

## High Input Voltage Adjustable 3-Terminal Linear Regulator

### Features

- ▶ 13.2V to 450V input voltage range
- ▶ Adjustable 1.20V to 440V output regulation
- ▶ 5% output voltage tolerance
- ▶ Output current limiting
- ▶ 10 $\mu$ A typical ADJ current
- ▶ Internal junction temperature limiting

### Applications

- ▶ Off-line SMPS startup circuits
- ▶ Adjustable high voltage constant current source
- ▶ Industrial controls
- ▶ Motor controls
- ▶ Battery chargers
- ▶ Power supplies

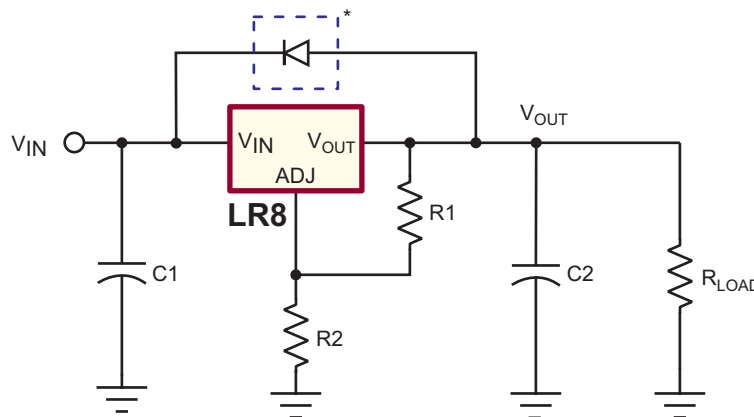
### General Description

The Supertex LR8 is a high voltage, low output current, adjustable linear regulator. It has a wide operating input voltage range of 13.2V to 450V. The output voltage can be adjusted from 1.20V to 440V provided that the input voltage is at least 12V greater than the output voltage. The output voltage can be adjusted by means of two external resistors R1 and R2 as shown in the typical application circuits. The LR8 regulates the voltage difference between VOUT and ADJ pins to a nominal value of 1.20V. The 1.20V is amplified by the external resistor ratio R1 and R2. An internal constant bias current of typically 10 $\mu$ A is connected to the ADJ pin. This increases  $V_{OUT}$  by a constant voltage of 10 $\mu$ A times R2.

The LR8 has current limiting and temperature limiting. The output current limit is typically 20mA and the minimum temperature limit is 125°C. An output short circuit current will therefore be limited to 20mA. When the junction temperature reaches its temperature limit, the output current and/or output voltage will decrease to keep the junction temperature from exceeding its temperature limit. For SMPS start-up circuit applications, the LR8 turns off when an external voltage greater than the output voltage of the LR8 is applied to VOUT of the LR8. To maintain stability, a bypass capacitor of 1.0 $\mu$ F or larger and a minimum DC output current of 500 $\mu$ A are required.

The device is available in TO-243AA (SOT-89), TO-252 (D-PAK), and TO-92 packages.

### Typical Application Circuit



\*Required for conditions where  $V_{IN}$  is less than  $V_{OUT}$ .

## Ordering Information

| DEVICE | Package Option |         |         |
|--------|----------------|---------|---------|
|        | TO-243AA       | TO-252  | TO-92   |
| LR8    | LR8N8-G        | LR8K4-G | LR8N3-G |

-G indicates package is RoHS compliant ("Green")

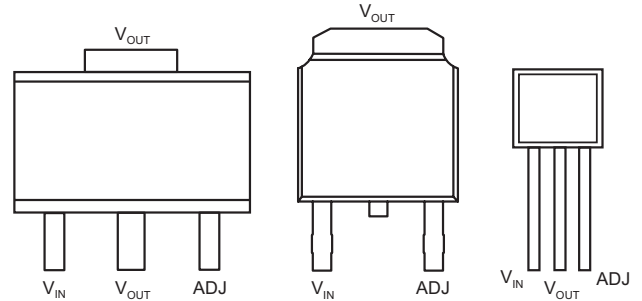


## Absolute Maximum Ratings

| Parameter                                    | Value           |
|----------------------------------------------|-----------------|
| $V_{IN}$ input voltage (voltages ref to ADJ) | -0.5V to +480V  |
| Output voltage range                         | -0.5V to +470V  |
| Operating ambient temperature range          | -40°C to +85°C  |
| Operating junction temperature range         | -40°C to +125°C |
| Storage temperature range                    | -65°C to +150°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.

