



**Si91861**

**Vishay Siliconix**

## 400-mA Smart Regulator for Network Interface Card

### FEATURES

- Single Fixed 3.3-V Output
- Linear Regulator for 5-V Power Input
- Auxilliary Input Can Be Bypassed
- Automatically Switches Between Linear Regulator and Bypass Mode
- Linear Regulator: 3.3-V  $\pm 3\%$  Output at 400-mA Current; 600-mA Peak Output Current
- Low Bypass Switch Voltage-Drop: <55-mV at 150 mA
- Built-in Short Circuit and Thermal Shutdown Protection

- Low Supply Current
- SOIC-8 Package

### APPLICATIONS

- Network Interface Cards (NIC)
- PCMCIA Cards
- Cardbus
- Desktop Computers/Workstations

### DESCRIPTION

The Si91861 provides a constant 3.3-V output with multiple inputs. This function is required in many power interface applications, such as the Network Interface Card (NIC). The Si91861 is offered in small SOIC-8 package with up to 2-W power handling capability. The complete application circuit uses only three external components.

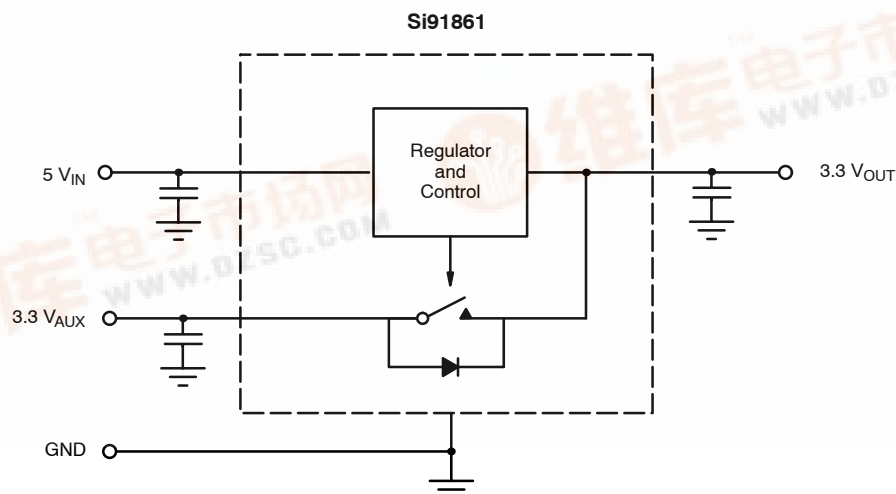
The linear regulator steps down from the 5-V supply ( $5 V_{IN}$ ) to 3.3 V. A 200-m $\Omega$  bypass switch is integrated to connect the 3.3-V<sub>AUX</sub> input to the output. The power drawn priority is

$5 V_{IN} > 3.3 V_{AUX}$ , where the selection is done internally and automatically by the Si91861. The power handling capability is as such as to carry at least 400-mA continuous load current for any power input condition.

In order to satisfy the stringent ambient temperature requirements in many applications, the Si91861 is rated for the industrial temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

The Si91861 is available in both standard and lead (Pb)-free packages.

### FUNCTIONAL BLOCK DIAGRAM



# Si91861

## Vishay Siliconix



### ABSOLUTE MAXIMUM RATINGS

Pin 2, 4 Voltage ..... -0.3 V to 6 V  
 Linear Regulator Output Current ..... 600 mA  
 Bypass Switch Current ..... 600 mA  
 Maximum Junction Temperature,  $T_{J(max)}$  ..... 150°C  
 Storage Temperature,  $T_{STG}$  ..... -55°C to 150°C  
 ESD (Human Body Model) ..... 2 kV

Package Power Dissipation<sup>b</sup>

$P_D$  ..... 2W (internally limited via thermal shutdown)

Thermal Impedance ( $\theta_{JA}$ )<sup>a</sup> ..... 62.5°C/W

Notes

a. Device mounted with all leads soldered or welded to PC board.

b. Derate 16 mW/°C above  $T_A = 25^\circ\text{C}$

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.

