



## LR3965

CMOS IC

### 1.5A LOW DROPOUT LINEAR REGULATOR

#### DESCRIPTION

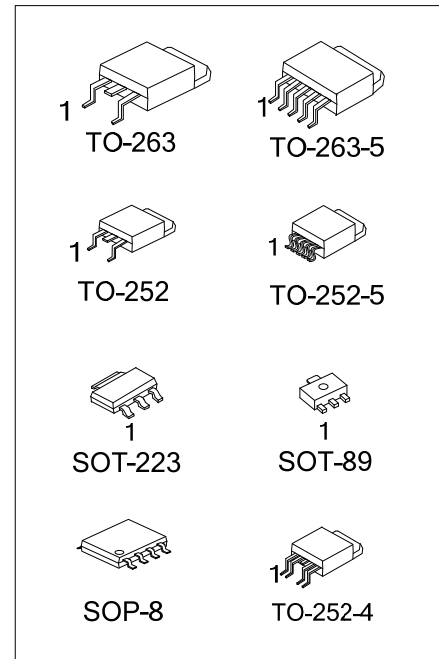
The UTC **LR3965** belonged to low-noise, low-dropout, linear regulators operate from 2.25V to 6V input and are guaranteed to deliver 1.5A. Wide range of preset output voltage options are available. Built-in low on-resistance transistor provides low dropout voltage and large output current. The UTC **LR3965** is designed and optimized for battery-powered systems to work with low noise.

The UTC **LR3965** consumes less than 0.01 $\mu$ A in shutdown mode. Other features include ultra low dropout voltage, current limiting protection, thermal shutdown protection and high ripple rejection ratio.

#### FEATURES

- \* 1.5A Guaranteed Output Current
- \* 0.01 $\mu$ A Shutdown Current
- \* 40mV Dropout at 150mA Load
- \* Low Temperature Coefficient
- \* Current Limiting Protection
- \* Thermal Shutdown Protection
- \* Excellent Line/Load Transient
- \* Sense Option Improves Load Regulation

#### ORDERING INFORMATION



| Ordering Number    |                    | Package  | Pin Assignment |   |   |   |   |   |   |   | Packing   |
|--------------------|--------------------|----------|----------------|---|---|---|---|---|---|---|-----------|
| Lead Free          | Halogen Free       |          | 1              | 2 | 3 | 4 | 5 | 6 | 7 | 8 |           |
| LR3965L-xx-AB3-C-R | LR3965G-xx-AB3-C-R | SOT-89   | G              | I | O | - | - | - | - | - | Tape Reel |
| LR3965L-xx-AA3-A-R | LR3965G-xx-AA3-A-R | SOT-223  | G              | O | I | - | - | - | - | - | Tape Reel |
| LR3965L-xx-AA3-D-R | LR3965G-xx-AA3-D-R | SOT-223  | I              | G | O | - | - | - | - | - | Tape Reel |
| LR3965L-xx-TN3-A-R | LR3965G-xx-TN3-A-R | TO-252   | G              | O | I | - | - | - | - | - | Tape Reel |
| LR3965L-xx-TN3-A-T | LR3965G-xx-TN3-A-T | TO-252   | G              | O | I | - | - | - | - | - | Tube      |
| LR3965L-xx-TN3-D-R | LR3965G-xx-TN3-D-R | TO-252   | I              | G | O | - | - | - | - | - | Tape Reel |
| LR3965L-xx-TN3-D-T | LR3965G-xx-TN3-D-T | TO-252   | I              | G | O | - | - | - | - | - | Tube      |
| LR3965L-xx-TQ2-A-R | LR3965G-xx-TQ2-A-R | TO-263   | G              | O | I | - | - | - | - | - | Tape Reel |
| LR3965L-xx-TQ2-A-T | LR3965G-xx-TQ2-A-T | TO-263   | G              | O | I | - | - | - | - | - | Tube      |
| LR3965L-xx-TQ2-D-R | LR3965G-xx-TQ2-D-R | TO-263   | I              | G | O | - | - | - | - | - | Tape Reel |
| LR3965L-xx-TQ2-D-T | LR3965G-xx-TQ2-D-T | TO-263   | I              | G | O | - | - | - | - | - | Tube      |
| LR3965L-xx-TN4-R   | LR3965G-xx-TN4-R   | TO-252-4 | S              | I | G | O | A | - | - | - | Tape Reel |
| LR3965L-xx-TN4-T   | LR3965G-xx-TN4-T   | TO-252-4 | S              | I | G | O | A | - | - | - | Tube      |
| LR3965L-xx-TN5-R   | LR3965G-xx-TN5-R   | TO-252-5 | S              | I | G | O | A | - | - | - | Tape Reel |
| LR3965L-xx-TN5-T   | LR3965G-xx-TN5-T   | TO-252-5 | S              | I | G | O | A | - | - | - | Tube      |
| LR3965L-xx-TQ5-R   | LR3965G-xx-TQ5-R   | TO-263-5 | S              | I | G | O | A | - | - | - | Tape Reel |
| LR3965L-xx-TQ5-T   | LR3965G-xx-TQ5-T   | TO-263-5 | S              | I | G | O | A | - | - | - | Tube      |
| LR3965L-xx-S08-R   | LR3965G-xx-S08-R   | SOP-8    | S              | I | O | A | G | G | G | G | Tape Reel |
| LR3965L-xx-S08-T   | LR3965G-xx-S08-T   | SOP-8    | S              | I | O | A | G | G | G | G | Tube      |

