

## LM150/LM350A/LM350 3-Amp Adjustable Regulators

### General Description

The LM150 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 3A over a 1.2V to 33V output range. They are exceptionally easy to use and require only 2 external resistors to set the output voltage. Further, both line and load regulation are comparable to discrete designs. Also, the LM150 is packaged in standard transistor packages which are easily mounted and handled.

In addition to higher performance than fixed regulators, the LM150 series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is accidentally disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An output capacitor can be added to improve transient response, while bypassing the adjustment pin will increase the regulator's ripple rejection.

Besides replacing fixed regulators or discrete designs, the LM150 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., avoid short-circuiting the output.

By connecting a fixed resistor between the adjustment pin and output, the LM150 can be used as a precision current

regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

The part numbers in the LM150 series which have a K suffix are packaged in a standard Steel TO-3 package, while those with a T suffix are packaged in a TO-220 plastic package. The LM150 is rated for  $-55^{\circ}\text{C} \leq T_J \leq +150^{\circ}\text{C}$ , while the LM350A is rated for  $-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$ , and the LM350 is rated for  $0^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$ .

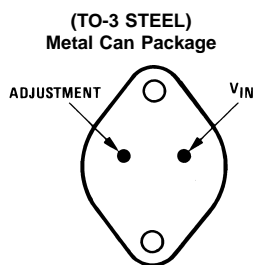
### Features

- Adjustable output down to 1.2V
- Guaranteed 3A output current
- Guaranteed thermal regulation
- Output is short circuit protected
- Current limit constant with temperature
- P+ Product Enhancement tested
- 86 dB ripple rejection
- Guaranteed 1% output voltage tolerance (LM350A)
- Guaranteed max. 0.01%/V line regulation (LM350A)
- Guaranteed max. 0.3% load regulation (LM350A)

### Applications

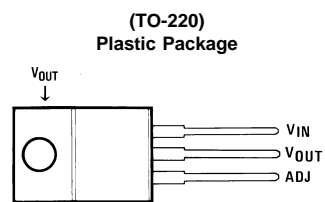
- Adjustable power supplies
- Constant current regulators
- Battery chargers

### Connection Diagrams



Case is Output

**Bottom View**  
Order Number LM150K STEEL  
or LM350K STEEL  
See NS Package Number K02A  
Order Number LM150K/883  
See NS Package Number K02C



**Front View**  
Order Number LM350AT or LM350T  
See NS Package Number T03B

### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Note 4)

Power Dissipation	Internally Limited
Input-Output Voltage Differential	+35V
Storage Temperature	-65°C to +150°C

Lead Temperature	
Metal Package (Soldering, 10 sec.)	300°C
Plastic Package (Soldering, 4 sec.)	260°C

ESD Tolerance TBD

Operating Temperature Range	
LM150	-55°C ≤ T <sub>J</sub> ≤ +150°C
LM350A	-40°C ≤ T <sub>J</sub> ≤ +125°C
LM350	0°C ≤ T <sub>J</sub> ≤ +125°C

### Electrical Characteristics

Specifications with standard type face are for T<sub>J</sub> = 25°C, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, V<sub>IN</sub> - V<sub>OUT</sub> = 5V, and I<sub>OUT</sub> = 10 mA. (Note 2)

Parameter	Conditions	LM150			Units
		Min	Typ	Max	
Reference Voltage	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V, 10 mA ≤ I <sub>OUT</sub> ≤ 3A, P ≤ 30W	<b>1.20</b>	<b>1.25</b>	<b>1.30</b>	V
Line Regulation	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V (Note 3)		0.005	0.01	%/V
			<b>0.02</b>	<b>0.05</b>	%/V
Load Regulation	10 mA ≤ I <sub>OUT</sub> ≤ 3A (Note 3)		0.1	0.3	%
			<b>0.3</b>	<b>1</b>	%
Thermal Regulation	20 ms Pulse		0.002	0.01	%/W
Adjustment Pin Current			<b>50</b>	<b>100</b>	μA
Adjustment Pin Current Change	10 mA ≤ I <sub>OUT</sub> ≤ 3A, 3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V		<b>0.2</b>	<b>5</b>	μA
Temperature Stability	T <sub>MIN</sub> ≤ T <sub>J</sub> ≤ T <sub>MAX</sub>		1		%
Minimum Load Current	V <sub>IN</sub> - V <sub>OUT</sub> = 35V		<b>3.5</b>	<b>5</b>	mA
Current Limit	V <sub>IN</sub> - V <sub>OUT</sub> ≤ 10V	<b>3.0</b>	<b>4.5</b>		A
	V <sub>IN</sub> - V <sub>OUT</sub> = 30V	0.3	1		A
RMS Output Noise, % of V <sub>OUT</sub>	10 Hz ≤ f ≤ 10 kHz		0.001		%
Ripple Rejection Ratio	V <sub>OUT</sub> = 10V, f = 120 Hz, C <sub>ADJ</sub> = 0 μF		<b>65</b>		dB
	V <sub>OUT</sub> = 10V, f = 120 Hz, C <sub>ADJ</sub> = 10 μF	<b>66</b>	<b>86</b>		dB
Long-Term Stability	T <sub>J</sub> = 125°C, 1000 hrs		0.3	1	%
Thermal Resistance, Junction to Case	K Package		1.2	1.5	°C/W
Thermal Resistance, Junction to Ambient (No Heat Sink)	K Package		35		°C/W

