

# LM317

## 3-TERMINAL ADJUSTABLE REGULATOR

SLVS044H – SEPTEMBER 1997 – REVISED DECEMBER 2001

- Output Voltage Range Adjustable From 1.2 V to 37 V
- Output Current Greater Than 1.5 A
- Internal Short-Circuit Current Limiting
- Thermal Overload Protection
- Output Safe-Area Compensation
- Package Options Include Plastic Small-Outline Transistor SOT-223 (DCY), Flange Mounted (KTE) and Heat-Sink Mounted (KC) Packages

### description

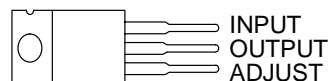
The LM317 is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.2 V to 37 V. It is exceptionally easy to use and requires only two external resistors to set the output voltage. Furthermore, both line and load regulation are better than standard fixed regulators. The LM317 is packaged in the KC (TO-220AB) and KTE packages, which are easy to handle and use.

In addition to having higher performance than fixed regulators, this device includes on-chip current limiting, thermal overload protection, and safe-operating-area protection. All overload protection remains fully functional, even if the ADJUST terminal is disconnected.

The LM317 is versatile in its applications, including uses in programmable output regulation and local on-card regulation. Or, by connecting a fixed resistor between the ADJUST and OUTPUT terminals, the LM317 can function as a precision current regulator. An optional output capacitor can be added to improve transient response. The ADJUST terminal can be bypassed to achieve very high ripple-rejection ratios, which are difficult to achieve with standard three-terminal regulators.

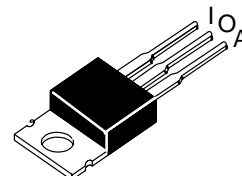
The LM317 is characterized for operation over the virtual junction temperature range of 0°C to 125°C.

KC PACKAGE  
(TOP VIEW)

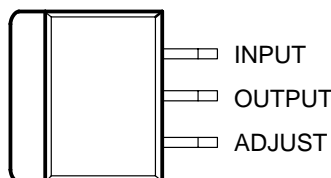


The OUTPUT terminal is in electrical contact with the mounting base.

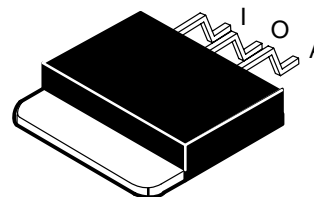
TO-220AB



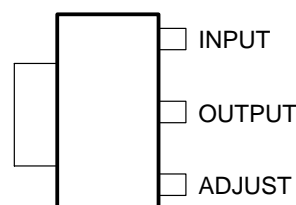
KTE PACKAGE  
(TOP VIEW)



The OUTPUT terminal is in electrical contact with the mounting base.



DCY PACKAGE  
(TOP VIEW)