Note: Pin Assignment: I:V<sub>IN</sub> O:V<sub>OUT</sub> G:GND S: SHDN A: ADJ/SENSE/SS/POK

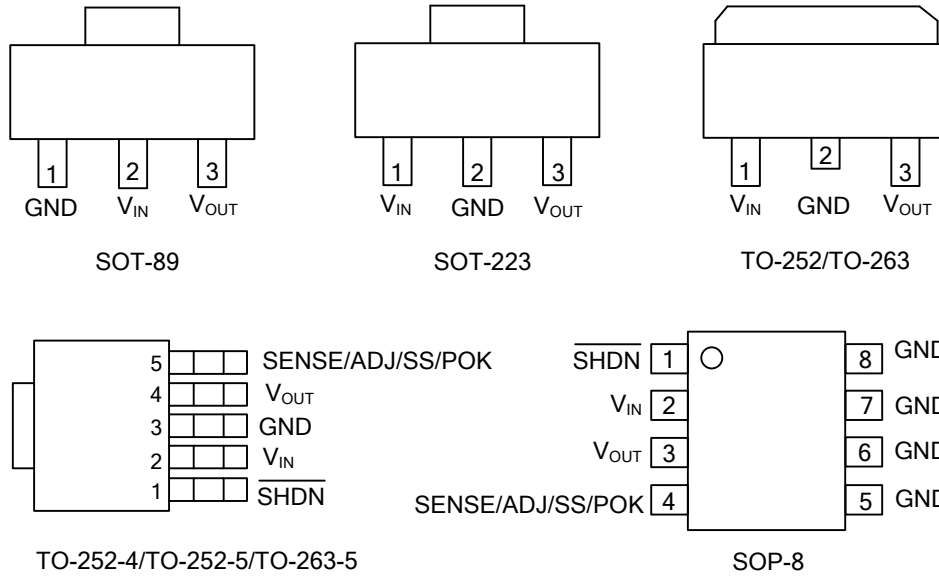
## ORDERING INFORMATION(Cont.)

|  |  |
|--|--|
| <p>LR3965L-xx-AA3-D-R</p> <p>(1)Packing Type<br/>(2)Pin Assignment<br/>(3)Package Type<br/>(4)Output Voltage Code<br/>(5)Lead Free</p> | <p>(1) R: Tape Reel, T: Tube<br/>(2) refer to Pin Assignment<br/>(3) AA3: SOT-223, AB3: SOT-89, TN3: TO-252<br/>TN4: TO-252-4, TN5: TO-252-5, TQ2: TO-263,<br/>TQ5-TO-263-5, S08: SOP-8<br/>(4) xx: refer to Marking Information<br/>(5) G: Halogen Free, L: Lead Free</p> |
|--|--|