### Electrical Characteristics

Specifications with standard type face are for T<sub>J</sub> = 25°C, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, V<sub>IN</sub> - V<sub>OUT</sub> = 5V, and I<sub>OUT</sub> = 10 mA. (Note 2)

Parameter	Conditions	LM350A			LM350			Units
		Min	Typ	Max	Min	Typ	Max	
Reference Voltage	I <sub>OUT</sub> = 10 mA, T <sub>J</sub> = 25°C	1.238	1.250	1.262				V
	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V, 10 mA ≤ I <sub>OUT</sub> ≤ 3A, P ≤ 30W	<b>1.225</b>	<b>1.250</b>	<b>1.270</b>	<b>1.20</b>	<b>1.25</b>	<b>1.30</b>	V
Line Regulation	3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V (Note 3)		0.005	0.01		0.005	0.03	%/V
			<b>0.02</b>	<b>0.05</b>		<b>0.02</b>	<b>0.07</b>	%/V
Load Regulation	10 mA ≤ I <sub>OUT</sub> ≤ 3A (Note 3)		0.1	0.3		0.1	0.5	%
			<b>0.3</b>	<b>1</b>		<b>0.3</b>	<b>1.5</b>	%
Thermal Regulation	20 ms Pulse		0.002	0.01		0.002	0.03	%/W
Adjustment Pin Current			<b>50</b>	<b>100</b>		<b>50</b>	<b>100</b>	μA
Adjustment Pin Current Change	10 mA ≤ I <sub>OUT</sub> ≤ 3A, 3V ≤ (V <sub>IN</sub> - V <sub>OUT</sub> ) ≤ 35V		<b>0.2</b>	<b>5</b>		<b>0.2</b>	<b>5</b>	μA

## Electrical Characteristics (Continued)

Specifications with standard type face are for  $T_J = 25^\circ\text{C}$ , and those with **boldface type** apply over **full Operating Temperature Range**. Unless otherwise specified,  $V_{IN} - V_{OUT} = 5\text{V}$ , and  $I_{OUT} = 10\text{ mA}$ . (Note 2)

Parameter	Conditions	LM350A			LM350			Units
		Min	Typ	Max	Min	Typ	Max	
Temperature Stability	$T_{MIN} \leq T_J \leq T_{MAX}$		<b>1</b>			<b>1</b>		%
Minimum Load Current	$V_{IN} - V_{OUT} = 35\text{V}$		<b>3.5</b>	<b>10</b>		<b>3.5</b>	<b>10</b>	mA
Current Limit	$V_{IN} - V_{OUT} \leq 10\text{V}$	<b>3.0</b>	<b>4.5</b>		<b>3.0</b>	<b>4.5</b>		A
	$V_{IN} - V_{OUT} = 30\text{V}$	0.3	1		0.25	1		A
RMS Output Noise, % of $V_{OUT}$	$10\text{ Hz} \leq f \leq 10\text{ kHz}$		0.001			0.001		%
Ripple Rejection Ratio	$V_{OUT} = 10\text{V}$ , $f = 120\text{ Hz}$ , $C_{ADJ} = 0\text{ }\mu\text{F}$		<b>65</b>			<b>65</b>		dB
	$V_{OUT} = 10\text{V}$ , $f = 120\text{ Hz}$ , $C_{ADJ} = 10\text{ }\mu\text{F}$	<b>66</b>	<b>86</b>		<b>66</b>	<b>86</b>		dB
Long-Term Stability	$T_J = 125^\circ\text{C}$ , 1000 hrs		0.25	1		0.25	1	%
Thermal Resistance, Junction to Case	K Package					1.2	1.5	$^\circ\text{C/W}$
	T Package		3	4		3	4	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient (No Heat Sink)	K Package					35		$^\circ\text{C/W}$
	T Package		50			50		$^\circ\text{C/W}$