### RECOMMENDED OPERATING RANGE

5- $V_{IN}$  ..... 4.5 V to 5.5 V  
 3.3- $V_{AUX}$  ..... 3 V to 3.6 V

3.3  $V_{OUT}$  Loading ..... 1 mA to 400 mA  
 Operating Ambient Temperature,  $T_A$  ..... -40°C to 85°C

| SPECIFICATIONS                                       |                                           |                                                                                                                                                                                            |            |                   |                       |                  |                  |                   |
|------------------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------|-----------------------|------------------|------------------|-------------------|
| Parameter                                            | Symbol                                    | Test Conditions<br>Unless Otherwise Specified<br><br>5 V <sub>IN</sub> = 5 V, 3.3 V <sub>AUX</sub> = 3.3 V<br>I <sub>OUT</sub> = 1 mA, C <sub>IN</sub> = 4.7 μF, C <sub>OUT</sub> = 2.2 μF |            | Temp <sup>a</sup> | Limits<br>-40 to 85°C |                  |                  | Unit              |
|                                                      |                                           |                                                                                                                                                                                            |            |                   | Min <sup>b</sup>      | Typ <sup>c</sup> | Max <sup>b</sup> |                   |
| Regulator Mode                                       |                                           |                                                                                                                                                                                            |            |                   |                       |                  |                  |                   |
| Output Voltage (Regulator)                           | V <sub>O(reg)</sub>                       | 0 mA < I <sub>OUT</sub> < 400 mA, 5 V <sub>IN</sub> > 4.5 V                                                                                                                                |            | Full              | 3.201                 | 3.3              | 3.399            | V                 |
| 5 V <sub>IN</sub> Select                             |                                           | Rising Edge of Hysteresis                                                                                                                                                                  | Threshold  | Full              |                       | 4.30             | 4.475            |                   |
|                                                      |                                           |                                                                                                                                                                                            | Hysteresis | Full              |                       | 230              |                  | mV                |
| Ground Pin Current<br>In Regulator Mode <sup>d</sup> | I <sub>GND</sub>                          | I <sub>O</sub> = 0 mA                                                                                                                                                                      |            | Full              |                       | 0.3              | 0.8              | mA                |
|                                                      |                                           | I <sub>O</sub> = 400 mA                                                                                                                                                                    |            | Full              |                       | 0.7              | 1.6              |                   |
| Peak Output Current (Regulator)                      | I <sub>O</sub>                            | t <sub>PW</sub> = 2 ms                                                                                                                                                                     |            | Full              | 600                   |                  |                  |                   |
| Output Noise Voltage (Regulator)                     | e <sub>N</sub>                            | BW = 50 Hz to100 kHz, I <sub>OUT</sub> = 150 mA                                                                                                                                            |            | Room              |                       | 300              |                  | μV <sub>rms</sub> |
| Ripple Rejection (Regulator)                         | Δ3.3 V <sub>OUT</sub> /Δ5 V <sub>IN</sub> | I <sub>OUT</sub> = 150 mA                                                                                                                                                                  | 1 kHz      | Room              |                       | 60               |                  | dB                |
|                                                      |                                           |                                                                                                                                                                                            | 10 kHz     | Room              |                       | 40               |                  |                   |
|                                                      |                                           |                                                                                                                                                                                            | 100 kHz    | Room              |                       | 30               |                  |                   |
| Dynamic Line Regulation                              | ΔV <sub>O(line)</sub>                     | V <sub>IN</sub> = 4.5 V ∙ ∙ 5.5 V<br>t <sub>R</sub> /t <sub>F</sub> = 2 μs, I <sub>OUT</sub> = 150 mA                                                                                      |            | Room              |                       | 10               |                  | mV                |
| Dynamic Load Regulation                              | ΔV <sub>O(load)</sub>                     | I <sub>OUT</sub> : 1 mA to 150 mA, t <sub>R</sub> /t <sub>F</sub> = 2 μs                                                                                                                   |            | Room              |                       | 20               |                  |                   |
| V <sub>OUT</sub> Turn-On-Time                        | t <sub>ON</sub>                           |                                                                                                                                                                                            |            | Room              |                       | 15               |                  | μs                |
| Thermal Shutdown Junction Temperature                | T <sub>J(sd)</sub>                        |                                                                                                                                                                                            |            | Full              |                       | 165              |                  | °C                |
| Thermal Hysteresis                                   | T <sub>HYST</sub>                         |                                                                                                                                                                                            |            | Full              |                       | 20               |                  |                   |
| Short Circuit Current                                | I <sub>SC</sub>                           | 3.3 V <sub>OUT</sub> = 0 V                                                                                                                                                                 |            | Room              |                       | 900              |                  | mA                |
| Bypass Mode (5 V <sub>IN</sub> = GND)                |                                           |                                                                                                                                                                                            |            |                   |                       |                  |                  |                   |
| Output Voltage                                       | V <sub>O(BP)</sub>                        | 0 mA < I <sub>OUT</sub> < 150 mA                                                                                                                                                           |            | Full              | 3.247                 |                  |                  | V                 |
| Bypass Switch On-Resistance                          | r <sub>DS(on)</sub>                       | 3.0 V ≤ V <sub>AUX</sub> ≤ 3.6 V                                                                                                                                                           |            | Full              |                       | 0.2              | 0.35             | Ω                 |
| Ground Current <sup>d</sup>                          | I <sub>GND</sub>                          | 0 mA < I <sub>OUT</sub> < 400 mA                                                                                                                                                           |            | Full              |                       | 200              | 400              | μA                |