## Pin Configurations



TO-243AA (SOT-89)  
(top view)

TO-252 (D-PAK)  
(top view)

TO-92  
(front view)

## Product Marking

Product marking for TO-243AA:

LR8 \*

where \* = 2-week alpha date code

## Electrical Characteristics (Test conditions unless otherwise specified: -40°C < TA < 85°C.)

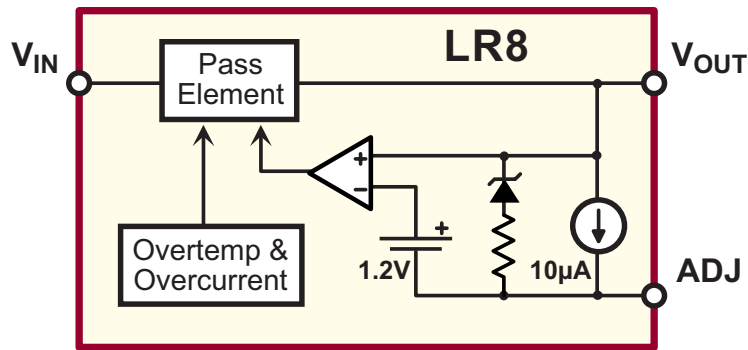
| Symbol             | Parameter                          | Min  | Typ   | Max  | Units      | Conditions                                                                               |
|--------------------|------------------------------------|------|-------|------|------------|------------------------------------------------------------------------------------------|
| $V_{IN} - V_{OUT}$ | Input to output voltage difference | 12   | -     | 450  | V          | ---                                                                                      |
| $V_{OUT}$          | Overall output voltage regulation  | 1.14 | 1.20  | 1.26 | V          | $13.2V < V_{IN} < 400V$ ,<br>$R1 = 2.4K\Omega$ , $R2 = 0$                                |
| $V_{OUT}$          | Overall output voltage regulation  | 375  | 400   | 425  | V          | $R1 = 2.4K\Omega$ , $R2 = 782K\Omega$                                                    |
| $\Delta V_{OUT}$   | Line regulation                    | -    | 0.003 | 0.01 | %/V        | $17V < V_{IN} < 400V$ , $V_{OUT} = 5V$ ,<br>$I_{OUT} = 0.5mA$                            |
| $\Delta V_{OUT}$   | Load regulation                    | -    | 1.4   | 3.0  | %          | $V_{IN} = 17V$ , $V_{OUT} = 5V$ ,<br>$0.5mA < I_{OUT} < 10mA$                            |
| $\Delta V_{OUT}$   | Temperature regulation             | -1   | -     | +1   | %          | $V_{IN} = 17V$ , $V_{OUT} = 5V$ , $I_{OUT} = 10mA$ ,<br>$-40^\circ C < T_A < 85^\circ C$ |
| $I_{OUT}$          | Output current limit               | 10   | -     | 30   | mA         | $T_J < 85^\circ C$ , $V_{IN} - V_{OUT} = 12V$                                            |
| $I_{OUT}$          | Output current limit               | -    | -     | 0.5  | mA         | $T_J > 125^\circ C$ , $V_{IN} - V_{OUT} = 450V$                                          |
| $I_{OUT}$          | Minimum output current             | -    | 0.3   | 0.5  | mA         | Includes R1 and load current                                                             |
| $I_{ADJ}$          | Adjust output current              | 5    | 10    | 15   | $\mu A$    | ---                                                                                      |
| C2                 | Minimum output load capacitance    | 1    | -     | -    | $\mu F$    | ---                                                                                      |
| $DV_{OUT}/DV_{IN}$ | Ripple rejection ratio             | 50   | 60    | -    | dB         | 120Hz, $V_{OUT} = 5V$                                                                    |
| $T_{LIMIT}$        | Junction temperature limit         | 125  | -     | -    | $^\circ C$ | ---                                                                                      |