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

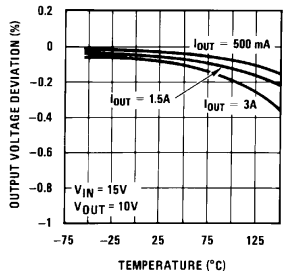
**Note 2:** These specifications are applicable for power dissipations up to 30W for the TO-3 (K) package and 25W for the TO-220 (T) package. Power dissipation is guaranteed at these values up to 15V input-output differential. Above 15V differential, power dissipation will be limited by internal protection circuitry. All limits (i.e., the numbers in the Min. and Max. columns) are guaranteed to National's AOQL (Average Outgoing Quality Level).

**Note 3:** Regulation is measured at a constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specifications for thermal regulation.

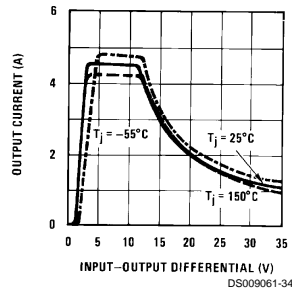
**Note 4:** Refer to RETS150K drawing for military specifications of the LM150K.

## Typical Performance Characteristics

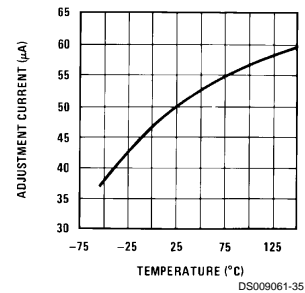
**Load Regulation**



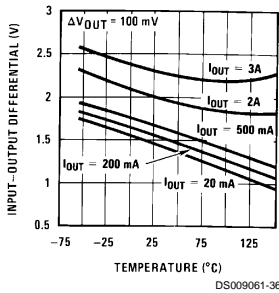
**Current Limit**



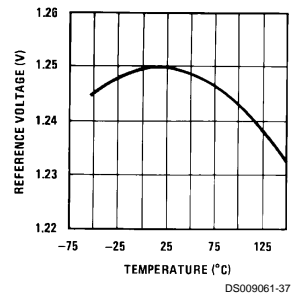
**Adjustment Current**



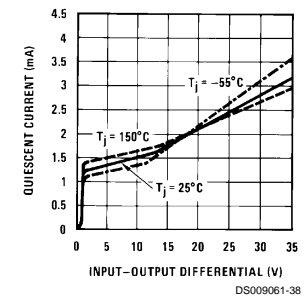
**Dropout Voltage**



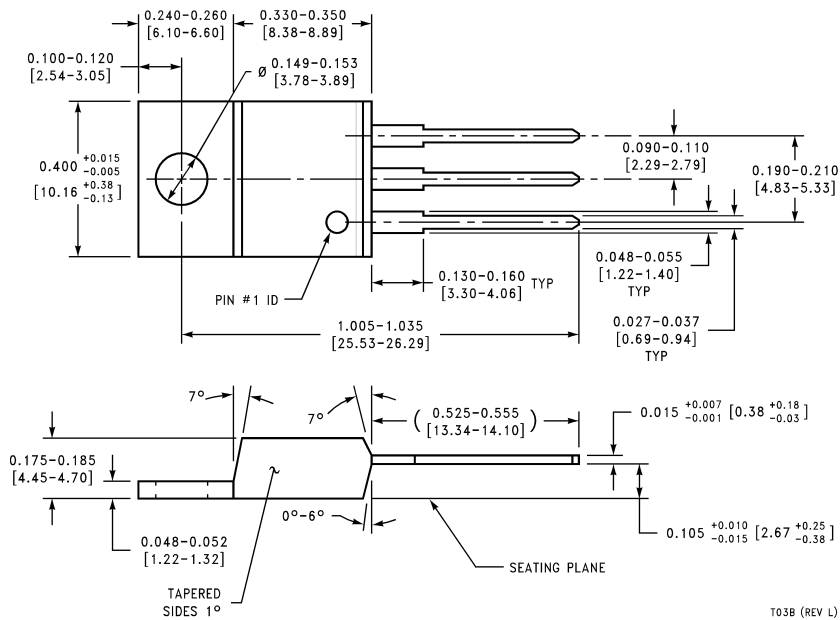
**Temperature Stability**



**Minimum Operating Current**



**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**3 Lead Molded TO-220 (T)  
 Order Number LM350AT or LM350T  
 NS Package Number T03B**

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