Notes

a. Room = 25°C, Full = -40 to 85°C.

b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum.

c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing. Typical values at 25°C ambient.

d. Ground pin current includes the IC supply current and the current to drive the linear regulator or bypass switch.



## TIMING WAVEFORMS

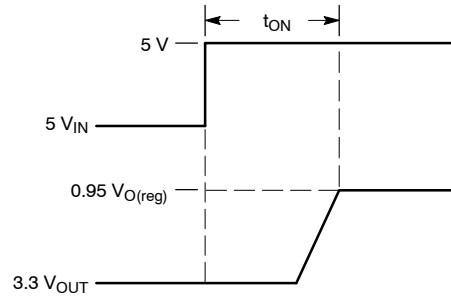
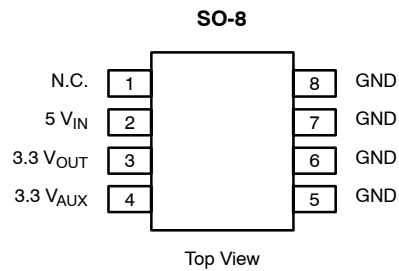


FIGURE 1. Timing Diagram

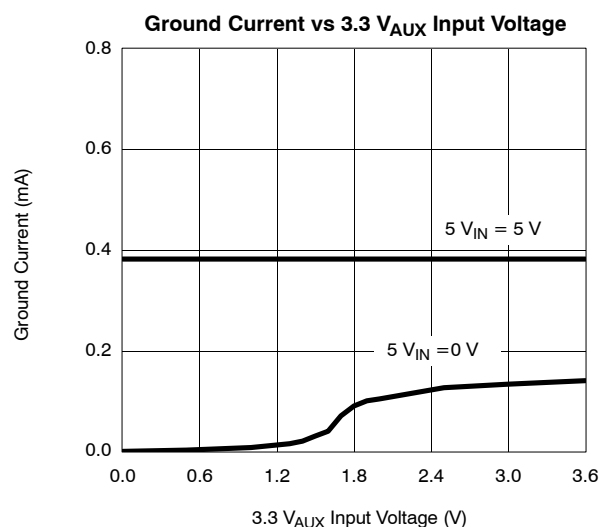
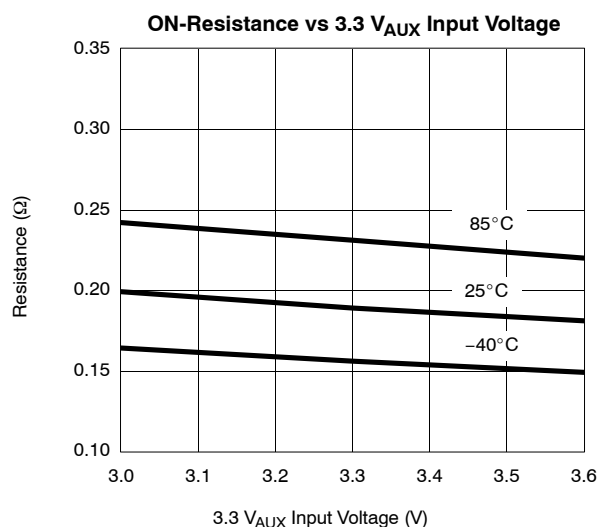
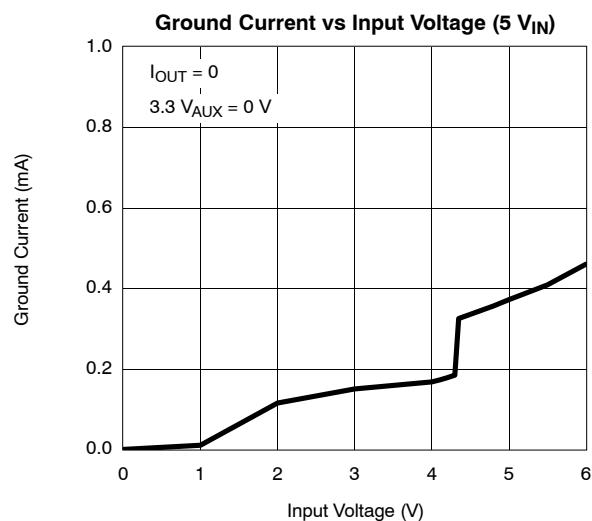
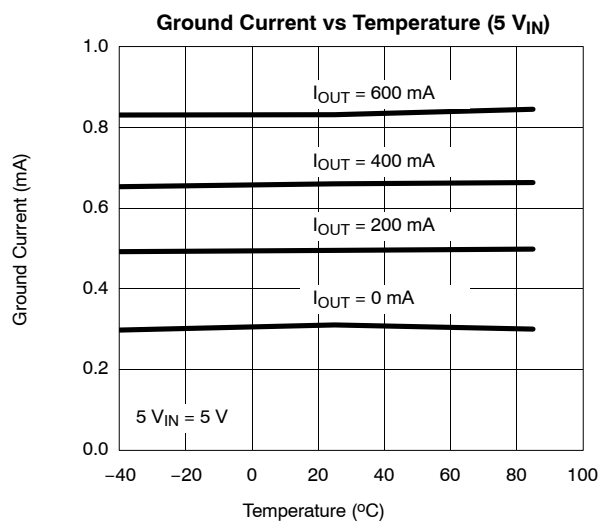
## PIN CONFIGURATION



| PIN DESCRIPTION |               |                                              |
|-----------------|---------------|----------------------------------------------|
| Pin Number      | Name          | Function                                     |
| 1               | N.C.          | Not connected. No effect to device operation |
| 2               | $5 V_{IN}$    | Power input for the Regulator                |
| 3               | $3.3 V_{OUT}$ | Output 3.3 V                                 |
| 4               | $3.3 V_{AUX}$ | Power input for the bypass function          |
| 5, 6, 7, 8      | GND           | Ground                                       |

| ORDERING INFORMATION |                   |               |
|----------------------|-------------------|---------------|
| Part Number          | Temperature Range | Package       |
| Si91861DY-T1         | -40 to 85°C       | Tape and Reel |
| Si91861DY-T1—E3      |                   |               |
| Si91861DY            |                   | Bulk          |
| Eval Kit             | Temperature Range | Board Type    |
| Si91861DB            | -40 to 85°C       | Surface Mount |