## Thermal Characteristics

| Package  | Power Dissipation<br>@ $T_A = 25^\circ\text{C}$ | $\theta_{JC}$<br>$^\circ\text{C/W}$ | $\theta_{JA}$<br>$^\circ\text{C/W}$ |
|----------|-------------------------------------------------|-------------------------------------|-------------------------------------|
| TO-92    | 0.74W                                           | 125                                 | 170                                 |
| TO-243AA | 1.6W                                            | 15                                  | 78†                                 |
| TO-252   | 2.5W                                            | 6.25                                | 50†                                 |

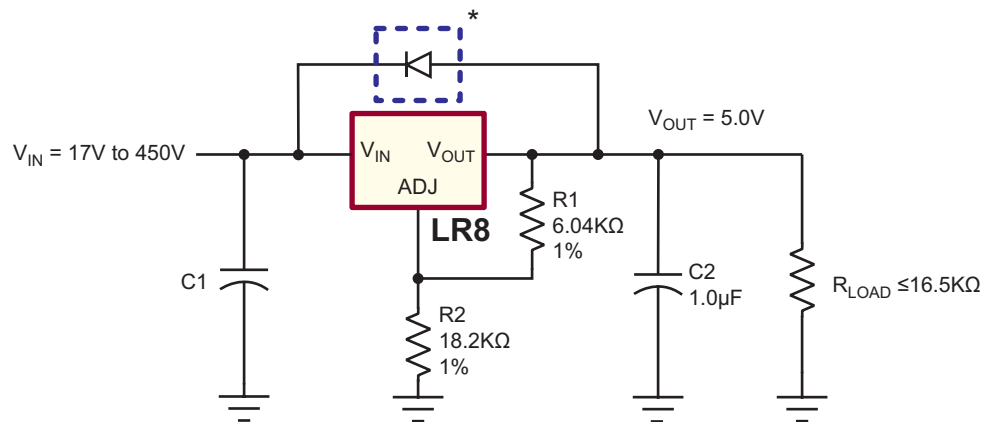
†Mounted on FR4 board, 25mm x 25mm x 1.57mm.  
Significant PD increase possible on ceramic substrate.