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 **TEXAS  
INSTRUMENTS**

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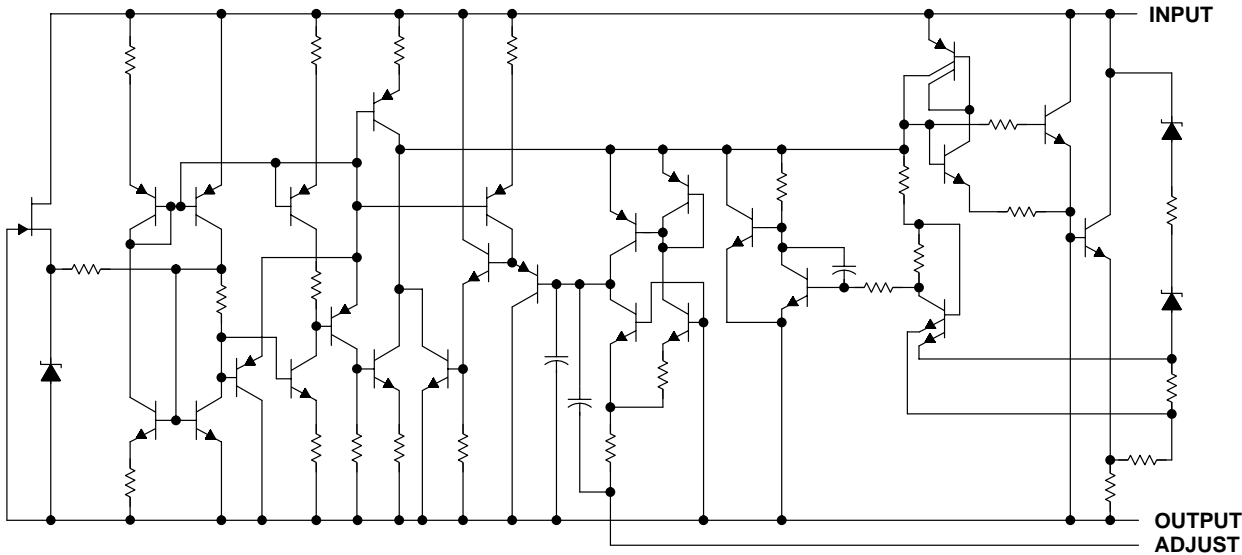
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AVAILABLE OPTIONS

Table with 4 columns: TJ, PACKAGE DEVICES, HEAT-SINK (DCY)†, HEAT-SINK MOUNTED, TO-220 (KC), PLASTIC FLANGE MOUNTED, POWER FLEX (KTE)‡. Rows include temperature range 0°C to 125°C and corresponding part numbers LM317DCY, LM317KC, LM317KTER.

† The DCY package also is available taped and reeled, e.g., LM317DCYR.
‡ The KTE package has the same footprint as TO-263 and can be mounted on a TO-263 land pattern. The KTE package is only available taped and reeled.

schematic diagram



absolute maximum ratings over virtual junction temperature range (unless otherwise noted)§

- Input-to-output differential voltage, VI – VO ..... 40 V
- Package thermal impedance, θJA (see Notes 1 and 2): DCY package ..... 49°C/W
(see Notes 1 and 3): KC package ..... 25°C/W
(see Notes 1 and 2): KTE package ..... 23°C/W
- Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C
- Storage temperature range, Tstg ..... –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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
- 1. Maximum power dissipation is a function of TJ(max), θJA, and TA. The maximum allowable power dissipation at any allowable ambient temperature is PD = (TJ(max) – TA)/θJA. Operating at the absolute maximum TJ of 150°C can affect reliability.
  - 2. The package thermal impedance is calculated in accordance with JESD 51-5.
  - 3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

Table with 4 columns: Parameter, Description, MIN, MAX, UNIT. Rows include VI – VO (Input-to-output voltage differential), IO (Output current), and TJ (Operating virtual junction temperature).