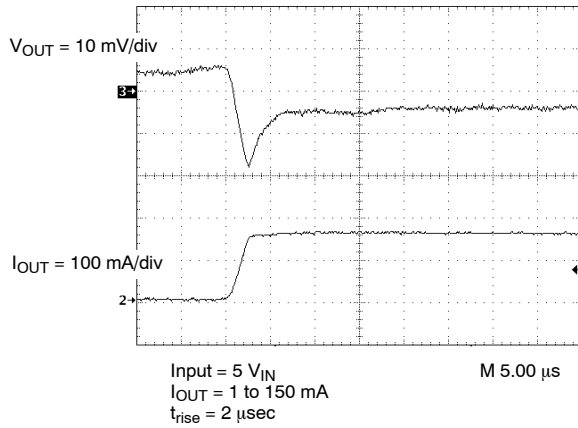
## TYPICAL CHARACTERISTICS



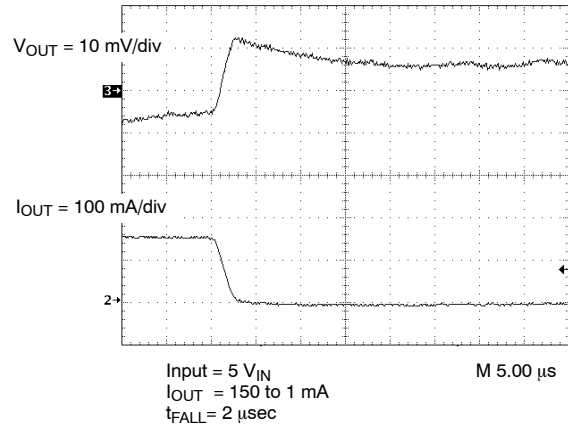


## TYPICAL WAVEFORMS

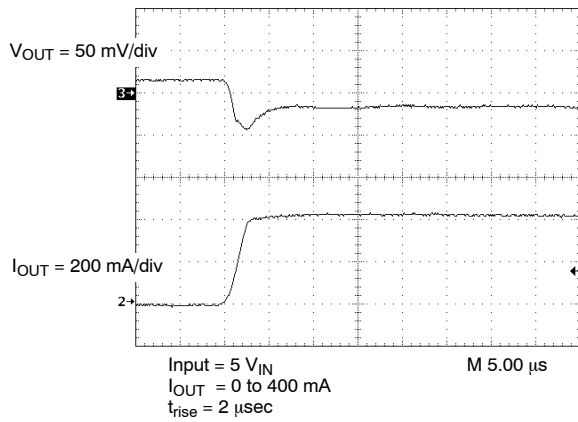
Load Transient Response-1