## MARKING INFORMATION

| PACKAGE                          | VOLTAGE CODE  | MARKING |
|----------------------------------|---|---------|
| SOT-223                          |   |         |
| SOT-89                           | 12 :1.2V<br>15 :1.5V<br>18 :1.8V<br>25 :2.5V<br>33 :3.3V<br>50 :5.0V            |         |
| TO-252<br>TO-263                 |   |         |
| TO-252-4<br>TO-252-5<br>TO-263-5 | 12 :1.2V<br>15 :1.5V<br>18 :1.8V<br>25 :2.5V<br>33 :3.3V<br>50 :5.0V            |         |
| SOP-8                            | 12 :1.2V<br>15 :1.5V<br>18 :1.8V<br>25 :2.5V<br>33 :3.3V<br>50 :5.0V<br>AD :ADJ |         |

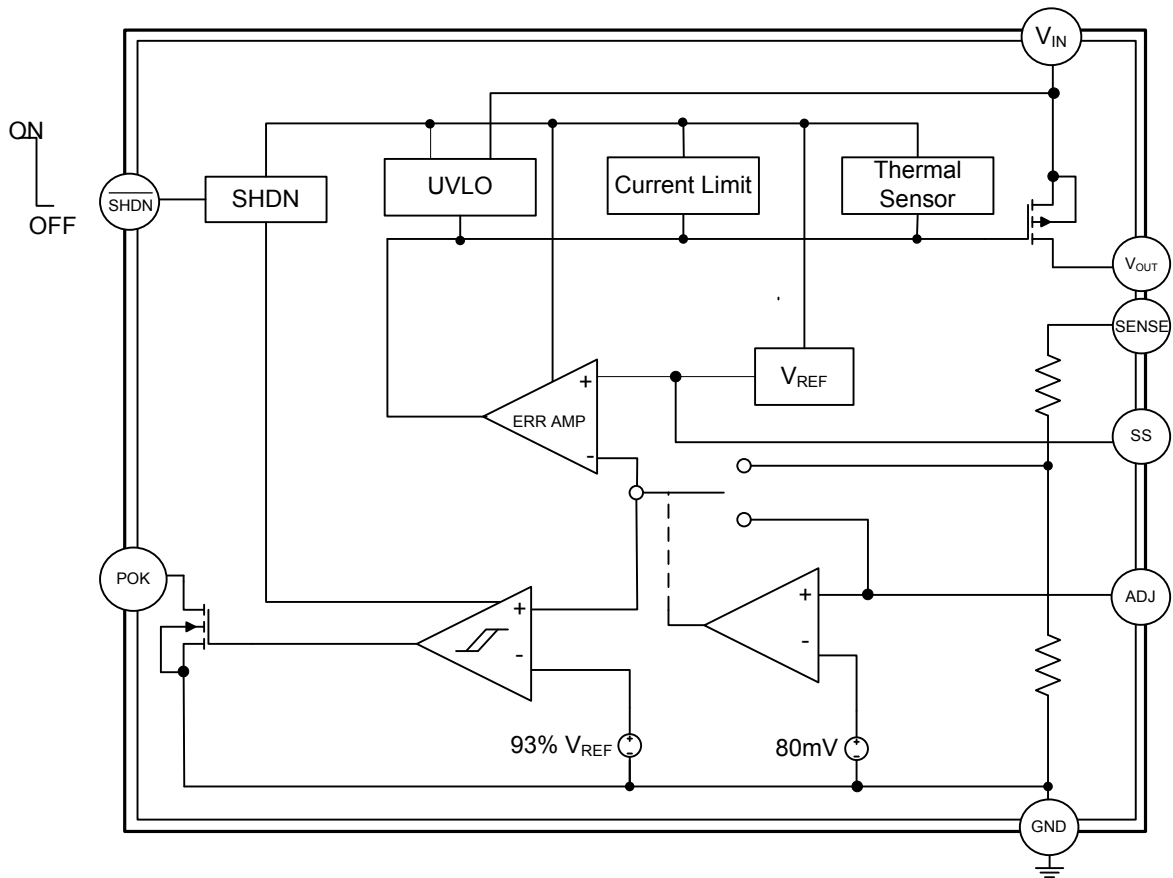
## ■ PIN CONFIGURATION



## ■ PIN DESCRIPTION

| PIN NAME                 | DESCRIPTION  |
|--------------------------|--|
| $V_{IN}$                 | Power Input Voltage. Supply voltage can range from 2.25V to 6V. Bypass with a 68 $\mu$ F capacitor to GND.   |
| GND                      | Ground   |
| $\overline{\text{SHDN}}$ | Active-Low Shutdown Input. A logic low at $\overline{\text{SHDN}}$ reduces supply current to 0.01 $\mu$ A. In shutdown, the POK output is low. Connect $\overline{\text{SHDN}}$ to $V_{IN}$ for normal operation.  |
| $V_{OUT}$                | Output Voltage   |
| ADJ                      | Voltage-adjust Input. Connect ADJ to GND for preset output. Connect an external resistive voltage-divider from $V_{OUT}$ to ADJ to set the output voltage between 0.8V and 6V. The ADJ regulation voltage is 800mV |
| SENSE                    | Remote sense pin.  |
| SS                       | Soft start time setting. For adjustable soft start time version, connect a capacitor from SS to gnd to set the soft start time.  |
| POK                      | Open-Drain, Active-Low Power-OK Output. POK remains low while the output voltage ( $V_{OUT}$ ) is below the POK threshold.   |

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING ( $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

| PARAMETER             |                          | SYMBOL    | RATINGS    | UNIT               |
|-----------------------|--------------------------|-----------|------------|--------------------|