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**electrical characteristics over recommended ranges of operating virtual junction temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS†		MIN	TYP	MAX	UNIT
Input voltage (line) regulation‡	$V_I - V_O = 3\text{ V to }40\text{ V}$	$T_J = 25^\circ\text{C}$		0.01	0.04	%V
		$T_J = 0^\circ\text{C to }125^\circ\text{C}$		0.02	0.07	
Output voltage (load) regulation	$I_O = 10\text{ mA to }1500\text{ mA}$	$C_{ADJ} = 10\text{ }\mu\text{F}\S, T_J = 25^\circ\text{C}$	$V_O \leq 5\text{ V}$		25	mV
			$V_O \geq 5\text{ V}$		0.1	0.5 % $V_O$
		$T_J = 0^\circ\text{C to }125^\circ\text{C}$	$V_O \leq 5\text{ V}$		20	70 mV
			$V_O \geq 5\text{ V}$		0.3	1.5 % $V_O$
Thermal regulation	20-ms pulse,	$T_J = 25^\circ\text{C}$		0.03	0.07	% $V_O$ /W
ADJUST terminal current				50	100	$\mu\text{A}$
Change in ADJUST terminal current	$V_I - V_O = 2.5\text{ V to }40\text{ V}, P_D \leq 20\text{ W}, I_O = 10\text{ mA to }1500\text{ mA}$			0.2	5	$\mu\text{A}$
Reference voltage ( $V_{ref}$ ) (OUTPUT to ADJUST)	$V_I - V_O = 3\text{ V to }40\text{ V}, P_D \leq 20\text{ W}, I_O = 10\text{ mA to }1500\text{ mA}$		1.2	1.25	1.3	V
Output-voltage temperature stability	$T_J = 0^\circ\text{C to }125^\circ\text{C}$			0.7		% $V_O$
Minimum load current to maintain regulation	$V_I - V_O = 40\text{ V}$			3.5	10	mA
Peak output current	$V_I - V_O \leq 15\text{ V}, P_D < P_{MAX}$ (see Note 1)		1.5	2.2		A
	$V_I - V_O \leq 40\text{ V}, P_D < P_{MAX}$ (see Note 1), $T_J = 25^\circ\text{C}$		0.15	0.4		
Output noise voltage (RMS)	$f = 10\text{ Hz to }10\text{ kHz}, T_J = 25^\circ\text{C}$			0.003		% $V_O$
Ripple rejection	$V_O = 10\text{ V}, f = 120\text{ Hz}$	$C_{ADJ} = 0\text{ }\mu\text{F}\S$		57		dB
		$C_{ADJ} = 10\text{ }\mu\text{F}\S$		62	64	
Long-term stability	$T_J = 25^\circ\text{C}$			0.3	1	%/1k Hrs

† Unless otherwise noted, the following test conditions apply:  $|V_I - V_O| = 5\text{ V}$  and  $I_{O\text{MAX}} = 1.5\text{ A}$ ,  $T_J = 0^\circ\text{C to }125^\circ\text{C}$ . Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

‡ Input regulation is expressed here as the percentage change in output voltage per 1-V change at the input.

§  $C_{ADJ}$  is connected between the ADJUST terminal and GND.

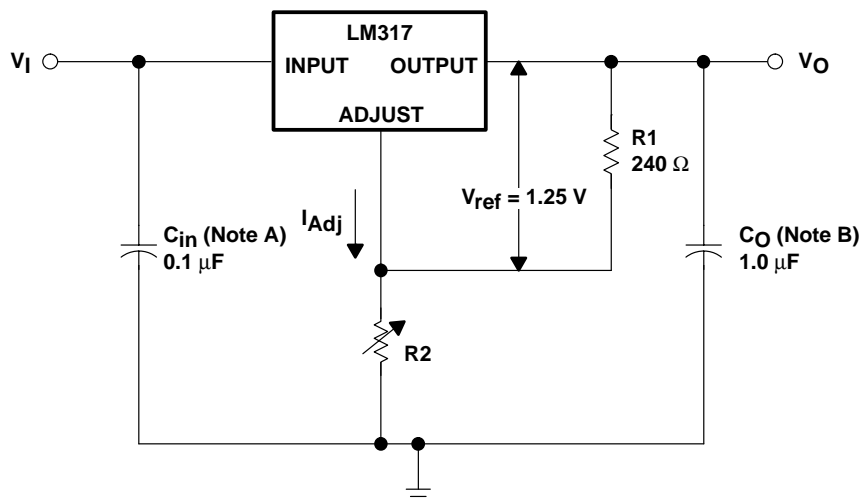
NOTE 4: Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of  $150^\circ\text{C}$  can affect reliability.

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### APPLICATION INFORMATION



NOTES: A.  $C_{in}$  is not required if the regulator is close enough to the power-supply filter.

