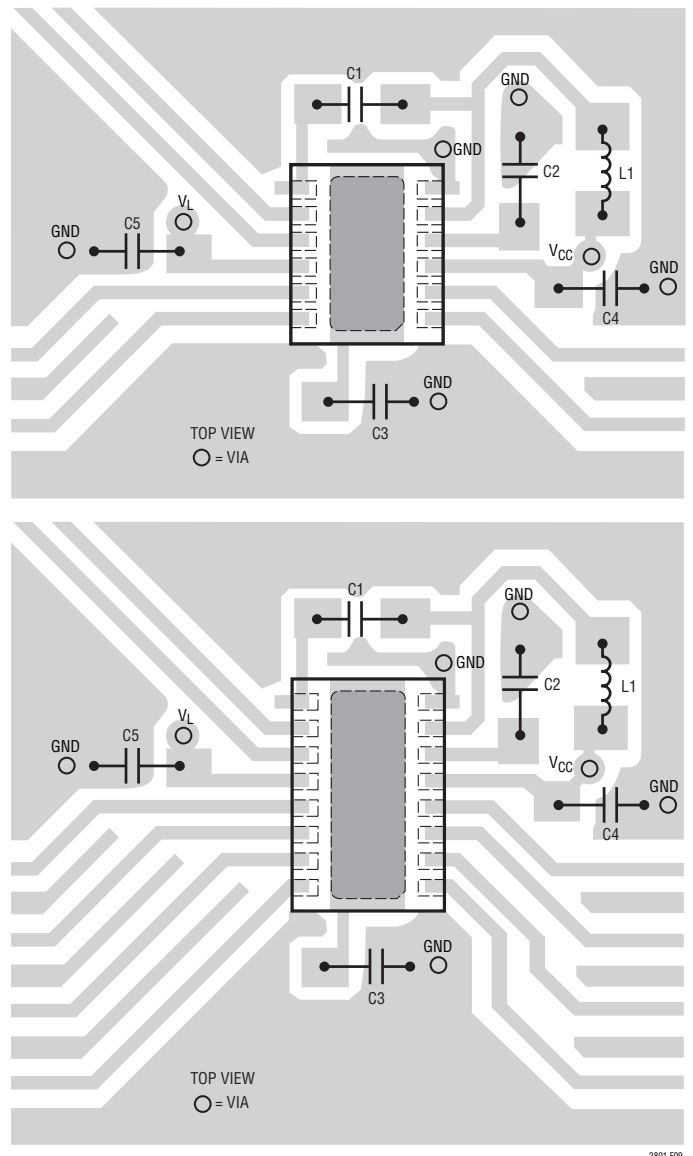


**Figure 9. Recommended Board Layouts for (a) Single and (b) Dual Transceiver Parts**

2801234fe

## TYPICAL APPLICATIONS

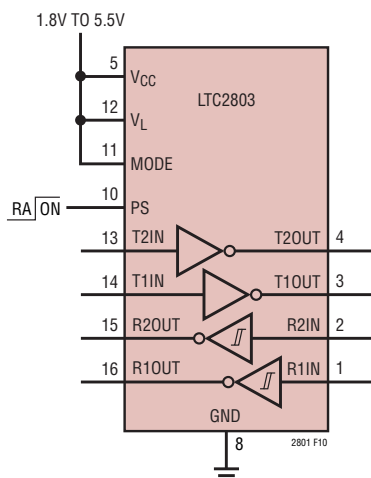


Figure 10. Power-Saving Receivers-Active Mode

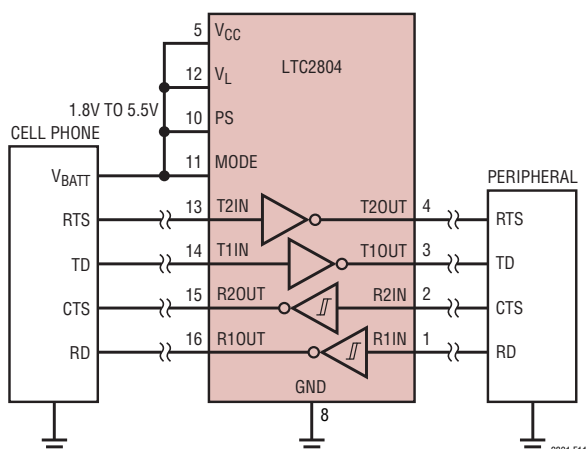


Figure 11. Cellphone Peripheral Interface

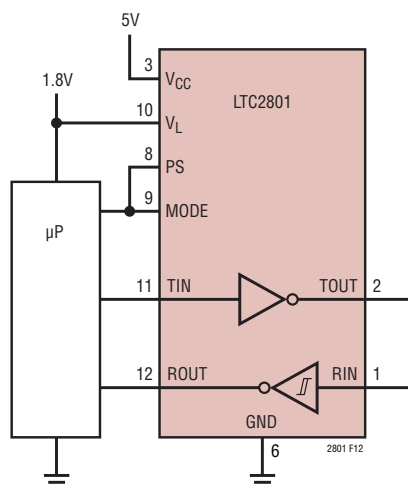


Figure 12. 1.8V Microprocessor Interface