## Functional Block Diagram



## Typical Application Circuits

Figure 1: High Input Voltage, 5.0V Output Linear Regulator



\* Required for conditions where  $V_{IN}$  is less than  $V_{OUT}$

$$V_{OUT} = 1.20V \left( 1 + \frac{R2}{R1} \right) + I_{ADJ} R2$$

## Typical Application Circuits

Figure 2: SMPS Start-Up Circuit

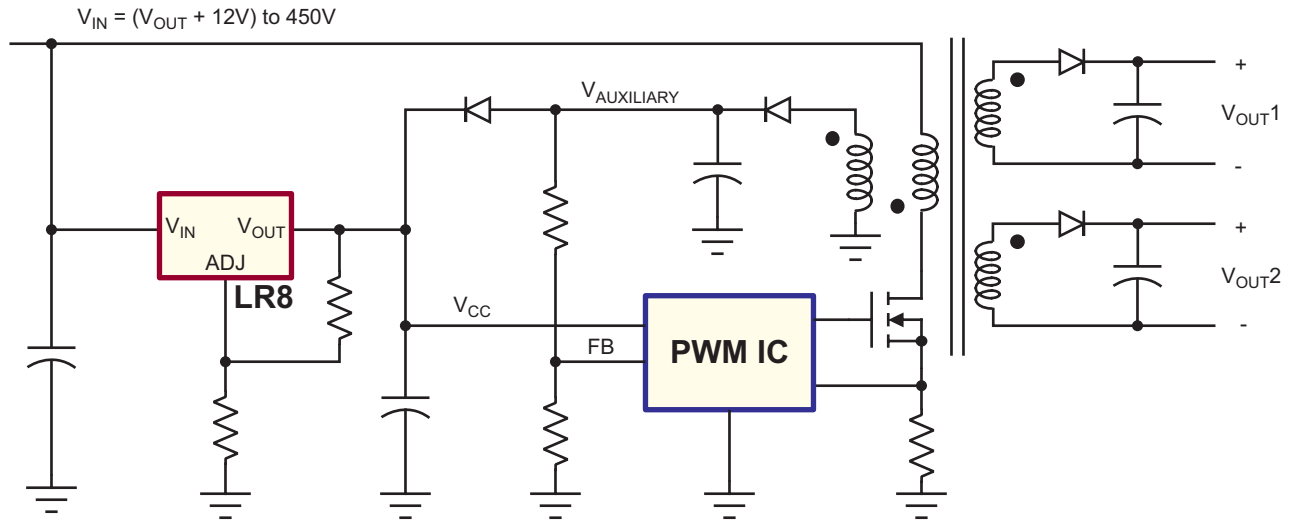
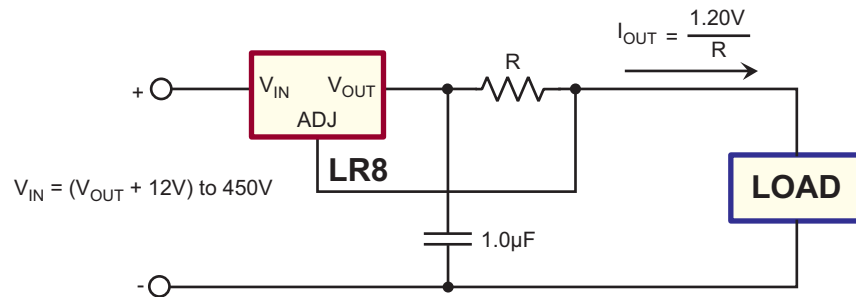
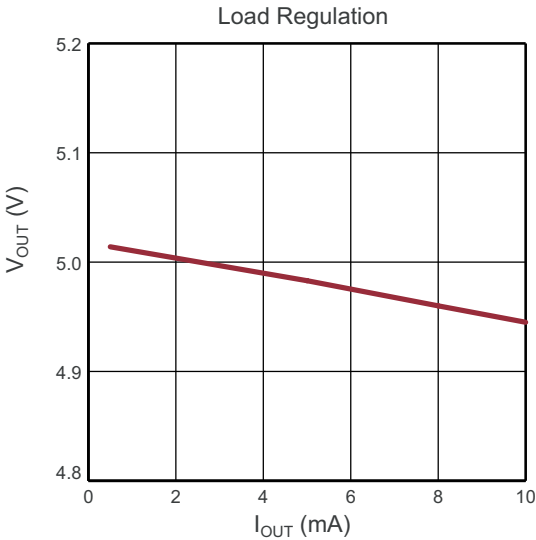
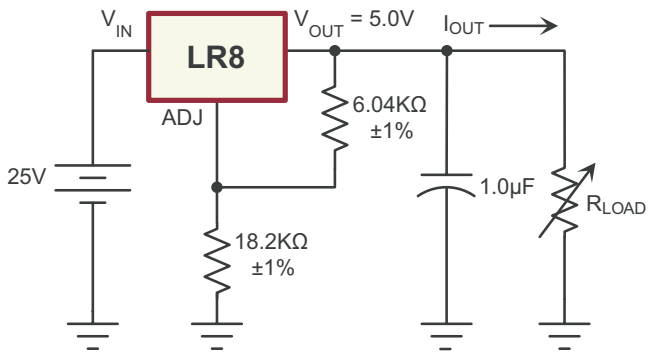
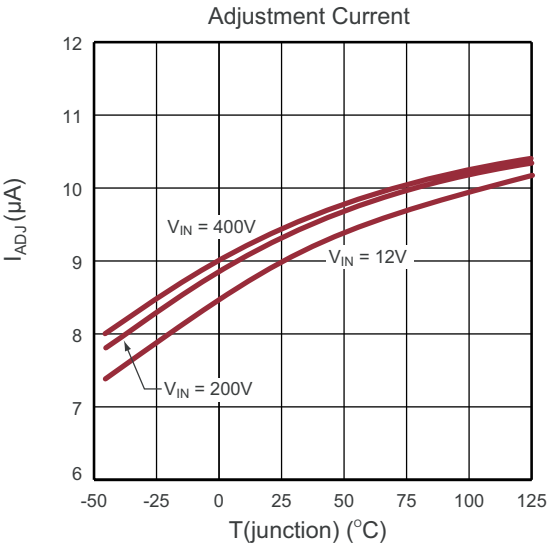
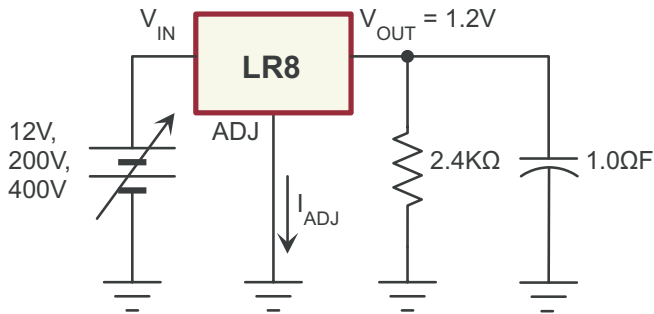
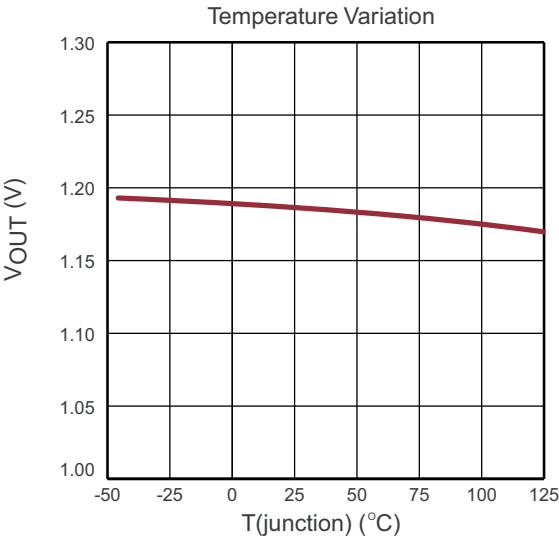
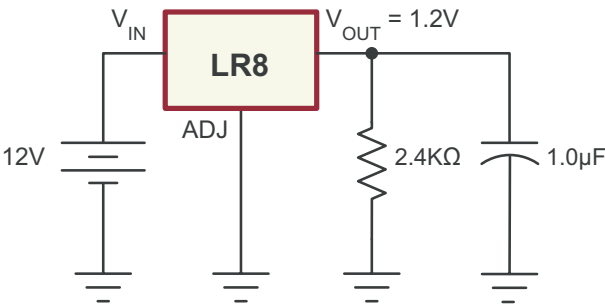