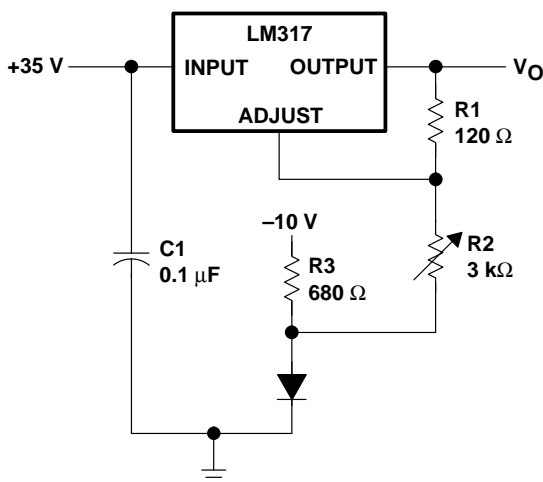
B.  $C_O$  improves transient response, but is not needed for stability.

$V_{out}$  is calculated as:

$$V_{out} = V_{ref} \left( 1 + \frac{R2}{R1} \right) + (I_{Adj} \times R2)$$

Since  $I_{Adj}$  is typically 50  $\mu A$ , it is negligible in most applications.

**Figure 1. Adjustable Voltage Regulator**



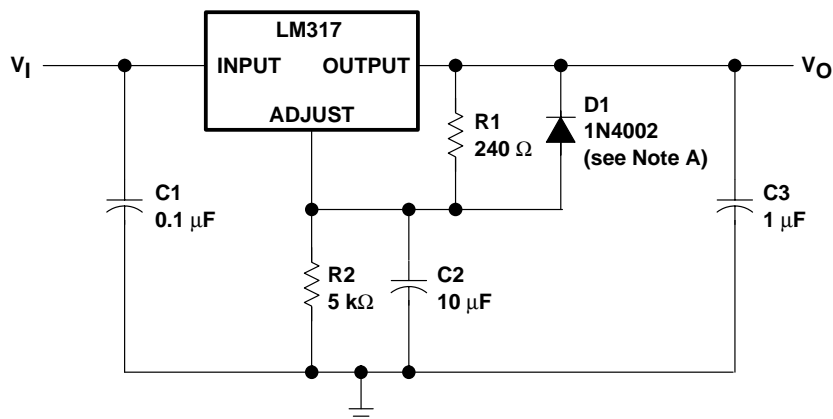
$V_{out}$  is calculated as:

$$V_{out} = V_{ref} \left( 1 + \frac{R2 + R3}{R1} \right) + I_{Adj}(R2 + R3) - 10 \text{ V}$$

Since  $I_{Adj}$  is typically 50  $\mu A$ , it is negligible in most applications.

**Figure 2. 0-V to 30-V Regulator Circuit**

## APPLICATION INFORMATION



NOTE A: D1 discharges C2 if the output is shorted to ground.