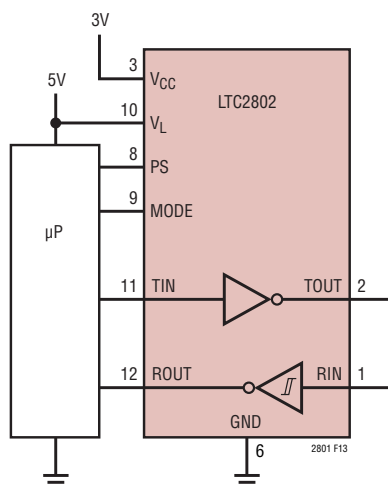


Figure 13. 5V Microprocessor Interface

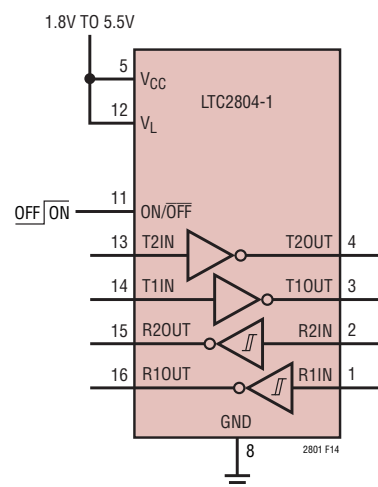


Figure 14. Power-Saving Shutdown Mode

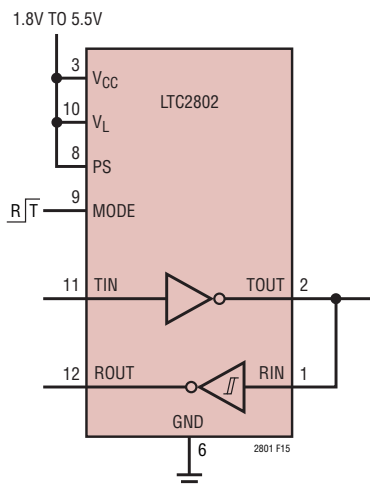


Figure 15. Half-Duplex on Single Line, Separate ROUT, TIN

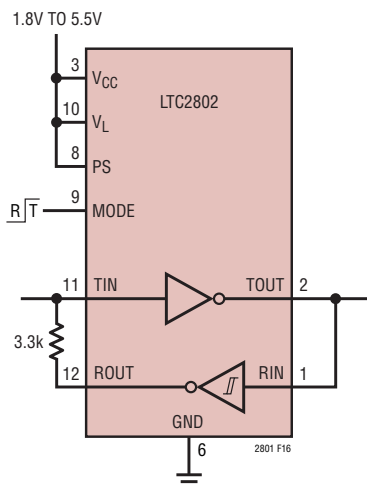


Figure 16. Half-Duplex on Single Line

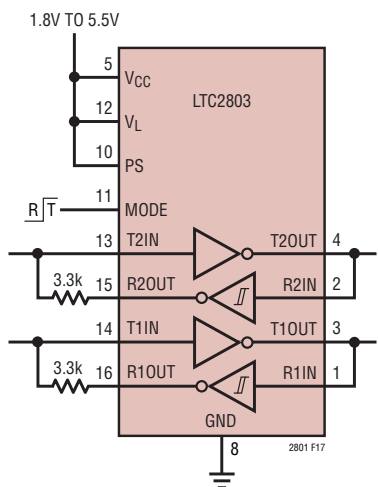
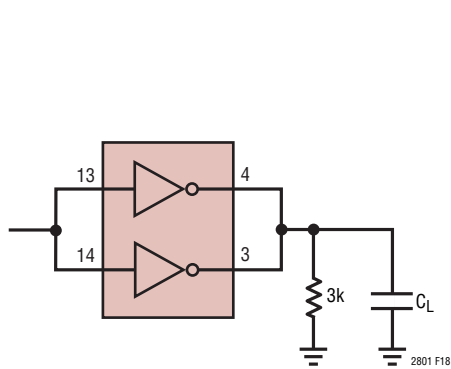