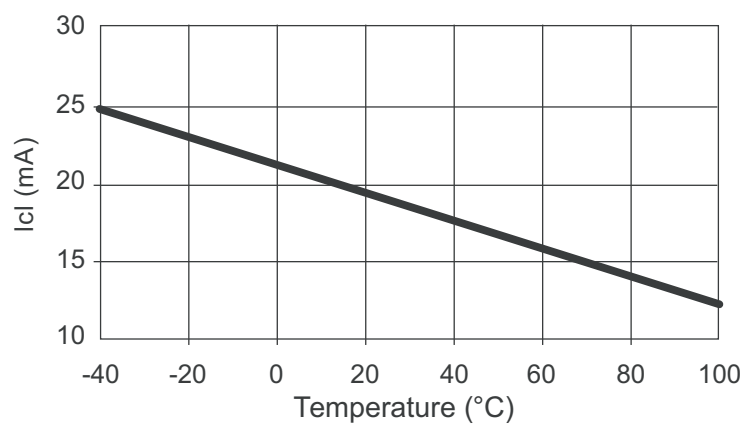
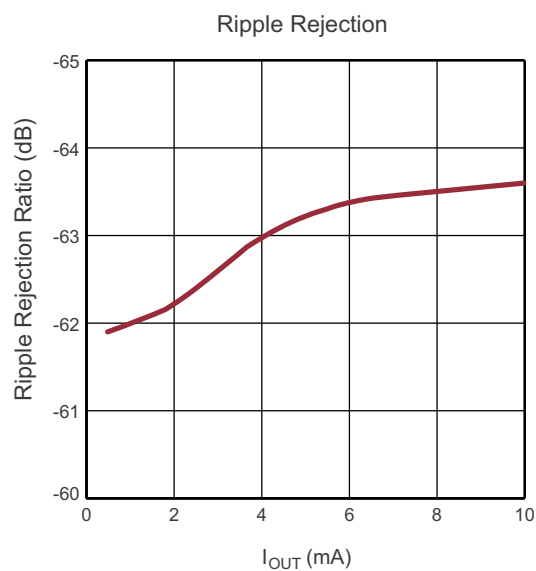
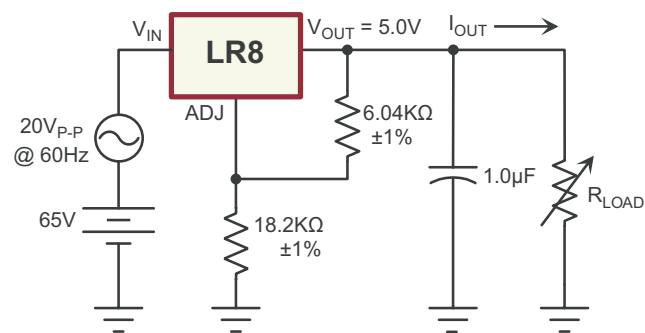
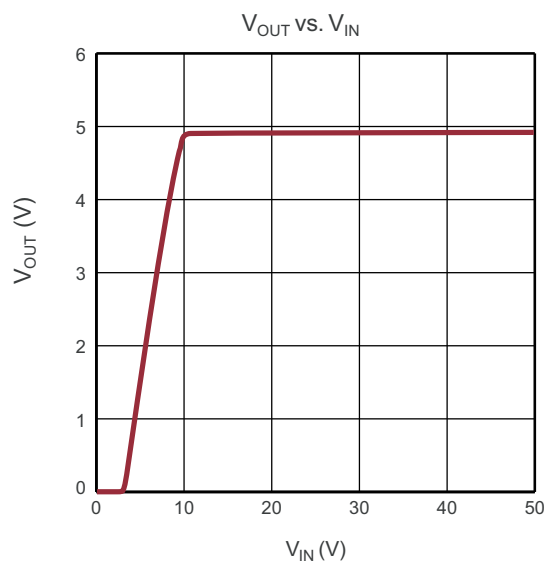
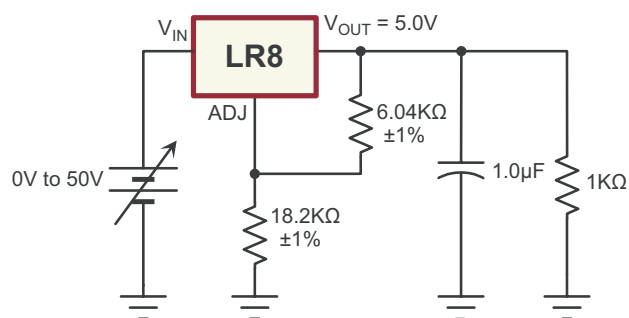
Figure 3: High Voltage Adjustable Constant Current Source