Figure 3. Adjustable Regulator Circuit With Improved Ripple Rejection

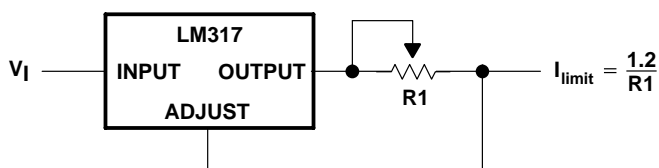


Figure 4. Precision Current-Limiter Circuit

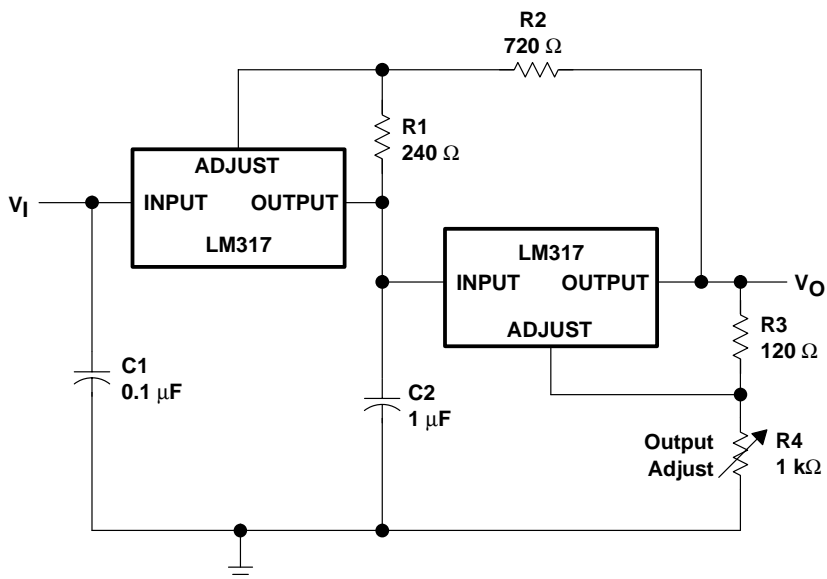


Figure 5. Tracking Preregulator Circuit

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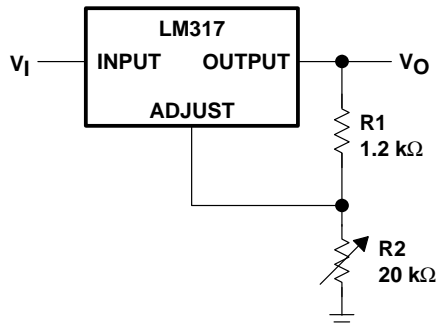
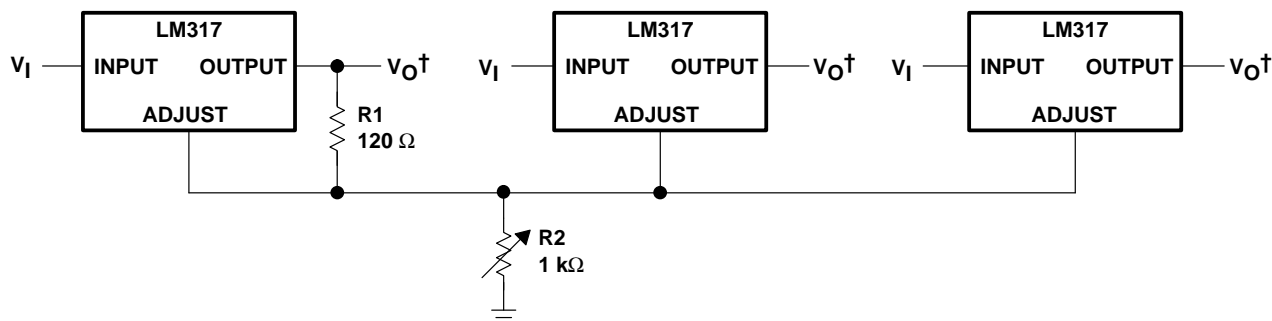
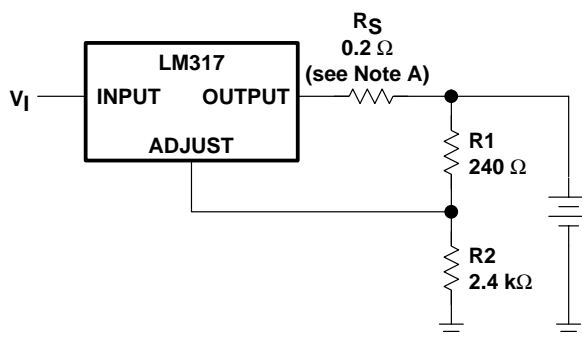


Figure 6. 1.2-V to 20-V Regulator Circuit With Minimum Program Current



† Minimum load current from each output is 10 mA. All output voltages are within 200 mV of each other.

Figure 7. Adjusting Multiple On-Card Regulators With a Single Control



NOTE A:  $R_S$  controls the output impedance of the charger.

$$Z_{OUT} = R_S \left( 1 + \frac{R_2}{R_1} \right)$$

The use of  $R_S$  allows for low charging rates with a fully charged battery.