| Supply Voltage        |                          | $V_{IN}$  | 6.5        | V                  |
| Power Dissipation     | SOP-8                    | $P_D$     | 606        | mW                 |
|                       | SOT-223                  |           | 714        |                    |
|                       | SOT-89                   |           | 500        |                    |
|                       | TO-252/TO-252-5/TO-252-4 |           | 952        |                    |
|                       | TO-263/TO-263-5          |           | 1250       |                    |
| Junction Temperature  |                          | $T_J$     | +125       | $^{\circ}\text{C}$ |
| Operating Temperature |                          | $T_{OPR}$ | -40 ~ +85  | $^{\circ}\text{C}$ |
| Storage Temperature   |                          | $T_{STG}$ | -65 ~ +150 | $^{\circ}\text{C}$ |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ THERMAL DATA

| PARAMETER           |                          | SYMBOL        | RATINGS | UNIT                 |
|---------------------|--------------------------|---------------|---------|----------------------|
| Junction to Ambient | SOP-8                    | $\theta_{JA}$ | 165     | $^{\circ}\text{C/W}$ |
|                     | SOT-223                  |               | 150     |                      |
|                     | SOT-89                   |               | 180     |                      |
|                     | TO-252/TO-252-5/TO-252-4 |               | 112     |                      |
|                     | TO-263/TO-263-5          |               | 64      |                      |
| Junction to Case    | SOP-8                    | $\theta_{JC}$ | 20      | $^{\circ}\text{C/W}$ |
|                     | SOT-223                  |               | 15      |                      |
|                     | SOT-89                   |               | 50      |                      |
|                     | TO-252/TO-252-5/TO-252-4 |               | 12      |                      |
|                     | TO-263/TO-263-5          |               | 4       |                      |