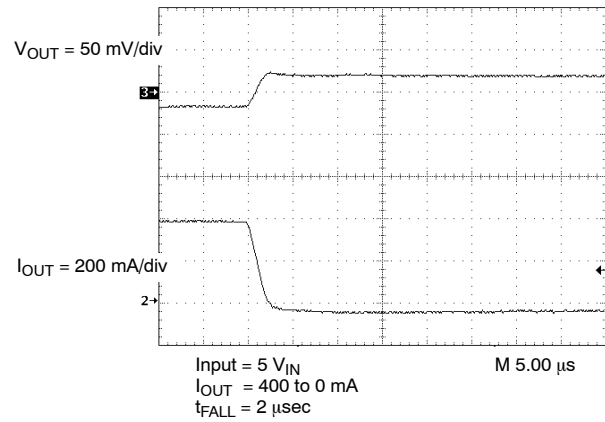
Load Transient Response-2



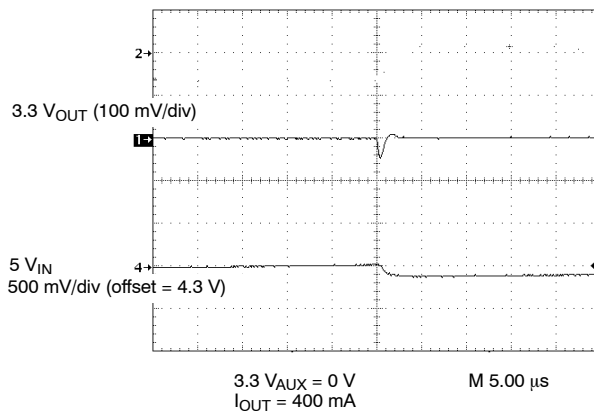
Load Transient Response-3



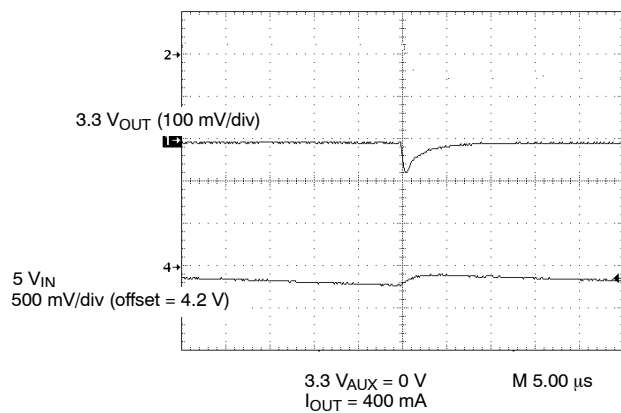
Load Transient Response-4