Typical Performance Curves

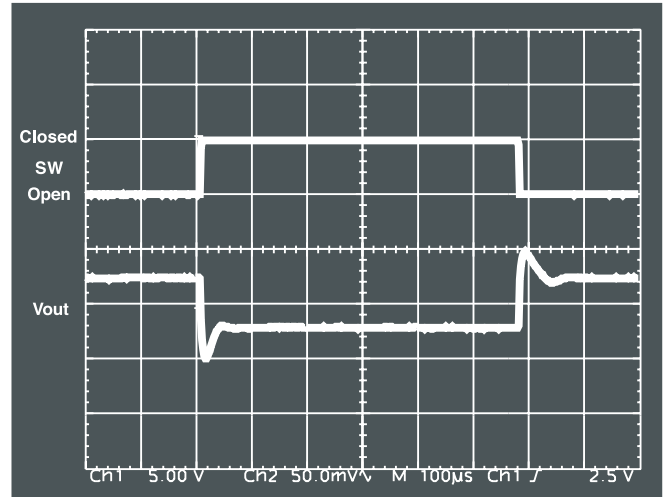
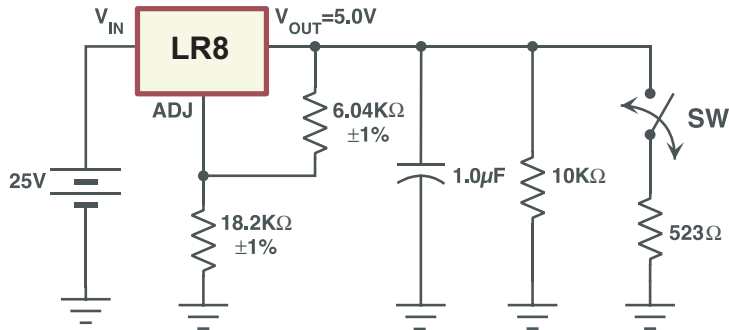


# Typical Performance Curves (cont.)



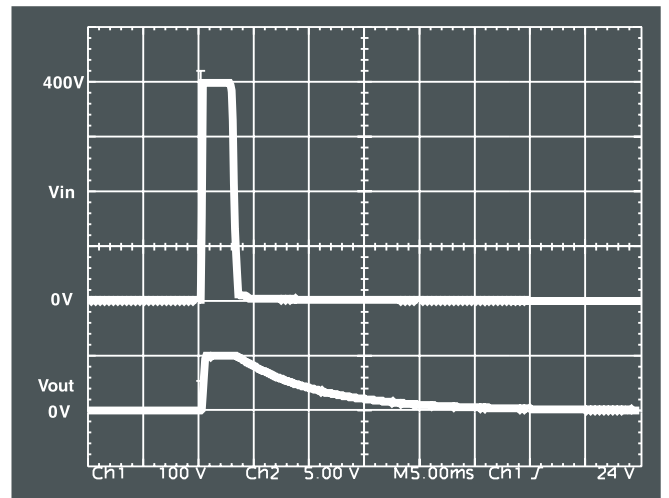
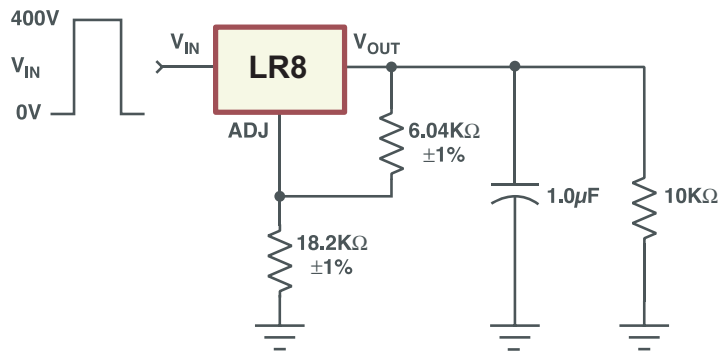
## Typical Performance Curves (cont.)