## ■ ELECTRICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$ ,  $V_{IN} = V_{OUT} + 1\text{V}$  or  $V_{IN} = 2.25\text{V}$  whichever is greater,  $C_{IN} = 68\mu\text{F}$ ,  $C_{OUT} = 33\mu\text{F}$ , unless otherwise specified)

| PARAMETER                                    | SYMBOL  | TEST CONDITIONS   | MIN                             | TYP  | MAX   | UNIT                |
|--|---|---|---------------------------------|------|-------|---------------------|
| Input Voltage                                | $V_{IN}$  |   | Note1                           |      | 6     | V                   |
| Output Voltage Accuracy (Preset Mode)        | $V_{OUT}$   | $T_A = 25^\circ\text{C}$ , $I_{OUT} = 1\text{mA} \sim 1.5\text{A}$        | -2                              |      | 2     | %                   |
|  |   | $T_A = 0 \sim 85^\circ\text{C}$ , $I_{OUT} = 1\text{mA} \sim 1.5\text{A}$ | -3                              |      | 3     | %                   |
| Maximum Output Current                       | $I_{OUT}$   |   |                                 | 1.5  |       | A                   |
| Short-Circuit Current Limit                  | $I_{LIMIT}$   | $V_{OUT} = 0\text{V}$   |                                 | 2.5  |       | A                   |
| Ground Pin Current                           | $I_{GND}$   | $I_{OUT} = 0\text{mA}$  |                                 | 200  |       | $\mu\text{A}$       |
|  |   | $I_{OUT} = 1\text{mA}$ to $1.5\text{A}$                                   |                                 | 250  |       | $\mu\text{A}$       |
| Dropout Voltage (Note 2)                     | $V_D$   | $I_{OUT} = 1.5\text{A}$   | $V_{OUT(NOM)} \leq 1.8\text{V}$ | 1000 | 1050  | mV                  |
|  |   |   | $1.8\text{V} < V_{OUT(NOM)}$    |      | 550   |                     |
| Line Regulation (Note 3)                     | $\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$ | $V_{IN} = V_{OUT} + V_D \sim 6\text{V}$                                   |                                 | 0.08 | 0.55  | %/V                 |
| Load Regulation (Note 3, 4)                  | $\Delta V_{OUT}$                                      | $V_{IN} = V_{OUT} + V_D$ , $I_{OUT} = 10\text{mA} \sim 1.5\text{A}$       |                                 | 0.25 | 0.5   | %                   |
| Output Voltage Noise                         | $e_N$   | $f = 10\text{Hz}$ to $1\text{MHz}$ , $C_{OUT} = 33\mu\text{F}$            |                                 | 300  |       | $\mu\text{V}_{RMS}$ |
| Shutdown Supply Current                      | $I_{OFF}$   | $\overline{\text{SHDN}} = \text{GND}$                                     |                                 | 0.01 | 5     | $\mu\text{A}$       |
| Shutdown Threshold                           | $V_{IH}$  |   | 1.6                             |      |       | V                   |
|  | $V_{IL}$  |   |                                 |      | 0.6   | V                   |
| Thermal Shutdown Temperature                 | $T_{SHDN}$  |   |                                 | 170  |       | $^\circ\text{C}$    |
| Thermal Shutdown Hysteresis                  | $DT_{SHDN}$   |   |                                 | 20   |       | $^\circ\text{C}$    |
| ADJ Voltage                                  | $V_{REF}$   | Measured on ADJ, $I_{OUT} = 10\text{mA}$                                  | 0.774                           | 0.8  | 0.826 | V                   |
| ADJ Mode Threshold                           |   |   |                                 | 80   |       | mV                  |
| Adjustable Output Voltage                    |   |   | 0.8                             |      | 5     | V                   |
| POK Output Low Voltage                       | $V_{OL}$  | Sinking $2\text{mA}$  |                                 | 5    | 50    | mV                  |
| Operating Voltage Range for Valid POK Output |   | Sinking $100\mu\text{A}$  | 1.0                             |      | 5.5   | V                   |
| POK Output High Leakage Current              |   | $V_{POK} = 5.5\text{V}$   |                                 |      | 100   | nA                  |
| POK Threshold                                |   | Rising edge, referred to $V_{OUT(NOM)}$                                   | 90                              | 93   | 96    | %                   |