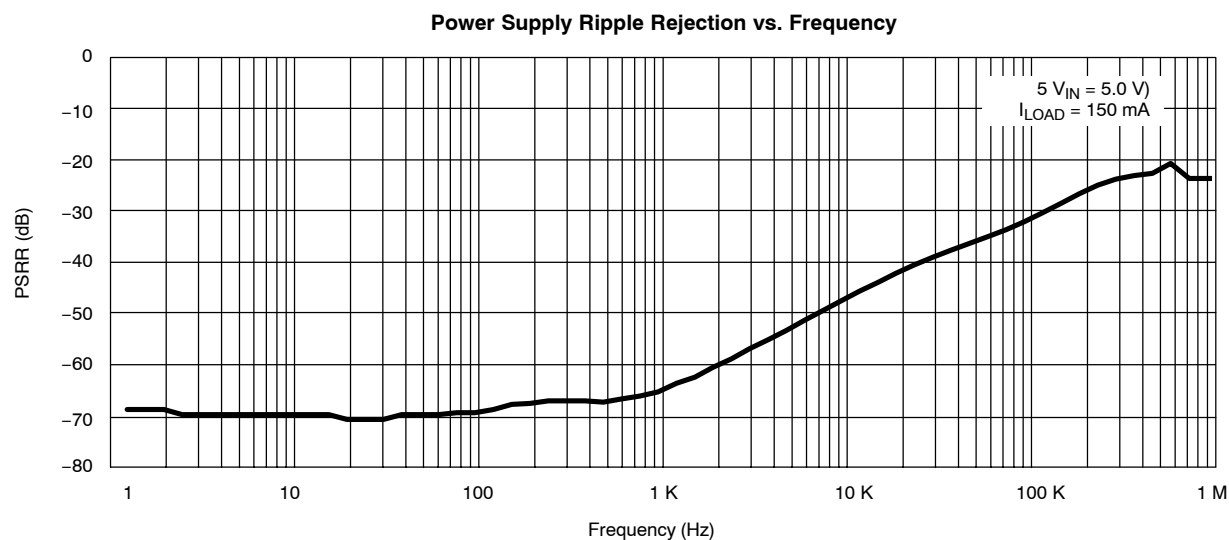
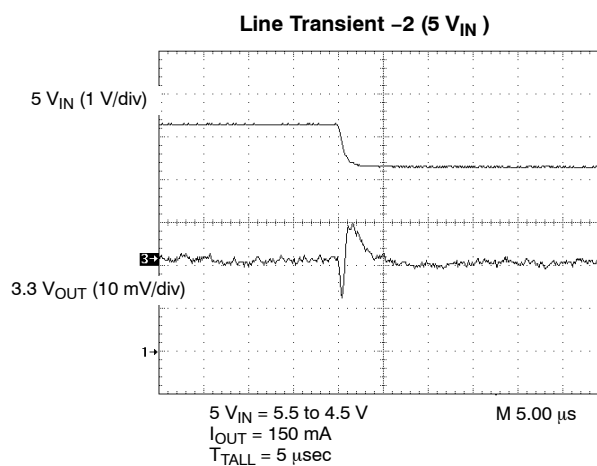
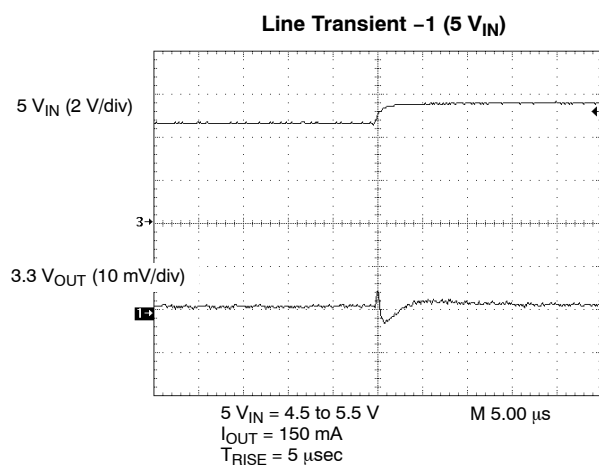
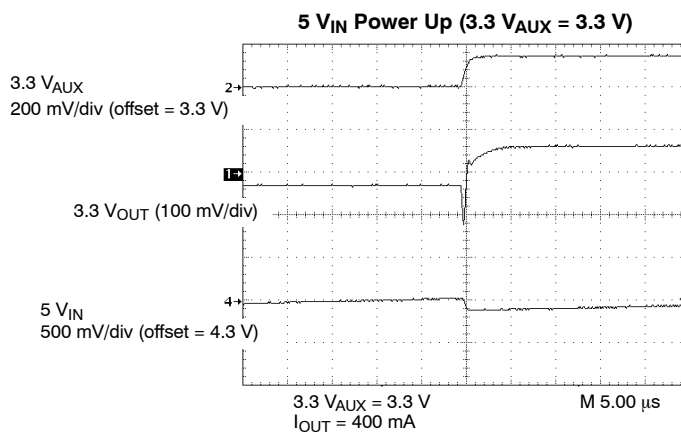
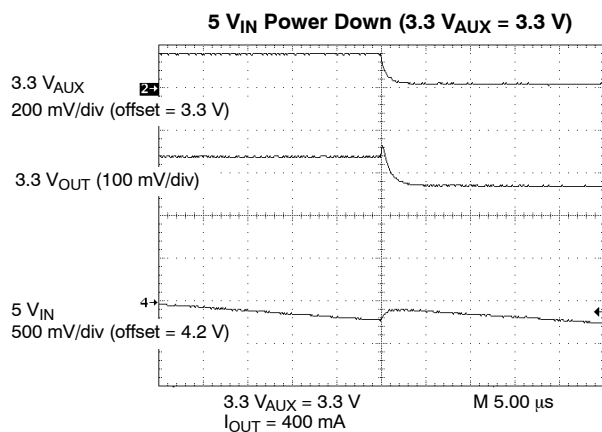
5- $V_{IN}$  Power Up