Figure 8. Battery-Charger Circuit

## APPLICATION INFORMATION

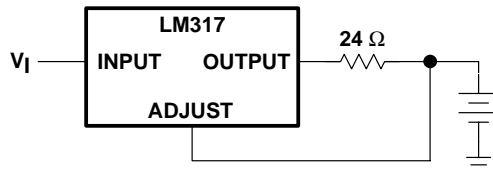


Figure 9. 50-mA Constant-Current Battery-Charger Circuit

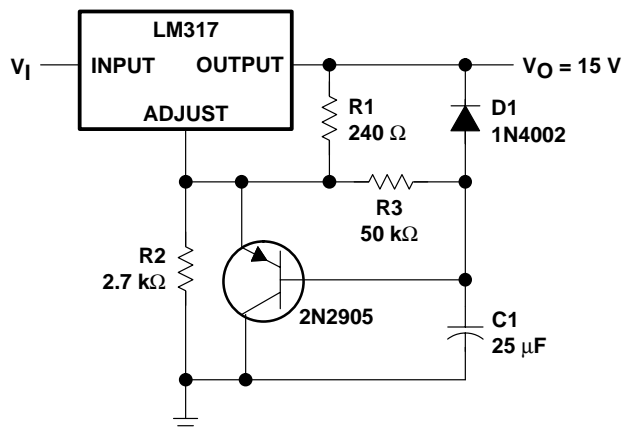


Figure 10. Slow Turn-On 15-V Regulator Circuit

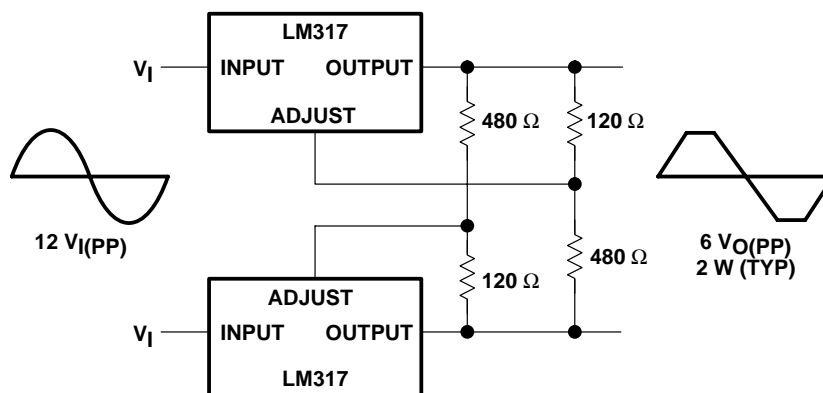
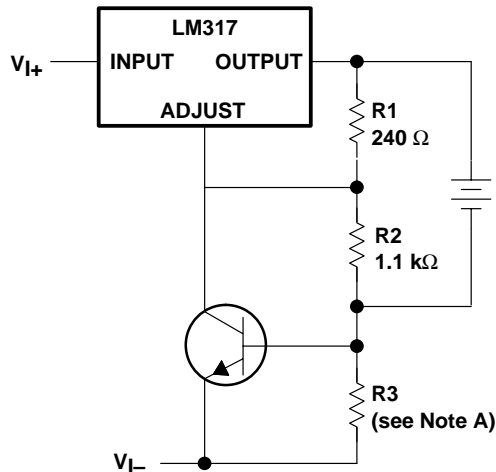