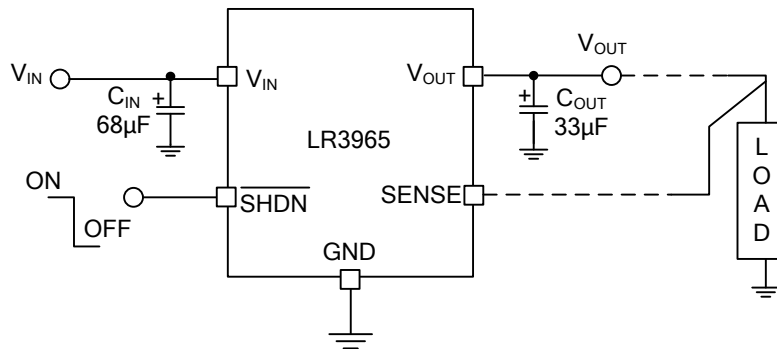
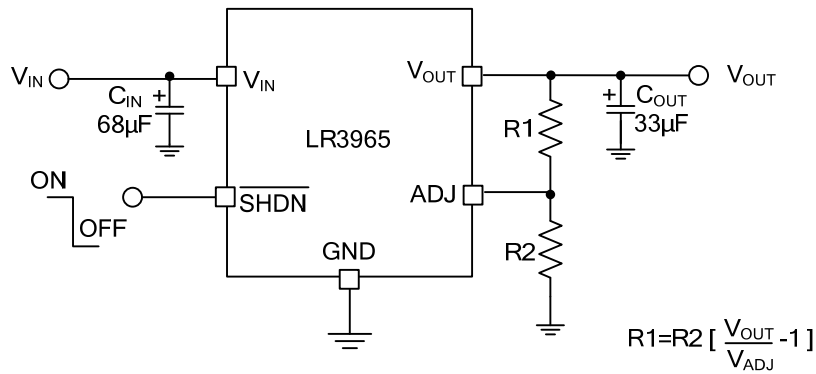
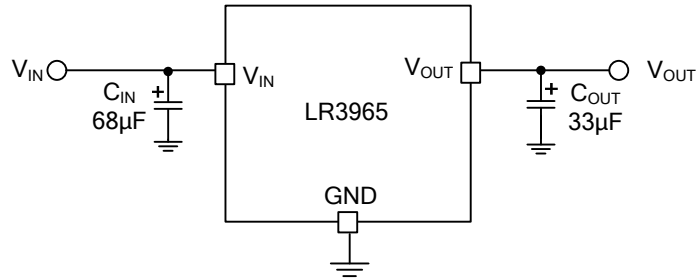
Note 1: The minimum operating value for  $V_{IN}$  is equal to either  $[V_{OUT(NOM)} + V_D]$  or  $2.25\text{V}$ , whichever is greater

2: Dropout voltage is defined as the voltage from the input to output when output is 2% below the nominal value.

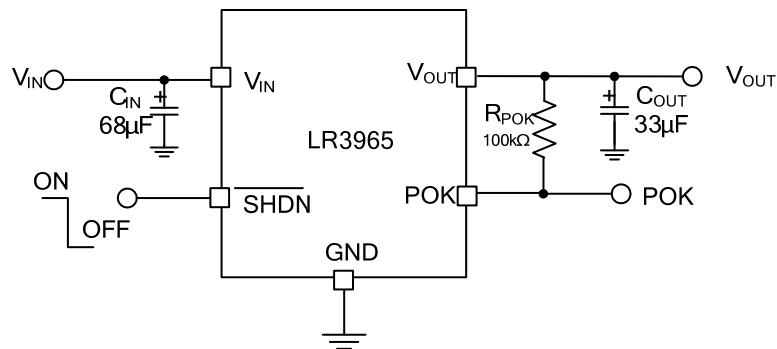
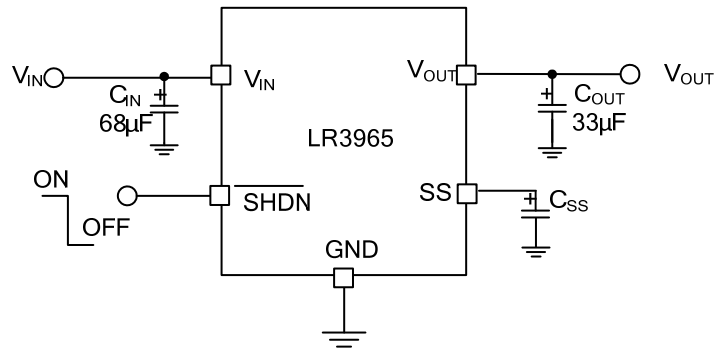
3: Output voltage line regulation is defined as the change in output voltage from the nominal value resulting from a change in the input line voltage. Output voltage load regulation is defined as the change in output voltage from the nominal value as the load current increases from no load to full load.