Figure 17. Half-Duplex Dual Transceiver

## TYPICAL APPLICATIONS



| DATA RATE<br>(kbps) | $C_L$ (nF) | LTC2803 | LTC2804 |
|---------------------|------------|---------|---------|
| 100                 | 5          | X       | X       |
| 250                 | 2          | X       | X       |
| 1000                | 0.5        | X       | X       |

Figure 18. Driving Larger Loads

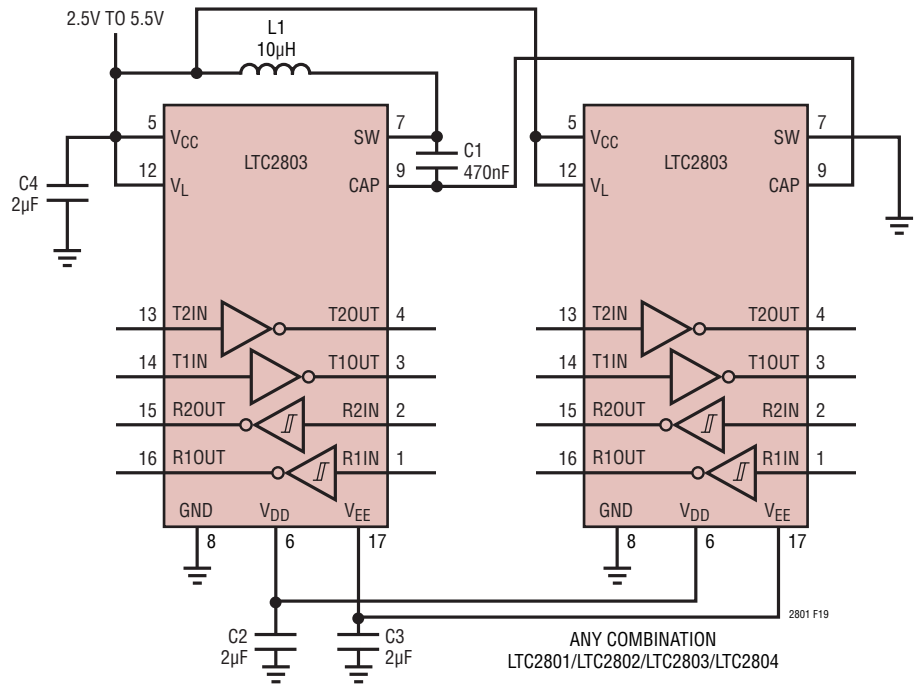
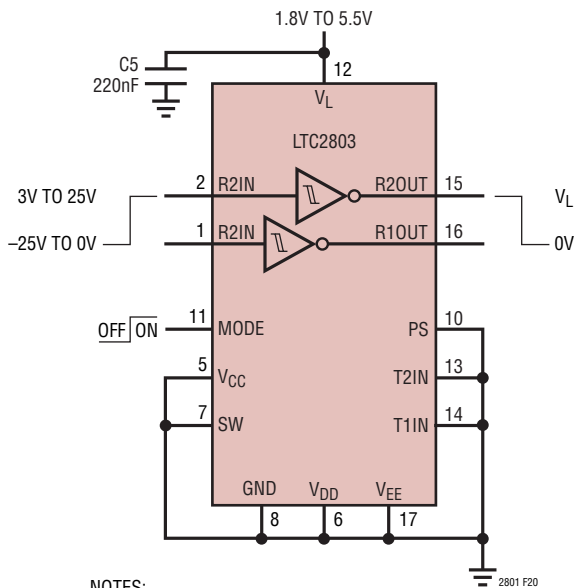


Figure 19. Quad Transceiver ( $2.5V < V_{CC} < 5.5V$ )



- NOTES:
1. NO L1 OR C2-C4 NEEDED.
  2. RECEIVERS ACTIVE MODE SHOWN HAS NO DC HYSTERESIS.
  3. SEE DUTY CYCLE GRAPH IN TYPICAL PERFORMANCE SECTION.