Figure 11. AC Voltage-Regulator Circuit

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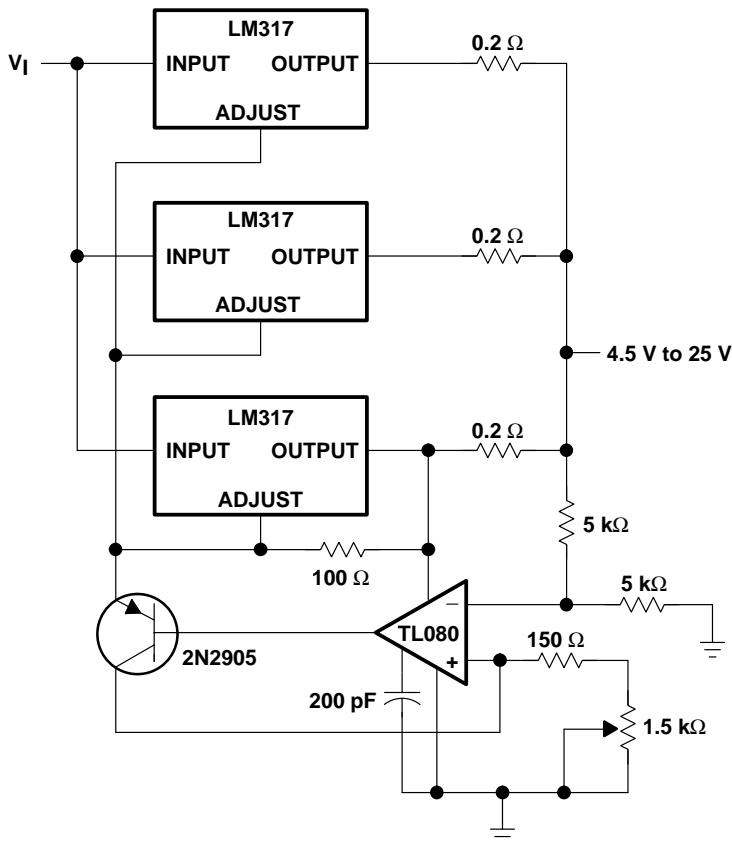
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## APPLICATION INFORMATION



NOTE A: R3 sets the peak current (0.6 A for a 1- $\Omega$  resistor).

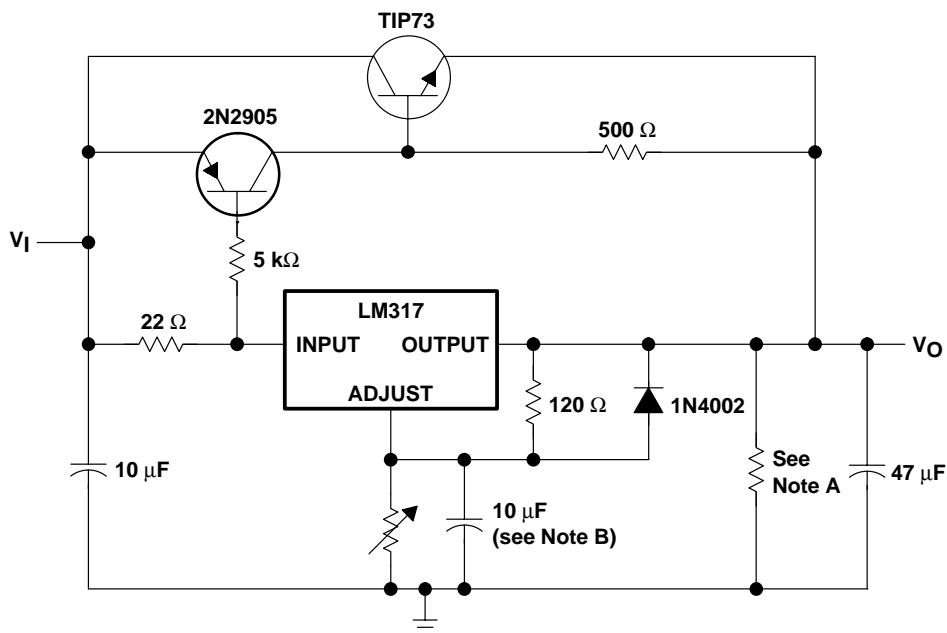
### Figure 12. Current-Limited 6-V Charger Circuit



### Figure 13. Adjustable 4-A Regulator Circuit



# APPLICATION INFORMATION



- NOTES: A. The minimum load current is 30 mA.  
B. This optional capacitor improves ripple rejection.

**Figure 14. High-Current Adjustable Regulator Circuit**

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