4: Regulation is measured at constant junction temperature by using a 20ms current pulse. Devices are tested for load regulation in the load range from  $10\text{mA}$  to  $1.5\text{A}$

■ TYPICAL APPLICATION CIRCUIT

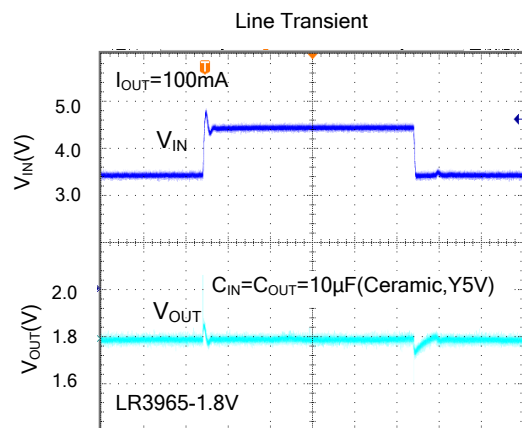
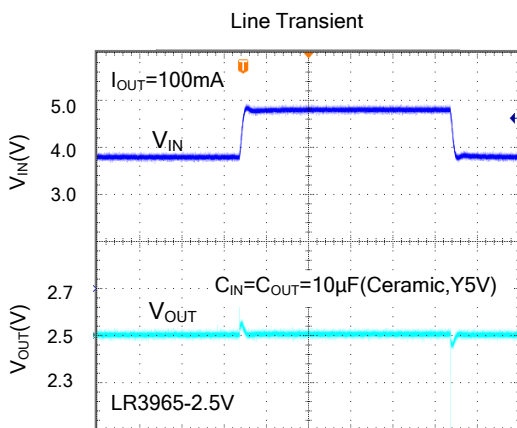
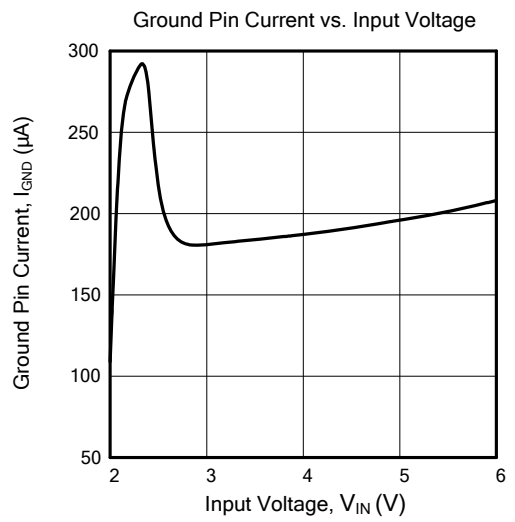
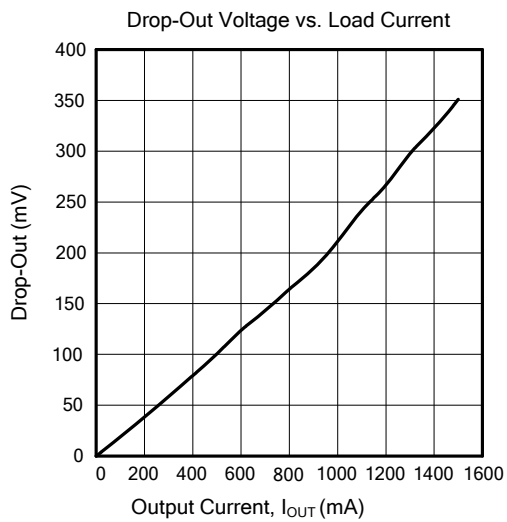
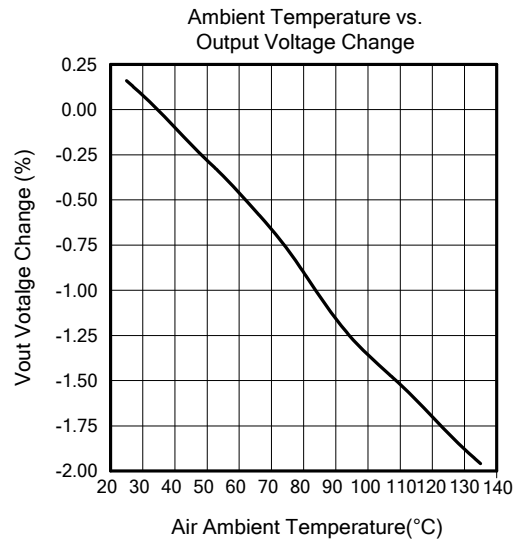
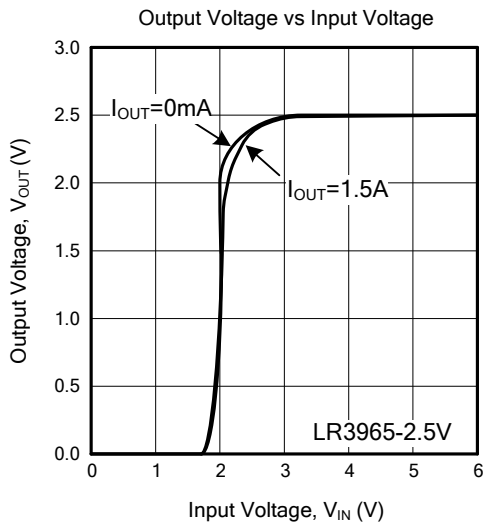