Figure 20. 100kbps Dual Inverting Level Translator ( $I_L = 15\mu A$  Static)

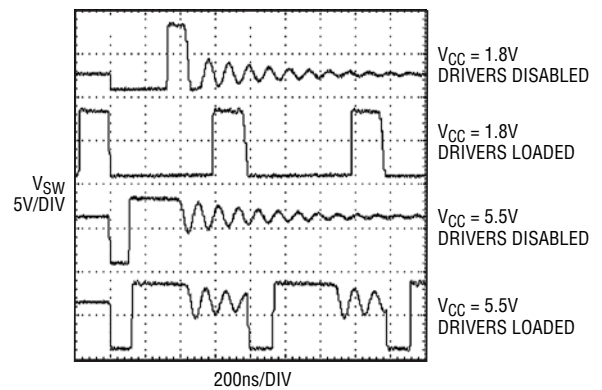
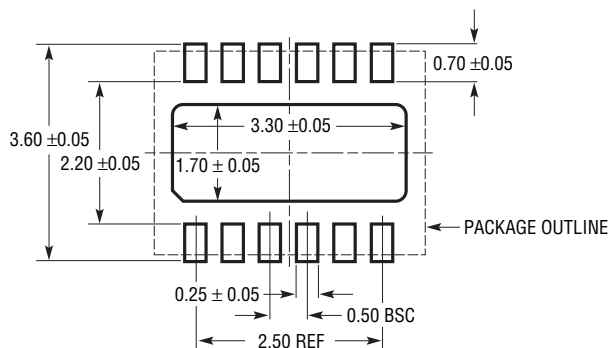