5- $V_{IN}$  Power Down

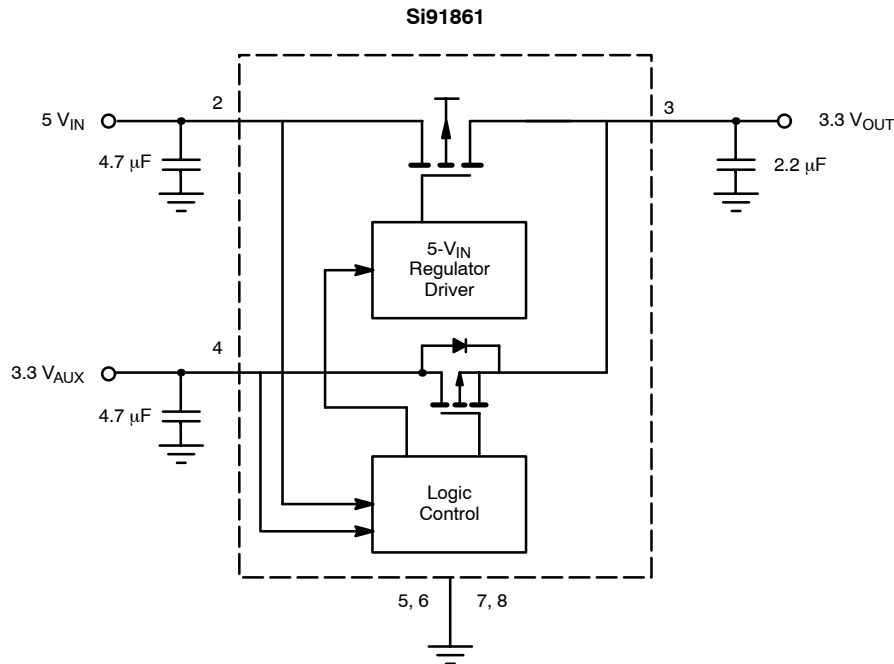


**TYPICAL WAVEFORMS**





## BLOCK DIAGRAMS AND TYPICAL APPLICATION CIRCUIT



## DETAIL DESCRIPTION

During normal operation, the 5- $V_{IN}$  input powers the fixed 3.3-V output (3.3  $V_{OUT}$ ) through an internal linear regulator. If 5  $V_{IN}$  falls below 4.07 V, the output (3.3  $V_{OUT}$ ) is powered from 3.3- $V_{AUX}$  input. The power drawn sequence is from 5  $V_{IN}$ , then 3.3  $V_{AUX}$ . The device prevents reverse current from flowing from the output to any unbiased or low voltage input.

### Linear Regulator Mode

The output is regulated at 3.3 V when the 5- $V_{IN}$  pin is more than 4.30 V. The linear regulator will regulate the output until the 5- $V_{IN}$  pin fall below 4.07 V.

### Bypass Mode

When the 5- $V_{IN}$  pin falls below 4.07 V, the output is powered by 3.3  $V_{AUX}$  through a 0.2- $\Omega$  internal switch.

### Thermal and Over-current Protection

Thermal protection limits total power dissipation in the device. It safeguards the device in the event of fault conditions. When the junction temperature exceeds 165°C, the device turns off. The device turns back on once its junction temperature cools down by approximately 20°C. The device has overcurrent protection (typically at 900 mA) when it operates in linear regulator mode. A continuous short at output pin (3.3  $V_{OUT}$ ) will result in a pulsed output as the thermal protection circuitry cycles the device on and off. For continuous operation, do not exceed the junction rating of 150°C. In bypass mode, the device is not current limited.