■ TYPICAL APPLICATION CIRCUIT (Cont.)

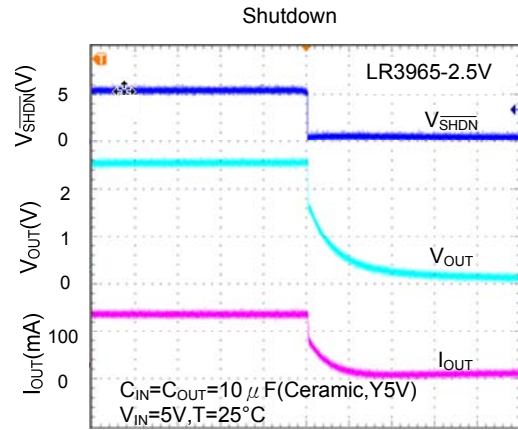
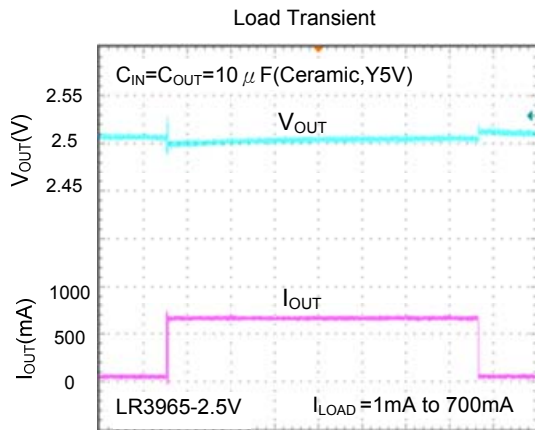




## TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS (Cont.)



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