### Load Transient Response

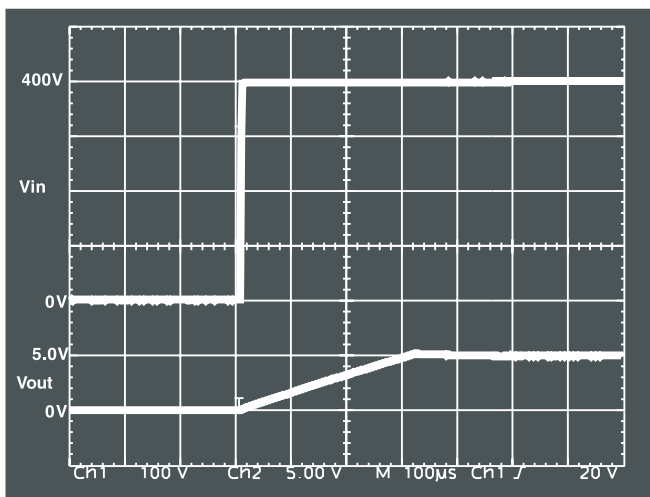


Load Transient Response

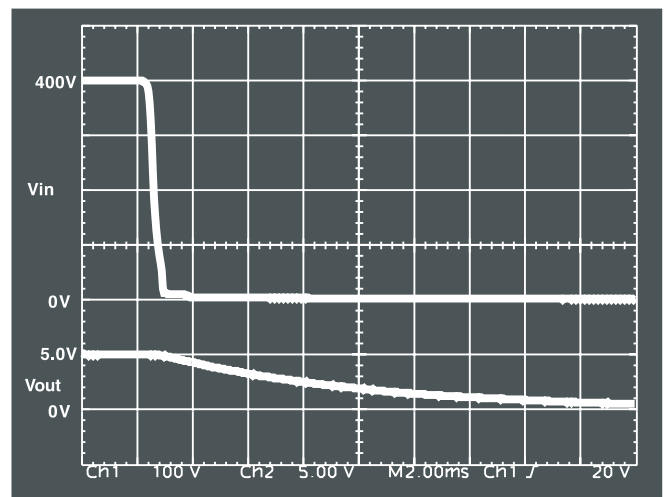
### Line Transient Response



Line Transient Response



Line Power Up Transient

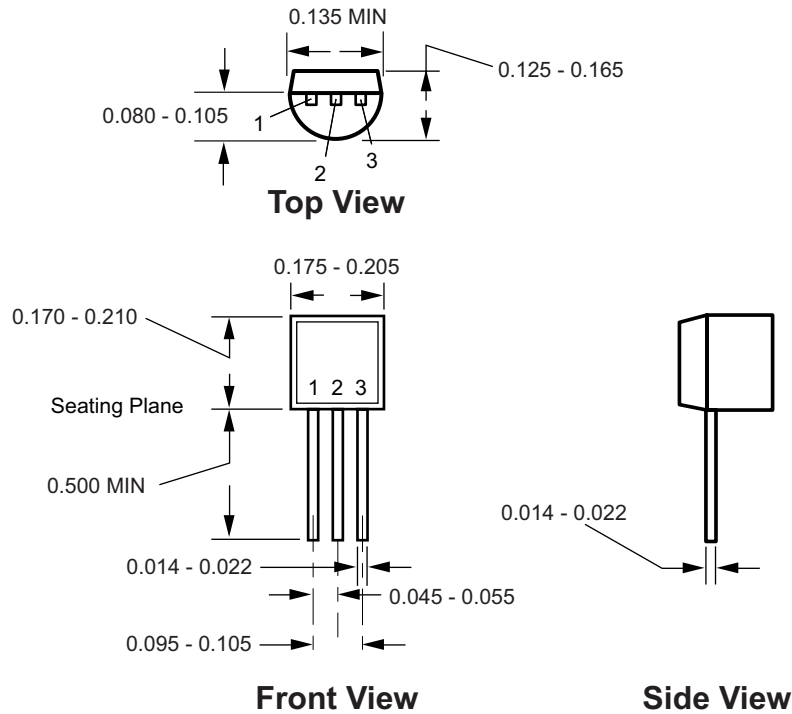


Line Power Down Transient





### 3-Lead TO-92 Package Outline (N3)



**Notes:**

All dimensions are in millimeters; all angles in degrees.

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <http://www.supertex.com/packaging.html>.)

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