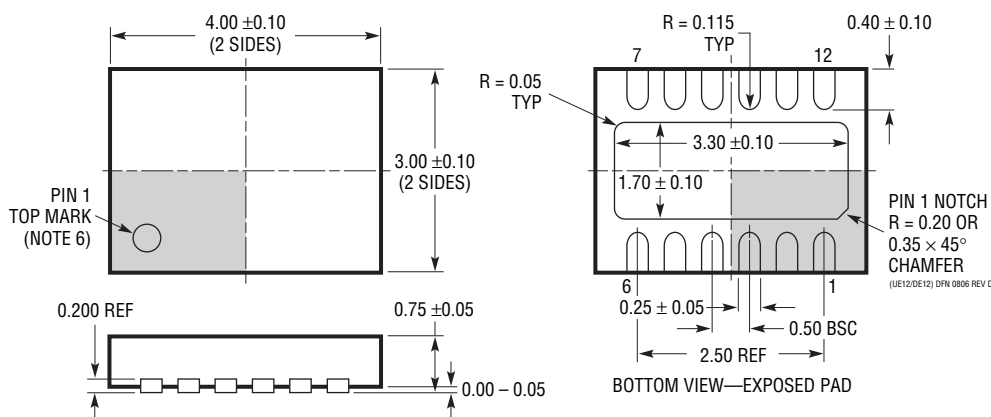
Figure 21. Typical SW Pin Waveforms

## PACKAGE DESCRIPTION

**DE/UE Package**  
**12-Lead Plastic DFN (4mm × 3mm)**  
(Reference LTC DWG # 05-08-1695 Rev D)



RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS  
APPLY SOLDER MASK TO AREAS THAT ARE NOT SOLDERED

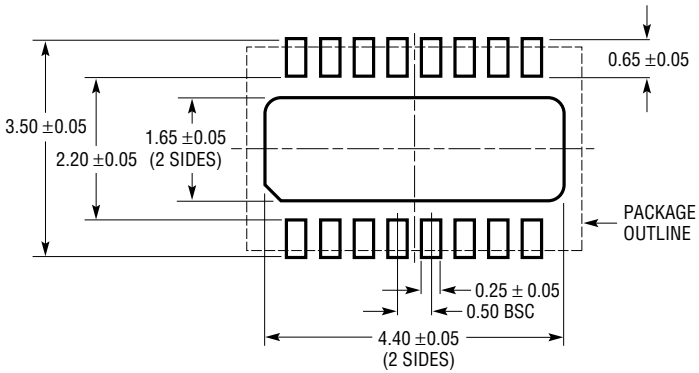


**NOTE:**

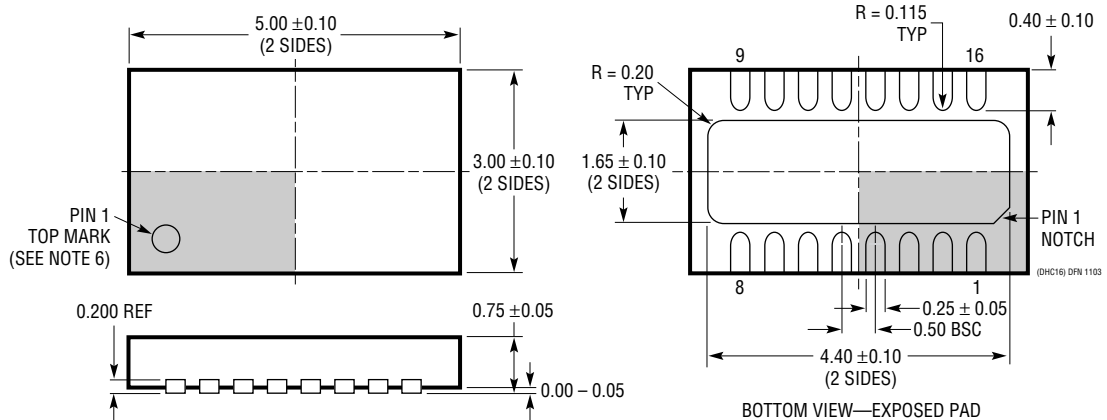
1. DRAWING PROPOSED TO BE A VARIATION OF VERSION (WGED) IN JEDEC PACKAGE OUTLINE M0-229
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

## PACKAGE DESCRIPTION

**DHC Package**  
**16-Lead Plastic DFN (5mm × 3mm)**  
(Reference LTC DWG # 05-08-1706)



**RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS**

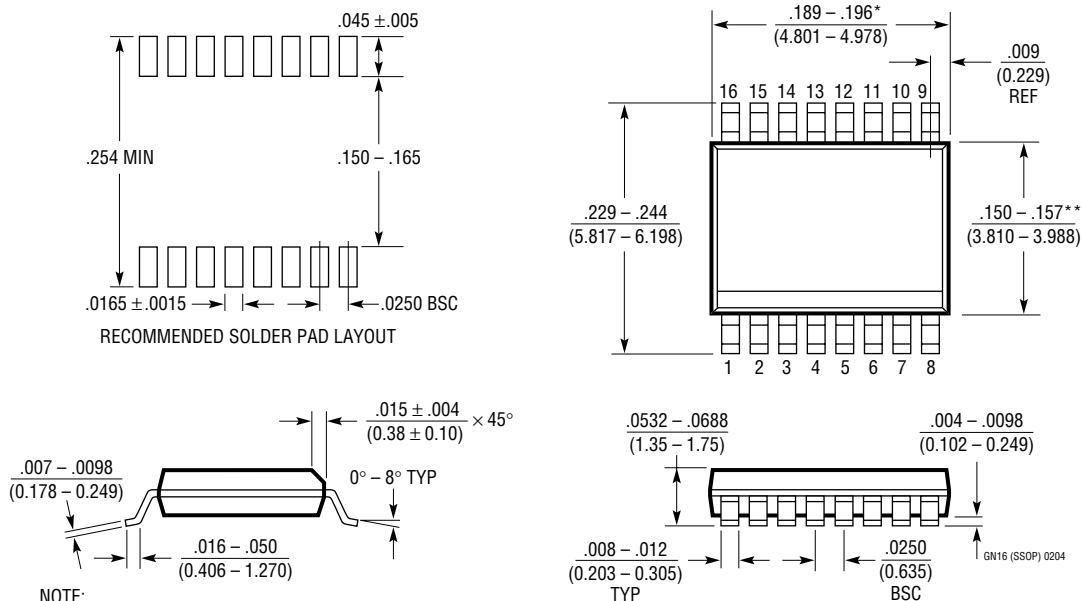


**NOTE:**

1. DRAWING PROPOSED TO BE MADE VARIATION OF VERSION (WJED-1) IN JEDEC PACKAGE OUTLINE MO-229
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

## PACKAGE DESCRIPTION

**GN Package**  
**16-Lead Plastic SSOP (Narrow .150 Inch)**  
(Reference LTC DWG # 05-08-1641)



**NOTE:**

1. CONTROLLING DIMENSION: INCHES

2. DIMENSIONS ARE IN  $\frac{\text{INCHES}}{\text{MILLIMETERS}}$

3. DRAWING NOT TO SCALE

\*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED  $0.006^*$  ( $0.152\text{mm}$ ) PER SIDE

\*\*DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED  $0.010^*$  ( $0.254\text{mm}$ ) PER SIDE

## REVISION HISTORY (Revision history begins at Rev E)

| REV | DATE | DESCRIPTION                                                                 | PAGE NUMBER |
|-----|------|-----------------------------------------------------------------------------|-------------|
| E   | 5/10 | Replaced Product Selection Guide                                            | 1           |
|     |      | Labeled packages with appropriate part numbers in Pin Configuration section | 2           |
|     |      | Changed title of Table 1 in Mode Control section                            | 8           |
|     |      | Updated Feature Summary section                                             | 9           |
|     |      | Revised first sentence of Power Saving Modes section                        | 10          |

TYPICAL APPLICATION

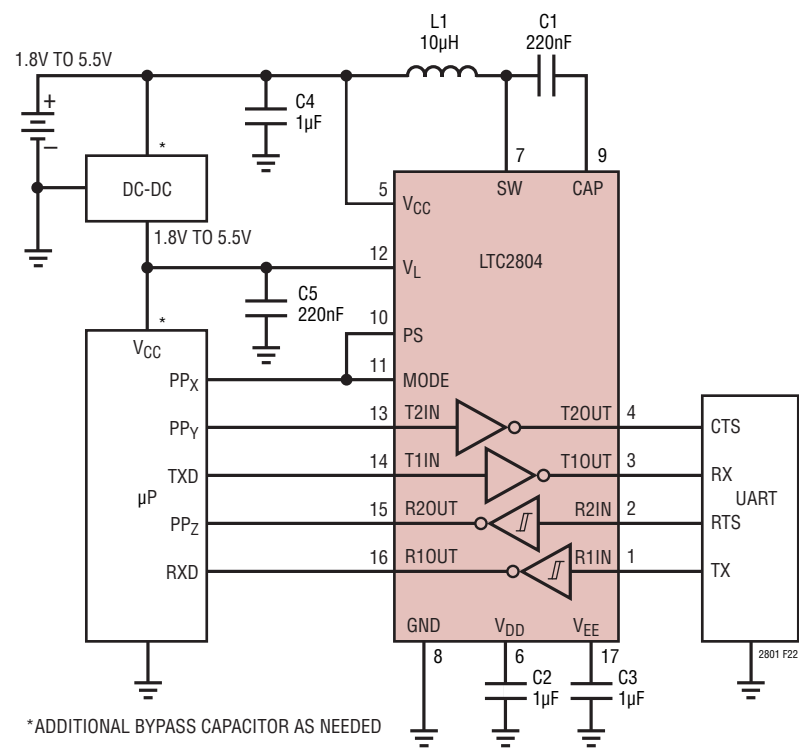


Figure 22. Diagnostic Port Operating Directly Off Unregulated Battery Voltage

RELATED PARTS

| PART NUMBER      | DESCRIPTION                           | COMMENTS                                         |
|------------------|---------------------------------------|--------------------------------------------------|
| LT1780/LT1781    | 2-Driver/2-Receiver RS232 Transceiver | Single 5V Supply with 0.1μF Capacitors, 15kV ESD |
| LTC1337          | 3-Driver/5-Receiver RS232 Transceiver | Ultralow Power for DTE Applications              |
| LTC1338          | 5-Driver/3-Receiver RS232 Transceiver | Ultralow Power for DCE Applications              |
| LT1039/LT1039-16 | 3-Driver/3-Receiver RS232 Transceiver | 30kΩ Input Impedance for Multidrop Applications  |
| LTC1348          | 3-Driver/5-Receiver RS232 Transceiver | True RS232 Levels on 3.3V Supply                 |